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THE RUSSIAN FEDERATION'S INTERNATIONAL SCIENCE AND TECHNOLOGY COOPERATION:

AN OVERVIEW AND DEVELOPMENT ISSUES

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This report has been prepared as part of the Russian International Affairs Council's project *Russia's International Science and Technology Cooperation*. The report looks into the present state of Russian science in comparative perspective, analyses Russia's key goals and objectives in terms of improving the international competitiveness of domestic science, provides an overview of Russian legislation on international science and technology cooperation, and identifies the key issues that international science and technology cooperation is expected to help resolve. The author identifies a number of priority areas in Russia's international science and technology cooperation and proposes a number of steps to promote Russia's interests in international science and technology cooperation.

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INTRODUCTION

International science and technology cooperation has been attracting close attention both from individual countries and influential international organizations during the second half of the 20th and the beginning of the 21st centuries. Many countries consider international science and technology cooperation, which has become an intersection of interests of science, science and technology policy, and foreign policy, as a tool for developing their own scientific potential and achieving economic growth over the long term.

In January 2000, the Government approved the *'Concept of State Policy of the Russian Federation on International Science and Technology Cooperation'*.[1]

The specific situation of the late 1990s–early 2000s, which saw a transition towards an innovation-driven, market-based economy and Russia's accelerated entry into international markets for R&D-intensive goods and services, have been reflected in the *'Concept on International Science and Technology Cooperation'* (2000).

The Concept set forth the following long-term goals:

- facilitating Russia's transition to innovation-driven development, as well as the establishment of a Russian innovation and technology component for the multi-polar world;
- ensuring Russia's full and economically effective participation in global integration processes in science, technology and R&D-intensive manufacturing;

[1] 'Concept of State Policy of the Russian Federation in the Area of International Science and Technology Cooperation.' URL: http://www.mid.ru/bdomp/ns-osndoc.nsf/e2f289bea62097f9c325787a0034c255/14e730204ca8d223432569fb004872a5 (in Russian).

- increasing the level of competitiveness of national science and technology, and Russia's entry into the global market for intellectual products, R&D-intensive goods and services;
- developing new forms of international cooperation and strengthening the role of innovation and technology in Russia's international science and technology cooperation;
- harmonizing the infrastructure of Russia's international science and technology cooperation and adapting it to global practices;
- ensuring Russia's scientific and technology security.

It is worth noting that many of the declared goals have not been achieved in full. This is because the areas and objectives of international science and technology cooperation were largely aimed at resolving specific problems of Russia's economic development while touching upon the commercial interests of potential international partners by proposing the creation of hypothetical formations such as 'integrative growth nuclei' in Russia. While the *'Concept of International Science and Technology Cooperation'* (2000) has a lot of weaknesses, it has still set forth the areas that are vital for preserving and developing Russia's scientific and technology potential, such as scientific and technology security, information services and international cooperation in fundamental research. Since international science and technology cooperation is above all cooperation in science, let us review the state of Russian science and its development trends after 2000.

1. THE CURRENT STATE AND DEVELOPMENT TRENDS OF RUSSIAN SCIENCE

Over the past ten years, the Government of the Russian Federation has consistently implemented a policy aimed at supporting science. In particular, from 2002 to 2012, federal spending on non-military science increased more than tenfold (from 31.05 billion roubles in 2002 to 355.92 billion roubles in 2012). At the same time, domestic expenditure on research and development rose from 135 billion roubles in 2002 to 699.9 billion roubles in 2012 (in actual prices).[2] The average salary in the public science sector rose from 9,700 roubles per month in 2006 to 32,540 roubles per month in 2012.[3] At the same time the Russian research and development sector is still suffering from negative dynamics in a number of important indicators.

1.1. AN OVERVIEW OF THE KEY DEVELOPMENT INDICATORS OF RUSSIAN SCIENCE

The group of indicators describing the state of science is normally divided into two large sub-groups: science and technology potential (indicators such as funding, number of employees, number of top-class researchers, etc.) and scientific activity performance (indicators including the number of publications, patent statistics data, technology balance of payments, etc.).

Below is a brief overview of several key development indicators for Russian science.

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[2] Rosstat data.

[3] Statistical Review: Russian Science in Figures: 2013. Scientific Research Institute – Federal Research Centre for Projects Evaluation and Consulting Services. 2013 (in Russian).

According to *Rosstat* data, domestic research and development expenditures have demonstrated a steady pattern of growth over the past few years (see Table 1):[4]

Table 1.

Domestic Research and Development Spending in the Russian Federation

20	02	2004	2006	2008	2009	2010	2011	2012
Domestic research and development expenditures, billion roubles								
in actual prices	135.0	196.0	288.8	431.0	485.8	523.4	610.4	699.9
in fixed 1989 prices	4.34	4.60	4.94	5.49	6.06	5.72	5.77	6.10
as a percentage of GDP	1.25	1.15	1.07	1.04	1.25	1.13	1.09	1.12

Source: Rosstat. URL: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/science_and_innovations/science (in Russian)

Federal budget spending on science has also trended up in recent years (Table 2).

Table 2.

Federal Budget Funding of Science (in Actual Prices)

20	02	2004	2006	2008	2009	2010	2011	2012
Federal budget spending on non-military science, million roubles	31,055.8	47,478.1	97,363.2	162,115.9	219,057.6	237,644.0	313,899.3	355,920.1
including:								
fundamental research	16,301.5	24,850.3	42,773.4	69,735.8	83,198.1	82,172.0	91,684.5	86,623.2
applied research	14,754.4	22,627.8	54,589.8	92,380.1	135,859.5	155,472.0	222,214.8	269,296.9
as a percentage of:								
federal budget spending	1.51	1.76	2.27	2.14	2.27	2.35	2.87	2.76
GDP	0.29	0.28	0.36	0.39	0.56	0.51	0.56	0.56

Source: Rosstat. URL: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/science_and_innovations/science (in Russian)

Table 3 shows employment data for the Russian research and development sector in recent years. The data confirm the trend towards a decrease in overall numbers of personnel engaged in research and development.

Figure 1 shows an analysis of trends in domestic research and development expenditure per researcher from 2000 to 2011 in current prices and fixed 2000 prices. An interesting fact should be noted: although this indicator continued to grow steadily in terms of fixed prices after the 2008–2009 crisis (albeit at a slower pace), in fixed 2000 prices, the crisis resulted in a decline, at least in 2010–2012.

[4] Domestic R&D expenditures: full R&D expenditures in a given country during a certain period. Source: Frascati Manual 2002. Proposed Standard Practice for Surveys of Research and Experimental Development. OECD 2002. P. 121.

Table 3.

Research and Development Personnel (number of people)

	Total	Researchers	Technicians	Support staff	Others
2002	870,878	414,676	74,599	232,636	148,967
2004	839,338	401,425	69,963	223,356	144,594
2006	807,066	388,939	66,031	213,579	138,517
2008	761,252	375,804	60,218	194,769	130,461
2009	742,433	369,237	60,045	186,995	126,156
2010	736,540	368,915	59,276	183,713	124,636
2011	735,273	374,791	61,562	178,449	120,471
2012	726,318	372,620	58,905	175,790	119,003

Source: *Russian Science in Figures: 2013.* Scientific Research Institute – Federal Research Centre for Projects Evaluation and Consulting Services. 2013.

Positive changes can be observed in the average age of researchers in 2012 compared to 2000 (Figure 2), with a growth in the number of young researchers under the age of 29. At the same time, the number of researchers over 70 years old more than doubled.

Performance of the Russian Research and Development Sector

One of the key research and development sector performance indicators is the productivity of scientific activity. Both globally and in Russia, a distinction is made between the outcomes of scientific activity in fundamental and applied research, which are normally evaluated separately, mainly because their goals are different.

Under Russian legislation, "fundamental scientific research is experimental or theoretical activity aimed at obtaining new knowledge about the key laws of the structure, functioning and development of human beings, society and the environment."[5] Applied research, on the other hand, "is aimed mostly at the application of new knowledge to achieve practical goals and specific objectives. Scientific research is aimed at obtaining new knowledge for the purpose of its subsequent practical application (targeted scientific research) and (or) at the application of new knowledge (applied scientific research), and is carried out through scientific and research work."[6]

Because of the differences in the nature and goals of fundamental and applied research, different groups of indicators are used to assess the productivity of these two areas of science. The number of publications and citations in scientific

[5] Definition entered into force on January 11, 2009 by Federal Law No. 309-FZ dated December 30, 2008.

[6] Definition entered into force on November 3, 2013 by Federal Law No. 291-FZ dated November 2, 2013.

Table 4.

Qualitative Indicators of Russian Publications in International Peer-Reviewed Scientific Journals, 1996–2012

	Total number of articles	Number of citable articles	Number of citations	Number of self-citations	Number of citations per article	Number of self-citations per article	Number of cited articles	Number of non-cited articles	percentage of articles written with international co-authors	percent-age of articles in Eastern Europe	per cent of articles globally
1996	30,560	30,469	214,166	63,247	7.01	2.07	16,951	13,609	23.99	45.24	2.69
1997	30,903	30,844	231,180	68,783	7.48	2.23	18,118	12,785	25.84	44.56	2.66
1998	31,373	31,272	232,620	66,350	7.41	2.11	18,113	13,260	26.33	44.57	2.69
1999	30,001	29,920	236,699	67,954	7.89	2.27	18,200	11,801	28.06	42.88	2.57
2000	30,560	30,411	231,171	67,216	7.56	2.20	18,583	11,977	27.86	42.07	2.50
2001	31,047	30,825	210,644	64,458	6.78	2.08	19,090	11,957	24.40	41.78	2.36
2002	31,475	31,173	204,256	63,842	6.49	2.03	18,797	12,678	24.33	40.68	2.29
2003	31,894	31,577	226,972	66,229	7.12	2.08	20,250	11,644	32.15	38.43	2.23
2004	31,820	31,585	221,365	61,813	6.96	1.94	19,606	12,214	33.74	36.64	2.02
2005	36,341	36,093	201,987	60,815	5.56	1.67	20,965	15,376	32.75	36.45	2.07
2006	33,262	32,942	170,353	51,456	5.12	1.55	19,467	13,795	34.77	32.91	1.81
2007	33,740	33,446	147,967	45,344	4.39	1.34	18,973	14,767	34.27	31.45	1.74
2008	34,069	33,622	127,172	37,606	3.73	1.10	18,404	15,665	32.59	29.46	1.69
2009	34,674	34,158	85,350	28,737	2.46	0.83	16,732	17,942	31.71	29.35	1.64
2010	36,718	36,189	52,110	17,577	1.42	0.48	13,730	22,988	29.12	27.98	1.66
2011	39,005	37,467	17,850	6,336	0.46	0.16	7,216	31,789	28.54	28.26	1.67
2012	39,766	37,568	12,503	4,501	0.31	0.11	5,041	34,725	29.53	27.14	1.63

Source: SCImago Journal and Country Rank, 2013. URL: http://www.scimagojr.com/countrysearch.php?country=RU journals are the key indicators for evaluating the performance of fundamental science. This is called 'publication activity'.

The outcomes of applied research are measured with a different set of indicators, primarily: the number of patents filed and granted, exports of hi-tech products, technology balance of payments, etc.

Publication Activity

According to the *SCImago Journal and Country Rank* portal, which makes its calculations based upon the *SCOPUS Database*,[7] while the amount of Russian publications abroad rose slightly between 1996 and 2012, their quality tended to deteriorate steadily (Table 4). Meanwhile, the overall amount of Russian scientific publications in *SCOPUS* peer-reviewed international journals rose from 30,560 in 1996 to 39,766 in 2012, whereas the number of citations decreased from 214,166 to 12,503 during that period. Even the number of self-citations fell from 63,247 to 4,501 (Figure 3), as did the number of citations per article, from 7.01 to 0.31 (Figure 4). The number of cited articles, which in 1996 amounted to slightly more than half of all publications (16,951), was less than third of that (5,041) in 2012. The share of articles by Russian authors decreased not only globally (from 2.69 per cent in 1996 to 1.63 per cent in 2012), but also in Eastern European countries (from 45.24 per cent in 1996 to 27.14 per cent in 2012).

The effectiveness of Russia's applied research in recent years can be assessed, in particular, by the indicators listed in Table 5 describing the recorded results of intellectual activity. As we can see, all indicators rose steadily.

Table 5.

Productivity of Russian Science in Applied Research (2000–2012)

20	00	2005	2007	2010	2011	2012
Patents granted:						
inventions	17,592	23,390	23,028	30,322	29,999	32,880
useful models	4,098	7,242	9,757	10,581	11,079	11,671
industrial prototypes	1,626	2,469	4,020	3,566	3,489	3,381
Registered:						
computer software	1,388	3,282	5,308	8,073	9,700	11,471
databases	107	327	426	733	891	1,332
integrated circuit topologies	5	32	55	110	108	176
trademarks and service marks	21,725	29,447	30,724	35,178	35,954	40,106
appellations of product origin	37	23	25	22	22	31

Source: *Russian Science in Figures: 2013.* Scientific Research Institute – Federal Research Centre for Projects Evaluation and Consulting Services. 2013 (in Russian).

[7] *SCOPUS* is a bibliographic database containing abstracts and citations for academic journal articles. It covers nearly 21,000 titles, of which 20,000 are peer-reviewed journals in science, technology, medicine and the social sciences.

Using the year 2000 as a baseline, Figure 5 matches this Table. It demonstrates that the number of registered integrated circuit topologies, databases and registered computer software was rising at the fastest pace. This result confirms a high level of competitiveness of Russian software developers.

As shown above, the key development indicators of the Russian research and development sector (for example, funding indicators) has grown steadily over the past ten years. At the same time, a whole range of indicators suggests a certain decline in the performance of Russian science, pointing out some imbalances between its input and output parameters.

First of all, there is an imbalance between growing funding on the one hand and dwindling performance on the other. While federal budget spending (and domestic research and development expenditure as a whole) is on the rise, the sector is demonstrating a trend towards declining international publication activity and citations. These indicators (as well as the share of Russia's publications globally, its publication activity rating, etc.) are the key tool for comparing research and development outcomes across countries (in particular, with regard to public-domain fundamental research). The decline in publication activity signals a decrease in the effectiveness of the entire science sector. Besides, the number of researchers in Russia has been in decline as well. Figure 6 demonstrates a trend of declining key performance indicators in Russian science, as federal budget research and development funding continues to rise.

In addition to evaluating development trends in Russian science, it is important to look at the growth and decline rates in science development indicators of other countries in comparison with Russia.

1.2. CROSS-COUNTRY COMPARISONS

Very few international sources regularly publish data on the structure, performance and funding of Russian science. The ones that do include: the *Thomson Reuters* projects *Science Watch, Web of Knowledge* and *Web of Science*; the *SCImago Journal and Country Rank* (*SJR*) project sponsored by the University of Granada in Spain; the *SCOPUS* bibliography and reference database; and *OECD* (*Organisation for Economic Cooperation and Development*) publications, including: the *OECD Main Science and Technology Indicators* (*MSTI*); *OECD Science, Technology and Industry Outlook*; *OECD Science, Technology and Industry Scoreboard*; the *OECD STAN* and *ANBERD* databases, etc. In addition to this, overviews of global science status and development trends are published by a number of respected organizations, including the U.S. *National Science Foundation*, *RAND Corporation*, etc.

In comparing the development indicators of Russian science with other countries, the most complete system is used by *OECD* in its *STAN* database and the *OECD Main Science and Technology Indicators* publication.

Russian sources that provide international comparisons of science indicators include the *Russian Science in Figures* statistical yearbook issued by the Ministry of Education and Science's Scientific Research Institute – Federal Research Centre for Projects Evaluation and Consulting Services, and the Higher School of Economics' *Science and Technology Indicators in the Russian Federation*. Both publications use statistical data from *Rosstat*, and the only difference is the set of indicators included.

Comparisons on the key indicators of the scientific potential, performance and funding in Russia and the world's leading countries present the following picture.

Research and Development Spending

As Figure 7 shows, Russia was lagging behind all of the world's leading countries in 2012 on one of the key funding indicators (research and development expenditures as a percentage of GDP), with 1.09 per cent. The best indicators in 2012 were in South Korea (4.36 per cent), Israel (4.20 per cent), Finland (3.55 per cent), Sweden (3.41 per cent), Japan (3.34 per cent), Denmark (2.98 per cent), and the United States (2.79 per cent). Comparisons for 2000 and 2012 clearly show the countries where attention to science and technology and innovation policy changed the fastest (China, South Korea, Slovenia, etc.).

Personnel Potential

According to *OECD* data, during the period 2000–2012, the total number of researchers (full-time equivalent) in almost all *OECD* countries either rose steadily, or remained almost unchanged (e.g., in Japan). Only in Russia this indicator demonstrated a steady declining trend (see Figure 8).

The indicator for the number of researchers per 10,000 people employed is an indicator of an economy's overall research and development intensiveness. According to this indicator, Russia lags substantially behind many countries, with 63 researchers per 10,000 people employed in economy in 2011 (Figure 9). Notably, in 2000 this indicator was 78 in Russia.

Comparisons of Publication Activity

SCImago Journal and Country Rank (*SJR*) is one of the most popular projects for assessing the performance of scientific activity.[8] It collects and analyses data

[8] Source: *SCImago Journal and Country Rank*, 2013. URL: http://www.scimagojr.com/countrysearch.php

on documents published in international peer-reviewed scientific journals. The *SJR* website publishes scientific and analytical reports on journals and countries, as well as publication activity ratings and citations statistics gleaned from the *SCOPUS* database, which indexes more than 18,500 science and technology titles as well as medical journals issued by around 5,000 publishers worldwide.

SJR assesses and compares the performance of countries in scientific activity on six key indicators:

- the number of documents published in indexed journals;
- the number of citable documents;
- the number of citations;
- the number of self-citations;
- number of citations per document;
- the Hirsch Index.[9]

Russia ranked 16th, 16th, 22nd, 21st, 157th, and 21st on these indicators, respectively, in 2012. As an example, Table 6 contains a ranking of 25 leading countries on the 'Total number of published documents' indicator.

In another example, Figure 10 shows a comparison of the international publication activity of the BRICS countries (Brazil, Russia, India, China and South Africa) in mathematics for the period 1996–2012. From 2003 until the present time, the Russian Federation has trailed China in the number of published articles in mathematics, in which Russian scientists had always been considered among the world's strongest. The figure also shows that Russia also lagged behind India on this indicator in 2011.

International comparisons of scientific activity across countries in 2012 are shown in the charts (see below) plotted using the *SCImago Journal and Country Rank* project database (based on countries ranked in the top 25 in the corresponding rankings).

The number of publications in *SCOPUS*-indexed scientific journals in 2012 (Figure 11) was as follows: United States – 537,308; China – 392,164; Russia – 39,766. As we can see, U.S. authors exceeded their Russian counterparts in terms of the number of scientific publications by more than 13 times, while Chinese authors exceed the Russians almost tenfold.

With regard to the number of citations, U.S. authors were cited 341,608 times in *SCOPUS*-indexed scientific journals in 2012; UK authors were cited 106,306 times; Chinese authors 105,523 times; and Russian authors 12,503 times (Figure 12). We can thus see that U.S. authors were cited roughly 27 times more

[9] The Hirsch index is an index of scientific citations that measures the relative stability of scientists. It can also be used to assess the scientific results of organizations and countries. The Hirsch index = *h*, if a person has published h articles with more than h citations. So, if *h* = 12, a person has published 12 articles, each of which has a citation score above 12.

Table 6.

Scientific Activity Output According to Scimago Journal and Country Rank, 2012

Country	Documents published	Citable documents	Citations	Self-citations	Citations per document	Hirsch Index
1. The United States	537,308	493,337	341,608	194,260	0.64	1,380
2. China	392,164	383,117	105,523	62,551	0.27	385
3. The United Kingdom	152,877	137,413	106,306	36,218	0.7	851
4. Germany	143,284	132,505	95,320	35,540	0.67	740
5. Japan	118,768	111,893	50,816	18,510	0.43	635
6. France	102,474	95,534	61,977	19,797	0.6	681
7. India	98,081	91,366	25,665	11,829	0.26	301
8. Italy	85,027	77,747	54,621	18,813	0.64	588
9. Canada	84,990	79,017	54,256	15,560	0.64	658
10. Spain	76,699	70,539	44,019	13,993	0.57	476
11. South Korea	67,688	64,581	26,804	8,260	0.4	333
12. Australia	67,584	62,200	43,082	14,118	0.64	514
13. Brazil	55,803	53,083	17,580	6,465	0.32	305
14. The Netherlands	48,918	44,801	41,366	10,325	0.85	576
15. Taiwan	40,387	38,493	16,059	4,932	0.4	267
16. The Russian Federation	39,766	37,568	12,503	4,501	0.31	325
17. Iran	39,384	37,384	10,007	4,913	0.25	135
18. Switzerland	36,042	33,513	33,732	8,120	0.94	569
19. Turkey	33,911	31,323	10,938	3,631	0.32	210
20. Poland	31,948	30,666	13,850	4,723	0.43	302
21. Sweden	31,127	29,055	22,769	5,205	0.73	511
22. Belgium	26,829	24,970	20,254	4,688	0.75	454
23. Malaysia	20,838	20,134	5,135	2,598	0.25	125
24. Denmark	19,903	18,300	16,822	3,926	0.85	427
25. Austria	19,825	18,268	14,723	3,043	0.74	378

Source: *SCImago Journal and Country Rank*.
URL: http://www.scimagojr.com/countryrank.php?area=0&category=0&region=all&year=2012&order=it&min=0&min_type=it

frequently than their Russian counterparts, while authors from the United Kingdom and China were cited eight times more frequently.

Comparisons on the Hirsch Index (Figure 13) also point to the weak standings of Russian science. For example, U.S. publications score an H-Index rating of 1,380, as opposed to 325 for Russian publications. It means that only 325 publications by Russian authors (from almost 40,000 publications) were cited more than 325 times each.

In its 2012 report, the U.S. *National Science Foundation* released some interesting data signalling a relative decline in the number of articles co-authored by Russian researchers scientists from other countries, in particular, in the STEM fields (science, technology, engineering and mathematics) (Table 7) in 2010 compared to 2000.

Table 7.

Share of STEM Articles in International Peer-Reviewed Journals Co-Authored with Scientists from Other Countries, percent

Rankings	Countries	2000 2	010
1	The United States	43.8	42.9
2	Germany	20.0	18.8
3	The United Kingdom	19.0	18.7
4	France	15.3	13.8
5	China	5.0	13.0
6	Canada	9.3	10.1
7	Italy	9.3	9.4
8	Japan	10.4	8.2
9	Spain	6.1	8.1
10	Australia	5.3	7.1
11	The Netherlands	6.7	6.9
12	Switzerland	5.8	6.1
13	Sweden	5.4	4.8
14	South Korea	2.3	4.4
15	Belgium	4.0	4.3
16	The Russian Federation	6.9	3.7
17	India	2.1	3.3
18	Brazil	2.8	3.0
19	Austria	2.6	2.9

Source: Science and Engineering Indicators 2012. National Science Foundation, United States.

Comparisons of Performance in Applied Research

Patent Activity

One of the key indicators of the success of applied research and development is patent activity, whose quantitative assessment is performed based on registration data of the results of research and development or other intellectual activity in the form of inventions, new technical solutions, etc.

Under an *OECD* proposal, triadic patent family indicators are used for statistical analysis and the study of countries' international patent activity.[10] Table 8

[10] Triadic patent family is a series of corresponding patents filed at the *European Patent Office* (*EPO*), the *Japan Patent Office* (*JPO*) and the *United States Patent and Trademark Office* (*USPTO*), which together recognize one or more patent priorities. The main purpose of the triadic patent family is to avoid duplication of patent registrations filed in different organizations. Source: OECD (2009), 'Patent Systems and Procedures', in *OECD Patent Statistics Manual*, OECD Publishing. URL: http://dx.doi.org/10.1787/9789264056442-4-en

Table 8.

Number of Triadic Patent Families

	2000	2006	2007	2008	2009	2010	2011
Japan	14,947	13,501	13,552	12,253	12,219	12,793	13,239
The United States	13,874	13,878	13,265	12,924	12,260	12,272	12,505
Germany	5,829	5,184	5,172	5,030	5,070	5,057	5,031
France	2,155	1,934	1,930	1,944	1,936	1,906	1,939
South Korea	732	1,578	1,651	1,346	1,481	1,630	1,702
The United Kingdom	1,641	1,479	1,414	1,377	1,373	1,365	1,360
Sweden	622	659	688	672	639	669	668
China	71	316	412	446	664	708	909
The Netherlands	1,027	882	829	819	824	766	805
Switzerland	815	726	675	668	676	684	678
Italy	641	584	580	575	564	566	562
Canada	526	513	521	485	486	496	469
Belgium	329	326	328	320	297	310	307
Austria	277	289	279	269	290	298	294
Finland	353	265	271	265	271	280	277
Israel	323	301	281	281	269	267	261
Denmark	226	244 25	5	257	224	235	241
Spain	145	134	133	137	142	139	140
Norway	106	82	80	75	91	84	86
Ireland	32	63	73	71	68	63	68
The Russian Federation	73	43	44	41	40	46	47
Hungary	29	28	33	32	32	33	34
Poland	9	14	18	20	24	29	28
South Africa	37	26	24	27 23		24	23
Czech Republic	9	19	20	21	19	21	21
Turkey	4	11	9	9	12	16	16
Portugal	2	10	18	14	11	11	11
Greece	6	13	11	9	9	7	7
Slovenia	9	6	6	7	6	6	5
Estonia	1	4	3	3	3	3	3
Slovakia	2	3	3	3	2	3	3

Source: Calculations based on data from *Main Science and Technology Indicators*, OECD, 2013/2.

shows the patent activity of a number of countries, including Russia.[11] The Russian Federation is behind almost every developed country on this indicator, demonstrating both low patent activity in general and negative growth rates in 2006–2009. There was a small increase in 2010 and 2011. But patent activity in China in

[11] Main Science and Technology Indicators, OECD, 2013/2.

2011 was approximately 19 times that of Russia, with Japan outstripping Russia by almost 300 times. It is also worth noting that the values for this indicator in the East European and Baltic countries are even lower than Russia's. With the exception of China, the BRICS countries demonstrated approximately the same results as Russia. It is also worth mentioning that the values for the number of triadic patent families in Japan and the United States had been in decline until 2009, before picking up slightly in 2010 and 2011.

Technology Balance of Payments

The 'Technology balance of payments', or 'balance of payments for technology', indicator is used to assess the technology export to import ratio. The corresponding statistical databases record nontangible transactions on technology-related data trades, including patent rights, patent licenses, non-patented inventions and knowhow, as well as the provision of related science and technology services.

Essentially, the technology balance of payments for an individual country is calculated as a difference between proceeds from technology it sells and payments for technology it acquires.

Figure 14, which shows a comparison of technology balances of payments for selected *OECD* countries and Russia in 2011, shows which countries were net sellers (positive balances) and net buyers (negative balances) of technology.

As far as trends in the import and export of Russian technology are concerned, Figure 15 presents the corresponding visualizations based on the data from the *OECD* publication *Main Science and Technology Indicators,* 2013/2.

This chart demonstrates that steady growth of Russia's export and import operations in technology, which emerged in 2006–2008, was interrupted by the 2008–2009 economic crisis. However, while technology imports have been recovering since 2010, exports are yet to show any growth.

A consistent policy implemented in 2000 by the Government of the Russian Federation aimed at supporting Russian science has brought about a number of positive results (growth in research and development funding, salary increases in science, and a growth in relative numbers of young scientists). However, negative trends persist in certain areas (decreases in some publication activity indicators, a negative balance of technology payments, and a low level of patent activity). More active international science and technology cooperation could make a significant difference for the development of Russian science, while at the same time strengthening the Russian Federation's positions in the global arena.

2. THE ROLE OF INTERNATIONAL SCIENCE AND TECHNOLOGY COOPERATION IN RUSSIA'S STATE SCIENCE AND TECHNOLOGY POLICY

Federal Law No. 127-FZ '*On Science and the State Science and Technology Policy (as amended by Federal Law No. 291-FZ dated November 2, 2013)*' dated August 23, 1996 sets forth the key organizational principles for international science and technology cooperation as an integral part of the state science and technology policy.[12]

The law sets the following goals: "... increasing the contribution of science and technology to the development of the economy and the state, achieving crucial social objectives, ensuring progressive structural transformation in material manufacturing, increasing its efficiency and the competitiveness of its products, improving the environmental situation and protection of the state's information resources, strengthening the state's defence capabilities and the security of people, society, and the state, and integrating science and education."[13]

It follows from the above that the main role of Russia's international science and technology cooperation is to achieve the goals of the state science and technology policy, i.e. *to facilitate in every possible way the development of the research and development sector, improving the performance of scientific activity, and increasing the contribution of science to the country's economic development*. However, the present state and trends of Russian science point to yet another, no less important goal of international science and technology cooperation: *resolving problems obstructing the effective development of the research and development sector in the Russian Federation*.

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[12] See Article 16 'International Scientific and Science and Technology Cooperation of the Russian Federation'.

[13] Federal Law No. 127-FZ 'On Science and State Science and Technology Policy' (as amended by Federal Law No. 291-FZ dated November 2, 2013) dated August 23, 1996.

2.1. THE CURRENT PROBLEMS OF RUSSIAN SCIENCE AND HOW THEY CAN BE RESOLVED THROUGH THE INTERNATIONAL SCIENCE AND TECHNOLOGY COOPERATION

Opinions vary as to why Russian science is struggling in its development. In this regard, the low level of state funding for science in general,[14] the lack of industry's interest in the outcomes of research and development, the 'brain drain', and many other possible reasons have been mentioned.[15]

Problem areas that could benefit from more active international science and technology cooperation include the following:

- the relative decline in the ability of Russian science to deliver results;
- imbalances in the age structure of scientific personnel, negligible inflow of young talent, emigration of young researchers;
- falling behind in a number of important areas of science and technology;
- the low level of Russian integration into the global scientific community, including insufficient preparedness of Russian scientists for participation in international projects and programmes (such as proficiency in foreign languages, a lack of knowledge of the procedures for making applications and how to register intellectual property, etc.);
- the low level of research and development intensiveness of the Russian economy;
- the poor results of innovation activity;
- inadequate training of science professionals in terms of modern technology development;
- the weak grant funding system.

In addition to the fact that the development of Russian science is suffering from certain problems that could be more easily resolved through international science and technology cooperation, it is worth noting that the organization of international science and technology cooperation has issues of its own.

The main issue is the absence of a systemic approach to ensuring Russia's participation, above all else, in international research projects and in the work of international organizations engaged in science and technology and innovation policy.

Another problem is the fact that Russian scientists and scientific organizations lack the necessary experience in working on international projects. This

[14] Mindeli L., Chernykh S. Problems of the Financing of Russian Science. In: *Russian Education and Society*, 2010. Vol. 52, N. 9. P. 21–38.

[15] Report on the State of Science in the Russian Federation. Russian Association for the Advancement of Science. 2012. URL: http://www.ecolife.ru/zhurnal/articles/10472 (in Russian)

primarily involves preparing the required applications, calculating the financial parameters of participation, defending their intellectual property rights as part of international projects, etc. This issue has come to the forefront after Russian scientists and research teams attempted to participate in the *EU Framework Programme* projects.[16]

These and other difficulties have lead to the poor performance of Russia's international science and technology cooperation. As a result, little use is made of global experience – not only in terms of using modern tools in Russia's science and technology policy, but also in a wide variety of areas of the Russian economy, primarily in hi-tech sectors related to organizing and conducting applied research and development for the purposes of innovation development and the effective commercialization of the results of intellectual activity.

2.2. PROTECTING RUSSIA'S INTERESTS IN INTERNATIONAL SCIENCE AND TECHNOLOGY COOPERATION (KEY PRINCIPLES)

Based on all of the above, we can conclude that, at the present stage, international science and technology cooperation covers two key areas:

1) Conducting joint research in areas of interest to a number of scientific organizations, countries and international entities. In this case, an intellectual product obtained as a result of joint efforts represents common property, unless the parties agree otherwise. Russia's interests in carrying out joint international research projects should consist, above all, in acquiring cutting-edge experience in organizing and conducting research, discussing scientific hypotheses, finding joint solutions to important scientific problems, etc.

2) International knowledge transfer in different forms, both tangible and intangible. Keep in mind that knowledge transfer is currently one of the key tools of globalization in science and innovation.

The Russian Federation's interests in developing international science and technology cooperation in terms of knowledge transfer consist in:

- capitalizing on (studying and adapting to Russian conditions) global experience in managing the state science sector, as well as monitoring, performance evaluation and research and development funding;
- carrying out joint projects that would allow for the acquisition of world-class scientific knowledge, as well as expertise and modern instruments for conducting research;

[16] Kiselev V., Gurova A. On the Possibility of Associated Membership of the Russian Federation in the EU Seventh Framework Programme. Information and Analysis Bulletin No. 2, 2010. Scientific Research Institute – Federal Research Centre for Projects Evaluation and Consulting Services. 2013. Moscow (in Russian).

– carrying out joint applied research projects, acquiring and adapting experience in commercialization the results of scientific activity;
– carrying out international exchanges of scientific data, researchers, postgraduate and doctoral students for the purpose of increasing the personnel potential of Russian science;
– ensuring the participation of Russian scientists in international scientific forums and research programmes aimed at resolving global problems;
– ensuring the participation of Russian scientists in large international research projects to find solutions to technological and technical problems, develop advanced technology, etc.

Whatever form international science and technology cooperation involving Russian scientists might take, its key principle should be dedicated participation that ensures the transfer of advanced experience, knowledge and technology to the Russian Federation.

3. KEY GOALS AND OBJECTIVES OF THE RUSSIAN FEDERATION'S INTERNATIONAL SCIENCE AND TECHNOLOGY COOPERATION

The goals and objectives of the Russia's international science and technology cooperation are set out in the legislation of the Russian Federation in accordance with the role and place of international science and technology cooperation in state policy, as well as with the existing documents in the area of socio-economic, science and technology development.

Let us have a look at the key provisions defining the goals and objectives of international science and technology cooperation.

1) The 'Concept of State Policy of the Russian Federation on International Science and Technology Cooperation' adopted in 2000 for the period until 2005 (and still in effect now) has set some quite specific goals stemming from the tasks related to the transition to a market economy[17], including:

– facilitating Russia's transition to innovation-driven development, as well as the establishment of a Russian innovation and technology component for the multi-polar world;
– ensuring Russia's full and economically effective participation in global integration processes in the area of science, technology, and R&D-intensive manufacturing;
– increasing the level of competitiveness of national science and technology, and Russia's entry into the global market for intellectual products, R&D-intensive goods and services;
– developing new forms of international cooperation, and strengthening the role of the innovation and technology component in Russia's international science and technology cooperation;
– harmonizing the infrastructure of Russia's international science and technology cooperation and adapting it to global practices;
– ensuring Russia's scientific and technology security.

[17] Approved by the Government the Russian Federation on January 20, 2000.

Admittedly, these goals are still relevant today. However, to this date no assessment has been made as to the extent to which the objectives set forth in the Concept have been achieved, even though in that same year, the Ministry of Science of the Russian Federation (the precursor of the Ministry of Education and Science) developed a 'Schedule of Urgent Measures for the Period 2000–2001' for carrying out the provisions set forth in the document.[18]

2) The 'Foundations of the Policy of the Russian Federation in the Development of Science and Technology until 2010 and Beyond', approved by Instruction No. Pr-576 of the President of the Russian Federation dated March 30, 2002, named international science and technology cooperation among the most important areas of state policy on science and technology (see Section III of the 'Foundations...'). It emphasized that "...a crucial task is to create favourable conditions and mechanisms for the development of mutually beneficial and equitable international cooperation in science, technology and innovation."

3) The 'Concept of Long-Term Social and Economic Development of the Russian Federation until 2020', developed in accordance with an Instruction of the President of the Russian Federation following the July 21, 2006 meeting of the State Council,[19] in the sub-section entitled 'The Development of Science, a National Innovation System, and Technology' set objectives aimed at resolving existing problems of Russian science and developing an R&D-intensive economy, including:

– ensuring Russia's participation in global technology projects, international programmes and research networks for the purposes of integrating the country into the global science and technology environment;
– establishing a mechanism for supporting the creation and capitalization of Russian hi-tech brands, compensating expenditures on foreign patent applications and protecting intellectual property rights abroad, and increasing attention paid to this area of foreign economic activity on the part of embassies and trade representative offices of the Russian Federation, and also as part of the activity of inter-governmental commissions on trade and economic cooperation;
– supporting the acquisition of foreign assets: technology donors and centers for training personnel, including engineering and project companies;
– developing and supporting academic exchange and internship programmes with the participation of Russian and international students and lecturers, attracting world-class scientists to teach in Russia;
– engaging Russian academics working abroad in the development of Russian science and technology, including paying them to teach and participate in Russian scientific projects.

[18] URL: http://www.bestpravo.ru/rossijskoje/lj-gosudarstvo/p6a.htm

[19] 'Concept of Long-Term Social and Economic Development of the Russian Federation until 2020'. Approved by Order No. 1662-r of the Government of the Russian Federation dated November 17, 2008.

4) The ‘Strategy for Innovative Development of the Russian Federation 2020’ (Innovation Russia 2020).[20]

The section entitled ‘Strengthening International Science and Technology Cooperation’ set forth seven priority areas for international science and technology cooperation for the upcoming period, which largely overlap with the objectives set by the ‘*Concept of Long-Term Social and Economic Development*’:

- intensifying the participation of Russian research organizations and companies in international science and technology programmes for multilateral cooperation, including the *EU Framework Programmes for Research and Technological Development and Demonstration Activities*, as well as international technology platforms;
- entering bilateral and multilateral international agreements to stimulate cooperation in science and technology and innovation in priority areas. The potential for cooperation between hi-tech manufacturers across the CIS, including development of joint manufacturing and trading activity in countries of the emerging Common Economic Space, will be realized to the fullest extent;
- developing international cooperation among state-owned companies, including carrying out programmes for innovation-driven development, and encouraging the creation of international science and technology centres, as well as corporate research and development centers in Russia;
- expanding internship support for Russian researchers abroad and foreign researchers in Russia, and hosting international scientific conferences in Russia;
- eliminating barriers to strengthening international cooperation, including easing the visa regime for foreign researchers and ensuring the recognition of foreign scientific degrees when accrediting educational institutions;
- intensifying Russia’s participation in the activities of international and regional standardization organizations. Expanding the private sector’s support for the participation of Russian specialists in the development of international and regional standards;
- providing the Russian economy with highly qualified foreign specialists. Building a system where Russian companies are present in trade representative offices, formulating assignments for trade representative offices to attract highly qualified specialists, establishing a coordinating body to search and recruit highly qualified foreign specialists, designing training and internship programmes jointly with leading higher education institutions, and creating and maintaining databases of foreign specialists and the needs of Russian companies.

[20] ‘Strategy for Innovative Development of the Russian Federation 2020.’ Approved by Directive No. 2227-r of the Government of the Russian Federation dated December 8, 2011.

The contents of the above documents, primarily of the 'Strategy for Innovative Development of the Russian Federation until 2020', highlight one important factor than could disorient potential Russian participants in international science and technology cooperation. This factor is the ideas of encouraging cooperation in the area of innovation emerging as a result of an arbitrary convergence of the notions of research and development activity and innovation activity. This happens because of a simplified understanding of the innovation process model prevailing in Russia. Even Russian scientists very often think of the innovation process model as a linear sequence of four stages: research – innovation – manufacturing – sales. As a matter of fact, the innovation process model is much more complicated,[21] driven by a multitude of factors, and in general only partially incorporates the results of scientific activity. Those innovations that emerge as a result of the direct commercialization of research and development achievements are most often radical innovations, that is, they assume completely new products (goods or services) with radically new characteristics.

Without going into details and specifics of innovation activity that distinguish it from scientific activity (conducting research and development), we would like to point out the main difference between the two:

– scientific activity is aimed at obtaining new knowledge;
– innovation activity is intended for commercial benefit.[22]

In this regard, more attention should be paid to Russian scientific organizations performing tasks geared towards integration into the global innovation system; engaging foreign companies in the implementation of innovation projects based on Russian scientific output; innovation-driven cooperation on priority areas of science and technology development, etc. If left unattended, such an approach could inflict commercial damage upon Russian organizations developing advanced technology. It may also significantly reduce the effects of carrying out promising Russian discoveries that may benefit the country's economic development, or even lead to a loss of rights to the commercialization of important scientific discoveries. On the other hand, carrying out international innovation projects based on scientific output in the Russian Federation and in accordance with Russian legislation, if implemented in practice – as is the case in many other countries – would contribute to the competitive economic growth of the country.

[21] Kiselev V. Industry Science in the New Model of Innovation Process // Innovations, 2013. No. 5 (175) (in Russian).

[22] Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data, 3rd Edition. OECD/EC. 2005.

4. PRIORITY AREAS FOR THE RUSSIAN FEDERATION'S PARTICIPATION IN INTERNATIONAL SCIENCE AND TECHNOLOGY COOPERATION

Under the present circumstances, international science and technology cooperation is subject more than ever before to the influence of globalization, which, on the one hand, is encouraging the internationalization of manufacturing, research and development, science and technology data exchanges, technology trade, etc. On the other hand, globalization is changing the traditional forms and mechanisms of international science and technology cooperation, as well as the role of the state in regulating these processes.

Like many other development programmes, the Russian Federation's international science and technology cooperation has been traditionally based on defining goals and objectives, as well as on identifying priority areas. Thus, the key areas of international science and technology cooperation as set by the existing *'Concept of State Policy, of the Russian Federation on International Science and Technology Cooperation'* adopted in 2000 can be summarized as follows:

- international integration of Russia's fundamental and applied science;
- building integrative ties in science and technology, developing international cooperation programmes in the fundamental and applied sciences, establishing international scientific centers and organizations jointly with CIS states;
- establishing 'centers of international integration' for Russian fundamental science (joint research institutes, centres, laboratories, etc.) in Russia on the basis of leading scientific institutions and science cities;
- developing international science and technology cooperation with industrially developed nations and realizing the existing potential of the national fundamental science for the purpose of strengthening Russia's positions in international integration, cooperation and division of labour in fundamental science;

- using the achievements of Russian science to solve the global problems and achieve the objectives of sustainable development of the modern civilization (ecology, energy and transport of the 21st century, climate change, combating AIDS, information infrastructure, etc.), as well as global security problems (international terrorism, drug trade, information wars);
- disseminating information about the achievements of Russian science abroad;
- ensuring the participation of Russian scientists and research teams in competitions for grants, scholarships, etc., from foreign sources.

At the same time, the present state of Russian science, and the decline of its role in innovation-driven development and modernizing the country's economy, needs refining of the goals, objectives and areas of the Russian Federation's international science and technology cooperation. Based on analysis of the current state and development trends of Russian science, as well as the objectives set for the intensification of its role in economic modernization, it would seem appropriate to define areas of international science and technology cooperation based not only on Russian science's capabilities to participate in international projects and programmes, but also on the need to facilitate solutions to the problems of its organization, management mechanisms, funding, performance assessment, and so on.

The above assessments of the key problems facing Russian science and the proposed principles for carrying out international science and technology cooperation (see Sections 2.1. and 2.2.) make it possible to formulate the following areas for Russia's participation in international science and technology cooperation.

4.1. COOPERATION IN FUNDAMENTAL RESEARCH, INCLUDING PARTICIPATION IN MULTILATERAL SCIENCE AND TECHNOLOGY PROJECTS AND PROGRAMMES

Only a few countries (six or seven at most) currently have the capability to conduct fundamental research in a wide area of sciences. Russia has retained such a capability, although it still has problems mentioned above.

Since the main goal of fundamental research is to obtain new knowledge, which, as a rule, is published in the public domain and is intended for common use, this area of science presents the most favourable environment for developing international cooperation.

Bringing together scientists from different countries to conduct fundamental research is normally motivated by the complicated nature of problems at hand, the study of which is only possible using unique research facilities that often either exist only in certain countries, or have been built as part of large-scale international projects (the Large Hadron Collider, ITER, EXFEL, etc.).

Besides, the past few decades have seen the development of cooperation in research into problems that are faced by the whole humanity (such as global warming, sustainable development, forecasting earthquakes and other natural disasters, etc.) as part of international scientific forums (e.g., the *OECD Global Science Forum*).

There are many types of cooperation in the area of fundamental research. The forms of international science and technology cooperation have been set forth in the above-mentioned strategic documents. As far as scientific cooperation in the area of fundamental research is concerned, the forms of international science and technology cooperation can be briefly summarized as follows:

- bilateral cooperation with foreign countries as part of intergovernmental agreements on science and technology cooperation that determine the key forms and conditions for: interaction among scientific organizations; conducting joint research projects; exchanging research results; setting the provisions for internships for individual scientists; the use of unique research facilities, and so on;
- participation in international research projects and programmes;
- participation in international scientific conferences and seminars;
- international researcher, postgraduate and doctoral student exchanges;
- bringing highly qualified academics to Russia, including representatives of the Russian scientific diaspora abroad, to teach special courses at Russian universities with advanced postgraduate programmes;
- cooperation on finding solutions to global problems.

Russia's participation in international science and technology cooperation in fundamental research must pursue specific goals, such as eliminating current problems (see section 2.1.), increasing the potential of Russian science, expanding the scientific competencies of Russian research organizations, raising investments in scientific infrastructure, etc.

4.2. COOPERATION IN APPLIED RESEARCH AND COMMERCIALIZING INTELLECTUAL PROPERTY

In international and Russian practice, applied research is differentiated from so-called *experimental development*. This involves "activity based on knowledge acquired as a result of conducting scientific research or based on practical experience and aimed at safeguarding human life and health, creating new materials, products, processes, devices, services, systems or methods, and their further enhancement."[23] Essentially, experimental development is a logical con-

[23] Federal Law 'On Science and the State Science and Technology Policy' (version in effect from January 1, 2014).

tinuation of applied research. The definitions of applied research and experimental development make it clear that they, as a rule, are carried out for the benefit of certain organizations (or agencies) with the purpose of using the results of specific research to achieve objectives of an economic nature through patenting research results and the subsequent licensing of their use by creating an innovative product and taking it to market, or otherwise. This is called commercialization of intellectual property.

One of the features that differentiates cooperation in applied research from cooperation in fundamental research is the composition of the participants in joint projects. Fundamental research projects are carried out by scientists representing different organizations in one or several countries, all of which have equal rights to the results of their research. Joint applied research projects involve, as a rule, organizations engaged in different types of activity, one being the customer and the other the contractor. The contractor's involvement in carrying out a project can vary depending on the forms of interaction between them.

Three key forms of agreements exist that determine the conditions for interaction between a customer and a contractor in joint applied research: grant, contract and cooperative agreement.

Grants are, perhaps, the main form of funding of fundamental research. However, they can also be used to fund applied research as part of international cooperation programmes to resolve global problems, particularly those with a strong social component: the prevention of natural disasters, environmental security, fighting the consequences of climate change, etc.

Contracts for applied research (or experimental development) are used when the contractor assumes an obligation to perform agreed-upon research and transfer its results to the customer, which is the exclusive owner of the intellectual activity results and has full rights to their commercialization.

Cooperation agreements envisage the joint participation of the customer and the contractor in conducting research. Commercialization of intellectual property in this case is carried out in accordance with the provisions of the cooperative agreement.

With regard to organizing and carrying out international science and technology cooperation projects in applied research for Russian enterprises and scientific organizations, three sub-areas can be identified:

- participating in applied research as part of international cooperation programmes aimed at resolving global problems;
- performing applied research under contracts with foreign companies and international organizations;

– Russian enterprises funding applied research and experimental development performed by foreign scientific organizations under contracts or cooperative agreements (provided the intellectual property are transferred to the Russian side).

There has been much talk recently about the commercialization of research and development results, inventions and technology obtained by Russian scientific organizations and universities, including those resulting from international projects.[24] The Federal Law '*On Science and the State Science and Technology Policy*' defines the commercialization of scientific and (or) science and technology results as an activity aimed at putting such results into economic turnover.[25] In other words, commercialization envisages either selling the rights to the use of such results (if a corresponding protection document has been duly drafted), or using the results of research in innovation activity, individually or jointly with a Russian or a foreign partner.

Therefore, since commercialization envisages obtaining economic benefit, the discussion of organizing international cooperation on the commercialization of applied research results moves from the domain of scientific cooperation and into the domain of economic interaction, requiring a thorough elaboration of a whole number of aspects, such as:

– intellectual property rights and the rights to the terms and conditions of commercialization agreements;
– the terms and conditions for setting up manufacturing facilities (location, timing, targeted markets) and profit sharing;
– the possibilities for using the products for special purposes, etc.

One thing should be noted: developed countries are keeping very close tabs on the participation of foreign organizations in the commercialization of national intellectual activity results and unlicensed technology transfers. For example, in the United States, such matters are regulated by the export controls legislation. In April 2013, the Russian Government issued a resolution on regulating the activity of international organizations on Russian territory.[26] It can be also viewed as

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[24] For example, projects of the 'Inventor and Optimizer' Foundation. (http://i-r.ru/index.php?m=activity) or the Main Areas of International Activity on the Technology Platform Medicine of the Future (http://tp-medfuture.ru/per centD0per centBCper centD0per centB5per centD0per centB6per centD0per centB4per centD1per cent83per centD0per centBDper centD0per centB0per centD1per cent80per centD0per centBEper centD0per centB4per centD0per centBDper centD0per centBEper centD0per centB5-per centD1per cent81per centD0per centBEper centD1per cent82per centD1per cent80per centD1per cent83per centD0per centB4per centD0per centBDper centD0per centB8per centD1per cent87per centD0per centB5per centD1per cent81per centD1per cent82per centD0per centB2per centD0per centBE-2/) (both in Russian).

[25] Article 2 of Federal Law 'On Science and the State Science and Technology Policy' (as amended by Federal Law No. 254-FZ dated July 21, 2011).

[26] Resolution No. 367 of the Government of the Russian Federation 'On the Approval of the Rules for International Organizations to Obtain the Right to Issue Grants in the Territory of the Russian Federation for Performing Specific Research and Science and Technology Programmes and Projects, Innovation Projects, and Performing Specific Scientific Research on Grantor-Defined Terms' dated April 23, 2013.

an attempt to regulate cooperation between Russian research organizations and individual scientists with their foreign partners.

Given the relatively low R&D-intensity of the Russian economy, the unimpressive output of its innovation activity, and the fact that its system of training scientific personnel is not up to the requirements of modern technological development, we can argue in favour of the following areas of international science and technology cooperation that would increase demand among Russian enterprises for applied research and experimental development results:

- arranging training in intellectual property commercialization project management for young Russian scientists and postgraduate students abroad;
- inviting leading foreign experts to teach special courses on applied research organization and the commercialization of intellectual property at Russian universities;
- participating in international congresses and scientific conferences on innovation and technology development.

4.3. INTERNATIONAL EXCHANGES OF SCIENTIFIC DATA, RESEARCHERS, POSTGRADUATE AND DOCTORAL STUDENTS

International science and technology cooperation, whatever form it might take, involves the transfer of knowledge, both through exchanges of scientific data and the participation of scientists from different countries in international conferences, symposiums and research projects. Developing international science and technology cooperation, expanding scientific exchanges, acquiring advanced experience organizing and conducting research and development, and other forms of scientific cooperation are key elements of science and technology policy of both developed and rapidly growing economies.

At present, one of the main areas of science and technology cooperation among *OECD* countries is the promotion of international scientific exchanges, or more precisely, ensuring the transparency of scientific information and data obtained as part of publicly funded research projects. This area of international science and technology cooperation is based on the understanding that facilitating access to results of scientific research paid for with taxpayers' money will have a positive effect on the development of science and innovation. Decisions on implementing a policy of transparency in publicly funded science and innovation have been made at the executive level at the European Union[27] and the *OECD*.[28]

[27] Recommendations on Access to and Preservation of Scientific Information. EU. 2012.

[28] OECD Principles and Guidelines for Access to Research Data from Public Funding. OECD, 2008.

The *'Concept of State Policy of the Russian Federation on International Science and Technology Cooperation'* adopted in 2000 also included exchanges of science and technology information and data as one of the key forms of international science and technology cooperation carried out as part of international agreements; however, this provision has not been substantially elaborated any further.

International data exchanges, being one of the key forms of international science and technology cooperation in fundamental research, primarily involve research presentations delivered at scientific conferences, symposiums and seminars, as well as publishing articles in foreign and international (publications of international organizations) scientific journals. The modern level of information technology development has substantially expanded data exchange possibilities.

International researcher exchanges involve reciprocal internships of mostly young researchers at research institutions linked by partner ties or other arrangements, including intergovernmental agreements on international science and technology cooperation, and inviting prominent foreign academics to teach at higher education institutions or direct scientific research.

International postgraduate and doctoral student exchanges, the goal of which is to collect the necessary scientific information for dissertations in accordance with intergovernmental agreements, are practiced by all developed and many developing nations. Over the past 15–20 years, writing and defending dissertations at foreign research organizations and universities has become increasingly popular among Russian doctoral candidates. There have also been cases, however few and far between, where foreign doctoral students have come to Russia to write and defend their dissertations. This form of international science and technology cooperation is normally practiced as part of inter-university cooperation agreements.

Given the substantial expansion of international ties among Russian research institutions and universities,[29] we should expect to see an increase in international exchanges as a form of international science and technology cooperation, particularly in the area of inter-university cooperation.

Presentation of the results of Russia's science and technology activity abroad. International scientific data exchanges, both in the form of scientific publications and reports at conferences and symposiums, involve the presentation of results of completed research, primarily in fundamental science.

This is an established global practice that is necessary, first of all, to make official priority claims to discoveries, and secondly, to improve the rating of

[29] For example, the Financial University under the Government of the Russian Federation had cooperation agreements with 30 partner institutions in 18 countries in 1994. In 2013, it maintained close bilateral ties with as many as 120 partner institutions, as well as with educational and research and development centres and finance and banking institutions in 50 countries. URL: http://international.fa.ru/Pages/Home.aspx (in Russian).

one's organization (or university). Without going into the details of Russia's science model, where the university sector in 2012 was responsible for just 9.3 per cent of domestic research expenditures,[30] it is worth noting that most Russian publications in foreign journals come from employees of academic institutes.

The above-mentioned decline in the performance of Russian science's publication activity (see section 1.1.) suggests that international science and technology cooperation in this area should be intensified. At the same time, we need to develop different forms of presenting Russian scientific achievements to the global community, such as participating in international conferences, exhibitions and major seminars.

Furthermore, international scientific events based at Russian scientific research organizations should be held more often. It is worth noting that conducting international scientific conferences, symposiums and exhibitions in Russia is preferable to having Russian scientists participate in foreign events. This is because, in the former case, it is possible to ensure the transfer of advanced scientific knowledge to a wider range of Russian researchers, which is particularly important for young scientists.

4.4. ATTRACTING FOREIGN INVESTMENTS INTO SCIENCE AND TECHNOLOGY

According to data from Scientific Research Institute of the Ministry of Education and Science of the Russian Federation, foreign-sourced funds as a share of Russia's domestic research and development spending decline consistently between 2000 and 2012: 2000 – 12 per cent; 2005 – 7.6 per cent; 2011 – 4.3 per cent; 2012 – 4.0 per cent.[31]

In this regard, an area of international science and technology cooperation that deals with originating and carrying out projects aimed at attracting foreign investments in science and technology should gain importance in the immediate future. In this case, that means both foreign-sourced research and development spending and direct foreign investments in joint projects for the commercialization of Russian intellectual property.

It is worth noting that Russia has created the necessary infrastructure for this, the key elements of which include a system of 113 unique research facilities owned by Russian research institutions that enable research in the most

[30] Statistical Review: Russian Science in Figures: 2013. Scientific Research Institute – Federal Research Centre for Projects Evaluation and Consulting Services (in Russian).

[31] Statistical Review: Russian Science in Figures: 2013. Scientific Research Institute – Federal Research Centre for Projects Evaluation and Consulting Services (in Russian).

promising areas of science.[32] This infrastructure also comprises special science and innovation economic zones and the *Skolkovo Innovation Center* for the development and commercialization of new technology, which is currently under construction.

4.5. PARTICIPATION IN THE ACTIVITIES OF INTERNATIONAL ORGANIZATIONS

Participation in the activities of international organizations is one of the key areas of international science and technology cooperation. It is necessary for both understanding modern development trends of different areas of science and setting appropriate national science and technology policies.

From the standpoint of international science and technology cooperation, two key types of international organizations should be distinguished:

International non-governmental research institutions, whose members can include scientific institutes or individual scientists. The main goal of such organizations is to disseminate and exchange knowledge in specific research and development areas, coordinate research and arrange scientific conferences and symposiums. The *International Council for Science* (*ICS*) has become the main organization of this type, bringing together a large number of international research institutions, unions, associations, etc.[33] The *ICS*'s main goal is to ensure international cooperation in the promotion of science. *ICS* members include scientific organization and individual countries, as well as international scientific unions, societies and institutes (the *International Mathematical Union*, *International Union of Crystallography*, *International Society for Computational Biology*, etc.).

The main goal of Russian research organizations in the activities of international non-governmental research institutions should be international 'benchmarking', that is, comparing the level of Russian research activity with the best global achievements and identifying success factors.

Another no less important goal is to ensure Russian scientists' leadership in international organizations in whose areas of specialization they possess undisputable competencies.

International intergovernmental organizations, whose charters include studying science and technology policy issues, creating corresponding information systems and databases, and developing recommendations required by states to develop national science and technology policies. Such organizations include the

[32] The www.ckp-rf.ru website on unique stands and installations (in Russian).

[33] URL: http://www.icsu.org/

United Nations (which achieves the goals of science and technology development through individual programmes), *UNESCO*, *UNIDO*, *OECD*, etc.

States participating in intergovernmental organizations assume a number of obligations, including paying membership fees and supporting information and analytical activity (including supplying the relevant bodies with national statistical data on the relevant subjects).

The main factor determining the need for Russia to participate in the activities of intergovernmental organizations engaged in science and technology development is the opportunity it presents to draw upon global experience in developing state science and technology and innovation policy. And the main goal of this participation should be to study and develop proposals on adapting the best global practices in state science, technology and innovation policy to Russian conditions, setting priorities for the development of science and technology, managing the state science sector, etc.

Another important area of activity of intergovernmental organizations is establishing research projects and consolidating efforts of scientists in different countries in the 'Big Science'.[34] The *OECD Global Science Forum* was founded in 1992 as a platform for holding consultations, where government representatives and scientists can discuss carrying out 'Big Science' projects, such as underwater research of super high-energy neutrinos, international electron accelerators, nuclear physics, global biodiversity, etc.

One important area must involve the active participation of Russian representatives in setting the agenda of research programmes planned by international intergovernmental organizations.

The participation of Russian scientists in the projects of the *EU Framework Programmes* can be considered part of cooperation with international organizations.[35] However, despite the high importance of such interactions, a number of problems and obstacles exist to the equal participation of Russian organizations in the *European Union* research programmes, and their resolution requires considerable organizational efforts on the part of state authorities.[36]

In the run-up to the active phase of the *EU Horizon 2020* programme for 2014–2020, it is necessary assess the problems and results of the participation

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[34] Big Science is a style of scientific research developed during and after World War II that defined the organization and character of much research in physics and astronomy and later in the biological sciences. Big Science is characterized by large-scale instruments and facilities, supported by funding from government or international agencies, in which research is conducted by teams or groups of scientists and technicians. Source: Encyclopedia Britannica. URL: http://www.global.britannica.com/EBchecked/topic/64995/Big-Science

[35] The latest EU framework programme for 2014–2020 is called *Horizon 2020*.

[36] Gurova A., Kiselev V. On the Possibility of Associated Membership of the Russian Federation in the EU Seventh Framework Programme. Information and Analysis Bulletin No. 2, 2010. Scientific Research Institute – Federal Research Centre for Projects Evaluation and Consulting Services (in Russian).

of Russian organizations in previous *EU Framework Programmes*. It is important for cooperation on the *Horizon 2020* programme to have specific and achievable goals and to serve the development of the Russian research and development sector, as well as the goals of the innovation-driven development of the Russian economy.

4.6. COOPERATION IN RESOLVING GLOBAL PROBLEMS

The modern world faces a large number of global problems (or 'Global Challenges'), the resolution of which requires the combined efforts of many states. Among these problems, the *World Bank* has named the following as the most pressing: global warming and climate change, environmental protection, the spread of dangerous diseases, biodiversity protection and resource management, including using the world's oceans and outer space for the benefit of humanity.[37]

The main threat is that, if these global challenges are not resolved, they will lead to a substantial deterioration of living conditions on Earth.

Consolidating the efforts of individual countries to meet the global challenges is realized, above all, in research conducted as part of international projects. Many foreign universities offer research programmes aimed at finding solutions to global problems, host international conferences and symposiums, and establish forums for scientists from different countries to communicate with each other.

Established in 1996, the *Millennium Project* is a good example of international science and technology cooperation in finding solutions to global problems.[38] The project is aimed at resolving the problems of environmental safety, organizing scientific research, improving education, developing healthcare, etc. Training is offered as part of the project in the methodology of analysing critical situations and future challenges.

Admittedly, international science and technology cooperation in resolving global problems, just like domestic research on this subject, is not among Russia's priorities, although this area of international science and technology cooperation is very important. On the one hand, exchanges of expertise and cooperation in finding solutions to a number of global problems (for example, protecting biodiversity, etc.) are of scientific interest to Russia. On the other hand, international science and technology cooperation in areas such as the rational exploitation of mineral resources and the results of space research is of specific economic interest.

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[37] URL: http://www.web.worldbank.org/wbsite/external/extaboutus/0,,contentMDK:20627105~pagePK:51123644~ piPK:329829~theSitePK:29708,00.html

[38] URL: http://www.millennium-project.org/millennium/index.html

4.7. THE ROLE OF THE RUSSIAN SCIENTIFIC DIASPORA IN THE DEVELOPMENT OF RUSSIA'S INTERNATIONAL SCIENCE AND TECHNOLOGY COOPERATION

The subject of maintaining ties with the Russian scientific diaspora and the question of its participation in the development and reforming of Russian science and the system of higher professional education have become quite popular in publications, at conferences and in internet forums in recent years. This problem emerged as a result of the 'brain drain' from Russia during the 1990s and has since become a subject of discussion and study in its own right. At present, there are no precise figures on the size of the Russian scientific diaspora. According to Andrei Korobkov, a professor at Middle Tennessee State University in the United States, in 2010, physicists accounted for 33.6 per cent of the Russian scientific diaspora; biologists accounted for 22.8 per cent; technical sciences 12.7 per cent; mathematicians 9.3 per cent; and chemists 6.1 per cent.[39] According to the estimates by E. Pismennaya and S. Ryazantsev, approximately 100,000–150,000 Russian émigrés can be considered as belonging to the scientific diaspora, with approximately 70 per cent of them working in the United States.[40]

Successful scientists of Russian origin work mainly at universities and large corporations.

Scientific diasporas are a fairly widespread phenomenon in the modern world. They first emerged as a result of the migration of skilled personnel from developing countries to North America and Europe. In many countries, scientific diasporas have united into associations that the countries the migrants came from consider a source of advanced knowledge or as partners in development.

Some countries (such as Austria, Germany and the United States) offer state-sponsored programmes aimed at maintaining contacts with compatriots, with a special emphasis on representatives of scientific diasporas. Such programmes, carried out via diplomatic missions, include, as a rule, supporting graduates of national universities at conferences and round tables, issuing training grants, providing free access to scientific publications, etc. For instance, the U.S. Department of State maintains contacts with approximately one million U.S. university graduates, including U.S. citizens working in different countries.[41] The gov-

[39] Korobkov A.V., Zaionchkovskaya Z.A. The Scale and Social Impact of the Russian Intellectual Migration. Association for Slavic, East European, and Eurasian Studies 42nd Annual National Convention. Los Angeles, CA, November 2010.

[40] Pismennaya E.E., Ryazantsev S.V. The New Russian Diaspora. Certain Development Aspects // Migration Law. #4. Pp.20-23. 2012

[41] URL: http://www.germany.usembassy.gov/germany/alumni_initiative.html

ernment of Austria also maintains ties with its own scientific diaspora, which numbers around one thousand in North America alone. For instance, the embassy of Austria in the United States hosts annual meetings, data exchanges and discussions of various scientific problems. The Office of Science and Technology of the Austrian embassy in the United States has overseen the creation of the Austrian Scientists and Scholars in North America association.[42]

Returning to the subject of cooperation with Russian research institutions and universities, it is worth noting that, according to opinion polls conducted in the United States, representatives of the Russian diaspora would be interested in such types of interaction as:

- visiting Russia to conduct consultations and participate in conferences;
- providing expert opinions (on scientific projects, state programmes and plans, regional projects) and peer reviews of articles;
- participating in joint projects executed in parallel in Russia and the United States;
- teaching at Russian universities;
- creating joint structures – chairs at universities or laboratories at research institutions;
- arranging for Russian students to visit the United States to gain experience operating modern equipment and get an idea about how science can be organized differently.[43]

The above list of potential areas of cooperation with the Russian scientific diaspora looks solid and potential results are in particular demand, yet such interaction can hardly be possible unless there is an appropriate state-supported programme in place the Russian Federation. It is Russia that should initiate and support – including providing financial support – ways to urge the Russian scientific diaspora to address the problem of increasing the performance of Russian science.

[42] URL: http://www.ostina.org/en/volume-35-october-11-2012/volume-35-october-11-2012-news-from-the-network-austrian-researchers-abroad/9th-annual-austrian-science-talk-held-in-washington-dc

[43] Dezhina I. Russia's International Scientific Cooperation // World Economy and International Relations. 2010. No. 2, pp. 28–37 (in Russian).

5. PROMOTING AND DISSEMINATING THE RESULTS OF INTERNATIONAL SCIENCE AND TECHNOLOGY COOPERATION IN RUSSIA

Promoting the results of international science and technology cooperation among Russian research and higher education institutions is an important success factor for achieving its goals and objectives. In this regard, it appears appropriate to create, under the auspices of the Ministry of Education and Science, an information analysis system of international science and technology cooperation of the Russian Federation. Maximum use of internet technology that would ensure transparency of information and its accessibility to all cooperation participants is a prerequisite for achieving efficiency in this area.

An important area of promoting international science and technology cooperation in Russia is supporting the activity of the so-called national points of contact for cooperation with the European Union previously created by the Ministry of Education and Science of the Russian Federation as part of the key areas of the *Seventh Framework Programme for Research and Technological Development and Demonstration Activities*.[44] It is necessary to continue supporting the activity of those points of contact as part of the key areas of the *Horizon 2020* EU programme.

Events Hosted by the Russian House for International Scientific and Technological Cooperation

The *Russian House for International Scientific and Technological Cooperation* was established in 1992 at the initiative of the then-existing Ministry of Science and Technical Policy. Its purpose is to create the necessary conditions for Russian organizations interested in commercializing proprietary technologies and experimental scientific and technological developments abroad, as well as for foreign

[44] Order No. 62 of the Ministry of Education and Science of Russia 'On Russian National Points of Contact in the Areas of the Seventh Framework Programme for Research and Technological Development and Demonstration Activities (2007–2013)', dated February 21, 2007 (as per the November 24, 2010 version).

organizations interested in entering the Russian market as investors in the domestic science, technology and manufacturing spheres.[45] In 2014 alone, the *Russian House for International Scientific and Technological Cooperation* will be showcasing an exhibition of Russian scientific institutions and enterprises at 16 international science, hi-tech and innovations trade show.

The *Russian House for International Scientific and Technological Cooperation*'s activity can be tentatively divided into three large areas:

1) Organizing and conducting specialized technology exhibitions, seminars, and presentations abroad.

2) Providing information and analytical support to activities involving the transfer and commercialization of technology, including:

– establishing a data bank on Russian technologies that have no analogues anywhere in the world;
– drafting proposals aimed at improving Russian legislation in the areas of international science and technology cooperation and international industrial cooperation;
– preparing and publishing analytical materials and recommendations for Russian members of the Association on matters concerning the functioning of the international technology market, its development prospects, and how to operate on it.
– preparing recommendations for foreign members of the Association on the most lucrative and promising investments in the science and technology sphere of the Russian economy.
– conducting proprietary research and development work in priority areas of science and technology through the creation of temporary research teams.
– performing research and development for state needs.

3) Organizing and supporting international science and technology and investment projects, including:

– establishing international science and technology projects and providing legal support to them.
– transferring domestic technology abroad for the purpose of creating joint manufacturing ventures.
– sourcing foreign orders for scientific research to be performed by Russian specialists in Russia.
– exporting the results of science and technology activity and importing research and development equipment.

[45] Russian House of International Science and Technology Cooperation. URL: http://www.rd-mnts.ru/index.php?option=com_frontpage&Itemid=1 (in Russian).

– Year of Science Format Events

The *Year of Science* events are one of the newer tools for the development of international science and technology cooperation. The opening ceremony of the *EU–Russia Year of Science 2014* took place in Moscow on November 25, 2013. The programme of this event is expected to include: conferences and round table discussions on matters of cooperation between Russian and European research institutions and universities: familiarization with the key provisions of the EU *Horizon 2020* programme: exchanges of scientific delegations, etc. While it is still too early to assess the outcomes of such events, it is evident that they will facilitate the development of international science and technology cooperation and the promotion of the results of such cooperation in Russia.

Despite the above examples, it should be acknowledged that the results of international science and technology cooperation in Russia need to be promoted and disseminated far more actively, primarily through the efforts of the agency responsible for this sphere of activity, that is, the Ministry of Education and Science of the Russian Federation. Remarkably, the official website of the Ministry of Education and Science provides no links to events sponsored by the *Russian House for International Scientific and Technological Cooperation* or any other Russian initiatives and projects that are part of international science and technology cooperation, except information about official events and meetings.

6. KEY RISKS AND RUSSIA'S SCIENCE AND TECHNOLOGY SECURITY IN INTERNATIONAL SCIENCE AND TECHNOLOGY COOPERATION

The globalization of the world economy and the growth in the R&D-intensity of goods and services manufacturing have predetermined a substantial increase in the scale of international science and technology cooperation. Like any other cooperative scientific activity, international science and technology cooperation is subject to a number of risks. These risks can be divided into three key groups.

The first group includes risks that are inherent in any scientific research: errors in selecting areas and subjects of research, errors in determining the amount of funding, the required devices, etc.

The second group includes risks arising from organizing and conducting cooperative research projects, that is, projects carried out in conjunction with several entities, including scientific, industrial and financial entities. In this case, the risks included in the first group are joined by risks related to errors in selecting partners that could prove unable to perform their part of the work, allocating responsibility for performing different work stages, or planning how to use the results of the completed work.

The third group includes risks that are inherent mainly in international science and technology cooperation projects. This group comprises risks stemming from the following aspects:

- a lack of information regarding the competencies of foreign partners. consequence of this is the risk that their competencies may be overestimated, and the entire project could fail as a result. In addition to this, intellectual property rights could be lost if the Russian side's part in the project is the contribution of previously obtained research results;
- the corporate and national specifics of foreign partners (recording insignificant results or oral agreements, the organization of work, etc.). Such specifics in general could lead to difficulties with project management and slow down research;

- a large number of participants in an international project. In this case, difficulties could arise with project management and achieving the set goals;
- underestimating the strategic importance of the results of future projects completed jointly with foreign partners. This is perhaps the main risk inherent in international science and technology cooperation, particularly in the area of applied research and the commercialization of intellectual property. Some foreign experts advise against organizing international projects in cases where the area of cooperation has a strategic importance in terms of security (information, technology, etc.); [46]
- activities of foreign research and development organizations in the host country. Initiatives of this kind are often aimed at using human resources of the host country – primarily highly qualified researchers – to benefit your own projects. The main risk such projects present is a 'brain drain' from Russian science. Another potential risk involves losing the unprotected results of intellectual activity obtained by the host country's scientists. The above-mentioned April 2013 Resolution of the Government of the Russian Federation could partially mitigate those risks for Russia. The Resolution has introduced special rules for international organizations to register and obtain the rights to issue grants in the Russian Federation for carrying out specific research and science and technology programmes and projects, innovation projects, and conducting specific scientific research on terms and conditions established by grantors.[47]

At the same time, it should be noted that the '*Strategy for Innovation-Driven Development of the Russian Federation until 2020*' essentially ignores any such risks. For instance, one of the provisions on its list of key measures for implementing the Strategy stipulates "attracting research divisions of major global companies to the Skolkovo Innovation Center, technology developpment zones, science cities and closed administrative territorial formations."[48] An advertisement by a foreign hi-tech company that is a *Skolkovo* resident about internship positions available to young Russian scientists and postgraduate students at that company's research centre is a good example. The company offers initial temporary employment for six months with an option of subsequent full-time employment subject to the results of the internship. What's more, potential recruits are expected to meet the

[46] Finne T. R&D Collaboration: The Process, Risks and Checkpoints. Information Systems Audit and Control Association. 2003, pp. 18–22.

[47] Resolution No. 367 of the Government of the Russian Federation of 'On the Approval of the Rules for International Organizations to Obtain the Right to Issue Grants in the Territory of the Russian Federation for Performing Specific Research and Science and Technology Programmes and Projects, Innovation Projects, and Performing Specific Scientific Research on Grantor-Defined Terms' dated April 23, 2013.

[48] Appendix No. 2 to the Strategy for Innovation-Driven Development of the Russian Federation until 2020 'List of Key Implementation Steps of the Strategy for Innovation-Driven Development of the Russian Federation until 2020', section VI, p. 52.

toughest of requirements. Such an offer could essentially mean cherry-picking the most talented Russian researchers with a potential offer of further employment in the company's foreign divisions.

The 'National Security Strategy of the Russian Federation until 2020' defines science, technology and education as one of the areas of national security.[49] ***In this regard, it is worth pointing out that accounting for the risks inherent in planning, organizing and carrying out international science and technology cooperation projects, as well as in participation of Russian representatives in international scientific programmes, has considerable importance for ensuring the science and technology security of the Russian Federation.***

[49] Approved by Decree No. 537 of the President of the Russian Federation dated 12 May 2009.

7. PROPOSED ORGANIZATIONAL CHART AND MECHANISMS FOR IMPLEMENTING INTERNATIONAL SCIENCE AND TECHNOLOGY COOPERATION

One of the key factors preventing Russia's efficient international science and technology cooperation is the lack of attention paid to ensuring the country's participation in international research programmes and the projects of international organizations that deal with science, technology and innovation policy.

Given the importance of international science and technology cooperation for the development of the research and development sector and national security in science, technology and education, it would be helpful to organize Russia's international science and technology cooperation according to the principle of verticality. It would be appropriate to place strategic matters for organizing and carrying out international science and technology cooperation under the jurisdiction of the Presidential Council for Science and Education, for instance, by establishing an interdepartmental working group on international science and technology cooperation.

The overall control and coordination of Russia's participation in international research organizations and major research projects and programmes should be entrusted to the Ministry of Education and Science, which is also in charge of cooperation with international intergovernmental organizations to the extent of its competencies and organizes and coordinates cooperation with foreign countries in accordance with signed agreements. The participation of Russian research institutions and individual scientists in international conferences, symposiums and research projects and programmes should be placed within the responsibility of the Russian Academy of Sciences, research foundations, the Kurchatov Institute National Research Centre, state science centres, industry specific research institutions, universities and other participants in international science and technology cooperation in accordance with their charters and Russian legislation.

It appears appropriate to create a system of informational and analytical support for international science and technology cooperation, which should include several analytical centres/institutes (in various areas of specialization). They should be assigned with: systematizing the relevant international experience and developing proposals on how to adapt and use it in Russia; monitoring the activity of international organizations and large projects in science and technology; developing proposals with regard to positions of Russian delegations at international events; advising on the organization, management, financing and thematic content of corporate research projects; selecting foreign partners, etc.

The organizational chart of international science and technology cooperation should be designed in such a way as to focus the attention on its key participants, that is, research and higher-education institutions, scientific teams and individual scientists taking part in international science and technology cooperation projects and programmes. An information and analytical system must ensure their effective participation in international science and technology cooperation events and, most importantly, analyse and summarize the outcomes of their work on international projects, and draft recommendations on the subsequent use of their accumulated experience. Any matters that require strategic decisions should be reviewed by the *Interdepartmental Working Group on International Science and Technology Cooperation* under the Presidential Council for Science and Education, and should be discussed and decided upon at the Council's meetings.

Figure 16 shows an organizational scheme of international science and technology cooperation of the Russian Federation.

As for the mechanisms for carrying out international science and technology cooperation, they are generally known and substantially developed, although they tend to change over time (for example, the procedures for participating in the *EU* Framework Programmes or the *OECD* working bodies). The following key groups of mechanisms for carrying out international science and technology cooperation of the Russian Federation can be identified:

– informational and analytical support mechanisms;
– organizational mechanisms;
– management and funding mechanisms;
– performance assessment and decision-making mechanisms.

The organizational chart and mechanisms for carrying out international science and technology cooperation proposed in this section only cover the key points and can be expanded and supplemented further. However, no matter how the system for supporting and promoting international science and technology cooperation of the Russian Federation is configured, special attention should be paid to ensuring the efficiency of Russian participation.

8. MEASURES FOR PROMOTING RUSSIA'S INTERESTS IN INTERNATIONAL SCIENCE AND TECHNOLOGY COOPERATION

In addition to the existing measures based on the above-mentioned key areas of modern science and technology cooperation (section 2.2.), and taking into account the strategic goals and objectives of Russia's international science and technology cooperation (Chapter 3), it would seem appropriate to implement a number of additional measures –primarily those of a legal and regulatory, informational and analytical, and organizational nature – in order to help promote Russian interests.

Developing a Concept of International Science and Technology Cooperation for the Russian Federation

In the short term, it is necessary to define a legal and regulatory framework for Russia's international science and technology cooperation. Based on the existing legislation, primarily the Federal Law '*On Science and the State Science and Technology Policy*', it is necessary to develop a new Concept for developing international science and technology cooperation that would reflect the new objectives and goals of Russia's innovation-driven development and the modernization of its economy, while also carrying out the priority tasks of science and technology development and critical technologies. Structurally, the Concept could include the following sections:

- strategic goals and objectives of Russia's international science and technology cooperation until 2020 and beyond;
- principles for carrying out international science and technology cooperation;
- priority areas for Russia's participation in international science and technology cooperation;
- improving the legal and regulatory framework of international science and technology cooperation;

- organizational chart and mechanisms for carrying out international science and technology cooperation;
- promoting the results of international science and technology cooperation;
- regulating matters relating to the commercialization of intellectual activity results as part of international science and technology cooperation projects;
- activities of foreign scientific institutions in the Russian Federation;
- ensuring scientific and technology security when carrying out international science and technology cooperation.

Creating an Interdepartmental Working Group on International Science and Technology Cooperation

To achieve these strategic objectives, it would be appropriate to create an interdepartmental working group on international science and technology cooperation under the Presidential Council for Science and Education, whose jurisdiction should include making decisions on such important matters of international science and technology cooperation as:

- participating in large international scientific programmes and projects, e.g., the EU *Horizon 2020* programme;
- setting priorities for participating in the activities of international organizations;
- amending programme documents of the Russian Federation related to international science and technology cooperation (e.g., the *State Science Programme 2020*);
- the activities of foreign research organizations in the Russian Federation, etc.

Creating an Information and Analytical System for International Science and Technology Cooperation

An information and analytical system (IAS) for international science and technology cooperation is intended to facilitate effective activities of all Russian participants – scientists, research institutions and teams, higher education institutions, ministries and agencies – in international projects and programmes.

It would seem appropriate to set up an international science and technology cooperation IAS under the auspices of the Ministry of Education and Science of the Russian Federation, either on the basis of one of its affiliated agencies, or by establishing a specialized interdepartmental centre to work in cooperation with research and development institutes, the Russian Academy of

Sciences, research foundations and universities. The international science and technology cooperation IAS should be responsible for searching, analysing and providing information on all aspects of international science and technology cooperation. Additionally, the international science and technology cooperation IAS's brief should include:

- monitoring international science and technology cooperation projects and programmes in Russia;
- registering (in agreement with the Ministry of Education and Science) international agreements signed by Russian research organizations and universities with foreign partners;
- organizing the activities of national contact points on cooperation with the EU *Horizon 2020* programme;
- analysing the results of the participation of Russian institutes, individual scientists and representatives of government ministries in international projects, and drafting recommendations on subsequent use of their accumulated experience;
- maintaining contacts with representatives of the Russian scientific diaspora abroad.

The functions of the international science and technology cooperation IAS can be laid out in more detail in a Statute of the information and analytical system, or in other documents.

International Publication Activity

Promoting publications by Russian researchers in *Web of Science*-cited scientific journals and generally expanding the international publication activity of Russian scientists should be considered not as a goal in and of itself, but rather as an important performance indicator of Russian science, and also as a means for expanding internationally conducted research.

The objective of increasing international publication activity is often taken too narrowly, that is, as increasing the number of articles published in international scientific journals. Clearly, when formulated this way, this objective appears to be fairly difficult. At the same time, it is worth noting that internationally recognized scientific journals publish and, accordingly, cite not only scientific articles. In particular, the user manual for the *Web of Science* scientific publications database,[50] released by the *Thomson Reuters Corporation* in 2009, lists documents containing scientific information that can be accepted for publication. These include articles, literature and database reviews, publishers' materials, hardware and software reviews, information notices, reprints, etc. Therefore, the level of

[50] WEB OF SCIENCE® 8.0.2009 The Thomson Reuters Corporation.® URL: http://www.lib.vt.edu/help/handouts/databases/wos-workbook-8.pdf

publication activity, as well as of international ties, will rise substantially if it is not limited to publication of scientific articles.

It would seem appropriate to put the scientific councils of research and higher education institutions in charge of matters involving the publishing of scientific results, including authors' information notices about materials sent for publication in foreign and Russian science journals. Such an approach would, on the one hand, raise the prestige of the Russian scientific press, while on the other hand, help satisfy the priorities of Russian science in achieving scientific results.

Promoting Russian Interests as Part of Cooperation with International Intergovernmental Organizations on Science and Technology Policy Matters

This area of international science and technology cooperation is under the jurisdiction of the Ministry of Education and Science of the Russian Federation and includes, among other things, exchanging experience and, jointly with representatives of other countries, developing recommendations on state policies in the area of science.

In this area, it would seem appropriate:

1. To study of experience of foreign countries, as well as the findings and recommendations of international organizations on the matters and tools of modern science, technology and innovation policy in order to adapt them for Russian conditions. Translate into Russian, and disseminate among public employees, internationally recognized manuals on matters of state policy in science, innovation, education, etc., used by all developed and most developing countries.[51] The primary value of internationally recognized manuals is that they introduce and explain the relevant terms and definitions.

2. To organize the systemic participation of ministry and agency representatives, as well as experts, in the activities of international intergovernmental organizations. Ensure that advanced foreign experience is obtained, adapted and disseminated. Use Russia's participation for the purposes of shaping the working agendas of such organizations with account taken of the interests of the Russian Federation, which is already possible and partially done, for example, through the participation of Russian representatives in the activities of certain committees and expert and working groups of the *Organisation for Economic Cooperation and Development* and the *United Nations Economic Commission for Europe*.

[51] Such manuals include: 1) Frascati Manual 2002. Proposed Standard Practice for Surveys of Research and Experimental Development. OECD 2002; 2) Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data, 3rd Edition. OECD/EC. 2005, among others.

Measures to Intensify Work with the Russian Scientific Diaspora

Taking into account the above-mentioned problems concerning cooperation between countries and their scientific diasporas, it would seem appropriate to take the following steps to intensify cooperation between Russian research institutions and representatives of the Russian scientific diaspora:

1) An interdepartmental council should be created, with assistance from the Ministry of Education and Science and the Ministry of Foreign Affairs, to organize cooperation with representatives of the Russian scientific diaspora. The main goal of such a council would be to coordinate their interaction with Russian research institutions and universities in carrying out such activities as:

- giving lecturing, consulting, participating in scientific conferences;
- providing expert evaluation of scientific projects;
- organizing joint research projects;
- creating joint entities, such as university chairs, laboratories at scientific institutions, etc.

2) The Ministry of Foreign Affairs should consider establishing a system of interaction with representatives of the Russian scientific diaspora at Russian embassies, possibly using the Austrian Foreign Ministry or the U.S. Department of State as an example. The main objective is to maintain contacts with representatives of the Russian scientific diaspora and to set up meetings with leading Russian scientists.

FOR ENTRIES

Russian International Affairs Council

Printed in Russia

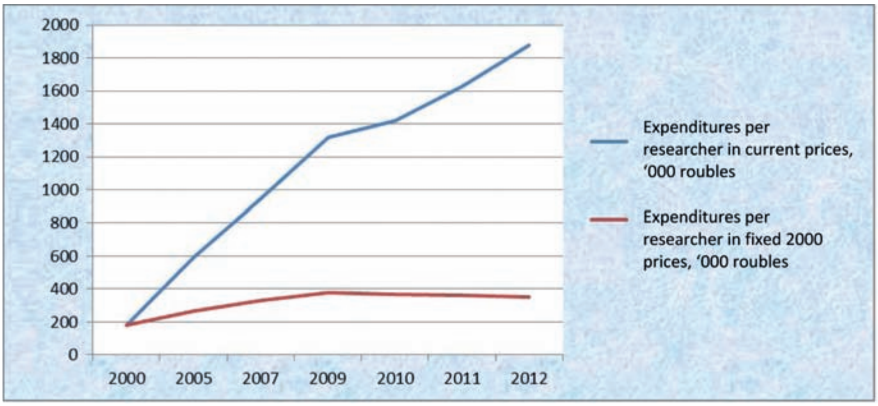


Figure 1. Domestic Research and Development Spending per Researcher, 2000–2012

Source: Author's calculations based on data from 'Russian Science in Figures: 2013.' Scientific Research Institute – Federal Research Centre for Projects Evaluation and Consulting Services. 2013.

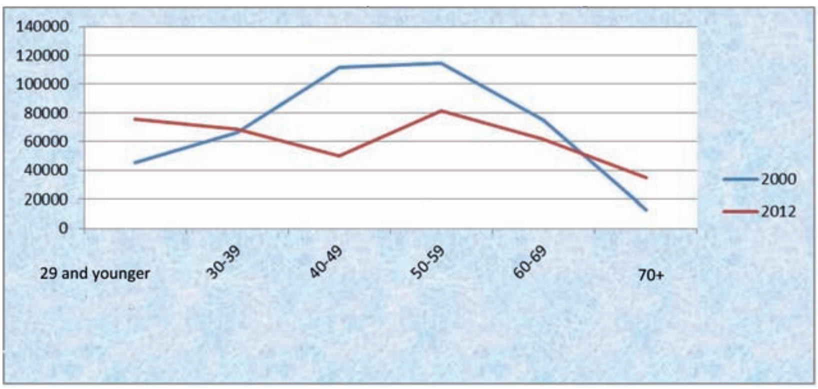


Figure 2. Age Structure of Russian Researchers in 2000 and 2012

Source: Author's calculations based on data from 'Russian Science in Figures: 2013.' Scientific Research Institute – Federal Research Centre for Projects Evaluation and Consulting Services. 2013.

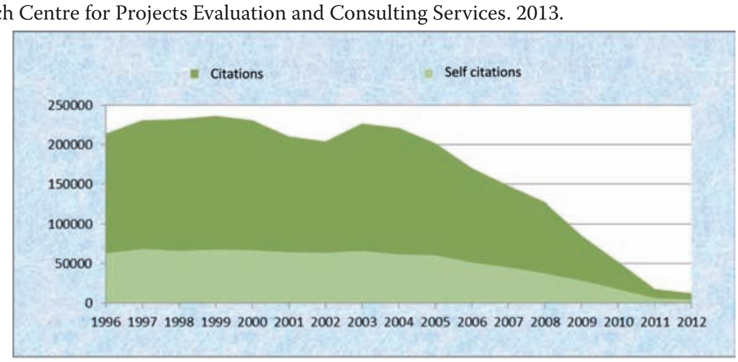


Figure 3. Citation and Self-Citation Dynamics of Articles Published by Russian Scientists in International SCOPUS Peer-Reviewed Scientific Journals

Source: S CImago Jour nal and Coun try R ank, 2013. UR L: h ttp://www.scimagojr.com/countrysearch.php?country=RU

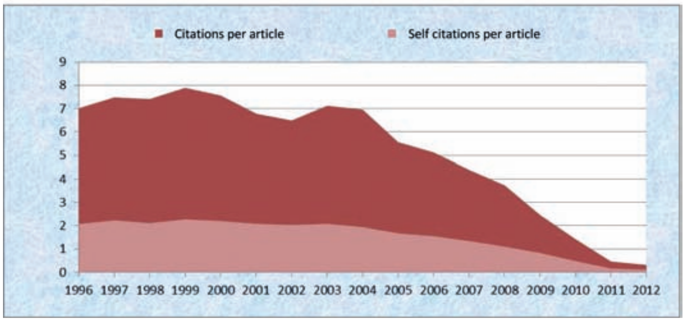


Figure 4. Citation and Self-Citation Dynamics per Article Published by Russian Scientists in International SCOPUS Peer-Reviewed Scientific Journals

Source: S CImago Jour nal and Coun try R ank, 2012. UR L: h ttp://www.scimagojr.com/countrysearch.php?country=RU

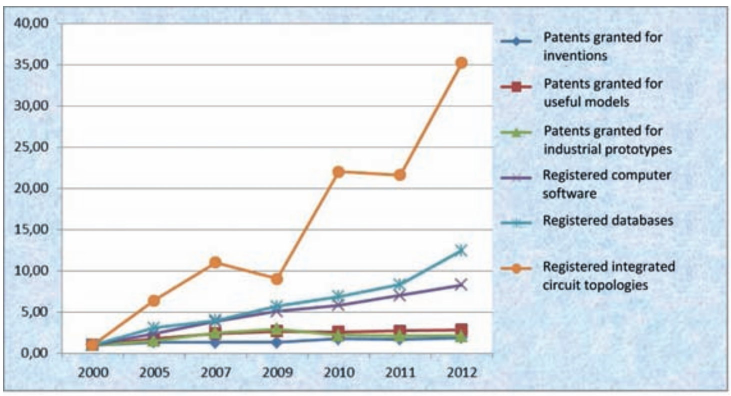


Figure 5. Relative Growth Performance of Intellectual Activity in Russian Research and Development Sector, 2000–2012

Source: Author's calculations based on data from 'Russian Science in Figures: 2013.' Scientific Research Institute – Federal Research Centre for Projects Evaluation and Consulting Services. 2013.

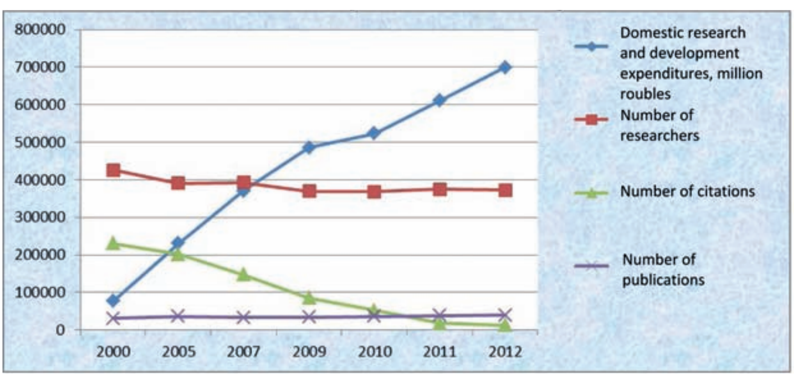


Figure 6. Russian Science Performance Trends

Source: Calculations based on SCImago Institutions Rankings. URL: http://www.scimagojr.com/countrysearch.php?country=RU

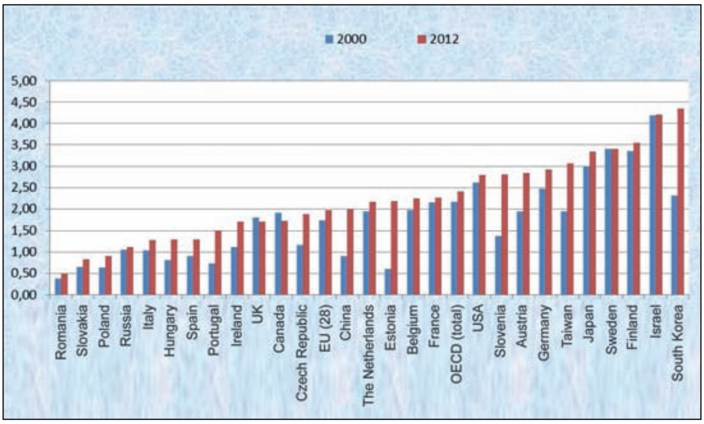


Figure 7. Research and Development Spending as a Percentage of GDP in 2000 and 2012

Source: Calculations based on data from Main Science and Technology Indicators, OECD, 2013/2.

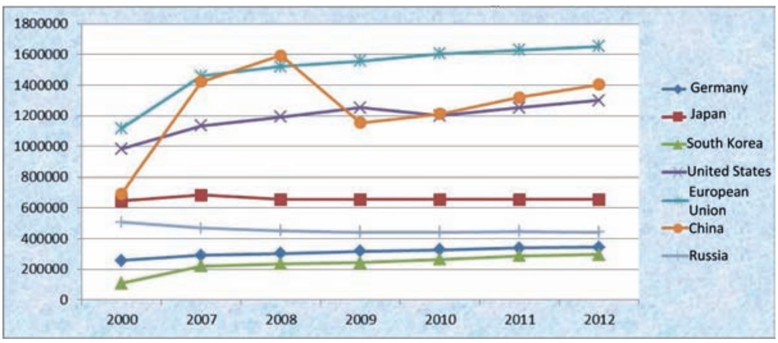


Figure 8. Dynamics of the Number of Researchers in Selected OECD Countries and Russia in 2000–2012

Source: Calculations based on data from Main Science and Technology Indicators, OECD, 2013/2.

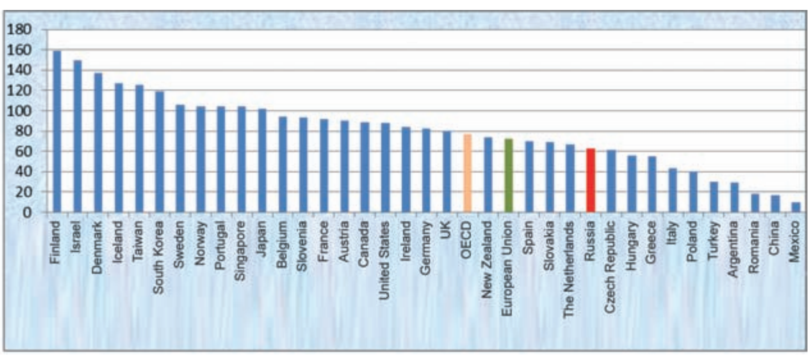


Figure 9. Number of Researchers per 10,000 People Employed by County (2011[1])

Source: Calculations based on data from Main Science and Technology Indicators, OECD, 2013/2.

[1] OECD is yet to provide more recent data on the number of researchers per 10,000 people employed indicator.

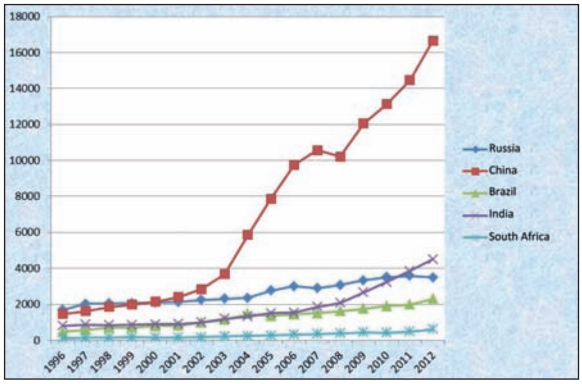


Figure 10. International Publishing Activity of BRICS Countries in Mathematics, 1996–2012

Source: Calculations based on SCImago Institutions Rankings. URL: http://www.scimagojr.com/compare.php?c1=RU&c2=CN&c3=BR&c4=IN&area=2600&category=2601&in=it

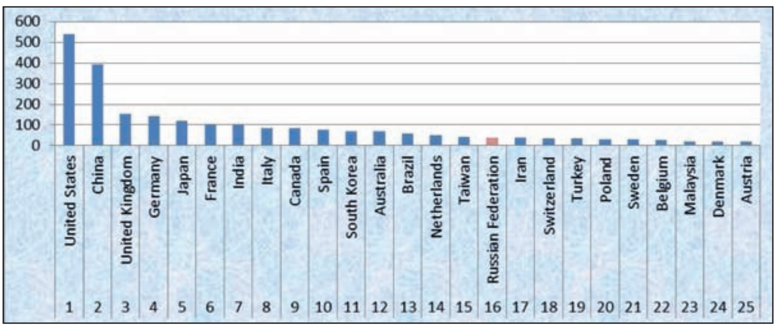


Figure 11. Number of Publications in SCOPUS-Indexed Journals, 2012, thousands

Source: Calculations by the author using the SCImago Journal and Country Rank database

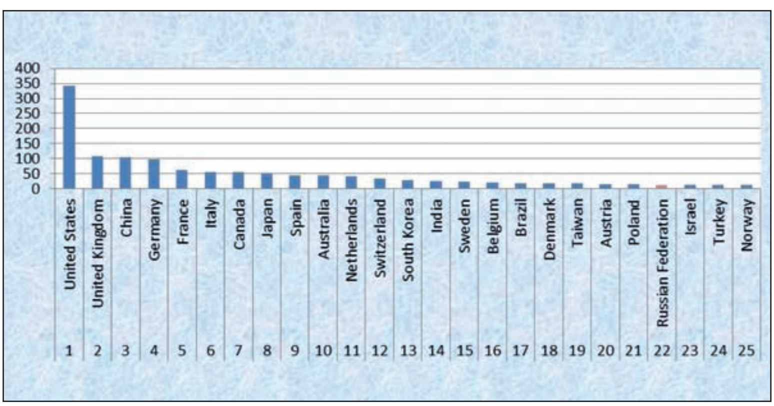


Figure 12. Number of Citations in SCOPUS-indexed Journals, 2012, thousands

Source: Calculations by the author using the SCImago Journal and Country Rank database

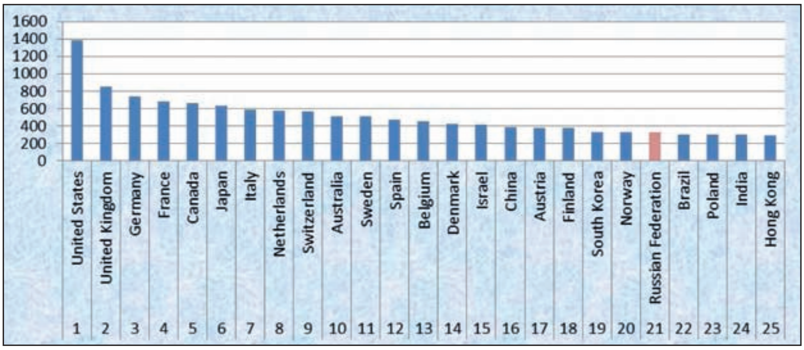


Figure 13. Hirsch Index for Countries Based on Documents published in SCOPUS--indexed Journals, 2012

Source: Calculations by the author using the SCImago Journal and Country Rank database

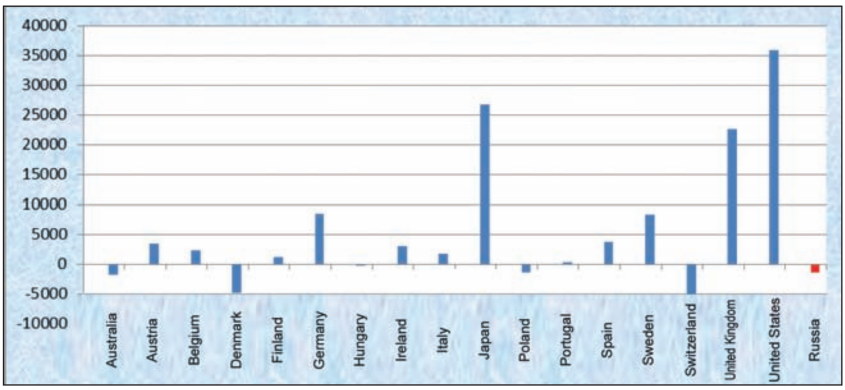


Figure 14. Balance of Technology Payments for Selected OECD Countries and Russia, 2011

Source: Calculations based on data from Main Science and Technology Indicators, OECD, 2013/2.

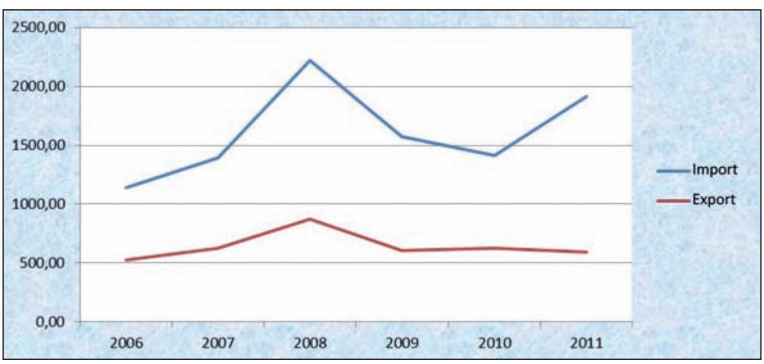


Figure 15. Russian technology export/import ratio in 2006–2011, USD million

Source: Author's calculations using Main Science and Technology Indicators, OECD, 2013/2.

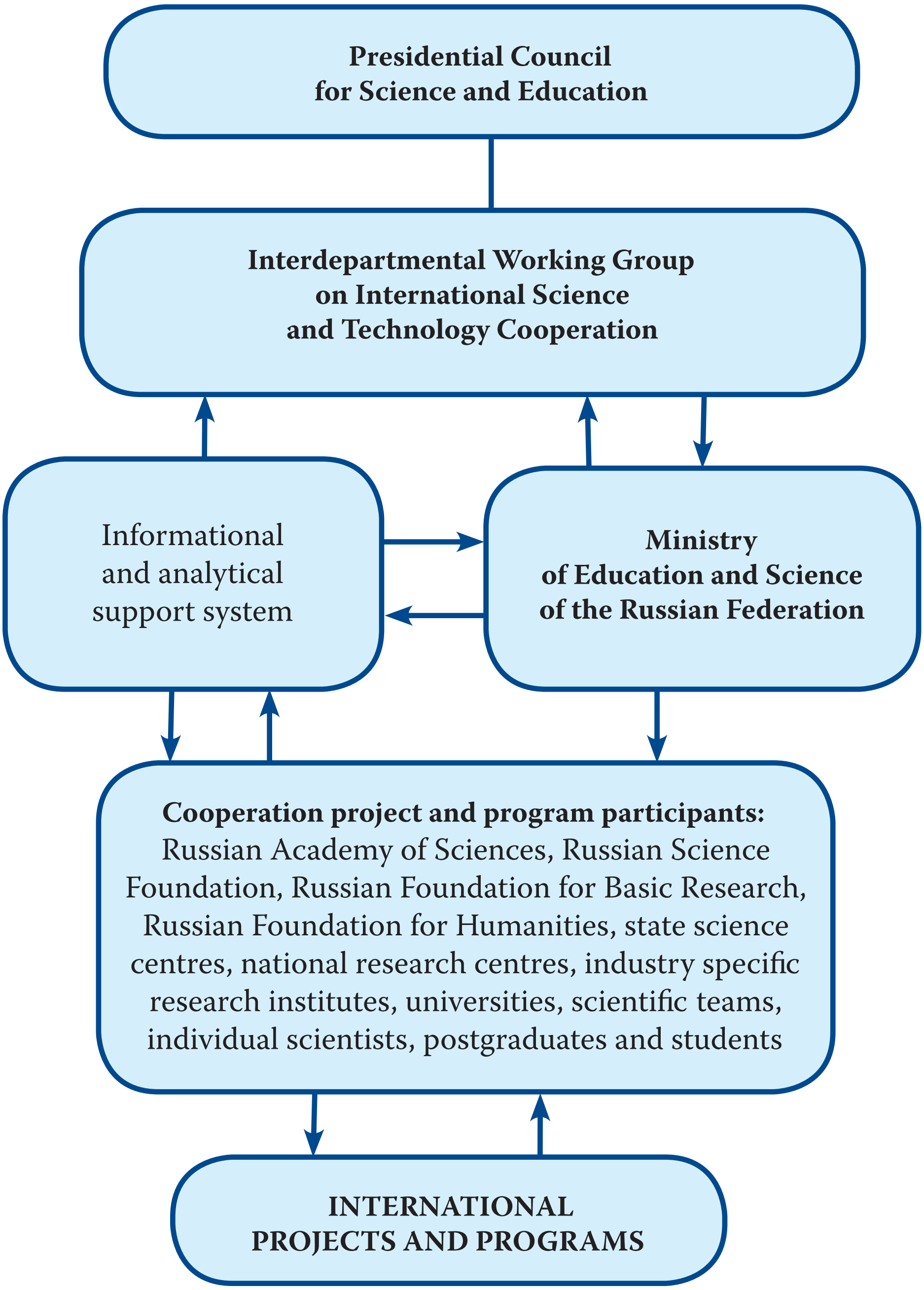
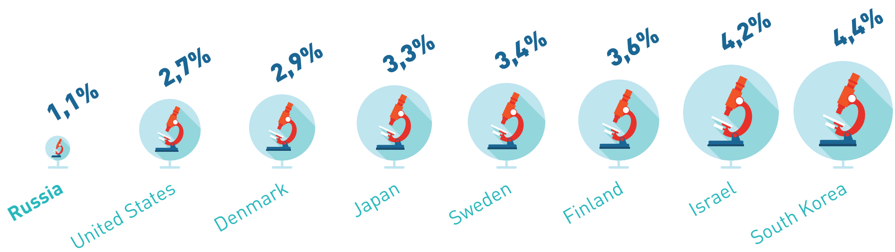


Figure 16. Organizational Chart of International Science and Technology Cooperation in the Russian Federation (Draft).

RUSSIA WITHIN THE INTERNATIONAL SYSTEM OF SCIENTIFIC AND TECHNICAL COOPERATION

Expenditures on R&D as a % of GDP by country



Russia's position in international publishing activity

from 1996 to 2012

30%
Increase in the number of Russian publications reviewed within the **SCOPUS system**

94%
Reduction in the number of citations

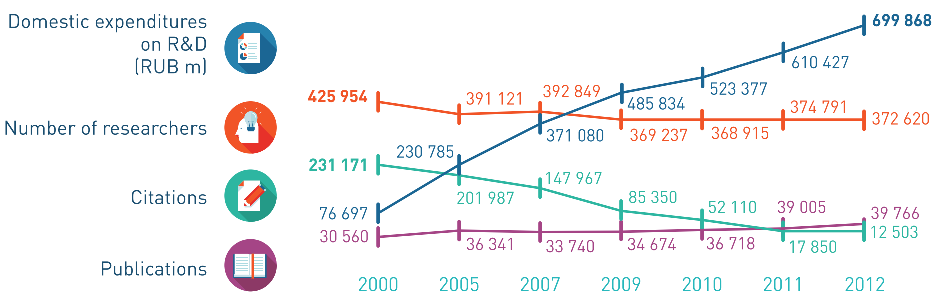
Scientific performance ranking
SCImago Journal and Country Rank

16
position

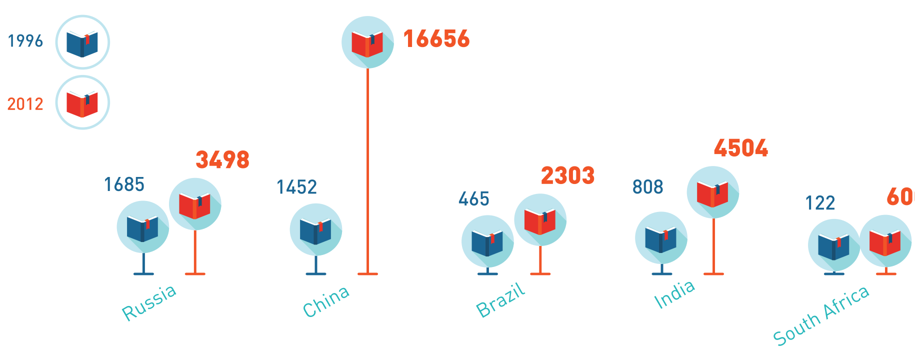
157 position
in terms of the number of citations calculated per one publication

2012

Changing performance indicator trends in Russian science



International publishing of the BRICS countries in mathematics



Emigration of scholars from Russia

A **50%** drop in the number of scientists leaving Russia forever

A **100%** increase in the number of scientists leaving temporarily

In the 2000s compared to the 1990s

left Russia for permanent residence **476 000** people

including

102 000 with a higher education

665 with an academic degree

During the period from 2002 to 2010

Over the same period,
200 000 people left for temporary employment

Structure of the Russian scientific diaspora by sector

- Chemists: 6,1%
- Mathematicians: 9,3%
- Technical scientists: 12,7%
- Biologists: 22,8%
- Physicists: 33,6%

2010

Structure of the U.S. scientific diaspora

40% of researchers with doctorates in the United States are foreigners

- From the former USSR: 6%
- From the United Kingdom: 7%
- From India: 14%
- From China: 22%