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Science and Technology Development in Russia and China: Comparative Analysis and the Prospects of Cooperation

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Abstract. The relevance of the article consists in the fact that taking into account modern global economic changes and the specialization of the Russian economy, it (the economy) is searching for ways to integrate optimally into the international division of labor; at the same time, cooperation with China becomes

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important. The main idea and goal of the study is to conduct a comparative analysis of science and technology development in Russia and China and to identify prospects for their cooperation in the modern world economy. Scientific novelty of the work consists in the fact that it analyzes the state of international cooperation in science and technology, and this analysis takes into account the overall situation in trade and economic cooperation, and manifestations of science and technology cooperation in trade; besides, the analysis takes into account science and technology cooperation factors such as the place of countries in the global innovative development, the presence of similar national priorities of science and technology development, and similar types of policy documents. Our typology of manifestations of science and technology cooperation includes spatial, sectoral and institutional parameters. We propose to take into account the specifics determined by modern trends in global economic development. The use of these approaches should contribute to the maximum integration of the priorities of science and technology cooperation between Russia and China and help the countries become leaders in the world market. In the course of the study we use comparative, causal, economic and statistical analysis, analysis of policy documents, and analysis of science and technology cooperation on geographical, sectoral and institutional parameters. Science and technology cooperation factors that we identify and the typology of manifestations of such cooperation are the main results of our study.

Key words: international science and technology cooperation, Russia and China, cooperation priorities, global economic environment, manifestations of science and technology cooperation, typology of manifestations, position of countries in the international division of labor, cooperation prospects.

Modern world economic context as a determinant of science and technology development

Speaking about the prospects of Russian-Chinese cooperation on science and technology, we should proceed from the specifics of the current period in the development of global economic relations. It consists in the gradual shift of the center of gravity from the hegemonic countries of the world economy to its so-called periphery and is expressed in the following:

– a growing range of global economic challenges that the Russian economy has to deal with, such as the imposition of international economic sanctions, which determines the shift in emphasis in cooperation with the countries of the Asia-Pacific region;

– an increasing importance of the role of emerging economies in the global economy;

– strengthening the cooperation between emerging economies, their unification in the form of new integration entities (Shanghai Cooperation Organization (SCO), BRICS, Eurasian Economic Union), against the background of traditional integration associations becoming weaker (EU, etc.); China increased its share in the structure of Russian exports (in the course of 10 years, from 4.5 to 10.9% in 2008–2017) and imports (from 13.0 to 21.2%)[1];

– the emergence of international infrastructure mega-projects.

In particular, the increasing role of emerging economies in the world economy is a particularly relevant statement for Asia where their largest representatives – China, India, Malaysia, Thailand, Indonesia, and Vietnam – are situated; they are characterized by rapid growth promoted, among other things, by their

[1] Calculated from: Customs statistics of foreign trade. Website of the Federal Customs Service of Russia. Available at: http://stat.customs.ru/apex/f?p=201:7:571014685148678::NO (accessed 20.04.2018).

"Asian accumulation cycle". The aggregate GDP based on PPP of the seven largest emerging countries (including the BRICS nations: Russia, Brazil, China, and India; as well as Mexico, Indonesia, and Turkey) in 2013 exceeded the combined GDP of the G7 (35.0% of world GDP vs. 32.4%). By 2017, this ratio was 37.5% and 30.6%. China's GDP based on PPP has been ahead of the U.S. since 2014 (in 2014: 16.5% of world GDP vs.15.8%; in 2017: 18.2% vs. 15.3%)[2].

At the same time, both Russia and China have significant reserves of resources *(Fig. 1)*. The BRICS and SCO associations, a significant contribution to which is made by China and Russia, are not as comparable to the associations of developed countries in terms of their contribution to world GDP as they exceed them in terms of their share in the structure of the world's human and mineral resources. For instance, the population of SCO is three times larger than the EU and NAFTA taken separately, and the population of the BRICS is twice as large. As for mineral resources, it would suffice to mention energy sources. In terms of natural gas reserves, the SCO and BRICS outstrip NAFTA in more than three times, and EU – in thirty times. BRICS and the SCO have large reserves of coal, especially in comparison with the EU. Thus, with regard to resources, they are leaders.

New international infrastructure mega-projects include the Silk Road Economic Belt and the 21st Century Maritime Silk Route Economic Belt [1, pp. 119–120].

In general, according to S.Yu. Glazyev, a new world economic order is being formed [2, p. 26]. Russia and China are major participants of this process. One of the most important factors for Russia is the necessity to remain competitive in the global economy, become the most important participant in international science and technology cooperation, and occupy a worthy place in the international division of labor, especially when the world economy is shifting toward a new technological order, developed economies use advanced technologies, and emerging economies start to use them.

With this in mind, Russia's international economic cooperation with China serves to strengthen the countries' positions in the world economy. In this regard, the purpose of our paper is to identify priorities of and prospects for the development of science and technology cooperation between Russia and China in the modern world economy. Scientific novelty and significance of the work consist in the fact that it provides a comprehensive vision of the manifestations of Russian-Chinese cooperation in science and technology, taking into account current trends in global economic development.

Comparative assessment of the level of scientific and technological development in Russia and China

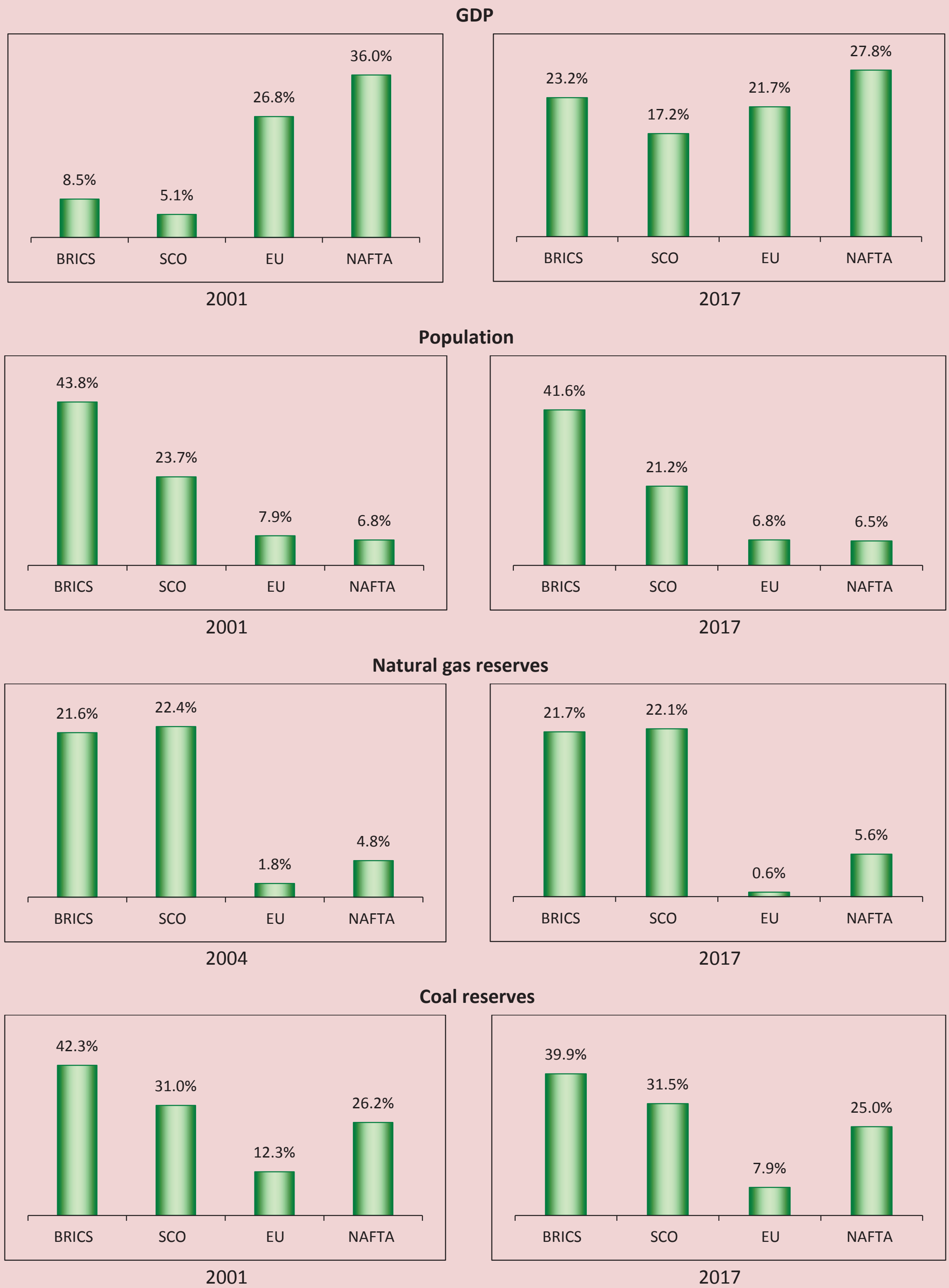
In terms of the level of scientific and technological development, China is significantly ahead of Russia on a number of indicators. In global economic cooperation, China is a leader in many respects: in terms of GDP, exports, international investment, population (and hence human resources) *(Tab. 1)*.

China occupies a leading position in the global manufacturing industry, too *(Tab. 2)*. It is a world leader in the production of machine tools, motor vehicles, computers, electronics and optics, and industrial robots [3, pp. 12-18].

Such leadership depends largely on the innovation policy carried out in the country. The rating on the indicators of innovative development is shown in *Table 3*.

[2] India vs. China: the race of innovation has already begun. *Vesti. Ekonomika*. 22.07.2015. Available at: http://www.vestifinance.ru/articles/60402 (accessed 16.04.2018).

Figure 1. Shares of associations of developed and emerging economies in the structure of world GDP and world reserves of resources, %



Source: compiled and calculated from: World Economic Outlook Database, April 2018. International Monetary Fund. Available at: http://www.imf.org/external/pubs/ft/weo/2018/01/weodata/index.aspx; Indicators. World Bank website. Available at: http://data.worldbank.org/indicator; BP statistical review of world energy. BP website. Available at: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/downloads.html (accessed 14.07.2018).

Table 1. Russia and China in global economic relations, 2017

Indicator		Russia	China
GDP, trillion USD (share in the world)		1.5 (1.9%)	12.0 (15.0%)
GDP growth (2017 to 2001)		4.64-fold	8.94-fold
Population, million people (share in the world)		145 (1.9%)	1386 (18.4%)
GDP per capita, USD		10608	8643
Exports, billion USD (share in the world)		353 (2.0%)	2263 (12.8%)
Imports, billion USD (share in the world), 2017		238 (1.3%)	1842 (10.3%)
Foreign direct investment, billion USD (share in the world), 2016	inflow	38 (2.2%)	134 (7.7%)
	outflow	27 (1.9%)	183 (12.6%)
Sources: compiled and calculated from: World Economic Outlook Database, April 2018. International Monetary Fund. Available at: http://www.imf.org/external/pubs/ft/weo/2018/01/weodata/index.aspx; Data center. UNCTADstat. Available at: http://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx?IF_ActivePath=P,5&sCS_ChosenLang=en; Indicators. World Bank website. Available at: http://data.worldbank.org/indicator (accessed 10.07.2018).			

Table 2. China's share in global manufacturing production [3]

Production	Share, %
Metalworking machines	27.6
Motor vehicles	29.6
Computers, electronics and optics	34.1
Industrial robots	29.6

Table 3. Global innovation index 2017 and its components: the place of Russia and China in the world*

Indicator	Russia	China
Global Innovation Index (rank), including:	45	22
Institutions	73	78
Human capital & research	23	25
Infrastructure	62	27
Market sophistication	60	28
Business sophistication	33	9
Knowledge & technology outputs	45	4
Knowledge creation	22	5
Patents by origin/bn PPP$ GDP	15	1
High- & medium-high-tech manufactures, %	51	14
High-tech exports less re-exports, % total trade	44	1
ICT services exports, % total trade	76	77
Creative outputs	62	26
Creative goods exports, % total trade	49	1
* Sub-indices of the global innovation index are shown in bold. Source: Dutta S., Lanvin B., Wunsch-Vincent S. *The Global Innovation Index 2017: Innovation Feeding the World (10th Edition)*. Johnson Cornell University, INSEAD, World International Property Organization, 2017. 432 p. Pp. 209, 281.		

The Russian and Chinese economies are roughly comparable in terms of "institutions" (73rd and 78th places) and "human capital & research" (23rd and 25th places). China is a leader in the rest of the sub-indices; and in some cases it is ahead of many other economies (see Tab. 1). But according to some particular indices, the Russian economy is not inferior to the Chinese economy. For example, in terms of infrastructure, they include "information & communication technologies" (36th vs. 48th position), "electricity output" (25th vs. 51th); in terms of market sophistication, they include "ease of getting credit" (40th vs. 55th), "microfinance gross loans, % GDP" (60th vs. 73rd), "ease of protecting minority investors" (52nd vs. 98th), "applied tariff rate" in trade (66th vs. 76th); in terms of business sophistication, this is the proportion of women employed in high positions (Russia ranks second), "intellectual property payments, % total trade" (16th vs. 32nd), "ICT services imports, % total trade" (35th vs. 99th); in terms of knowledge and technology outputs, they include "intellectual property receipts" (37th vs. 67th), "ICT services exports, % total trade" (76th vs. 77th), "FDI net outflows" (24th vs. 45th).

Our analysis shows that, China has made significant progress in innovative development for 2006–2018.

Another global rating assesses the global competitiveness of manufacturing *(Tab. 4)*.

Over the years (2010, 2013, 2016), China is the leader in the global manufacturing competitiveness index (see Tab. 1). It is the largest owner of supercomputers; in China in 2016, their number became the same as in the United States and their quality was even higher. However, in this regard, Russia is also among the top ten countries. China ranks 4th in the number of patents, being inferior only to Japan, the U.S., and the European Union [4, pp. 15-16].

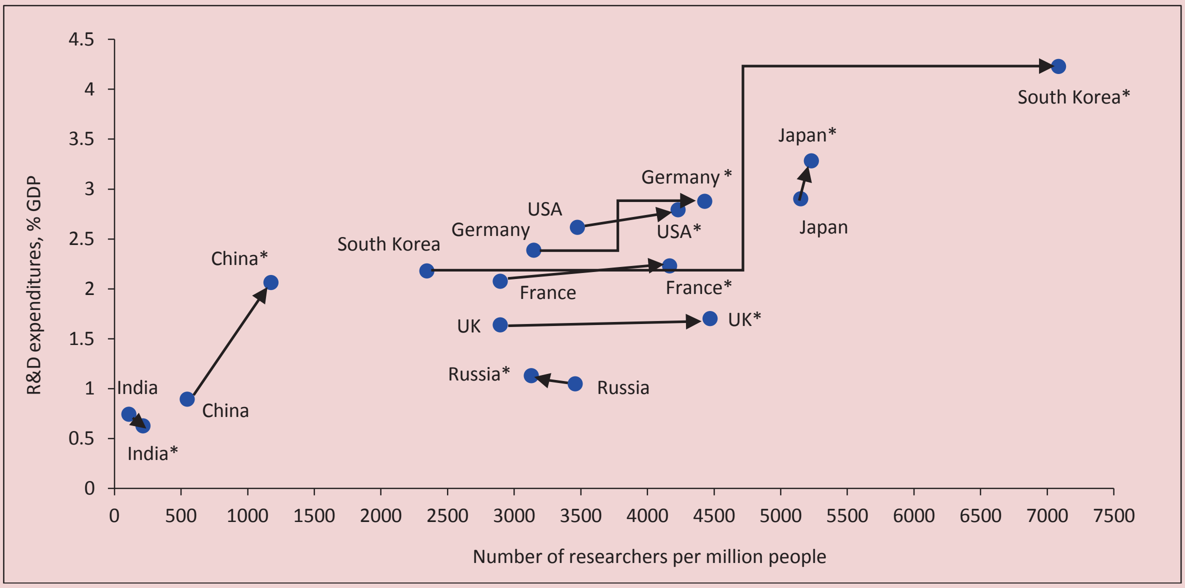
It should be noted, however, that China's leadership in world production (see Tab. 2) and the absolute indicators of its global manufacturing competitiveness (see Tab. 4) are largely related to the enormous amount of human capital (i.e. population) (see Tab. 1).

If we consider the dynamics of the two main indicators of research potential such as R&D expenditure in % of GDP and the number of researchers per one million population – for the period from 2000 to 2015, then it is clear that South Korea is a leader in these indicators and has the greatest dynamics of their development *(Fig. 2)*. Its R&D expenditure in % of GDP for 15 years has doubled, and the number of its researchers has tripled. Japan and Germany rank second; they have been more successful in increasing these figures than other G7 countries. The United States follows them with a slight lag: it also managed to increase both indicators. The change in the indicators of France and the UK was mainly due to a 1.5-fold increase in the relative number of researchers. Despite the fact that according to this indicator Russia is significantly closer to the level of developed countries than China and India, of all the above countries Russia is the only one that has experienced a decrease in the number of researchers during this period. China managed to achieve the level of the UK and France in this indicator by doubling its R&D expenditure.

Table 4. Indicators of global manufacturing competitiveness in Russia and China

Indicator		Russia	China
Global manufacturing competitiveness (rank), 2016		32	1
Number of supercomputers		7 (8 place)	168 (1 place)
Number of researchers per million population, people	2000	3459	547
	2015	3131	1177
Ratio of research and invention expenditure to GDP, %	2000	0.985	0.893
	2015	1.132	2.067
R&D expenditures per capita (PPP), USD (2016)		259	322
Sources: compiled and calculated from: 2016 Global Manufacturing Competitiveness Index Report highlights. Website of Valve Manufacturers Association. Available at: http://c.ymcdn.com/sites/www.vma.org/resource/resmgr/2016_mow_presentations/MOW_2016_-_Dollar.pdf (accessed 20.06.2017); [4]; World Bank statistics (http://data.worldbank.org/indicator) and UNESCO statistics (http://data.uis.unesco.org/Index.aspx?DataSetCode=SCN_DS&popupcustomise=true&lang=en#) (accessed 10.07.2018).			

Figure 2. Ranking of countries by number of researchers and R&D expenditure, in 2000 and 2015 (*)



Name of the country without "*" means 2000, with "*" – 2015 (number of researchers in the US and France–2014).
Source: World Bank statistics. Available at: http://data.worldbank.org/indicator. Accessed 10.07.2018.

At the same time, we should not forget that, although Russia lags far behind China in terms of patent applications, this indicator does not reflect such aspects as the economic importance and quality of patents. China has sharply increased its R&D expenditure, but it should be noted that Russia is making efforts to increase remuneration of researchers (a relevant document has been adopted, and conditions are being created: funding is organized in a decent amount through research foundations in order to improve the quality of research), efforts are taken to increase the share of young researchers. In addition, the high shares of the Chinese economy in the global structure of various manufacturing industries largely reflect not only and sometimes not so much the scientific and technological as the economic success of China, whose economy has managed to master many technologies thanks to entrepreneurial spirit and an active catch-up modernization, when many transnational corporations, being attracted by the low cost of labor, placed their manufacturing in China, and the Chinese gradually managed to master these technologies.

Differences and common points in the vision of scientific and technological development in Russia and China

Currently, both Russia and China are in the global trend of innovative development. Russian researchers point out (in particular, on the example of the pharmaceutical industry) that the program for industrial development will be successful in the case of innovative development of the industry [5, p. 125]. Chinese researchers, for example, Xu Bai and Yun Liu, also emphasize that it is important for emerging economies to implement innovation, R&D investment strategies, allocate resources rationally, and manage R&D effectively [6, p. 14]. China's current five-year development plan (since 2016) considers sustainable economic development, innovative growth and economic modernization as prime goals, as earlier [7, pp. 27, 29]. Along with industrial development, China is also considering the issue of moving toward a low-carbon economy [8, pp. 187-188]. Studies show that technological progress is an effective means of reducing carbon emissions [9, p. 14]. There is a potential for international research cooperation (for example, in medicine), too [10].

In China, the need to modernize and improve its scientific and technological level was recognized back on the eve of economic reforms (Deng Xiaoping spoke about it in 1978) [11, p.5]. In the early 2000s, new directions for the development of China were integrated into a scientific development concept aimed at changing the growth model in the direction of intensive, innovation [12, p. 22]. In the mid-2000s, special attention was paid to strengthening the link between production, education and science [13, p. 487]. Xi Jinping, speaking at the 19th Congress of the Communist Party of China, pointed out that China is to implement modernization by 2050 [11, p. 5]. It is expected that a “basic socialist modernization” of China will be carried out in 2020–2035. In economic development, it is planned to shift the focus from “rapid” to quality development. It is planned to continue the construction of an “innovation power”. It also planned to integrate the Internet and artificial intelligence with the real economy [14, pp. 61, 63].

China’s experience in supporting innovative development is of interest, too. For instance, special tax incentives are granted to “enterprises of new and high technologies”, to “enterprises that service advanced technologies”, and to small innovative enterprises [15, p. 44]. An important prerequisite for scientific and technological development is the interest on the part of the corporations in acquiring and applying R&D results [16, p. 21]. This is due to the fact that the barriers hindering the development of science and technology sphere in China, included a low level of investment in science and innovation, problems in the allocation of resources for innovation, and inefficient relations between science and manufacturing [17, p. 55]. In fact, Russian scientific and technological development is facing the same problems.

The focus on scientific and technological development will enable China to shift from an extensive to intensive model of economic growth, and Russia – to ensure economic growth and reduce its dependence on exports of energy resources [18, p. 90].

The focus of Russia and China on innovative development largely determines the change in their role and place in the world economy. Therefore, it is necessary to pay special attention to the prospects and needs of scientific and technological cooperation of the partner countries, taking into account the current world economic situation and common interests in strengthening their positions in the international division of labor.

General points in the development of the regulatory framework of scientific and technological development in China and Russia.

China has adopted the “Medium and long-term state program for scientific and technological development” for the years 2006–2020, which involves the implementation of large research projects, development of industrial innovation and commercialization of know-how [16, p. 9]. The Chinese Academy of Sciences launched a Program of action aimed at improving the international competitiveness and addressing key problems of the national economy [19, p. 21]. In Russia, in turn, the expected results of the state program "Development of science and technology" (for 2013–2020) include the creation of scientific and technological reserve demanded by economic sectors, expansion of the practical application of scientific research findings, the country's achieving leading positions in patent activity. At the end of 2016, the Science and Technology Development Strategy of Russia (Decree of the President of the Russian Federation dated December 1, 2016) was adopted; it aimed at ensuring Russia's transition to advanced digital, intelligent production technologies and materials, environmentally friendly and resource-saving energy, personalized medicine, highly productive agriculture, finding solutions to techno-, biogenic and other threats, and to ensuring transport and communication connectivity of the country. Also, the Russian state program "Development of the industry and increasing its competitiveness for the period up to 2020" is aimed at creating a competitive, sustainable, structurally balanced industry, capable, among other things, of developing advanced industrial technologies and oriented toward the formation of new markets for innovative products.

We should also point out the National Technology Initiative (until 2035) – a long-term program aimed to create conditions to help domestic companies become leaders in the markets of high-tech industries, which will determine the world economic structure in the next 15–20 years. Among the priority areas of NTI are ten markets, which are based on the priorities of scientific and technological development of Russia identified in the Science and Technology Development Strategy of the Russian Federation (adopted December 1, 2016). Since 2017, the Russian Export Center is implementing the program "Made in Russia", which involves voluntary certification and labeling of products aimed at supporting exports.

Currently, China has an industry development plan "Made in China 2025", aimed at creating efficient industry capable of producing goods with high added value, comparable to the goods of developed economies. The plan is aimed at the development of internal production innovations and creation of local brands. It is planned to provide support to 10 key production sectors (chip manufacturing, shipbuilding, machinery and robotics, railway communication, energy equipment, cars that use energy-saving technologies and new energy sources, regenerative medicine, etc.)[3].

In China, a special fund for development of small and medium-sized innovative enterprises was established in 2012. Zones of new and high technologies (China National High-Tech Industrial Development Zone), or technology parks are the main organizational form of infrastructure support for the innovative development of small and medium-sized businesses[4].

In the Russian economy in this field, Federal Law "On industrial policy" (dated December 31, 2014) provides for the creation of industrial parks, industrial technology parks and industrial clusters. To date, 79 regions have industrial parks and industrial technology parks that are operating, being under construction or planned to be constructed[5].

[3] India vs. China: the race of innovation has already begun. *Vesti. Ekonomika*. 22.07.2015. Available at: http://www.vestifinance.ru/articles/60402 (accessed 16.04.2018).

[4] Information about the tools to support innovation and stimulate demand for innovation in China. Innovation: information portal of the Ministry of Economic Development. Available at: *innovation.gov.ru/sites/.../gosudarstvennoe_regulirovanie_innovacionnoy-2.doc (accessed 19.5.2017).*

[5] List of Russia's industrial parks 2018. Available at: http://russiaindustrialpark.ru/industrialparks_catalog_perecheny_spisok_russia (accessed 25.04.2018).

Thus, we can distinguish the following **common points** in scientific and technological development in Russia and China:

– substantial resources for economic growth and scientific and technological development;

– understanding of the high importance of scientific and technological development for sustainable economic development, innovative growth, modernization of the economy, increasing the competitiveness of national goods in the domestic and international markets, optimal integration into the international division of labor, which is reflected in the strategic policy documents of economic development;

– the need to implement scientific and technological developments in different ways and through international cooperation, and this benchmark is laid in strategic policy documents.

We can highlight the following distinctive features:

– different resources for economic growth: in Russia it is, first of all, natural resources (mineral resources, forest, etc.), and in China – human resources;

– different specialization in the world market: Russia exports mostly energy resources, China – machinery, equipment and vehicles;

– different goals of scientific and technological development: China plans to turn from a world center for assembly of products into a high-tech economy, Russia has to address the issues of import substitution, reducing dependence on energy exports and achieving stable economic growth;

– difference in the development of the high-tech sector: high-tech developments in Russia are of a higher level, but their prevalence is often low; in China, developments can be medium-tech, but they are actively implemented and used in the world market. In this sense, the Chinese practice of introducing high technologies and the Russian experience of their creation can be the subject of exchange of experience.

Typology of scientific and technological cooperation between Russia and China

Russia and China have extensive experience in scientific and technological cooperation. This cooperation was particularly active during the Soviet period and subsequently intensified since the 2000s. Currently, Russian-Chinese scientific and technological cooperation has a wide range of manifestations, which can be classified by a number of parameters.

Institutional parameter.

1. Bilateral cooperation. It includes the above intergovernmental and other agreements (between the Russian and Chinese academies of sciences).

2. Multilateral cooperation. For example, in the framework of BRICS and SCO agreements. In particular, BRICS is developing cooperation in the scientific and technological field in a multilateral format. To date, the BRICS member states, in accordance with the BRICS Research and Innovation Initiative, have launched the BRICS framework program in the field of science, technology and innovation and adopted the Regulations on the BRICS Working Group on Research Infrastructure and Mega-Science Projects (and its meeting was held). The BRICS Network University has a potential for research collaboration; its participating institutions provide education in at least one of its six priority areas: energy, computer science and information security, the study of the BRICS countries, environment and climate change, water resources and neutralization of pollution, and economics[6].

[6] BRICS Network University. Available at: https://nu-brics.ru / (accessed 26.6.2018).

Branch-wise parameter.

Russia cooperates with Chinese scientific organizations on a wide range of natural sciences: physics (energy conversion, astrophysics, diagnostics of structures of micro- and optoelectronics, x-ray and neutron radiation, plasma physics, microwave radiation), geology (tectonics, oil and gas presence), ecology (industrial pollution of the atmosphere), chemistry (chemical protection of plants), industrial technology (technological products made of polymeric materials, work with promising materials, anti-corrosion coatings, diamond synthesis, etc.)[7]. We can provide examples of collaboration between leading scientific organizations such as the Institute of Physics and Technology of the Russian Academy of Sciences and Peking University, the Institute of Atmospheric Physics of the Russian Academy of Sciences and the Institute of Atmospheric Physics of the Chinese Academy of Sciences, etc. And the result of such cooperation is joint ventures, which use joint high-tech developments. Thus, RAS Institute of Problems of Chemical Physics and the Chinese Academy of Engineering Physics established a joint Chinese-Russian industrial company Sichuan Mianyang Lier for the production of plant protection chemicals, organic intermediates, technological products made of polymeric materials. RAS Institute for High Temperatures and Great Wall Corporation established the "Tigol" joint venture, which manufactures equipment for coating titanium nitride and other advanced materials[8].

In addition to academic science, scientific and technological cooperation in the real sector is carried out in the field of mechanical engineering. First of all, it is power engineering. The construction of Tianwan Nuclear Power Plant by Rosatom is an example of a project successfully implemented in China. At the end of 2017, the 3rd power unit of Tianwan NPP was launched (the 1st and 2nd units were launched in 2007). Currently, the 4th power unit is under construction. Given the fact that Rosatom is involved in the construction of nuclear power plants in India (Kudankulam), Vietnam (Ninh Thuận), China (Tianwan), Bangladesh (Rooppur)[9], we can speak about the leadership of Russian technologies on the world market of NPP construction[10].

Another area is the aircraft industry. In particular, Russia and China have launched (in 2014) a project to assemble the Russian civil short-haul aircraft SSJ100 in China[11]. In 2016, an intergovernmental agreement was signed on the joint creation of a wide-body long-haul passenger aircraft seating 250–300 people, which, thanks to its modern characteristics, can occupy a significant market share in Russia and China, as well as in third countries. At the same time, an intergovernmental agreement was signed on cooperation in the creation of a promising civilian heavy-lift helicopter AHL, which can be used in difficult climatic conditions, the development of which will be carried out by the Chinese state company AVICOPTER with the assistance from Russian Helicopters. It is estimated that the demand for it in China by 2040 may be more than 200 vehicles[12].

[7] International cooperation agreements of RAS. RAS website.

[8] International cooperation agreements of RAS. RAS website.

[9] NPPs under construction abroad. Website of Rosatom. Available at: http://archive.rosatom.ru/aboutcorporation/bild_npp_2/ (accessed 20.02.2017).

[10] Unit 3 of Tianwan Nuclear Power Plant has been launched. *Website of Rosatom*. 30.12.2017. Available at: http://www.rosatom.ru/journalist/news/sostoyalsya-energopusk-bloka-3-aes-tyanvan-kitay/ (accessed 25.04.2018).

[11] Russia launched the production of parts for SSJ-100 to be assembled in China. *RIA Novosti*. 10.12.2014. Available at: https://ria.ru/east/20141210/1037599125.html (accessed 03.05.2018).

[12] M. Klimentyev. Russia and China signed dozens of cooperation agreements. *RIA Novosti*. 25.06.2016. Available at: https://ria.ru/world/20160625/1451799581.html (accessed 03.05.2018).

Spatial parameter.

More than 30 academic institutions cooperate with scientific organizations of China within the framework of interinstitutional direct agreements; it is mainly the central institutes of RAS, but there are also successful examples of cooperation with regional institutes. For instance, the Joint Institute of Geology, Geophysics and Mineralogy of the Siberian Branch of RAS cooperates with the Institute of Geotectonics of the Chinese Academy of Sciences: they collected data on the geology of South China, North Vietnam and Burma, on the basis of which an original model of tectonics of Southeast Asia was developed. The Institute of Metallurgy of the Ural Branch of RAS in collaboration with the Institute of Chemical Metallurgy of the Chinese Academy of Sciences established a joint venture for the production of anti-corrosion coatings on the basis of powder metallurgy technology[13]. Besides, another development by the Ural Branch of RAS in the field of metallurgy (control of processes in blast furnaces, increasing their service life) has already been implemented at enterprises of Shandong province. The Ural Agricultural Research Institute cooperates with Chinese scientific institutions on the cultivation of seed crops and livestock.

Cooperation is also carried out in the form of joint technology parks: by 2010, technology parks have been established in Quhua, Harbin, Changchun, Shenyang, and Moscow ("Druzhba"), as well as Yantai zone for industrial development of new high technology. So, the founders of technology park in Changchun are the government of Jilin province, the Chinese Academy of Sciences, Novosibirsk Oblast Administration, and the Siberian Branch of RAS [20, p. 15]. In some cases, Chinese companies become residents of Russian special economic zones and industrial parks. For instance, in the Tula Oblast, a plant of the Chinese company Great Wall, the anchor investor of Uzlovaya Industrial Park, is being constructed. In the Lipetsk Oblast, the largest investor of the Lipetsk special economic zone is the Chinese automotive concern Lifan[14].

We can also mention the Moscow – Kazan high-speed railway project, which was taken up by a consortium of design institutes led by Mosgiprotrans and Nizhegorodmetproekt with the participation of China Railway Eryuan Engineering Group. In this case, in terms of production (both rolling stock and equipment for the tracks), localization is expected[15].

In the case of the Sverdlovsk Oblast, cooperation is carried out mostly with Heilongjiang province, which contributes the most to the scientific and technological cooperation with Russia [13, p. 466]. The regions have been cooperating in the economic sphere for a number of years. Back in 1991, an agreement was signed on friendly relations between the Sverdlovsk Oblast and Harbin. In 2016, the governments of the Sverdlovsk Oblast and Heilongjiang province signed an agreement on trade, economic, scientific, technological and humanitarian cooperation. Yekaterinburg and Harbin alternate annually as a venue for the international exhibition "Russian-Chinese EXPO"[16]. In 2017, during a visit of the Chinese delegation to the Sverdlovsk Oblast, an agreement on scientific and technological cooperation was signed between the Ural Branch of RAS and the Academy of

[13] International cooperation agreements of RAS. RAS website.

[14] Zhoga G. A flying railroad car. *Ekspert-Ural,* 2015, no. 30, pp. 10-16.

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Sciences of Heilongjiang province. It involves establishing joint innovation centers, which will serve as a platform for joint research. The Ural Branch of RAS was a partner of the organizing committee of the international exhibition of scientific and technological achievements held in 2017 in Harbin (the administrative center of Heilongjiang)[17]. In July 2018, the first academic assembly of scientific and technological cooperation between Russia and China (co-organizers are the Federal Agency for Scientific Organizations of Russia, the Ural Branch of RAS, the Office of the Plenipotentiary Representative of the President of the Russian Federation in the Ural Federal District, Heilongjiang Academy of Sciences, China) was held within the framework of Innoprom and the 5th Russian-Chinese EXPO.

Prospects for the development of Russian-Chinese scientific and technological cooperation

Many researchers point out favorable prospects of economic cooperation with China. So, it is emphasized that the Silk Road Economic Belt (SREB) initiative provides an opportunity for the revival of the economic potential of Asian countries [21, pp. 43-52]. According to N.I Atanov, the Eurasian Economic Union will take certain segments of the Eurasian common market in the framework of SREB [1, p. 119].

In the context of global economic challenges such as international economic sanctions, the possibility of optimal integration of the Russian economy into the international division of labor in the new conditions is associated with the development of economic cooperation with China, a country that has similar interests in relation to integration into the global market. Amid rapidly changing international economic relations (in particular, between Russia and Western developed economies, between the U.S. economy and other economies, including Chinese, etc.), Russia will have to intensify the development of a new approach to bilateral strategic partnership with China.

Scientific and technological development of the economy is of great importance for efficient integration into the international division of labor. As the analysis has shown, both Russia and China consider the scientific and technological factor as the one that determines global competitiveness of their economies, as well as their place and role in the world economy as a whole. Both Russia and China have an understanding of the importance of developing innovative potential, have a rich experience of such development, and have created a broad institutional framework for this.

The prospects for the development of Russian-Chinese scientific and technological cooperation are due, among other things, to some "complementarity" of scientific and technological development in the sense that Russia has a developed scientific and fundamental base, and China has developed a system for implementing R&D results [13].

The prospects for the development of scientific and technological cooperation between Russia and China are related to the potential areas of development of the market of scientific and technological products of associations such as BRICS and SCO, in the framework of which Russia and China interact.

Besides, the promising areas of scientific and technological cooperation include the search for and implementation of a wide range of optimal forms of Russian-Chinese scientific and technological cooperation at the level of scientific organizations, enterprises, and scientific units of enterprises. The analysis allows us to identify the following promising forms of cooperation: interinstitutional direct

[17] Chinese interest. *Nauka Urala*, 2015, no. 16.

contracts, technology parks and joint innovation centers, joint production of high-tech companies, joint exhibitions of scientific and technological achievements, provision of engineering services to the partner country, joint development of models (as, for example, in civil aviation), use of opportunities of the international multilateral program in the field of science, technology and innovation adopted within the framework of BRICS.

Technology parks are a modern form of Russian-Chinese scientific and technological cooperation. We can highlight the following problems of the Russian-Chinese technology parks in the Russian territory: high risk in the implementation of commercial high-tech projects, incompleteness of Russian technologies in terms of their use in the production process, lack of experience, lack of knowledge of partners and the absence of risk insurance, lack of governmental support of innovative activities [20, p. 17].

Given the need for a permanent reliable representative in China, in terms of sales of the Russian scientific and technological product, technology parks will be more effective if it has a branch (representative office) in the Chinese territory.

Thus, international scientific and technological cooperation takes into account the overall geo-economic picture and its manifestation in world trade and production; it also takes into account scientific and technological cooperation factors such as the place of countries in global innovation development, the presence of similar national priorities of scientific and technological development and similar types of policy documents. The proposed typology of manifestations of scientific and technological cooperation includes spatial, sectoral and institutional parameters. It is proposed to take into account the specifics determined by modern trends in global economic development. The use of these approaches should contribute to the maximum integration of the priorities of scientific and technological cooperation between Russia and China in the achievement of their leading positions in the world market.

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