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# Research on application of principal component statistical analysis in the financial early-warning

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ABSTRACT: Under the background of market economy, the environment of enterprises is changing rapidly, so the management layer urgently needs to know the financial situation in advance, in order to take measures to resolve risks. Based on 25 domestic listed companies, this paper uses SPSS software and statistical method of principal component analysis to establish the financial early warning model that is suitable for the listed companies in China. Taking Maotai Company as an example, this paper conducts prediction analysis, and obtains the conclusion that it has some practical guidance, and proposes a suggestion that the combination with qualitative and quantitative analysis can predict risks more comprehensively and accurately.

*Keywords*: financial early warning; principal component analysis; modeling; application

## 1 RESEARCH BACKGROUND

Under the background of global economic integration and China's economic market, the environment of enterprises is changing rapidly. In the process of normal operation, the company promptly and accurately sends out the early warning signal through tracking and monitoring the financial operation process, and timely finding out problems, thus helping the company's management layer to timely adjust the company's development strategy and take corresponding measures to solve problems according to the early warning results, in order to eliminate the business distress in the bud, and try to avoid the company's financial distress [1]. The establishment of financial early warning model depends on the interdisciplinary intersection, covering a wide range, and showing science and art, so it has strong comprehensiveness, with higher requirements on the modeler. In the modeling process, how to process data after acquisition of data, and constantly make these data consistent with the use rules of statistical methods is the value of being engaged in the research of model method [2]. Under the dual-power pushing of the solid support of theoretical knowledge and the strong demand of reality, application for the statistical method in the research of the change trend of financial situation of the company is pursued by the domestic and foreign experts and scholars.

Foreign researchers have researched a set of suitable and feasible financial early warning model after many years of theoretical exploration and practice exploration, but the model established under foreign environment and conditions is not necessarily suitable for China's enterprises, because specific analysis should be carried out for specific things. In addition, the data used for establishment of model should be timeliness, so that the model established in this way can timely reflect the development of the times. The related interest parties urgently need to establish a financial analysis system which can send out the early warning signal, so it is very necessary to research the financial early warning model that is suitable for China's national conditions at the current stage.

## 2 OVERVIEW OF RELEVANT RESEARCH

For the enterprises with financial distress, domestic and foreign researchers have conducted empirical research in the very earlier period, and have achieved some results in terms of the financial distress definition and early warning model. Foreign scholars generally view the bankrupt state of the company as a sign of its financial distress. Altman believes that the existence of financial distress is manifested by the com-

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pany's inability to pay off its debts [3]. Deaki believes that the companies in financial distress only include companies that have undergone bankruptcy, insolvency, or bankruptcy liquidation due to relevant interests [4]. Beaver defines the financial distress as four stages, namely, bank overdraft, default in corporate bonds, failure in payment of preferred dividends and declaration of bankruptcy [5]. Foster puts forward the continuous stages of enterprise failure, including the following five stages: decline in sales volume of major products, deferred payment of short-term debts, failure in timely payment of preferred dividends, due default in corporate bonds and declaration of bankruptcy [6]. According to the difference in the financial situation, Lau divides the company into five stages from financial stabilization to bankruptcy liquidation [7]. Yu Xuying defines the company's financial distress as company's failure to repay its current liabilities and company's liabilities exceeding the assets [8]. Zhao Ailing believes that the financial distress is usually manifested as the company's failure to pay the costs or matured debts [9]. Liu Liang believes that the company can be identified as the company in financial distress only when the listed companies suffer from two consecutive years of losses.

William Beaver selects 79 pairs of failing and successful companies to establish a univariate early warning model [11]. Edwardi.altman establishes Z-value multi-model [12]. Ohlson is the first to introduce the logical regression approach to the research filed of financial distress early warning [13]. Chen Jing finds out significant difference in the comparison with six financial indicators by taking 27 listed companies and 2 non-listed companies as samples [14]. Zhou Shouhua believes that the establishment of Z-value model does not consider the changes of cash flow, so they transform Z-value model and finally establish F-fraction model for prediction of financial distress [15].

Various models have a certain application space and limitations. The statistical method is characterized by being simple to calculate, easy to use and explain, but it is not applicable to increasingly changing environment of the company's operation, nor unable to meet the increasingly increasing precision requirements. This research uses the principal component analysis to establish the financial distress early warning model, and carries out statistical analysis of the company's financial situation, thereby judging the company's operating results.

## 3 ESTABLISHMENT OF FINANCIAL EARLY WARNING MODEL BY USING PRINCIPAL COMPONENT ANALYSIS

### 3.1 *Principal component analysis*

#### 3.1.1 *Basic principle of principal component analysis*

Assuming that p financial indicators (expressed by $x_1$, $x_2$, $x_3$…..$x_p$) are respectively selected for n listed companies to research the financial situation of n listed companies. To denote the data matrix as X, then $X=(x_1, x_2, x_3,..., x_p)^T$, setting the ensemble average of X as $\mu$, and the covariance matrix as $\Sigma$. After the linear transformation, a new aggregate variable is formed, denoted as Y. Denoting the coefficients as $U=(u_1,...,u_p)$, $u_i=(u_{1i},...u_{pi})^t$, the new aggregate variable is $Y=(y_1,...y_p)^T$. The expression is as follows:

$$\begin{cases} y_1 = u_{11}x_1 + u_{21}x_2 + ... + u_{p1}x_p \\ y_2 = u_{12}x_1 + u_{22}x_2 + ... + u_{p2}x_p \\ ..... \\ y_p = u_{1p}x_1 + u_{2p}x_2 + ... + u_{pp}x_p \end{cases} \quad (1)$$

Since $var(y_i)=var(u^t_iX)=u^t_i\Sigma u_i$, assuming that any given constant is C value, then $var(cy_i)=var(cu^t_iX)=cu^t_i\Sigma u_ic=c^2u^t_i\Sigma u_i$. In the actual application for the above formula, the specified coefficients are determined by the following principles:

1. $u_{1i}^2 + u_{2i}^2 + u_{3i}^2 + ... + u_{pi}^2 = 1 \quad (i = 1,2,3...,p)$
2. $y_i$ has nothing to do with $y_j$ ($i \neq j$, $i = 1,2,3...,p$)
3. Rank various variables: the most bigest variance of $y_1$, the most smallest variance of $y_p$.

The aggregate variables, $y_1,y_2,...,y_p$ are respectively called as the first, second,…p-th principal component of the original variable. In the research of the practical application of specific issues, we can only select the largest principal component of the former variance, which greatly simplifies the complexity of the problem.

#### 3.1.2 *Geometrical significance of principal component analysis*

For the sake of intuition, its geometrical significance can be explained by the simplest binary normal variables [16]. Assuming that there are n samples, each sample has two observational variables $x_1$ and $x_2$. The data matrix is shown in Table 1.

Table 1. Two-dimensional data matrix

| | $x_1$ | $x_2$ |
|---|---|---|
| Sample 1 | $x_{11}$ | $x_{12}$ |
| Sample 2 | $x_{21}$ | $x_{22}$ |
| …… | | |
| Sample n | $x_{n1}$ | $x_{n2}$ |

In the plane determined by two variables, the scattered n sampling points are ribbon-like, as shown in Figure 1.

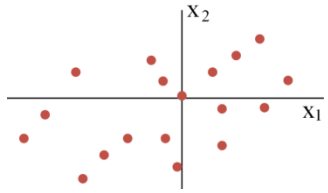


Figure 1. Scatter diagram of sampling points in the plane

To counterclockwise rotate $x_1$-axis and $x_2$-axis, obtaining the new $y_1$-axis and $y_2$-axis, as shown in Figure 2.

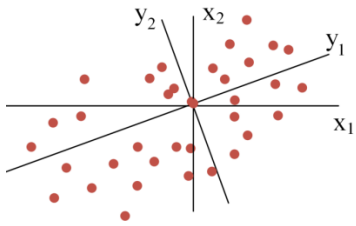


Figure 2. Scatter diagram of coordinate axis after rotation

Since y-axis is obtained by rotation of x-axis, according to the rotation formula of trigonometric function:

$$\begin{aligned} y_1 &= x_1\cos\theta + x_2\sin\theta \\ y_2 &= x_1(-\sin\theta) + x_2\cos\theta \end{aligned} \tag{2}$$

The above transform shows that two new variables, $y_1$ and $y_2$ are the linear combination of the original variables. The fluctuations of n sampling points on the two-dimensional plane can be clearly seen according to the diagram after rotation. Most of these fluctuations can be come down to fluctuations in the direction around $y_1$-axis, and the fluctuation on $y_2$-axis is smaller. To basically concentrate the information contained in the raw data on $y_1$-axis after rotation, the fluctuation of n sampling points in the direction around $y_1$-axis is the largest, and the variance is also the largest. That is, the difference in each point is mainly manifested in the direction of $y_1$-axis. Therefore, in the research, we can only consider the impact of aggregate variable $y_1$, without considering the impact of related information of $y_2$. Using the aggregate variable $y_1$ to replace the original variable $x_1$ and $x_2$, and using principal component analysis can not only simplify the problems, but also reflect most of information of the problem, and reduce the lost information. This method not only plays a role of information enrichment for a large amount of raw data, but also has the irrelevant nature of $y_1$ and $y_2$, of which excludes each other's information, so as to avoid information overlapping, resulting in false problems. For the formed principal component, $y_1$ is called as the first principal component, while $y_2$ is called as the second principal component. In general, we use the first principal component to solve problems. Through such transformation and reduction in the one-dimensional space by the two-dimensional space can simplify the system structure, and seize the principal contradiction of the problem.

#### 3.1.3 *Design of model*

Modeling by the principal component analysis consists of the following three steps: (1) to select a certain number of companies with a good financial status and the same number of companies with a bad financial status as research samples, and select a good financial ratio among these companies. The financial ratio selected should be characteristic, such as the indicators that can comprehensively reflect the company's debt paying ability, profitability, growth capacity and other aspects, important financial indicators that can effectively guide the company's financial risk, and indicators that can accurately show that the company's financial situation gets worse with the decrease of ratio and the company's financial situation gets better with the increase of ratio. (2) The principal component processing is given to the selected financial indicators. To find out the financial indicators of two paired samples as much as possible, carry out T test through SPSS software and screen out the indicators that can be the best to distinguish between the indicators of two paired samples can find out the best financial indicators as original variables for subsequent modeling, and then the principal component characteristic value and contribution rate table can be obtained through testing of the correlation coefficient matrix test according to the original financial data, thus determining the principal component indicator accordingly. After operation of SPSS software, the final financial early warning model can be obtained. (3) The latest samples are selected again and the model is used to predict the company's prospects. Combined with the current situation, the effectiveness of model is evaluated.

### 3.2 *Establishment of financial early warning model*

#### 3.2.1 *Sample selection*

This paper respectively searches 25 ST companies on Tencent and Sina Financial Network as samples of the companies in financial distress. Meanwhile, the equivalent matching principle is used to select the same number of normal companies as the companies with paired samples. The data samples are shown in Table 2.

#### 3.2.2 *Establishment of financial early warning model*

The principal component analysis is used to establish the model, which is divided into the following steps:

First, the raw data is standardized [17], so as to eliminate the impact of different financial indicators due to the difference in the dimensions, and the standardized

Table 2. Sample data

| No. | Listed company Stock name | Non-listed company Stock name | No. | Listed company Stock name | Non-listed company Stock name |
|---|---|---|---|---|---|
| 1 | Zhongda | Kaile Science and Technology | 14 | Qingqi | Zhongchuan Share |
| 2 | Kejian | Shenzhen SED | 15 | Yizhi | Hexing Packaging |
| 3 | Shenghua | Jingxin Pharmaceutical | 16 | Beici | Wenzhou hongfeng |
| 4 | Zhujiang | Nanjing Zhongbei | 17 | Fenghuang | Zhonghai Haisheng |
| 5 | Taiguang | Star-net Communication | 18 | Guoheng | Xiangyu Share |
| 6 | Shaogang | Jinling Mining | 19 | Zinc industry | Jiaozuo Wanfang |
| 7 | Hehua | Yusanxia A | 20 | Angang | Baotou Steel Share |
| 8 | Dadi | Beixin Luqiao | 21 | Changyou | COSCO Shipping |
| 9 | Baoshuo | Jiangsu Suopu | 22 | Tianlong | Huitong Energy |
| 10 | Nanhua | Yunnan Yanhua | 23 | Lianhe | Xi'an Catering |
| 11 | Jintai | Lianhuan Pharmaceutical | 24 | Guotong | Conant |
| 12 | Jiulong | Huatian Hotel | 25 | Huanghai | Jinma Share |
| 13 | Xingye | Tianlun Property | | | |

indicator data can be as the basic data information for follow-up analysis. Meanwhile, supposing that the standardized financial indicators are respectively $ZX_1$, $ZX_2$, $ZX_3$, .....$ZX_{13}$, which respectively represent the current ratio, quick ratio, stockholders' equity ratio, debt-to-equity ratio, earnings per share, net assets per share, turnover rate of accounts receivable, net profit ratio of assets, debt-to-asset ratio, growth rate of business revenue, net profit growth rate, cash withdrawal rate of all assets and cash flow ratio. Then SPSS statistical software is used for principal component analysis of 13 important financial indicators of 25 companies in financial distress, so as to select the important principal components. To click the factor analysis and design the characteristic value of greater than 1, the following table is obtained after operation.

(1) Principal component analysis and overlapping information

Table 3. Financial correlation matrix

| | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ | $X_8$ |
|---|---|---|---|---|---|---|---|---|
| $X_1$ | 1.00 | 0.91 | 0.54 | 0.82 | 0.08 | 0.50 | 0.19 | -0.25 |
| $X_2$ | 0.09 | 1.00 | 0.39 | 0.50 | 0.056 | 0.31 | 0.22 | 0.18 |
| $X_3$ | 0.54 | 0.39 | 1.00 | 0.59 | -0.08 | 0.64 | 0.25 | 0.42 |
| $X_4$ | 0.81 | 0.50 | 0.59 | 1.00 | 0.06 | 0.59 | 0.13 | 0.31 |
| $X_5$ | 0.08 | 0.06 | -0.08 | 0.06 | 1.00 | 0.02 | 0.12 | 0.46 |
| $X_6$ | 0.50 | 0.31 | 0.64 | 0.59 | 0.02 | 1.00 | 0.41 | 0.15 |
| $X_7$ | 0.19 | 0.22 | 0.26 | 0.13 | 0.12 | 0.41 | 1.00 | 0.25 |
| $X_8$ | 0.25 | 0.18 | 0.42 | 0.31 | 0.46 | 0.15 | 0.25 | 1.00 |

Continued Table 3

| | $X_9$ | $X_{10}$ | $X_{11}$ | $X_{12}$ | $X_{13}$ |
|---|---|---|---|---|---|
| $X_9$ | 1.00 | -0.4 | -0.09 | -0.55 | -0.41 |
| $X_{10}$ | -0.4 | 1.00 | 0.05 | 0.41 | 0.18 |
| $X_{11}$ | -0.09 | 0.05 | 1.00 | 0.28 | 0.14 |
| $X_{12}$ | -0.55 | 0.41 | 0.28 | 1.00 | 0.46 |
| $X_{13}$ | -0.41 | 0.17 | 0.14 | 0.46 | 1.00 |

As can be seen from the above table, the correlation coefficient of each indicator is basically greater than 0.25, then the principal component analysis can be used. The principal component analysis uses the dimensionality reduction thought to make multiple dependent variables aggregate into a few variables, so the principal component analysis is applicable to the dependency data among the indicators [18]. Therefore, in the use of the principal component analysis, the financial indicator variables can be selected as much as possible, so as to contain comprehensive financial information, and give better play to the principle component analysis and obtain better effect.

(2) Initial solution of factorization

Commonality refers to how much raw information is extracted from the original variable by the principal component. The initial solution to factor analysis in Table 4 shows the commonality data for all variables [19]. In the principal component analysis, the information is understood as the difference between various samples relative to the mean value state, and then the variance is used to describe the amount of information in the variable.

Table 4. The common factor variance

| | Initial value | Extracted value |
|---|---|---|
| Zscore (current ratio ST) | 1.00 | 0.93 |
| Zscore (quick ratio ST) | 1.00 | 0.85 |
| Zscore (stockholders' equity ratio ST) | 1.00 | 0.87 |
| Zscore (debt-to-equity ratio ST) | 1.00 | 0.87 |
| Zscore(earnings per share ST) | 1.00 | 0.90 |
| Zscore (net assets per share ST) | 1.00 | 0.68 |
| Zscore (turnover rate of accounts receivable ST) | 1.00 | 0.80 |
| Zscore (net profit ratio of assets ST) | 1.00 | 0.81 |
| Zscore (debt-to-asset ratio ST) | 1.00 | 0.89 |
| Zscore (growth rate of business revenue ST) | 1.00 | 0.72 |
| Zscore (net profit growth rate ST) | 1.00 | 0.77 |
| Zscore (cash withdrawal rate of all assets ST) | 1.00 | 0.84 |
| Zscore (cash flow ratio ST) | 1.00 | 0.65 |

The second column shows the initial commonality. The initial commonality uses the principal component analysis to extract all characteristic roots for 13 original variables. That is, after comprehensive consideration of all factors and components, all variances of the variables expressed by the default value of commonality in the system – 1 can be explained. The purpose of principal component analysis is to find the components with the number of less than the number of variables, so all the characteristic roots may not be taken.

The third column is the commonality of the extracted characteristic roots. It refers to the commonal-

Table 5. Total variance explained

| Component | Initial characteristic value | | | Extracted quadratic sum | | |
|---|---|---|---|---|---|---|
| | Total variance | Percentage | Accumulation % | Total variance | Percentage | Accumulation % |
| 1 | 4.67 | 35.96 | 35.96 | 4.67 | 35.96 | 35.96 |
| 2 | 2.08 | 16.04 | 52.00 | 2.08 | 16.04 | 52.00 |
| 3 | 1.54 | 11.83 | 63.82 | 1.54 | 11.83 | 63.82 |
| 4 | 1.24 | 9.51 | 73.34 | 1.24 | 9.51 | 73.34 |
| 5 | 1.06 | 8.12 | 81.45 | 1.06 | 8.12 | 81.45 |
| 6 | 0.75 | 5.75 | 87.2 | | | |
| 7 | 0.53 | 4.08 | 91.28 | | | |
| 8 | 0.485 | 3.74 | 95.01 | | | |
| 9 | 0.32 | 2.45 | 97.46 | | | |
| 10 | 0.21 | 1.6 | 99.07 | | | |
| 11 | 0.08 | 0.59 | 99.65 | | | |
| 12 | 0.03 | 0.26 | 99.9 | | | |
| 13 | 0.01 | 0.08 | 100.00 | | | |

Table 6. Component matrix

| | Component 1 | Component 2 | Component 3 | Component 4 | Component 5 |
|---|---|---|---|---|---|
| Zscore (current ratio ST) | 0.80 | -0.47 | 0.028 | 0.13 | -0.22 |
| Zscore (quick ratio ST) | 0.64 | -0.52 | -0.07 | 0.37 | -0.16 |
| Zscore (stockholders' equity ratio ST) | 0.74 | -0.21 | -0.02 | -0.45 | 0.29 |
| Zscore (debt-to-equity ratio ST) | 0.85 | -0.28 | 0.05 | -0.11 | -0.25 |
| Zscore(earnings per share ST) | 0.13 | 0.11 | 0.84 | 0.37 | 0.16 |
| Zscore (net assets per share ST) | 0.71 | -0.1 | 0.19 | -0.16 | 0.31 |
| Zscore (turnover rate of accounts receivable ST) | 0.43 | 0.14 | -0.12 | 0.31 | 0.71 |
| Zscore (net profit ratio of assets ST) | 0.46 | 0.4 | 0.57 | 0.06 | 0.10 |
| Zscore (debt-to-asset ratio ST) | -0.09 | -0.33 | 0.13 | 0.56 | -0.04 |
| Zscore (growth rate of business revenue ST) | 0.10 | 0.77 | 0.01 | -0.31 | -0.14 |
| Zscore (net profit growth rate ST) | 0.04 | 0.30 | -0.64 | 0.5 | 0.14 |
| Zscore (cash withdrawal rate of all assets ST) | 0.54 | 0.63 | -0.14 | 0.20 | -0.31 |
| Zscore (cash flow ratio ST) | 0.63 | 0.28 | -0.06 | 0.29 | -0.27 |

ity of the extracted characteristic roots under the condition that the characteristic root is greater than 1. If the value of the extracted column is larger, it indicates that more information is extracted. The commonality of the extracted column of 13 variables in Table is more than 65%, indicating that the information loss of these variables is less, the variables can be explained by the factors, and the effect of factor extraction is better.

(3) Situation of each principal component explaining total variance of original variable

In Table 5, the second column lists the variance of the original variables explained by each principal component; the third column lists the percentage of the total variance of all original variables explained by each principal component; the fourth column is the accumulating contribution rate of each principal component to the variance of original variables. The characteristic value and contribution rate of each principal component can be obtained by the above results. The characteristic value of the first principal component is 4.67, which explains 35.9% of the total number of original variable information. This paper selects the principal components according to the principle of accumulating contribution rate of about 85%. The above table selects five principal components to replace 13 original financial indicators, which contain the amount of information related to 81.5% of the original indicator.

(4) Component matrix table

Component matrix refers to the correlation coefficient matrix between the principal component and the standardized variable, that is, the standardized variable can be expressed by the approximate linearization of principal component (See Table 6).

Supposing that five principal components are respectively $Z_1$, $Z_2$, $Z_3$, $Z_4$, $Z_5$, by taking the cash flow ratio ST as an example, according to the table, the following linear expression can be obtained:

$$ZX_{13}=0.633\times Z_1+0.286\times Z_2-0.059\times Z_3+0.284\times Z_4-0.273\times Z_5$$

The expression indicates that the first principal component contains most information of the cash flow ratio. Similarly, we can also obtain all the information represented by the principal components.

(5) Component score coefficient matrix

Table 7 gives out the coefficient information of principal component with variables, which is the final result of the principal component analysis.

The principal component expression solved here is the standardized principal component, that is, the variance of the principal component solved is 1, rather than the characteristic value of the correlation matrix of the original variable. The variance of the first principal component in the above formula is 2.6, and the variance solved in the formula should be 1. To solve the expression of the unstandardized principal component and the original variable, there is only a need to multiply the above formula by the square root of the

Table 7. Component score coefficient matrix

| | Component 1 | Component 2 | Component 3 | Component 4 | Component 5 |
|---|---|---|---|---|---|
| Zscore (current ratio ST) | 0.17 | -0.23 | 0.02 | 0.10 | -0.21 |
| Zscore (quick ratio ST) | 0.16 | -0.10 | -0.01 | -0.36 | 0.27 |
| Zscore (stockholders' equity ratio ST) | 0.18 | -0.13 | 0.03 | -0.09 | -0.24 |
| Zscore (debt-to-equity ratio ST) | 0.18 | -0.13 | 0.03 | -0.09 | -0.24 |
| Zscore(earnings per share ST) | 0.03 | 0.05 | 0.55 | 0.30 | 0.15 |
| Zscore (net assets per share ST) | 0.15 | -0.05 | -0.13 | -0.13 | 0.29 |
| Zscore (turnover rate of accounts receivable ST) | 0.09 | 0.07 | -0.08 | 0.25 | 0.66 |
| Zscore (net profit ratio of assets ST) | 0.12 | 0.19 | 0.37 | 0.05 | 0.09 |
| Zscore (debt-to-asset ratio ST) | -0.17 | -0.16 | 0.08 | 0.29 | -0.04 |
| Zscore (growth rate of business revenue ST) | 0.02 | 0.37 | 0.01 | -0.25 | -0.13 |
| Zscore (net profit growth rate ST) | 0.01 | 0.14 | -0.41 | 0.41 | 0.13 |
| Zscore (cash withdrawal rate of all assets ST) | 0.11 | 0.30 | -0.09 | 0.16 | -0.29 |
| Zscore (cash flow ratio ST) | 0.14 | 0.14 | -0.04 | 0.23 | -0.26 |

Table 6. Component matrix

| | Component 1 | Component 2 | Component 3 | Component 4 | Component 5 |
|---|---|---|---|---|---|
| Zscore (current ratio ST) | 0.80 | -0.47 | 0.028 | 0.13 | -0.22 |
| Zscore (quick ratio ST) | 0.64 | -0.52 | -0.07 | 0.37 | -0.16 |
| Zscore (stockholders' equity ratio ST) | 0.74 | -0.21 | -0.02 | -0.45 | 0.29 |
| Zscore (debt-to-equity ratio ST) | 0.85 | -0.28 | 0.05 | -0.11 | -0.25 |
| Zscore(earnings per share ST) | 0.13 | 0.11 | 0.84 | 0.37 | 0.16 |
| Zscore (net assets per share ST) | 0.71 | -0.1 | 0.19 | -0.16 | 0.31 |
| Zscore (turnover rate of accounts receivable ST) | 0.43 | 0.14 | -0.12 | 0.31 | 0.71 |
| Zscore (net profit ratio of assets ST) | 0.46 | 0.4 | 0.57 | 0.06 | 0.10 |
| Zscore (debt-to-asset ratio ST) | -0.09 | -0.33 | 0.13 | 0.56 | -0.04 |
| Zscore (growth rate of business revenue ST) | 0.10 | 0.77 | 0.01 | -0.31 | -0.14 |
| Zscore (net profit growth rate ST) | 0.04 | 0.30 | -0.64 | 0.5 | 0.14 |
| Zscore (cash withdrawal rate of all assets ST) | 0.54 | 0.63 | -0.14 | 0.20 | -0.31 |
| Zscore (cash flow ratio ST) | 0.63 | 0.28 | -0.06 | 0.29 | -0.27 |

variance of the first principal component. Through calculation, $Z_1$, $Z_2$, $Z_3$, $Z_4$ and $Z_5$ can be represented by $ZX_1$, $ZX_2$, $ZX_3$, .....$ZX_{13}$ linear, denoted as $Z_i=F(ZX_i)$.

$Z_1$ is mainly explained by the debt-to-equity ratio ($ZX_4$). The coefficient of this financial indicator is greater than that of other financial indicators. Therefore, we think that $Z_1$ represents the company's long-term internal growth capacity. There is more than 35% of confidence in evaluation of the company finance by using the principal component $Z_1$. Therefore, this financial indicator is an important indicator reflecting the company's financial situation. $Z_2$ is mainly explained by the growth rate of business revenue ($ZX_{10}$). The coefficient of this financial indicator is greater than that of other financial indicators. Therefore, we think that the second principal component represents the company's growth ability. $Z_3$ is mainly explained by the earnings per share ($ZX_5$). The coefficient of this financial indicator is greater than that of other financial indicators. $Z_3$ represents the vested interests of the company's internal shareholders. $Z_4$ is mainly explained by the net profit growth rate ($ZX_{11}$). The coefficient of this financial indicator is greater than that of other financial indicators. $Z_4$ represents the company's profitability. $Z_5$ is mainly explained by the turnover rate of accounts receivable. The coefficient of this financial indicator is greater than that of other indicators. $Z_5$ represents the enterprise asset management ability.

To substitute the standardized sample data into the linear expression of $Z_i=F(ZX_i)$, the principal component score of each financial indicator can be calculated by EXCE table. The calculation results are shown in Table 8.

Table 8. The principal component scores

| Sample No. | $Z_1$ score | $Z_2$ score | $Z_3$ score | $Z_4$ score | $Z_5$ score |
|---|---|---|---|---|---|
| 1 | 2.29 | 0.41 | 0.08 | 1.00 | -0.07 |
| 2 | -2.45 | 1.39 | 2.18 | 0.39 | -1.09 |
| 3 | 1.96 | 2.28 | -0.09 | 0.49 | -0.24 |
| 4 | 0.12 | -1.05 | 0.43 | -0.45 | -0.25 |
| 5 | -4.36 | -3.83 | 0.71 | -0.93 | 1.45 |
| 6 | 0.79 | 0.96 | 0.23 | -0.77 | -0.27 |
| 7 | 0.45 | 0.60 | 0.23 | 0.26 | 1.79 |
| 8 | 1.20 | 0.06 | 0.35 | -0.39 | 0.83 |
| 9 | -2.82 | 1.99 | 0.99 | 0.85 | -1.17 |
| 10 | 1.21 | 0.66 | 0.01 | 0.73 | 1.35 |
| 11 | -4.22 | 0.59 | -1.21 | 1.96 | -1.02 |
| 12 | 0.48 | -0.10 | 0.61 | -1.61 | -0.53 |
| 13 | -2.75 | -2.45 | 0.66 | 1.74 | -0.18 |
| 14 | -0.06 | 0.35 | -0.07 | -0.36 | -0.02 |
| 15 | -0.25 | 1.57 | 0.63 | -0.73 | -0.19 |
| 16 | 2.96 | -1.86 | 1.45 | -1.49 | -1.90 |
| 17 | -1.5 | -0.34 | -4.51 | -1.49 | -1.02 |
| 18 | 4.37 | -2.52 | -0.5 | 2.14 | -1.43 |
| 19 | -0.41 | 0.49 | -1.73 | -0.37 | 0.19 |
| 20 | 1.95 | 0.29 | -0.32 | -0.42 | 1.58 |
| 21 | 1.21 | -0.36 | -0.34 | 0.09 | -0.73 |
| 22 | -0.89 | 0.73 | 0.25 | 0.5 | 1.26 |
| 23 | 1.86 | -0.81 | -0.5 | 1.21 | 1.41 |
| 24 | -4.98 | 0.90 | -0.58 | -0.41 | 0.34 |
| 25 | -6.24 | 0.04 | 1.02 | -1.96 | -0.07 |

Viewing from the total variance table and the component matrix table explained, the main difference of the financial situation of each company is reflected in the first principal component, and the contribution rate is 36%. Meanwhile, the first principal component reflects the company's debt-to-equity ratio to a maximum extent, so the financial ratio occupies a more important position in the financial forecast. In addition, the company's profitability also occupies a certain importance.

To constitute the principal component coefficient by taking the contribution rate of each principal component as the numerator, and the total contribution rate as the denominator, the discrimination function under the principal component analysis can be obtained. Supposing that the comprehensive evaluation score is F, then the following function:

$$F = \frac{\lambda_1}{\sum_{i=1}^{13}\lambda_i} Z_1 + \frac{\lambda_2}{\sum_{i=1}^{13}\lambda_i} Z_2 + \frac{\lambda_3}{\sum_{i=1}^{13}\lambda_i} Z_3 + \frac{\lambda_4}{\sum_{i=1}^{13}\lambda_i} Z_4 + \frac{\lambda_5}{\sum_{i=1}^{13}\lambda_i} Z_5 \quad (3)$$

According to the contribution rate of the total variance table explained, to substitute into the above formula, the financial early warning model can be obtained:

$$F = 0.3595Z_1+0.1602Z_2+0.118Z_3+0.095Z_4+0.081Z_5$$

## 4 APPLICATION OF FINANCIAL EARLY WARNING MODEL

The purpose of modeling is to quickly capture some changes in the finance when the company does not have a significant financial distress, so as to make judgment and improve the management and operation level of the company. In the third chapter, the financial early warning model is obtained:
$F=0.3595Z_1+0.1602Z_2+0.118Z_3+0.095Z_4+0.081Z_5$.

### 4.1 *Prediction of the company's future financial situation by using the financial early warning model*

The research analyzes the financial report of the first quarter in 2014 by taking the listed company, Guizhou Maotai as an example. The financial indicator data required for modeling are as follows: current ratio is 4.73; quick ratio is 3.22; stockholders' equity ratio is 0.86; debt-to-equity ratio is 5.54; earnings per share is 3.80; net assets per share is 6.95; turnover rate of accounts receivable is 9.00; net profit ratio of assets is 0.86; debt-to-asset ratio is 0.14; growth rate of business revenue is 0.06; net profit growth rate is 0.05; cash withdrawal rate of all assets is 0.004; cash flow ratio is 0.02.

The above financial indicators are brought into the financial early warning model system, finally $F=2.23$. According to the judgment criteria of the early warning model: when the value of F is greater than 0.75, the company can be judged as the listed company with a good financial status.

The corporate annual report shows that, Guizhou Maotai maintains a high growth rate for 13 consecutive years from listing in 2001 to 2013. In 2013 and 2014, it is the adjustment period of the liquor industry, and the market demand reduces. The increase of anti-corruption effort and significant reduction in the official consumption level directly result that the income growth rate of Guizhou Maotai in 2014 is 6%.

According to the use of the above financial early warning model, we can see that Guizhou Maotai Company still has a good development momentum. Through comprehensive analysis of the development strategy of Guizhou Maotai Company, the company's financial statements show that Guizhou Maotai still achieve the goal of performance growth, because Guizhou Maotai Company takes a positive measure, that is, to open the dealer's threshold, which is an important motivating factor. Exploration of the channel of the dealer means more channels for Maotai spirit flowing to the market, thus increasing the company's performance to a certain extent.

In summary, in the analysis of future financial forecast of Guizhou Maotai, in addition to quantitative analysis by using the necessary early warning model, there is also a need to research the company's internal and external environment, company's responsive policies and a series of conditions, in order to conduct qualitative analysis. The company's financial development status can be fully reflected through the quantitative and qualitative analysis methods. The final conclusion is as follows: at present and in the future period of time, Guizhou Maotai has a good development momentum, with a stable financial situation. For a relatively long time in the future, there is still a need to use the financial early warning model to update prediction. Meanwhile, in the quantitative analysis, we also take into account a series of factors, such as the consumer market, supplier and dealer market, domestic economic environment confronted by Guizhou Maotai, and there are certain worries in the follow-up development of Guizhou Maotai. In the first quarter of 2014, Guizhou Maotai consumed year-round market in the current year earlier with a large number of dealer's group purchase as a prerequisite, thus submitting an excellent financial statement in the first quarter. Therefore, the prediction of the future development state of Guizhou Maotai requires integration of all aspects of factors and constant real-time update, so that we can fully speculate the development trend of listed companies.

### 4.2 *Evaluation of model prediction effect*

Through inference analysis of application examples, we know that the use of financial early warning model

can better predict the financial situation of listed companies in a period of time. Meanwhile, in addition to prediction by using the quantitative analysis method, adequate understanding of the company's internal and external environment and qualitative analysis is also very important. Comprehensive use of quantitative analysis method and qualitative analysis method can comprehensively predict the company's financial situation.

## 5 RESEARCH CONCLUSION

The research uses the principal component analysis for modeling analysis of the financial early warning, and draws the following conclusions: 1. To integrate and optimize more original variables into fewer principal component indicators, and save most of the information, with the help of SPSS software, the modeling for the listed companies becomes simple and convenient. 2. In addition to using quantitative analysis method, the use of qualitative analysis method as the assisted understanding tool can help the managers better understand the company finance, and make management decisions more sensibly and correctly. 3. It is easy to understand and simple to establish the financial early warning model based on the principal component analysis, with a certain practical value.

In the actual application for the model, we should also pay attention to the following issues: 1. In addition to analysis of the company's financial situation by establishment of the financial early warning model, there is also a need to combine with the qualitative analysis method. It can improve the model's early warning capability. Sometimes, the qualitative analysis method is more flexible and effective than the quantitative analysis method. 2. The design of the financial early warning model needs to focus on the principle of practicality. The research of the financial early warning model should not only consider the accuracy of forecast, but also focus on the effectiveness. There are some shortcomings in modeling by using the statistical methods, such as assumption preconditions, failure to consider non-financial factors, but its ability to explain and operation is simple. On this basis, we generally use the statistical methods to establish the early warning model and make prediction in the practical work.

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