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Research on Early Financial Warning of Retail Trade based on Fisher Discriminant Analysis

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Abstract: In the current fluctuating macro-environment, financial risk early warning is essential for all walks of life, especially for the trade and retail industry, which has been seriously impacted. Based on the five dimensions of profitability, solvency, operational capacity, development capacity, and corporate governance, this paper first establishes a stochastic forest model. Considering the poor interpretability of the model, this paper constructs an optimized Fisher discriminant financial early warning model based on the six indexes selected by the random forest model. The empirical results show that the accuracy of the model can reach 90.5%, which is significantly better than the original statistical model and can effectively help enterprises to prevent financial risks.

1. Introduction

With the rapid development of the economy and the changing social situation, all walks of life face unknown challenges. A series of black swan events have seriously affected the financial and economic situation of enterprises. Therefore, enterprises need to introduce a financial early warning model, get risk warnings in advance, adjust strategic direction in time, and avoid falling into a financial crisis. Recently, many domestic scholars have studied the early financial warning of different industries. For example, Guan Yin, Li Xinyue, and Zhu Jiaming[1] are studied From the four aspects of solvency, operation ability, profitability, and development ability. Therefore, this paper uses the financial early warning model based on the Bayesian discriminant method. It is concluded that the model has certain universality for China's manufacturing enterprises and can help enterprises detect their financial situation and prevent financial risks in advance. Li Cai[2]BP neural network model is used to predict the financial risk of feed listed companies, and the accuracy of the model is 81.8%, which is more accurate for financial risk early warning. Huang Yueyue[3]This paper uses the logistic regression method to build a financial risk early warning model for small and medium-sized Internet service enterprises.

The accuracy of the prediction model can reach 83.8%, and these enterprises should pay attention to the improvement of profitability, cash flowability, and development ability. The above research only uses a machine learning model or a traditional statistical model, and each has its advantages and disadvantages. With the birth of the fourth industrial revolution, the rapid development of the Internet is constantly improving and improving people's quality of life. Retail e-commerce platforms also came into being. Online shopping platforms such as Taobao, Jingdong,

Pinduoduo, and HEMA provide various products and services. Consumers can enjoy door-to-door delivery with just a touch of their fingers. A variety of choices, and convenient services, With the continuous development of retail prices in the impact. In particular, with the outbreak of the epidemic, offline supermarkets are facing the problem of closing stores for epidemic prevention, which leads to a decrease in passenger flow again. Therefore, building a financial early warning model for retail trade is very important. There is little research on this industry in China, which needs further research and exploration. In this paper, combining the advantages and disadvantages of the machine learning and statistical models, the stochastic forest model is used to optimize the Fisher discriminant financial early warning model. It can improve the accuracy of the model and better predict the financial risk of the commerce and retail industry.

2. Establishment of index system and data sources

According to the situation of the commercial retail industry, this paper constructs the financial early warning index system from five dimensions: profitability, solvency, operation ability, development ability, and corporate governance[4]. Profitability reflects the ability of enterprises to obtain capital appreciation, which is the fundamental significance of enterprises' sustainable survival. Under this dimension, this paper selects sales profit rate (x_1), return on net assets (x_2), and gross profit margin (x_3) as corresponding indicators. Solvency refers to the ability of an enterprise to repay its liabilities with assets, which reflects the financial situation and operating ability of an enterprise. It is an area that investors and creditors pay close attention to it. Under this dimension, this paper selects asset-liability ratio (x_4), equity ratio (x_5), current ratio (x_6), and quick ratio (x_7) as corresponding indicators. Operating capacity refers to the turnover and utilization efficiency of enterprise assets under the constraint of the external market environment. In this dimension, this paper selects the inventory turnover rate (x_8), accounts receivable turnover rate (x_9), and accounts payable turnover rate (x_{10}) as the corresponding indicators. Development ability refers to the potential ability of an enterprise to expand its scale and strength.

Table 1. Financial early warning index system

Type	Financial index	Symbol	Definition
Profitability	The net profit rate of sales	X_1	Net profit / operating income
	Return on net assets	X_2	Net profit / average net assets
	The gross profit margin of sales	X_3	Gross profit / operating income
Solvency	Asset liability ratio	X_4	Total liabilities / total assets
	Equity ratio	X_5	Total liabilities / total shareholders' equity
	Current ratio	X_6	Current assets / current liabilities
	Quick ratio	X_7	(current assets inventory) / current liabilities
Operational capacity	Inventory turnover	X_8	Main business cost / average inventory
	The turnover rate of accounts receivable	X_9	Main business income / average accounts receivable
	The turnover rate of accounts payable	X_{10}	Main business cost / average accounts payable
Capacity development	The growth rate of operating revenue	X_{11}	Business volume growth / current revenue
	The growth rate of total assets	X_{12}	(total assets of the current period - total assets of the previous period) / total assets of the previous period
	Capital accumulation rate	X_{13}	Increase in owner's equity in the current period / total owner's equity at the beginning of the current period
	rate of capital accumulation	X_{14}	Owner's equity at the end of the current period/owner's equity at the end of the previous period
Corporation governance	Number of directors	X_{15}	Number of directors on the board of directors

Under this dimension, this paper selects the growth rate of operating income (x_{11}), the growth

rate of total assets (x_{12}), the capital accumulation rate (x_{13}), and the rate of maintaining and increasing the value of capital (x_{14}) as the corresponding indicators. Corporation governance is a set of process systems to control and manage enterprises, and it is also the premise to ensure the standard and effective operation of the company. This paper selects the number of directors (x_{15}) as the corresponding index in this dimension. Therefore, the index system, as established in Table 1.

The data in this paper are all from the Oriental Fortune choice terminal. According to the Shenyi industry classification standard, we get the relevant financial indicators of 92 non-ST enterprises and 11 st enterprises from the commercial retail industry in 2021. This paper selects 10 ST and 12 non-ST enterprises by random sampling to construct the follow-up model.

3. The financial early warning model is based on Stochastic Forest Model

3.1 Research ideas

It is necessary to build a financial early warning model for retail trade in the current social environment. Although the financial risk early-warning model constructed by traditional statistical methods has strong interpretability, its accuracy is generally low. Therefore, this paper wants to build a financial risk early warning model for the retail trade industry through the random forest model. The random forest model is a typical machine learning model. The model will randomly extract the same amount of data from the original data set to form new data sets and obtain multiple decision trees. According to the results of these multiple decision trees, a more accurate final result can be obtained.

3.2 Result analysis

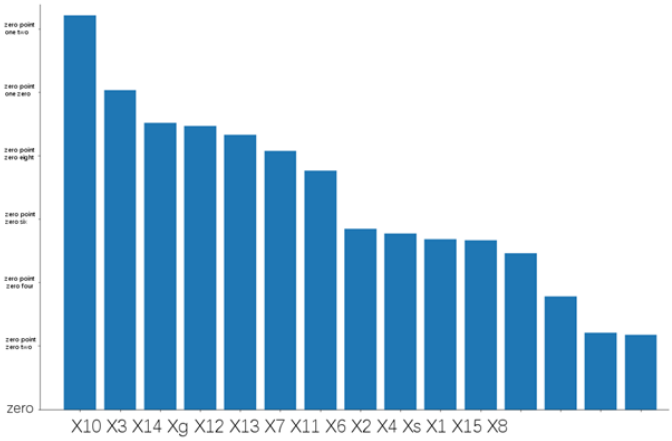

Figure 1. Importance ranking of financial indicators

This paper quantifies ST enterprises as one and non-ST enterprises as zero to analyze the stochastic forest model. Based on the data of 22 enterprises, 30% of the data were randomly selected as the test set and 70% of the data as the training set, and 1000 decision trees were trained.85%, and the prediction accuracy of sklearn can reach 100%. Based on the financial situation evaluation system of the Commerce and retail industry constructed above, the model ranked the importance of indicators according to the number of times each index appeared in establishing the model, as shown in Figure 1. It can be seen from this graph that the six indexes, such as the turnover rate of accounts payable (x_{10}), the gross profit rate of sales (x_3), the rate of maintaining and increasing the value of capital (x_{14}), the turnover rate of accounts receivable (x_9), the growth rate of total assets (x_{12}) and the capital accumulation rate (x_{13}) have the important impact

on the financial situation. Of these six indicators, the accounts payable turnover ratio greatly impacts the financial situation. Due to many goods purchased in the commercial and retail industry. Generally, credit sale is adopted for purchasing. Accounts payable is essentially an interest-free loan. Therefore, the trade and retail industry needs to use the form of credit reasonably and cautiously to ensure the credit of enterprises and strive for more delays in the payment time limit for enterprises. Meanwhile, three of the six indicators belong to the dimension of development capacity. It is very consistent with the macro background of the current trade and retail industry.

4. Financial early warning model based on Fisher discriminant analysis

4.1 Research ideas

Although the prediction accuracy of the stochastic forest model is high, it is essentially a black-box model with poor interpretability and no intuitive expression, which is convenient for enterprises to pay attention to critical financial indicators. Fisher discriminant analysis is a traditional statistical model with weak accuracy and vital interpretation. Based on the six important financial indicators obtained from the random forest model above, we can try to build an optimized financial early warning model based on the Fisher discriminant method. It can obtain a financial early warning model with substantial explanatory and high precision, which organically combines the advantages and disadvantages of machine learning and statistical model.

4.2 Result analysis

4.2.1 Model test

Before constructing the financial early warning model of the Fisher discriminant method, this paper makes a significance test on the data of two types of enterprises using the same test of average group value and the equality test of the covariance matrix. It uses the Wilke lambda test to test the significance of the model.

Table 2. Equivalence test of group mean

Type	Wilke lambda	F	Degree of freedom 1	Degree of freedom 2	Significance
The turnover rate of accounts payable	.896	2.326	1	20	.143
The gross profit margin of sales	.713	8.033	1	20	.010
rate of capital accumulation	.813	4.611	1	20	.044
The turnover rate of accounts receivable	.841	3.773	1	20	.066
The growth rate of total assets	.902	2.180	1	20	.155
Capital accumulation rate	.813	4.611	1	20	.044

The same test of group average can verify whether there is a significant difference in financial indicators between a good financial situation and a financial crisis. The results are shown in Table 2. According to the p-value corresponding to the test statistic F, when the significance level value is 0.05. There are significant differences in gross profit margin, capital maintenance, appreciation rate, and capital accumulation. When the significance level is 0.1, the accounts receivable turnover rate is significant. When the significance level is 0.2, the turnover rate of accounts payable and the growth rate of total assets are significant. To sum up, five indicators have a particular significance.

Box test can verify whether there is a significant difference in the covariance matrix between different types of enterprise financial indicators. The constructed financial early warning model is effective when there are significant differences. Based on the test results, when judging whether the covariance matrix of ST and non-ST enterprises are equal, the significance p-value is almost 0 (the degree of freedom 1 is 15, the degree of freedom 2 is 1481.542). It can be concluded that there is a significant difference between the two types of the enterprise covariance matrix, which is suitable for the establishment of a financial early warning model based on the Fisher discriminant method.

The Wilke lambda method can help test whether the Fisher discriminant model is significant. Only when the model is significant can it have practical application significance to the commerce and retail industry. Based on the chi-square test statistics, under the condition of 5 degrees of freedom, the significance p-value is almost zero, which indicates that the model has vital significance and has particular application significance.

4.2.2 Model results

Based on the six important financial indicators obtained from the random forest model, the financial early warning model based on the Fisher discriminant method was constructed by SPSS software, and its corresponding function equation was obtained. SPSS software automatically did not use the capital accumulation rate index in the analysis process.

$$Y = 0.063X_3 + 0.004X_9 - 0.004X_{10} + 1.621X_{12} + 1.132X_{14} - 3.979 \quad (1)$$

Meanwhile, the model can also get the function value of the group centroid corresponding to the two types of enterprises. When the enterprise is an ST enterprise, the function value at the group centroid is -1.876. When the enterprise is a non-ST enterprise, the function value at the group centroid is 1.563. The value of the model is -15.65. In real life, commercial and retail enterprises can bring in relevant financial indicators according to the above discriminant function and calculate the corresponding y value. The y value is compared with the center value. When the y value of an enterprise is greater than the central value of -0.1565, it is demonstrated that the current financial situation of the enterprise is much better. When the y value is closer to the central value, it is indicated that the enterprise needs to strengthen the control of the financial situation to avoid falling into a financial crisis.

When the y value of the enterprise is less than the central value of -0.1565, it is represented that the current financial situation of the enterprise is poor. The enterprise is needed to make strategic adjustments in time. We can also get the standardized discriminant function equation by SPSS software

$$Y^* = 1.197X_3^* + 1.105X_9^* - 0.109X_{10}^* + 0.717X_{12}^* + 0.590X_{14}^* \quad (2)$$

Through the above equation, the influence degree of the five indicators is obtained on the financial situation. The influence degree of gross profit rate of sales, the turnover rate of accounts receivable, the growth rate of total assets, value maintenance and appreciation rate of capital, and turnover rate of accounts payable decrease successively, and the influence of turnover rate of accounts payable on the financial status of enterprises are negatively correlated. Therefore, the retail trade industry can focus on the indicators that have a more significant impact on the financial situation and supervise and control them to effectively avoid financial risks.

4.2.3 Model effect

The construction of the above model shows that the prediction accuracy of the model can reach 95.5% for the original data, 91.7% for the enterprise with a good financial condition, and 100% for

the enterprise with a financial crisis. Meanwhile, the model is verified by the "left one and keep one" method [5]. Each time a sample is extracted from the data set to verify the model constructed by other data, which can effectively solve the problem of overfitting to a certain extent. Through the verification of the left one method, the accuracy rate of the model prediction can reach 90.9%, 91.7% for the enterprises with good financial status, and 90% for the enterprises with a financial crisis, as shown in Table 3.

Table 3. Prediction results after optimization of discriminant function

Categories			Forecast team member information		Total
			0	1	
Original A	count	0	11	1	12
		1	0	10	10
Cross check B	count	0	11	1	12
		1	1	9	10

Note: A. correctly classified 95.5% of the original grouped cases; B. 90.9% of the grouped cases with cross-validation were correctly classified.

This paper also compares the accuracy of the Fisher discriminant financial early warning model before and after optimizing the stochastic forest model. As shown in Table 4, the prediction accuracy of the financial early warning model before the optimization is as high as 100% for the original data. However, the prediction accuracy rate is as low as 54.5% under the "leave one" method, and only 58.3% for the enterprises with good financial conditions, The accuracy rate of enterprise forecast on the financial crisis is only 50%. It is obtained that the traditional model has an overfitting problem. However, after using the stochastic forest model to optimize the financial early warning model, the prediction accuracy of the left one method is significantly improved. It is shown that the optimization method can better solve the low accuracy of the traditional statistical model. Then, it can get a financial early warning model with high accuracy and strong explanatory power.

Table 4. Prediction results of discriminant function before optimization

Categories			Forecast team member information		total
			0	1	
Original A	count	0	12	0	12
		1	0	10	10
Cross test B	count	0	7	5	12
		1	5	5	10

Note: A. correctly classified 100% of the original grouped cases; B. 54.5% of the grouped cases with cross-validation were correctly classified.

5. Conclusions and suggestions

By selecting financial indicators by the stochastic forest model, the financial early warning model of the Fisher discriminant method is obtained. The optimization method significantly improves the prediction accuracy rate to 90.9%, which provides a financial early warning model with high accuracy and strong explanatory advantages for commercial retail enterprises. Based on the financial early warning model of the commercial retail industry, the following suggestions are put forward

1) The gross profit rate of sales is the most critical index for enterprises. The business retail

industry needs to innovate the marketing mode to attract more consumers, create income, and improve the gross profit rate of enterprise sales. In addition, the capital growth rate and the capital growth rate belong to the three dimensions of capital growth rate. Under the current social background, the e-commerce platform has occupied most of the market share of the retail trade. Therefore, the industry must make strategic reforms and adjust the business model in time. It continuously accumulates capital and improves their potential development ability, which avoids bankruptcy due to financial risks.

2) When the calculated y value is close to the central value, the enterprise should improve the risk awareness and incorporate the financial risk into the corporate governance system. After the company gets the financial risk warning, there should be a corresponding processing strategy and control personnel. Moreover, enterprises should learn lessons and find the root cause of financial risk and timely rectification, which avoids the recurrence of the financial crisis. With the development of the times, enterprises should constantly update the index system of the financial early warning model or adjust it according to its situation. Therefore, the financial early warning model can keep pace with the times and be effective.

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