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The main directions in cooperation between the Russian scientific organizations and research institutions of the «global triad» (USA, EU and Japan)

Las direcciones principales en la cooperación entre las organizaciones científicas rusas y las instituciones de investigación de la "tríada global" (EE. UU., UE y Japón)

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Contents

ABSTRACT:

The article analyzes the dynamics of the development of bilateral scientific cooperation between Russia, from one hand, and the global triad countries on the other in terms of the publication activity of research organizations for the period from 2007 to 2016. The author deals with the main scientific areas that are of mutual interest for the Russian research organizations and their partners from the "global triad". The major forms of the network interaction between research institutions are also reviewed.

Keywords: international scientific and technological cooperation, research organizations, scientific collaborations, publication activity.

RESUMEN:

El trabajo analiza la influencia mutua del capital intelectual de las universidades y regiones de su ubicación. Como base, se utilizó el método de estudio de casos de los programas de desarrollo de las principales universidades rusas. Se analizaron proyectos estratégicos que permitieron establecer la existencia y la influencia mutua significativa del capital intelectual disponible de universidades y regiones. Las interrelaciones cualitativas establecidas pueden convertirse en una base para su posterior análisis cuantitativo, y también utilizarse en la práctica de la gestión de universidades y regiones para mejorar su uso en la implementación de programas de desarrollo.

Palabras clave: cooperación científica y tecnológica internacional, organizaciones de investigación, colaboraciones científicas, actividad de publicación.

1. Introduction

1.1. The relevance of the study

The science went beyond national frontiers in the context of globalization and accelerating the pace of scientific and technological development. In today's world, the achievement of breakthroughs in the advanced fields of science and technology is beyond the capabilities of a single country. In this regard, scientific and technological cooperation between countries is actively developing today on a bilateral and multilateral basis, including through the auspices of various international organizations.

It is worth to be mentioned that the United States, the EU and Japan, according to UNESCO and the National Science Foundation, had maintained a high level of R&D intensity and spending rates on research and development for the period under review. Moreover, Triadic patent families filed at the European Patent Office, the United States Patent and Trademark Office and the Japan Patent Office are frequently used as an indicator for assessing technological competitiveness of nations at the global level.

To date, one of the priorities of state policy of the Russian Federation is to strengthen the influence and increase the contribution of the Russian science and education to the development of the world scientific and educational space. To this end, federal authorities have taken measures to improve the competitiveness of scientific institutions and provide an opportunity for an objective assessment of their effectiveness. For instance, according to the Decree of the President of the Russian Federation No 599 “On measures for the implementation of state policy in the education and science field” signed May 7, 2012, the Government of the Russian Federation was tasked with increasing the share of publications of the Russian researchers by 2015 in the total number of publications in world scientific journals, indexed in the Web of Science database, up to 2.44 percent. Similarly, federal system for monitoring scientific organizations, which was launched by the Decision of the Government of the Russian Federation No. 312 of April 8, 2009 "On the assessing the effectiveness of scientific organizations, performing R&D activities and technological works for civil purposes" and other legislation, called for a greater reliance on data from multidisciplinary academic databases such as Scopus and Web of Science, which is used as the main indicator in calculating threshold levels for the determination of the effectiveness of scientific organizations in the respective reference groups, as well as a tool for benchmarking the performance of the Russian scientific organizations with research institutions of economically developed countries.

In recent years significant changes have occurred, from the point of view of the problem under consideration, in the Russian system of higher education.

21 major Russian universities are participants of the project 5 - 100 launched by the Russian Ministry of Education and Science in order to increase their competitiveness among the world's leading scientific and educational centers. According to the schedule of programme implementation, at least five higher educational institutions of 21 major Russian universities should enter the top 100 world universities according to ARWU — Academic Ranking of World Universities, THE — Times World University Rankings, QS World University Rankings, etc.

In addition, the data from information & analytical systems of peer-reviewed literature is being actively used today to develop an internal quality management system for the Russian HEIs, as well as performance criteria for researchers and faculty in the context of the transition to an effective contract in fulfillment of the programme of the gradual improvement of salary system applicable to staff members of State and municipal bodies for 2012-2018, approved by the Government Directive of November 2012.

Thus, major bibliometric databases and world ratings have a significant impact on the development of the system of scientific organizations and higher education in Russia, including by redistributing budgetary financing in favor of those scientific and educational institutions that demonstrate the best results in terms of the number of publications and

citations in the Web of Science, Scopus databases, etc., as well as improving positions in the international rankings.

In this regard, the relevance of this study is determined by the priorities of state policy and the latest developments in the system for assessing the effectiveness of the Russian scientific organizations.

With a view to identifying the dynamics, main directions and mechanisms for promoting cooperation between the Russian scientific organizations and research institutions of the "global triad", this study analyzes the concept of a "research organization" in the countries in question. On the basis of a quantitative analysis of joint articles in scientific journals indexed by Scopus and Web of Science, the publication activity of research institutions, the main scientific directions, as well as the priority mechanisms for the development of scientific collaborations, are investigated.

The time frame proposed (2007 - 2016) is due to the following circumstances:

• EU enlargement process (Bulgaria and Romania became EU member states in 2007);

• features and practice of indexing scientific articles in the Scopus and Web of Science databases that result in the half a year time lag between publication of an article in a scientific journal and its indexation. Thus, data on the number of joint publications for 2017 at the time of writing this study may be irrelevant;

• the need to separate and compare the two periods of state policy in research and development. The Decree of the President of the Russian Federation No. 599 of May 7, 2012 can be called a watershed between them. The first period is 2007-2012, most of which is related to the presidency of Dmitry Medvedev and the course of his administration to accelerate the country's innovative development. In addition, the global financial and economic crisis was the main challenge of this period of time. During the period 2012-2016, which fell on Vladimir Putin's presidency, Russia's relations with Western countries had severely deteriorated. In this regard, this study will determine the impact of global economic and geopolitical factors on the dynamics of bilateral scientific and technological development of Russia's cooperation with the "global triad".

1.2. Literature review

The article raises the problem of international scientific collaborations, in whose creation research organizations had played an important role. At the moment this topic has been studied in Russia and abroad in terms of the main forms of scientific collaborations, internal and external factors that influence their formation.

For instance, the interaction of scientific teams on an extraterritorial basis is being considered in the context of the development of a networked organization of scientific activity, which is studied in the works by Voronina & Ratner (2014), Parfyonova (2014), Ryazanova (2017), etc.

The authors classify and analyze various forms of the network organization of science, including scientific collaborations (horizontal integration), technology transfer network (vertical integration), competence transfer network (mixed integration), and virtual scientific communications.

As the factors affecting growth in the international scientific collaborations are concerned researchers such as Wagner & Leydesdorff (2005) divide them into internal and external. The reputation capital of a scholar, the competition between researchers (Katz & Martin, 1997) and the growing interdisciplinary nature of science (Hwang, 2008) may refer to the internal factors, while the growth in information and communication technologies (Wagner, 2008), state science policy (Oldham, 2005), national research infrastructure are considered as external.

It should be noted that a considerable amount of literature has also been devoted to the study of scientific organizations. For instance, management aspects are revealed in the works by Maltseva (Maltseva, Barsukova, et al., 2017; . Maltseva, Gridchina, et al., 2017),the issues on the performance evaluation are raised by Opel (1998), Kanellopoulos

(2006), etc.

At the same time, the assessment of the impact of the network organization on the performance of the research organizations was not considered in the literature.

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2. Methodology

To achieve the research goals bibliometric methods are used in the article, which were elaborated by Western scholars, for instance, Garfield (1964), Price (1965) Cole & Cole (1973).

Within the framework of the proposed methodology, indicators such as the number of publications as well as patent applications are used to assess the effectiveness of both scientific organizations and individual researchers. Moreover, citation is reviewed as a mechanism of dialogue in science (Small,1978).

Subsequently, the methodology of bibliometrics was expanded through the use of indicators such as the evaluation of scientific communications, scientific policy, etc. (Hess, 1997).

In the article the dynamics of the development of scientific relations is evaluated on the basis of an analysis of the quantitative data presented in Scopus and Web of Science.

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3. Results

3.1. Approaches to the definition of a research organization in Russia, the EU and the United States

In Russia, according to the Federal Law No. 127-FZ of August 23, 1996 “On Science and State Science and Technology Policy", scientific organizations are institutions for which scientific or scientific and technical activities are the main. Consequently, higher education institutions, whose mission is, first of all, the training of highly qualified personnel, doesn't fall into that category, according to the logic of the law. However, the analysis of literature on the problems of development of research activities in Russia shows that scientific organizations and universities can be dealt with in the same context. For instance, the National Research University the Higher School of Economics, within the framework of the federal targeted programme for Research and Development in Priority Areas of Advancement of the Russian Scientific and Technological Complex for 2014-2020, carried out the project "Creation of a knowledge network for the exchange of best practices for the management of research and scientific and technical results on the basis of an inter-agency monitoring system for the effectiveness of scientific and educational organizations", which investigated management practices in HEIs and research organizations alike.

There is no universally accepted definition of a scientific organization in the member states of the European Union and the US. Moreover, there are some differences in the understanding of scientific organization at supranational and national levels in the EU. For instance, according to the "*Community framework for state aid for research and development and innovation*" published in 2006, “research organization” means an entity, such as university or research institute, irrespective of its legal status (organized under public or private law) or way of financing, whose primary goal is to conduct fundamental research, industrial research or experimental development and to disseminate their results.

In general, the criteria for the identification of an entity as a research organization are:

• type of activity (research). At the same time, the legislator suggests that this activity for the organization should be the main one;

• the right of the institution to independently administration of its assets, including intangible assets.

Meanwhile, the Department for Business, Innovation and Skills of the UK doesn’t include universities as research and innovative organizations. It is stressed that for these organizations, research should be the main activity.

In Denmark, the public research organizations include institutions whose main objective is to

conduct scientific research. However, the term does not apply to the establishments of the Ministry of Culture and universities. At the same time, the Law on research in archives, libraries and museums, etc. of March 27, 1996 reserves for the establishments of that kind the right to engage in such activities.

In France, a public institution of a scientific and technological nature is a legal entity of public law with administrative and financial autonomy, whose activities are aimed at:

- development and progress of research in all fields of knowledge;
- evaluation of research results in the public interest;
- exchange and dissemination of scientific knowledge;
- training of scientific personnel and conducting research;
- organization of open access to scientific data, etc.

No pre-judgment measures of constraint, such as attachment or arrest, against property of a such legal entities may be taken, while they have the right to collect their debts through an "executive document" that exempts public law entities from the obligation to apply to a court to protect their rights. In addition, under public law general statute of limitations for debts and related claims for public research institution is 4 years.

In the United States, in accordance with article 501 (c) of the US tax code, scientific organizations are exempt from federal income tax. At the same time, the tax code does not define the term "science" or "scientific". In this regard, the interpretation of these definitions should be based on law enforcement practices and the precedent-setting nature of court decisions. Thus, in the case of the "IIT (Illinois Institute of Technology) Research Institute v. U.S." of October 15, 1985, the US Claims Court stated that the US Congress, in determining the above-mentioned terms, should rely on a generally accepted understanding of the meaning of these words. Based on the definition of the term "science" in dictionaries, the court decided that science should be understood as a process in which knowledge is systematized or classified through observation, experimentation or argumentation.

The US Code of Federal Regulations states that in order to comply with the criteria of the tax code, an organization must conduct research in the public interest. In this case, according to the rules, it is necessary to distinguish between the terms "research" and the derivatives of the word "science", since the essence of research is determined through the purpose to which they are directed. In this regard, research should be consistent with a scientific goal. In other words, the American legislator argues that not every research organization is scientific. For example, scientific research is not a type of activity related to temporary operations for trade or industry: for example, “the ordinary testing or inspection of materials or products or the designing or construction of equipment, buildings, etc.”

At the same time, federal scientific institutions of the United States (i.e. those who are funded out of the national budget) include organizations engaged in research in the areas of state priority such as defense, space, health, etc., for instance, National Aeronautics and Space Administration (NASA), the Nuclear Regulatory Commission, the US Department of Energy, the National Institutes of Health (NIH), and others.

The so-called "think tanks" are organizations that carry out strategic research, analyze and develop recommendations on domestic and foreign policy issues that can be taken into account by politicians and the general public when making decisions in these areas. The "think tanks" can be either affiliated institutions or independent institutions created on a permanent basis, rather than on an ad hoc basis. These institutions often serve as a bridge between the academic community and government structures, the state and civil society, serving the public interest through expertise that translates the results of fundamental and applied research into a language that is understandable and accessible to politicians and the general public (McGann, 2018: 8).

University of Pennsylvania has developed the Global Go To Think Tank Index, which includes resource indicators, utilization indicators (client capital), output and impact indicators.

Organization for Economic Cooperation and Development, of which Japan is a member, defines public research institutes as entities, which in addition to carrying out research, can

also train personnel and provide consulting and other types of services. At the same time, it is pointed out that state plays an overwhelming role in financing or managing these institutions (OECD, 2011: 26-27).

However, in Japan and in many countries, public research institutes are identified as a separate category, which are subject to strategic and policy documents in the field of science. Thus, the National Institute of Advanced Industrial Science and Technology (AIST), the Institute of Physical and Chemical Research (RIKEN) and the Japan Aerospace Exploration Agency (JAXA) are the largest public research institutions in Japan (Suzuki, Tsukada & Goto, 2015).

Thus, the main problem in determining the scientific organization is the status of universities. As a rule at the national level universities and state research institutes are delineated in terms of their involvement in scientific activities. For this reason, it is believed that the institution is considered scientific regardless of the form of ownership, the main function of which is the generation of knowledge and their dissemination through publications, registration of patent rights, participation in scientific events, etc.

At the same time, in the context of the development of the world scientific and educational space, the research capabilities and resources of some universities are comparable not only with large state-funded research institutions, but with the budgets of individual countries. For instance, the endowment fund of Harvard University in 2016 amounted to 35.6 billion dollars, which is 3.5 times more than the funds provided in the RF budget for education in the same year.

In this regard, in this study, universities and research institutions are viewed as organizations that, while carrying out research and development in the interests of the state, not only promote technological re-equipment and modernization of the economies of individual countries, but also through the development of cooperation contribute to world scientific and technological progress

3.2. Dynamics and main areas of cooperation between research organizations of Russia and scientific institutions of the "global triad"

As the research results show, the internationalization of science is becoming one of the most important factors in the development of scientific organizations. In practice, this means that the knowledge gained will rather find its application outside the host region. Moreover, organizations that carry out world-class research will play a more significant role in regional development (including through the branding of the territory) than institutions conducting research in the interest of the region (Power & Malmberg, 2008).

In this regard, the main trend in the development of scientific research at the present stage is the increase in academic mobility, the publication activity of researchers, including the growth of the number of joint articles, the development of scientific collaborations in general.

The spread of information and communication technologies, overcoming the block confrontation in the world geopolitics and other factors related to the globalization processes gave impetus for the network organization of scientific activity. In the early 1990s was published the work by Rothwell, in which he gave the definition of the fifth generation of R&D, by which he meant cutting-edge studies based on system integration and network interaction (Rothwell, 1992).

With the Russia’s recovering from an extended period of crisis of 1990s related to financing problems, the brain drain and aging of the personnel of research organizations it became possible to develop a network models of the organization of scientific activity.

Conceptual and policy documents adopted in 2006-2008 (Review of the Foreign Policy of the Russian Federation of March 28, 2007, federal targeted programme for Research and Development in Priority Areas of Advancement of the Russian Scientific and Technological Complex for 2007-2012, federal targeted programme "Scientific& Scientific-Pedagogical

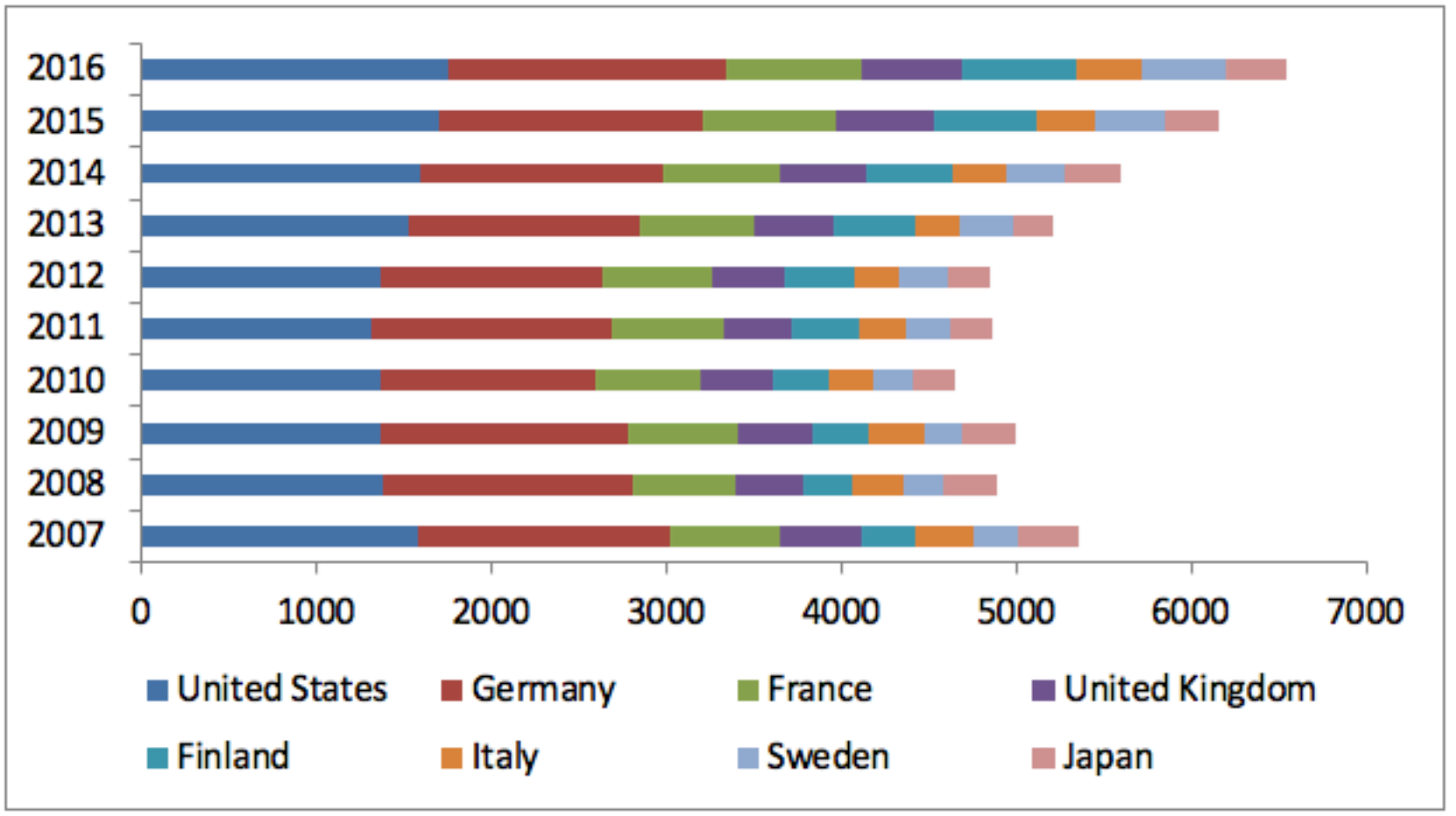
Human Resources for Innovative Russia in 2009-2013") reflected the need to expand Russia's global presence in accordance with its economic capabilities, increase the volume of exports of high-tech products and enhance the publication activity of Russian researchers in world's leading scientific journals, etc.

During the 2000's such forms of organization of scientific work as "mirror laboratories" are being more widely applied in some metropolitan and regional universities and scientific organizations in Russia. These research bodies were created similar to the foreign laboratories under the supervision of compatriots living abroad (Dezhina & Ponomarev, 2013).

"Mirror laboratories" were established in the Nizhny Novgorod Institute of Applied Physics of the Russian Academy of Sciences in partnership with the Nizhny Novgorod State University, Novosibirsk State University with cooperation with French, British and other European universities. The hiring of foreign researchers in the Russian universities and scientific organizations with the aim of technological learning, studying the new forms and methods of training of scientific personnel is becoming one of the priority tasks addressed by federal targeted programmes, strategic projects in the field of science and innovation development (for instance, one of them aimed at creation of the innovative center "Skolkovo").

Analysis of the publication activity of the Russian researchers and their foreign counterparts shows an active growth of the number of joint articles after 2012 (Fig. 1)

Figure 1
The number of joint articles in scientific journals indexed in the Scopus database, authorship of which belongs to at least one researcher from Russia, as well as at least one scholar from the United States, individual EU countries and Japan, published for the period from 2007 to 2016.



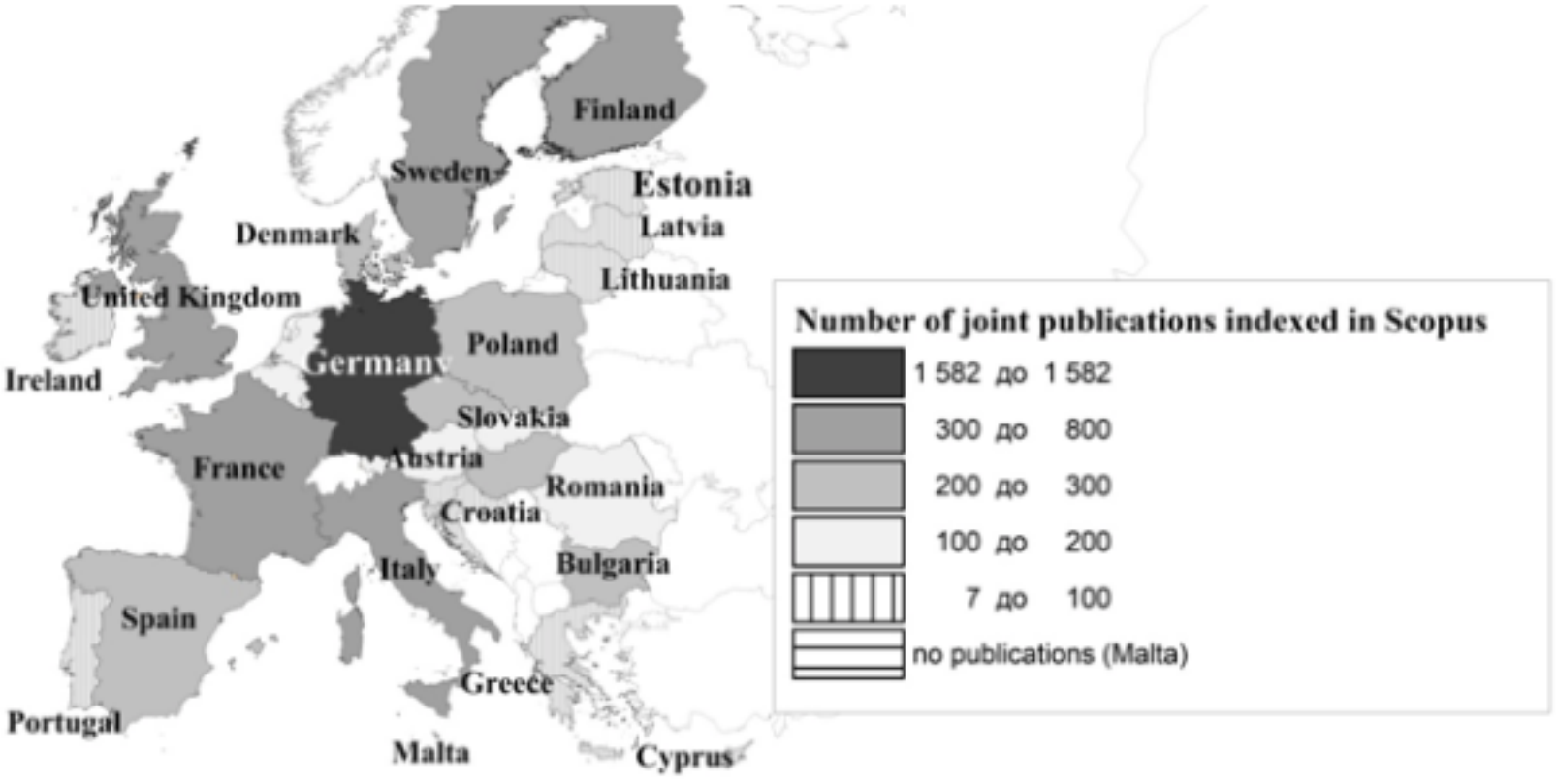
Source: Elsevier (Hereinafter the publications prepared by the international team of researchers, i.e. representatives of three or more countries, are not taken into consideration).

This figure shows that after a slight reduction in 2010, caused, apparently, by the consequences of the global financial and economic crisis, the average growth rate of joint publications with leading countries after 2012 amounted to 7.7 percent per year.

However, only those EU member states, which accounted for more than half of all joint publications in scientific journals indexed in Scopus, were included in the sample (Fig. 2).

Figure 2
The distribution of EU member states by the number of joint publications published in 2016 with the Russian researchers in scientific journals indexed

in the Scopus database

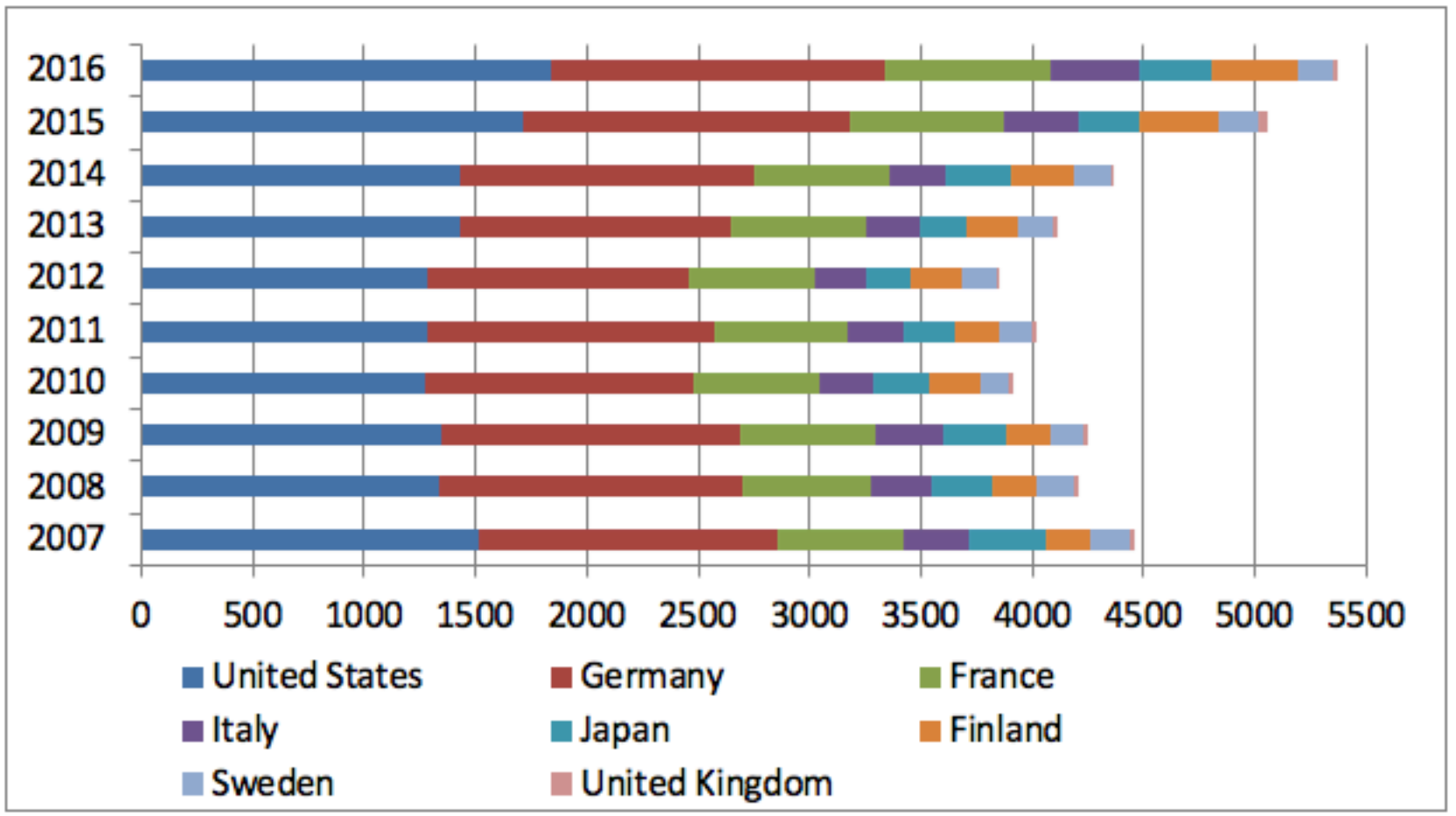


Source: Elsevier

Thus, over the past 10 years, the Russian researchers have been working most actively in preparation for scientific articles with their colleagues from the United States, as well as Germany, Britain, France, Italy, Sweden and Finland (among partner-countries from EU member states).

The analysis of the publication activity of the authors of the joint articles indexed in the Web of Science database confirms the findings (Fig. 3).

Figure 3
Number of joint articles in scientific journals indexed in the Web of Science database, authorship of which belongs to at least one researcher from Russia, as well as at least one scientist from the United States, individual EU member states and Japan, published for the period from 2007 to 2016.



Source: Clarivate Analytics

The figure shows that the scientific organizations from the USA and Germany were the main

partners of the Russian research institutions. At the same time, the share of joint publications with British scientists in comparison with the publications indexed in Scopus database is insignificant. It is also possible to observe a sustained upward trend in the number of joint publications after 2012. The same pattern was apparent for the articles indexed in Scopus.

The distribution of joint articles published in scientific journals on fields of scientific knowledge is presented in Table 1.

Table 1
Priority areas of knowledge on which joint articles of researchers from Russia, Japan and individual EU member states were published in scientific journals indexed in Scopus and Web of Science for the period from 2007 to 2016 (the average for the group of countries).

Scopus		**Web of Science**	
Physics and Astronomy	40,83%	Physics	42,14%
Materials Science	17,36%	Chemistry	26,27%
Engineering	15,59%	Engineering	20,55%
Chemistry	13,08%	Materials Science	18,37%
Earth and Planetary Sciences	11,49%	Mathematics	17,68%
Mathematics	11,37%	Biochemistry, Molecular Biology	15,25%
Biochemistry, Genetics and Molecular Biology	9,93%	Science, Technology, Other Topics	10,71%
Agricultural and Biological Sciences	8,15%	Spectroscopy	9,40%
Medicine	7,06%	Optics	9,19%
Computer Science	6,85%	Genetics, Heredity	6,93%

Source: Elsevier, Clarivate Analytics, the author's own calculations (Top 10 scientific areas, according to the Elsevier and Clarivate Analytics classification, the column sum is not 100 per cent, since one publication can refer to two or more fields of science).

Thus, the natural areas of research dominate over the social and humanitarian subjects. Among the main factors that influenced the growth of the number of publications in the field of exact and natural sciences, one can attribute the presence of a unique research infrastructure, which allows scientific organization to gain competitive advantages in the world scientific and educational space.

For instance, Institute for High Energy Physics of the National Research Center “Kurchatov Institute”, Special Astrophysical Observatory of the Russian Academy of Science and Landau Institute for Theoretical Physics were in the top of Clarivate Analytics rankings 2016 of the most cited research institutes in Russia (which over the past 10 years published more than 1,000 articles and other research works indexed in the Web of Science Core Collection) (Belyaeva, 2016).

National Research Nuclear University MEPhI and the Institute for Nuclear Research of the Russian Academy of Sciences were amongst the winners of the Web of Science Awards -2017 in the nomination for the Best Publication Strategy.

The Special Astrophysical Observatory of the Russian Academy of Sciences has the main observational capabilities of Russia and astronomical instruments that allow conducting unique astrophysical studies.

In 2001 the Astronomical Data Center of the Institute of Astronomy of the RAS and the Special Astrophysical Observatory of the RAS have initiated a project to create the Russian Virtual Observatory (RVO) in order to provide the Russian astronomical community with a convenient and effective tool for accessing foreign data sources and to combine the Russian astronomical information resources. The RVO, thus became an important component of integration into the international virtual observatory (Malkov, 2012).

The RVO was designed to increase the capabilities of astronomical research by integrating astronomical archives and a database distributed throughout the world. The RVO became a member of the "International Virtual Observatory" alliance, which included specialized research institutions of the "global triad" — the European Space Agency, the Japanese Virtual Observatory and the US Virtual Observatory Alliance.

Another tool for the development of networking between scientific organizations in Russia is the integrated research plans (IRPs), which were initiated by the Federal Agency for Scientific Organizations (FASO Russia) in the framework of the implementation of the concept of program management of research. It is assumed that IRPs will be aimed at solving important fundamental and applied problems. They will be implemented by several research teams from scientific organizations subordinate to FASO Russia. At the same time, the coordination of research does not imply the integration of the participating institutions on the legal base. The goal of the development of horizontal integration is the joint work of strong teams on important tasks within the framework of the programs of the Russian Academy of Sciences.

According to the methodological recommendations on the formation and planning of the implementation of the IRPs, the IRPs can be initiated by the President of the Russian Federation, the Government of the Russian Federation, federal executive bodies, scientific organizations subordinate to the FASO Russia. Thus, the IRPs will be formed in two ways — initiative and directive.

It is planned that by 2020 up to 80 percent of research will be conducted through the IRPs. At the same time, the implementation of these plans also seeks to ensure the principle of subsidiarity, when issues related to the allocation of funding for scientific organizations are delegated by the center to the regional level to improve management (Volchkova, 2016).

Promising example of the implementation of the IRPs includes a pilot project "Advanced Materials with Multilevel Hierarchical Structure for New Technologies and Reliable Structures" involving 10 scientific organizations subordinate to the FASO Russia from Tomsk, Novosibirsk, Omsk, Yekaterinburg, Perm, Ufa), 14 Russian and foreign universities, more than 15 large industrial companies and corporations (Psakhe, 2016).

The analysis of the publication activity of the research organizations involved in the implementation of the IRPs showed a significant increase in the number of publications in material science indexed in Scopus. Thus, the number of articles indexed in this database, whose authorship belongs to the staff of the National Research Tomsk Polytechnic University, and also the number of joint publications with their counterparts from, for example, the Berlin Technical University, has more than doubled (from 588 to 1260) for the period from 2015 to 2016.

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4. Conclusions

Thus, the analysis of the effectiveness of the Russian scientific organizations in terms of publication activity revealed the following patterns:

- research organizations from the USA and Germany became key partners of the Russian scientific institutions in carrying out research;

- the share of research organizations of natural sciences, which publish the results of joint research with their foreign partners, far exceeds the number of scientific organizations

specializing in the field of humanities and social sciences;

- sanction policy of the countries of the "global triad" in relation to Russia has not affected the effectiveness of joint scientific research. Moreover, since 2012 there have been steady growth rates of the number of joint publications. Based on the fact that in 2010 there was some reduction in the number of joint articles, one can conclude that there is a stable correlation between this indicator and the slowdown in economic development due to the world financial and economic crisis;

- network forms of organization of scientific activity contribute to enhancing the contribution of the Russian science to world scientific thought.

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