

Networks as Drivers of National Innovative System Development in the Conditions of Globalization

Alexander Kurochkin^{1,*}, and Svetlana Morozova¹

¹St. Petersburg University, Faculty of Political Science, Department of Russian Politics, Smolny 1/3, 191124, St. Petersburg, Russia

Abstract.

Research background: The modern social, political and economic challenges of the Fourth Industrial revolution and development of the Network Society actualized the problem of maximizing of effectiveness of innovative policy analysis as one of the key factors of economic and political competitiveness of national states, regions, cities and urban agglomerations in Global World.

Purpose of the article: The study focuses on the impact of networking on the effectiveness of national innovative development in the context of globalization. In this vein, the main ways of network interaction are considered and the network model of innovation policy is analyzed.

Methods: Modern innovation policy is a synthesis of scientific, economic, industrial, and partly regional policy of the state, aimed at the formation and maintenance of an adequate institutional environment for the process of creating, disseminating and introducing innovations. Thus the key feature of the research methodology is the combination of the New Institutional Approach and the Network Theory.

Findings & Value added: The study provides a detailed analysis of international experience in the field of open innovation and innovative development based on network interaction. Moreover, the authors present the classification of countries that are leaders in the process of building information (communicative) and network infrastructure. Particular attention is paid to issues of network interaction at the global level and the case of Russian innovation system in this context.

Keywords: *digital innovation; network; globalization; open innovations; global networking*

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*Corresponding author: a.kurochkin@spbu.ru

1 Introduction

The growth of business innovation activity and the process of producing new knowledge as a whole constitute the fundamental foundations of the modern states competitiveness on the world stage, and also determine key indicators of socio-economic development within the country (quality of life, income level, basic demographic indicators, etc.). Today, almost everywhere the structure of innovative development is changing significantly, which is determined, first of all, by the fact that in the process of developing and implementing innovative policies, decisions quickly become outdated and require constant correction. As a result, ideas about the innovation process, and, consequently, the ways to manage it, are inevitably changing.

At the moment, traditional relation forms in state innovation policy are being supplanted by network structures based on interregional and international scientific cooperation. Based on the analysis of existing approaches to the study of the «network» category in innovation, Zараichenko I.A. quite accurately formulated the concept of an innovative network: «it is a polycentered set of independent subjects of innovative activity, combined by communication links and resource flows, providing technology transfer through the exchange of resources and / or diffusion of innovations, contributing to the emergence of a network effect as a consequence of the economic effect of increasing returns» [1, p.248]. Thus, the backbone elements of the innovation network are infrastructure, institutions and resources.

The main goal of this research is to analyze and assess the impact of network interaction on the effectiveness of national innovative development in the context of globalization.

2 Theoretical Frameworks and Methods: Network Model of Innovation Policy

As mentioned earlier, the key feature of the research methodology is the combination of the New Institutional Approach and the Network Theory in innovation policy.

During the first two thirds of the twentieth century, two competing approaches dominated the system of ideas about innovation and its role in economic development. The first can be conditionally defined as an approach based on the driving force of market demand, recognized as the main catalyst for technological innovations. Market dynamics, respectively, determined the sectoral structure of innovation activity. However, far from always in practice it is possible to correlate the needs of the market and the appearance of relevant innovations. Often it is not demand that forms innovation, but innovation itself over time that forms demand.

The second approach can be defined as the dependence of technological development on innovative momentum. It determines the decisive role in the innovation process not of market conditions, but of individual innovators (scientists, entrepreneurs, etc.) and, accordingly, is based on the principles of a linear model of innovative development formulated by J. Schumpeter [2], which can be summarized as follows:

- a new idea and technology can always be brought into the form of the final product and demanded by the market;
- an entrepreneur taking on innovative risks is the main driving force of technological development;

- innovative impulses (or waves in Schumpeter's terminology) emanating from individual innovators lead to a process of «creative destruction», which consists in erosion, destruction of existing economic structures and relations and thereby contributes to their significant renewal.

However, this model suffers from excessive technological determinism, and, therefore, ignores the social, cultural, institutional and other factors of the innovation process. In addition, this approach is not able to adequately explain the commercial success of some innovations and the failures of others: as a result, the possibilities of innovative development are limited by a certain set of technological development trajectories.

By the 1980s, the economic theory of innovation and the sociology of management had a strong idea that neither the first model nor the second already corresponded to the realities of innovative development at the end of the 20th century and were not able to adequately reflect the modern innovation process. This revealed the need to develop a new model of innovative development [3].

A number of modern researchers have devoted their scientific works to innovation policy [4-7]. In this vein, the analysis of the meaning and impact of network theory and the network approach refers to the key issues of modern innovation policy [8-13].

Modern innovation policy is a synthesis of scientific, economic, industrial, and partly regional policy of the state, aimed at the formation and maintenance of an adequate institutional environment, as well as resource support for the process of creating, disseminating and introducing innovations. Therefore, when considering the models for the development and implementation of innovation policy, it is important to remember its complex nature, which is not limited to the economic or managerial component. It is also necessary to take into account the relationship of effective innovation policy with the innovative potential of the public administration system, which is determined primarily by the willingness and ability of the state apparatus to update the forms and contents of its own activities, the openness and flexibility of its structure, as well as the focus and dynamics of administrative reforms.

The connection between a successful innovation policy and the provision of effective internal and external communications both in the public administration system and in society as a whole seems very transparent. Almost any innovative system in the modern network world is based on mechanisms that ensure the free production and circulation of knowledge, as well as a high level of cooperation and business cooperation between the elements of this system. The network model, from our point of view, can be recognized as the most appropriate model for the development and implementation of an innovation policy. This model of innovation policy implies:

- freedom of communication and the availability of flexible management structures;
- openness of the process of developing innovative policies for all interested actors;
- definition of a clear institutional framework for interactions within the innovation system;
- the pro-active position of the state in the innovation system.

Further, based on the above theory and methodology, we will conduct an analysis of international experience in the national innovative system development in the context of globalization. The authors will offer their own classification of innovative development models that exist in the modern global world.

3 Results: Global Experience of the Breakthrough Innovative Development

In the framework of the previously discussed coordination model of innovation policy, the key role along with the state is played by intermediary structures that ensure intersectoral innovation cooperation. This is the so-called Open Innovation Accelerators - organizations-accelerators of the innovation process, engaged in the search for knowledge centers, establishing stable links between unrelated or loosely connected knowledge centers, as well as providing strategic planning for innovative development. The technological infrastructure of the innovation ecosystem is made up of open innovation platforms or hubs, which are virtual systems that combine various tools for finding counterparties, setting innovative tasks, disseminating the best solutions, entering into formal agreements, and transferring decision concepts.

Examples of successful innovative platforms to date have accumulated quite a few. In the United States, their creation was enshrined in B. Obama's innovative development program, introduced in 2011, and became the core of state innovation policy. The international platform of MIT community created by the Massachusetts Institute of Technology (MIT) [14] is of the greatest interest. It combines the efforts of researchers and entrepreneurs from the USA, Honduras, Nicaragua, Peru, India, Pakistan and others. The platform provides an accelerated product development process in the context of broad cross-border cooperation, which makes it possible evaluation of developed innovations, conducting joint clinical trials, accumulation of resources.

The development of technology platforms at the supranational level is carried out by the European Union. The main center producing them within the EU is the European Institute of Innovation and Technology (EIT), created in 2010. This institute developed the concept of knowledge and innovation communities, which expands the functionality of technological platforms, introducing a significant social component into them and providing interaction of a wider circle of actors than research centers and entrepreneurs. Since 2010, the EIT has launched eight innovation communities: Alumni, Climate-KIC, Digital, Food, Health, InnoEnergy, Manufacturing, Urban Mobility [15]. A distinctive characteristic of these communities is the basic task of finding a pan-European strategy for innovative development and, accordingly, reducing the fragmentation of the innovation sector along national borders within the EU.

Through Knowledge and Innovation Communities, the EIT strengthen cooperation among businesses (including SMEs), higher education institutions and research organizations, form dynamic pan-European partnerships, and create favourable environments for creative thought processes and innovations to flourish. Thus, Innovation Communities are Europe's, if not the world's, largest innovation network.

The concept of open innovation has become an important prerequisite for the emergence and functioning of global innovation networks, the internationalization of national innovation companies.

Examples of multinational companies that actively use open innovation are British Telecom, BMW, Bayer, General Mills, DSM, Philips, Procter and Gamble, Unilever, Natura, SAP, Lego and others.

Next, we will present an author's approach to the analysis of international experience in innovative development.

An important basis for the classification of various models of innovative development is the degree and direction of improving the network infrastructure that ensures the effective coordination of various actors in the production, implementation and organization of innovative products industrial production. At the macro-regional level, the simplest classification allows us to identify at least three groups of countries that can be

united by a number of common characteristics within the framework of specific models of innovative development. Evaluation of the level of technological development and the quality of human capital (primarily in terms of the creative potential of the nation), the content and dynamics of the transformation of national economies in the context of the new globalization and the fourth industrial revolution allow us to identify groups of countries that are leaders in the process of building information and network infrastructure. Moreover, the methods for constructing this infrastructure, its contents, as well as macro-regional operational characteristics, are very different [16].

This classification is close to the typification of various forms of the information economy implementation, highlighted by M. Castels [17]. The first model is North American, with obvious US dominance, the second is North European, whose leaders are Sweden, Finland and Germany, and also has taken over the past 10 years a number of leading positions in the development of science-intensive industries (primarily IT industries) Estonia and, finally, the third - East Asian, where Singapore, South Korea and Japan are dominant. Table 1 presents each of the above models.

Table 1. Innovation Development Models.

Model of innovative development	Countries	Characteristic
North American	USA, Canada, UK	This model can be defined as an open information society, driven by the forces of the market, the sociocultural dominants of which are: liberal (in various variations) ideology, absolute priority of individual freedom and incentives to achieve individual success, atomization of society and high competition within the social structure. North American model is characterized by an increased role of the state in the development and implementation of a national innovation strategy. Despite the traditionally market orientation, innovative development here is increasingly associated with the support of government funds and various forms of partnership between the state and business. Another significant change is determined by the process of internationalization and networkization of innovative developments, which inevitably changes the focus of this model on the internal interests of the United States.
North European	Scandinavian, Baltic countries, partially Germany and the Netherlands	This model differs significantly from the North American primarily in its sociocultural basis. The innovative culture in the countries of Northern Europe has a number of features that make it an effective basis for the formation of a network society. It should be noted that the development was preceded by the institutionalization of the state innovation policy, stimulating and directing the innovative activity of citizens.
East Asian	South Korea, Singapore, Japan	This model is characterized by high achievements in the development of organizational, technical and institutional network infrastructure. These measures contributed to the creation of a sustainable basis for quality technological development and innovation.

Source: Author's own work

4 Discussions

Let us consider in more detail the specifics of network innovation development of several countries indicated in the table.

North American model of innovative development of the first developed and has long been a benchmark for the rest of the world. The technological development and construction of the information network infrastructure within this model is primarily associated with the Silicon Valley phenomenon (a conglomerate of cities on the peninsula between the cities of San Francisco and San Jose, USA), which has become synonymous with American innovation success. Founded on the basis of the Stanford Industrial Park in the early 1950s, Silicon Valley remains the leading and largest innovative cluster in the United States today, despite the creation of many other technology parks over the past 30 years.

The activation of state innovation policy has become a significant catalyst for the development of the US network innovation system in the last decade. In 2012, the Barack Obama administration launched the America Makes project, which has become the most significant manufacturing innovation institute (IMI) out of 14 currently making up the National Network for Manufacturing Innovation (NNMI) or, for short, Manufacturing USA, the platform for the implementation of public-private partnerships, cooperating with industrial, academic and government partners for the purpose of cooperation, joint investment in the development of industrial innovations and accelerate commercialization.

Manufacturing USA project can rightly be considered the most significant institutional innovation implemented in the US innovation system over the past four decades. Today, the development institutes that are part of Manufacturing USA are focused on the development of advanced manufacturing technologies related to modern materials, photonics, additive manufacturing, robotics, biotechnology, green energy production, modern lightweight composite materials, flexible hybrid electronics, and biopharmaceutical manufacturing, modern semiconductor components.

As noted above, despite the pronounced market orientation of innovative development, since the early 2000s. the state in the United States is actively stimulating the innovative activity of enterprises, in particular, implementing programs to support the innovation-oriented small business (SBIR) and technology transfer (Small Business Technology Transfer Research) (STTR).

Another distinguishing feature of the US innovation system is the robust protection of intellectual property rights. According to a study conducted in 2019 by the Center for Global Innovation Policy, the United States is the world leader in the protection of patent rights, trade secrets, copyrights, trademarks and service marks [18].

A similar strategy for innovative development is being implemented in Canada. Here, the leading program to foster the innovative development of small and medium-sized businesses is the Canada's Industrial Research Assistance Program (NRC IRAP) [19], implemented by the National Research Council of Canada. Based on this program, innovation-oriented small and medium-sized enterprises are provided with financial assistance, consulting services of the best specialists in the field of high-tech business and R&D.

Canadian innovation policy aims to achieve the country's industrial leadership primarily in the field of artificial intelligence and quantum computing. The Canadian Institute for Advanced Research (CIFAR) [20] is a global charitable organization that invests in research and organizes networking between universities and research centers. CIFAR facilitates breakthroughs in the field of artificial intelligence through the Learning

in Machines & Brains program, which is part of Canada's national strategy to establish the country's international leadership in artificial intelligence research.

Not having, unlike the United States, a significant impact on global innovation trends, the United Kingdom, nevertheless, has its own innovation trends. An important distinguishing feature of the UK innovation system is the fact that the majority of innovative research institutes are controlled and coordinated by the non-governmental organization United Kingdom Research and Innovation (UKRI) [21], founded in 2018.

The UK is a European technology center, one of the leaders in the field of the digital economy and is one of the group of leading digital governments in the world. Here, over the past few years, numerous programs in the digital economy have been implemented. For example, the Digital Marketplace, a platform for high-tech small businesses that offer their solutions to government agencies, and the Connection Voucher Scheme, a financing program through which more than 40,000 small businesses have access to high-speed Internet. It also occupies a leading position in Europe in the presence of a foreign innovation-oriented business.

Clusters created for research in the field of artificial intelligence, machine learning, cybersecurity and technology support the creation of new highly qualified jobs and ensure the growth of productivity of science-intensive sectors of the country's economy as a whole.

The UK government seeks to increase investments aimed at implementing TechCity UK and TechNorth programs, which were created to coordinate the British ecosystem of clusters, accelerators and technology parks based on TechNation, a development institution representing a national network of innovative projects. This institute supports technology researchers by integrating them and providing ample opportunities for growth and enhancement of digital entrepreneurship skills.

The leaders in innovation development in Germany are the German Research Center for Artificial Intelligence (DFKI), the innovation research institutes of the Fraunhofer Society, an alliance of nine leading German universities of technology: Aachen, Berlin, Braunschweig, Darmstadt, Dresden, Hanover, Karlsruhe, Munich and Stuttgart.

The R&D organization in Germany also has its own peculiarity: it does not have a central mechanism coordinating research and identifying priority areas. Universities and research institutions are funded both from national funds and from land budgets.

At the federal level, the Federal Ministry of Education and Research (BMBF) and the Federal Ministry of Economics and Energy (BMWi) bear the main responsibility for implementing German innovation policy. Some line ministries support their own research institutes (Federal Ministry of Food and Agriculture; Federal Ministry of the Environment, Nature Conservation and Nuclear Safety; Federal Ministry of Health; Federal Ministry of Defense, etc.).

An important component of the state scientific and technological policy of Germany is the promotion of the internationalization of the country's research infrastructure by achieving a level of research work in universities and non-university research institutions that would attract more foreign students and scientists, and, as a result, create the basis for development international innovation culture.

If a breakthrough in the spread and development of innovative technologies in the United States occurred in the 1980s - early 1990s, in Northern Europe - in the first half of the 1990s, then in the countries of Southeast Asia (the so-called «young tigers») it occurred in the middle - second half of the 1990s. The obvious «new leaders» here are South Korea and Singapore. The achievements of these states are very significant, especially against the background of the modest successes of neighboring countries in the development of network infrastructure [16].

Singapore is a unique city-state that gained independence only in 1965. All these years, Singapore developed within the framework of a de facto one-party and generally authoritarian political system and, accordingly, did not experience the consequences of a competitive political struggle.

Strict centralization of the political decision-making process and the relatively weak participation of civil society institutions in it are associated with this quality of the country's political system. However, the specifics of the political and legal culture painlessly allows regulating this issue to Singaporean government bodies, which creates a stable basis for high-quality technological development and innovation.

Back in 1995, one of the first sites in the world was created in Singapore, which is considered the prototype of modern e-government. In 2000, a mega-project was launched here to create the most modern e-government portal in the world. Integrated portals of state institutions «Singapore Government Online» and the service center «Electronic Citizen» (eCitizen) have been deployed, providing comprehensive services for citizens, including access to electronic forms of tax and other payments, a medical card, car registration, student registration in school, and for companies - access to the electronic public procurement system, information on preferential lending schemes, consulting, etc.

This significant reserve has ensured the effective implementation of the «intellectual or clever nation» (Smart Nation) project.

The Smart Nation project in Singapore has several distinctive characteristics that generally correspond to the characteristics of the East Asian model of innovative development. Firstly, this is an initiative government project in which the state acts as the coordinator and the center of innovative development stimulating the activity of business and citizens. The government is actively using financial, educational and administrative tools to involve more actors in the project.

Considering the Russian contribution to global innovation process, it seems important to describe the following opportunities and obstacles.

In Russia, the main document that defines the state policy in the field of innovation is the Strategy for Innovative Development of the Russian Federation for the period until 2020 [22], according to which the key tasks of Russia's development are: increasing the openness of the national innovation system and economy; increasing the degree of integration of the country in world processes; creation and use of innovations; expansion of bilateral and multilateral international cooperation.

The main participants in the Russia's innovation process are: companies with state participation (60), territorial clusters (25), technology platforms (9), development institutions (8). The main subjects of innovation in Russia are: business incubators (193), technology parks (159), technology transfer centers (111), collective use centers (73), etc. An innovative ranking of Russian regions is led by St. Petersburg, Moscow, Nizhny Novgorod Oblast, the Republic of Tatarstan, Tomsk Oblast [23].

In Russia, there are currently trends towards the formation of innovation networks, including with the participation of national enterprises and organizations in global innovation networks.

For example, since 2008, the Union of Innovation and Technology Centers of Russia (ITC) [24] has been implementing the Gate to Russian Innovation Networks project (Gate2RuBIN - Russian Business Innovation Network), a national and international scale project - a project for Russia's participation in the Enterprise Europe Network - EEN). The overall goal of the Gate2RuBIN project is to promote the development of scientific, technological and business cooperation between small and medium enterprises and scientific organizations of Russia and the EU to increase their competitiveness.

Another example is the Russian Technology Transfer Network (RTTN) [25] established in 2002. Now it unites more than 50 innovation centers from 40 regions of

Russia and the CIS countries specializing in technology transfer. The network is a tool of national and regional innovation infrastructure, which allows to efficiently distribute technological information and search for partners for implementing innovative projects.

The network is developing as a structure of a distributed type - each center / network member provides technology transfer services to customers in its region (innovative companies, scientific and educational organizations), interacting with network members from other regions, as well as network partners from other countries.

The most important competitive advantage of RTTN is the use of an adapted European technology transfer methodology, which allows technology transfer not only on a national scale (inter-regional transfer), but also internationally.

Nonetheless, the use of open innovation tools in Russia has not yet received a systemic spread, despite the available individual examples. This may be due to both the lack of information and knowledge in the field of open innovation tools and its capabilities, and insufficient motivation to use them, as well as the lack of high-quality services of innovative intermediaries in the Russian innovation market.

5 Conclusion

Having analyzed the impact of network interaction on the effectiveness of national innovative development in the context of globalization, as well as having considered the main global trends of innovative development and their refraction through the experience of implementing macro-regional models, we can formulate the following conclusions.

The presence of relatively stable trajectories of innovative development on a global macro-region scale impedes the universalization of innovation management methods and technologies on a global scale. At the same time, without exception, all national economies and macroregions are subject to general global trends, determined primarily by the effects of new globalization and the fourth industrial revolution, and, therefore, are forced to look for effective answers to the challenges they generate.

The second conclusion concerns a substantial and widespread growth in the importance of the state as a key actor in innovative development, provided that its role and place in this process is significantly transformed. We are talking about updating the coordination function and, accordingly, the need to develop the dynamic capabilities of the public administration system while maintaining the role of the main investor in the innovative development of the economy.

The analysis of successful global experience in the field of innovative development also allowed us to formulate the necessary measures for the effective implementation of the innovative development concept in Russia and other countries where the national innovation system needs development and improvement.

These measures involve, first of all, network interaction, international cooperation and open innovation:

- Innovative infrastructure development;
- Strengthening the integration of the national innovation system elements through the creation and development of innovation networks;
- Strengthening the interaction and coordination of the activities of federal and regional executive bodies, development institutions and other subjects of innovation policy;
- Creation and development of open innovation platforms aimed at both inter-regional and international network innovation;
- Expanding forms of international cooperation and attracting financing from foreign investors (including the formation of a marketing strategy for their targeted attraction);

- The conclusion of bilateral and multilateral international agreements in order to strengthen scientific, technical and innovative cooperation (not limited to the countries of the European Union).

As already concluded above, the most important role in the implementation of the above measures is assigned to the state. We list the key functions that the state should perform in the framework of the innovation policy coordination:

- Institutional and organizational support of the representatives cooperation process of various fields involved in the innovation process. This function is realized through the creation of the necessary regulatory framework, institution or resource incentives for organizations of intermediaries or accelerators of innovative activities, various forms of stimulating effective international cooperation (removing institutional and, possibly, cultural and ideological barriers);
- Creation of the necessary technological infrastructure at the state level and the alignment of technological conditions for innovation at the level of individual regions and municipalities (modern types of wired and wireless communications, a sufficient number of public Internet access points, the availability of public databases, etc.);
- The formation of virtual systems for the exchange of best practices (benchmarking) of the organization and innovation process regulation, the creation of open databases on innovations (in industry and territorial sections), as well as the promotion of business participation in the work of such systems;
- Development of an educational policy, firstly, corresponding to the goals and objectives of innovative development (i.e., aimed at the formation of innovative settings in society, the development and teaching of new methods for searching, processing and analyzing information, the translation of world and domestic experience of innovative development, etc.), secondly, aimed at solving the problem of overcoming cognitive mismatch during the production of new knowledge.

These conditions can be used by local authorities as a key to breakthrough development of national innovative system.

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