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Features of the Advancement of Science as an Integral Part of the National Innovation System in Modern Russia

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Abstract

The study explores current tendencies in science and innovation in Russia and gives an assessment of perspectives for optimization of the national innovation system. The paper reviews the main trends in the development of science and innovation in the modern world. A comparative analysis of the historical experience in science and innovation in Russia is made that reveals the dominating role of the state and the military character of the national innovation system. The evaluation of the current national innovation system shows the inclination of the Russian state to preserve the traditional system. Extrapolation of the results of the current policy, even to the near future, indicates further degradation of the national innovation system is likely. The findings of the study demonstrate the need to work out a strategy for development of the national innovation system in which the government will have to energize other parts of the innovation system, such as private companies, entrepreneurs, and universities, and create an open and competitive environment with free access to resources for every participant to achieve the full potential of the national innovation system.

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Keywords: innovation, national innovation system, science

1. Introduction

The paper deals with the Russian government policy in the field of science and innovation development. The study focuses on the analysis of traditional principles of science and technology policy in Russia as well as their transformation in post-Soviet Russia. The analysis also aims to reveal the main contradictions and problems related to the implementation of the government's policy toward innovation development to find the historical and cultural roots of their formation.

Current science of science treats the process of scientific knowledge and innovation as a complex system with a number of interacting factors which give rise to new ideas and knowledge. This knowledge in turn may contribute to the development of new products, processes, organizations, and the opening of new markets (Schumpeter, 1939; Schumpeter, 1967). Today many researchers, when analyzing the process of obtaining new knowledge (primarily,

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knowledge about how to change the world) and innovations use the system approach developed by Freeman, Lundvall, and Nelson (Freeman, 1987; Lundvall, 1992;Lundvall, 1998; Lundvall, 1999; Lundvall, 2003; Nelson, 1988), known as the national innovation system (NIS) concept. Several, recent papers have been written on the analysis of the innovation policy of modern Russia that apply the methodology based on the NIS concept (Ivanov, 2011; Ivanov, 2004; Golichenko, 2006). At the same time, there are new contributions that give parallels between science and innovations in modern Russia, in the Soviet Union and in the pre-Soviet Russian Empire. The American historian of science, Loren Graham (Graham, 1998), wrote about the negative effect of "Lysenkoism" on Russian genetics. Later, Graham together with the Russian science theorist I.Dezhina, analyzed the formative stages of the Russian scientific system during the 1990-2000 transitory period (Graham, 2008). Still there are few studies that show the historical, cultural and institutional trends of development that are still impacting the shaping of the Russian scientific and innovation policy.

This paper attempts to answer the following questions:

- What are the principal cultural and institutional trends in the development of modern science as a key element of national innovation systems?
- What historical, cultural and institutional factors play a major role in shaping the specific character of the Russian national innovation system?
- What main principles of Russia's strategic development could provide competitiveness of the national innovation system?

The results of the research will contribute to the understanding of the features of national innovation systems which have been formed under the influence of historical, cultural and institutional trends of the development of nations and states. The proposed conclusions could be integrated into the national strategy of shaping and operating Russia's innovation system.

The structure of the paper is as follows:

Section 1 – Introduction and rationale of the research.

Section 2 – Theoretical framework of the research based on the concept of the national innovation system.

Section 3 – Methodology of the research.

Section 4 – Overviews the modern development trends in science and innovation.

Section 5 – Historical process of the formation of cultural and institutional differences between research and innovation policies in Western Europe and Russia that includes a comparative analysis of the major goal sets in the development of science and innovation in pre-revolutionary Russia and the USSR.

Section 6 – Specific strategy for innovation development in Russia today and possible approaches for increasing the efficiency of Russia's innovation system.

2. Theoretical framework of research. National innovation system and cultural aspects of scientific and innovative performance

In this paper science is seen as a system of activities used to reveal new true knowledge. This is how scientific realism, which we will draw on (Hacking, 1983), treats the goal setting of science.

Since the end of the 19th century, science has been closely associated with the development of technology (Habermas, 2003). Further development of applied and basic scientific research is inconceivable without creating appropriate technical means for their implementation. In addition, science has become increasingly dependent on staffing and financial support of its activities on the part of the organizations concerned (public and private companies, educational institutions, employers, etc.). This interaction is initially established within the boundaries of particular nation-states. The concept of national innovation systems (NIS) has been proposed to consider the interaction of various institutions that have a significant impact on the development of science, engineering and technology (Freeman, 1987; Lundvall, 1992; Lundvall, 1998; Lundvall, 1999; Lundvall, 2003; Lundvall, 2007; Nelson, 1988). Within the NIS concept the national innovation system is treated as a system consisting of elements and relationships which interact in production, dissemination and application of new and economically useful knowledge (Lundvall, 1992). The theory helps organize and specify the analysis and provide the basis for rational action (Lundvall, 1992). The concept of national innovation systems investigates the relationships between

technological development and the institutional basis of innovative activity and separates cultural and institutional aspects that influence the process of obtaining new knowledge and technologies. The NIS concept creates conditions for the comparative analysis and assessment of the place and role of different components of the national innovation system. It also helps identify applicable features of the national character. The analysis performed using the conceptual foundation of the national innovation system reveals significant historical, cultural and institutional factors that influence the activity of various institutions involved in the development and implementation of the strategy of the country's innovative development.

3. Methodology of research

The socio-humanitarian nature of the study determined the choice of methods and approaches of the research. The specifics of the problem, which are related to the explication of philosophical and cultural foundations of the transformation of scientific activities as part of the national innovation system in Russia and identification of trends in their development, led to the choice of the comparative method as the primary method in addressing a range of tasks of the study. One of the key methods of the study is the use of a system approach, which creates the most complete picture of the variety of factors that have a significant impact on scientific activities and other elements of the national innovation system. The research program involves consideration of the problems of formation of modern education within a historical context, which implies the use of the comparative-historical method. The study intends to use the idealization method to determine the probable evolutionary trends of scientific activities as well as other components of the national innovation system.

4. Modern trends in the development of science and innovation

Currently there is a lot of talk about the growing role of science and the results of its activity in the development of individual states and the world community at large. Intensification of research to acquire new knowledge about the world creates preconditions for the invention of new technical facilities and production technologies and creates conditions for innovation in all areas of public life and society. Science has an impact on culture and well-being of people around the world.

Competition and cooperation between many countries now takes place not only in economics and politics, but also in science. This is caused by the fact that countries' economic and political status as well as their population's well-being are largely derived from the activities of their scientific community. That is why, among the trends in the development of many countries of the modern world, until recently, focused on the maximum preservation of tradition in economics, politics and social life, we see the adoption of a strategy to build and maintain market economic relations and a growing interest in innovation and intensification of research. Among the countries are those with established traditions of the capitalist mode of production and those that are very cautiously introducing elements of capitalism. Not all of them have radically changed the basis of their socio-economic and political systems, but in order to ensure sustainable development of science and innovation in their national innovation systems they must change. It is clear that the countries' future largely depends on science. Science raises hope that can be transformed into investment flows into the country's economy as well as the development of industry and education. It is not the result that really counts here and now, but the movement in this direction.

In turn, modern scientific activity is highly dependent on the conditions created by governments and public bodies to intensify research. This dependence is expressed not only in the need to provide the resource base for scientific research, but also in the choice of priorities, setting of objectives, selecting of the means of scientific research, and also determining the application of the knowledge gained. In this connection it should be noted that modern science is increasingly abstracted from the solution of particular problems, focusing instead on the search for more general patterns. The American physicist Weinberg noted that biologists are more indulged in genes than inflammation of joints, and physicists would rather study proton-proton collisions at an energy of 20 trillion electron volts (eV) than just 20 eV» (Weinberg, 1992).

However, skepticism is growing about the effectiveness of many areas of research and about the assessment of potential implementation of knowledge gained in the course of theoretical research in the field of applied science or

engineering. Weinberg therefore wrote that the more fundamental physical principles we discover, the less relevant they are to us (Weinberg, 1992).

There has been the formation of a gap between the needs of theoretical and experimental sciences (primarily in financial and material resources) and the capability of societies to provide them. Modern science is not always able to assess the potential practical impact of research results, which can be expressed in technical objects, financial benefits of technology in practice, and so on, but requires the community to develop long-term programs for financing large-scale research. Therefore, the society sometimes refuses to support the scientific community because of the doubt that the discovery of new phenomena can lead to the creation of useful technical and technological applications. It is partly due to this kind of doubt that the financing and construction of the superconducting supercollider was discontinued in the USA in 1993. However, isolated cases of termination of major research projects do not negate the presence of global trends associated with an increase in funding of science. Further, it should be noted that the purpose of scientific and cognitive activity has always been to get the truth. Modern social and cultural context has not substantially changed the significance of achieving this goal for scientists, but some emphasis has changed. Since modern science is a transition from the solution of particular problems to finding common laws (Weinberg, 1992), an important social consequence of this step was the statement of inability to address these issues through the efforts of individual scientists or groups of scientists limited by capabilities of the national state. Scientists should be involved in research of various scientific communities that have access to expensive equipment and an array of information. The choice of research methods is possible only in the presence of appropriate technical means which are created by joint efforts of many countries. Thus, globalization and internationalization of research are the most important conditions for providing scientists with access to information and appropriate technical means for research. Because of this, modern science can hardly develop in the narrow confines of the nation-state, or their scientific community, isolated from interaction with colleagues from other countries.

In recent years, a large number of funds for research and development programs have been established. Smaller and more flexible organizational structures like laboratories and temporary scientific teams, rather than large institutions, are turning into the basic funded structural unit of science. In the implementation of large-scale research projects consortia of scientists from different countries, such as the LHC (Large Hadron Collider), the International Thermonuclear Experimental Reactor (ITER), and others come to the front.

The scale of current scientific problems and, consequently, the efforts taken by the scientific community to solve them, predetermined the fact that the knowledge obtained by numerous research teams is distributed over many hundreds and thousands of publications. This has led to the need to enhance and expand communication between researchers of the scientific community (Ardashkin, 2003).

Since globalization covers many areas of life, especially economics and innovation, some researchers have proposed considering innovative processes at different levels of organization - regional (Cooke,1996; Maskell and Malmberg, 1997) and sectoral (Breschi and Malerba, 1997). However, the present study, in which we discuss the development features of the national innovation system in Russia, will not consider these approaches as alternatives.

Thus, we can say that the national system of innovation meets the contemporary trends only if it ensures adherence of science and technology to internationalization of scientific research, removes obstacles to international mobility of brainpower; provides for the expansion of opportunities for research funding; and facilitates rapid commercialization of scientific knowledge, technical products or production technology. In other words, advanced national innovation systems develop with increasing openness and diversity of interaction with other national innovation systems and their players and institutions.

5. Historical, cultural and institutional distinctions in the formation of research and innovation policies in Western Europe and Russia

The shaping of modern advanced science is not the result of efforts of individuals or corporations. It is the result of coordinated, concerted long-term efforts of the state, society and corporations to meet the needs of the community, economy, production and the military for knowledge, techniques and technologies of production to ensure people's well-being and safety. The foundation stone of modern science, in which the leading role is played by natural science, was laid in a geographically limited region of the world, Western Europe, and in a fairly limited period of

time, the 17th century. Science exerted greater influence on the growth of productive forces and gradually occupied an important place in the capitalist system of economic relations. Among other things, it helped justify the shaping of industry as the technical instrument of economic management in support of the state's aim at increasing the comfort of life and labor productivity. In this regard, J. Habermas noted a twofold advantage of the capitalist mode of production over the preceding ones. It manifested itself in the creation of the economic mechanism that extended the expansion of subsystems of purposeful-rational actions, as well as in the formation of the dominate system that could adapt to the new rational requirements of progressive subsystems (Habermas, 2003). Thus, science as one of the subsystems of purposeful-rational action becomes a means of ensuring the existence and development of the capitalist mode of production. The functioning of science in the developed world has always been, and still is, characterized by the fact that it provided an opportunity for technical application of knowledge that created conditions for the expansion of comfort of life and increase in the range of goods and services. In turn, the state and society under the domination of the capitalist mode of production have become obliged to care about further expansion and improvement of the comfort of life, economic competitiveness, and increase in freedom of creativity manifestation, rationalization and democratization of management activities at all levels of the state. This fact formed the basis of close relationships between science and the scientific community on the one hand, and various social institutions on the other.

Increasing needs of social production and consumption led to the formation of stable relationships between science and technology by the end of the 19th century. In response, the state and society began to allocate more substantial resources (human, material, financial) to conduct scientific research. Science was no longer a matter of talented and obsessed individuals. The scientific community began to grow and one of the most distinct trends in the development of natural sciences, especially physics, was a huge increase in the cost of research. Additionally, in capitalist society, as shown by J. Habermas (Habermas, 2003), science performs an ideological function that manifests itself in the generation of a technocratic consciousness that creates the prospect of emancipation of the human race, fair and free from domination and conciliating both sides of the interaction.

The spread of science (mainly natural science) beyond Western Europe paralleled the emergence and formation of institutions of bourgeois society. This relationship can be traced in the history of many countries in Europe, Asia and America. This is also the case in the history of Russia, where the institutionalization of scientific activity took place in parallel with the decay of the traditional society and the transition to capitalist relations. The results of scientific research of Russian scientists and inventors suggest that by the end of the 19th century Russia had developed a complex system of innovation. This system included the following:

- Government agencies (Ministry of National Education, Ministry of War, Ministry of Railways)
- Non-governmental organizations under the control of the state (St. Petersburg Academy of Sciences, the Free Economic Society, the Russian Geographical Society, the Russian Historical Society, etc.)
- Higher education institutions (universities and institutes, schools and academies)
- Research teams funded by private individuals and organizations.

Thanks to these organizations, Russian science has begun its invasion of the world's scientific thought since the 1860s (Bovykin, 2001). During this period, Russian scientists formulated the theory of the chemical structure of organic compounds (A. Butlerov), the periodic law of chemical elements (D. Mendeleev), the theory of the development of multicellular organisms the doctrine of phagocytosis (I. Mechnikov), the teaching of conditioned reflexes (I. Pavlov), and began the research into aerodynamics (N. Zhukovsky) and geochemistry (V. Vernadsky).

In this period the development of Russian science and technology, to a large extent, was determined by the state's needs for arms and transport. In the absence of other active subjects of innovative activity the active role of the state provided significant advances in Russian science and technology. Before the break of World War I the projects on creating wireless communication, multi-engine airplanes, fast ships, rapid-and long-range artillery systems, locomotives, diesel engines, and others had been developed and put into practice.

At the same time, liberalization of social and political life in the last years of the Russian Empire and increased financial opportunity of private firms helped to expand the range of subjects of research and educational activities in Russia. The national scientists and inventors oriented themselves on topics that lay outside the interests of the government departments, but not on the demands posed by the government departments. This allowed Russian

scientists to make significant progress in the field of chemistry, physics, medicine, electrical engineering, energy, aviation, etc. The foundation was laid for further studies that enabled Russian science to continue to be productive even in time of social revolution and civil war. Suffice it to say that in the famine that gripped Petrograd (St. Petersburg) in the early 1920s even individual efforts of Russian scientists resulted in significant discoveries. In particular, A.A. Friedman in his papers, published in 1922-1924, gave a non-stationary solution of the cosmological problem on the basis of the general theory of relativity, or, to put it simply, proposed a theory of the expanding Universe (Zel'dovich, 1964). However, the process of changing of the national innovation system was interrupted by the revolutionary events of 1917. Due to this, some of the goals of scientific activity along with the orientations of socio-economic and political development in Soviet society changed, but the priority to serve the needs of the state in the military sphere was preserved. The fact is that from the standpoint of the Marxist theory of historical materialism, the transition from capitalism to communism construction should be carried out in the most advanced and economically developed countries. This process occurs due to the fact that the level of development of productive forces reaches such a point that it does not correspond to the prevailing industrial relations, which entails their change, as well as the change of the social and political relations which are based on them. Stalin's interpretation of the Marxist idea of the transition from capitalism to communism through the recognition of the possibility to build socialism in one country did not significantly alter the main content of the ideas of historical materialism, but placed greater responsibility on the Soviet Union in ideological terms. The USSR had to show the world not only an advanced economy and a society based on the idea of social justice, but also to create cutting-edge science. Without the creation of advanced science to talk about the possibility of building a new society was equivalent to exercising in Sufism. However, the reality was somewhat different. The system of state capitalism was created in the Soviet Union (Pipes, 1990) that gradually developed a system which guaranteed a minimum of basic goods, job protection and stability of income. Its formation required considerable effort and costs on research and development of technology on the part of the state and society. However, ensuring the welfare of citizens was not the main goal of the development of Soviet science. The development of economy and science in the USSR was not determined by the needs of the Soviet citizen and society. It was determined by the decisions of the Communist Party and the government, which first and foremost emphasized the goal of preserving the world's first socialist state in a hostile capitalist environment. That is why the leaders of science and technology in the USSR were invoked to address a range of issues, whose diversity was mainly confined to the problems of maintaining international prestige of the Soviet Union and to ensure public safety (Romanovsky, 2004).

To sum up, we can say that for decades in the emerging Russian national innovation system a leading role was played by public authorities. They defined the purpose of development of science and technology, allocated resources and evaluated the results. This fact influenced the unilateral nature of the Russian innovation system, in which the role of other players/participants, apart from the state, could not be clearly traced. It is obvious that in the transition to a market-oriented economy such a system could not be maintained. Only those elements of NIS could survive that were supported by the state or were able to adapt. But how should the targets of development of Russian science and the national innovation system as a whole sound? Did the situation in national science change compared to the Soviet era? For modern Russia the answer to this question is crucial. This is due to the fact that, despite more than twenty-years since the collapse of the Soviet Union, we cannot confidently say that the Soviet past has become history and the Russian economy has embarked on building a market economy. In addition, ensuring the military security of the country is a hot-button issue. These facts make us raise a question of setting goals of modern Russian science and the problem of their correspondence to the world trends. This will be the point at issue in the next section.

6. Features of the development strategy of the national innovation system in modern Russia. Conclusions

Over the past decades since the collapse of the Soviet Union the national innovation system in Russia has undergone some changes that were caused by many factors related to the socio-economic and political instability in the late 1990s, liberalization of the political regime and economic performance in the late 1990s and early 2000s, and a complicated international position in the early 2010s.

As a result of these processes, a transformation of the national innovation system in Russia took place. New participants/players appeared, such as private firms and private universities, multinational corporations, international

research foundations, and so on. Many believed that this fact alone would create conditions for enhancing the mobility of researchers, academic exchanges and intensify the communication between Russian and foreign scientists. But the reality was more depressing. It does not make much sense to list all the consequences of the degradation that had gripped Russian science in the given period of time. Many of them are listed in the document entitled "Strategy of Innovative Development of the Russian Federation for the period till 2020", which came out in 2011.

This document says that Russia lags behind developed countries in many respects. The current, optimal scenario for Russia is to develop the sectors of the economy that have a competitive edge and implement a catch-up strategy for the rest of the economic sectors.

The analysis of this policy document and the nature of the activities of the state in the field of innovation policy in recent years make it possible to assert that the Russian Government is likely to once again choose the development of the innovation system with the dominant role of the state. Moreover, in the activities of the innovation system it plans to act both as a customer and contractor of scientific research and a consumer of the final product. Moreover, there again looms the militaristic orientation of the Russian innovation system because only in this area does Russia continue to maintain its leadership in the world while substantial financial resources acquired in recent years by oil and gas exports produce a certain illusion of restoring a modern equivalent of the old Soviet innovation system. Is this the best choice?

Not only Russia, but also many other governments seek to create the most optimal system of scientific research, education and innovation that would correspond to the essential requirements of globalization and competitiveness. There are three possible strategies that in this case can be adopted and implemented:

1. Model of a free market
2. Model of central planning
3. Model involving coordination of the free market by the central planning (Dill & Van Vught, 2009).

Let's briefly examine the feasibility of each of the presented models. Implementation of the first model is believed to be impossible a priori because of the absence of the developed market mechanism in Russia. The applicability of the second model can be traced on the content of the "Strategy of Innovative Development of the Russian Federation for the period till 2020." But this choice may not be optimal because Russia's historical experience shows that the dominance of the centralized model will undoubtedly lead to militarization of the country's national innovation system, degradation of the private sector of the economy and ultimately, inability of the education system to keep up with international standards and reduction of researchers' mobility, etc. (although foreign policy and economic preconditions of recent years for the choice of this model cannot be neglected). Implementation of the third model of development requires an increasing role of the state in the field of scientific research as well as liberalization of the political regime and economic activity. Also the choice of the third model implies a reduction of the state's role in the country's innovation system. The state should focus on well-defined lines for its participation in the activities of the national innovation system. They are as follows:

• to define strategic sectors, to develop plans, to provide maximum freedom to other subjects in the innovation system (universities, businesses, research teams, and so on) in the choice of forms, methods and means of their participation;

• to create a competitive environment in the field of innovation. This implies involvement of new participants - private firms and entrepreneurs, universities, international foundations and organizations;

• to ensure maximum accessibility and transparency of information, material and financial resources for the subjects of innovation policy.

We believe that the fulfillment of these principles is the first and most important step towards the realization of the strategy of innovation development in Russia. Otherwise, there is a fear that essential elements of the USSR's innovation system would be re-established, which previously demonstrated a lack of competitiveness in the modern world. But the system is able to give a noticeable short-term effect provided there is enormous financial, material and human labor support for their implementation. The reinstatement of the Soviet centralized national system of innovation in historical perspective can lead to even more devastating consequences that will exceed the negative aftermaths of the collapse of the Soviet Union for its citizens and the world.

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