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R95 **Russian Economy in 2021. Trends and outlooks**. **(Issue 43)** / [V. Mau et al; scientific editing by Kudrin A.L., Doctor of sciences (economics), Radygin A.D., Doctor of sciences (economics), Sinelnikov-Murylev S.G., Doctor of sciences (economics)]; Gaidar Institute. – Moscow: Gaidar Institute Publishers, 2022. – 568 pp.: illust.

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The review “Russian Economy. Trends and Outlooks” has been published by the Gaidar Institute since 1991. This is the 43th issue. This publication provides a detailed analysis of the most significant trends in the Russian economy, global trends in the social and economic development. The work contains 6 big sections that highlight different aspects of Russia’s economic development, which allow to monitor all angles of ongoing events over a prolonged period: global economic and political challenges and national responses, economic growth and economic crisis; the monetary and budget spheres; financial markets and institutions; the real sector; social sphere; institutional changes. The work is based on an extensive array of statistical data that forms the basis of original computation and numerous charts confirming the conclusions.

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6.4. The state of science and innovation in Russia in 2021[2]

In 2021, the sphere of science underwent institutional changes connected with completion of the system of state management of science. Collegiate bodies were created, which contribute to the strengthening of centralization and unification of accountability for budget financing. The state program of scientific and technological development was formed, which now combines all budget expenditures for civil research and development. Priority support for university science continued with a stronger focus on practical applications. The influence

2 This section was written by: *Dezhina I.G.*, Doctor of Economic Sciences, Leading Researcher, Gaidar Institute, Head of the Analytical Department on Science and Technology Development, Skolkovo Institute of Science and Technology.

of the pandemic was clearly noticeable in the field of technological innovations. There was a reduction of internal expenses of companies on research and development with a simultaneous decrease in the intensity of partnerships with academic institutions and universities.

6.4.1. Changing the science management system

2021 saw changes in the system of regulation of academic activity. In addition to the existing structures, two collegial bodies were established — an advisory group under the Council on Science and Education under the President of the Russian Federation, where the strategy of scientific and technological development will be elaborated, and the Commission on scientific and technological development under the Government of the Russian Federation, which coordinates the implementation of the strategy. Two decrees were issued simultaneously — on March, 15 No. 143 "About measures on increase of efficiency of the state scientific and technical policy"[1] (hereinafter — the first decree) and 144 "About some questions of Council at the President of the Russian Federation on a science and formation"[2] (hereinafter — the second decree)

The first decree provides for the establishment, as a permanent body under the RF government, of the Commission for Scientific and Technological Development, which, according to its mandate, will plan and coordinate state scientific and technical policy. The Commission is authorized to coordinate the work of federal bodies of authority, Russian Academy of Sciences, state corporations and development institutes with the aim to provide the coherence of the processes from academic research to the use of their results for the socio-economic development of the country. The powers of the Commission include participation in budget planning for research and development of civil purposes. By its tasks and functions the new body reminds the USSR State Committee on Science and Technology (SCST), [3] though it does not cancel either strategic development carried out by the RF Ministry of Science and Higher Education or the expert function of RAS. Every year by September 1st the Commission would have to provide information to the Presidential Council on the fulfillment of main directions of state scientific and technical policy, state program of scientific and technical development, the most important innovation projects of state importance. The Commission consists of ministers, the president of the Russian Academy of Sciences, the director of the Russian Science Foundation, and a number of governors.[4]

The second decree envisages creation of a consultative group at the Council under the President of the Russian Federation, which consists of scientists and

1 Executive Order pf the President of the Russian Federation of 15.03.2021 No. 143 "On measures to improve the effectiveness of state science and technology policy". URL: http://www.kremlin.ru/acts/bank/46506

2 Executive Order of the President of the Russian Federation of 15.03.2021 No. 144 "On Some Issues of the Presidential Council on Science and Education". URL: http://publication.pravo.gov.ru/Document/View/0001202103150024?index=0&rangeSize=1

3 *Alexander Mekhanik*: Science and technology policy has been revisited. 17.05.2021. URL: https://stimul.online/articles/sreda/nauchno-tekhnicheskuyu-politiku-podvergli-revizii/

4 *Dmitry Chernyshenko*: The Presidium of the Commission for Scientific and Technological Development of Russia was approved. 07.02.2022. URL: http://government.ru/news/44508/

specialists, who are not members of the Council. The group will develop and approve innovative projects of state importance, federal scientific and technical programs on the issues, which require separate decision of the president of the country. It is headed by the secretary of the Council, who is the president's aide ex officio.

Due to the institutional changes that took place, adjustments were made to the state program "Scientific and Technological Development of the Russian Federation" (hereinafter referred to as SP STD).[1] Now all financial resources for civilian research and development are consolidated in the STDP. In addition, the accounting of the results of scientific and technological activity is changing: it is planned that it will be carried out by stages of research and development using the scale of the level of readiness of technologies.[2] Consequently, a unified system of management of scientific and technological activity is introduced.

One of the key indicators of the State Program of Science and Technologies, concerning the volume of financing of research and development, has also been adjusted. Earlier in the ranking of countries by the volume of research and development Russia was to be in the top ten by 2030. Now a more difficult task is set — to take the 7th place. It is possible only on the condition of increasing the volume of extrabudgetary funding and this goal is also set in the Program. By 2030, the share of extrabudgetary expenditures for research and development should amount to 75% of total expenditures, i.e., to increase 2,5 times. However, this index concerns not all SP STD, but only the sub-program on formation and realization of complex scientific and technical programs.[3] The possibility of such a radical change in the ratio between the sources of funding is not obvious, but this goal itself can be considered in a positive way, because so far, the share of the state in funding research and development is excessive.

The NTD GP identifies thematic priorities, some of which the President outlined in his Address to the Federal Assembly.[4] These are pharmaceuticals, energy, climatic aspects and the agro-industrial complex. The GP STD in general follows the priority directions, which were defined in 2016. The Strategy for Scientific and Technological Development of the Russian Federation. Therefore, it is possible to state continuity in the state documents of different levels of the lists of thematic areas, which should receive priority state support.

Complex scientific and technical programs and projects (CSTP) were named as the main tool for implementation of the Strategy of scientific and technological development of the Russian Federation, however by the end of 2021 only one such

1 The RF Government Decree of 22.10.2021 No. 1814 "On Amendments to the State Program of the Russian Federation 'Scientific and Technological Development of the Russian Federation'". URL: http://www.consultant.ru/document/cons_doc_LAW_399365/#:~:text=Постановление%20Правительства%20РФ%20от%2022.10,с%2028%20октября%202021%20года

2 Scale of technology readiness levels is a list of stages of manufacturing and verification of the object of development from an idea to a serial sample, manufactured sequentially by laboratory, pilot, industrial full-scale technology. *Source*: Ministry of Science and Higher Education of the Russian Federation. URL: https://fcpir.ru/upload/medialibrary/955/gt_57_14vn_metodika-ugt-_002_.pdf

3 URL: https:// нтр.рф/indicators-and-ratings/indicator/cube34/

4 Presidential address to the Federal Assembly. 21.04.2021. URL: http://kremlin.ru/events/president/news/65418

program was launched.[1] At the same time, the Coordination Council on the priority directions of scientific and technological development of the Russian Federation considered 14 proposals on the development of CSTP and approved 11 of them.[2] The reason for such slow deployment of CSTPs lies in the extremely complicated system of their approval and reporting. The stimulus for the emergence of new CSTPs could be an established system of management and decision-making in science, which should lead to the development of the selected priority areas. And meanwhile in the Report of RAS "About realization of the state scientific and technical policy in the Russian Federation" it was stated that Russia continues to be a leader only in the field of defense technologies (*Table 9*).[3]

Table 9

Global leaders in key technology areas

Technology areas	Rating of leading countries				
	1	2	3	4	5
Agriculture, foodstuffs	USA	China	India	Brazil	Japan
Medicine, biotechnologies	USA	Great Britain	Germany	Japan	China
Nanotechnology, new materials	USA	Japan	Germany	China	Great Britain
Energy	USA	Germany	Japan	China	Great Britain
Defense, security	USA	**Russia**	China	Israel	Great Britain
Electronics, computer memory	USA	Japan	China	South Korea	Germany
Software, information management	USA	India	China	Japan	Germany
Car industry	Japan	USA	Germany	China	South Korea
Aviation, rail transportation	USA	Japan	China	Germany	Франция

Source: RAS's report "On the implementation of state scientific and technical policy in the Russian Federation". 2021. P. 35.

Another tool to stimulate large-scale development appeared in October: The Government Edict dated 06.10.2021, No. 2816-p defined a list of 42 major projects (strategic initiatives) of socio-economic development of the Russian Federation until 2030. As for technological projects, those were priority areas related to agro-industrial

1 The name of the program is "Creation of Pilot Production of Domestic Protein Components - the Basis of Dry Dairy Products for the Nutrition of Newborns and Children up to 6 Months of Age". It was approved by the Government Edict of 20.07.2021 No. 2010-p. *Source*: The government approved an innovative project for the production of components for dry milk mixes. 22.07.2021. URL: http://government.ru/news/42846/

2 RAS's report "On the implementation of state scientific and technical policy in the Russian Federation" (approved by the RAS's general meeting held on April 20-21, 2021).

3 Clarivate Analytics' 2021 analysis of research fronts based on the publication activity of countries (according to the Scopus database) generally confirms this conclusion. According to Clarivate, Russia ranks 18th in the world in the degree of influence on the development of various scientific fields, with a relatively better position in physics (14th place in the world) and mathematics (15th place in the world). *Source*: Research Fronts: Active Fields, Leading Countries // Clarivate. 2021. P. 10.

complex (AIC), energy sector as well as new means of transportation. The idea is to link "national programs, national projects and national goals" through strategic initiatives into a single whole.[1]

In general, the idea of centralized regulation, planning and budgeting, as well as end-to-end assessment by stages of the innovation cycle is implemented. In this case, the stages of the innovation cycle will be determined on the basis of the scale of technology readiness, which is more applicable to the assessment of applied and experimental developments, but not for fundamental research.

6.4.2. Sources and scale of science funding

Financing of science in 2021 declined with a simultaneous decrease in the share of extrabudgetary sources of funding. According to preliminary estimates, last year the level of domestic spending on research and development fell to 0.9% of GDP.

The share of extrabudgetary funding in many academic institutions dropped as the pandemic led to a reduction in the number of domestic industrial partners.[2] At the same time, due to sanctions, revenues from foreign customers went down and international cooperation itself became more complicated. In this context, amendments to the law "On Education" concerning educational activities and affecting the organization of international academic cooperation were discouraging.[3] The law gives the government the authority to determine the procedures and forms of educational activity. These amendments are in line with the regulation introduced in 2012 by the Federal Law "On Foreign Agents"[4] and, as a follow-up to it, the law on undesirable foreign organizations in May 2015.[5]

Educational activities are defined broadly — as "carried out outside of educational programs..., aimed at dissemination of knowledge, experience, formation of abilities, skills, values and competence for the purpose of intellectual, spiritual, moral, creative, physical and (or) professional development of a person, satisfaction of his educational needs and interests". In terms of international academic cooperation the innovations are as follows:

- International cooperation of educational institutions will be coordinated by federal agencies to prevent negative foreign interference in the educational process;

1 Meeting of the Council for Strategic Development and National Projects. 19.07.2021. URL: http://kremlin.ru/events/president/news/66217

2 *Volchkova N*. With a "minus" sign. Union activists assessed the interim results of the academic year // Poisk. 10.09.2021. No. 37. P. 3.

3 The amendments came into force on June 1, 2021. Source: Federal Law "On Amendments to the Federal Law 'On Education in the Russian Federation'" No. 85-ФЗ of 05.04.2021. *Source*: Official Internet Portal of Legal Information. URL: http://publication.pravo.gov.ru/Document/View/0001202104050036?index=5&rangeSize=1

4 Federal Law "On Amendments to Certain Legislative Acts of the Russian Federation Regarding Regulation of Activities of Nonprofit Organizations Performing the Functions of a Foreign Agent" of 20.07.2012 No. 121-FZ. URL: http://www.consultant.ru/document/cons_doc_LAW_132900/

5 Federal Law "On Amendments to Certain Legislative Acts of the Russian Federation" of 23.05.2015 No. 129-ФЗ. URL: http://publication.pravo.gov.ru/Document/View/0001201505230001?index=0&rangeSize=1

- Educational organizations will be able to conclude contracts with foreigners and foreign organizations only after receiving a conclusion from the Ministry of Science and Higher Education of the Russian Federation or the Ministry of Education.

To develop the provisions of the Law, the Ministry of Education developed a draft order containing strict regulatory norms, but the draft was withdrawn owing to a significant number of negative comments on the regulation.gov.ru portal. In September, there appeared a draft order of the Ministry of Science and Higher Education of the Russian Federation, which contained milder normative regulation, but it still dramatically raised the level of control over international cooperation and its forms. Despite the fact that the Ministry refused the idea to conduct expert examination of agreements on international academic cooperation before their conclusion, and only twice a year consider already concluded agreements,[1] the suggested form of accounting presupposes collection of rather detailed information on international cooperation.

The regulation applies only to those research institutes and universities that receive budgetary funds for research and development, and this is the majority of institutions in the science sector of the country. Accounting of contracts will be carried out by the federal budget institution — Scientific and Technical Institute of Inter-Branch Information.[2] At the same time, the organization participating in the international project should send to this institute a form (record card), in which a rather extensive amount of information is requested:

— the name of the contract and the field of science to which it relates;
— date of signing the contract, implementation timeline;
— participating institutions on the Russian and foreign side;
— a summary of the work and expected results;
— planned rights sharing to the results of intellectual activity;
— a list of persons who have access to state secrets and participate in the implementation of the contract;
— planned trips abroad for specific project participants.

This list indicates that international cooperation is being placed under close scrutiny. The question remains open as to how information, including personal and sensitive data, will be compiled and used. This regulation proposed by the Ministry of Science and Higher Education of the Russian Federation is still a draft order, but in all likelihood it will be adopted.

In view of this, the new legislation restricts the international activity of educational institutions, including complicating the invitation of foreign specialists. Meanwhile, international cooperation is gradually decreasing, if we evaluate it by the dynamics of the number of scientific articles in foreign co-authorship. This trend is the opposite of what is happening in world science. In 2014, there were around 27% of Russian publications in international co-authorship (of the total

1 The Ministry of Education and Science will require research institutes and universities to register agreements on international cooperation // TASS. 22.09.2021. URL: https://tass.ru/obschestvo/12476563

2 URL: http://www.consultant.ru/cons/cgi/online.cgi?req=doc&base=PNPA&n=78137#6me1vqSz3ot1d4c

decline over 5 years was 5 p.p.[1] At the same time, Russia is not a major partner for any of the 25 countries with the largest number of publications.[2] Recent examples are characteristic of the pattern of cooperation between researchers on COVID-19. Judging by the international publications in co-authorship, Russia was outside the collective efforts of researchers from different countries.[3]

Finally, the number of private domestic foundations allocating funds for academic research is not growing (there are very few such foundations, and those that exist have very modest budgets). In foreign countries it is one of the important sources of funding of science, especially socio-humanitarian and biomedical.

Thus, the state budget remained the main source of funding of science, and against the backdrop of reduction of other sources its importance increased. The main peculiarity of budgeting of state expenditures on civil research and development was their concentration within the framework of the state program of scientific and technical progress. Changes also took place in connection with reformation of scientific funds — the Russian Foundation for Basic Research (RFBR) and the Russian Science Foundation (RSF), which entailed essential redistribution of funds for basic research between them. Due to the fact that the main grant competitions were transferred to the competence of the Russian Foundation for Basic Research, its budget grew, and it is planned to increase annually, although unevenly. It is worth noting that in the beginning of the reform of scientific funds the government emphasized that the total budget of the Russian Foundation for Basic Research and the Russian Foundation for Basic Research will not change. However, the budget for 2022—2024 testifies to the contrary. There is a clear reduction of budget appropriations for competitive grant research (*Table 10*). According to the budget for 2021—2023, the sum of financing of the two funds was to amount to Rb47 bn in 2022 and Rb47.3 bn in 2023. However, in the new budget the total financing of RFBR and RFF will amount to only Rb37.9 bn in 2022 and Rb41.7 bn in 2023.

Table 10

Public allocations for fundamental research

Type of expenses	2022	2023	2024
Fundamental research (subdivision of the FCD), Rb bn	227.4	254.2	256.9
Share in total expenditures on civilian R&D, %	*49.2*	*53.3*	*53.8*
Russian Foundation for Basic Research	12.1	6.0	18.3
Russian Science Foundation	25.8	34.7	28.0

Sources: Appendix 10 to the explanatory note, Appendices 11 and 14 of Federal Law No. 390-FZ of 06.12.2021 "On the Federal Budget for 2022 and for the Planning Period of 2023 and 2024"; own

1 Indicators of science: 2016. Statistical compendium. M.: NRU HSE, 2016. P. 286; Indicators of science: 2021. Statistical compendium. M., 2021. S. 331.

2 According to the Scopus database, for the period 2015–2020. *Kwiek M*. The Globalization of Science: The Increasing Power of Individual Scientists // The Oxford Handbook of Education and Globalization / ed. P. Mattei, X. Dumay, E. Mangez, J. Behrend. Oxford: Oxford University Press. 2021.

3 American Academy of Arts and Sciences. America and the International Future of Science. Cambridge, Mass.: American Academy of Arts and Sciences, 2020. P. 10.

calculations.

On the whole, the growth of budget allocations for civilian research is planned only for 2023, and only by 3%. It means stagnation of financing of civilian science, while even now the expenses for it are at the level of 1% of GDP. At the same time the expenses on fundamental research[1] will be growing at a rate of 8—10% per year, and by 2024 their share should reach 53,8%.[2] Meanwhile, in absolute terms they became a little less than it was planned in the last budget cycle.

The item of expenses on fundamental research is also notable for the level of financing of separate organizations. The allocations for fundamental research carried out at the Kurchatov Institute R&D Center will be growing at a fast pace. By 2024, they should grow 2.2-fold in comparison with 2022 and make Rb13,6 bn. For comparison, the growth of allocations to fundamental research carried out at Lomonosov Moscow State University over the same period of time is planned to be equal to 9%, so that by 2024 they will reach Rb4.8 bn. In the meantime, the Kurchatov Institute continues to expand by adding new institutions to its ranks. In 2021, such affiliated institution became the All-Russian Research Institute of Aviation Materials which joined SIC on the basis of the decree of the RF Government Edict of 21.04.2021 1032-r. [3]

The national project "Science and Universities" is the main beneficiary of budget redistribution. Appropriations for it will increase by 5—8% compared to Law No. 380-FZ. Nevertheless, the increase in funding applies only to two of the four federal projects included in the National Project. It is worth noting an 11—15% increase in funding in 2022—2023 for the federal project "Development of Integration Processes in Science, Higher Education and Industry", which is important in view of the weak links between science and higher education institutions and the private commercial sector. Positive changes also include an 18-20% increase in R&D infrastructure spending during 2023—2024 under the federal project "Development of Research and Training Infrastructure", as the low research equipment renewal rate is becoming a growing problem. Meanwhile, a significant reduction (by 2024 — nearly by half) is provided for the least resource-intensive Federal Project "Human Capital Development for Regions, Industries and the Research and Development Sector". The Federal Project "Development of Large-Scale Scientific and Scientific-Technological Projects in Priority Research Areas" is also expected to see a slight reduction in allocations. In particular, competence centers of the National Technological Initiative are financed within its framework. On the whole, the proposed redistribution of funds between federal projects of the National Project "Science and Universities" should be recognized as reasonable.

1 Defined in the budget classification line "fundamental research" (0110) of the section "National issues".

2 This tendency corresponds to the trends of European countries, but is opposite to what is happening, for example, in the USA, where state financing of fundamental research is gradually decreasing in favor of applied and experimental works. There the share of budget appropriations for fundamental research fell to 42%. *Source*: The State of U.S. Science and Engineering 2020. URL: https://ncses.nsf.gov/pubs/nsb20201/u-s-r-d-performance-and-funding#federal-r-d

3 URL: http://publication.pravo.gov.ru/Document/View/0001202104220013

The Fund for Assistance to Small Innovative Enterprises in Science and Technology is again in a negative trend. Budget allocations for its activity will remain practically unchanged in the course of three years (in the range of Rb14.3—14.6 bn), while in the budget for 2021—2023 it was planned to increase the allocations to Rb17.4 bn in 2023. Taking into account that for small innovative business it is one of the main sources of financing of research and development, stagnation of the budget of the Fund may negatively affect the small science-intensive enterprises sector.

Thus, the volumes of the planned budgetary allocations for civilian science are decreasing in comparison with the indicators of the previous planning period. Simultaneously the imbalance between the directions of expenses grows, which is especially evident from parameters of financing of separate organizations of the sphere of science and higher education and the chosen projects.

6.4.3. Human resources and science outcomes

The Global Innovation Index, released in 2021, again showed that the weakest components of the Russian innovation system are the quality of public administration and the degree of compliance with laws.[1] The country invariably takes higher positions by the resources invested than by the results obtained. At the same time the quality of human capital in the Russian innovation system is rated the highest.[2]

That said, the staffing situation in science is not developing according to the optimal scenario. The number of researchers for the year declined by 0.5%, which, although a little, is a stable trend. Since 2015, the number of researchers has fallen by nearly 9%.[3] At the same time, the share of researchers aged 30—39 continued to drop as the youngest cohort — up to 29 years old — continued to grow. This means that the field of science is not becoming more attractive for graduates of universities and graduate schools.

The "brain drain" in Russian science has decreased, but has not stopped. The inflow of personnel to the country was modest: according to a survey conducted by the Higher School of Economics, in 2021 678 foreign researchers came to the country (in 2019—815), and most of them do not have a degree, which means they are not specialists of the highest qualification. The main influx of personnel came from countries such as Kazakhstan, Belarus, Ukraine, China, and Germany.[4] At the same time, they mainly go to countries with developed science, which means that they are quite competitive specialists.[5] The spread of emigration among scientists,

1 Global innovation Index 2021. URL: https://www.wipo.int/global_innovation_index/en/2021/?gclid=EAIaIQobChMIxeXFqYjh9AIV8xJ7Ch3WvglqEAAYASAAEgJkYfD_BwE

2 Through general quantitative indicators-such as the number of graduates in science and engineering-the proportion of women among those with candidate of sciences and doctoral degrees.

3 *Ratai T., Tarasenko I.* The Scale of Employment in Russian Science // Science. Technologies. Innovations. Express information. Moscow, NRU HSE. 13.10.2021.

4 *Vasilieva A.* The Russian Field of Scientific Experimentation // Kommersant. 04.02.2022. No. 20. C. 3. URL: https://www.kommersant.ru/doc/5195522

5 *Guskov A.E., Selivanova I.V., Kosyakov D.V.* Migration of Russian Researchers: Analysis Based on the Naukometric Approach // Biosphere. 2021. No. 1. P. 14.

despite the pandemic, has also become significant. Every third researcher would prefer to continue their research career abroad, and of the scientific youth up to 39 years old — almost every second.[1] So, in the circulation of academic personnel, the quality of the inflow gives way to the outflow of.

The source of replenishment of higher qualification personnel - postgraduate education — has been in crisis in recent years. The proportion of graduates who have defended a dissertation by the time they graduate stands at about 9%, whereas in 2010 it was 28.5%.[2] Since 2012, graduate school has become the third level of higher education, so it does not have to end with the defense of a thesis, which, among other things, led to such a drop in the level of defenses. Characteristically, this trend is the opposite of global trends.[3] A positive change may occur next year, as the legislative regulation of graduate school is changing as of March 1, 2022. It will now become mandatory to submit your thesis for defense by the time you graduate from graduate school. In addition, the institution will have the right to hire a graduate student in a full-time position, including a researcher or teacher, as well as to pay for the work from grants. So far, with low graduate student stipends, only 60% of graduate students have been included in any research projects at their institutions.[4] However, it is not only regulatory problems that have caused such a drop in the number of defenses. On the one hand, the conditions that are given to scientists for work, and on the other hand, the pressurizing system of formal requirements for scientific results play a role. This view is supported by the fact that young researchers tend to view adequate funding, minimal bureaucracy and freedom of scientific creativity as key factors in their decision to pursue science.[5] While in science the opposite condition to desires of young scientists is fixed: financing is modest, and bureaucracy grows.[6]

Despite human and financial constraints, performance indicators, measured by the number of publications indexed in international databases, continued to grow. Russia's share reached 3.06% of the global publication flow[7] and entered the world's top 10 countries by this indicator. At the same time, the citation rate of Russian articles was lower than the world average, amounting to 0.74 in 2021, while the world average was 1.0. In 2019, this index was 0.75, i.e. the level of interest in Russian publications is not growing.[8] In terms of the number of highly

1 According to a survey conducted in 2021 on a sample of 7200 people representing various scientific fields, universities and academic institutions from 80 regions of the Russian Federation. See: *Gusev A.B., Yurevich M.A.* Russia's Science Policy – 2021. Moscow. Buki Vedi, 2021. P. 67.

2 *Nefedova A*. The Russian postgraduate school is becoming internationalized // Science. Technologies. Innovations. Express information. Moscow. NRU HSE. 21.05.2021.

3 *Terentiev E.A., Kuzminov Ya.I., Frumin I.D.* Science without youth? The Crisis of Graduate Studies and Possibilities of Overcoming It. Moscow. NRU HSE, 2021.PC. 11.

4 Ibid. P. 20.

5 *Gusev A.B., Yurevich M.A*. Russia's Science Policy – 2021. Moscow. Buki Vedi, 2021.

6 This is particularly evident in resource-intensive initiatives, such as Project 5-100. Its research participants constantly complained about the growing bureaucracy, and this is reflected in numerous studies.

7 Scopus data base. *Source*: National Science Foundation, URL: https://ncses.nsf.gov/pubs/nsb20214/publication-output-by-country-region-or-economy-and-scientific-field

8 Overview of Research Activity in Russia: Productivity, Quality, Use of Resources // Elsevier. 2018–2021; Elsevier. Февраль 2022 г. С. 6.

cited scientists, the country is in 33rd place with a share of 0.09% of the global indicator. In absolute terms it looks tragic: there are only 6 such scientists in Russia, whereas in the USA there are 2,650, in China — 770, in Germany — 345.[1] Thereafter, the policy of increasing the visibility of Russian science through the growth of its productivity has demonstrated obvious quantitative successes, but has not yet affected the quality of academic research.

The rapid growth in the number of publications is now occurring worldwide, and this is cause for some concern, since it is leading to a decline in the number of original ideas. A recent study based on 90 million articles in 241 subject areas and almost 2 billion citations shows that the growth of new ideas is minimal.[2] On top of that, increasingly formalized requirements for the structure of scientific articles lead to the canonization of widely cited authors, which ultimately becomes a brake on development. Thus, in terms of "scientific performance problems," Russian science has fit into the global context, giving an example of contrasting achievements — high growth rates of quantity with relatively low quality.

6.4.4. Initiatives to support and promote science

Last year, several large-scale programs were completed, first of all Project 5-100 and the Program of Basic Academic Research, and new programs — "Priority-2030" and the program of basic academic research to 2030 were initiated. In addition, the selection of world-class research and education centers (RECs) continued, and the creation of carbon polygons commenced — a tribute to the rapidly expanding global environmental and climate agenda.

Project 5-100 and "Priority-2030"

In 2021, Project 5-100 ended, and it was replaced by the federal Program "Priority 2030". All the universities participating in Project 5-100 (these are 21 universities) continued to receive additional budget funding under the new initiative. However, the programs have only partial continuity. The number of participating universities in Priority 2030 has grown significantly (to 106, of which 5 are creative universities), and two tracks of development have emerged: (1) to achieve research leadership and (2) to promote territorial development.

Last year the results of Project 5-100, for the implementation of which around Rb80 bn were allocated, were summed up. At the beginning of the year, the Accounting Chamber issued a report summarizing the project's achievements and problems. The key conclusion is that Project 5-100, which is aimed at bringing five Russian universities into the first hundred in the world rankings by 2020 (ARWU, THE and QS) did not reach this goal. At the same time, according to bibliometric indicators the high schools participating in Project 5-100 have achieved great

1 *Weiss A*. New Tools, Old Tricks: Emerging Technologies and Russia's Global Tool Kit. Carnegie Endowment for International Peace, 2021. P. 17. URL: https://carnegieendowment.org/files/202104-Weiss_Russia_Global_Tool_kit.pdf

2 *Chu J.S.G., Evans J.A.* Slowed canonical progress in large fields of science // PNAS. 2021. Vol. 118. No. 41. URL: https://www.pnas.org/content/pnas/118/41/e2021636118.full.pdf

success, including in comparison with the sphere of Russian science in general (*Table 11*).

Table 11

Publications of Project 5-100 universities, % of the total number of Russian publications

Year	Share of publications in Web of Science, %	Share of publications in Web of Science, in first quartile magazines, %
2012	17.4	19.7
2019	33.3	47.7

Source: Report on the results of the expert-analytical event "Analysis of the effectiveness of measures of state support of Russian universities, aimed at improving their competitiveness among the world's leading research and educational centers". // Accounting Chamber. 02.02.2021. P. 3, 20.

Nevertheless, some data indicate that the increase in the number of articles was obtained at the expense of their quality.[1] In particular, it was this project's universities that actively used strategies to rapidly raise the number of publications — from hiring highly cited authors to publishing in "predatory" journals. The loss of quality in the pursuit of quantity is evidenced by the fact that the citation of the papers of the universities participating in Project 5-100 is several times lower than the average for the referring universities, i.e., foreign universities of comparable size and profile.[2]

However, the more serious problem of the Project was the growing gap between the participating universities and the rest of the universities.[3] The hope that Project 5-100 would create centers of growth, which would pull up all the others, has not been realized. Moreover, in a number of cases the stratification was exacerbated by monopolization, as the strongest professors and researchers from other universities began to move to Project 5-100 universities to work.[4]

The opinion of the academic community on the results of Project 5-100 is also of interest: like the Accounts Chamber, the majority of researchers considered the project to have failed to achieve its goals. Characteristically, there were more pessimists among university employees than the average for the sample (*Table 12*).

The long-term state support of a small number of selected universities has not had a serious effect on the state of university science, and, moreover, signs of stratification have increased, including in the group of "selected" universities themselves. This is confirmed by the opinion of the Minister of Science, according

1 *Trubnikova E.I.* The 5-100 Project: A View Through the Prism of Institutional Corruption Theory // Mir Rossii. 2020. Vol. 29. No. 2. P. 72–91.

2 *Dezhina I.G.* Winner's Choice" in Contemporary Russian Science Policy // Public Administration Issues. 2021. No. 3. P. 59.

3 *Lovakov F., Panova F., Sterligov I., Yudkevich M.* Does government support of a few leading universities have a broader impact on the higher education system? Evaluation of the Russian University Excellence Initiative // Research Evaluation. 2021. URL: https://doi.org/10.1093/reseval/rvab006

4 *Vasilieva A.* Russian universities have picked up their rankings. Educational institutions are in the top 100, but not those // Kommersant, 09.04.2021. URL: https://www.kommersant.ru/doc/4763225

Table 12

Opinion of representatives of the academic community on the results of Project 5-100

Answer option	Percentage who chose this answer, all respondents, %	Percentage of university employees who chose this answer, %
Success	14.7	17.6
[redacted]		
I have no information	39.2	34.9
Hard to answer	9.3	8.6
Total	100	100

Source: Compiled on data from: *Gusev A. B., Yurevich M.A*. Russia's Scientific Policy – 2021. Moscow: Buki Vedi, 2021. P. 42.

to which the level of academic research is "the Achilles' heel of most Russian universities; there is no real science in some of them. Such a result may be related to the way in which Project 5-100 formulated its goals: the emphasis was placed on parameters related to national prestige (getting into the ratings), rather than on the development of science as such.

At the end of June 2021, the Russian Ministry of Science and Higher Education announced the launch of the 10-year "Priority-2030" program aimed at improving competitiveness of Russia in the sphere of education, science and technology. Consortiums of higher educational institutions (not necessarily legally registered) with each other and/or with academic institutes became an important element of the program.[1] Immediately after the announcement of the new program such consortia began to be created, mainly on a regional basis.[2] To all appearances, this activity is stimulated by the desire to receive funds from the program, as nothing prevented the consortiums from joining together to resolve various tasks in the past as well.

"Priority" winners were selected in October 2021.[3] In fact, there are three directions in the program. The first is made up of 17 universities, which receive basic funds and additional funding for achieving "research leadership". The second is made up of 28 higher educational institutions, which are also granted extra funds for achieving "territorial and/or sectoral leadership". The third direction is the remaining 61 universities, which receive only the basic part of financing to the tune of Rb100 mn. The total financing of Priority-2030 program through the end of 2022 will make more than Rb47 bn. As it was in Project 5-100, the winners of the first and second directions are divided into three groups, which differ in the volume of additional funding. The proportions remain practically the same as they were in Project 5-100: in addition to the base part by the end of 2022 the universities of the first group will receive Rb994 mn, the second — Rb426 mn, the third — Rb142 mn.

1 *Falkov V.N*. Priority 2030 program will help to reduce the gap between universities // TASS. 02.04.2021. URL: https://tass.ru/obschestvo/11056067

2 Russian Ministry of Science and Higher Education. Twelve consortiums were created to participate in the Priority 2030 program. 12.07.2021. URL: https://minobrnauki.gov.ru/press-center/news/?ELEMENT_ID=36637

3 URL: https://minobrnauki.gov.ru/documents/?ELEMENT_ID=40845

The novelty of Priority-2030 is that it has a rotation mechanism. That is why next year the universities that did not receive funds under the program or did not apply for the competition will be able to take part in the new selection. In particular, there will be a rotation among the first and second choice universities, which will be granted extra funding. In addition, the state's expectations from Priority 2030 universities are clearly formulated, including their scientific work. The minimum requirements are imposed on the universities, which will receive only the basic part of the grant. The efficiency of their scientific activity will be estimated by the traditional indicators: the volume of research and development per one scientifically-pedagogical employee (SPE) and the volume of expenses on research and development from own funds per one SPE.

Additional evaluation parameters for those striving to become leaders in research: the number of publications, which will be counted according to stricter criteria than it was in Project 5-100 (only articles in the first and second quartiles of Web of Science and Scopus will be taken into account), the amount of income from the results of intellectual activity per one scientific employee, which is also difficult to fulfill. It is worth noting that the tightening of the parameters of scientometric evaluation is in opposition to global trends, where the influence of scientometrics is fading. In particular, European countries are beginning to prohibit by law the use of research chops (such as impact factors of journals) when addressing any personnel issues.[1]

The universities in the track of territorial or sectoral leadership will be additionally assessed according to the following parameters: the number of publications in Web of Science and Scopus for the last 3 years per one employee; the volume of funds from research and development and scientific and technical services under contracts with organizations of the real sector of economy and at the expense of the subject's budget and local budgets per one employee; the volume of income from intellectual activity results per employee. Thus, the requirements for the quality of publications were relaxed for them, but the reporting on attraction of extra-budgetary funds was augmented. At the same time, when selecting universities for this track, the contribution made by applicant universities to their regional economy was not assessed. There is an experience of such evaluation abroad, but in Russia, except for single cases, the evaluations are limited to a set of traditional indicators for science that do not reflect the contribution of universities to the economic development.

Fundamental research program

In 2021, the Program of fundamental research of the state academies of sciences was completed. The main part of the program is a summary of research topics in the context of disciplines. In it, the formulations are given as research descriptions (names), but not what should be studied and why. Only specialists in

1 *Woolston C.* Impact factor abandoned by Dutch university in hiring and promotion decisions // Nature. 25 June 2021. URL: https://www.nature.com/articles/d41586-021-01759-5?fbclid=IwAR1Jly3bHpFIUW6sDTlGvS3Pvv7lT9fd8M2dz9u89VZVe2ehr8yPcDMj31c

the relevant (often quite narrow) fields of knowledge can evaluate whether these works have been performed and how effectively they have been done.

The indexes of achievement of the program's goals were similar to those established for the National Project "Science and Universities. These include the number of articles indexed in the Web of Science database, the proportion of researchers younger than 39 years old, patents, and other formal indicators. Such estimates give little indication of the program's real contribution. Even estimates of citations or changes in the number of highly cited scientists representing the RAS would be more accurate in terms of measuring the impact of the program on the development of Russian basic science and increasing its visibility in the world.

In addition to formal indexes of performance evaluation, the text of the program identified the areas on which its implementation will affect: (1) there will be conditions and prerequisites for intensification of innovation activity, support of the scientific priority of Russia in the global fundamental research, as well as for return of the advanced positions of Russian fundamental science; (2) effective participation of Russia in the international division of labor in the scientific and technical sphere will be ensured.

Indirectly, the level of realization of these intentions can be assessed by Russia's position in the global research fronts. According to Clarivate estimates, in 2021, Russia ranked 18th in the degree of influence of its scientific achievements on the world science. Thus, the best positions the country has in the areas related to physics (14th place) and mathematics (15th place). This indicates that there were no significant disciplinary shifts from what has traditionally been the case. If the program has contributed to a change in the scientific agenda, it is indistinguishable at the level of country generalizations.

The new program of development of fundamental research until 2030 became a sub-program within the State Program Scientific and Technical Research (SP STR). It sets three indexes of achievement of their targets. The first one is the number of scientists who have articles in scientific publications of the first and second quartiles, indexed in international databases (with their number equal to 47,300 by the end of 2020, the objective by 2030 is to have 30,800 such scientists).[1] The other two are spending on fundamental research (currently — 0.19% of GDP, the target is 0.14% of GDP) and the number of areas of scientific specialization, in which Russia ranks among the top ten (currently, leadership is recorded in 14 areas, the target is to remain leaders in 14 areas as well). Thus, for the basic academic research programs, it is planned to raise resources (from an assumption that GDP will grow essentially by 2030) at decrease in requirements to results, and results themselves are not pegged to the purpose of reception of wider return from a science.

World-class scientific and educational centers

Within the framework of the Program for the creation of world-class scientific and educational centers (SEC) five centers were identified, and thus, their total number reached 15 — the limit established in the documents of the program.

1 URL: https://нтф.рф/indicators-and-ratings/indicator/cube6/

The new winning centers turned out to be interregional (*Table 13*), since the experience of the 2020 competition has shown that such applications have a better chance to be supported. At the same time, the number of participants per SEC has settled at 30—40 institutions, regardless of the number of regions participating in a particular SEC. However, the models of SECs are diverse. Among them, it is possible to distinguish those focused on partnership with industry (Perm Krai, Ural SEC) and those relying on academic institutions and universities (Northwestern (Tyumen and others) and Belgorod).

Table 13

Typology of organizations participating in world-class SECs

Region where SEC is located	Number of universities	Number of research institutes	Number of companies	Total
Year of Establishment — 2019				
Belgorod	21	31	22	74
Kuzbass	6	4	14	24
Nizhniy Novgorod region	6	6	16	28
Perm Krai	2	1	27	30
Tyumen region, Yugra, Yamal-Nenets AO	10	13	7	30
Year of Establishment – 2020				
Samara, Penza, Tambov, Ulianovsk regions and Republic of Mordovia	20	6	18	44
Sverdlovsk, Kurgan, Chelyabinsk regions	9	10	48	67
Arkhangelsk, Murmansk regions, Nenets AO	14	8	20	42
Tula region	8	0	16	24
Republic of Bashkortostan	7	3	21	31
Year of Establishment – 2021				
Sakhalin region, Yakutia, Kamchatka Krai, Magadan region, Chukotka AO	8	19	17	44
Krasnoyarsk Krai, Republic of Khakassia, Tyva	9	5	14	28
Irkutsk region, Republic of Buryatia	8	12	15	35
Sebastopol, Crimea	9	9	16	34
Volgograd region, Krasnodar Krai, Postov region	13	8	19	40

Source: Own compilation on data URL: https:// ноц.рф/centers

The peculiarity of the initiative to create SECs is that with a large number of participants and large-scale plans to promote regional development, funding from the federal budget is modest. With a view to SEC, it is from 1 to 13% of the total funding of the center, and in absolute amount it varies at Rb100-200 mn. Regional budget and extra-budgetary funds account for the main share in SECs funding. Nevertheless, the federal budget plays an important symbolic role, reflecting the state support of a particular region and governor. In general, SECs are “governor’s” projects, because federal funding was received by those centers, in which the governor personally participated in the creation of the program. Achievement of performance indexes, thus, is the area of the governor’s responsibility. Amidst

growing centralization of management, it is likely to help mobilize the work of SECs. Meanwhile, it reduces the flexibility of management of centers, sets them primarily to work on indicators. In this case, the indicators of goal achievement are mainly economic, such as gross regional product (GRP) growth, the amount of taxes paid to the regional budget, the change in export volumes, the amount of attracted extra-budgetary funding, etc. It is obvious that research activities in SECs should be applied, practice-oriented. The ability of SECs to meet such indicators is not obvious, and the development of the first five SECs created by an administrative decision in 2019 is still inertial. Apparently, the uncertainty in the development of SECs has been noted at the highest level of management, since last year a plan was announced to rotate SECs. Namely, every year one center in each top five will be replaced by the regional SEC that was among the candidates for competition support. The idea is that this should create competition and thus incentives for development.[1] So far, the principles of rotation have not been worked out; in particular, there are no criteria for evaluation of mono-regional and inter-regional SEC. Besides, following the results of the joint session of the State Council and the Council on Science and Education, past on December 24, 2021, the President instructed to analyze the centers and submit proposals on the revision of programs, including the system of SEC management. The idea of SECs evaluation is justified, in particular, a number of large companies, which have started to cooperate with SECs, do not understand the advantages of this format, as compared to the traditional bilateral partnership "Research Institute (University) — Company".[2]

Carbon polygons

The Russian science policy has not remained aloof from the world trends related to the climate agenda and the need to reduce the carbon footprint. Presented in July 2021 by the European Commission Environmental Green Deal plan assumes a reduction of carbon dioxide emissions by 2030 by 55% compared with 1990 levels.[3] Accordingly, the topic of methods for measuring the "carbon footprint" has become more relevant in the scientific sphere. Moreover, in 2021 there were new calculations of the carbon footprint of scientific activity itself. It has been calculated that if, for example, a scientist sends 30 emails a day, he causes CO2 emissions of around 600 kg per year, and building a communications and information system worth 5,000 euros is equivalent to CO2 emissions of around 2.8 tons per year (without taking into account the carbon impact of its exploitation).[4]

1 From the transcript of the 503rd plenary session of the Federation Council. 14.04.2021. URL: https://leo-mosk.livejournal.com/8727219.html; https://leo-mosk.livejournal.com/8727493.html
2 Science and education centers: hope or a headache for the region. Discussion. Gaidar Forum. 13.01.2021.
3 *Pazi M., Leibin V*. The Science of Green Hype // Expert. November 1, 2021. No. 45. URL: https://expert.ru/expert/2021/45/nauka-zelenogo-khaypa/
4 *Egerev S., Dezhina I.* Science Communication in the Age of the Pandemic: Lessons for Russia // Science Management: Theory and Practice. 2022. No. 1 (accepted for publication).

In Russia, in July, a Federal Law No.296-FZ "On limiting greenhouse gas emissions" (of 02.07.2021) [1] was passed, and the Ministry of Science and Higher Education came up with the idea of building a network of carbon polygons.[2] In July, programs for the development of 7 carbon polygons[3] were approved, by September it was decided to create 14 polygons,[4] and by December — 16.[5] Therefore, last year it was one of the most dynamically developing initiatives. A carbon polygon is an area where greenhouse gases will be monitored and methods will be developed to calculate the ability of the environment to absorb carbon from the atmosphere. To carry out this work, it is planned to allocate federal funding in the amount of several tens of millions of rubles per polygon per year with the presence of parity support from non-budgetary sources.

According to experts,[6] the quality of polygon programs is very different: there are projects of experimental teams, which will produce breakthrough scientific results, and there are projects aimed primarily at the creation of infrastructure, including the construction of campuses. The idea of the Ministry, however, is not only in the development of science, but also in the performance of educational and outreach functions, including raising the level of culture in the field of climate agenda among students and schoolchildren.[7] Therefore, it is planned to link the activities of the carbon polygons with the work of the world-class SECs.[8]

6.4.5. The impact of the pandemic: developing open science

In 2021, attention to the problems of "open science" as a clear consequence of the pandemic intensified. For Russia, moving in this direction can raise the importance of domestic science even while maintaining the current level of productivity.

Last year, UNESCO issued recommendations for open science, stating the forms of open science:[9] open access to scientific knowledge, including scientific publications, open research data, software, code and hardware; open scientific infrastructure; open involvement of public actors; and open dialogue with other

1 URL: https://rg.ru/2021/07/07/fz-ob-ograni4enii-vybrosov-parnikovyh-gazov-dok.html#:~:text=N%20296-Ф3%20"Об%20ограничении%20выбросов%20парниковых%20газов",-Принят%20Гос ударс твенной%20Думой&text=1.,-Нас тоящий%20Федеральный%20закон&text=Целью%20настоящего%20Федерального%20закона%20является,снижении%20уровня%20выбросов%20парниковых%20газов.

2 In 2020, the first carbon polygon was created in Kaluga region.

3 They will be located in the Kaliningrad, Sakhalin, Sverdlovsk, Novosibirsk, Tyumen regions, Chechnya and Krasnodar Krai.

4 URL: https://tass.ru/v-strane/12490843

5 The carbon polygon program was expanded to 16 regions // TACC. 09.12.2021. URL: https://tass.ru/ekonomika/13153387

6 *Romanovskaya A.* The hype surrounding forest-climate projects threatens to falsely prioritize the fight against climate change // Kommersant. 10.08.2021. URL: https://www.kommersant.ru/doc/4928811

7 *Suchkova S.* How Russia creates a network of carbon landfills, and why they are needed // Recycle. 03.11.2021. URL: https://recyclemag.ru/article/rossiya-sozdaet-karbonovih-poligonov-zachem-nuzhni

8 *Astakhov K.* How carbon landfills will help «repair» the planet // Nezavisimaya gazeta.23.11.2021. URL: https://www.ng.ru/science/2021-11-23/12_8308_planet.html

9 UNESCO Recommendation on Open Science. UNESCO, 2021. URL: https://en.unesco.org/science-sustainable-future/open-science/recommendation

knowledge systems. National plans for open science have begun to appear in individual countries. In France, the government released the Second National Plan for Open Science 2021—2024.[1] It plans, among other things, to create a national platform for scientific data, promote open source software policies, and develop open science skills. At the same time, the budget for open science in the country will be tripled.

Regionally, Europe and Asia are moving most vigorously toward open access (accounting for 40 and 33% of open access articles in 2021, respectively). This is where the number of public research foundations demanding open access publication of their funded papers is surging. Consequently, more and more journals are moving towards open access policies. In this case, the authors themselves pay for the publication of articles, as a rule, covered by grants or academic institutions where they work.

The scale of the transition to open access varies greatly across disciplines. The Springer Nature study found that today, of the roughly 1 million open access articles,[2] 44% are in medicine and 17% in the life sciences. At the same time, the number of articles in the social sciences and humanities is escalating: their share of open access articles doubled between 2015 and 2020, although it is more difficult for them than for the natural and technical sciences due to a lack of funding to pay for publishing articles. This study also confirmed that when an article is published in open access, the number of its readers expands dramatically — on average, each such article is cited 1.63 times more often[3] than articles in closed access, and they have a markedly higher number of downloads. In Russia, the transition to open access publications will require, first of all, revision of the budgets of both foundations, scientific institutions and higher educational institutions.

The next direction, moving to open data, is even more controversial. In theory, it could lead to the collapse of international collaboration if access to such data no longer requires personal relationships. Open data, on the other hand, can facilitate connections for sharing by researchers from different countries. So far, measurements of COVID-19 research collaborations demonstrate that scientists are reluctant to share their data with other researchers. In particular, only 9% of articles on coronavirus topics contained appendices of raw data.[4] In the meantime, there were even fewer articles on other topics with open data — only about 1% of the total number.

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1 Second French Plan for Open Science. Generalising open science in France. 2021–2024. URL: https://www.ouvrirlascience.fr/second-national-plan-for-open-science/

2 *Inchcoombe S.* Guest Post: What Can We Learn from One Million Open Access Articles? Scholarly Kitchen. 07.12.2021. URL: https://scholarlykitchen.sspnet.org/2021/12/07/guest-post-what-can-we-learn-from-one-million-open-access-articles/?utm_medium=email&utm_source=FYI&dm_i=1ZJN,7NTVH,E29D5V,V7QHC,1

3 Going for Gold: Exploring the Reach and Impact of Gold Open Access Articles in Hybrid Journals. While Paper. Springer Nature. 2021, P. 3. URL: file:///D:/Library/Downloads/Going%20for%20gold%20white%20paper%20(Springer%20Nature).pdf

4 *Grove J.* Data sharing on Covid research ‘disappointing’, says EU chief // Times Higher Education. 26 May 2021. URL: https://www.timeshighereducation.com/news/data-sharing-covid-research-disappointing-says-eu-chief?utm_source=newsletter&utm_medium=email&utm_campaign=editorial-daily

The politics of data discovery are directly related to the formation of different platforms. The pandemic pushed the creation of open platforms even further, showing the importance not only of rapid and open publication of research, but also of real-time collaboration among academics to achieve a common goal quickly.

Therefore, there are both more accessible tools of scientific inquiry and new financial models, which, in turn, affect the work of institutions and research teams.

In Russia, participation in the development of open science is manifested mainly at the level of individual journals, rather than scientific policy as a whole. In the academic community, pirate libraries of scientific literature (for example, Sci-Hub, a platform for circumventing paid access to publications) have become the most popular tool for open science, due to the fact that not all academic institutions are able to pay for full access to library resources. A recent blitz survey of more than a thousand Russian researchers showed that at least half of them would see their scientific work suffer noticeably or severely if they lost access to pirate libraries, and for 15% it could lead to the termination of their work.[1]

Most likely, the issues of funding during the transition to open science can become the main ones in Russia. In this case, the integration into the practice of open science will take place, first of all, through the development of academic cooperation and under the pressure of different state programs and initiatives establishing requirements to publish in foreign journals of the first and second quartiles. In this context, at a minimum, Russian academic foundations will have to search for ways of budgetary support of grant holders' publications in open access journals. It is worth noting that the redistribution of funding may be significant: according to estimates, Russian authors paid about $10 mn (Rb760 mn) for open access publications in 2020, and not always in quality publications, and this is 5-fold the budgetary costs for maintaining all scientific journals of the Russian Academy of Sciences.[2] Accordingly, a discussion arose on how to redirect such large-scale financial flows to the development of the domestic information base.

In addition to funding, the principles of open science also affect the ethics of research. With the openness of platforms, data and peer review, compliance with ethical norms of data use becomes a necessity. For Russia this will mean a restructuring of institutions, forcing them to refocus their work from formal fulfillment of reporting indicators to ensuring growth in the quality of scientific research.

6.4.6. Status and initiatives in technological innovation

There was no revival in the innovation sphere last year, because investment in new technological projects slowed down due to the pandemic. First of all, it

1 Telegram channel Russia Research. 14.12.2021. URL: https://t.me/trueresearch/1274

2 *Belyaeva S.* And a little embarrassing. Is it worth paying from the budget for publications in dubious journals? // Poisk. 11.02.2022. № 7. C. 14. URL: https://poisknews.ru/magazine/i-nemnozhko-stydno/

can be traced through the parameters of partnership of academic institutions and universities with companies. In the field of state policy, we can note the beginning of the construction of scientific and technological valleys, as well as the continuation of the reform of institutes for development, which has not yet brought obvious changes.

Dynamics of scientific and technological development

The systemic problem of low business spending on research and development and weak cooperation between companies and scientific institutions and universities was exacerbated by the pandemic. Intensity of funding of research and development decreased for almost one third (30.1%) of high-tech industrial enterprises. In the meantime, 19.5% of companies, on the contrary, expanded their research programs,[1] however the total balance remained negative.

At the same time, two-thirds of the companies investing in research and development did not cooperate with scientific organizations and universities,[2] and the dynamics of the share of companies that order research or scientific and technical services to scientific organizations and universities is decreasing. According to recent estimates the share of such companies was less than 30%.[3] Last year almost half of high-tech companies ceased cooperation with research institutes and universities.[4] At the same time earlier (according to the data for 2020) 76.8% of organizations attracted partners for research and development only on an ad hoc basis, i.e. cooperation was irregular. [5]

The reduction in interactions cannot be entirely attributed to the effects of the pandemic. Regardless of it, there are barriers to the development of cooperation on the part of both companies and universities. Companies complain about overpricing and insufficient quality of research, which are carried out by academic institutions and universities. Especially high price is set by the universities for their work.[6] Besides, it is admitted insufficiency and weak effects of measures of state stimulation of cooperation (including such as development of cooperation of Russian universities, academic institutions and industrial enterprises, programs of innovative development of companies with state participation, cooperation within innovative clusters), as well as measures aimed at stimulation of corporate investments into research and development independently from the factor of partnership with academic institutions and universities (tax benefits, assistance in protection of rights for results. In turn, universities point out that companies'

1 *Vlasova V.,Rud V*. Effects of the COVID-19 pandemic on innovation in Russian high-tech // Science. Technologies. Innovations. Express information. Moscow. NRU HSE. 27.05.2021.
2 *Vlasova V*. Industry-science cooperation and public policy instruments utilization in the private sector // Journal of Business Research. 2021. Vol. 124. P. 519–528. URL: https://doi.org/10.1016/j.jbusres.2020.10.072.
3 *Simachev Yu.V., Kuzyk M.G*. Interaction between Russian business and science: points of contact and stumbling blocks // Voprosy Ekonomiki. 2021. No. 6. P. 103–138. URL: https://doi.org/10.32609/0042-8736-2021-6-103-138
4 *Vlasova V.,Rud V*. Effects of the COVID-19 pandemic on innovation in Russian high-tech // Science. Technologies. Innovations. Express information. Moscow. NRU HSE. 27.05.2021.
5 *Vlasova V*. Who does business cooperate with when developing innovations? // Science. Technologies. Innovations. Express information. Moscow. NRU HSE. 08.12.2021.
6 Ibid, p. 126.

orders for research and development are too applied and highly specialized, and such projects have very short implementation schedules.

In the area of venture financing of technological projects, there was some revival of activity compared to 2020, but the main investors were single "ecosystem" companies — Sber, VK (formerly Mail.ru Group), Yandex, MTS and VTB, which accounted for 22% of all deals. This is twice as much as a year before.[1] At the same time, state companies (with the exception of Sber) became buyers of startups in only 2% of cases. Thus, state companies prefer to deal with their own developments rather than buy external companies. The absolute leader in the number of start-ups is Moscow, although few companies successfully develop here as well. The reasons are underdevelopment of infrastructure, low availability of investments, staffing problems and state of science.[2] The list of factors shows that it is the science-intensive companies which experience the most problems of development.

Science and technology valleys

Last year the construction of scientific and technological valleys commenced, where close cooperation between science and industry is expected. Since January 2021, the technological valley "Vorobiovy Gory" (on the basis of the Moscow State University) and "Composite valley" in the Tula region began to be built.

Valleys are ideologically similar to collective centers for developers and consumers of technology. They should house testing grounds for new products, so that it is possible not only to do research and development, but also to test their results at pilot industrial facilities. Certification centers and engineering centers are also important, that is, a complex of organizations that create and test new technology. The task of personnel training is also built into the design of the valleys, as it is supposed to establish their partnership with the key university (respectively, in the valleys under construction it is Moscow State University and Tula State University).

Projects of the valleys can be seen as a development of the ideas behind the construction of the Skolkovo Innovation Center, where an interface was created for interaction between scientists and technology developers, including small companies. However, the scale of initiatives is different. In the Tula valley among the participants-residents around 40 technological companies are expected.[3] In "Skolkovo", thanks to the fact that now the residents do not have to physically locate on the territory of the innovation center, there are almost 3,000 start-ups, 10% of which have revenues over Rb100 mn per year.[4] The

1 According to a study of more than 300 Russian-speaking representatives of the venture capital market, "FinTech and EdTech have become the most attractive niches for investors in 2021" // Inc. 09.12.2021. URL: https://incrussia.ru/news/fintech-i-edtech/

2 *Boos V.O., Gokhberg L.M., Ivanova E.A.*, et. al. Innovative Moscow: Strategic Challenges and Tactical Responses / Edited by L.M. Gokhberg, E.S. Kutsenko. Moscow. NRU HSE. 2021. P. 11.

3 *Leibin V.* Material for victory // Expert. 22.02.2021. № 9. URL: https://expert.ru/expert/2021/09/material-dlya-pobedy/

4 *Balashova A.* Head of Skolkovo Ventures – RBC: "Startups started to be wary of taking government money." // RBC. 04.03. 2021. URL: https://www.rbc.ru/interview/technology_and_media/04/03/2021/602a80da9a7947cabe097bc7

valleys being created are similar to "Skolkovo" in that the valleys will have similar tax benefits.[1]

Continuing the reform of technological development institutes

Institutional changes associated with the reform of development institutes, launched in 2020, passed without excesses and serious transformations. Development institutes of technological profile, which were transferred to VEB. RF, practically did not change their profile and principles of work. There was a formal change in the form of binding areas of work of institutes to the national development goals of Russia until 2030,[2] these were formulated so broadly that it was not too difficult to adjust the agenda to them.

Development institutes, as before, will report on the results of their work by the number of new jobs created thanks to their investments and the growth of revenues of the financed companies. As a rule, such data, especially in generalized form, tell little about the effectiveness of investments made.[3] That is why, there was a lot of expert advice on how to change the system of evaluation indexes. Among others, it is recommended to "count" technologies and new products in kind, which should more clearly show the result. Proposals also concern complex accounting as the state goals, and the interests of business. However, despite the discussions, the reporting has not changed significantly.

It is planned that in the future VEB.RF will determine the priorities of development institute's activity, control the elaboration of their strategies and the achievement of efficiency indicators. Finally, its functions will include reorganization or liquidation of institutes for development with the possibility of transferring property to its authorized capital and performing their functions.[4]

Among the development institutions, the most noteworthy last year was the activity of Rusnano JSC in connection with the losses found in the organization.[5] In November, there was a threat of default of Rusnano during redemption of its bonds issue. On November 19, the Moscow Stock Exchange on instructions of the Bank of Russia suspended trading in company's bonds. Rusnano acknowledged the debt accumulation and commenced to discuss restructuring options. Meanwhile, the Ministry of Finance intends to prevent the situation when the company fails to fulfill its obligations.[6]

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1 *Mekhanik A.* Valley of technology and science related to commerce and factories // Stimul online. 22.02.2021. URL: https://stimul.online/articles/sreda/dolina-tekhnologiy-i-nauk-otnosyashchikhsya-k-torgovle-i-fabrikam/?fbclid=IwAR1Q_PgPV9d4SHAk0d7kGW7kb_6twQAP_tZRk1AEKwD4hECnDtoyx-TK0c8

2 There are five national goals: to preserve the population and its health; to create opportunities for self-realization and talent development; to provide a comfortable and safe living environment; to provide decent, efficient labor and successful entrepreneurship; to transform digitally.

3 *Sokolov A.* Institute for development have failed to innovate // Vedomosti. 01.03.2021. URL: https://www.vedomosti.ru/economics/articles/2021/03/01/859742-instituti-razvitiya

4 *Kruchkova E.* Institutes for development will be taken into a holding company // Kommersant. 23.04.2021. C. 2. URL: https://www.kommersant.ru/doc/4783664

5 Rusnano's net loss according to IFRS for 2020 increased 3.2-fold // TASS. 02.04.2021. URL: https://tass.ru/ekonomika/11061621

6 *Tepliakov S.* Siluanov named the causes of Rusnano's problems with debts // Forbes. 31.12.2021. URL: https://www.forbes.ru/finansy/451635-siluanov-nazval-priciny-problem-rosnano-s-dolgami

Since the creation of Rusnano in 2007, the total amount of state support came to Rb590 bn[1] (Rb130 bn was allocated in the form of the initial direct contribution, the rest — in the form of state guarantees against obligations). Since then, the development institute has supported 109 projects,[2] in fact, engaged in venture capital financing. The crisis could be caused by the fact that most of the projects are long-term and with a long payback period, and investment in them was carried out on borrowed funds. The percentage of successful projects is unknown, there are only estimated experts' assessments, ranging from "complete failure" to "zero status" and even "small plus", if we consider not only individual projects of Rusnano, but the portfolio as a whole.[3] The latest available data on the aggregate efficiency of Rusnano's projects ends in 2019.

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Last year saw changes in the system for managing scientific and technological development. In addition to the Ministry of Science and Higher Education of the Russian Federation and the Russian Academy of Sciences, new collegiate bodies received the functions of expertise and goal-setting. The new management structure strengthens centralization, which is connected with the idea of end-to-end planning and reporting. A part of the new management system is the state program of scientific and technological development, which unites all expenses on the civil research and development, and it also allows to build the end-to-end reporting on the stages of the innovation cycle. On the one hand, it should increase transparency and synergy, but on the other hand, the single hierarchical system is difficult to manage.

The problem of raising the practical impact of science has become more frequently discussed at the state level. As the President of the country noted, "unique discoveries should not remain only a scientific breakthrough - they should certainly serve the people".[4] Among new tools of state policy the world class SEC and the Priority-2030 program resolve the task of increasing contribution of scientific research in economic development, first of all regional. In particular, they aim at the growth of cooperation of universities and academic institutions with companies. However, the last year the level of business activity in support of research and development somewhat decreased, including under the influence of the pandemic.

Growing publication activity is a positive trend in science, however this trend may be unsustainable when the staffing situation remains problematic. The

1 Meeting with Sergei Kulikov. 02.12.2020. URL: http://kremlin.ru/events/president/news/64536
2 *Boiko A*. Siluanov spoke about Rusnano's reboot // Ведомости. 30.11.2021. URL: https://www.vedomosti.ru/economics/articles/2021/11/30/898246-perezagruzka-rosnano
3 *Starostina Yu*. Chubais as a statesman did not protest. How Rusnano found itself on the verge of default // The Bell. 03.12.2021. URL: https://thebell.io/chubajs-kak-gosudarstvennyj-chelovek-protestovat-ne-stal-kak-rosnano-okazalas-na-grani-defolta
4 Meeting on the development of genetic technologies. 17.11.2021. URL: http://kremlin.ru/events/president/news/67119

outflow of researchers from science continues, and the share of the youngest generation, researchers under 29 years old, is decreasing. Postgraduate studies are still a weak source of higher qualification manpower, as the number of defended dissertations drops. It is connected not only with peculiarities of postgraduate studies regulation, but also with conditions that are given to scientists for work, including both mobilizing and pressurizing system of formal requirements to scientific results.

The visibility of Russian science can be enhanced if there is more active involvement, including at the level of public policy, in the movement toward open science. For this purpose, it is important to pay more attention to creation of open science platforms and participation in joint research with partners from other countries. The government science foundations can help boost international cooperation, including through greater use of science diplomacy tools. However, the issue of financing open access will be a complicated one within the framework of this agenda.