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Factors Affecting R&D Share in University Revenues: Case of Russia

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Abstract: Recent government projects and initiatives (such as Priority 2030) have significantly increased the role of universities in creating and commercializing innovations in Russia. One of the most important indicators of university performance in these programs is R&D revenue. Its values have a significant deviation between universities that lead to different importance of R&D activities and make some universities more R&D oriented than others in the terms of their economics. This orientation can be considered an important factor of university sustainability as it allows it to be less dependent on admission volume which varies due to demographic waves and other endogenous factors. This paper studies the factors affecting the R&D orientation of big Russian universities. Monitoring the Efficiency of Higher Education Institutions provides sufficient data on Russian universities for such study including the share of R&D revenue in the total value of revenue which is used as a measure of R&D orientation. This study analyses the factors affecting this indicator using the data from the 49 largest Russian universities between 2015 and 2020 to build econometric panel data models. The modelling proves the significance of various factors such as entrance scores of students, the number of publications per faculty member, the share of young researchers, the ratio of average salary to the regional average salary, and the share of faculty members holding doctoral degrees. The research highlights the connection between publication performance and R&D activities and the importance of supporting young researchers in the development of scientific entrepreneurship.

Keywords: economics of universities; university management; R&D; Monitoring of the Efficiency of Higher Education Institutions; Russia

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1. Introduction

Universities are becoming an increasingly important and institutionalized part of the creation of innovative products (Geuna and Muscio 2009) as they are largely responsible for the initial stages of innovation. These processes can be described under the framework of the triple helix model of innovation (Etzkowitz and Leydesdorff 1995) which is based on the interactions between universities, industry, and government. In Russia, such interactions have been actively intensified in recent years. The proof (as well as one of the reasons) of this growth is the active participation of universities in innovation infrastructure facilities (such as research and education centers—RECs).

The commercialization of research is a key part of the widely used concept of the entrepreneurial university developed by Etzkowitz (1983, 1993). Indicators of scientific entrepreneurship are included in several past and current projects and initiatives of the Russian government aimed at developing the higher education system, including the most recent «Priority 2030». One of the declared goals of «Priority 2030» is the "Integration of university science to the real economy".

In Russia, the ability of universities to get money from research is especially relevant because of the huge influence of demographic waves that started from WWII (Ryazantsev and Rybakovskii 2021) which significantly varied the number of school alumni in different years. Thus, it can help universities to be less dependent on tuition fees and make their

economics more sustainable. Moreover, decreasing such dependence can allow for increasing the quality of admission as universities would be able to set a higher threshold and not enroll low-ability students. However, the question is how to make the university more R&D oriented.

The aim of the study is to analyze the factors of university transformation into scientific entrepreneurship. The results of the study allow us to draw important conclusions about the nature of the entrepreneurial activities of universities, as well as to increase the R&D orientation of universities and make universities more sustainable.

Section 2 provides a review of the existing research on the topic. Section 3 describes the data used for analysis and applied methods. Section 4 contains the results of econometric modelling with comments and interpretation. Section 5 gives additional discussion and policy recommendations based on the results. Finally, Section 6 concludes the paper.

2. Literature Review

Different papers already analyzed the factors of the entrepreneurial activity of universities. Riviezzo et al. (2019) found out that the entrepreneurial orientation of universities relates to the size of the university and the overall level of R&D spending in the country of the university.

Van Looy et al. (2011) analyzed the number of patents, the number of spin-offs, and the number of R&D contracts of European universities. The most important finding was that in all the models, the university number of publications indexed by the Web of Science was significant and positively connected. Moreover, the authors found the positive influence of university size on patents and R&D contracts.

A positive relationship between university publications and entrepreneurial activity has been also confirmed in several other studies (Azoulay et al. 2007; Calderini and Franzoni 2004; Czarnitzki et al. 2007; Fabrizio and Di Minin 2008) and the explanation can be that all these activities are driven by "research efforts and competencies" (Breschi et al. 2005). At the same time at the level of individual researchers, Audretsch et al. (2006) found the negative influence of citations on scientific commercialization.

Sun (2021) highlights the importance of the attitude and ability of top university management in achieving good R&D results. Other papers also mention such factors as university-industry cooperation, flexible management systems, and national promotion of entrepreneurial behavior in general (Carayannis et al. 2016).

Sandler and Gladyrev (2020) already analyzed factors affecting R&D revenue per faculty member, but this analysis does not reflect the general R&D orientation of universities as big universities are more likely to have higher revenues of all types (even taking these values per faculty member). Current research does not analyze the value of R&D revenue, but the R&D orientation of universities' commercial activities (R&D share in the total revenue).

3. Materials and Method

The study uses economic, structural, and scientometric data for the 49 largest universities in Russia from 2015 to 2020 (294 observations in total) downloaded from the Monitoring of the Efficiency of Higher Education Institutions.[1] Although the Monitoring was launched in 2013, the first two reports used other sets of indicators, this is the reason why only data since 2015 is used.

The sample was composed to include all major universities in Russia with high scientific output and high values of revenue and R&D revenue. Small universities that never participated in big state programs and did not apply for such participation should not be considered along with big universities as these universities do not have strict obligations to achieve any values of considered indicators. It means that the intention and ability of their management to increase these indicators is not trustworthy.

Thus, the sample (Table 1) includes all participants of the 5–100 project (the main state project of university development in the last decade), all federal universities (except

Crimean), all NRUs (except St. Petersburg AU RAS), and several other Russian universities included in the TOP-500 international QS or THE rankings.

Table 1. Russian universities included in the sample.

University	5–100	Federal	NRUs
Immanuel Kant Baltic Federal University	+	+	
Belgorod State National Research University			+
Voronezh State University			
Higher School of Economics	+		+
Far Eastern Federal University	+	+	
Irkutsk National Research Technical University			+
Kazan Federal University	+	+	
Kazan National Research Technical University			+
Kazan National Research Technological University			+
Ogarev Mordovia State University			+
Moscow Aviation Institute			+
Moscow State Institute of International Relations (MGIMO)			
Moscow State University of Civil Engineering			+
Bauman Moscow State Technical University			+
Moscow State University			
Moscow Institute of Physics and Technology	+		+
Moscow Power Engineering Institute			+
National University of Science and Technology (MISiS)	+		+
National Research University 'Moscow Institute of Electronic Technology			+
National Research University of Information Technologies, Mechanics, and Optics (ITMO)	+		+
National Research Nuclear University MEPhI	+		+
Lobachevsky State University of Nizhny Novgorod	+		+
Novosibirsk State Technical University			
Novosibirsk State University	+		+
I.M. Sechenov First Moscow State Medical University	+		
Perm State University			+
Perm National Research Polytechnical University			+
Gubkin Russian State University of Oil and Gas			+
Russian Presidential Academy of National Economy and Public Administration			
Pirogov Russian National Research Medical University			+
Peoples' Friendship University of Russia	+		
Plekhanov Russian University of Economics			
Samara National Research University named after academician S.P. Korolev	+		+
St.Petersburg Mining University			+
St.Petersburg State University			
St.Petersburg Electrotechnical University 'LETI'	+		
Peter the Great St. Petersburg Polytechnic University	+		+
Saratov State University n.a. N.G.Chernyshevsky			+

Table 1. *Cont.*

University	5–100	Federal	NRUs
Northern (Arctic) Federal University		+	
North-Eastern Federal University		+	
North-Caucasus Federal University		+	
Siberian Federal University	+	+	
Tomsk State University	+		+
Tomsk Polytechnical University	+		+
Tyumen State University	+		
Ural Federal University	+	+	
Financial University under the Government of the Russian Federation			
South Ural State University	+		+
Southern Federal University		+	

The main research method is regression analysis using panel data models with random effects. The R&D share in the total revenue (Number 2.8 in the Monitoring) was taken as the dependent variable.

Twelve variables were taken as explanatory variables (Table 2). The choice of variables was determined both by a review of existing research on the topic and the desire to choose the most representative and important indicators from each of the four categories of variables: entrance scores, scientometric indicators, internationalization, and faculty members' characteristics. Moreover, the total revenue of the university was taken to control for the size of the university's economy. All values are given for one considered year (the shares and ratios are given for the end of the year).

Table 2. Explanatory variables in the model.

Indicator	Notes	Number in the Monitoring	Reason of Inclusion
Total revenue of the university	In billions of rubles	-	To study the scale effect
Entrance scores			
Mean entrance score of students paid by the government (as the result of competitive selection)	From 0 to 100	1.2.	To study the effect of students with high skills and the attractiveness of university for such students
Mean entrance score of students paid by themselves	From 0 to 100	1.3.	
Normalized minimum entrance score	From 0 to 100	1.4.	
Scientometric indicators			
The number of WoS citations per 100 faculty members	-	2.1.	To study the effect of the scientific performance of the university in terms of citations
The number of WoS publications (of all types) per 100 faculty members	-	2.4.	To study the effect of the scientific performance of a university in terms of the number of publications
Internationalization			
The share of students involved in foreign exchange programs	From 0 to 100	3.6.	To study the effect of internationalization in terms of student mobility

Table 2. *Cont.*

Indicator	Notes	Number in the Monitoring	Reason of Inclusion
The share of foreign faculty members	From 0 to 100	3.8.	To study the effect of internationalization in terms of foreign faculty members
Faculty members' characteristics			
The share of young faculty members	From 0 to 100	2.13.	To study the effect of young researchers
Ratio of the faculty's average salary to the average salary in the region	-	4.3.	To study the effect of financial motivation
The share of faculty members holding a doctoral degree	From 0 to 100	7.4.	To study the effect of holding a doctoral degree
The share of full-time faculty members	From 0 to 100	7.5.	To study the effect of the ratio between full-time and part-time faculty members

4. Results

Table 3 shows the results of econometric modelling. The analysis uses panel data model with random effects and robust standard errors. In total, 8 of the 12 variables are significant at a 10% significance level at least (seven of them at 5% and three of them at 1%). Positive coefficient signs indicate a direct relationship, and negative ones indicate a reverse relationship.

Table 3. Regression analysis. Dependent variable—R&D share in the total revenue.

Variable	Coefficient (Std Error)
Total revenue of the university	−0.375 ** (0.186)
Mean entrance score of students paid by the government (as the result of competitive selection)	−0.097 (0.132)
Mean entrance score of students paid by themselves	−0.357 *** (0.128)
Normalized minimum entrance score	0.224 ** (0.09)
The number of WoS citations per 100 faculty members	0 (0.001)
The number of WoS publications per 100 faculty members	0.034 ** (0.013)
The share of students involved in foreign exchange programs	−0.876 * (0.486)
The share of foreign faculty members	−0.227 (0.195)
The share of young faculty members	0.233 *** (0.077)
Ratio of the faculty's average salary to the average salary in the region	0.038 ** (0.016)
The share of faculty members holding a doctoral degree	0.999 *** (0.375)
The share of full-time faculty members	−0.049 (0.064)
Constant term	24.253 ** (11.482)

*** significant at 1%; ** significant at 5%; * significant at 10%.

4.1. Entrance Scores

Entrance scores were the main subject of multicollinearity concerns as these variables have the highest correlation coefficients (between 0.72 and 0.87). Despite this, two of the three variables' coefficients are significant at a 5% significance level: mean entrance score of students paid by themselves (reverse relationship) and normalized minimum entrance score (direct relationship). It is interesting to notice that these two variables have different coefficient signs. This can be explained by the correlated, but different nature of these indicators: the first shows the competitiveness of programs in general, and the second shows the requirements for new students (set by quotas or the minimum allowable score). The first indicator may have an inverse relationship with the share of R&D revenue because its high values most often indicate high volumes of new students and high revenues based on their fees (which reduces the share of R&D revenue). High values of the second indicator may indicate that the university is interested in the high quality of admission more than in the financial outcome of this admission. Such a desire is more common in universities with high scientific productivity.

4.2. Scientometic Indicators

The connection between entrepreneurial outcome and publication activity is a subject of much previous research (e.g., Azoulay et al. 2007). The current model discovered the direct influence of scientific output on the share of R&D revenues which provides a possible mechanism of this connection: scientific output relates to the R&D capabilities of universities. At the same time, the number of citations is insignificant in the model. However, it does not mean that quantity is more important than quality as these characteristics have a close connection (Michalska-Smith and Allesina 2017; Hayati and Ebrahimy 2009; Lawani 1986).

4.3. Internationalization

Variables reflecting internationalization have low significance in the model. Despite the possible suggestion about the connection between the high share of foreign faculty members and university competencies, the model does not give any evidence about the influence of foreign researchers on the share of R&D revenues. These results are consistent with previous research that did not find an influence of internalization variables on revenue from research per faculty member (Sandler and Gladyrev 2020). At the same time, there is weak evidence that international student mobility is significant in the model, but with a negative sign. It can be explained by the fact that international mobility has a closer connection with education rather than with research.

4.4. Faculty Members' Characteristics

One of the most significant variables in the model is the share of young researchers. In the previous papers, the mean age of researchers was already considered a determinant of scientific output in general (Frenken et al. 2017; Sandler et al. 2022; Vasiljeva et al. 2020), but now this factor can be described as a determinant of university ability to get money from R&D activities.

The average salary in the organization (as a ratio to the average salary of the region) was also determined as an important positive factor that shifts the university towards being more R&D-oriented. It can be explained by the motivation and positive selection of faculty members with high salaries: high-skilled specialists prefer working in the university to working somewhere else.

The share of faculty members holding a doctoral degree is the last and strong positive determinant of the R&D orientation of universities. It can be explained by the connection between holding a doctoral degree and skills.

4.5. Scale Effect

The reverse influence of the university's total revenue on R&D share in total revenue indicates that the richest universities have lower shares of R&D revenue. It can be considered evidence of the current dependence of the biggest Russian universities on tuition fees. At the same time, it can be natural that tuition fees provide a bigger (but less stable) source of money for universities.

5. Discussion

The results prove the importance of scientific publications and their close relationship with getting money from scientific activities. Even though the causal relationship here is not obvious as both indicators can be an outcome of "research efforts and competencies" (Breschi et al. 2005), the complementarity of these activities is trustworthy. It means that for pursuing the transformation into entrepreneurial universities the number of publications should be kept as important criteria for assessing universities. At the same time, the author believes that it is worth giving more attention to Q1–Q2 publications (by JCR and SJR/SNIP) and to be very careful with considered types of papers. This process has been already started with «Priority 2030».[2] It can decrease the existing problem of publishing in predatory journals which leads to inefficient spending of state funding and economic losses (Balatskiy and Yurevich 2021). The next step here can be the creation of white lists of journals (as a more flexible and controlled quality indicator than the quartiles), but it is important to provide quality expert assessment and transparent criteria for the inclusion of journals in the list.

The positive impact of the share of young scientists on R&D revenue is an argument in favor of attracting them to universities, as well as the creation of additional state support programs, scholarships, and grants aimed at this. It is also important to notice that the number of such scholarships and grants is important, but the transparent and competitive selection procedure is important as well (Knyazkova et al. 2019). Moreover, the size of these scholarships and grants should be high enough to force young scientists to choose a scientific career. One of the proofs of this statement was found in the analysis: the ratio of the faculty's average salary to the average salary in the region is also a significant positive factor of R&D orientation in the created model.

The connection between student entrance scores and the R&D orientation of universities is a topic that was not covered in the literature before. In Russia, since 2009 the Unified State Exam (EGE) serves both as a school final examination and for university entrance. Despite some criticism, the exam significantly increased the competitiveness of admission in big universities and provide more opportunities to applicants from small cities and remote regions (Denisova-Schmidt and Leontyeva 2014). The analysis proved that R&D orientation is more associated with the entrance score threshold set by the university for applicants (through quotas or directly) than with the mean entrance score. The trivial explanation can be that universities with high thresholds lose money that they do not get from tuition fees. However, it also can be interpreted in the following way: to transform universities into R&D-oriented it is more important to avoid bad students than to attract good students (even taking into account the high correlation between these factors). Without students with low entrance scores universities can increase the complexity and scientific orientation of educational programs as well as the requirements for passing the courses. Moreover, setting high thresholds for applicants is the way to decrease the dependence on demographic waves as the number of enrolled students is controlled by the university.

6. Conclusions

The participation of universities in the initial stages of national and global value chains by making R&D activities and the creation of innovations is an important feature of modern universities. The ability to commercialize research activities is one of the main elements of the new state program "Priority 2030". Before the key indicators of state programs

were based on international publications, but in 2022 due to the concerns of following international publication activity, the focus was shifted to R&D revenues.

This research determined the factors affecting R&D orientation in university revenues. The most important result of the study is the determined connection between R&D revenues and variables such as the number of publications and the share of young scientists. These findings can be used by university managers and policy-makers to transform university economics into more R&D-oriented and less dependent on tuition fees (in Russia it can be especially important because of demographic waves). Moreover, it can allow increasing the quality of admission. As a result, it can make the economics of universities more sustainable.

The major research limitations are caused by the fact that only big Russian universities were taken for the analysis. In Russia and some other post-communist countries, the factors affecting the R&D orientation of universities can differ from other counties because before the 1990s, universities there were not involved in both entrepreneurial activities and research activities of high level. Major research responsibility in the Soviet Union was given to the Academies of Sciences and its branch institutes (Uvarov and Perevodchikov 2012). Moreover, these factors can be different for small universities that never participated in big state programs and never had strict obligations about scientific indicators.

Despite the Monitoring of the Efficiency of Higher Education providing a valuable array of various data for Russian universities it is also necessary to mention some concerns about the quality of this data (Tsivinskaya and Guba 2020). Future research can be more focused on the data from other reliable sources where this substitution is possible (e.g., scientometric indicators of universities from SciVal and RSCI).

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Conflicts of Interest: The author declares no conflict of interest.

Notes

[1] Monitoring of the Efficiency of Higher Education Institution. URL: https://monitoring.miccedu.ru/?m=vpo, accessed on 24 January 2023.

[2] "Priority 2030" page on the official website of the Ministry of Science and Higher Education of the Russian Federation. URL: https://minobrnauki.gov.ru/action/priority2030/, accessed on 24 January 2023.

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