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MODELS AND METHODS OFTHE CRISIS CONDITION ASSESSMENT OF ENGINEERING INDUSTRY BUSINESS ENTITIES

Abstract. The article provides an analytical assessment of the crisis condition of engineering industry business entities. As the assessment methods were used statistical method, establish causation, integral indicator for the models of bankruptcy probability, integrated indicator of crisis, cluster analysis by the level of adaptive capacity and discriminant analysis. As a result of the application of these methods the analytical conclusions were done. Established that the engineering industry is indeed in crisis due to a number of problems solution of which must occur at the national level. However, given the uncertainty about the length of the implementation and the effectiveness of government measures to overcome the industry crisis, business entities are offered to develop measures to adapt to the crisis conditions of operation.

Keywords: crisis, assessment of the crisis condition, financial indicators, adaptation, adaptive potential.

JEL Classification: G32, L2, L5, L6

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МОДЕЛІ ТА МЕТОДИ ОЦІНКИ КРИЗОВОГО СТАНУ СУБ'ЄКТІВ ПІДПРИЄМНИЦТВА МАШИНОБУДІВНОЇ ГАЛУЗІ

Анотація. У статті проведено аналітичну оцінку кризового стану суб'єктів підприємництва машинобудівної галузі і зроблено аналітичні висновки. Встановлено, що галузь машинобудування дійсно знаходиться у кризовому стані через ряд проблем, вирішення яких повинно відбуватись на державному рівні. Однак враховуючи невизначеність щодо тривалості впровадження та результативності державних заходів з подолання галузевої кризи, суб'єктам підприємництва запропоновано розроблення заходів з адаптації до кризових умов функціонування.

Ключові слова: криза, оцінка кризового стану, фінансові показники діяльності, адаптація, адаптаційний потенціал.

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МОДЕЛИ И МЕТОДЫ ОЦЕНКИ КРИЗИСНОГО СОСТОЯНИЯ СУБЪЕКТОВ ПРЕДПРИНИМАТЕЛЬСТВА МАШИНОСТРОИТЕЛЬНОЙ ОТРАСЛИ

Аннотация. В статье проведена аналитическая оценка кризисного состояния субъектов предпринимательства машиностроительной отрасли и сделаны аналитические выводы. Установлено, что отрасль машиностроения действительно находится в кризисном состоянии из-за ряда проблем, решение которых должно происходить на государственном уровне. Однако учитывая неопределенность относительно продолжительности внедрения и результативности государственных мер по преодолению отраслевого кризиса, субъектам предпринимательства предложена разработка мер по адаптации к кризисным условиям функционирования.

Ключевые слова: кризис, оценка кризисного состояния, финансовые показатели деятельности, адаптация, адаптационный потенциал.

Формул: 0; рис.: 8; табл.: 2; библ.: 15.

Introduction. Engineering industry is one of the leading industries in Ukraine. It has a decisive influence on the pace of scientific and technological progress, productivity and the economy of the country as a whole. However, in recent years, engineering industry is characterized by a number of problems that lead to a decrease in the volume of sales, losses, or even bankruptcy of business entities in the industry. The scale of these and other problems allows us to assume that today there is not only the crisis of individual engineering units, but also the crisis of the industry as a whole. In this case, these problems need to be solved mostly at the state level, since a separate business unit cannot cope with the industrial crisis. However, taking into account the uncertainty concerning the duration of implementation and the effectiveness of state measures of overcoming the industrial crisis, the topical question is, in our opinion, if it is possible to stabilize the situation at the micro level. According to the author, although a separate business unit cannot overcome the crisis on its own, however, it is able to try to adapt to adverse environmental conditions through the introduction of certain adaptation measures. The effectiveness of such measures depends, among other things, on a timely and reliable analytical assessment of the crisis situation of business entities.

Literature review and the problem statement. A lot of researchers took an analytical assessment of the crisis situation of business entities, namely: Blank I.A. [1], Arefieva O. V. [2], Kuzenko T. B. [3], Nieskorodieva I.I. [4], Koshkin V.I. [5], Utkin E. A. [6], Hriaznova A. H. [7], Meier K. i Sten D. [8], Akoff R. L. [9], Turylo A. M. i Bohachevska K. V. [10], Kulikov P. M. [11], Mazaraki A. A. i Kasianova A. O. [12] and others. However, in the works of scientists insufficient attention is paid to the peculiarities of such an assessment in a global or industrial crisis. As we have already noted, a separate business unit is not able to overcome the industrial crisis on its own, and therefore there is a need to develop measures for adaptation to crisis conditions of functioning. Necessary basis for the development of such measures is the assessment of the adaptive capacity of business entities, with which we propose to complement the general analytical assessment of the crisis situation of business entities in the engineering industry.

The purpose of the study is to conduct an analytical assessment of the crisis situation of business entities in the engineering industry. The methods of evaluation are the following: the

statistical method, the method for establishing causal relationships, the integral index on the models of bankruptcy probabilities, the integral indicator of the crisis state, the cluster analysis by the level of adaptive potential and the discriminant analysis.

Research results. According to the author, the first step in analytical assessment of the crisis situation of business entities in the engineering industry should be the determination of the main problems of engineering and their origin, as well as the investigation of the consequences of such problems, one of which is, among other things, falling volumes of sold products. In addition, the result of this study will make it possible to finally state whether the current situation is a crisis of the industry as a whole (the crisis on the mesolevel), or the concept of crisis can be used only concerning individual economic units, that is, the crisis is present only at the micro level.

The list of main problems in the field of engineering is presented in the Concept of the National Target Economic Program for the Development of Industry for the period up to 2020. The document identifies these problems as problems of industrial development in general, but considering that engineering is one of the priority sectors of the national economy, all these problems are related to it directly. The range of the above problems is presented in Fig. 1, where we also identified the linkages between the problems and the reasons that, in our opinion, caused them.

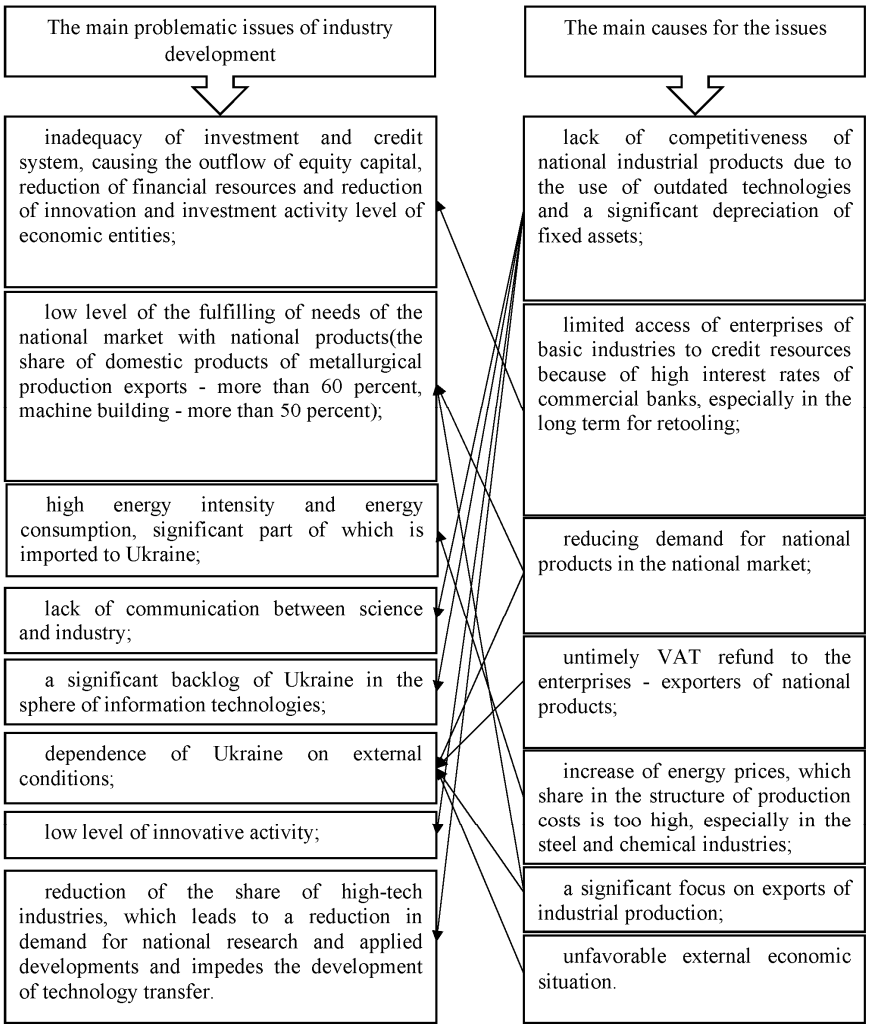

Figure 1. The main problematic issues of industrial development and the main causes of problems
Source:compiled by the authors on the base of [13]

As the main consequence of the above-mentioned problems, we can observe a sharp decline in the volume of sales of engineering products. In the Concept of the National Target Economic Program for the Development of Industry for the period up to 2020, it is noted that the demand for mechanical engineering products is one of the decisive factors influencing the situation in the

industry. At the same time, the document stresses that the share of machine building in the volume of processed products in the processing industry amounted to 18.7 percent in 2012, which is 4 times lower than the level of developed countries [13]. Given the fact that in recent years this figure has dropped to about 10 percent, the situation inengineeringindustry appeared to be quite critical.

In fig. 2. the trend in the change in the volume of sales of engineering products in general and by types in 2011-2014is reflected.

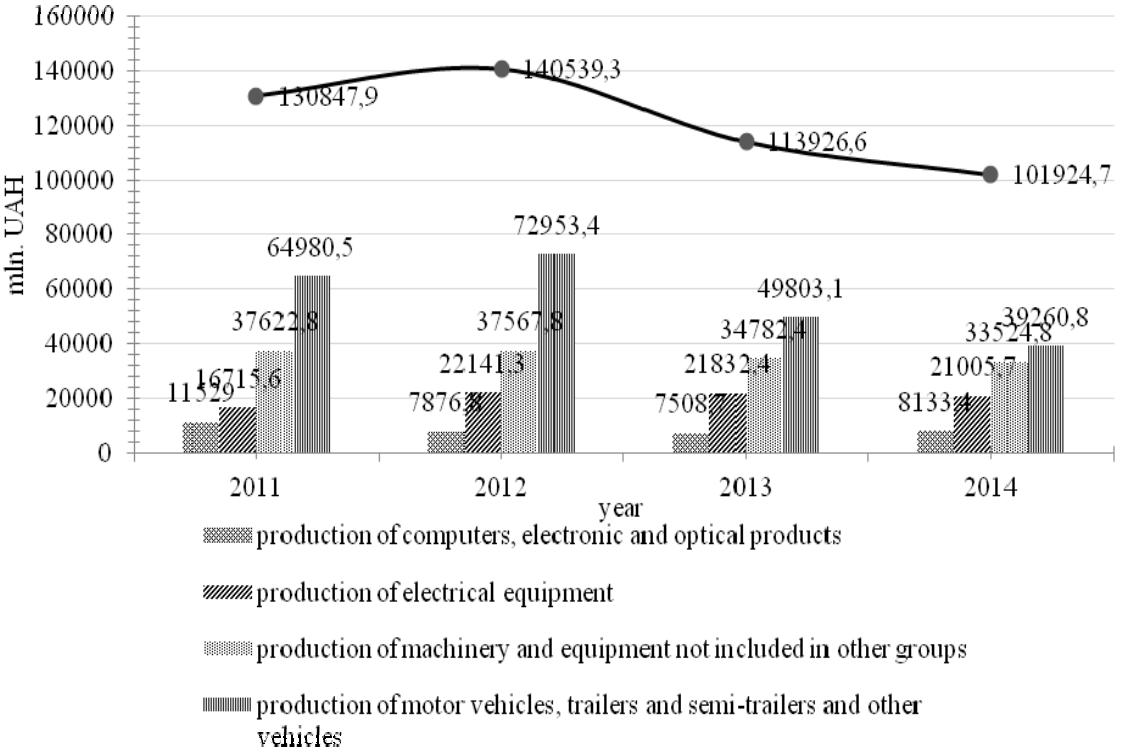

Figure 2. Volume of sold engineering products in general and by types in 2011-2014
Source: calculated by the authors on the base of [14]

From Fig. 2. it can be concluded that in comparison with 2011, in 2014 the volume of sold mechanical engineering products has decreased significantly. The largest volume of sales was in 2012, after which we can observe a tendency of its decrease. If we pay attention to the volume of sales of engineering products by type, it becomes clear that such a decrease began mainly due to the reduction in sales of motor vehicles, trailers and semitrailers and other vehicles, which, moreover, have the largest share in the total volume of sales of engineering products .

Consequently, according to the results of the first step in conducting an analytical assessment of the crisis condition of business entities in the engineering industry, we can state that the mechanical engineering industry is in a state of crisis, due to a number of specific problems, most of which, in our opinion, need to be resolved at the state level. However, taking into account that the implementation of state measures to improve the situation may take a long time, we consider it expedient to analyze how we can influence the situation at the enterprise level.

The information base for further research is the financial statements of twenty engineering enterprises of Ukraine, a list of which is presented in the table. 1. (henceforth, the symbol will be used in the article).

Table 1

Engineering enterprises for research

№	Business entity (BE)	Symbol of BE
1	PJSC "Avtramat"	A
2	OJSC "Turboatom"	B
3	PJSC "Odessa Machine-Building Plant"Chervona hvardiia"	C
4	PJSC "Kharkiv Order"Znak poshany"machine-building factory "Chervonyi Zhovten"	D
5	PJSC "Kharkiv Electrotechnical Plant" Ukrelectromash "	E
6	PJSC "S. Ordzhonikidze Kharkiv Tractor Plant"	F
7	PJSC "Pavlohrad Plant of Automatic Lines and Cars"	G
8	PJSC "Verkhnodniprovsk machine-building factory"	H
9	PJSC "Grebinki Machine-Building Plant"	I
10	PJSC "Kremenchug Plant of Road Machines"	J
11	PJSC "Poltava Machine-Building Plant"	K
12	PJSC "Korosten Machine-Building Plant"	L
13	PJSC "Berdychiv Machine-Building Plant"Progress"	M
14	PJSC "Korosten Plant of Chemical Engineering"	N
15	PJSC "Novograd-Volyn Plant of Agricultural Machinery"	O
16	PJSC "Kharkiv Bearing Plant"	P
17	PrJSC "Spetsbudmash"	Q
18	PJSC "Sumy Pump and Power Engineering Plant"Nasosenergomash"	R
19	PJSC "Beryslav Machine-Building Plant"	S
20	PJSC "Smilian Machine-Building Plant"	T

Source: compiled by the authors on the base of [15]

We propose to analyze the financial statements of the above mentioned business entities in the following sequence:

integral assessment of the crisis state on the basis of bankruptcy probability models;

integral analysis of the crisis state by taxonomy;

cluster analysis by indicators of adaptive potential.

The results of an integrated assessment of the crisis state on the basis of bankruptcy probability models are presented in Table 2.

Table 2

Matrix of the calculation results of integral indicators on bankruptcy probability models for 2011-2014 *

Model \ BE	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
2011																				
D. Duran Method	T		T		T	T	T		T	±	T	T	T	T	±	T	T	T	±	±
E. Altman Two-Factor Model																				
E. Altman Five-Factor Model			T			T	T							T						
L.V. SprinheytModel						T	T				T	T		T	T					
R. Lis Model	T				T	T	T				T	T	T	T						
R. Taffler Model							±					±								
J.Depalian Model			T															T		
R.S.Sayfulin and G.G. KadikovMethod			T		T	-	T		T					T		T	T			
R-account model						-														
O.P. Zaitseva Model	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tereshchenko Universal Model	T				±	±	T		±		±	T	±	±		±	±		±	
Result	3	0	4	0	3	4	6	0	2	0	3	4	2	5	1	2	2	2	0	0

Continuation of table 2

2012																				
D. Duran Method	±		T	±	T	T	T		±		T	±	T	T	±	T	T	±	±	±
E. Altman Two-Factor Model																				
E. Altman Five-Factor Model			T		T	T	T									T	T			
L.V. Sprinheyt Model	T		T		T	T	T				T		T		T	T				
R. Lis Model			T		T	T	T		T		T					T				
R. Taffler Model	T		T		±	±					±					±	T			
J.Depalian Model			T														T			
R.S. Sayfulin and G.G. KadikovMethod			T		-	-	T						T	T		T	T			
R-account model					-	-														
O.P. Zaitseva Model			T		-	-	T		T		T	T	T	T		T	T	T	T	
Tereshchenko Universal Model	T		T	±	T	T	T		±		±	±	T	±	±	T	±	±	±	±
Result	3	0	9	0	5	5	7	0	2	0	4	1	5	3	1	7	6	1	1	0
2013																				
D. Duran Method	T		T	±	T	T	T		3	±	3	3	3	3	±	3	3	±	±	±
E. Altman Two-Factor Model																				
E. Altman Five-Factor Model	T		T		T	T	T				T			T		T	T			
L.V. Sprinheyt Model	T		T		T	T	T		T		T		T	T	T	T				T
R. Lis Model	T		T		T	T	T		T						T	T				T
R. Taffler Model	T		T			T	T		±		±					T	±			
J.Depalian Model			T				T									T				
R.S. Sayfulin and G.G. KadikovMethod	T		-	-	T	-	T				T		T	T		T				
R-account model			-	-		-														
O.P. Zaitseva Model			-	-	T	-	T					T	T	T		T	T	T	T	
Tereshchenko Universal Model	T		T		T	T	T		±		±	±	T	±	T	T	±		±	±
Result	7	0	7	0	7	6	9	0	3	0	4	2	5	5	3	9	3	1	1	2
2014																				
D. Duran Method	T		T		T	±	T	±	T		T	T	T	T	±	T	T	T	T	±
E. Altman Two-Factor Model																				
E. Altman Five-Factor Model	T		T		T		T				T	T	T	T		T	T		T	
L.V. Sprinheyt Model	T		T		T		T		T		T	T	T	T		T			T	
R. Lis Model	T		T		T	T	T		T		T	T		T		T			T	T
R. Taffler Model	T		T				T				?	?				T				
J.Depalian Model			T				T									T				
R.S. Sayfulin and G.G. KadikovMethod	T		-	-	T	-	-				T	T	T	T		-	T		-	
R-account model			-	-		-	-									-			-	
O.P. Zaitseva Model			-	-	T	-	-		T			T	T	T		-	T		-	
Tereshchenko Universal Model	T		T		±		T	±	±		T	T	T	T		T	±	±	T	
Result	6	0	6	0	6	1	6	0	4	0	5	6	5	6	0	6	4	1	5	1

* There is no bankruptcy threat - empty cell; financial sustainability is violated - (±); threat of bankruptcy - (T); the calculated integral factor of the model does not make sense due to the negative value of equity or the lack of necessary data for calculation - (-).

Source: calculated by the authors on the base of [15]

Summing up the results of calculating the bankruptcy probability models presented in Table 2, we can note that in 2011 the business entities, which in half or more of these models (that is, in which the summary of the column is 5 or higher) was 3, in 2012 - 7, in 2013 - 8, and in 2014 - 9 Thus, by the end of the investigated period, almost half of thebusiness entities are threatened with bankruptcy, which again confirms that the state of the engineering industry is critical.

We propose an integrated analysis of the crisis condition using the taxonomy method on the basis of the following financial ratios:Own Working Capital Sufficiency

Ratio,CoverageRatio,Quick Liquidity Ratio,AbsoluteLiquidityRatio,Own Working Capital Sufficiency For Stocks And Expenses Ratio,Financial Autonomy Ratio, Equity ManeuverabilityRatio, Concentration Of Debt Capital Ratio, Debt ToEquity Ratio, Turnover Of Receivables, Turnover Of Stocks,Turnover Of Assets, Receivables To Payables Ratio, Own To BorrowedFunds Ratio,Turnover Of Payables,Profitability Of CostsRatio,Profitability Of Activity Ratio,Profitability Of AssetsRatio,ProfitabilityOfEquityRatio.

We propose to use 19 indicators, which, according to the results of our research, are most often used by crisis management specialists.

The results of the integrated analysis of the crisis condition by the taxonomy method are presented in fig. 3.

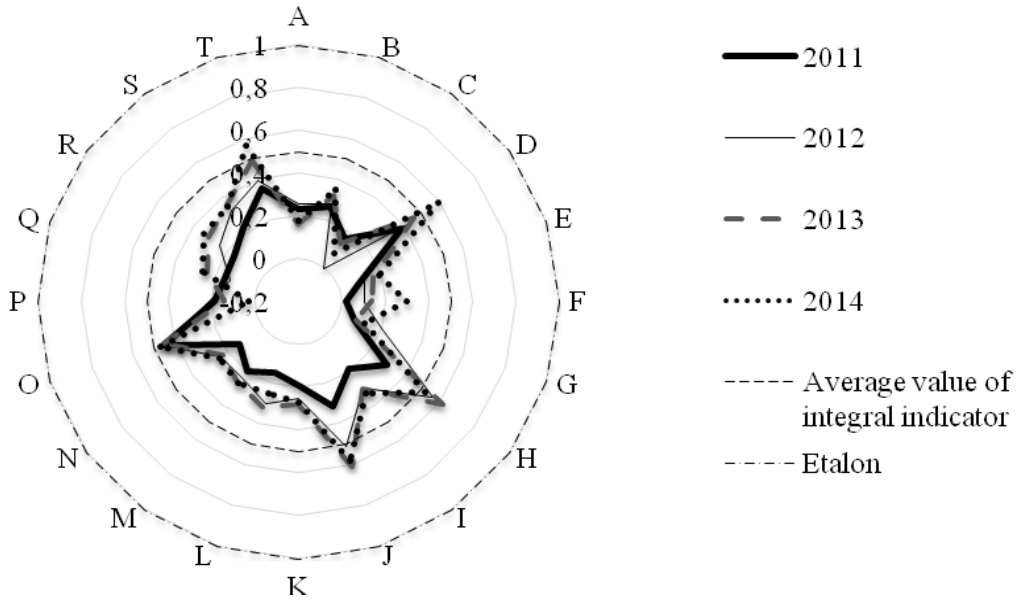

Figure 3. Positioning of business entities on the scale of qualitative assessment by levels of the integral indicator of the crisis condition in the dynamics for 2011-2014
Source: calculated by the authors on the base of [15]

The result of the assessment of integral indicators also confirms that the engineering industry is in crisis, because the value of most indicators for the entire period does not exceed even 0.5, while the value of the benchmark is equal to 1.

Consequently, for today, the engineering industry is really in crisis condition. As we have already noted, in such conditions, the actions of a separate economic unit should be directed not so much to overcome the crisis, but to adapt to the crisis conditions of functioning. The basis for the development of adaptation measures, in addition to the above assessment of the crisis situation of business entities, should be the assessment of adaptation capacity.

Proceeding from the fact that in the economic literature there is no single sufficiently developed approach to the assessment of the adaptation potential in the context of crisis management, we suggest to carry out a cluster analysis by the indicators determined by the surveyed experts. About 20 business entitieswere selected as respondents, leading experts in economics and finance were our experts. From the list of ratios proposed by us for taxonomic analysis they identified five indicators which, in their opinion, most fully characterize the existing adaptive potential of business entities in the engineering industry: Ratio Of Own Working Capital Sufficiency, Coverage Ratio, Absolute Liquidity Ratio, Financial Autonomy Ratio, Profitability Of Activity Ratio.

In fig. 4. results of the conducted cluster analysis are presented. In tabl. 3. symbols of indicators (variables) on which the analysis was made are given.

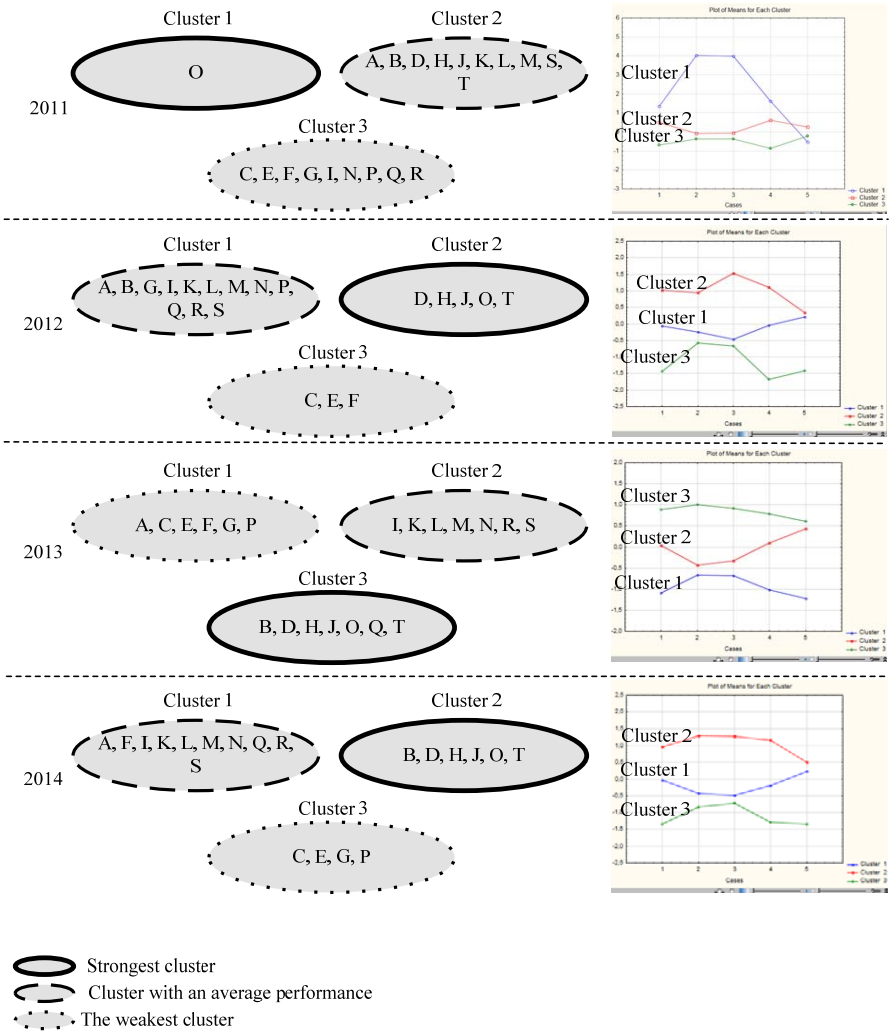

Figure 4. The composition of clusters formed by the iterative k-means method in 2011-2014 by the level of adaptive potential and medium graphs
Source: calculated by the authors on the base of [15]

The quality of the classification obtained by cluster analysis can be verified using a discriminant analysis, the results of which are presented in Fig. 5

N=20	Discriminant Function Analysis Summary (Spreadsheet2) No. of vars in model: 5; Grouping: Cluster Number (3 grps) Wilks' Lambda: ,05111 approx. F (10,26)=8,9011 p< ,0000 **Wilks' Lambda**	Partial Lambda	F-remove (2,13)	p-value	Toler.	1-Toler. (R-Sqr.)
Ratio Of Own Working Capital Sufficiency	0,053895	0,948231	0,354871	0,707851	0,712471	0,287529
Coverage Ratio	0,070540	0,724482	2,471934	0,123077	0,883481	0,116519
Absolute Liquidity Ratio	0,065063	0,785477	1,775225	0,208146	0,936984	0,063016
Financial Autonomy Ratio	0,076612	0,667064	3,244191	0,071960	0,755952	0,244049
Profitability Of Activity Ratio	0,067598	0,756018	2,097675	0,162353	0,927368	0,072632

Figure 5. Results of discriminat analysis
Source: calculated by the authors on the base of [15]

According to Wilks' Lambda, which is 0.05111, we can conclude that the classification is correct. The greater the significance of Wilks' Lambda, the more important is the variable in the procedure of discrimination.

As a validation of training samples, see the results of the classification matrix (Fig. 6).

Group	Percent Correct	G_1:1 p=,33333	G_2:2 p=,33333	G_3:3 p=,33333
	Classification Matrix (Spreadsheet2) Rows: Observed classifications Columns: Predicted classifications			
G_1:1	100,0000	6	0	0
G_2:2	100,0000	0	10	0
G_3:3	100,0000	0	0	4
Total	100,0000	6	10	4

Figure 6.Classification Matrix
Source: calculated by the authors on the base of [15]

According to the results of the classification matrix (Fig. 6), it can be concluded that the objects are split correctly into three groups by means of cluster analysis.

In fig. 7. the parameters of the classification functions are presented.

Variable	Classification Functions; groupin G_1:1 p=,33333	G_2:2 p=,33333	G_3:3 p=,33333
Ratio Of Own Working Capital Sufficiency	-4,5470	-3,22980	-4,19556
Coverage Ratio	5,4369	1,99751	0,92378
Absolute Liquidity Ratio	11,4499	0,98753	-0,15354
Financial Autonomy Ratio	35,3882	15,86113	3,80054
Profitability Of Activity Ratio	3,4094	1,14051	-3,36925
Constant	-31,7943	-5,26477	-6,14488

Figure7.Parameters of the classification functions
Source: calculated by the authors on the base of [15]

These functions can be used in the future to assign a particular business entity to one of the clusters.

For more information, you can view the results of the canonical analysis, for which it is expedient to construct a scattering diagram for the values (Fig. 8).

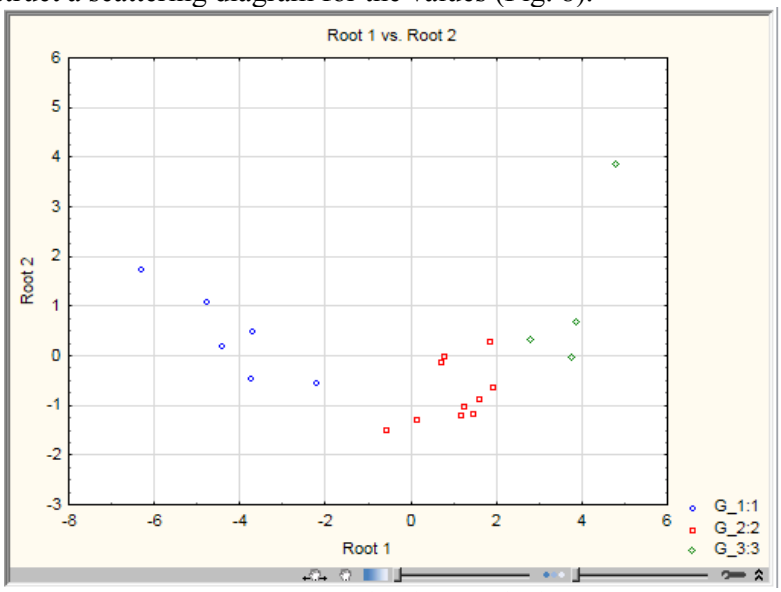

Figure8.Scatter plot of canonical values
Source: calculated by the authors on the base of [15]

Using this chart, it is possible to determine the contribution that each discriminat function places in the distribution between the groups.

Consequently, the classification of business entities by the level of adaptive potential by the method of cluster analysis is adequate. In the process of discriminant analysis, functions that can be used in the future for assigning a particular business entity to one of the clusters are constructed.

Thus, cluster analysis by the level of adaptive potential allowed to divide the investigated business entities into three clusters, among which the strongest cluster demonstrates the highest adaptive potential, while the weakest, respectively, the lowest. Analysis of the indicators on which the analysis was conducted allows us to identify which weaknesses exist in business entities with low adaptive potential, after which it is possible to go to the development of appropriate adaptation measures.

Conclusions. Summing up the above, it should be noted that the engineering industry is in crisis, the way out of which we see in the implementation of effective state-level measures. However, given the uncertainty about the speed and effectiveness of government measures, we consider it advisable to implement adaptation measures at the micro level in order to adapt to the crisis conditions of functioning. The basis for developing such measures is the assessment of the crisis situation and adaptive potential in the article, and hence the direction of further research willbe the development of adaptation measures and adaptation strategy of the business entity.

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