

# Research on Enterprise Financial Risk Based on Radial Basis Function Neural Network

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**ABSTRACT**

This article takes A-share manufacturing listed companies in the Shanghai and Shenzhen stock markets as the research subjects. Firstly, 22 financial indicators were preliminarily determined based on the selection principles of warning indicators. Then, financial data of companies in financial crisis and normal companies in 2023 were obtained from the Guotai An database, and descriptive statistics were conducted using SPSS software. Subsequently, data from 135 financially distressed companies and 270 financially normal companies were extracted and subjected to significant difference testing using STATA software. Ultimately, 19 financial indicators were determined, and two financial warning models were constructed. The following conclusions were drawn: (1) Manufacturing listed companies that have fallen into financial crisis difficulties have not been resolved, and the number of financially distressed companies each year remains basically unchanged. (2) Compared with financially normal companies, companies in financial crisis face greater debt repayment pressure, limited development space, weaker profitability, and lower operational efficiency; (3) The prediction performance of the neural network financial warning model and the multivariate discriminant financial warning model is good, with prediction accuracies of 86.8% and 84.8%, respectively, both reaching over 80%. Among them, the radial basis function neural network financial warning model has better predictive performance and can effectively control and prevent financial risks.

**KEYWORDS**

Financial risk; Manufacturing industry; radial basis function neural network; Multivariate discrimination

## 1 Introduction

Enterprise financial risk research refers to the prediction, control, and treatment of financial risks arising from the daily operating activities, investment activities, and fundraising activities of listed companies. If the financial risks of enterprises can be accurately predicted, timely measures can be taken to prevent financial crises and protect the interests of investors and enterprise managers. In the era of rapid economic development, how to effectively solve market pressure, reduce financial risks, and enable enterprises to operate stably and even stand out in the rapids is a problem that all enterprises need to face. The manufacturing industry plays a crucial role in the development of China's national economy, More than half of listed companies are in manufacturing. Therefore, this article conducts research on corporate financial risks through listed companies in the manufacturing industry as representatives, mainly studying the following issues: the gap between financial crisis companies and financially normal companies in terms of four aspects of financial indicators; (2) Comparison of Financial Early Warning Model Prediction Performance between Radial Basis Function Neural Network.

## 2 Empirical Design and Analysis

### 2.1 Selection of financial indicators

Based on the selection criteria<sup>[1]</sup> of previous scholars' indicators and the systematic, comprehensive, and dynamic principles of financial indicators, 22 specific financial indicators were initially selected as the research indicator system from four levels: debt paying ability, development ability, operational ability, and profitability of enterprises(See Table1).

Table 1 Preliminary research indicators

| Indicator cat-<br>egory                         | code | Indicator Name        | Indicator calculation formula                                |
|-------------------------------------------------|------|-----------------------|--------------------------------------------------------------|
| solvency                                        | X1   | Liquidity Ratio       | Current assets/total assets                                  |
|                                                 | X2   | Cash asset ratio      | Closing cash and cash equivalents balance/total assets       |
|                                                 | X3   | current ratio         | Total current assets/total current liabilities               |
|                                                 | X4   | quick ratio           | End of period quick assets/end of period current liabilities |
|                                                 | X5   | cash ratio            | (Cash limit+short-term investments)/Current liabilities      |
|                                                 | X6   | Asset liability ratio | Total liabilities/total assets                               |
|                                                 | X7   | Equity multiplier     | Total assets/total owner's equity                            |
|                                                 | X8   | debt-to-equity ratio  | Total liabilities/shareholder equity                         |
| Data source: Compiled from reference literature |      |                       |                                                              |

Table 1 Preliminary research indicators (Continued).

| Indicator category     | code | Indicator Name                      | Indicator calculation formula                                                                                                                                              |
|------------------------|------|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Development capability | X9   | Fixed asset growth rate             | (End value of net fixed assets for the current period - Initial value of net fixed assets for the current period)/Initial value of net fixed assets for the current period |
|                        | X10  | Total Assets Growth Rate            | (Total assets of the current period, total assets of the previous period) -1                                                                                               |
| operating capacity     | X11  | Fixed asset ratio                   | Net fixed assets/total assets                                                                                                                                              |
|                        | X12  | Accounts receivable turnover rate   | Net sales revenue/average balance of accounts receivable                                                                                                                   |
|                        | X13  | Inventory turnover rate             | Operating costs/average inventory                                                                                                                                          |
|                        | X14  | current asset turnover              | Net revenue from main business/average total current assets                                                                                                                |
|                        | X15  | Fixed asset turnover                | Operating revenue/annual average net fixed assets                                                                                                                          |
|                        | X16  | Total Asset turnover                | Operating revenue/annual average total assets                                                                                                                              |
| PROFITABILITY          | X17  | return on assets                    | (Total profit+financial expenses)/average total assets                                                                                                                     |
|                        | X18  | Net profit margin of total assets   | Net profit/total asset balance                                                                                                                                             |
|                        | X19  | Net profit margin of current assets | Net profit/current asset balance                                                                                                                                           |
|                        | X20  | Net profit margin of fixed assets   | Net profit/balance of fixed assets                                                                                                                                         |
|                        | X21  | Roe                                 | Total operating profit/owner's equity                                                                                                                                      |
|                        | X22  | Sales expense rate                  | Selling expenses/operating income                                                                                                                                          |

Data source: Compiled from reference literature

## 2.2 Empirical testing and result analysis

### 2.2.1 Significance test

270 companies were randomly selected from financially normal companies. Conduct a single sample K-S test on the data of financially distressed companies and financially normal companies in a ratio of 1:2 to determine if the indicators follow a normal distribution. The test results are shown in Table 2.

Table2 Single sample Kolmogorov-Smirnov test

|     | N   | Normal parameters a, b |                | The most extreme difference |                                   |           | Kolmogorov-Smirnov Z | Asymptotic significance (bilateral) |
|-----|-----|------------------------|----------------|-----------------------------|-----------------------------------|-----------|----------------------|-------------------------------------|
|     |     | mean                   | standard error | absolute value              | the first month of the lunar year | burden    |                      |                                     |
| X1  | 405 | 0.570109               | 0.183560       | 0.036506                    | 0.022120                          | -0.036506 | 0.734676             | 0.653                               |
| X2  | 405 | 0.125022               | 0.122179       | 0.153218                    | 0.146103                          | -0.153218 | 3.083449             | 0.000                               |
| X3  | 405 | 2.350200               | 3.284278       | 0.251186                    | 0.249136                          | -0.251186 | 5.055019             | 0.000                               |
| X4  | 405 | 1.883034               | 3.048194       | 0.277485                    | 0.277485                          | -0.275366 | 5.584274             | 0.000                               |
| X5  | 405 | 0.640865               | 2.030381       | 0.376166                    | 0.309983                          | -0.376166 | 7.570200             | 0.000                               |
| X6  | 405 | 0.595469               | 1.602030       | 0.362549                    | 0.359499                          | -0.362549 | 7.296164             | 0.000                               |
| X7  | 405 | 2.958290               | 11.388267      | 0.388347                    | 0.369389                          | -0.388347 | 7.815331             | 0.000                               |
| X8  | 405 | 1.958290               | 11.388267      | 0.388347                    | 0.369389                          | -0.388347 | 7.815331             | 0.000                               |
| X9  | 405 | 0.130530               | 0.966491       | 0.294520                    | 0.294520                          | -0.265110 | 5.927109             | 0.000                               |
| X10 | 405 | 0.045305               | 0.452631       | 0.214387                    | 0.214387                          | -0.137607 | 4.314447             | 0.000                               |
| X11 | 405 | 0.221273               | 0.150285       | 0.070484                    | 0.068815                          | -0.070484 | 1.418468             | 0.036                               |
| X12 | 401 | 21.370769              | 101.474240     | 0.417878                    | 0.411226                          | -0.417878 | 8.367994             | 0.000                               |
| X13 | 399 | 6.322788               | 20.928270      | 0.382676                    | 0.335711                          | -0.382676 | 7.643938             | 0.000                               |
| X14 | 405 | 1.133799               | 0.850494       | 0.131038                    | 0.131038                          | -0.106889 | 2.637090             | 0.000                               |
| X15 | 405 | 248.827676             | 3449.016147    | 0.496706                    | 0.496706                          | -0.471254 | 9.996024             | 0.000                               |
| X16 | 405 | 0.611057               | 0.518043       | 0.159218                    | 0.159218                          | -0.133692 | 3.204202             | 0.000                               |
| X17 | 405 | -0.141065              | 1.538698       | 0.399433                    | 0.399433                          | -0.371253 | 8.038435             | 0.000                               |
| X18 | 405 | -0.165015              | 1.623643       | 0.405544                    | 0.405544                          | -0.364583 | 8.161413             | 0.000                               |
| X19 | 405 | -0.320563              | 2.697273       | 0.390043                    | 0.390043                          | -0.352109 | 7.849469             | 0.000                               |
| X20 | 405 | -183.842456            | 3590.547701    | 0.500801                    | 0.468356                          | -0.500801 | 10.078433            | 0.000                               |
| X21 | 387 | -0.325156              | 3.020142       | 0.401775                    | 0.401775                          | -0.365645 | 7.903843             | 0.000                               |
| X22 | 405 | 0.086539               | 0.100444       | 0.217370                    | 0.217370                          | -0.195903 | 4.374483             | 0.000                               |

Data source: Stata software output results

As can be seen from Table 2, only X1 has an asymptotic significance greater than 0.05, indicating that X1 follows a normal distribution, while the other indicators do not follow a normal distribution. Therefore, an independent sample T-test was performed on X1 and a non-parametric test was performed on X2-X22, as shown in Table 3 and Table 4.

Table 3 Independent sample T-test

| X1                                      | Levene test for variance equation |       | T-test of mean equation |         |                  |              |                      |                                                |                |
|-----------------------------------------|-----------------------------------|-------|-------------------------|---------|------------------|--------------|----------------------|------------------------------------------------|----------------|
|                                         | F                                 | Sig.  | t                       | df      | Sig. (bilateral) | mean D-value | standard error value | The 95% confidence interval for the difference |                |
|                                         |                                   |       |                         |         |                  |              |                      | lower limit                                    | superior limit |
| Assume equal variance                   | 4.909                             | 0.027 | -2.799                  | 403     | 0.005            | -0.053706    | 0.019187             | -0.091425                                      | -0.015986      |
| Assume that the variances are not equal |                                   |       | -2.632                  | 228.760 | 0.009            | -0.053706    | 0.020405             | -0.093911                                      | -0.013500      |

Data source: Stata software output results

Table 4 Nonparametric tests

|     | Mann-Whitney U | Wilcoxon W | Z      | Progressive significance |
|-----|----------------|------------|--------|--------------------------|
| X2  | 25600.000      | 62185.000  | 6.641  | 0.000                    |
| X3  | 26510.000      | 63095.000  | 7.461  | 0.000                    |
| X4  | 25952.000      | 62537.000  | 6.958  | 0.000                    |
| X5  | 26965.000      | 63541.000  | 7.862  | 0.000                    |
| X6  | 9590.000       | 46175.000  | -7.776 | 0.000                    |
| X7  | 14045.000      | 50630.000  | -3.764 | 0.000                    |
| X8  | 14045.000      | 50630.000  | -3.764 | 0.000                    |
| X9  | 26568.000      | 63.153.000 | 7.513  | 0.000                    |
| X10 | 31458.000      | 68043.000  | 11.916 | 0.000                    |
| X11 | 19048.000      | 55633.000  | 0.741  | 0.459                    |
| X12 | 18303.000      | 54349.000  | 0.440  | 0.660                    |
| X13 | 17355.000      | 53940.000  | -0.056 | 0.956                    |
| X14 | 22794.000      | 59379.000  | 4.114  | 0.000                    |
| X15 | 21992.000      | 58577.000  | 3.392  | 0.001                    |
| X16 | 24774.000      | 61359.000  | 5.897  | 0.000                    |
| X17 | 30511.000      | 67096.000  | 11.063 | 0.000                    |
| X18 | 31410.000      | 67995.000  | 11.873 | 0.000                    |
| X19 | 30812.000      | 67397.000  | 11.334 | 0.000                    |
| X20 | 30076.000      | 66661.000  | 10.672 | 0.000                    |
| X21 | 25193.000      | 61508.000  | 9.202  | 0.000                    |
| X22 | 15449.000      | 52034.000  | -2.500 | 0.012                    |

Data source: Stata software output results

From Table 3, it can be seen that under the confidence level of 5%, the P-value for X1, which follows a normal distribution, is less than 0.05, indicating a significant difference in the current asset ratio between financially healthy companies and those in financial distress. From Table 4, it is evident that the P-values for X11, X12, and X13, which do not follow a normal distribution, are greater than 0.05, failing the Mann-Whitney U test.

### 2.2.2 Radial base network output results

This paper uses sample data from 405 companies as the research sample, setting the ratio of training samples to test samples at 7:3. The number of training sample companies is set to 281, and the total number of test sample companies is 106. After excluding 18 companies, the total number of valid sample listed companies is 387 (see Table 5). By using STATA software to process the selected samples and indicators, financial crisis companies are set to 0, and financially normal

Table 5 Summary of case handling

|             |           | N   | percentage |
|-------------|-----------|-----|------------|
| sample book | training  | 281 | 72.6%      |
|             | test      | 106 | 27.4%      |
|             | valid     | 387 | 100.0%     |
|             | Excluded  | 18  |            |
|             | amount to | 405 |            |

Data source: Stata software output results

companies are set to 1.

Table 6 Output results of radial base network

| sample book | Observed         | It has been predicted |       |                    |
|-------------|------------------|-----------------------|-------|--------------------|
|             |                  | 0                     | 1     | Correct percentage |
| training    | 0                | 62                    | 21    | 74.7%              |
|             | 1                | 16                    | 182   | 91.9%              |
|             | Total percentage | 27.8%                 | 72.2% | 86.8%              |
| test        | 0                | 22                    | 13    | 62.9%              |
|             | 1                | 7                     | 64    | 90.1%              |
|             | Total percentage | 27.4%                 | 72.6% | 81.1%              |

Data source: Stata software output results

The output results of the radial basis function neural network model show that the overall accuracy rate of the training samples reaches 86.8%, with the prediction accuracy rate for non-ST companies reaching as high as 91.9%, and for ST companies, it reaches 74.7%. The accuracy rate for test samples also reaches 81.1%, with the prediction accuracy rates for non-ST and ST companies being 90.1% and 62.9%, respectively. The overall prediction level of the model is good, but the accuracy rate for ST companies is lower than that for non-ST companies. This is due to the relatively smaller number of ST companies compared to non-ST companies in 2019, which limits the scope of sample selection. In 2021, scholar Yan Jie<sup>[2]</sup> defined the misclassification of non-financial crisis companies as the first type of error and the misclassification of financial crisis companies as the second type of error. We use this to analyze the probability of Type I and Type II errors in radial basis function processing results. In the training set, there were 198 financially normal companies, of which 16 were misclassified as ST companies, resulting in a Type I error probability of 8.1%; there were 83 financial crisis companies, of which 21 were misclassified as non-ST companies, leading to a Type II error probability of 25.3%. In the test set, 7 out of 71 financially normal companies were misclassified, and 13 out of 35 financial crisis companies were misclassified. The probability of Type I errors was 9.9%, while the probability of Type II errors was 37.1%.

### 2.2.3 Output results of discriminant analysis

Discriminant analysis is a predictive statistical method that classifies and identifies observed samples based on their quantitative characteristics, and judges their attributes. Using STATA software to analyze and test data indicators, while constructing a neural network model, the data is also entered into the discriminant analysis model. The software output results are shown in Table 7.

Table 7 Classification results a

| Financial crisis status |       | Forecast group |      |      | amount to |
|-------------------------|-------|----------------|------|------|-----------|
|                         |       | members        |      |      |           |
| initial                 | count | 0              | 1    |      |           |
|                         |       | 85             | 33   |      | 118       |
|                         | %     | 26             | 243  |      | 269       |
|                         |       | 72.0           | 28.0 |      | 100.0     |
|                         |       | 1              | 9.7  | 90.3 | 100.0     |

Source: Stata software output. Here a indicates that 84.8% of the initial grouped cases have been correctly classified.

Through the above analysis, it can be found that among the training samples in discriminant analysis, there are 269 financially normal companies, of which 26 were incorrectly classified as ST companies. Therefore, the probability of committing Type I error is 9.7%. There are 118 companies facing financial crises, of which 33 were incorrectly classified as non-ST companies. Thus, the probability of committing Type II error is 28%. Considering the output results of radial basis function, both methods have a significantly higher probability of committing Type II errors compared to Type I errors. By comparing the categories assigned by the discriminant analysis method with the original categories, the accuracy rate of the discriminant analysis method is 84.8%. Based on the above empirical results, it can be seen that both models have good predictive effects, with correct discrimination rates of 86.8% and 84.8%, respectively, both exceeding 80%. This validates Hypothesis 2 of the study, which states that the discriminative effect of the neural network model is superior to that of the multivariate discriminant financial early warning model, demonstrating better discriminative ability.

## 3 Conclusions

This paper starts with the theory of corporate financial risk, studying relevant literature on financial crises caused by financial conditions in domestic and international companies. It summarizes their research content, methods, and

achievements. After gaining a basic understanding of financial risk, financial crisis, neural networks, and financial early warning, SPSS software was used to conduct descriptive statistics on the financial data of A-share manufacturing companies listed in the Shanghai and Shenzhen stock markets in 2019, analyzing the statistical results. STATA software was employed for sample significance difference testing and model construction, analyzing the test results and empirical results. Finally, the following conclusions are drawn. First, the financial crisis issues of manufacturing companies in our country have yet to be resolved. Although the proportion of financially troubled companies among listed firms in the manufacturing sector shows a downward trend each year, the actual number of such companies remains relatively stable. This indicates that the challenges faced by financially troubled companies have not been adequately addressed, and both enterprises and the securities market need to continue strengthening their efforts in maintenance and development. Second, in the comparison of financial indicators, companies with financial crises generally perform poorly. In terms of debt repayment capability, these companies face poor cash flow and significant debt pressure; regarding development capability, their growth potential is hindered, preventing further development; operational efficiency and profitability indicators show that the revenue generated by the operational methods of financially troubled companies is relatively low. Thirdly, the empirical results of the model show that both the neural network model and the multiple discriminant model have good prediction effect, with the prediction accuracy of 86.8% and 84.8% respectively, both of which can reach more than 80%. Among them, the radial basis neural network financial early warning model has better prediction effect, which can effectively control and prevent financial risks.

#### 4 Propose

Based on the research conclusions and previous relevant literature, the following four suggestions are given: First, strengthen legal system construction and jointly build a green securities market. Companies should enhance their legal systems and improve financial risk management mechanisms. By establishing various inspection departments to monitor the flow of funds in real time, they can effectively protect the rights of small and medium shareholders. The securities market should also emphasize market supervision, improve laws and regulations, strictly combat illegal activities, protect investors' interests, and maintain the construction of a green securities market. Second, optimize the corporate operating structure and enhance innovation capabilities. In an era of fierce competition where only the fittest survive, if business leaders do not wish to be eliminated by the market, they must not only focus on their existing business models but also continuously innovate, develop new products and services, and refine their production and operation structures. By doing so, they can create their own advantages among numerous competitors and strengthen their core competitiveness. Third, respond to national policies and establish a corporate brand effect. Business operations should not only consider their own development but also keep pace with the nation's progress, paying attention to economic policies and understanding the living conditions of the people. When a company's development plans align with the realities of the people, its products and services can truly meet the needs of the public. By building such a corporate brand effect, large enterprises can establish a positive image and ensure long-term success; small and medium-sized enterprises can receive poverty alleviation support from the state, attract more investment and financing sources, and promote their growth and expansion. Fourth, enhance risk awareness and strengthen financial early warning. In the process of economic development, the competitive environment for businesses is becoming increasingly fierce. It is crucial to remain vigilant against risks at all times to avoid losses that could impact business operations and growth. Companies should integrate risk awareness into their daily operations, closely monitoring potential negative factors, ensuring effective communication from top to bottom, and improving risk consciousness. By addressing the weak points in internal control mechanisms, introducing financial early warning systems can continuously reinforce the early warning mechanism, thereby reducing the occurrence of financial risks.

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