Research Article

Study on Risk Analysis and Decision-Making of Small- and Medium-Sized Enterprises on BP Neural Network Algorithm

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Received 27 December 2021; Accepted 22 January 2022; Published 3 March 2022

Academic Editor: Punit Gupta

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Artificial neural network algorithm has strong nonlinear mapping function. BP neural network algorithm is the representative of artificial neural network algorithm. Due to the relatively small scale of small, medium, and micro enterprises and lack of mortgage assets, the biggest market risk they usually face is credit risk. In order to avoid huge economic losses for banks, the impact of risk analysis on credit decision-making is the key. Therefore, the establishment of a scientific and complete credit risk assessment system has become the primary task. This paper mainly uses BP neural network algorithm to analyze the risk of small and medium-sized enterprises and solve the problem of credit decision-making. First, analyze the various influencing factors that cause credit risk, and layer the factors according to the degree of risk; secondly, use the fuzzy comprehensive evaluation method in mathematical modeling to rank each factor; then, use the fuzzy analytic hierarchy process to calculate the weight of each indicator factor as calculated by establishing the risk value function, using the function expression of the annual interest rate and the total credit formula to calculate the total credit, which solves the problem of the loan line of each enterprise, and use the optimal linear programming to give priority to the selection of the line and the interest rate. Enterprises: finally, for enterprises that do not have a credit rating, reasonable adjustments are made to the quota by establishing lending qualification expression, taking into account the impact of unexpected external factors, establishing an improved annual interest rate function, and achieving an optimized credit strategy through the establishment and solution of the model. The goal of optimizing credit strategy has been achieved.

1. Introduction

In practice, due to the relatively small scale of small, medium, and micro enterprises and lack of collateral assets [1], banks usually rely on credit policies, corporate transaction bill information, and the influence of upstream and downstream companies to provide companies with strong strength and stable supply-demand relations and provide loans and give preferential interest rates to companies with high reputation and low credit risk. Banks first evaluate the credit risk of small, medium, and micro enterprises based on their strength and reputation and then determine whether to lend and credit strategies such as loan limits, interest rates, and maturity based on factors such as credit risk.

A certain bank has a loan amount of 100,000 to 1 million yuan to an enterprise that is determined to lend; the annual interest rate is 4% to 15%; and the loan period is 1 year. Relevant data include the relevant data of 123 companies with credit records, the relevant data of 302 companies without credit records, and the 2019 statistics on the relationship between loan interest rates and customer churn rates. Then, how to establish a model to study the credit strategy for small, medium, and micro enterprises based on the actual situation and the data information in the attachment has become a key issue in bank lending.

For the bank's credit strategy, the following three issues need to be addressed:

- (1) Quantify the credit risk of the 123 companies in Annex 1 and give the bank's credit strategy for these companies when the total annual credit is fixed.
- (2) On the basis of question 1, conduct a quantitative analysis of the credit risk of the 302 companies in Annex 2 [2] and give the bank's credit strategy for these companies when the total annual credit is 100 million yuan.
- (3) The production and operation and economic benefits of enterprises may be affected by some sudden factors, and sudden factors often have different effects on different industries and different types of enterprises. Considering the credit risk of each company in Annex 2 and the impact of possible sudden factors (such as the novel coronavirus epidemic) on each company, the bank's credit adjustment strategy when the total annual credit is 100 million yuan is given.

2. Problems Analysis

In response to question 1, we are required to quantify customer credit risk. The first problem is to find out the key factors that affect credit risk. We can consider the fuzzy analytic hierarchy process [3] to establish systematization and hierarchy. In a structured system, the elements in the system are compared in pairs, and a matrix is generated for quantitative analysis. After determining the collective evaluation (level) of the credit risk factors (indicators) of 123 companies, the fuzzy priority relationship matrix is obtained through custom data, and the fuzzy judgment matrix is calculated through the formula, then the weight of each factor level is determined, and the priority is judged. The most important risk factors can be obtained.

In response to problem 2, the goal is to solve the problems of credit risk quantification, loan interest rates, and bank credit optimal strategies. Because of the relevant data and loan interest rates of 302 companies with no credit records, the risk value cannot be calculated based on the reputation rating and default. Therefore, the relationship between the average profit rate and the risk is mainly considered, and the function is obtained by fitting the data in Annex 1. This problem can be solved; use the function of problem 1 to get the annual interest rate of 203 companies; use the formula of problem 1 to calculate the quota of each enterprise, and then use the combination optimization program and planning method to adjust the credit limit.

In response to question 3, focus on the sudden factors that affect the production and operation and economic benefits of the enterprise, and use the data in Annex 2 as the basis for analysis. Several questions are mainly considered. First, why are many companies operating negatively? Second, what is the reason why the corporate credit line is not within the scope of the bank's requirements? Third, how to reduce customer churn rate? In view of the above problems, the model designed in question 1 and question 3 can be improved.

3. Credit Strategy Based on Risk Quantitative Analysis

For question 1, it is necessary to find the credit factors to quantify the risk. Because the company has historical records, the fuzzy evaluation method can be considered; if the influencing factors can be determined, consider using the multiweight relationship [4] to calculate the risk value. From the risk value, the annual interest rate can be obtained by using a piecewise function or a fitting method; combined with the annual interest rate, on the basis of calculating the credit limit, linear programming and optimization methods can be used to select the optimal credit strategy.

3.1. Rating of Credit Factors. The first problem of question 1 is to find the important factors of credit evaluation. In order to select the factors that affect the credit of small and micro enterprises, the fuzzy comprehensive evaluation method is used to evaluate the credit decision, comprehensively considering various factors related to credit risk and based on indicators. The selection principle finally determines the level of the indicator system for corporate credit risk evaluation. The specific evaluation indicator structure is shown in Table 1.

Find the weights of the pairwise comparison matrix between the criterion layer and the target layer [5].

First, the criterion layer compares the target pair by pair and establishes the priority relationship matrix $G = (g_{ij})_{n \times n}$ with $g_{ij} = (1, 0.5, 0)$ to establish a priority matrix:

$$\begin{vmatrix} A_1 & B_1 & B_2 & B_3 & r_1 \\ B_1 & 0.5 & 1 & 1 & 2.5 \\ B_2 & 0 & 0.5 & 1 & 1.5 \\ B_3 & 0 & 0 & 0.5 & 0.5 \end{vmatrix}. \quad (1)$$

According to formula (2), the fuzzy judgment matrix is calculated, and then the square root method formula (3) is used to calculate the weight of the level index.

$$r_{ij} = \frac{r_i - r_j}{2n} + 0.5, \quad (2)$$

$$w_i = r_i \sum_{i=1}^m \bar{r}_i \quad (i = 1, 2, \dots, m), \quad (3)$$

$$r_i = \sqrt[n]{\prod_{j=1}^n r_{ij}} \quad (j = 1, 2, \dots, m). \quad (4)$$

Second, the criterion layer establishes a fuzzy consistent judgment matrix for the target:

$$\begin{vmatrix} A_1 & B_1 & B_2 & B_3 & W_1 \\ B_1 & 0.50 & 0.67 & 0.83 & 0.430 \\ B_2 & 0.33 & 0.50 & 0.67 & 0.316 \\ B_3 & 0.17 & 0.33 & 0.50 & 0.200 \end{vmatrix}. \quad (5)$$

TABLE 1: The structure of corporate credit evaluation indicators.

First level indicator		Secondary indicators
Causes of corporate credit risk A1	Enterprise's own reasons B1	Reputation level C1
		Number of violations C2
		Bill information C3
	Bank's own reasons B2	Upstream and downstream companies influence C4
		Industry risk C1
		Professionalism of assessors C2
		Enterprise size C3
		Credit strategy C4
		Government administrative intervention C1
		Macro factor B3
	National legal system C2	
	National economy C3	
	Vicious struggle between banks C4	

Find the weight coefficient of the pairwise comparison matrix of the plan layer to the target layer.

First, the priority comparison matrix corresponding to the enterprise's own factor criteria is

$$\begin{vmatrix} B_1 & C_1 & C_2 & C_3 & C_4 & r_1 \\ C_1 & 0.5 & 1 & 1 & 1 & 3.5 \\ C_2 & 0 & 0.5 & 0 & 1 & 1.5 \\ C_3 & 0 & 1 & 0.5 & 1 & 2.5 \\ C_4 & 0 & 0 & 0 & 0.5 & 0.5 \end{vmatrix}. \quad (6)$$

Second, the company's own factor criteria establish a fuzzy consistent judgment matrix:

$$\begin{vmatrix} B_1 & C_1 & C_2 & C_3 & C_4 & W_2 \\ C_1 & 0.5 & 0.75 & 0.625 & 0.875 & 1.420 \\ C_2 & 0.25 & 0.5 & 0.375 & 0.375 & 0.768 \\ C_3 & 0.375 & 0.625 & 0.5 & 0.75 & 1.149 \\ C_4 & 0.125 & 0.625 & 0.25 & 0.5 & 0.663 \end{vmatrix}. \quad (7)$$

Then, the priority comparison matrix corresponding to the bank's own factor criteria is

$$\begin{vmatrix} B_2 & C_1 & C_2 & C_3 & C_4 & r_3 \\ C_1 & 0.5 & 1 & 1 & 1 & 3.5 \\ C_2 & 0 & 0.5 & 1 & 1 & 2.5 \\ C_3 & 0 & 0 & 0.5 & 1 & 1.5 \\ C_4 & 0 & 0 & 0 & 0.5 & 0.5 \end{vmatrix}. \quad (8)$$

Then, the fuzzy consistent judgment matrix corresponding to the bank's own factor criterion is

$$\begin{vmatrix} B_2 & C_1 & C_2 & C_3 & C_4 & W_3 \\ C_1 & 0.5 & 0.625 & 0.75 & 0.875 & 0.894 \\ C_2 & 0.375 & 0.5 & 0.625 & 0.75 & 0.723 \\ C_3 & 0.25 & 0.375 & 0.5 & 0.625 & 0.976 \\ C_4 & 0.125 & 0.25 & 0.375 & 0.5 & 1.404 \end{vmatrix}. \quad (9)$$

In addition, the priority comparison matrix corresponding to the macro factor criterion is

$$\begin{vmatrix} B_3 & C_1 & C_2 & C_3 & C_4 & r_4 \\ C_1 & 0.5 & 0.5 & 0 & 0 & 1 \\ C_2 & 0.5 & 0.5 & 0.5 & 0 & 1.5 \\ C_3 & 1 & 0.5 & 0.5 & 0 & 2.0 \\ C_4 & 1 & 1 & 1 & 0.5 & 3.5 \end{vmatrix}. \quad (10)$$

Finally, the fuzzy discriminant matrix corresponding to the macro factor criterion is

$$\begin{vmatrix} B_3 & C_1 & C_2 & C_3 & C_4 & W_4 \\ C_1 & 0.5 & 0.4375 & 0.375 & 0.1875 & 0.535 \\ C_2 & 0.5625 & 0.5 & 0.4375 & 0.25 & 1.130 \\ C_3 & 0.625 & 0.5625 & 0.5 & 0.3125 & 1.307 \\ C_4 & 0.8125 & 0.75 & 0.6875 & 0.5 & 1.027 \end{vmatrix}. \quad (11)$$

From the above calculation and analysis, it can be seen that the more weighted factors are C2 and C4 in B2; that is, the credit risk is mainly determined by the credit rating and bill information of the company's own factors, and C1 (national economy) is also affected by B3 (macro factor) [6] and other factors.

$$V_{ij} = w_i \times w_{ij}. \quad (12)$$

From formula (12), it can be concluded that the ranking of the influence of each factor on the credit decision of the enterprise is shown in Table 2.

3.2. Calculation of Risk Value Based on Multiweight Relationship. The quantitative analysis of the credit risk G of the 123 companies in Annex 1 is as follows.

First, construct the weight term sum risk value function, as shown in

$$G = P \times P_3 + D \times P_1 + W \times P_2, \quad (13)$$

$$P = \frac{S - C}{4}, \quad (14)$$

TABLE 2: Weights of corporate credit evaluation indicators [7].

First level indicator		Secondary indicators	Weight w
Causes of corporate credit risk A1	Own cause B1	Reputation level C1	1.420
		Number of violations C2	0.768
		Bill information C3	1.149
		Upstream and downstream companies influence C4	0.663
	Bank's own reasons B2	Industry risk C1	0.894
		Professionalism of assessors C2	0.723
		Enterprise size C3	0.976
		Credit strategy C4	1.404
	Macro factor B3	Government administrative intervention C1	0.535
		National legal system C2	1.130
		National economy C3	1.307
		Vicious struggle between banks C4	1.027

$$D = \begin{cases} 0.9 & C_1 = A \\ 0.7 & C_1 = B \\ 0.5 & C_1 = C \\ 0 & C_1 = D \end{cases}, \quad (15)$$

$$W = \begin{cases} 0 & \text{breach of contract} \\ 1 & \text{no breach of contract} \end{cases}. \quad (16)$$

Among them, formula (14) is to calculate the average annual profit rate.

Then, use Excel to calculate the profit of each company = total expenditure (tax included) - total income (after tax). The total expenditure (including tax) here = SUMIFS (input invoice information! \$G\$2:\$G\$210948, input invoice information! \$A\$2:\$A\$210948, A2, input invoice information! \$H\$2:\$H\$210948, "Valid invoice"), Total income (after tax) = SUMIFS (output invoice information! \$E\$2:\$E\$162486, output invoice information! \$A\$2:\$A\$162486, A2, output invoice information! \$H\$2:\$H\$162486, "Valid invoice").

Finally, by using formulas (13)–(16) to calculate, finally calculate the risk Y . Specific data are shown in Table 3.

3.3. Calculate the Annual Interest Rate. After calculating the risk value in Annex 1, the evenly distributed risk value range is $[0, 9.21]$. According to the data in Annex, the value difference of the annual interest rate is 0.004. Therefore, the

corresponding value of the risk value and the annual interest rate is obtained as shown in Table 4.

Perform data fitting on the data in Table 1 to obtain the calculated annual interest rate function, as shown in formula (22), and the specific annual interest rate is shown in Table 5.

$$Z = E + Q, \quad (17)$$

$$E = \frac{Y \times (1 - Y_2)}{I}, \quad (18)$$

$$G_2 = \frac{R - J}{J}, \quad (19)$$

$$I = T - U, \quad (20)$$

$$Q = E \times P_i, \quad (21)$$

$$y = 1E - 05x^2 - 0.0122x + 0.1505. \quad (22)$$

Calculate the total credit Z of the enterprise by formulas (17)–(21).

Use goal planning [8] to judge whether to lend to enterprises under the condition of maximizing the interests of banks:

$$E(x) = \max \sum_{i=1}^n Y_i x_i (1 + Y_i) M_i. \quad (23)$$

Among them,

$$M_i = \begin{cases} 0 & \text{credit rating is D} \\ 1 & \text{the credibility level is atleast C} \end{cases}, \quad 10 \leq Y_i x_i \leq G_i \leq 0.15. \quad (24)$$

3.4. Calculate the Credit Limit of Each Company. x_i represents the loan amount, corporate credit line = last year's sales revenue $\times$ (1 - previous year's sales profit rate) $\times$ (1 + estimated sales revenue growth rate) / number of capital turnover. Among them, the number of turnover = accounts receivable turnover days - accounts payable turnover days, the credit limit in 2021 is determined by

calculating the 19–20 income growth rate and the number of capital turnover [9]. The specific data is shown in Table 6.

Through the above quantification of credit risk, the annual credit interest rate and credit limit can be calculated, and then the target planning model analysis can be used to obtain the credit strategy. First, if the bank wants to insure the collection, it can consider giving priority to mortgage

TABLE 3: Sample table of enterprise risk value data.

Enterprise code	Company name	Reputation rating	Rank weight	Breach of contract	Default weight	Average annual profit rate	Risk
E1	***Electric Appliance Sales Co., Ltd.	A	0.9	No	1	-0.3874844	0.688335602
E2	***Technology Co., Ltd.	A	0.9	No	1	2.63621849	2.182256471
E3	***Electronics (China) Co., Ltd. *** Branch	C	0.5	No	1	9.52389829	5.341012428
E4	***Development Limited Liability Company	C	0.5	No	1	6.22735183	3.71228772
E5	***Supply Chain Management Co., Ltd.	B	0.7	No	1	-0.1086503	0.703979141
E6	***Decoration Design Engineering Co., Ltd.	A	0.9	No	1	0.14092075	0.949404716
E7	***Home Appliances Co., Ltd. *** Branch	A	0.9	No	1	7.07898782	4.377295512

TABLE 4: Corresponding value of risk value and annual interest rate.

Value at risk	Annual interest rate	Value at risk	Annual interest rate	Value at risk	Annual interest rate
9.21	0.04	5.920714286	0.0785	2.631428571	0.1185
8.881071429	0.0425	5.591785714	0.0825	2.3025	0.1225
8.552142857	0.0465	5.262857143	0.0865	1.973571429	0.1265
8.223214286	0.0505	4.933928571	0.0905	1.644642857	0.1305
7.894285714	0.0545	4.605	0.0945	1.315714286	0.1345
7.565357143	0.0585	4.276071429	0.0985	0.986785714	0.1385
7.236428571	0.0625	3.947142857	0.1025	0.657857143	0.1425
6.9075	0.0665	3.618214286	0.1065	0.328928571	0.1465
6.578571429	0.0705	3.289285714	0.1105	0	0.15
6.249642857	0.0745	2.960357143	0.1145		

TABLE 5: Sample table of corporate annual interest rate data.

Enterprise code	Company name	Reputation rating	Rank weight	Breach of contract	Default weight	Risk	Annual interest rate
E1	***Electric Appliance Sales Co., Ltd.	A	0.9	No	1	0.688335602	0.142107044
E2	***Technology Co., Ltd.	A	0.9	No	1	2.182256471	0.123924093
E3	***Electronics (China) Co., Ltd. *** Branch	C	0.5	No	1	5.341012428	0.085624913
E4	***Development Limited Liability Company	C	0.5	No	1	3.71228772	0.105347901
E5	***Supply Chain Management Co., Ltd.	B	0.7	No	1	0.703979141	0.14191641
...	...	...	...	...	...	...	...

TABLE 6: Sample table of corporate credit line data.

Enterprise code	Company name	Risk	2020 income (after tax)	2020 profit margin	19–20 revenue growth rate	Turnover	2021 quota
E1	***Electric Appliance Sales Co., Ltd.	0.688335602	73231470	-0.2228772	-0.95	94	48151.8
E2	***Technology Co., Ltd.	2.182256471	49935565	4.35035404	-0.81	-700	45669.9
E3	***Electronics (China) Co., Ltd. *** Branch	5.341012428	15380416.5	20.3692017	-0.89	335	97897.7

loans for enterprises with low risk. Choose companies with high annual interest rates; second, if banks want to maximize their benefits, they can expand credit lines or regulate annual interest rates for companies with high credit risks to maximize their annual returns.

4. Credit Strategy for Companies with No Credit History

For problem 2 the main solution is to carry out risk quantification, loan interest rate and bank credit optimal strategy for enterprises without credit records.

4.1. Quantify the Credit Risk of Companies with No Credit History. Because of the relevant data and loan interest rates of 302 companies with no credit records, the risk value cannot be calculated based on the credit rating and default or not. Therefore, the relationship between the average profit rate and the risk is mainly considered [10]; by fitting the data in Annex 1, the derived function can solve the problem.

First, determine the annual interest rate according to the method in question 1. The process is as follows.

First, use formula (25) and formula (26) to calculate the total expenditure (including tax) and total income (after tax) of each enterprise, then calculate the profit, and finally, use formula (27) to calculate the average profit of each enterprise rate.

$$Z(i) = \sum_{j=1}^k Q(i)(j). \quad (25)$$

Among them, $i = E124, E125, \dots, E425$, Q is the amount of the input invoice, and j is the serial number of the input invoice of the i enterprise.

$$S(i) = \sum_{j=1}^m G(i)(j). \quad (26)$$

Among them, $i = E124, E125, \dots, E425$, G is the total fare tax on output, and j is the serial number of the output invoice of enterprise i .

$$A(i) = \frac{G(i)(j) - Q(i)(j)}{Q(i)(j)/n}. \quad (27)$$

Among them, $i = E124, E125, \dots, E425$, and n is the number of effective operating years.

Second, from the data relationship between the annual profit rate and the risk value in Annex 1, the risk value function is fitted by fitting: $y = -8E - 09x^2 + 0.4941x + 0.6467$, and the specific risk value is shown in Table 6 and Table 7.

4.2. Calculate the Annual Interest Rate. Using problem 1 function $y = 1E - 05x^2 - 0.0122x + 0.150$ to get the annual interest rate of 203 companies, the data sample table is shown in Table 8.

4.3. Credit Line Adjustment Strategy. Calculate the quota of each enterprise using the formula for calculating quota in question 1, and then adjust the quota according to the total amount of 100 million.

Strategy 1: select the legal limit range (100,000 to 1 million) and companies with purchase and sales data in 2020. Companies with low risk and high returns are preferred. Use the C# program to obtain the business portfolio and its credit line according to the conditions, and get the total amount of loans. The total income is 3497942.5 yuan, and the total income is 383611.8845 yuan. The specific data is shown in Table 9. This strategy minimizes the risk of repayment and maximizes the income of the lending bank, but it cannot meet the condition of a total loan of 100 million yuan.

Strategy 2: choose a company with purchase and sales data in 2020, with low risk and high return priority. In order to solve the problem of strategy 1, expand the scope of the line, use the C# program to obtain the business portfolio and its credit line according to the conditions, and get the total loan amount of 83966019.96. The total income is 919,9847.981 yuan. The specific data is shown in Table 10. This strategy expands the quota range to 10,000~40,000,000 yuan, minimizes the risk of repayment, and maximizes the income of the loan bank. According to the optimal linear programming method [11], run the C# program to achieve the goal of the total loan amount closest to 100 million.

5. Improvement of Credit Strategy Based on Emergencies

Question 3 needs to consider the unexpected factors that affect the company's production and operation and economic benefits. By calculating the purchase and sales invoice data of each company in Annex 2, we found the following problems:

- (1) Affected by the new crown virus epidemic in 2020, many companies will experience negative growth in their operations
- (2) The credit line of the enterprise is not within the range required by the bank
- (3) Excessive annual corporate credit interest rates may cause serious loss of customers

In view of the above analysis, these problems can be solved through strategies such as focusing on assessing the changes in the company's purchase and sales invoice data in 2019, adjusting the credit limit, and improving the calculation method of the annual interest rate.

5.1. Reassessment of Companies That Have No Record of Purchase and Sales Invoices in 2020. Focus on assessing the data of purchase and sales invoices in 2019, and calculate the profit growth rate from 2018 to 2019. This is the credit reference for 2021. The formula in Excel changes to: =COUNTIFS(output invoice information! \$A \$2: \$A\$162486, A2, output invoice information!\$H\$2: \$H\$162486, "valid invoice", output invoice information!\$I\$2:

TABLE 7: Sample table of process data for calculating Annex 2 risk value.

Enterprise code	Company name	Risk	Total expenditure	Total income	Average annual profit rate
E124	Self-employed E124	0.586753595	844202797.2	741780368	-0.1213244
E125	Self-employed E125	0.617094302	1001201809	941211364	-0.0599184
E126	Self-employed E126	2.149774437	128818723.6	520691098	3.04204516
E127	Self-employed E127	182.5994278	1765558.94	651937955	368.253011

TABLE 8: 203 corporate annual interest rate data sample table.

Enterprise code	Company name	Risk	Annual interest rate
E124	Self-employed E124	0.586753595	0.143345049
E125	Self-employed E125	0.617094302	0.142975258
E126	Self-employed E126	2.149774437	0.124318967

TABLE 9: 203 corporates' loan strategy data.

Enterprise code	Company name risk	Risk	Annual interest rate	2021 quota	Income
E149	***Construction labor Service Co., Ltd.	78.6259881	0.04	140987.6	5639.5052
E176	***Technology Co., Ltd.	8.778604263	0.044171667	157082.4	6938.5915
E144	***Labor Service Co., Ltd.	5.662303789	0.081740511	220474.2	18021.67
E392	***Technology Co., Ltd.	5.461949443	0.084162546	146091.3	12295.419
E234	***Mechanical and Electrical Equipment Trading Co., Ltd.	4.086490945	0.100811805	378987.4	38206.4
E303	***Book Distribution Co., Ltd.	3.486049648	0.10809172	886724.1	95847.533
E243	***Technology Co., Ltd.	3.392272855	0.109229346	207823.5	22700.43
E407	***Decoration Engineering Co., Ltd.	2.374062469	0.1215928	238903.3	29048.921
E302	***Electromechanical Equipment Co., Ltd.	1.476475579	0.132508798	275226.5	36469.927
E307	***Communication Engineering Co., Ltd.	1.091490391	0.137195731	128036.2	17566.024
E313	***Logistics Co., Ltd.	0.955389312	0.138853378	122741.0	17043.004
E232	***Investment Development Co., Ltd.	0.784912808	0.140930225	594865.0	83834.46

TABLE 10: 203 corporates' loan strategy 2 data.

Enterprise code	Company name	Risk	Annual interest rate	2021 quota	Income
E343	***Hardware Tools Business Department	1501.178169	0.04	14834298.2	593371.9
E359	***Kitchen Supplies Business Department	1050.753956	0.04	2924976.0	116999
E375	***Electrical Department	870.0656293	0.04	302790.5	12111.62
E382	***Education Information Consulting Co., Ltd. *** Branch	335.911581	0.04	935355.9	37414.23
E215	***Construction Engineering Co., Ltd.	139.7314732	0.04	57732.1	2309.285
E149	***Construction Labor Service Co., Ltd.	78.6259881	0.04	140987.6	5639.5052
E422	***Children's Clothing Store	14.05858053	0.04	125885.8	5035.43
E399	***Decoration Engineering Co., Ltd.	10.98344746	0.04	237148.3	9485.9306
E176	***Technology Co., Ltd.	8.778604263	0.044171667	157082.4	6938.5915
E144	***Labor Service Co., Ltd.	5.662303789	0.081740511	220474.2	18021.67
E392	***Technology Co., Ltd.	5.461949443	0.084162546	146091.3	12295.419
E413	***Stone Crafts Co., Ltd.	5.357296826	0.085427985	99596.6	8508.336
E254	***Equipment Installation Engineering Co., Ltd.	5.238550658	0.086864106	1193160.7	103642.8
E362	***Building Materials Co., Ltd.	4.730884788	0.093007018	2039255.1	189665
E210	***Construction Engineering Co., Ltd.	4.443812652	0.09648296	25676.5	2477.342
E234	***Mechanical And Electrical Equipment Trading Co., Ltd.	4.086490945	0.100811805	378987.4	38206.4
E398	***Medical Management Consulting Co., Ltd.	3.936529644	0.102629301	160134.2	16434.462
E303	***Book Distribution Co., Ltd.	3.486049648	0.10809172	886724.1	95847.533
E243	***Technology Co., Ltd.	3.392272855	0.109229346	207823.5	22700.43
E415	***Advertising Design Service Department	2.494874076	0.12012478	40176.9	4826.241
E315	***Tire Co., Ltd.	2.465996416	0.120475655	15648.5	1885.268
E407	***Decoration Engineering Co., Ltd.	2.374062469	0.1215928	238903.3	29048.921
E409	***Plastic Co., Ltd.	2.304318966	0.122440407	14148.8	1732.382
E406	***Tendering Agency Co., Ltd.	2.227985901	0.123368211	4772155.3	588732.3
E250	***Plastic Factory	1.82336773	0.12828816	48162.6	6178.688
E354	***Advertising Co., Ltd.	1.803160504	0.128533956	10605.9	1363.223

TABLE 10: Continued.

Enterprise code	Company name	Risk	Annual interest rate	2021 quota	Income
E372	***Auto Repair Co., Ltd.	1.779281527	0.128824424	26574.1	3423.388
E276	***Sports Facilities Engineering Co., Ltd.	1.555535584	0.131546663	18595.4	2446.165
E298	***Electrical Maintenance Service Co., Ltd.	1.547518376	0.131644224	13606.4	1791.204
E302	***Electromechanical Equipment Co., Ltd.	1.476475579	0.132508798	275226.5	36469.927
E256	***Materials Co., Ltd.	1.393742208	0.13351577	94308.9	12591.72
E305	***Labor Service Co., Ltd.	1.360741454	0.13391747	8349441.3	1118136
E355	***Carpet Business Department	1.264860734	0.135084698	38700704.4	5227873
E171	***Quality Inspection And Testing Station	1.256349819	0.135188316	27279.9	3687.92
E393	***Commercial And Trade Limited Company	1.186267081	0.136041614	892782.4	121455.6
E307	***Communication Engineering Co., Ltd.	1.091490391	0.137195731	128036.2	17566.024
E347	***Stainless Steel Material Co., Ltd.	1.084168799	0.137284895	2967322.6	407368.6
E249	***Construction Engineering Co., Ltd.	1.054026283	0.137651989	64464.9	8873.723
E313	***Logistics Co., Ltd.	0.955389312	0.138853378	122741.0	17043.004
E335	***Excavator Leasing Operation Department	0.900990849	0.139516029	1112123.0	155159
E397	***Hairy Crab Business Department	0.878407001	0.139791151	118020.2	16498.186
E361	***Survey And Design Engineering Co., Ltd.	0.878205611	0.139793604	13616.8	1903.548
E169	***Architectural Design Co., Ltd.	0.867856955	0.139919677	29880.3	4180.849
E160	***Steel Structure Engineering Co., Ltd.	0.800656764	0.140738398	13465.4	1895.099
E232	***Investment Development Co., Ltd.	0.784912808	0.140930225	594865.0	83834.46
E279	***Environmental Packaging Co., Ltd.	0.755090716	0.141293595	28942.8	4089.433
E334	***Mechanical Technology Co., Ltd.	0.743188632	0.141438622	76938.9	10882.13
E297	***Construction Machinery Leasing Co., Ltd.	0.723080704	0.141683644	32156.6	4556.064
E300	***Construction Engineering Co., Ltd.	0.720388899	0.141716445	30338.3	4299.442
E293	***Materials Co., Ltd.	0.596137139	0.143230681	20606.9	2951.545

TABLE 11: Growth rate of revenue of some enterprises in 2020.

Enterprise code	Company name	Risk	Annual interest rate	2020 expenditure (tax included)	2020 income (after tax)	2020 profit margin	19–20 revenue growth rate
E186	***Construction Labor Service co., Ltd.	13.29270342	0.04	1	1	0	–1.00
E128	Self-employed E128	12.94731484	0.04	1	1	0	–1.00
E166	***Construction Engineering Co., Ltd.	12.17331368	0.04	1	1	0	–1.00

TABLE 12: Credit lines calculated by certain companies based on revenue growth rates in 2019.

Enterprise code	Company name	Risk	Annual interest rate	2020 expenditure (tax included)	2020 income (after tax)	2020 profit margin	19–20 revenue growth rate	Turnover	2021 quota
E186	***Construction Labor Service Co., Ltd.	13.29270342	0.04	1	1	0	–1.00	–181	4078933.0
E128	Self-employed E128	12.94731484	0.04	1	1	0	–1.00	–561	11635616.4
E166	***Construction Engineering Co., Ltd.	12.17331368	0.04	1	1	0	–1.00	692	1171434.3

I\$162486, 2019)-COUNTIFS(input invoice information!\$A\$2: \$A\$210948, A2, input invoice information! \$H\$2:\$H\$210948, “valid invoice”, input invoice information! \$I\$2:\$I\$210948, 2019). The specific data comparison is shown in Tables 11 and 12.

5.2. Adjust Credit Limit. For some corporate credit lines, macrocontrol can be implemented in accordance with

policies. The credit line can be increased if the credit line is less than 100,000, and the credit line can be reduced if the credit line is greater than 1 million.

5.3. Improve Annual Interest Rate. According to the data analysis, if the annual interest rate is too high, it will lead to a sharp increase in the customer churn rate. Therefore, in order to ensure that the customer churn rate is less than 50%,

TABLE 13: Annex 1 correspondence between corporate risk value and annual interest rate.

Reputation rating	Risk	Interest rate	Reputation rating	Risk	Interest rate	Reputation rating	Risk	Interest rate
B	0.308035	0.0785	B	0.870827	0.0627	A	2.106037	0.0498
C	0.43323	0.0782	C	0.885318	0.0621	A	2.182256	0.0494
C	0.602095	0.0775	A	0.921991	0.0616	A	2.211497	0.049
C	0.613443	0.0769	A	0.949405	0.0611	C	2.259863	0.0485
C	0.650022	0.0762	B	0.996121	0.0606	B	2.406582	0.0481
C	0.650045	0.0756	A	1.00881	0.06	B	2.416484	0.0477
C	0.652995	0.0749	B	1.017842	0.0595	A	2.423647	0.0473
A	0.688336	0.0743	B	1.023288	0.059	B	2.588746	0.0469
C	0.690585	0.0737	A	1.059018	0.0585	B	2.671114	0.0465
B	0.692255	0.073	B	1.108265	0.058	C	2.807199	0.0461
B	0.700992	0.0724	A	1.124168	0.0575	C	3.125604	0.0457
B	0.703979	0.0718	A	1.12627	0.0571	B	3.303712	0.0453
B	0.714014	0.0712	A	1.158062	0.0566	B	3.576327	0.045
A	0.724354	0.0706	A	1.19084	0.0561	C	3.685514	0.0446
B	0.727404	0.07	C	1.206253	0.0556	C	3.712288	0.0442
B	0.738483	0.0694	C	1.209741	0.0551	C	3.856233	0.0438
B	0.753467	0.0688	C	1.312666	0.0547	B	4.048533	0.0435
C	0.755346	0.0682	C	1.360376	0.0542	A	4.377296	0.0431
B	0.757424	0.0676	A	1.398631	0.0538	A	5.00316	0.0427
B	0.760574	0.0671	B	1.421465	0.0533	C	5.164616	0.0424
B	0.781265	0.0665	A	1.426184	0.0528	C	5.341012	0.042
A	0.805959	0.0659	C	1.533839	0.0524	B	5.782902	0.0416
A	0.810297	0.0654	B	1.721949	0.052	B	6.10317	0.0413
C	0.828054	0.0648	A	1.824604	0.0515	A	6.381905	0.0409
A	0.830954	0.0643	B	1.832157	0.0511	C	6.990441	0.0406
B	0.853665	0.0637	C	2.018004	0.0506	B	8.842854	0.0402
B	0.867381	0.0632	B	2.078559	0.0502	B	9.211668	0.04

FIGURE 1: Improved annual interest rate function fitting effect diagram.

the annual interest rate can be controlled within 0.0785. For this, we renew the annual interest rate. The function is refitted. Redivide the data in Annex 1 as shown in Table 13.

Use Excel to perform trending fitting and get an improved annual interest rate function:

$y = 3E - 06x^5 + 0.0016x^4 - 0.0109x^3 + 0.0402x^2 - 0.0767 + 0.1074$. The fitting effect is shown in Figure 1.

Through the calculation and comparison of the two functions ($y = 1E - 05x^2 - 0.0122x + 0.150$, $y = 3E - 06x^5 + 0.0016x^4 - 0.0109x^3 + 0.0402x^2 - 0.0767 + 0.1074$),

TABLE 14: Comparison of annual interest rate data before and after the improvement.

Enterprise code	Company name	Risk	Annual interest rate	Improve annual interest rate
E418	***Marketing Planning Co., Ltd.	4.446935282	0.096445142	0.077741233
E210	***Construction Engineering Co., Ltd.	4.443812652	0.09648296	0.077639054
E151	***Road & Bridge Engineering Co., Ltd.	4.421320197	0.096755374	0.076911235
E236	Self-employed E236	4.305518904	0.098158044	0.073384643
E353	***Tax Accountant Firm Co., Ltd.	4.204064239	0.099387158	0.070582929
E234	***Mechanical And Electrical Equipment Trading Co., Ltd.	4.086490945	0.100811805	0.067647979
E408	***Air Conditioning Refrigeration Co., Ltd.	3.959225983	0.102354198	0.064819217

the annual interest rate of some companies has been reduced, which has achieved the effect of reducing the customer churn rate. The specific data sample table is shown in Table 14.

During the experiment, BP neural network model, Fisher model, and logistic model are used to predict the risk of small and medium-sized enterprises [12]. According to the experimental results, compared with the other two models, the prediction accuracy of the model based on BP neural network (compared with the actual situation) is higher, which can ensure the prediction results and accuracy to a certain extent.

6. Conclusion

For the article's model design ideas for small, medium, and micro enterprises' credit decision-making, analysis is carried out according to the characteristics of the attached data provided by the title. First, use the fuzzy evaluation method to find the three factors that affect credit risk: reputation rating, default or not, and average profit rate, and use the addition of factor weights to get the function to calculate the credit risk value; secondly, find the function based on the risk value. The annual interest rate is used to calculate the credit limit of each enterprise through a function. According to the linear programming optimization theory, the program is used to find the best mortgage credit enterprise portfolio and provides an effective credit strategy; finally, based on the analysis of the data, analyze the operation of many enterprises. The reasons for negative growth, corporate credit lines not within the scope of bank requirements, and severe customer churn have been proposed to solve the above problems by changing the data changes in the invoicing and sales invoices of the assessed companies in 2019, adjusting the credit lines, and improving the calculation method of annual interest rates. The main advantages are as follows:

- (1) The fuzzy evaluation method can prepare to find out the key factors affecting credit risk.
- (2) The calculation methods of credit risk value, annual interest rate, credit line, etc. are scientific, and the result data is reasonable and reliable.
- (3) Fitting based on the data in Annex 1 to ensure the accuracy of the related questions of the calculation question 2 and question 3.

- (4) The mathematical model is combined with Excel to ensure the scientificity and accuracy of the model, and the C# program is used to realize the combination problem [13], which solves the batch data that cannot be processed manually.
- (5) When the sample size of the data set increases significantly, compared with other models, the accuracy of enterprise risk prediction based on BP neural network model is higher.

After many experiments, it was found that there are deficiencies.

The large amount of data in the invoicing and sales invoices of enterprises and the excessive number of combinations result in a relatively long time for data processing. Some programs may cause problems such as memory overflow due to excessive data volume, and the degree of program optimization needs to be improved.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

The authors acknowledge Guangxi Higher Education Undergraduate Teaching Reform Project (2019JGB271), Natural Science Foundation of Guangxi in 2016 (2016GXNSFAA380102), Natural Science Foundation of Guangxi in 2016 (2016GXNSFAA380188), Junior Middle School Teacher's Basic Ability Promotion Project of Guangxi in 2017 (2017KY0797), and National Social Science Foundation in 2019 (19XJY015).

References

- [1] R. Zhang, "The exploration and practice of the credit loan model of technology-based small, medium and micro enterprises," *China Business Forum*, vol. 30, no. 16, pp. 135–137, 2021.

- [2] Z. Wang, Z. Wang, and H. Wan, "Decision-aid model based on quantitative analysis of credit risk," *Information and Computer (Theoretical Edition)*, vol. 33, no. 10, pp. 52–56, 2021.
- [3] M. Sun and H. Wang, "Application of fuzzy analytic hierarchy process to the economic evaluation of composite wood structure buildings," *Journal of Northeast Forestry University*, vol. 49, no. 7, pp. 111–115, 2021.
- [4] W. Tao and Y. Gui, "Model research on factors affecting the high-quality development of foreign trade from the perspective of spatial measurement," *Mathematics in Practice and Knowledge*, vol. 51, no. 15, pp. 113–122, 2021.
- [5] Z. Dong and S. Mou, "Matrix factorization recommendation algorithm based on user rating weight," *Journal of Jilin Teachers College of Engineering and Technology*, vol. 37, no. 5, pp. 92–94, 2021.
- [6] H. Su and W. Guo, "Optimization of credit risk evaluation indexes for banks' small and micro enterprises," *Finance and Accounting Monthly*, vol. 41, no. 1, pp. 27–32, 2020.
- [7] Y. Yu and X. Wang, "Construction of the evaluation index system for the credit ability of private enterprises——based on a survey questionnaire of 12 industries and 300 enterprises in Guangdong Province," *Mathematics in Practice and Knowledge*, vol. 50, no. 8, pp. 307–315, 2020.
- [8] X. Zhang, N. Li, and H. Fan, "Research on the credit decision of small, medium and micro enterprises based on multi-objective planning," *Contemporary Economics*, vol. 37, no. 6, pp. 24–29, 2021.
- [9] Y. Gu, L. Huang, C. Lin, and C. Cao, "Research on the credit model of small, medium and micro enterprises based on risk level," *Software Engineering*, vol. 24, no. 7, pp. 56–59+55, 2021.
- [10] W. Meng, "Interest rate risk management of commercial banks in interest rate marketization," *Oriental Corporate Culture*, vol. 7, no. 18, p. 207, 2010.
- [11] Y. Zhang, "Research on the calculation method of the compromise optimal solution of the multi-level linear programming process," *Journal of Lanzhou University of Arts and Science (Natural Science Edition)*, vol. 34, no. 4, pp. 23–27, 2020.
- [12] Y. Cheng, "Application of BP neural network in financial early warning of urban investment company," *Modern business*, vol. 16, no. 22, pp. 25–27, 2021.
- [13] Y. Qin, "Application of an improved heuristic algorithm in solving combinatorial optimization problems," *Journal of Anhui Vocational College of Electronics and Information Technology*, vol. 20, no. 1, pp. 19–24, 2021.