THE SPRAWL OF THE MOSCOW URBAN INNOVATION SYSTEM

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Abstract

Urban innovation systems are diverse spaces that feature complex interactions of firms, research institutions, universities, public bodies, nonprofit organizations, and other stakeholders, including the citizens in the sense of living labs and smart city concepts. Central cities are the nodes of national innovation growth. They enjoy the clustering of high-tech and knowledge-intensive industries, corporate headquarters and subsidiaries of MNCs, localization of modern science and technology infrastructure, accumulation of financial resources, and the advanced labor market. The institutional density is found to foster cross-fertilization and inter-organizational networking. The aim of this study is to analyze the spatial expansion of the Moscow urban innovation system against the background of the contraction of the country's innovation space. We deploy the method of spatial scientometrics for measuring the development trajectory of networking in corporate research done within the urban innovation system of Moscow. The analysis incorporates all B2B collaborations resulted in documented output indexed in the Scopus database. The research results suggest a strong integration of corporate sector R&D with state-owned research institutes and universities. It is also found that Moscow agglomeration is becoming increasingly integrated into a hub-and-spoke structure, facilitating knowledge spillovers and innovation diffusion.

Key words: urban innovation system, innovation policy, Moscow agglomeration

JEL Code: O32, O36, R12

Introduction

Central cities are the backbone of the territorial innovation systems and the nodes of economic growth. They benefit from the agglomeration effect accumulating clusters of related industries and a large labor market with an inflow of qualified, talented, and ambitious people resulting from inter-regional and international migration. Moreover, major cities and urban agglomerations consolidate national intellectual capital, financial resources, administrative

and political power, being, therefore, widely recognized for sculpturing the shape and outlining the development trajectory of national innovation systems (Caragliu and Del Bo, 2019; Florida et al., 2017; Pancholi et al., 2014). Of particular importance are the capital cities hosting the headquarters and R&D centers of largest companies in the country.

Corporate research is said to be the driver of knowledge commercialization and innovation. Clusters of high-tech and knowledge-intensive industries generate demand for applied research, invest in localization of modern science and technology infrastructure, and initiate inter-organizational networking with 'knowledge-generating institutions' in the framework of science-technology-innovation (STI) mode (Burström and Peltonen, 2018; Isaksen and Trippl, 2017). This implies that urban innovation systems have strong (and possibly easy-to-reveal) linkages between the industry-academia-government institutions of the triple-helix model of reciprocal relations (Cai and Etzkowitz, 2020). However, the methodological issue of capturing these interactive dynamics and mapping correlation between industries and fields of science remains highly ambiguous. Above all, the geography of knowledge sourcing does not exclusively rely on local context but extensively integrate trans-local elements in processes of knowledge production and innovation (Clark et al., 2018; Zaman, 2019). As mentioned by Yao et al. (2020), innovation activity in cities goes beyond local interactions being part of a functionally interdependent system, thus, challenging research strategies for the identification of intercity networks.

What is more, it is unclear how strong are the aforementioned triple-helix STI ties in resource-driven economies. On the one hand, at the times of increasing prices on raw materials companies are interested in technologies maximizing the production output; on the other hand, the thrive for economic resilience forces the extraction companies for investing in diversification and innovation (Brunelle and Spigel, 2017). Yet diversification towards manufacturing and services remains limited in resource-rich countries (Lashitew et al., 2020).

The aim of the study is to identify the current development trajectory of research collaboration networks of leading national companies within the urban innovation system using the example of the capital of Russia – Moscow, one of the largest innovative megacities in the world. In our research, we focus on large companies in the city as generators of new knowledge and the most important nodes of the regional innovation system. We suggest, building on earlier research, that innovative companies should be interested in working closely with universities to produce commercializable knowledge. The objectives of the study are to assess both the institutional density of such networks and their geographic coverage,

and also to determine the established relationships between the research fields of knowledge production and the types of economic activity, where it is commercialized.

1 Research methodology

The research is focused on the largest companies in Russia that form the core of the Moscow city innovation system. The sample of the analyzed companies was formed in two stages. At the first stage, a list of major companies registered in Moscow and the Moscow region was formed based on the annual ranking of the largest Russian companies by revenue – RAEX-600, compiled by the Expert ranking agency (raex-a.ru/ratings/raex-600/2020). Further, for all ranked companies, metadata were downloaded from the SPARK Interfax database (www.spark-interfax.ru), including: full and abbreviated name in Russian and English, region and date of registration, type of economic activity, average number of employees and revenue for 2016-2020. According to the generated database for 600 enterprises, 55% of them are located in the metropolitan area, incl. 279 in Moscow and 53 more in the Moscow region.

At the second stage, the resulting sample of 332 companies was supplemented with their scientometric portrait, including the number of publications, citations, h-index, the leading field of research. For each company, an individual search string was done in the Scopus database by full, abbreviated and brand name in English for the period 2015-2020.

An example of a search query for Russian railways (RZD):

(AFFILORG (rzd OR rzhd OR "Russian railways" OR "Rossiyskie zheleznye dorogi") AND AFFILCOUNTRY (Russia)) AND PUBYEAR >2014 AND PUBYEAR <2021*

As a result of scientometric analysis, 55 organizations of the initial sample had publications, incl. 50 from Moscow. The aggregate dataset for 55 Moscow organizations was further exported to the SciVal analytical system, which made it possible to build the distribution of scientific connections by countries, organizations and fields of science. Thus, a final database of sample organizations was obtained to measure the structure and geography of networks in corporate research conducted within the Moscow city innovation system.

The construction of a network-relations map between the type of economic activity and the field of science for 55 Moscow companies in the sample was carried out using the VOSviewer software. When forming the figure, not only the presence of connections was taken into account, but also their strength, expressed in the number of co-authored publications in Scopus for 2015-2020. A total of 23 different types of economic activities were identified: Agro-Industrial Complex; Banks and Financial Institutions; Chemical and

Petrochemical Industry; Coal Industry; Commerce; Construction; Electric Power; Housing and Utilities; ICT; Industrial and Infrastructure Construction; Insurance; Internet Service; Mechanical Engineering; Media; Non-Ferrous Metallurgy; Nuclear Power; Oil and Gas Industry; Pharmaceutical Industry; Precious Metals and Diamonds Industry; Retail; Service Companies; Siderurgy; Transport and Logistic. They correspond to 20 research areas: Agricultural and Biological Sciences; Arts and Humanities; Biochemistry, Genetics and Molecular Biology; Business, Management and Accounting; Chemical Engineering; Chemistry; Computer Science; Decision Sciences; Earth and Planetary Sciences; Economics, Econometrics and Finance; Energy; Engineering; Environmental Science; Immunology and Microbiology; Materials Science; Mathematics; Medicine; Pharmacology, Toxicology and Pharmaceutics; Physics and Astronomy; Social Sciences.

2 Research results

Table 1 presents data on the 55 largest companies in Russia, the core of the Moscow City Innovation System in the context of economic activities. Most (56%) companies represent 5 types of activities: Commerce; Banks & financial institutions; Oil & Gas industry; Transport & logistic; Mechanical engineering. At the same time, the largest in terms of turnover are oil and gas companies. Rosneft, Gazprom, and Lukoil occupy top three places in the 2019 RAEX-600 ranking in Russia with an annual sales volume of over $ 110 billion each. Oil and gas companies also account for the largest share of publication activity – almost 43% of all publications in the sample. In second place in terms of the amount of generated research output is the company Yandex, operating in the field of Internet service. It accounts for almost 15% of the publications in the sample. The state corporation Rosatom is in third place with 6% of publications. Calculation of the correlation coefficient between the number of scientific publications and the volume of turnover shows a close relationship between these indicators (0.75). There is also a fairly high degree of dependence between the number of publications and the amount of the company's net profit (0.69). This indicates that the largest companies are more interested in developing research activities, while smaller ones invest less in R&D. The correlation coefficient between the age of the company and the number of scientific publications was also calculated, its value of 0.20 indicates a weak dependence on how long the company has been in the market and its interest in R&D.

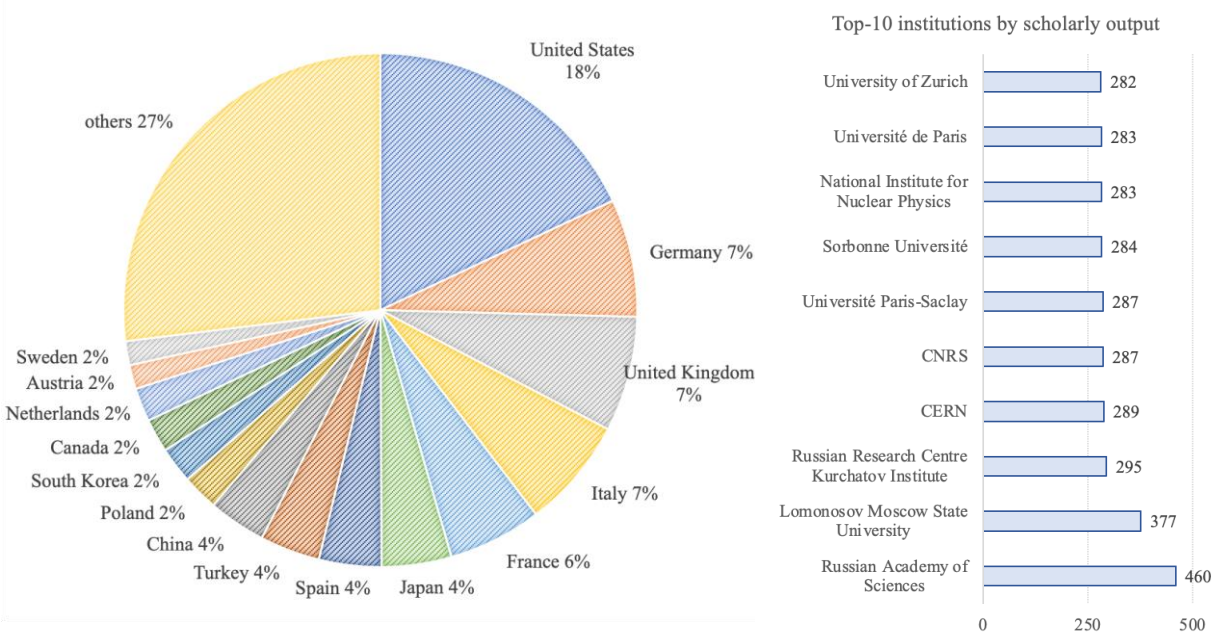
Tab. 1: The largest innovative companies in Moscow and the Moscow region, 2016-2020

Type of economic activity	Largest organizations			Research output	
	No.	%	Name	No.	%
Commerce	10	18.2	Protek, KMR I SNG, FK Puls, Mersedes-Bents Rus, Yunilever Rus, Sanofi Rossiya, Prodimeks,Shneider Elektrik, Eichpi ink, Irvin 2	36	0.9
Banks & financial institutions	6	10.9	Sberbank, Bank GPB, Alfa-Bank, Bank Uralsib, Renessans Kredit, Absolyut Bank	73	1.9
Oil & Gas industry	6	10.9	NK Rosneft, Gazprom, Lukoil, NGK Slavneft, Russneft, Zarubezhneft	1626	42.8
Transport & logistic	5	9.1	RZHD, Transneft, Aeroflot, Mosgortrans, Gk Novotrans	312	8.2
Mechanical engineering	4	7.3	Transmashkholding, RKK Energiya, GKNPTS Im. M.V. Khrunicheva, Kontsern Ruselprom	196	5.2
ICT	3	5.5	Laboratoriya Kasperskogo, Ai-Teko, Megafon	18	0.5
Electric power	3	5.5	INTER RAO, OEK, SO EES	26	0.7
Construction	2	3.6	Reneissans Konstrakshn, FODD	2	0.1
Siderurgy	2	3.6	Evrazkholding, KHK Metalloinvest	191	5.0
Agro-industrial complex	1	1.8	GK Sodruzhestvo	2	0.1
Housing and utilities	1	1.8	Mosvodokanal	8	0.2
Industrial & infrastructure construction	1	1.8	Mosinzhproekt	4	0.1
Internet service	1	1.8	Yandeks	558	14.7
Nuclear power	1	1.8	Rosatom	230	6.1
Precious metals & diamonds industry	1	1.8	Polyus	129	3.4
Retail	1	1.8	Internet Resheniya	1	0.0
Service companies	1	1.8	Aero-Sheremetevo	7	0.2
Media	1	1.8	VGTRK	1	0.0
Insurance	1	1.8	Sogaz	23	0.6
Coal industry	1	1.8	SUEK	200	5.3
Pharmaceutical industry	1	1.8	Farmstandart	3	0.1
Chemical & petrochemical industry	1	1.8	Gruppa Poliplastik	2	0.1
Non-ferrous metallurgy	1	1.8	RUSAL	147	3.9
Total	55	100	-	3795	100

Source: compiled on the basis of the 2019 RAEX-600 ranking data, SPARK and Scopus databases

The collaboration of the largest innovative companies in Moscow and the Moscow region has a wide geographical and institutional coverage, uniting a significant number of countries and organizations. In addition to Russia, the network of cooperation stretches over 74 countries (Fig. 1), being truly international. The first positions are occupied by the United States, featuring 18% of all articles affiliated with companies in the sample published in 2016-2020 done in collaboration. Also, stable relations have been established with Germany, Great Britain, Italy, France and Japan – countries that are recognized as world innovation leaders. It can be expected that such interactions support the knowledge flows through ‘global pipelines’ (Bathelt and Li, 2020) between the major nodes of the global innovation system, which positively affects the research potential of Moscow companies.

Fig. 1: Geography of research collaboration of the largest innovative companies in Moscow and the Moscow region, 2015-2020



a) The country's share in the number of co-authored publications

b) Top institutions by the number of joint publications

Analysis of the organizational structure of the interaction of the companies in the sample in the interests of new knowledge production showed the leading role of the academic and government sectors for collaborations – Table 2. Identifying the real interactions of large innovative companies in Moscow and the Moscow region on the basis of spatial scientometrics, we see empirical confirmation of the triple helix model "business-university-government". At the same time, our data also show that links within this model can cross national borders and be international. Thus, out of 899 cooperation organizations of all sectors, only 26.4% are located in Russia.

Tab. 2: The structure of research cooperation of the largest innovative companies in Moscow and the Moscow region, 2015-2020

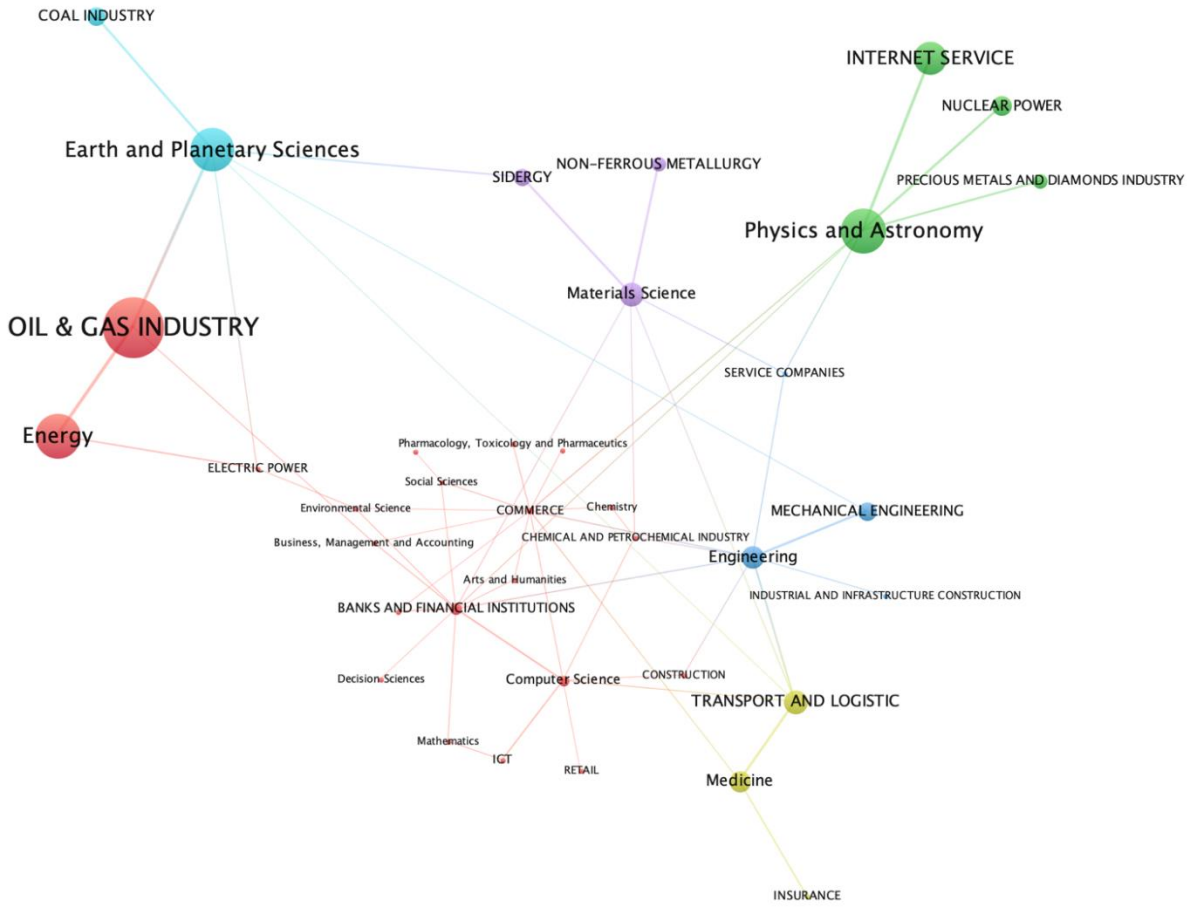
Sector	Organizations		Authors		TOP-5 cooperating organizations by the number of research output
	No.	%	No.	%	
academic	640	71.2	6524	59.9	Lomonosov Moscow State University; Université Paris-Saclay; Sorbonne Université; Université de Paris; University of Zurich
corporate	35	3.9	229	2.1	Schlumberger; Microsoft USA; Air Liquide S.A.; Fujikura Ltd.; Baker Hughes INTEQ
government	176	19.6	4028	37.0	Russian Academy of Sciences; Russian Research Centre

					Kurchatov Institute; CERN; CNRS; National Institute for Nuclear Physics
medical	40	4.4	76	0.7	South Ural State Medical University; St. Joseph's Hospital and Medical Center; Dana-Farber Cancer Institute; Military Medical Academy, Saint Petersburg
other	8	0.9	27	0.2	Institute for Research for Fundamental Sciences; Eötvös Loránd Research Network; Japan Synchrotron Radiation Research Institute
Total	899	100	10884	100	-

Source: compiled from Scopus data

When building the trajectory for the development of research cooperation networks of the largest Moscow companies within the framework of the city's innovation system, it is necessary to analyze the knowledge fields that are most actively developing in corporate research and their connection with the real sector of the economy. The constructed map (Fig. 2) of the relationship between types of economic activity and the fields of knowledge for the largest innovative companies in Moscow and the Moscow region clearly illustrates which areas of knowledge have received practice-oriented development in recent years.

Fig. 2: Map of the relationship between types of economic activity and the fields of knowledge for corporate R&D in Moscow and the Moscow region, 2016-2020



Source: compiled from Scopus, RAEX-600 in VOSviewer

Note: capital letters indicate the types of economic activities, lowercase letters – fields of knowledge

First of all, these are Earth and Planetary Sciences and Energy, which serve as a source of knowledge for 12 large capital industrial companies associated with the extraction and processing of minerals (Oil & Gas industry, Coal industry, Siderurgy, Electric power). In 2016-2020, the leaders in terms of the volume of generated publications and citations belonged to two companies with a H-index of 14: in Earth and Planetary Sciences is Gazprom, in Energy is Lukoil. In second place is Physics and Astronomy, in the development of certain areas of which companies in the areas of Internet service, Nuclear power, Precious metals and diamonds industry, Service companies, Commerce are interested (companies are representatives of the auto concerns KIA and Mercedes). In 2016-2020, the leaders in the volume of generated publications and citations in Physics and Astronomy belonged to two companies Yandex (h-index 43) and Rosatom (h-index 16). Large Moscow companies are engaged in the development of research in the field of medicine, whose activities are related to the movement of people (Russian Railway Company, RZHD with h-index 10), their life insurance (Sogaz insurance company – h-index 2) and the sale of pharmaceutical products (Sanofi Rossiya – h-index 3). Also, a number of corporate research is carried out in the field of engineering, including in intersection with Materials Science; Physics and Astronomy; Chemistry; Computer Science. The largest number of publications is generated by the Rocket and Space Corporation Energia named after S.P. Korolev (h-index 8). The least demanded by Moscow companies is conducting their own research in the field of social sciences and humanities, economics and management. The volume of Scopus publications in these areas of knowledge is small – on average 3 publications per organization. Most of them are affiliated with financial organizations.

Conclusion

The metropolitan region, which unites Moscow and the Moscow region, is the core of the national innovation system of Russia, accumulating about half of the largest companies interested in innovative activities. About 17% of them during 2015-2020 conducted research activities, the marker of which became Scopus publications, which makes them generators of knowledge, and not just consumers in the process of innovation. The industry specificity of the Moscow economy has influenced the areas of knowledge developed by the corporate sector: Earth and Planetary Sciences, Energy, Physics and Astronomy. It was found that the

larger the company, the more it is integrated into the R&D industry. At the same time, it does not matter whether it is a young company or has been on the market for more than one decade. In this regard, the development trajectory of the corporate research sector in Moscow is set by large companies, whose annual revenue exceeds $ 100 billion.

The geography of collaborations of metropolitan innovative companies in research is extensive. They not only interact locally, but also exchange knowledge through global pipelines with the world's leading research institutions. The innovation system of Moscow through the research networks of its largest companies is connected with the innovation systems of the leading innovative countries of the world (USA, Germany, Great Britain, Italy, France, Japan, etc.). The emerging model of interaction between institutions repeats the triple helix model in terms of the relationship between business, academia, and public sectors. At the same time, its international character was revealed.

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