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EFFECTIVENESS OF UNIVERSITIES' IN THE CONTEXT OF FUNDING BASED ON RESULTS AND THE LEVEL OF ACHIEVEMENTS

EFICACIA DE LAS UNIVERSIDADES EN EL CONTEXTO DEL FINANCIAMIENTO EN FUNCIÓN DE LOS RESULTADOS Y EL NIVEL DE LOGROS

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ABSTRACT

The article presents the characteristics of the sources and organization of financing based on the results of scientific and innovative activities of Russian universities. A system of indicators of the effectiveness of a university's scientific and innovative activities has been developed, based on which the analysis of individual indicators of five Russian universities has been carried out. The influence of the level of funding based on the results of scientific and innovative activities on the effectiveness of research work has been analyzed. An analysis of the indicators of the results of scientific and innovative activities of Russian universities has shown that the diversification of the sources of funding for scientific research in the educational environment of universities, namely, effective financial management, which provides for the targeted use of finance for the implementation of universities' scientific and innovative activities, is of the greatest importance.

Keywords:

University, scientific and innovative activity, integrated efficiency assessment, volume of financial receipts.

RESUMEN

El artículo presenta las características de las fuentes y la organización de la financiación a partir de los resultados de las actividades científicas e innovadoras de las universidades rusas. Se ha desarrollado un sistema de indicadores de la eficacia de las actividades científicas e innovadoras de una universidad, en base al cual se ha llevado a cabo el análisis de indicadores individuales de cinco universidades rusas. Se ha analizado la influencia del nivel de financiación basado en los resultados de las actividades científicas e innovadoras sobre la eficacia de los trabajos de investigación. Un análisis de los indicadores de los resultados de las actividades científicas e innovadoras de las universidades rusas ha demostrado que la diversificación de las fuentes de financiación de la investigación científica en el entorno educativo de las universidades, a saber, la gestión financiera eficaz, que prevé el uso específico de las finanzas para la implementación de las actividades científicas e innovadoras de las universidades, es de la mayor importancia.

Palabras clave:

Universidad, actividad científica e innovadora, evaluación integrada de la eficiencia, volumen de ingresos financieros.

INTRODUCTION

The existence of national economies in the context of globalization challenges and the era of high technology and intellectualization necessitates the rapid production of new knowledge and the implementation of economic policy, the purpose of which is, first of all, to ensure macroeconomic stability and create prerequisites for progressive socio-economic development (Vdovina et al., 2021; Kormishova et al., 2021). To this end, the important tasks of the state on the way to building a competitive national economy are to determine strategic guidelines for innovative development, ensuring economic growth and the fullest use of available resources and especially increasing the efficiency of universities' scientific and innovative activities (Karashchuk et al., 2020; Tyurikov et al., 2021).

Building a competitive economy in Russia is not possible without creating a set of measures to ensure the development of the scientific sector and its potential. The strategic priorities in the field of Russian science should be decisive steps to adopt state programs to support and prevent the outflow of intellectual resources.

The importance of the development of science and innovation in each country is a key indicator of the progress of society, its intellectual growth, and the economic recovery of the state. However, as I.E. Frolov (2015) notes, the effective performance of one's social functions directly depends on the amount of funding for science, the use of these funds for their intended purpose, and the interested and benevolent attitude of the state. According to N.B. Medvedeva (2015), increasing the efficiency of financial support for scientific research and innovation will make it possible to significantly improve the productivity of production and the competitiveness of the country as a whole.

An urgent problem in these conditions remains the improvement of criteria and indicators of the social and economic efficiency of universities' scientific and innovative activities, considering their status, development strategy, mission, and goals of the activity, as well as the improvement of models for the formation of financial potential (Garanin, 2021).

Scientific research has empirically revealed a high and stable dependence of the country's technological level on the knowledge intensity of GDP, which is calculated as a share of GDP (Molchanov, Molchanova, 2016). Thus, with the value of this indicator 0.4-0.5%, science performs a socio-cultural function, 0.6-0.9% – supports the formed technological potential, and with a value above 0.9%

– ensures the economic development of society (Ma et al., 2015).

Therewith, the study (Khabib, Teplyakova, Krasnov, 2019) provides evidence that, firstly, the level of funding for science plays an important role in ensuring the welfare of the state; secondly, that there is a lower level of economic development (the so-called level of «raw materials economy»). It is important to finance both fundamental and applied scientific research.

A significant number of research papers have been devoted to the problems of financing scientific research, diversification of sources of funding for scientific, scientific, and technical activities of universities, and innovative development. The issues of financial support for the development of science, scientific and innovative activities, and scientific research have been presented in (Bloch et al., 2016; Aagaard, Schneider, 2016). Sources of research funding have been analyzed in (Yan et al., 2018). Strategies for financing research and development of universities have been developed in (Huang, 2018). Considerable attention has been paid in (Aagaard, 2017) to the development of scientific and innovative activities and ensuring effective implementation of innovation policy through state support of science. The experience in choosing effective models of functioning in the sphere of scientific activity has been presented in (Dolgikh, Pershina, 2017); the influence of higher school science in reforming the national economy has been analyzed.

According to researchers (Bloch, Sørensen, 2015), the main directions and sources of financing of universities' scientific and innovative activities include the following: financing of fundamental and applied research; financing of applied scientific and scientific-technical (experimental) developments; basic financing; training of scientific personnel; support of scientific research of young scholars; support of objects that make up the national heritage; development of scientific infrastructure – creation of centers, laboratories; provision of scientific conferences; economic agreement – ordering of individual scientific research; paid services within the framework of legislation – expertise, consultations, laboratory analyses and sample studies, etc.; grants, projects – orders for scientific research; scientific and technical cooperation within the framework of intergovernmental agreements; state order for implementation of individual projects; charitable contributions to the development of science, etc.

Meanwhile, an important point is that effectiveness eventually becomes relevant. As noted in (Minat, 2020), world practice gives us examples of the following models

of public financing of education: performance-based financing, expenditure-based financing, contractual financing. Each model of public financing is characterized by its advantages for one country and disadvantages for another. Performance-based financing allows for avoiding inefficient work of educational institutions and obtaining high indicators per unit of resource (Bollen et al., 2017).

According to researchers (Garner et al., 2013), the performance-based financing of university science is more effective than the one that has been used up to now – expenditure-based financing. One of the basic principles that are laid down in the procedure for evaluating the effectiveness of scientific institutions is to conduct both a quantitative analysis of statistical and scientometric data (Jung et al., 2017) and a qualitative (expert) assessment of all available information about a scientific institution and its activities (Boyack, Paul, 2011). The priority of qualitative (expert) evaluation of the effectiveness of the scientific institution and its departments is important (Aagaard, Kladakis, Nielsen, 2020).

Another stimulating factor in the development of higher education and science is the ranking of universities in both national and international rankings (Wahls, 2016). Today, most ratings are formed by scientific indicators, namely, based on the indicators of the Scopus database, which shows the citation of scientific articles published by the university or its employees in scientific publications. The Hirsch index is a quantitative indicator that is formed based on actual scientific publications and the number of their citations (Kalpazidou Schmidt, Graversen, 2018). The analytical and bibliometric component of the Web of Science indexing and citation system is no less significant, which has become an effective tool for measuring quantitative and qualitative indicators of scientific activity that characterize its performance. Web of Science allows evaluating the results of scientific activity of scholars, research teams, organizations, conducting their comparative analysis (Gök, Rigby, Shapira, 2016).

However, the issue of the impact of financing scientific and innovative activities in higher education on its effectiveness has not been sufficiently investigated and requires rethinking in modern conditions.

The purpose of the study: to identify and evaluate the relationship between the results of research work of universities, their financial potential, and academic reputation.

The following main tasks are defined following the set goal:

- to systematize the list of indicators of the effectiveness of universities' scientific and innovative activities;

- to carry out a comparative analysis of the results of the research work of universities, considering the sources and volumes of their funding;

- to assess the relationship between the results of research work of universities with their financial potential and academic reputation, which will determine the effectiveness of scientific and innovative activities in the future.

Research hypothesis: the amount of funding for scientific and innovative activities has a significant impact on the level of achievements of universities and their employees, but is not always used effectively.

MATERIALS AND METHODS

The methodological apparatus of the research included both theoretical (analysis of scientific literature) and statistical (analysis of university performance indicators) research methods.

We formed a list of indicators of the effectiveness of a university's scientific and innovative activities, given in Table 1, using the criteria of grouping by effectiveness, productivity, and diversification of income from scientific activities for this purpose.

Table 1. The system of indicators of the effectiveness of a university's scientific and innovative activity

Criteria	Indicators
Effectiveness	<ol style="list-style-type: none"> 1. The number of defended dissertations for the degree of Doctor of Sciences; 2. The number of defended dissertations for the degree of Candidate of Sciences; 3. The number of registered objects of intellectual property rights; 4. The number of publications, as well as citations in publications with an impact factor, as well as in other publications that are included in the international scientometric databases Scopus, Web of Science; 5. The number of published monographs, textbooks, teaching aids; 6. The total number of scientific works that are carried out on a competitive basis at the expense of all customers; 7. The number of scientific works that are carried out on a competitive basis at the expense of state customers; 8. The number of scientific papers that are carried out on a competitive basis (projects, grants, and the like) at the expense of non-state customers; 9. The number of students-winners of All-Russian competitions of scientific works; 10. The Hirsch index.
Productiveness	<ol style="list-style-type: none"> 1. The percentage of successfully defended dissertations on time among those who studied in doctoral studies and completed doctoral studies; 2. The percentage of successfully defended dissertations on time among those who studied in the graduate program and completed postgraduate studies; 3. The number of registered objects of intellectual property rights per researcher; 4. The number of appearances in publications with an impact factor, as well as in other publications that are included in the international scientometric databases of Scopus, Web of Science per 100 teachers and researchers. 5. The percentage of students-winners of All-Russian competitions of scientific papers from among those studying at the university; 6. The share of researchers in the total number of employees of the institution; 7. The amount of income from scientific activities per teacher and researcher.
Diversification of income from scientific activities	<ol style="list-style-type: none"> 1. Total receipts from scientific works that are carried out on a competitive basis at the expense of all customers; 2. Proceeds from scientific works that are carried out on a competitive basis at the expense of state customers; 3. Proceeds from scientific works that are carried out on a competitive basis at the expense of non-state customers; 4. The share of proceeds from scientific activities in the total income of the institution; 5. The share of proceeds from project activities in total revenues from scientific activities.

We analyzed the impact of the level of financing of scientific and innovative activities on the effectiveness of research work using the above indicators and the individual indicators of five Russian universities formed on their basis.

The indicators of scientific and innovative activity of universities analyzed in this study were the share of income from scientific activities (SA) in total funding (in %); the number of publications in journals indexed in the Scopus and Web of Science databases per 100 teachers (T) and researchers (R); income from SA per one T and R (thousand rubles); the number of registered patents for inventions and utility models per 100 R; the amount of income from SA per one R (thousand rubles); the number of students-winners of All-Russian competitions of scientific papers (% of the total number of students); the share of R in the total number of employees (in %); the volume of income from SA per publication in journals indexed in the Web of Science and Scopus databases (thousand rubles); the Hirsch index.

The study was carried out on the example of the following universities: Russian State University of Tourism and Services Studies (RSUTS), Synergy University (SU), Moscow State University of Technology and Management Named after K.G. Razumovsky (MSUTU), Moscow Polytechnic University (MPU), Russian State Social University (RSSU).

An analysis of individual indicators of scientific and innovative activities by universities in 2020-2021 was carried out (Table 2) based on the information data of universities that are published on their websites, namely: financial documents, staffing tables, rector's reports, reports on indicators of scientific and technical activities.

To carry out a comprehensive assessment of the impact of performance-based financing of scientific activities on the level of research results, we considered individual indicators of the effectiveness of scientific and innovative activities of the universities under study, placing them according to the level of importance (Table 1) and applying weighting coefficients to them. We used the Fishbein model (Jung et al., 2017) to calculate the weighting coefficients of the proposed indicators:

$$W_i = 2(n-i+1)/n(n+1)$$

where n is the number of partial indicators; i is the rank (ordinal number of the partial indicator) by the level of its importance.

We calculated the integral indicators of the effectiveness of scientific and innovative activities for two years (2020, 2021) of each of the studied universities, reflected in Table 3 using indicators-stimulators and indicator-destimulators of universities and certain weighting coefficients (Table 2).

The integral assessment of the university's activity (Iy) is calculated using the formula

$$Iy = \sum W_i X_i$$

where X_i is the standardized value of a particular indicator, W_i is its weighting coefficient.

RESULTS AND DISCUSSION

The individual indicators of the effectiveness of scientific and innovative activity of universities in 2020-2021, obtained based on the analysis of information data of universities, are presented in Table 2.

Table 2. Selected indicators of the effectiveness of universities' scientific and innovative activities in 2020-2021.

	Significance rank (weighting coefficient)	RSSU	RSUTS	MSUTU	SU	MPU
		2020/2021				
The share of income from scientific activities (SA) in total funding, %	1 (0.183)	3.9/5.2	9.7/14.4	8.3/7.0	3.1/2.9	9.6/7.1
The number of publications in journals indexed in database of Scopus (Web of Science) per 100 pages	2 (0.163)	16.7/16.0	23.1/23.9	19.7/23.1	8.5/9.2	11.1/18.3
The income from SA per one T and R, thousand rubles.	3 (0.146)	1.48/2.88	3.41/12.84	16.4/13.12	1.43/1.94	3.68/3.30
The number of registered patents for inventions and utility models per 100 R	4 (0.126)	30.8/26.2	7.3/6.1	36.7/43.3	7.4/19.9	76.6/90.3
The amount of income from SA per one R, thousand rubles.	5 (0.108)	126.50/ 138.70	147.03/ 204.89	193.51/ 181.48	179.22/ 198.61	240.69/ 253.36
% of students-winners of all-Russian competitions of scientific papers from among the students	6 (0.092)	0.34/0.23	0.15/0.13	0.72/0.77	0.04/0.01	0.16/0.18
The share of R in the total composition of employees	7 (0.074)	3.4/4.8	7.6/8.5	5.8/5.6	2.6/2.4	6.0/5.9
The amount of income from SA per publication in journals indexed in the databases of Web of Science, Scopus, thousand rubles.	8 (0.054)	109.63/ 98.15	157.49/ 254.43	158.94/ 118.92	110.40/ 103.62	153.94/ 149.31
The amount of income from SA for 1 patent, thousand rubles.	9 (0.036)	411.1/ 530.0	2023.1/ 3350.0	527.5/ 419.0	233.9/ 220.0	3,258.3/ 1,273.5
The Hirsch Index	10 (0.018)	40/43	53/60	33/39	35/37	65/70

The integral assessment of the universities' activities is presented in Table 3.

Table 3. Integral assessment of the effectiveness of universities' scientific and innovative activities

Universities	Integral indicator 2020/2021
MSUTU	6.982 / 6.980
MPU	6.436 / 6.528
RSUTS	5.200 / 5.727
RSSU	4.327 / 5.128
SU	3.491 / 3.577

The degree of use of scientific potential characterizes the effectiveness of the scientific activity, which is recommended to be analyzed in the context of research and development areas in terms of indicators that cover research conducted,

scientific and technical developments created and implemented, publication of scientific results, defense applications, and titles.

Based on the data in Table 2 we can observe that the personnel and financial potential, which are managed by Russian universities, are used by them in different ways. Considering the share of revenues from scientific activities in total revenues, RSUTS has the best funding, which differs significantly from others, and the indicator of a low level of funding for scientific activities is currently noticed in the SU. The percentage of income from scientific activities in total university admissions ranges from 2.9 to 14.4. If we compare such an effectiveness measure as the income from the scientific activity, which falls on one researcher, then the MPU is the best.

We agree with the opinion of scholars that a special need today for universities is the search for new, alternative sources of funding, including through grant proposals and the construction of an effective system of private investment in scientific research, which will make it possible to expand financial opportunities for science and, as a result, the construction of an innovative economy (Dolgikh, Pershina, 2017; Bloch, Sørensen, 2015). Orders for scientific research by enterprises and businesses and commercialization of objects of intellectual property rights are important in modern conditions, which contributes to the development of Russian universities (Bollen et al., 2017).

According to the data in Table 2, the indicator of diversification of sources of funding for scientific activities, namely, income from research and innovation per teacher and researcher, is the most effective at MSUTU, which, as we can reasonably say, positively affects the effectiveness of the research work of its employees. If, for example, the amount of income from the implementation of scientific activities in MSUTU is twice as high as in MPU, then this indicator is four times higher considering its weight value per teacher or researcher.

Analyzing the activities of Russian universities on objects of intellectual property rights registered by the university or its employees, MSUTU is also the best in quantitative terms. However, if we consider the indicators of the effectiveness of universities' scientific and innovative activities, we observe the presence of significantly higher indicators in MPU (the number of registered patents for inventions and utility models per 100 researchers is twice as much as in MSUTU). Meanwhile, the RSUTS directs its activity more towards publications in journals indexed in the international scientometric databases of Scopus

and Web of Science, while the RSSU and SU have a less financial burden on one publication.

According to the data in Table 2, the use of financial potential to achieve scientific results is most effective at MSUTU, although it ranks third among the universities studied in terms of the share of income from scientific activities. At the same time, we observe the effective use of intellectual potential – researchers, teachers, winning students, publications and patents. Thus, RSUTS, which ranks third in assessing the effectiveness of scientific and innovative activities, has the highest proportion of researchers in the total number of employees and revenues from scientific activities in the structure of the total volume, which, in our opinion, are important factors in achieving its academic reputation.

CONCLUSIONS

The desire of Russian universities to be among the best forces them to improve their quality indicators and develop and reach a higher level. Having analyzed sample indicators of scientific and innovative activity of individual universities with the help of information posted on university websites, their staffing, and financial support, it was found that the amount of funding for scientific and innovative activity has a significant impact on the level of achievements of universities and their employees, but is not always used effectively. This confirms the hypothesis of the study.

The main indicator of the level of achievements of an educational institution, in our opinion, is the ability of its employees to receive scientific results – publications, patents, etc., which will be in demand on the market and will have further practical implementation.

It is important in a competitive environment to search for additional sources of funding for the socio-economic development of universities, which allows them to expand their scientific and innovative activities, increase their efficiency, intellectual and financial potential, which in turn will contribute to the implementation of scientific results in practical applications and the progress of science in general.

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