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ALTERNATIVE FUZZY APPROACH TO EVALUATE THE CREDIT RISKS OF COMPANIES: CASE STUDY

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1. Bank and SMEs Relationships

Risk factor is a concept that it should be consider as very important on banking sector. Many studies regarding to prediction of financial failure have been done so far. However, since only financial data is not enough for the prediction of financial failures regarding to SEMs (Small and Medium Sized Enterprises), which are based on our economy, in this study, systems, which they use qualitative data, considered as effective over the results, have been discussed and trials have been done with fuzzy logic approach.

Fuzzy Logic Applications regarding to decision support systems like credit evaluating analysis are the researches of recent times [1]. The aim of this study is to take required precautions in advance by suggesting alternative fuzzy based method for the prediction of financial failures of SEMs that risk measurements is more difficult than large-scale corporate companies.

Credit Evaluating System at Banking. Credit application, which it passes from evaluating stages, takes long journey. It follows the similar process at all banks. On current banking system, which competition is increased, decision making period is reduced and capital allocation is mandatory, single variable models, ratio analysis, fund flow statement analysis, cash flow analysis and statistical models, logistic regression, discriminant analysis, multiple regression which they use qualitative data, are used. Used method shows some differences among the banks according to data quantity, intensity of variables inside the model, standardization of used data etc.

Banks, which they use credit evaluation with traditional credit evaluating methods (it is based on experiments and subjective factors that they are not standardized) before economic crisis, have started to consider risk evaluating more important after middle of 90s. Generally evaluating score, forms of letter, number or combination of these, is obtained from scorecards on small-scaled credits; it is obtained from detailed evaluating systems when credit and customer volume increased.

Bank Side of Credit Having a Problem, and Its Cost in Terms of Socio-Economy. Banks earn money by selling the deposit money in their hand. One of the main tools is the credit mechanism while they sell deposit money. Credits take an importance place to use existing resources and to canalize them to the production in terms of macro economy. If this mechanism does not work healthy, it cause high volume cost at banks and on socio economic structure [2].

2. Establishment of Fuzzy Based Rules

The companies have been classified as failed or success according to their credit repayments as per Turkey Banking Regulation and Supervision Agency promulgated on 30.06.2001, 24448 numbered on Turkey Official Newspaper.

In our study, totally 109 SME's applied for the credit to the bank which it has branch offices around Turkey and 54 of them are failed in terms of financially, have been examined.

At the first stage, a model classified as "successes" and as "failed" for the credit allocation, has been created with supervised training. For that purpose, C&RT decision tree model of SPSS Clementine® 10.1 has been used, 33 inputs and 1 output have been evaluated. 8

rules, which they establish decision tree mechanism for credit allocation, have been found by using C&RT algorithm.

By running the model, totally 8 rules have been found as 4 positive, and 4 negative. The positive and the negative situations will be used as the outputs.

When the rules are examined; 7 input variables have been found as important; *rating, net profit/shareholder's equity, accounts receivables turnover rate, inventory cycle, tangible assets/shareholder's equity, current rate and net profit/assets.*

Later, fuzzification has been applied to these rules on FIS (Fuzzy Inference System) Editor of Matlab® 7.0.1. Mamdani approach has been used as based on FIS model, and on created model, 7 inputs and 2 outputs ("credit level to be allocated" and "collateral level to be taken") have been used.

In this study *zmf* and *smf* types are used to assign membership functions. The information is given in below that is related with these membership functions [3].

ZMF: Z-shaped built-in membership function: $\mu(x) = zmf(x,[ab])$. The parameters a and b locate the extremes of the sloped portion of the curve as given by:

$$\mu(x) = \begin{cases} 1, x \le a \\ 1 - 2\left(\dfrac{x-a}{b-a}\right)^2, a \le x \le \dfrac{a+b}{2} \\ 2\left(\dfrac{b-x}{b-a}\right), \dfrac{a+b}{2} \le x \le b \\ 0, x \ge b \end{cases}$$

SMF: S-shaped built-in membership function: $\mu(x) = smf(x,[ab])$. The parameters a and b locate the extremes of the sloped portion of the curve as given by:

$$\mu(x) = \begin{cases} 0, x \le a \\ 2\left(\dfrac{x-a}{b-a}\right)^2, a \le x \le \dfrac{a+b}{2} \\ 1 - 2\left(\dfrac{b-x}{b-a}\right), \dfrac{a+b}{2} \le x \le b \\ 1, x \ge b \end{cases}$$

Parameters for the input variables are assigned as critical value and ±30% of critical value to the membership functions by using Matlab® Fuzzy Logic Toolbox.

Input Variables: The first rule is; "*If rating* ≤ 3.67 *then credit is failed*". The critical values are 3.67 and 4.771 (30% greater then 3 .67) for Z-shaped built-in membership function.

The critical values are 2.567 and 4.771 (30% greater then 3 .67) for Z-shaped built-in membership function. The figure 3 is shown at below. This figure shows the values that have a rating less then 3.67 and greater than 3.67.

Similarly the critical values are 2.567 and 4.771 (30% less then 3 .67) for S-shaped built-in membership function. The other 6 input variables have been drawn as similarly.

Output Variables: Output 1 is used for negative situations. The parameters are [0 0 1]. This output will be used to define "collateral level to be taken".

The second output variable will be used to define "credit level to be allocated". The parameters are [0 1 1].

3. Results

Output 1 and Output 2 dependent variables have been observed by 109 pieces data take in place in order in rules page. Output1 has been used to define collateral level while Output2 has been used to define to be given credit amount.

Credit Allocation Ratio (CAR) and Performance are defined as below to be able to compare fuzzy logic approach with traditional banking credit system

Credit Allocation Rate (CAR): It is the ratio of allocated credit to requested credit.

$$CAR = \frac{AllocatedCredit}{\mathrm{Re}\,questedCredit} \times 100\%$$

Performance: It is the ratio of repayment of allocated credit to the firm

$$Performance = \frac{\mathrm{Re}\,paymentAmount}{AllocatedCredit} \times 100\%$$

Considering bankrupted companies and successful companies separately results have been showed at below.

Credit Allocation Rate of the Bankrupted Companies: Traditional Bank Approach: 54 pieces companies have been applied for 64.7 Million TL loan demand. 54.7 Million TL Credit has been allocated by Bank. With Traditional Bank Approach, Credit Allocation Rate is;

$$CAR = \frac{54.7}{64.7} \times 100\% = 84\%$$

Fuzzy logic Approach: 54 pieces companies have been applied for 64.7 Million TL loan demand. 22 million TL have been predicted to allocate with developed programme. With Fuzzy Logic Approach, Credit Allocation Rate is;

$$CAR = \frac{22}{64.7} \times 100\% = 34\%$$

Traditional Bank Approach: 54 pieces companies have been applied for 64.7 Million TL loan demand. 54.7 Million TL Credit has been allocated by bank and 15.4 Million TL has been taken back. With Traditional Bank Approach, Performance is;

$$\text{Performance} = \frac{15.4}{54.7} \times 100\% = 28\%$$

Fuzzy Logic Approach: 54 pieces companies have been applied for 64.7 Million TL loan demand to the bank. 36.4 million TL has been predicted to allocate to the company with developed programme, 22 Million TL has been predicted for assurance. For this case with Fuzzy Logic Approach, Performance is;

$$\text{Performance} = \frac{22}{36.4} \times 100\% = 60\%$$

Credit Allocation Rate of Successful Companies: Traditional Bank Approach: 55 pieces company have been applied for 80.9 Million TL loan demand to the bank. 61.4 Million TL credit has been allocated by bank. For this case Credit Allocation Rate of Traditional Bank Approach;

$$CAR = \frac{61.4}{80.9} \times 100\% = 76\%$$

Fuzzy Logic Approach: 55 pieces company have been applied for 80.9 Million TL loan demand to the bank. 52.6 Million TL credit has been predicted to allocate by developed programme. For this case Credit Allocation Rate of Fuzzy Logic Approach;

$$CAR = \frac{52.6}{80.9} \times 100\% = 65\%$$

Performance of Successful Companies: Because there is no problem on repayments of credits for both approach performances are %100.

Repayment Performances have been shown separately at below with the tables 1 and 2.

Table 1. Traditional Bank Approach.

	Bankrupted Companies	Successful Companies
Credit Allocation Rate	% 84	% 76
Repayment Performance	% 28	% 100

Table 2. Proposed Fuzzy Logic Approach.

	Bankrupted Companies	Successful Companies
Credit Allocation Rate	% 34	% 65
Repayment Performance	% 60	% 100

While %76 of loan demands is allocated to the successful companies with traditional bank approach, %65 is allocated with fuzzy logic approach. Despite the fact that % 11 differences are seen on fuzzy logic approach, this difference is not %11 according to bank profit. It is as far as rate of interest over the %11 differences.

Calculated credit results of suggested method and the results coming from real bank decisions have been compared and it is defined that new method reduces %32 of the losses caused by traditional credit policy of the bank.

References

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