

RATING AS A PART OF BEHAVIORAL SCORING OF LEGAL ENTITIES



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Abstract. The article shows what the rating for evaluation of the borrower and indicates the principles of construction the ratings of legal entities is. Main indicators, that characterize the functioning of entities, and their limit values were analyzed. The regularities of the financial indicators were set for the sample according to the ratings. Also, the rule base was built based on fuzzy logic and the criteria that should guide the prediction of the rating of the enterprise in a half year was allocated.

Keywords: *rule base, rate, method rating assessment default, legal entity, borrower, financial indicators.*

Introduction

The assessment of credit risks of the enterprise is a very important issue for the banks, who should evaluate their borrowers. Therefore, it is necessary to determine the financial condition of the enterprise, its weaknesses, as well as the ability to provide a forecast of its activities and the probability of non-repayment of the loan to its creditor.

The possibility of non-repayment of the loan lead us to make a study of the principles, criteria, methods of assessing the effectiveness and financial stability of the borrowers - legal entities.

Literature review. A research among Ukrainian and foreign scientists was made. Problems of credit risks were described by: V. Vitlinsky, V. Kochetkov, O. Lavrushin, M. Messer, O. Pernarivsky, I. Pasichnyk, J. Sinki, I. Fischer and others. These scientists have created a theoretical basis for solving the problem of credit risks. However, in my opinion, the proposed approaches do not fully take into account the need for future prediction of the borrower's rating, for which it is necessary to determine the list and values of financial indicators.

Research methodology. The purpose of the article is to develop a methodological approach to rate the borrowers - legal entities. To achieve this goal we need to find solution for the following research tasks: determining the economic essence of the borrower's rating; generalization of domestic and foreign experience in rating borrowers - legal entities; improvement of the existing rating policy (used by one of the Ukrainian banks); development of economic and mathematical models for assessing the risk of bankruptcy and forecasting the default of the borrower; experimental study of the adequacy of models to assess the rating of an individual borrower in six months.

Research results. Based on the data from the balance sheet and the report on financial results, the financial indicators were calculated and their values were found. After that it is possible to form a rule base for determining the rating of borrowers - legal entities.

Rating (assessment, assignment to class, category) is an assessment of the position of the analyzed object on a scale of indicators. Our model was built on the basis of the rating scale of the one of Ukrainian bank. The rating scale consists of 12 main categories, according to which counterparties are classified into 2 groups: performing (categories 1 - 10) and non-performing (11 - 12). In turn, performing clients are divided into two classes: investment (categories 1 - 5) and non-investment class (6 - 10).

This rating scale is quite flexible. It allows you to increase with a sign "+" or decrease with a sign "-" ratings of counterparties in categories from 1 to 10. This contributes to a better differentiation of companies within one category. For example, category 1 consists of 1+, 1 and 1-, etc.

The methodological approach that we will use for establishing the borrower's rating is based on the theory and methodology of comprehensive analysis of the enterprise. The final rating of the borrower takes into account all the most important parameters (indicators) of financial and economic activities that characterize the production potential of the borrower, profitability of its products, efficiency of production and financial resources.

Also, the methodological approach that we will use is comparing the system of indicators which characterize the financial and economic condition of the borrower, with the conditional reference borrower, who has the best results on all comparable indicators.

Step 1. We take historical data for legal entities for the beginning of year X and the same legal entities for the mid-year.

Step 2. We are choosing the maximum possible number of financial indicators to cover as wide range as possible. We took 60 indicators (depreciation ratio of fixed assets, inventory coverage ratio, etc.). The assessment of financial condition can be objectively carried out not through one, even if it the most important indicator, but only with the help of a system of indicators that can characterize in details the economic situation of the enterprise.

Step 3. We sort our surveyed companies according to the bank's rating, and for clarity we build graphs for each coefficient to see the relationship between the values of indicators, ranging from the highest value of the rating to the lowest. Divide the plane of the chart into three parts - to the hatched vertical line (as shown in Fig. 1 and 2) of the enterprise with an investment rating, between the hatched and solid - with non-investment, and after a solid - default enterprises.

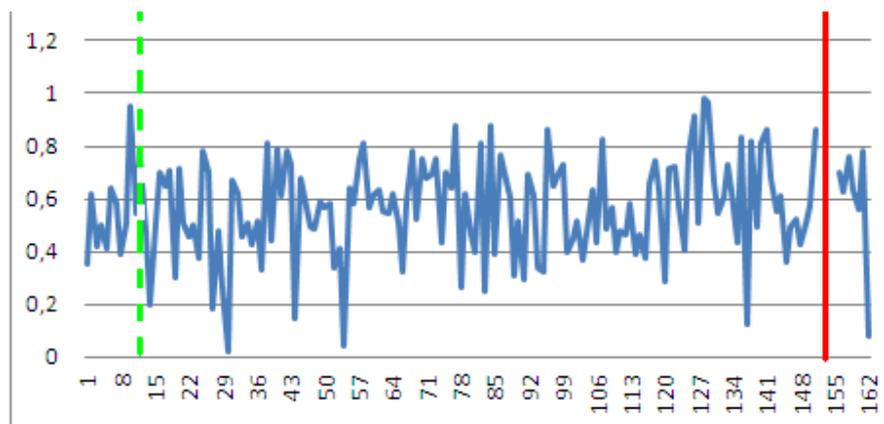


Figure 1. Disposal rate of fixed assets

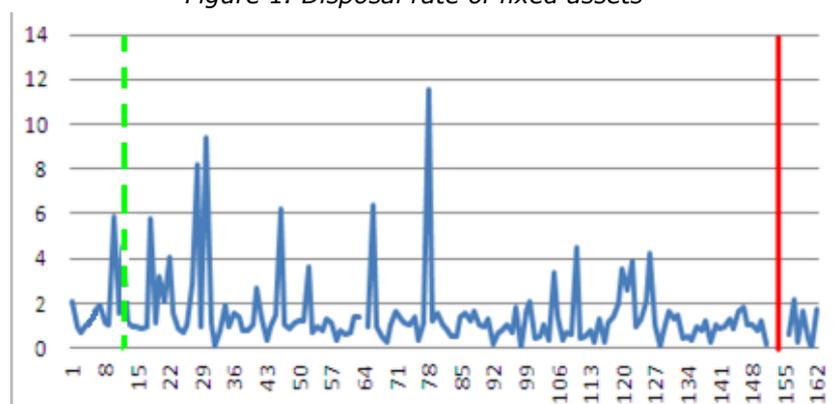


Figure 2. Coverage ratio, or current liquidity ratio

Step 4. We must select the most informative indicators and discard all uninformative ones in order to avoid overloading the model.

So, we rated, sorted and plotted our borrowers. As a result, we obtained two groups of graphs. The main part of them are not informative at all, there is no distinction between bankruptcies and stable enterprises, as, for example, we can see at Fig. 1.

Only 17 of the 63 indicators (namely: liquidity solvency ratio; return on assets; estimated solvency ratio; financial dependence ratio; ratio of own and borrowed funds; resource return, or

turnover of enterprise assets; turnover ratio of accounts payable; capital ratio of accounts payable; renewal of fixed assets, the main indicator of profitability, the ratio of monetary solvency (absolute liquidity), return on total capital, turnover of mobile funds, return on resources (assets) of the enterprise from operating income, the share of fixed assets in the assets of the enterprise, critical liquidity ratio, coverage ratio, or current liquidity ratio) have a certain distinction between bankruptcies and stable enterprises, as, for example, we can see at Fig. 2. But this is still a large number of input factors to build a model, so let's move to the next step.

Step 5. To select the most informative indicators, we will try to analyze them not only graphically, but also taking into account the accuracy of the value of the indicator in each group.

We find a conditional boundary between stable and default enterprises. Draw this limit (as, for example, in Fig. 3) and calculate the error: how many stable enterprises fell into the group of defaults, and how many defaults have the value of this coefficient as in stable enterprises.

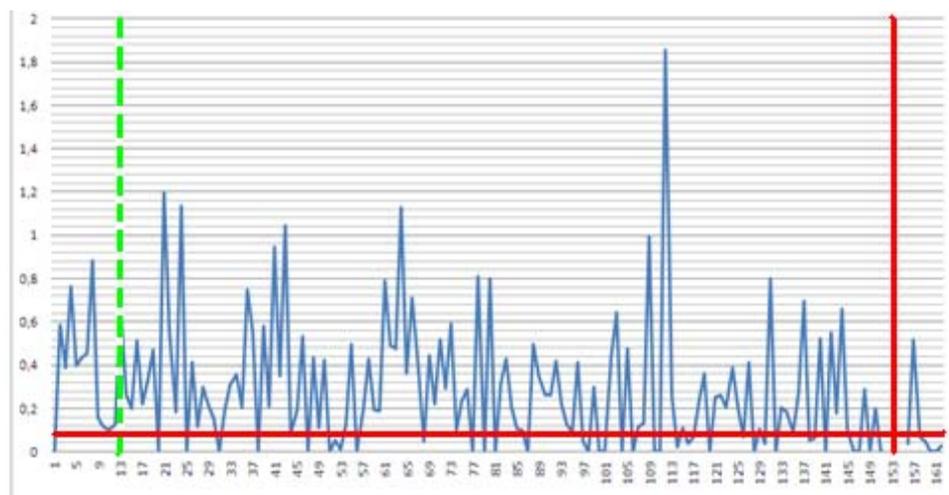


Figure 3. Return on total capital

Fig. 3. Shows the following borders: to the dashed vertical line of the enterprise, we have enterprises with an investment rating, between the dashed and solid vertical - with a non-investment, after a solid vertical - default. A solid horizontal line is the boundary which separating the value of the coefficient for stable and default enterprises.

Let's take a look at the example of the coefficient of return on total capital. When the limit value of the coefficient is set at 0.07 units, we get an accuracy of 83% (only 6 out of 35 "good" borrowers will fall into the group of defaults). If we move the limit (solid horizontal line at Fig. 3) up, for example, to a value of 0.1, the error will be 66% (i.e., 12 out of 35 stable borrowers will fall into the group of defaults). And if we move the limit down, for example, to a value of 0.05, then also 6 of the 35 stable borrowers will fall into the group of defaults, but 2 default borrowers will fall into the group of defaults.

Therefore, the value of the limit at 0.07 gives the smallest error. Also here it is possible to trace some dependence - the smaller the indicator, the greater probability of default of the given legal entity.

Based on the selected indicators, we will build a rule base. We need to "teach" the system to make correct predictions about the rating. To do this, we are using a model based on fuzzy logic. This choice was made precisely because in our case there are no clear boundaries between the values of indicators, and we set them only on the basis of the above statements. Subsequently, when building the model, these limits can be adjusted.

At this stage, we have selected 8 indicators that with a probability of at least 70% shows what the borrower's rating will be in six months, taking in account data from the balance sheet and statement of financial performance today.

However, not all the coefficients could be divided by one clear boundary (as at Fig. 3), so the set had to be divided not into two (stable and default), but into three groups - stable, default and indefinite, as shown at Fig. 4.

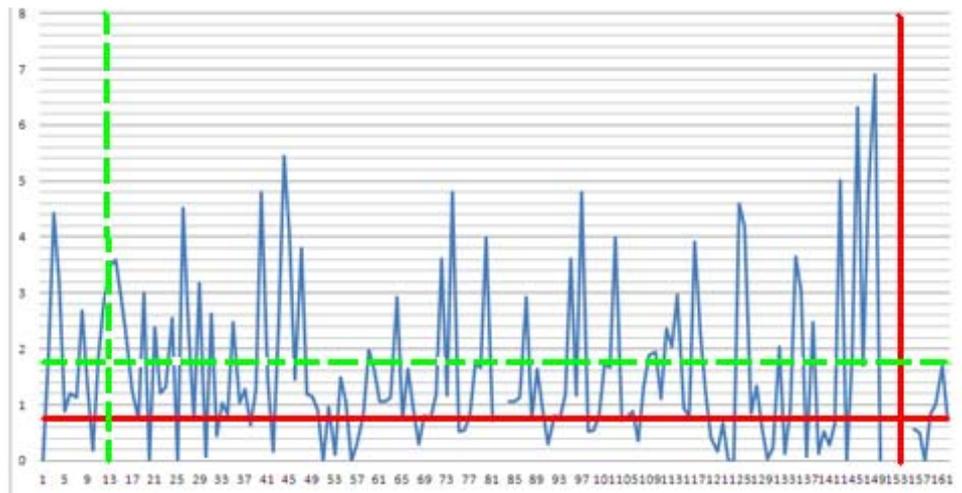


Figure 4. Mobile funds rotation

The following distinctions are shown at fig.4: to the dashed vertical line – we can see enterprises with an investment rating, between the dashed and solid vertical – with a non-investment rating, after a solid vertical – default. To the continuous horizontal line – default enterprises, between the continuous horizontal and dashed horizontal – are not defined enterprises, above the dashed horizontal – stable ones.

As a result, 8 coefficients out of 63 financial indicators have reached the final sample. For the convenience, we will put them in one table.

Table 1.

**The value of financial indicators for the forecasting
the rating of the enterprise in six months**

Nº	Indicator
1	Liquidity solvency ratio
2	Estimated solvency ratio
3	Ratio of own and borrowed sources of funds
4	Resource return, or turnover of enterprise assets
5	Accounts payable turnover ratio
6	Fixed assets renewal rate
7	Return on total capital
8	Mobile funds rotation

Step 6. To build a rule base, we first need to define the boundaries of the terms of belonging function for each indicator.

A term is an any element of a term set. For example, if the system load can be high, medium and low, then "system load" is a linguistic variable; linguistic scores "high", "medium", "low" are terms which together form a term set. The term is described by a fuzzy set using the belonging function. The belonging function is a function that allows to any element of an universal set to determine its degree of belonging to a fuzzy set.

For example, according to the indicator of "turnover of mobile funds" we will draw the boundaries - to the value of the indicator of 0.75 units we will refer it to the low term, from 0.75 to 1.7 - to medium, and above 1.7 - to high. In the MS Excel environment, this is described using formulas such as =IF(selection2!M5<base!\$L\$3;"H";IF(selection2!M4<\$L\$5;"C";"B")).

Now, for the each company we pull its rating in a six months to build a rule base for the model, which will not just refer the company to the correct rating, but which will predict its rating in six months. So, we will teach our system to make forecasts based on the developed rule base.

If we go over all the values from the existing knowledge base, we get 147 rules (according to the number of enterprises that we took for analysis). Among them, of course, some rules are repeated. We get 83 unique sets (high, medium, low) among the described terms, but this is too much as for set of rules for building a model.

We take only those crucial rules which are repeated for several borrowers (because unique combinations of values should not be interpreted as rules).

After such elimination we have 24 rules left. Next, we analyze each rule. The sample will include only those that meet the following criteria:

- if this rule shows that having the described set of values of financial indicators, a high rating needs to be assigned to the company, the described set of values should not be performed for a borrower with a rating of default or close to default, and vice versa (otherwise, this rule can not be considered as reliable);

- the more number of borrowers has this rule fulfilled - the more reliable it is;

- we prefer the rules that are performed for borrowers who have a certain dynamics of rating change in a six months diapason, over those whose rating remained the same (if the rule of getting to the high term is for a borrower who had, for example, an average rating, and in a six months his rating became high, the rule can be considered reliable).

Discussion of research results. As a result of the analysis, we obtained a rule base, consisting of 6 rules given in table. 2.

Table 2.

Knowledge base for rating assessment of borrowers - legal entities

Here, H-the low term, C-medium and B – high.

Linguistic values of input indicators								Rules weight	Output variable
X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	w	Z
H	H	C	H	H	H	H	H	w_1^H	H
B	C	H	C	B	H	H	B	w_1^C	C
C	C	H	H	H	B	H	B	w_2^C	C
H	H	H	H	H	B	H	B	w_3^C	C
B	C	H	B	B	B	B	B	w_1^B	B
B	C	B	B	B	B	B	B	w_2^B	B

This rule base now can be used by the bank in everyday life for rating and provision making. And the model of detecting the rules is easy in implementing, needs Excel only, so no additional costs for software is needed.

Conclusions

This article proposes a methodological approach for building a knowledge base for further modeling of the rating forecasting system, as well as the possibility of non-repayment of a credit by borrowers - legal entities. In forming such approach, an analysis of real data was performed. The existing rating policy (used by one of the Ukrainian banks) was improved and the adequacy of the models to assess the rating of an individual borrower in six months was experimentally investigated.

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