

Analysis and Forecasting of Credit Institutions Bankruptcy Using Neural Network Modeling

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Abstract. This work is devoted to the study of the probabilistic bankruptcy state of Russian Federation credit institutions. It develops a tool (neural network) designed to assess the financial condition (bankruptcy) of banks. Data collection and generalization are carried out, the results of numerical modeling are shown. The neural network is created and optimized with the help of collected training sample. Subsequently, several tasks related to the assessment of financial condition are solved. The work has an applied nature, as the results can be useful for credit institutions of the Russian Federation.

1. Introduction

The bankruptcy problem of credit institutions is very relevant at present. Their important role is to ensure the development of the economy, such organizations are considered to be the main ensuring link of stable development. This raises the possibility question of analyzing and forecasting the financial condition of commercial enterprises for the future.

Many publicists were engaged in research in the field of neural network model creation [2],[3],[4]. In particular, [1] created a model that takes into account only the internal parameters of credit institutions. In [5] along with the internal parameters used quality parameters that affect the accuracy of the forecast. Also, the internal parameters of the organization were used in the work [6], which set the task of assessing the financial condition of the oil and gas sector.

In the works [7],[8],[9],[10],[11],[12] various methods of teaching neural networks, which are used in various fields of activity, are considered. For example, in navigation [13], in optimal control problems [14], in regression problems with large amounts of data [15].

A distinctive feature in this work is the creation of a new neural network model that takes into account foreign economic parameters, such as inflation, the dollar rate, the RTS index and the price of oil.

2. Problem statement

When setting the forecasting task, the hypothesis is introduced that there are some regularities between the bank's financial indicators and bankruptcy recognition.

2.1. Applicable Parameters

The bankruptcy of organizations depends on the performance of the company.

The Bank of Russia sets standards that each credit institution must comply with. The Central Bank orders credit organizations to comply with 9 regulations [16]. In this paper, 8 of them will be used, since they are publicly available and are displayed in reporting forms.

The sustainability of each country's economy is characterized by different indicators. One of the main ones are 4 indicators.

These criteria will be chosen as input parameters for programming the neural network since they are accessible and included in the official standards of the Russian Federation Central Bank.

- *The ratio of capital adequacy of the bank (X_1);*
- *Instant liquidity ratio (X_2);*
- *Current liquidity ratio (X_3);*
- *Long-term liquidity ratio (X_4);*
- *Standard maximum size of large credit risks (X_5);*
- *The maximum size ratio of loans, bank guarantees, and guarantees provided by the bank to its members (shareholders) (X_6);*
- *The total risk ratio of bank insiders (X_7);*
- *The use ratio of own bank funds (capital) for the purchase of other legal entities share (X_8);*
- *Inflation rate (X_9);*
- *Dollar rate (X_{10});*
- *RTS Index (X_{11});*
- *Brent price per barrel (X_{12}).*

2.2. Data

The set consists of 155 banks, 85 of which, for the period 2016-2017, revoked the license, and the remaining 70 continued their activities over the same period.

The dependent variable will assume a value of zero if the license has been revoked from the bank, and a value of one if the bank continues its operation.

The creation, optimization, training, testing of the neural network was performed using the Statistica Neural Networks neuron packet.

3. Neural network modeling

After determining the input and output parameters, we determine the distribution of the sample set. We need to achieve the smallest error in teaching the INS, so we assign 85% of all values to the training sample. We divide the rest of the sample into the test set (10%) and the test set (5%) [17], [18].

3.1. Structure and training

The optimal structure of a neural network is a multilayer perceptron [19], which has twelve input neurons, one hidden layer with ten neurons and one output neuron. The hyperbolic tangent was used as the activation function of neurons of the hidden layer.

As for the learning algorithm, in this work we use the Broyden – Fletcher – Goldfarb – Shanno algorithm (BFGS), since it is the most suitable for this task [20]. After the appropriate settings, the next step is to train our neural network. After training, we obtain the following results, presented in table 1.

Table 1. Learning outcomes.

Title	Learning correlation coefficient	Testing correlation coefficient	Learning error	Testing error	Learning algorithm	A hidden layer activation function
MLP	0.9719	0.9185	0.0069	0.022	BFGS	Tanh

The graph of the absolute error is presented in figure 1. The graph of the root-mean-square error is presented in figure 2. With it, high interpolating properties of the neural network are observed. Dots indicate deviations from the data entered by us. As you can see, the number of points, the magnitude of the absolute error of which does not exceed 0.2, is quite small, and we can assign them to the category of emissions.

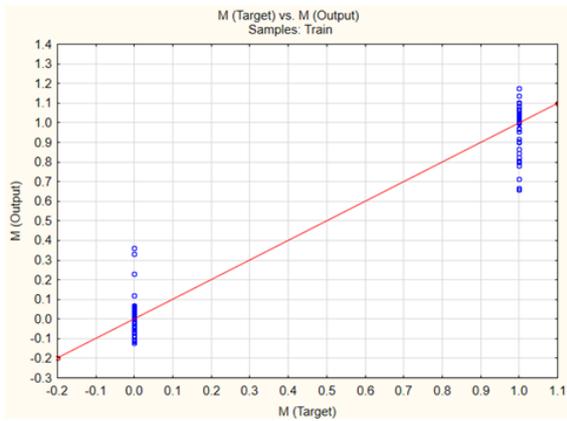


Figure 1. Absolute error graph.

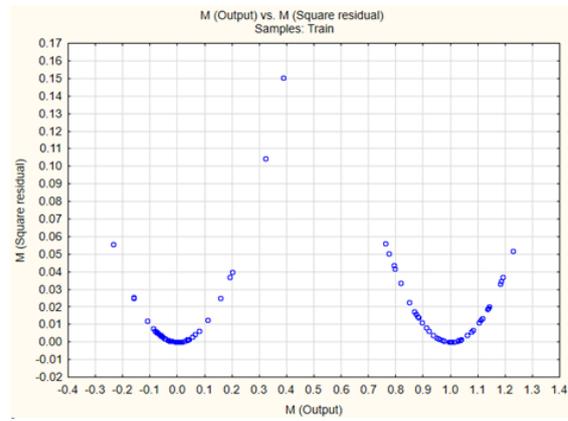


Figure 2. Standard error graph.

3.2. Model-checking

The created and customized neural network model will be tested with specific examples. We create a new sample of 10 examples, presented in abbreviated form in table 2.

Table 2. Created value selection.

Title	X_1	...	X_{12}	Y
Neftyanoy Alliance	0	...	49.4	0
Finars Bank	31.148	...	49.4	0
Mezhtopenergo-bank	12.953	...	48.86	0
Arsenal	31.072	...	47.66	0
New Symbol Bank	21.877	...	47.66	0
Bank Otkritie Financial Corporation	11.876	...	52.1	1
Tinkoff Bank	16.267	...	52.24	1
VTB Bank	12.164	...	46.8	1
UniCredit Bank	18.646	...	46.81	1
Sberbank	15.872	...	42.33	1

The data are taken for 2017 and represent 10 banks, 5 of which have revoked the license, and the remaining 5 continued their activities over the period.

Applying the configured neural network to our sample, we obtain the data in table 3.

Table 3. Comparative characteristics of set and model numerical values.

Invariant Y	Model Y	MSE
0	0.173687	0.030167
0	0.264174	0.069788
0	0.207798	0.04318
0	0.01972	0.000389
0	0.139942	0.019584
1	1.224785	0.050528
1	1.1704	0.029067
1	1.073445	0.005394
1	0.991413	7.37E-05
1	0.890423	0.012007

As you can see, the neural network coped well with the goal.

4. Conclusion

So, the bankruptcy is a significant threat to organizations, since this process can have a significant impact on the economy of the country as a whole. A promising direction in the study of this problem is the use of neural systems.

As part of this work, a neural network has been created and optimized that is capable of solving the problem of assessing the financial condition of a credit institution.

At the beginning of the study, the standards of the Russian Federation Central Bank were studied, which served as input parameters for the neural network. The foreign economic parameters, which have a greater influence on the country's economy as a whole, and in particular on the banking sector, were analyzed. Based on them, a training sample was compiled, consisting of 8 standards of the Russian Federation Central Bank and 4 external parameters. Further, in the intellectual environment Statistica, the neural network itself, which is a perceptron, was created and its configuration was made.

In contrast to the previous work [1], new input parameters were added, which represent a characteristic of the country's economy. Also, the magnitude of the learning error was reduced from 4% to 0.69%, and the generalizing ability increased from 88% to 97%.

In the course of training, results have been obtained that speak of excellent accuracy and generalizing ability of the network.

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