Publication Activity of Russian Researches in Leading International Scientific Journals

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ABSTRACT

The primary aim of this research report is to analyse the dynamics and structure of the publications of Russian authors, as well as to define the place of Russian science in the global scientific process. Bibliometric analysis methods are the main methods for quantitative analysis of scientific cooperation, efficiency, and other aspects of scientific activity. The information base for this research includes materials from science citation databases containing bibliographic descriptions of the articles published in scientific journals (mainly written in English) in a significant number of fields of science. Various parameters (e.g. dynamics of the number of publications, the number of citation, the level of co-authorship, the scientific specialization index, etc.) at various levels of aggregation (e.g. individual researchers, research organizations, countries and regions of the world) can be calculated based on these data. The results of bibliometric studies can be used in a number of ways:

- analysis of latest trends in the development of various scientific fields;
- evaluation of the effectiveness of research organizations;
- overall assessment of the scientific potential of Russia (its strengths and weaknesses);
- identification the most productive scientists in various fields of science;
- drawing the international comparisons of publications;
- analysis of collaboration networks of scientific teams.

The paper analyses the basic indicators of the publication activity of scientists in Russia and the leading countries over the period between 2001 and 2011. Publication activity of Russian scientists is analysed in the context of specific areas of science. This allows the identification of areas of specialization of Russian publications. The paper also examines the dynamics of highly-cited publications and the indicators of the international scientific collaboration of Russian researchers. In this paper materials of Web of Science database were used for analysis of publication activity.

KEYWORDS: publication activity; bibliometric indicators; publications of Russian authors; the level of citation; cross-country analysis.

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INTRODUCTION

The international and national science citation indices contained in the bibliographic descriptions of articles and reference lists are used in bibliometric analysis. Evaluation of the publication activity in Russian statistics practice began fairly recently [1–5]. Despite its rapid development, the Russian science citation index (RSCI) still fails to reflect the publication activity of Russian scientists adequately. Against this background, the materials of the science citation databases Web of Science (WoS) and the electronic analytical database Essential Science Indicators based on Web of Science were chosen as the information base for this work. Web of Science (WoS) was established by Eugene Garfield in 1964. Web of Science is the first science citation database in the world owned by the Thompson Reuters information corporation. As of 2011, the Web of Science comprises approximately 48 million entries of scientific publications in over 15 thousand scientific journals. The database includes material presented in more than 148 thousand scientific conferences. The database includes science publications dating back to 1900.

The Essential Science Indicators (ESI) in cross-country terms contains data on three basic publication activity indicators (the number of publications ("papers" column in ESI database); the number of citations received by these publications ("citations" column in ESI database), and the average number of citations per paper ("Citations per paper" column in ESI database) for 144 countries over the past 10 years. In turn, this ten-year period is divided into five-year sub-periods (at the time of writing, the data for 2001–2005, 2002–2006, 2003–2007, 2004–2008, 2005–2009, 2006–2010, and 2007–2011 were available in ESI database). Total number of publication was grouped into the 22 fields of science (according to the classification of the Essential Science Indicators).

Studied sample includes countries with more than 10 000 publications in ESI database for the years 2001 – 2011. This sample consists of 57 countries. In certain cases, all the countries of the world will be under analysis.

A publication is affiliated to a certain country (Russia for example) if its author (or at least one of the co-authors) specified this country (Russia) in his or her working address. The terms "publications by Russian authors", "Russian publications", "publications of Russia" are used as synonyms. The following types of documents are classified under the term "publication": "article", "proceedings paper", and "review".

When performing a cross-country analysis of publication activity, one should take into account the fact that English-language publications currently dominate the science citation data-

bases. English-language publications accounted for 94.8% of the total number of publications presented in the WoS database between 1990 and 2011. At the same time publications in the French, German, Russian, Japanese, and Chinese languages accounted for only 1.2, 1.1, 0.6, 0.22, and 0.1%, respectively. Moreover, the profiles of the publication activity in such fields of science as mathematics, computer science, natural science, and engineering are not sufficiently complete in these databases with area of social sciences and the humanities being the least complete. These limitations should be taken into account when interpreting bibliometric data.

GLOBAL TRENDS IN PUBLICATION ACTIVITY

The basic indicator of publication activity is the number of publications in peer-reviewed scientific journals. When comparing the publication activities of different countries, the share of publications attributed to the countries in the total world number of publications result in the countries rank in the global ranking of the number of publications. As mentioned, the international citation databases contain a relatively small number of non-English-language publications. Consequently, the analysis of the publications of non-English-speaking authors will focus primarily on their English-language papers, which actually constitute a relatively small share of the total number of publications in these countries. For example, only 10% of all Russian publications are indexed in the Web of Science database [1]. Therefore, the indicators of publication activity are artificially underestimated for such countries as Russia, Japan, China, India, as well as for Southeast Asia, Latin America, and the Middle East countries.

Web of Science database integrates five science citation databases:

– Science Citation Index Expanded (SCI-EXPANDED);

– Social Sciences Citation Index (SSCI);

– Arts & Humanities Citation Index (A&HCI);

– Conference Proceedings Citation Index-Science (CPCI-S); and

– Conference Proceedings Citation Index-Social Science & Humanities (CPCI-SSH).

Data from all the databases within the Web of Science database are used for all the calculations, tables, and figures in this paper.

Table 1. Language structure of Russian papers: 2001 – 2011 (%)

Language	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
English	94.1	91.3	93.0	93.0	93.9	94.2	94.0	95.0	94.7	94.4	94.8
Russian	4.6	6.3	4.5	5.0	4.1	3.8	4.4	3.5	3.1	1.9	3.9
Other languages	1.3	2.5	2.5	2.0	2.0	2.0	1.6	1.5	2.2	3.7	1.3

Notes: 1. The language structure of Russian papers was calculated as the dynamics of the share of Russian papers written in languages specified in the table (English, Russian, other languages) in the total number of publications by Russian authors for each year specified in the table.

2. In order to obtain the primary data from the Web of Science database, the option "Analyze results" was used (for the selected country "Russia" and the selected time period "2001 - 2011"); the initial data were then loaded from the category "Languages." The following types of documents were selected for the analysis: articles, proceedings paper, and review.

Source: author`s calculations on Web of Science database materials. All databases of the Web of Science portal were used.

Data on scientific publications can be presented in the WoS database in different ways using the option "Analyze results." *Table 1* shows the language structure of publications by Rus-

sian authors in scientific journals indexed in the Web of Science. The overwhelming majority (93–95%) of papers are English-language publications. Throughout the studied period, the share of Russian-language publications in the total number of Russian publications in scientific journals indexed in the Web of Science varies between 1.9 and 6.3%.

In 2011, the number of Russian publications in WoS slightly decreased in comparison with 2001 (*Table 2*). The minimal number of Russian publications over the studied was reached in 2006 (27,462 publications), followed by slight growth. The share of Russian publications in the global number of publications has dropped from 2.97% in 2001 to 2.12% in 2011.

Table 2. Dynamics of Russian publications: 2001 – 2011

Year	Number of Russian publications	Shares of Russian publications in the total world number of publications, %
2001	28 665	2.97
2002	29 612	3.00
2003	28 648	2.75
2004	28 835	2.64
2005	28 281	2.45
2006	27 462	2.24
2007	28 926	2.16
2008	30 673	2.16
2009	30 904	2.09
2010	29 224	2.06
2011	28 573	2.12

Notes: ***1.*** The option "Analyze results" was used to obtain the primary data in the Web of Science portal (for the selected country "Russia"); the initial data were then loaded from the category "Publication years."
2. The following types of documents were selected for the analysis: article, proceedings paper, and review.
Source: author`s calculations on Web of Science database materials. All databases of the Web of Science portal were used.

Over the past decade, the U.S. led the absolute world leader on the number of publications in WoS (*Table 3*). Over the period of 2001–2011, Russia has lost 6 positions in this ranking, dropping from 9th to 15th place, overtaken by Spain, Australia, South Korea, Brazil, and the Netherlands. The positions of Canada and Western European countries remained almost unchanged.

Table 3. Top 25 countries in the world rating for the number of publications

№	2001			2011		
	Country	**Number of publications by the country**	**Share of the country in the total world number of publications, %**	**Country**	**Number of publications by the country**	**Share of the country in the total world number of publications, %**
1	USA	303 917	31.48	USA	366 507	27.13
2	Japan	86 096	8.92	China	184 029	13.62
3	Great Britain	83 582	8.66	Great Britain	105 411	7.80
4	Germany	77 982	8.08	Germany	97 070	7.19
5	France	55 259	5.72	Japan	79 751	5.90
6	China	44 575	4.62	France	67 990	5.03
7	Canada	38 645	4.00	Canada	58 855	4.36
8	Italy	38 453	3.98	Italy	55 253	4.09
9	Russia	28 667	2.97	Spain	50 256	3.72
10	Spain	26 350	2.73	India	46 172	3.42
11	Australia	25 483	2.64	South Korea	45 971	3.40
12	The Netherlands	21 779	2.26	Australia	44 244	3.28
13	India	19 272	2.00	Brazil	34 122	2.53
14	South Korea	19 194	1.99	The Netherlands	33 523	2.48
15	Sweden	17 422	1.81	Russia	28 577	2.12
16	Switzerland	15 566	1.61	Taiwan	28 553	2.11
17	Brazil	13 324	1.38	Switzerland	24 655	1.83
18	Taiwan	13 018	1.35	Turkey	23 470	1.74
19	Poland	12 824	1.33	Iran	21 768	1.61
20	Belgium	11 964	1.24	Sweden	21 389	1.58
21	Israel	10 836	1.12	Poland	20 818	1.54
22	Finland	8 822	0.91	Belgium	18 686	1.38
23	Austria	8 779	0.91	Denmark	13 468	1.00
24	Denmark	8 754	0.91	Austria	12 852	0.95
25	Turkey	7 233	0.75	Israel	12 493	0.93

Notes: 1. In order to obtain the data on the total world number of publications in the Web of Science portal, the retrieval request "PY=2001 AND 2011" was input in the "Advanced search" insertion; the option "Analyze results" was then used to load the initial data from the category "Document types." The following types of documents were selected for analysis: article, proceedings paper, and review.

2. The option "Analyze results" was used to obtain the data on the number of publications in the countries studied on the Web of Science portal (for 2001 and 2011); the initial data were then loaded from the category "Countries/territories." The following types of documents were selected for analysis: article, proceedings paper, and review.

3. The sum of the shares for all countries is higher than 100%, since some papers were prepared in international co-authorship.

Source: author`s calculations on Web of Science database materials. All databases of the Web of Science portal were used.

Iran showed the highest growth of number of publications among the studied countries: by a factor of 11.5 over 2001–2011 (*Table 4*). Malaysia, Pakistan, China, Saudi Arabia, Thailand, and Turkey also showed high increase (more than 200% over the studied period) in the number of number of publications in WoS. Among European countries, Portugal showed the highest increase in the number of publications (149% over the 2011–2011). On the other hand some countries showed a decrease in the number of publications in scientific journals indexed in

WoS in 2011 in comparison with 2001: Japan (by 7.4%), Venezuela (by 8.2%), and Belarus (by 15.9%).

Table 4. Country composition of the studied sample with the most dynamically increasing number of publications: 2001 – 2011

Country	Number of publications		The number of publications increased in 2001 – 2011 by a factor of
	2001	2011	
Iran	1 891	21 768	11.51
Malaysia	1 216	8 713	7.17
China	44 575	184 029	4.13
Pakistan	739	5 682	5.47
Saudi Arabia	1 451	5 651	3.89
Thailand	1 727	5 991	3.47
Turkey	7 233	23 470	3.24

Notes: In order to obtain the primary data from the Web of Science portal, the option "Analyze results" was used for the countries specified in the table; the initial data were then loaded from the category "publication years." The following types of documents were selected for the analysis: article, proceedings paper, and review.
Source: author`s calculations on Web of Science database materials. All databases of the Web of Science portal were used.

Countries with a rapidly increasing publication activity have improved their positions in the global ranking of the number of publications. Iran's position improved by 23 places (jump from the 42nd place in 2001 to the 19th place in 2011). Malaysia improved its position by 15 ranks (from the 45th place in 2001 to the 34th place in 2011). Some other countries (mainly from Asia and Latin America) also significantly improved their position in this ranking: Pakistan by 11 positions; Portugal by 9 positions; Turkey by 7 positions; Columbia by 6 positions; Saudi Arabia, Thailand, Brazil, and China by 4 positions each. In contrast some countries (mainly from Eastern Europe) have lost many positions in the global ranking of number of publications. The following countries from the studied sample have lost 6 and more positions: Russia and Venezuela (6 positions), Hungary, Bulgaria and Slovakia (7 positions), Belarus (8 positions), and Ukraine (12 positions).

The dynamic growth of publication activity in developing countries led to a weakening of the dominance of the U.S. in the world science. In 2001, the share of the USA in the total world number of publications was 31.5%; in 2011, it decreased to the level of 27.1%. Meanwhile, the share of the second country in the rating increased from 8.9% in 2001 (in 2001, the second position was held by Japan) to 13.6% in 2011 (in 2011, the second position was held by China).

The data on the publication activity of different countries in the electronic analytical database Essential Science Indicators (ESI database) developed on Web of Science materials are

presented in the “Countries/territories” subsection in the “Citation Rankings” section (option “View table of graph data”).

The following indicators are provided for a specified country for five-year periods as well as for the whole period of 2001–2011 (option "View table of graph data"):

1) Number of papers;

2) Number of citations;

3) Average citations per paper.

In essence, the latter indicator is the ratio between the second and the first indicators. All three indicators can be calculated both for each of the 22 fields of science specified by WoS and for the total number of publications (“All fields” category). The same indicators are available for the total world number of scientific papers. The data on global indicators of publication activity are presented in the “Baselines” subsection in the “Citation Analysis” section (“View field rankings table” option). Similar to the case of individual countries, the global indicators of publication activity can be calculated both for the 22 fields of science and for the total number of publications for the specified five-year periods and for the whole period of 2001–2011.

It should be noted here that the total number of publications of a certain country during a certain five-year period can be obtained via the summing up the numbers of publications (and citations) of all 22 fields of science. In other words, the subjects of 22 fields of science specified in the Essential Science Indicators do not overlap. Meanwhile, the global number of publications (and citations) obtained via the summing up of publications of all countries exceeds the real total world number of publications (and citations), due to the fact that some papers result from international collaboration. Subsequently, these publications are assigned to all the countries whose authors participated in these publications. Therefore, by summing up the number of publications (and citations of these publications) of all countries, some papers (and citations) will actually be accounted several times.

The thematic structure of Russian publications in WoS differs from the global one (*Table 5*). Physics is the most significant field of science in Russia. Publications on physics accounted for 28% of the total number of Russian publications in 2001–2011. The second and the third most significant fields of science are chemistry (22.2%) and engineering (7.6%).

Table 5. Distribution of publications over fields of science (%)

Field of science	World structure		Russian structure	
	2001 – 2005	2007 – 2011	2001 – 2005	2007 – 2011
Biology & biochemistry	6.08	5.17	4.01	3.48
Immunology	1.33	1.14	0.16	0.20
Clinical medicine	20.79	21.24	4.70	5.09
Computer science	2.97	2.09	1.20	0.84
Mathematics	2.47	2.81	4.42	5.46
Materials science	4.60	4.70	6.25	6.01
Microbiology	1.66	1.69	1.27	1.20
Molecular biology and genetics	2.83	2.78	2.12	2.24
Multidisciplinary	0.17	0.17	0.07	0.13
Geosciences	2.83	2.92	7.11	8.08
Space science	1.31	1.15	3.31	3.23
Plant & animal science	5.56	5.42	2.29	2.60
Environment/ecology	2.57	2.88	0.90	1.50
Neuroscience & behaviour	3.16	2.85	0.78	0.78
Social science	4.06	5.12	1.08	0.95
Psychiatry/psychology	2.38	2.49	0.50	0.44
Agricultural science	1.85	2.30	0.70	0.77
Engineering	8.02	8.66	7.95	7.27
Pharmacology & toxicology	1.79	1.96	0.19	0.46
Physics	9.71	8.98	28.29	27.34
Chemistry	12.31	11.62	22.58	21.76
Economics & business	1.54	1.84	0.10	0.18

Notes: The distribution of publications over fields of science was calculated as the dynamics of the shares of the publications in the specified fields of science in the total number of publications.
Source: author`s calculations on of Essential Science Indicators database materials (section "Citation Rankings, subsection "Countries/territories" country "Russia," option "View table of graph data" for Russian indicators ; section "Citation Analysis," subsection "Baselines," option "View field rankings table" for the total world indicators).

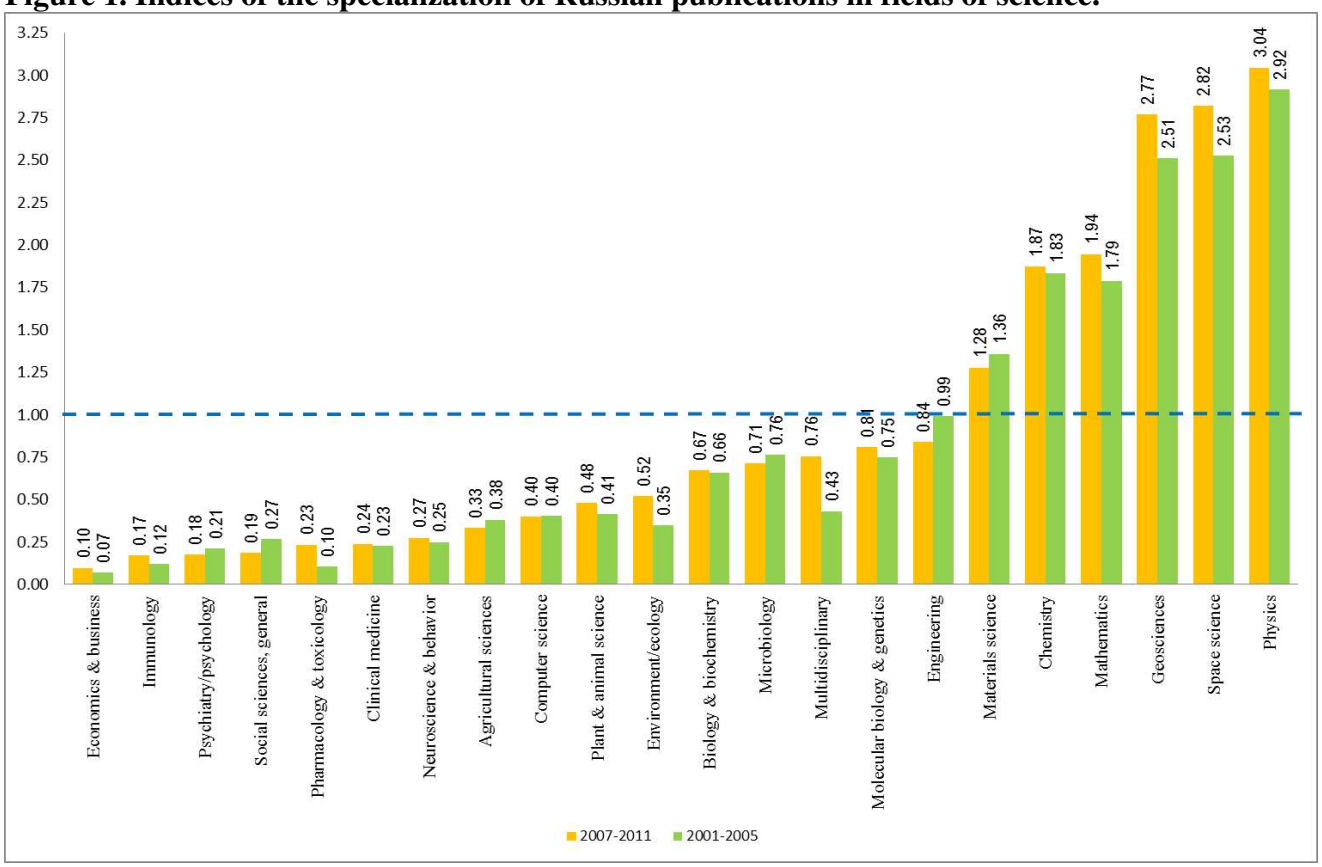
Clinical medicine is the most significant field of science in the world structure of publications: its share in the total number of scientific publications was 21.0% in 2011 – 2011. The second and the third most significant fields of study are chemistry (12.0%) and physics (9.3%). The share of Russian publications on clinical medicine, computer and social sciences in total world number of publications was very small. No significant changes in the thematic structure of Russian publications were observed during the studied period. Nevertheless, it should be noted that in the structure of Russian publications the share of publications on pharmacology & toxicology, economics & business, multidisciplinary studies, and environment/ecology considerably increased.

By comparing the thematic structure of scientific publications in a specific country with the same global structure, it is possible to calculate the index of scientific specialisation of the country [1]. This index is calculated as the ratio between the shares of publications in the field of studies *i,* within the total number of publications of country *j,* and the same indicator for the global structure of publications. If this index is greater than 1 in a certain discipline, thus this

discipline belongs to the sphere of scientific specialization sphere of that particular country.

The main areas of scientific specialization of Russian science are physics, space science, and geosciences (*Fig. 1*). Significant areas of specialization include mathematics, chemistry, and materials science. Publications on pharmacology and toxicology, economics and business, and multidisciplinary studies showed the most significant increase in the index of scientific specialization in 2007–2011 in comparison with 2001–2005 On the contrary, index of scientific specialization for publications on social sciences decreased dramatically.

Figure 1. Indices of the specialization of Russian publications in fields of science.

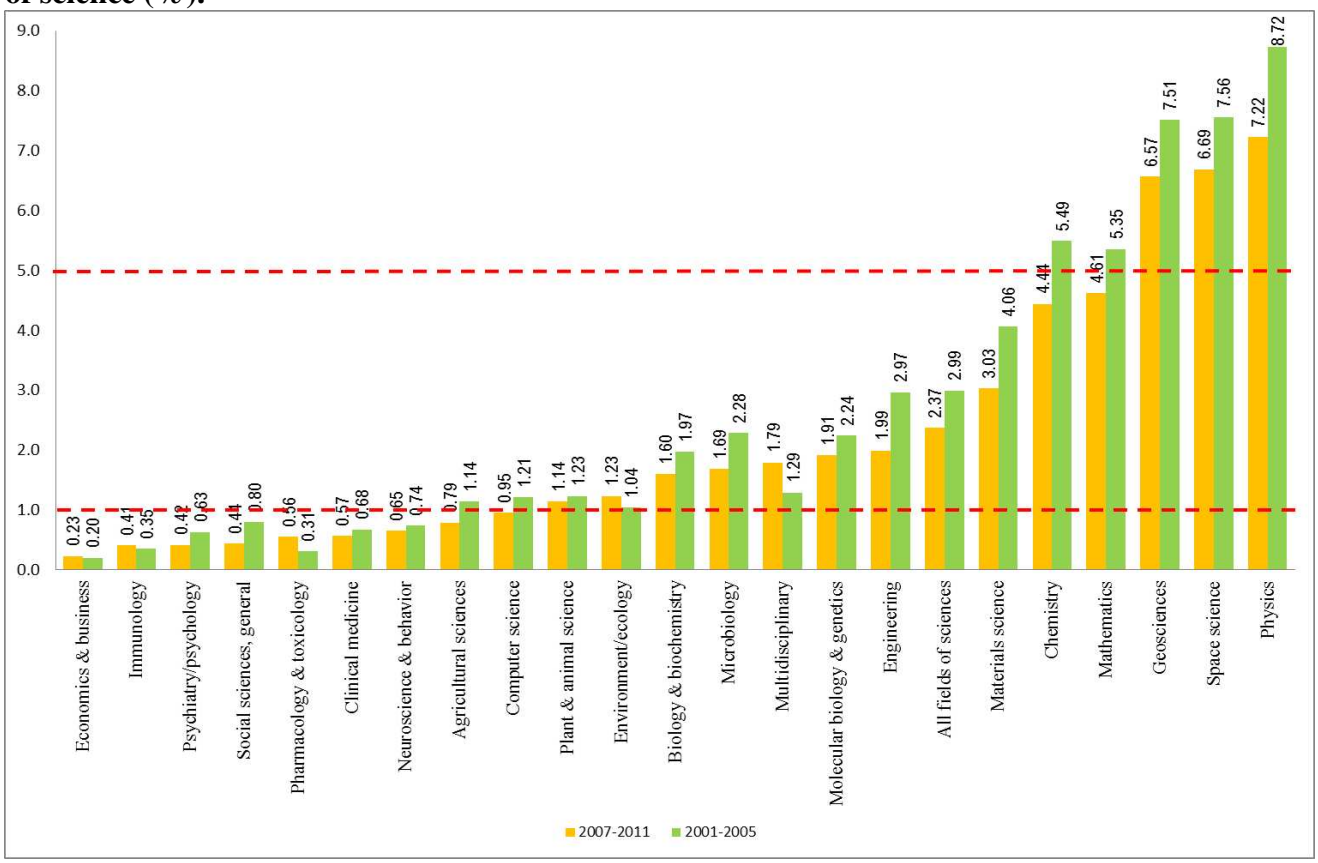


Source: author`s calculations on calculations performed by the authors using the materials of Essential Science Indicators database materials (section "Citation Rankings, subsection "Countries/territories" country "Russia," option "View table of graph data" for indicators for Russia; section "Citation Analysis," subsection "Baselines," option "View field rankings table" for the total world indicators).

Russian authors have contributed substantially to the total global number of scientific papers (*Fig. 2*) on physics (7.9% of the total world number), space science (7.1%), and geosciences (6.7%). Russian publications on chemistry, mathematics, and materials science were also significantly presented in the world science: they accounted to 3–5% of the total world

number in 2001–2011. As previously mentioned, Russia has lost positions in world science over the period of 2001 – 2011. Let us analyse this phenomenon in the context of fields of science. In 2007–2011 in comparison with 2001–2005 Russian publications on social science, psychiatry & psychology, materials science, and engineering have lost their positions in the world science more dramatically than publication s on other field of science. The share of Russian publications in the other areas of its scientific specialization has also decreased. Meanwhile, Russia has strengthened its position in the fields of multidisciplinary studies, as well as pharmacology & toxicology, over the studied period.

Figure 2. Shares of Russian publications in the total world number of publications on fields of science (%).



Source: author`s calculations on calculations performed by the authors using the materials of Essential Science Indicators database materials (section "Citation Rankings, subsection "Countries/territories" country "Russia," option "View table of graph data" for Russian indicators; section "Citation Analysis," subsection "Baselines," option "View field rankings table" for the total world indicators).

MAJOR TENDENCIES IN PUBLICATION CITATION

Citation indices are used to evaluate the scientific impact of the publications of a certain researcher or a country in general. The average number of citations per publication is the basic indicator, which is determined as the ratio between the number of citations on the publications published by a specific country and the number of these publications in scientific journals reviewed by the science citation database over a certain period of time. This indicator is typically assessed for a certain period of time (usually, 3–5 years) rather than for one year. The reason can be explained as follows: some period is necessary before a publication included in the international citation database can accumulate a significant number of citations. Let us note that in the context of this work indicator "average number of citations per publication" refer three kinds of scientific documents: article, proceedings paper and review.

The following procedure is used in the Essential Science Indicators database to calculate the average number of citations per paper. There are two basic indicators:

- total number of publications ("Number of papers" indicator in ESI database) of a specific country published during the specified 5-year period (2001–2005 for example) in scientific journals, indexed by Web of Science ("Number of papers" indicator in ESI database);

- number of citations on this publications during this (2001–2005) 5-year period ("Number of citations" indicator in ESI database).

So the average number of citations per paper (ACP further) indicator is simply the ration of B and A indicators. Such an approach to calculation the ACP indicator allows cross-time evaluation of average level of citation of publications.

Analysis of citation indicator should be performed with caution. The number of citations does not always adequately represent the quality of publications, since opportunities to be citied are not equal for authors of different countries. So-called "Matthew effect that has been repeatedly observed in different fields of science [6–10] should be mentioned here. The Matthew effect was first mentioned in 1968 in the article of the American sociologist Robert Merton in *Science* [6, 7]. The researcher analysed the psychosocial factors affecting the recognition and evaluation of scientific papers. The Matthew effect means that scientific research carried out by famous authors is somehow superior to that made by their less outstanding colleagues. The effect was named in light of the flowing quote from the Gospel According to St. Matthew: "For unto every one that hath shall be given, and he shall have abundance: but from him that hath not shall be taken even that which he hath" (Matthew 25:29, King James Version). In context of countries

Mathew effect means that publication from "prestigious" (e.g. from the USA) country has, other thing equal, (it is assumed that the article from the U.S. author and the article from Tajik author are devoted to the same problem, have the equal scientific level and are written in the same language with the same level of the grammatical correctness), more opportunities than the publication from "unprestigious" (e.g. from Tajikistan) country.

The countries with a small number of publications in the international science citation databases often have extremely high level of the ACP indicator. Let us use the following example to illustrate. The first three positions in the ranking of the ACP indicator level over the period of 2001–2011 were held by the Bermuda Islands, Panama, and Gambia, respectively. The value of the ACP indicator in these countries was 23.7, 17.9, and 17.0 citations per paper, respectively. Gabon and Guinea-Bissau were also among the top 20 countries of this ranking. However, in all these countries with the exception of Panama, the total number of publications in scientific journals indexed by WoS over the period of 2001–2011 was below 1,000 (in Panama, the number of papers was 2,098).

According to ESI data, Russia held the 123th position (out of 144) in the world rating on the ACP indicator level. The average number of citations received by a Russian paper published over the period of 2001–2011 was relatively low: 4.87, much lower than the global average of 10.57 citations per paper. Despite this, Russia held the relatively high position of 21st in the ranking of the absolute number of citations received by papers.

Table 6 lists the first 20 countries for the level of the ACP indicator within the studied sample. English-speaking countries and Northern European countries hold the first 12 positions in this ranking, whereas Russia holds the 47th position out of 57 countries.

The value of the ACP indicator in all countries characterized with rapidly growing publication activity was lower compared to the global level. Among these countries, Thailand stood had the highest value of the ACP indicator: 7.57 citations per paper (the 72nd position in the world). The other countries characterized by a rapid increase in the number of scientific papers in the leading world journals held positions below the top 100 in the global ranking of the value of the ACP indicator. Iran, the country with the most dynamic increase in the absolute number of papers among the countries of the studied sample, had one of the lowest indicators of the average number of citations per paper in the world – 4.19 citations per paper (133rd position in the world rating). The value of the ACP indicator in European countries was higher than in Asian countries. Japan had the highest average number of citations per paper among Asian countries: 10.35

citations per paper and he 35th position in the world rating for this indicator).

Table 6. The average number of citations per paper in the leading countries: 2001 – 2011

№	Country	Average number of citations per paper for the country	Number of publications of the country	Position of the country in the ranking of the number of publications
1	Switzerland	16.61	194 618	16
2	USA	15.83	3219337	1
3	Denmark	15.83	104 212	23
4	The Netherlands	15.53	268 385	14
5	Sweden	14.82	189 413	18
6	Great Britain	14.79	912 495	2
7	Belgium	13.69	147 261	21
8	Finland	13.59	94 209	25
9	Germany	13.20	836 694	4
10	Canada	13.15	479 354	7
11	Austria	12.92	102 129	24
12	Israel	12.72	117 251	22
13	Norway	12.56	77 118	29
14	France	12.32	598 138	6
15	Australia	11.97	323 344	10
16	Italy	11.81	458 871	8
17	Ireland	11.51	49 358	37
18	New Zealand	10.84	61 205	34
19	Spain	10.42	364 197	9
20	Japan	10.35	815 789	5

Notes: 1. The top 20 countries from the studied sample in terms of the average number of citations per paper are considered.

2. All indicators were calculated for the total number of publications over the period of 2001 – 2011 in scientific journals indexed in the Web of Science.

3. The average number of citations per paper is determined as the ratio between the number of citations received in 2001 – 2011 by the publications of the country published in 2001 – 2011 to the number of these publications.

Source: author`s calculations on calculations performed by the authors using the materials of Essential Science Indicators database materials (section "Citation Rankings, subsection "Countries/territories," option "View table of graph data" for indicators of the countries listed in the table; section "Citation Analysis," subsection "Baselines," option "View field rankings table" for the total world indicators).

Among the BRIC countries, Brazil had the maximum level of the ACP indicator: 6.37 citations per paper (100th position in the global ranking). In China and India, the average number of citations per paper was also higher than in Russia: 103rd and 108th positions in the world, respectively (6.15 and 5.87). Estonia stands out among the countries of the former Soviet Union for the highest value of the ACP indicator: 9.35 citations per paper (45th position in the world). In all Baltic countries, the average number of citations per paper was higher than in Russia. On the contrary, the average number of citations per paper in Central Asian countries, as well as in Belarus and Ukraine, was lower than that in Russia. Azerbaijan had the lowest value of the ACP indicator among the former USSR countries: 2.71 citations per paper, 143rd position in the

global ranking. Serbia held the lowest 144th position in the world rating on the value of the ACP indicator with 2.66 citations per paper.

Table 7. Top 25 countries of the world ranking of the number of citations of publications

№	2001 – 2005			2007 – 2011		
	Country	Number of citations of the publications of the country	Share of the country in the total world number of publication citations, %	Country	Number of citations of the publications of the country	Share of the country in the total world number of publication citations, %
1	USA	8 736 259	47.5	USA	11 542 290	42.2
2	Great Britain	2 231 223	12.1	Great Britain	3 330 285	12.2
3	Germany	1 900 402	10.3	Germany	2 788 268	10.2
4	Japan	1 576 262	8.6	China	2 219 953	8.1
5	France	1 244 048	6.8	France	1 852 765	6.8
6	Canada	971 332	5.3	Japan	1 840 922	6.7
7	Italy	870 611	4.7	Canada	1 641349	6.0
8	The Netherlands	650 939	3.5	Italy	1 462 765	5.3
9	Australia	572 221	3.1	Spain	1 111348	4.1
10	China	569 874	3.1	The Netherlands	1 086 107	4.0
11	Spain	549 353	3.0	Australia	1 071 029	3.9
12	Switzerland	529 890	2.9	Switzerland	857170	3.1
13	Sweden	471 150	2.6	South Korea	677 451	2.5
14	Belgium	308 583	1.7	Sweden	666 464	2.4
15	South Korea	288 106	1.6	India	587 965	2.1
16	Denmark	265 646	1.4	Belgium	551 464	2.0
17	Israel	262 033	1.4	Brazil	436 681	1.6
18	Russia	258 172	1.4	Denmark	426 175	1.6
19	India	225 529	1.2	Taiwan	413 885	1.5
20	Finland	217 603	1.2	Austria	347 819	1.3
21	Austria	215 013	1.2	Israel	338 029	1.2
22	Brazil	185 243	1.0	Russia	317 770	1.2
23	Poland	178 917	1.0	Finland	309117	1.1
24	Taiwan	173 626	0.9	Poland	302 810	1.1
25	Norway	140 394	0.8	Turkey	267 440	1.0

Notes: 1. The indicator "number of citations per publications of the country" is the number of citations received over the period of 2001 – 2005 (and 2007 – 2011) by the publications of the country in 2001 – 2005 (and 2007 – 2011).

2. The total world number of citations received by the publications is calculated for the actual number of the scientific publications of all the countries present in the Essential Science Indicators (section "Citation Analysis," subsection "Baselines," option "View field rankings table").

Source: author`s calculations on calculations performed by the authors using the materials of Essential Science Indicators database materials (section "Citation Rankings, subsection "Countries/territories," option "View table of graph data" for indicators for the countries listed in the table; section "Citation Analysis," subsection "Baselines," option "View field rankings table" for the total world indicators).

As mentioned previously, the analytical database Essential Science Indicators enables one to dynamically compare the average number of citations per paper and the absolute number of citations received by publications. Among the countries of studied sample, the most significant growth (by more than 50%) in the average number of citations per paper was shown by such

countries as Singapore (89.7%), Tunisia (68.5%), Iran (61.6%), China (60.4%), Egypt (57.9%), Algeria (57.4), Greece (55.8%) and Turkey (50.3%).

The U.S. was the stable global leader on absolute number of citations received by publications over the studied period. The dominance of the U.S. over the other countries in terms of this indicator is even more pronounced than that in terms of the number of publications (*Table 7*). The papers published by U.S. authors during the period of 2001–2011 received 45.3% of the total world number of citations. This indicator fell slightly from 47.5% to 42.2% over the studied period. The shares of Great Britain and Germany, which held the second and third positions, respectively, in the ranking of the number of citations over the period of 2001–2011, remained almost unchanged over the specified period. Russia held the 22nd position in this ranking. During the specified period, Russia lost by 4 positions dropping from 18th to 22nd.

China, which held the second position in the ranking of number of publications, ranked 7th in the ranking of the number of citations (5% of the total world number of citations). Over the period under analysis, China improved its rank by 6 positions: jumping from 10th to 4th place. In addition to China some other countries with dynamic publication activity also improved their positions in this ranking: Iran (10 positions), Pakistan (8 positions), Malaysia (7 positions), China (6 positions), Brazil, Singapore, and Taiwan (5 positions each). Among the countries of the studied sample under more than threefold increase in the number of citations on publications issued over the period of 2001–2011 was observed in Iran (7.4 times), Pakistan (5.9 times), Malaysia (4.8 times), China (3.9 times), Algeria (3.7 times), Thailand (3.4 times), Nigeria (3.2 times), and Columbia (3.1 times). However, a dramatic increase in the absolute number of citations on publications did little to help these countries to score high citation indices.

The following countries lost positions in the ranking of the number of citations on publications: Russia, Estonia and Israel lost 4 positions each; New Zealand and Slovakia 5 positions each; Ukraine lost 6 positions, Hungary and Venezuela both lost 8 positions. As in the case for the number of publications, the positions of the North European and North American countries in the ranking of the number of citations remained almost unchanged over the period of 2001–2011. Despite the loss of position in the ranking of the number of citations on publications, Hungary held the relatively high 38th position in the rating for the level, in contract to Venezuela, which held the 84th position. Israel, New Zealand, and Estonia also held relatively high positions: 17th, 28th and 45th, respectively.

Table 8. Distribution of the citations on publications over fields of science (%)

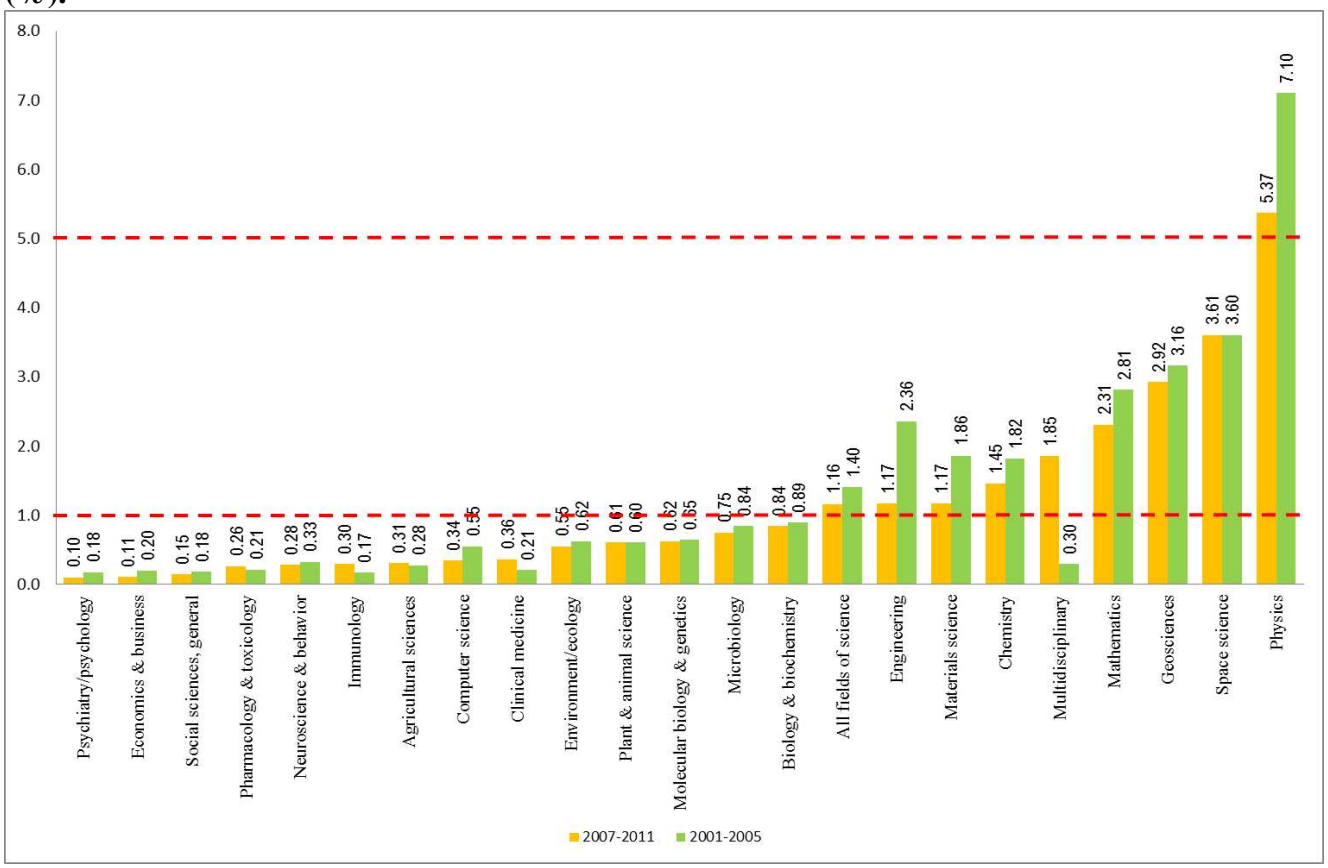
Field of science	World structure		Russian structure	
	2001 – 2005	2007 – 2011	2001 – 2005	2007 – 2011
Biology & biochemistry	10.47	7.63	6.66	5.54
Immunology	2.98	2.29	0.36	0.59
Clinical medicine	25.56	25.09	3.79	7.81
Computer science	0.82	0.91	0.32	0.27
Mathematics	0.68	0.94	1.36	1.86
Materials science	2.46	3.75	3.26	3.78
Multidisciplinary	0.07	0.12	0.01	0.20
Microbiology	2.64	2.35	1.59	1.52
Molecular biology and genetics	7.82	6.20	3.60	3.33
Geosciences	2.19	2.58	4.93	6.48
Space science	2.02	1.81	5.18	5.61
Plant & animal science	3.69	3.69	1.59	1.94
Environment/ecology	2.16	2.98	0.96	1.42
Neuroscience & behaviour	5.68	4.79	1.33	1.17
Social science	1.48	2.10	0.19	0.27
Psychiatry/psychology	2.00	2.36	0.25	0.21
Agricultural science	1.04	1.46	0.20	0.39
Engineering	2.92	4.37	4.90	4.39
Pharmacology & toxicology	2.05	2.29	0.31	0.52
Physics	8.60	7.67	43.49	35.49
Chemistry	12.09	13.71	15.65	17.15
Economics & business	0.58	0.91	0.08	0.09

Notes: The distribution of the publication citations over fields of science is calculated as the dynamics of the shares of citations for publications in the specified fields of science in the total number of citations on publications.
Source: author`s calculations on calculations performed by the authors using the materials of Essential Science Indicators database materials (section "Citation Rankings, subsection "Countries/territories" country "Russia," option "View table of graph data" for Russian indicators; section "Citation Analysis," subsection "Baselines," option "View field rankings table" for the total world indicators).

The distribution of citations on Russian publications over the fields of science for Russian papers, as well as the structure of papers, strongly differed from the world distribution (Table 8). 37.5% of all the citations over the period of 2001–2011 were received by Russian publications on physics. The share of the remaining fields of science in the total number of citations on publications by Russian authors was considerably lower. Nevertheless, the share of citations received by Russian publications on physics decreased in 2007–2011 as compared to that in 2001–2005. Meanwhile, the share of citations received by Russian publications on clinical medicine substantially increased from 3.8% to 7.8%.

The field of clinical medicine was dominant in the world structure of citations, accounting for 25.2% of the total number of citations. Chemistry and physics held the second and third positions in terms of the number of citations received (12.1% and 8% of the total number of citations, respectively). The share of citations received by the publications on biology & biochemistry decreased most significantly in the world structure of science over the period of 2001–2011.

Figure 3. Share of citations of Russian publications in the total world number of citations (%).



Source: author`s calculations on calculations performed by the authors using the materials of Essential Science Indicators database materials (section "Citation Rankings, subsection "Countries/territories" country "Russia," option "View table of graph data" for indicators for Russia; section "Citation Analysis," subsection "Baselines," option "View field rankings table" for the total world indicators).

The shares of citations on Russian publications in the total world number of citations for different fields of science are presented in *Fig. 3*. Russian publications on physics and astronomy received the largest share of the total world number of citations in comparison to the papers from other fields of science (the total being 6.1% over the period of 2001–2011). Russian publications on mathematics, geosciences, and space science received 2%–4% of the total world number of citations.

The share of citations on Russian publications on physics and engineering in the total world number of such citations seriously decreased over the period of 2001–2011. On the other hand, this indicator for publications on multidisciplinary studies increased considerably (from 0.3 to 1.9%).Table 9 lists the values of the ACP indicator for Russian publications from different fields of science over the period of 2001–2011. Russian publications o immunology had the

highest average number of citations per paper. However, the world level of the ACP indicator for publications on immunology was higher than the Russian one.

Table 9. The average level of citations of Russian publications: distribution over fields of science: 2001 – 2011

Field of science	2001 – 2005		2007 – 2011	
	Average number of citations per publication by Russian authors	The ratio between the average number of citations per publication by Russian authors and the world indicator	Average number of citations per publication by Russian authors	The ratio between the average number of citations per publication by Russian authors and the world indicator
Immunology	4.6	0.48	7.21	0.73
Space science	3.15	0.48	4.18	0.54
Biology & biochemistry	3.35	0.45	3.83	0.53
Clinical medicine	1.62	0.31	3.69	0.64
Multidisciplinary	0.39	0.23	3.65	1.04
Neuroscience & behavior	3.41	0.44	3.6	0.44
Molecular biology & genetics	3.42	0.29	3.58	0.33
Physics	3.1	0.81	3.12	0.74
Microbiology	2.52	0.37	3.03	0.44
Pharmacology & toxicology	3.35	0.68	2.71	0.47
Environmental science	2.16	0.60	2.28	0.45
Geosciences	1.39	0.42	1.93	0.44
Chemistry	1.39	0.33	1.9	0.33
Plant & animal science	1.39	0.49	1.8	0.54
Materials science	1.05	0.46	1.51	0.39
Engineering	1.24	0.79	1.45	0.58
Agricultural science	0.58	0.24	1.22	0.39
Economics & business	1.6	0.99	1.15	0.48
Psychiatry & psychology	1.01	0.28	1.13	0.24
Mathematics	0.62	0.53	0.82	0.50
Computer science	0.53	0.45	0.78	0.36
Social science	0.35	0.22	0.67	0.33
All fields of sciences	2.02	0.47	2.41	0.49

Notes: All indicators calculated for the total number of publications indexed in the Web of Science database over the period of 2001 – 2011.

Source: author`s calculations on calculations performed by the authors using the materials of Essential Science Indicators database materials (section "Citation Rankings, subsection "Countries/territories" country "Russia," option "View table of graph data" for Russian indicators; section "Citation Analysis," subsection "Baselines", option "View field rankings table" for the total world indicators).

Russian publications on mathematics, social and computer sciences had the lowest value of the ACP indicator in comparison with publications from other fields of science over the period of 2001–2011. In 2001–2005, the value of the ACP indicator for Russian publications on economics & business was comparable to the corresponding world indicator. However, the level of ACP indicator of Russian publications from these fields, as well as those from the field of pharmacology & toxicology, decreased in 2007–2011 by 28% and 19%, respectively.

Russian publications on multidisciplinary studies showed quick growth of the value if the ACP indicator over the studied period: from 0.39 in 2001–2005 to 3.65 in 2007–2011. In 2007–2011, only the publications on multidisciplinary sciences had the level of the ACP indicator comparable to the world indicator. Russian publications on clinical medicine also showed relatively strong (by a factor of 2.28) increase of the ACP level over the studied period. In the world structure of science, publications on molecular biology & genetics had the highest value of the ACP indicator.

DYNAMICS OF HIGHLY-CITED PUBLICATIONS

Highly-cited publications are a relatively small group of the most influential scientific publications. A publication in a certain field of science is considered to be highly cited if it is among the 1% of the most frequently cited publications in this field of science. Since the citation trends (frequency and time distribution of the citations) vary significantly in different fields of science, and the earlier published articles are cited more frequently than newly published ones, the distribution of citations over the years and individual fields of science are taken into account when determining the highly cited papers.

Table 10. Distribution of highly cited publications over fields of science: 2001 – 2011

Field of science	World	Russia	Share of Russian highly cited publications in the total number of highly cited papers, %	Specialization index of Russian publications
Biology & biochemistry	5 501	46	0.84	0.79
Immunology	1 252	2	0.16	0.15
Clinical medicine	21 783	104	0.48	0.45
Computer science	2 544	3	0.12	0.11
Mathematics	2 377	27	1.14	1.08
Materials science	4 572	27	0.59	0.56
Microbiology	1 646	6	0.36	0.35
Molecular biology & genetics	2 806	18	0.64	0.61
Multidisciplinary	180	4	2.22	2.11
Plant & animal science	2 872	55	1.92	0.23
Geosciences	1 240	27	2.18	1.82
Space science	5 789	14	0.24	2.07
Environment/ecology	2 762	16	0.58	0.55
Neuroscience & behavior	3 012	4	0.13	0.13
Social science	4 562	5	0.11	0.10
Psychiatry & psychology	2 477	3	0.12	0.11
Agricultural science	2 041	3	0.15	0.14
Engineering	7 890	91	1.15	1.09
Pharmacology & toxicology	1 848	4	0.22	0.21
Physics	8 600	508	5.91	5.61
Chemistry	11 699	77	0.66	0.62
Economics & business	1 722	1	0.06	0.06
Total	99 175	1 045	1.05	

Notes: 1. All indicators were calculated for the total number of highly cited publications in the scientific journals indexed in the Web of Science database over the period of 2001 – 2011.
2. The data for December 2011 are listed in the table.
Source: author`s calculations on calculations performed by the authors using the materials of Essential Science Indicators database materials (section "Most cited papers," subsection "Highly cited papers").

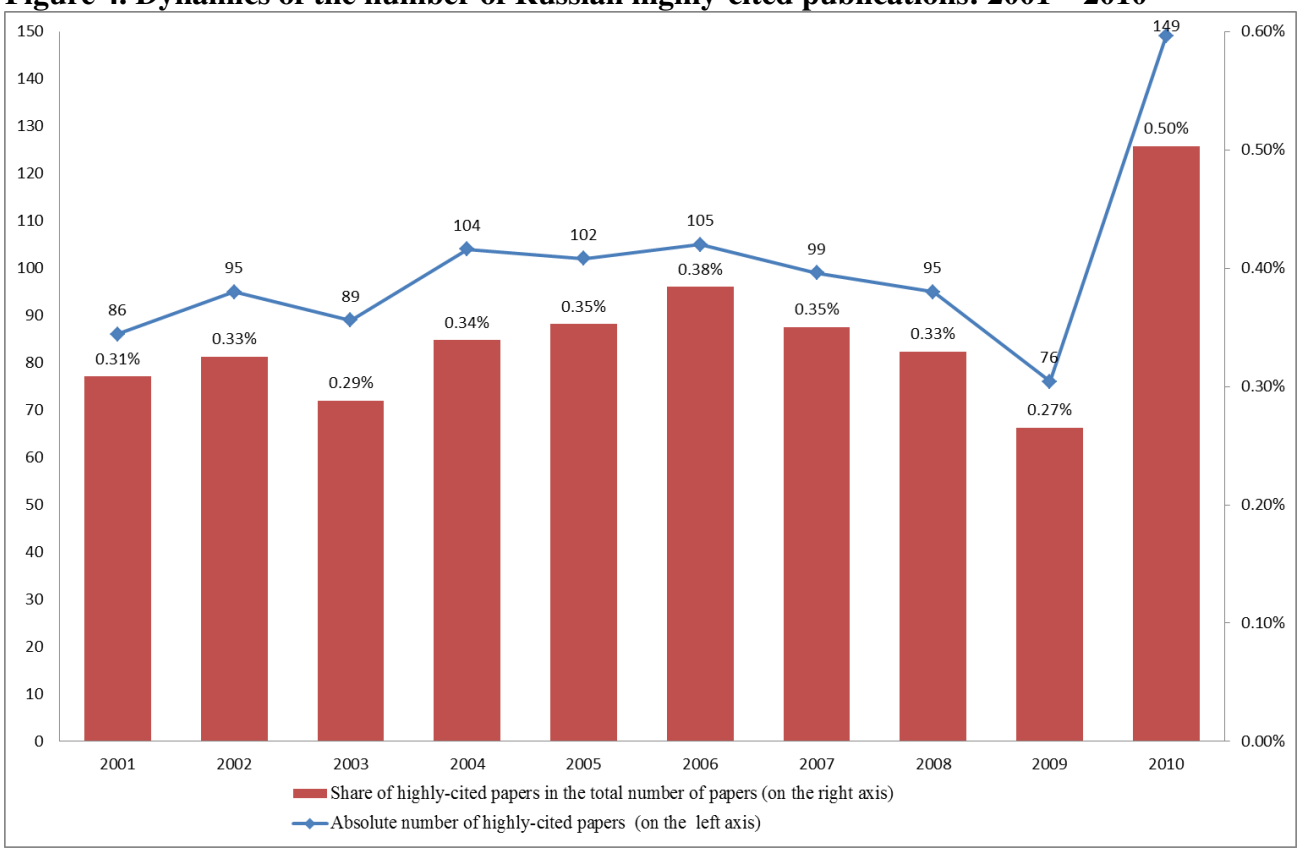
The highly-cited publications are frequently a result of international collaboration, which may bring together authors from different countries. Many of them form the so-called research fronts, the most topical and rapidly developing areas of research and developments in the world. The highly cited publications characterize the science system of a certain country to some extent

[11, 12].

The index of scientific specialization for the highly-cited publications is calculated using the same procedure as for "usual" publications.

The dynamics of highly-cited Russian publications is shown in *Fig. 4*. Their distribution over the fields of science is listed in *Table 10*. After a significant reduction in 2009, the number of highly cited papers in Russia increased to an even higher extent in 2010.

Figure 4. Dynamics of the number of Russian highly-cited publications: 2001 – 2010



Source: author's calculations on calculations performed by the authors using the materials of Essential Science Indicators database materials (section "Most cited papers," subsection "Highly cited papers").

In the total world structure of highly-cited publications the following fields of science were the most important over the period of 2001 – 2011: clinical medicine (22.0%), chemistry (11.8%), physics (8.7%), and engineering (8%). The shares of Russian highly-cited publications from different fields of science in their total world number are given in *Table 10*). Russian highly-cited publications on physics accounted for almost half (48.6%) of their total number. Clinical medicine, engineering, chemistry, and geosciences in sum accounted for another 28.6% of Russian highly-cited publications in 2001 – 2011.

Highly-cited publications on physics had the highest index of scientific specialization: Its share in the total number of the highly cited publications by Russian authors is more than five-fold higher than the identical world indicator. In Russia, the share of highly-cited publications on physics in the total number of highly cited papers is ~48%, whereas world indicator is ~8.6%. Hence, the index of scientific specialisation of Russian highly-cited publications on physics is 48%/8.6% = 5.6. It is also should be noted that geosciences, space science, and mathematics were areas of specialisation of Russian highly-cited publications. These highly-cited Russian publications contribute most substantially to world science. On the contrary, Russian publications in the field of immunology, pharmacology & toxicology, neuroscience and behavior, psychiatry & psychology, economics & business, computer science, and social science prove the lowest potential of being highly cited.

Thus, the position of Russia in world science is strongest in the field of physics. Approximately half of highly-cited Russian publications and a significant share of the total number of Russian publications in scientific journals indexed by Web of Science are publications on physics.

Table 11. The main indicators of highly cited publications of the leading countries: 2001 – 2011

Country	Number of highly cited publications	Position in the ranking of the number of highly cited publications	Share of highly cited publications of the country in the total world number of highly cited publications, %	Share of highly cited publications in the total number of publications of the country, %
USA	55 953	1	34.10	1.83
Great Britain	14 505	2	8.84	1.76
Germany	12 649	3	7.72	1.61
France	7 155	4	4.37	1.28
Canada	6 717	5	4.09	1.49
China	5 856	6	3.57	0.70
Japan	5 659	7	3.45	0.73
Italy	5 097	8	3.11	1.19
The Netherlands	4 808	9	2.93	1.91
Australia	4 210	10	2.57	1.38
Switzerland	4 171	11	2.55	2.30
Spain	3 584	12	2.18	1.06
Sweden	2 747	13	1.68	1.53
Belgium	2 310	14	1.41	1.68
Denmark	1 940	15	1.18	1.98
South Korea	1 773	16	1.08	0.63
Israel	1 450	17	0.88	1.31
Austria	1 438	18	0.87	1.50
India	1 238	19	0.76	0.42
Finland	1 172	20	0.72	1.32
Russia	1 045	21	0.63	0.39

Notes: 1. All indicators were calculated for the total number of highly cited publications in the scientific journals indexed in the Web of Science over the period of 2001 – 2011.
2. The 2011 data correspond to the situation by the beginning of data for December 2011 are listed in the table.
Source: author`s calculations on calculations performed by the authors using the materials of Essential Science Indicators database materials (section "Most cited papers," subsection "Highly cited papers").

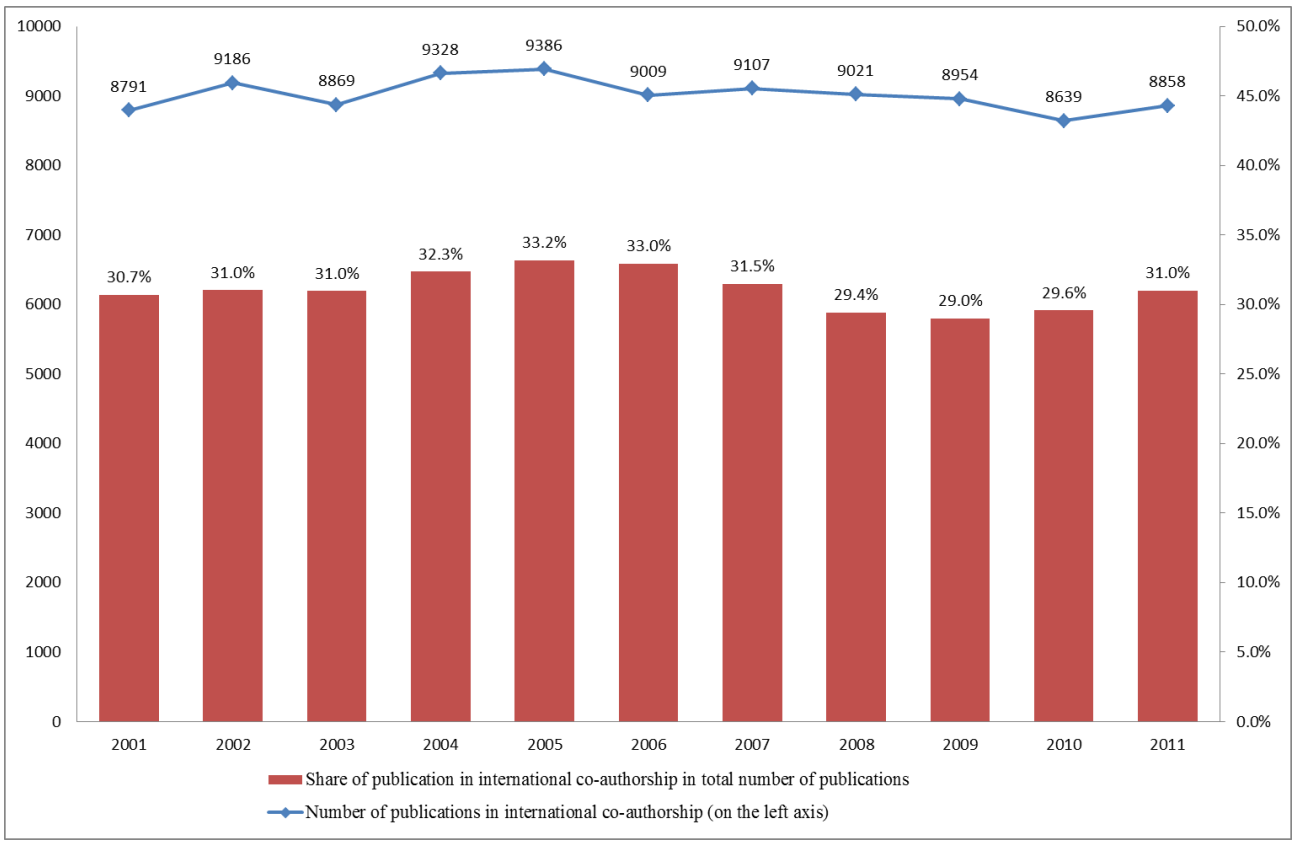
Table 11 allows for analysis of positions of highly-cited Russian publications in the world (*Table 11*). As previously mentioned for the total number of publication the USA was the once again the stable global leader in terms of highly-cited publications, with 34.1% of their total world number. The second and third positions in the global ranking of the number of highly-cited publications were held by Great Britain (8.8%) and Germany (7.2%), respectively. China with the largest number of highly cited publications among the Asian countries held the sixth position in this ranking. Russia held the 21st position with 0.64% of total world number of highly-cited publications.

Over the period of 2001 – 2011, Switzerland had the highest share of highly cited publications in the total number of publications among the countries listed in *Table 11 (2.3)*. On the contrary, in Russia this indicator was the lowest among the countries listed in *Table 11 (0.39%)*.

INTERNATIONAL CO-AUTHORSHIP

The last section of this work is a brief review of the major directions of international co-authorship by Russian authors (methods for evaluating the international co-authorship were discussed in [13–15]). The intensity and direction of international collaboration are typically measured using the analysis of co- authorship indicators for researchers from different countries (e.g., [1–5, 14, 16–18]). Publication is considered to be written in international co-authorship if there are authors from at least two countries in the list of co-authors. In such publications, authorship is ascribed to all of the co-authors in an identical degree, irrespective of the share of contribution of the individual author to the paper.

Figure 5. Basic indicators of international collaboration by Russian authors: 2001 – 2011



Note: The number of publications of Russian authors prepared in international co-authorship was calculated using the materials of the Web of Science database using the following procedure: the publications were tallied for each year over the studied period and all countries, except for Russia, using the option "Analyze results" of the Web of Science database for the country "Russia" in the category "Countries/territories."
Source: author`s calculations on Web of Science database materials.

A high share of papers published in international co-authorship in the total number of publications of a country can be indicative both of its central position in the international re-

search networks and of a lack of self-sufficiency within the framework of national science. In line with the changes in scientific production in the world, which assume the formation of larger research groups, a tendency towards hyper- and mega-authorship bringing together tens of authors from different countries has appeared in certain fields of science (the methods and methodology of assessing the "multinationality" of publications written in international co-authorship were discussed in [10, 19, 20]).

Table 12. The main scientific partners of Russia

№	2001			2011		
	Country	Number of publications in co-authorship	Share of publications in the total number of Russian publications in international co-authorship, %	Country	Number of publications in co-authorship	Share of publications in the total number of Russian publications in international co-authorship, %
1	Germany	2389	27.18	Germany	2564	28.95
2	USA	2158	24.55	USA	2366	26.71
3	France	1076	12.24	France	1499	16.92
4	Great Britain	902	10.26	Great Britain	1390	15.69
5	Japan	681	7.75	Italy	924	10.43
6	Italy	651	7.41	Spain	730	8.24
7	Sweden	493	5.61	Japan	665	7.51
8	The Netherlands	432	4.91	China	635	7.17
9	Poland	423	4.81	Poland	621	7.01
10	Switzerland	346	3.94	Switzerland	582	6.57
11	Canada	319	3.63	Ukraine	540	6.10
12	Ukraine	318	3.62	Canada	514	5.80
13	Spain	315	3.58	Sweden	508	5.73
14	Finland	260	2.96	The Netherlands	494	5.58
15	Belgium	246	2.80	Finland	490	5.53
16	South Korea	220	2.50	Czech Republic	457	5.16
17	Czech Republic	216	2.46	Belgium	425	4.80
18	China	202	2.30	Austria	405	4.57
19	Israel	185	2.10	South Korea	398	4.49
20	Austria	151	1.72	Brazil	361	4.08
21	Brazil	150	1.71	India	331	3.74
22	Denmark	150	1.71	Taiwan	310	3.50
23	Mexico	149	1.69	Belarus	299	3.38
24	Norway	147	1.67	Australia	299	3.38
25	Australia	140	1.59	Greece	288	3.25

Notes: 1. The total of the shares for the countries is higher than 100%, since some papers were prepared in co-authorship with researchers from more than one country.
2. The procedure for calculating the total number of publications by Russian authors in international co-authorship is described in the legend to *Fig. 5*.
Source: author`s calculations on Web of Science database materials.

The share of publications written in international co-authorship in the total number of publications is considered to be a relative indicator of the level of integration of researchers of a

particular country into the global scientific community. The basic indicators of the level of integration of Russian researchers into the global scientific community are shown in Fig. 5. The share of publications prepared in international co-authorship in the total number of Russian publications over the period of 2001–2011 fluctuated around 29%–33%. It corresponded to the absolute number of approximately 9,000 publications. However, a decrease in the number of publications prepared in international co-authorship started in 2008.

Researchers from the USA and Germany were the main foreign partners of Russian researchers (Table 12): 26%–27% of the total number of Russian publications in international collaboration was prepared in co-authorship with researches from these countries. French and British researchers were also significant partners of Russian scientists. The strengthening of scientific links between Russia and Asian countries should also be noted. The number of publications by Russian authors in co-authorship with their Indian, Chinese and Taiwanese, and South Korean colleagues increased by a factor of 3.6; 3.1, and 4.6, respectively, over the period of 2001–2011. The development of scientific cooperation between Russia and European countries was less dynamic. Among the former USSR countries only Ukraine and Belarus were included in the cohort of the 25 most significant scientific partners of Russia.

Table 13. Share of publications in co-authorship with Russian researchers in the total number of publications of the country: 2001 – 2011 (%)

Country	2001	Country	2011
Turkmenistan	40.00	Georgia	30.94
Tajikistan	24.00	Belarus	27.66
Armenia	19.83	Armenia	26.29
Kazakhstan	17.87	Kyrgyzstan	23.44
Georgia	17.56	Kazakhstan	23.18
Ecuador	16.35	Mongolia	19.29
Uzbekistan	13.02	Azerbaijan	18.04
Mongolia	12.50	Uzbekistan	15.45
Belarus	8.48	Tajikistan	14.81
Ukraine	6.40	Ecuador	13.61
Azerbaijan	5.44	Ukraine	10.34

Notes: **1.** The indicators listed in the table are calculated as follows: for each country, the number of publications in co-authorship with Russian researchers is the indicator "Record count" in the box "Russia," which is shown after the function "Search within results for Countries/territories" in the option "Analyze results" in the Web of Science database is executed. The following types of documents were selected for the analysis: article, proceedings paper, and review.
2. The countries whose share of publications in co-authorship with Russian researchers in the total number of publications of the country was higher than 10% in 2001 or 2011 are listed.
Source: author calculations on Web of Science database materials.

On the other hand, Russia was an important scientific partner for Central Asian and Cau-

casian countries, as well as for Mongolia, Ecuador, Ukraine, and Belarus (*Table 13*). Meanwhile, Russia was an insignificant scientific partner for such countries as the USA, Germany, France, and Great Britain. For these countries the share of publications prepared in co-authorship with Russia, in the total number of publications in co-authorship amounted to less than 3.5%.

In Northern European countries, the level of integration of researchers of these countries into the global scientific community was considerably higher than in Russia (approximately 50%). This indicator was even higher in Indonesia, Cyprus, Tajikistan, Turkmenistan, Kyrgyzstan, and Uzbekistan: 60–65% in recent years [21–23]. This indicator was also high for countries with transition economies (e.g., Latvia, Estonia, and Belarus). The indicator has always been high for such countries as Germany, France, and Canada: almost half of all publications made in these countries were the result of international collaboration. On the contrary, among the top 30 countries in number of publications, this indicator is the lowest for China, India, Turkey, and Iran. In general, the level of integration of researchers into the global scientific community in European countries was higher than the level observed in Asian countries.

Bibliometric analysis of the patterns of academic co-authorship at the world level have shown a significant increase in the number of publications prepared in international collaboration during the past 20–30 years. This phenomenon can interpreted as the sign of the deepening of specialization and globalization of knowledge production. In particular, the increasing role of the BRIC countries in international collaboration has been noted; with Russia as a leader on this indicator among the four BRIC countries. The number of Russian publication in Web of Science database prepared in international co-authorship over the period from 1980 to 2011 jumped from 3% to 31%, reaching parity with the level achieved by the USA.

The distribution of Russian publications in international co-authorship over various fields of science generally corresponds to the areas of the scientific specialization of Russia: physics holds a significant lead (in particular, solid body physics and sub-disciplines studying nuclear processes, fields and particles; optics and spectroscopy, and plasma physics). These disciplines are followed by astronomy & astrophysics, material science, physical chemistry, instrument engineering, biochemistry & molecular biology, geosciences, mathematics, and electronics.

CONCLUSIONS

The publication activity of Russian scientists and the research efficiency of the leading scientific countries were reviewed. The dynamics of the number of publications in scientific journals indexed in the Web of Science database and the basic citation indicators was analysed for the countries of studied sample (countries with more than 10000 publication in scientific journal, indexed by Web of Science over the period of 2001 – 2011) . The fields of scientific specialization for Russia were also identified. Moreover, the analysis has demonstrated that Russia lost positions in the world science over the period from 2001 to 2011. Countries with dynamic publication activity rose to overtake Russia in the world rating. The most significant loss of position for Russia occurred in the fields that are considered of traditional strength for Russia (physics, engineering, materials science, chemistry and mathematics). Furthermore, the average number of citations per paper in Russia was one of the lowest in the world.

The conclusions concerning the scientific specialization of Russia can be drawn through analysis of the distribution of publications over various fields of science. The majority of Russian publications were in natural sciences and engineering, whereas the world structure of science was characterized by the predominance of publications on medical and biological sciences. The most significant contribution the Russian scientific output came from publications on physics. These publications accounted for almost 50% of Russian highly cited publications and for 20% of the total number of Russian publications. Russian publications on physics were much more broadly represented in the world science in comparison with publications in other fields of science. Moreover, Russian scientific papers on physics significantly contributed (in comparison with publications in other fields of science) to the total number of Russian publications in international co-authorship.

The level of integration of Russian researchers into the world scientific community was relatively high. However, this indicator was higher in European countries (in particular, in Northern European countries). The main scientific partners of Russian researchers were scientists from the USA, Germany, Great Britain, and France. Scientific cooperation between Russian scientists and their colleagues from Asian countries (primarily from China, India and South Korea) considerably strengthened over the period of 2001 – 2011.

The following conclusions can be drawn from the analysis of the publication activity in the other countries. In 2001–2011, the U.S. clearly held the leading positions in the world science. The publication activity in Asian countries was much more dynamic than in European

countries. Iran demonstrated the highest growth rate of the indicators of publication activity among the countries of the studied sample. However, the citation indicators and the level of international scientific collaboration were in European countries were higher than in Asian countries. Therefore, a significant rearrangement in world science has occurred over the past 10 years. Developing countries (primarily China, and also Iran, Thailand, Turkey, Malaysia, Brazil, Pakistan, and India) have begun closing the gap with the established leaders (North American countries, Northern European countries, and Japan). Because of the strengthening in this trend, Russia's lagging will manifest itself to an even greater extent. By the next decade Russia may lose its status as one of the world's great scientific countries without timely reforms in scientific policy.

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