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ANALYSIS OF THE COMPARATIVE EFFICIENCY OF RUSSIAN UNIVERSITIES FROM 5-100 PROGRAM

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Abstract

The functioning of higher education is a priority area of state policy. Determining the importance of developing this sphere, it should be noted that the activities of universities should be measurable not only in terms of achieving specific indicators, but also in terms of the efficiency of using financial resources allocated from the federal budget. Management of the higher education system is a multi-level and complex process of distributing tasks to the level of higher educational institutions, the implementation of which ensures the achievement of goals defined by state policy. Considering the management of universities at the highest level, the government is the initiator of the impact, regulating the system of higher education and each university in particular not directly, but indirectly, through the formation of various kinds of short, medium and long-term target documents. In the work, based on the application of the dea method, an analysis was made of the comparative effectiveness of universities from the state development program 5-100. Leading universities were identified, and benchmarks were allocated for each less efficient university. The model was built on both input and output parameters, which allowed the authors to give recommendations on improving the effectiveness of universities and their achievement of benchmarks.

1. Introduction

Transformation of the existing way of functioning of physical, biological, digital technologies leads to an irreducible growth of automated processes that play an important role in the development of mankind. This happens under the influence of technological changes that stimulate the onset of the stage of a new industrial revolution.

There are three reasons why today's transformations are not just a continuation of the third industrial revolution, but the appearance of the fourth: the speed, scale and influence of systems. Industry 4.0 innovations are spreading at an exponential, rather than linear, speed as before. Industry 4.0 is a predictable event involving the introduction of cyberphysical systems in the production and service of various human needs. It is expected that the revolution, which is based on network technologies, will entail systemic, radical, large-scale changes that will affect not only science and the economy, but also the social sphere, public and private life, and education. The fourth industrial revolution is seen in the framework of the new technological order as the reconstruction, revival of industrial production on the technological basis of the sixth technological order, interpreted as a group of technological aggregates connected with each other by similar technological chains and forming reproducing values.

2. Problem Statement

Many authors conduct research on determining the place and role of modern universities in the chain of industrial products and the innovation system of society (Blume et al., 2017; Bonaccorsi, 2016; Gjelsvik, 2108; Popescu, 2011).

The term "Fourth Industrial Revolution" was formulated as part of the German initiative in Germany in 2011, which defined it as a means of increasing the competitiveness of the country's manufacturing industry through enhanced integration of cyberphysical systems. It was included as a draft of the state Hi-Tech strategy of Germany until 2020, describing the concept of smart manufacturing based on the global industrial network of the Internet of things and services. In 2016, the President of the World Economic Forum, Klaus Schwab, covered the theme of Industry 4.0 and its consequences, which was the starting point of the desire of each country to achieve a technological breakthrough.

In connection with all of the above, many authors in their works study the issues of the effectiveness of universities both through a rating system and using more complex models (Lendel, 2010; Sevinc, 2014; Sterlacchini, 2008)

Some scientists even consider universities as the main drivers for the development of regions, territories, and even the entire non-profit sector (Hanushek, 2016; Yasnitskaya et al., 2015).

3. Research Questions

Digitalization of education as a trend involves providing students with access to educational resources, to remote data from the results of scientific experiments and research, to a library of engineering problems and problems, as well as to the creation of distributed labor, research and educational teams using information systems. The implementation is based on the translation of all available information into a digital form, accessible to the entire world community. Storage of the entire array of information is carried

out in cloud services, which are a collection of data with real-time access. To work in a large amount of data, you need Internet skills, the ability to analyze and reflect, which are formed in the educational environment. Thus, the student interacts with the technology of "big data", studying the accumulated material, and leaving a "digital footprint" for conducting analytical studies of the environment in which it operates. The technology of "big data" is a combination of methods, software tools for processing a large amount of data to obtain the necessary results, inaccessible when processed by conventional methods.

4.   Purpose of the Study

To assess the effectiveness of universities from an economic point of view, it is necessary to use a method that allows you to analyze the results of universities from the standpoint of qualitative and quantitative parameters.

One such method for analyzing university performance is the Data Envelopment Analysis (hereinafter - DEA) method. This is a nonparametric method for assessing a group of existing facilities, which allows identifying effective and ineffective groups of higher education institutions. DEA is based on the construction of the boundary of efficiency, which is an analogue of the production function, when the results of activities are presented not in a scalar but in a vector form, that is, in the production of several types of results of operations.

5.   Research Methods

There are two models of the DEA method: an entry-oriented model and an exit-oriented model. In this paper, only one is focused on entry. The difference between the two is that in the output-oriented model, the result will be the issuance of recommendations for increasing the output parameter values y_j without increasing the input values x_j, where j is the number of the economic object, and for the input-oriented model, recommendations for changing quantities x_j.

As a measure of the effectiveness of universities, the conditional value T is calculated. In this case, universities for which this parameter is equal to unity are effective, and universities where $T < 1$ are ineffective.

In the DEA model, inputs and outputs can be measured on different scales, which allows you to evaluate the effectiveness with a different set of resources, and also allows you to rank objects by levels of efficiency. The calculation results make it possible to identify inefficient universities and give recommendations for improving their effectiveness. All of the above are features of this method.

A financial indicator will be used as an input parameter. As for the weekend, we will include among them indicators characterizing the results of universities, reflecting the effectiveness of the use of allocated funds.

The study used a model focused on entry and exit. The number of input parameters is 1, the number of output parameters is 5, the number of universities analyzed is 7. They are:

- Kazan Federal University;
- Siberian Federal University;

- Far Eastern Federal University;

- Ural Federal University;

- National Research University "Tomsk State University";

- National Research University "Tomsk Polytechnic University";

- National Research University "Nizhny Novgorod State University".

Input parameter:

University revenues from the federal budget, amount for 2014-2018, thousand rubles - X1.

Output Parameters:

The total amount of funds received from R&D performed on their own, the amount for 2014-2018, thousand rubles - Y1.

Number of small enterprises, the average value for 2014-2018, units - Y2.

The share of foreign students in the total number of students, the average value for 2014-2018,% - Y3.

The fourth industrial revolution technology application rating is Y4.

The proportion of scientific and research workers who have the degree of candidate and doctor of science in the total number of scientific and research work of an educational organization, the average value for 2014-2018, % - Y5.

The data for the study were taken over a five-year period from 2014 to 2018 and are presented in Table 01.

Table 01. Initial data for calculating the effectiveness of universities

University	X1	Y1	Y2	Y3	Y4	Y5
TSU	19962878.25	7830913.1	44	13.80	0.67	74.92
KFU	22277677.03	7002891.6	41	9.19	0.83	70.43
UrFU	25399768.78	7158289.5	83	5.88	0.75	63.93
TPU	20741089.53	9154582.4	49	24.21	0.67	72.77
FEFU	36209453.76	3575284.5	20	6.19	0.71	58.96
SFU	32756825.45	2926246.7	37	1.75	0.75	61.17
NNSU	12236542.28	5115629	16	2.64	0.67	75.03

Sources of data on the results of universities are reports on self-examination of higher education institutions, reports on the results of monitoring of the effectiveness of educational institutions of higher education by the Ministry of Science and Higher Education of the Russian Federation in the period from 2014 to 2018.

Table 02 shows the results of calculating the effectiveness of universities in the exit-oriented model.

We compare the obtained results with the initial data and indicate the proposed recommendations. Effective universities, according to calculations, are the Nizhny Novgorod State, Tomsk Polytechnic and Ural Federal Universities.

Table 02. Results of an exit-oriented university performance model

University	T	Y1	Y2	Y3	Y4	Y5
FEFU	0.40	15329340.7	56	15.6	1.8	200.5
KFU	0.88	8672841.2	46	10.4	0.9	100.9
NNSU	1	5115629.0	16	2.6	0.7	75.0
SFU	0.52	11764278.1	71	7.3	1.4	149.6
TSU	0.96	8146369.1	46	15.9	0.7	77.9
TPU	1	9154582.4	49	24.2	0.7	72.8
URFU	1	7158289.5	83	5.9	0.8	63.9

In these universities, funds allocated from the federal budget are effectively used and transformed into performance results. For less efficient universities, "standard" universities are proposed using the DEA method. Their experience is the closest to the data and can be borrowed to increase their effectiveness. In particular, for Tomsk State University, whose measure of efficiency T is 0.96, and Kazan Federal University with a value of T equal to 0.88 reference universities are all three effective universities, for the Siberian Federal University with an efficiency of 0.52 "reference" universities are Nizhny Novgorod and Ural universities, for the Far Eastern University with T equal to 0.4 reference points are Nizhny Novgorod and Tomsk Polytechnic universities.

6. Findings

In order to increase the efficiency of higher education institutions, it is necessary to turn to recommendations for changing the value of output parameters, the achievement of which will correspond to the competent execution of budget funds. We compare the initial and recommended values for universities in Table 03.

Table 03. Comparison of output values for less efficient universities

University	Data	Y1	Y2	Y3	Y4	Y5
TSU	Source	7830913,1	44	13.8	0.7	74.9
TSU	Featured	8146369,1	46	15.9	0.7	77.9
KFU	Source	7002891,6	41	9.2	0.8	70.4
KFU	Featured	8672841,2	46	10.4	0.9	100.9
SFU	Source	2926246,7	37	1.8	0.8	61.2
SFU	Featured	11764278,1	71	7.3	1.4	149.6
FEFU	Source	3575284,5	20	6.2	0.7	59.0
FEFU	Featured	15329340,7	56	15.6	1.8	200.5

As noted earlier, an exit-oriented model generates recommendations for changing output parameters. Let's consider each of them in more detail.

For Tomsk State University, the effectiveness measure of which is close to unity, namely 0.96, it is recommended to increase the total amount of funds received from performing research and development work from 7,830,913.1 thousand rubles. up to 8 146 369.1 thousand rubles, which is achieved through the implementation of more scientific and research work that can be commercialized. An increase in the number of small enterprises to 46 can also help ensure the efficient use of funds allocated from the federal budget.

The share of foreign students in the total number of students should be 15.9%, and the proportion of graduate teachers should be increased by 3%.

As for Kazan Federal University, it is recommended to increase the amount of funds from research and development by 1,669,949.6 thousand rubles, the number of small enterprises by 5 units, to ensure the attraction of foreign students undergraduate programs, specialty and magistracy, as well as assist in obtaining the degree of candidates and doctors of science to the teaching staff. As for the rating indicator for the application of technologies of the fourth industrial revolution, it is at an approximately necessary level. In the case of increasing the previously specified output parameters using modern technologies, the level of the rating value will also grow.

For the Siberian Federal University, the amount of funds received from R&D is quite high and, if it is reduced, this will not adversely affect the efficiency of using the university's federal funds. According to calculations, it is considered necessary to double the number of small innovative enterprises, organize work to actively attract foreign citizens to the number of students, and also help to increase the number of graduate teachers from 61.2 to 149.6%. The recommendation, according to the applied rating, is formed incorrectly, since the maximum value is 1, respectively, it is sufficient and necessary to ensure the use of modern technologies in the process of training and the implementation of scientific activities of the university to achieve the maximum possible indicator.

At the Far Eastern Federal University, in which the efficiency of using funds from the federal budget is the lowest of all the universities considered, a decrease in revenues from the implementation of research and development and development funds will not adversely affect the final value of T. At the same time, recommendations are made according to which the increase in the number small enterprises from 20 to 56 units, an increase in the number of foreign students in the total number of students from 6.2 to 15.6%, as well as an increase in the share of graduate teachers it more than three times, will ensure the growth of efficiency of use of budgetary funds.

7. Conclusion

Thus, the DEA method used can be used to determine ways to improve the efficiency of universities in terms of the competent use of funds received from the federal budget. Taking into account the recommendations received by universities, which are the main sources of innovation, scientific research and highly qualified specialists, can stimulate the socio-economic development of the subject of the Russian Federation, while having an impact on the country's economy and its macroeconomic stability in general.

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