

NATIONAL INNOVATION SYSTEMS: THE FUNDAMENTAL APPROACHES TO DEFINITION AND EVALUATION

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Abstract: *current scientific paper is considering the fundamental conditions and evolution of national innovation system (thereafter-NIS) concept. The prevailing tools of NIS monitoring were analyzed, and the aggregative assessment of Russia's innovative system was performed.*

Keywords: *innovation, national innovation system (NIS), the concept of NIS, the historic-empirical approach, the "Aalborg School" approach, the monitoring of innovation systems, indicators of NIS condition assessment, index of competitive growth, index of economy' innovation rate, R&D costs, the rate of innovation activity, technologies exchange, technologies patent.*

1. INTRODUCTION

In modern conditions the role and place of government in world economic space, the living standards and quality of life, the national security rate are defined by, mainly, processes of creation the new knowledge and technologies, and, also, by their application effectiveness in social-economic sphere. In developed countries, according to specialists' researches, from 80 to 95 % of GDP increase is provided by machinery and technology based on new knowledge. Innovation way of development enables us to perform technological breaks and maintain the competitiveness of national economies at the highest level. This became possible due to creation of national innovation systems (NIS), which, according to the results of American scientists' researches, should be considered as the fundamental achievement of the 20th century.

2. THE FUNDAMENTAL REGULATIONS OF NATIONAL INNOVATION SYSTEMS CONCEPT

The NIS concept began to shape in 1980s. It was based on scientific works of C. Freeman[2], B. V. Lundvall[3], R. Nelson[5] and other scientists. These researches are based on the general methodological principles:

- knowledge is the main feature of economic development;
- innovations stipulate the competitiveness between the entrepreneurs, which is projected as the core factor of economic dynamics;
- the content and direction of innovation activity are determined by its institutional component.

The most significant regulations of current concept are:

- innovation process is implemented according to the non-linear model, the cycling interconnection of all elements and subsystems of NIS is foreseen, innovations (excluding break technologies) are demand-oriented;
- there are many NIS models, which consider national, economic and social-political conditions;
- NIS are considered as evolutionary, quasidynamic systems;
- the structure, level of development and interaction of innovation infrastructure's objects play a key role in stability and manageability of NIS, in general;
- it is important to use the analytic instruments of NIS to develop the innovation policy, projections and planning.

Foregoing regulations found their reflection in definitions of “national innovation system” concepts, which were formulated by founders of conception and their followers (table 1).

Table 1: Approaches to the definition of “national innovation system” concept

Definition (author/source)	Commentary
The network of institutions in public and private sectors, in result of which activity and interaction the new technologies are created, imported, modified and distributed (Freeman C. [2]).	The attention is emphasized on the institutional aspect of system
The innovation system is shaped from the elements and relationships, which interact in production, distribution and usage of new and economically useful knowledge... nation system includes elements and relationships located within the borders of nation state. (Lundvall V.-A. [3]).	The key attention is pay to intrasystem characteristics (elements of system and their interaction), the set of elements is not strictly outlined.
The complex of institutions, which interactions determine the innovation activity of national companies (Nelson R. [5]).	Institutional component of the system is accentuated, nothing is limited the innovation activity but level of companies.
National institutes, their incentives and competences systems, which determine the extent and directions of technological education (activity, which generate changes) within the country (Patel P., Pavitt K. [6]).	The attention is emphasized to the role of stimulus and competences of institutes in the process of NIS functioning, and, also, to the necessity of technological study.

Definition (author/source)	Commentary
<p>The set of various institutes, which in aggregation and individually endow in development and distribution of new technologies and shaping the limits where the governments shape and implement the policy of influence for innovation processes... This is the system of interconnected institutes for creation, maintaining and transfer of knowledge, skills and tools, which determine the development of new technologies (Metcalf S. [4]).</p>	<p>The attention is emphasized on the role of NIS in development and distribution of new technologies.</p>
<p>The aggregate of interconnected organizations (structures) functioning in manufacturing and commercial selling of scientific knowledge and technologies within the national borders (small and large companies, universities, labs, industrial parks and business incubators). At the same time, NIS is a complex of law, financial and social type institutes, which provide innovation processes and possess national roots, traditions, political and cultural peculiarities (Ivanova N.I. [9]).</p>	<p>The NIS structure is defined, the attention is emphasized to the diversity of system's institutes.</p>
<p>System of preparation and decision making targeted to maintenance, development and transformation of Russia's technological potential into its economic growth's determinative (Shvandar V.A., Gorphinkel V.Y. [10]).</p>	<p>The core attention is emphasized to decision-making process and purposes of NIS functioning.</p>
<p>The aggregate of subjects and objects of innovation activity, which interact in process of creating and realization of innovation products and implement their activity within the government policy in innovation system field. ("The core destinations of Russia's policy in the field of NIS development till the end of 2010" [12])</p>	<p>The core attention is emphasized to the creating and realization of innovation products, and, also, to the role of government innovation policy in the process of NIS functioning.</p>
<p>The aggregate of institutions refer to the private and state sectors, which, by individually and interaction ways, stipulate the development and distribution of new technologies within the specific country (Marenkov N.L. [11]).</p>	<p>The attention is emphasized on the role of NIS in development and distribution of new technologies.</p>
<p>The aggregate of subjects of innovation activity, institutions, which support it, and interconnections between them (Aphonin I.V. [8]).</p>	<p>The structure of system was defined in general.</p>

In spite of quite decided differences in cited definitions, they are united by, in first, system type of NIS concept, which reveals during the interaction of its elements; and secondly, institutional aspect of the system; and thirdly, its functional purpose.

Generally, there are two main approaches clearly distinguish within the research of innovation systems, which foreign scientists determined as historic-empirical and “Aalborg School” approaches. The differences between these approaches are about structure and purposes of NIS functioning.

The first mentioned approach assumes the record of institutional and industrial structures influence for the activity of industrial companies and industries with accounting of national specifics. The core attention is given to the historical development of national institutions.

The main task of innovation system, according to this approach, is to be the ground of development and empiric analysis of innovation processes in existent national socio-economic context [7]. Current approach was broadly used NIS models of different countries by C. Freeman [2] in his researches.

The second approach, titled “Aalborg School”, based on the idea of interactive study. This approach is based on principles which were determined by their founder, V. Lundvall [3]:

1. knowledge – the core resource of modern economy, stipulate the paramount importance of education processes;
2. education – interactive, i.e. social process, where the wide range of economic subjects should participates (developers and users of new technologies, R&D and other organizations).

Thereby, Aalborg approach assumes the NIS consideration in abstract meaning, emphasize the attention on the role of knowledge, education and institutions in innovation process.

It has to be mentioned, that during recent years the range of NIS development problems is actively being developed by Russian scientists. It is reflected in official papers as in numerous scientific publications [7-13 and etc.].

The modern researches of NIS concept developed it with regard to other levels of economy. Nowadays, in economic such conceptions as “innovation system of company”, “regional innovation system”, “sector (industrial, cluster) innovation system”, “global innovation system”.

As in [7] was mentioned, the main term of various innovation system functioning is the presence of tight and effective interaction with science, education, financing, strategy of government and companies, and, also, shaping the interconnection network between companies.

3. TOOLS OF INNOVATION SYSTEMS MONITORING

For the evaluation of condition and evolution of NIS development, by current time were developed and practically are used several approaches to the appropriate indicators systems [13]. The examination of several approaches is given below.

For the first time the system of indicators for intercountries relative analysis of innovation systems was proposed by Entrepreneurship Directorate of European Union commission. The system includes 16 indicators grouped by following way:

1. Human resources
 - the share of universities graduates in areas of science and technologies within the total amount of graduates;
 - the share of employees with academic degrees and qualified engineers;

- the share of workmen employed at the mid – and high-tech manufacturing;
 - the share of employees in sector of high-tech services;
2. Generation of knowledge
 - budgetary financing of R&D industry;
 - financing of R&D industry by private business;
 - the amount of patents used in high-tech industries per 1 mln. people;
 3. Distribution and usage of knowledge
 - the share of small- and average-scale enterprises (SAE), which operate in innovation area as households;
 - the share of SAE which conduct the innovation activity in cooperation;
 - the ration of innovation costs in manufacturing sector to the total circulation;
 4. Innovation finances, markets and results
 - venture investment in technological companies (in % to GDP);
 - capitalization of new/parallel markets (in % to GDP);
 - the share of innovation products selling within the market of manufacturing sector;
 - the amount of Internet users per 100 people;
 - the volume of IT market (in % to GDP);
 - alteration of high-tech products' output share in total amount of OECD manufacturing.

The practical usage of coerced indicators system enables to compare the innovation systems due to various aspects and, thereby, reveal strengths and weaknesses of governments' innovation policies.

World Economic Forum conducts the evaluation of national innovation systems, using the index of competitive growth. The components of this index are:

1. index of economy innovation capability, which defines the ability of national economy for sustainable growth within the medium-term perspective issued from the current level of economic development;
2. the quantity of R&D personnel;
3. the quality of innovation policy in part of intellectual property protection, measures for financial support and stimulation of subjects' innovation activity;
4. the terms of shaping of innovation clusters;
5. the quality of innovation infrastructure;
6. companies' directivity for innovation.

After all, the World Financial Forum's methodology let not just reveal the problem places and reserves for rising of level of national innovation systems due to separate directions, but, also, evaluate the influence of individual parameters of innovation development for the total level of country's competitiveness.

World Bank Institute, within the implementation of the "knowledge for development" program, shapes the database, which consist of several dozen of indicators united into four groups: economic stimulus and institutional system; education and human resources; efficiency of innovation system; development of innovation infrastructure. The grand assessment of innovation systems based on 3 indicators: quantity of scientific R&D workers, quantity of patents registered by The Patent and trademarks office of the USA; quantity of articles published in scientific magazines. The value of these indicators are estimated as in absolute expression as per 1 mln. of citizens, which enables to conduct much accurate intercountries analysis.

There are several others tools of NIS monitoring to be used in the international and local practice, in particular, map of European innovation space, Eurobarometer and etc. Methodology and methodological instructions for definition of significant share of foregoing indicators, which are characterizes the development level of NIS, are used in Russia.

Statistical services of different stages, specializing institutions and centers, analytic groups form and publish appropriate sets of indicators. However, the estimation of results for condition and tendencies of NIS key parameters changings of Russia is the prima facie evidence of lack for international organizations' complex analysis.

4. THE AGGREGATIVE ASSESMENT OF RUSSIA'S INNOVATION SYSTEM CONDITION

According to the official papers of Russia, the condition of NIS is characterized by the following basics indicators:

1. unit weight of inner costs for R&D in GDP;
2. unit weight of innovation companies among the total amount in Russia;
3. unit weight of innovation products in total sales volume in domestic and international markets;
4. export-import balance of technological innovations (state-of-the-art industrial technologies).

Let's evaluate the level and dynamic of foregoing and some others indicators of country's innovation sphere[14].

The unit weight of inner costs for R&D in GDP, first of all, gives the evidence of low level of Russia's economy innovation. This indicator's value was changing from 1 to 1,28% throughout 2000-2009, which is not just lower then level of developed countries, but then some developing countries. Most actively (about 70% from total amount of costs) assets were being invested into developments – the stage of innovation process, which can be characterized by lower risk level, then fundamental and applied researches.

Analyzing the dynamic of companies conducted R&D in Russia it has to be mentioned the reducing of their total number relatively 1995 (for 12,9%) and 2000 (for 13,7%). In addition, an aimed tendency of 2006-07 for increasing their total amount did not receive the prolongation in further years because of reducing the amount of almost all categories of scientific organizations.

According to the Russian annual statistics the share of innovation companies in Russia's manufacturing throughout 2000-2009 was stably low (9,3-10,6%). The innovation situation in industrial sector of economy is determined by several industries: oil-processing industry (the unit weight of innovation companies in 2009 – 32,7%), manufacturing of electrical optical equipment (25,7%), chemical industry (23,6%). The high level of scientific potential emerged in these industries promotes the actively adoption of innovations in manufacturing. Russia's innovation sphere of manufacturing is characterized by low rates of innovation activity results. It is approved by, first of all, the balance of innovation and industrial production volumes in general (4,2 – 5,5% in 2000-09). Examining this rate in terms of basic types of economic activity, it should be mark out the manufacturing of vehicles and equipment, chemical industry, and, also, the manufacturing of electrical and optical equipment. The unit weight of innovation products in total amount of shipped goods of these industries in 2009 was accordingly 16,2; 11,4 and 9,9%.

Innovation activity of domestic enterprises, more often, adds up to acquisition of technological equipment. The share of accounts for these purposes in total amount of industrial enterprises' costs for technological innovations is about 60%. Current circumstance promotes the increasing of technological gap between Russia's enterprises and the international companies.

The main financial source of innovation in manufacturing was and is the companies' owned assets: more than 70 % of technological innovation is being financed by owned assets. Just the lack of financial resources, accordingly to the specialists' opinions, is the main limiting factor of industrial companies' innovation activity. The second important source in 2009 was the foreign investments. Considerable investments inflow of foreign partners is the evidence of positive changes in Russia's investment climate.

Nevertheless, the analysis of country's contribution into world output and high-tech products export (according to various estimates from 0,4 to 1%) acknowledges the fact of low competitiveness of Russian enterprises at the international market of scientific production.

At the same time, we must mention the positive dynamic of state-of-the-art technologies and nanotechnologies created in our country. Their total amount in 2009 reached 897 units, which is 130,4% growth to 2000 mark. More than 55% of created technologies obsess the novelty; significantly grew the unit weight of principal new technological decisions, 15,6% in 2009. Analysis of quantity dynamic of used industrial technologies also let us makes a conclusion about their [technologies] annual growth in compare to previous year. With this fact the export-import balance of technologies traditionally takes the negative value (-183,4 mln. usd in 2009). In technologies of economic activity types export structure the construction industry prevails, in import structure – manufacturing activity; by cost of agreements' object accordingly 50,3 and 68,1 %. The most significant contribution to technological exchange, according to the statistics, made by entrepreneurship sector.

The geography of technological exchange in Russia is quite wide. In 2009 domestic technologies most actively were being exported by such countries as USA (8,7% of total inflows), Germany (6,9%) and The Republic of Korea (6,0%). In its turn, Russia's technological import was defined by Switzerland (15,2%), USA (13,1%), Germany (9,9%) and several other countries.

In the capacity of positive tendency in innovation area it has to be noticed the number increasing of applications of Russian scientists for patents of available models. In addition, the rate of issued patents number, which had been demonstrated the negative dynamic since 2004, throughout 2008-09 has grown and reached the maximum level of 10 years period – 50 509 units. And the balance of issued patents to the total amount of patent applications exceeded 0,9.

Thereby, in tote, contradictory tendencies can be noticed in Russia's innovation area. Possessing the high research potential, the government demonstrates quite low results of scientific developments' practical implementation.

5. CONCLUSION

The research of core regulations of NIS concept allowed being convinced in complexity, significance and ambiguity of as theoretical aspects of this problem as of practical aspects of innovation systems management at the government level. The presence of different approaches and tools of NIS monitoring demands thoughtful, comprehensive and, at the same time, critical analysis in purposes of practical usage for making the destinations of

national innovation policy. It is necessary not just consider achievements of international scientific thought and practice, but also develop them with an allowance of national specifications and new conditions of economic systems functioning.

REFERENCES

- [1] Castellacci F., Grodal S., Mendonca S., Wibe M. Advances and Challenges in Innovation Studies // Journal of Economic Issues, - Vol. XXXIX, - №1, March, 2005.
- [2] Freeman C. Technology and Economic Performance: Lessons from Japan. - Pinter, London, 1987.
- [3] Lundvall V.-A. National System of Innovation. - Pinter, London, 1992.
- [4] Metcalfe S. The Economic Foundations of Technology Policy Equilibrium and Evolutionary Perspectives / in P. Stoneman (ed.) Handbook of the Economics of Innovation and Technological Change, Blackwell Publishers, – Oxford, 1995.
- [5] Nelson R. National Innovation Systems. A Comparative Analysis. – Oxford, 1993.
- [6] Patel P., Pavitt K. The Nature and Economic Importance of National Innovation Systems. // STI Review, №14, OECD, Paris, 1994.
- [7] Атоян В.Р., Казакова Н.В. О некоторых подходах к анализу развития инновационных систем в глобализирующемся мире. // Инновации. - 2007. - №3. – С. 27-34.
- [8] Афонин И.В. Иннова-ционный менеджмент и экономическая оценка реальных инвестиций: Учебное пособие. – М.: Гардарики, 2006.
- [9] Иванова Н.И. Нацио-нальные инновационные системы // Вопросы экономики. – 2001. - №7. – С. 59-70.
- [10] Инновационный менеджмент: учебник / под ред. проф. В.А. Швандара, проф. В.Я. Горфинкеля. – М.: Вузовский учебник, 2004.
- [11] Маренков Н.Л. Инноватика: Учебное пособие. – М.: КомКнига, 2005.
- [12] Основные направления политики РФ в области развития инновационной системы на период до 2010 года // Инновации.– 2005. – №7. - С. 3-6.
- [13] Туккель, И.Л. Управление инновационными проектами: учебник / И.Л. Туккель, А.В. Сурина, Н.Б. Культин / Под ред. И.Л. Туккеля. – СПб.: БХВ-Петербург, 2011. – 416 с.
- [14] <http://www.gks.ru>