

## Model Tools of Credit Risks Assessment of Agricultural Enterprises in International Trade

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**Abstract.** The paper aim is improving the methodological tools for agricultural enterprise's credit risks assessment and classification as participant of international trade market.

The proposed approach differs from the existing approaches by complexity and systematicness, on the bases of usage of multilevel factor system of the borrower's assessment by local and aggregate components. The object of research is set of credit risks affecting crediting processes in agricultural sector of Ukrainian economy.

The following economic and mathematical methods of scientific research were used: factor and comparative analysis (to highlight classification specific features of agricultural sector crediting), methodology of integrated rating (for rating of local components of risk), methods of factor analysis (to confirm the hypothesis of grouping of agricultural enterprises credit risks by components), hierarchical and iterative methods of cluster analysis (to distinguish agricultural enterprises classes by risk level).

The proposed methodology is tested on a sample set of observations for 14 agricultural enterprises of Ukraine for 2018 year for the selected 38 credit risk indicators.

On the bases of economic and mathematical tools for estimating and analyzing the aggregate system of agricultural enterprises credit risk indicators, namely the methodology of factor analysis, the hypothesis regarding the grouping and formation of agricultural enterprises credit risk classes has been improved. Five major systemic groups of external and internal risks which are specific to agrarian enterprises are identified: mortgage risks, system providing risks, system forming risks, natural and climatic risks, production risks. The obtained classes by risk level by the studied components on the basis of cluster analysis methods make possible to determine the set of critical and safe states in general and by local components and to choose effective behavior trajectory for agricultural enterprise creditworthiness increasing.

The assessment results using proposed methodology laid in the bases of scenarios development of agricultural sector lending, make possible to develop a set of measures for strategic and tactical management of agricultural enterprise's creditworthiness and adjust their behavior in international markets.

**Keywords:** agricultural enterprises, credit risks, economic and mathematical tools, assessment, classification, indicators, external environment, internal risks

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## I Introduction

Effective lending to the agrarian sector in modern conditions is one of the most important tasks of the Ukrainian banking system. Lending to the agricultural sector in our country remains one of the main problems that hinder agriculture development, which is one of the main economic sectors. The problem of financial support for the agricultural sector of the economy is the neglect of the specificity of agricultural production and features of the agricultural sector of the economy during lending.

Special attention should be given to increasing the enterprises' creditworthiness of the branches which are budget-forming for Ukraine and which are focused on international trade, in particular the agricultural sector enterprises. Since a lot of agricultural enterprises are export-oriented and provide significant portion of foreign currency earnings to the country the primary government tasks are realization of measures to resume lending to the agricultural sector, as well as to find ways for credit mechanism improvement in order to increase the volume of lending to agricultural sector enterprises and reduce the lending risks in this sector.

One of the areas that take enterprises to substantially new level in relation to competing companies is economic entities lending improvement, especially in the agricultural sector of Ukraine economy, which is currently the leader of national economy and significant subject of international trade market.

Specificity of lending to an agrarian sector of the economy has been the subject of research in papers of such Ukrainian authors as L. Berezina, V. Gubenko, G. Yevtushenko, N. Tymkov and A. Sheshenya, O. Kovalenko, O. Nepochatenko and V. Yudin, M. Sayenko, I. Yatsiv, as well as foreign scientists S. Adidto, K. Gan and G. Nartea, H. Aimin, J. Deunink, K. Kerels, L. Bass and D. Van Gizgegем, N. Yankelova, D. Masar and S. Morykova, M. Janowicz-Lomott, K. Liskava, S. Riethong, P. Schreinmacher, K. Groverman and T. Berger etc.

Berezina (2013) emphasizes that the results of this branch work of economy depend substantially on factors beyond the control of the person, for example, weather conditions, which not only significantly increases the riskiness of enterprises activity, but also threatens macroeconomic stability, since the share of agroproducts in state total export was more than 40%.

Hutorov, Lupenko, Yermolenko, Dorokhov (2018) define the features of the credit facility, due to various factors influencing the activities of agricultural enterprises on the basis of their classification according to classification factors, namely: natural-climatic, economic, social, legal and institutional factors.

Gubenko (2010) carries out an analysis of the institutional principles of lending to the agricultural sector which makes possible to determine the components of the institutional environment of bank lending to economic entities in agricultural sector of economy and their functional purpose.

The principles and functions of crediting of agrarian sector were specified in paper Gubenko (2010). Among the functions of crediting the author emphasizes the role of innovation-investment function, the implementation of which contributes to attracting financial resources and accumulation of additional resources by credit institutions for the agricultural sector of economy, which will eventually lead to increase in economic performance of agricultural enterprises.

Yatsiv (2013) affirmed that agricultural risks are not independent, but rather related to each other and as part of system that incorporates all available risk management tools, strategies and policies.

Jankelova, Masar, Moricova (2017) explored approaches to risk management and risk mitigation tools which are the most commonly used. They used a scale to assess the importance of different strategies which influence companies' indicators.

At the same time, the issues of improving the directions of complex evaluation of agribusinesses lending efficiency, as well as methodological approaches to the assessment and risks aggregation of agricultural sector enterprises remain underdeveloped.

Thus, agricultural enterprises activity efficiency, as well as their creditworthiness level as a resultant indicator of financial and economic activity effectiveness, largely depends on the risks level, which is determined by a large number of internal and external environmental factors, which are directly influenced on enterprises goals, tactics and strategies and the negative effects of which are threatening to creditworthiness loss.

Significance and logical incompleteness of the mentioned problems are determined their relevance. Therefore, in order to determine the leading directions of the enterprises' creditworthiness management policy as an indicator of development level in the future, it is necessary to improve the tool of external and internal risk assessment, which provides:

- continuous monitoring of the financial situation, i.e. the potential assessment (both internal and external) for neutralization and overall localization the financial and economic crisis threat;
- defining measures for all risks types minimization to ensure appropriate creditworthiness level;
- evaluating the effectiveness of measures of localization and overcoming the negative impact of various factors, as well as evaluating these measures, the timing of their implementation and the results that can be expected.

## **II Methodology and Data**

The main purpose of the system of agricultural enterprises creditworthiness ensuring is achievement stable and maximally effective functioning in a non-stationary and aggressive environment, taking into account the perspective dynamics of development, which is achieved when solving the relevant tasks and implementation of functions on the basis of proper organizational and legal support. For adequate assessment, analysis, forecasting, and management of agricultural enterprise's creditworthiness in terms of external and internal factors, the pressing issue is the usage of approaches, methods, and models existing nowadays, as well as their improvement through aggregation and integrated usage.

One way for agricultural sector lending improvement is credit risk reduction as a way of minimization of its negative impact (Bezrodna, Ivanova, Onyshchenko, Lypchanskyi, Rymar (2019)). On the bases of research results, we consider that agricultural enterprise's credit risk is partial or total loss of income by the creditor due to the

default of the borrower, and the probability of collateral loss by debtor.

The following empirical hypotheses are the basis of the research:

Hypothesis 1. The state of external and internal factors influences the uneven development of economic entities in agricultural sector of economy and determines their strengths and weaknesses of activity, risk stability in lending.

Hypothesis 2. The existence of systematic general and local classification groups of external and internal credit risks specific to agricultural enterprises. But there may be differences specific to agrarian enterprises, with certain differences depending on certain conditions and factors.

Hypothesis 3. The presence of critical and safe states of influence of credit risk factors in general and by local components, the analysis of which makes possible to choose an effective behavior trajectory in different risk conditions for agricultural enterprise creditworthiness increasing.

Credit risk research involves the following tasks of assessing and classifying credit risks:

- 1) formation of factors system for credit risk assessment;
- 2) integrated assessment of credit risks level by local components;
- 3) factor analysis of credit risk indicators, their classification, and aggregation;
- 4) classification of enterprises by the risk level according to the allocated aggregate components.

For these problems solving, we propose a methodological approach with modern economic and mathematical tools used for assessing and classifying agricultural enterprise's credit risks to develop adequate management measures for economic entities. The improved methodological approach containing four main steps for the implementation of the selected research objectives concerning agricultural enterprise credit risk assessment and analysis is presented in Fig. 1 and include the stages that provide solutions tasks mentioned above.

During the research the following methods were used: scientific abstraction, logical generalization (in the analysis of categorical apparatus), analysis and synthesis (for data structuring and agricultural enterprises risk assessment), induction and deduction (for research algorithm development), factor and comparative analysis (to distinguish specific features of agrarian sector lending classification), methodology of integrated rating assessment (for rating of risk local components), methods of factor analysis (to confirm the hypothesis of grouping agroenterprises credit risks by components), iterative and hierarchical cluster analysis methods (for agricultural enterprises classes selection by risk level).

The research information base is legislative and regulatory acts concerning agricultural complex crediting, official statistical information of the National Bank of Ukraine and the State Statistics Service of Ukraine, analytical reviews, financial reports of enterprises available on the following information resources: National Bank of Ukraine (<https://bank.gov.ua>), Association "Ukrainian Agrarian Business Club" (<http://www.ucab.ua/en>), Ministry of Agrarian Policy and Food of Ukraine (<https://agro.me.gov.ua/ua>), State Statistics Service of Ukraine (<http://www.ukrstat.gov.ua/>), Stock Market Infrastructure Development Agency of Ukraine (<https://smida.gov.ua>) and the authors' calculations.

The sample set of observations for 14 Ukraine agricultural enterprises for 2018 for

38 credit risk indicators was checked for robustness and representativeness and the following statistical limitations were taken into account:

- validity and expediency of the presence of indicators in the research;
- minimizing time spent and costs for obtaining information about indicator value or its calculation;
- sufficient limited number of indicators necessary for economic interpretation of research results without content loss;
- compliance of the indicators with the existing statistical reporting system.

### III Results and analysis

Let us consider in more detail the essence of credit risk assessment and their classification for agricultural enterprises.

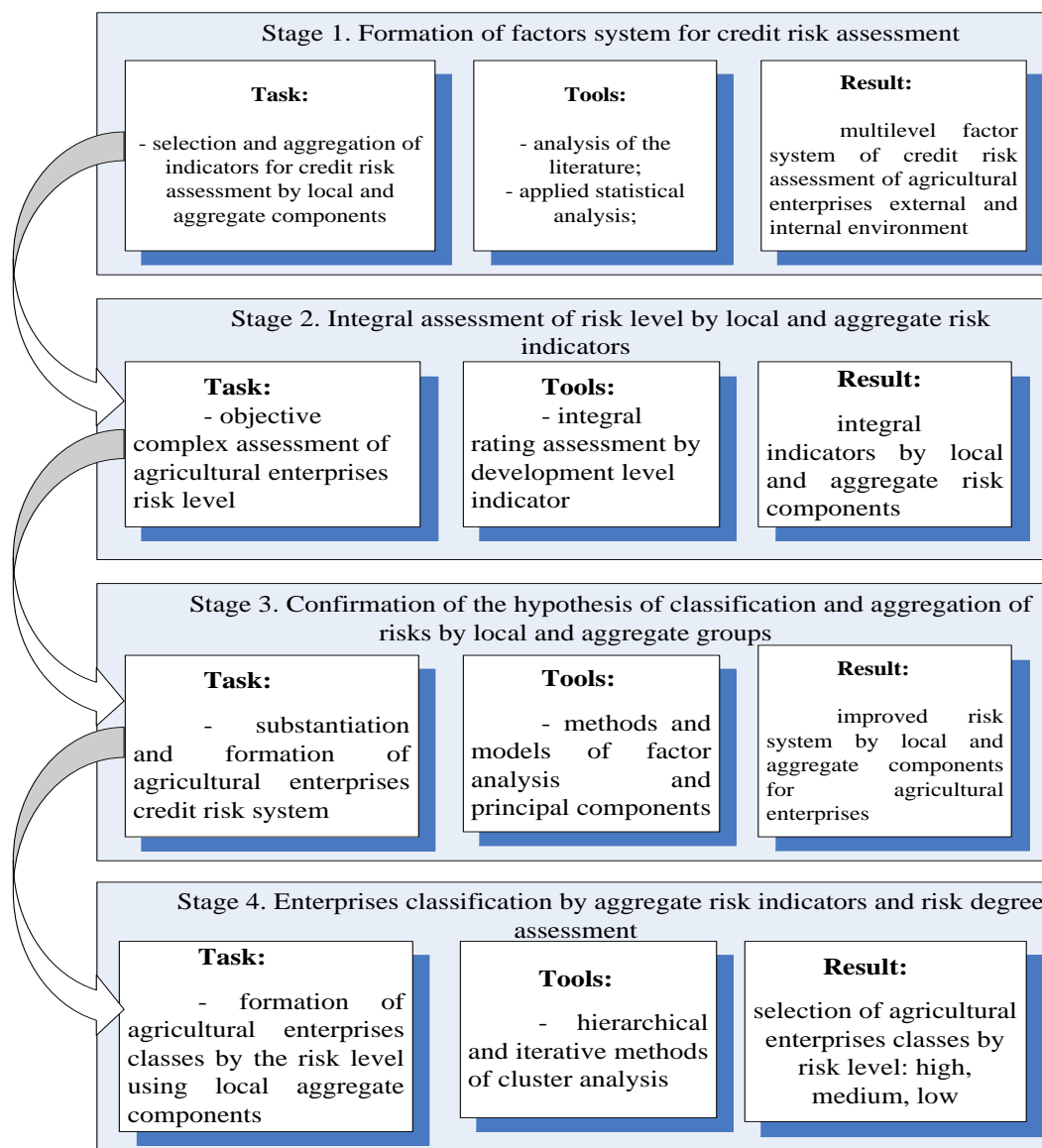
**Stage. 1. Formation of factors system for credit risk assessment.** For assessment the borrower's creditworthiness, the main tasks are aggregation and analyzation the set of credit risks that are important for creditworthiness monitoring from the perspective of the borrower (agricultural enterprise). Therefore, during the study of external and internal risks it is necessary to identify both positive and negative sides of the factors influence on creditworthiness level and take into account the degree of its impact on the activity. This fact is confirmed in papers Berezina, L. (2013), Martynchyk, O. (2014), Sergienko, O., Tatar, M. (2015), Vitlinskyy, V., Velykoivanenko, G. (2004), Yatsiv, I. (2013), Yepifanov, A., Vasylyeva, T., Kozmenko, S. (2012).

The basic principles that should be followed when research organizing are the principles of objectivity, development, systematicity, flexibility, regularity and relevance.

Therefore, when forming factor system of indicators for assessment, the following features of the external and internal environment of agricultural enterprises existence and their associated risks should be taken into account:

- agricultural enterprise external environment is a complex of factors, conditions, legislation, communications systems, regulatory systems and common business practices, conditioned by the level of development of financial, economic, moral and legal relations within which the enterprise interacts with clients, creditors, other counterparties, regulators and fiscal bodies (it is stated in paper Gubenko (2010));
- external environment state is characterized by instability, dynamism, integration, uncertainty and sometimes aggressive influence on agricultural enterprises activity (Klebanova, Kyzym, Chernyak (2010), Shtal, Buriak, Amirbekuly, Ukubassova, Kaskin, Toiboldinova (2018));
- the main characteristics of agricultural enterprises external environment are environmental factors interrelation, complexity, uncertainty, mobility of external environment (Smovzhenko, Azarenkova (2014));
- internal risks are factors that are directly generated by the enterprise itself or part of its internal environment, such as financial resources availability level, unsatisfactory structure of assets and liabilities, personnel incompetence, equipment wear (Sergienko, Tatar (2011));
- the influence of internal environment factors is unfavorable, so internal risks can

lead to creditworthiness and liquidity levels decrease, required reserves amount increase, inefficient management decisions adoption, assets profitability decrease, large number of production loss (Yatsiv (2013));



**Fig. 1.** The main stages of agricultural enterprises credit risk assessment and classification

– internal threats, as a rule, are conditioned by the presence of prerequisites for negative, unlawful personnel actions, uncontrolled usage of production means and

violation of enterprise activity regime; internal credit risks are persistent and independent of enterprise reputation, location, business value or the presence of external threats (Levkina, Kravchuk, Sakhno, Kramarenko, Shevchenko (2019)).

Highlighted features make it necessary to assess and analyze the agricultural enterprises external environment as accurately as possible, as well as to determine the nature and strength of possible risk actions for adequate management behavior in each situation and to formulate an aggregate indicators system for borrower risks assessing. The paper proposes the initial structure of the borrower's credit risk, which consists of the following components:

- system risks: currency risk ( $R_{vr}$ ), interest rate risk ( $R_{pr}$ ), inflation risk ( $R_{ir}$ ), price risk ( $R_{zr}$ ), government regulation risk ( $R_{dr}$ );
- mortgage risks: liquidity decrease risk ( $R_{zl}$ ), risk of collateral loss ( $R_{vz}$ );
- natural and climatic risks: temperature fluctuations ( $R_{tk}$ ), precipitation ( $R_o$ ), wind ( $R_v$ );
- production risks: risk of crop or its part loss ( $R_{vtv}$ ), risk of productivity decrease ( $R_{zpr}$ ), technological risk ( $R_{tech}$ ).

The developed indicators system for borrower risk assessing is presented in Tab. 1. It was compiled by the results of the analysis of scientific and methodological literature [14; 29; 30; 31], the selection of indicators was carried out on the basis of expert evaluation.

**Table 1.** Aggregate indicators system for borrower risk assessing

№	Risk	Indicators
<b>System risks</b>		
1	Currency risk ( $R_{vr}$ ):	<ul style="list-style-type: none"> <li>- exchange rate;</li> <li>- number of currency contracts;</li> <li>- export of goods and services;</li> <li>- import of goods and services</li> </ul>
2	Interest rate risk ( $R_{pr}$ ):	<ul style="list-style-type: none"> <li>- banks interest rates on credits in national currency;</li> <li>- interest rates of banks on deposits in national currency;</li> <li>- National Bank of Ukraine discount rate</li> </ul>
3	Inflation risk ( $R_{ir}$ ):	<ul style="list-style-type: none"> <li>- inflation rate;</li> <li>- industrial products producers price index;</li> <li>- agricultural producers price index</li> </ul>
4	Price risk ( $R_{zr}$ ):	<ul style="list-style-type: none"> <li>- current transfers;</li> <li>- taxes</li> </ul>
5	Government regulation risk ( $R_{dr}$ ):	<ul style="list-style-type: none"> <li>- the rate of increase / decrease in real wages;</li> <li>- relations between economic and political structures;</li> <li>- private capital protection;</li> <li>- business legislation change</li> </ul>
<b>Mortgage risks</b>		
6	Liquidity decrease risk ( $R_{zl}$ ):	<ul style="list-style-type: none"> <li>- liquidity ratio;</li> <li>- solvency ratio;</li> <li>- ratio of liquid assets to total assets;</li> </ul>

7	Risk of collateral loss ( $R_{vz}$ ):	- ratio of inactive loans to total gross loans; - failure to fulfill contractual obligations of counterparties
Natural and climatic risks		
8	Temperature fluctuations ( $R_{tk}$ ):	- average temperature for seasons; - deviation from the normal temperature regime
9	Precipitation ( $R_o$ ):	- rainfall; - intensity of extreme weather events (storms, hurricanes, floods, droughts);
10	Wind ( $R_v$ ):	- wind speed; - wind direction
Production risks		
11	Risk of crop or it part loss ( $R_{vrv}$ ):	- insurance contracts number; - deterioration of soil quality; - unforeseen weather conditions; - environmental pollution level; - theft at work
12	Risk of productivity decrease ( $R_{zpr}$ ):	- labor productivity; - staff turnover; - efficiency of wages; - low-skilled workers usage
13	Technological risk ( $R_{tech}$ ):	- fixed assets depreciation degree; - investments in fixed assets

### Stage 2. Integral assessment of risk level by local and aggregate risk indicators.

For assessment of integral risk level by the selected components, the integrate rating method on the bases of taxonomic indicator of development level was used (this method was proposed by Z. Helwig and was presented in Azarenkova, Belenkova (2011) and Ayvazyan, Bukhshtaber, Yenyukov (1989).

The integral index is normalized and varies from 0 to 1, which makes possible to rank the investigated objects according to credit risks level. This indicator is easy to interpret: its values close to 1 correspond to smaller values of the general credit risks level, which positively affect the creditworthiness of the analyzed objects, and values close to 0, to larger values of credit risk indicators, which negatively affect the creditworthiness level. The integral index calculation is proposed by Pluta (1980).

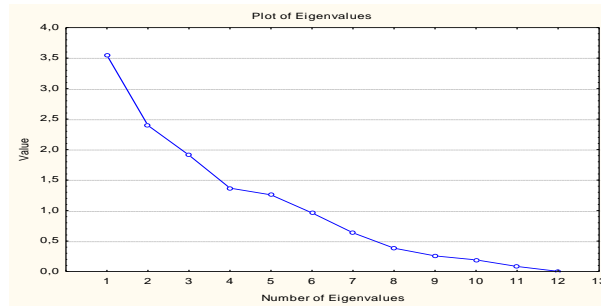
On the bases of calculations results, we can conclude that none of the surveyed enterprises can be uniquely classified and assigned to the corresponding risk group, since for some components we have high risks level and for others – medium or low risk level. However, it confirms the hypothesis of the strengths and weaknesses of the agricultural enterprise and provides a list of opportunities and threats in the direction of which the company should move to improve creditworthiness.

### Stage 3. Confirmation of the hypothesis of classification and aggregation of risks by local and aggregate groups.

For confirmation the hypothesis of the proposed classification and aggregation of risks by local and aggregate groups according to the studied indicators on the bases of literature sources analysis and improvement of evaluation for agricultural enterprises



in the paper we use the methodology of multivariate factor analysis and the principal components method as a procedure for factor analysis of grouping of similar features into a homogeneous set of factors. Plot of Eigenvalues calculated in Statistica for determining the number of principal components of the local credit risk groups is presented in Fig. 3.



**Fig. 3.** Plot of Eigenvalues for determining the number of principal components of the local credit risk groups

The assessment results of informativeness level of the main factors by credit risks (the value of eigenvalues and explanatory variance) is shown in Fig. 4. So we can see that all five components have a root value greater than 1 (one) and overall explanatory variance of 80,63%, which confirms the hypothesis of risk aggregation across the five major groups.

Eigenvalues (Spreadsheet47)				
Extraction: Principal components				
Value	Eigenvalue	% Total variance	Cumulative Eigenvalue	Cumulative %
1	3,54806	27,2928	3,54807	27,2928
2	2,39680	18,4369	5,94487	45,7297
3	1,90953	14,6887	7,8544	60,4185
4	1,36837	10,5259	9,22277	70,9444
5	1,25852	9,6809	10,4813	80,6254

**Fig. 4.** The assessment results of informativeness level of the main factors by credit risks for agricultural enterprises

The values of the factor loadings of the initial characteristics (local components of risk) with the selected 5 main factors are shown in Fig. 5.

The task of recognizing the principal components is explained by the desire for simple structure of principal component, which is always easier to interpret. As a result of factor analysis methodology implementation by the method of principal components on the basis of the significance of factor loadings, the following aggregated groups are distinguished by credit risks indicators:

Variable	Factor Loadings (Equamax raw) (Spreadsheet47) Extraction: Principal components (Marked loadings are >,500000)				
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
R_vr	-0,15365	<b>0,86439</b>	0,47279	0,19093	-0,11828
<b>R_pr</b>	-0,36061	0,04180	0,12453	<b>0,70009</b>	0,13488
R_ir	0,10445	0,10244	0,08545	<b>0,81525</b>	0,35544
R_zr	0,14914	-0,07301	-0,07132	<b>-0,78043</b>	0,47279
R_dr	0,06931	<b>0,93619</b>	-0,12285	0,13116	0,04797
R_zl	<b>-0,74814</b>	0,23403	-0,31166	0,15586	0,03268
R_vz	<b>-0,69488</b>	-0,46237	0,00011	-0,21385	0,14516
R_tk	0,15043	-0,09703	<b>0,89912</b>	-0,04276	-0,09849
R_o	0,19891	-0,01466	<b>0,50388</b>	0,13500	0,26309
R_v	0,26986	0,41712	<b>0,61071</b>	0,07076	-0,18206
R_vtv	-0,41793	-0,11077	-0,26867	-0,24248	<b>0,73084</b>
R_zpr	-0,08505	-0,02281	-0,05017	-0,01850	<b>0,94602</b>
R_tech	0,42204	0,33885	-0,44739	0,14903	<b>-0,60437</b>
Expl.Var	1,81598	2,13892	2,36137	2,73907	1,42595
Prp.Totl	0,13969	0,16453	0,18164	0,21069	0,10968

**Fig. 5.** The values of the factor loadings of the initial characteristics for agricultural enterprises

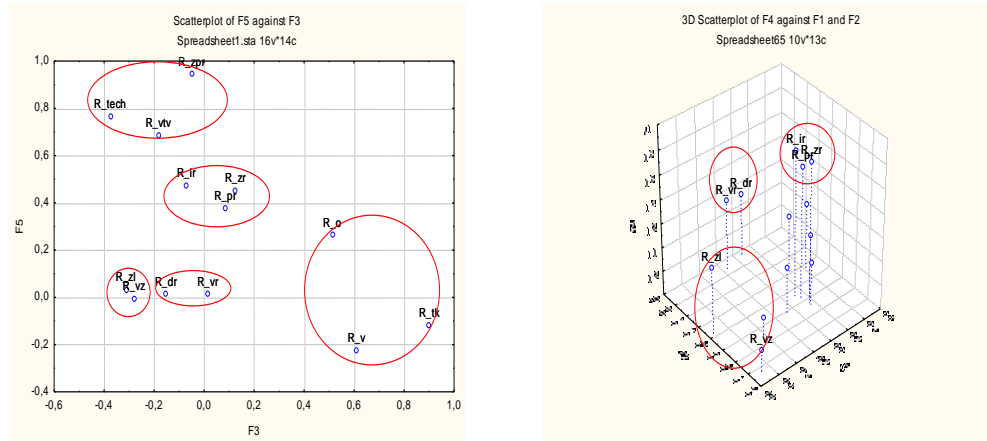
- 1) *F1* – mortgage risks: liquidity decrease risk ( $R_{zl}$ ), risk of collateral loss ( $R_{vz}$ );
- 2) *F2* – system providing risks: currency risk ( $R_{vr}$ ), government regulation risk ( $R_{dr}$ );
- 3) *F3* – natural and climatic risks: temperature fluctuations ( $R_{tk}$ ), precipitation ( $R_o$ ), wind ( $R_v$ );
- 4) *F4* – system forming risks: interest rate risk ( $R_{pr}$ ), inflation risk ( $R_{ir}$ ), price risk ( $R_{zr}$ );
- 5) *F5* – production risks: risk of crop or it part loss ( $R_{vtv}$ ), risk of productivity decrease ( $R_{zpr}$ ), technological risk ( $R_{tech}$ ).

The sample scatterplots of the principal factors in the two- and three-dimensional factor spaces are presented in Fig. 6.

Confirmation of the importance of input indicators ( $X_j$ ) which are involved in the formation of main components names can be obtained by calculation when informativeness coefficient determining (Soshnikova, Tamashevich (1999):

$$K_u = \frac{\sum_j a_{jr}^2 (W_2 - W_3)}{\sum_{j=1}^m a_{jr}^2}$$

where:  $W_1$  – subset of insignificant weights;  $W_2$  – subset of significant weights;  $W_3$  – subset of significant weights that do not participate in the formation of the main components name;  $W_2 - W_3$  – subset of significant weights involved in the name formation;  $a_{jr}^2$  – value of factor loading.



**Fig. 6.** The sample scatterplots of the principal factors in the two- and three-dimensional factor spaces for agricultural enterprises

A set of explanatory aggregate principal components is considered satisfactory if  $K_u$  values lie within the range of 0,75–0,95.

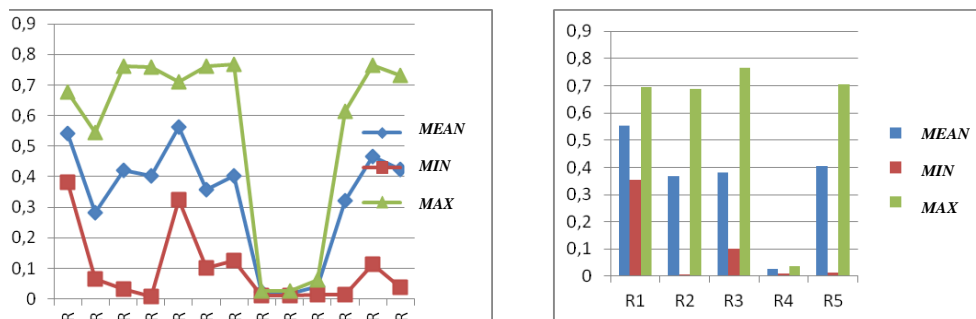
The results of factor analysis of the agricultural enterprises by the formed local credit risk indicators and their components are presented in Tab. 2.

**Table 2.** Results of factor analysis of credit risk classes for agricultural enterprises

Components of aggregate credit risk classes	Designation of factors / (variance percentage)	Designation of local risk groups	Informative-coefficient	Name of local credit risk components / (factor loading)
System providing risks	$F2$ (18,44 %)	$(R_{vr})$	0,87	currency risk (0,86)
		$(R_{dr})$		government regulation risk (0,93)
System forming risks	$F4$ (10,53 %)	$(R_{pr})$	0,79	interest rate risk (0,7)
		$(R_{ir})$		inflation risk (0,82)
		$(R_{zr})$		price risk (0,78)
Mortgage risks	$F1$ (37,29 %)	$(R_{zl})$	0,8	liquidity decrease risk (0,75)
		$(R_{vz})$		risk of collateral loss (0,69)
Natural and climatic risks	$F3$ (14,69 %)	$(R_{tk})$	0,78	temperature fluctuations (0,9)
		$(R_o)$		precipitation (0,5)
		$(R_v)$		wind (0,61)
Production risks	$F5$ (9,68 %)	$(R_{vtv})$	0,81	risk of crop or it part loss (0,73)
		$(R_{zpr})$		risk of productivity decrease (0,95)
		$(R_{tech})$		technological risk (0,60)

Thus, the implemented methodology of factor analysis makes possible to improve the system of risk classification and to identify two significant subgroups of risks in the group of systemic risks by initial classification and to take this into account in further research, because this is agricultural enterprises feature.

On the bases of obtained results, it can be concluded that agricultural enterprises are characterized by rather large deviations from the mean values and significant disparities in the aggregated risk groups, which gives the basis for further classification and formation of enterprises classes with more homogeneous states for the development of more acceptable and specific solutions for each situation. The graph of the main statistical characteristics (average, minimum and maximum values) for 14 agricultural enterprises by local and aggregate risk indicators is presented in Fig. 7.



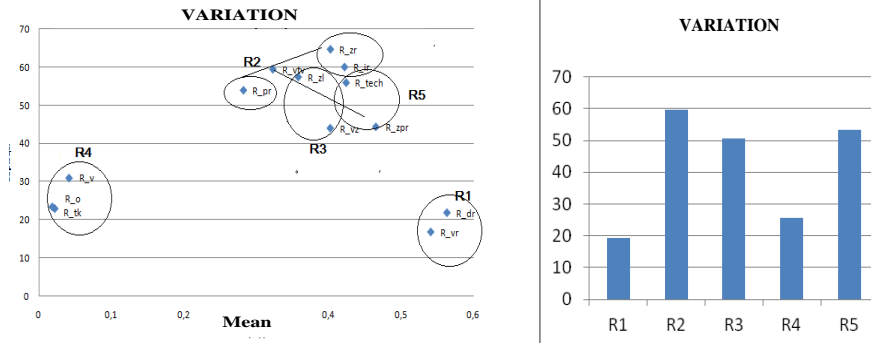
**Fig. 7.** Graph of the main statistical characteristics by local and aggregate risks indicators for agricultural enterprises

Risk grouping by variation and mean for the studied enterprises and variation by aggregate risk groups is shown in Fig. 8.

The obtained distribution shows that set by both local components in the groups and aggregate risk factors are not sufficiently homogeneous. The variation coefficient is less than 33% for systemic risk factors (currency and government regulation risks) and natural and climatic risk factors; the most heterogeneous are mortgage risks, which reflect the different credit status of agricultural enterprises.

#### **Stage 4. Enterprises classification by aggregate risk indicators and risk degree assessment.**

As the results of the previous research it was revealed that agricultural enterprises are very different from each other in terms of the risks in each specific area, the cluster analysis was used for objectification the results and formation of enterprises classes which are characterized by common risks (Soshnikova, Tamashevich (1999)).



**Fig. 8.** Credit risk grouping by variation and mean value and by variation and aggregate risk groups for agricultural enterprises

The enterprises classification by credit risk level on the basis of cluster analysis methods is presented in Tab. 3. It shows enterprises distribution into three groups:

L – low risk level, M – medium risk level, H – high risk level.

**Table 3.** Classification of agricultural enterprises by aggregate components of credit risk on the bases of cluster analysis methods

№	Name of agricultural enterprise	R1	R2	R3	R4	R5
1	PJSC "Gunivskaya Agro Firm"	M	L	M	M	H
2	PJSC "Agro Firm "Verbivske"	H	L	L	H	M
3	PJSC «Ohoche»	H	M	H	M	L
4	PJSC "Agro Firm «Provesyn»"	H	M	H	H	L
5	PJSC "Agro Firm «Rosia»"	L	H	M	H	H
6	OJSC Malovyskivska Agro Firm "Agrotech-service"	L	L	H	L	H
7	PJSC "Agro Firm named after G. S. Skovoroda"	H	M	L	H	M
8	JSC "Ukraina"	H	H	L	H	L
9	PJSC "Agro Firm «Yatran»"	M	M	L	L	M
10	OJSC "Agro Firm «Globyvyska»"	L	M	M	M	H
11	OJSC "Agro Firm «Zorya Novobuzya»"	H	H	M	H	H
12	CJSC «Kolos»	M	L	L	H	L
13	CJSC «Agro Firm «Sumy-Nasinna»"	H	L	H	L	H
14	CJSC 14 «Tsukrove»	L	M	M	H	L

According to the implemented methodology, the main characteristics of the internal and external environment of agricultural enterprises are identified, which form certain risks of creditworthiness loss. The risks system is formed on the bases of external and internal environment factors affecting the creditworthiness level, among

which is a group of systemic risks, and a group of natural and climatic risks, which is the basis for assessing the external competitive environment, economic, natural and climatic situation in the country as a whole. Also, mortgage risks and production risk groups are selected, using which comparative analysis makes possible to identify internal competitive advantages and risk prevention options for each company.

#### **IV Conclusions**

On the bases of economic and mathematical tools for assessment and analysis of the aggregate system of agricultural enterprises credit risk indicators are obtained such results:

- 1) local and aggregate integrated indicators of internal and external environmental risks were calculated using integrated rating assessment;
- 2) their main statistical characteristics were determined and investigated.
- 3) five main systemic groups of external and internal risks, which are specific to Ukraine agricultural nowadays, are selected:
  - mortgage risks: liquidity decrease risk, risk of collateral loss;
  - system providing risks: currency risk, government regulation risk;
  - system forming risks: interest rate, inflation and price risks;
  - natural and climatic risks: temperature fluctuations, precipitation, wind;
  - production risks: risk of crop or it part loss, risk of productivity decrease and technological risk.
- 4) the hypothesis of grouping and formation of credit risk classes for agricultural enterprises is improved on the bases of integral and factor analysis methodology;
- 5) using methods of cluster analysis the classes of risk levels such as low, medium, high were identified for each group of risks.

So estimation of classes of agricultural enterprises by the risk level by the studied components makes it possible to determine the set of critical and safe states in general and by local components and to choose an effective trajectory of behavior for agricultural enterprise creditworthiness increasing and competitiveness ensuring in global competitive markets.

The results implementation of credit risk assessment, analysis and classification make possible to increase the management decision validity and agricultural enterprises efficiency and to improve the policy of credit activity in the agricultural sector of the economy.

The proposed methodological tools for agricultural enterprise's credit risks assessment and classification can be applied in modified version in other countries taking into account the specifics of these countries, their level of development, banking system development level, competition level in the agricultural sector in these countries, etc.

The study can be expanded by identification the specific risks inherent in each entity, as well as the country and at the international level. The main areas of further research are creation of mechanism for crediting agricultural enterprises during international trade, which provides a set of measures by the state and banking system aimed at developing an effective integration mechanism for interaction with the agri-

cultural sector; increasing the volume of financial support for agricultural enterprises through the mechanism of cheaper loans; development and use of all possible sources for raising capital in lending to agriculture sector.

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