Cooperation and Partnership in Science and Technology in Modern Russia

M Arkhipova[1], *V* Sirotin[1,*],and *V* Afonina[2]

[1]Department of Statistics and Data Analysis, National Research University Higher School of Economics, 20 Miasnitskaya Street, Moscow 101000, Russia
[2]Department of Economics and Finance, MGIMO University, 3 Novo-Sportivnaya, Odintsovo, Moscow Region 143007, Russia

Abstract. The paper is about main trends of cooperation activity in research and development in Russia nowadays. It is focused on types of cooperation and types of partners in joint projects. Special attention is paid to cooperation in manufacturing. This makes it possible to diagnose possible points of innovation growth, that is, types of manufacturing activities that are of interest to both Russian and foreign partners. The study of the partnership in the dynamics allowed us to see a reduction in the share of suppliers of equipment, raw and materials in joint projects, as well as the share of consulting firms. To study the factors that have a decisive influence on the cooperation activity of organizations, a logit model is created. It shows that the probability of cooperation increases with the growth of novelty of the created advanced production technologies, innovation and patent activity of enterprises. The proposed aggregate indicator of cooperation activity can provide regular monitoring of cooperation and partnership in R&D.

1 Introduction

Nowadays, it becomes more and more evident that the growth of world economy will be determined by the progress in science and technology which provide the appropriate use of capital and human sources. A lot of factors foster progress of innovation development, and cooperation is one of the most important among them. It helps organizations and firms to reach their goals when they lack sources for generating innovations. Cooperation helps realizing research and development projects and creating innovative products and services. Especially it concerns high-tech industries, where innovations are generated on the base of linked fields of science and knowledge. Partnership provides additional possibilities to cope with the problems of the research and development project diversification [1]. The main question is what kind of cooperation is most effective now. The determinants of cooperation activity and their impact on the process are also of great importance. It can be useful in forming federal and department target programs, development strategies of state corporations, programs of fundamental research in Academy of Sciences and leading universities and research centers.

2 Methodology

2.1 Literature and data source review

Lots of researchers pay great attention to problems of cooperation in innovation development and the role of their solving for sustainable economic growth. Understanding the scope of innovation, the characteristics of innovative firms and the internal and systemic factors that can influence innovation activity is a prerequisite for conducting and analyzing policies to promote innovation [2]. In a difficult economic situation, both in the global and national-regional markets, many enterprises and organizations are faced with the problem of lack of resources – financial or human, without which it is hardly possible to produce competitive products based on technological innovations.

The most preferable form of cooperation in developed countries is cooperation of enterprises on the stage of precompetitive joint research and development (R&D) and creation of venture enterprises for R&D. Such a preference can be explained by the fact that the result of precompetitive research as public good can be the base for the development of own commercial product by each firm participant of cooperation [3].

Science and technical cooperation creates the basis for the development of a new type of economy. Organizations enter into close interaction and raise productivity and efficiency by joining their efforts and minimizing possible risks. Cooperation in creation and using innovations often takes place at the junction of different sectors of economy that promote integration of scientific and technical knowledge from different fields, and as a result to the creation of new competitive products [4].

Different sources supply researchers with data for modeling and analyzing the processes in innovation development and cooperation activity. This can help to

* Corresponding author: vpsirotin@yandex.ru

© The Authors, published by EDP Sciences. This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (http://creativecommons.org/licenses/by/4.0/).

find the main trends in different aspects of the considered topic. According to the Oslo manual [5], paragraph 276, sources of information on cooperation in science and technology include open sources - internal sources of the enterprise (e.g. R&D) and publicly available sources (e.g. patent information), as well as sources of information universal for all types of cooperation on the base of supply chains when there is collaboration between either consumers and suppliers, or organizations in the frame of joint projects with other enterprises and research organizations.

In Russia, a survey of organizations in order to identify their links in innovation, and in particular the presence of cooperative ties, and cooperation of organizations is established in Sections 7 and 10 of form No. 4-innovation. For the convenience of presentation and analysis of the results, the data on joint projects are divided into several groups: in countries or regions location of partners cooperation (Russia; CIS countries; the EU countries and candidates; USA and Canada; India and China; and other countries), by types of cooperation (permanent cooperation; cooperation carried out within the framework of a specific project; and one-time, or informal, cooperation that not related to a special project), and by types of partners (organization in the group, which includes the organization; consumers of goods, works, services; suppliers of equipment, materials, components, software; competitors in the industry; consulting, information firms; scientific organizations; universities or other higher education institutions). Such organization of observation allows to obtain data on cooperation in two main aspects: types of innovation cooperation partners relative to their geographical location and types of partners relative to the type of cooperative ties involved.

2.2 Modeling the propensity to cooperate and cooperation activity

In the study, the logit regression model was used to find the significant factors that impact propensity to cooperate.

$$y = \left((1 + e^{z}\right)^{-1} \quad (1)$$

where z is a linear combination of factors x_j with corresponding coefficients and a constant.

As a dependent variable the binary one were used that presents the fact of cooperation in R&D. The type of economic activity (TEA) was used as an observation for the model identification.

Initially, 26 different characteristics of scientific cooperation in various aspects were considered. Only ten of them were left for further modeling After correlation analysis to avoid multicollinearity:

x_1 – the degree of novelty of the created technologies (the ratio of number of essentially new created technologies to overall number of the created advanced technologies);

x_2 – the number of technologies used;

x_3 – the number of purchased new technologies;

x_4 – the number of patent applications for inventions;

x_5 – the share of specialists with higher professional education in the total number of employees performing R&D;

x_6 – the share of expenditure on applied research and development in the internal current expenses on R&D;

x_7 – the share of innovative products in the shipped products;

x_8 – the share of organizations with ready-made innovations in the last three years;

x_9 – the share of own funds of organizations in the cost of technological innovations;

x_{10} – the share of organizations for which the Russian market is the most important.

After stepwise procedure in the process of identification, the model the factors with statistically significant coefficients were obtained.

In order to assess the regions of Russia by the degree of development of scientific and technical cooperation, the integral indicator of cooperation activity were constructed for Russian regions. It is based on five variables describing different aspects of cooperation activity:

f_1 – the number of joint research and development projects per thousand people;

f_2 – the number of joint projects with scientific organizations per thousand people;

f_3 – the share of organizations involved in the development of joint research and development projects, %;

f_4 – the number of patents granted for inventions per thousand people;

f_5 – the number of patents granted for utility models of units/thousand people.

The coefficients for aggregation of these factors into the indicator were obtained using principal component analysis.

3 Results

In recent years, Russia has been facing an unfavorable situation in the sphere of economic cooperation with foreign partners. But the problems act at the same time as a general driver for cooperation, and the overall number of joint projects tends to be more numerous (Figure 1).

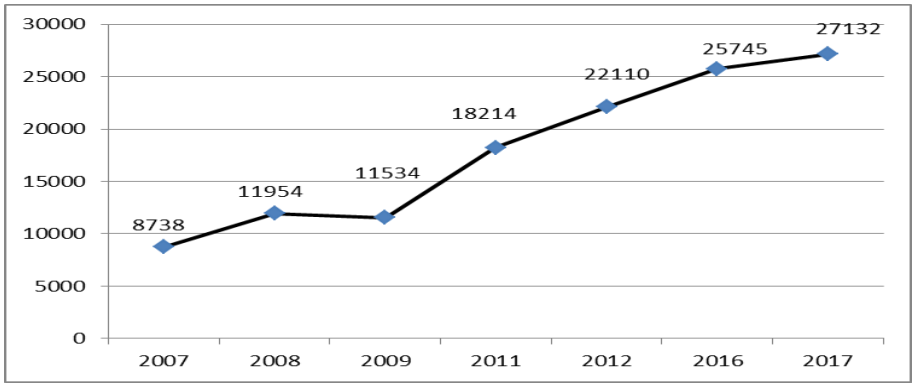

Fig. 1. Number of joint projects in last decade (2007-2017 years) (Data source: Federal States Statistics Service of Russian Federation (http://www.gks.ru)).

The introduced sanctions against Russian business make it difficult to cooperate with partners from other countries and cause a tendency of preferential orientation of domestic organizations to internal cooperation. The vast majority of joint research and development projects (about 93% of the total number of joint projects for the development of technological innovations) are carried out jointly with Russian organizations and only in about 7% there are foreign partners.

If we analyze the main partners of joint projects, we can see that 5% of them are carried out with the countries of Europe and the European Union and 2% - the CIS countries. The orientation of Russian organizations to the domestic market is also largely due to the insufficient level of novelty of the developed innovations and technologies for the world market, as well as undemanding Russian market, characterized by a low level of demands of the Russian consumer to the quality of the goods and services.

In the study of the types of partners of joint projects (Figure.2) we can pay attention to the shift of interest in cooperation, towards scientific organizations and universities, since 2016.

According to the results of surveys conducted by the Interdepartmental Analytical Center (IAC), in 2015, 70% of research organizations and 91% of universities performed R&D in the interests of industry. All types of partnerships, especially with scientific organizations and educational institutions of higher education, are more characterized by project-specific cooperation than by ongoing cooperation. The exception is the ratio of the types of cooperation in cooperation with the group, which includes the organization, where permanent cooperation is slightly higher than cooperation in a particular project. The least popular among all types of cooperation is one-time or informal cooperation, which is not associated with any specific project.

The study of cooperation activity in the context of sectors of the economy and TEA is the most effective to identify possible points of economic growth, which are formed at the junction of several sectors of the economy and areas of knowledge in the conditions of close scientific and technical cooperation. Among the types of economic activities, it should be noted high-tech manufacturing, which includes the production of pharmaceutical and medical products, the production of components for radio and communications, as well as aircraft and spacecraft. These activities are characterized by the introduction of new technologies through joint development with other organizations. Thus, in 2017, 34.1% of organizations engaged in high-tech industries developed innovations together with other organizations through scientific and technical cooperation to carry out research and development. For low-tech industries, the

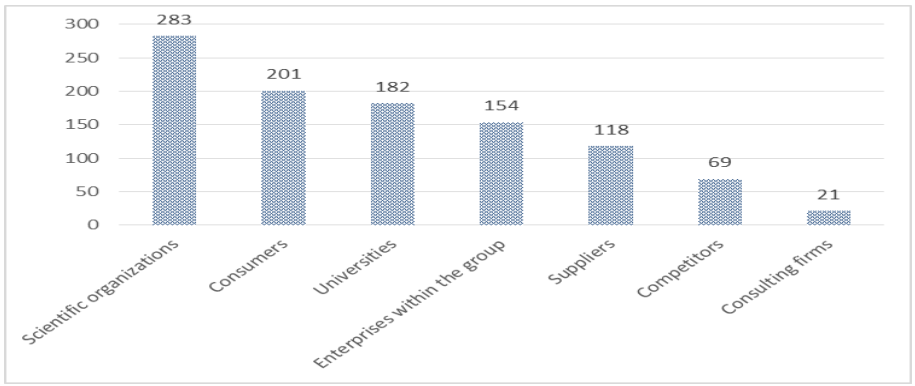

Fig. 2. Number of partners of different types in joint projects in 2017 (Data source: Federal States Statistics Service of Russian Federation (http://www.gks.ru)).

Table 1. Index of Cooperation Activity for some Russian Regions in 2017 year.

Leading regions	Index value	Following regions	Index value
Moscow	1.00	Altai Republic	0.07
Kamchatka	0.72	Republic of Tuva	0.07
Magadan region	0.71	Republic of Chechnya	0.06
Saint-Retersburg	0.68	Republic of Komi	0.06
Tomsk region	0.67	Pskov region	0.06
Republic of Tatarstan	0.55	Sakhalin region	0.05
Moscow region	0.54	Adygeya Republic	0.04
Sverdlovsk region	0.51	Republic of Kalmykia	0.01
Novosibirsk region	0.51	Republic of Ingushetia	0.00
Nizhny Novgorod region	0.49	Nenets Autonomous district	0.00

value of this indicator was at the level of 26%.

We can see the high cooperation activity of pharmaceutical firms, 30% of them cooperates with organizations of CIS countries. This fact may indicate more favorable conditions of cooperation provided by the post-Soviet countries and their interest in the joint development of new types of pharmaceutical products due to the high resource base preserved in Russia.

Foreign partners showed the greatest interest in cooperation in such activities of high-tech industries as Medical devices and Aircraft production, which characterizes these TEA as points of growth of innovation activity in Russia. It should be noted that the term points of growth of innovation activity we use for activity, in which both Russian and foreign partners are interested in cooperation.

The study of the types of partners in the dynamics allows us to see that as partners of joint projects, the share of suppliers of equipment, raw materials and materials, as well as the share of consulting firms, has sharply decreased. The least popular in Russia are third-party consulting or information firms, the share of which among the partner organizations for joint innovation cooperation is only 2%. For comparison, in 2005 and 2010 the share of suppliers in joint projects was the highest. Cooperation with suppliers is typical for such TEA as Production of aircraft and Office and computer equipment. In the Production of aircraft, the Consumers of goods and services and Alliances and consortia also show a tendency to cooperation.

At the next stage of the study a logit regression model was created. It allows us to predict the probability of high cooperation activity in R&D. Ten of the most informative indicators were selected as independent variables, have a sufficiently significant relationship with the binary dependent variable y that has a unit value in the case of high cooperation activity and zero value otherwise

As a result of the coefficients estimation, the main component z in the model (1) was identified as (2).

$$z = -11.28 + 3.77x_1 + 0.83x_4 + 6.57x_7 \quad (2)$$

The probability to cooperate in high tech TEA is usually substantially higher than in others, e.g. for Collection and recycling of waste and scrap the value of z in 2017 was — 0.736 that gives the probability of cooperation 0.324, at the same time for Manufacture of medical devices, precision and optical instruments, clocks and other time devices the corresponding probability was estimated at the level of 0.978.

All the coefficients in the model are statistically significant, its R2(McFadden)=0.784, and LR statistic=112.3. Jackknife procedure for the model verification shows that the estimated probability of correct forecasting is quite good for both zero and unit level of the observed variable y: 0.909 and 0.889 correspondently. So, the proposed model has an acceptable sensitivity and sufficient stability.

Analysis of the main components of the feature space {fj}, characterizing the cooperative activity in its various aspects allowed us to identify one main component explaining 56.9% of the variance of the initial features. This component after unification may be used as an integral indicator of cooperation development in R&D. The coefficient values are presented in Table 1 for some regions of Russian Federation.

The proposed measure of cooperation activity provides assessment that can be made on the regular base.

4 Conclusion

The analysis of the situation in various sectors of the Russian economy shows that the international scientific, technical and technological cooperation plays an important role in increasing the competitiveness of enterprises' products, contributes to the creation of new niches and the promotion of modern advanced technologies in the domestic Russian market. Internal cooperation acts as a support to compensate the losses caused by sanctions and restrictions in international business and trade, and the role of scientific organizations and universities in this issue becomes higher. Enterprises and organizations of high tech types of activity show higher propensity to cooperation than others, and the measure of this propensity can be estimated with the binary regression model.

The significant drivers of cooperation activity are turned to become the novelty of the created technologies, patent activity and activity in producing innovative goods and services.

Cooperation activity of Russian regions may be estimated using corresponding index constructed on the base of principle component analysis applied to main characteristics of cooperation and partnership. Low level of this index should be considered in positive sense as a potential for the future improvement in this sphere.

References

[1] M. Arkhipova, V. Sirotin, Cooperation and partnership in innovative development of Russian Federation, Proc. 9th European Conf. on Innovation and Entrepreneurship, Belfast, Belfast: University of Ulster, 410-419 (2014).

[2] K. Blind, The influence of regulations on innovation: a quantitative assessment for OECD countries, Research Policy, **41**, 391-400 (2012).

[3] V. Chandra, I. Osorio-Rodarte, C.A. Primo Braga, Korea and the BICs, Brazil, India and China: Catching-up Experiences, Innovation and Growth Chasing a Moving Frontier, Paris: The World Bank, 25-67 (2009).

[4] Science, Technology and Industry Scoreboard, OECD Publishing, (2013). DOI: 10.1787/sti_scoreboard-2013-en.

[5] Oslo Manual, Guidelines for Collecting. Reporting and Using Data on Innovation, 4th ed., OECD publishing (2018).

[6] F. Bogliacino, M. Pianta, Engines of growth. Innovation and productivity in industry groups, Structural Change and Economic Dynamics, **22**, 41-53 (2011).

[7] M. Edwards-Schachter, E. Castro-Martínez, M. Sánchez-Barrioluengo, Motives for international cooperation on R&D and innovation: empirical evidence from Argentinean and Spanish firms, Int J of Technology management, **62**, 128-151 (2013).

[8] Y. Geum, S. Lee, B. Yoon, Y. Park, Identifying and evaluating strategic partners for collaborative R&D: Index-based approach using patents and publications, Technovation, **33**, 211-224 (2013).

[9] L. Gokhberg, Transformation of R&D in the post-socialist countries: Partners and trends. Innovation and Structural Change in Post-Socialist Countries: A Quantitative Approach, D. ed S. Dyker and S. Radosevic, Dordrecht, Netherlands: Kluwer Academic Publishers (1999).

[10] J. Hagedoorn, Organizational modes of inter-firm cooperation and technology transfers, Technovation, **10**, 17-30 (1990).

[11] H. Barros, The Effects of Innovation Partnership, Foreign Ownership and Enhanced Management Practices on the Use of Patents in Brazilian Manufacturing, Proc. EuroMOT, Hsinchu, Taiwan (2011).

[12] D. Teece, Profiting from technological innovation: implications for integration, collaboration, licensing and public policy, Strategic Management and Research Policy, Singapore: McGraw Hill Int. Ed. (2004).

[13] A. Porter, N. Newman, Xao-Yin Jin, D. Johnson, J. Roessner, High Tech Indicators-based Competitiveness of 33 Nations report, Georgia Institute of Technology, 30332-0345 (2007).

[14] Private Partnerships for Research and Innovation: an Evaluation of Dutch Experience, Paris: OECD (2004).

[15] Regions of Russia: Social and Economic Indicators (2018) [Electronic resource]. Available at: http://www.gks.ru.

[16] V. Sirotin, M. Arkhipova, Cooperation and Innovation Activity: study of the relationship at the regional level, Proc 10th European Conference on Innovation and Entrepreneurship, Genoa, Italy, ed. L Beltrametti and R P Dameri, Genoa: University of Genoa, 673-682 (2015).