CORPORATE RESEARCH COLLABORATION AND THE DIFFUSION OF TECHNOLOGIES IN RUSSIA

Andrey Mikhaylov – Anna Mikhaylova

Abstract

Innovation activity tends to cluster in a few favorable locations – learning regions, innovative milieus, regional innovation systems, etc., making them the cause and effect of socio-economic growth and prosperity. By considering a national innovation system these advanced locations are the largest cities and urban agglomerations. They accommodate high-tech and research-intensive industries with high-performing firms integrated into the global production and innovation networks. Particular attention of innovation policies should therefore be the efforts of increasing global competitiveness of major locations of the country while fostering inter-regional networking and the diffusion of technologies. The study evaluates the geography of corporate R&D at inter-regional level (between central places and the innovation periphery). The research design is based on quantitative data of corporate research sourced from Scopus bibliometric database. The dataset is exported to SciVal for measuring the performance parameters. The spatial distribution of firms and the network ties are processed in QGIS. The research results demonstrate hyper-concentration of corporate R&D in the major cities, dominated by the capital city. Moscow occupies the role of trendsetter with a distributed geography of partnerships within and beyond metropolitan area. Large industrial cities across the federal districts act as semi-independent growth nodes.

Key words: regional innovation system, innovation policy, corporate research, Russia

JEL Code: O32, O36, R12

Introduction

The geography of knowledge production and innovation activity is distributed across a limited number of locations providing a fertile ground for industry clusters. These favorable ecosystems are being extensively studied and conceptualized in numerous territorial innovation models, such as innovative milieux, regional clusters, industrial districts, new industrial spaces, learning regions, etc. Scholars argue that the shrinkage of the geographical

distance caused by digitalization, the development of e-commerce, and logistics has caused non-trivial consequences – the increase in demand for co-location (Han et al., 2018).

Spatial proximity has become a natural response of companies to intensified competition and increased complexity of industrial technologies, innovation, and production. The fact of 'being there' decreases the time required for B2B collaboration and enables a rapid reaction to market trends or feedback. Being part of a local community provide the benefit of casual contacts and knowledge 'spillovers', integrates the company into the established cultural, organizational, cognitive norms further reinforcing the proximity to other elements of the ecosystem (Balland et al., 2021; Wang and Kafouros, 2020). Mature and cohesive innovation systems form reciprocal inter-organizational ties in 'quintuple helix' format, including the relations between the industry, higher education and research institutions, government bodies, NGOs (Carayannis et al., 2018). Institutional thickness and rich territorial capital of metropoles predefine their competitive advantage in accumulating high-tech and research-intensive industries (Rodríguez-Pose, 2020; Zukauskaite et al., 2017).

With that, Henn and Bathelt (2018), Cooke (2017) and other prominent researchers have proven the need for extra-local linkages. Economic resilience requires knowledge sourcing across industries and spaces in the search for complementary competences and expertise. Previous studies indicate a mosaic of knowledge domain spread across national innovations systems (Miguelez & Moreno, 2018; Mikhaylov et al., 2020). Therefore, it is reasonable to assume that companies, in an effort to improve their competitiveness and reduce the cost of innovation will diversify their channels of obtaining knowledge. The superiority of the benefits of collaborative knowledge generation versus territorial costs is an important factor in shaping the geography and structure of corporate research network.

This study aims to identify the most significant regions with a predominance of corporate R&D based on an assessment of the national network of research collaborations of the largest companies in Russia. The hypothesis of our research is that industrial and service companies that independently engage in R&D in the interests of developing their core activities, firstly, have a high degree of geographic localization, and, secondly, they act as nucleus-attractors for the formation of large scientific interorganizational networks ensuring the flow of knowledge between organizations, regions and countries.

1 Research methodology

The study of the corporate research network was carried out using the example of the largest companies in Russia. The research strategy was based on a combination of two methods of analysis: scientometric and geoinformation, which formed the basis of the methodology used. Achievement of the goal set at the beginning of the study required solving the problems of determining a sample of companies, forming a base of scientometric, geoinformation and statistical data, development of geoinformation visualization and scientometric data presentation, economic and geographic typology of regions.

To ensure the principle of objectivity, the sampling of national companies is based on the results of the rating of the largest enterprises and organizations in Russia by the volume of revenue – RAEX-600. The ranking is done since 1999, annually compiled by the rating agency Expert on the basis of financial statements provided by the companies, as well as open statistical data of the Federal State Statistics Service of the Russian Federation (Rosstat) and data from the largest SPARK database on Russian companies. The rating has no restrictions on the type of activity, including banks, insurance companies, non-state pension funds (NPF) and leasing companies, which allows ensuring organizational diversity.

The latest available rating was published in 2020 based on data for 2019 (raex-a.ru/ratings/raex-600/2020), providing information on the names of 600 companies, type of activity, sales volume for 2018 and 2019, profit before tax and net profit for 2019, as well as places in the rankings of 2020 and 2019. Further, using open data on the Internet, the name of each organization was assigned a unique taxpayer identification number (TIN). Based on the formed TIN database, metadata for each company was downloaded from the SPARK Interfax database (www.spark-interfax.ru) about its full and abbreviated name, full registration address, type of activity in accordance with the All-Russian Classifier of Economic Activities.

To conduct a scientometric analysis, the formed database of 600 largest companies in Russia was supplemented with data from the Scopus abstract database on the number of publications and citations, the Hirsch index for 2016-2020, the primary field of knowledge (in case of equivalence, several research fields were indicated). For each company, an individual advanced search was carried out in Scopus by name, which included all possible variants of its spelling in English.

As a result of the addition of scientometric indicators for further analysis, 110 companies were selected that had in 2016-2020 non-zero values for the number of indicators. The data on the final sample are presented in Table 1.

Tab. 1: The largest companies in Russia conducting research activities

Region	Number of companies	Activity type	Papers indexed	Research area
Moscow	50	agro-industrial complex; banks; housing and utilities; engineering, industrial and infrastructure construction; internet service; ICT; mechanical engineering; atomic industry; oil and gas industry; wholesale; precious metals and diamonds industry; retail; media; insurance; building; telecommunications; transport and logistic; coal industry; chemical and petrochemical industry; non-ferrous metallurgy; ferrous metallurgy; electric power	3622	Agricultural and Biological Sciences; Arts and Humanities; Business, Management and Accounting; Economics, Econometrics and Finance; Social Sciences; Decision Sciences; Chemical Engineering; Chemistry; Computer Science; Engineering; Materials Science; Mathematics; Earth and Planetary Sciences; Environmental Science; Energy; Engineering; Immunology and Microbiology; Medicine; Physics and Astronomy
Republic of Tatarstan	9	banks; chemical and petrochemical industry; mechanical engineering; electric power industry; oil and oil and gas industry;	296	Computer Science; Health Professions; Medicine; Neuroscience; Energy; Engineering; Materials Science; Physics and Astronomy; Biochemistry, Genetics and Molecular Biology; Energy
Sverdlovsk region	8	non-ferrous metallurgy; mechanical engineering; banks; electric power	64	Engineering; Materials Science; Physics and Astronomy; Chemistry; Computer Science; Decision Sciences; Energy
St. Petersburg	7	banks; pharmaceutical industry; Housing and utilities; transport and logistic; food industry; telecommunications and communications; mechanical engineering	116	Economics, Econometrics and Finance; Medicine; Earth and Planetary Sciences; Engineering; Economics, Econometrics and Finance; Engineering; Computer Science
Tyumen region	6	chemical and petrochemical industry; oil and gas industry	229	Earth and Planetary Sciences; Energy; Materials Science
Moscow region	5	mechanical engineering; service companies; wholesale; pharmaceutical industry	173	Engineering; Materials Science; Physics and Astronomy; Chemistry; Biochemistry, Genetics and Molecular Biology; Pharmacology, Toxicology and Pharmaceutics
Kemerovo region	3	chemical and petrochemical industry; ferrous metallurgy; coal industry	13	Engineering; Chemical Engineering; Energy; Environmental Science; Earth and Planetary Sciences
Krasnoyarsk region	3	non-ferrous metallurgy; precious metals and diamonds industry; electric power industry	73	Earth and Planetary Sciences; Materials Science; Physics and Astronomy; Energy
Samara region	3	mechanical engineering; non-ferrous metallurgy; chemical and petrochemical industry	23	Materials Science; Chemical Engineering; Chemistry; Environmental Science
Tula region	3	electric power industry; chemical and petrochemical industry	3	Energy; Chemical Engineering; Chemistry
Chelyabinsk region	3	ferrous metallurgy; non-ferrous metallurgy	45	Materials Science; Earth and Planetary Sciences
Krasnodar	2	ferrous metallurgy; retail	3	Materials Science; Mathematics

region				
Bryansk region	1	agro-industrial complex	1	Pharmacology, Toxicology and Pharmaceutics
Vologda region	1	ferrous metallurgy	69	Materials Science
Irkutsk region	1	oil and gas industry	23	Energy
Kaliningrad region	1	mechanical engineering	1	Economics, Econometrics and Finance; Social Sciences
Perm Krai	1	chemical and petrochemical industry	11	Earth and Planetary Sciences
Republic of Bashkortostan	1	chemical and petrochemical industry	1	Engineering; Materials Science
Republic of Sakha (Yakutia)	1	precious metals and diamonds industry	130	Earth and Planetary Sciences
Rostov region	1	mechanical engineering	4	Engineering

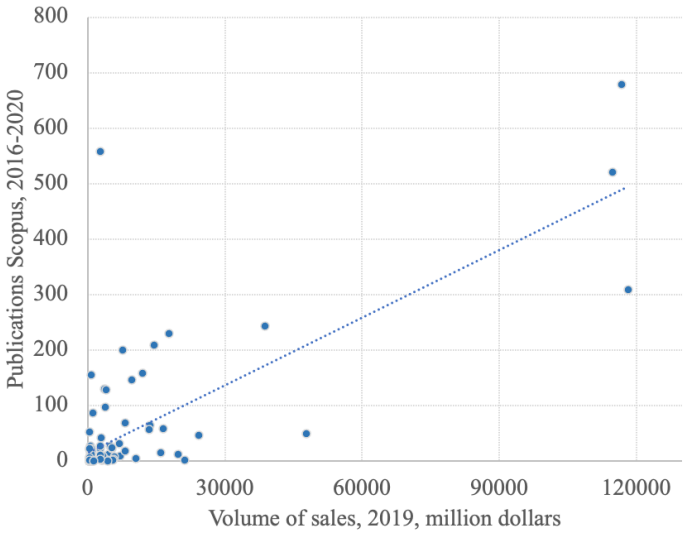
Source: based on RAEX-600, SPARK, Scopus

To build research collaboration networks using the SciVal analytical tool for the 7 research-intensive companies (Gazprom, Lukoil, Russian Railways, Rosneft Oil, Korolev Rocket and Space Corporation Energia, RUSAL, Yandex), a data was generated and exported with information on partners who have co-authored publications with the company, including the full name of the organization, country of location, affiliation to one of the sectors (academic, corporate, government, medical, other), the number of joint publications, citations, authors, citations per publication. Data on Russian organizations participating in research collaborations with sample companies were geocoded and mapped using the QGIS package. As a result, a network of corporate research cooperation was built, which included the actors with strongest interactions within the framework of the national innovation system of Russia.

2 Research results

The geography of the largest Russian companies that had Scopus publications in 2016-2020 is characterized by a strong concentration in Moscow – tab. 1. Nearly half (45.5%) of the companies are located here, accounting for 73.9% of research output. In second place is the Republic of Tatarstan with 8.2% of companies and 6.0% of publications. A significant position in the development of corporate research by corporate research are occupied by the Sverdlovsk region, St. Petersburg, Tyumen region, Moscow region, and the Republic of Sakha (Yakutia). Figure 1 shows the relationship between the volume of revenue and the number of research. The correlation coefficient between these indicators is 0.744, which indicates strong relationship between the company’s turnover and research performance.

Fig. 1: Distribution of the largest Russian companies by revenue volume and number of publications



Source: based on RAEX-600, Scopus

Table 2 presents data on 13 large Russian companies, featuring over 100 Scopus-indexed publications for 2016-2020 with a total share of 75% of all publications affiliated with 110 companies in the sample. The activities of most of these companies are associated with the extraction and processing of minerals (primarily the oil and gas industry), which associated to the priority research areas they develop: Earth and Planetary Sciences, Energy, Physics and Astronomy, Engineering, Materials Science. However, we note that Yandex is the leader in terms of demand for its research output, which has, on average, 14 citations per article, and the h-index is 43, followed by Rosatom (with 5.6. Citations per article and h-index 16). Both companies are developing research in the field of Physics and Astronomy.

Tab. 2: Top Russian companies in the sample by the number of Scopus-indexed publications, 2016-2020

Name	Industry	Subject area	Company age	Revenue, USD billion	Publications	Citations	h-index
Gazprom	oil and gas industry	Earth and Planetary Sci	28	116.8	678	958	14
Yandex	internet service	Physics and Astronomy	20.5	2.7	558	7857	43
Lukoil	oil and gas industry	Energy	28	114.8	521	717	14
Rosneft Oil	oil and gas industry	Energy	25	118.2	309	378	8
Russian Railways	transport and logistic	Medicine	17.5	38.8	244	880	10
Rosatom	atomic industry	Physics and Astronomy	13	17.8	230	1294	16
Tatneft	oil and gas industry	Energy	19	14.4	209	335	10
SUEK	coal industry	Earth and Planetary Sci	21	7.5	200	267	8

Evrazkholding	ferrous metallurgy	Materials Science	21	11.9	159	188	7
Energia	mechanical engineering	Engineering	26.5	0.8	156	300	8
RUSAL	non-ferrous metallurgy	Materials Science	20	9.7	147	247	8
ALROSA	precious metals	Earth and Planetary Sci	28.5	3.6	130	323	11
Polyus	precious metals	Physics and Astronomy	15	4.0	129	291	9

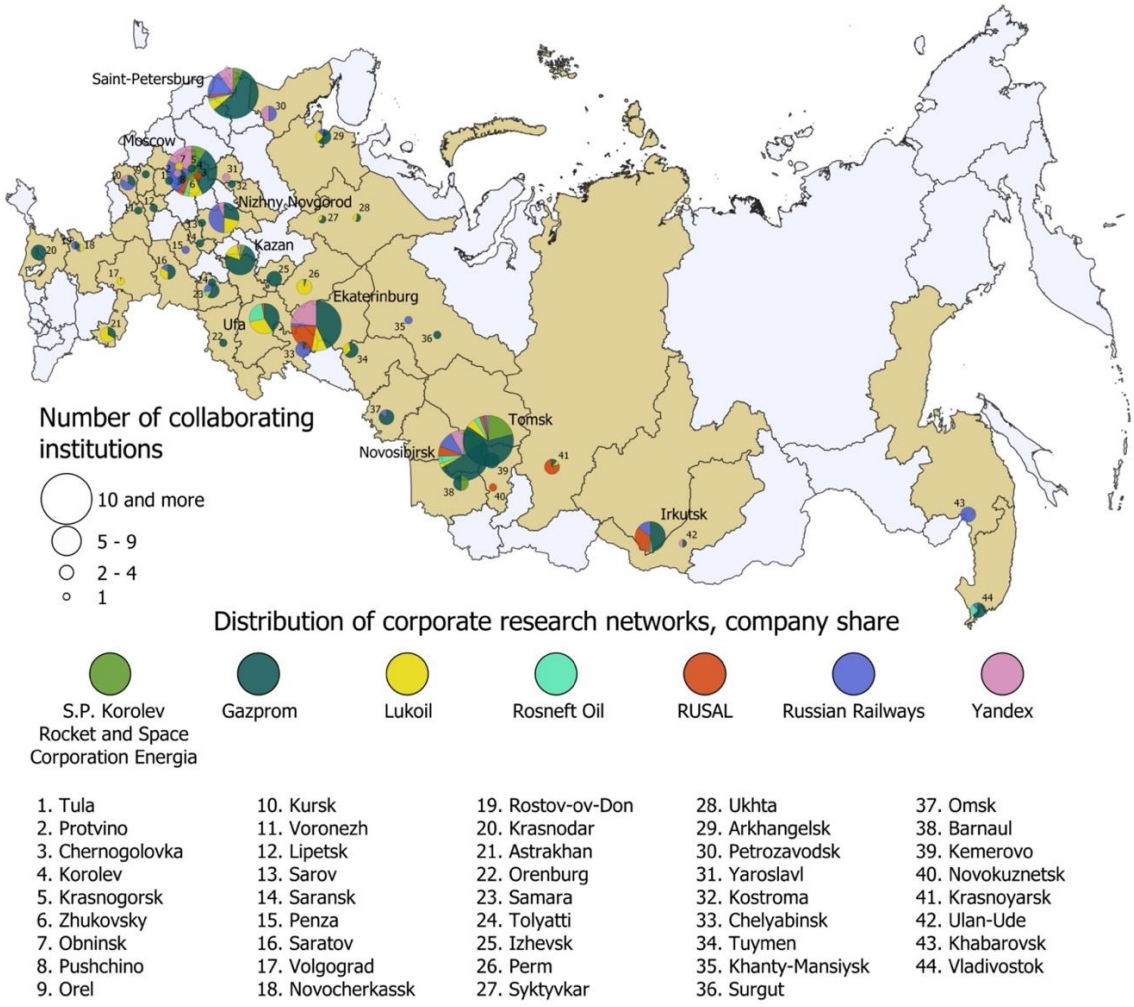
Source: based on RAEX-600, SPARK, Scopus

Since these companies account for the bulk of publications of the largest companies in Russia, it is also true that the network of research collaborations built for them will reflect the main territorial and structural patterns of the distribution of the national network of corporate research. The export of publications of the above companies for 2015-2020 into the analytical tool SciVal allowed uploading data on research cooperation for 7 of them: Gazprom, Lukoil, Russian Railways, Rosneft Oil, S.P. Korolev Rocket and Space Corporation Energia, RUSAL, Yandex. A total of 231 partner organizations were identified for 7 surveyed companies in 53 cities of 42 regions of Russia featuring joint research (Fig. 2). About 55.4% of them belong to the academic sector and another 41.6% to the state sector, the remaining 3% belong to the medical, corporate and other sectors.

Only 3 research organizations cooperate with all 7 research companies at once, namely the Russian Academy of Sciences (Moscow), Lomonosov Moscow State University (Moscow), RAS – Siberian Branch (Novosibirsk), in co-authorship with which more than 400 publications have been made. Also, a number of large Russian scientific organizations are located in Moscow – Moscow Institute of Physics and Technology, Skolkovo Institute of Science and Technology, I.M. Gubkin Russian State University of Oil and Gas, National University of Science and Technology "MISIS", etc., and other large cities of Russia: St. Petersburg – St. Petersburg State University; Tomsk – Tomsk Polytechnic University, Tomsk State University; Kazan – Kazan Volga Region Federal University; Krasnoyarsk – Siberian Federal University; Ufa – Bashkir State University, etc.

The leaders in the number of joint research with 7 companies in the sample are large Moscow organizations: Russian Academy of Sciences (228 articles); Lomonosov Moscow State University (132 articles); Skolkovo Institute of Science and Technology (98 articles); I.M. Gubkin Russian State University of Oil and Gas (92 articles). In other regions of Russia (excl. Moscow and the Moscow region), the most stable cooperation has been established with Siberian Federal University (Krasnoyarsk), RAS – Siberian Branch (Novosibirsk), Ufa State Petroleum Technological University (Ufa), Tomsk Polytechnic University (Tomsk), Tyumen State Oil and Gas University (Tyumen). More than 40 Scopus publications have been published by 7 companies in the sample from each of these organizations.

Fig. 2: Geography of the corporate research network of the 7 largest companies in Russia, 2015-2020



Source: based on Scopus

Another indicator of engagement in collaborative research with businesses is the number of researchers who have co-authored articles. The largest number (at least 50 authors in each) falls on 10 organizations, of which 6 are located in Moscow (Russian Academy of Sciences; Russian Ministry of Health; I.M. Gubkin Russian State University of Oil and Gas; Scientific Research Institute of Natural Gases and Gas Technologies; Skolkovo Institute of Science and Technology; Lomonosov Moscow State University), as well as in Krasnoyarsk (Siberian Federal University), Novosibirsk (RAS – Siberian Branch) and Ufa (BashNIPIneft). In addition to classical universities and institutes of the RAS, specialized universities with industrial specialization (for example, in the field of oil and gas), as well as the Skolkovo Institute of Science and Technology are actively involved in cooperation.

Conclusion

Russian business is still not sufficiently involved in the research process, which is also reflected in the relatively low share (18%) of the 600 largest national companies that have publications in Scopus. Companies with a large volume of revenue are more interested in conducting R&D and developing research collaborations. Most corporate research is developing in natural sciences, which is due to the industry specifics of the Russian companies. The geography of the partner network in corporate research is wide and includes a significant number of regions of the Russian Federation, however, the dominant position remains with Moscow, where the head offices of most of the country's largest companies are located. Structural features in building interactions between research and entrepreneurial organizations demonstrate the prevalence of the academic and public sectors. At the same time, while Moscow largely accounts for classical universities, in the regions the specialized organizations with an industrial focus of research prevail. Among the most developed regions in terms of concentration of corporate research are Sverdlovsk, Tomsk, Novosibirsk, Nizhny Novgorod, Irkutsk regions, the Republic of Tatarstan, and the Republic of Bashkortostan.

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Contact

Andrey S. Mikhaylov
Immanuel Kant Baltic Federal University,
236041, Kaliningrad region, Kaliningrad, Ulitsa Aleksandra Nevskogo, 14
Institute of Geography of Russian Academy of Sciences
119017, Moscow, Staromonetnyy Pereulok, 29
mikhailov.andrey@yahoo.com

Anna A. Mikhaylova
Immanuel Kant Baltic Federal University
236041, Kaliningrad region, Kaliningrad, Ulitsa Aleksandra Nevskogo, 14
tikhonova.1989@mail.ru