

Estimation of social significance of copper mining enterprises using the method of least squares

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Abstract — The article discusses the theoretical and practical aspects of PLS-PM modeling the social significance of copper industry enterprises as an indicator reflecting the contribution of companies to the development of the territories of their production facilities and / or parent enterprises.

The purpose of the research is to present the results of a study of the influence of factors characterizing the social significance of a business (using the example of Uralelectromed OJSC), by constructing an appropriate PLS-PM model.

To achieve this purpose the authors briefly considered OJSC Uralelectromed as an object of study; built a PLS-PM model characterizing the influence of factors on the social significance of copper industry based on the study of the development indicators of Uralelectromed OJSC; graphically presented the PLS-PM model using the SmartPLS software package; interpreted the obtained data.

As an informational basis for the PLS-PM modeling, were used the results of a special survey conducted by 25 economists. In order to increase the representativeness of the research, candidates and doctors of economics from the Accounting, Analysis and Audit Department of Ural Federal University, as well as employees of the economic services of NeoStrategy CJSC, Priority Finance Management Company, Medinvestconsulting LLC and LLC Uralmedytorg took part in the survey.

The construction of the PLS model of the social significance of copper industry enterprises allowed the authors to formulate a hypothesis about the possibility of using analytical data to formulate management procedures, by operating factors that have the greatest impact on the indicator of social significance.

Keywords — *copper industry enterprises; factor modeling; PLS-PM modeling; partial least squares; economic analysis; Uralelectromed OJSC; social significance; social responsibility.*

I. INTRODUCTION

Issues of social significance and responsibility of business quite sharply arise at almost every meeting of large

businessmen with government officials (both regional and local, and at the federal level). At the same time, social significance means not only the creation of workplaces and ensuring the inflow of tax revenues to budgets of various levels, but also the participation of large companies in financing (either full or on a public-private partnership basis) social or infrastructure projects, as well as participation in charitable and sponsorship activities in the territories of the economic interests of companies [7,9].

Due to the unevenness of the influence of factors determining the social importance of the copper industry, in the author's view, it is advisable to measure them using the method of partial least squares (PLS). The PLS-PM (Partial Least Squares Path Modeling) method is widely used today by scientists engaged in basic and applied research. [12,13,14,15,16,18]. The PLS-PM methodology has proven itself well when analyzing high-dimensional data in a poorly structured environment.

Thus, the purpose of this article is to present the results of a study of the influence of factors characterizing the social significance of a business (using the example of Uralelectromed OJSC), by building an appropriate PLS-PM model.

To achieve this goal, the following tasks were set and solved: a brief description of Uralelectromed OJSC as an object of research is presented; a PLS-PM model was constructed characterizing the influence of factors on the social significance of Uralelectromed OJSC; PLS-PM model is graphically represented using the SmartPLS software package; data obtained are interpreted.

II. THE RESEARCH METHOD

A. Brief Description of Uralelectromed OJSC as an Object of Study

Uralelectromed OJSC is the largest Russian producer of copper products. The main activity of the company is the

processing of copper scrap and blister copper and the production of finished copper products (copper cathodes, wire rod, copper powder, etc.) [8].

The Russian copper industry is represented by three main market players: OJSC “Ural Mining and Metallurgical Company” (a vertically integrated holding structure in which OJSC Uralelectromed produces the main volumes of copper products), OJSC MMC Norilsk Nickel and CJSC “Russian Copper Company” [3,5]. The competition in the domestic copper market between the main participants is not determined by the volume and (or) quality of the products produced, but by access to the sources of the main raw materials. This situation is aggravated by the fact that world prices for copper are determined on the London Metal Exchange (LME), so there is practically no price competition in the market. [1,10].

Thus, OJSC “Uralelectromed” is a typical enterprise of the copper industry of the Russian Federation, therefore, the patterns identified based on a study of its activities can be extrapolated to the industry as a whole. [4,6].

B. Building a PLS-PM model characterizing the influence of factors on the social significance of OJSC Uralelectromed the Integrity of the Specifications

We presented a PLS-PM model characterizing the social significance of OJSC Uralelectromed [2]. To solve this problem, the author selected the following indicators characterizing the social significance of the copper industry enterprise (Table 1).

TABLE I. INDICATORS OF THE SOCIAL SIGNIFICANCE OF THE COPPER INDUSTRY

№	Indicator	Unit of measure	Designation in the model
<i>1. Indicators of the economic participation of the company</i>			
1	Average number of employees	Pers.	IE1
2	Payroll	Thousands of rubles	IE2
3	Volume of investments at the expense of own funds	Thousands of rubles.	IE3
4	The amount of taxes paid to budgets of various levels and transfers to extra-budgetary funds (estimated value obtained on the basis of the authors' calculations)	Thousands of rubles.	IE4
<i>2. Indicators of social responsibility of the company</i>			
5	The cost of maintaining social facilities on the balance sheet	Thousands of rubles	ISO1
6	Media Financing	Thousands of rubles	ISO2
7	Expenditure on medical care	Thousands of rubles.	ISO3
8	Expenditure on cultural work	Thousands of rubles.	ISO4
9	Expenditure on sports work	Thousands of rubles	ISO5
10	Expenditure on charity	Thousands of rubles	ISO6
11	Expenditure on providing workers with social services	Thousands of rubles	ISO7
12	Expenditure on training and staff development	Thousands of rubles	ISO8
13	Payments to the employees	Thousands of rubles.	ISO9
<i>3. Indicators of the social significance of the company</i>			
14	Execution of a copper production plan	%	ISZ1
15	Capacity utilization (Refined copper (copper cathode))	%	ISZ2
16	Capacity utilization (Electrolytic Copper Powder)	%	ISZ3
17	Capacity utilization (copper sulfate)	%	ISZ4

The initial model of the social significance of a copper industry enterprise can be represented structurally as follows (Figure 1).

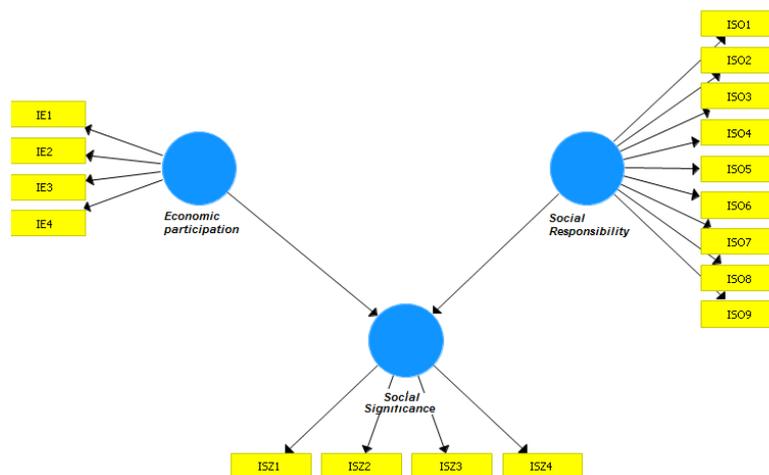


Fig. 1. The model of the social significance of the copper industry enterprise (compiled using the software SmartPLS).

We considered the model presented in Figure 1 in more detail. Latent variables are represented by circles (one latent endogenous variable “Social significance” and two latent exogenous variables “Social responsibility” and “Social participation”), explicit variables (indicators from table 1) in the presented model are presented in the form of rectangles. The interrelation of latent variables between themselves forms the inner part of the system model, the interrelations of latent variables with explicit variables represent the outer part of the model.

For the purpose of analyzing the social significance of this enterprise, the dynamics of the values of the indicators presented in Table 1 for 2010-2013 [11] was considered. The data for 2009 and 2014 were not taken into account due to their unrepresentativeness due to the impact of the effects of the crisis (in the global economy and the Russian economy, respectively). The values of indicators and their dynamics were evaluated depending on the degree of their influence on the indicator of social significance on a five-point scale. Scientists from the Accounting, Analysis and Audit Department of the Ural Federal University were involved in the assessment to ensure the objectivity of the results obtained. The research was also attended by specialists of consulting organizations CJSC NeoStrategy, LLC Management Company Priority Finance and LLC Medinvestconsulting, as well as experts of the economic service LLC Uralmedytorg. A total of 25 respondents participated in the study. According to the results of the initial research, it was decided to take into account the questionnaires of all the surveyed specialists and employees of the department.

The results of the evaluation of the values and dynamics of the performance indicators of OJSC Uralelectromed are presented in Table 2.

The PLS analysis of the model presented above was carried out by consistent implementation of the following steps:

1. Identification of internal consistency in the units;
2. Testing the significance of variables in the external model
3. Verification of the internal model.

All calculations in the presented stages of the analysis were performed automatically using the software SmartPLS [17].

The implementation of the first stage - “Identification of internal consistency in units was carried out by calculating the coefficient Cronbach alpha (α_K). The values of the coefficients for units of latent variables are as follows:

Social significance - 0.701 (value can be characterized as sufficient);

Social responsibility - 0.715 (value can be characterized as sufficient);

Economic participation - 0.709 (value can be characterized as sufficient).

Thus, the value of the Cronbach alpha coefficient across all three units is permissible ($\alpha_K > 0.7$), which indicates consistency within the Social Significance, Social Responsibility and Economic Participation units.

To implement the second stage of the study which is checking the significance of variables in external models - we systematized data on external weights of variables and load factors of variables inside the model. Variables in blocks were considered to be significant if the corresponding value of the load factor would exceed 0.500 (average correlation). The set of variables and the corresponding blocks after the exclusion of insignificant variables would be as follows (Table 3).

TABLE II. BASELINE DATA FOR BUILDING A PLS-PM MODEL CHARACTERIZING THE SOCIAL SIGNIFICANCE OF COPPER INDUSTRY ENTERPRISES (BASED ON THE EXAMPLE OF URAL ELECTROMED OJSC)

Questionnaire number	Assessment of the value and dynamics of indicators characterizing the social significance of copper industry enterprises (on the example of Uralelectromed OJSC)																
	IE1	IE2	IE3	IE4	ISO1	ISO2	ISO3	ISO4	ISO5	ISO6	ISO7	ISO8	ISO9	ISZ1	ISZ2	ISZ3	ISZ4
1	5	4	5	4	3	4	5	5	4	4	5	5	4	5	4	4	4
2	5	3	4	4	2	4	5	4	3	5	4	4	4	4	3	3	2
3	4	4	4	3	4	3	4	4	4	4	4	3	5	5	4	4	3
4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
5	4	3	5	3	3	4	5	5	3	3	3	5	4	5	3	3	3
6	4	3	3	4	2	3	4	4	4	4	3	4	4	3	3	3	3
7	5	4	5	3	3	3	5	4	3	3	3	5	5	5	2	2	2
8	5	4	5	4	3	4	4	5	4	4	4	5	4	4	4	4	4
9	4	3	4	3	3	4	5	5	4	4	5	4	5	5	3	3	3
10	5	4	5	4	3	4	5	5	5	5	4	5	4	4	4	4	4
11	4	4	4	4	4	4	5	4	4	4	4	4	4	4	3	3	3
12	5	5	5	4	3	3	3	3	3	3	3	5	3	4	3	3	3
13	4	3	5	3	3	4	5	5	3	3	3	5	4	5	3	3	3
14	4	4	4	3	4	3	4	4	4	4	4	4	4	4	4	4	4
15	5	3	5	4	3	3	5	5	3	3	3	5	3	4	4	3	4
16	4	4	5	4	4	4	4	5	5	4	5	5	4	5	5	4	4
17	4	3	4	2	2	3	4	4	3	3	3	4	3	3	3	3	3
18	5	4	5	4	3	4	4	5	4	4	4	4	4	4	3	3	3
19	4	4	5	4	4	4	3	4	3	3	3	4	4	4	3	2	2
20	5	4	5	4	3	4	5	5	4	4	4	5	4	4	4	4	4
21	5	4	5	4	3	4	5	5	4	4	4	5	4	4	4	4	4
22	5	4	5	3	3	3	5	5	3	3	3	5	5	5	2	2	2

23	5	4	5	4	3	4	5	5	4	4	4	5	4	4	4	4	4
24	5	3	4	4	2	4	5	4	4	5	4	4	4	4	3	3	4
25	5	4	5	4	3	4	5	5	4	4	4	5	4	4	4	4	4

TABLE III. SIGNIFICANT INDICATORS OF THE EXTERNAL MODEL AND THEIR VALUES

№	Unit title	Variable	External weight	Load index
1	Economic participation	IE4	0,671	1,086
2	Social responsibility	ISO5	0,330	0,743
		ISO6	0,224	0,503
		ISO7	0,281	0,632
3	Social significance	ISZ2	0,352	0,890
		ISZ3	0,363	0,916
		ISZ4	0,345	0,873

C. Graphic representation of the PLS-PM model, which characterizes the influence of factors on the social significance of Uralelectromed OJSC

For the implementation of the third stage which is the verification of the internal model - we graphically represented the internal model with the indication of the path coefficients (Figure 2).

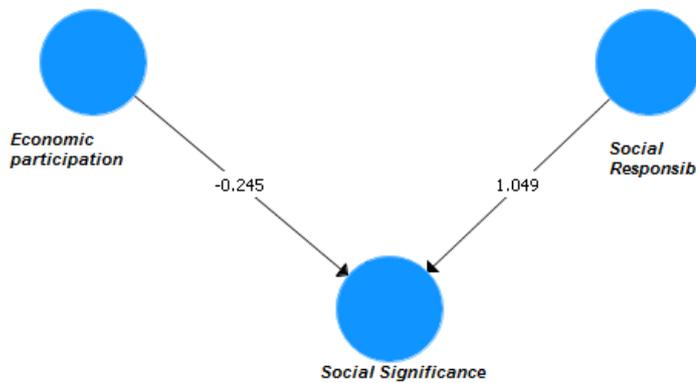


Fig. 2. Internal model with indicators of path coefficients.

Next, the authors presented the consolidated statistics on the model under consideration. (Table 4).

TABLE IV. CONSOLIDATED STATISTICS OF THE MODEL

№	Set title	R ²	The proportion of the extracted dispersion
1	Economic participation	0,000	0,395
2	Social responsibility	0,000	0,216
3	Social significance	0,858	0,606

As can be seen from table 4, the value of the indicator R² for the target unit “Social significance” exceeds 85%. The share of the extracted dispersion characterizes the average share of the dispersion of the unit indicators. The value of this indicator in only one unit (Social significance) exceeds 50%, therefore, the internal model is not completely satisfactory, however, for the purposes of this study, we will consider it suitable.

Thus, the final model of the social significance of the copper industry can be represented as follows. (Figure 3)

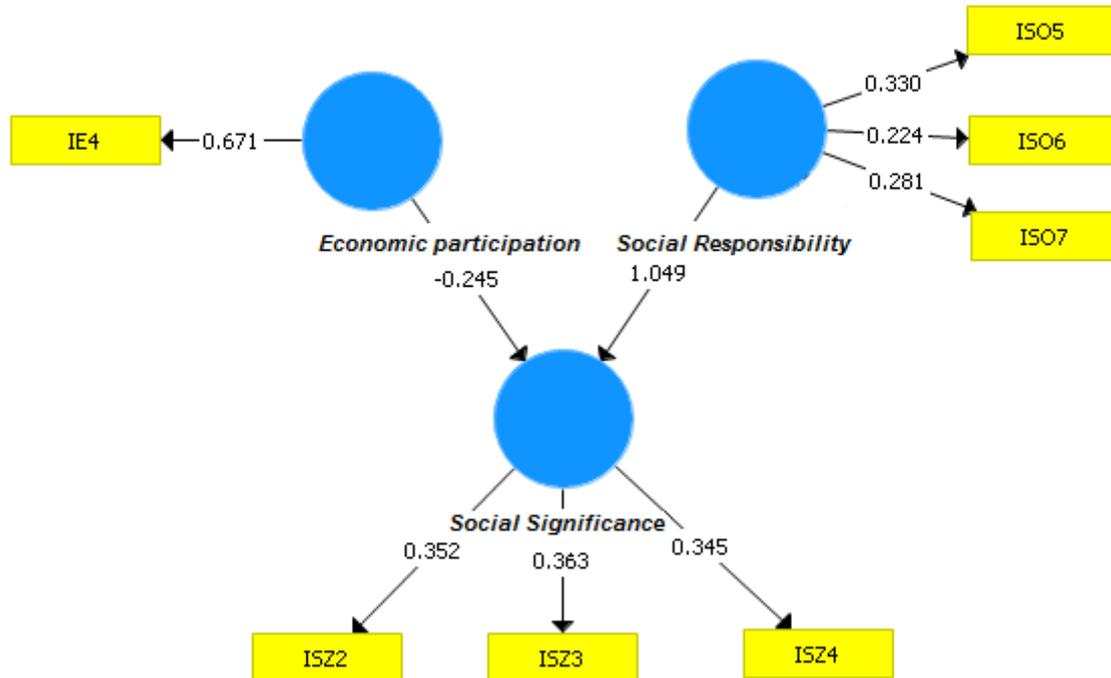


Fig. 3. The final model of the social significance of copper industry enterprises (based on the data of Uralelectromed OJSC).

D. Interpretation of data obtained by constructing a PLS-PM model characterizing the influence of factors on the social significance of Uralelectromed OJSC

As can be seen from the final model presented in Figure 4, only the indicators of the latent exogenous variable ‘Social Responsibility’ (influence power 1.049) affect the level of social significance. In addition, the analysis of the results of this study showed a rather interesting fact - the lack of influence of the factors of the ‘Economic participation’ variable on the endogenous variable ‘Social significance’, which can be reasonably indirectly influenced by the indicators included in this block on the specialists who participated in the study. Nevertheless, the data obtained allow us to formulate an assumption that the social significance of a copper industry enterprise can be quite significant both with its substantial economic participation in the life of the territories of the company's economic interests and without such participation.

According to the obtained results, it is advisable to assess the level of social responsibility by three factors:

- sports work;
- expenditure on charity;
- expenditure on providing workers with social services.

The level of social significance also depends on three factors:

- capacity utilization (Refined copper (copper cathodes));

- capacity utilization (Electrolytic Copper Powder);
- capacity utilization (copper sulfate).

According to the formed model, the most striking factor in economic participation is the amount of taxes paid to the budgets of various levels and the amount of payments to extra-budgetary funds.

III. RESULTS

Thus, in this article, the authors presented the results of the construction and analysis of the PLS-PM model, which characterizes the social significance of the copper industry (based on the example of OJSC Uralelectromed).

In the course of the study, the following results were obtained: on the basis of a survey of 25 respondents, the general format was substantiated and a PLS-PM model was constructed that characterizes the social significance of the copper industry (using the example of Uralelectromed OJSC) and it was found that only indicators of the latent exogenous variable ‘Social Responsibility’ affect the level of social significance, in particular: the expenditure on sports work, the expenditure on charity and the expenditure on providing workers with social services.

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