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Methodical approaches to economic assessment of sustainable development of mining and metallurgical holding

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© I. A. Altushkin, Yu. A. Korol, A. E. Cherepovitsyn*

The factors of assessment of sustainable development were chosen and analyzed. Innovation potential in production, management and financing spheres was substantiated together with necessity and significance of clear definition of development purposes of holding, made by majority shareholders, and will of these shareholders for realization of strategy, which takes into account the raw material and labor resources provision. There were offered the values for assessment of efficiency of methods of sustainable development of mining and metallurgical holding. There was made an assessment of developmental stability of copper branch holding.

Key words: assessment factors, sustainable development, efficiency assessment, methods of development, assessment criteria, competitive advantage, competition, absolute efficiency, NPV, EBITDA.

Increasing of stability of functioning of mining and metallurgical holdings is one of the most important problems of national economy. The stability problem can not be solved by only balancing and finding of the best ratio of internal and external short-term and long-term factors. Modern conditions require the usage of such innovations in production and management, which make it possible to carry out the formation and development of competitive advantages of mining and metallurgical holding. The choice of technological and managerial novations, together with working out of strategic ways of development on the basis of their introduction, define the results of activity of mining and metallurgical holding and require the substantiation of mechanism of sustainable development.

Methods of assessment of factors of developmental stability of industrial enterprises are various. In the authors' opinion, these methods can be considered as acceptable only if the possibility of usage of methods of assessment of sustainable development is confirmed in practice.

At the same time, the system of values should be analytically simple and should give an objective assessment of the Company's activity. This system should also decrease the subjectivity risks in the process of analysis and decision-making.

In addition, this system should take into account the following factors:

– peculiarities of manufacturing and interconnection of various production stages within vertically-integrated structure;

– organization and management systems of holding;

– indicators of innovation processes and economic values of business in whole.

Assessment method should include the values, which describe both presence and quality of primary resources (strategic for enterprise), and results of usage of resource base of mining and metallurgical holding in creation of its competitive advantages.

Certain criteria, which make it possible to do the following operations, are offered for practical use:

– quick and operative formation of mechanism of sustainable development of enterprise, without large calculations of interconnected values;

– carrying out of analysis of this mechanism;

– informed decision-making.

Taking into account the foregoing requirements, the authors offer the method, which consists in assessment of the purpose and will of shareholders; provision of raw materials and labor resources; and innovation potential in the sphere of production and management.

The authors are convinced, that mining and metallurgical holding can be competitive only if majority shareholders have a clear definition of activity purposes of this holding and a will for realization of its development strategy, providing the reaching of the foregoing purposes. That's why, during the assessment, the purpose and will of shareholders are essential and immediate tasks. This condition of sustainable development is offered to be measured by the "yes"/"no" type logical value. Further assessment of holding is not prospective if shareholders have no clear understanding of purposes and tasks, given to the Company, and no realizable strategy of its competitiveness. Development of this holding can not be considered as stable despite the financial and other values at the moment of assessment.

It is reasonable to make an assessment of raw material resources provision factor by an absolute value — period of provision of holding with primary reserve stocks (in years), expressed by the formula (1), in comparison with payback period, wear-out or amortization of fixed assets:

* **I. A. Altushkin**, Chairman of Board of Directors; **Yu. A. Korol**, Vice-President, phone: +7 (343) 365-29-00, "Russian Copper Company" JSC, Yekaterinburg; **A. E. Cherepovitsyn**, Professor, Head of a Chair of Organization and Management, National Mineral Resource University, Saint Petersburg, Russia.

$$T = \text{Reserves/M} > N, \quad (1)$$

where: T — period of provision of reserves of primary resources, years; Reserves — amount of balance reserves of ore and metal, according to the $A + B + C_1 + C_2$ category on the deposits, which are directly or indirectly controlled by the holding, tones of ore (or metal); M — the capacity of mining and metallurgical holding on the processing of ore or metal, tones per year; N — payback period or wear-out and amortization of fixed assets, years.

If the conditions of the formula (1) are taken into account, the mineral resources provision is offered to be assessed by the "yes" logical value. In the opposite hand, the mineral resources provision is offered to be assessed by the "no" logical value.

Table 1 describes the example of assessment of reserves provision for four abstract companies. In this example, the Company No. 1 can be considered as sustainable in the reserves provision, because raw materials provision increases the payback periods and complete amortization of primary equipment and buildings.

Companies No. 2, No. 3 and No. 4 do not correspond to the criteria of raw material resources provision because of the shorter reserves provision period, in comparison with payback period and amortization of primary equipment.

During the consideration of stability of the Company operation or creation tasks of new production, the abstract value (which makes an assessment of averaged status of labor resources) is insignificant, in contrast to the specific position with presence or absence of personnel, which can develop the business of this direction. This peculiarity is shown by the practice of decision working-out and decision-making during the business assessment in modern conditions. Sometimes, the developmental stability of the Company depends on one or two high-qualified specialists. At the same time, absence of qualified management leads to absence of possibility of realization of potential in large teams.

That's why, the factor of assessment of labor resources provision in the proposed method (both on the stage of project beginning, and during its realization) is proposed to be assessed by subjective index: "yes" with presence of labor resources, and "no" with absence of labor resources.

Russian copper branch depends directly on the situation on the world market of raw materials. That's why, all companies have to estimate their competitiveness, taking into account the prices of raw materials and final products on the world market.

The formula of calculation of price on copper products includes such values as the cost of processing stage and payed amount of metal. Basically, these indices are defined by the level of technology and status of production assets of the world market leaders.

In connection with this, assessment of innovation potential in the production sphere requires the analysis of level of production costs and basic technological values of certain enterprise, in comparison with the global scale. This analysis makes it possible to do the objective conclusions about the ability of the Company (Holding) to hold out the competitiveness for raw materials and markets and to guarantee its sustainable development.

For the purpose of comparability of costs in copper branch, it is reasonable to accept the values of cost of extraction, concentration and metallurgical processing, referred to one dry metric tone (dmt) of processed ore (concentrate). This is caused by the fact, that prevail part of costs on these production stages depends on the volume of extracted and processed ore, but not on its metal content.

Table 2 shows an example of comparison of *TC* costs (metallurgical production stage) and *RC* costs (refining production stage, referred to 1 tone of extracted metal) during the consideration of abstract mining and metallurgical holding, which consists of three production stages: extraction, ore concentration and metallurgical processing.

The data about the level of the world leaders' costs are published in special public journals and are shown on the websites of analytic companies, including such companies as CRU International Limited [1]. The changes of the global scale of absolute values of *RC* and *TC*, are shown in

Table 1
Example of analysis of reserves provision

Company	Reserves, th. t of copper	Production capacity, th. t of copper per year	Provision (T), years	Payback period (N), years	Amortization of primary equipment (N_1), years	Correspondence	Provision, yes/no
1	800	60	13.3	5	10	$T > N_1$	Yes
2	600	60	10.0	15	7	$T < N$	No
3	800	100	8.0	3	10	$T < N_1$	No
4	800	100	8.0	9	10	$T < N, N_1$	No

Table 2
Comparison of costs on processing of copper raw materials in mining and metallurgical holding

Values	*TC*, USD/dmt	*RC*, USD/t	Payed amount of metal, %		
			Cu	Au	Ag
Global scale of CRU [2]	73.3	162.9	(25 – 1*) = 96	(4 – 1*) = 75	(40 – 30*) = 25
Mining and metallurgical holding (Russia)	70.0	113.0	94.0	89.0	88.0
Correspondence, yes/no	Yes	Yes	No	Yes	Yes
Index	1	1	0	1	1

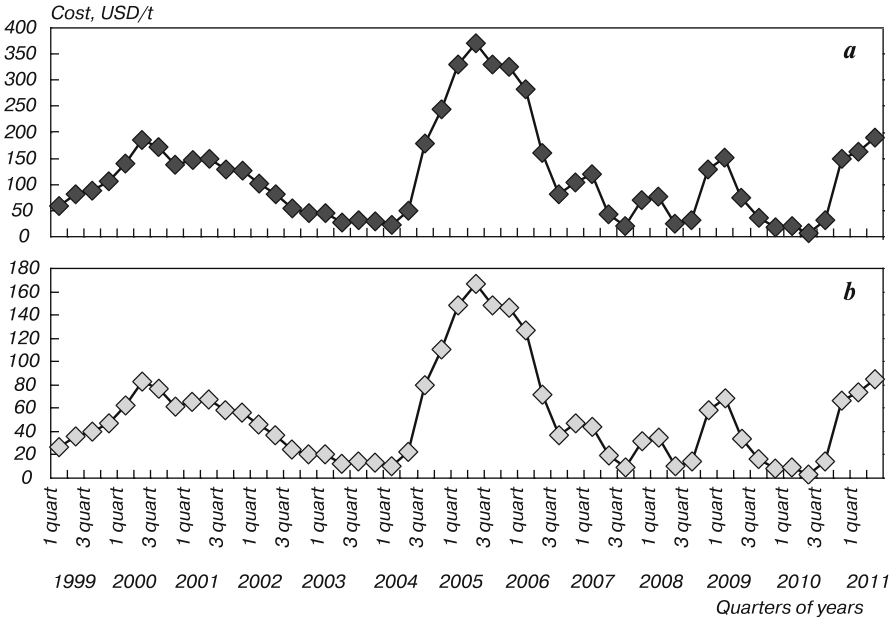
*1% for copper, 1 and 30 g/t for gold and silver respectively — internationally accepted discounts for calculation of payed amount of metals, defined by technological level of world market leaders.

the picture. During the table-filling, there was defined that the copper content in concentrate is 25%, and gold and silver contents are 4 g/t and 40 g/t, respectively.

In the given example, the global production data are taken as of the first quarter of 2011, and are equal to 73.3 USD/dmt and 162.9 USD/t for *TC* and *RC*, respectively [2].

In case, if the production stage values of the considered mining and metallurgical holding are below the global scale, than this positive tendency is reflected by taking of index, equal to 1. Otherwise, the index is equal to zero.

This situation is similar for metals extraction: in case, when payed amount of metals on the world market is below the reached level of their extraction at mining and metallurgical holding, the value gets the index, equal to 1. Otherwise, the value gets the index, equal to zero.



Changes of the global scale of cost of *RC* (*a*) and *TC* (*b*) [2]

In the Table 2, the values for mining and metallurgical holding, characterizing the industrial costs during the raw materials processing (*TC* and *RC*), are below the global scale, which is a significant competitive advantage and corresponds to the criteria of sustainable development (index is equal to 1).

During the extraction of copper from raw materials in the considered example, the values of mining and metallurgical holding are below the global scale and do not correspond to the accepted international criteria. According to this, the values get the index, equal to zero.

Extraction of gold and silver in the process of technological production stage are significantly above the global scale and correspond to the criteria of sustainable development.

Multiplication of obtained indices makes it possible to define the resulting value, which estimates the correspondence of certain data of vertically-integrated metallurgical holding to the global scale of development. This index is equal to zero in the considered example. According to this, the Company can not be considered as stably developing in connection with the fact that actual extraction of copper into final products is below the global scale. In connection with this, during the purchasing of concentrate, metallurgical enterprise will pay for the copper, which subsequently will be hard to extract. In turn, this will reduce the financial-economic values of the Company, till its complete downfall with worsening of market situation and incapacity to purchase the raw materials for production.

Subjective value of assessment of innovation potential in management sphere is proposed to be defined by the following criteria: rate of working out and decision-making, decision fulfillment and responsibility for the made decision. Table 3 shows the examples of such analysis.

Table 3
Comparison of subjective values of innovations in management

Company	Decision-making	Decision realization	Responsibility	Correspondence	Index
5	Yes	Yes	Yes	Yes	1
6	Yes	Yes	No	No	0
7	No	Yes	Yes	No	0

Table 4
Initial data for analysis of assessment of developmental stability of mining and metallurgical holding

Company	Basic metal reserves, mln. t	Metal production capacity, th. t	*T*, years	N_1, years	*N*, years	Actual *TC*, USD/ dmt	Actual *RC*, USD/t	Actual extraction of copper, %	Global conditions of *TC*, USD/ dmt	Global scale of *RC*, USD/t	Copper extraction by market leaders, % [2]
A	1.0	50.0	20.0	10.0	10.0	60.0	150.0	97.0	73.3	162.9	96.0
B	2.0	200.0	10.0	7.0	5.0	80.0	112.0	98.0	73.3	162.9	96.0

Table 5
Factors of assessment of developmental stability of mining and metallurgical holding

Factors	Company		Correspondence		Index	
	A	B	A	B	A	B
Purpose and will	Yes	Yes	Yes	Yes	1	1
Resources provision:						
labor	Yes	Yes	Yes	Yes	1	1
reserves	20.0 > 10.0	10.0 > 7.0	Yes	Yes	1	1
Innovation potential:						
production:		Yes	No	1	0	0
TC	60.0 < 73.3	80.0 > 73.3	Yes	No	1	0
RC	150.0 < 162.9	112.0 < 162.9	Yes	Yes	1	1
extraction	97.0 > 96.0	93.0 < 96.0	Yes	No	1	0
management:	Yes	No	Yes	No	1	0
decision-making	Yes	Yes	Yes	Yes	1	1
realization of decision	Yes	Yes	Yes	Yes	1	1
responsibility for decision	Yes	No	Yes	No	1	0
Final value of stability					1	0

In case, if at least one criteria does not correspond to the stated requirement, the final index will be equal to zero, which will show the status of the Company, which does not correspond to the sustainable development value.

Considering the given example, only the Company No. 5 corresponds to the criterion of sustainable development in the sphere of management and has the index, equal to 1.

Such an approach to estimation of innovation potential in management sphere is connected with predominance of subjective nature of assessment of management systems. The shareholders' approach to understanding of the fact, which, in their opinion, will correspond and contribute to sustainable development of the Company, will be shown both during the administrative decision-making, and during the assessment of this criteria. Undoubtedly, during such analysis, various groups of analytics can have different opinions, which will be shown on the final conclusion about the assessment of developmental stability of enterprise. However, in authors' opinion, the possibility to make a decision about developmental stability is mostly required for the shareholders, which define the development of the holding.

Current market conditions, ways of business development, and its financial-economic values, competitiveness and development prospects will undoubtedly make certain corrections into the subjective assessment of management systems and induce it to change.

According to the proposed method, the analysis of accepted factors and criteria for assessment of stability or instability of the company development should have the following results:

– provision of mining and metallurgical holding with labor resources;

– provision of the Company with raw material resources;

– correspondence of the basic production figures to world market conditions, formed by the leaders in this industrial sphere;

– correspondence of management systems to the set tasks and requirements of shareholders.

This method is acceptable only for assessment of enterprises (companies, holdings), which have a possibility of self-dependent purchasing of raw materials and realization of final products in market conditions. It is unreasonable to use the offered method for assessment of the enterprises, which are included in vertically-integrated structure and work by internal transfer prices.

Table 4 and Table 5 show the example of analysis of assessment of developmental stability for two vertically-integrated mining and metallurgical companies (A and B), as of the first quarter of 2011.

The final stability value was calculated by multiplication of received indices of each Company. In the considered case, the final index for the Company A is equal to 1. According to this, the Company A can be considered as

stably developing. The same index for the Company B will be equal to zero in connection with the following facts:

– level of costs for the concentrate processing is higher than the world prices;

– extraction of copper is below the global scale;

– managing staff of the Company has no responsibility for the made decisions.

The final index is equal to zero, which shows the unstable development of the Company B, which is reflected by the following factors:

– absence of the competitive ability of this Company on the raw materials market, caused by higher price of metallurgical production stage;

– low technological values of existing scheme and used equipment (copper extraction);

– high managerial risks, caused by absence of responsibility for made and realized decisions.

Taking into account the interests of majority shareholders during the assessment of developmental stability, only two criteria (stable or unstable development) are offered for application.

Usage of intermediate criteria (semi-stabled development, average-stabled development, etc) has only subjective nature and can lead to underestimation or overestimation of any values of assessment.

In modern dynamically developing conditions of world economy, the backlog (even insignificant) of any criteria can lead to significant loss of competitive advantages in future. That's why, during the consideration of accepted basic factors and criteria of assessment of developmental stability of mining and metallurgical holding, it is very important to define the correspondence of all values to criteria of comparison and choice.

Instability of the Company development, defined by the offered method, does not describe the certain collapse of such direction of business, its downfall and liquidation. The offered method of assessment makes it possible to define the bottle-necks and concentrate the forces of shareholders on overcoming of disadvantages in the Company development. This method also allows to define the sequence of operations in the newly formed enterprises and vertically-integrated structures for correspondence to requirements of the world market of metallurgical products, formation and improvement of competitive advantages of enterprises.

The given method is realized within the vertically-integrated mining and metallurgical holding, which carries out the extraction, purchasing and processing of metallurgical raw materials. However, this method can be also used for the assessment of holdings on final steps of metallurgical production stages: from the blister copper to wire rod or other copper products. In this case, the formula of world market price for blister copper and copper scrap, is used by analogue of copper concentrates consideration. Discounts for the production stages, metals extraction and presumptive damages are the subjects of global analysis and can be used for assessment of developmental stability of metallurgical holdings, which have no mining production, on the basis of integrating data of analytic companies [1, 2].

The considered method of analysis of developmental stability of mining and metallurgical holding allows to make a conclusion only about the stable or unstable type of development of holding. According to this analysis, it is possible to focus the attention of shareholders on the problems, which turn the Company to instability mode, and conversely. At the same time, the practice often has a situation, when it is necessary to make an assessment of efficiency of the chosen developmental direction of the Company from several methods, corresponding to the stability criteria.

During the analysis of methods of estimation of efficiency of business and methods of their calculation, three classic values are proposed to be used for estimation of efficiency of methods of sustainable development of mining and metallurgical holding: NPV (free cash flow), E (comparative efficiency of development) and EBITDA.

Calculation of NPV and EBITDA is carried out according to the standard universally accepted formulas.

During the assessment of stability of various methods of development of mining and metallurgical holding with simultaneous mastering of investment resources in initial period with observance of normative dates of construction (1–3 years), there is proposed the usage of simplified formula (2) of the calculation of E:

$$E = (C_1 - C_2) + E_{am}(K_s^1 - K_s^2), \quad (2)$$

where: C_1, C_2 — specific costs of methods, given to 1 t of output products in the period of reaching of the project capacity; K_s^1, K_s^2 — specific capital investments of methods, given to 1 t of output products; E_{am} — inverse value of the useful life of primary equipment, equal to –0.14.

Analysis of methods with usage of the E value allows to make a conclusion about the advantage of one of the methods, in comparison with specific costs and capital investments. Negative value of comparative efficiency tells about the advantage of the first method before the second one, by two considered criteria.

This article describes the comparative assessment of stability of "Russian Copper Company" JSC by two ways of development (Table 6, Table 7), which differ from each other by the quality of processed copper concentrate [3]. Amount of processing of concentrate and final financial values is taken according to the results of work, carried out in 2011.

In the first method (A), the actual average content of copper in concentrates, obtained on mining and concentration factories of the Company, is equal to 14.4%.

In the second case (B), due to realization of additional investments and introduction of innovation technologies, this content is equal to 18%.

Growth of metals content in the concentrates leads to the growth of their extraction on metallurgical production stage, decreasing of costs on ecological activities against a background of simultaneous additional losses on concentration production stage and necessity of additional investments in mining and concentration production.

During the comparison of production figures and calculation of absolute efficiency of development, the data about their changes are given for the clearness and simplification of analysis (Table 6, Table 7).

There are shown the values of efficiency of development of mining and metallurgical holdings by the example of the following companies:

For the Company A:

NPV in 2011, mln. USD 111.3
EBITDA, mln. USD 345.7

For the Company B:

decreasing of extraction of metals in concentrate, %:
copper 1.0
gold 5.0
silver 10.0
decreasing of output, t:
copper 600
gold 0.03
silver 2.6
increasing of extraction of metals on metallurgical production stage, t:
copper 332.0
gold 0.03
silver 3.0
decreasing of marketable products, mln. USD 2.4
decreasing of costs on production stage, mln. USD. 28.7
NPV in 2011, mln. USD 127.7
additional capital investments, mln. USD 12.0
comparative efficiency of development (E), mln. USD 27.02
EBITDA, mln. USD 373.0

According to the given data, it is shown that both considered methods correspond to the criterion of sustainable development.

Increasing of copper content in concentrate in the method B leads to decreasing of its extraction by 1%. Decreasing of extraction of gold and silver will make 5.0% and 10.0% respectively, which leads to additional losses of metals. However, the growth of metals extraction on

Table 6
Initial data for comparative assessment of developmental stability of mining and metallurgical holding

Company	Reserves provision (T), years	Amortization period (N_1), years	Payback period (N), years	Actual TC_{act}, USD/dmt	Actual RC_{act}, USD/t	Actual extraction of copper, %	Global conditions of TC, USD/dmt [2]	Global scale of RC, USD/t	Copper extraction by market leaders, %
A	18.2	4–12	5–7	84.0	113.0	96.5	85.0	162.9	96.0
B	18.2	4–12	5–7	63.0	113.0	98.0	85.0	162.9	96.0

Table 7
Factors of comparative assessment of developmental stability of mining and metallurgical holding

Value	A	B	Correspondence		Index	
Purpose and will	Yes	Yes	Yes	Yes	1	1
Resources provision:						
labor	Yes	Yes	Yes	Yes	1	1
reserves	18.2 >12.0	18.2 > 12.0	Yes	Yes	1	1
Innovation potential:						
production:		Yes	Yes	Yes	1	1
TC	84.0 < 85.0	84.0 < 85.0	Yes	Yes	1	1
RC	113.0 < 162.9	113.0 < 162.9	Yes	Yes	1	1
extraction	96.5 > 96.0	96.5 > 96.0	Yes	Yes	1	1
management:	Yes	Yes	Yes	Yes	1	1
decision-making	Yes	Yes	Yes	Yes	1	1
realization of decision	Yes	Yes	Yes	Yes	1	1
responsibility for decision	Yes	Yes	Yes	Yes	1	1
Final value of stability					1	1

metallurgical production stage, caused by higher quality of concentrate, leads to additional output of final products (although in the smaller amount, than it was suggested). Finally, the output of marketable products in the method B is decreased by 2.4 mln. USD.

At the same time, the costs on metallurgical production stage are decreased by 28.7 mln. USD. Taking into account the attraction of additional capital investments, the NPV of the second method is higher by 16.4 mln. USD.

During the comparison of specific costs of methods and additional capital investments through absolute developmental efficiency, there is received the positive result, equal to 27.02 mln. USD, which shows the preferability of the second method of development before the first one.

The carried out calculation of the third assessment index EBITDA also showed the efficiency of the second method.

As a result of comparison of all values of assessment of efficiency of sustainable development (NPV, *E*, EBITDA) there can be made a conclusion about the categorical advantages of the second method and economic reasonability of development of competitive advantages, due to increasing of the quality of copper concentrate for improvement of developmental stability of mining and metallurgical holding.

Conclusions

The given method of assessment of developmental stability of mining and metallurgical holding on the basis of analysis of the main factors (purpose and will of shareholders, provision with raw material and labor resources, innovation potential in the sphere of production and management) makes it possible to do the assessment of developmental stability of mining and metallurgical holding and to make certain decisions about the ways of increasing of its competitiveness and further development.

Usage of NPV, E and EBITDA values within the considered method makes it possible to make an assessment and choice of the most suitable and reasonable method of sustainable development of mining and metallurgical holding.

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