Fundamentals for evaluating the efficiency of innovative activities of high-tech enterprises

Fundamentos de la evaluación de la efectividad de la actividad de la innovación de empresas de alta tecnología

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Contents

ABSTRACT:

This article considers the theoretical and methodological framework for evaluating the effectiveness of innovation in enterprises of high-tech industries. The article has an overview of the main components of the process of evaluating the effectiveness of innovative activities of enterprises. The algorithm for evaluating the effectiveness of innovative activities of high-tech enterprises was developed as part of this study, which is based on the use of factor analysis and the method of shell analysis.
Keywords: Innovation activity, efficiency of innovation, evaluation of the effectiveness of innovation, high-tech enterprises

RESUMEN:

Este artículo estudia los fundamentos teóricos y metodológicos de la evaluación de la efectividad de la actividad de innovación en las empresas de industrias de alta tecnología. Este artículo contiene un resumen de los principales componentes del proceso de evaluación de la efectividad de la actividad de innovación de las empresas. En este estudio fue desarrollado un algoritmo de evaluación de la efectividad de la actividad de la innovación de empresas de alta tecnología basado en análisis factorial y el método de análisis de entorno de funcionamiento.
Palabras clave: Actividad de la innovación, efectividad, innovación, evaluación de la efectividad de la actividad de la innovación, las empresas de alta tecnología.

1. Introduction

Nowadays prospects of the dynamic development of the domestic economy, ensuring national security, strengthening Russia's position in the world community are largely determined by the development and effective implementation of innovations and advanced high technologies. In this case, it becomes obvious the problem of assessing the effectiveness of innovative activities of high-tech enterprises, the level of innovative development of industries and territories to a greater extent depends on the effectiveness of innovative activities. (Doroshenko, 2018; Kostromitskaya and Somina, 2017; Melnik and Ermolaev, 2019; Verevka, 2018).

In modern conditions, the scientist's economists are actively studying the issues of scientific, technological and innovative development of the Russian economy, including the theoretical and methodological aspects of evaluating the effectiveness of innovation in high-tech industries.

Some aspects of innovation activities in various fields are reflected in the research of A.V. Barantseva, A.P. Berdashkevich, G.Ya. Goldstein, L.M. Hochbert, A.V. Davydova, I.G. Dezhin, S.D. Ilyenkova, I.S. Kuznetsova, Yu.P. Morozova, O.L. Petrenko, A.I. Prigogine, B.G. Saltykova, V.M. Savushkina and others.

The researches of foreign and domestic economists among them D. M. Keynes, D. Neuman, R.M. Solow, B. Duran, L.V. Kantorovich, V.V. Leontyeva, Yu.A. Doroshenko, I.V. Somin, A.I. Ilyin, Smorodinova R.V. and others are devoted to study of various economic systems and phenomena with the help of economic and mathematical methods.

Despite the developed problem which is under study there are many aspects of the methodology for evaluating the effectiveness of innovation in high-tech access do not provide sufficient reflection in the scientific literature, for example, the development of an evaluation algorithm that predetermines the relevance of these studies.

2. Methodology

The methodological basis and informational base of this research are a comprehensive analysis and a systematic approach to reviewing the works of Russian and foreign economic scientists, materials of scientific conferences and articles related to the study of the issues of evaluating the effectiveness of innovative activities of industrial enterprises.

Methodical research tools include factor and correlation-regression analysis, mathematical methods for ranking and comparing economic indicators and also the method of enveloped data analysis based on the use of mathematical programming methods, the postulates of the theory of production functions and the Pareto principle of optimality.

3. Results

3.1. The main components of the process of evaluating of the innovation activities' effectiveness of enterprises in the high-tech sector

In modern economic conditions, issues of expediency of technological modernization of industrial enterprises with sufficient potential for increasing the production of innovative competitive products and expanding the output of high technology products are relevant. At the same time, the assessment of the effectiveness of innovation activity allows the company to improve its position in the market and move on to the search for new empty niches, that is, there is a need for new innovative developments. Especially these issues are important for high-tech enterprises.

Because of efficiency evaluation is a rather complex and multifaceted process, it is necessary to take into account its main components, which are presented in the figure 1.

Figure 1
Main components of the process of evaluating the
innovative activities' effectiveness of the enterprise
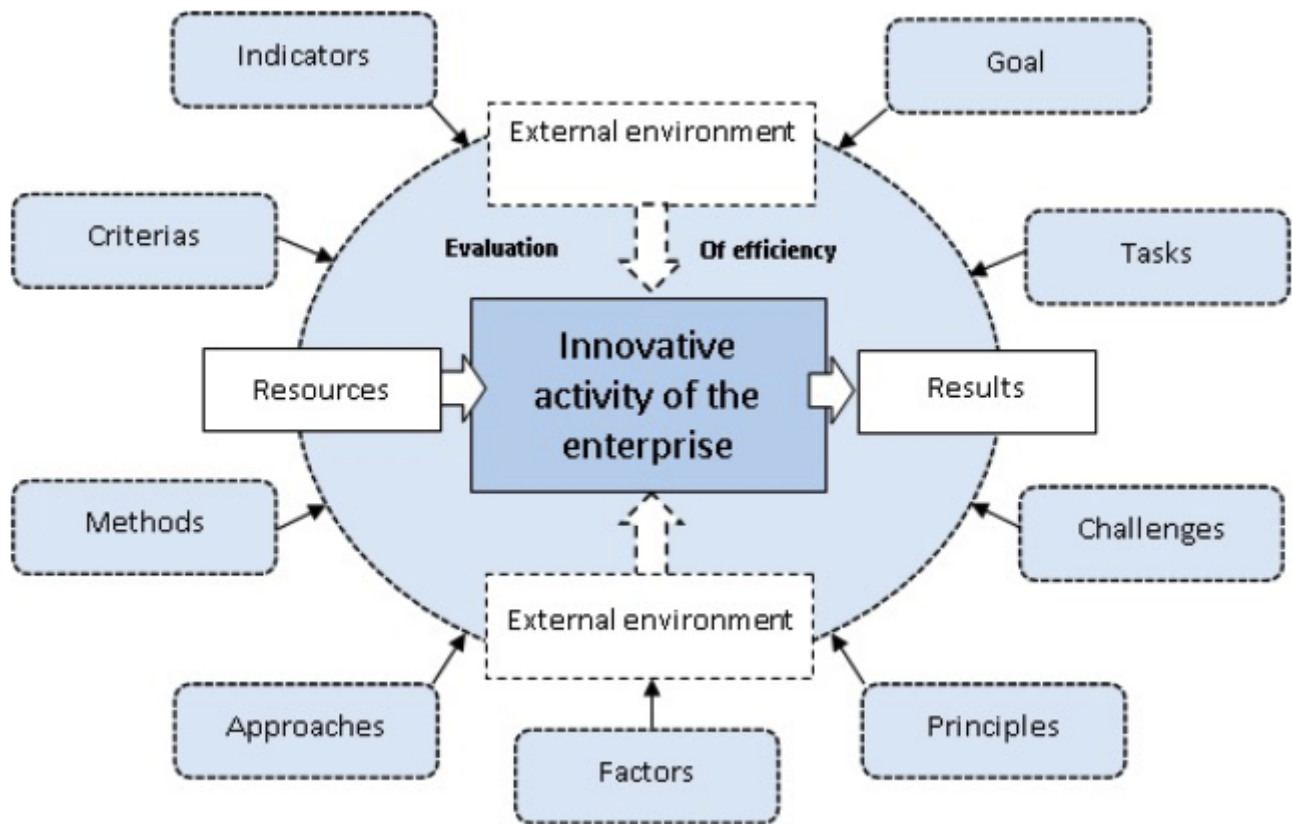
In our research we will dwell on some of the presented components. Defining the goals and objectives of the evaluation of innovation are unique to all enterprises in the high-tech sector. However, they are mainly set to minimize the cost of production, maximize profits, increase the competitive advantages of products, increase the share of existing and conquer new markets, etc.

Nowadays a universal and generally accepted approach to evaluating the effectiveness of innovation has not been found in practice, that is why it is difficult to objectively evaluate innovation at the federal and regional levels, as well as at the level of an individual enterprise. In the evaluation of the effectiveness of innovation in high-tech enterprises, there are some problems associated with the specifics of innovation and the economic sector and affecting the process and results of this evaluation. Analysis of economic literature (Nadjafova, 2018; Smorodinov and Smorodinova, 2014) allowed us to main problems:

1. The uncertainty in the structure of the effectiveness of innovation.
2. The disintegration of individual stages and stages of innovation activity, as well as indicators to evaluate its effectiveness.
3. The inability to measure or calculate individual indicators of effectiveness.
4. The difficulty of determining the time lag between the formation of resources (the stage of creating innovations) and the results of innovation activities (the stage of implementation and commercialization).

5. The low predictability and complexity of forecasting the results of innovation, as a result, a wide range of risks.

6. The presence of incomplete or inaccurate initial information due to the lack of access to officially confirmed statistical data, as a result, a low degree of reliability of the obtained analytical results.

In our opinion, the solution of the above problems may be the observance of following principles (Gyylfanov, 2018; Erygina and Smorodinov, 2016; Oskina, 2019):

1. Accuracy, availability and understandability of the source data and calculations in the framework of the performance evaluation.
2. Systematic construction of a complex for evaluating the effectiveness of innovation activities for all components of this process.
3. Communication skills, i.e. consideration of systemic links between stages and stages of innovation activity.

4. Accounting for the time factor, including accounting for the time difference and unequal costs, as well as the time difference between investments and the results obtained.

5. Modeling innovation using specialized software.

6. Making adjustments to the tasks and resources in accordance with the results of the implementation of innovation activities.

7. Achieving the maximum effect of the implementation of innovation.

The starting point in assessing the effectiveness of innovation is the interpretation of factors contributing to its intensification and inhibition. This contributes to obtaining quantitative characteristics of the significance of these factors for the conduct of the innovation activity of the enterprise and makes it possible to better understand the nature of the phenomenon being studied. And this allows, as far as possible, to influence the identified factors, to intervene in the relevant economic process in order to obtain the desired results.

Since innovation includes all aspects of the functioning of industrial enterprises, many approaches to assessing its effectiveness have been applied in practice, among which are targeted, high-quality, integral, resource-potential, costly, production, labor, investment, project, financial and process approaches (Kostromitskaya and Somina, 2017). In turn, within each approach to assessing the effectiveness of innovation activities, various methods are applied (Amelin and Khudoshina, 2018; Khachaturova, 2019).

Criteria and indicators of efficiency of innovation are selected in accordance with the above components of the assessment (Zhamkova, 2018).
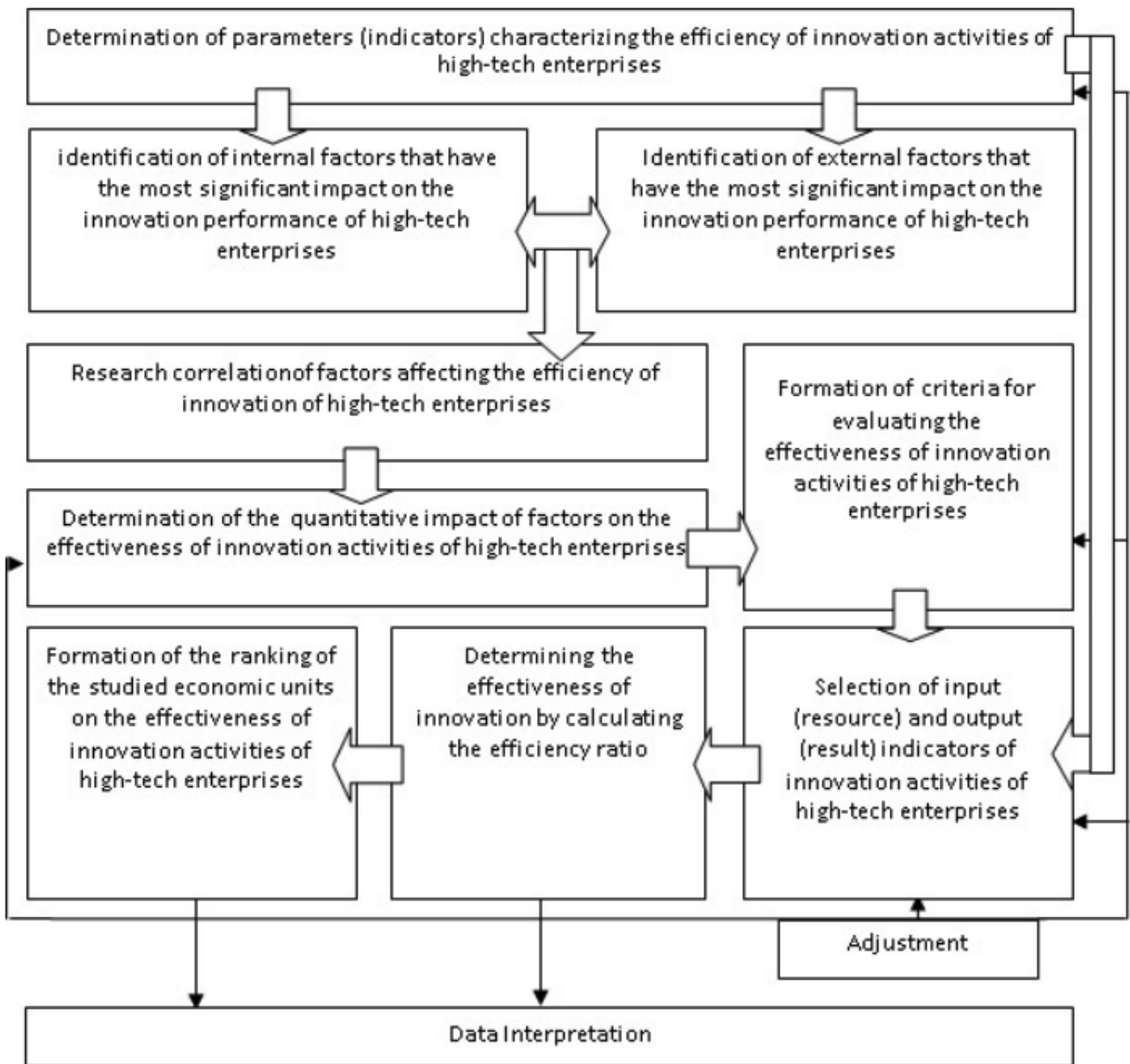
It should be noted that the development of methodological aspects of evaluating the effectiveness of innovative activities of enterprises, in particular, high-tech ones, by developing an evaluation algorithm based on the above components of the assessment process is a pressing issue that requires a scientific, methodical and practical solution.

3.2. Development of algorithm for evaluating the effectiveness of innovation activities of enterprises in the high-tech sector

In order to overcome the existing problems and for eliminating the drawbacks of the existing approaches and methods, it is necessary to improve the applied methodological aspects of performance evaluation. These problems are partially solved by using an algorithm for evaluating the effectiveness of innovation activities of high-tech enterprises, taking into account the above information and presented in the figure 2.

Figure 2
Algorithm for evaluating the effectiveness of
innovation activities of high-tech enterprises

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│  Determination of parameters (indicators) characterizing the efficiency  │
│           of innovation activities of high-tech enterprises              │
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| identification of internal factors that have the most significant impact on the innovation performance of high-tech enterprises | Identification of external factors that have the most significant impact on the innovation performance of high-tech enterprises |

| Research correlation of factors affecting the efficiency of innovation of high-tech enterprises | Formation of criteria for evaluating the effectiveness of innovation activities of high-tech enterprises |

| Determination of the quantitative impact of factors on the effectiveness of innovation activities of high-tech enterprises | |

| Formation of the ranking of the studied economic units on the effectiveness of innovation activities of high-tech enterprises | Determining the effectiveness of innovation by calculating the efficiency ratio | Selection of input (resource) and output (result) indicators of innovation activities of high-tech enterprises |

Adjustment

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┌─────────────────────────────────────────────────────────────────────────┐
│                          Data Interpretation                             │
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The basis of this algorithm is the use of factor analysis and the method of shell analysis, also known as the method of analyzing the operating environment. One of the methods of factor analysis is the method of main factors, which allows to measure the impact of the entire set of factors affecting the object under study, and to determine the shares of the influence of main factors (Makoveev, 2016; Trunova and Ilyina, 2016). In the framework of the proposed approach, we consider it appropriate to use this particular method.

It is advisable to supplement factor analysis with a correlation-regression analysis, which makes it possible to assess the degree of influence on the object of study of already determined factors. These factors are described by indicators, the combination of which, together with the data characterizing the dynamics of the object of study, form the basis of statistical observations, which sets the basis of the reseach. The selection of indicators characterizing the innovation activities of high-tech enterprises is rather problematic due to the specifics of innovation activities and the industry.

The factor analysis with a correlation-regression analysis technique is universal. However, to obtain more objective assessment results, it is necessary to take into account the peculiarities of innovation activity for each high-tech industry and, as a result, the selection of indicators that best reflect them.

The method of enveloped data analysis fully implements an economic approach to evaluating the effectiveness of innovation activity, which consists in correlating the results of activity with the resources spent for obtaining these results. (Arabshahi and Fazlollahtabar, 2017; Kalapouti and Petridis, 2017; Thanassoulis, 2001).

A feature of this method is the separation of indicators characterizing the efficiency of high-tech enterprises into resource indicators (input) and performance indicators (output) (Banker and Podinovski, 2017). In certain situations, the same indicator can be attributed both to resources and to results. Also note that the indicators selected at the initial stage of the analysis can be used to characterize the innovation activities of high-tech enterprises.

Further, we determined effective enterprises by building a border of efficiency and for all others - a measure of their inefficiency. Calculate the efficiency ratios.

Applying of the method of enveloped data analysis makes possible the rating of high-tech enterprises according to the results of the comparison of the obtained efficiency ratios.

Evaluation of the effectiveness of innovation activities of high-tech enterprises is a complex, multifaceted and continuous process. As a result, it should be carried out at an industrial enterprise constantly in order to exercise control and, if necessary, to amend planned performance indicators or change means and ways to achieve them. In order to make a more accurate assessment it is necessary to adjust the data at each of its stages.

Thus, we may say that the proposed algorithm is universal: it can find its application not only in high-tech, but also in medium-and low-tech enterprises, in particular, to compare the effectiveness of their innovation activities and assess their place among competitors.

4. Conclusion

Summing up, it should be noted that the scientific results obtained in this work can be used as a basis for further research, in particular, for a more in-depth study of the relationship between the efficiency of innovative activities of high-tech enterprises and the innovative development of industries, regions and states. Along with this, such an analysis is advisable to carry out not only in relation to enterprises of high-tech industries, but also to enterprises of medium and low-tech sectors of the economy in order to obtain a more complete picture of the efficiency of the domestic industry in general.

The above requires improvement of the applied methodology due to the expansion of the mathematical apparatus and the use of all the functionality of the applied methods, in particular, the definition of recommended / target values of indicators that will ensure the effectiveness of innovation in industry. In addition, it is necessary to conduct a detailed analysis of deviations of actual indicators from recommended / targeted to determine the directions of ensuring the effectiveness of innovative activities of industrial enterprises.

Source of financing

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