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Methodological aspects of machine-building complex economic security from the position of innovative and investment sustainability: macroeconomic cross-section

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Abstract. The article is devoted to the formation of an assessment methodology for monitoring threats to the economic security of the Russian machine-building complex branches from the perspective of innovative and investment sustainability. The theoretical basis for the study was the results of an analysis of accumulated foreign experience and current Russian practice on the assessment of economic security at the federal and industry levels. Based on the studied approaches, taking into account the identified advantages and disadvantages, the authors have developed a methodology for regular monitoring of threats to economic security in the innovation and investment sectors, which allows not only to monitor the progress of government programs in accordance with target indicators, but also to determine threshold values as some indicators. The assessment mechanism is based on the calculation of the integral index, which is formed taking into account particular indicators that are previously subjected to complex standardization by the amount of discrepancy between their actual and threshold values, with subsequent interpretation of the assessment results from the position of risk level and identification of factors that have a negative impact. The results of the study can be used by regional and federal government bodies to monitor risks and threats in the innovation and investment sphere of the machine-building complex, as well as to adjust existing regulatory, strategic documents and improve mechanisms for ensuring the economic security of the branches of the machine-building complex.

1. Introduction

The machine-building complex, being the most important basic component of industry, largely determines the development trends of both the Russian and the global economy as a whole. The state and level of development of the engineering complex determines not only the industrial and economic security of the country, but also the defense potential, as well as the political independence of the state. One of the features of the development of the machine-building complex in Russia is the dispersal of machine-building enterprises over a vast territory with a significant concentration of production, which determines their city-and system-forming nature. In this regard, it can be argued that the engineering complex as a whole creates the basis for the infrastructure and social development of territories, and also provides employment for a significant part of the working population.

However, the machine-building complex, like any other industry sector, is experiencing difficulties and problems, facing challenges of a regional, national and global scale. The main problems and directions of the development of the complex are fixed in state industry programs of the Russian Federation. The program documents also contain target indicators for the development of industries



according to various macroeconomic scenarios, however, there is no regular monitoring system that allows timely identification of industry problems and further adjusting target indicators.

In this regard, the goal of this study is to formulate a methodology for regularly monitoring the economic security of the branches of the engineering complex, which allows not only to monitor the progress of government programs in accordance with target indicators, but also to determine threshold values as some indicators of problems and imbalances in the development of any industry of the engineering complex.

For the purposes of this study, the authors propose to introduce the concept of "economic security of the industry", taking into account two key aspects: 1) the industry, as an economic subsystem, which should be organically integrated into the national economy and ensure the optimal functioning of its enterprises; 2) the industry, participating in the national and international division of labor, which must provide a number of conditions under which sustainable economic growth (expanded reproduction) will be possible. Based on the foregoing, in the authors' opinion, the economic security of the industry should be understood as the state of balance of interests of the industrial aggregate of enterprises and the national economy, which ensures the condition of its (industry) integrity and sustainable economic growth.

2. Methods

The analysis of industry program documents allows us to conclude that there are two approaches to assessing the effectiveness of their implementation. The first approach is based on the methods of comparative analysis of industry development indicators presented in dynamics. On the one hand, assessing the dynamics of indicators is a convenient way to analyze the pace of development of the industrial sector. On the other hand, there are problems of adequate perception of indicators: how to interpret the growth rate, in addition to stating the actual state - a decrease or increase. According to the authors, the dynamics of the indicators laid down in the program documents, in assessing the development of the relevant industry sector, in reality, cannot be the basis for determining problem situations. This is due to the lack of a specific basis for comparison, the so-called reference value of the indicator, when compared with which you can identify the problem. Consequently, the dynamics can give an assessment of the pace of development, but not the level of stability of the corresponding industrial sector.

The second approach, which is most widely used in international practice [1], is based on the fact that the results of their implementation are considered the basis for assessing the effectiveness of the implementation of state programs. So, for example, in the Consolidated Annual Report on the Implementation and Evaluation of the Efficiency of State Programs of the Russian Federation submitted by the Ministry of Economic Development of Russia for 2015 "The Methodology for Evaluating the Efficiency of Implementation of State Programs of the Russian Federation" is focused on the analysis of the following information: assessment of parameters (indicators); assessment of the effectiveness of the implementation of key activities; assessment of cash execution; performance evaluation of a responsible executor. In accordance with this methodology, the analysis of the degree of achievement of the planned values of parameters (indicators) is carried out on the basis of the formation of an integrated assessment of the achievement of the planned values of all indicators of the program, taking into account the input significance factors for each indicator. This approach allows one to quantify the level of implementation of state programs relative to the set targets, to have an idea of a certain distance separating the actual state of the industry from the planned level, and, as a result, to outline a set of tasks to increase the effectiveness of the implementation of the main activities of the state program. However, according to the authors, this methodological approach does not allow to identify the problem in each specific direction, as well as to reveal the degree of failure to achieve individual indicators. In connection with the foregoing, it can be argued that the assessment system, based on the formation of an aggregate indicator of achievement of planned values, can be used to form regular monitoring of problems and prospects for the development of branches of the engineering complex, taking into account a certain modification.

A method of comparing actual indicators of industry development with established threshold values may be the most indicative, according to the authors, from the point of view of identifying systemic problems in the development of the industrial sector. Moreover, in the aspect of ensuring the state of stability, a prerequisite is both compliance with the reference parameter and an improvement in the sample of indicators in dynamics.

In general, the formation of a system of threshold values was widespread in determining the level of economic security [2-5], as well as the level of sustainability [5-10] of socio-economic systems (at the territorial level, industries, business entities). According to these directions, the threshold value is the boundary of the indicator beyond which negative phenomena for the economy begin, associated with potential or already occurring crisis phenomena. In addition, the threshold value should contain the so-called "security zone", i.e. direction of limiting the threshold value. If the value of the indicator is not included in the "security zone", then we can talk about the presence of a risk situation (threat) determined by this indicator.

Thus, based on the theory of economic security and the sustainability of socio-economic systems, according to the authors, it is advisable to determine the criteria and development indicators at the level of a specific industry, as well as their acceptable (reference) values, the compliance with which gives reason to state that sustainable development exists. The correct determination of the quantitative parameters of threshold values in this case will significantly affect the reliability of the assessment results. Moreover, the presence of a criterion for the multiplicity of threshold values, differentiated by their content and specificity, requires almost the same multiplicity of methods for their calculation. Under the influence of a number of factors in each specific industry and the technical and economic situation, the list of threshold values, as well as the system of methods for their assessment, should be subject to adjustment.

3. Results

As a result of the theoretical analysis [3, 5, 13-15] three main methods for assessing the identification of threats and problem situations in the theory of economic security were identified: the method of simple normalization by a threshold value, the method of complex normalization by a threshold value, the method of normalization by the difference. These methods, despite the presence of specific features, are implemented in a certain sequence.

Primarily, a selection of initial parameters (indicators) is determined that characterize the state of economic security of the state and the degree of its security. Further, the indicators are quantified and standardized in order to bring them to a comparable form and comparable units of measurement.

For practical purposes, various methods (models) are used to normalize indicators. Some standardization models use the so-called threshold values of indicators that separate the dangerous state of an object from a safe one. However, in the national practice there is no generally accepted approach to the selection of indicators and the determination of their threshold values. To establish threshold values, we apply the method of averaged comparison with indicators of other countries in a fixed period of time and expert estimates.

After the standardization procedure, a number of approaches provide for the calculation of the value of the integrated indicator for groups of normalized indicators and (or) the object as a whole. Using the expert method, the interval of changes in the values of the integral indicator is divided into sub-intervals (levels), for which increasing or decreasing degrees of safety are assigned.

The integrated indicator of normalized parameters can be represented in three ways: in the form of a product of parameters, their sum and in the form of a metric [16]. In the general case, the ranks of generalizing indicators calculated in different ways by the same object do not necessarily have a similar order and may not coincide.

Summarizing the advantages and disadvantages of scientific approaches to assessing the identification of threats, the most justified from the point of view of practical implementation, according to the authors, a technique seems to be based on the formation of an integral index. The integral index (or indicator) is formed taking into account particular indicators, which are previously subjected to complex standardization by the amount of discrepancy between their actual and threshold values. The mechanism for conducting regular

monitoring of threats to the economic security of the branches of the engineering complex is presented in accordance with figure 1 and includes 6 stages.

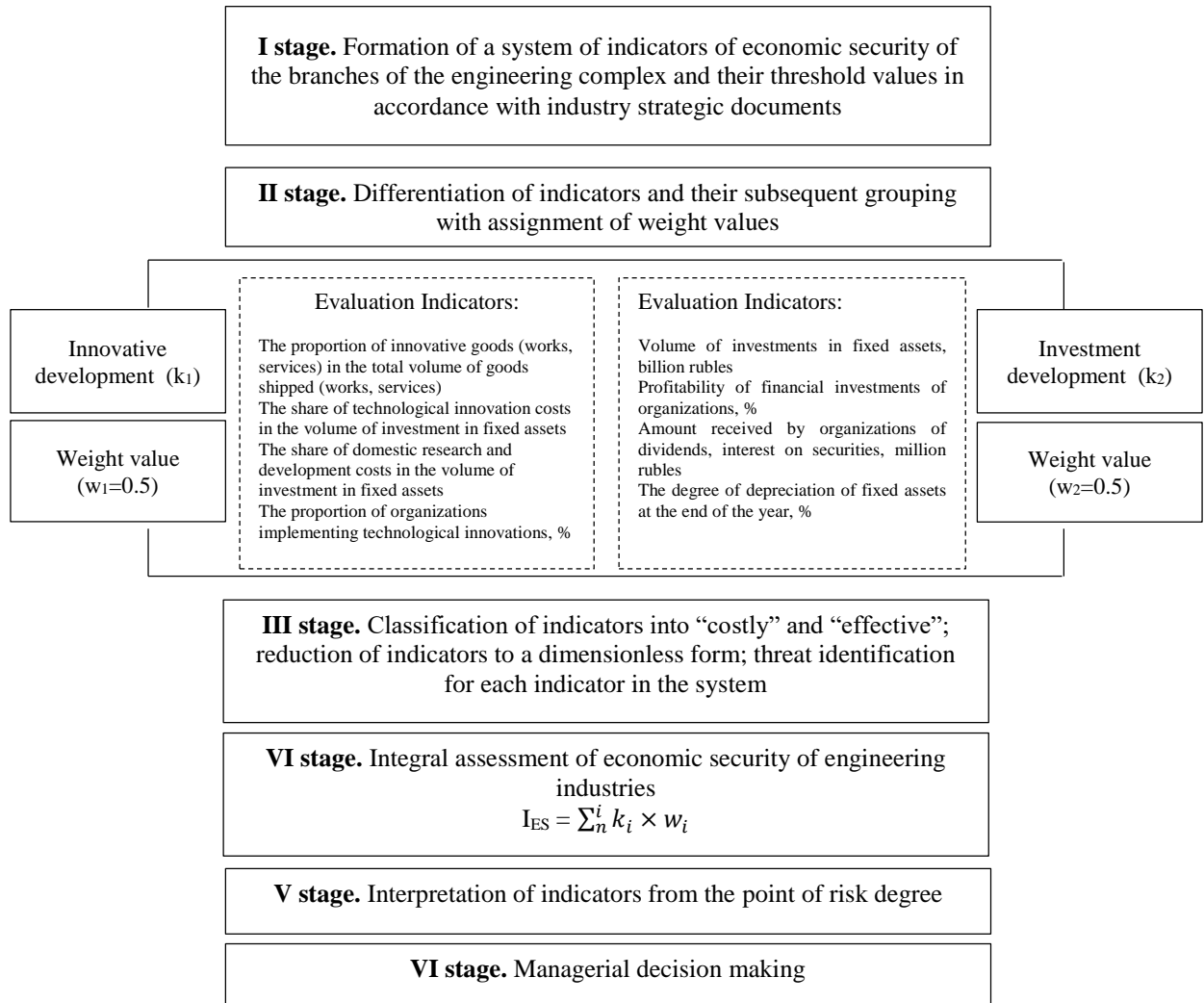


Figure 1. Algorithm of the methodology for assessing threats to the economic security of the branches of the engineering complex (on the example of innovative and investment projection).

At the first stage, a system of indicators is formed to conduct the monitoring procedure based on strategic goals and the availability of statistical data. At the same time, a system of indicators can be presented that reflects in general the state of development of the branches of the machine-building complex, or criteria and assessment indicators can be differentiated by groups and directly reflect the state of development of the industry in production, investment, financial, innovative, environmental and personnel aspects. In relation to industry program documents, the scenario and target values of industry development indicators are determined according to actual data.

Further, to identify problems and negative trends in the development of industry in order to formulate correct conclusions based on monitoring results, it is proposed to develop a system of target (threshold) values for each indicator in the system.

When forming threshold values for indicators for assessing threats (risks) and negative trends, it is proposed to use two concepts: 1) introducing only one threshold value for the evaluation indicator, which involves two classes of security conditions: normal or crisis; 2) the introduction of multi-threshold systems with a deeper assessment of the quality of industry state parameters. All dependencies between

the assessment indicators and their threshold values must be considered in dynamics. In the case of massive “spikes” and exceptions inherent in the market, persistent patterns are manifested, which should be thoroughly investigated.

At the second stage, indicators are differentiated and then grouped together with weight values assigned. Following the stated research topics, the authors consider it important to focus on sustainable innovation and investment development, it is these areas and their regular monitoring that significantly affect sustainable economic growth. In this regard, to assess the economic security of the industry from the perspective of innovation and investment sustainability, it is advisable to group the indicators in two blocks (k_i) (figure 1), each of which is assigned a weight value (w_i). In the framework of this study, an assumption was made about the equivalent significance of each group of indicators ($w_i = 0.5$).

The authors do not exclude that, depending on the objectives of monitoring economic security, the list of groups of indicators, as well as their composition, can be changed. On the other hand, when determining such particular indicators, it is important to take into account two key criteria: 1) indicators should be suitable for conducting a comparative analysis of economic security; 2) sources of information on indicators should ensure the reliability of the data. Therefore, it is advisable to formulate a system of assessment indicators based on the following principles [17]: target orientation, consistency, comprehensiveness, comparability, time orientation, information and analytical security, reliability and transparency, practice-oriented significance.

In the third stage, in accordance with the proposed evaluation algorithm, all indicators are divided into two groups: a group of indicators, the threshold value for which is the minimum acceptable level to ensure the normal functioning of the industry (minimum threshold value); group of indicators, the threshold value for which is the maximum acceptable level to maintain the normal functioning of the industry (maximum threshold value). The indicators of the first group will agree to be called “spectacular.” The growth of these indicators will lead to an increase in the level of economic development of the industry. The indicators of the second group, that is, those whose growth will lead to a deterioration in the level of economic development, will be considered “costly”.

Further, the indicators are brought to a dimensionless form by the method of complex rationing [14]. After reducing the indicators to a dimensionless form, it is possible to present and analyze them in a single coordinate system.

Thus, “effective” indicators should be normalized by the formula (1), “costly” indicators should be normalized by the formula (2).

$$y_i = \left\{ \begin{array}{l} \frac{(1-\frac{a}{x})}{2^{\frac{\ln \frac{10}{3}}{a}}}, \text{ если } \frac{x}{a} > 1 \\ 2^{-\log_{10} \frac{a}{x}}, \text{ если } \frac{x}{a} \leq 1 \end{array} \right., i = \overline{1, n}, \quad (1)$$

where y_i – normalized value of the i -th indicator; a – indicator threshold value; x – actual value of the indicator; n – number of indicators in the system.

$$y_i = \left\{ \begin{array}{l} \frac{(1-\frac{x}{a})}{2^{\frac{\ln \frac{10}{3}}{a}}}, \text{ если } \frac{x}{a} < 1 \\ 2^{-\log_{10} \frac{x}{a}}, \text{ если } \frac{x}{a} \geq 1 \end{array} \right., i = \overline{1, n}, \quad (2)$$

where y_i – the same as in formula (1); a – the same as in formula (1); x – the same as in formula (1); n – the same as in formula (1).

Normalization is a kind of ranking of indicators depending on how far the actual value of the indicator is from its threshold level. The main purpose of applying normalization in this case is to identify threats (risks, problems) to the development of the industry, which correspond to indicators that are farthest from their threshold values in comparison with other indicators included in the system.

Next, the threat is identified (the presence of a risk situation) based on the normalized value obtained, in accordance with which the indicator characterizes the risk/risk-free situation. Moreover, depending on the value obtained, the degree of risk can be differentiated into five groups (table 1).

Table 1. Risk areas used in identifying a threat (problem situation) in industries.

Risk zone	Critical risk	Significant risk	Moderate risk	Stability zone
Indicator values	0.26 – 0.6	0.61 – 0.85	0.85 – 1.0	1.01 – 1.75

At the fourth stage, a composite index (integral indicator) is calculated that characterizes the development of the industry as a whole, the calculation of which is carried out according to a system of indicators in accordance with formula (3); or for each group of indicators in case of their differentiation according to certain projections (investment and innovation) in accordance with formula (4).

$$I_{ES} = \sqrt[n]{\sum_{i=1}^n f_i}, \quad i = \overline{1, n} \quad (3)$$

where I - composite index (integral indicator) characterizing the state of development of the industry as a whole (or a specific projection); f_i – normalized value of the i -th indicator in the system; n – number of indicators in the system.

$$I_{ES} = \sum_n^i k_i \times w_i \quad (4)$$

At the fifth stage, in accordance with table 1, the results are interpreted (values of the composite index) from the point of view of risk.

As part of the final stage, according to the results of the assessment, depending on the targets, a managerial decision is made.

4. Conclusion

According to the authors, the proposed system for monitoring threats to the economic security of the branches of the engineering complex is characterized by the presence of an integrated approach. Based on the goals and objectives of the implemented industrial policy at the federal and regional levels, the set of indicators used for assessment can be adjusted or differentiated (in this case, innovative and investment projections). In this case, it is advisable to carry out an aggregate assessment based on the differentiation of indicators into two groups: 1) “effective” indicators, the growth of which will lead to an increase in the level of economic development of the industry; 2) “costly” indicators, whose growth will lead to a deterioration in the level of economic development.

During the monitoring procedure, it is possible to set a different planning horizon (short, medium and long term), depending on the scale of the goals of state authorities at the macro, meso and micro levels (state, region, business entity).

The proposed approach to the monitoring system can be translated into socio-economic systems of various types (federal, regional, local, corporate), taking into account the definition of an appropriate system of criteria and indicators, their distribution into “costly” and “effective” (if necessary), as well as the formation of threshold values for the compliance of the parameters with the basic principles of the methods proposed for use.

The combination of various methods (indicative, normalized values method, integral), allows to ensure the adequacy of the monitoring system. As a result, the analysis of the assessment results becomes the basis for the development by the federal and regional authorities of a set of measures aimed at achieving strategic results, identifying problems and imbalances in the development of industries, and in general, involves a managerial decision to implement measures aimed at their sustainable development.

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References

- [1] Evstafieva E Yu 2011 Foreign experience in organizing the evaluation of state programs *Bulletin of the Irkutsk State Economic Academy* **1** 62-4
- [2] Oleinikov E A 2004 *Economic and National Security* (Moscow: Exam)
- [3] Senchagova V K 2012 *Economic Security of Russian Regions* (Nizhny Novgorod)
- [4] Illarionov A 1998 Criteria of economic security *Issues of Economics* **10** 35-58
- [5] Diagel O Yu, Koneva O V and Dyagel A V 2016 Methodological support for assessing economic security: a microeconomic section *Innovative development of the economy* **4(34)** 323-36
- [6] Azapagic A 2004 Developing a framework for sustainable development indicators for the mining and minerals industry *Journal of Cleaner Production* **12** 639-62
- [7] Krajnc D and Glavic P 2005 A model for integrated assessment of sustainable development *Resources, Conservation and Recycling* **43** 189-208
- [8] Suresh B, Erinjery J J and Jegathambal P 2016 Indicators and Influence Factors for Sustainability Assessment of Inclusive Smart Innovation Clusters *Journal of Geological Resource and Engineering* **7** 305-27
- [9] Tan F and Lu Z 2016 Assessing regional sustainable development through an integration of nonlinear principal component analysis and Gram Schmidt orthogonalization *Ecological Indicators* **63** 71-81
- [10] Veisi H, Liaghati H and Alipour A 2016 Developing an ethics-based approach to indicators of sustainable agriculture using analytic hierarchy process (AHP) *Ecological Indicators* **60** 644-54
- [11] Zhao J and Chai L 2016 A Novel Approach for Assessing the Performance of Sustainable Urbanization Based on Structural Equation Modeling: A China Case Study *Sustainability* **8(9)** 910
- [12] Vissarionov A B and Gumerov R R 2017 On the use of limit (threshold) values of indicators of economic security of the Russian Federation *Management Sciences* **3** 12-20
- [13] Gordienko D V 2012 Assessment of the level of economic security of China and the United States during the global financial and economic crisis *China in world and regional politics. History and modernity* pp 242-79
- [14] Mityakov E S and Kornilov D A 2015 On the question of choosing weights when finding integral indicators of economic dynamics *Economics, Innovation and Management* **2**
- [15] Karpova V V and Korableva A A 2017 *Theory and practice of assessing economic security (on the example of the regions of the Siberian Federal District)* (Novosibirsk: Publishing House of IEOPP SB RAS)
- [16] Kolesnichenko E A and Osmanov Zh D 2015 Economic Security of Key Sectors of the Russian Economy: A Structural Approach to Research *Forestry magazine* **2** 187-202
- [17] Ruiga I R et al 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **315** 022073