Evaluation Study of Enterprise Credit—Based on Logistic Model Credit Evaluation and Empirical Analysis

Guo Feng  
Beijing Wuzi University, Beijing, 101149, China

Qin Huilin  
Beijing Wuzi University, Beijing, 101149, China

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Evaluation Study of Enterprise Credit—Based on Logistic Model Credit

Evaluation and Empirical Analysis

Feng Guo, Huilin Qin
Beijing Wuzi University, Beijing, 101149, China

Abstract: Based on the analysis of representative evaluation methods, through certain financial indicators, using the financial data of listed companies of China, we use the Logistic regression method to build the credit evaluation model. We make empirical analysis from 126 samples, 19 financial indicators and 7 factors, the results match the results of credit rating agencies and the actual situation of the company.

Keywords: credit evaluation; Logistic regression; factor analysis

1. INTRODUCTION

Both in theory and in practice, the corporate credit rating plays an important role in the market economy and its impact on the development of the market economy is enormous. Corporate credit is also called the corporate financial credit. The nature of corporate finance is the movement of enterprise funds and its economic relations. From the specific contents of the corporate credit, corporate credit is essentially a commitment to pay for the premise of capital movement and its economic relations. Corporate credit evaluation is a comprehensive evaluation of the financial strength of enterprises, as well as the quality of the enterprises.

Under the conditions of market economy, the credit rating is an important part of the maintenance and development of the credit relationship, maintaining the social and economic order. Credit evaluation is done by independent rating agencies. They keep an objective, independent principle and evaluate business management and organization of the assessment system, the development prospects of the industry, the enterprise's core competitiveness, operating efficiency, profitability, solvency, marketing, risk management, corporate influence, social image, advanced technology, corporate culture. These factors would reveal the development of enterprises and reflect the overall level of the enterprise. Credit evaluation reveals the credit status of the enterprises in the same industry in a concise, standard way[1].

As we all know, subjective judgment has a great influence in the field of credit rating. Therefore strengthening objective component in subjective factor is a subject worth the effort. Many scholars have done a lot of work in this field. This article, based on the theory study of credit rating, compare and abroad on the basis of the credit evaluation theory is widely used, and the representative of the corporate credit evaluation method proposed credit evaluation model.

2. SUMMARIZATION OF PROFESSIONAL DOCUMENTS

2.1 The outline of Western credit evaluation techniques and methods

Although there are varieties of credit evaluation techniques, they all based on the principles of the theory of Western economic credit, following the internal logic of the credit evaluation techniques, using internal innovation or exogenous transplantation[2]. From the view of the dimesion of history development, the Western credit evaluation technology went through the period of experience on judge, the period of the mathematical model and the period of system integration[3].

Feng Guo. Email: guofeng80050@sina.com
2.1.1 The period of experience on judge

Before 1950s, credit evaluation techniques are characterized as judging by an expertise. Credit analysis expert made their conclusion by reading customer application materials and doing some credit factor analysis. The evaluation method used in this period by Moody (Moody) and Standard & Poor's (S & P) is a financial analysis methods based on experience[4]. In addition, financial ratio analysis which is based on experience is also common experience on judge during this period.

2.1.2 The period of mathematical model

In order to overcome the subjectivity of the method of expertise judge, since the 1960s, the development of the credit evaluation techniques began steering transplantation mathematical methods, especially on the development on the research and application of statistical methods. Some studies directed at the company based on the purpose of takeover evaluation (Reisman et al, 1967), some studies based on the portfolio's risk management (Biesman, 1968), some research is for the efficiency of the company's portfolio financing (Reisman et al, 1966)[5]. Markowitz portfolio selection theory (1959), however, is a major milestone in this period. The mathematical models on financial theory have broad application prospects and opened the way to the mathematical model of the credit evaluation techniques.

2.1.3 The period of Systems integration

Based on mathematical assumptions and limitations, and the practical application of computational complexity, the development of the credit evaluation technology has entered into a new period of innovation based on artificial intelligence, computer and systems technology since 1990s. A number of new credit evaluation methods have emerged.

In the early 90's, on the one hand, the qualitative variable credit evaluation methods have gradually identified by people, in order to solve the discrimination in classic method, which lacks qualitative variables, decision support systems, and multi-objective decision-making systems have emerged and boomed. On the other hand, with the development and application of artificial intelligence, Expert Systems and Neural Network have been applied into the field of research on credit evaluation. In addition, KMV Company invented Expected Default Frequency Model in 1993 based on the option pricing model. In the late 1990s, Data Envelopment Analysis, DEA was introduced into the evaluation and analysis of credit evaluation[6].

2. 2 Study on China’s corporate credit rating

Our study on credit evaluation techniques and methods began in the 1990s. The methods of assessing corporate bond credit rating are as follows: First, given the index weight of each factor according to its importance[7]; second, comparing the actual situation of enterprises which issue the bonds with this system to draw the actual points[8]; finally, determined the credit rating according to the level of the actual points. This method has extra importance as China's first corporate bond credit evaluation index system[9].

Of enterprise credit evaluation model is most concentrated in the hierarchical scoring model, also part of the neural network model and risk measurement model. Stratification scoring model constructed 21 centuries ago is basically the main quantitative financial indicators, into the 21st century, the construction of hierarchical scoring model introduced qualitative indicators, and to pay equal attention to the quality of financial indicators and qualitative indicators to quantitative construct the evaluation index system trends. Hierarchical scoring model indicators mainly rely on expert opinion or subjective speculation technically gradually moving towards the use of theoretical and empirical analysis[10].

3. DESIGN OF CREDIT EVALUATION MODEL

3.1 Factor Analysis

Factor analysis is a statistical method used to integrate observed intricate variables (or samples) into a
potentially lower number of unobserved variables called factors. It searches for correlations between observed variables and factors, and classifies these variables according to different factors at the same time. The basic idea of factor analysis is to reduce a number of indicators into a few composite ones through dimensionality reduction under the principle of missing as least data information as possible. The purpose is not only to find the common factors, but also get the knowledge of each common factor’s actual significance. The method to transform factor loading is called factor rotation, which can simplify the loading matrix so as to interpret each common factor. There are some orthogonal rotation methods, among which Varimax rotation is the most commonly used.

In this paper, we use Varimax rotation and get seven common factors. The output satisfies “simple structure”, and we can get clear economic explanation. Therefore we can evaluate samples on different perspectives according to the score of each sample on different factors.

3.2 Logistic regression

The Logistic model was first proposed by Martin in 1977. Martin defined 58 troubled Federal Reserve member banks from about 5,700 ones between 1900 and 1977, and selected the net profile rate of total assets and other 7 financial ratios from 25 financial indicators to predict the probability of companies’ bankruptcy and default, thus established the Logistic regression model. By using this model, he set risk cordon according to the banks and investors’ risk preferences, hence successfully made risk positioning and decision-making.

The Logistic model uses Logistic function regression to predict binary outcomes (good or bad, etc.). The regression coefficients are usually estimated using maximum likelihood estimation. And the goal is to find the linear relationship between the dependent variable and a set of independent variables.

In this paper, we use Logistic regression model to study the probability of default, and propose a modeling method for the quantitative measure of credit risk.

The Logistic regression model can be defined as follows:

\[
p = \frac{1}{1 + e^{-z}}
\]

\[
z = b_0 + b_1x_1 + b_2x_2 + \ldots + b_nx_n
\]

where \(x_i\) (\(i = 1, 2, \ldots, n\)) is the \(i\)th independent variable in the credit evaluation. It reflects the corresponding characteristics of the enterprise.

\(b_i\) (\(i = 0, 1, 2, \ldots, n\)) is the \(i\)th regression coefficient which is estimated by maximum likelihood estimation.

\(p \in (0, 1)\) is the probability that an enterprise is not into credit crisis.

By this definition we could see that if \(p\) is more away from 0, the less likely the enterprise into credit crisis, and vice versa.

4. THE ESTABLISHMENT OF THE MODEL AND EMPIRICAL ANALYSIS

4.1 Index Selection

There are many differences between the domestic and foreign evaluation modes, they have their own focus. But in general, each evaluation model basically contains the following financial indexes: corporate profitability, solvency, operational capability, and the ability to grow\(^{[11]}\).

This article used 19 financial indexes to reflect the overall situation of the company’s financial statement.

### 4.2 Index Selection

Currently, there are thousands of listed companies in China. Tens of thousands of data are waiting to be processed. But it is impossible and unnecessary to analyze all those data. Thus, how to carry out the sample data from the raw materials to reflect the true situation of the company is very critical.

This article chose the representative industry, listed companies and the key indexes build the evaluation model. Sample data come from the credit rating results of Shanghai Stock Exchange 50 Index. We use these data testing the accuracy and usefulness of the system. In accordance with this article, we collect the relevant data from the SSE 50 index in 2010, excluding the incomplete sample, retained 126 samples out of 150 to do empirical analysis.

### 4.3 Analysis Model of Structured Factors

Using SPSS software calculates the correlation between the 19 original variables. The result shows that variable X1 has strong correlation with X2, X3, X5, X6, X7 and X8, X15, X14 and X11, X12, X18 and X19. This means that these variables are related to the same group factors. Based on this analysis, we decided to use factor analysis.

Table 1 shows the result of Bartlett’s Test of Sphericity and KMO. KMO is an indicator of the value of correlation coefficient and partial correlation coefficient. The more its value is close to 1, the better the analysis. Bartlett’s Test of Sphericity is used to determine whether the correlation matrix is the identity matrix. We can see Sig=0.000, which shows a strong correlation between those variables. At the same time, the value of KMO is 0.721, which is fit for factor analysis.

<table>
<thead>
<tr>
<th>Table 1. KMO and Bartlett's test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaiser-Meyer-Olkin Measure of Sampling Adequacy.</td>
</tr>
<tr>
<td>Bartlett's Test of Sphericity</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Table 2 shows the value of factored characteristic and the variance contribution rate. As we can see, the eigenvalue of the first seven ingredients are all greater than 1, and the accumulated contribution rate is 88.526%. That is to say, we can use seven factors to describe 88.526% information of the data. This result matches the requirement of the main factor, under the condition of reducing the analysis indicators, the loss of information is relatively small, we can use less factors to make more comprehensive analysis of the data.

<table>
<thead>
<tr>
<th>Table 2. Factor eigenvalue and contribution rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main factor</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>
We take all the 19 empirical factors into the Z-Standardization and then put them into the factor score formula; we could get the six public and factor score of the company. Based on this, we would be able to understand their operating capacity, profitability, solvency and development capabilities.

4.4 Build the credit evaluation model of Logistic regression

Since the Logistic functions can only take the value between 1 and 0, so when we use the Logistic method to classify the model, we can only divide it into two types. Based on the credit rating results of Dagong Global Credit Rating Co., Ltd, we defined the credit rating which is higher than A as 1, this indicates that the credit situation is fine. We defined the credit rating which is below A as 0; this indicates that there is some risk on the credit situation of the company. Take the credit status (1 or 0) as the dependent variable, seven male factor scores as independent variables to establish the Logistic regression Credit evaluation model by running SPSS software to two types of pattern classification of these 126 samples, the calculated results are shown in Table 3 and Table 4.

<table>
<thead>
<tr>
<th>Variables</th>
<th>B</th>
<th>S.E</th>
<th>Wald</th>
<th>Df</th>
<th>Sig.</th>
<th>Exp(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>f1</td>
<td>-261.427</td>
<td>22476.510</td>
<td>.000</td>
<td>1</td>
<td>.991</td>
<td>.000</td>
</tr>
<tr>
<td>f2</td>
<td>-409.377</td>
<td>25600.081</td>
<td>.000</td>
<td>1</td>
<td>.987</td>
<td>.000</td>
</tr>
<tr>
<td>f3</td>
<td>17.987</td>
<td>402.439</td>
<td>.002</td>
<td>1</td>
<td>.964</td>
<td>64839125.413</td>
</tr>
<tr>
<td>f4</td>
<td>-116.793</td>
<td>12295.616</td>
<td>.000</td>
<td>1</td>
<td>.992</td>
<td>.000</td>
</tr>
<tr>
<td>f5</td>
<td>-349.363</td>
<td>43228.029</td>
<td>.000</td>
<td>1</td>
<td>.994</td>
<td>.000</td>
</tr>
<tr>
<td>f6</td>
<td>-64.017</td>
<td>12814.757</td>
<td>.000</td>
<td>1</td>
<td>.996</td>
<td>.000</td>
</tr>
<tr>
<td>f7</td>
<td>0.846</td>
<td>2219.760</td>
<td>.000</td>
<td>1</td>
<td>1.000</td>
<td>2.331</td>
</tr>
<tr>
<td>Constant</td>
<td>-381.044</td>
<td>5920.099</td>
<td>.004</td>
<td>1</td>
<td>.949</td>
<td>.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Observed</th>
<th>Predicted</th>
<th>Percentage Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logic</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>98</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>28</td>
</tr>
<tr>
<td>Overall Percentage</td>
<td>0</td>
<td>82</td>
</tr>
</tbody>
</table>
probability of good credit:  
\[ p = \frac{1}{1 + e^{-z}} \]

\[ z = -381.044 - 261.427f1 - 409.377f2 + 17.987f3 - 116.793f4 - 349.3035f5 - 64.017f6 + 0.846f7 \]  

...(2)

Take the 7 common factor score into formula (2), we can obtain the probability of the enterprises with good credit, usually, if the value is less than 0.5, the event will not occur, and that the corporate credit situation is not predictable good, there is a certain risk; credit is in good condition if the value is greater than 0.5. This article selected empirical data, which is the 126 samples, generated into the Logit model; Table 4 shows the results misjudged the number of samples for identification accuracy rate of 100%.

5. CONCLUSIONS

Based on theoretical study, this article proposed credit evaluation model through factor analysis and regression analysis. This model provides a viable method for company credit rating. The indicators in this article are recognized as important financial indicators, after calculation, there are strong correlation between the indicators, which provided the foundation for factor analysis. We can not make a comprehensice comparison and analysis of the company solely based on the data system. We must use some number analytic method to process the indirectly related data. In this way, the information contained can be reflected by several factors, and carry out the composite score of the company. Then we make the regression of Logistic to get the credit rating of the company.

The results of our empirical analysis matched the actual credit situation of the company and the results of credit rating agency. So this credit evaluation method fits for Chinese enterprises and the direction of our model is correct. However, the model is only a preliminary exploration; we need improve the model in depth and breadth. In addation, this article did not do an analysis on the development of the stage because of the restrictions on sample size, but the credit rating has some difference in different industries and different stages. In further research, we should take in all the data of listed companies and do industries research to complete our research.

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