

USE OF THE STRESS TESTING METHOD IN DIAGNOSTICS OF CRISIS AT AN ENTERPRISE

Aleksei Bykov

Belarusian State Economic University, 220109, ul. Krasina, 23-15, Minsk, Belarus. e-mail: *bylexa@mail.ru*

Abstract. The enterprise's diagnostic system, which can define the crisis stage and the causes of crisis, is developed. The diagnosing is carried out through the simulation of fluctuations of criteria, which describe the main processes on the enterprise, in the frame of stochastic parameters, estimated beforehand. As against known diagnostic models, the proposed system forms the verbal description of lacks in work of the enterprise with the indication of reliability of the given results.

1. Introduction

According to the theory of management science, the analysis of researched object or system is the first necessary stage, which starts the decision-making process. If an enterprise is considered as the researched system, then the diagnostics of the enterprise and its environment is realizing on the analysis stage. The procedure of diagnostics gets the special importance in anti-crisis management, because the intensity of destructive changes is extremely great in the company, which is in crisis situation, and its chances to survive directly depend on a duly and correct estimation of its financial and economic status.

Traditionally procedure of quantitative diagnostics in anti-crisis management assumes use of multivariate forecasting models, developed with the use of discriminant or regression analysis, and also rating models, developed with the use of "decision tree" method [1]*. These models allow to relate the researched enterprise to a class of "normal", the probability of bankruptcy on which is considered as low, or "problem", the probability of bankruptcy on which is considered as high, on the basis of the analysis of data of the financial statements. As the examples of multivariate forecasting models the indexes of Altman, Beaver, Taffler and also more perfect economic-mathematical methods, as neural networks and genetic algorithms, could be considered [2].

In spite of the fact that as the multivariate forecasting models, as well as the rating models used for diagnostics of bankruptcy are extremely widely distributed, they have a number of essential lacks, namely:

- the given type of models allows to diagnose crisis only after the enterprise actually has carried the economic damage, but cannot reveal the crisis phenomena at early stages, when the financial parameters of the enterprise are within the limits of norm;
- the development of the multivariate forecasting models requires providing the analysis of large volume of the homogeneous statistical information about results of functioning of many companies, which in conditions of constant changes of the legislation and practice of application of procedures of bankruptcy (as in Belarus) is frequently inconsistent or absent in general;
- the multivariate forecasting models don't reveal and don't explain the causes of crisis, that makes them not suitable for the analysis of situation and for the substantiation of managerial decisions.

The technique, which is proposed in the given paper, has the system approach to diagnostics of crisis status of the enterprise, and is deprived of a number of problems and lacks, which are inherent to the multivariate forecasting models, as well as the rating models. The developed technique of diagnostics allows solving the following tasks:

- to reveal the crisis processes at the enterprise at early stages, before insolvency and bankruptcy status has been reached;
- to define the causes of crisis at the enterprise, that makes expedient its use not only for diagnostics, but also for the decision-making;
- to estimate a degree of probability (reliability) of the received diagnosis.

The mathematical model of crisis process at the enterprise lays in a basis of the offered technique. Five efficiency criteria have been developed for description of this model. Another important element of the

* - Only the quantitative methods of diagnostics working at the minimal participation of the experts are considered in the given paper. The analysis of existing early warning systems (EWS), the highly skilled experts are the basic elements of which, leaves for frameworks of the publication.

technique of diagnostics is the technology of stress testing allowing to simulate dynamics of development of crisis process on the basis of stochastic initial parameters of the model.

2. The crisis process at the enterprise

The crisis should be considered not as a static status, but as a process. The development of crisis process at the enterprise assumes consecutive passing of several stages, namely strategic crisis, crisis of result, crisis of liquidity, and insolvency.

The enterprise receives the economic damage on each crisis stage, and the size of damage the is more, than more deeply is stage of crisis. The example reflecting dynamics of damage, received by the enterprise, as reduction of cost of the capital at various stages of crisis process is given in a Fig. 1.

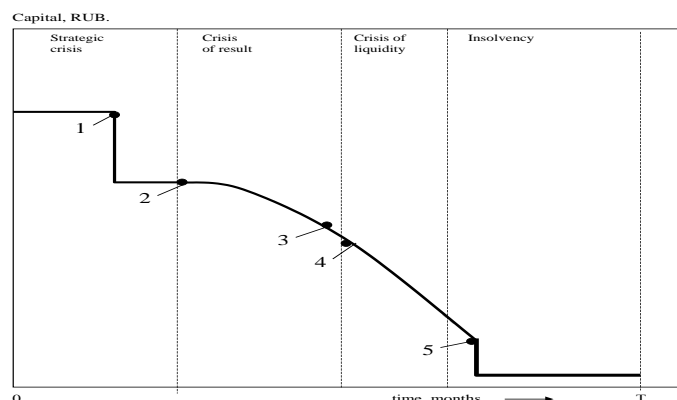


Fig.1 Development of the crisis process.

Let's consider the mechanism of development of crisis process, using points (1) - (5), designated on the diagram (see Fig. 1).

Point (1) - beginning of strategic crisis caused by fall of the market cost of the company. The causes of reducing the cost of the company may be different, like poor competitive position, or bad quality of goods, low equity-debt ratio, etc. The crisis process at the given stage is convertible, as the reduction of cost of the company hasn't been reflected in financial results of its activity.

Point (2) - beginning of the crisis of result. The enterprise will not be able to attract additional loans for financing its current assets because of the internal rate of return (IRR) of the enterprise has become lower than the interest rate, together with low liquidity or low equity-debt ratio. This leads to additional risks: absence of an opportunity to attract additional loans may compel the enterprise to distract money from the operation activity for duly payments, that will result reduction of sales, profit and cash-flow.

Point (3) - the enterprise becomes unprofitable and provides the reduced reproduction irrespectively of used source of capital. The volumes of operational activity can still be kept at a former level at the expense of use of depreciation for financing an operational activity, but the opportunities for the internal investments in long-term assets are absent.

Point (4) - beginning of the crisis of liquidity. The operational cash-flow (sum of the profit and depreciation) became negative, and the enterprise doesn't have reserves for updating a working capital. Each operational cycle the enterprise loses its current assets at a volume, which equals the negative size of the operational cash-flow. Volume of operational activity and sales are reduced. Since this point the enterprise has no chance to stop the crisis without special measures.

Point (5) - insolvency. The current assets are absent or less then the current debts due to pay. If the enterprise became bankrupt it will be either liquidated or reorganized - in any case rights on the part of the company's assets will be redistributed for the benefit of the creditors, and the owner of the enterprise will lose partially or completely the invested capital.

The model of the crisis process is fixed in a basis of the determined model of diagnostics allowing to reveal the current stage of crisis at the enterprise on the basis of a number of criteria.

3. Determined model of diagnostics of crisis

The process of diagnostics with use of the offered technique is carried out on the basis of the following information:

- data of the annual financial statements;

- standards and benchmarks of the efficiency criteria;
- expert ratings of some characteristics of the enterprise and its environment (such as share of variable and fixed costs in the total costs; the average interest rate for commercial loans and credits; the producers' price index; etc).

After input of the initial information about the enterprise and its environment some groups of financial and economic parameters, which are shared into three levels of hierarchy, are calculated:

- indexes - the basic parameters from the financial statements of the enterprises used in the further calculations;
- indicators - the absolute and relative parameters designed on the basis of indexes;
- efficiency criteria - the integrated factors and models designed with use of the indicators.

Five efficiency criteria are used in the developed technique, the precise description of which is given in the articles [3-5]:

- forecasting ratio of total debts to total assets, which reflects the financial risk of the business;
- criterion of productivity, which characterize the anti-crisis stability of the enterprise;
- the model of internal rate of return (IRR) of the company in inflation conditions, which appraises the efficiency of the company and its ability to attract additional loans and credits;
- the combined forecasting model of expecting time of insolvency, which can fix the liquidity crisis and insolvency under condition, when the enterprise cannot attract additional loans;
- the modified liquidity ratio, which estimates the causes of possible changes of liquidity in the forecasting year.

Further all the designed efficiency criteria and indicators are compared to the established standards or benchmarks. Thus the parity of the criteria and their standards forms the set of situations, each of which has some economic sense. The subsequent analysis of all received situations with the help of a set of the logic rules allows to characterize a status of the enterprise and to reveal the causes of crisis. Ten logic rules are used in the technique, and each rule characterizes the certain threat to the enterprise. Each of the certain combination of various threats forms the diagnosis of the enterprise (see Tab. 1):

Table 1

Revealing the stage of crisis depending on a combination of threats to the enterprise

The stage of crisis	The main threats
No crisis	are absent
Strategic crisis	low productivity; low share of equity in liabilities
The crisis of result	is not possible to attract loans due to: IRR lower then interest rate, together with low liquidity or low share of equity in liabilities
The crisis of liquidity	risk of reduction of volumes of operational activity under condition of impossibility to attract loans
Insolvency	risk of the termination of operational activity under condition of impossibility to attract loans

The determined model of diagnostics allows to reveal only one of the stages of crisis, which are specified in tab. 1, depending on a combination of the revealed threats. The realization of stress testing will allow to forecast so-called crisis profile, which means the probability of the case, when the enterprise will fall in one of the listed stages of crisis the next year.

4. Technology of stress testing

Stress testing can be defined as the "examination of the potential effects on a firm's financial condition of a set of specified changes in risk factors, corresponding to exceptional but plausible events" [6]. The stress testing on the researched enterprise within the framework of the developed model will be carried out on the basis of the following algorithm:

Step 1. Choice of the indicators, which are the normally distributed randoms. Their changes determine the values of the efficiency criteria used in the technique. Five indicators for stress testing have been defined, in particular, the equity-debt ratio; the parity of value added to the cost of assets; the time of current assets turnover; the share of fixed costs in overall costs; the parity of variable costs and sales.

Step 2. The probabilistic parameters of stress testing for each random indicator, as the mathematical expectation (M_j), the standard deviation (σ_j) and the coefficient of variation (ν_j), are defined on the basis of the statistical data.

Step 3. The values of the random indicators are generated. The calculation of the efficiency criteria will be carried out on the basis of these values, thus each efficiency criteria is the function of some random indicators:

$$EC_i = f(I_1, I_2, \dots, I_j), \quad (1)$$

where EC_i - efficiency criterion used in the technique;

$I_j = (M_j, \sigma_j)$ - normally distributed random indicator describer by the parameters of the mathematical expectation (M_j) and the standard deviation (σ_j).

Step 4. On the basis of the established logic rules and in view of threats given in Tab. 1, the current stage of crisis is chosen.

Step 5. The steps 3 and 4 of the present algorithm are counted N times, after that the estimation of probability of every $\langle j \rangle$ stage of crisis ($j \in [1;6]$), which submitted in tab. 1, occurs. Probability P_j calculated in formula (2):

$$P_j = \frac{C_j}{N}, \quad (2)$$

where P_j - probability of the case, when a status of the enterprise is appreciated by $\langle j \rangle$ stage of crisis;

C_j - the number of cases, when a status of the enterprise is appreciated by $\langle j \rangle$ stage of crisis during simulation;

N - total number of iterations.

The results of the stress testing, which has been carried out on the basis of the above-stated algorithm can be submitted as the diagram given in a Fig. 2. The forecasting period, during which the results of the diagnostics are considered as authentic, makes one year, that is caused by the features of the used efficiency criteria.

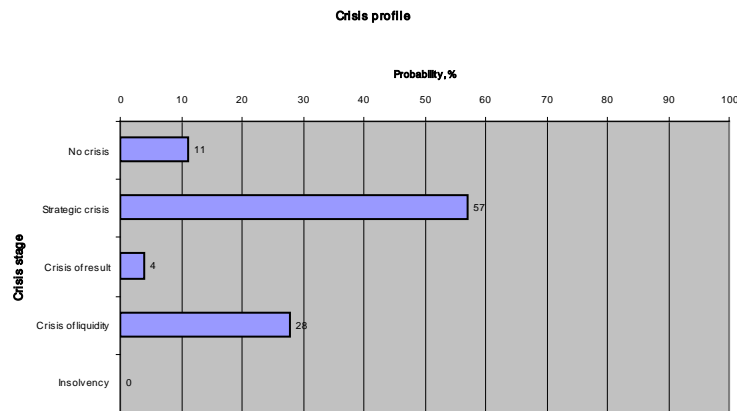


Fig. 2. The diagram of the crisis profile constructed on the basis of results of stress testing

5. Results of approbation of the technique and conclusions

The approbation of the developed technique on seven different Belarusian enterprises concerning various spheres of economy, has allowed to establish, that:

- the reliability of results of diagnostics of insolvency of the enterprises on the basis of the given technique is not lower, than with use of known forecasting models as Altman's Z-score, Beaver ratio and others;

- the developed technique allows to reveal early stages of crisis previous to insolvency, that is impossible with use of multivariate forecasting models, and rating models;

- the developed technique allows to define the major threats to the enterprise with the indication of reliability of the received results, that is impossible at use of other models of diagnostics. The example of results of rating of reliability of realization of threats is submitted in a Fig. 3.

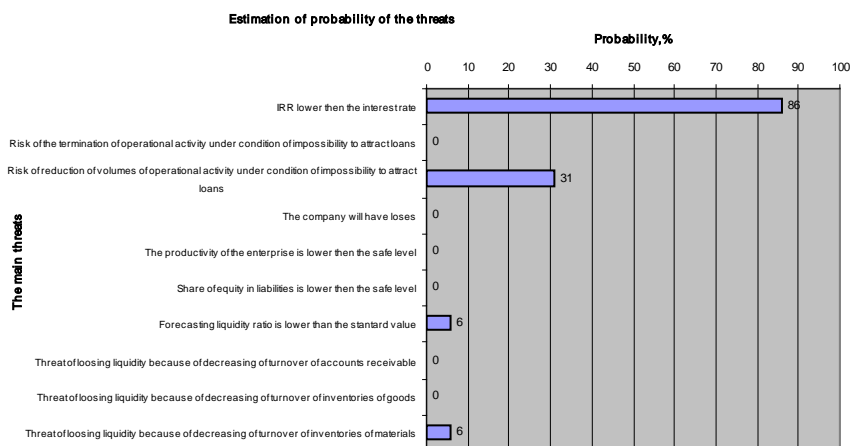


Fig. 3. The diagram of reliability of threats to the enterprise developed on the basis of results of stress testing.

The approbation of the developed technique allows to conclude, that it has essential advantages in comparison with known methods of crisis diagnostics at the enterprise and can be used for information maintenance of the decision-making process, in particular, in process of development of anti-crisis strategy at the enterprise.

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