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Antirecessionary Policy Methods for Agricultural Enterprises on the Cluster Analysis basis.

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ABSTRACT

The article proposes financial state assessment methodology for agricultural enterprises based on their clustering according to a range of financial indicators. The research was carried out on Voronezh region materials. By means of the analysis of hierarchical tree clustering, the authors selected groups of companies, equal in the type of financial state, and made recommendations for crisis management formation strategy, its goals and anti-crisis measures.

Keywords: cluster analysis, financial state, anti-crisis strategy, agricultural enterprises, Voronezh region.

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INTRODUCTION

The need for crisis management in agricultural enterprises is dictated by the specific nature of agricultural production, a high level of risk and external environment uncertainty. Agricultural producers are often faced with such problems as the lack of funding, the complexity of established production system and the slow rates of its development, the obsolescence of fixed assets, an insufficiently qualified management, etc. Each of these problems may provoke a company crisis. The current problems of anti-crisis management strategies concerning agricultural enterprises in the countries with transitional economies according to a number of reasons (the lack of methodical and information support of management, the low level of management skills, etc.) are of particular importance and need to be addressed because of agricultural food market globalization and a competitive struggle increase.

Despite a considerable amount of research on strategic and anti-crisis management and planning, the issues of scientific-methodological and practical approaches substantiation to the development anti-crisis management strategies by agricultural enterprises remain insufficiently developed. Existing typological methods of financial state analysis take into account an industral specifics to a small extent, so the use of self-learning methods and the algorithms for the classification of agricultural producers according to "financial health" state remains to be an actual one. Cluster analysis, the applications of which are being actively researched in the field of financial and economic condition evaluation concerning the enterprises of various branches, deserves a special attention among such instruments [1- 4].

METHODS

Nowadays cluster analysis is one of the most common and effective methods for classification problem solution. Cluster analysis is a multivariate statistical procedure, which provides the collection of data containing the information about object sampling, and then the ordering of objects in comparatively homogeneous groups (clusters), so that each cluster consists of similar objects, and the objects of different clusters differed significantly [5, 6].

An important advantage of cluster analysis is that it allows you to perform the partition objects under study not by one parameter but by a set of classifiers; the wider the set of features is, the more likely the identification of a natural division into classes, free of a researcher's subjectivity. Besides, cluster analysis is applicable at the absence of a priori hypotheses about the division of studied objects into classes, which is especially important during the initial stages of a study.

The following objectives of cluster analysis are determined:

1. Understanding of data by cluster structure identification providing a sample partition into the groups of similar objects, to which allows to simplify further processing of data and decision-making, applying a personal method of analysis to each cluster.
2. Data compression, providing the reduction of an excessively large sample, due to the selection of the most typical representatives from each cluster for further study.
3. The revealing of data novelty, providing for the revealing of atypical objects which can not be attached to any of the clusters.

Hierarchical clustering may be applied within each of the abovementioned approaches, providing the fragmentation of large clusters into smaller ones, and the smaller ones in its turn into the smallest ones. The result of hierarchical clustering is a branched hierarchical structure, at that each object is characterized by the enumeration of all clusters to which it belongs.

The procedure proposed in this study concerning the identification of agricultural enterprise types, similar by financial stability degree, provides the development of a representative sample for agricultural enterprises as the objects described by a set of variables which are the indicators of financial condition. Since the studied symptoms have various types of scales and different sizes, the data are proposed to standardize in such a way that each variable has the mean value equal to 0 and a standard deviation equal to one.

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The most obvious and universal is the algorithm of tree clustering, which allows you to consider the combination of studied objects into clusters in details at different levels of a hierarchical tree. In order to calculate the distance matrix between objects the Manhattan distance method [7] was used, providing the determination of distance metrics as the module sum of coordinate variable differences:

$$p_E\left(Y_i, Y_j\right) = \sum_{k=1}^{n} \left| x_{ik} - x_{jk} \right|,$$

where Y_i and Y_j – are the objects compared by pairs,
x_{ik} and x_{jk} – k-variables of i-th and k-th object respectively.

In order to bind and combine clusters it is proposed to apply the rule of full communication [8], according to which the distance between clusters is determined by the largest distance between any two objects in different clusters (i.e., by "the most distant neighbors").

MAIN PART

In order to test the proposed method fetch the sampling of studied objects was performed, which included 91 large agricultural enterprises located on the territory of Anninsky, Bobrovsky, Liskinsky, Podgorensky, Pavlovsky and Rossoshansky municipal districts of the Voronezh region of Russia. The abovementioned areas are agricultural ones traditionally and form a single territorial array, which stretches from north to south; besides, they are located far enough away from the regional center that allows you to neutralize the distorting effect of "economic gravity" made by megapolis on the development of the surrounding area territories.

Each sampling object was described by 13 variables [9], which characterize separate aspects of an enterprise financial condition at the end of 2014:

X_1 - Absolute liquidity ratio;
X_2 - Interim liquidity ratio;
X_3 - Current liquidity ratio;
X_4 - Current assets coverage ratio;
X_5 - Coefficient of autonomy;
X_6 - Debt capital ratio;
X_7 - Financial stability ratio;
X_8 - Current assets to equity ratio;
X_9 - Financial activity ratio;
X_{10} - Profitability of primary activity, %;
X_{11} - Sales margin according to net profit, %
X_{12} - Return on equity, %;
X_{13} - Return on assets, %.

The branch clustering result of 91 selected agricultural enterprises according to 13 signs of financial condition performed in the application package Statistica 12.0 is shown on Figure 1.

The tree-like graph shows all the steps of studied object combining into clusters, i.e. one may see an initial classification step when each of the objects represents a separate cluster, and a final stage, when all studied objects make a single cluster. 5 - 10 rather obvious clusters may be seen on an obtained hierarchical tree. At this stage of analysis "atypical" enterprises are highlighted, merging with other clusters only at a great distance.

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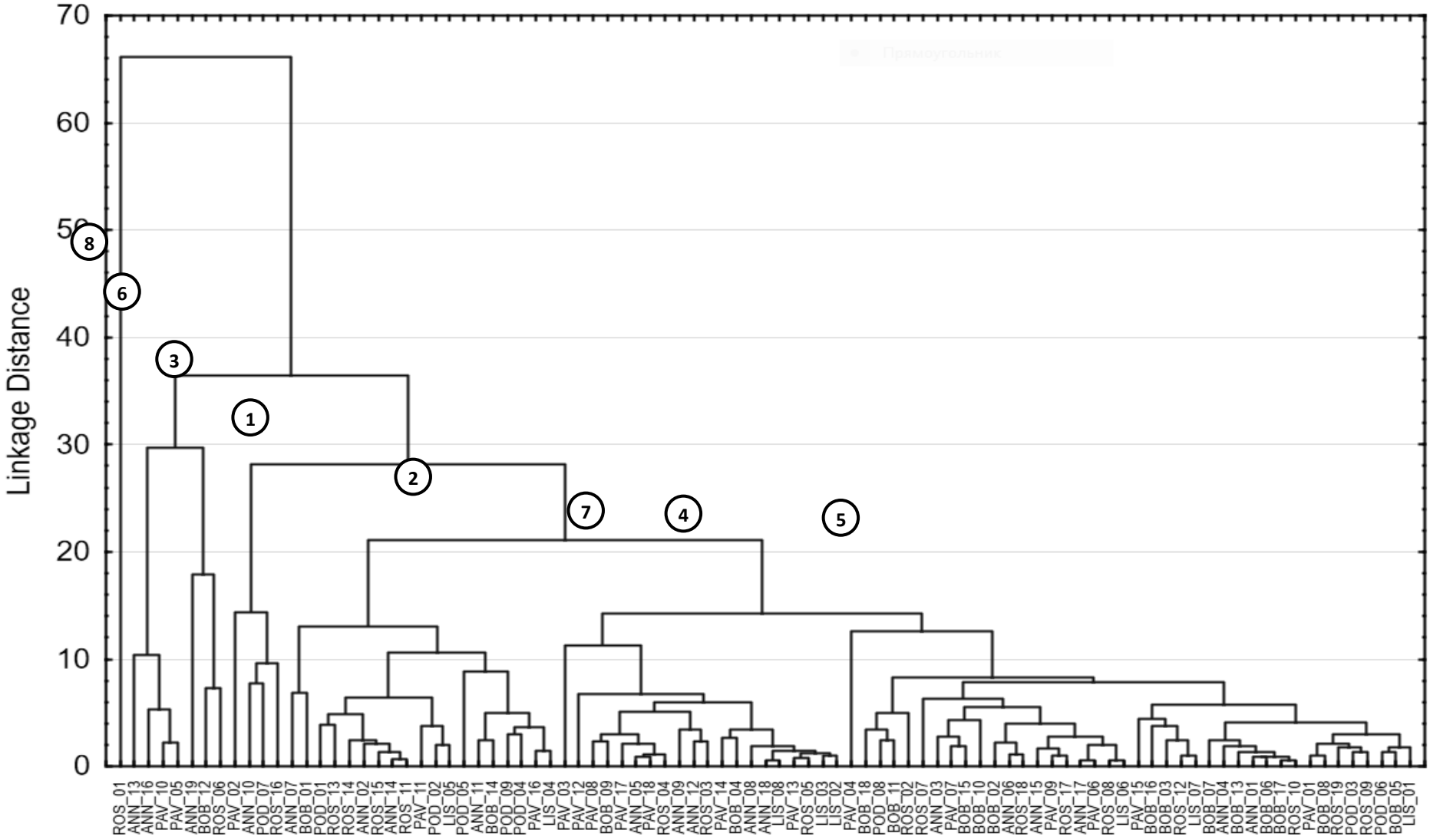

Figure 1. Hierarchical clustering tree of 91 agricultural enterprises in Voronezh area according to 13 signs of financial condition (enterprise codes are presented on a horizontal line)

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In order to clarify the number and the composition of clusters, which will be used for the development of agricultural enterprise anti-crisis strategies as the "templates", the cluster analysis was performed by k-means methods. This method provides the setting of fixed reference number of clusters (k) directly by a researcher, followed by iterative formation of k clusters as homogeneous as possible inside, but at a maximum distance from each other. In order to make a decision about the number of classes two criteria were used in final classification: to minimize the number of small clusters containing 1-2 enterprise, and, if possible, to prevent the formation of large, heterogeneous "superclusters" (containing more than 25% of a sample). The partitioning of samples into 8 classes - 6 typical and 2 atypical ones (Figure 1, Table 1) is considered as an optimal one from this point of view.

Table 1. Comparative analysis of averaged cluster values

X	Indicator	Classes								Sampling in general
		Typical						Atypical		
		1	2	3	4	5	6	7	8	
X_1	Absolute liquidity ratio	1.60	0.96	15.45	0.07	0.09	0.01	0.10	0.01	1.26
X_2	Interim liquidity ratio	2.92	1.87	25.96	0.36	0.40	0.55	1.09	0.08	2.38
X_3	Current liquidity ratio	17.42	10.26	85.02	1.58	1.62	1.09	1.13	0.08	10.41
X_4	Current assets coverage ratio	0.80	0.82	0.99	0.09	0.22	-0.40	0.12	-11.62	0.30
X_5	Coefficient of autonomy	0.82	0.83	0.94	0.35	0.38	0.21	0.61	-8.46	0.48
X_6	Debt capital ratio	0.18	0.17	0.06	0.65	0.62	0.79	0.39	9.46	0.52
X_7	Financial stability ratio	0.90	0.92	0.99	0.59	0.63	0.46	0.61	-8.46	0.64
X_8	Current assets to equity ratio	0.55	0.48	0.52	-0.15	0.16	0.01	0.08	1.03	0.26
X_9	Financial activity ratio	0.28	0.25	0.08	3.86	1.64	21.41	0.63	-1.12	2.92
X_{10}	Profitability of primary activity, %	51.71	27.50	28.73	20.40	10.35	-17.07	-9.37	-3.65	23.18
X_{11}	Sales margin according to net profit, %	34.57	18.02	11.16	16.08	3.02	-13.29	10.99	-16.41	14.61
X_{12}	Return on equity, %	41.08	10.89	13.50	28.00	5.73	-26.66	105.34	-95.5	16.68
X_{13}	Return on assets, %	25.33	8.83	8.09	8.78	2.32	-12.12	64.77	-85.82	8.76
Number of objects in a class		19	20	4	19	20	7	1	1	91

Cluster 1 enterprises have an absolute financial stability. The assets of a company are liquid ones and are financed mainly by equity. The companies of this cluster have the highest profit margins, including the ones calculated on net profit.

Cluster 2 enterprises are characterized by normal financial condition and generally have similar indicators to cluster 1 enterprises, but at the same time, all calculated margin indicators are much lower - the margin of main activity and the profitability of sales are lower in 2 times, the return on equity is lower in 4 times, the return on assets is lower in 3 times.

Cluster 3 enterprises almost do not use their own capital, the liquidity ratios are many times higher than standard ones, which indicates an irrational investing. A sufficiently high level of profitability allows to make the conclusion about a normal financial condition of this cluster companies.

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Cluster 4 enterprises are characterized by the following common features: the values of liquidity ratios are slightly below the standard ones, the share of loan capital is quite large. Own working capital is financed from its own sources only at 9%, which indicates that the threat of its loss. The financial state of enterprises is characterized as an unstable one.

Liquidity and financial stability indicators of cluster 5enterprises are similar to the values of cluster 4 enterprises, but the share of own working capital is higher here. At the same time, the margin values are significantly lower.

Cluster 6 is formed by unprofitable enterprises with a high share of a debt capital and the absence of own working capital. The enterprises of this cluster have a critical financial situation.

Cluster 7 and 8 are atypical ones and include one enterprise. A distinctive of cluster 7 enterprise is the loss from main operations and the availability of net profit at the expense of other income obtaining. Therefore, the profitability indicators of equity and the profitability of assets are large enough.

Cluster 8 enterprise has a significant uncovered loss and bad debts. This enterprise is in a state of bankruptcy.

The performed study allowed to develop the main trends of crisis management strategies for the analyzed agricultural enterprises [10], included into eight identified clusters (Table 2).

Table 2. Recommended measures defined by anti-crisis management strategy for the agricultural enterprises of the Voronezh region

Anti-crisis purposes and measures	Cluster							
	1	2	3	4	5	6	7	8
Purposes:								
An enterprise solvency restoration				+	+	+	+	+
The development of an adequate level of financial security						+		+
Search for cost reduction ways						+		+
Restoration of financial stability							+	
The provision of an enterprise sustainable growth	+			+	+			
Financial stability provision in a long run		+	+					
Enterprise market value maximizing	+	+	+					
Measures:								
An enterprise investment activity improvement	+	+	+	+				
The investment in "human capital"	+	+	+	+				
The sale of obsolete assets and the liquidation of inefficient structures, the acquisition of new assets	+							
The increase of funds turnover, the reduction of financial and production cycle	+	+	+					
Receivables composition and duration control	+							
Profit increase from an enterprise main activity					+	+	+	+
Strict control of fiscal discipline, careful selection of debtors						+		+
The provision of an enterprise solvency in a short term (i.e. the provision of short-term liabilities by liquid assets)				+	+	+	+	+
Equity share increase in current assets financing				+	+	+	+	+
The prevention of arrear emergence					+	+	+	+
The optimization of an enterprise financial flows						+		+
The search for ways of cost maximum reduction (rationalization of stocks, the sale of excess or underutilized equipment, the reduction of costs for the acquisition of raw materials and materials)			+			+		+
Pre-emptive use of own financing sources						+	+	+

The implementation of proposed measures will allow to increase the financial stability for agricultural enterprises and to reduce the likelihood of bankruptcy.

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SUMMARY

The classification procedure of agricultural enterprises described in this article according to the degree of financial stability, based on the use of hierarchical cluster analysis can be used to develop the advice on anti-crisis management strategies, as well as to monitor the financial condition of enterprises in the region.

CONCLUSIONS

The specificity of transformation economy agricultural sector today requires objectively the development of new approaches and methodologies for the assessment and the forecasting of agricultural producer financial condition. Self-learning algorithms and methods are applied more and more often as an instrumental base for their development, including cluster analysis, which allows to classify the objects under study, considering a variety of symptoms, as well as to neutralize the impact of a researcher's subjectivism on the classification results.

The proposed evaluation method in this study concerning the financial condition of agricultural enterprises is based on the clustering of last financial indicators in a set was tested using the Voronezh area example. Based on the analysis of hierarchical clustering tree the groups of companies were determined, the model ones according to the level of "financial health", for which anti-crisis management strategies were formulated.

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