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IN THE ECONOMIC CYCLE****А.Р. Каньковская****НАЦИОНАЛЬНЫЕ И РЕГИОНАЛЬНЫЕ ИННОВАЦИОННЫЕ СИСТЕМЫ  
В УСЛОВИЯХ ЭКОНОМИЧЕСКОГО ЦИКЛА**

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The article formulates the principles underlying the functioning of the national innovation system in the economic cycle and the priorities of the innovation at various levels of the national economy. The problem of the development of regional innovation systems as open complex systems is stated.

COMPLEX SYSTEM. LONG-TERM TECHNOLOGICAL CYCLE. NATIONAL INNOVATION SYSTEM (NIS). REGIONAL INNOVATION SYSTEM (RIS). TECHNOLOGICAL DEVELOPMENT.

Сформулированы принципы функционирования национальных инновационных систем в условиях экономического цикла и приоритеты инновационной деятельности на различных уровнях национальной экономики. Рассмотрена проблема развития региональных инновационных систем как открытых больших систем.

БОЛЬШАЯ СИСТЕМА. ДОЛГОСРОЧНЫЙ ТЕХНОЛОГИЧЕСКИЙ ЦИКЛ. НАЦИОНАЛЬНАЯ ИННОВАЦИОННАЯ СИСТЕМА (НИС). РЕГИОНАЛЬНАЯ ИННОВАЦИОННАЯ СИСТЕМА (РИС). ТЕХНОЛОГИЧЕСКОЕ РАЗВИТИЕ.

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The innovative activity of all economic agents is the principal factor in the creation and maintenance of a high level of competitive advantage. But cyclical fluctuations have an influence both on the objectives of the formation and on the development of the national innovation system.

The national innovative system (NIS) of the country consists of three main components: the research and development sector (basic and applied sciences), the educational sector (the system of higher and postgraduate education), the business sector (corporations, integrated business groups, small, medium, and large businesses). The linkage between these components which determines the national model of the NIS in Russia, is a very knotty problem at the federal and regional levels in consequence of the revolutionary transformation of the economic system in the 1990s. Now the national economy consists of many elements with conflicting interests and this conflict is particularly acute in the different phases of the economic cycle.

In a recession, the main interest of the majority of the economic agents is a survival only. So they operate on the principle of compensation

costs producing the goods with simplified functions and sell them at a discount. This behaviour can revive demand for their products.

The analysis of the indicators of the innovation activity of Russian enterprises showed the reduction of the share of organizations implementing technological innovations and the proportion of expenditure on technological innovation in the total value of output during the recession and the crisis of 1998 [1]. In the phase of the recovery we can see some increase in these indices.

During the recovery firms are trying to maximize profits, their investment activity primarily is aimed at solving the problems of speculation in the stock markets. Innovations are not beneficial in this phase of the economic cycle.

In 2001–2004, during the recovery of the Russian economy, a few sectors showed a significant increase in the level of innovative activity [1]: mining, leather, wood products, non-metallic mineral products, electric, electronic, and optical equipment. In other sectors, the innovation activity decreased or changed slightly. The main type of innovation activities of industrial enterprises was the purchase of machinery and equipment (63 %). In 2004, the production design was carried

out by 35.5 % of the firms, research and development by 33 %. It is below the 2001 level (39.7 and 35.6 % respectively) [1].

This statistics shows a significant reduction in the innovative activity of enterprises during the recession and an uneven growth during the recovery. Growth occurs mainly in the sectors which are in the process of the technological expansion. In other sectors, especially in these preserving outdated technological structures, the growth of innovative activity does not take place. It is necessary for businesses within the national innovation system to solve this problem.

Theoretical works on the problems of the formation and functioning of NIS do not pay attention to the factor of the cyclic recurrence. National studies do not contain the analysis of the impact of economic cycles on the functioning and development of the NIS [2-5]. In most national surveys, NIS are considered at the tactical level, and the concept and the strategy are neither investigated nor debated. Though many OECD countries already had NIS with long history, this approach still seems quite unsubstantiated.

The basic principles of the functioning and the development are as follows [6, p. 28]:

- creation of the conditions for innovation activities of firms and research organizations;
- creation of the framework conditions for the diffusion of modern technologies;
- development of the cooperation and strategic partnership between government, research and development agencies, and industry;
- formation of the innovative clusters and networks;
- development of the procedures for financing the early stages of an innovation process;
- development of learning and retraining;
- monitoring the current status of the NIS by government agencies.

Nevertheless, there is no principle which takes into account the impact of the cyclical factors. So it is necessary to include the principle of cyclic recurrence in the group of basic principles. According to this principle the system of priorities of innovation and industrial policies is based on the forecast of the long-term economic cycles, and the support of the innovation activity of enterprises is based on the analysis and forecast of medium- and short-term economic cycles.

The national innovation system is exposed to globalization as well as other members of the world economy. This influence becomes apparent in:

- the increasing degree of integration of individual elements of national innovation systems into a single world system;
- the strengthening of the bonds ‘science – production’ at the global level;
- the intensification of the collaboration between the public and the private sectors in the innovation system;
- the integration of national educational systems.

Obviously, the globalization of innovation leads to more profound disparities in countries’ development. Countries with effective systems of innovation increase scientific and technological cooperation, implement large-scale projects which are important both scientifically and commercially ensuring the expansion of production and creating new jobs. The economic growth rate may not be high, but this approach provides growth for the medium- and long-term perspectives. Countries with weak or underdeveloped innovation systems are not able to use innovative resources, and therefore they follow an extensive way ensuring their economic growth due to the natural resources. In such a case, the economic growth is linked to the world market conditions. An example of this is the dynamics of Russia’s GDP.

In these circumstances, it becomes necessary to form and develop an innovative system of Russia and to increase its effectiveness. In recent years, the Russian innovation system has experienced a strong influence of destructive processes of diverse nature, especially the socio-political and socio-economic processes. So now, in Russia, we can see some elements of the innovation system with the destructive gaps between them. Consequently, the priority of economic growth is the formation of the innovation system, which implies the consolidation of the disparate elements and the determination of the strategic goal of the NIS.

In our view, the strategic goal of the NIS is to create and maintain a constantly high level of competitive advantage by continuously developing knowledge, the access to specific resources taking into account geopolitical, economic, and geographic factors and features of the institutional environment, the strategic controlling in the creation and the dissemination of knowledge and technology. So, the strategy of the innovative development is, on the one hand, an integral part of an overall strategy of the national economy, and, on the other hand, the backbone of the national and regional innovation systems.

According to the theory of complex systems, we can decompose the strategic goal of the NIS. We can use the following principles of decomposition:

- an area – strategies of development areas and regions are formulated as part of the national strategy;
- a sector – the overall strategic goal is decomposed to the strategic goals of industrial, educational, infrastructural and market subsystems;
- a field of science.

National innovation system includes regional innovation systems, which, unfortunately, are characterized by the same problems as the entire national system. The problem of the development of the regional innovation system and its effective 'embedding' in the national system is more important for major scientific and industrial centers with high intellectual and innovative, scientific, industrial and cultural potential.

It should be noted that the development of the NIS should involve not only the basic sciences. Industrial science is very important, too. In addition, there are weak links in the system 'science – engineering – manufacturing' in Russia. The development of links between research organizations and industry will move the core funding from the public to the private sector. If the industrial economy perceives science in terms of short-term commercial viability, large firms of the post-industrial society are well aware of the need to fund basic scientific research to participate in large cooperative projects to ensure their long-term competitiveness and sustainability.

Of course, this process should be gradual and in line with the rate of the economic development. It is necessary to take into account the business cycle when various government programs and projects of innovative development are created. We must analyze not only long-term cycles, which are associated with the change of technological structures, but also medium- and short-term ones. In our opinion, mid-cycles need special attention because now they pose the greatest threat to the world and national economies.

A special role in the NIS is played by the innovative small businesses as a market entity ensuring adaptability of the system. Small firms, which are the source of numerous scientific, technological, and organizational innovations, are experimenting widely in the creation and the development of various elements of market mechanisms, as well as in establishing links between them. The exceptional flexibility and mobility of a

small business enables it to maximize the opportunities offered by the market which cannot be implemented in the medium and large businesses.

Small businesses' activities are located in close relation with other agents of the economy: large and medium-sized enterprises, public authorities, financial institutions and educational institutions. In larger cities, which are scientific, industrial, financial and cultural centers, the variety and the complexity of links between different economic actors are highest.

The extent and the form of integration of large and small firms largely depend on the industries in which firms operate. In the manufacture of high technology products, small firms are often highly specialized, giving rise to close cooperation links with big business.

Usually, regional innovation systems (RIS) are regarded as terms of the NIS. As a rule, the standard concept of innovation systems at the regional level comprises the same set of postulates that is formulated for the NIS:

- development and adoption of measures aimed at strong growth in the number of regional universities and research institutes, university technology parks (the spin-out companies) and the close linking of local firms to external sources of knowledge;
- involvement in the region of highly skilled labor force and actively promoting the growth of professional qualifications of the already existing staff;
- networking of business incubators to support small business innovation at the initial stage of the activity;
- establishing and long-term financing of a research organization which monitors, on a regular basis, the key to major regional industry clusters and technology markets;
- the establishment of effective mechanisms of interaction and long-term cooperation between regional companies, research organizations, and government agencies;
- development of formal and informal networks which form a single culture of the business environment;
- ensuring the flow of venture capital into the region.

With this approach, the regional innovation system is regarded as a smaller version of the national innovation system including, of course, certain resource limitations, in connection with which the RIS pay more attention to a selection of priority sectors which can give a rise to well-functioning cluster.

This view of the place of regional innovation systems in the NIS is fundamentally flawed. The national innovation system is not simply the sum of smaller regional components. It is a great system consisting of a sub regional innovation system. In turn, the regional innovation system itself is an open complex system, which is fully characterized by the features common to all complex systems.

Regional innovation systems combine elements in different ways: industry science dominates in one system, higher school – in another; some regions need to upgrade skills and retain highly skilled professionals and others must involve staff from other regions in any scenario. Some regions develop relatively apart, others are actively involved in cross-border cooperation. Therefore, management at the national level should take this into account the structural and content diversity as accurately as possible, so it is need a transition from pattern management to complex systems management.

The analysis of the major theories of long-term technological cycles gives us a possibility to produce a new enlarged and more complete classification of technological cycles which best reflects the technological development of the world.

Technological development involves the evolution of technology, which, in turn, implies a certain chronology of the transition from one technological system to the other ones. The main feature of this classification is that it carries an attempt to review technological development since the beginning of mankind. Another feature of this classification is that the duration of a technological system means a period of time from the first developments of the technology to the mass application of human activity and, consequently, the obsolescence of the technologies that make up the core of every technological cycle.

As the historical sources give different data on the appearance of inventions and discoveries characterizing fundamental technological shifts the estimation of the periods of technological cycles will always be very rough [7, 8]. The technological cycles have very fuzzy boundaries; they overlay each other and even cross each other. That is why the duration of the technological cycles is very approximate.

Our calculation of the duration of the technological cycles [9] shows that their dynamics tends to decrease. However the reduction of the duration of the technological structures is observed

up to 1980-90s, and then we see an increase in the duration (the 16<sup>th</sup> technological cycle during 1990 and 2100). Forecast duration of further technological cycles (Tab. 1) is realized by the application package of statistical programs SPSS.

Table 1

Forecasts estimated duration of the technological cycles

Number of the technological cycles	17	18	19	20	21
Forecasts estimated duration of the technological cycles	132	156	179	202	226

It should be noted that the first fifteen of the sixteen cycles involve on empirical technologies. The fundamental technology is built on already established scientific and technological base. They are associated with the identification of the fundamental laws of nature which tend to increase product life cycle, as well as create the possibility of constructing diverse classes and systems and their possible use in various industries. A striking example to support this statement is one of the latest trends in the development of advanced science, namely, nanotechnology.

The results obtained in the course of the study allow us to formulate the basic concept of the effective development of national and regional innovation systems.

The way to the fundamental technological cycle requires special attention to the formation of the directions and priorities for basic scientific research.

In the transition to a fundamental technological cycle it is necessary to build on a systematic basis and to strengthen links between basic science and high education by providing a single target vector studies (taking into account the difference of objective functions and differences in sources of funding).

The increase of the duration of the technological cycles is dual, therefore. On the one hand, a sufficient time period for the formation and development of a scientific school is formed, and a long-term sustainable development of the national economy is provided. On the other hand, the economic return from the currently ongoing prospective basic research becomes a matter of the distant future.

The effective development of the national innovation system requires minimizing the proportion of relict technological structures in the



economy. At present, institutions of the NIS ignore the existence of such structures because they focus on finding and developing innovations, while old technologies are still being used in a number of industries. Therefore, one of the actual tasks of the NIS and its subsystems (regional and sectoral) is the identification of relict technologies and industries to transfer them to a new, advanced level. The identification of the elements of primitive cycles forms a group of priority areas for scientific research within the national innovation system and its subsystems.

The overall strategic objective of the NIS is the creation and ongoing maintenance of the high level of competitive advantages by continuously

developing knowledge and an access to specific resources. However, the cyclical nature of economic development requires linking the strategic objectives with the tactical purpose of the NIS, which is a sustainability of the functioning of NIS agents at different stages of the economic cycle. It is clear that, being left to themselves, these agents will solve the problem of survival in the recession, and, during the upturn, their objective to expand the activities in the short term. The strategic development is possible only in the segment of big business.

As a result, we can offer some directions of state innovation policy in maintaining the functioning and development of the NIS (Tab. 2).

Table 2

**Recommended directions of state policy on the functioning and development of NIS and RIS in various stages of the economic cycle**

Subjects NIS	Phase of the cycle	
	Recession	Recovery
Science		
Fundamental	Investment to the priority research areas; Formulation of the priorities for the medium and long term; Maintenance of the other branches of science at the level of preservation of the existing potential	Active development of priority research areas; Funding for breakthrough projects
Industrial	Increased state involvement in venture capital financing; Formation of state order for innovative goods and services at the level of preservation of the existing potential; Insurance against risks of innovation; Co-financing of training programs for industry research	Search and usage of reserves of organizational resources in the ‘Science – Technology – Production’; Increase the state order for innovative products and services; Insurance against risks of innovation
Education		
High	Promotion of research through grants and competitions	Funding for training in specialties relevant to the medium and long term; Stimulation of research through grants and competitions; Inclusion of students’ innovation work into the state educational standards
Postgraduate	Promotion of training in the field of the real sector	Strengthening control over the quality of educational services
Business		
Large	Insurance against risks of innovation	Involvement of the big business in the development priorities of the economy
Small	Maintaining clusters of small innovative companies around the major subjects of the NIS and RIS; Increase of the state involvement in venture financing and creation of opportunities for small business to access to these resources Formation of state order for innovative goods and services at the level of preservation of the existing potential	Creation of clusters of small innovative companies around the major subjects of the NIS and RIS; Increase the state order for innovative goods and services

It is not a complete system of recommendations but only an example to show the way in the state innovation policy in different stages of the economic

cycle. The analysis of the NIS as a complex system ensures the effectiveness of the functioning and development of national and regional systems.

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