Original Paper

doi 10.15826/recon.2022.8.2.012
UDC 378.3
JEL I22, I23, H52

Factors of research groups' productivity: The case of the Ural Federal University

D.G. Sandler[1], D.A. Gladyrev[1] ✉, D.M. Kochetkov[1, 2], A.D. Zorina[1]
[1] *Ural Federal University, Ekaterinburg, Russia;* ✉ *d.a.gladyrev@urfu.ru*
[2] *Centre for Science and Technology Studies, Leiden University, Leiden, Netherlands*

ABSTRACT
Relevance. One of the main goals of state university support programs in Russia is to increase the number of scientific publications. In 2021, Project 5-100 was replaced by the program PRIORITY 2030 (Strategic Academic Leadership Program). The new program increased the significance of the factors affecting the number of publications in universities and the issue of the optimal allocation of funding among research groups.
Research objective. This study examines the factors that affect the productivity of research groups at the university. Unlike the majority of other studies on this topic, this study analyzes scientific productivity at the level of research groups.
Data and methods. The study was possible due to the availability of data for 79 research groups at the Ural Federal University for the period from 2014 to 2020. The total number of articles and the number of articles in journals with an impact factor of more than two were used as indicators of research groups' performance. To determine the factors influencing these indicators, we used econometric models for panel data. We used two separate samples: for social sciences and humanities and for other sciences.
Results. We identified the following factors affecting the performance of research groups: the number of participants, the age of the research group, the supervisor's scientific age, and the amount of funding (the possibility of obtaining more funds or being denied funds). The most interesting result is the following: the supervisor's scientific age and increased funding have a negative impact on the group's performance. The article provides possible explanations for these results.
Conclusion. Since the purpose of creating and funding research groups is primarily to increase their productivity, the results may be in favor of younger supervisors. University managers may also be interested in the ambiguous impact of increased funding: we suppose that research groups are more motivated not by the actual funding but by the prospective amount they may get.

KEYWORDS
research groups, university economics, economics of higher education, science management, scientometrics, econometric analysis

ACKNOWLEDGEMENTS
The research funding from the Ministry of Science and Higher Education of the Russian Federation (Ural Federal University Program of Development within the Priority-2030 Program) is gratefully acknowledged.

FOR CITATION
Sandler, D.G., Gladyrev, D.A., Kochetkov, D.M., & Zorina, A.D. (2022). Factors of research groups' productivity: The case of the Ural Federal University. *R-economy*, *8*(2), 148–160. doi: 10.15826/recon.2022.8.2.012

Факторы продуктивности исследовательских групп: пример Уральского федерального университета

Д.Г. Сандлер[1], Д.А. Гладырев[1] ✉, Д.М. Кочетков[1, 2], А.Д. Зорина[1]
[1] *Уральский федеральный университет, Екатеринбург, Россия;* ✉ *d.a.gladyrev@urfu.ru*
[2] *Центр исследований науки и технологий, Лейденский университет, Лейден, Нидерланды*

АННОТАЦИЯ
Актуальность. Одной из основных целей программ поддержки государственных университетов в России является увеличение количества научных публикаций. В 2021 году Проект 5-100 был заменен программой ПРИОРИТЕТ 2030 (Программа стратегического академического лидерства). Новая программа увеличила значимость факторов, влияющих на количество публикаций в университетах, и вопроса оптимального распределения финансирования между исследовательскими группами.
Цель исследования. В данном исследовании рассматриваются факторы, влияющие на продуктивность исследовательских групп в университете. В отличие от большинства других исследований по этой теме, данное исследование анализирует научную продуктивность на уровне исследовательских групп.

КЛЮЧЕВЫЕ СЛОВА
исследовательские группы, экономика вуза, экономика высшего образования, управление наукой, наукометрия, эконометрический анализ

Online ISSN 2412-0731

Данные и методы. Исследование стало возможным благодаря наличию данных по 79 научным группам Уральского федерального университета за период с 2014 по 2020 годы. В качестве показателя работы исследовательских групп используются показатели её общего числа статей и числа статей в журналах с импакт-фактором более двух. Для определения факторов, влияющих на эти показатели, использовались эконометрические модели панельных данных. Мы использовали две отдельные выборки: по социально-гуманитарным наукам и по прочим наукам.
Результаты. Выявлены следующие факторы, влияющие на результаты работы групп: количество участников, возраст исследовательской группы, научный возраст руководителя группы и объем финансирования. Наиболее интересный результат заключается в следующем: научный возраст научного руководителя и увеличение финансирования негативно сказываются на результативности группы. В статье приведены возможные объяснения этих результатов.
Вывод. Поскольку целью создания и финансирования исследовательских групп является прежде всего повышение их научной результативности, результаты могут говорить в пользу назначения более молодых руководителей. Университетских управленцев также может заинтересовать неоднозначное влияние увеличения финансирования: мы полагаем, что исследовательские группы больше мотивированы не фактическим финансированием, а будущей суммой, которую они могут получить.

БЛАГОДАРНОСТИ
Исследование выполнено при финансовой поддержке Министерства науки и высшего образования Российской Федерации в рамках Программы развития Уральского федерального университета имени первого Президента России Б.Н. Ельцина в соответствии с программой стратегического академического лидерства «Приоритет-2030»

ДЛЯ ЦИТИРОВАНИЯ
Sandler, D.G., Gladyrev, D.A., Kochetkov, D.M., & Zorina, A.D. (2022). Factors of research groups' productivity: The case of the Ural Federal University. *R-economy*, *8*(2), 148–160. doi: 10.15826/recon.2022.8.2.012

研究小组的科研效率：以乌拉尔联邦大学为例

桑德勒[1]，格拉德列夫[1]✉，科切特科夫[1, 2]，佐丽娜[1]
[1] 乌拉尔联邦大学，叶卡捷琳堡，俄罗斯；✉ d.a.gladyrev@urfu.ru
[2] 莱顿大学科学技术研究中心，莱顿，荷兰

摘要
现实性：俄罗斯大学支持项目的主要目标之一是增加科研成果。2021年，“5-100大学计划”被“优先2030计划”（战略学术领导力计划）所取代。新的计划聚焦于大学的科研出版数量，并优化研究小组之间的科研资金分配。
研究目标：本研究考察了影响大学各研究小组科研效率的因素。与其他研究相似主题的大多学者不同，我们把目光转向研究小组的科研效率。
数据与方法：本文收集了乌拉尔联邦大学2014–2020年79个研究小组的数据，这使研究成果具有代表性。数据来源是科研论文的总数和影响因子大于2的论文数量。为了确定影响科研效率的因素，我们采用了经济面板数据模式。另外，我们将科研数据分为两块：社会人文学科和其他学科。
研究结果：研究得出了影响科研效率的因素：参与者人数、研究小组的成立时间、小组组长的科研年龄及研究经费。最有趣的结果如下：研究小组组长的科研年龄和研究经费的增加对小组的科研结果有消极影响。本文对这些结果提出了可能的解释。
结论：创建和资助研究小组的目的主要是提高参与者的科研绩效，从而有利于任命更年轻的组长。大学的管理层可以对科研经费进行多层计划：我们认为，更能激励研究小组成员的不是实际科研经费，而是未来可以获得的额度。

关键词
研究小组，大学经济学，高等教育经济学，科学管理，科学计量学，计量模型分析

供引用
Sandler, D.G., Gladyrev, D.A., Kochetkov, D.M., & Zorina, A.D. (2022). Factors of research groups' productivity: The case of the Ural Federal University. *R-economy*, *8*(2), 148–160. doi: 10.15826/recon.2022.8.2.012

Introduction

In any economy, universities and research organizations have limited and usually insufficient resources to provide funding for all possible topics and projects. Every year, universities and academic institutions have to distribute limited funds between their research groups to maximize the overall research performance. Government agencies and scientific foundations are dealing with a similar problem by setting models and rules for funds distribution between organizations, teams, and individual scientists. Sometimes the task is different – how to measure the effectiveness of current funding and reallocate funds without negative consequences. There is a need for the data on the factors affecting research groups' performance to allow for more evidence-based decision-making. In this case, it

Online ISSN 2412-0731

is possible to maximize the efficiency of the research funding system.

We have chosen research groups as the main actor in knowledge generation. Usually the data on research groups are not available and we can find only the data on universities, countries or individual researchers. But since we have access to the performance indicators of research groups at the Ural Federal University, it is possible to conduct such analysis.

The purpose of the study is to determine the factors of research groups' effectiveness. The number of publications was chosen as the main performance indicator. To achieve this goal, we collected the data on 79 research groups from the Ural Federal University (Ekaterinburg, Sverdlovsk region) for the period from 2014 to 2020 and studied its connection with the regional economy. Another issue to be considered was data representativeness. Based on the data from the Ural Federal University, we have built econometric models to study the influence of different factors on research productivity and analyzed the results.

Literature review

The idea of using econometric methods to study the factors that affect R&D is not new. Such studies were conducted in the second half of the 20th century (Pakes, 1978; Griliches, 1979; Hall, Griliches and Hausman, 1986; Pardey, 1989). Many scholars studied the impact of university research on economic growth (Jaffe, 1989; Acs, Audretsch and Feldman, 1994; Jaffe and Trajtenberg, 1996; Martin, 1998; Varga, 1998, 2000, 2001; Fischer and Varga, 2003; Riddel and Schwer, 2003). Evaluations were made of research teams' effectiveness based on a combination of econometric and scientometric methods (Adams et al., 2005). Among other things, these studies raised the question of the size and composition of research groups (Perovic et al., 2016). Quite illustrative in this respect is the study of the effectiveness of university hospitals in Tehran, performed on the basis of a combination of nonparametric analysis methods-data envelope analysis (DEA) and stochastic frontier analysis (SFA) (Rezapour et al., 2015)in Tehran, Iran. METHODS: This study was conducted in 2012; the research population consisted of all hospitals affiliated to Iran and Tehran medical sciences universities of. Required data, such as human and capital resources information and also production variables (hospital outputs.

There is a substantial body of research that establishes links between scientometric, economic, and other indicators at the university level (Zinchenko and Yegorov, 2019; Geiger, 2004). In particular, for Russian universities, it was shown that the number of publications is higher in the universities that: 1) are engaged in research in physics; 2) have a higher share of international collaborations; 3) accept students with a higher entrance score; 4) have a larger share of Master's and PhD students; 5) have higher levels of citations; 6) have a higher share of foreign students; 7) have a higher level of salaries in comparison with the region's average (Sandler & Gladyrev, 2020). A high positive correlation between the number of publications and their quality (usually measured by the level of citations of these articles or the journal in general) has also been revealed by international studies at the level of individual researchers (Michalska-Smith and Allesina, 2017), at the university level (Hayati and Ebrahimy, 2009), and at the national level (Lawani, 1986).

Other studies have shown a positive effect of collaboration (Landry et al., 1996), especially international (Aldieri et al., 2018; Aldieri et al., 2019). A J-shaped impact of government funding was also revealed in some sectors, but there was no impact of business funding (Beaudry & Allaoui, 2012). There is evidence of the positive impact of the long-term university-industry interactions (Garcia et al., 2020). In a study based on the university data in Leuven (Belgium), the authors have shown higher scientific productivity of female researchers and researchers with an academic degree (De Witte & Rogge, 2010). Another study based on the Spanish data, on the contrary, demonstrated a higher scientific performance of male researchers (Albert et al., 2016). Some other studies compared young and older researchers: it was found that the young researchers have a higher level of scientific performance (Levin and Stephan, 1989; Albert et al., 2016). It is also worth noting that all these factors can have a different impact on scientific productivity, depending on the level of the considered journals (Jung et al., 2017).

Data and methods

We used the data on the performance of 79 research groups of the Ural Federal University (Ekaterinburg) for the period from 2014 to 2020. The data were provided by the University's Department of Strategic Development and Marketing. Due to the fact that not all research groups

Online ISSN 2412-0731

were functioning during the entire reviewed period, the total number of observations was 438.

From an organizational point of view, a research group (in the University's documentation it is referred to as a "competence center") is a team selected on a competitive basis in order to support its members' research activities. Commitments to work on a specific topic formulated by the research team are recorded in the project passport, which also specifies the planned indicators for the number of publications, the amount of R & D, and additional indicators.

Annually, a special commission of reputable researchers (direct conflicts of interest are excluded) evaluates each group's activities: the dynamics of the key indicators and correspondence to the obligations taken. These evaluations are used further by the special council that divides research groups into several funding groups. Groups with better results receive more funding. Every year, from 2 to 5 groups are denied funding for a year or are completely withdrawn from the project. Instead, several new research groups are introduced on a competitive basis.

One of the signs of the project's success is a significant increase in the University's publication activity (see Table 1): the total number of publications almost tripled in 6 years and research groups kept more than a half of the University's articles for almost all of the years (and more than 60% of articles in journals with an impact factor of more than 2). Despite these results, we assume that there is still room for improvement in terms of the funding system's efficiency.

In this study, we took all the variables included in research groups' reports, with the exception of the number of articles in journals with IF>5 (as only few research groups have such publications). One variable (the supervisor's scientific age) was collected manually for all research groups from Scopus.

The original dataset has eight variables:

1) **ARTICLES** is the number of articles of the research group indexed in Scopus and Web of Science in the reporting year.

2) **ARTICLES IN IF>2** is the number of articles of the research group in journals with IF>2 indexed in Scopus and Web of Science in the reporting year.

3) **FUNDING** is the amount of funding for the research group in the reporting year, million rubles.

4) **PARTICIPANTS** is the number of participants in the research group at the end of the reporting year.

Table 1

Dynamics of the number of articles published by the University's researchers indexed in Scopus and Web of Science

Year	Total number of articles	Articles of research groups	Share of research groups' articles	Total articles in IF>2 journals	Articles of research groups in IF>2 journals	Share of research groups' articles in IF>2 journals
2014	1413	836	59.16%	275	201	73.09%
2015	1742	1091	62.63%	387	265	68.48%
2016	2334	1256	53.81%	480	350	72.92%
2017	2930	1482	50.58%	611	391	63.99%
2018	3253	1594	49.00%	710	437	61.55%
2019	3772	1992	52.81%	954	567	59.43%
2020	3946	2001	50.71%	991	639	64.48%

Source: compiled by the authors

Table 2

Descriptive statistics

	ARTICLES	ARTICLES IN IF>2	FUNDING	PARTICIPANTS	PROJECT AGE	SOCIAL-HUM	SUPERVISOR'S SCIENTIFIC AGE	R&D
Average	23.21	6.507	2.263	19.925	3.753	0.18	23.388	12.969
Median	17	2	1,4	15	4	0	0	0
Maximum	107	68	15.593	112	7	1	53	398.61
Minimum	0	0	0.08	1	1	0	14.76	32.77
Standard deviation	20.465	10.383	2.686	16.956	1.967	0.385	23.39	12.97

Source: compiled by the authors

Online ISSN 2412-0731

5) **PROJECT AGE** is the number of the year when the research group received funding (starting from 2014, when the program in its current format was launched).

6) **SOCIAL-HUM** is a binary variable equal to 1 if the research group belongs to social sciences and arts & humanities (there are 15 such groups with 79 observations) and 0 otherwise (there are 64 such groups with 359 observations);

7) **SUPERVISOR'S SCIENTIFIC AGE** is the number of years since the first supervisor's Scopus-indexed article was published.

8) **R & D** is the declared amount of R&D income of the research group, million rubles.

The main statistical characteristics of the variables are shown in Table 2.

The econometric models took into account the panel data structure; the tests proved that the best model is a model with fixed effects.

The main variable is Δ ARTICLES; an additional model also uses the variable Δ ARTICLES IN IF>2. The analysis of the second model is less interesting, since the selected indicator has a very low deviation (a significant number of research groups do not have any articles in journals with an impact factor higher than two). It should be noted that different subject areas have different average impact factors.

The impact of the total time that the research group has been receiving organized funding was considered in variable PROJECT AGE. The model also included variables Δ FUNDING and Δ R & D. Using variables Δ ARTICLES, Δ FUNDING and Δ R & D (instead of ARTICLES, FUNDING, and R & D directly) helps us overcome endogeneity and outliers. Taking into account the fact that the effect of funding growth can be lagged, the models were created with both the current and the previous period value.

Since many of the considered dependencies are not strictly linear, preference was given to nonlinear dependencies. For this reason, the model did include natural logarithms of PARTICIPANTS and the SUPERVISOR'S SCIENTIFIC AGE.

The SOCIAL-HUM variable was used to divide the sample into two and create a separate model for each of them. This is done under the assumption that research groups in social sciences and arts & humanities are significantly different from others. Table 3 confirms this assumption: almost all the key indicators differ in comparison with the research groups specializing in social sciences and the humanities.

Table 3

Average values by category of research groups

	Social sciences and humanities (N = 79)	Other sciences (N = 359)
Average number of articles	12.48	25.57
Average number of articles in journals with IF > 2	0.59	7.81
Average annual funding, mln	1.45	2.44
Average number of participants	16	20.79

Source: compiled by the authors

Thus, the following variables were taken as explanatory variables:

1. PROJECT AGE
2. ΔGROWTH
3. ΔFUNDING
4. LOG (PARTICIPANTS)
5. LOG (SCIENTIFIC AGE OF THE SUPERVISOR)
6. R & D

The issue of representativeness should be also considered. Is it possible to use the Ural Federal University's data to study the performance factors of research groups in general? There is a number of reasons for considering the University's research groups as a representative sample: the university has a very high scientific performance (it ranks 10th among all the Russian institutions and 7th among universities by the total number of publications in 2015–2020, according to SciVal); it also boasts a diversity of subject areas. It should, however, be noted that the University's scientific performance is connected with the structure of Sverdlovsk Region's economy (and to some extent to that of other neighboring regions). At the same time, we can assume that the University's scientific performance also affects the structure of the region's economy. The impact of research on the economic development of regional economies is one of the tasks of the federal program "Priority 2030"[1].

Table 4 shows how the distribution of subject areas at the Ural Federal University differs from the national-level distribution. These differences include a higher share of articles in Physics and Astronomy, Materials Science and Chemistry, and a lower share in Medicine, Environmental Science, Energy and Agricultural and Biological Sciences.

[1] https://priority2030.ru/about

Online ISSN 2412-0731

Table 4

Comparison of the share of subject areas of publications of the Ural Federal University and in Russia as a whole

Subject fields	Share in Russia	Share of the University
Physics and Astronomy	14.4%	21.4%
Engineering	12.2%	12.4%
Materials Science	9.7%	16.5%
Computer Science	6.6%	5.9%
Medicine	6.5%	<2%
Earth and Planetary Sciences	6.2%	2.6%
Chemistry	6.0%	8.6%
Mathematics	5.7%	6.0%
Social Sciences	4.8%	4.3%
Environmental Science	4.6%	2.9%
Biochemistry, Genetics and Molecular Biology	3.8%	<2%
Energy	3.3%	<2%
Agricultural and Biological Sciences	2.9%	<2%
Chemical Engineering	2.8%	<2%
Arts and Humanities	2.6%	2.1%

Source: SciVal from 2016 to May 2022

Table 5 shows the differences between the economy of Sverdlovsk region and the national economy. These differences include a lower share of natural resources in Sverdlovsk Region and a higher share of manufacturing.

The parallels between the deviations in the University's subject areas from the national ones and between the deviations of the regional economy from the national economy are shown in Table 6. The main positive deviations in the University's subject areas are related to physics, chemistry and materials sciences and these deviations can be connected with the dominance of the most powerful branch of Sverdlovsk region's economy – manufacturing. On the contrary, the subject areas corresponding to earth sciences, energy, environmental economics, and agriculture at the Ural Federal University are below the national average, which can be explained by the lower (in comparison with the national) share of the region's economy in mining and agriculture. All of these findings are consistent with the previous studies that noted close links between universities, government, and business in Russian regions (Vlasova & Lyashenko, 2021).

Table 5

Industry structure of gross value added in 2019 in Russia

Branch	Share in Russia	Share in Sverdlovsk Region	Difference between Sverdlovsk region and country in general
Agriculture, forestry, hunting, fishing and fish farming	4.1	2.4	–1.7
Natural resources / mining	13.5	2.1	–11.4
Manufacturing	16.8	31.9	15.1
Provision of electric energy, gas and steam; air conditioning	2.9	3.9	1
Water supply; water disposal, organization of waste collection and disposal, activities to eliminate pollution	0.6	1.1	0.5
Construction	5.4	4	–1.4
Wholesale and retail trade; repair of motor vehicles and motorcycles	14.2	12.7	–1.5
Transportation and storage	7.3	7.5	0.2
Activities of hotels and public catering	1	1	0
Information and communication activities	3	2.4	–0.6
Financial and insurance activities	0.5	0.2	–0.3
Real estate operations	10	10.4	0.4
Professional, scientific and technical activities	4.3	4.2	–0.1
Administrative activities and related additional services	2.3	2	–0.3
Public administration and military security; social security	5.6	5.7	0.1
Education	3	3.1	0.1
Health and social services activities	4	4.1	0.1
Activities in the field of culture, sports, leisure and entertainment	1	0.7	–0.3
Provision of other types of services	0.5	0.6	0.1
Activity of households as employers	0	0	0

Source: Rosstat: https://gks.ru/bgd/regl/b21_14p/Main.htm

Online ISSN 2412-0731

Table 6

Comparison of the differences in scientific performance between the University and Russia and corresponding branches of the regional economy and Russia

Branch	Difference between Russia and Sverdlovsk region	Subject area	Difference between Russia and the University
Mining	Russia: 13.5% SR: 2.1% ↓	Earth and Planetary Sciences	Russia: 6.2% UrFU: 2.6%↓
		Environmental Science	Russia: 4.6% UrFU: 2.9%↓
		Energy	Russia: 3.3% UrFU: <2%↓
Manufacturing	Russia: 16.8% SR: 31.9% ↑	Physics and Astronomy	Russia: 14.4% UrFU: 21.4%↑
		Materials Science	Russia: 9.7% UrFU: 16.5%↑
		Chemistry	Russia: 6.0% UrFU: 8.6%↑
Agriculture, forestry, hunting, fishing and fish farming	Russia: 4.1% SR: 2.4% ↓	Agricultural and Biological Sciences	Russia: 2.9% UrFU: <2%↓

Source: SciVal from 2016 to May 2022 and Rosstat: https://gks.ru/bgd/regl/b21_14p/Main.htm

Among the factors that speak in favor of the representativeness of the data is the fact that the University was formed relatively recently by merging a classical and technical university (with different cultures of academic activity). The final argument is that the sample includes groups that differ in terms of their research experience and the level of citation. It should be noted that the detected dependencies will be sufficiently reliable only for the Ural Federal University, and in other universities, due to historical, organizational and subject area differences, the patterns may be different.

Some variables were not used for our analysis because their variation was too low. The most interesting of these variables is the supervisor's gender. Table 7 shows the distribution of research groups by the supervisor's gender and subject area. Of the 79 research groups under review, 60 are supervised by men and 19, by women. At the same time, among the groups in social sciences and the humanities, women lead 9 out of 15 research groups.

Table 7

Statistics of research groups by the supervisor's gender

	Social sciences and humanities	Other sciences	Total
Male	6	54	60
Female	9	10	19

Source: compiled by the authors

Results

The correlation matrix (see Table 8) gives us a basic understanding of the relationships between the variables and helps us make sure that the resulting models will not have multicollinearity (high correlation between the factors).

It should be noted that an increase in the number of articles does not result in a decrease in their quality. The correlation coefficient between an increase in the number of articles and an increase in the number of articles in journals with IF>2 is 0.56. Thus, the goals of increasing the total number and quality of articles are not contradictory and even accompany each other. Previously, a similar link was established for Russian universities (Sandler & Gladyrev, 2020), and now it has been demonstrated at the level of individual research groups. Our conclusions, however, cannot be interpreted in such a way that an increase in the number of articles will always be accompanied by an increase in their quality.

Table 9 shows the results of the first model with fixed effects, where the explained variable is the growth in the number of articles of the research group.

The most reliable factor determining the growth in the number of articles is the size of the given research group. This means that an increase in the size of the research group leads to an increase in the number of scientific articles and this result is not as trivial as it may seem. Often, es-

Online ISSN 2412-0731

pecially when the recruitment of new members of the research group is limited only to university employees, students, and postgraduates, it may seem that new members of the group will not give a significant increase in articles (or will do it only with a lag); and the main growth potential lies in increasing the productivity of the group's core. The results show that this is not true.

An interesting and even paradoxical result connected with the coefficient of the supervisor's scientific age is as follows: a negative sign and high statistical reliability indicate that the more experienced is the supervisor, the lower is the group's rate of publication growth; and vice versa. Some reservations, however, should be made regarding the interpretation of this result: it does not mean that groups with an experienced scientific supervisor have a low scientific outcome, but that such groups are less likely to increase their scientific performance, and their potential is already realized. Since one of the main goals of forming research groups is increasing their scientific productivity by using university funding, this result can be used in favor of appointing younger managers. Some previous studies have shown the lower scientific performance of more senior researchers in many subject areas (Levin and Stephan, 1989; Albert et al., 2016).

Table 8

Correlation matrix

	Δ ARTICLES	Δ ARTICLES IN IF>2	PROJECT AGE	Δ FUNDING	LOG(PARTICIPANTS)	LOG(SUPERVISOR'S SCIENTIFIC AGE)	Δ R&D
Δ ARTICLES	1.00						
Δ ARTICLES IN IF>2	0.56	1.00					
PROJECT AGE	0.01	0.10	1.00				
Δ FUNDING	–0.09	–0.10	0.44	1.00			
LOG(PARTICIPANTS)	0.20	0.11	0.38	0.04	1.00		
LOG(SUPERVISOR'S SCIENTIFIC AGE)	–0.02	0.03	0.10	–0.05	0.18	1.00	
Δ R & D	–0.05	–0.03	–0.03	–0.12	0.03	0.03	1.00

Table 9

Model for the number of the research group's articles

Variable	Explained variable – Δ ARTICLES			
	Other subject areas		Social sciences and humanities	
	(1)	(2)	(3)	(4)
PROJECT AGE	–0.456 (0.71)	0.67 (1.01)	2.24 (1.37)	3.83*** (1.2)
Δ FUNDING	–0.22 (0.49)		–1.53* (0.73)	
Δ FUNDING(-1)		–0.55 (0.55)		–0.85** (0.36)
LOG(PARTICIPANTS)	6.76*** (2.34)	4.67 (3.31)	7.8* (3.75)	9.48*** (2.75)
LOG(SUPERVISOR'S SCIENTIFIC AGE)	–10.85** (5.22)	–10.29* (5.56)	–14.28** (6.09)	–21.1*** (5.17)
Δ R & D	–0.036* (0.02)	–0.03* (0.018)	–0.072 (0.19)	–0.11 (0.16)
CONSTANT	20.39 (15.68)	18.2 (14.9)	–7.59 (7.48)	–8.91* (4.95)

Panel data model with fixed effects
Robust standard errors are shown in parentheses
*** significant at the 1% significance level
** significant at the 5% significance level
* significant at the 10% significance level

Online ISSN 2412-0731

The role of funding growth is also a paradoxical result at first glance. We could expect a reliable direct relationship between increased funding and the growth in the number of articles, but it is not observed both for current and previous funding; moreover, there is some evidence in favor of the inverse relationship. It is fair to note that the statistical reliability of this result is not high. One explanation for this result is the motivation factor: research groups whose funding has been reduced or increased slightly are more motivated to achieve high scientific performance in the hope of receiving higher funding for the next year. The groups that have already received substantial funding can be satisfied with merely maintaining the last year's level of performance. Thus, it is possible that a prospective increase in funding is a stronger motivating factor than maintaining the same level of funding.

For the growth in R & D, the results are also interesting: in all the models the dependence is negative (but only in two models this coefficient is significant at the 10% significance level). It means that the higher is the growth in R & D income, the lower is the increase in the number of articles. This may indicate that income-generating research work and scientific publications are not complementary activities, but rather substitutes – at least in terms of the dynamics of the indicators.

Table 10 shows the results of the second model, where the explained variable is the number of articles of the research group in journals with an impact factor of more than two.

The results of this model show approximately the same results as it was for the first model. The growth in the number of articles in journals with IF>2 is also positively connected with the number of participants in the research group, negatively connected with the supervisor's scientific age (but this result is statistically significant only for social sciences and arts & humanities), and there is weak evidence of the negative impact of increased funding on the growth in the number of articles. Like in the previous model, there is a negative impact of the growth in research volumes for other sciences.

We found a significant impact of the project's period for projects in social sciences and arts & humanities, where the number of publications in high-impact journals tends to be lower (WoS Arts and Humanities Citation Index doesn't have IF at all). It can be assumed that the accumulated experience and interaction within the team allow research groups to increase their publications in such journals over time.

Table 10

Model for the number of research group articles in journals with IF>2

Variable	Explained variable – Δ ARTICLES IN IF>2			
	Other subject areas		Social sciences and humanities	
	(1)	(2)	(3)	(4)
PROJECT AGE	0.413 (0.48)	0.83 (0.72)	1.65** (0.73)	2.11** (0.86)
Δ FUNDING	–0.57* (0.32)		–0.84 (0.63)	
ΔFUNDING(–1)		–0.39 (0.36)		0.04 (0.39)
LOG(PARTICIPANTS)	2.63** (1.26)	2.07 (1.52)	2.71* (1.27)	3** (1.33)
LOG(SUPERVISOR'S SCIENTIFIC AGE)	–1.67 (2.81)	–2.96 (2.6)	–5.34** (2.33)	–8.43** (3.66)
Δ R & D	–0.017** (0.007)	–0.013* (0.007)	0.08 (0.69)	0.08 (0.07)
Constant term	–3.1 (7.2)	0.23 (5.01)	–6.95 (3.12)	–4.75 (2.57)

Panel data model with fixed effects

Robust standard errors are shown in parentheses

** significant at the 5% significance level

* significant at the 10% significance level

Online ISSN 2412-0731

Conclusion

This paper contributes to the study of the factors of scientific productivity at the level of research groups. The econometric models based on the data of the Ural Federal University have brought to light the factors that affect the scientific performance of research groups.

The main factor influencing the growth in the number of articles is the number of research group's participants. The positive effect of this factor turned out to be statistically significant for most of the models. The influence of the next two factors was paradoxical. First, there is a negative influence of the supervisor's academic age on the growth in the number of articles. Although the paper explains this result as well as cautions against its misinterpretation, the main recommendation is that more credit should be given to younger managers. Secondly, the negative impact of increased funding on the growth in the number of articles of the research group. This result is explained by the specific motivation of research groups, but it should also be interpreted with great caution, especially because it can affect the university leadership's decision-making regarding funding allocation.

The age of the research group is also one of the factors that positively affects the growth in scientific performance, but only for social sciences and arts & humanities, and especially for high-impact articles. Perhaps this is because social sciences and arts & humanities in Russia are younger, which is why the effect of the creation of such groups is stronger.

In both models for other sciences, a negative relationship between the growth in articles and the growth of R&D income was detected. This suggests that a simultaneous growth in these indicators can be problematic.

The value of these results may be influenced by the fact that only research groups of the Ural Federal University are included in the sample. This was a forced limitation caused by the fact that we had access only to one university's data on individual research groups while the corresponding data for other universities are closed. It is shown that the structure of the Ural Federal University's publications to some extent reflects the specifics of Sverdlovsk region, and with a high degree of reliability, the conclusions can be applied only to this university, but the large sample size and variety of subject areas allow us to assess the possibility of applying these conclusions to other universities optimistically.

It will be interesting to observe the changes in the performance of research groups in connection with the launch of the new *PRIORITY 2030* federal program in Russia and changes in the target indicators in comparison with the previous program (*Project 5-100*). Due to the new emphasis on the number of articles in the first and second quartiles, we should expect an increase in the number of high-quality publications. It is unlikely that this increase will lead to a decrease in the total number of publications (as quality and quantity usually go together), but the growth rate of the total number of publications of research groups is likely to decrease.

References

Acs, Z.J., Audretsch, D.B., & Feldman, M.P. (1994) 'R&D spillovers and recipient firm size'. *The Review of Economics and Statistics*, 76, 336–340.

Albert, C., Davia, M.A., & Legazpe, N. (2016). Determinants of research productivity in Spanish academia. *European Journal of Education*, *51*(4), 535–549.

Adams, J.D., Black, G.C., Clemmons, J.R., & Stephan, P.E. (2005) 'Scientific teams and institutional collaborations: Evidence from U.S. universities, 1981–1999'. *Research Policy*, 34(3), 259–285. https://doi.org/10.1016/j.respol.2005.01.014

Aldieri, L., Guida, G., Kotsemir, M., & Vinci, C.P. (2019). An investigation of impact of research collaboration on academic performance in Italy. *Quality & Quantity*, *53*(4), 2003–2040.

Aldieri, L., Kotsemir, M., & Vinci, C.P. (2018). The impact of research collaboration on academic performance: An empirical analysis for some European countries. *Socio-Economic Planning Sciences*, *62*, 13–30.

Beaudry, C., & Allaoui, S. (2012). Impact of public and private research funding on scientific production: The case of nanotechnology. *Research Policy*, *41*(9), 1589–1606.

Online ISSN 2412-0731

De Witte, K., & Rogge, N. (2010). To publish or not to publish? On the aggregation and drivers of research performance. *Scientometrics*, *85*(3), 657–680.

Fischer, M. M. and Varga, A. (2003) 'Spatial knowledge spillovers and university research: Evidence from Austria'. *Annals of Regional Science*, 37, 303–322.

Garcia, R., Araújo, V., Mascarini, S., Santos, E.G., & Costa, A.R. (2020). How long-term university-industry collaboration shapes the academic productivity of research groups. *Innovation*, *22*(1), 56–70.

Geiger, R.L. (2004). Knowledge and money: Research universities and the paradox of the marketplace. Stanford University Press.

Griliches, Z. (1979) 'Issues in assessing the contribution and development of research to productivity growth'. *The Bell Journal of Economics*, *10*(1), 92–116. https://doi.org/10.2307/3003321

Hall, B.H., Griliches, Z., & Hausman, J.A. (1986). Patents and R and D: Is There A Lag? *International Economic Review*, 27, 265–283.

Hayati, Z., & Ebrahimy, S. (2009). Correlation between quality and quantity in scientific production: A case study of Iranian organizations from 1997 to 2006. *Scientometrics*, *80*(3), 625–636.

Jaffe, A.B. (1989). Real effects of academic research. *The American Economic Review*, 79, 957–970.

Jaffe, A.B., & Trajtenberg, M. (1996). Flows of knowledge from universities and federal laboratories: Modeling the flow of patent citations over time and across institutional and geographic boundaries. *Proceedings of the National Academy of Science*, 93, 12671–12677.

Jung, H., Seo, I., Kim, J., & Kim, B.K. (2017). Factors affecting government-funded research quality. *Asian Journal of Technology Innovation*, *25*(3), 447–469.

Landry, R., Traore, N., & Godin, B. (1996). An econometric analysis of the effect of collaboration on academic research productivity. *Higher Education*, *32*(3), 283–301.

Lawani, S.M. (1986). Some bibliometric correlates of quality in scientific research. *Scientometrics*, *9*(1-2), 13–25.

Levin, S.G., & Stephan, P.E. (1989). Age and research productivity of academic scientists. *Research in Higher Education*, *30*(5), 531–549.

Martin, F. (1998). The economic impact of Canadian university R&D. *Research Policy*, 27, 677–687.

Maslennikov, V.V. (2013). Project management of scientific activities of the university. Methodological tools. Moscow: Paleotype

Michalska-Smith, M.J., & Allesina, S. (2017). And, not or: quality, quantity in scientific publishing. *PloS ONE*, *12*(6).

Pakes, A.S. (1978). *Economic incentives in the production and transmission of knowledge: an empirical analysis*. Harvard University, Cambridge, MA.

Pardey, P.G. (1989). The Agricultural Knowledge Production Function : An Empirical Look. *The Review of Economics and Statistics*, *71*(3), 453–461.

Perovic, S., Radovanovic, S., Sikimic, V. and Berber, A. (2016). Optimal research team composition: data envelopment analysis of Fermilab experiments. *Scientometrics*, *108*(1), 83–111. https://doi.org/10.1007/s11192-016-1947-9

Rezapour, A., Ebadifard Azar, F., Yousef Zadeh, N., Roumiani, Y.A., & Bagheri Faradonbeh, S. (2015). Technical efficiency and resources allocation in university hospitals in Tehran, 2009–2012. *Medical Journal of the Islamic Republic of Iran*, *29*(1), 839–850.

Riddel, M., & Schwer, R.K. (2003). Regional innovative capacity with endogenous employment: Empirical evidence from the U.S. *Review of Regional Studies*, 33, 73–84.

Sandler, D.G., & Gladyrev, D.A. (2020). Construction of a cost-effective system of target indicators for the development of university research activities, taking into account correlation dependencies. *Statistics and Economics*, *17*(4), 71–84

Varga, A. (1998). *University research and regional innovation: A spatial econometric analysis of academic technology transfers*. Boston: Kluwer.

Online ISSN 2412-0731

Varga, A. (2000). Local academic knowledge transfers and the concentration of economic activity. *Journal of Regional Science*, 40, 289–309.

Varga, A. (2001). Universities and regional economic development: Does agglomeration matter? In Johansson, B., Karlsson, C., & Stough, R. (eds). *Theories of endogenous regional growth: Lessons for regional policies*. New York/Berlin: Springer-Verlag, pp. 345–367.

Vlasova, N.Y., & Lyashenko, E.A. (2021). University-business-government relations in the development of the institutional environment of Russian regions. *R-Economy*, *7*(4), 214–224.

Zinchenko D.I., Egorov A.A. (2019). Modeling the effectiveness of Russian universities. *Economic Journal of the Higher School of Economics*, *23*(1), 143–172.

Information about the authors

Daniil G. Sandler – PhD in Economics, Associate Professor at the Department of International Economics and Management, Graduate School of Economics and Management; Leading Researcher, Research Laboratory for University Development Issues, First Vice-Rector (Economics and Strategy), Ural Federal University (19 Mira Str., 620002 Ekaterinburg, Russia); Scopus Author ID: 56581474400; ORCID: 0000-0002-5641-6596; e-mail: d.g.sandler@urfu.ru

Dmitry A. Gladyrev – Senior Lecturer at Department of Economics, Graduate School of Economics and Management, Ural Federal University (19 Mira Str., 620002 Ekaterinburg, Russia); Scopus Author ID: 57208191401; ORCID: 0000-0001-5746-0495; e-mail: d.a.gladyrev@urfu.ru

Dmitry M. Kochetkov – PhD in Economics, Senior Researcher at the Laboratory for University Development, Ural Federal University (19 Mira Str., 620002 Ekaterinburg, Russia); PhD Candidate at the Center for Science and Technology Studies, Leiden University (Willem Einthoven Building, Kolffpad 1, 2333 BN Leiden, Netherlands); Scopus Author ID: 57194605735; ORCID: 0000-0001-7890-7532; e-mail: d.kochetkov@cwts.leidenuniv.nl

Anna D. Zorina – Deputy of Head, Department of Strategic Development and Marketing, Ural Federal University (19 Mira Str., 620002 Ekaterinburg, Russia)

ARTICLE INFO: received *April 15, 2022*; accepted *June 2, 2022*

Информация об авторах

Сандлер Даниил Геннадьевич – кандидат экономических наук, доцент кафедры международной экономики и менеджмента, Институт экономики и управления; ведущий специалист научно-исследовательской лаборатории по проблемам университетского развития, первый проректор по экономике и стратегическому развитию, Уральский федеральный университет (620002, Россия, Екатеринбург, ул. Мира, 19); Scopus Author ID: 56581474400; ORCID: 0000-0002-5641-6596; e-mail: d.g.sandler@urfu.ru

Гладырев Дмитрий Анатольевич – старший преподаватель кафедры экономики, Институт экономики управления, Уральский федеральный университет (620002, Россия, Екатеринбург, ул. Мира, 19); Scopus Author ID: 57208191401; ORCID: 0000-0001-5746-0495; e-mail: d.a.gladyrev@urfu.ru

Кочетков Дмитрий Михайлович – кандидат экономических наук, старший научный сотрудник научно-исследовательской лаборатории по проблемам университетского развития, Уральский федеральный университет (620002, Россия, Екатеринбург, ул. Мира, 19); аспирант Центра исследований науки и технологий, Лейденский университет (2333 BN, Нидерланды, Лейден, Willem Einthoven Building, Kolffpad 1); Scopus Author ID: 57194605735; ORCID: 0000-0001-7890-7532; e-mail: d.kochetkov@cwts.leidenuniv.nl

Зорина Анна Дмитриевна – заместитель директора управления стратегического развития и маркетинга, Уральский федеральный университет (620002, Россия, Екатеринбург, ул. Мира, 19); e-mail: a.d.zorina@urfu.ru

ИНФОРМАЦИЯ О СТАТЬЕ: дата поступления *15 апреля 2022 г.*; дата принятия к печати *2 июня 2022 г.*

Online ISSN 2412-0731

作者信息

桑德勒•丹尼尔•根纳季耶维奇——经济学博士，国际经济管理系副教授，经济管理学院，大学发展研究实验室资深专家，经济与战略发展第一副校长，乌拉尔联邦大学（邮编：620002，俄罗斯，叶卡捷琳堡，米拉大街19号）；Scopus Author ID: 56581474400; ORCID: 0000-0002-5641-6596; 邮箱：d.g.sandler@urfu.ru

格拉德列夫•德米特里•阿纳托利耶维奇——经济系高级讲师，经济管理学院，乌拉尔联邦大学（邮编：620002，俄罗斯，叶卡捷琳堡，米拉大街19号）；Scopus Author ID: 57208191401; ORCID: 0000-0001-5746-0495; 邮箱：d.a.gladyrev@urfu.ru

科切特科夫•德米特里•米哈伊洛维奇——经济系博士，大学发展研究实验室高级研究员，乌拉尔联邦大学（邮编：620002，俄罗斯，叶卡捷琳堡，米拉大街19号）；莱顿大学科学技术研究中心博士在读（邮编：2333 BN，荷兰，莱顿，Willem Einthoven Building, Kolffpad 1）；Scopus Author ID: 57194605735; ORCID: 0000-0001-7890-7532; 邮箱：d.kochetkov@cwts.leidenuniv.nl

佐丽娜•安娜•德米特里耶夫娜——战略发展与市场部副部长，乌拉尔联邦大学（邮编：620002，俄罗斯，叶卡捷琳堡，米拉大街19号）；邮箱：a.d.zorina@urfu.ru

Online ISSN 2412-0731