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Boosting research productivity in top Russian universities: the circumstances of breakthrough

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Abstract
The Russian project for enhancing competitive ability enforced top 21 universities to stimulate the research output actively. The results surpassed expectations with the fivefold increase in the number of publications from 2010 to 2016. This paper discusses the background and reasons for this phenomenal rise and explores in detail the most significant strategies to boost research productivity and publication output. In our study, a classification of university publications is proposed in accordance with the strategies for stimulating the publication activity, mainly corresponding with the set of measures applied by university management. The analysis made it possible to rank the strategies for contributing to the growth of publication activity, to identify the leading strategies for individual universities, and showed a significant difference between universities in the set of explicitly or implicitly applied strategies. The most effective strategy was the Additional paper, associated with the authors, indicated the affiliation of the university as complementary to their main institution. The next most important and fastest growing was the Russian conferences strategy thanks to the efforts of the organizers of domestic conferences to promote their proceedings in Scopus. A notable place is also occupied by the strategy connected with the attraction of prominent authors, which we called Headhunted author. It was possible to determine the role of the Predatory journals strategy in the growth of the publication activity, fortunately, this strategy turned out to be highly localized in only 2 of the 21 universities participating in the project and is visibly declining. It was possible to show that the share of publications in domestic journals, despite the constant increase in their presence in Scopus is steadily falling in the case of leading universities. One of the significant results of the study is an assessment of the dynamics of the average authors' productivity, which grows insignificantly and almost reached one article per author per year. This fact also shows that the growth of publication activity of top Russian universities is mainly associated with an increase in the number of faculty involved.

Keywords Research output · Russian universities · University rankings · Bibliometric analysis · Science policy · Research evaluation · 5top100 project

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Introduction

Which budget does a university need to achieve an international level? Global competition in education marketplace and tasks for enhancing the status of domestic science results in the emergence of a number of government programs or projects to support universities.

Japanese "Global University Project" including 37 universities was launched in 2014 and will last 10 years. Universities were divided into two categories; A category embraces 13 universities which are intended to enter top 100 international universities (with $5 million financing annually), B category includes 24 universities which must lead Japanese community to globalization (with $2–3 million financing annually). For A category universities, the following indices are calculated: citations, international coauthorship, joint international projects, as well as educational projects. The main goal of the program includes an increase in international competitive performance, rather than direct support of research activities (Yonezawa and Shimmi 2015).

In 1990s Chinese government paid increasing attention to the development of higher education system. In 1995 the project No 211 was launched aimed at improvement of education quality, educational organization, methods of education management, as well as an increase in efficiency of scientific research. In China in 1998 "985 Project" started for strengthening global positions of leading Chinese universities. Universities were divided into the following categories: the first one includes universities that must become leaders among other world universities; the second category comprises those that must became world-class universities; and the third one comprises universities that must become leaders in China.

During Phase I (1999–2003) general financing was $2 billion per 34 universities; during Phase II (2004–2007)—$2.7 billion per 39 universities. Financial distribution between universities varied and depended on a category. For example, Beijing and Tsinghua universities from the first category got $263 million for each one. Interestingly, government was the only source of funding, while universities from other categories contracted with local provinces. The main standard of performance was the number of publications in international journals. Thus, the main goal of Chinese government includes not only increase in publication activity at universities but also improvement of scholarly output presentation in the international scientific community (Zhang et al. 2013; Ziyatdinova and Valeeva 2012).

In South Korea, in 1999 The Brain Korea 21 project was launched for the development of world-class research at universities, reformation of the higher education system, etc. For 7 years approximately $1.2 billion was invested in the higher education with 75% investments in those organizations that should become world-class research universities. After the program completion it was concluded that it helped universities to achieve and consolidate leading positions at the domestic level but failed to make them equal to Harvard, University of Tokyo, etc. (Lee 2000; Shin 2009).

In Taiwan, in 2005 a Plan to Develop First-Class universities and Top-level Research Centers obtained $1.56 billion to enhance competitive ability of universities. The second stage started in 2011. Financing was designated for key universities conducted natural science research. Concurrently in 2005, a Program for promoting academic excellence at universities was launched. New evaluating standards resulted in the growth of publications in international journals (Chou and Ching 2012).

Historically, the majority of basic research in Russia was conducted in the institutions of the State Academies of science, while the main aim of universities and other higher

education institutions was to provide education and training (Gokhberg et al. 2009). This situation was often considered as the major weakness of the Russian Science and Technology sector (Klochikhin 2012). Since the end of 1990s, the Russian State initiated a series of federal target-oriented programs oriented at increase in the status of university research and turning former teaching universities into science-focused institutions (Block and Khvatova 2017). In the course of the reforms the increasing number of university lecturers were obliged to convert themselves into researchers, the research infrastructure of the universities was enhanced significantly. The major part of the reforms was the division of all universities into several distinct groups. Along with two elite universities with special status (Lomonosov Moscow State University and Saint-Petersburg State University) nine federal universities representing every federal district of Russia were organized since 2007 and later 29 universities received a status of national research universities.

In 2012 a 5top100 project started according to the Decree of the President of the Russian Federation No 500 "On measures for implementation of state education and science policy". The project aimed to enhance competitive ability of Russian universities. The main goal of the Project includes promoting at least five Russian universities to enter the top hundred of leading international universities according to the global universities rank. Initially, the project included 15 universities, but in 2015 additional 6 universities entered the project.

Each university gained 592.4 million rubles (approx. $10 mln) in the first 2013 year. In subsequent years, aggregate financing exceeded 30 billion rubles (approx. $500 mln). Each university obtained either bigger or smaller funding depending on changes of its position in the rank. In the last 2 years, the highest subsidizing was allocated to National Research University the Higher School of Economics, ITMO University, Kazan Federal University, National University of Science and Technology MISIS, National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), Moscow Institute of Physics and Technology and Novosibirsk State University. For the further budget assignments in October, 2017 the Council of the Program divided the universities into three groups, according to their results (Table 1). It worth to be mentioned, that Samara state aerospace university was merged with Samara state university in 2016 year, but at the time of data collection Scopus already joined their organizational profiles, so it didn't affected the results of this research.

Plans for the development of universities in the Project comprises different measures aimed at not only strengthen on competitive positions in the global market of learning services but also an increase in their research and development potential. Forming a sustainable basis for university science as opposed to USSR practice to concentrate basic research in the State Academy of Sciences is a sustainable priority of the Russian Ministry of Education and Science. In 2006–2010, it resulted in forming a network of federal and national research universities. In (Rodionov et al. 2014) the authors noted that academic reputation and citation rate of publications are the weak points of Russian universities aspiring to lead positions in global ranks. Therefore, the 5top100 project council pays significant attention to scientometric indices, including a number of publications indexed in Web of Science (WoS) and Scopus databases.

This study revealed that summarized scholarly output of Russian researchers in Scopus in 2010–2016 increased by 80%. At the same time, the number of publications affiliated with universities of the 5top100 project increased more than 5 times—from 5092 in 2010 to 26,415 in 2016. The steep rise began in 2013 and have been continuing all subsequent years.

Table 1 Russian universities from 5top100 project (number of faculty members and students are extracted from http://5top100.com, group was assigned by Program Council in October, 2017)

No	University	City	Abbr.	Faculty	Students	Group in 2017
1	Immanuel Kant Baltic Federal University	Kaliningrad	BFU[a]	776	7706	3
2	Far Eastern Federal University	Vladivostok	FEFU	2521	23,000	3
3	National Research University The Higher School of Economics	Moscow	HSE	2652	35,100	1
4	ITMO University	St. Petersburg	ITMO	1000	11,200	1
5	Kazan Federal University	Kazan	KFU	2355	24,624	2
6	St. Petersburg Electrotechnical University	St. Petersburg	LETI	1132	8271	3
7	National Research Nuclear University MEPhI (Moscow Engineering Physics Institute)	Moscow	MEPhI	1100	7064	1
8	National Research University MIPT (Moscow Institute of Physics and Technology)	Dolgoprudny Moscow Reg.	MIPT	1906	6492	1
9	National University of Science and Technology MISIS (Moscow Institute of Steel and Alloys)	Moscow	MISIS	1500	17,000	1
10	Novosibirsk State University	Novosibirsk	NSU	2500	7000	1
11	Peoples' Friendship University of Russia	Moscow	RUDN[a]	2800	32,000	2
12	Samara State Aerospace University named after academician S.P. Korolyov	Samara	SamNRU	1455	16,130	3
13	The First Sechenov Moscow State Medical University under Ministry of Health of the Russia	Moscow	Sechenov[a]	2000	17,000	2
14	Siberian Federal University	Krasnoyarsk	SFU[a]	3084	31,670	3
15	St. Petersburg State Polytechnic University	St. Petersburg	SPBPU	2238	31,172	2
16	South Ural State University	Chelyabinsk	SUSU[a]	2200	28,000	3
17	Tomsk Polytechnic University	Tomsk	TPU	1700	15,000	2
18	Tomsk State University	Tomsk	TSU	1116	16,000	1
19	Lobachevsky State University of Nizhni Novgorod	Nizhny Novgorod	UNN	2100	30,000	3
20	Ural Federal University	Ekaterinburg	UrFU	3991	35,000	2
21	Tyumen State University	Tyumen	UTMN[a]	1111	19,449	2

[a]Joined project in 2015

Such significant increase in scholarly output attracted high interest in its reasons and strategies of enhancing of publication activity implemented in Russian universities (Poldin et al. 2017; Turko et al. 2016). Executives of the Universities also revealed some key elements of their strategies to boost publication activities (Galazhinskiy and Kollantai 2016; Osipov 2016). Among them are such direct measures as: establishing publication count as a key performance indicator; increased rewards for published articles; financial

support for academic trips, attending at the international conferences, whose proceedings are indexed in Scopus; invitation of reputable professors and researchers; publishing in Russian journals indexed in Scopus. The problem of increased number of publications in "predatory" journals was also discussed, as an example, when increasing the quantity hardly leads to impairing the quality.

In current study continuing our previous investigation (Guskov et al. 2017) we tried to analyze the scholarly output of 5top100 universities to detect main trends of enhancement of publication activity based on bibliometric analysis of publications and previous interpretations by other researchers. For instance, such strategies include intentional efforts of universities to attract prominent efficient researchers in the main staff. Less expensive is to engage part-time researchers using different conditions that lead to the presence of double or triple affiliations per author in articles. Due to poor English of many Russian scientists, another strategy includes publication in Russian journals indexed in WoS and Scopus databases. Enhanced funding of universities enables them also to send more researchers at foreign conferences. Special efforts can also be directed at promoting domestic conferences proceedings to get indexed in WoS or Scopus. Finally, we can see that some authors publish their results in predatory journals. Almost all these strategies rely greatly on the increased financial capacity obtained by universities under the 5top100 project.

Materials and methods

To determine the contribution of each strategy to the growth of publication activity, one can only classify each individual publication; analysis of this kind is not available via standard features of citation indexing services or analytical tools. We performed our research based on the data from the Scopus database. Scopus was selected due to its identification schema for organizations, publication sources and authors (Kotsemir and Shashnov 2017) and its application programming interfaces (APIs). All publication bibliographic metadata was exported using the Scopus Search API with the query by university AF-ID (affiliation ID) and timespan from 2012 to 2016. Due to its limitations for publications with more than 100 authors their data were completed via the Scopus Abstract Retrieval API. After that, we formed a list of all authors affiliated with the studied universities and additionally obtained data of all other papers of these authors for the same period. Using Scopus Title List, Scopus Discontinued Sources List (https://www.elsevier.com/solutions/scopus/content) and a list of predatory publishers (https://scholarlyoa.com/publishers/) compiled by Jeffrey Beall that we had downloaded on January 3, 2017 before its cancellation, we formed publication category "Discontinued and Predatory". List of Russian journals approved for indexing in Scopus (http://elsevierscience.ru/news/416/obnovlennyj-spisok-rossijskih-izdanij-prinyatyh-k-indeksacii-v-scopus) enabled us to detect publications in Russian journals (including those formally issued by foreign publishers). As for conference proceedings, we used Scopus Abstract Retrieval API for obtaining data on conferences that enabled us to detect scientific meetings, held in Russia.

Analysis of the whole publications corpus of authors who were at least once affiliated with the studied universities during the analyzed period made it possible to detect researchers whose share of publications affiliated with university increases up to 100% in analyzed years. Part of those authors continued to indicate another affiliation in publications. We assume that those authors starting as temporary or external part-time workers became permanent employees at one of the universities.

These steps enabled us to classify all publications according to the following strategies:

1. Russian conference

This approach implies promotion and publication Russian conference proceedings in Scopus indexed serials and inspiration of scientific academic trips of university researchers. This segment demonstrates the most aggressive growth: in 2016 about 6000 papers were registered which 30-fold higher than in 2010. This suggests that universities learned how to attract the attention of eminent publishers (Elsevier, Springer, etc.) to their conferences that publishes selected works in their special issues indexed in Scopus. Even one of such conference can add more than 200 publications to university's scholarly output.

2. Foreign conference

Within this category, we mean publication of Scopus-indexed proceedings of conferences held abroad. This approach is related to stimulation of scientific trips at international conferences. It is more expensive, but well promotes the development of international collaboration.

3. Predatory journal

Papers were published in predatory journals or other serials with a doubtful reputation that were excluded from Scopus or registered in Beall's list. This strategy is easily applicable; however, it clearly violates academic ethical issues. Unfortunately, we should acknowledge the active use of this method: since 2014 Russian scientists have published more than 1500 papers per year in 110 predatory journals, although before this year only sporadic cases were registered. However, some universities were not spotted in this approach; therefore, it is possible for the university administration to prevent the authors from publishing in those serials.

4. Russian journal

According to this strategy, papers were published in Russian serials indexed in Scopus, which was not marked as predatory. This strategy includes both more active collaboration with those journals, and measures to get university serials indexed in Scopus. This resource is limited by the number of Russian journals; therefore, in absolute figures the increase was modest: from 2300 to 2500 publications to 4000 annually. The share of publications in the journals included in the Scopus after 2009 raised from 4% in 2010 to 18% in 2016.

5. Headhunted author

This approach includes engagement of prominent researchers in the university staff. To detect this strategy, we selected those authors whose papers in 2010–2012 were not affiliated with the studied university, but all papers in at least 2 years between 2013 and 2016 were affiliated with the university. If such headhunted researcher was the leader among coauthors according to the total amount of papers, we believe that he/she is a leader of a research team in the university and attributed his/her papers to this strategy. Only articles in non-Russian and non-predatory journals are included.

6. Additional paper

Articles in non-Russian and non-predatory journals where all university-affiliated authors indicates at least another one affiliation (there are no authors having the only university affiliation) and none of them was classified as headhunted author were categorized as additional papers. This is the most efficient and controversial strategy since it includes both

the results of collaborative projects and those cases when a university pays part-time researchers for this affiliation indication without sufficient reasons. The number of such papers increased from 900 to 1300 in the first period to 7000 in 2016.

7. Genuine

This strategy comprises all other publications. We can state with certainty that the vast majority (> 90%) of these publications are articles and reviews in international academic serials and at least one author indicated only the university in affiliation line. It should be noted that this part of publications is least of all exposed to manipulation since those serials a priori have no conflicts of interests when selecting Russian publications.

Resulting classification represents sequential selection of more or less complete subsets from the whole set. Selection of the publications for strategies 1–2 was based on the document type, 3–4—on a specific journal list, whereas strategies 5–6 were processed using affiliation information. Every publication could be attributed to the one strategy. The final distribution is shown in "Appendix 1".

We did not conduct any additional procedures for eliminating ambiguities, since only one of these strategies (Headhunted Author) potentially depends on possible errors. To make an assessment of possible errors a random subset of 100 from the total of 9471 publications in this category was made and checked de visu. Some minor ambiguities in affiliation data were found but they do not affect the result of strategies detection. However some ambiguities in Scopus data, or rather duplicated author profiles affects the calculation of total number of authors. Our assessment shows that the number of authors can be overestimated by 10–20% and is relatively evenly distributed over time.

Analysis of the structure of increase in publication activity was carried out by comparison of two 3-years periods, i.e. 2010–2012 and 2014–2016. Difference between a number of publications in the corresponding category in earlier and latter periods enabled us to evaluate the contribution of one or another strategy into the general increase of scholarly output. These time periods were selected based on noticeably prominent inflection in number of publications growth rate in most universities (13 from 21) attributable to 2013 (another 5—in 2012 and 2015) regardless of the year of entry in the 5top100 project.

Findings

Figure 1 depicts general scholarly output of all 21 universities according to mentioned above categories. It demonstrates that before 2013 increase in the annual amount of publications was less than 23%, but since 2014 growth rates sharply changed. At its peak the growth was 65% in 2014; in 2015 it was 33%. Moreover, it is obvious that this growth predominantly concentrated in categories Additional paper, Russian conference and Headhunted author. Figure 2 shows the structure of increase in the amount of publications in 2014–2016 as compared to 2010–2012. Of note, prevailing strategies vary from one university to another (Table 2).

As it seen from Table 2, the majority of universities used Additional papers strategy most frequently. Exceptions are: KFU with the extremely high share of papers in predatory journals, ITMO frequently sending researchers at international conferences; LETI, TPU, SUSU and SamNRU which organize domestic conferences of international level, and UTMN efficiently engaging eminent researchers into its staff. One can also see that several universities (especially HSE) extensively promote publication activity of their main staff.

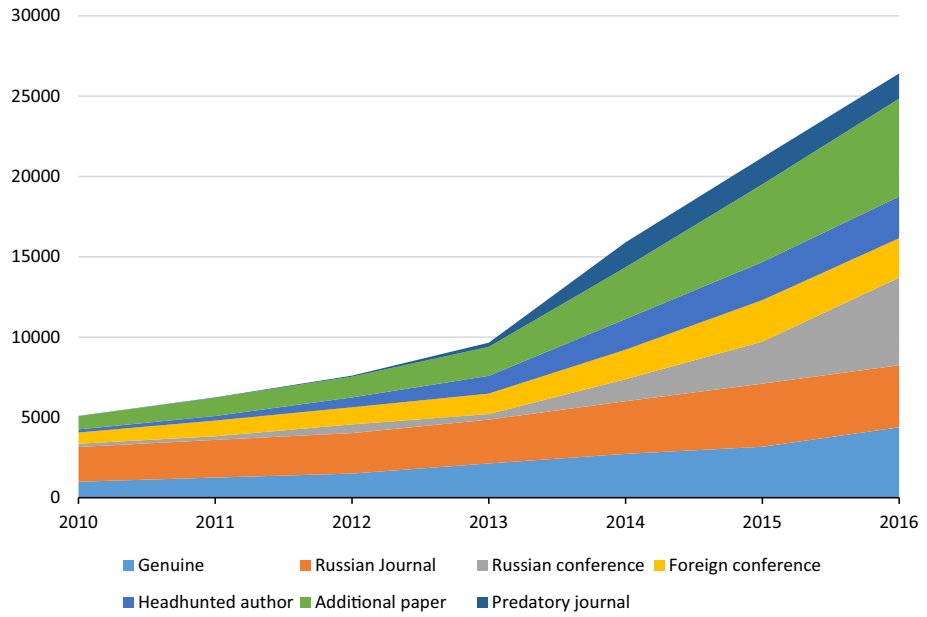

Fig. 1 General scholarly output of 5top100 Russian universities

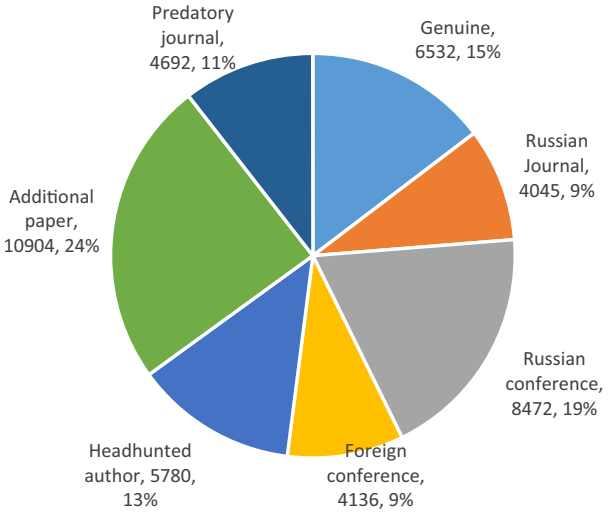

Fig. 2 The structure of increase in scholarly output of 5top100 universities in 2014–2016 as compared to 2010–2012

Except for the use of strategies mentioned above, we should note several additional trends typical for the described period of development of Russian science.

Slight increase in average productivity of researchers

In 2010, 6430 researchers affiliated with the studied universities published 5092 papers (with a performance ratio 0.79), and in 2016, 26,499 researchers published 26,415 papers

Table 2 The share of strategies in the whole increase scholarly output of university in 2014–2016 as compared to 2010–2012, divided by categories (green is for leading strategy and red is for minor one per university)

University	Genuine	Russian journal	Russian conference	Foreign conference	Additional paper	Headhunted author	Predatory journal
FEFU	15%	6%	10%	9%	26%	17%	17%
BFU	24%	17%	7%	8%	20%	11%	13%
ITMO	11%	5%	16%	28%	24%	13%	2%
KFU	17%	9%	6%	3%	11%	5%	49%
UNN	15%	10%	4%	9%	43%	15%	3%
MEPhI	13%	10%	25%	12%	26%	11%	4%
MIPT	9%	4%	9%	6%	53%	17%	1%
HSE	37%	11%	7%	10%	25%	9%	2%
MISIS	29%	14%	5%	2%	35%	13%	1%
NSU	4%	2%	8%	3%	54%	27%	1%
RUDN	25%	4%	7%	9%	25%	8%	21%
LETI	9%	8%	59%	11%	9%	4%	0%
SamNRU	14%	10%	31%	21%	11%	4%	9%
SFU	20%	26%	17%	0%	23%	7%	8%
SUSU	13%	18%	43%	9%	2%	9%	4%
SPBPU	14%	12%	20%	11%	26%	10%	7%
Sechenov	26%	29%	1%	1%	27%	13%	3%
TPU	12%	4%	53%	5%	11%	7%	8%
TSU	12%	5%	30%	6%	33%	11%	2%
UTMN	13%	18%	5%	3%	7%	44%	10%
UrFU	22%	14%	11%	11%	24%	12%	6%

(with a performance ratio 0.996). Moreover, the peak of this growth occurred in 2014–2016 ("Appendix 2").

Performance ratio of authors varies in different universities ranging from 0.5 to 1.4. In 2016, leader universities including NSU, TSU, MEPhI, MIPT, and ITMO demonstrated at least 1.2 performance ratio. As for SFU, SUSU and Sechenov University, they showed 0.8 or lower performance ratio with the relatively small number of publications and low level of national collaborations. Nevertheless, the conclusion that high-performance ratio among authors represents the high-quality management of scientific research is believed to be speculative and needs to be studied in detail.

Dynamics of this ratio ether increased in all analyzed universities or remained constant on rare occasions including HSE (1.1–1.2), RUDN (0.8–0.9), KFU (0.8–0.9), and SFU (0.7–0.8). TSU and MISIS demonstrated the most marked increase: 0.8–1.4 and 0.6–1.1 respectively. Mixed dynamics was registered in universities with the low number of authors including UTMN and BFU.

Actual productivity may be slightly greater due to overestimation of number of authors, as was mentioned above.

Significant increase in the number of authors published Scopus-indexed papers

A slight increase in the productivity of researchers shows that, in the main, the growth of publication activity was due to a general increase in the number of contributing authors

(Fig. 3). A more detailed analysis (Table 3) shows that the number of active authors in different universities has grown at different rates, the most impressive growth rates are noted in such universities as BFU, UTMN, HSE, TPU. To a large extent, this is due to the effect of a low base, but in some cases (for example, HSE, TPU), the active expansion of the university is also added.

It can also be noted that in most universities the number of authors published in 2016 is significantly less than the number of faculty members. Only in five universities—TPU, TSU, MEPhI, ITMO, and KFU the opposite ratio is observed. Exceeding the number of active authors can be explained by an overestimation of the number of authors according to Scopus data, and participation in publishing activities of senior and post-graduate students, other university-affiliated authors not included in the faculty. A significant excess of the number of faculty members over contributing authors may indicate reserves of further extensive growth by involving more academics in the publishing process and increasing their productivity.

It is worth noting that in Russia research work has relatively recently become an integral part of the everyday activity of university faculty and prior to 2008, there were no strong requirements in Russian science to publish results in international journals. These factors allowed universities to increase quickly the number of contributing authors involving faculty in research and pushing them to publish their results in journals indexed by WoS and Scopus. In the majority of universities' special programs were launched to redirect authors to international journals. These projects include English language courses, academic writing, internal review and consulting, a system of incentive reward, etc. Furthermore, government projects were initiated, one of them the national program for promoting Russian journals in international databases WoS and Scopus. The obtained results revealed that those measures were justified resulting in significant growth of integration of Russian researchers into a global science.

Consistent increase in average number of affiliations per author

From 2010 to 2016 this index gradually increased from 1.17 to 1.30. It is expected and is a consequence of popular strategy Additional paper. We can explain this fact as an evidence of the increase in collaborative studies. However, the most usual situation includes an unreasonable indication of additional affiliations by authors working in several organizations while the study was carried out only in one of them. It is confirmed by (Kotsemir and Shashnov 2017): «The question here: should the university management ask those member

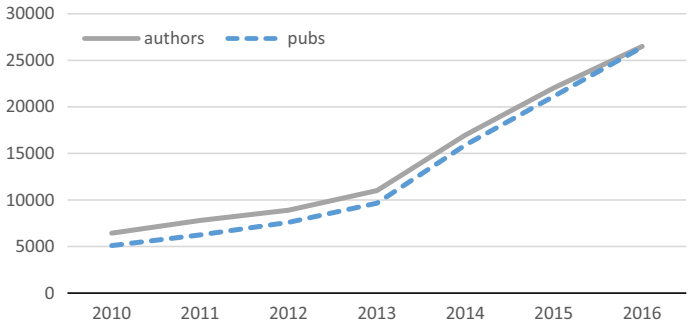

Fig. 3 Dynamics of number of Russian authors and publications of 5top100 universities

Table 3 Number of contributing authors per year per university

University	2010	2011	2012	2013	2014	2015	2016	2016/2010 ratio	Faculty
BFU	10	40	26	63	95	150	201	20.1	776
FEFU	151	169	285	421	547	673	845	5.6	2521
HSE	158	242	397	563	796	992	1421	9.0	2652
ITMO	263	366	402	532	1049	1371	1635	6.2	1000
KFU	454	535	705	1006	1988	2775	2881	6.3	2355
LETI	124	206	180	192	358	456	583	4.7	1132
MEPhI	546	669	693	859	1224	2279	1993	3.6	1100
MIPT	420	473	484	778	1013	1150	1402	3.3	1906
MISIS	268	406	402	477	624	785	980	3.7	1500
NSU	750	918	1007	1107	1713	1966	2139	2.8	2500
RUDN	236	270	265	303	343	384	728	3.1	2800
SamNRU	214	223	237	245	428	609	773	3.6	1455
Sechenov	269	300	266	432	482	568	776	2.9	2000
SFU	286	337	355	419	522	616	722	2.5	3084
SPBPU	439	520	579	734	1156	1348	1571	3.6	2238
SUSU	261	154	142	187	275	462	591	2.3	2200
TPU	305	434	785	572	1431	1785	2942	9.6	1700
TSU	367	489	449	519	1030	1380	1628	4.4	1116
UNN	401	467	514	618	839	1042	1153	2.9	2100
UrFU	565	631	781	1036	1327	1576	1849	3.3	3991
UTMN	20	25	31	48	58	105	212	10.6	1111

staff for whom the studied university is not the primary place of work to set down their affiliation with the university in *all* his/her publications». Of note, such cases sometimes are inconsistent with research ethics and can be caused by science policy of university or scientific organization.

Indeed, it is an intricate challenge to detect a share of actual participation of one or another organization (as well as an author) in research. In each specific case, only authors can solve this problem; consequently, only sociological survey can detect the size of this problem that transcends the scope of this work.

Dependence of universities' publication activity on collaboration with the Russian Academy of Sciences

Comparison of the university and academic science is an actively discussed issue in Russia (Mokhnacheva and Kharybina 2011; Ivanov et al. 2014; Mazov and Gureev 2017). On the one hand, SCImago Institutions Rankings demonstrates high positions of the universities located among the most prominent branches of the Russian Academy of Sciences. It makes it able to conclude that collaborative integration of scientific resources of the Russian Academy of Sciences and domestic higher school is one of the most efficient ways to enhance the international competitive ability and scientific achievements of Russian universities (Aref'ev 2015). In (Ivanov et al. 2016) the authors show that 5-top 100 project

universities actually use this strategy as confirmed by enhanced scientific collaboration between universities and RAS research organizations. On the other hand, in the last 10 years, these two sectors of national science are direct competitors for public funding that inevitably results in their permanent comparison and even opposition.

Novosibirsk Academgorodok is the most remarkable example of tight collaboration comprising 30 academic institutes and NSU campus (Kupershtokh and Apolonskiy 2014). This symbiosis of education and scientific activity proved itself as successful since 9160 out of 10,371 NSU papers were published in collaboration with RAS institutes for 7 years. Whereas the collaboration with academic institutions can be significant factor for universities' output, we made an additional exploration of the share of such publications.

The share of publications in collaboration with research institutes of the Russian Academy of Sciences, reaching a peak of almost 41% in 2011, declined slowly over the next few years and amounted to a little more than 38% in 2016. However, the level and dynamics of cooperation with the RAS differ markedly in different universities (Table 4). It is expected that the NSU will stand out with an average of about 86% of articles written in the collaboration with the Russian Academy of Sciences, and this share has grown in recent years from 83% in 2010 to 89% in 2016. SFU, MIPT, and FEFU publish in a collaboration with the RAS more than 50% of the articles, but in these universities the proportion of these articles is slightly reduced in recent years. In the next group of

Table 4 Share of publications in collaboration with RAS by university by year

University	2010 (%)	2011 (%)	2012 (%)	2013 (%)	2014 (%)	2015 (%)	2016 (%)	Average (%)
BFU	30	25	16	21	23	34	39	27
FEFU	51	59	58	54	49	53	55	54
HSE	9	17	15	18	18	19	22	17
ITMO	12	17	19	22	25	26	26	21
KFU	24	24	24	21	16	16	16	20
LETI	18	24	20	31	27	22	22	23
MEPhI	28	36	40	38	35	38	35	36
MIPT	57	56	55	60	60	60	57	58
MISIS	22	25	20	22	26	30	32	25
NSU	83	87	85	85	85	89	89	86
RUDN	29	25	30	25	26	27	24	27
SamNRU	36	36	29	31	22	29	32	31
Sechenov	23	27	30	21	22	23	21	24
SFU	61	64	66	59	57	55	55	60
SPBPU	30	34	40	37	39	41	34	36
SUSU	17	21	11	13	9	7	8	12
TPU	18	23	23	28	27	29	28	25
TSU	33	35	39	38	46	49	42	40
UNN	37	36	31	34	45	46	41	39
UrFU	32	33	32	29	34	38	40	34
UTMN	18	25	29	28	26	13	21	23

universities with an average share of the collaboration with the Russian Academy of Sciences of 30–40% we can notice TSU and UNN, in which this share has stepped up sharply in 2014.

If we consider the change of average values for the two triennial periods 2014–2016 and 2010–2012, then the most noticeable growth of collaborations with academic science was demonstrated by TSU, ITMO, UNN, BFU, and the biggest drop was by KFU, SFU, and SUSU. Obviously, the highest level of cooperation is achieved in the locations of major scientific centers of the Russian Academy of Sciences—Moscow, Novosibirsk, Vladivostok, Krasnoyarsk, Tomsk, St. Petersburg, Ekaterinburg, Nizhny Novgorod. It is interesting that there is a positive correlation (Pearson coefficient 0.71) between RAS collaboration ration and the impact of Additional paper strategy on the university's publication flow growth (Fig. 4).

Some illustrative examples

Kazan Federal University (KFU)

Beginning in 2010 KFU showed growth from 353 to 2602 publications in 2016. This university is one of the leaders according to funding.

Figure 5 depicts that the leading strategy in this university is publishing in predatory journals. Interestingly, in 2013 KFU published only 8 papers in those journals, and in 2015 there were 1125 papers in predatory journals.

When analyzing subject areas, we revealed that the most part of these papers belongs to social sciences and humanities, i.e. Arts and Humanities; Economics, Econometrics and Finance, and Social Sciences.

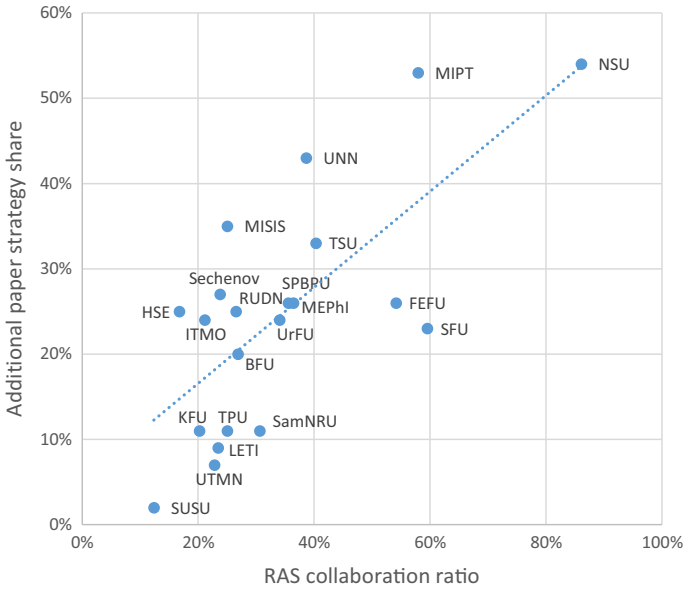

Fig. 4 Additional paper strategy impact on the publication flow growth correlation with RAS collaboration ratio by university

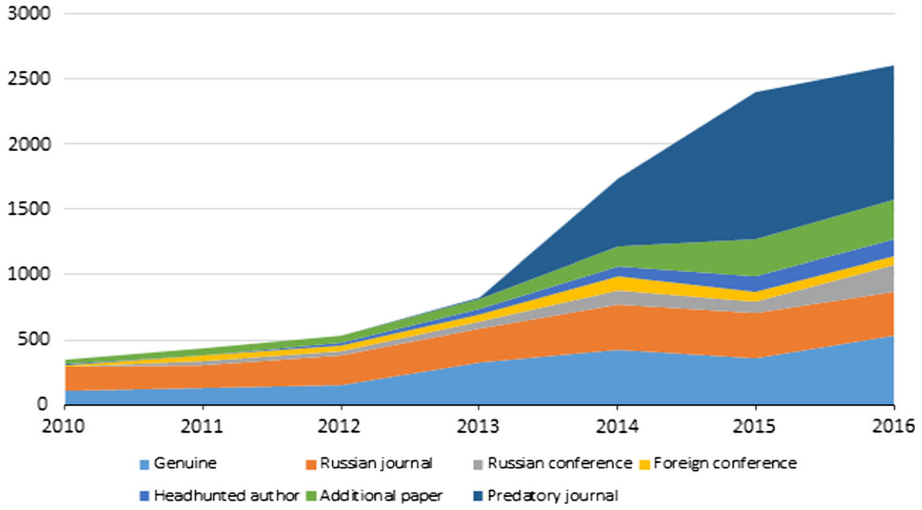

Fig. 5 Strategies for increasing publication activity at KFU

More detailed analysis of authors published papers in this category shows that "leaders" work at Institute of Management, Economics and Finance; Institute of Psychology and Education, and Institute of Philology and Intercultural Communication. Moreover, head of laboratories and administrative personnel publish papers in predatory journals the most frequently.

Up to 2015 inclusive, the most popular journals among KFU authors include Asian Social Science, Mediterranean Journal of Social Sciences and Life Science Journal that were excluded from Scopus in 2015. We registered the peak of this strategy in 2015 when 1125 papers were published in 33 predatory journals.

Since 2016, we detected an insignificant decrease in the number of papers in predatory journals that is believed to be caused by the exclusion of those journals from Scopus. However, leading authors published papers in predatory journals began to publish in new serials of the same low quality including Academy of Marketing Studies Journal and International Business Management that were also excluded as of March 2017. The use of the strategy to publish papers in predatory serials have been discussed in mass media[1] and it should be noted that further use of this approach can result in a reduction of funding under 5top100 project.[2]

Of note, KFU demonstrated the good growth of papers in Scopus even without using this strategy, since the number of publications except for those in predatory journals increased from 353 in 2010 to 1578 in 2016.

Novosibirsk State University (NSU)

NSU predominantly uses Additional paper and Headhunted author strategies. As Fig. 6 shows, these approaches have been registered starting in 2010, but their active development occurred after NSU entered the 5top100 project.

[1] https://m.business-gazeta.ru/article/339712.

[2] http://expert.ru/expert/2017/21/peredoviki-vuzovskoj-nauki/.

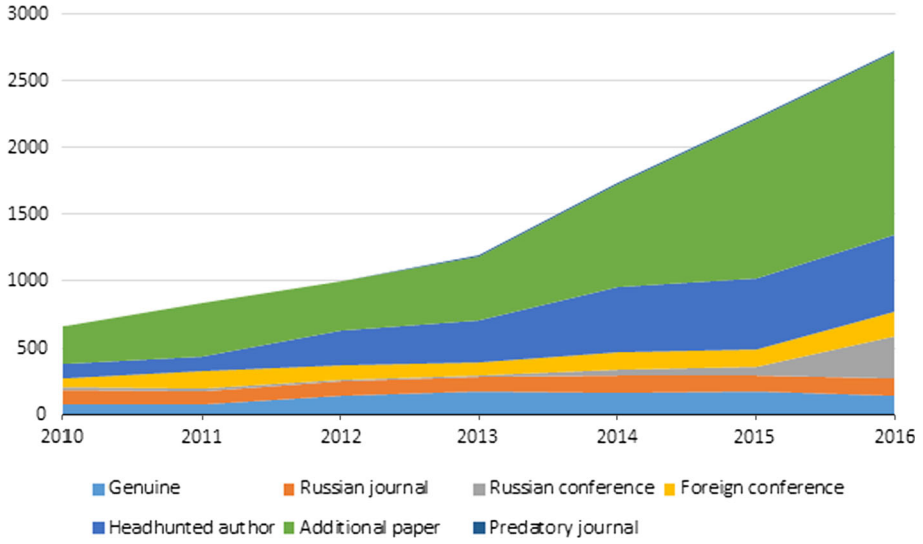

Fig. 6 Strategies for increasing publication activity at NSU

Engagement of authors and papers in this university is easily available due to academic institutes of the Russian Academy of Sciences located near. A number of researchers from these institutes concurrently work in the university as lecturers. NSU remarkably stands out from the others due to its small size (in terms of the number of students) and a large amount of authors, since it was initially founded in a close cooperation with academic basic science (Mazov and Gureev 2017). It provides the university with the incredible correlation of the number of lecturers (the majority of whom work in the university as part-time staff) to the number of students. Therefore, the main part of papers in publication flow of the university is the result of collaborative work with the Russian Academy of Sciences institutions (Fig. 7).

The first Sechenov Moscow State Medical University under Ministry of Health of the Russian Federation (Sechenov University)

Sechenov University entered the 5top100 project in 2015 and is now the only university training students in the medical field. Since 2010 this university has mainly used the strategy Russian journal (Fig. 8). The most popular journals among university staff include Terapevticheskiy Zhurnal, Zhurnal Psikhologii i Psikhiatrii im. Korsakova, Vestnik Rossijskoj Akademii Meditsinskikh Nauk, Kardiologiya, and Pharmaceutical Chemistry Journal. A share of papers published in these journals is 50% from the total amount of publications, with 64% of papers published in top-10 journals.

National Research University the Higher School of Economics (HSE)

HSE is an example of a university with the successful development of publication activity (Fig. 9). In contrast to other universities, HSE was founded in 1992 and since 1995 research became valuable integral part of its activities. HSE demonstrates steady growth in number of publications during 2010–2016. The major subject fields at this university are

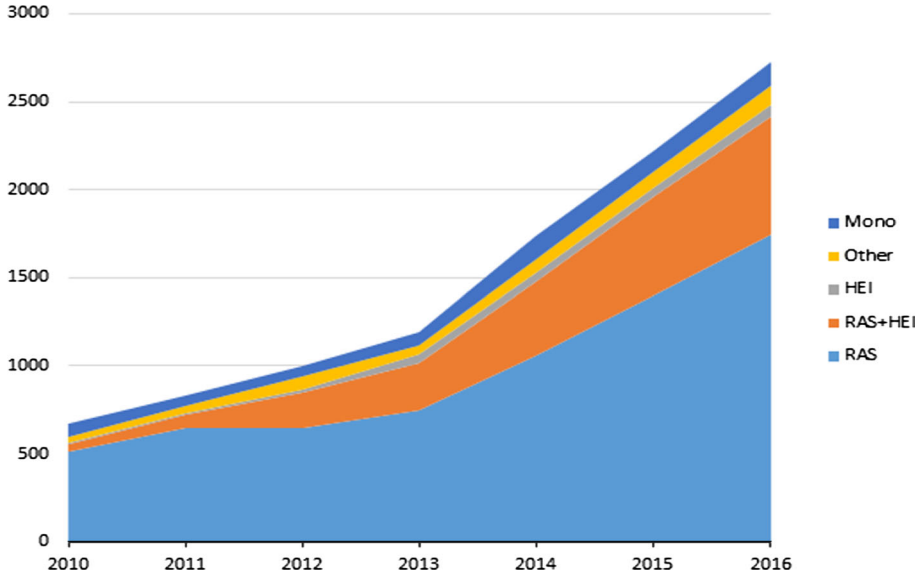

Fig. 7 Distribution of papers of NSU according to the model of collaboration. Number of papers, written in collaboration with: RAS—institutes of Russian Academy of Sciences; RAS + HEI—Institutes of RAS and other 5-top100 universities; HEI—other 5-top100 universities; Other—other institutions; Mono—non-colaborative papers

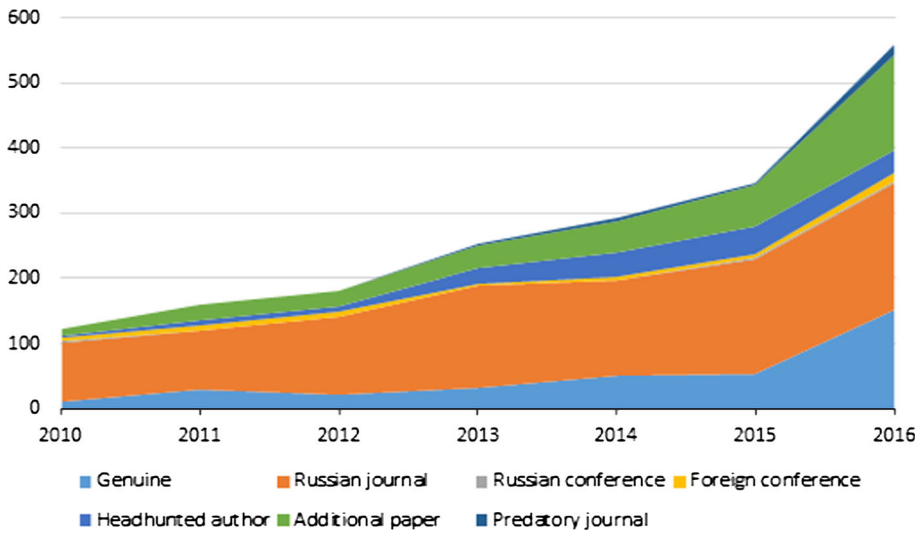

Fig. 8 Strategies for increasing publication activity at Sechenov University

Social Sciences, Mathematics, and Computer Sciences. Since 2010 the university has developed such subject areas as Physics and Astronomy, Earth and Planetary Sciences, etc. When analyzing data in detail, we found that almost all authors in these fields work in a

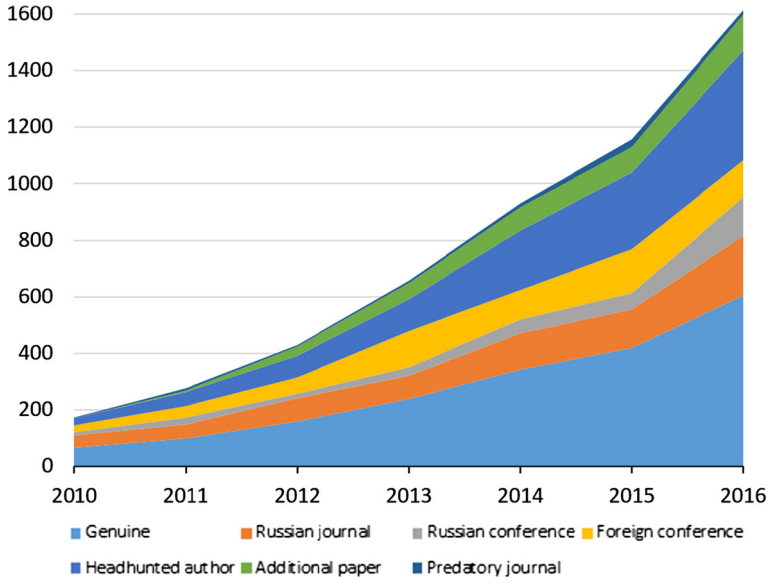

Fig. 9 Strategies for increasing publication activity at HSE

division of HSE in Nizhny Novgorod that works in close collaboration with Institute of Applied Physics of the Russian Academy of Sciences.

Tomsk Polytechnic University (TPU)

TPU predominantly engages Russian conferences strategy (Fig. 10). In 2012 an outbreak of such publications was caused by International Forum on Strategic Technology held by the university. In proceedings of this from 213 papers were published.

When studying geographical locations of conferences in which TPU staff takes part, we detected that rather than Moscow and St. Petersburg researchers published in Tomsk (total more than 50 conferences with 2400 publications for 6 years), Kemerovo, Omsk regions and Altai Krai (Table 5), which are much more closer each other.

An approach based on the promotion of domestic conferences with the inclusion of conference proceedings in international citation databases and participation in such conferences is efficient when regarding increase in the number of publications. However it seems that conference papers gain less citations than journal articles on average (Garousi and Fernandes 2017), this fact pushes university executives to shift motivation to publications in high-impact journals (Osipov 2016).

Besides, TPU is an indicative example of effective resistance to publication in predatory journals. Just after inclusion in the 5top100 universities project in 2014, TPU published 312 papers (23%) in journals of dubious reputation. Next year the number of such papers eightfold decreased and stopped to grow due to the administrative control.

ITMO University

The main drivers for increasing publication activity in ITMO include Foreign conferences (1744 publications for all period) and Additional paper (1146 papers). The first strategy is

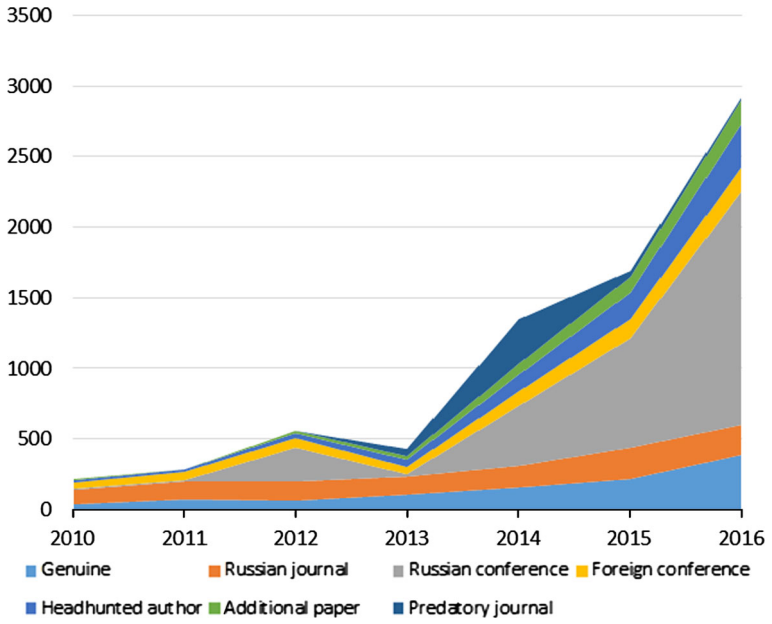

Fig. 10 Strategies for increasing publication activity at TPU

Table 5 Geographical locations of conferences in which TPU staff takes part

Region	2010	2011	2012	2013	2014	2015	2016	Total
Tomsk	0	0	222	0	369	636	1259	2486
Yurga	0	0	0	0	0	49	165	214
Altai	0	2	4	2	18	12	70	108
Omsk	0	0	0	0	0	51	7	58
St. Petersburg	1	0	2	1	5	1	42	52
Moscow	2	0	2	0	1	2	38	45
Novosibirsk	1	0	1	0	14	9	15	40

actively used in such subject areas as Engineering (416 papers), Computer Sciences (605 papers) and Physics and Astronomy. Interestingly, in the latter research field, Russian journal strategy (480 papers) was also used despite the large amount of papers in main categories (441 and 577 papers, respectively).

Tyumen State University (UTMN)

UTMN primarily used Headhunted author strategy especially since 2013. Out of total amount of papers (594), almost half of them (219) belong to this category. When studying papers according to subject areas, one can note that Agricultural and Biological Sciences is predominant with 218 papers. Generally, it is an effort of two researchers taking this job

after working at Nizhni Novgorod Referral Center of Federal Service for Veterinary and Phytosanitary Inspection and Nikitskiy Botanical Gardens, National Scientific Center, Yalta. It should be noted that since 2013 international collaboration has significantly enhanced.

Discussion

The 5top100 project was launched in 2013 and counted 54 university applicants from which 15 participants were selected. Nevertheless, in 2015 another six universities entered the project. It is evident that by the project beginning each university had its own background, strong and weak points, unique possibilities and limitations. At the moment we can affirm that those factors had the direct effect on their further development including a selection of strategies to boost research productivity being one of the main KPI in the project.

The proposed method of investigating the growth of the publication activity of universities showed that different models were formed in them (Fig. 11). Analysis of these existing models, as well as changes in the structure of the publication flow, allows us to highlight significant trends both in general for all universities—participants in the project, and for each of them separately.

Many administrators and academics in the universities participating in the project probably made considerable efforts to achieve high growth rates and absolute values of the number of publications indexed in leading international databases, not always paying

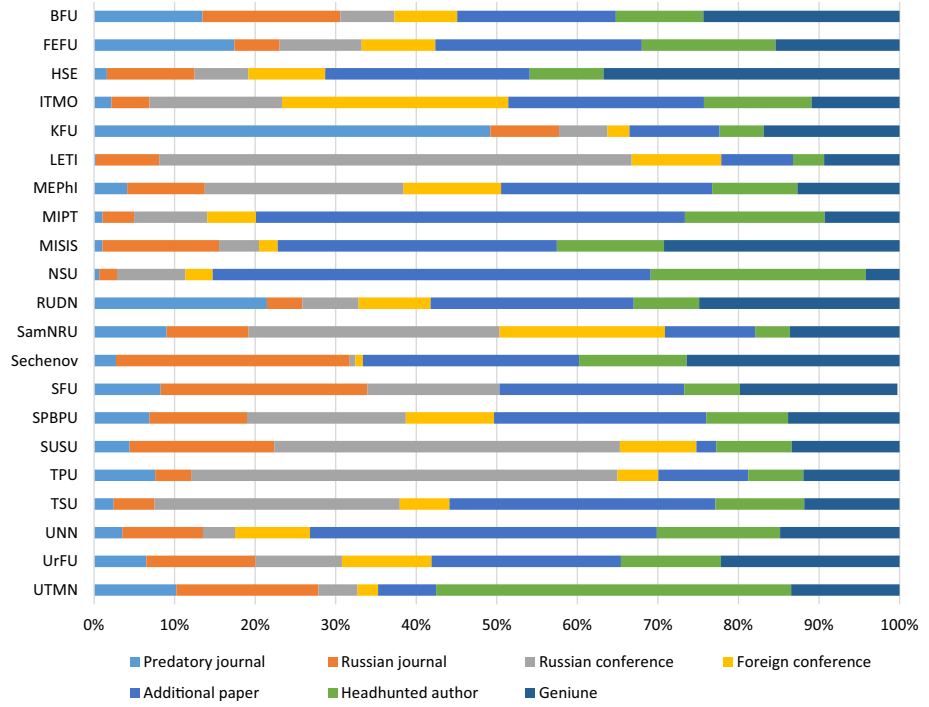

Fig. 11 The structure of increase in scholarly output of 5top100 universities in 2014–2016 as compared to 2010–2012 by university

attention to their quality. Judging by the results of the research, the side effects of this process have become such practices as publication in journals with a dubious reputation, stimulating the faculty to not always justified addition of university affiliation in publications, somewhat excessive attention to publications in the materials of Russian conferences. In many ways, these practices are the usual growing pains that inevitably accompany such a rapid transformation of Russian science. We see significant examples related to efforts to attract active scientists both from other scientific organizations in Russia and abroad, to intensify international scientific mobility, expressed in albeit suffering from changes in the exchange rate of the national currency, but still active participation of Russian researchers in international conferences.

We believe that the most organic model of growth is the training of researchers in the universities themselves, stimulating the activity of faculty members, which is expressed in the Genius strategy. Ultimately, this is the most significant goal of stimulating the publication activity; its result is a constant increase in the number of faculty members who publish the results of their work in international scientific journals.

We also believe that universities with stable external collaborations had the best opportunities for the development. Strong international relations, cooperation with the Russian Academy of Sciences and other research centers makes it possible to encourage its researchers and executives to publish collaborative papers (Additional paper strategy) and in some cases to engage new successful researchers into a university staff (Headhunted author). Of note, in the last few years, it is difficult for universities to attract foreign researchers since the income of researchers in Russia is humble (Altbach et al. 2012). Finally, the 5top100 project itself boosted collaboration among its participants resulting in an increase in the number of collaborative papers.

Our study revealed that collaborative strategies are the most efficient in regions with large scientific centers with a rich background. First, we mean Moscow, St. Petersburg and Novosibirsk, as well as Nizhni Novgorod, Ekaterinburg, Tomsk, Krasnoyarsk, and Vladivostok. As for the other participants, they have objectively lower collaborative opportunities; thus, they had to rely on the other strategies.

Holding international conferences at university with the following publication of conference proceedings indexed in Scopus is the second successful strategy. This approach requires considerable human and financial resources; thus, it was not widespread in Russia before 2014. It is worth noting that holding significant scientific conference always represented a high level of university, but at the same time university executives frequently paid insufficient attention to the quality of conference proceedings. In turn, the emergence of scientometric requirements opened new opportunity since the majority of conference participants work at a university. Consequently, the majority of them can publish their results in Scopus or WoS-indexed conference proceedings. The other side of this coin is low citedness of such publications. We know from private conversations that this effect lead to significant decline in university authority (in terms of average citations per paper) and some universities are revising the use of this strategy.

This approach seems to be attractive for some researchers since it is independent of the knowledge of English and high requirements for academic writing accepted in leading international journals. On the other hand, the majority of Russian journals fall in the 3rd or 4th quartiles,[3] so their citedness is lower than the average international level resulting in weak growth of university authority. Besides, there is an oversupply of manuscripts in

[3] According to Scimago Journal Ranks, there were 270 Russian journals in Scopus in 2016, having distribution by quartiles Q1–Q4: 7/46/100/107.

editors' hand in those journals; therefore, it is impossible to increase notably the number of papers in such serials.

Predatory journals use extremely aggressive marketing strategies and provide the easiest way to publish results for insufficiently experienced authors. In this case, lack of experience comprises not only inability to prepare a paper of high quality appropriate for a highly ranked journal but also lack of knowledge of modern science ethics requirements. In order to evade it university executives must adhere to relevant science policy. Executive attitude to science ethics can significantly affect researchers selecting one or another strategy.

The nature of this explosive growth nevertheless remains a big question. How sustainable these achievements are, how the change in funding and state scientific policy can affect the situation only time will tell. Given the doubtful nature of a notable part of this growth, it may appear that it was largely a manifestation of the Goodhart's law—"Any observed statistical regularity will tend to collapse once the pressure is established for it for control purposes". At the same time, it is entirely permissible that even Predatory journal strategy can be interpreted as a kind of application of the "Fake it till you make it" principle and in due course the quantity will be able to go into quality. It seems to us that further monitoring of the publication activity of universities of the 5top100 project, especially supplemented by qualitative analysis, will allow answering this question.

Conclusion

Universities participating in the 5top100 project demonstrated a high level of elasticity of scientific productivity, measured by the number of publications indexed in the leading international databases of government requirements and the amount of funding. To a large extent, this elasticity was a consequence of the active involvement of faculty in the publication activity, which resulted in a significant increase in the number of authors of scientific papers. Despite the gradual increase in the average productivity of authors, it has not yet reached one article per author per year. At the same time, this allows us to hope for a further increase in the publication flow of leading universities, connected both with the involvement of the remaining part of the faculty, and with the increase of personal productivity.

Depending on the circumstances caused by the peculiarities of the geographic location, the specifics of the university and the history of its development, the universities demonstrated significantly different approaches in the choice of strategies for increasing the publication activity.

The largest contribution was, on average, of the Additional paper strategy, it can be noted that all institutions that rely on it in the first place (NSU, MIPT, UNN, TSU, FEFU) except one (MISIS) are in close collaboration with the institutes of the Russian Academy of Sciences (about half of the publications in 2016, and in NSU—almost 90%). If we look only at publications in Additional paper and Headhunted author strategies, then this share is still much higher.

The next most important strategy is the Russian conference, dominating with a noticeable separation in three universities—LETI, TPU, and SUSU, and in the first two this strategy is responsible for more than half of the increase in the number of publications. This strategy is also the most dynamically growing—since 2010 the share of articles of all universities in this strategy has grown from almost 4% to more than 20%.

The share of Geniune publications has slightly decreased from almost 20% to almost 17% mainly due to the increase in the share of Headhunted author and Additional paper

strategies, this strategy is responsible for 15% of the total growth of publication activity and is leading in the HSE. Headhunted author is the leading strategy for UTMN. The peak of this strategy was reached in 2014 and since then its impact has been significantly reduced, but it has caused a 13% increase in overall publication activity.

The Predatory journal strategy, which attracts the most public attention, is connected with the social sciences and traces well in the growth of KFU's publication activity (almost 50%). The strategy also has a notable share in RUDN. The strategy was clearly manifested in 2013 and its peak came in 2014—almost 10% of all publications of all project participating universities. Since then, the share of this strategy has invariably fallen largely because of the intense discussion and serious pressure from the scientific community and regulatory bodies.

The Foreign conference strategy leads in ITMO, its influence has slightly decreased in recent years, probably due to the change in the national currency rate, which led to a significant increase in the cost of foreign trips of Russian scientists. Nevertheless, about 9% of the increase is due to this strategy.

Finally, the Russian journals strategy divides the last place with Foreign conferences with a 9% share in the gain. It should be noted that this is the only strategy with a clearly defined tendency to a permanent decline, since 2010 its share has consistently fallen from 42.5 to 14.6% in 2016. This strategy is leading in Sechenov university with a small margin.

Project 5top100 should be completed by 2020, so it is too early to sum it up, but it is already clear that this project and other initiatives to develop basic scientific research in Russian universities have had a great impact on the landscape of Russian science. The project significantly contributed to the increase of scholarly output of Russian authors, since total number of publications of the 5top100 universities quintupled from 5092 to 26,415 in 2010–2016 period. According to Scimago Journal and Country Rank in 2016 Scopus indexed 73,207 Russian publications (in contrast to 40,001 in 2010) accounting for 2.64% in international publication flow. It significantly exceeds the number of publications before the start of the 5top100 program in 2012: 45,137 papers (1.66%). The proposed method of classification of publications and results of this analysis allow one to look under the hood of these processes and to better understand their structure and dynamics, to examine the resources of this outstanding growth and its disorders and peculiarities.

Acknowledgements The authors would like to thank Vadim N. Gureyev, Ph.D. for text improvements and valuable feedback.

Appendix 1

See Table 6.

Table 6 Number of publications of the Project Top5-100's participants by strategies

	2010	2011	2012	2013	2014	2015	2016	Total
FEFU	113	142	283	512	644	725	897	3316
Genuine	18	21	33	90	86	116	136	500
Russian journal	52	54	79	116	104	86	92	583
Russian conference	6		16	2	44	31	123	222
Foreign conference	11	25	25	46	47	109	63	326
Additional paper	25	37	68	117	144	178	251	820
Headhunted author	1	5	46	77	90	121	128	468
Predatory journal			16	64	129	84	104	397
BFU	10	28	25	57	91	171	187	569
Genuine	3	8	9	21	29	32	53	155
Russian journal	6	14	4	10	23	39	28	124
Russian conference		2	2		4	8	18	34
Foreign conference	1	1	7	14	9	12	18	62
Additional paper		2	1	4	13	33	33	86
Headhunted author		1	2	6	10	19	16	54
Predatory journal				2	3	28	21	54
ITMO	199	271	325	489	1138	1638	1963	6023
Genuine	13	37	57	76	132	164	242	721
Russian journal	106	87	113	104	161	188	143	902
Russian conference	11	28	17	42	134	196	375	803
Foreign conference	54	92	87	170	372	516	453	1744
Additional paper	9	25	35	50	193	363	471	1146
Headhunted author	6	2	16	45	123	191	237	620
Predatory journal				2	23	20	42	87
KFU	353	433	533	828	1737	2397	2602	8883
Genuine	114	135	158	325	421	363	537	2053
Russian journal	179	173	218	262	355	345	332	1864
Russian conference		34	40	54	105	88	207	528
Foreign conference	16	41	45	56	106	75	69	408
Additional paper	40	46	51	77	152	282	308	956
Headhunted author	4	3	21	46	81	119	125	399
Predatory journal		1		8	517	1125	1024	2675
UNN	305	336	368	474	703	942	1050	4178
Genuine	57	68	70	94	121	143	181	734
Russian journal	185	178	182	174	174	270	270	1433
Russian conference	9	3	18	7	13	22	62	134
Foreign conference	35	56	37	73	69	98	118	486
Additional paper	15	23	47	99	216	296	299	995
Headhunted author	4	7	14	27	84	96	103	335
Predatory journal		1			26	17	17	61
MEPhI	437	589	696	723	1114	2135	2415	8109
Genuine	142	172	276	270	276	423	391	1950
Russian journal	158	208	172	194	248	374	296	1650

Table 6 continued

	2010	2011	2012	2013	2014	2015	2016	Total
Russian conference	19	13	40	36	94	326	625	1153
Foreign conference	73	97	100	92	157	326	264	1109
Additional paper	43	88	84	58	190	459	599	1521
Headhunted author	2	11	24	72	112	181	161	563
Predatory journal				1	37	46	79	163
MIPT	402	433	519	871	1177	1455	1618	6475
Genuine	45	62	54	71	99	137	194	662
Russian journal	92	84	87	113	98	132	146	752
Russian conference	8	20	27	19	57	74	187	392
Foreign conference	87	61	94	105	119	151	147	764
Additional paper	149	153	200	396	602	745	697	2942
Headhunted author	21	53	57	165	194	202	238	930
Predatory journal				2	8	14	9	33
HSE	172	275	428	657	930	1158	1614	5234
Genuine	66	99	158	237	341	418	603	1922
Russian journal	42	48	81	83	130	137	212	733
Russian conference	11	24	19	30	49	58	136	327
Foreign conference	25	41	56	128	104	156	131	641
Additional paper	25	49	78	113	209	271	390	1135
Headhunted author		6	33	57	82	90	126	394
Predatory journal	3	8	3	9	15	28	16	82
MISIS	162	332	376	418	603	802	1096	3789
Genuine	26	46	62	86	162	187	262	831
Russian journal	93	206	192	204	197	258	272	1422
Russian conference	2	13	15	14	5	39	67	155
Foreign conference	28	44	72	46	63	66	53	372
Additional paper	11	17	14	44	90	173	344	693
Headhunted author	2	4	16	21	73	78	88	282
Predatory journal		2	5	3	13	1	10	34
NSU	668	832	1001	1191	1734	2221	2724	10,371
Genuine	74	81	146	171	165	171	140	948
Russian journal	110	91	102	115	134	128	133	813
Russian conference	24	19	13	3	35	62	314	470
Foreign conference	69	130	112	101	138	128	186	864
Additional paper	288	393	373	482	779	1188	1359	4862
Headhunted author	102	118	255	316	480	533	578	2382
Predatory journal	1			3	3	11	14	32
RUDN	216	217	233	257	274	323	684	2204
Genuine	54	61	60	78	85	92	151	581
Russian journal	108	105	129	124	100	105	164	835
Russian conference	13	4	9	7	11	18	40	102
Foreign conference	7	12	13	16	14	24	49	135
Additional paper	21	25	15	21	43	40	133	298

Table 6 continued

	2010	2011	2012	2013	2014	2015	2016	Total
Headhunted author	6	7	6	7	9	18	42	95
Predatory journal	7	3	1	4	12	26	105	158
LETI	99	125	126	170	293	381	530	1724
Genuine	12	15	22	27	42	45	42	205
Russian journal	41	58	49	57	75	67	73	420
Russian conference	7	9	11	20	70	151	307	575
Foreign conference	27	25	24	38	54	65	52	285
Additional paper	9	15	14	16	36	37	41	168
Headhunted author	3	2	6	12	15	14	15	67
Predatory journal		1			1	2		4
SamNRU	193	194	214	205	443	610	825	2684
Genuine	25	32	38	48	89	71	109	412
Russian journal	113	106	117	93	159	164	143	895
Russian conference	6	8	12	9	32	111	281	459
Foreign conference	24	21	22	32	47	137	145	428
Additional paper	24	26	21	19	37	86	91	304
Headhunted author	1	1	2	4	21	15	23	67
Predatory journal			2		58	26	33	119
SFU	232	275	274	313	425	498	591	2608
Genuine	40	46	47	62	79	92	106	472
Russian journal	74	95	98	114	142	148	166	837
Russian conference	16	12	19	21	29	55	84	236
Foreign conference	33	36	30	24	29	37	31	220
Additional paper	64	76	71	79	107	121	152	670
Headhunted author	5	9	7	12	17	29	26	105
Predatory journal		1	2	1	22	16	26	68
SUSU	171	107	110	135	231	428	498	1680
Genuine	18	17	24	36	40	55	67	257
Russian journal	107	64	59	50	113	133	122	648
Russian conference	6	2		3	18	129	191	349
Foreign conference	29	17	18	29	26	68	43	230
Additional paper	11	7	6	4	6	10	27	71
Headhunted author			3	12	22	19	34	90
Predatory journal				1	6	14	14	35
SPBPU	379	431	484	567	1232	1550	1545	6188
Genuine	83	91	103	145	218	241	238	1119
Russian journal	165	158	158	137	239	324	286	1467
Russian conference	18	13	11	33	98	148	394	715
Foreign conference	65	95	109	122	141	272	188	992
Additional paper	38	62	78	87	273	420	284	1242
Headhunted author	9	12	24	41	103	125	125	439
Predatory journal	1		1	2	160	20	30	214
Sechenov	122	161	181	254	292	347	559	1916

Table 6 continued

	2010	2011	2012	2013	2014	2015	2016	Total
Genuine	11	29	21	33	51	53	151	349
Russian journal	91	92	120	155	147	175	194	974
Russian conference	2					3	4	9
Foreign conference	4	6	7	5	4	7	13	46
Additional paper	11	23	25	34	48	62	146	349
Headhunted author	3	9	8	24	39	43	36	162
Predatory journal		2		3	3	4	15	27
TPU	212	288	555	427	1349	1692	2918	7441
Genuine	39	70	66	102	153	220	388	1038
Russian journal	99	133	131	128	158	214	210	1073
Russian conference	14	5	239	18	425	779	1649	3129
Foreign conference	39	55	71	52	102	138	174	631
Additional paper	14	17	32	50	118	184	309	724
Headhunted author	7	6	14	32	81	115	166	421
Predatory journal		2	2	45	312	42	22	425
TSU	278	402	356	463	1216	1942	2254	6911
Genuine	54	81	68	93	149	218	354	1017
Russian journal	130	175	149	190	206	258	212	1320
Russian conference	13	17	23	13	230	487	668	1451
Foreign conference	31	52	35	46	114	103	171	552
Additional paper	45	64	56	69	312	669	629	1844
Headhunted author	5	13	25	51	135	186	204	619
Predatory journal				1	70	21	16	108
UTMN	11	16	24	61	101	148	233	594
Genuine	2	3	5	11	10	20	38	89
Russian journal	7	11	17	18	21	27	63	164
Russian conference	1				1	3	18	23
Foreign conference	1	1	1	1	2	5	7	18
Additional paper		1	1	2	2	5	26	37
Headhunted author				29	63	73	54	219
Predatory journal					2	15	27	44
UrFU	447	472	717	1004	1254	1545	1875	7314
Genuine	110	102	145	222	237	343	451	1610
Russian journal	228	233	292	335	345	430	389	2252
Russian conference	19	3	25	21	29	101	244	442
Foreign conference	59	89	113	121	179	201	219	981
Additional paper	16	21	69	110	176	249	395	1036
Headhunted author	11	22	39	87	129	164	156	608
Predatory journal	4	2	34	108	159	57	21	385

Appendix 2

See Table 7.

Table 7 Dynamics of average researcher's efficiency (= publications/author)

University	2010	2011	2012	2013	2014	2015	2016	Average
HSE	1.1	1.1	1.1	1.2	1.2	1.2	1.1	1.1
MIPT	1.0	0.9	1.1	1.1	1.2	1.3	1.2	1.1
UTMN	0.6	0.6	0.8	1.3	1.7	1.4	1.1	1.1
NSU	0.9	0.9	1.0	1.1	1.0	1.1	1.3	1.0
TSU	0.8	0.8	0.8	0.9	1.2	1.4	1.4	1.0
FEFU	0.7	0.8	1.0	1.2	1.2	1.1	1.1	1.0
ITMO	0.8	0.7	0.8	0.9	1.1	1.2	1.2	1.0
SamNRU	0.9	0.9	0.9	0.8	1.0	1.0	1.1	0.9
BFU	1.0	0.7	1.0	0.9	1.0	1.1	0.9	0.9
MEPhI	0.8	0.9	1.0	0.8	0.9	0.9	1.2	0.9
SPBPU	0.9	0.8	0.8	0.8	1.1	1.1	1.0	0.9
UrFU	0.8	0.7	0.9	1.0	0.9	1.0	1.0	0.9
MISIS	0.6	0.8	0.9	0.9	1.0	1.0	1.1	0.9
RUDN	0.9	0.8	0.9	0.8	0.8	0.8	0.9	0.9
KFU	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.8
TPU	0.7	0.7	0.7	0.7	0.9	0.9	1.0	0.8
UNN	0.8	0.7	0.7	0.8	0.8	0.9	0.9	0.8
SFU	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.8
LETI	0.8	0.6	0.7	0.9	0.8	0.8	0.9	0.8
SUSU	0.7	0.7	0.8	0.7	0.8	0.9	0.8	0.8
Sechenov	0.5	0.5	0.7	0.6	0.6	0.6	0.7	0.6
Average	0.79	0.80	0.85	0.88	0.94	0.96	1.00	0.89

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