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METHODOLOGICAL PECULIARITIES OF PROBABILITY ESTIMATION OF BANKRUPTCY OF AGRARIAN ENTERPRISES IN UKRAINE

Purpose. *The purpose of the study is to develop the concept of complex estimation of bankruptcy probability of agrarian enterprises in Ukraine, taking into account the specifics of agricultural activities.*

Methodology / approach. *To achieve the purpose, the following research methods were used: abstract-logical (at disclosing the essence of the concept of "bankruptcy"); dialectical (for theoretical generalizations on determining the problems and ways to overcome them, drawing conclusions); expert estimations, comparative analysis, analysis and synthesis (at developing the concept of estimating the probability of bankruptcy); relative indicators-coefficients (at studying models for estimating the probability of bankruptcy occurrence); monographic (for in-depth study of separate types of factors affecting the probability of bankruptcy); graphical and tabular (at presenting the research results).*

Results. *It has been proven that the discriminant analysis for estimating the probability of bankruptcy (the construction of multifactor models that summarize the most important financial indicators in the integrated index) does not take into account the industry characteristics of agrarian enterprises. The concept of bankruptcy diagnostics is proposed, which combines discriminant analysis and expert estimation of qualitative signs of a possible crisis of an agrarian enterprise. The indicators selected for expert examination cover non-financial factors – the risks and threats to agricultural production in Ukraine, and their generalization may specify the risk of bankruptcy occurrence. The scoring model has been derived by the method of expert estimations, the scale has been developed, which is combined with the discriminant one that will enable to bring the results of the research into the interval of the indicator for estimating the occurrence of bankruptcy.*

Originality / scientific novelty. *The definition of the term "bankruptcy" has been improved: the author's definition combines the economic and legal approaches to it. The main risks of agricultural activities in Ukraine have been specified and their impact on the probability of bankruptcy of agrarian enterprises has been outlined. It has been developed the methodological concept for estimating the probability of bankruptcy of agrarian enterprises, which takes into account informal factors. For the first time, in order to predict the bankruptcy of agrarian enterprises, it has been proposed to combine discriminant analysis and expert estimation of qualitative indicators that increase its risk in agriculture.*

Practical value / implications. *The application of the developed methodology provides an opportunity for the agrarian enterprise of timely responding to the threats of financial crisis and bankruptcy in order to prevent them. The proposed approach can be used as an element of estimating the insurance risk or investment attractiveness of agricultural enterprises. In case of its adaptation, the methodology can be used in foreign practice.*

Key words: *agriculture, bankruptcy, methods of estimating the probability of bankruptcy.*

Introduction and review of literature. Bankruptcy is an inseparable mechanism of market economy, a tool for freeing the market from inefficient enterprises. In market conditions, any entity can go bankrupt, differing only in the degree of risk of bankruptcy occurrence. That is why monitoring the signs of insolvency and possible financial crisis, estimating the probability of bankruptcy occurrence are necessary for a rapid response to the threats.

Because of the absence of relevant information in open sources, it is possible to estimate the dynamics of agrarian enterprises' bankruptcies in Ukraine only indirectly. For example, the number of economic entities "Agriculture, forestry and fishing industry" over the past decade decreased by 6.1 % – from 80,321 in 2010 to 75,450 in 2019 [1]. But, given the well-grounded fears that after the opening of the agricultural land market in Ukraine on July 1, 2021, small farmers will find it difficult to compete with agro-holdings and the number of bankruptcies of agrarian enterprises may increase.

In practice however, classical approaches of discriminant analysis are widely used to estimate the probability of bankruptcy and the methodological provisions approved by the Government bodies are also used, the generally accepted "record of diagnosis" of bankruptcy is currently absent.

In our opinion, the problem consists not only in the fact that bankruptcy estimation is the estimation of risks that are difficult to measure, but also its methodology cannot be universal. Bankruptcy prediction must be based not only on the calculation of financial coefficients, but also take into account the conditions and specifics of business activities' sectors. Thus, the study of methodology for estimating the probability of bankruptcy of agrarian enterprises in Ukraine remains topical.

Although, the entrepreneurs have long been interested in the issue of assessing the probability of bankruptcy, effective attempts to create the methods for estimating it were recorded only in the second half of the XX century.

Theoretical, methodological and practical aspects of bankruptcy risk were considered in the works of such prominent scientists as E. I. Altman [2], J. Argenti [3], W. Beaver [4], F. H. Knight [5], T. Scone [6], G. L. V. Springate [7], J. N. Tetens [8], and others. Modern foreign scientists, in particular, D. Alaminos, A. del Castillo, M. Á. Fernández [9], A. Jaki, W. Cwiek [10], J. Horváthová, M. Mokrišová [11], B. Prusak [12], T. Shumway [13], N. Bărbuță-Mișu, M. Madaleno [14] have achieved significant results in improving the models of diagnosing and estimating bankruptcy of companies. At present, many studies are being conducted to predict the bankruptcy of neural networks, researching neural network methods of T. Hosaka [15], A. Papana, A. Spyridou [16] and others.

Among the recent publications, J. B. Heaton's paper [17] attracts attention: the author provides data concerning errors in estimating the probability of bankruptcy according to Altman's model in 98–98 % of cases and proves that modern bankruptcy prediction models must be based not on accounting ratios but on market data. O. Lukason and A. Andresson, whose approach is new, prove that the information on the company's debt for tax gives a higher accuracy of forecasts than its financial ratios, so it is expedient to combine these indicators in a combined regression model [18].

At the same time, many scholars pay attention to the need of taking into account industry risks when analyzing the probability of bankruptcy. For example, A. Lilia and J.-P. Huiban [19], after examining the activities of food industry companies in France proved that the structure of bankruptcy risk in this area differs from the risks of other manufacturing enterprises.

The peculiarities of estimating bankruptcy probability of agrarian enterprises are studied by R. Dinterman, A. L. Katchova, M. J. Harris [20], K. Valaskova, P. Durana, P. Adamko, J. Jaros [21], G. V. Savytska [22].

Ukrainian scientists have also developed methodological recommendations for estimating the probability of enterprise's bankruptcy aimed at diagnosing its financial and economic state by structural indicators of production activity. The methods of estimating the probability of bankruptcy are currently being studied, in particular, by O. O. Tereshchenko [23], T. O. Melikhova [24], V. I. Rudyka, and Yu. M. Velykyi [25]. Sector aspects of analyzing the probability of bankruptcy have been covered in the works of such Ukrainian agricultural scientists as A. V. Chupis [26] and O. M. Tranchenko [27].

The methodology of estimating the probability of bankruptcy proposed by A.V. Chupis [26] is the first one developed by the Ukrainian economist for agrarian enterprises. However, its disadvantage is including of only two indicators of financial state in the discriminant model and ignoring the indicators of profitability. That is why the use of this method does not provide high accuracy in estimating the probability of bankruptcy.

The discriminant model of bankruptcy prediction developed by O. O. Tereshchenko [23], in particular its variant, which includes ten financial indicators, has gained wide recognition. The coefficient values of universal independent variables of these indicators in the regression equation are differentiated depending on the type of enterprises' economic activities. That is, improving the quality of estimating the probability of bankruptcy of an agrarian enterprise according to this model is provided by the industry differentiation of financial indicators' impact on the possibility of the study object default. According to the author, the error in estimating the probability of bankruptcy for agrarian enterprises does not exceed 7.8 %.

O. M. Tranchenko also used discriminant analysis to predict the bankruptcy of agrarian enterprises [27]. Fewer number of regression equation variables (six) is the peculiarity of his model. It is also characterized by including here not only financial indices, but also return on investment – the index characterizing the use of basic means of activity. However, the model has an economically illogical connection – the increase in return on investment increases the probability of bankruptcy. The scholar explains this in the following way: as in the agrarian enterprises of Cherkasy region during the study period, their own agricultural machinery was mostly worn out, it was actively rented, which led to a decrease in operating costs and increased the risk of bankruptcy. According to the author' data, the accuracy of predicting the bankruptcy of an agrarian enterprise according to this model makes 89.3 % in the year of forecasting and 76.8 % during the two-year period. However, taking into account the above-mentioned

methodological feature, the prediction for other objects will likely be less accurate.

The considered above and other available models are based mainly on the calculation of financial ratios and do not take into account the impact of industry risks and business conditions in a particular country, so the methods of estimating the probability of bankruptcy need further improvement, considering the specifics of the agrarian sector.

The purpose of the article. The purpose of the study is to develop the concept of complex estimation of bankruptcy probability of agrarian enterprises in Ukraine, taking into account the specifics of agricultural activities.

To achieve this goal, the following tasks were set:

– to summarize the main factors that increase the probability of bankruptcy for agrarian enterprises in Ukraine;

– to consider the most widespread methods of estimating the probability of bankruptcy of agrarian enterprises;

– to propose the concept of the authors' methodology of estimating the probability of bankruptcy of agrarian enterprises.

Methodological approaches to estimating the probability of bankruptcy of agrarian enterprises are the object of study.

Results and discussions. Estimating the probability of bankruptcy involves, first of all, a clear definition of this term. At present, the available definitions of "bankruptcy" characterize this process mainly from the legal or economic point of view.

Definitions of bankruptcy in the Ukrainian legislation are given in the Code of Ukraine in Bankruptcy Proceedings, the Commercial Code and indirectly in the Criminal Code. The key phrases in the legal definitions of this term are "the court pronounced inability of the debtor to restore his (her) solvency" and "financial insolvency". However, it is incorrect to identify bankruptcy with insolvency in general, as there are several levels of insolvency, in particular, the current one, which most companies experience from time to time.

Definitions of the term "bankruptcy", which represent the most widespread approaches to the definition according to the financial aspect, specify that in case of bankruptcy the lack of payment means to cover liabilities is critical or supercritical, i.e. the sum of debt significantly exceeds high- and medium-operating assets. However, in determining the essence of bankruptcy by economists, the attention is not paid to the fact that this state can only be evidenced in the court. We propose the definition that combines both the economic and legal aspects of bankruptcy recognition: "Bankruptcy is a court-recognized state of supercritical entity's insolvency, characterized by the insufficiency of its operating assets to pay liabilities".

The agrarian sector is one of the riskiest sectors of the economy, in which it is difficult to estimate the probability of failure. The reason of it is the presence of threats and risks inherent both in any area of business activities and certain industry.

In our opinion, the methodology of estimating bankruptcy probability of an agrarian enterprise must take into account the degree of entrepreneurial risk in the industry. Theoretical and methodological aspects of business risks in the agrarian

sector have been studied by us in previous papers [28].

The essence of separate threats and their possible impact on the loss of solvency, and as a consequence on bankruptcy probability of an agrarian enterprise, have been worked out in detail in Table 1.

Table 1

The main threats to agricultural activities and their impact on increasing the probability of an agrarian enterprise bankruptcy

Peculiarity of agricultural production	Possible threats associated with the peculiarity of the activity	The impact of the threat on the probability of bankruptcy
1. Impossibility of complete control over the production process and its result due to dependence on weather and climatic conditions, biological processes	Complete or partial loss of finished products, biological assets of crop growing and livestock farming, production stocks, etc. as a result of emergencies, adverse weather conditions, animal and plant diseases	Receiving less than due incomes from selling products. Decrease in assets, in particular, high- and medium-operating. Bearing losses as a result of losing resources and products
2. Interaction with the environment, the state of the environment	Risk of reducing soil fertility. Decreasing the amount of manufactured products, reducing their quality, banning the selling of low-quality products. The possibility of environmental pollution, the results of which are fines, the loss of reputation, deterioration of relations with local authorities and the community	Losses as a result of reduced revenues from selling products and paying fines for environmental pollution
3. Seasonal prevalence of technological processes	The uneven use of resources during the year, fluctuations in the need for working capital	The necessity for additional financing of current needs in certain periods
4. Long duration of production cycle for some industries (livestock farming, horticulture, viticulture, etc.)	Impossibility to react quickly to changes in market conditions (for example, it takes more than three years to grow a dairy herd, more than five years – to create a new orchard, and more than three years – a vineyard, etc.)	Significant investment lag between investment and payback. In the conditions of inflation, it devalues the income. The need for loan financing of current needs
5. The need for following technological continuity	The lack of irreplaceable resources (feed, fuel, seeds during the sowing period, etc.) can lead to complete or partial loss of products	The necessity to direct a significant part of working capital to the formation of production stocks
6. The use of part of own products in manufacturing	Part of the manufactured products remains to satisfy the internal needs (seeds, young animals, feed, etc.). Self-reproduction of a part of resources reduces the level of production marketability	The reduction of income from selling products. Insufficient volume of manufacturing own products leads to costs for their buying
7. Significant area of production, remoteness from places of selling	Large transport costs. Product losses during transportation	Increased logistics costs. Possible losses of income because of poor quality and/or products' loss during transportation.

Continuation of table 1

8. Orientation of many enterprises to export products	Changing the state of international markets. The existence of export quotas for certain goods. The dependence of income on the national currency exchange rate	Loss of part of income
9. The use of leased land	The possibility of termination or non-renewal of the lease agreement by landowners	Possible reducing the manufacturing of products as a result of reducing the sown areas. Revenue reduction
10. The lack of highly qualified personnel in the industry	The low level of labor productivity, product shortages	Loss of assets and revenues
11. Instability of land and tax legislation in the agrarian sector	The possibility of reducing or losing land areas. Increasing tax and other pressures; adopting the laws and regulatory enactments that reduce the efficiency of the industry functioning	Reduction or termination of production. Increase in costs, decrease in incomes

Source: the authors' development using [29; 30; 31].

The threats considered in points 9–11 of Table 1, are mainly caused by the Ukrainian realities, but may also be topical for other countries.

Ineffective management, erroneous financial strategy or its absence, high level of fixed assets' depreciation (may lead to production suspension, decrease in obtained products and/or deterioration of their quality) and other internal economic threats increase the probability of bankruptcy of a particular agrarian enterprise.

The probability of bankruptcy is also affected by the conditions of doing business in Ukraine, which increase the risk of any business activity, regardless of the field, in particular: high interest rates on bank loans; a high level of corruption; possible illegal takeovers; lower prices for similar imported products. An agrarian enterprise cannot influence these external factors, but it can detect them and develop the strategy to respond to these threats.

In addition to industry, each specific agrarian enterprise has specific risks that expand the typical list.

The risks can push any agrarian enterprise to bankruptcy, but small and medium-sized farms are the most vulnerable, while agro-holdings have the opportunity to insure and hedge their risks.

The typical consequences of the threats' impact on the financial and economic condition of the agrarian enterprise and the probability of bankruptcy, summarized in Table 1, are outlined in Fig. 1.

Monitoring, timely detecting signs of financial crisis and critical insolvency, potential risk factors for bankruptcy and estimating their significance enable to find ways to improve the financial situation and prevent bankruptcy. Estimating the probability of bankruptcy occurrence has certain common features with estimating the probability of any event that may or may not occur.

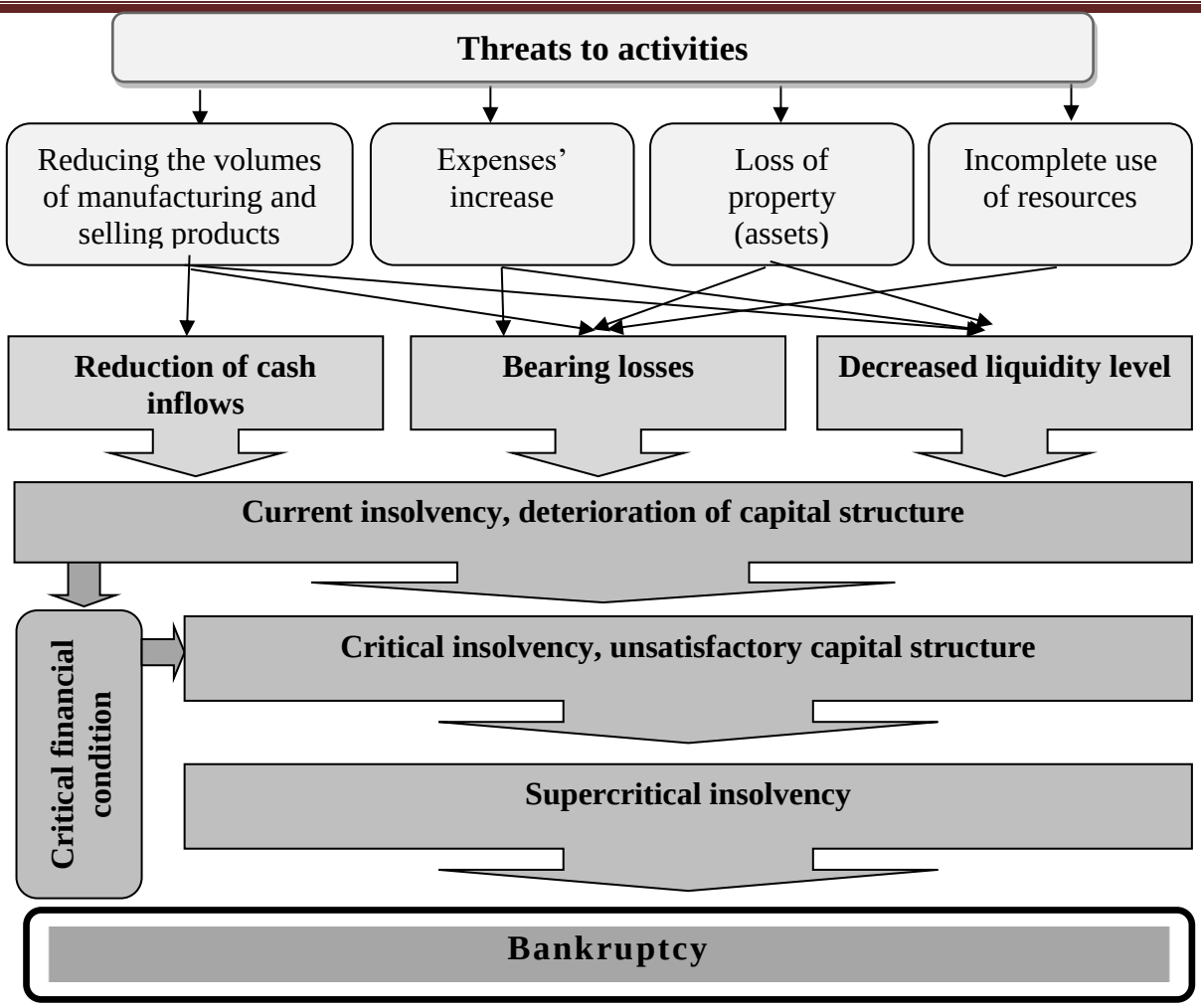

Fig. 1. The impact of activities' threats on the indicators of the probability of bankruptcy

Source: the authors' development.

However, bankruptcy is not an accidental event, but is the final (but not obligatory) stage of a long period of inefficient operation of the agrarian enterprise, accompanied by the disruption of the normal work rhythm and financial problems. Therefore, the signs that precede default can be detected in advance.

Generalization of bankruptcy probability factors is reached by means of multifactor models by calculating integrated index. Discriminant analysis is one of the methods for detecting the manifestations of financial crisis.

The most common multifactor models for bankruptcy prediction are models based on processing financial indicators in order to calculate the integrated index:

- two-factor and five-factor E. I. Altman's model;
- G. L. V. Springate's model;
- discriminant model of R. Lis;
- discriminant model of R. Taffler and G. Tisshaw;
- W. Beaver's test;
- universal discriminant function;
- solvency diagnostics index of J. Conan and M. Holder, and others.

The model of E. I. Altman (1983 version), the founder of the modern analysis of

bankruptcy probability has the following form:

$$Z = 0.717K_1 + 0.847K_2 + 3.107K_3 + 0.420K_4 + 0.995K_5, \quad (1)$$

where K_1 K_2, K_3, K_4, and K_5 are the coefficients calculated by the formulas:

K_1 = the average annual value of own operating capital / the average annual value of assets. It characterizes financial stability and solvency;

K_2 = the net profit (loss) / the average annual value of assets. It characterizes the return on assets;

K_3 = profit (loss) from ordinary activities before taxation / the average annual value of assets. It characterizes the return on assets;

K_4 = the average annual cost of owner capital / the average annual value of liabilities. It reflects the capital structure;

K_5 = net income (revenue) from selling / the average annual value of assets. It characterizes the turnover of assets.

The obtained results of the index calculation are interpreted as follows:

$Z < 1.23$ – a very high probability of bankruptcy;

$1.23 < Z < 2.89$ – a high probability of bankruptcy;

$Z > 2.9$ – a very low probability of bankruptcy.

According to the similar principle – the calculation of bankruptcy indicators by financial indices, the models listed above and others like them are constructed. Most of them are attempts to improve or adapt Altman's model to particular conditions.

Common advantages of these models for estimating the probability of bankruptcy are the following:

- the use of a small number of coefficients, which ensures the simplicity and speed of calculations;
- the availability of information for the calculation of indicators (financial statements are the source);
- the possibility to compare different objects using integrated estimation;
- mostly certain and clear conclusions;
- the possibility not only to predict bankruptcy, but also to estimate the risk zone, in which the company is located.

For a long time, there were no doubts about the sufficient accuracy of obtained results. However, in 2020, data were published that 98–99 % of firms with Z-criteria below the threshold (1.23) did not file for bankruptcy within two years [17].

Along with the calculation of indices, comparative and qualitative methods to estimate the probability of bankruptcy are also used by diagnosing problems in management, finance, and other aspects of enterprises' activities. This group of methods includes, in particular, the method of J. Argenti, the method of T. Scone, the methods of Ernst & Whinney company (now called Ernst & Young), and the method of V. V. Kovaliov

The method of J. Argenti consists in receiving answers to questions in the form of "yes" or "no", which enable to identify drawbacks in the activities of the studied subject, the mistakes made by its managers and the first symptoms of insolvency. Each answer to the question is assessed with a certain number of scores (for example, 15 scores are

given for a slow and not always adequate response to changing market conditions, 8 scores – for autocracy in the company's top management, etc.); by these scores "A-account" aggregate index is calculated. The value of the calculated index is the basis for estimating the probability of bankruptcy. Thus, the method estimates the state of informal factors that will enable to identify management crisis in the company [3].

The similar approach is the basis of T. Scone's method. The range of aspects covering the issues of his test is wider – they concern business activity, specialization, financial stability, and management. In particular, work in the seasonal industry, the excess of short-term liabilities over circulating assets, combining the positions of the chairman of the board of directors and the executive director by one person, etc. are considered threatening [6].

The methodology of Ernst & Whinney company consists in estimating qualitative characteristics of the company, among which are both quite traditional (for example, market leadership) and quite unexpected (for example, a fountain in the reception).

However, when applying these methods, it is often possible to obtain opposite conclusions as to bankruptcy probability of the object.

In our opinion, the estimation of bankruptcy probability of agrarian enterprises requires considering industry specifics. Indicators of financial and economic condition are taken into account in the structure of integrated index in the discriminant analysis, but the probability of the agrarian enterprise bankruptcy directly depends on non-financial factors of the first order, such as weather conditions, market situation of certain products, size and level of the agrarian enterprise specialization, farm land ownership, and quality of the personnel's work, etc. Thus, these threats can be considered as the factors that affect the likelihood of developing critical insolvency of the agrarian enterprise, so they cannot be ignored when devising bankruptcy probability model.

From our standpoint, the process of estimating the probability of bankruptcy should be carried out by stages (Fig. 2).

At the first stage, the outgoing information is selected for further analysis.

It is expedient to start the prediction of possible bankruptcy with informal analysis – qualitative estimation of sources and causes of risks through expert evaluation. As a result of this stage of the analysis, non-numerical, descriptive characteristics of the impact of each type of risk on the probability of supercritical insolvency are obtained. Because of the lack of standard evaluation criteria, researchers independently formulate the characteristics of the threats' impact on activities. For example, such characteristics can be divided in the following way:

- minimal impact – such a threat almost does not increase the likelihood of bankruptcy risk of the enterprise;
- insignificant impact – such a threat may increase the risk of bankruptcy only under exceptional circumstances or in combination with other threats;
- significant impact that considerably increases the risk of bankruptcy;
- the determining factor, the availability of which will lead to the state of financial crisis and bankruptcy with a high level of probability.

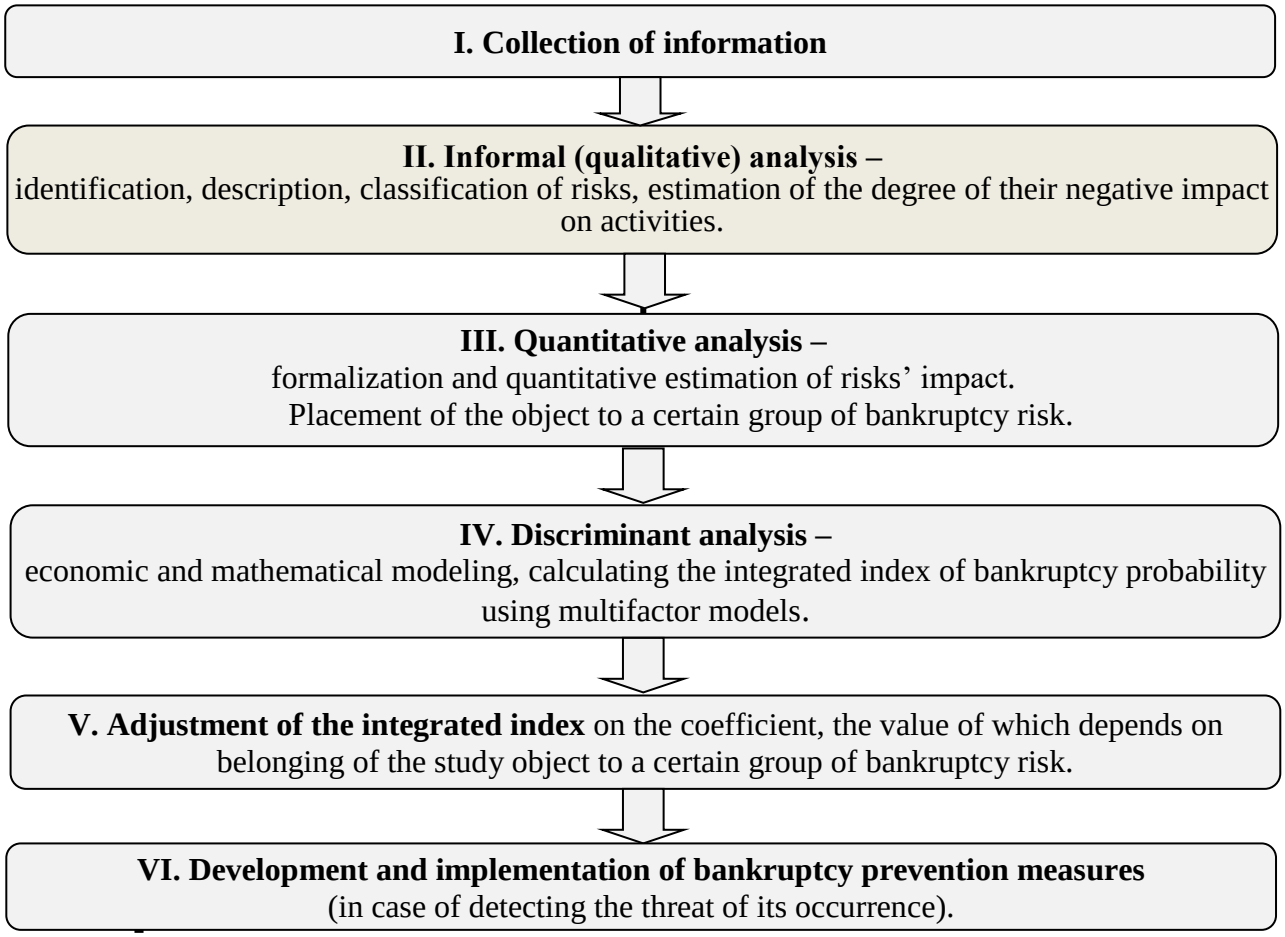

Fig. 2. The main stages of bankruptcy probability analysis

Source: the authors' development.

We propose to use the characteristics of "insignificant impact", "admissible impact" and "critical impact" in estimating the degree and form of negative impact of the most threatening risks on the activities of an agrarian enterprise (Table 2).

The negative impact of each threat is estimated on a scale of:

- 1 score, if the threat insignificantly increases the probability of bankruptcy, the degree of threat is impossible or difficult to determine;
- 2 scores, if in case of unfavorable event, the probability of bankruptcy will increase significantly, but not critically;
- 3 scores, if there is a risk of significant losses, financial crisis or critical insolvency;
- 5 scores, in cases when even a single negative impact of the factor can lead to bankruptcy. Such consequences are underlined in column 3 of the Table.

The proposed scoring of experts' answers on the impact of the most significant threats can be further specified by the results of large-scale approbation.

As a result of quantitative analysis, qualitative risk characteristics acquire numerical values. The summing up of quantitative estimations of each risk's impact on the activities of a given agrarian enterprise forms the generalized estimation of its tendency to the risk of bankruptcy. This generalized estimation allows the study object

to be classified as a certain group of bankruptcy risk.

Table 2

Estimation of the impact of the most significant threats on outcomes of agrarian enterprises

Factors that increase the probability of bankruptcy	The degree and forms of possible negative impact on the activity		
	Insignificant impact – 1 score	Admissible impact – 2 scores	Critical impact – 3 scores / 5 scores
1. Adverse weather conditions	insignificant expenses, losses can be compensated by insurance	reduction of the yields and fodder base	complete loss of received products, bearing losses
2. Natural disasters	insignificant decrease in yield, admissible product losses	insufficient receiving of farm products	complete loss of received products, bearing losses
3. Narrow specialization	the company is diversified	specialization in 2–3 kinds of products that give more than 80 % of income	manufacturing of only one type of product
4. Opening of the market of agricultural lands	will have a positive effect, will not affect	unknown, difficult to determine	significant reductions of acreage or bankruptcy are possible
5. Production and technological (non-following the production process) in crop growing	insignificant soil exhaustion, insignificant yield decrease	reduction of yields and quality of products, essential revenue reduction	reduction of soil fertility or its exhaustion, crop loss, bearing losses
6. Production and technological (non-following the production process) in livestock farming	insignificant reducing of animal productivity, their premature culling, loss of profit	significant livestock reduction, significant decrease in the amount of products, deterioration of their quality, revenue reduction	livestock reduction, loss of products, bearing losses
7. Competitive (reduction of demand for products, their competitiveness, etc.)	reduced demand for the company's products is hardly probable	revenue reduction as a result of decreasing the volumes of selling and/or lower prices	losing customers, bearing losses, being ousted by competitors
8. Resource (lack of basic resources, depreciation of fixed assets)	the main technological processes are provided with the necessary resources	there is a risk of improper performing technological operations	cessation of production, loss of products, bearing losses
9. Credit	the company finances operating costs at its own means	problems with financing current activities because of inability to obtain borrowed funds	as a result of non-receiving the loan or impossibility of its repayment there is a risk of bankruptcy
10. The size of the enterprise	belongs to agro-holding	large or medium enterprise	small farming

Continuation of table 2

11. Criminal, corruption crimes that impede economic activity	proper internal security system, no or unknown cases of corruption crimes in the region and industry	insignificant losses as a result of stealing finished products, fuel and lubricants, etc. Possible destabilization of activities	significant losses as a result of criminal activity, the possibility of significant losses, termination of activities
12. Risks of animal and plant diseases	owing to the peculiarities of production process and insurance, the risks are minimal	receiving less than due products	complete loss of received products, bearing losses
13. Risks of self-reproduction	will not significantly affect, the necessary resources are on the market	additional costs as a result of external resources' replenishment	temporary cessation of production, loss of part of products, additional costs
14. Prohibitions or restrictions on selling certain types of products	will not significantly affect	products will be used for internal needs	revenue reduction, bearing losses
15. Transport	insignificant expenses, damage of the goods compensated by the carrier	increase in costs because of low transportability of certain kinds of products, irregularities in transport operations, etc., loss of part of the goods, reduced sales	possible loss of goods during transportation, loss of customers, bearing losses
16. Financial and investment	difficult to determine	additional costs that may not paid-back	bearing losses as a result of incorrect investment policy
17. Inflation, hryvnia devaluation	difficult to determine	increased costs, receiving less incomes than due	bearing losses
18. Increasing tax pressure or abolishing tax benefits in the agrarian sector	unknown, difficult to determine	increased costs in tax settlements	possibility of significant expenses, receiving less profit
19. Prohibition or restriction of export/import of certain types of goods	insignificant costs	revenue reduction, impossibility to obtain the necessary imported goods, etc.	receiving losses, the probability of partial cessation of activities
20. Instability of the political situation	unknown, difficult to determine	possible loss of several buyers or suppliers	possibility of termination of activity

Source: the authors' development using [28].

Estimating the impact of threats on the results of activities stipulates the involvement of experts, questioning of competent persons, highly qualified specialists on the researched problem. Experts estimate the risk of bankruptcy occurrence of a

particular agrarian enterprise using intuition, knowledge and professional experience. To conduct expert examination, it is necessary to create a group of at least three persons from the employees of the enterprise and independent specialists (scientists, highly qualified employees of other agrarian enterprises, etc.).

The subjectivity of experts, which can significantly distort the results, is the disadvantage of expert estimations. Therefore, it is necessary to check experts' estimations for coordination by the concordance coefficient. This can be done using generally available calculator programs that perform calculations and interpret their results online.

We propose to conduct risk analysis by using the system of indices, which are given in Table 2.

According to the results of estimating all components for each expert by summing up these assessments, the total value of the indicator is found (it may be within the range from 20 to 80).

Individual estimations of experts are averaged in the final integrated estimation according to the formula of arithmetic mean simple. The final integrated estimation can also range from 20 to 80 scores, and its value is a criterion for scoring – the assignment of the enterprise, the study object, to a certain group of bankruptcy risk.

The corresponding groups shown in Fig. 3 have the following characteristics:

- "the green zone", up to 30 scores – a low or moderate level of bankruptcy risk according to qualitative characteristics of the activity. The coefficient for correcting the integrated index, which will be calculated at the next stage, makes 1.00, i.e. the integrated index does not require correction;

- "the grey zone", 30–60 scores – the risk to go bankrupt, determined by non-financial characteristics of the activity, is probably higher for enterprises in this group than for enterprises in "the green group". Since the identified threats slightly increase the probability of bankruptcy, we propose to use the provisions of mathematical statistics: for practical research the confidence level of probability $p = 0.954$ is sufficient, i.e. the objective measure of the possibility of a particular event makes 95.4 %, and the level of significance in such cases is $\alpha = 1\text{-}p = 1\text{-}0.954 = 0.046$. The last level is used as a correction factor for the result of discriminant analysis: $K = 1 + 0.046 = 1.046$;

- "the red zone", over 60 scores is a dangerous level of bankruptcy risk by the determined threats. Thus, the risk of bankruptcy for agrarian enterprises of this group is probably higher than for enterprises of the "green group" and probably higher than for the "grey group", so the level of significance is doubled based on the interval step in scores ($30 \cdot 2 = 60$). Accordingly, the correction factor is $K = 1 + (0.046 \cdot 2) = 1.092$.

The values of the correction factors are currently theoretically substantiated, but they can be specified by the results of multiple practical approbations.

An example of conducting the second stage of estimating the probability of bankruptcy is given in Table 3.

Expert estimations are checked for consistency by the concordance coefficient using math.semestr online calculator. The value of the coefficient $W = 0.7$ indicates

the average degree of experts' consensus. The calculated Pearson's criterion $\chi^2 = 39.86$ exceeds the tabular value (30.14) at the significance level of $\alpha = 0.05$, so the value of the concordance coefficient is a non-random value, and the obtained results can be used at drawing conclusions as to the influence of the factors on the results of given enterprise's activities.

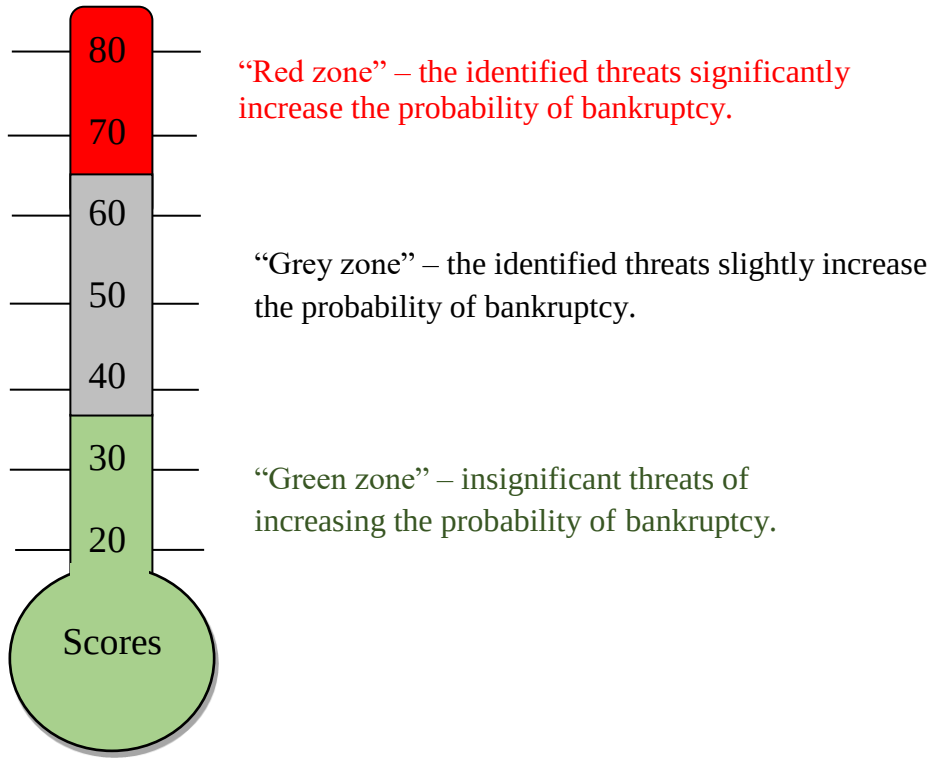

Fig. 3. Integrated estimation of the threats' impact on the probability of bankruptcy of an agrarian enterprise, scores

Source: the authors' development.

According to the results of questioning three experts on the risks of the enterprise's activities that specializes in grain production and poultry farming, the integrated index of 50 scores was calculated. This means that the study object is in the "grey group", i.e. there is insignificant probability that industry risks will increase bankruptcy probability of the enterprise. The correction factor for the "grey group" makes 1.046, therefore, the integrated index calculated at the next stage of discriminant analysis, should be adjusted to this indicator.

The third stage of diagnostics is bankruptcy prediction by calculating the integrated index using multifactor models. We will demonstrate discriminant analysis on Altman's model of 1983 because of its wide-spreading.

For the above given example (the agrarian enterprise belonging to the group with undetermined risk), the calculated value of the Z-score makes 1.176. The results of the model's calculation are given in Table 4.

As it has been mentioned above, the "neutral boundary" of the probability of bankruptcy in Altman's model is Z-score = 1.23, i. e. according to this approach, the company is not threatened with bankruptcy; however, taking into account the

correction factor, it is already on the verge of the interval.

Table 3

Risk estimation of the impact of the most significant factors on the results of economic activity of the agrarian enterprise "*"
(specialization – grain production and poultry farming)**

Factors that cause uncertainty of performance results	Experts' questioning results (scores)			
	The 1st expert	The 2nd expert	The 3d expert	Average rating
1. Adverse weather conditions (winter frosts, drought, hail, etc.)	5	5	5	5
2. Natural disasters (hurricane, downpour, fire, earthquake, etc.)	5	2	5	4
3. Narrow specialization	2	3	2	2
4. Opening of the market of agricultural lands	2	2	5	3
5. Production and technological in crop growing	2	2	2	2
6. Production and technological in livestock farming	2	5	5	4
7. Competitive	1	1	2	1
8. Resource	5	2	2	3
9. Credit	1	1	1	1
10. The size of the enterprise	2	2	2	2
11. Criminal, corruption crimes that destabilize economic activity	2	5	2	3
12. Risks of animal and plant diseases (epidemics, diseases, pests, etc.)	2	2	1	2
13. Risks of self-reproduction	2	3	3	3
14. Prohibition or restriction of selling certain types of products	3	3	3	3
15. Transportation	2	3	3	3
16. Financial and investment	2	2	2	2
17. Inflation, hryvnia devaluation	2	2	3	2
18. Increasing tax pressure or cancellation of tax benefits in the agrarian sector	2	2	1	2
19. Prohibitions (restrictions) on export/import of certain types of goods	2	2	2	2
20. Instability of the political situation	1	1	1	1
Together	**47**	**50**	**52**	**50**

Source: survey conducted by the authors.

Thus, despite the favorable forecast of discriminant analysis, such an enterprise should form the system of protective mechanisms of anti-crisis management in accordance with the detected factors and the intensity of their impact.

If an agrarian enterprise does not use Altman's model to predict bankruptcy, but another one or several models, the correction of integrated index is conducted similarly. It is used the calculation methodology and evaluation criteria of integrated index (score scales), determined by the authors of a particular model. The correction factors for all the models have the same values (1.0 for the "green zone", 1.046 – for the "grey" and

1.092 for the "red" ones), and their use can change the value of the calculated integrated index and shift the agrarian enterprise to the group with a higher bankruptcy risk.

Table 4

The results of quantitative estimation of bankruptcy probability of the enterprise "*"**

Stage of analysis	Effective indicator	The essence of the effective indicator
1. The result of quantitative analysis of threats to activities	50	According to the value of integrated estimation (Fig. 3), internal and external threats to activity, with the probability of 95.4%, insignificantly increase the risk of bankruptcy. The correction factor for the result of the discriminant analysis makes K = 1.046
2. The result of the discriminant analysis of the probability of bankruptcy using Altman's model (formula 1)	1.176	The calculated indicator is lower than Z-score = 1.23, i.e. in the coming years the company is not threatened with bankruptcy
3. Specification of the discriminant analysis' result taking into account the correction factor	1.176 · 1.046 = 1.230	The company is at the lower boundary of the interval (1.23–2.89), which determines quite a high probability of bankruptcy

Source: questioning conducted by the authors.

At the last stage, agrarian enterprises, in which the threat of bankruptcy has been detected, must quickly develop the complex of measures to prevent it. Bankruptcy prevention plan for each company must include measures to prevent exactly those threats that were identified at the previous stages of the analysis. According to the results of expert assessment (Table 3) for the enterprise, the study object, critically affecting threats were identified and graded according to the degree of their impact on the activities (Table 5).

As we can see, the most serious threats to the given agrarian enterprise are external risk factors – adverse weather conditions and natural disasters. Therefore, in order to reduce critically dangerous impact of these factors on economic activities, the enterprise needs to minimize losses by insuring risks. The company has to respond to internal risks using the strategy of early detection and prevention of possible threats.

General recommendations for agrarian enterprises with a high probability of bankruptcy are the following:

- the formation of an effective strategy for making managerial decisions to attract, allocate and use financial resources;
- the creation of reserve funds for stocks of the most important resources and capital to cover possible costs;
- increasing the competitiveness of products;
- the diversification of non-competitiveness risks of the enterprise;
- increasing the turnover of operating assets;
- the optimization of the ratio of own and borrowed funds, etc.

Table 5

The revealed treats to economic activities of the agrarian enterprise "*" (specialization – grain production and poultry farming)**

Factors that cause uncertainty of performance results	Mean score according to the questioning of experts	Source of threat
1. Adverse weather conditions (winter frosts, drought, hail, etc.)	5	External (exogenous) factor
2. Natural disasters (hurricane, downpour, fire, earthquake, etc.)	4	External (exogenous) factor
3. Production and technological in livestock farming	4	Internal (endogenous) factor
4. Opening of the market of agricultural lands	3	External (exogenous) factor
5. Prohibition or restriction of selling certain types of products	3	It can be both external and internal
6. Criminal, corruption crimes that destabilize economic activity	3	It can be both external and internal
7. Resource	3	Internal (endogenous) factor
8. Risks of self-reproduction	3	Internal (endogenous) factor
9. Transport	3	Internal (endogenous) factor

Source: questioning conducted by the authors.

Thus, the main concept of our proposals to improve the existing methodology for estimating the probability of bankruptcy is the combination of financial indices and quantitative estimation of risks that have the greatest impact on the activities of agrarian enterprises. Owing to the complex approach, our proposed improvements will increase the accuracy of estimating the prospects for the development of the agrarian sector and the probability of its bankruptcy.

Conclusions. The specifics of the Ukrainian enterprises' work in the agrarian sector are a complex of risks and threats that require timely response to prevent bankruptcy. Specifying the main risks to agricultural activities in Ukraine enabled to classify and schematize their impact on the probability of agrarian enterprises' bankruptcy.

The proposed definition of the term "bankruptcy" combines legal and economic aspects, it emphasizes that bankruptcy is recognized only by the court and the given definition also specifies that the bankrupt experiences not just insolvency, but supercritical insolvency.

At present, the most common methodological approaches to estimating the probability of bankruptcy occurrence are discriminant analysis – the creation of multifactor models (universal, not adapted to enterprises of different industries) and the methods of qualitative estimation of the probability of bankruptcy. We propose to combine these two approaches and take into account industry risks as factors that increase the probability of bankruptcy.

We propose to analyze the probability of bankruptcy in the following sequence:

1. Detecting risks and estimating the degree of negative impact on activities. We

have systematized the factors that may increase the risk of bankruptcy of agrarian enterprises.

2. Expert quantitative estimating in scores for the degree of impact of separate threats on the probability of bankruptcy.

According to the results of estimating all the components by their summing up, the total value of the index is found, according to which the study object is attributed to one of three groups of bankruptcy risk: with a low or moderate level (the correction factor is 1.00), the admissible level (the correction factor is 1.046), and with a critically dangerous level of risk (the correction factor is 1.092). In our opinion, the introduction of the correction factor for agrarian enterprises is necessary because of the greater unpredictability of agrarian activities, which increases the probability of unexpected bankruptcy.

3. The calculation of probability of bankruptcy integrated index by using multifactor models.

4. The adjustment of the integrated index to the correction factor in accordance with a definite group of bankruptcy risk.

5. Making managerial decisions to prevent bankruptcy.

Thus, using the method of expert estimations, the scoring model was created; also the scale was developed and combined with the discriminant model. Owing to this, the score scale was evaluated and the results of the study were derived to the indicator interval to estimate the onset of bankruptcy.

Our further research will be aimed at repeated testing of the proposed methodological approach on the materials of various agrarian enterprises and observing them for at least 2–3 years to verify bankruptcy predictions concerning the entities that, according to our estimations, are classified as critically dangerous.

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