

**Guryanova L. S.**

*professor of the economic cybernetics department, doctor of science in economics,  
e-mail: guryanovalidiya@gmail.com*

**Gvozdytskiy V. S.**

*lecturer of the economic cybernetics department, Phd in economics  
e-mail: gvozdikramm@gmail.com*

**Klebanova T. S.**

*head of the economic cybernetics department, doctor of science in economics  
e-mail: t\_kleb@ukr.net*

**Milevskiy S. V.**

*associate professor of the economic cybernetics department, Phd in economics,  
Simon Kusnets Kharkiv National University of Economics, Kharkiv,  
Ukraine; e-mail: milevskiysv@gmail.com*

### **FORECASTING AS A BASIC ELEMENT OF THE CORPORATIONS MANAGEMENT SYSTEM**

**Abstract.** The article is devoted to the development of an effective forecasting unit as an integral element of corporate management systems, including the financial management system. The expediency of proactive management modern technology introduction in the financial management system and subsystem of corporate enterprises anti-crisis management is proved. The necessity of developing a powerful forecasting unit within the framework of solving the problem of preventing financial crises in corporate systems is substantiated. The use of the socio-economic forecasting progressive method, the "Caterpillar" method, is substantiated. Approbation of the model complex showed that the financial condition of the corporation under investigation in the forecast period may be characterized by an increase in the level of the crisis threat, while for a number of subsidiaries there is a high probability of bankruptcy, which leads to the need to implement anti-crisis measures in the corporate structure.

**Keywords:** "caterpillar" method, corporation, financial crisis, forecasting, management system, model

**JEL Classification:** C53, G30, M21

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**Гур'янова Л. С.**

*д.е.н., професор кафедри економічної кібернетики  
Україна; e-mail: guryanovalidiya@gmail.com*

**Гвоздицький В. С.**

*к.е.н., викладач кафедри економічної кібернетики  
Україна; e-mail: gvozdikramm@gmail.com*

**Клебанова Т. С.**

*д.е.н., зав. кафедри економічної кібернетики  
Україна; e-mail: t\_kleb@ukr.net*

**Мілевський С. В.**

*к.е.н., доцент кафедри економічної кібернетики  
Харківський національний економічний університет ім. С. Кузнеця,  
Україна; e-mail: milevskiysv@gmail.com*

### **ПРОГНОЗУВАННЯ ЯК ОСНОВНИЙ ЕЛЕМЕНТ СИСТЕМ УПРАВЛІННЯ КОРПОРАЦІЙ**

**Анотація.** Стаття присвячена розробці ефективного блоку прогнозування як невід'ємного елементу систем управління корпорацій, в т.ч. системи фінансового управління. Обґрунтовано використання прогресивного методу соціально-економічного

прогнозування – методу «Гусениця». Доведено ефективність застосування запропонованих моделей прогнозування на прикладі вітчизняної сільськогосподарської корпорації.

**Ключові слова:** корпорація, метод «Гусениця», модель, прогнозування, система управління, фінансова криза

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**Гурьянова Л. С.**

*д.э.н., профессор кафедры экономической кибернетики  
Украина; e-mail:guryanovalidiya@gmail.com*

**Гвоздицкий В. С.**

*к.э.н., преподаватель кафедры экономической кибернетики  
Украина; e-mail:gvozdikramm@gmail.com*

**Клебанова Т. С.**

*д.э.н., зав. кафедры экономической кибернетики  
Украина; e-mail:t\_kleb@ukr.net*

**Милевский С. В.**

*к.э.н., доцент кафедры экономической кибернетики  
Украина; e-mail:milevskiySV@gmail.com*

*Харьковский национальный экономический университет им. С. Кузнеця*

## **ПРОГНОЗИРОВАНИЕ КАК ОСНОВНОЙ ЭЛЕМЕНТ СИСТЕМ УПРАВЛЕНИЯ КОРПОРАЦИЙ**

**Аннотация.** Статья посвящена разработке эффективного блока прогнозирования как неотъемлемого элемента систем управления корпораций, в т. ч. системы финансового управления. Обосновано использование прогрессивного метода социально–экономического прогнозирования – метода «Гусеница». Доказана эффективность применения предлагаемых моделей прогнозирования на примере отечественной сельскохозяйственной корпорации.

**Ключевые слова:** корпорация, метод «Гусеница», модель, прогнозирование, система управления, финансовый кризис

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**Introduction.** The current state of Ukraine's economy is characterized by instability in almost all spheres of economic activity, unfavorable trends are noticeable in many sectors. And as a result, about 40% of all domestic enterprises operate with losses. In recent years, the problem of Ukrainian business entities bankruptcy has become much more acute. So, on average, about 9 domestic enterprises a day filed a bankruptcy case. And this problem is most acute now in the corporate sector. As known, despite a relatively small number among all Ukrainian enterprises (less than 0.1%), corporations produce more than 60% of Ukraine's GDP. That is why the crisis phenomena in any corporate enterprise have serious consequences for the whole national economy. An effective solution to overcoming the crises in these enterprises is to improve corporate governance systems, namely, financial management systems that should be based on the principles of modern proactive management technology. As the experience of the domestic corporations functioning shows, with the timely or systematic non–use of such modern technologies, the possible negative losses from financial crises that have emerged in corporate enterprises are times more than the time and material costs associated with their implementation in the corporate system. The introduction of a proactive approach allows timely diagnosis of negative phenomena and processes, developing appropriate effective management solutions and preventing crises. Thus, each corporation financial management system must have a powerful forecasting block, and the article is dedicated to forecasting as an integral and main element of corporate governance.

**Literature review and the problem statement.** The development of prediction models for assessing the financial crises threat (and in particular, the models for enterprises bankruptcy diagnosing) within the framework of the financial management system began to be engaged only from the second half of the 20th century. The given questions are highlighted in the works of such

domestic and foreign scientists as: E. Altman, V. Beaver, I. Blagun, V. Vitlinsky, V. Voronina, Y. Zaichenko, G. Kadikov, M. Kizim, A. Matviychuk, A. Morozevich, A. Nedosekina, D. Olson, R. Sayfulin, G. Sprinkyta, R. Tuffler, O. Tereschenko, G. Haidarshina, O. Chernyak, D. Chessera and others. In particular, the following aspects of financial management were investigated: selection of the most significant factors influencing the probability of enterprises bankruptcy, analysis of the most appropriate methods for assessing the crisis formation threat in enterprises, analysis of different approaches to the formation of enterprise crisis management policy, introduction of econometric modeling in the process of financial analysis, etc.

But in these works less attention is paid to the problem of complex improvement of the enterprises financial management system (including corporations) – in many cases the development and implementation of tools for diagnosing crisis phenomena in a specific period of time is a central issue. And, accordingly, it is proposed to improve the system of financial management by solving this particular problem. In this paper, the significance of forecasting as an integral part in the process of the corporations financial management system functioning, both in normal conditions and in the current financial crisis of any degree, is substantiated.

**Research results.** The financial system of any enterprise of a corporate type has a subsystem of financial state control and a subsystem of crisis management. In today's conditions of uncertainty and risks, the task of crisis management should not only prevent the crisis, but also provide the early identification of a point of bifurcation, its prediction, which would allow to prevent irreversible negative changes and reach a new level of development with the least negative consequences. And for this reason, now the main direction of crisis management modern improvement in corporate systems is the proactive management technology. The feature of the subsystem of proactive crisis management (PCM) is that it, on the one hand, has to perform the functions inherent in any management system (planning, organization, motivation, coordination and control), and, on the other hand, the fulfillment of these functions has a specific orientation [10, 13]. The difference between proactive anti-crisis management and conventional anti-crisis management is the detection of "signals" that can lead to negative phenomena, during monitoring and comprehensive diagnosis of financial condition. And in the special place is the problem of clear identification of the weak signal precisely as a signal of a threatening stable existence of the enterprise [13]. The main criterion for identifying a signal is the threat of bankruptcy at the enterprise.

In previous studies [4, 15] a methodical approach was proposed on the basis of proactive crisis management consisting of 5 blocks. Its application determines the threat of financial crises both in affiliated enterprises and in the corporation as a whole, the impact of the crisis in affiliated enterprises on the financial position of the corporation is estimated, the financial position of the corporate enterprises is foreseen in future periods, and the complex of optimal anti-crisis measures for the corporation is determined. Implementation of this approach will allow timely diagnose the possibility of a financial crisis in a particular enterprise and the corporation as a whole, determine its depth, as well as develop and adopt appropriate crisis management decisions.

The study [4] justified the choice of tools for implementing each of the blocks of approach. Thus, it has been proved that in today's conditions of uncertainty and risks, as a tool for modeling the assessment of the threat of financial crisis formation for corporations, it is most appropriate to use a method based on the application of neural networks and the mathematical apparatus of fuzzy logic; to predict the values of financial indicators of a corporate enterprise financial condition – the "caterpillar" method. The mentioned tools combine most of the positive features used in other relevant methods, and their application coincides with the essence of the proactive crisis management introduction in the corporation. However, in order to obtain higher adequacy of models, it is proposed to use them in a complex manner with other economic and mathematical methods.

Many famous models for bankruptcy diagnosis (various modifications of the Altman model, models of Taffler, Beaver, Fox, Fulmer, Davidova and Belikova, Sayfulin–Kadykov etc.) with some precision determine the probability of bankruptcy once during the forecast period (a year or two,

three and more). However, recent studies [2, 5–8, 12, 15] show that in nowadays their accuracy is greatly reduced, and it can be increased through the development and implementation of a financial management system powerful forecasting unit, the raw data from which can also be used in constructed models for assessing the threat of financial crisis formation.

The algorithm for implementing the prediction unit proposed in the work is presented in Fig. 1 [3, 15].

The results of the specified algorithm phase 1 implementation should coincide with those obtained in the previous blocks of the methodological approach (in the development of appropriate neuro–fuzzy models for assessing the threat of financial crises in corporate systems). It should be noted that there is a fairly wide range of methods that allow to obtain a substantiated information space that meets all the essential requirements [1]. Formation of information space is given in [9]. Thus, a system of the corporate system financial condition indicators was defined: X1 – coefficient of fixed assets suitability; X2 – fast liquidity ratio; X3 – coefficient of financial autonomy; X4 – the coefficient of assets turnover; X5 – activity profitability. The current system of indicators describes the financial situation from the point of view of all areas of the enterprise, so it allows to adequately evaluate it.

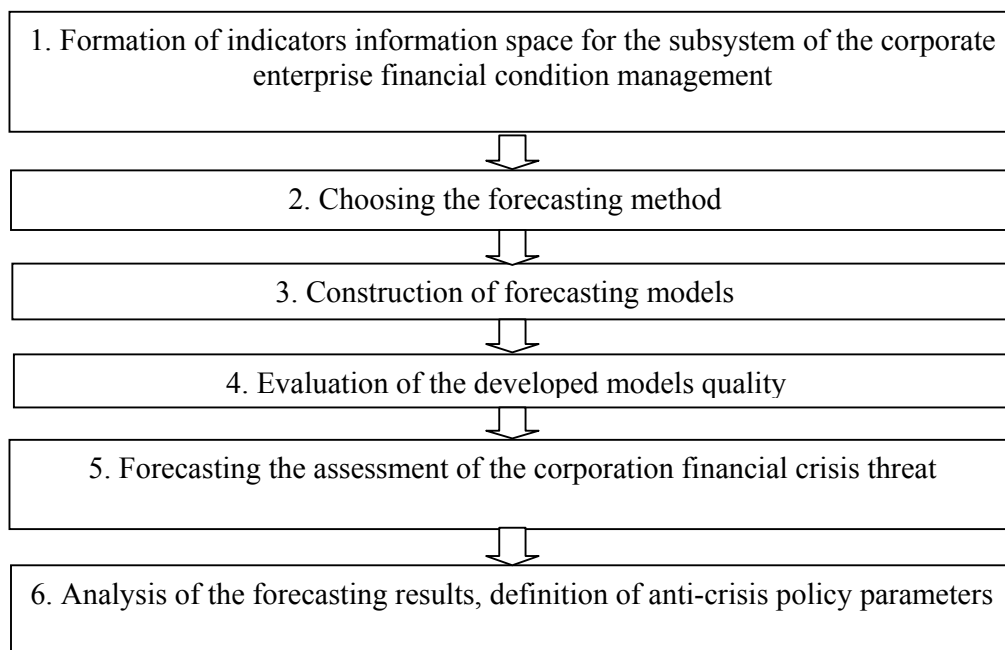


Figure 1. Algorithm for implementing the "Forecasting" block

As already mentioned above, as the tool for forecasting (step 2 of the algorithm (Fig. 1)), the latest "caterpillar" method was chosen. This method is intended to study the structure of time series, combining the advantages of many other methods, in particular, Fourier analysis and regression analysis. At the same time, it is characterized by simplicity and visibility in management [16]. When implementing this method, as with adaptive methods of forecasting, there is a smoothing of a time series; as with spectral analysis, a series is decomposed into components (including harmonic components); as well as the theory of catastrophes, the "caterpillar" method allows to adequately assess sharp, abrupt changes in a series and shows the correct direction of processes development, etc.

At stage 3 of the algorithm (Fig. 1), the development of forecasting models is carried out. The basic version of the "caterpillar" method is to convert a one–dimensional series into a multidimensional with the help of one–parameter displacement procedure (hence the name – caterpillar), to study the resulting multidimensional trajectory by analyzing the main components (singular expansion) and restoring (approximating) the number of selected main components [14].

The result of the method is the expansion of the time series into simple components: slow trends, seasonal and other periodic or oscillatory components, as well as noise components [14]. The resulting decomposition can serve as the basis for forecasting both the series itself and its individual components.

The main parameter of the method is  $M$  – the length of the caterpillar. That is, the task of choosing this length is an extremely important step. With geometric interpretation, this parameter is the dimensionality of the space in which the trajectory of a multidimensional broken line is investigated, to which the initial time series is translated by the "caterpillar" procedure. The natural condition is  $M < N / 2$ , because the dimension of the set of  $k$  points (vertices of the broken) in the  $M$ -dimensional space does not exceed  $\min(M, k-1)$ . In general, the choice of caterpillar length essentially depends on the task solved by this method. To achieve the goal set out in this study, it is first appropriate to visually analyze the graphs of the source data and try to determine the approximate frequency [14].

At stage 4 of the algorithm of the block (Fig. 1), the quality of the constructed models is estimated using known statistical criteria [11], and the logic of the economic interpretation of the obtained results is checked.

At stage 5 of the algorithm, the predicted values of the financial indicators are used in the neuro-fuzzy models constructed in the previous blocks for assessing the threat to the financial state of both subsidiaries and the corporation as a whole.

In step 6, an analysis of the results is carried out. The significance of assessing the threat of crises is analyzed in the dynamics, determined the factors that led to current situations, the pre-selected set of all possible anti-crisis alternatives, depending on a certain class of crisis, etc.

The above-mentioned algorithm for the implementation of the "Forecasting" block (Fig. 1) was tested on an example of a domestic agricultural corporation. The model for assessing the threat of crisis in the corporation parent company was based on a sample of 36 non-state major enterprises of the agricultural sector corporations in Ukraine, among which there are 12 bankrupts, and 24 normally functioning corporations. The model for assessing the threat of financial crises in affiliated enterprises was based on a sample of 40 non-state subsidiaries of the agricultural sector corporations in Ukraine, among which there are 24 normally functioning enterprises and 16 bankrupts. This model was tested on 5 subsidiaries of the investigated corporation. It also evaluated the impact of crises on these subsidiaries on the financial position of the corporation as a whole and developed a scheme for crisis management of this corporation.

Forecasting with the "caterpillar" method was made using the CaterpillarSSA 3.4 application package. Note that the implementation of the method was carried out at the same time for all series:  $X_1$ – $X_5$  (all of them have the same dimension). This program allows for multidimensional research. In fig. 2 showed the graph of the output series of the subsidiary №1.

From Fig. 2 it can be concluded that the series have annual frequency, which was also confirmed by a series of averaged covariates. That is, the length of the caterpillar should be multiple to 12. That is, for this case, it is advisable to choose the length of the caterpillar, equal to 4.

For the analysis of the main components in the implementation of the "caterpillar" method, an analysis of the covariance matrix eigenvalues characteristics is carried out. According to the results of this analysis, it was concluded that after about the 4th main component there is noise (uniform decrease of very small eigenvalues).

In Fig. 3 showed one-dimensional graphs of eigenvectors and main components. According to the results of the visual analysis, one can not conclude whether there is any of the main components is the component of the trend. That is, all the pairs of the main components can be related both to the trend, and to the low-frequency component (which is formally vague). The most obvious presence of the semi-annual (main components 3–6) periodicals.

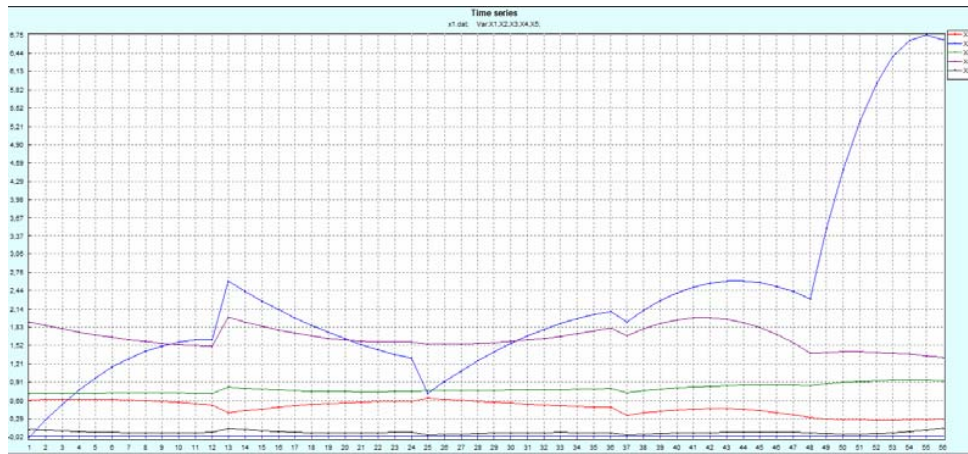


Figure 2. The output data graph

One-dimensional graphs of the main components are presented in Fig. 3

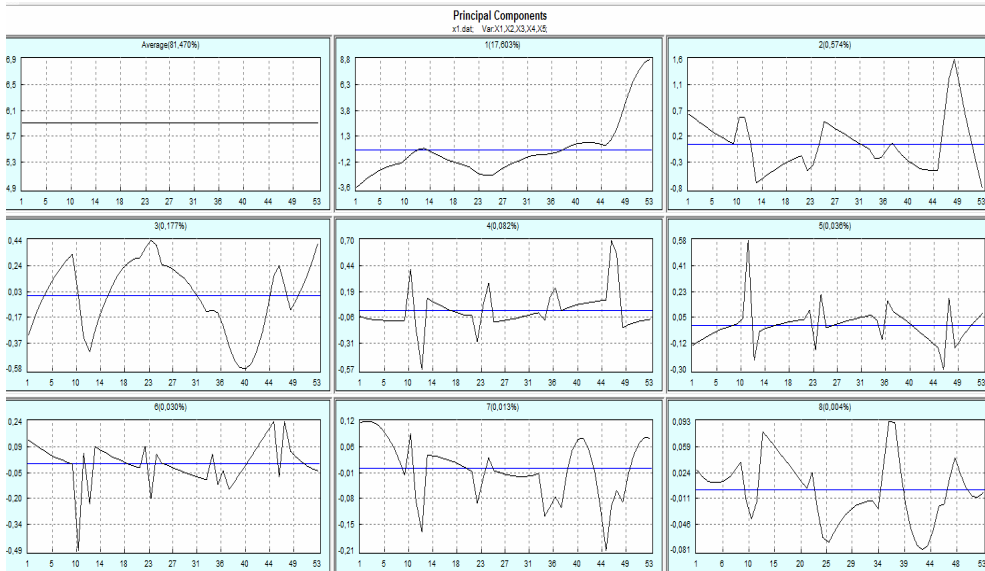


Figure 3. One-dimensional graphs of the main components

Two-dimensional graphs of the main components are presented in Fig. 4

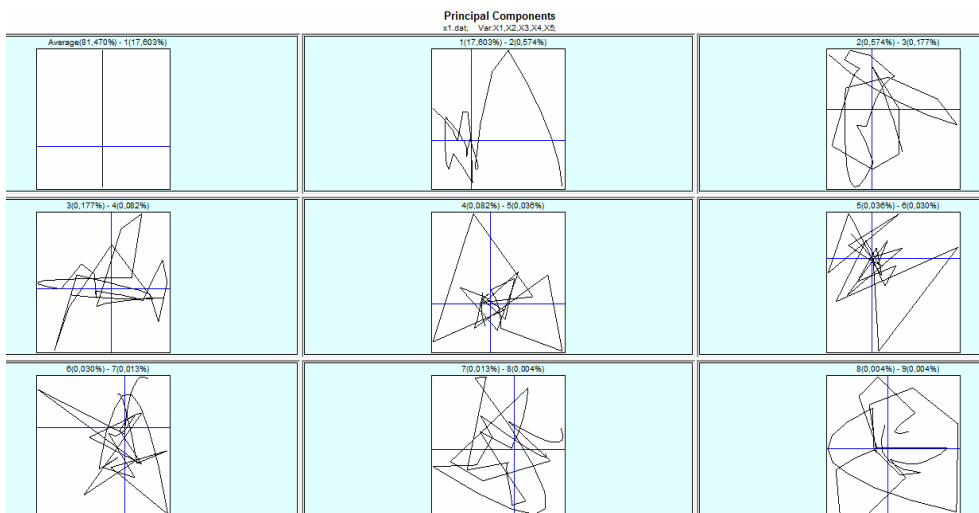


Figure 4. Two-dimensional graphs of the main components

To facilitate the breakdown of the main components in pairs, two-dimensional graphs of main components are used (Fig. 4). After all, the two-dimensional image of the sinus and cosine forms a unit circle, then the harmonic component with the whole period is depicted in the form of a regular polygon with the number of vertices, equal to the magnitude of the period. When the amplitude changes, the polygon is converted into a spiral (this is obvious in Fig. 4) [14].

Using the results of the analysis of the graphs of the eigenvectors and the main components, the series was restored by selected components (the first three). The graph of output and restored values is presented in Fig. 5.

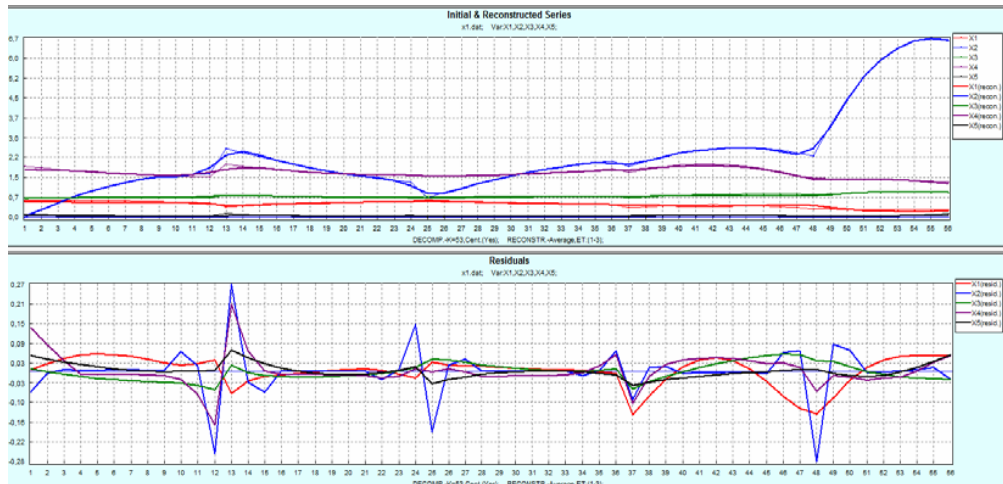


Figure 5. Restored values and errors

As seen from Fig. 5, the output and recovered rows almost coincide, since the contribution of the average and the first three main components is 99.8%. Below, Fig. 6 shows a number of residues, that is, the difference between the initial and the restored rows – they were also insignificant.

The graph of the predicted values with confidence intervals (0,95) is presented in Fig. 6.

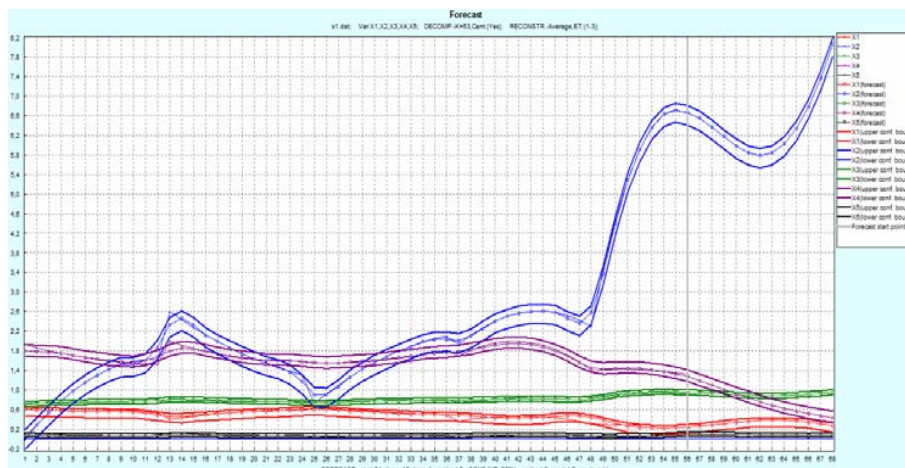


Figure 6. Confidence intervals for predictive values

The adequacy of this forecast is estimated by the criterion of the mean absolute percentage error (m.a.p.e). So, for the series X1, m.a.p.e. – 7.78%; for the series X2 m.a.p.e. – 2.15%; for the series X3 m.a.p.e. – 2.59%; for the series X4 m.a.p.e. – 1.80%; for the series X5 m.a.p.e. – 5.70%. As can be seen, the results of forecasting for all series of indicators are excellent, so the results of forecasting indicators X1–X5 for SE №1 can be used, because all the absolute m.a.p.e. values less than 10% [11].

Similarly, forecast models for all series of indicators for all subsidiaries and the corporation as a whole were constructed. For the construction of forecasting models for other SCs, the length of

the caterpillar was equal to 4 and 12, for the main enterprise of the corporation – length 3. For all the series of all enterprises for forecasting, the restored data was used for forecasting.

In general, the results of forecasting can and should be used in further research. Forecasting of the corporation and subsidiaries future state was made for the following year ( $t = 60$ ) in three ways: pessimistic (based on the forecasted values of the lower intervals), optimistic (by the values of the upper interval) and realistic (based on the forecasted results).

The forecast values for the three options for all enterprises are presented in table 1.

Table 1

Forecasting results				
Subsidiary company	Series	Forecast by value		
		pessimistic	realistic	optimistic
№1	x1	0,261	0,339	0,391
	x2	5,745	5,996	6,139
	x3	0,850	0,903	0,955
	x4	0,827	1,108	1,159
	x5	0,064	0,082	0,105
Subsidiary company	Series	Forecast by value		
		pessimistic	realistic	optimistic
№2	x1	0,475	0,484	0,511
	x2	0,191	0,200	0,224
	x3	0,625	0,684	0,704
	x4	1,108	1,159	1,241
	x5	-0,056	0,019	0,089
№3	x1	0,470	0,532	0,583
	x2	1,688	1,741	1,792
	x3	0,677	0,798	0,846
	x4	0,848	1,023	1,246
	x5	0,115	0,157	0,185
№4	x1	0,233	0,249	0,263
	x2	0,305	0,345	0,375
	x3	0,041	0,090	0,121
	x4	1,212	1,290	1,366
	x5	-0,113	-0,078	-0,018
№5	x1	0,778	0,813	0,833
	x2	10,014	10,628	10,952
	x3	0,996	0,999	1,000
	x4	0,017	0,043	0,088
	x5	11,528	12,051	12,310
Corporation	x1	0,195	0,269	0,288
	x2	2,912	2,946	2,986
	x3	0,859	0,956	0,988
	x4	0,780	0,793	0,809
	x5	0,099	0,125	0,142



We use the obtained predictive values in constructed neuro–fuzzy models in MatLab environment. The results of modeling for all subsidiaries and corporation in general are presented in table 2.

Table 2

Forecast estimates of the financial crises threat

Company	Current estimate	Forecast estimate		
		Pessimistic	Realistic	Optimistic
№1	–0,320	–0,216	–0,535	–0,623
№2	0,513	0,495	0,501	0,374
№3	0,481	0,757	0,735	0,565
№4	1,337	1,241	1,031	0,839
№5	0,000	–0,163	–0,188	–0,189
Corporation	–0,541	0,396	0,113	–0,182

Thus, as we see from table 2, the overall financial position of the corporation will deteriorate significantly: the assessment of the financial crises threat will increase from –0.541 in the current year to 0.396 on a pessimistic forecast and –0.182 on optimistic. In any case, the threat will increase very much. Also, the state of the SC №3 will deteriorate considerably: according to the realistic and pessimistic variants of the forecast, the threat of the enterprise bankruptcy can be characterized as large. On the SC №1, №2 and №4. For the first two mentioned companies threats is very low, but for SC №4 it still is, on the contrary, very large, and the onset of a catastrophic crisis at this company is very likely.

That is, based on the results of the simulation, one can conclude that the management of both the corporation and its subsidiaries needs to act more sensibly in the near future, since in the long run the estimated threat of bankruptcy may increase significantly. But still the corporate inclination to bankruptcy can be estimated as significant, so it is advisable to develop a scheme for crisis management.

Consequently, the use of built models allows corporations to significantly reduce potential losses through the early identification of the financial crisis threat and the appropriate implementation of preventive, proactive anti–crisis measures.

**Conclusions.** Thus, the implementation of the proposed algorithm of the forecasting unit in the system of corporations financial management will allow timely prevention of the onset of financial crises in corporate enterprises and improve the efficiency of the organization as a whole.

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