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FACTOR ANALYSIS OF ASSESSMENT OF THE ECONOMIC POTENTIAL OF MINING COMPANIES

Purpose. Development and testing of the application of factor analysis to assess the economic potential of mining companies.

Methodology. In the course of the scientific research, the authors used general scientific and special methods of cognition, such as analysis – for a critical assessment of the possibility of applying factor analysis; logical generalization – for the structural components of the assessment of the economic potential of mining companies; quantitative and qualitative comparisons – to highlight the results of factor analysis; scientific abstraction and systematization – for setting out proposals regarding the implementation of the use of factor analysis to assess the economic potential of mining companies.

Findings. In the course of the research, an assessment of the economic potential of mining companies was carried out and proposals were offered regarding the possibility of using factor analysis during such an assessment. The authors have formed methodological principles for assessing the value of the economic potential of project participants and developed a typification of options for the formation of economic potential.

Originality. In the course of the study, the authors selected and systematized the factors affecting the size of the formed economic potential of mining companies. The results of an expert assessment of the impact of factors on the size of the economic potential are presented. The authors also proposed a criterion for an integrated assessment of the influence of factors characterizing both quantitative and qualitative aspects of the process of forming the economic potential of project participants.

Practical value. The results of the study can be used by practitioners, scientists, and civil servants (the Ministry of Education and Science of Ukraine and its structural subdivisions, local self-government bodies in the field of education and science) for the development of further prospects. Establishing ties with educational and research organizations, high-tech companies, as well as with government agencies will allow for effective exchange of experience, adaptation of educational programs, and development of skills in the application of factor analysis to assess the economic potential of mining companies.

Keywords: *factor analysis, the economic potential of the company, analysis, mining companies*

Introduction. For modern civilization the mining industry is one of the key resources in the technical system of life support and a global commodity in the international trade system. It is extremely difficult to overestimate the role of the mining industry in the life of modern society.

The direction in which the world market of the mining industry is moving nowadays has an impact on the world economy, determines the pace of development, contributes to economic growth or causes the onset of recession. These trends largely determine the course of economic development of each individual country. Moreover, this market has turned into a kind of political arena, the dominance in which makes it possible to conduct the foreign policy of many countries.

Maintaining a high level of mining volumes requires timely renewal and replenishment of the mineral-raw material base, and a significant area has been created in the country for this, since there is a sufficient number of explored prospective deposits that can be included in the development.

However, the development of a new deposit is associated with the need for significant capital investments in the development of both the production itself and the territorial infrastructure, and it may be economically impractical for the mining business without state support in this area. That is why state structures are assigned an important role in the implementation of projects for the creation of new mining centers.

It should also be noted that the creation of such centers will lead to the development of other types of industrial and economic activity in the territory of their location, which will undoubtedly affect the increase in the economic growth of the region.

Therefore, the search for mutually beneficial ways of interaction between the state and the mining business in the implementation of projects for the development of promising deposits will be of crucial importance.

Literature review. The work of such scientists as Liashenko V. I., Volkov V., Osadcha N. V., Horoshkova L., Haliasovska O. V., Shatska Z. Ia., Artiukh T. M., Hanziuk T. D., Fedii V. V., Hryhorenko I. V., and others is devoted to the problems of researching the economic aspects of the mining industry, including in terms of export and import.

Academic economists Volkov V., Horoshkova L. in their writings stated that Ukraine has a considerable supply of mineral resources of non-metallic minerals. According to their characteristics, these resources meet the standards of suitability for use and have the appropriate composition and technological properties for use in various industries of Ukraine and the world [1].

Shatska Z. and Hanziuk T. note that "today the mining industry is a branch of international specialization. Among the world's leading countries, the largest mining countries are the USA, Canada, Australia, the Republic of South Africa and China. Among the developing countries, India, Indonesia, Congo, Zambia, Brazil, Mexico, Venezuela, and Chile should be mentioned. Developing countries are suppliers of mineral

raw materials for industrially developed countries. In these countries, raw materials are extracted in an amount that is several times higher than their internal needs, therefore a significant amount of extracted raw materials is exported" [2].

Artiukh T., Fedii V., Hryhorenko I. note that the negative state of own production is caused by:

1) depletion of reliable oil reserves;

2) difficult accessibility to the development of deposits, because about 75 % of reserves are located at a depth of more than 2.5 km;

3) technical backwardness;

4) insufficient volumes of exploratory drilling;

5) delays in the search and development of new deposits, in particular in the shelf area of the Black and Azov seas [3].

Liashenko V., Osadcha N. and Haliasovska O. note that "both for the development of the mining industry and to ensure the interests of the people of Ukraine as the owners of the subsoil, it is proposed to introduce a number of measures to improve regulatory mechanisms and develop financial and regulatory regimes for stimulating the use of subsoil, namely:

- involvement of new investments in the mining and metallurgical industries;
- work with mineral and raw-material resources should be carried out at a deeper level;
- ensuring the necessary balance between the extraction of minerals and the reproduction of the mineral-raw material base" [4, 5].

The following scientists were engaged in the study on the problems of assessing the economic potential: Vaskivska K., Lozinska L., Halimuk Yu., who note in their work that the enterprise can and should strive for the formation and continuous development of its economic potential. This development is possible under appropriate socio-economic and market conditions. The economic potential should be directed to strengthening competitive market positions, the following factors of success can be noted as fundamental: knowledge, skills, mobility, modern technologies, a widely developed marketing component, mixed types of production, a wide range of available products [6].

Scientist Shkromida N. carried out a complex combined assessment of the components of economic potential, which forms reliable information about the state of production enterprises, and indicated that it is necessary to determine the factors that caused the changes and eliminate them for the future [7].

Bieloborodova M. and Shapoval V. in their works consider integrated production systems that have high economic potential with small volumes of production. The authors characterized the effectiveness of the introduction of the integration of production systems, under the condition of a change in indirect costs decreasingly [8].

Azhaman I., Hronska M., Pushchina N. proposed the use of the method of income capitalization during the assessment of the actual value of the enterprise. According to the authors, the application of the above methodology will provide an opportunity for the enterprise to actually assess its capabilities. Also, on the basis of this methodology and the results obtained after application, enterprises will be able to develop and implement appropriate measures aimed at increasing the economic potential of the enterprise [9].

The authors Masiuk Yu., Kachur V. draw a parallel between the economic potential and the business activity of the enterprise. The following classification features of business activity were noted:

- the scope of activity;
- the content of objects to be evaluated;
- a stage of the life cycle of the enterprise;
- the degree of relation to the economic entity;
- a branch of business activity;
- analyzed time period;
- the scale of planning;
- the degree of reality;
- orientation;
- the level of business activity [10].

Scientists Zhuvahina I., Kohutenko K. in their writings proposed the following definition of the "economic potential of the enterprise", which consists in the possibility of the combined resources used at the enterprise and available competencies to achieve results for interested parties using business processes. The structure of the economic potential is revealed and the classification is provided according to classification features and types of potential manifestations [11].

Kobets S., Vashchenko O. in their work revealed a methodical approach to the comprehensive assessment of the economic potential of the enterprise. This methodical approach consists in the availability of public reporting, the universality of application and makes it possible to obtain quantitative estimates [12].

Applying a methodical approach in the practical activity of the enterprise, one should take into account the mandatory implementation of six stages:

1) selection of structural components of the economic potential of the assessed enterprise;

2) selection of indicators that meet their characteristics and can be attributed to the economic potential of the evaluated enterprise;

3) formulation of the number of points for the relevant indicators of the components of the economic potential of the assessed enterprise;

4) determination of the sum of points for each structural component of the economic potential of the assessed enterprise;

5) calculation of a comprehensive indicator of the economic potential of the evaluated enterprise by calculating points for all components;

6) documentation of a complex indicator of the economic potential of the analyzed enterprise [12].

Questions related to the economic potential of companies have always occupied a special place among scientists' and economists' research interests and have been the subject of constant discussions. However, market relations require adaptation of the assessment of the economic potential of production companies.

Unsolved aspects of the problem. The scientific achievements of the scientists listed above are important for the formation of theoretical foundations and practical application of the assessment of the economic potential of mining companies.

However, the issues of a comprehensive analysis using various methods and components that can affect the final results of the companies' operation remain open.

The purpose of the article is to develop and test the use of factor analysis to assess the economic potential of mining companies.

Methods. In the course of the scientific research, the authors used a number of general scientific and special methods of cognition, such as:

- analysis and logical generalization – for the structural components of the assessment of the economic potential of mining companies;
- quantitative and qualitative comparisons – to highlight the results of factor analysis;
- scientific abstraction and systematization – for setting out proposals regarding the implementation of factor analysis for the assessment of economic potential.

Results. Economic potential includes production, natural, scientific-technological and socio-cultural components, and as a result, is a generalizing indicator. The size of the economic potential can be determined by the volume, degree of perfection, scale and structure of productive forces.

Economic potential is a broad concept, and its assessment should be understood as the result of determining and analyzing the qualitative and quantitative characteristics of the managed entity, as well as the management process itself.

The evaluation of the economic potential of the enterprise is understood as a process of determining and analyzing the qualitative and quantitative characteristics of the evaluated enterprise.

In order to assess the significance of mining and geological, production, climatic, investment, economic, ecological, regional and other spheres and branches of influence on the value of economic potential, the possibility of applying factor analysis was considered in the paper.

When considering the role of various spheres and regions affecting the economic potential of mining companies, factor analysis as a research method is a modern universal tool for comprehensive study on various conditions and objects of the studied area. When applying factor analysis, it is possible to identify hidden peculiarities that characterize existing relationships between the variables being studied.

In order to establish the most significant factors and their structure, the method of components was used, the essence of which is related to the establishment of groups of factors that are not correlated with each other, which at the same time have the most significant effect on the amount of economic potential of various types of mining companies.

Another significant feature of the method of principal components is its ability to reduce the number of analyzed factors, based on the possibility of selecting only those factors that carry the largest amount of information necessary for the interpretation of research results.

The described toolkit was used when considering different components of the influence of different groups of factors on the value of different types of economic potential of mining companies. At the same time, the following was achieved:

1. Conducting studies on the factor structure.

2. Study on quantitative significance of factors in groups.

Conducting research on the assessment of the degree of influence of various factors on the value of various types of economic potential is implemented in the following sequence.

The conditions for factor analysis were verified:

- possibilities of their quantitative assessment;
- sufficient number of observations;
- homogeneity of the formed groups of factors;
- symmetry of distribution of factors.

In order to carry out the procedure for researching the closeness of the influence of factors on the value of various types of economic potential of mining companies, a differentiated assessment of factors by sources (areas) of their origin was applied. An analysis of groups of factors that have the most significant impact on the amount of economic potential of various types was performed [13, 14].

When conducting a factor analysis, ten qualitatively different types of factors were identified, which to varying degrees affect the value of different types:

The first category includes geological factors: thickness of the formation, depth of occurrence, quality of coal.

The second category – factors characterizing mining and technological conditions: development method, mining capacity.

The third category – factors characterizing the level (depth) of mining complexity: coal beneficiation, coal processing.

The fourth category – climatic conditions: mild, moderate, extreme.

The fifth category is the investment climate: stable, unstable.

The sixth – the state of market demand: stable, unstable, decreasing.

The seventh category – economic factors: competitiveness, profitability of extraction, sustainability of development.

The eighth category – environmental factors: the level of water pollution, the level of air pollution; the level of pollution of the earth's surface.

The ninth category – factors characterizing saturation with competitive reserves of mineral raw materials: high, medium, low.

The tenth category – factors characterizing the possibility of creating new types of economic activity in the adjacent territories in the future: high, medium, low.

As a result of the analysis, the peculiarities of the directionality of influencing factors, three possible groups of influence were revealed (Table 1).

The first type of factors – there are factors whose nature of influence on the economic potential of mining companies is presented in the form of a comparative assessment in relation to some parameters averaged over the coal industry.

The second type of factors – factors whose nature of influence on the value of the economic potential is presented as the inclusion or exclusion of some components of production.

The third type of factors are factors whose nature of influence on the economic potential is based on the selection and assessment of one of the possible states of the elements of the external environment.

To carry out the procedure for establishing quantitative estimates of the degree of influence of the factors presented above on the economic potential of mining companies, the method of expert assessments was used (50 experts in this field were involved).

At the same time, the purpose of conducting expert evaluations involving the implementation of logical and mathematical procedures was to obtain generalized information from specialists, intended for the search and formation of rational solutions.

Thus, on the basis of the opinion of 50 members of the expert group, an assessment of the influence of factors on the effectiveness of decisions regarding the choice of an option for the formation of the economic potential of mining companies was carried out.

Currently, the methods of expert evaluation of experts' opinions consist in the desire to identify information individually from each of the interviewed specialists. At the same time, the ultimate goal of such methods is to obtain final data based on the quantitative processing of assessments of all experts involved in the survey.

Among such methods, the "Delphi" method is one of the most common and proven methods of expert evaluations.

The advantage of the methods of expert evaluations is their relative speed, flexibility and independence from various influences and orientations and opinions that have developed or are being formed.

Table 1

The nature of the influence of the identified types of factors on the economic potential of mining companies of Ukraine

Characteristics of analyzed types of factors	Type of influence factors		
	"1"	"2"	"3"
1. Geological	+	–	–
2. Mining and technological	+	–	–
3. Complexity of production	–	+	–
4. State of the climate	–	–	+
5. Investment climate	–	–	+
6. Market demand	–	–	+
7. Economic	+	–	–
8. Ecological	+	–	–
9. Saturation of the region with competitive reserves of mineral resources	–	–	+
10. The need of the surrounding territories for the development of economic activity	–	–	+

The most significant disadvantages of expert assessment methods include a rather high risk of subjectivity associated with the possibility of limited knowledge of at least one of the experts.

The methods of expert assessment are based on the use of a questionnaire survey of experts, in compliance with the rules for the protection of information from survey participants and its anonymity [15, 16].

The following steps were taken to apply the expert evaluation method:

1. An anonymous individual survey of experts was conducted using a questionnaire. The invited experts provided answers to the questions set out in the questionnaire. After that, the results of the questionnaire were processed and the collective opinion of the group of experts was reflected in the relevant documents.

2. The results of the questionnaire were communicated to the experts, and they were offered the assigned evaluations with arguments for the reasons for their disagreement with the collective judgment.

New estimates are processed again, and the transition to the next stage is carried out. Practice shows that after a number of stages, experts' answers stabilize.

The advantage of the Delphi method is the use of feedback during the survey, which significantly increases the objectivity of expert assessments [17, 18].

However, this method requires considerable time to implement the entire multi-stage procedure.

The basic steps of the expert evaluation procedure are:

- organization of the procedure for experts' work;
- the choice of the method for obtaining information from experts and the technology of its processing;
- the procedure for searching and selecting experts, preparing the form and content of questionnaires;
- conducting an interactive expert survey of specialists;
- implementation of technologies for evaluating information presented in questionnaires;
- preparation of final decisions based on the study of questionnaires;
- preparation of the arrangement based on the results of the examination.

To carry out an expert assessment of the degree of influence of the above factors on the economic potential of mining companies, an expert survey of the following specialists was conducted:

- mining;
- business;
- management;
- construction;
- science;
- ecology;
- economics.

Three levels of influence of factors are used as a basis for conducting assessments, where:

1 is extremely negative influence of the factor;

10 is extremely positive influence of the factor.

The results of the expert assessment of the influence (of each of the ranges of values described above) of the factors on the value of the economic potential are presented in Table 2.

As a result of the conducted research, it was established that the economic potential of mining companies is affected by different factors that characterize both quantitative and qualitative parameters.

None of the factors received the maximum average score from the experts. In general, the grades range from 5 to 6.

As evidenced by the obtained average values of expert assessments (Table 2), the formation of the economic potential of mining companies is most influenced by geological factors (in terms of reservoir capacity and coal quality), climatic conditions, environmental factors (level of water, air, land pollution) and saturation of the region with competitive reserves of mineral and raw material resources.

Table 2

Assessments of experts regarding the possibility of forming the economic potential of mining companies

Characteristics of factors	Average value
1. Geological:	
Formation capacity:	
- above average	8
- below average	5
Depth of occurrence:	
- more than average	4
- less than average	5
Coal quality:	
- above average	7
- below average	6
2. Mining and technological conditions:	
Development method:	
- open	6
- underground	4
Mining capacity:	
- above average	6
- below average	5
3. The complexity of production includes the creation of:	
Prepared coal:	
- yes	6
- no	4
Coal processing:	
- yes	6
- no	5
4. Climatic conditions:	
- soft	6
- moderate	5
- extreme	4
5. Investment climate:	
- stable	5
- unstable	4
6. Market demand:	
- stable	6
- unstable	4
- decreasing	3
7. Economical:	
- competitiveness	6
- profitability of extraction	5
- sustainability of development	4
8. Ecological:	
- level of water pollution	5
- air pollution level	4
- level of land pollution	6
9. Saturation of the region with competitive reserves of mineral and raw material resources:	
- high	6
- average	5
- low	4
10. The need of the surrounding territories for the development of economic activity:	
- high	5
- average	4
- low	6

Conclusions. Identified and systematized factors significantly affect the economic potential of mining companies.

Methodological principles for assessing the economic potential of the participants have been formed.

The results of an expert assessment of the influence of factors in terms of geological and mining-technological conditions, the complexity of mining, climatic conditions, investment climate and market demand, economic and environmental factors, saturation of the region with competitive reserves of mineral and raw materials and the needs of adjacent territories in the development of economic activity are given.

A criterion for integrated assessment of the impact of factors characterizing both quantitative and qualitative aspects of the process is proposed.

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Застосування факторного аналізу для оцінки економічного потенціалу гірничодобувних компаній

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Мета. Розробка та апробація застосування факторного аналізу для оцінки економічного потенціалу гірничодобувних компаній.

Методика. У ході наукового дослідження авторами було використано загальнонаукові та спеціальні методи пізнання, такі як: аналіз – для критичної оцінки можливості застосування факторного аналізу; логічне узагальнення – для структурних складових оцінки економічного потенціалу гірничодобувних компаній; кількісні та якісні порівняння – для висвітлення результатів застосування факторного аналізу для оцінки; наукова абстракція й систематизація – для викладення пропозицій у частині впровадження застосування факторного аналізу для оцінки економічного потенціалу гірничодобувних компаній.

Результати. У процесі дослідження проведена оцінка економічного потенціалу гірничодобувних компаній і надані пропозиції щодо можливості використання факторного аналізу під час виконання такої оцінки. Авторами сформовані методичні засади оцінки величини економічного потенціалу учасників проєктів і розроблена типізація варіантів формування економічного потенціалу.

Наукова новизна. У ході дослідження авторами зроблені вибір і систематизація факторів, що впливають на величину формованих економічних потенціалів під час освоєння перспективних вугільних родовищ. Наведені результати експертної оцінки впливу факторів на величину економічного потенціалу освоєння цих родовищ. Також авторами запропоновано критерій інтегрованої оцінки впливу факторів, що характеризують як кількісні, так і якісні сторони процесу формування економічного потенціалу учасників проекту освоєння перспективного вугільного родовища.

Практична значимість. Результати дослідження можуть бути використані практиками, науковцями, державними службовцями (Міністерство освіти і науки України та його структурні підрозділи, органи місцевого самоврядування в галузі освіти та науки) для розвитку подальших перспектив. Встановлення зв'язків із освітніми й дослідницькими організаціями, високотехнологічними компаніями, а також з органами державного управління дозволить ефективно обмінюватися досвідом, адаптувати освітні програми й розвивати навички застосування факторного аналізу для оцінки економічного потенціалу видобувних компаній.

Ключові слова: *факторний аналіз, економічний потенціал компанії, аналіз, видобувні компанії*

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