Cooperative Strategies in the Age of Open Innovation: Choice of Partners, Geography and Duration

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Abstract

In the era of "open innovation", the choice of a cooperative strategy is one of the most significant factors determining the effectiveness of innovation activities. The authors investigate the typical configurations of cooperative networks in Russian manufacturing, including the choice of partners, the role of spatial distance, and the duration of joint projects. Using the firm-level data (1,324 in 2015 and 545 in 2018) the paper evaluates the role of cooperation in the innovation outcomes in terms of innovation novelty and export capacity.

The most common cooperative strategy is vertical cooperation, which is the involvement of clients and suppliers in the process of innovative development. The geography of cooperation rarely extends beyond a region's borders and is mostly of an irregular (short-term) nature. A small number of enterprises that engage in international cooperation tend to rely upon long-term linkages with academia, which is a distinctive feature of the most innovative Russian companies, including those involved in the creation and distribution of intellectual property.

Keywords: open innovation; innovation activity; innovation cooperation; networks; geography; duration; industry-science cooperation; manufacturing

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The generation of knowledge and ideas, and their practical implementation in innovations is a network phenomenon that involves the results from the organized interaction of many participants. While an individual invention can be made in isolation, the regular and systematic development of innovations is impossible without cooperation. Cooperative interaction between various actors is at the core of the contemporary companies' innovation models. It serves as the basis for a systemic approach to innovative development on a national scale. Such models are typical for the most advanced innovation-oriented players who control global value chains.

In contrast to an ideal situation where all actors implement the best possible strategies, in reality, a high degree of interconnectedness between the firms' innovations as well as a broad scope of cooperation networks remain rather the exception. This study illustrates this phenomenon using the empirical evidence obtained by surveying Russian companies. Key structural characteristics of network innovation partnerships, geographical and temporal aspects of cooperation in the development and implementation of innovations in Russia have been studied. A popular, but not indisputably confirmed hypothesis about the relationship between the "openness" of a strategy and the innovation productivity was tested. The network factor's impact upon the differences in companies' innovation capabilities, their ability to create innovations new to the market, and to participate in global value chains were assessed. Configurations of cooperation networks' innovative businesses were also examined.

Cooperation has been a central topic to all actual models of innovation processes. The very emergence of the innovation concept, in addition to the traditional "linear model" describing the impact of technological progress on economic development was largely due to the need to take into account the diverse knowledge channels and flows required to apply innovations (such as technology borrowing, third-party development, etc.).[1] In the late 1990s-early 2000s, a wealth of empirical evidence was accumulated, confirming the importance of external information sources for corporate innovation. The proactive position taken by the most productive industry players, in particular multinational corporations, contributed to the development of the "open innovation" model which recognizes the key role of all kinds of knowledge and technology flows in innovation [*Chesbrough*, 2003; *Carlsson et al*., 2011].

A systemic approach to analyzing countries' innovation capabilities, which is reflected in the framework "national innovation systems" concept [*Freeman,* 1987; *Lundvall,* 1992; *Nelson,* 1993], is also focused on cooperation issues. The strength of connections between innovation systems' specific components and actors is a decisive factor in the innovative productivity in the national, regional, and sectoral contexts [*Edquist,* 2011; *Fagerberg et al.,* 2005]. If such links are not sufficiently strong, it becomes a limitation and encourages making compensatory efforts and developing special support measures in the framework of national innovation policy.

Studying cooperation networks' configuration is closely related to other research areas related to development, catching up, and technological upgrading. The diversity and roles of companies' external information sources are studied by researchers of sectoral technological regimes [*Breschi et al.,* 2000], competitive advantages, and windows of opportunity in order to close the productivity gap with the world's leading economies and the technological development of national industries [*Humphrey, Schmitz,* 2002; *Lee,* 2020]. The length of cooperation is determined by the level of trust, the depth of actors' interaction, and their "institutional closeness" [*Boschma,* 2005; *Plewa et al.,* 2013]. This affects firms' absorption capacity, which is needed to promote the dissemination of advanced technologies and organizational practices at the national level. Geographic localization of knowledge chains is crucial in substantiating cluster policy and smart specialization strategies [*Balland et al.,* 2019].

The idea of making innovation process as open as possible was suggested on the basis of the experience of the most advanced global companies. However, not all innovation players use the available information dissemination channels, are integrated into mutual exchange networks, or share openness values. Surveys of enterprise innovation activities based on the framework approaches described in the Oslo Manual [OECD, Eurostat, 2018] – the international standard for measuring and interpreting innovative behavior indicators in the business sector – are the most important source of relevant empirical data. Methodological principles, a conceptual apparatus, a detailed system of definitions, and algorithms for framing questions and interpreting answers allow one to obtain internationally harmonized data on a wide range of characteristics of companies' innovation activities, suitable for comparative analysis.

Surveys carried out in line with the Oslo Manual have shown that openness is a multidimensional and complex phenomenon. The significant amount of accumulated empirical data indicates that enterprises are involved in cooperation to a different extent [*Dahlander, Gann,* 2010], while factors that determine the choice of partners and the formats of their interaction are heterogenous [*Belderbos et al.,* 2004b].

[1] About the non-linear innovation model see: [*Kline, Rosenberg*, 1986; *Godin*, 2008].

Researchers note the coexistence of both predominantly open and autonomous innovation strategies. Similar conclusions were made on the basis of Russian material. The relatively low level of companies' cooperation with the key national innovation system actors is reflected in the relevant national statistical indicators [HSE, 2019]. Kratzer et al. [*Kratzer et al.,* 2017] discovered that only about 10% of innovative manufacturing enterprises have both a proactively open culture and a detailed cooperation strategy.

Our research is devoted to the "mechanics" of cooperation links in the Russian context. How does the openness of cooperation networks' configuration affect companies' innovative capabilities? Is it true that the more "open" a company is, the more effectively it creates innovations new to the market? Do such companies have advantages facilitating their integration into global value chains? What is the role of businesses' ties with "institutional" knowledge producers – research and educational organizations compared with numerous other information sources for, and partners in the development of innovations? To answer these questions, the results of two waves of the Higher School of Economics' Monitoring of Enterprises' Innovation Activity survey were used.

Manufacturing enterprises, which are the object of our analysis, have a special place on the modern economic and technological development agenda since they have the highest demand for advanced production technologies. The radical transformation of this sector defines the prospects for a new industrial revolution – significantly increased global productivity and the reconfiguration of value chains [OECD, 2015]. The manufacturing industry also plays an important role in the structural transformation of the Russian economy since it makes a significant contribution to GDP (14.6% in 2019) and employment (14.3% of the national workforce in 2019). According to the innovation activity indicators [HSE, 2019], the highest number of companies successfully implementing technological innovations are concentrated in the manufacturing sector. Making adequate use of "windows of opportunity" to promote the growth of the national economy requires understanding the mechanisms for implementing innovative capabilities in manufacturing. Studying the role of the cooperation component as a factor in the success of innovation is necessary for the effective implementation and scaling of innovation-oriented business models.

Based on the review of theoretical approaches to studying innovative development cooperation, we have analyzed the cooperation network configurations typical for Russian manufacturing enterprises, including the location of partners and length of their interaction. Networking patterns were correlated with the companies' innovation performance. A special role that Russian enterprises' cooperation with R&D and educational organizations plays in the former's innovative capabilities was revealed. Firms' distinctive characteristics are presented as a basis for assessing the factors impacting the complexity and productivity of Russian businesses' cooperation strategies. Conclusions were made regarding the concept of "openness" and the empirical characteristics of cooperation strategies, which could help accomplish the objectives of accelerating technological development, stepping up innovation activity, and increasing enterprises' relevant capabilities.

Cooperation in Modern Innovation Models

Contemporary studies of innovation are based on the idea of nonlinear innovative development, application, and dissemination processes; the use of diverse innovation strategies; different configurations of innovation implementation chains; multiple sources of innovation ideas; and the particular importance of the effective interaction of both internal and external partners [*Leydesdorff et al.,* 2013; *Roud, Fursov,* 2011]. In the last three decades, research on innovation has been developing in line with the "chain" (nonlinear) model proposed in [*Kline, Rosenberg,* 1986]. Its key provisions are based on recognizing the economic role of the full range of possible innovation strategies, from full-scale research and development (R&D) to technology borrowing and the direct purchase of equipment. The departure from the linear model [*Godin,* 2006], understanding that a significant share of important innovations can be developed and implemented without conducting formal R&D on the basis of knowledge gained from experience ("doing, using, interacting") or outside of the enterprise, provided the key to explaining the technology diffusion processes and the catching-up as well as the advanced development of particular countries and industries.

Since the 1980s, researchers have recognized the key role of the cooperation factor in building companies' innovative capabilities in the framework of basic concepts such as the resource-based view of a firm [*Barney,* 2001; *Wernerfelt,* 1984], companies' absorptive capacity [*Cohen, Levinthal,* 1990], and dynamic capabilities [*Teece,* 2007]. This conceptual framework allows one to embed the current economic agenda into innovation management practice. By the late 1990s-early 2000s, systemic observations have revealed the evolution of business strategies towards strengthening companies' network connections [*Rosenbloom, Spencer,* 1996], including in the scope of the "open innovation" concept [*Chesbrough,* 2003]. Open innovations propose new cooperation models typical of the most advanced and proactive companies [*Chesbrough,* 2012], which consider the process of creating and implementing innovations as a combination of inbound and outbound knowledge flows [*Dahlander, Gann,* 2010], and thus use internal and external resources in the most efficient way possible with the help of new communication technologies.

The digital era provides new opportunities for opening the innovation process [*Nambisan et al.,* 2019] by expanding the range of participants, using new formats to share resources and intellectual activity results, and generating knowledge by synthesizing the actions of a wide range of diverse, independent, and uncoordinated actors through use of big data. As a result, cooperation strategies become more complex and heterogeneous.

Cooperation practices command serious attention in the scope of systemic empirical observations of the creation, implementation, and application of innovation. The current Oslo Manual edition [OECD, Eurostat, 2018] recommends one measure resources, innovation results, and the process of implementing new ideas separately, which allows for taking into account the diversity of companies' innovative behavior models and assessing the effectiveness of particular innovation implementation strategies in specific market, industry, and institutional settings.

The Oslo Manual defines innovations as new or improved products (services, business processes) brought to the market, which are significantly different from previously existing ones. All kinds of innovations are seen as economically significant: those new for the enterprise, but not for the market (reflect the process of accumulating competitiveness), new for the market, and new for the world. Innovation comprises the entire set of the firm's relevant activities, in any arrangement or combination: R&D, production design, engineering, acquisition of patent rights or licenses to use intellectual property, patenting (registration) of intellectual activity results, purchases of machinery, equipment and other fixed assets for innovation purposes, the development and acquisition of software and databases, planning, creation and implementation of new methods of doing business, organizing jobs and external relations, the marketing of new products, education and training of personnel, and other costs directly related to innovation [OECD, Eurostat, 2018, Chapter 4].

The above approach allows one to take into account the "openness" of the innovation process to the maximum possible extent. In terms of inbound knowledge flows, any type of innovation activity can be carried out by third-party organizations (through outsourcing, the procurement of relevant services, etc.) on a commercial basis, which is clearly reflected in innovation cost statistics. Companies use a wide range of information channels to develop and implement innovations. These include both internal (the company's own R&D, production, etc. divisions) and external sources. The sources of inbound knowledge flows include affiliated and non-affiliated enterprises (suppliers of equipment, materials and services); public and private R&D and educational organizations; customers, competitors, investors, other businesses, authorities, non-profit organizations, households, and individuals. In certain cases, a wider range of sources is considered, including informal ones (e.g., specialized exhibitions and conferences, etc.). Finally, companies' cooperation is analyzed, that is, the joint activities to develop innovations by counterpart type (in line with the list of external innovation sources).

Surveys based on the Oslo Manual approach are the main source of empirical data for harmonized (and therefore comparable) studies of the role of cooperation in companies' innovation. A quantitative analysis of various aspects of the relationship between cooperation and innovation strategies' productivity is based on the European Community Innovation Survey data. The results of these studies provide a framework for key hypotheses to empirically analyze the patterns common to cooperative innovation development strategies:

- Different forms of cooperation have different, but statistically significant effects upon innovative performance [*Belderbos et al.,* 2004a; *Laursen, Salter,* 2006; *Greco et al.,* 2016; *Wang et al.,* 2015]. In general, large firms have a greater propensity to engage in innovation cooperation [*Fritsch, Lukas,* 2001]. However, the effects vary significantly depending upon the types of innovations [*Aschhoff, Schmidt,* 2008; *Nieto, Santamaría,* 2007; *van Beers, Zand,* 2014].
- The effects vary greatly depending upon the type of economic activity (TEA). Depending on the specifics of the industry markets, certain network configurations are more common [*Arranz, de Arroyabe,* 2008; *Tether,* 2002]. Another source of variability is the differences in institutional conditions and competition regimes [*Kim, Vonortas,* 2014; *Srholec,* 2015].
- Involvement in cooperation networks is more important for innovative development compared to contributions from isolated cooperation partners [*Becker, Dietz,* 2004; *de Faria et al.,* 2010].
- In addition to the "breadth" of coverage (diversity of partners), the "depth" of cooperation, i.e., the intensity and duration of interaction with specific partners, plays a significant role [*Lhuillery, Pfister,* 2009; *Plewa et al.,* 2013]. The effects of such integration may vary depending upon the type of partner (e.g., in the case of industry-science cooperation, long-term research projects may be implemented, while cooperation with clients may involve additional product customization to meet customers' requirements).
- Spatial proximity is important to the extent that it does not depend upon the "cultural" proximity of cooperation partners – a common understanding of the context, the unity of objectives, and the ability to quickly exchange information over the course of a project [*Boschma,* 2005; *Torre,* 2008].
- Industry-science cooperation plays a special role [*Caloghirou et al.,* 2004; *Kaufmann, Tödtling,*

2001; *Perkmann, Walsh,* 2007]. The effectiveness of cooperation with R&D organizations and universities depends upon the overall technological level and innovative development of a country [*Castellacci,* 2008; *Dachs et al.,* 2008; *Hayter et al.,* 2018].

Harmonized international studies allow one to effectively identify specific national features. Cooperation success essentially reflects the quality of the innovation system. Creating conditions for the emergence and scaling of such cooperation is an important political objective associated with increasing the level and productivity of innovation. Network cooperation studies are a valuable source of insights into the current state of the innovation landscape in order to identify inefficiency and windows of opportunity as well as to fine-tune relevant policies.

In the Russian economy, the generally low involvement of enterprises in innovative activities is a key factor in the cooperation intensity. A number of quantitative studies identified the main barriers to scaling up innovation: limited availability of resources for companies, especially financial ones [*Kuznetsova, Roud,* 2013; *Teplykh,* 2015]; an unfavorable institutional environment in terms of the quality of government regulation; the low level of market competition; and the significant role played by the state in the economy [*Gokhberg, Kuznetsova,* 2015; *Yakovlev,* 2014]. The negative impact of these factors is evident both in real sector organizations' demand for innovations and in the productivity of companies already involved in innovative activities. As a result, Russian enterprises rarely implement breakthrough innovation projects leading to the development of high-tech products that are competitive on foreign markets [*Bessonova, Gonchar,* 2019]. "Openness" and network cooperation are practiced only by actively growing companies, for whom these activities make up an important part of their business models.

The quantitative parameters of cooperation processes in Russia are reflected in the official statistics of enterprises' innovation activity, in particular the proportion of organizations involved in joint R&D projects. In 2017 their share was 4.9% of the total number of manufacturing enterprises. The highest level of joint R&D was noted in high-tech sectors (in the production of computers, electronic, and optical products, 16.1% of companies are involved in such projects; in production of medicines and medical materials – 12.1%), and in certain other economic activity types (EATs) (in metallurgical production this figure is 12.1%, in the production of coke and petroleum products – 11.3%). It should be kept in mind that this indicator only reflects joint R&D, i.e., just some of the possible cooperation formats to develop innovations. The assessment of the activities' scale and of third-party organizations' contribution to the development and implementation of innovations by enterprises is based on indicators such as "Share of organizations in total number of those that applied ready-made technological innovations over past three years, mainly developed...by other organizations" (18.2%); "jointly with other organizations" (27.1%); "by changing or modifying products developed by other organizations" (5.8%); "on their own" (51.5%). Thus, the absence of external partners' significant contribution to innovative development was established for more than half of enterprises engaged in technological innovation. For manufacturing enterprises, the most valuable sources of information they need to create technological innovations are the consumers of their products and services (11% of organizations), suppliers of (raw) materials (5.4%), competitors (5%), and legislative and executive authorities (4.6%). R&D and educational organizations play a much less important role for most enterprises: academic R&D organizations account for 0.6%, industrial ones for 2.7%, and universities for 1.2% of the total number of surveyed organizations.

Aggregated official statistical indicators reflect the generally low level of cooperative ties in the Russian national innovation system. Studies that use data on individual enterprises present in-depth analyses of various aspects of cooperation, including quantitative parameters of factors, barriers, and drivers of business-science cooperation [*Roud, Vlasova,* 2020; Dezhina et al., 2018; Simachev et al., 2014]. One of the main conclusions of these studies is that partnership with R&D organizations goes beyond the traditional linear innovation model, since cooperation may not be limited to joint R&D projects and include various types of knowledge-intensive services, human capital development, or strengthening internal competencies. Such cooperation is based on cultural similarity, which allows one to overcome barriers to cooperation associated with different management strategies and the "target functionality" of companies and R&D organizations, which understand project success differently. The stereotype about Russian science's inability to provide high-quality applied results has not actually been confirmed. Rather, we should talk about different strategic goals of business and science due both to institutional and corporate specifics (e.g., short planning horizons) and the R&D sphere's structural features (the prevalence of public funding and the almost complete absence of mechanisms for attracting funds from other sources among R&D organizations' performance indicators).

There is a pronounced lack of studies presenting a micro-level analysis of companies' network innovative development cooperation with a wide range of partners (based on data for individual enterprises). In some cases (e.g., [*Bykova, Molodchik,* 2009]), the authors positively assess the relationship between cooperation and certain aspects of enterprises' performance. However, without the harmonized conceptual apparatus of the Oslo Manual, it is impossible

to compare and unambiguously interpret the identified patterns [*Kratzer et al.,* 2017]. Using Russian enterprises' open innovation strategic culture as an example, it can be demonstrated that only 9.3% of innovative manufacturing enterprises have developed an internal culture focused on the efficient absorption of external ideas and knowledge, which, taken together with the available statistical data, calls into question the development prospects for the country's innovation capabilities. Studying the diversity of innovation strategies, the compatibility of various partnership formats, and factors affecting the forms and nature of such cooperation becomes relevant to better understanding the mechanisms of the Russian national innovation system and shaping effective state science and innovation policy.

Methodology and the Basis of this Study

The results of two waves of the Monitoring of Russian Enterprises' Innovation Activity survey (2015 and 2018), conducted by the Institute for Statistical Studies and Economics of Knowledge (ISSEK) of the Higher School of Economics (HSE) since 2009 in the framework of the HSE Basic Research Programme[2] provided the empirical basis for this study. The survey covers manufacturing enterprises in at least 40 Russian regions, in all federal districts, which employ more than 15 workers; its methodology is based on the Oslo Manual [OECD, Eurostat, 2018]. Data was collected through a series of structured interviews with executive managers using a questionnaire. The questionnaire comprised several sections: general characteristics of the enterprise; development and implementation of innovations; innovation development cooperation; public support of innovation; use of advanced technologies; and organization of production.

In 2015, the survey was conducted across all manufacturing industries. The final sample comprised 1,324 enterprises, 805 of which (60.8%) were innovation-active, i.e., they developed and/or introduced at least one technological innovation in 2011-2013. In 2018, the survey covered high-tech and medium tohigh technology manufacturing firms (according to the OECD/Eurostat classification).[3] A total of 545 companies were surveyed; 422 of which (77.4%) were innovation-active. The survey data was weighted by population characteristics (the number of enterprises in each industry sector and size group) derived from the Federal State Statistics Service (Rosstat).

At the first stage, typical configurations of cooperation networks were investigated. To identify them, three aspects of the cooperation strategy were analyzed: the choice of partners, the role of spatial distance, and the duration of cooperation. These models were examined in terms of enterprise size, age, ownership structure, and type of economic activity. Cluster analysis served as the main research method. Differences in variables' average values across clusters were analyzed to assess the "openness" of innovation strategies.[4]

To operationalize the innovative performance, a typology covering two key dimensions was used: the degree of innovation novelty in accordance with Oslo Manual recommendations (new to the firm or new to the market) and enterprises' integration into global value chains through export activities (nonzero volume of products shipped to foreign markets). Four gradations of "advanced" innovators were constructed, within which the role of cooperation was investigated. The impact of cooperation networks' configuration upon enterprises' innovative capabilities was estimated using multivariate logistic regressions.

Particular attention was paid to the role of industry-science cooperation as a driver of technological innovation. A comparative analysis of entrepreneurial strategies, along with intellectual property creation and dissemination practices of enterprises engaged and not engaged in cooperation with R&D and educational organizations was carried out.[5] Taking into account that high- and medium-to-high-tech manufacturing enterprises demonstrate the highest level of innovative activity (the share of enterprises engaged in technological innovation of all enterprises in 2017 is 31.8% and 19.9% of organizations, respectively), the analysis was based on the 2018 survey data.

The Configuration of Cooperation Networks

To identify patterns in innovation partnership network configurations in the Russian manufacturing industry, three aspects of network cooperation were studied: choice of cooperation partners, geographic distance from them, and length of cooperation. The analysis allowed the authors to identify differences in enterprises' innovative behavior depending upon their cooperation strategy.

The results confirm that innovation is a network phenomenon. Cooperation plays an important role in Russian manufacturing enterprises' innovation strategies: the vast majority of respondents in the survey (98.5%) involve external organizations in their innovation projects. Practically all of them cooperate with members of their value chain, first of all, with direct consumers of their products (76.3%) and sup-

[2] For more, see: https://www.hse.ru/monitoring/innproc/, accessed on 20.08.2020.

[3] For more, see: https://ec.europa.eu/eurostat/statistics-explained/pdfscache/6384.pdf, accessed on 20.08.2020.

[4] The statistical significance of the differences in mean values between clusters was tested using the Kruskal-Wallis test.

[5] Fisher's criterion was applied to assess the significance of differences between companies engaged and not engaged in science-industry cooperation.

Table 1. **Cooperation Partners (share of those who chose the appropriate option in the total number of innovative enterprises, by innovation and enterprise type, %)**

Partners	Total	Firms by innovation status and export activity			
		New to firm, Non-exporters	New to firm, Exporters	New to market, Non-exporters	New to market, Exporters
	62.2	17.1	14.0	6.7	
Clients	76.3	77.0	71.0	73.5	88.6
Suppliers	73.8	74.1	78.1	64.9	77.9
Providers of services	31.1	31.1	35.7	28.1	25.9
Related value-chain members	29.6	29.1	30.3	25.7	39.7
Competitors	17.1	16.5	18.3	17.5	18.7
R&D organizations	25.0	19.1	39.9	16.9	58.3
Universities	18.5	15.9	25.8	15.3	29.9
Consulting firms	8.9	9.3	10.6	4.8	9.8
Public authorities	22.1	23.9	19.8	14.4	27.7

Question: Please indicate the type of innovation cooperation partner

Source: authors' estimates based on data from the HSE Monitoring of Enterprises' Innovation Activity, 2015

pliers of (raw) materials and components (73.8%) (Table 1).

However, the networking remains underdeveloped. Enterprises with a high innovative capabilities tend to have detailed cooperation strategies. Enterprises integrated into global value chains (23.8%) are more likely to involve R&D organizations and universities in their innovation projects (over 25% in each group) and cooperate with government agencies. More than half of the companies producing highly innovative products competitive on international markets (20.7%) cooperate with R&D organizations.

A cooperation strategy primarily focused on supply chain partners is more typical for small and low-tech enterprises (39.9%) who cooperate only with regional suppliers and consumers, and for large companies interested in exporting newly developed innovative products (42.6%) and integrating into national and global value chains (Table 2).

Less than 20% of the surveyed enterprises had a geographically wide network of partners. Global networking tends to increase with companies' more advanced industrial activities and ambition to compete with foreign manufacturers. A distinctive feature of advanced innovators is cooperating with R&D organizations and universities as well as involving public authorities and consulting firms in their innovation projects.

Due to the complexity and long duration of innovation projects, establishing long-term relationships with partners is a key to successful cooperation. Meanwhile, over 40% of Russian manufacturing enterprises only have irregular one-off contracts with their partners, mainly in the value chain framework (Table 3). About a third of enterprises maintain permanent contacts with customers and suppliers of (raw) materials and components but interact with other partners only occasionally. Enterprises' entry on foreign high-tech product markets and public participation in their ownership facilitates the expansion of their cooperation and the establishment of long-term partnerships, including with R&D organizations.

Classifying cooperation strategies by partners' geographical location and length of cooperation with them revealed that one-time contracts with regional and national suppliers and customers remain the most common cooperation model in the Russian manufacturing industry (Table 4). International network cooperation is extremely rare and only happens in the framework of long-term relationships, including those involving R&D organizations and universities in innovation projects.

Assessing the impact of openness upon the actual productivity of enterprises' innovation activities confirmed the hypothesis of its high importance for broad network cooperation with various partners (Table 5). For example, focusing on the domestic market and the development of incremental innovations require partnerships with the federal authorities, while to successfully export products, enterprises need to integrate into national and global value chains and cooperate with R&D organizations and/or universities. Furthermore, only participation in complex cooperation networks in the framework of long-term relationships with the R&D sector and market participants outside their value chain (i.e., competitors and related companies) and the region increases companies' chances to integrate into global value chains.

Advanced innovators tend to actively cooperate with the R&D sector. Strengthening industry-science cooperation and partnerships with value chain members outside the region play a key role in export-oriented manufacturing enterprises' activities. Establishing long-term relations with R&D organizations

Table 2. **Cooperation Network Configurations Based on the Spatial Proximity to Partners (cluster analysis results)**

A. Cooperation Models: Geographical Aspect

Clusters		Value chain: within region	Value chain: beyond region	Value chain: global, Science: within region	Value chain: global, Science: beyond region	Total
Cluster size		39.9	42.6	12.7	4.9	
Indicators: Innovation cooperation with (% of enterprises)						
Clients	R	73.4	34.1	85.1	30.0	56.1
	N	0.0	52.9	72.2	65.2	34.9
	F	0.0	9.1	27.6	17.4	8.2
Suppliers	R	67.1	17.4	76.1	34.2	45.5
	N	0.4	60.7	88.9	59.5	40.2
	F	1.6	16.5	47.6	38.5	15.6
Providers of services	R	26.6	7.6	84.2	14.6	25.3
	N	0.0	11.9	44.2	31.2	12.2
	F	0.0	1.2	17.7	8.5	3.2
Related value-chain members	R	24.1	4.0	54.5	30.6	19.7
	N	1.7	14.7	42.4	42.8	14.4
	F	0.0	3.1	8.8	6.7	2.8
Competitors	R	11.0	1.6	47.7	2.9	11.2
	N	0.9	4.6	38.5	21.0	8.2
	F	1.1	1.3	9.1	4.4	2.4
R&D organizations	R	11.5	4.1	42.8	55.7	14.5
	N	1.5	17.0	21.5	94.1	15.2
	F	0.0	1.9	0.0	10.1	1.3
Universities	R	9.5	7.2	44.1	51.6	14.9
	N	0.4	1.9	8.5	88.9	6.4
	F	0.0	0.1	0.0	9.3	0.5
Consulting firms	R	6.9	0.0	19.5	17.2	6.1
	N	0.0	1.9	10.1	15.6	2.9
	F	0.0	1.3	0.6	4.3	0.9
Public authorities	R	19.0	5.8	45.6	44.7	18.0
	N	0.4	5.6	12.2	43.3	6.2
	F	0.0	0.2	0.0	1.7	0.2

Partners: R — regional (located at a distance of less than 100 km); N — national (more than 100 km); F — foreign

Models of co-operation: — vertical (actors in supply chains); — horizontal (other market players); — institutional (R&D organizations); — consulting firms; — governmental bodies. The same legend is for Table 3A.

B. Enterprise Characteristics

Clusters	Value chain: within region	Value chain: beyond region	Value chain: global, Science: within region	Value chain: global, Science: beyond region	Total
Size:					
small (< 100 employees)	42.5	26.9	11.7	11.1	30.4
medium (100–500)	43.5	53.4	67.3	38.9	50.5
large (> 500)	14.0	19.7	20.9	50.0	19.1
Newly established (less than 5 years)	7.8	5.7	4.5	1.9	6.2
State ownership	13.7	5.9	7.2	29.0	10.3
Sector:					
low-tech	62.1	41.1	32.7	13.0	47.0
medium low-tech	20.2	20.9	24.8	18.5	21.0
medium high-tech	11.5	28.9	32.4	38.4	22.9
high-tech	6.2	9.1	10.1	30.1	9.1
Types of enterprises-technological innovators:					
new to firm, non-exporters	73.3	55.7	59.5	35.6	62.2
new to firm, exporters	8.9	22.5	20.5	28.4	17.1
new to market, non-exporters	16.7	12.5	12.8	8.5	14.0
new to market, exporters	1.1	9.4	7.2	27.6	6.7

Note: Black font highlights values that are beyong average (the last column), gray highlights values that are lower. Differences between clusters are statistically significant. The authors can provide group comparison results based on the Kruskal-Wallis test upon request. The same is applicable to the Table 3.

Source: authors' estimates based on data from the HSE Monitoring of Enterprises' Innovation Activity, 2015

Table 3. **Cooperation Network Configurations Based on the Duration of Cooperation (cluster analysis results)**

A. Cooperation Models: Temporal Aspect

Clusters		Value chain: one-time	Value chain: regular	Science: long-term	Networking: long-term	Total
Cluster size		43.8	35.4	15.4	5.4	
Indicators: Innovation cooperation with (% of enterprises)						
Clients	S	20.4	0.7	13.9	14.8	12.1
	M	13.0	15.7	17.0	10.9	14.5
	L	15.5	83.5	56.0	56.5	48.0
Suppliers	S	20.7	3.0	15.7	0.0	12.5
	M	15.2	20.2	14.8	32.2	17.8
	L	11.8	73.4	51.1	60.2	42.3
Providers of services	S	9.1	4.1	5.1	0.7	6.3
	M	4.0	10.7	5.9	15.5	7.3
	L	4.3	28.5	12.0	57.2	16.9
Related value-chain members	S	6.9	2.2	6.2	0.7	4.8
	M	7.4	4.0	9.8	15.9	7.0
	L	7.7	23.0	22.8	40.3	17.2
Competitors	S	2.0	3.3	0.3	14.8	2.9
	M	2.1	5.8	3.5	8.4	3.9
	L	0.9	17.9	9.0	34.9	10.0
R&D organizations	S	7.4	5.1	4.1	15.4	6.5
	M	0.9	3.2	25.9	13.4	6.3
	L	0.4	1.5	55.6	54.5	12.2
Universities	S	1.4	3.5	4.1	0.7	2.5
	M	1.9	3.1	14.3	36.2	6.1
	L	0.3	1.8	43.6	39.0	9.6
Consulting firms	S	2.8	2.3	3.3	14.8	3.4
	M	0.8	1.1	0.0	33.9	2.6
	L	0.0	0.0	0.0	51.4	2.8
Public authorities	S	4.0	2.0	4.9	0.7	3.2
	M	1.9	4.8	6.1	11.2	4.1
	L	7.0	14.4	22.5	55.9	14.7

Links: S — short-term (one-time and/or <1 year); M — medium-term (1-5 years), L — long-term (>5 years and/or regular)

B. Enterprise Characteristics

Clusters	Value chain: one-time	Value chain: regular	Science: long-term	Networking: long-term	Total
Size:					
small (< 100 employees)	32.9	35.1	12.6	30.2	30.4
medium (100–500)	49.9	50.8	55.1	40.4	50.5
large (> 500)	17.2	14.1	32.3	29.5	19.1
Newly established (less than 5 years)	8.4	6.3	2.2	0.0	6.2
State ownership	6.3	9.8	16.3	29.3	10.3
Sector:					
low-tech	53.0	51.9	16.1	55.4	47.0
medium low-tech	22.2	21.1	21.9	8.4	21.0
medium high-tech	19.7	18.1	43.3	21.5	22.9
high-tech	5.1	8.9	18.7	14.7	9.1
Types of enterprises-technological innovators:					
new to firm, non-exporters	63.8	69.2	40.5	65.0	62.2
new to firm, exporters	17.9	12.3	25.9	17.0	17.1
new to market, non-exporters	15.7	14.2	11.8	5.7	14.0
new to market, exporters	2.6	4.3	21.8	12.3	6.7

Note: Differences between clusters are statistically significant. The authors can provide group comparison results based on the Kruskal-Wallis test upon request.

Source: authors' estimates based on data from the HSE Monitoring of Enterprises' Innovation Activity, 2015

Table 4. **Cooperation Network Configurations (share of those who chose the appropriate model in the total number of innovative enterprises, %)**

Geographic scope	Duration				Total
	Value chain: one-time	Value chain: regular	Science: long-term	Networking: long-term	
Value chain: within region	21.5	14.2	2.9	1.3	39.9
Value chain: beyond region	20.9	13.8	7.0	0.8	42.6
Value chain: global, Science: within region	1.1	7.2	2.5	2.0	12.7
Value chain: global, Science: beyond region	0.3	0.3	3.0	1.3	4.9
Total	43.8	35.4	15.4	5.4	100.0

Source: authors' estimates based on data from the HSE Monitoring of Enterprises' Innovation Activity, 2015

and universities strengthens companies' innovation capabilities and increases their export opportunities.

Cooperation with Science as a Driver of Innovation

An analysis of cooperation networks' configurations showed that collaborating with the R&D sector is the most important strategic vector and attribute of innovative international-level companies. Let us see what the differences are between innovatively active enterprises cooperating with R&D organizations and/or universities and those who neglect it.

According to the survey results, R&D sector players are an important source of information for enterprises that rely on innovation as their main competitive advantage (Table 6). Over the course of innovative development, companies that introduce new (69.1%) and improve existing products (48.2%) most actively

Table 5. **Components of Cooperation Networks that Determine the Types of Enterprises – Technological Innovators in Russian Manufacturing**

Partners	Components of cooperation networks	Firms by innovation status and export activity			
		New to firm. Non-exporters	New to firm. Exporters	New to market. Non-exporters	New to market. Exporters
Value-chain members	Cooperation=Yes	0.035	0.025	–0.027	–0.033
		(0.071)	(0.049)	(0.054)	(0.037)
	Geography: out of region	**–0.141*****	**0.131*****	–0.006	0.016
		(0.039)	(0.028)	(0.029)	(0.018)
	Duration: more than 1 year	0.081	0.012	–0.056	–0.037
		(0.051)	(0.036)	(0.040)	(0.029)
R&D organizations and/or universities	Cooperation=Yes	**–0.108****	**0.085****	0.004	0.019
		(0.043)	(0.034)	(0.031)	(0.018)
	Geography: out of region	**–0.171*****	**0.071***	0.062	0.038
		(0.054)	(0.040)	(0.043)	(0.024)
	Duration: more than 1 year	**–0.153*****	**0.107*****	0.009	**0.038***
		(0.046)	(0.037)	(0.033)	(0.021)
Other market actors	Cooperation=Yes	–0.003	**–0.0465***	0.024	0.026
		(0.037)	(0.027)	(0.026)	(0.016)
	Geography: out of region	–0.026	–0.037	0.024	**0.039***
		(0.043)	(0.028)	(0.032)	(0.021)
	Duration: more than 1 year	–(0.028)	**–0.0505***	(0.047)	**0.031***
		(0.039)	(0.028)	(0.029)	(0.018)
Public authorities	Cooperation=Yes	0.024	–0.020	–0.039	0.035
		(0.046)	(0.032)	(0.031)	(0.022)
	Geography: out of region	**0.125****	–0.037	**–0.0994*****	0.011
		(0.061)	(0.041)	(0.032)	(0.026)
	Duration: more than 1 year	0.049	–0.042	–0.028	0.021
		(0.049)	(0.033)	(0.034)	(0.022)

Note: The results of three multinomial logit-models estimation by cooperation components (marginal effects). Additional control variables: size, age, state ownership, and sector. Statistically significant coefficients are presented in bold characters; *. ** and *** denote significance at 10%. 5% and 1%. respectively.

Source: authors' estimates based on data from the HSE Monitoring of Enterprises' Innovation Activity. 2015

Table 6. **Strategic Priorities of High and Medium-High Technology Manufacturing Enterprises (share of those who chose the appropriate option in the total number of innovative enterprises, %)**

Percentage of enterprises strategically focused on:	Cooperation with universities or R&D organizations in innovation		Total
	Yes	No	
Improving existing goods and services	48.2	45.4	46.8
Introducing new goods or services	69.1	60.9	64.8
Providing low-prices (price leadership)	16.4	34.7	25.9
Providing high-quality (quality leadership)	75.3	84.6	80.1
Guaranteeing adherence to delivery times	45.5	47.4	46.5
Providing product-related services	18.5	18.4	18.5
Satisfying established customer groups	12.4	18.1	15.3
Reaching out to new customer groups	35.3	27.0	31.0
Manufacturing one or a small number of key goods or services	13.1	11.5	12.2
Manufacturing a broad range of goods or services	17.8	21.8	19.9
Offering standardized goods or services	4.4	11.0	7.8
Offering customer-specific solutions	18.6	25.5	22.1
Compliance with international standards	15.7	25.4	20.8
Sustainable and responsible production (eco-friendly, ethical, etc.)	9.4	16.2	12.9

Question: Which of the following strategies is more important to the economic performance of your enterprise? Choose no more than four answers.

Note: Black font highlights values that are beyong average (the last column), gray highlights values that are lower. The authors can provide the results of checking the differences between enterprise groups using the Fisher test upon request.

Source: authors' estimates based on data from the HSE Monitoring of Enterprises' Innovation Activity, 2018.

cooperate with research organizations and universities to achieve commercial success. In contrast to those not involved in industry-science cooperation, they are more often focused on the strategic search for new customer groups (35.3%) and expanding their product line (13.1%).

Companies interacting with the R&D sector proactively generate, disseminate, and commercially apply new knowledge. They are the key technology market operators and the cornerstones of the innovation system. This is evidenced by their demand for the official protection of created intangible assets and involvement in intellectual property transfers, which are higher than the average for high- and medium-high technology manufacturing enterprises (Table 7). More than 40% of innovative enterprises cooperating with R&D organizations and universities have applied for a patent at least once over the past three years. Trademarks (26.1%), utility models (21.9%), and know-how (18.5%) were used less frequently. A much smaller share of enterprises (less than 6%) is involved in the transfer of intellectual property. The main dissemination channels are agreements on using know-how, licensing, and exchanging intellectual activity results.

The conducted empirical analysis provided a comprehensive picture of Russian manufacturing enterprises' cooperation strategies. It demonstrated that enterprises' ability to develop network cooperation determines the level of their innovative efforts (the capabilities to develop innovations that are new for the market) and their access to global value chains. A distinctive feature of the most innovative enterprises is the ability to establish close cooperation with R&D organizations and maintain long-term relationships.

Conclusion

This study intended to deliver empirical evidence from the Russian context on the variety of cooperative strategies and their impact upon innovative performance. A positive relationship has been demonstrated between the openness of innovation strategies and enterprises' innovation productivity expressed as the ability to produce products that are new for the market and are integrated into global value chains.

The survey results emphasize that in the Russian manufacturing industry, almost all innovation-active enterprises cooperate with external partners in developing innovations. However, only a few companies have an extensive partner network. Classifying cooperation strategies by partners' geographical location and length of cooperation revealed that the absolute majority of companies prefer one-time contracts with participants in regional and national value chains (direct consumers of their products and suppliers of (raw) materials and services), while international and long-term network cooperation remains underdeveloped.

Table 7. **Creation and Dissemination of Intellectual Property (share of those who chose the appropriate option in the total number of innovative enterprises, %)**

Question: During the period between 2016 and 2018, did your enterprise perform the following actions with IPRs? Please choose all the appropriate responses.	Cooperation with universities or R&D organisations in innovation		Total
	Yes	No	
Creation:			
Applying for a patent in Russia	43.1	25.8	34.2
Registering a trandmark	26.1	22.2	24.1
Applying for a utility model	21.9	14.5	18.1
Creating know-how	18.5	2.3	12.7
Claiming a copyright	9.1	6.7	7.9
Applying for a patent abroad	5.4	4.1	4.8
Registering an industrial design right	4.0	1.5	2.7
Dissemination:			
Contracting for know-how	6.0	3.9	4.9
License out its own intellectual property rights (IPRs) to others	5.2	2.3	3.7
Selling IPRs	3.1	4.7	4.0
Exchanging IPRs	2.2	1.1	1.6
Establishing franchise relations	0.4	2.1	1.3

Note: Black font highlights values that are beyong average (the last column), gray highlights values that are lower.
Source: authors' estimates based on data from the HSE Monitoring of Enterprises' Innovation Activity, 2018.

This research supports the statement that it is the integration into complex partnership networks and the joint implementation of innovation projects with counterparts from different sectors of the economy that contribute to strengthening enterprises' innovative capabilities. Integration into global value chains is facilitated by abandoning the rigid vertical cooperation model (limited by the value chain framework) and strengthening cooperation with R&D organizations. Increasing the level of business innovation (i.e., the ability to create solutions not available on the market) is directly related to establishing stable, long-term network connections, cooperating with Russian science (universities, academic organizations) and with market participants outside the value chain (competitors and related enterprises).

Therefore, enterprises with the highest innovative capabilities tend to cooperate with R&D and educational organizations. Active cooperation with universities and research organizations determines companies' ability to create highly innovative products that are competitive on foreign markets. Innovation (making new and improving existing products) is a key element of business models and a decisive factor in the commercial success of such companies, as opposed to those not involved in industry-science cooperation. Such enterprises can turn into "facilitators of technological dissemination" in the Russian innovation system and act as proactive technology market operators relatively more often by becoming involved in the creation and dissemination of intangible assets.

Company size has traditionally played a critical role in scaling network connections and developing innovation partnerships. In the Russian manufacturing industry, large high and medium-high technology enterprises are more likely to have detailed cooperation strategies. The variables associated with government participation in enterprise management are statistically significant. Such companies have a pronounced tendency to establish links with other institutional partners. However, the available data does not yet allow one to assess the effectiveness of these contacts.

Thus, a study based on Russian material has demonstrated that having an extensive partner network is a clear indicator that the enterprise has high innovative capabilities. Against this background, the weak development of innovation partnership networks in the Russian manufacturing industry and the low intensity of ties between the participants in innovative activities become a "bottleneck" of the national innovation system. Understanding enterprises' actual innovative behavior strategies and their possible development paths provides an empirical basis for developing support measures in the field of innovation. The key to strengthening innovation in the real sector and accelerating technological development is in promoting and scaling network collaboration and industry-science cooperation.

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References

Arranz N., de Arroyabe J.C.F. (2008) The choice of partners in R&D cooperation: An empirical analysis of Spanish firms. *Technovation,* vol. 28, no 1–2, pp. 88–100. DOI: 10.1016/j.technovation.2007.07.006.

Aschhoff B., Schmidt T. (2008) Empirical evidence on the success of R&D cooperation — happy together? *Review of Industrial Organization,* vol. 33, no 1, pp. 41–62. DOI: 10.1007/s11151-008-9179-7.

Balland P.A., Boschma R., Crespo J., Rigby D.L. (2019) Smart specialization policy in the European Union: Relatedness, knowledge complexity and regional diversification. *Regional Studies,* vol. 53, no 9, pp. 1252–1268. DOI: 10.1080/00343404.2018.1437900.

Barney J.B. (2001) Resource-based theories of competitive advantage: A ten-year retrospective on the resource-based view. Journal of Management, vol. 27, no 6, pp. 643–650. DOI: 10.1177/014920630102700602.

Becker W., Dietz J. (2004) R&D cooperation and innovation activities of firms — evidence for the German manufacturing industry. *Research Policy,* vol. 33, no 2, pp. 209–223. DOI: 10.1016/j.respol.2003.07.003.

Belderbos R., Carree M., Diederen B., Lokshin B., Veugelers R. (2004) Heterogeneity in R&D cooperation strategies. *International Journal of Industrial Organization,* vol. 22, no 8–9, pp. 1237–1263. DOI:10.1016/j.ijindorg.2004.08.001.

Belderbos R., Carree M., Lokshin B. (2004) Cooperative R&D and firm performance. *Research olicy,* vol. 33, no 10, pp. 1477–1492. DOI: 10.26481/umamet.2004020.

Bessonova E., Gonchar K. (2019) How the innovation-competition link is shaped by technology distance in a high-barrier catch-up economy. *Technovation,* vol. 86, pp. 15–32. DOI: 10.1016/j.technovation.2019.01.002.

Boschma R. (2005) Proximity and innovation: A critical assessment. *Regional Studies,* vol. 39, no 1, pp. 61–74. DOI: 10.1080/0034340052000320887.

Breschi S., Malerba F., Orsenigo L. (2000) Technological regimes and Schumpeterian patterns of innovation. *Economic Journal,* vol. 110, no 463, pp. 388–410. DOI: 10.1111/1468-0297.00530.

Bykova A., Molodchik M. (2009) Praktiki «otkrytykh innovatsii» v Rossii: empiricheskoe issledovanie innovatsionnogo povedeniia predpriiatii Permskogo kraia [Open innovation practices: empirical research of firm's innovation activity in Perm Region]. *Korporativnye finansy / Journal of Corporate Finance Research*, vol. 3, no 3, pp. 77–93. DOI: 10.17323/j.jcfr.2073-0438.3.3.2009.77-93 (in Russian).

Caloghirou Y., Kastelli I., Tsakanikas A. (2004) Internal capabilities and external knowledge sources: complements or substitutes for innovative performance? *Technovation,* vol. 24, no 1, pp. 29–39. DOI: 10.1007/s12130-005-1005-z.

Carlsson S., Corvello V., Schroll A., Mild A. (2011) Open innovation modes and the role of internal R&D. *European Journal of Innovation Management,* vol. 14, no 4, pp. 475–495. DOI: 10.1108/14601061111174925.

Castellacci F. (2008) Technological paradigms, regimes and trajectories: Manufacturing and service industries in a new taxonomy of sectoral patterns of innovation. *Research Policy,* vol. 37, no 6–7, pp. 978–994. DOI: 10.1016/j.respol.2008.03.011.

Chesbrough H. (2012) Open innovation: Where we've been and where we're going. *Research-Technology Management,* vol. 55, no 4, pp. 20–27. DOI: 10.5437/08956308x5504085.

Chesbrough H.W. (2003) *Open innovation: The new imperative for creating and profiting from technology*, Boston, MA: Harvard Business Press.

Cohen W.M., Levinthal D.A. (1990) Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly,* vol. 35, no 1, pp. 128–152. DOI: 10.2307/2393553.

Dachs B., Ebersberger B., Pyka A. (2008) Why do firms cooperate for innovation? A comparison of Austrian and Finnish CIS3 results. *International Journal of Foresight and Innovation Policy,* vol. 4, no 3–4, pp. 200–229. DOI: 10.1504/ijfip.2008.017577.

Dahlander L., Gann D.M. (2010) How open is innovation? *Research Policy*, vol. 39, no 6, pp. 699–709. DOI: 10.1016/j.respol.2010.01.013.

De Faria P., Lima F., Santos R. (2010) Cooperation in innovation activities: The importance of partners. *Research Policy,* vol. 39, no 8, pp. 1082–1092. DOI: 10.1016/j.respol.2010.05.003.

Dezhina I.G., Medovnikov D.S., Rozmirovich S.D. (2018) Otsenki sprosa rossiiskogo srednego tekhnologicheskogo biznesa na sotrudnichestvo s vuzami [Evaluating the demand of Russian medium-size technological companies in cooperation with higher educational institutes]. *Zhurnal Novoj ehkonomicheskoj associacii / Journal of the New Economic Association*, vol. 36, no 4, pp. 81–105. DOI: 10.31737/2221-2264-2017-36-4-4 (in Russian).

Edquist C. (2011) Design of innovation policy through diagnostic analysis: Identification of systemic problems (or failures). *Industrial and Corporate Change,* vol. 20, no 6, pp. 1725–1753. DOI: 10.1093/icc/dtr060.

Fagerberg J., Mowery D.C., Nelson R.R. (eds.) (2005) *The Oxford Handbook of Innovation,* Oxford (UK): Oxford University Press. DOI: 10.1093/oxfordhb/9780199286805.001.0001.

Freeman C. (1987) *Technology policy and economic performance: Lessons from Japan,* London: Pinter.

Fritsch M., Lukas R. (2001) Who cooperates on R&D? *Research Policy,* vol. 30, no 2, pp. 297–312. DOI: 10.1016/s0048-7333(99)00115-8.

Godin B. (2006) The linear model of innovation: The historical construction of an analytical framework. *Science, Technology and Human Values,* vol. 31, no 6, pp. 639–667. DOI: 10.1177/0162243906291865.

Godin B. (2008) *Innovation: The history of a category* (Project on the Intellectual History of Innovation Working Paper no 1), Québec: Institut national de la recherche scientifique.

Gokhberg L., Kuznetsova T. (2015) Russian Federation. *UNESCO Science Report: Towards 2030* (ed. S. Schneegans), Paris: UNESCO, pp. 343–363.

Greco M., Grimaldi M., Cricelli L. (2016) An analysis of the open innovation effect on firm performance. *European Management Journal,* vol. 34, no 5, pp. 501–516. DOI: 10.1016/j.emj.2016.02.008.

Hayter C.S., Nelson A.J., Zayed S., O'Connor A.C. (2018) Conceptualizing academic entrepreneurship ecosystems: A review, analysis and extension of the literature. *Journal of Technology Transfer*, vol. 43, no 4, pp. 1039–1082. DOI: 10.2139/ssrn.3137406.

HSE (2019) *Indikatory innovatsionnoi deyatel'nosti: statisticheskii sbornik* [Indicators of Innovation: Yearbook], oscow: HSE (in Russian).

Humphrey J., Schmitz H. (2002) How does insertion in global value chains affect upgrading in industrial clusters? *Regional Studies,* vol. 36, no 9, pp. 1017–1027. DOI: 10.1080/0034340022000022198.

Kaufmann A., Tödtling F. (2001) Science–industry interaction in the process of innovation: The importance of boundary-crossing between systems. *Research Policy,* vol. 30, no 5, pp. 791–804. DOI: 10.1016/s0048-7333(00)00118-9.

Kim Y., Vonortas N.S. (2014) Cooperation in the formative years: Evidence from small enterprises in Europe. *European Management Journal,* vol. 32, no 5, pp. 795–805. DOI: 10.1016/j.emj.2014.02.003.

Kline S., Rosenberg N. (1986) *The positive sum strategy: Harnessing technology for economic growth*, Washington, DC: National Academy Press. DOI: 10.17226/612.

Kratzer J., Meissner D., Roud, V. (2017) Open innovation and company culture: Internal openness makes the difference. *Technological Forecasting and Social Change,* vol. 119, pp. 128–138. DOI: 10.1016/j.techfore.2017.03.022.

Kuznetsova T., Roud V. (2013) Konkurenciya, innovacii i strategii razvitiya rossijskih predpriyatij (rezul'taty empiricheskih issledovanij [Competition, innovation and strategy: Empirical evidence from Russian enterprises]. *Voprosy Ekonomiki,* no 12, pp. 86–108. DOI: 10.32609/0042-8736-2013-12-86-108 (in Russian).

Laursen K., Salter A. (2006) Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms. *Strategic Management Journal,* vol. 27, no 2, pp. 131–150. DOI: 10.1002/smj.507.

Lee K. (2020) Openness and innovation in online higher education: A historical review of the two discourses. *Open Learning: The Journal of Open, Distance and e-Learning,* pp. 1–21. DOI: 10.1080/02680513.2020.1713737.

Leydesdorff L., Rotolo D., de Nooy W. (2013) Innovation as a nonlinear process, the scientometric perspective, and the specification of an 'innovation opportunities explorer. *Technology Analysis and Strategic Management*, vol. 25, no 6, pp. 641–653. DOI: 10.1080/09537325.2013.801948.

Lhuillery S., Pfister E. (2009) R&D cooperation and failures in innovation projects: Empirical evidence from French CIS data. *Research Policy,* vol. 38, no 1, pp. 45–57. DOI: 10.1016/j.respol.2008.09.002.

Lundvall B.Å. (1992) *National Systems of Innovation. Towards a Theory of Innovation and Interactive Learning*, London: Pinter.

Nambisan S., Wright M., Feldman M. (2019) The digital transformation of innovation and entrepreneurship: Progress, challenges and key themes. *Research Policy,* vol. 48, no 8, pp. 1–9. DOI: 10.1016/j.respol.2019.03.018.

Nelson R. (ed.) (1993) *National Innovation Systems,* New York: Oxford University Press.

Nieto M.J., Santamaría L. (2007) The importance of diverse collaborative networks for the novelty of product innovation. *Technovation,* vol. 27, no 6–7, pp. 367–377. DOI: 10.1016/j.technovation.2006.10.001.

OECD (2015) *The future of productivity. Joint Economics Department and the Directorate for Science, Technology and Innovation Policy Note,* Paris: OECD. DOI: 10.1787/9789264248533-en.

OECD, Eurostat (2018) *Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation* (4th ed.), Paris: OECD. DOI: 10.1787/24132764.

Perkmann M., Walsh K. (2007) University–industry relationships and open innovation: Towards a research agenda. *International Journal of Management Reviews,* vol. 9, no 4, pp. 259–280. DOI: 10.1111/j.1468-2370.2007.00225.x.

Plewa C., Korff N., Baaken T., Macpherson G. (2013) University–industry linkage evolution: An empirical investigation of relational success factors. *R&D Management,* vol. 43, no 4, pp. 365–380. DOI: 10.1111/radm.12021.

Rosenbloom R.S., Spencer W.J. (1996) The transformation of industrial research. *Issues in Science and Technology,* vol. 12, no 3, pp. 68–74.

Roud V., Fursov K. (2011) Rol' statistiki v diskussii o nauchno-tekhnologicheskom i innovatsionnom razvitii [The role of statistics in the debate on science, technology, and innovation]. *Voprosy Ekonomiki*, no 1, pp. 138–150. DOI: 10.32609/0042-8736-2011-1-138-150 (in Russian).

Roud V., Vlasova V. (2020) Strategies of industry-science cooperation in the Russian manufacturing sector. *Journal of Technology Transfer,* vol. 45, no 3, pp. 870–907. DOI: 10.1007/s10961-018-9703-3.

Simachev Y., Kuzyk M., Feygina V. (2014) Vzaimodejstvie rossijskih kompanij i issledovatel'skih organizacij v provedenii NIOKR: tretij ne lishnij? [R&D cooperation between Russian firms and research organizations: Is there a need for state assistance?]. *Voprosy Ekonomiki*, no 7, pp. 4–34. DOI: 10.32609/0042-8736-2014-7-4-34 (in Russian).

Srholec M. (2015) Understanding the diversity of cooperation on innovation across countries: Multilevel evidence from Europe. *Economics of Innovation and New Technology,* vol. 24, no 1–2, pp. 159–182. DOI: 10.1080/10438599.2014.897864.

Teece D.J. (2007) Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal,* vol. 28, no 13, pp. 1319–1350. DOI: 10.1002/smj.640.

Teplykh G. (2015) Draivery innovatsionnoi aktivnosti promyshlennykh kompanii v Rossii [Drivers of innovation activity of manufacturing enterprises in Russia]. *Prikladnaya ekonometrika / Applied Econometrics,* no 2 (38), pp. 83–110 (in Russian).

Tether B.S. (2002) Who co-operates for innovation, and why: An empirical analysis. *Research Policy,* vol. 31, no 6, pp. 947–967. DOI: 0.1016/S0048-7333(01)00172-X.

Torre A. (2008) On the role played by temporary geographical proximity in knowledge transmission. *Regional Studies,* vol. 42, no 6, pp. 869–889. DOI: 10.1080/00343400801922814.

Van Beers C., Zand F. (2014) R&D cooperation, partner diversity, and innovation performance: An empirical analysis. *Journal of Product Innovation Management,* vol. 31, no 2, pp. 292–312. DOI: 10.1111/jpim.12096.

Wang C.H., Chang C.H., Shen G.C. (2015) The effect of inbound open innovation on firm performance: Evidence from high-tech industry. *Technological Forecasting and Social Change,* vol. 99, pp. 222–230. DOI: 10.1016/j.techfore.2015.07.006.

Wernerfelt B. (1984) A resource–based view of the firm. *Strategic Management Journal,* vol. 5, no 2, pp. 171–180. DOI: 10.1002/smj.4250050207.

Yakovlev A. (2014) Russian modernization: Between the need for new players and the fear of losing control of rent sources. *Journal of Eurasian Studies,* vol. 5, no 1, pp. 10–20. DOI: 10.1016/j.euras.2013.09.004.