Sub-theme: Science, Technology and Innovation Policy

Title: Indicators of innovation potential of the country as means of the government policy modeling in the dominant and emerging technological regimes

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ABSTRACT

The objective of the study is to identify the impact of new technological cycles on the economic potential and improvement of science and technology policy in Russia due to the measures aimed at priority development of basic industries and the transition to a new technological cycle. Key economic and scientific-technical indicators can be used for evaluating existing and emerging technological cycles and government policy modeling.

KEYWORDS

Technological regime, indicators of innovation potential, investments, priority development, government policy.

1. INTRODUCTION

The role of each country in the world economy and politics of the XXI century is defined by its application of high-technologies - strategic indicators of the economical, political, defense power and national status of the country in the world. During the transition of the world economy to the sixth technological cycle Russia must choose the technologies and sectors where the country has competitive advantages and process stocks. In order to identify these technologies there should be used indicators of innovative activities.

Technological regimes are characterized by continuous periods of economic growth through sustainable changes in production. Successive substitution of technological cycles is implemented via investment back-logs and creation of leading scientific, technical, engineering technologies - important strategic resources of the state economy. One of the key factors of economic superiority is commercialization of innovations (intellectual property and intangible assets).

The present study aims to research two major issues: the development of a system of indicators for the analysis of the economic situation during the dominant and emerging technological cycles and building a neural network model of techno-economic development on the basis of selected indicators. The present article focuses on the first task. The authors suggest that based on the world developments of long-term forecasting models of economic growth an enhanced system of technical-economic development can also include a group of innovation indicators.

The study of most significant indicators involves the construction of a neural network model and training it. In the process of training a neural network model inputs indicators ranked by level of importance and allows to identify the most relevant indicators. Some of the indicators can be discarded without affecting the quality of the built network model of the technical-economic development. This principle can be applied to governance and policy modeling.

2. THE DOMINANT AND EMERGING TECHNOLOGICAL CYCLES

For two centuries, since 1770, the economies of major countries have past six technological cycles. According to the theory of Nikolay Kondratiev, scientific and technological revolution develops wavelike, with a several decade length of each cycle. A well-known Russian economist Sergey Glazyev, relying on ideas N. Kondratiev, introduced this scientific concept all

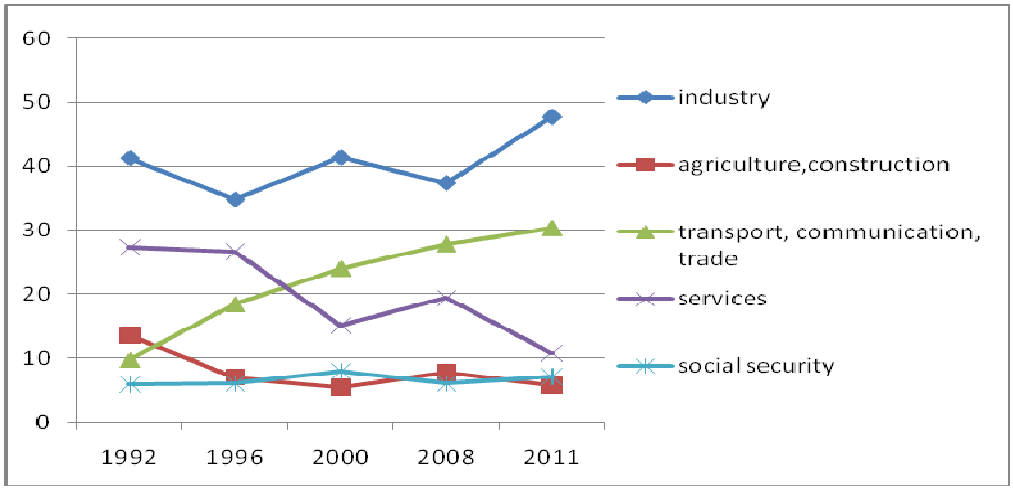
over again and has made a significant contribution to the theory of technological cycles. Description of the six technological cycles is well represented in the scientific and popular literature. The present study is to focus on assessing the potential in the fifth and sixth technological cycles for Russia. The most important are the following characteristics:

Fifth technological cycle (estimated 1985-2035) is based on the achievements in the field of electronics and microelectronics, nuclear energy, information technologies, genetic engineering, the beginning of nano-and biotechnologies, space exploration, satellite communications, video and audio equipment, the Internet, cell phones, globalization with rapid moving of products, services, people, capital and ideas [6].

Sixth technological cycle (estimated 2010-2050) is characterized by using molecular, cellular, nuclear, laser, nano-and biotechnologies and robots, artificial intelligence, compact and super efficient energy; hydrogen as a clean energy source; new medicine, appliances, means of transport and communications; stem cell engineering of living tissues and organs; significant increase of life span of humans and animals; high humanitarian technologies [14].

The essential characteristic of the process technological cycle rotation: discovery, invention start much earlier than mass development and application. So far, the origin is in one technological cycle and the massive use in the next one. This is reflected in the structure of national economies: the transitions between technological cycles are characterized by a coexistence of different technological structures in each historical period. Thus, what concerns the Russian economy, equity contribution is still in mining, metallurgy, transport (Fig. 1).

Figure 1. Investments in core capital divided by sectors of business activities (excluding the production of weapons and ammunition) in Russia from 1992 to 2011, % [5,7,8]



The graph above shows the dynamics of change in the share of investments in: industry - including electric power, oil, gas, coal, metallurgy, woodworking, light industry, food, agriculture and construction - including forestry and fishing, transport and communications - including transport via pipelines, providing services - including housing and communal services, social services - including education, health, culture, sports, public administration and defense, compulsory social insurance [4,5].

At a time when the next the technological system reaches maturity, the investment in the previously attractive areas become unprofitable. For investors, the real surprise is always there, in those moments financiers don't understand where to invest resources. The transition to a new long wave of the economic development happens only a few years after the investor becomes aware of where to invest, and science has to offer a set of new technologies. It takes some time until the capital finds application in industries of a new technological regime. In other words capital moves to new technological sectors of the economy, in which the management is ready to be moved [6].

Russia still has an opportunity to bet on new technologies of the sixth wave to climb up. Those who catch this wave get enormous profits and the intellectual rent is used to build up competitive capacities. From a technological point of view it is necessary to rely on advanced development [10].

Countries which actively develop and implement technologies a new way, are the leaders (England – 2nd regime, the USA, Japan, Korea – 4th regime, the U.S., China, India – 5th). Russia was one of the technological leaders during the period of the Soviet Union - in the 4th regime (from 1930 to 1970) together with the U.S., Western Europe and Japan.

According to S. Glazyev, the sixth technological regime is based on the complex of industries based on information and communications, nano- and biotechnologies, genetic engineering and molecular biology. Progress in the field of solar cells using nanotechnology is already reducing the unit cost of power generation to the level of thermal power plants. What's more, sunlight resource is virtually unlimited. Obviously, with the change of the energy structure of the world economy, Russian specialization on oil exports and raw materials would be ineffective [3,4].

In the 1930s, Russia used the theory of N. Kondratiev for the dynamic development of the economy. "Catching" fourth technological wave the USSR was in the lead, which allowed to be in the forefront of the fifth technological regime (the first artificial satellite, the first man in space). This theory has helped the developed countries of the West, and then the Asian «dragons» to make an innovation breakthrough and be significantly ahead of the rest of the world. Today it is time for ideas of N. Kondratiev to be the key for successful innovation and technological leap of Russia in XXI century [1,2].

3. METHODOLOGY

In terms of efficiency the most promising solution of the forecasting problem is neural network. Cognitive science (or neuroscience) and «smart» systems (interdisciplinary research on a wide range of problems associated with mental activity) are the main challenge and direction of development of basic science of the XXI century.

Currently the most powerful tool for long-term forecasting are computer-based simulation methods using mathematical macro models, which can objectively describe the dynamics of techno-economic development. Such macro models are developed by individual scientists or research teams, as well as large consulting and analytical centers and investment companies offering professional services in the field of consulting and auditing [11,12].

In the framework of the present study the results of expert seminars, as well as the remote expert evaluation have been used. An automated information system consisting of modules implementing various classification methods for accuracy of the forecast improvement and the algorithm of construction of neuro-fuzzy decision tree, as an evolutionary methodology for solving classification problems with adaptation parameters using neural network modeling, have been developed.

4. FINDINGS AND INTERPRETATIONS. INDICATORS OF INNOVATION POTENTIAL

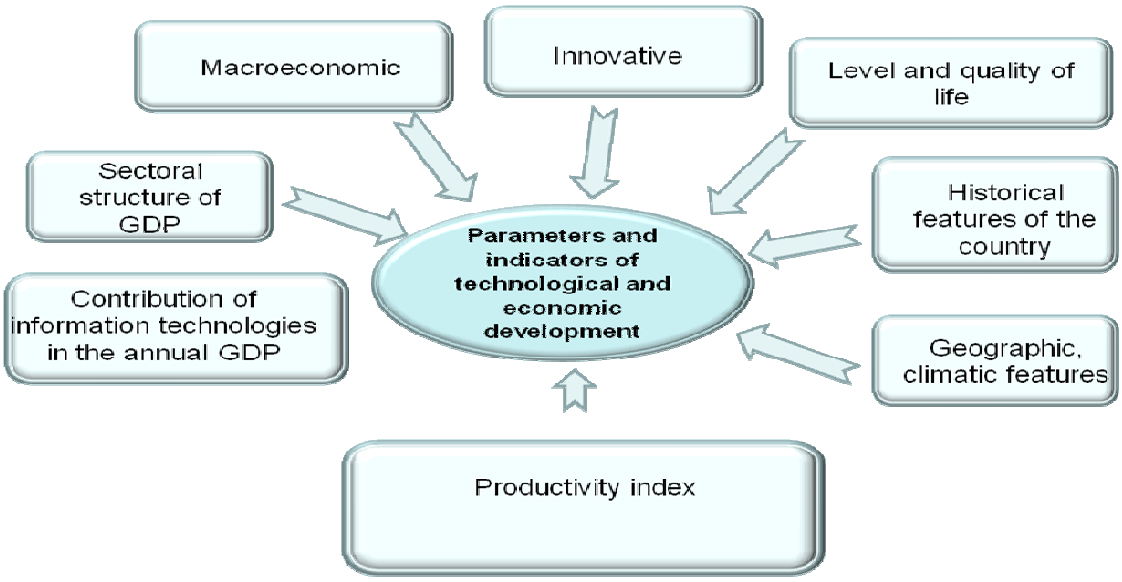
A necessary condition for the stable functioning and development of the economy is an effective innovation policy, leading to an increase of production, the growth of national income, and the development of industries and enterprises. However the fact is that the expenditures and revenues are deferred to the future periods and are forward looking. Uncertainty of future results depends on economic factors (market fluctuations, prices, exchange rates, inflation, etc.) which are not influences by the efforts of investors, and a sufficient number of non-economic factors (climatic and environmental conditions, political relations etc.), which can not always be accurate assessed [9,13].

Therefore, standard macroeconomic indicators were supplemented by our research group with indicators of innovation capacity and performance balance of technological structures of the national economy (see Table 1).

Table 1. Proposed innovation indicators:

Subcomponents of innovation potential			
Financial	**Personnel**	**Objective**	**Profit and lost**
Amounts of funding of the innovation sector by the state The share of investment in GDP	The number of employees related to innovation sector Their average salary Their average age Total share of people related to innovation sector	The number of organizations involved in research activities Amounts of funding of R&D assets	Sales volumes, costs and profits relating to innovation sector The number of exported and imported technologies The number of patent applications filed The number of issued patents

Figure 2. Advanced metrics of techno-economic development



Also, the indicators which can help researchers to identify trends and signals of the growing technological breakthroughs via implicit and indirect signs are of interest. The proposed additional indicators of evaluation of innovative potential are:

- increase of the number of employees in science and high-techs sector;
- the amount and structure of venture capital;
- private funding of R&D;
- the structure of R&D expenditure on different stages of research;
- cross-country flows of knowledge, international cooperation in science and innovation;

- co-operation between firms, research organizations and universities;
- inter country exchange of results of the innovation process;
- mobility of scientists and engineers, opportunity to go to study to the leading countries of innovative development;
- increase of financial transactions, including foreign direct investment; distribution of information and communication technologies;
- share of high-tech manufacturing and high-tech services;
- level of development of market services with increased demand of knowledge;
- increase of the share of high-tech products in the international exchange of goods, trade surplus of high-tech products;
- acceleration of patenting the results of inventions in the field of high technologies;
- number of patents of major foreign patent organizations and offices (according to areas of activities) in order to identify the "technological peaks";
- economic sectors which witnessed “production booms”;
- structure of investments in personnel training in Russia and abroad;
- analysis of specialists migration;
- list of technologies prohibited for sale in the U.S.;
- copied technologies, long-term programs and priorities in science and technology policy of China;
- industries with a lot of new companies;
- dumping technologies (to identify "dying" technologies)

Thus, taking into consideration the analysis of global forecasts, the segments of the market which could be of interest for Russia are to be identified, and the key players as well as the future technologies, including new products and services in the long term are to be defined.

5. CONCLUSION

Understanding the patterns of change in technological regimes can help to create a model of the current macroeconomic processes. Key economic and scientific-technical indicators can be used for estimating existing and emerging technological cycles in different countries. Thus, it is advisable for Russian analysts and economists to consider the countries, experience of which for various reasons is close to Russia, in the context of their innovation policy.

In 1990-2000-s new technologies have changed the structure of technological way, creating breakthrough industries. Empirical studies show that the integration of new countries in the number of technically advanced ones, as a rule, happens in the growing period of the next technological cycle. An innovative project of Russia is focused on advancing the research and implementation of technologies sixth of the technological cycle, with the acquisition of missing necessary technologies of the fifth one. It is necessary to take into account the indicators of innovation capacity and develop an enhanced system of techno-economic development.

6. DIRECTIONS FOR FUTHER RESEARCH

The key direction of the further research is collaboration with overseas expert in order to extend the number of additional indicators of evaluation of innovative potential and their assessment in the context of science, technology and innovation policies.

7. ACKNOWLEDGMENTS

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