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CRITERIA VALUATION OF MANAGEMENT SOLUTIONS FOR INNOVATION AND INVESTMENT DEVELOPMENT OF THE ENTERPRISE UNDER CONDITIONS OF UNCERTAINTY AND CONFLICT

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ABSTRACT

In today's complex conditions of enterprise operation, innovation processes in most of them are characterized by a set of complex complex organizational measures, which can be implemented only in the implementation of sequentially parallel information-saturated stages of making various management decisions. The article improves and further develops the criterion evaluation of economic decisions on innovation and investment development of the enterprise under conditions of uncertainty and conflict of production and financial and economic processes while taking into account the peculiarities of investment and innovation processes.
Based on research papers, the article improves the classification of decision criteria based on the methods of potential theory and the principles of maximum uncertainty functions and inaccuracy functions, which are related to the values of the estimation functional, characteristics of Bayesian sets and Bayesian surfaces.
It is proved that for the formation of criteria for certain aspects of ensuring the appropriate level of innovation and investment development of industrial enterprises in modern economic conditions it is advisable to use decision criteria based on methods of obtaining point estimates of the unknown vector of a priori probability distribution in a set. It is proposed to use the Khomenyuk criterion, as well as the Rosenbluth and Herfindahl-Hirschman indices, which are used in determining the indicators of evaluation of the results of economic activity of mining and processing enterprises of Ukraine. The calculations allowed to determine the company with the most stable level of innovation and investment development during the study period.
Based on the research, it is concluded that the results of assessing the level of stability of sustainable innovation and investment development of mining and processing enterprises taking into account the risk obtained using the proposed methodological approach can be used for further development of methodology for criterion evaluation of business decisions and conflict in the course of production and financial and economic processes.

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Introduction and problem statement. Innovation processes are characterized by a set of intricate complex organizational measures, which are implemented as a result of the implementation of sequential and parallel information-saturated stages of making a variety of management decisions. In view of this, taking into account the peculiarities of modern dynamic transformations taking place in the field of production and economic activity of industrial enterprises, there is an urgent need to provide the latter with the necessary methodological information to assess the effectiveness of innovation and investment processes and projects. However, it should be noted that investment and innovation processes and projects have their own characteristics. In particular, investment processes can be represented as a sequence of costs incurred in different periods of time in order to obtain different-time income. At the same time, the purpose of innovative projects is to develop and implement innovations in the practice of any business processes of the enterprise to obtain strategic advantages (improving the quality of products and processes, their efficiency, obtaining associated savings and benefits).

Summarizing the above, it can be argued that today it is especially important to ensure the progressive development of enterprises is to improve the methodology of formation of the mechanism of innovation and investment development of enterprises under uncertainty and conflict of market space based on the theory of economic justification of risk-based management decisions.

Analysis of recent research and publications. The analysis of literature sources showed that the issue of forming the mechanism of innovation and investment development of Ukrainian enterprises has recently received much attention [1, p. 86-89; 2, p. 38-42; 3, p. 53-61; 4, p. 29-44]. Possible ways to increase the efficiency of innovation in the context of isolation and implementation of economic, social and legislative components are considered, which, in particular, emphasizes the need to improve national methods for assessing «the effectiveness of investment, innovation, business management solutions in market conditions» [4, p. 35]. However, in our opinion, not enough attention is paid to the further development of the theory and methodology of multicriteria quantitative substantiation of economic management decisions [5; 6, p.14-16; 7, p. 32-45].

Forming the purpose of the article. The purpose of the article is to improve and further develop the criteria for evaluating management solutions on innovation and investment development of the enterprise under conditions of uncertainty and conflict of production and financial and economic processes.

Research results. For the practical solution of problems connected with improvement of methodology of formation of the mechanism of innovative and investment development of industrial enterprises in modern economic conditions, in our opinion, the important and key moment is the further development of criteria of economic decision-making under conditions of uncertainty and conflict of production and financial and economic processes. With this in mind, we will form a general classification of decision-making criteria based on the methods of potential theory and the principles of maximum uncertainty functions and inaccuracy functions. (fig. 1).

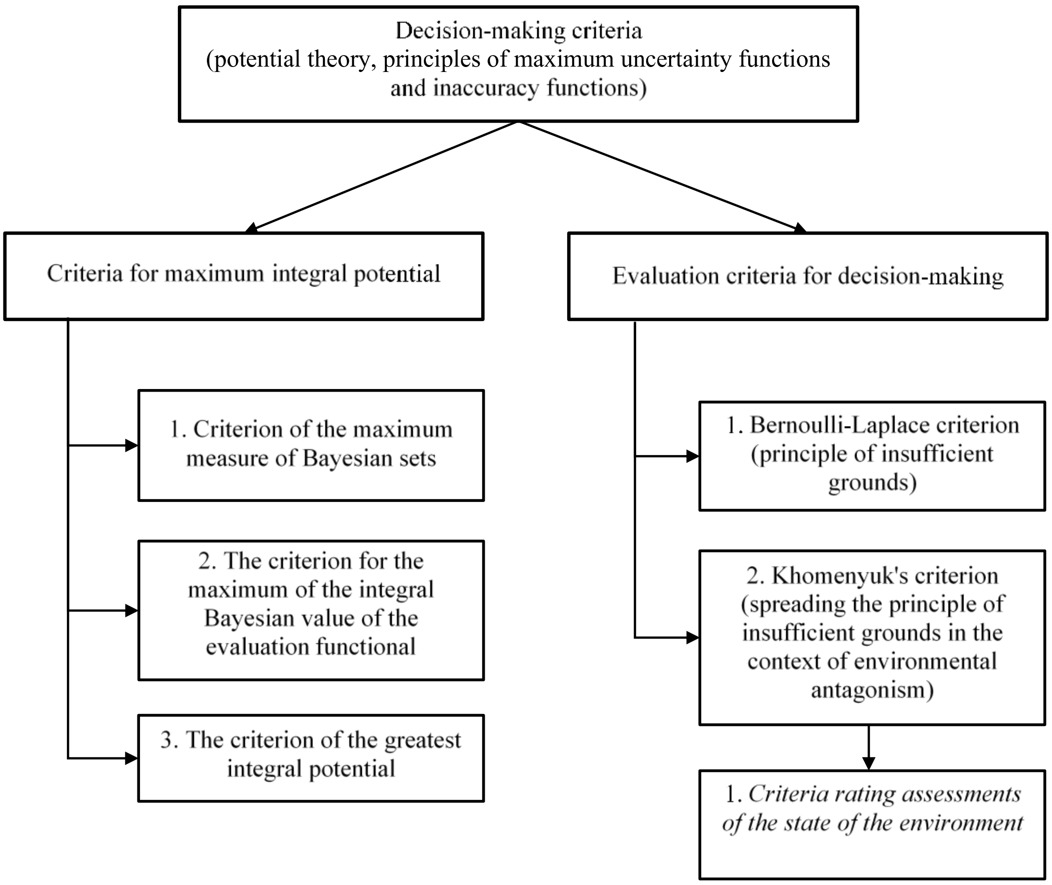


Fig. 1. Classification of decision-making criteria based on the methods of potential theory and the principles of maximum uncertainty functions and inaccuracy functions

The classification criteria for decision-making (fig. 1) are related to the values of the evaluation functional, the characteristics of Bayesian sets and Bayesian surfaces. The essence of these criteria should be considered on a formal presentation of the decision-making situation {Φ, Θ, F} [8, p. 93-94], where through $S_{\varphi 1}$, ..., denote the Bayesian sets of solutions φ_1 ..., φ_m, and through $\mu(S_{\varphi_k})$ – measure of the Bayesian set of the solution $\varphi_k \in \Phi$.

The criterion of maximum integral potential [8, p. 94-96]. Since we consider an information situation characterized by an unknown probability distribution, the principle of maximum measure (maximum volume) of Bayesian sets can be considered as a reasonable principle of solution selection. This principle corresponds to the proposition that the environment is more likely to choose an a priori distribution on Θ from a larger Bayesian set. This approach is based on the geometric interpretation of probabilistic assessment about the «behavior» of the environment.

The essence of the criterion of the maximum measure of Bayesian sets is that the optimal solution is a solution φ_{k0} (or many solutions $\overline{\Phi}$), that satisfies the condition:

$$\mu(S_{\varphi_{k_0}}) = \max_{\varphi_k \in \Phi} \mu(S_{\varphi_k}). \quad (1)$$

The following negative property of this criterion should be taken into account: at the maximum degree $\mu(S_{\varphi_k})$ of the Bayesian set $S_{\varphi_{k_0}}$, the following conditions undesirable for the control body may be fulfilled for some $\varphi_k \in \Phi$:

$$\int_{S_{\varphi_{k_0}}} B^+(\overline{p}, \varphi_{k_0}) d\overline{p} \le \int_{S_{\varphi_k}} B^+(\overline{p}, \varphi_k) d\overline{p}, \quad (2)$$

where the value $\int_{S_{\varphi_k}} B^+(\overline{p}, \varphi_k) d\overline{p}$ characterizes the integral (weighted average for all a priori distributions) Bayesian value of the estimation functional $F = F^+$ for the solution φ_k for all a priori distributions $\overline{p} \in S_{\varphi_k}$.

Therefore, in our opinion, in the context of improving the methodology of formation of the mechanism of innovation and investment development of industrial enterprises in modern economic conditions, it is necessary to make full use of the positive side of this criterion, which allows to determine a mixed solution $\alpha = (\alpha_1, ..., \alpha_m)$, components of which can be calculated as follows:

$$\alpha_i = \mu(S_{\varphi_k}) / \mu(P_{n-1}), \quad (3)$$

where $\mu(P_{n-1})$ – simplex measure P_{n-1}.

The criterion for the maximum of the integral Bayesian value of the evaluation functional. The essence of this criterion is based on the principle of the greatest possible value $\int_{S_{\varphi_k}} B^+(\overline{p}, \varphi_k) d\overline{p}$ for all decisions $\varphi_k \in \Phi$, according to which the optimal solution φ_{k_0} satisfies the following condition:

$$\int_{S_{\varphi_{k_0}}} B^+(\overline{p}, \varphi_{k_0}) d\overline{p} = \max_{\varphi_k \in \Phi} \int_{S_{\varphi_k}} B^+(\overline{p}, \varphi_k) d\overline{p}, \quad (4)$$

where the value $\int_{S_{\varphi_i}} B^+(\overline{p}, \varphi_i) d\overline{p}$ is the integral Bayesian value of the estimation functional $F = F^+$ for the solution $\varphi_k \in \Phi$.

One of the negative properties of this criterion is that it may be an undesirable condition $\mu(S_{\varphi_{k_0}}) \le \mu(S_{\varphi_k})$ for the governing body for some $\varphi_k \in \Phi$.

However, this criterion allows to determine the mixed solution α = (α_1, …, α_m), for example, by the following rule:

$$\alpha_i = \int_{S_{\varphi_i}} B^+(\bar{p}, \varphi_i) d\bar{p} \Big/ \int_{P_{n-1}} B^+(\bar{p}) d\bar{p} . \quad (5)$$

The criterion of the greatest integral potential. These shortcomings in the above two conditions can be compensated in some way by developing a new principle of choice based on the concept of solution potential. The integral potential of the solution $\varphi_k \in \Phi$ will be called the value:

$$\pi_{\varphi_k} = \frac{\int_{S_{\varphi_k}} B^+(\bar{p}, \varphi_k) d\bar{p}}{1 - \mu(S_{\varphi_k}) / \mu(P_{n-1})} . \quad (6)$$

The essence of the criterion of the greatest integral potential is that the optimal solution φ_{k_0} (or many such solutions $\bar{\Phi}$) is a solution that satisfies the following condition:

$$\pi_{\varphi_{k_0}} = \max_{\varphi_k \in \Phi} \pi_{\varphi_k} . \quad (7)$$

The physical essence of the formulated criterion is quite obvious and natural, because the maximum value π_{φ_k} is equivalent to the largest possible value of the numerator, namely the integral Bayesian value of the estimated value on the solution φ_k, and the smallest possible value of the denominator, which determines the geometric probability of the vector $\bar{p} = (p_1,..., p_{n-1})$ in S_{φ_k}.

The concept of the integral potential of the solution $\varphi_k \in \Phi$ can be used to give a mixed solution $\alpha = (\alpha_1, ..., \alpha_m)$ in the following form:

$$\alpha_i = \pi_{\varphi_i} \Big/ \sum_{s=1}^{m} \pi_{\varphi_s} . \quad (8)$$

Thus, in our opinion, to form criteria for certain aspects of ensuring the appropriate level of innovation and investment development of industrial enterprises in modern economic conditions, it is advisable to use decision-making criteria based on methods of obtaining point estimates p of unknown vector $\hat{p}$ of a priori probability distribution on the set Θ [8, p. 96-98; 9, p. 21].

In this case, we will use the principle of potential probability distribution based on the fact that the environment chooses with a higher probability (with less probability for $F = F^-$) such a state of the medium from the set Θ, on which the contribution to the total value of the estimation functional F^+ states $\varphi_k \in \Phi$ with Θ has a smaller value compared to other similar values. This principle, generally speaking, is a very real model of environmental behavior for the governing body, which seeks to reduce the value of the evaluation functional *F*+ (or increase in the case of $F = F^-$) for decision-making.

This principle is the basis of Khomenyuk's criterion, which can be applied to the analysis of decision-making situations {Φ, Θ, *F*, where the evaluation functional *F* is given in the form of a matrix F^+ (with a positive ingredient) or F^- (with a negative ingredient).

Thus, to improve the methodological approaches to diagnosis (analysis and evaluation) of the level of stability of sustainable innovation and investment development of industrial enterprises under uncertainty, we use Khomenyuk's criterion, which is based on the concept of "potential probability distribution" on the environment of the set Θ.

In this case, the potential vector of a priori probabilities of states of the medium from the set Θ is determined in the following form for $F = F^+$ and $F = F^-$, respectively:

$$\hat{p}_j = \frac{\sum_{i=1}^{m} (\max_{i=1,...,m} f_{ij}^+ - f_{ij}^+)}{\sum_{j=1}^{n} \sum_{i=1}^{m} (\max_{i=1,...,m} f_{ij}^+ - f_{ij}^+)}; \quad \hat{p}_j = \frac{\sum_{i=1}^{m} f_{ij}^-}{\sum_{j=1}^{n} \sum_{i=1}^{m} f_{ij}^-} \quad (j = 1, ..., n). \quad (9)$$

Thus, Khomenyuk's criterion is an extension of the principle of insufficient grounds in case the governing body uses the principle of potential distribution of probabilities of environmental states, according to which a higher a priori probability is given to environmental states that contribute less to the total value of the estimation functional. This approach is typical of methods for obtaining point estimates using the principle of maximum uncertainty functions of the third kind.

After the obtained estimates $\hat{p}_j$ of a priori probabilities p_j, the criterion rating estimates on the characteristics of the positivity of the state of the environment (years of the retrospective period) can be presented as follows:

$$R_j = 1 - p_j, \tag{10}$$

where $j = 1 \div n$; n – quantity of years in the retrospective period.

So, in our opinion, the concept of integrated solution potential can be used to obtain a mixed solution in the form of a set of estimates on many environmental conditions (within the years of the retrospective period), which are essentially weights in the formation (construction) of the evaluation functional. The latter, in particular, will reflect the level of ensuring the stability of sustainable innovation and investment development of the enterprise.

However, it should be noted that to assess the level of providing acceptable conditions for flexible development of industrial enterprises in the context of their renewal, economists have developed certain theoretical and methodological approaches to diagnose and assess the state of the enterprise. For example, in some works Samochkina V.N. [10, p. 18-25] the task of assessing the flexible development of the enterprise in the context of its propensity and ability to update is proposed to use an approach based on the function of automatic regulation.

In solving this problem, indicators are involved, which are widely used by managers-economists. Such indicators may be the size of assets and own funds, net income, sales, production costs and sales. Indicators derived from the above, in particular: profitability of sales, asset turnover and financial leverage, are becoming important.

We will form and introduce notation for the initial indicators for assessing the level of stability of sustainable innovation and investment development: РП - sales volume, UAH; A - assets of the enterprise, UAH; ЧП - net profit, UAH; ВА - equity, UAH; КО - capital for renovation, UAH.

Based on the above, it is possible to propose the construction of the evaluation functionality, which will reflect the level of stability of sustainable innovation and investment development of the enterprise, taking into account the risk:

$$F = \psi\{R_{np}, OA, ΦB, KO^*, IK\}, \tag{11}$$

where R_{np} – profitability sales (R_{np} = $ЧП/РП$), fraction of units; OA – asset turnover (OA = $РП/A$), fraction of units; $ΦB$ – financial leverage ($ΦB = A/BA$), fraction of units; KO^* – capital intensity of the upgrade ($KO^* = KO/РП$), fraction of units; IK – integrated assessment of competition intensity (monopolization) ($IK = f(A, ЧП, S_i, R_N)$, where S_i – market shares of enterprises; R_N – ranks (numbers) of enterprises by market shares), fraction of units.

Multi-criteria assessment of the level of stability of sustainable innovation and investment development, taking into account the risk is carried out according to the formula:

$$k_j^{(SD)} = (1 - p_j)\frac{1}{m}\left[R_{np}^N + OA^N + ΦB^N + KO^{N*} + IK^N\right], \tag{12}$$

where j = 1÷n – the quantity of years of the retrospective period (n = 5); p_j – weight point estimates based on the methods of potential theory and the principles of maximum uncertainty functions, which reflect a higher priority for retrospective periods, for which less contributions were made to the total value of the estimation functional (12); m – the quantity of components of the evaluation functionality (m = 5); index «N» indicates that in the future all computational operations will be performed with normalized values of the components of the functional (11).

Normalization of the components of the functional assessment of the level of stability of sustainable innovation and investment development of the enterprise allows to calculate its «reference» value ($k_{rv}^{(SD)}$) based on the principle of «insufficient basis» [9, c. 20]. In this case, for the retrospective and forecast periods, we can assume the existence of «equilibrium-sustainable» process of enterprise operation, assuming as a hypothesis that «equilibrium systems are not capable of development and self-organization, because they suppress deviations from their steady state, while development and self-organization provide for qualitative changes» [11, c. 98]. Then we have such a function (expression) to determine the «reference» value $k_{rv}^{(SD)} = 1 - 1/n$, where n – the quantity of years of the retrospective period.

Consider a practical example of the implementation of the proposed methodological approach to assessing the level of stability of sustainable innovation and investment development of the three mining and processing enterprises for the period 2013-2017 on the basis of the indicators given in table 1.

Table 1. Indicators for evaluating the results of economic activity of mining and processing enterprises

Indicator	Enterprise	2013	2014	2015	2016	2017
1. Sales volume, UAH million	PJSC «CGZK»	5672,95	6272,22	6531,71	7102,18	10727,6
	PJSC «PivnGZK»	13345,3	12570,7	13329,4	15106,5	23282,27
	PJSC «InGZK»	10352,3	11341,2	9489,52	11306,5	15711,29
2. Assets of the enterprise, UAH million	PJSC «CGZK»	7822,8	6573,3	7426,4	12610,8	14212,4
	PJSC «PivnGZK»	21821,4	32400,2	29624,8	38176,5	47503,86
	PJSC «InGZK»	24694,3	31002,2	36672,8	40485,9	49006,28
3. Net profit, UAH million	PJSC «CGZK»	1572,01	770,846	687,976	2218,23	2707,85
	PJSC «PivnGZK»	4442	1546	-1212	3613	7792
	PJSC «InGZK»	4713	976,2	-3499	-69,3	5711
4. Monopolization, the share of units.	PJSC «CGZK»	0,218	0,228	0,227	0,221	0,226
	PJSC «PivnGZK»	0,218	0,228	0,227	0,221	0,226
	PJSC «InGZK»	0,218	0,228	0,227	0,221	0,226
5. Own capital, UAH million	PJSC «CGZK»	6708,57	5543,35	6265,38	5958,360	7071,523
	PJSC «PivnGZK»	16035,6	23413,1	23955,7	30101,7	23928,348
	PJSC «InGZK»	17424,1	11667,1	9621,09	8943,17	14388,48
6. Capital for renovation, UAH million	PJSC «CGZK»	2835,54	953,831	130	877,797	821,515
	PJSC «PivnGZK»	824,199	419,398	447,264	437,974	401,44
	PJSC «InGZK»	248,2	216,5	194	113,7	103,28

Note: PJSC «CGZK» – private joint-stock company (PJSC) «Central Mining and Processing Plant», PJSC «PivnGZK» – PJSC «Northern Mining and Processing Plant». PJSC «InGZK» – PJSC «Ingulets Mining and Processing Plant».

Denote the components of the functional (12) through x_i : $R_{np}^N = x_1$; $OA^N = x_2$; $ΦB^N = x_3$; $KO^{N*} = x_4$; $IK^N = x_5$ and rewrite it as follows:

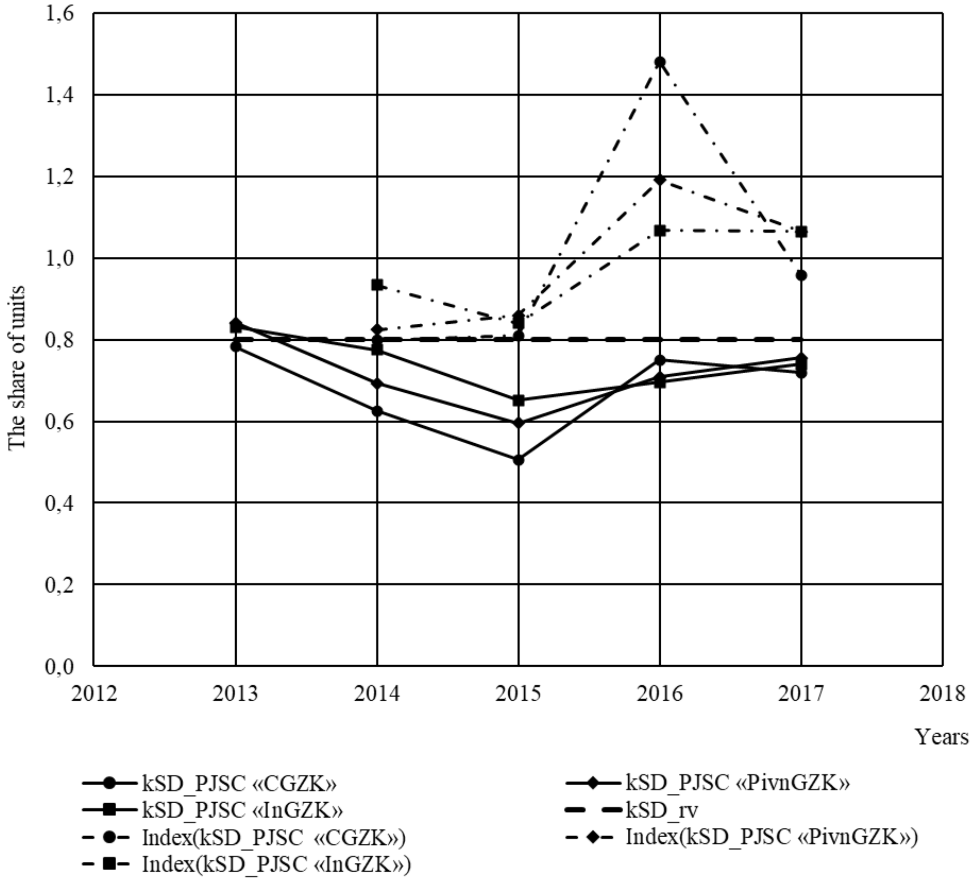
$$k_j^{(SD)} = (1 - p_j)\frac{1}{m}\sum_{i=1}^{m} x_i \text{, where } j = 1 \div 5;\ i = 1 \div 5. \quad (13)$$

Subject to, $p_j = \frac{1}{n}$, $\sum_{j=1}^{n} p_j = 1$ at $n = 5$, $x_i = 1$ ($i = 1 \div 5$) the reference value of the assessment of the level of ensuring the stability of sustainable innovation and investment development is calculated $k_{rv}^{(SD)} = 0{,}8$.

Applying to the quantitative assessments of the results of economic activity of mining and processing enterprises (table 1) means of normalization [9, p. 23-24] calculate the weight point estimates (p_j), based on the methods of potential theory and the principles of maximum uncertainty functions.

Herewith, the ingredient change procedure was applied to the Monopolization indicator determined using the Rosenblut and Herfindahl-Hirschman indices.

According to the formula (12), taking into account for each of the three mining and processing enterprises of the corresponding values p_j, calculated and built in the dynamics of assessing the level of stability of their sustainable innovation and investment development (fig. 2).



Note: kSD_PJSC «CGZK», kSD_PJSC «PivnGZK», kSD_PJSC «InGZK» – designation of estimates of the level of stability of sustainable innovation and investment development of mining and processing enterprises; kSD_rv – designation of the reference assessment of the level of stability of sustainable innovation and investment development of mining and processing enterprises; Index(kSD_PJSC «CGZK»), Index(kSD_PJSC «PivnGZK»), Index(kSD_PJSC «InGZK») – designation of indices of relevant indicators for assessing the level of stability of sustainable innovation and investment development of mining and processing enterprises.

Fig. 2. Dynamics of estimates of the level of stability of sustainable innovation and investment development of mining and processing enterprises

Analysis of the dynamics of indicators $k_j^{(SD)}$ and their indices allows us to conclude that the most stable level of innovation and investment development for the period 2013-2017 is inherent in the company PJSC «Ingulets Mining and Processing Plant». The dynamics of the indices of indicators for assessing the level of stability of sustainable innovation and investment development of PJSC «Central Mining and Processing Plant» shows that this company is able to more actively respond flexibly to the antagonistic behavior of the market environment.

At the same time, starting from 2013, all three enterprises have an assessment of the level of stability of sustainable innovation and investment development below the one adopted according to the proposed methodological approach $k_{rv}^{(SD)} = 0{,}8$. The reliability of the results of modeling the level of stability of sustainable innovation and investment development of enterprises according to model (13) can be said based on the fact that 2013-2014 were really particularly difficult in the context of both economic and political situation in Ukraine.

Conclusions. Thus, assessments of the level of stability of sustainable innovation and investment development of mining and processing enterprises, taking into account the risk, obtained using the proposed methodological approach can be used to further develop the methodology of criterion evaluation of business decisions on innovation and investment development of the enterprise. economic processes.

More in-depth research on the development of the theory and methodology of multicriteria quantitative substantiation of economic management decisions in the context of innovation and investment development of enterprises should be aimed at forming diagnostic tools and ranking its situations and appropriate levels.

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