Approaches to assessing the level of innovation development in manufacturing industries

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Abstract. Sustainable long-term development of the energy sector is impossible without a developed manufacturing industry and especially machine-building enterprises. The article offers a method for assessing the level of innovation development in the manufacturing industry and identifies the factors that have the greatest impact on the development of the process of creating and implementing innovations in this sector. A multi-factor regression model is constructed to determine the degree of influence of various socio-economic factors on the level of development of innovative activity in manufacturing industries, as well as to develop proposals and recommendations for its activation.

1 Introduction

Sustainable long-term development of the energy industry is impossible without a developed manufacturing industry and especially machine-building enterprises.

The manufacturing industry is one of the drivers of innovative development of the economy, since it is in this sector that the main production of the most technologically complex and high-tech products with high added value is concentrated. The variety of technological processes focused on manufacturing enterprises, on the one hand, makes this sector the main source of innovative products, goods and services, and, on the other hand, it is the main consumer of a wide range of innovative developments.

Given the recent events in Ukraine and sanctions against Russia by some developed countries, the development of innovative activities in the domestic processing industry is particularly relevant.

It should be noted that the manufacturing industry makes a great contribution to the economic development of the country. In 2013, enterprises in this sector accounted for almost 40% of GDP. Social significance is emphasized by the fact that about 15% of the total number of people employed in the economy work in the manufacturing industry.

However, in the process of market transformations, the products of domestic manufacturing enterprises have become significantly inferior in competition in international markets. There is a steady increase in imports and a decrease in exports of products of enterprises in this sector. For example, during the period 2005-2013, the share of exports of manufacturing enterprises in the total volume of Russian exports decreased by 0.7 percentage points and amounted to 16.6% in 2013.

It should be especially noted that in 2012 Russia occupied only 0.26% of the world market of machine-building products.

The low competitiveness of products produced by the domestic processing complex is due to the weak level of innovation development. Despite the fact that manufacturing enterprises make a significant contribution (almost 72% in 2013) to the formation of the total volume of innovative products, the level of their innovation activity for the period 2005-2013 did not exceed 13%, and the share of innovative products in the total volume of shipped products ~ 12%. This indicates a weak interest of manufacturing enterprises in innovative developments (table 1).

To identify factors that hinder the development of innovation in the manufacturing industry, it is necessary to be able to assess the level of its development.

Currently, a large number of works are devoted to assessing the level of innovative development of countries and regions. Research in this area has started relatively recently, but a number of methodological approaches to solving this problem have already been developed. In particular, the issues of assessing the level of development of innovative activity are considered in the works of: I. Novikova, I. M. Bortnik, G. I. senchen, E. P. Amosenok, V. A. Bazhanov, L. S. Veseloy, A.V. Sokolov, V. N. Borisov, O. V. Puchukayeva, N. N. Volkova, E. Romanyuk [1, 2, 3, 7, 8].

It should be noted that most publications offer methods for assessing the innovative development of territories by aggregating individual indicators into integrated ones, while very little attention is paid to measuring the innovative development of the industrial complex, including manufacturing industries.
Analysis of the advantages and disadvantages of the above methods for assessing the innovative development of territories and sectors of the economy showed that none of the developments can be used to measure the level of development of innovation in the manufacturing industry of the region (table 2).

The problem with using some methods (for example, the method of N. N. Volkova, E. I. Romanyuk) is that not all the indicators proposed for evaluation can be obtained from available statistical sources. The criteria proposed in the methodology can only be obtained by conducting additional research and studying the materials of accounting statements, which is quite difficult due to financial and time constraints. In addition, certain groups of indicators are assigned certain weights based on data from expert surveys, which, in our opinion, is quite controversial, since it has a subjective basis.

In the methodology of V. N. Borisov and O. V. Pochukayeva, it is proposed to assess the level of development of innovative activity in industries based on aggregation of 2 indicators: the share of products of innovative-active enterprises and innovative products in the total production volume. However, the assessment based on the presented indicators does not take into account the degree of involvement of manufacturing enterprises in innovative activities and labor productivity in the production of innovative products, which, in our opinion, is extremely important when evaluating the results of innovative activities in industries.

In this regard, the relevance of this study is to develop a methodology for assessing the level of development of innovation in the manufacturing industry based on available data from regional and Federal statistics that do not require additional research, as well as to use this methodology to build ratings of regions by the level of development of innovation in the manufacturing industry.

Taking into account the specifics of the problem being solved, we have proposed a methodology for assessing the level of development of innovation in the manufacturing industry, which includes 5 consecutive stages (table 3).

To assess the level of innovation development in the manufacturing industry, the following indicators were selected:

1. the Share of innovative products shipped by enterprises of the processing complex in the total volume of products shipped (this indicator reflects the volume of innovative products produced by enterprises of the processing complex. The higher the value of this indicator, the more dynamic the diffusion of innovations is).
2. the Share of innovative products shipped by enterprises of the processing complex in the total volume

| Indicator | Year | 2005 | 2010 | 2011 | 2012 | 2013 | 2013 to 2005 |
|-----------|------|------|------|------|------|------|---------------|
| MI contributio to the total volume of innovative products, % | | 84,8 | 79,7 | 62,1 | 68,7 | 71,8 | -13,0 |
| Share of innovative products shipped by MI in the total volume of goods shipped, works performed, services, % | | 7,0 | 6,7 | 6,8 | 9,6 | 11,6 | 4,6 |
| MI – manufacturing industry. | | | | | | | |

Source: Federal state statistics service. Mode of access: http://www.gks.ru;

| Methodology | Availability and objectivity of source data | Simplicity of methodology and calculations | Completeness of analysis of ID results | Applicability at the regional level | Applicability to the level of assessment of ID in the MI |
|-------------|-------------------------------------------|------------------------------------------|--------------------------------------|----------------------------------|----------------------------------|
| Factor analysis of the region’s innovation potential (amosenok E. P., V. A. Bazhanov) | + | - | + | + | - |
| Rating of regions by level of innovation development (A. B. Gusev) | + | + | - | + | - |
| Evaluation of the innovation system at the regional level (N. N. Volkova, R. I. Romanyuk) | + | + | - | + | - |
| Methods of assessing the level of development of innovative processes in mechanical engineering (V. N. Borisov, O. V. Pochukayeva) | + | + | - | + | + |
| Index of scientific and technical potential of the region (I. A. Kondakov) | + | + | - | + | - |

Source: compiled by the author.

"+"—full compliance with the criterion; "+-" does not fully meet the criterion; "-" does not meet this criterion.
of innovative products in the region (this indicator also reflects the volume of innovative products produced, but it allows you to determine the contribution of enterprises of the processing complex to the formation of the total volume of innovative products created in the region).

3. the level of innovation activity of manufacturing enterprises (this indicator allows you to assess the degree of involvement of manufacturing enterprises in innovation).

4. the volume of innovative products shipped by enterprises of the processing complex per employee (this indicator allows you to measure labor productivity in terms of production of innovative products).

The choice of these indicators is also due to the fact that they allow you to determine the scale of production forces in terms of production of innovative products, comprehensively measure the results of their innovation activities and conduct analytical comparisons with production and economic results.

The presented methodology makes it possible to assess the level of development of innovative activity in the manufacturing industry, taking into account the volume of output, the degree of involvement of enterprises in the sector in innovation, as well as labor productivity in the production of innovative products.

Based on the developed methodology, an analysis was carried out for all subjects of the Russian Federation for the period 2006-2013. It was found that a high level of innovation development in the manufacturing industry was observed in the regions and cities of the Volga (Samara, Nizhny Novgorod and Ulyanovsk regions, the Republic of Mordovia, the Chuvash Republic and Perm Krai), Central (Lipetsk and Yaroslavl regions, Moscow) and North-Western (Saint Petersburg) Federal districts. Among the regions with the lowest level of innovation activity development in the manufacturing industry entered the territory of the far Eastern (North Kuril Islands, Amur Oblast, Primorsky Krai, Sakhalin, Kamchatka), Siberian (Tomsk and Kemerovo regions, Krasnoyarsk Krai, Irkutsk) and North Caucasus (North Ossetia - Alania) Federal districts (table. 4).

The leading positions of the regions of the Volga, Central and North-Western Federal districts are largely due to the innovation policy implemented in these territories. In the leading regions, activities aimed at creating a favorable environment for the development and implementation of innovations in the manufacturing industry were carried out. For example, in the Samara region, infrastructure organizations have been created to support and promote innovative developments (the Regional innovation center, the Innovation Fund of the Samara region, the Regional venture Fund, the Regional technology transfer center, five business incubators, the center for innovative development and cluster initiatives,

Table 3. Methodology for assessing the level of development of innovation in the manufacturing industry.

| Stage name | Procedure |
|------------|-----------|
| 1. Identification of parameters for calculating the level of innovation development in the manufacturing industry (IDmi) | Determination of a set of statistical indicators that characterize the degree of development of innovative activity in manufacturing enterprises. |
| 2. Determination of standardized coefficients for each observation unit (territory) | When calculating standardized coefficients, the maximum or minimum values for each parameter were taken into account, depending on whether the parameter is direct or inverse. |
| 3. Determination of an integral indicator that characterizes the level of development of innovative activity in the manufacturing industry for each observation unit (territory) | Integral indicators were calculated using the following formula: |
| 4. Defining the boundaries of intervals and determining the observation units (territories) that fall into each group. | The interval of values of the integral indicator \([0; 1]\) was divided into 5 groups with the same interval value for each group. Since the distribution of observation units in groups does not correspond to the Gauss distribution law (it is not normal), the method of secondary rearrangement was applied with a certain proportion of population units set for each group (1st and 5th-15%, 3rd-30%, 2nd and 4th-20%). |
| 5. Interpretation of the results. | Source: developed by the author |
an Information and consulting Agency, and other organizations) [4]. Similar work was carried out in Moscow, Saint Petersburg, the Republic of Mordovia, Nizhny Novgorod and Yaroslavl regions.

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Table 4. Ranking of constituent entities of the Russian Federation in terms of development of innovative activity in manufacturing industry.

| Territory                              | 2006 – 2009 years | 2010 – 2013 years |
|----------------------------------------|------------------|------------------|
|                                        | Index value      | Rank             | Index value      | Rank             |
| Samara region                          | 0.707            | 1                | 0.692            | 1                |
| Republic of Mordovia                   | 0.570            | 5                | 0.685            | 2                |
| Moscow                                 | 0.569            | 7                | 0.644            | 3                |
| Lipetsk region                         | 0.523            | 10               | 0.637            | 4                |
| Chuvash Republic                       | 0.518            | 13               | 0.622            | 5                |
| Perm region                            | 0.672            | 2                | 0.613            | 6                |
| Saint-Petersburg                       | 0.569            | 6                | 0.613            | 7                |
| Nizhny Novgorod region                 | 0.578            | 3                | 0.612            | 8                |
| Ulyanovsk region                       | 0.572            | 4                | 0.598            | 9                |
| Yaroslavl region                       | 0.503            | 19               | 0.574            | 10               |
| Trans-Baikal Krai (Territory)          | 0.231            | 67               | 0.162            | 71               |
| Republic Of North Ossetia-Alania       | 0.212            | 68               | 0.153            | 72               |
| Republic Of Sakha (Yakutia)            | 0.098            | 75               | 0.128            | 73               |
| Republic Of Tyva                       | 0.104            | 72               | 0.121            | 74               |
| Jewish Autonomous region               | 0.101            | 78               | 0.106            | 75               |
| Chukotka Autonomous region             | 0.092            | 76               | 0.103            | 76               |
| Magadan region                         | 0.132            | 72               | 0.078            | 77               |
| Republic of Ingushetia                 | 0.000            | 79               | 0.049            | 78               |
| Chechen Republic                       | 0.000            | 80               | 0.009            | 79               |
| Republic Of Kalmykia                   | 0.000            | 78               | 0.009            | 80               |

Source: calculated by the author based on Rosstat data.