

Integral Evaluation of the Investment Effectiveness into Universities Development

Alexandr A. Tarasyev*, Anastasia E. Sudakova**,
Gavriil A. Agarkov ***

* Ural Federal University named after the first President of Russia B.N. Yeltsin, Mira 19, Yekaterinburg, Russia, 620002
(e-mail: alextarassiev@mail.ru).

** Ural Federal University named after the first President of Russia B.N. Yeltsin, Mira 19, Yekaterinburg, Russia, 620002
(e-mail: a-chusova@mail.ru).

*** Ural Federal University named after the first President of Russia B.N. Yeltsin, Mira 19, Yekaterinburg, Russia, 620002
(e-mail: g.a.agarkov@urfu.ru).

Abstract: In this article we examine the impact of international university rankings on their further development. The answers on questions about the influence of ratings indicators on higher educational institutions, as well as the effectiveness of universities financing in proportion to the position in the rating, were identified. The effectiveness of financial investments in universities when promoting one point in international rankings was calculated using an integrated assessment. Our hypothesis is that due to the achievement of target variables of the rating changes the universities structure: the effectiveness of scientific and innovation activity increases, which leads to an increase in the volume of income from this type of activity. From the point of view of scientific and practical importance, it is possible to group higher education institutions on the basis of the results obtained and allocate funds for them, which will allow achieving target indicators. Thus, this method allows you to evaluate the achievement of maximum results and optimize the funding flow.

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1. INTRODUCTION

The desire to create "world class" universities has become one of the most important directions of national economic strategies. In Russia one of the key provisions of domestic policy is that by 2020 five universities should enter the top 100 best universities in accordance with international standards (the Top 5/100 program) and 15 Russian universities should enter the top 200 of the best universities in the world. Currently, the top 100 universities include universities in the US (30 universities) and Great Britain (20 universities). Of all Russian universities at the moment, only the Moscow State University (according to ARWU, THE) and the St. Petersburg State University (according to data for 2014) are included in the Top-100 rating.

It should be noted that in this article we adhere to different assessments of the share of science in the rating methods. The inclusion of universities into the TOP ratings can serve as an indicator of the university effectiveness and prestige. In this regard, we can note the direct value of the rating - the benchmark for choosing a university by applicants and their representatives. But the achievement of an appropriate position in the ratings is an indirect guideline for the internal policy of universities, i.e. the achievement or performance of ratings is the result of university's staff work. However, it is worthwhile to realize that, one way or another, the higher education system is already developing according to the laws of the tertiary sector of economy using market instruments.

Under these conditions, we believe that it is necessary to evaluate the effectiveness of the market instruments use in the higher education system, taking into account changes in the structure of higher education.

We assess the effectiveness of the university's resources use in proportion to the position, held in the international rating, and represent an integral assessment of the financial impact on the positions of Russian universities in international rankings, based on the proposed hypothesis. The practical significance of the research is that, based on the obtained results, higher education institutions can be grouped in order to provide them with funding for the achievement of target indicators. This approach allows to maximize university's results and to optimize financing flows between groups of Russian universities. In addition, the assessment of the effectiveness of 1 point in international rankings is designated as one of the key tasks in the documents of the Ministry of Education and Science of the Russian Federation.

2. STRUCTURE OF THE HIGHER EDUCATION SYSTEM

Currently, in Russian Federation, higher education institutions have following graduation: 10 federal universities; 29 national research universities; 2 universities with a special legal status as unique scientific and educational complexes, which are the oldest universities of the country and are greatly important for the development of Russian society. Also in the structure of the higher education system

are included academies and institutes. Russian universities can be classified according to their subordination to ministries.

At present, Russian universities are accountable to 23 federal executive bodies, the largest of which, in addition to the Ministry of Education and Science of the Russian Federation (403 universities); are: the Ministry of Agriculture of the Russian Federation - 59 universities (14.6% of the number of universities of the Ministry of Education and Science); the Ministry of Health and Social Development of the Russian Federation has 46 universities (11.4%) and more than 200 thousand students at these universities; the Ministry of Culture of the Russian Federation - 48 universities (14.6%) for more than 67 thousand students. Training of specialists with higher education for the transport complex of Russia is carried out on the basis of 20 industrial higher educational institutions, which are under the jurisdiction of the Ministry of Transport of the Russian Federation through three Federal Agencies.

Higher educational organizations unite not only with other universities, but also actively join the scientific centers. Such a trend of enlarging the system of higher education is typical not only for Russia, but also for other countries. In the United Kingdom, in 2004, the Manchester Victorian University and the Manchester University Scientific and Technical Institute were merged to enter the TOP-25 of the world's best universities, with the goal of uniting the Cardiff University and the South Wales School of Medicine (2004). The process of unification of universities is connected with the fact that the latter aspire to occupy the highest positions of international ratings. In addition to enlarging higher education institutions, in order to improve their performance, an effective mechanism is the concentration of public finances in selected universities (Salmi J., Frumin I., 2007).

A fairly comprehensive analytical report on the presence of universities in international rankings for 2016 is presented in the article (Shestopalova A.V., 2016). Speaking about the effectiveness of the university and focusing on the rating indicators, it should be noted that authors of this article share the point of view of some authors and organizations that the rating system of universities is a market tool (Amsler, Bolsmann, 2012), which relates the education system to the tertiary sector of the economy. Using rating indicators it is possible to monitor and manage the higher education system (Carimova A.B., 2016), and, at the same time, absolute orientation to the ratings of the rating system (by the indicators that exist in the time) and the final positions of institutions of higher learning can lead our society to credentialism rather than meritocracy (Marginson S., Van Der Wende M., 2007).

3. CLASSIFICATION OF UNIVERSITIES RATINGS

Currently, a large number of Russian and foreign ratings have been developed for a varied evaluation of higher education institutions. The main goal of all rating systems (ratings of universities) is to inform the readership of the media, especially students and their parents, about the universities status, as well as to reflect the situation and trends in the market of higher education worldwide. Among the leaders in

foreign ratings are the Academic Ranking of World Universities (ARWU or Shanghai Ranking) of the Shanghai Jiao Tong University, the Times High Education (THE) of the British magazine specializing in higher education, QS University Ranking of the British consulting company Quacquarelli Symonds, specializing in international educational programs; among the Russian - the National rating of universities (IA Interfax), the rating of the universities of the rating agency "Expert RA", the rating of universities, compiled by the Ministry of Education and Science of the Russian Federation in the higher educational institutions effectiveness monitoring, etc. (Koksharov V.A., Sandler D.G., Kadochnikov S.M., Tolmachev D.E., 2012). The main difference between domestic and foreign ratings is the procedure for including universities. If Russian ratings rate higher education institutions of their choice, universities must apply QS and THE in order to qualify for foreign rankings.

The compilation of various types of ratings is now a widespread and controversial tool for analysis, and therefore approaches to the ranking of higher education institutions are periodically criticized by the expert community (Hazelkorn E., 2007). Some scholars, among the critics of university ranking, highlight the incompatibility of higher education institutions by their size (Ioannidis J.P.A., Patsopoulos N.A. et al., 2007), others - the incompatibility of the results of different ratings among themselves and the non-transparency of the methodology (Van Raan A.F.J., 2005), the third, based on the identification of the best rating criteria, offer the optimal variant of the methodology of rating universities (Taylor P., Braddock R., 2007). The latest critical remarks on the universities ratings are provided at the study on the mediation of the higher education system (Ester A., Shahjahan R.A., 2016). Another interesting point of view regarding the construction of a system of indicators for the universities ranking is presented in B. Kehm's article, in which the author discusses the system of indicators, in particular that in many rating systems the research component is given more importance, which does not allow to judge the quality of the university's work and about its educational activity directly (Kehm B.M., 2016), and draws attention to the fact that the final indicators of such ratings shift the employer's choice.

Table 1. Characteristics of international rankings World university ranking, 2017

| Characteristic | ARWU | THE WUR | QS WUR |
|---|-----------|-------------|------------|
| The dimension of the rating, incl. individual places | 500 univ. | 1001+ univ. | 1000 univ. |
| | 100 | 200 | 400 |
| Number of Russian universities in the ranking | 3 | 27 | 24 |
| incl. amount of Russian univ. with an individual rating | 1 | 1 | 10 |

Russian universities in 2017/2018 marked their presence in the three analyzed ratings: The Academic Ranking of World Universities (ARWU), Times Higher Education World

University Rankings (THE WUR), World University Rankings of Quacquarelli Symonds (QS WUR), Table 1.

It should be noted that, firstly, the ratings periodically increase their dimension, and secondly, the number of Russian universities included in the ratings lists also increases, and this is not always an interrelated process.

4. EFFICIENCY OF FINANCING APPOINTMENTS ON ONE POINT IN RATING

We conducted a short analysis of the effectiveness of investing in universities for one point in international rankings. The analysis was conducted on Russian universities for the period from 2012 to 2015 and foreign universities for 2014. The calculation was made by dividing the amount of funding for the university on place in the ranking, i.e. on the number of points on which the university has risen from the bottom position, in other words it can be said that in this way the cost of the position in the rating is calculated:

$$C_i^t = \frac{Cost_i^t}{K - R_i^t}, \quad (1)$$

where C_i^t - return of investments of the i -th university at the time t by one point in the rating, thousand rubles/point; $Cost_i^t$ - expenditure of the i -th university at time t , million rubles, in comparable prices by 2012;

$K=400$ - the bottom position of the rating, with which the other higher education institutions are compared;

R_i^t - the position of the i -th university (from the TOP-400 rating) at time t ;

t is the time interval for which data analysis and comparison is performed.

For example, if Moscow State University (MSU) occupies the 80th place in the ARWU ranking (Top 400), then the ratio of the total cost of the university in monetary terms to the difference in the position of the rating by individual places (in our methodology this value is 400, for comparability of the methods among themselves) in the rating (80). Figure 1 shows the data of the Moscow State University (MSU).

Analysis of data from the Moscow State University shows that the institution has approximately the same value estimate of one point in each of the analyzed ratings. The obtained values can be hypothetically explained by the fact that the Moscow State University has established positions in international rankings, and the university itself meets the requirements that are necessary for assigning it an international rating. In the dynamics there is a slight decrease in data for 2015, which happens due to a decrease in funding in the analyzed year. We can assume that the dynamics of the decline in funding may have a deferred lag in the reduction of positions in the ratings.

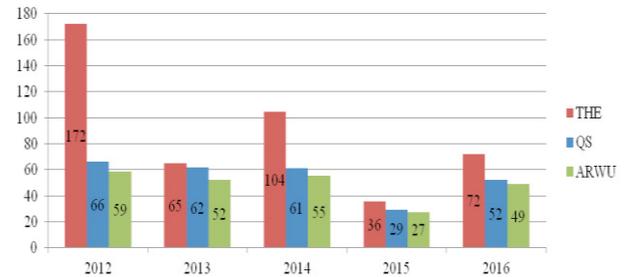


Fig. 1. The return of MSU funding investments by one point in the rating (Top-400) (data are presented in comparable prices in 2012), mln. rubles.

Analysis of the cost of funding for Russian universities in QS World University Ranking showed that the analyzed figures have different meanings. The most stable values of indicators are observed for Novosibirsk State University. For the Moscow State University, positive dynamics is characterized with an increase in the ranking and an increase in the return on investment. The opposite from MSU picture is observed in the Moscow State Institute of International Relations (MSIIR), this university has reduced its position in QS World University Ranking, while the total funding for the university has not decreased (in comparable prices to 2012). We analyzed 11 Russian universities (the article presents analysis only for those universities who take positions in the rating above 400 lines, because they have individual positions in the rating). The average return on financial resources commensurate with the position taken in the international ranking of the Top-800 according to QS for Russian universities is 374 million rubles for one point in the rating, while the lowest efficiency of using financial resources commensurate with the position held in the rating by Far Eastern Federal University (43 million rubles), Moscow State University (78 million rubles), Novosibirsk State University (101 million rubles), and Tomsk State University (165 million rubles).

As for the return of investments of foreign universities' funding by one point in the rating, it is worth noting that this indicator is lower than in Russian universities, i.e. in order to rise to 1 point in international rankings, foreign universities require large financial resources. The lowest effectiveness of investment return for 1 point in international rankings is held by those Russian universities who occupy the lowest positions. Opposite situation develops with foreign universities. Among the universities there is no apparent dependence of the effectiveness of the use of financial resources commensurate with the position held. For example, Harvard University ranks 1st in the ARWU rating, 2 - THE, 4 - QS, with the cost of 1 point in the rating of 4.4 billion rubles. Massachusetts University of Technology ranked third in the ARWU ranking, 5 - THE, 1 - QS, cost of 1 point - 1.5 billion rubles.

On the basis of data analysis, it can be assumed that the importance of the return of financial resources commensurate with the position held in the rating in foreign universities is constant, and there is no correlation between the position held and the amount of university revenues. This ratio of funding and the position held in the rating may indicate the

peculiarities of the incomes of each university (the ratio of state and commercial incomes) with equally high rates, estimated by rating agencies. In this regard, we present a model of the integral evaluation of the returns from the positions of Russian universities in international rankings. The basic function of describing the dynamics is as follows:

$$E(t_k) = \int_k^{k+1} \left(\frac{IS(t_k)}{I(t_k)} + \frac{S_{h>5}(t_k)}{S(t_k)} + \frac{P_{IF>3}(t_k)}{P(t_k)} \right) dt, \quad (2)$$

where $E(t_k)$ is the return effect from the positions of the i -th university in the current reporting period;

$IS(t_k)$ - (Income from science) - income of the i -th university from scientific and innovative activities in the current reporting period, thousand rubles;

$I(t_k)$ - (Income) income of the i -th university in the current reporting period, thousand rubles;

$S_{h>5}(t_k)$ - (staff with h -index > 5) - the number of authors of the i -th university, which have an h -index more than 5 in the current reporting period, according to the scientometric database WoS/Scopus;

$S(t_k)$ - (staff) - number of authors of the i -th university, in the current reporting period;

$P_{IF>3}(t_k)$ - (papers in journals with Impact factor > 3) - the number of articles of the i -th university published in journals indexed in the international citation bases WoS/Scopus, with an impact factor more than 3;

$P(t_k)$ - (paper) - the number of articles of the i -th university published in the journal indexed in the international citations WoS/Scopus.

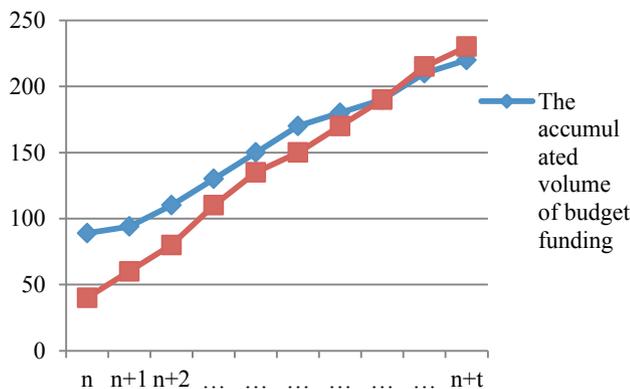


Fig. 2. The ratio of accumulated volume of budget and extrabudgetary fundings for the university

5. INTEGRAL EVALUATION OF FINANCIAL RETURN FROM THE POSITIONS IN INTERNATIONAL RATINGS

The conducted analysis of the indicators, according to which the ratings of universities and the analysis of the effectiveness of universities on one point in international rankings are calculated, allowed us to formulate the following hypothesis. Achievement of rating targets by universities changes their structure: the effectiveness of scientific and innovative activity of the university is increased, the volume of income from this type of activity increases. Conventionally, this hypothesis can be presented in the form of a scheme: university-science-rating. It is worth noting that the increase

in positions in international rankings has a direct and indirect impact on higher education institutions.

As a direct influence of the ratings on the activity of universities it can be stated that with the increase of the place of the university in the rating, it becomes more competitive from the position of its choice by the entrants and their representatives. Indirect influence is more multifaceted for comprehension, the essence of which lies in the fact that when the target quantitative and conditional indexes are achieved, the indicators of the scientific and innovative activity of higher educational establishments are increasing, for calculating the rating, the share of indicators that evaluate scientific activity is more than 50%:

- for the QS rating, this indicator is 60% (academic reputation is 30%, number of citations per staff member is 30%),
- for the THE rating - 70% (the university's reputation is 18%, the number of citations per staff member is 30%, the university's income from scientific research is 6%, the productivity of scientific researchers is 6%, international cooperation is 2.5%; the ratio of the number of students studying under the bachelor's program to the doctors of science of the university is 2.25%, the proportion of doctors in the total number of teaching staff is 6%),
- for the ARWU rating - 100%.

It is important to explain here how scientific research changes the structure of financing of universities only in the case of high-quality, competitive research by universities. In this connection, it becomes necessary to note that the impact of road map targets (the amount of funding, the number of documents in the WoS/Scopus databases, the percentage of articles in the international co-authorship (Scopus), the H-index or the Hirsch index (Scopus), etc.) international ratings is debatable. The significance of the indicators themselves is a compound methodology for rating universities, but the value of these indicators can be changed by increasing the competitiveness of research.

One of the reasonable points of view on this issue is the position of O. Moskaleva (Moskaleva O.V., 2014), who analyzed the dependence of the published indicators and the position of the universities, and presented a detailed report on the quantitative and qualitative characteristics of the publication activity of university staff. As a recommendation it is noted, that it is necessary to change the strategy of publishing activity: first, to change the policy of Russian journals included in the WoS/Scopus, to increase their level; second, to publish in more ranking journals.

S. Donetskaya (Donetskaya S., 2014) comes to a similar conclusion that O. Moskaleva, speaking of increasing the publication activity and the level of citation per article, suggests publishing many scientific works in journals with medium and high impact factors, while noting, that the main problem of Russian universities is the low level of the publication activity of teachers and the low demand for their scientific publications abroad.

The conclusions drawn by the experts, researchers and authors of the articles are very justified, since to improve their positions in international rankings, it is necessary to improve those indicators, whose weight in the total prevails. In the global world ratings (QS, THE, ARWU), more weight is assigned to such indicators as the level of citation, academic reputation, the number and scope of research, all these indicators are closely related to the results of scientific activity, which are mainly expressed in the publication activity. Authors of this article may disagree with the foreshadowing of the problem posed by a number of authors (Sheregi F.E., Arefyeva A.L., 2014), who emphasize in their publications an increase of publication activity level and the level of article citations, and to a lesser extent consider the problems of scientific research, which are top-priority in improving the quality of articles and their inclusion in high-ranking journals and increasing the level of citation.

The more significant the research is, from the position of the scientific community, the more it is cited and, as a rule, published in a high-ranking journal. In other words, the primary task of the Russian scientific community should lie in the field of introducing innovative methods and developments, and not in an effort to increase the publication activity and citation of articles.

Unlike Russian scientists, whose work places a great emphasis on publishing activity, foreign colleagues pay more attention to the indices (Hirsch index, impact factor of the magazine). So (Huang H.-M., 2012) conducts research on the impact of h-index on the impact of scientific research, and concludes that this relationship is confirmed, Bornmann L. and Daniel H.D. come to such conclusions. suggesting the hypothesis of the impact of h-index on the success of post-doctoral studies (Bornmann L., Daniel H.D., 2005). P. Weingart (Weingart P., 2005) also shifts the focus toward the need for the Hirsch index and the importance of highly cited scientists. Another significant scientometric indicator of the Journal Citation Report (JCR) ISI (ISI Impact Factor), and the high quantitative value of this indicator is an indicator of the quality of publications in such a journal (Zhang L., 2011).

Hypothetically, with the increase in positions in the ranking, the revenues from paid educational services increase. At the same time, raising the positions in the rating is not possible without increasing the competitiveness of scientific research, which, as a result, leads to attracting additional funding from state funds or from commercial structures. A comparison of funding levels occurs for each billing period, and the state of the balance of financing is possible when the calculated functions approach the total value in the time period under consideration:

$$Re(t_k) = \frac{E(t_k)}{F(t_k)}. \tag{3}$$

The basic function of describing the dynamics of budget financing is as follows:

$$\int_k^{k+1} F(t_k) = \int_k^{k+1} \left(\frac{F(t_k) \cdot \frac{F(t_k) / (V(t_k) + En(t_k))}{A(t_k)}}{L(t_k)} \right) dt, \tag{4}$$

- $F(t_k)$ – budget financing of the organization in the current reporting period;
- $F(t_{k+1})$ – budget financing of the organization in the next reporting period;
- $En(t_k)$ – income from the endowment fund in the current reporting period;
- $V(t_k)$ – total funding of the university;
- $A(t_k)$ – number of scientific and teaching staff;
- $L(t_k)$ – total number of the organization's staff.

The accumulation of extrabudgetary funding is described by the following function:

$$\int_k^{k+1} E(t_k) = \int_k^{k+1} \left(\frac{E(t_k) \cdot \frac{E(t_k) / (V(t_k) + En(t_k))}{A(t_k)}}{L(t_k)} \right) dt, \tag{5}$$

- $E(t_k)$ – extrabudgetary financing of the organization in the current reporting period;
- $En(t_{k+1})$ – extrabudgetary financing of the organization in the next reporting period;
- $En(t_k)$ – income from the endowment of the fund in the current reporting period.

At the same time, extrabudgetary funding is calculated in the form of the amount of funds raised for scientific development and the financial inflow obtained from paid students:

$$E(t_k) = \sum E_s(t_k) + \sum S_p(t_k), \tag{6}$$

- $E(t_k)$ – extrabudgetary financing of the organization in the current reporting period;
- $S_p(t_k)$ – income from students of contract form of training;
- $E_s(t_k)$ – income from borrowed funds for scientific development.

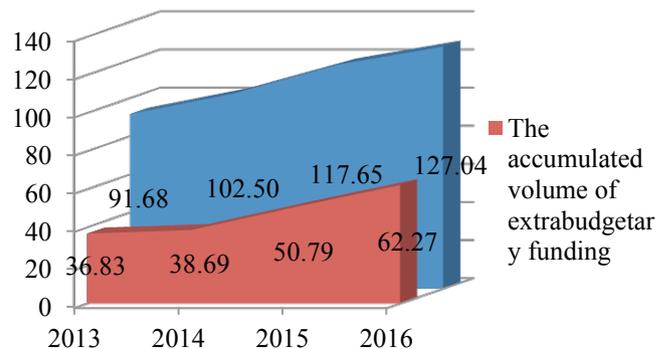


Fig. 3. The accumulated volume of funding for the university, mln. rubles.

Taking into account the general dynamics of the described functions, we obtain a convergence and intersection of the graphs of functions on the finite and infinite horizons. In this case, after passing the point $Re(t_k) = 1$, we get a high return on budget funds invested in the work of the educational

organization. Provided integral evaluation was applied to official data of the Ural Federal University and demonstrates a sustainable growth of university's financing per capita (figure 3).

6. CONCLUSIONS

The analysis of rating systems and the assessment of the effectiveness of financial investments by one point in international rankings led us to the hypothesis that the achievement of the target indicators of the rating by universities changes their structure: the effectiveness of the scientific and innovative activity of the university increases, and, consequently, the amount of income from this type of activity increases. In addition, the result of this research allows us to form some generalization of the work. Increasing positions in international rankings and strengthening the achieved positions is possible through the development of a competitive university science. The main benchmarks should be not only quantitative values, but above all qualitative ones, which can be evaluated through the Hirsch index of the scientist and the impact factor of the journal in which the articles of the university staff are published. In addition, practical application for further expansion, can have calculations for the cost of one item in international rankings. The result can be a theoretical basis for ranking universities and providing them with funding on a competitive basis.

7. ACKNOWLEDGMENTS

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