Simulation modeling in assessing the agricultural enterprise state in an emergency

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Abstract. The article proposes a methodology for assessing the sufficiency of financial resources in an emergency. The purpose of the study is to develop a methodology based on the method of simulation modeling to assess the sufficiency of resources and the sustainability of an agricultural enterprise in the event of an emergency. This set of methods for assessing the availability of enterprise financial resources for overcoming emergencies was implemented using algorithms for simulation of enterprise financial flows and their assessment in the program for investment calculations Project Expert 7.19. The program allows you to build simulation models of an enterprise, regardless of their industry and specificity. With the help of this software complex, it is possible not only to build a simulation model of an enterprise, but also to carry out its statistical evaluation. Together with the proposed method of detailing the initial data of annual financial and economic documents, this set of methods is a powerful tool for building and evaluating simulation models of agricultural and other enterprises, taking into account fluctuations in cash flow values during the year. Thus, the accuracy of the estimates obtained is significantly increased in comparison with methods based on the analysis of relative indicators or coefficients.

1 Introduction

Modern economic conditions, characterized by the transition from a planned economy to a market economy, have led to the shifting of concern for the material well-being of the population and economic entities in the private owners responsibility sphere [1-4]. Due to the high riskiness of production activities in the national economy all sectors, and the increased frequency of emergencies, as evidenced by statistics, a timely response of enterprises to the prevailing conditions is necessary [5-11]. Recently adopted legislative

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acts oblige enterprises and organizations to have reserves of financial resources and material resources for independent localization and elimination of the emergencies consequences [12-16].

Especially relevant is the problem of assessing the production risks impact in agricultural production in the crop production industry, since the latter is directly related to weather conditions that have a significant impact on the final result of the industry and inevitably leads to the cost of resources to eliminate their consequences [17, 18]. The costs of eliminating the natural emergencies consequences involve the financial resources and material resources reserves creation [19-23]. In market conditions, the creation of any financial and material reserves entails a decrease in economic efficiency and financial stability, therefore, the determination of a rational volume that can ensure overcoming emergency situations is an urgent task [24-27].

2 Methods and materials

The methodological approach to assessing the availability of financial resources for agricultural enterprises consists in synthesizing the simulation modeling method of the enterprise's activities and assessing its financial stability using the Monte Carlo statistical test method. Assessment of the security of the enterprise with financial resources consists in assessing the financial stability of the enterprise over a given time interval (the period of agricultural work).

The analysis methodology is built taking into account a certain sequence of actions, which involves obtaining various kinds of formalized and non-formalized information about the object, its subsequent formalization and processing, ending with a calculation that allows you to give an opinion on the enterprise security with financial resources. Thus, the financial resources provision assumes that in the agricultural production conditions, the enterprise is provided with financial resources that allow it to continue production and economic activities, to remain within the solvency framework in the emergency event, and not to fall under the bankruptcy definition.

Assessment of the financial resources availability for agricultural enterprises is based on the scheme and includes the following stages:

- collection and analysis of initial information;
- building the enterprise model;
- initial calculation;
- correction;
- calculation with corrected results;
- analysis of the constructed model stability.

3 Results and discussion

According to the analysis scheme, the first stage is "determining the characteristics of the investigated enterprise." As a source of data on the parameters of the enterprise, data provided by the enterprise itself or the relevant district agriculture department can serve. This paragraph defines the enterprise structure and the main parameters of its subdivisions (arable land and agricultural land, livestock and its structure, etc.). The information obtained and analyzed in this way will make it possible to take into account the unique nature and characteristics of each enterprise in the calculation [28-31].

The next step is to build a simulation model. Determined as the most suitable for the purpose of describing an agricultural enterprise, the simulation method was used as the basis for the developed methodology for assessing the financial resources availability for

agricultural enterprises. The method will allow describing the processes occurring at an agricultural enterprise from the point of view of system analysis, as well as applying the method of statistical tests to assess sustainability [32-34].

The simulation model underlying the methodology describes the processes occurring at the enterprise in terms of costs and cash flows. A database that reflects the economic aspects of enterprise production, sales and financial activities in a market environment, as well as calculation algorithms that transform this data into cash flow models and their characteristics. The calculations result is the construction of the enterprise's cash flow model, which reflects the difference between receipts and payments related to the production, the enterprise financial and investment activities, distributed over time, as well as the calculation of some financial indicators that make it possible to analyze the availability of the enterprise financial resources in emergency situations.

According to the model building algorithm, the first stage is the initial data collection and preparation. As a source of initial data for describing financial and economic activities, the annual financial report of an agricultural organization is used, containing the results of the production and financial activities of the enterprise for the reporting year. With the help of technological (calculated technological maps in plant growing and animal husbandry) and regulatory documentation, information from the forms of the annual report is detailed and distributed by blocks.

The external environment block contains information about the way the enterprise interacts with the external environment, which is represented by the state.

Inflation indicated in this block is taken into account only when building a simulation model based on forecast indicators. When making calculations, the initial data in which is information from annual reports, inflation is not taken into account, since it was already taken into account when they were compiled.

The production information block contains formalized data on the production and sale of products, works, services and is subdivided into two sections: production and sales. The listed indicators, their components, are presented in value terms, and based on the list of technological operations for the product particular type production and the time of their implementation, this information is distributed throughout the year by months. The sequence and composition of technological operations for each type of product manufactured at the enterprise is drawn up on the requirements basis for the particular product production in crop and livestock production. In the presence of subsidiary industries, technological operations on them are also taken into account, allowing to adequately form financial flows from production activities. Formalized and detailed information on the manufactured products sale is consistent with the results of the production division and allows you to get a complete picture of the company's products production and sale [35-38].

The financial information block contains a description of the enterprise financial side. The main information contained in this block reflects the enterprise interaction with credit institutions regarding the financial resources distribution. The main document for filling out this section is the accounts analysis receivable and payable of the enterprise or agreements with credit institutions, which spell out all the conditions for raising funds. Credit information should contain the time of obtaining the loan, the interest rate, the loan maturity, as well as the scheme by which the principal and interest are repaid. In addition, this block reflects information related to the share capital and investments carried out by the enterprise. This section in a formalized form also contains the enterprise achieved results at the time of the analysis beginning, the state of its assets and liabilities. Filling in the information for this section is carried out on the balance sheet basis. Further, in the settlement block, the formalized initial information is converted using settlement procedures into the cash flow components in each month of modeling (CF_1, CF_2, ..., CF_n).

Cash flow reflects receipts and payments in three areas of the enterprise, related to production, sales and financing [39-41].

After building a cash flow model, it is assessed and the satisfaction of the set restrictions is checked. The limitation is the lack of the cash flow deficit at any moment of the analyzed time interval. Deficiency is understood as the absence of a deficit of financial resources in the process of carrying out production, financial and investment activities, as well as in the moments of emergencies.

The cash flow value is not the only calculated indicator that is required for further analysis. Also, in this block, some performance indicators of the model are calculated, for example, one of them is the NPV indicator. The calculation of this indicator allows you to obtain additional information for further analysis.

The model of the enterprise cash flows built on the initial data basis and the calculated performance indicators are just a static reflection of the modeled system behaviour, fixed using the initial financial data for a certain period of time under the prevailing market conditions. Based on the analysis of only the cash flow obtained values, it is difficult to give an adequate assessment of the enterprise's financial resources security. To obtain such an estimate, it is necessary to use the methods of statistical analysis that allow taking into account stochastic processes in large systems to which the enterprise belongs. Therefore, it is necessary to conduct a statistical assessment of the simulation model stability through the cash flow model analysis.

The first stage of the model stability statistical assessment and the third in the general sequence is to check the sensitivity of the model resulting indicator to changes in the selected factors. The sensitivity analysis procedure is necessary to identify the most influencing factors on the resulting indicator of the model with a view to their subsequent inclusion in statistical analysis or stability analysis. NPV (net present value) was taken as the resulting indicator in the sensitivity analysis, since it fully reflects the essence of any commercial activity - the receipt of income on investment. As factors participating in the analysis and having a possible influence, the following were selected: products sales price, direct costs, staff salaries, general costs, tax rates, and loan rates.

After the factors selection, the NPV indicator is recalculated taking into account the change with a given relative step of the selected factors, regarding the behaviour of which they have an ambiguous opinion. As a calculation result, values are obtained for each of the analyzed factors, showing its influence on the model resulting indicator. Results are usually presented graphically. Along the abscissa axis, in relative units, the step of changing the factor is plotted during the analysis in the direction of increasing or decreasing its value. On the ordinate axis the values of the resulting feature (NPV) are plotted. The obtained intersection of the abscissa zero value and the value of the ordinate shows the efficiency point or NPV point reached during the analysis, and the lines show the trajectory and values of the change in the efficiency indicator with an increase or decrease in the eigenvalue of the factor in relative values. The sensitivity analysis result is the factors list from the total number involved in the analysis that have the greatest impact on the simulation model performance indicator. The criterion by which factors are selected from their total number in the sensitivity analysis is its contribution to the change in the resulting indicator. The size of the factors contribution to the change in the resulting indicator is carried out by ranking the factors relative values involved in the analysis, according to their contribution to the change in the efficiency indicator. Sensitivity analysis, due to its single-variance and static nature, cannot be a tool for accounting for uncertainty, but is intended to select factors that are involved in the analysis of financial stability.

The availability of financial resources of an enterprise during an emergency cannot be assessed solely on the enterprise's cash flow scarcity basis. To conduct an assessment, methods are required to simulate the probabilistic nature of changes in factors

characterizing the external environment in which the enterprise operates. Therefore, using the constructed model, it is necessary to "play" a certain number of options, with different (reasonable) deviations of the influencing factors values from their nominal level. Reasonable deviation of influencing factors can be varied. The deviation range of one or another parameter is established based on the analysis of statistical data reflecting the change in the indicator over time. The upper and lower limits of the factor change are set, respectively, equal to the upper and lower values of deviations ten percentage points (±10%), which in most cases, as practice shows, is more than enough [42-44].

The calculation of a model scenarios large number with a change in its external and internal parameters is a rather long process, and methods are needed that allow such calculations to be carried out in a short time. Mathematical statistics has methods to speed up the process of calculating options. These include the Monte Carlo statistical test method.

The result of statistical tests is the proportion of the model cash flow non-deficit calculated scenarios with a random combination and deviation of the selected uncertain factors within the specified limits. The resulting indicator characterizes the sustainability of the modeled enterprise. Taking into account that in the process of analysis using the Monte Carlo method, the stability of the enterprise cash flow model is assessed depending on changes in internal and external factors expressed in value terms. In our opinion, it is legitimate to speak not only about the stability of the enterprise simulation model from the systemic analysis view point, but about stability in the context of financial condition, financial stability. Thus, the obtained indicator of the cash flow stability, calculated using the Monte Carlo method, characterizes the enterprise financial stability, considered from the system analysis view point.

To interpret the results of statistical analysis, it will be necessary to determine the boundary of the estimated model minimum stability. The range of 80-100% is taken as the standard stability range. This range means that the probability of the enterprise deficit-free existence during the analysed period is quite high. However, a good indicator of sustainability does not yet guarantee that the cash flow will be deficit-free, so the average values of the performance indicators involved in the calculation should be considered. Satisfactory average values allow one to hope that most calculations will give acceptable results. For final conclusions, it is necessary to take into account the uncertainty parameter. If the average is obtained over a wide range of values, then each individual indicator can be very far from the optimal value. In other words, the greater the uncertainty, the greater the risk. A practically acceptable deviation can be considered values within 20% of the mean. Thus, the values of the normative range that determines the stability of the model in the method are equal to 80-100%. If the calculated stability indicator is lower than the normative one, then the hypothesis about the endowment of the enterprise with resources is rejected, and the scheme for financing and compensating for periods of cash flow deficit requires revision, after which the stability calculation is performed using the Monte Carlo method. This process is repeated until the standard value of the sustainability indicator is obtained.

4 Conclusion

This set of methods for assessing the enterprise financial resources availability for overcoming emergencies was implemented using algorithms for simulation of enterprise financial flows and their assessment in the program for investment calculations Project Expert 7.19. The program allows you to build an enterprise simulation models, regardless of their industry and specificity. With the help of this software complex, it is possible not only to build an enterprise simulation model, but also to carry out its statistical evaluation. Together with the proposed method of detailing the initial data of annual financial and

economic documents, this set of methods is a powerful tool for building and evaluating simulation models of agricultural and other enterprises, taking into account fluctuations in cash flow values during the year. Thus, the accuracy of the estimates obtained is significantly increased in comparison with methods based on the analysis of relative indicators or coefficients.

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