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SUBSTANTIATION FOR MINING AND CONCENTRATING ENTERPRISES' FINANCIAL STABILITY BASED ON INTEGRAL BANKRUPTCY INDICATORS

Abstract. The article deals with basic modern theoretical and practical aspects of financial stability of mining and concentrating enterprises with full cycle of mining and processing of minerals.

It was found that nowadays there is no clearly developed system of quantitative and target indicators of strategic management of sustainable development of modern mining and concentrating enterprises in conditions of economic instability.

Results. Basing on the usage of key models of multiple discriminant analysis – assessing the probability of bankruptcy, we have developed appropriate recommendations that reflect negative trends of further development of certain mining and concentrating enterprise and likelihood of termination of his activity in the short term.

Novelty. Obtained research results and relevant financial and economic calculations must be used in considered mining and concentration enterprises in order to improve the efficiency of their production and business activities, implementation of anti–crisis management measures and possibility of strengthening of competitive positions in the market of iron ore in conditions of uncertainty.

Practical significance. Basing on systematic research, we proposed scientific and methodical approach to substantiation of impact of priority aspects of the development of mining and concentrating enterprises on the effectiveness of their activity taking into account the development of competitive strategies of support and efficient exploitation of deposits in difficult economic conditions.

Keywords: financial stability, bankruptcy, model, financial position, mining.
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ОБГРУНТУВАННЯ ФІНАНСОВОЇ СТІЙКОСТІ ГІРНИЧО–ЗБАГАЧУВАЛЬНИХ ПІДПРИЄМСТВ НА ОСНОВІ ВИЗНАЧЕННЯ ІНТЕГРАЛЬНИХ ПОКАЗНИКІВ РІВНЯ БАНКРУТСТВА

Анотація. У даній статті висвітлено основні сучасні теоретичні та практичні аспекти фінансової стійкості гірничо–збагачувального підприємства. Розраховано та проаналізовано ключові моделі оцінки ймовірності банкрутства. На основі проведеного аналізу розроблено відповідні рекомендації щодо прийняття антикризових управлінських заходів у контексті визначених факторів і негативних тенденцій підвищення ймовірності банкрутства вітчизняних гірничозбагачувальних підприємств.

Ключові слова: фінансова стійкість, банкрутство, модель, фінансовий стан, гірничорудна галузь.

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ОБОСНОВАНИЕ ФИНАНСОВОЙ УСТОЙЧИВОСТИ ГОРНО–ОБОГАТИТЕЛЬНЫХ ПРЕДПРИЯТИЙ НА ОСНОВЕ ОПРЕДЕЛЕНИЯ ИНТЕГРАЛЬНЫХ ПОКАЗАТЕЛЕЙ УРОВНЯ БАНКРОТСТВА

Аннотация. В данной статье освещены современные теоретические и практические аспекты финансовой устойчивости горно–обогатительного предприятия. Рассчитаны и проанализированы ключевые модели оценки вероятности банкротства. На основе проведенного анализа разработаны соответствующие рекомендации по принятию антикризисных управленческих мероприятий в контексте определенных факторов и негативных тенденций повышения вероятности банкротства отечественных горно–обогатительных предприятий.

Ключевые слова: финансовая устойчивость, банкротство, модель, финансовое состояние, горнорудная отрасль.

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Problem statement. An industrial enterprise`s financial activity provides the basis for its functioning and development and is the main factor of its economic stability. Therefore, determining and analyzing bankruptcy risks is one of the most important tasks of business facilities while ensuring their financial stability. Thus, taking into account the current crisis trends in the mining industry of countries that produce iron ore, the primary task is to search for and introduce some ways of stabilizing and successfully developing mining enterprises that can be done by analyzing and optimizing finance management.

Analysis of the latest research and publications. Bankruptcy risk indicators and their analysis as a financial stability aspect have been touched upon in the works by such internationally recognized scholars as H. Tisshaw [1], R. Toffler [2], J. Conan, and M. Holder [3], E. Altman [4, 5], Karamzadeh Mani Shehni [6]. Such Ukrainian scholars as O. Tereshchenko [7], V. Fuchedzhy [8], S. Lysevych [9] and others have also made a significant contribution to the solution of bankruptcy and crisis management problems [5, 6].

Problem aspects previously unsolved. At the same time, a well–grounded solution of the problem of an enterprise's failure risk analysis while assessing its financial stability considering the specific activity of mining enterprises under unstable economic conditions and indefinite prices for their iron–bearing products requires some additional research. The level and dynamics of integral

indicators change should be considered taking into account Ukraine's mining industry development in accordance with the current negative trends on the iron ore market over the last five years.

The research aims at substantiating mining enterprises' financial stability by analyzing integral indicators of their bankruptcy level.

Material presentation. The negative tendencies in the mining industry nowadays make us search for some new ways to stabilize and ensure mining enterprises' development. Market fluctuations, sudden changes in prices for input and raw materials as well as for end products have a negative impact not only on mining enterprises, but also on the complex of enterprises and industries technologically and financially related to them. One of the most modern and efficient ways to overcome the crisis tendencies and stabilize a mining enterprise's activity is to introduce and implement some principles of sustainable development.

Development and implementation of an enterprise's sustainability strategy is a complex and structured process in terms of the input tasks and goals. Taking into account the negative tendencies in Ukraine's economy, the sustainability strategy development and ensuring is a decisive and innovative means of stabilizing mining enterprises' industrial and economic activity and efficient functioning.

We suggest treating an enterprise's strategic stability ensuring as the development of measures and formation of an organizational and economic mechanism for their implementation, aimed at achieving an enterprise's strategic goals and its further successful development considering of the overall impact of various production factors.

Accordingly, the strategic stability ensuring aims at minimizing the negative impact of the external and internal environment on an enterprise's activity; arranging the conditions for the effective implementation of the planned actions, business transactions; a maximum use of the internal potential to achieve and maintain competitive advantages accompanied by the improvement of the environment–related indicators.

The main principles of ensuring and maintaining an enterprise's strategic sustainability under unstable economic conditions include:

1) active response to changes of internal and external factors;

2) systematic management; consideration of possible risks;

3) application of indicators to provide a reliable assessment of an enterprise's stability;

4) integration with the overall management system;

5) orientation on achieving an enterprise's strategic goals;

6) development and use of high–quality instruments to substantiate economic decisions under unstable economic conditions.

Suitability strategy development is possible only on condition of detailing its structure considering its elements, and, accordingly, their characteristics, possibilities and prospects. Taking into account mining enterprises' specific functioning, the detailed strategic sustainability is most accurate in terms of their resource components. Creating a system of an enterprise's resources, we can divide them into groups such as technological, industrial, financial, labor, marketing and environmental sustainability.

Consequently, the stability of internal environment elements provides the stability of the whole enterprise development. Considering the interconnection and interdependence of components, the tendencies relating to a particular type can serve as a stabilizing factor for other types and ensure an enterprise's sustainability under unstable economic conditions.

Therefore, according to the given data, an enterprise's sustainability strategy development and ensuring is possible only if sustainability of every element of this system is provided. Considering the fact that a sustainable development is a complex and structured system with an extensive net of interconnections between its components, it should be noted that strategic sustainability can be achieved only if the stability of each system component is provided collectively. Thus, one of the main and most important elements in the overall strategic sustainability system of an enterprise's is its stable financial sphere in the nearest prospect.

Financial stability is the key element of the overall economic stability, the main indicator and a lever of managing an enterprise's financial and other areas of functioning.

In general, financial stability can be defined as an enterprise's ability to perform basic and other types of activity continuously, despite the risks and changes in the functioning environment that may occur in the process of its economic activity [1, p. 192]. Accordingly, an enterprise achieves its financial stability in case of introducing a set of measures aimed at effective formation, distribution and use of available financial and other associated resources with a stable level of solvency. Considering the current negative tendencies on the iron ore market and unstable economic conditions in general, the analysis and assessment of mining enterprises' financial sphere becomes the main task for ensuring their further sustainable development. The primary task is to evaluate an enterprise's economic security in terms of its possible failure, as in case of its bankruptcy the available and potential resources are not able to have a positive impact on its further restoration and operation.

Modern economics possesses a wide range of methods for evaluating an enterprise's failure risks. The developed methods and models can be divided into domestic and foreign. As to the number of the criteria used they can be divided into three groups:
- using a limited number of criteria (indicators);
- using a wide range of quantitative and qualitative indicators (a multicriterion approach);
- using integral criteria for predicting an enterprises' bankruptcy risks. [11, p. 324–325].

Yet, it is worth mentioning that currently in the economic literature we can find the following models of evaluating mining enterprises' financial state and failure risk [2, p. 15; 3, p. 31]:
1) Altman two–factor model *(the USA, 1968)*;
2) Altman Z–score (credit index) *(the USA, 1968)*;
3) R. Taffler and G. Tisshaw model *(Taffler, Tisshaw, Great Britain, 1977)*;
4) J. Conan and M. Holder model *(J. Conan, M. Holder, France, 1979)*;
5) the model developed by Irkutsk State Academy of Economics scholars *(Russia, 1999)*;
6) E. Myzykovsky and I. Sokolov model *(Russia, 2001)*;
7) A. Saifulin and G. Kadykov model *(Russia, 2003)*;
8) O. Zaitseva six–factor model *(Russia, 1998)*.

The Altman model is the most universal, and therefore, the most widely used method of assessing an enterprise's financial state, which looks like:

$$Z = -0,3877 - 1,0736\,x_1 + 0,0579\,x_2 \tag{1}$$

where x_1– current assets / current liabilities;
x_2 – long–term liabilities / total assets.

According to the E. Altman method, the Z–score negative value indicates a low bankruptcy risk, the positive one indicates a high prediction increasing along with the model indicator. After calculating the data of OJSC «Poltavsky GOK» which is a producer of high–quality iron–bearing pellets up to the world standards, we can conclude that for the analyzed years of 2013–2015, the economic activity of the enterprise is efficient, and its failure risk is fairly low. However, it should be noted that there is a negative tendency of this indicator value increasing in the mentioned period indicating the decreased ratio of current assets and current liabilities of OJSC «Poltavsky GOK» [14].

Despite the relative simplicity and universality, the Altman two–factor model does not fully reflect an enterprise's real situation and financial position. Besides, in its calculation short–term liabilities and assets are of great importance, this fact decreasing an enterprise's strategic efficiency.

Table 1

Bankruptcy prediction for OJSC «Poltavsky GOK» by E. Altman model

Indicators	2013	2014	2015	Absolute deviation	
				2015/2014	2015/2013
X_1	3,15743	1,0733	0,96048	–0,112814	–2,196946
X_2	0,074	0,11178	0,02331	–0,088462	–0,050681
Model	**–3,2101**	**–7,8702**	**–0,8836**	**6,9866**	**2,3265**

Source: authors` calculations

That is why Altman [4] offered a five–factor model of bankruptcy risk evaluation to analyze the activity of joint stock companies whose shares quote at the world market.

This model is as follows:

$$Z = 1{,}2x_1 + 1{,}4x_2 + 3{,}3x_3 + 0{,}6x_4 + x_5 \tag{2}$$

where x_1 – working capital/total assets;
x_2 – retained earnings/total assets;
x_3 – gross profit before tax/total assets;
x_4 – market value of equity/called capital;
x_5 – sales/total assets.

This model, also called Z–score, has the following critical limits: when Z> 2,99 an enterprise is financially stable; when Z <1,81 it is an absolute failure; [1.81; –2.99] is an uncertain zone. It is worth mentioning that this model is more universal and optimized compared to the previous one due to the gravimetric criteria reconsideration. Thus, the ratio of gross profit to total assets has the greatest influence on the Z–score, which corresponds to current distribution of priorities among enterprises.

According to the performed calculations (Table 2), the Z–score of OJSC «Poltavsky GOK» for 2013–2015 fluctuates greatly from 2.6 (financial stability) to 0.6 (financial instability).

Table 2

Z–score evaluation of OJSC «Poltavsky GOK»

Indicator	2013	2014	2015	Absolute deviation 2015/2013
x1	0,25628	0,41026	–0,52913	–0,78541
x2	0,30668	0,13483	–0,16066	–0,46734
x3	0,20565	0,2968	0,265758	0,060111
x4	0,96514	0,38207	–0,03987	–1,00501
x5	0,63148	0,67879	0,607799	–0,02368
Model	**2,62609**	**2,56854**	**0,600999**	**–2,02509**

Source: authors` calculations

R. Taffler and G. Tisshaw offered a different approach to determine bankruptcy risk. Their model is based on the analysis of assets and liabilities of various types, but the emphasis is put on the ratio of profits and liabilities:

$$T = 0{,}53x_1 + 0{,}13x_2 + 0{,}18x_3 + 0{,}16x_4 \tag{3}$$

where x_1 – profit before tax/current liabilities;
x_2 – current assets/ total liabilities;
x_3 – current liabilities/ total assets;
x_4 – sales revenue/ total assets.

According to the determined critical limits of the analysis, the bankruptcy risk is low when T> 0.3, and it is high when T <0.2.

The calculation results of this model as to OJSC «Poltavsky GOK» (Table 3) reveal that there is a negative dynamics of decreasing the indicator values for 2013–2015, and in 2014 the Taffler and Tisshaw model value was close to the critical –0.66. Yet, the calculation results confirm Ukrainian mining enterprises' instability and certain ambiguity in 2014.

Table 3

Taffler and Tisshaw model for OJSC «Poltavsky GOK»

Indicator	2013	2014	2015	Absolute deviation 2015/2013 pp.
x_1	0,29145	–1,63577	–0,10123	–0,39267
x_2	0,80924	0,66143	0,44110	–0,36814
x_3	0,15551	0,06832	0,98854	0,83303
x_4	0,63148	0,67879	0,60780	–0,02368
Model	**0,38870**	**–0,66007**	**0,27888**	**–0,10982**

Source: author`s calculations

The model for evaluating an enterprise's stability developed by the French scholars J. Conan and M. Holder is worth emphasizing. The French model of modern firms' failure prediction based on the multivariate discriminate analysis is as follows:

$$KG = –0,16x_1 – 0,22x_2 + 0,87x_3 + 0,10x_4 – 0,24x_5 \qquad (4)$$

where x_1 – cash and accounts receivable / total balance;
x_2 – net worth and long–term liabilities / balance;
x_3 – financial expenses / sales revenue;
x_4 – staff expenses / additional cost;
x_5 – profit before tax/ debt capital.
The critical limits of the model have the following values in Table 4.

Table 4

The critical limits of Conan and Holder model

Indicator value, relative units	0,21	0,048	0,002	–0,026	–0,068	–0,087	–0,107	–0,131	–0,164
Failure risk, %	100	90	80	70	50	40	30	20	10

Source: author`s calculations

The given model is one of the few emphasizing an enterprise's expenses and sales revenue as an important ratio for Ukrainian mining enterprises. The calculation results in this model confirm the general dynamics of OJSC «Poltavsky GOK» activity and reveal the increased bankruptcy risk in 2015. One of the most accurate and efficient models is the model developed by the Russian scholars (G.V. Davidov, A.Yu. Belikov) of Irkutsk State Academy of Economics (ISAE) [15] considering production costs in the enterprise financial analysis:

$$R = 8,38R_1 + R_2 + 0,054\,R_3 + 0,63\,R_4 \qquad (5)$$

where R_1 – working capital / total assets;
R_2 – net profit / net worth;
R_3 – sales revenue / total assets;
R_4 – net profit / total production costs.
Yet, this model is not adequate for evaluating bankruptcy risks of mining enterprises because of a great amount of an enterprise's working capital in the industry, this fact misrepresenting the calculation results to some degree.
Other models for evaluating the bankruptcy prediction of OJSC «Poltavsky GOK» are presented in Table 5.

Table 5

Calculation of other models for evaluating the bankruptcy risk of
OJSC «Poltavsky GOK»

Indicator	2013	2014	2015	Absolute deviation 2015/2013
Conan and Holder model				
x_1	0,35226	0,39229	0,32049	–0,03177
x_2	0,84449	0,93168	0,01146	–0,83303
x_3	0,08029	0,00000	0,07110	–0,00919
x_4	1,35693	–0,33285	–0,39376	–1,75069
x_5	0,08907	–0,15445	–0,09608	–0,18515
Model	**–0,05798**	**–0,26395**	**–0,00826**	**0,04972**
ISAE model				
R_1	0,41180	0,47858	0,45941	0,04762
R_2	0,05781	–0,36113	2,15280	2,09499
R_3	0,63148	0,67879	0,60780	–0,02368
R_4	0,06667	–0,26135	–0,26135	–0,32802
Model	**3,58475**	**3,52134**	**5,87085**	**2,28610**
Myzykovsky and Sokolov model				
R_{cl}	2,64796	7,00491	0,46474	–2,18322
R_A	0,02839	–0,09983	–0,08939	–0,11778
Model	**2,17380**	**5,14702**	**0,64318**	**–1,53062**
Saifulin and Kadykov model				
R_{cov}	0,49113	0,27645	–0,04152	–0,53265
R_{liq}	2,64796	7,00491	0,46474	–2,18322
R_{int}	0,63148	0,67879	0,60780	–0,02368
R_{man}	0,32566	0,43725	0,43725	0,11158
R_{pr}	0,09228	–0,40426	2,40988	2,31759
Model	**1,53641**	**1,10019**	**2,61869**	**1,08228**
Zaitseva six–factor model				
R_{loss}	0,00000	–0,36113	2,15280	0,00000
R_{debt}	2,06027	3,25712	4,26102	2,06027
R_s	2,64579	0,61014	59,83628	2,64579
$R_{sales\ loss}$	0,00000	–0,14708	–0,14708	0,00000
$R_{fin.risk}$	1,03612	2,61733	–25,08238	1,03612
R_{load}	1,58359	1,47321	1,64528	1,58359
Model	**0,99716**	**0,72974**	**10,55108**	**0,99716**

Source: authors` calculations

The Myzykovsky and Sokolov [16] failure risk model is simple and concise enough to calculate and looks like:

$$MS = 0,343 + 0,689x_1 + 0,224\ x_2 \tag{6}$$

where x1 – current liquidity ratio (R_{cl}) is calculated as the ratio of current assets to short–term liabilities)

x_2 – return on assets (R_A) is the ratio of net profit to the average value of an enterprise's assets.

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At the same time, the result analysis of OJSC «Poltavsky GOK» indicates some inaccuracy that can be explained by a narrow covering range of the analytical data concerning the enterprise's industrial and economic activity.

The Saifulin and Kadykov model [17] is more accurate and adequate for Ukrainian mining enterprises, the formula of which is:

$$R = 2R_{cov} + 0,1R_{liq} + 0,08R_{int} + 0,45R_{man} + R_{pr} \qquad (7)$$

where R_{cov} – asset coverage ratio;

R_{liq} – current liquidity ratio (Rcl);

R_{int} – output / balance (the ratio of advanced capital turnover intensity (output sold / advance capital));

R_{man} – gross profit / sales revenue (manager ratio, profitability of sales);

R_{pr} – profit before tax / net worth (net worth profitability).

According to the calculations, in 2013–2015 the activity of OJSC «Poltavsky GOK» is assessed as efficient, and the bankruptcy risk is low. However, 2014 is characterized by a sharp deterioration in the financial position of the enterprise and its economic security caused by failure risk increase.

One of the models with the widest range of bankruptcy risk analysis is A. Zaitseva six–factor model [18], which is:

$$R_{complex} = 0,25\ R_{loss} + 0,1\ R_{debt} + 0,2\ R_s + 0,25\ R_{sales\ loss} + 0,1\ R_{fin.risk} + 0,1\ R_{load} \quad (8)$$

where R_{loss} – loss ratio (net loss / net worth);

R_{debt} – credit debt / debit debt;

R_s – short–term liabilities / most liquid assets (the reciprocal value of the absolute liquidity indicator);

$R_{sales\ loss}$ – product sales loss ratio (net loss / product sales);

$R_{fin.risk}$ – financial risk ratio (debt capital / net worth);

R_{load} – load of assets (reciprocal value of asset circulation ratio).

The Zaitseva model results of OJSC «Poltavsky GOK» indicate the same general tendencies compared to the other analyzed models evaluating bankruptcy risks. However, one should note the relative overstatement of the calculated values that does not correspond to the enterprise's real financial state. This is largely the result of the financial results dynamics of OJSC «Poltavsky GOK» or rather, their change from the net profit in 2013 to the net loss in 2014–2015.

Considering some inaccuracy and fluctuations in calculating the bankruptcy risk for the comparative analysis of Ukrainian mining enterprises taking OJSC «Poltavsky GOK» as an example it is worth analyzing its competitor, Ukraine's powerful producer of iron–bearing products (high–quality concentrates), PJSC «InGOK» [19] (Table 6).

Table 6

Bankruptcy prediction for PJSC «InGOK»

Indicators	2013 p.	2014 p.	2015 p.	Deviations 2015/2013 pp.
Altman two–factor model	–3,77323	–1,533518	–1,417524	2,35571
Altman Z–score	4,01619	1,69824	0,82155	–3,19464
R. Taffler and G. Tisshaw model	0,9803	0,31064	0,20469	–0,7756
J. Conan and M. Holder model	–0,428	0,25205	0,99969	1,42773
ISAE model	6,81945	4,82694	5,06254	–1,7569
E. Myzykovsky and I. Sokolov model	2,56122	1,08955	0,9834	–1,5778
A. Saifulin and G. Kadykov model	2,35836	1,25163	0,33868	–2,0197
A. Zaitseva six–factor model	33,0668	21,204	27,6524	–5,4144

Source: authors` calculations

According to the calculation results, in 2013–2014, the functioning of PJSC «In GOK» is considered efficient and the bankruptcy risk is low. Yet, 2015 is characterized by a sharp financial deterioration affecting its economic safety leading to the increased failure risk. Consequently, the result dynamics of PJSC «InGOK» activity is similar to that of its Ukrainian competitor, OJSC «Poltavsky GOK». Thus, the analysis results reveal a common dynamics of financial deterioration in Ukrainian mining enterprises' financial position and the increased bankruptcy risk in 2015.

Thus, after having analyzed the financial stability of Ukrainian mining enterprises using the basic integral indicators for assessing bankruptcy risks, we can draw the conclusion about the effectiveness and adequacy of the models analyzing the above mentioned mining enterprises' activity. In particular, basing on performing complex calculations in the context of the likelihood of bankruptcy of modern mining enterprises it was confirmed that credit index by Altman, Conan and Golder model, Taffler and Tisshaw are the most universal and accurate for the mining industry as their methodology of calculation gives the most likely outcome for these enterprises.

However, it should be noted, that the most adequate model is five–factor model by Altman – credit index. This model takes into account the dynamics of gross and retained earnings, pays great attention to the change of total assets, focuses on working capital and eliminates the effect of capital raised on the financial position of the mining and concentrating enterprise.

Conclusions. Thus, the comprehensive analysis results make us conclude that the current negative tendencies of price decreasing for iron ore raw materials, caused by the demand fall, will intensify the reduction of Ukrainian mining enterprises' competitive advantages in case of general tendencies of destabilizing the national economy and the world iron ore market (confirmed by the falling commodity prices for ore at the iron ore market up to $50 in May 2016, while in April it reached $75). In general it can be assumed that the financial and economic situation of the mining enterprises analyzed (OJSC «Poltavsky GOK» (which specializes in producing iron ore pellets) and CJSC «Inguletskyi GOK» (which specializes only in producing iron ore concentrate) will gradually deteriorate in case of trends of variances of prices on iron ore during 2017 in range 50 $ –70 $. Although at the beginning of 2017 the price of 1 ton of marketable ore slightly increased to $ 93 and 1 ton of steel – to $ 470 (versus $ 377 in 2016) there is no clear certainty about saving in the short term of this trend especially in terms of reduction of demand for iron ore. The most likely manifestations of these negative tendencies are the decreased iron–bearing product profitability and production in general, the decreased personnel and equipment productivity, the reduction of an enterprise's assets and market value, the increased demands for paying loan debts, liquidity and solvency decrease, business activity minimization, foreign currency fluctuations at the world market, negative trends of inflation growth, which could result in a complete mining enterprises' failure in the near future.

According to the calculations as of 2013–2015 and taking into account the current peculiarities and crisis on the iron ore market in order to reduce the bankruptcy risk for the mentioned mining enterprises we suggest analyzing and considering the following aspects of their further economic activity to solve the problems of their functioning in the short term:

• increase of the amount and structure of current assets to optimize an enterprise's economic activity;

• net worth reduction by decreasing retained profits;

• significant increase in current liabilities of domestic enterprises;

• increase in cost of products sold with a simultaneous decrease in an enterprise's net income;

• increased expenses of various types per unit of ferriferous commodity (administrative, sales, other operating and financial expenses) etc.

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