PREDICTING OF ENTERPRISE'S FINANCIAL STABILITY BY SIMULATION MODELS

TEA MUNJISHVILI
Doctor of Economics,
Associate Professor of Ivane Javakhishvili Tbilisi State University, Georgia
tea.munjishvili@tsu.ge

We analyzed 20 mathematical models used in the assessment of enterprise's financial stability: models of Altman's five-factor (4 models), Altman Sabato, Richard Taffler, Olson, Dzvizhevskiy, Springate, Fulmer, Diupon (two models), Lisi, Lego, Conan and Golden, Deplane, Chesser, Irkutsk State Economic Academy, Perfiliev and Shermeta. Their advantages and difficulties in practical use in underdevelopment and post-soviet countries (such as Georgia) have been identified. Our goal is to select and develop a model from the mathematical models used in the assessment of enterprise's financial stability under simulation mode that will enable us without statistical data to:

1. Proof the possibility to evaluate the financial position of the enterprise with selected economic indicators, based on modeling; 2. Calculate the probability of reliability / unreliability of each of the indicator and the combination of indicators by considering the possible financial conditions of the enterprise; 3. calculate in the selected mathematical model the share of each indicator and the combination of indicators in the financial position of the enterprise; 4. implement the modeling of impact share of each of the indicator and the combination of indicators to the expected financial condition of the enterprise; 5. Show the financial development strategies of the enterprise based on the modeling; 6. Calculate the risk of a financially unstable enterprise and to develop ways to prevent it; 7. Choose the optimal option for development the enterprise and to use this option to monitor the financial stability of the enterprise, based on modeling; 8. Assess the enterprise's financial stability and to predict the enterprise's bankruptcy, based on the actual data.

Given the nature of economics, apart from the selected indicators in any model, it is important to determine the values of the b_i coefficients of this model. According to the model authors and some researchers, any mathematical model for assessment the enterprise's financial stability is common for this type of enterprise and country and it can be used in any country. This thesis is not empirical and it is proved by experiments. In this way, scientific researches can not lead to the desired results in countries where there is not available long-term statistical data about the bankruptcy. Such countries are the developing countries of the post-soviet space. That is why there is an idea to develop an approach which will allow us to provide the basis for the economical-mathematical model of the enterprise's financial stability about bankruptcy, when there is no statistical data available.

1.1. Method for Task Solution

We have two ways for realizing this task:

The First, in the economic mathematical model, the logical links between the selected economic indicators should be considered. Assess the financial stability of the enterprise by comparing actual values with normative values of indicators evaluated by expert(s);

The second is to develop an individual economic-mathematical model of financial stability assessment and prediction for a particular enterprise.

With our developed computer simulator FINSIM-PRO2018, the second approach for developing the economic-mathematical model of enterprises' financial stability and prediction is realized. FINSIM1-PRO2018 is written in VB.NET programming language, the data base is organized in SQL Server [1]. The program has multilingual support. It has Georgian, English and other languages support.

Out of the 20 models we have reviewed to develop an economic-mathematical model for the financial stability of the enterprise, 14 models are used in the simulator: models of Altman (4 models), Altman-Sabato, Fulmer, Springate, Dzvizhevskiy, Olson, Conan-Golden, Taffler, Lego, Lisi, Chesser.

The essence of the second approach for developing the economic-mathematical model for enterprise's financial stability and prediction is as follows:

The first: $m_i \in M$ model will be selected from the chosen range of models and the average of input arguments (indicators) in the model will be calculated according to the actual data of the S_j enterprise.

There comes a task when arguments (indicators) of model f_i = Const in the $Z = f_i \emptyset k_t$ equation, k_t values of the input coefficients (variables) are to be found in the model. To find the values of the coefficients in which Z shows the stability of the enterprise's financial stability or to calculate the different values of Z for the different values of the variable (coefficients) in their Δ changing dynamics. Thus, multiple options of Z are calculated that are different from the values of input coefficients. The evaluation of the results by the rules adopted in the chosen model of any option is automatically carried out;

The second: optimal option will be selected from the range of options. Optimization criteria is a minimum of bankruptcy prediction error. The economic-mathematical model for assessment of financial stability S_j enterprise is different from the reference $m_i \in M$ model by values of the coefficients;

The third: Next step is to modify the model by the actual data of the S_j enterprise. Here comes a task different from the first task. While in the $Z = f_i \emptyset k_t$ equation f_i = Const coefficients of the model, the f_i input arguments (variables) in the model are to be found. To find values for t_i, $i = 1$, n year for which Z shows the stability of the enterprise's financial stability or to calculate the different values of Z, for the different values of the variable (coefficients) in their Δ changing dynamics.

For any $m_i \in M$ models, multiple options of the plan are calculated for t_i, $i = 1$, n year. Then the optimal option will be chosen from the vast majority of the plans. The optimization criteria is the minimum of bankruptcy prediction error. This model is used as a guide for enterprise's financial stability and bankruptcy prediction.

Both tasks are the tasks of optimization. Out of the 14 models we discussed, for two models (Fulmer, Olsen) it is a non-linear optimization task and for the rest 12 models - linear optimization.

Based on the reference model, the process of development of economic-mathematical model for S_j enterprise's financial stability with the simulation method FINSIM-PRO2018 is as follows /fig.1/:

Any student or specialist can start working with FINSIM-PRO2018. In the first time student starts working with the system, he/s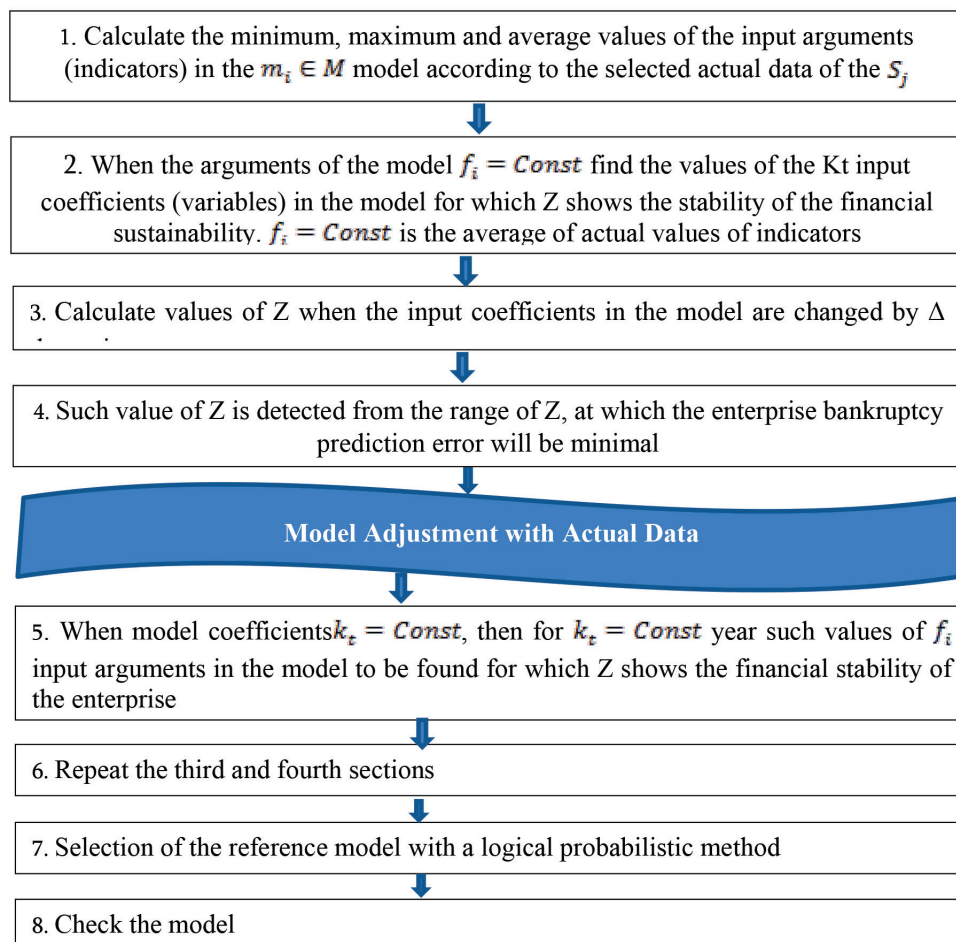he enters his/her personal number, name and surname. Before or after the start of identification, the student can get acquainted with the technology to start working with the system by the video clip.

The next stage of identification is to select an enterprise. In the database there is stored the actual data of enterprises operating stable and even one bankrupted enterprise sorted with the fields. At the same time, in the list of enterprises there is added one entry called "Virtual Enterprise". Using the example of a virtual enterprise, the student must select such values of economic indicators (arguments) that result the enterprise being financially stable or bankrupt.

After selecting the enterprise, the list of models existing in the system will be dropped-down. By clicking on one of the title, the model description, purpose, scope of use, clear look of the model with description of economic indicators used in model, rules for evaluating financial stability of the enterprise calculation result, an integral measure of the enterprise financial stability assessment by Z.

After the model selection, the main window will be opened in which simulation is carried out. Here it can also be called the video to get acquainted with modeling process. Thus, the enterprise is selected, average of the indicators (arguments) in the model is displayed with default, the model is shown and the coefficients within it.

Fig.1. Stages of development of economic-mathematical model for enterprise's financial stability assessment and prediction.

1. Calculate the minimum, maximum and average values of the input arguments (indicators) in the $m_i \in M$ model according to the selected actual data of the S_j

2. When the arguments of the model $f_i = Const$ find the values of the Kt input coefficients (variables) in the model for which Z shows the stability of the financial sustainability. $f_i = Const$ is the average of actual values of indicators

3. Calculate values of Z when the input coefficients in the model are changed by Δ

4. Such value of Z is detected from the range of Z, at which the enterprise bankruptcy prediction error will be minimal

Model Adjustment with Actual Data

5. When model coefficients $k_t = Const$, then for $k_t = Const$ year such values of f_i input arguments in the model to be found for which Z shows the financial stability of the enterprise

6. Repeat the third and fourth sections

7. Selection of the reference model with a logical probabilistic method

8. Check the model

The first Step of Simulation

The values of the arguments in the model are constant and coefficients are variable. The default minimum value of the ratio is 0,001. We calculate a minimum, and maximum values of Z and values of Z in a specified range of values by the indicated set step / Fig. 2 /

Fig.2. Main window of simulation - simulation results are presented in the table, figure
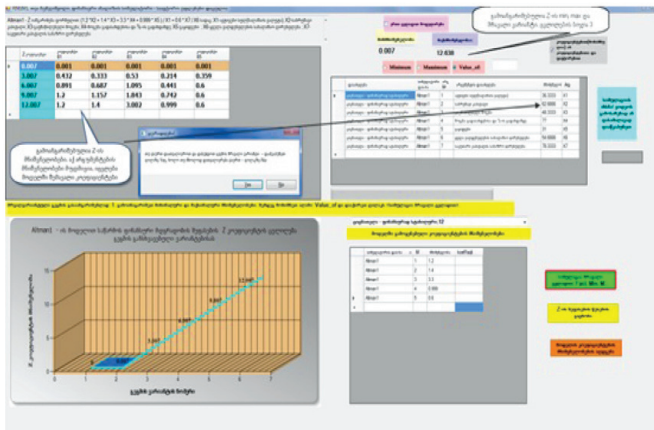
Value of Δ step is determined by us. Number of iteration = $(Z_{max} - Z_{min})/Δ$. Naturally, the question arises what should be the value of Δ. At this stage we can limit ourselves with general advice - Δ must be the value that the number of iteration and the calculation time is not great. The calculation results are reflected in animated and sound effects, in the form of multi-optional plan [1]

In addition to multiple options of the plan, we can calculate the desired value of Z and see with what values of the arguments can it be achieved

The Second Step of Simulation

At this stage our goal is to test the possibility of using the selected model to assess the financial stability of the enterprise. We choose one of the coefficients obtained in the preceding stage of modeling and performing modeling, while the values of the coefficients are constant and the values of the arguments are changed. The actual, minimum, maximum values of Z are calculated and the multiple options of Z in their values range/Fig. 2/

Similar works are performed for a failed enterprise.

The modeling results are reflected in Excel for further analysis. After closing the form depicted on Fig. 3, student conducts analyzing of results. The purpose of the analysis is to evaluate the modeling results and select a particular model for implementation of the enterprise's financial stability and bankruptcy prediction. Selection criteria for n option of

$M^i_n ∈ m^i$ i model is the following: Select the option for which the difference of Z values between financially stable and bankrupted enterprises is minimal. As a block-scheme, it can visualized as follows: /Fig. 3/

For selection of the final option of the model, modeling is carried out with other models also. After completion the simulation by a student, Excel will introduce a sum sheet of simulation results. The data analysis is carried out with some algorithms. Student chooses and justifies selection of the reference option of model.

After selecting the reference option the student performs modeling of reference option with one variable. The result of modeling is to determine the weight of arguments in the model. It shows the importance of the argument in the model. This enables the financial analyst to redistribute the resources so that the enterprise's financial stability is maintained.[3]

The final stage of simulation is the integral assessment of the student knowledge. The reference model and virtual enterprise is taken for the base. The input values indicators (arguments) in the model of virtual enterprise are zero. The purpose of the modeling is to select such values taking into account the weight of the indicators in the model on the basis of which the value of the calculated Z will fall into the stability or bankruptcy zone.

The final stage of simulation is debriefing. Here the examination of simulation results is conducted by the teacher. During the debriefing, the teacher discusses the work done by each student (group). Analysis of the findings made by the students is carried out by the teacher by using of the special program.

In / 6/ the requirements for the debriefing leader are not new. It is fully detailed in the method of management of intellectual processes - in the work/4/ devoted to the psycho- evrestical programming method. Student's opinions and proposals expressed during the group discussions will be taken into consideration by the lecturer.

Conclusions and recommendations:

1. In the current economic-mathematical models for enterprise's financial stability and bankruptcy prediction there are considered the specifics of the economy, industry and enterprises of developed countries. One of the bases of modeling is the statistics of enterprise bankruptcy;

Fig.3. Block scheme to select a reference option
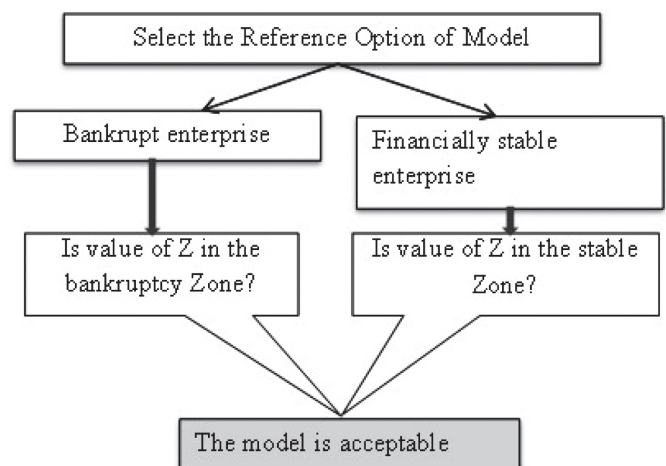
2. There is no bankruptcy statistics in the post-soviet and developing countries. Therefore, it is necessary to find a method that will allow us to select a model from economical-mathematical models without processing statistical data of the enterprises' bankruptcy, considering only the features of the economy, industry and enterprise of this country and to develop the obvious face of this model with its modification.

3. Simulation method is used as a method of realization of the task.

With the program package FINSIM-PRO2018 developed by us in simulation mode is implemented:

• Selection of the value of input coefficients in the model without changing the content of arguments;

• Changing the content of one or more arguments in the base model selected from the range of models and choosing the values of the coefficients from the minimum value (from 0.001) to the value of the coefficients in the base model (to the maximum value). Within the bounds of the minimum and maximum values, the integral value of the model, of coefficient Z, with the change of Δ step;

• Calculation of weight fo $j = \overrightarrow{1,2 \dots k}$

$$\forall a_j \; a_j \in m_i \; ; i = \overrightarrow{1,2,\dots. n,}$$

$$m_i \in M$$

• Calculation of Z and making predictions based on the actual value of the selected enterprise or the actual value of ti year. Examination of the prediction made with the model based on data of a similar bankrupt enterprise;

• Visualization of any calculation results with tables, diagrams, animated effects, sound, and reports.

1. By FINSIM-PRO2018 it is implemented: at the design stage - development of the economic-mathematical model of the enterprise, and at the functioning stage - assessment of enterprise's financial sustainability e and bankruptcy prediction for any period of time.

2. FINSIM-PRO2018 is an important component for training a financial analyst. In simulation mode the student chooses and justifies selection of the reference an option of the model, performs modeling on the reference option with one variable. The result of modeling is to determine the weight of input arguments in the model. It shows the importance of argument in the model. This allows the financial analyst to redistribute the resources so that the enterprise's financial stability is maintained.

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SUMMARY

FINSIM-PRO2018 is an important component for training a financial analyst. In simulation mode the student chooses and justifies selection of the reference option of model, performs modeling on the reference option with one variable. The result of modeling is to determine the weight of input arguments in the model. It shows the importance of argument in the model. This allows the financial analyst to redistribute the resources so that the enterprise's financial stability is maintained. The final stage of teaching is - debriefing. Here the examination of simulation results is conducted by a teacher. During the debriefing, the teacher examines the work performed and conclusions made by each student (group). Analysis of the conclusions made by the students is carried out by a special program.