Developing the Model of the Innovative Economy of Russian Regions in the Arctic

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Abstract. In the paper the authors shows that nowadays the economy of the Arctic regions is based on the increasing exploitation of natural resources. Due to the tough economic situation and distrust of Russian companies on behalf of numerous developed economies, presentation of one’s own scientific achievements can contribute to improvement of the country’s image. The analysis of the current situation in the innovative activity of Russia’s Northern regions confirms that these regions do not have proper innovative infrastructure relevant to their needs. The paper considers main indicators that characterize innovative activity, infrastructure, science development in Russian regions of the Arctic. In addition, the authors describes factors that affect formation of the innovative activity, which either contribute to or prevent from creating the innovative cluster in these regions. There has been proposed the model of the innovative economy for the Arctic regions of the Russian Federation.

1. Introduction
The Russian statistics of innovations [Federal State Statisticcs Service. – Access mode: http://www.gks.ru/] as an independent branch of the statistical observation is comparativley new. The first single survey of the innovative activity of Russia’s Northern regions was conducted in 1995. Most data collected at the time are not taken into account nowadays. The systematic collection of informaiton started after decree No. 138 of the State Statistical Committee of the Russian Federation of August 22, 1995 “On establishing the form of the Federal state statistical observation on technological innovations of the industrial enterprise”.

The purpose of creating and introducing any innovations, regardless of enterprise’s activity, its structure, management type, is to maximize profits and to reduce costs. The introduction of innovations can become the best solution. Although the government has recently undertaken a lot of measures to overcome this problem, this has not led to significant success. As it was before, most of the output of the process industry in the Northern regions 2017 was presented by oil products (fig.1), where the highest percentage of the fixed capital investments throughout the economic sectors was made into the fuel and energy complex, transport, communication (fig.2).

The comprehensive analysis of innovative processes in the Russian regions of the Arctic is impossible without R&D assessment in each region. However, these regions have few organizations that deal with research and development. In addition, the number of R&D employees in these organizations are insignificant.
One of the main quantitative indicators for efficiency of innovative processes in the region is inventive activity, which reflects engineering and technological achievements in the regional economy. It is assumed that invention data are most informative, as they are the ones that can be the foundation for products and technologies.

2. Theoretical aspects of the problem

Innovative economy (knowledge economy, intellectual economy) is the type of the economy based on the flow of innovations, on the constant technological improvement, on the production and export of high tech goods with higher VAT on technologies. It is assumed that profits result from innovators’ and scientists’ intellect, information environment, rather than material production (industrial economy) and finance concentration (capital) [1].

Generally, innovative economy is the economy that is able to use any useful innovations (patents, licenses, know-how, acquired or one’s own technologies etc.) for the benefit of the society.

The challenges of the new time, which Russia has recently faced, are increasingly revealing disadvantages of the existing economic structure. It is obvious that the resource exploiting type of the national economy cannot solve all the essential tasks imposed on the country and achieve the anticipated growth rates without sacrificing the social and environmental situation in the north of Russia.

Nevertheless, for recent two decades Russian scientists have made a lot of efforts to develop methodology of managing the economy, infrastructure, social and other issues in the Arctic regions.

Development of the innovative activity is touched upon in the following publications: Austrian economist J. Schumpeter [2], German innovation researcher G. Mensch [3], British economist C. Freeman [4], Dutch economist J. Van Duijn [5], American economists R. Foster [6] and P.F. Drucker [7], Russian economists S.Y. Glazyev [8], Didenko N. [9], Skripnuk D.[10] et al.

The purpose of this paper is to build a model of the innovative economy for the Russian regions in the Arctic with allowance for environmental issues in the High North [11,12]. The paper emphasizes that global environmental problems are related to the need for increasing electric power generation [13].

3. Analysis of international practice of building innovative economy in the Arctic states.
In order to develop the innovative economy model, international experience and its applicability to the Russian Arctic has been studied along with the structure and peculiarities of some Arctic countries’ innovative policy.

One of the key principles of the innovative development in Norway is to ensure cooperation between education and science: there is a considerable number of both public and private research institutions, which account for almost 23% of total research expenditures and about 27% of all research activities. All higher education institutions in Norway are to conduct fundamental research and prepare scientists making use of graduates’ papers and doctoral programs. Higher education institutions are responsible not only for research work and academic staff training, but also for commercial implementation of inventions designed by their co-researchers. The share of government investments is relatively high.

Among specific features of the American innovative sphere development, it is worth pointing out emergence of new institutions: science and technology parks and venture capital funds, which are de facto independent from the federal public authorities. The second crucial feature is the exceptionally high activity of small innovative businesses. Other features include a considerable proportion of high-qualified immigrants in the USA and high competition level among innovative sphere participants. As a weak point in the American innovation system, we note the need for legislation to regulate funding of small businesses.

Development of the Canadian innovation system commenced in the mid 1940s and owed much to the advance of the USA in the same sphere. By this time, there had already been created certain background for further scientific and technological development, which included the university education system with concurrent scientific research work carried out, inter alia, in cooperation with British and American scientists, and public authorities specifically intended for scientific advancement. Currently, the basic document regulating the Canadian innovation system development is the strategy approved in 2007, which is referred to as "Mobilizing Science and Technology to Canada's Advantage". This strategy is aimed at development of environmental protection, energy sector, natural resources, medicine and IT.

While assessing state programs for innovative economy development adopted by the Arctic states, the following measures can be distinguished as having a potential for boosting the innovative development of the region:

1) Introduction of a tax deduction system for entities engaged in research and development;
2) Involvement of the government in funding research and development activities carried out by raw materials companies;
3) Working out a programme for stimulating non-residents to localize their manufacture on the territory of the country;
4) Encouraging research and development activities in higher education institutions;
5) Introduction of high taxes on oil production in order to increase the amount of technological innovations aimed at cost-cutting.

4. Building a model of innovative economy for the Russian Arctic

The chosen type of the model is the system of simultaneous econometric equations [14].

In order to derive each equation of the innovative economy model, ADL-model has been selected (autoregressive distributed lags), which reflects the dependence of the current value of a variable on both lagged values of this variable and current and lagged values of other variables.

The extended version of such models’ development methods includes the following sequence of actions:

1) Formulating the purposes of building the model,
2) Reasoning and choice of exogenous and endogenous variables of the model,
3) Systematizing endogenous and exogenous variables of the model in the form of a table that reflects nature and structure of their relations,
4) Formulating the model in general terms (1)

\[
\begin{align*}
  y_1^i &= f \left( y_{1,j}^i, y_{2,i}, x_{1,i}, x_{2,i}, \ldots, x_{n,i} \right) \\
  y_2^i &= f \left( y_{1,j}^i, y_1^i, x_{1,i}, x_{2,i}, \ldots, x_{n,i} \right) \\
  y_3^i &= f \left( y_{1,j}^i, y_2^i, x_{1,i}, x_{2,i}, \ldots, x_{n,i} \right) \\
  y_4^i &= f \left( y_{1,j}^i, y_1^i, x_{1,i}, x_{2,i}, \ldots, x_{n,i} \right) \\
  y_5^i &= f \left( y_{1,j}^i, y_2^i, x_{1,i}, x_{2,i}, \ldots, x_{n,i} \right) \\
  y_6^i &= f \left( y_{1,j}^i, y_3^i, x_{1,i}, x_{2,i}, \ldots, x_{n,i} \right) \\
  y_7^i &= f \left( y_{1,j}^i, y_4^i, x_{1,i}, x_{2,i}, \ldots, x_{n,i} \right) \\
  y_8^i &= f \left( y_{1,j}^i, y_5^i, x_{1,i}, x_{2,i}, \ldots, x_{n,i} \right) \\
  y_9^i &= f \left( y_{1,j}^i, y_6^i, x_{1,i}, x_{2,i}, \ldots, x_{n,i} \right) \\
  y_{10}^i &= f \left( y_{1,j}^i, y_7^i, x_{1,i}, x_{2,i}, \ldots, x_{n,i} \right)
\end{align*}
\]

(1)

5) Preparing informational background of the model in the form of time series,
6) Calculation of endogenous and exogenous model variables,
7) Testing time series for stationarity. Choosing the method of solving the model. Testing for multicollinearity in case of stationarity of series,
8) Checking autocorrelation of all time series. Selection of indicators with a correlation coefficient less than 0.7,
9) Presenting the model's set of equations in a structural form, (2)

\[
\begin{align*}
  y_1^2 &= a_1 x_1^{t-1} + a_2 x_2^t + a_3 y_1^2 + a_4 y_2^2 + a_5 y_3^2 + a_6 y_4^2 + a_7 y_5^2 + a_8 y_6^2 + a_9 y_7^2 + a_{10} y_8^2 + a_{11} y_9^2 + a_{12} y_{10}^2 \\
  y_2^2 &= b_1 x_1^{t-1} + b_2 x_2^t + b_3 y_1^2 + b_4 y_2^2 + b_5 y_3^2 + b_6 y_4^2 + b_7 y_5^2 + b_8 y_6^2 + b_9 y_7^2 + b_{10} y_8^2 + b_{11} y_9^2 + b_{12} y_{10}^2 \\
  y_3^2 &= c_1 x_1^{t-1} + c_2 x_2^t + c_3 y_1^2 + c_4 y_2^2 + c_5 y_3^2 + c_6 y_4^2 + c_7 y_5^2 + c_8 y_6^2 + c_9 y_7^2 + c_{10} y_8^2 + c_{11} y_9^2 + c_{12} y_{10}^2 \\
  y_4^2 &= d_1 x_1^{t-1} + d_2 x_2^t + d_3 y_1^2 + d_4 y_2^2 + d_5 y_3^2 + d_6 y_4^2 + d_7 y_5^2 + d_8 y_6^2 + d_9 y_7^2 + d_{10} y_8^2 + d_{11} y_9^2 + d_{12} y_{10}^2 \\
  y_5^2 &= e_1 x_1^{t-1} + e_2 x_2^t + e_3 y_1^2 + e_4 y_2^2 + e_5 y_3^2 + e_6 y_4^2 + e_7 y_5^2 + e_8 y_6^2 + e_9 y_7^2 + e_{10} y_8^2 + e_{11} y_9^2 + e_{12} y_{10}^2 \\
  y_6^2 &= f_1 x_1^{t-1} + f_2 x_2^t + f_3 y_1^2 + f_4 y_2^2 + f_5 y_3^2 + f_6 y_4^2 + f_7 y_5^2 + f_8 y_6^2 + f_9 y_7^2 + f_{10} y_8^2 + f_{11} y_9^2 + f_{12} y_{10}^2 \\
  y_7^2 &= g_1 x_1^{t-1} + g_2 x_2^t + g_3 y_1^2 + g_4 y_2^2 + g_5 y_3^2 + g_6 y_4^2 + g_7 y_5^2 + g_8 y_6^2 + g_9 y_7^2 + g_{10} y_8^2 + g_{11} y_9^2 + g_{12} y_{10}^2
\end{align*}
\]

(2)

10) Transition to the reduced form of the model,
11) Testing the model for identifiability,
12) Choosing the means of evaluating parameters of the structural model,
13) Test the adequacy of the model's reduced form equations on the basis of Fisher's variance ratio,
14) Search for coefficients of the reduced form of the model,
15) Forecasting, trend building,
16) Drawing conclusions.

5. Data

Statistical data on exogenous and endogenous variables serve as an informational basis for the research. In regard to qualitative data, which are statistically immeasurable, they can be obtained by means of expert surveys conducted in order to gather quantitative information.

All the selected variables have been split into two groups: endogenous (internal) and exogenous (external).

A possible set of endogenous variables includes the results of innovative development of regions. Exogenous variables have been selected on the basis of the proposed approaches. The author believes, that these variables reflect specifics of the studied range of issues in the region. Among basic factors influencing endogenous variables are:

a) Social and economic development of the region including education
b) Innovation activity in the region including expenditures on research and development
c) Innovative policy of the region

**Endogenous variables**

- \( y_1 \) - proportion of entities involved in innovations to the total number of companies
- \( y_2 \) - proportion of innovative goods to the total volume of shipped goods, performed works, rendered services
- \( y_3 \) - proportion of expenditures on innovations to the total amount of shipped goods, performed works, rendered services
y4 – a relative share of small businesses involved in technological innovations within a fiscal year to the total number of surveyed small businesses

y5 – a relative share of innovative goods, works, services in the total amount of shipped goods, performed works, services rendered by small businesses

**Exogenous variables**

1) x1i – an amount of funds invested in scientific research and development from budgets at all levels

2) x2i – gross regional product per capita

3) x3i – quality of innovative policy (benefits and exemptions)

4) x4i – a number of granted patents

5) x5i – import of technology

6) x6i – a number of employees involved in scientific research and development

7) x7i – company's revenue

8) x8i – consumption of innovative goods (services)

The model of innovative economy proposed below is a system of econometric equations that reflect a set of indicators crucial for innovative economy as well as factors having a considerable impact on these indicators.

Thus, the model of innovative development of the region can be presented as the following set of equations (3):

\[
\begin{align*}
y_1 &= f(x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, y_3, y_4) \\
y_2 &= f(x_1, x_2, 4x_4, x_6, y_1, y_3, y_4) \\
y_3 &= f(x_1, x_7, x_3, y_1, y_2, y_8) \\
y_4 &= f(x_1, x_3, x_2, x_8, y_1, x_7) \\
y_5 &= f(x_3, x_4, x_8, y_3, y_4)
\end{align*}
\]

(3)

6. **The course of action for building innovative economy in the Russian Arctic**

The course of action is a set of consecutive steps aimed at improving the state of exogenous factors.

1) Development of a short-term program of events (compliant with the State Programme "Strategy of Innovative Development of the Russian Federation until 2020") intended for ensuring timely implementation of all activities stipulated by the State Program of Activities;

2) Satisfaction assessment of the region's subjects involved in the innovative activity in accordance with the basic business parameters and conditions, determination of problematic factors, expert assessment of their significance;

3) Putting forward proposals to correct problematic factors and discussing proposals with the subjects of innovative activities;

4) Finding additional funding for scientific research and innovations in the subject's budget;

5) Developing the algorithm to provide benefits and exemptions for the subjects involved in the innovative activities (it is advisable to work out a complex of measures specially for small businesses).

7. **Results and conclusions**

Undoubtedly, 21st century is the era of innovative technologies and innovative solutions. Owning a technology, skill or methodology makes an economic entity either the leader or the underdog. It is more and more obvious that innovations are the key to successful development of the economy as a whole and each economic region in particular. For this very reason it is imperative for Russia to commit to building an innovative model of the economy, taking into account the Arctic region.

The above-mentioned statements make the research extremely interesting and up-to-date. The author achieved the following results: a) analysis of the current innovative activity of Northern regions of the country; b) identifying weaknesses in the innovative development of the regions; c) analysis of the factors that influence the innovative development of the regions; d) analysis of the international
experience of building the innovative economy in the Arctic states; e) building the model of the innovative economy in the region; f) putting forward proposals for building the innovative economy in the regions of Russian North.

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