The Estimation and Prediction of Credit Rating with an Application to SMEs in China

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Abstract

SMEs play an increasingly important role in promoting the growth of national economics, alleviating employment pressure, optimizing the economic structure, increasing foreign trade, etc. Promoting the development of SMEs has become an urgent strategic task in our country at present. However, because of the asymmetric distribution of information between SMEs and financial institutions affects the financing behavior of financial institutions and financing efficiency, and the recovery period of the financing in SMEs is difficult to calculate, the uncertainty risk of default, leading to financial institutions will put a lot of harsh conditions in SMEs when giving credit, which greatly hindered the development of SMEs.

This article is based on the domestic and foreign advanced rating methods and technologies, combining with theoretical and practical experience domestic credit rating, to solve the financing difficulties of SMEs and in view of the current situation and the characteristic of the development of SMEs at present stage in China, to work out some feasible credit rating method for SMEs.

The author applied several up-to-date methodologies that are widely used in a lot of fields to the estimation and prediction of corporate credit rating, with GHK simulator succeeded in the estimation and prediction process using three-year data, which is a very highlight of this paper as by far now traditional maximum-likelihood can estimate and predict using only two-year data.

With this progress, this author aims to test the feasibility of this methodology on the

application of corporate credit rating of SMEs in China as the next step.

And this paper introduced the traditional method being used in China for corporate credit rating as a comparison. As we can find out that the traditional method is complicated and of low-efficiency, which requires not only the financial data but also evaluations from experienced experts via questionnaire or some other form. This kind of emphasis on qualitative information is highly valued in corporate credit rating process when the object is big enterprises or international corporations because of their higher motivation in manipulating financial statements, thus simply relying on quantitative information is insufficient.

However when it comes to SMEs like the cited example in this paper, a cost-efficiency calculation will be necessary taking into account of the number of SMEs in China as well as the emergency of their financing problem.

Therefore, the author will work on this part further in two steps.

First is to examine the feasibility of the methodology with GHK simulator developed in this paper to corporate credit rating for SMEs in China.

Second is to compare the efficiency of this methodology with the traditional method used in China.

After these two steps, the author will move to build up a more complete corporate credit rating system for SMEs by including more financial indicators in order to give a more thorough evaluation. And at the same time the author will also work on expand the methodology for estimation and prediction using more years so as to improve the accuracy.

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Chapter 1 Introduction

1.1 Research background

With the development of social economic and diversity in means of trading, the trading mode transited to credit transactions gradually, so the probability of credit risk has increased. In order to avoid the credit risk, reducing transaction costs, people paid more attention to the credit records and expected credit ability of transaction object.

Initially in the western countries, credit rating is mainly used measuring a particular securities, from the economic, political, legal and other risks, and with special symbols to indicate the bond principal and interest on schedule payment or reliability of stock returns.

Then again it is brought into business use in industrial, commercial or financial industry, evaluation of the credit status, debt repayment ability, and to certain symbol marking the reliable credit degree. Thus, credit rating came into being a tool of management in commercial enterprises especially for financial and credit management.

For investors, evaluating an enterprise's credit rating comprehensively and accurately, is a wise way to avoid risk reasonably and can lead them to right investment decisions.

For enterprises, who make full use of their credit reputation, have obtained investors' favor, laying a solid foundation for the development of enterprise growth. Perfect credit rating system will help enterprises to guard against business risks, provide good conditions for the construction of a modern enterprise system, help to build up a capital

market that is full of fairness, justice and honesty, through which conducive to commercial banks to strengthen credit risk management and maintain the stability of the financial system. Therefore, foreign commercial banks and credit rating agencies, such as Moody's Investors Service, Standard & Poor's Financial Services LLC and Fitch Ratings etc., take the evaluation of enterprise credit extremely seriously and have established their own evaluation system.

Since the 1980s, China began to introduce enterprise credit rating, and its application have made considerable progress after nearly three decades of development. But so far, China's credit rating system is still not perfect, and the main disadvantage is that each index score method is rough, ignoring the fuzzy nature of the credit rating process. Too much emphasis is put on the evaluation of quantitative indicators while ignoring the qualitative indicators. In addition to general business terms, on one hand there is a strong need for credit rating to avoid unnecessary transaction among different parties which bring losses, and on the other hand, relying on the rating agencies results high cost of credit rating and the promotion of credit rating by certain restrictions.

To solve the above problems, this paper aims to work out a feasible and efficient corporate credit rating system for SMEs considering SMEs' vital role in the development of China's economy in the future and their critical financing problems lasted for a long time which blocked them from further growing, with reference to the previous studies and the most developed credit rating organisms worldwide.

1.2 Research significance

As we all know, the establishment and development of enterprises without the bank's strong support will be severely constrained. If this problem is not resolved, companies will be very difficult. In reality, enterprises need funds to solve the funding gap between the production business processes urgently. However, on the other side commercial banks which have a large deposit not loaned out, this situation became a sharp contrast, the dislocation of the demand and supply of funds illustrate that only solve the financing problem of enterprises, can we achieve enterprises and commercial banks a win-win situation.

From this we can see that it’s an urgent problem to develop and establish a suitable corporate credit rating index system. During the specific operation process, we need to solve two major problems: First, select the appropriate indicators that can be actually obtained because most SMEs in China are private companies whose annual financial statements are not that regulative and complete to which we can have access to very limited financial information. Second, find a method that is not only feasible but is efficient as well considering the huge amounts of SMEs in China. When we considered the above two problems, establishing the enterprise credit rating index system can meet the need of practical operation.

As an important tool for credit risk management, SMEs credit rating system can be used to reveal and manage credit risk of SMEs, therefore, building a credit rating system in adapt to the development characteristics of China's SMEs in order to have a objective and comprehensive rating of SMEs, will have a significance in alleviating the problem of financing difficulties of SMEs, promoting China's national economy healthy and

rapid development.

(1) Significance of SMEs in China

Bottleneck of restricting the development for SMEs is due to information asymmetry, which leads to difficulties in financing. Building a new credit rating index system in consistent with the features of SMEs, SMEs may base on this to strengthen credit awareness, improve their management and consciously to overcome the breach. So setting a good image of credibility, to strengthen the comprehensive competitiveness of enterprises and to broaden the financing channels, to reduce financing costs, thereby accelerating the development of themselves.

(2) Significance of China's commercial banks

Commercial banks often tend to reduce the risk to refusing the financing needs of a large number of SMEs because of the lacking of understanding for the real situation of SMEs. To construct a set of scientific and reasonable index system of credit rating for commercial banks to assess credit risk, improving the bank credit risk control and the ability of management and control. Therefore cultivating a group of potential of SMEs, which accelerates the business development of SMEs and provides a way for banks to develop new customers.

(3) Significance of the national economy

Constructing a new SMEs credit rating index system can promote the exchange and

cooperation between SMEs and commercial banks and save the collection and collation of information costs, thereby reducing the transaction cost, which will solve not only the problem of SMEs financing difficulties, but also provide the basis for the construction of social credit system. SMEs can take full use of their own advantages to contribute to economic development, increasing employment opportunities, promoting economic restructuring, which is an important driving force for the entire national economy.

1.3 Foreign and domestic research of credit rating

1.3.1 Development of foreign credit rating

The history of the development of the credit rating has been more than 100 years in the world. It first started in 1909 by John Moody “Moody's Analysis of Rail road investment” in railway bond rating in American as a service product, After that rating index experienced from traditional univariate evaluation to the various evaluation process of gradual improvement. There are mainly three traditional credit rating index systems, "5C" index system (character, capacity, capital, collateral, condition), "5P" index system (personal, purpose, payment, protection, perspective) and OLAPP index system (liquidity, activity, profitability and potentiality). Currently, the most authoritative credit rating index systems are mainly Moody's Investors Service, Standard & Poor’s Financial Services LLC., Fitch Ratings Inc. and Dun & Bradstreet.

Although the United States subprime mortgage crisis broke out, the reason is mainly due to the implementation of the credit evaluation results are not strictly implemented the authority of the evaluation system remains unquestionable.

(1) Moody's corporate credit rating index system

Moody believes that the core of credit rating evaluation is the debt paying ability and willingness to repay of evaluating object, which was the object specific default risk and default severity assessment. Rating index mainly: business background and history; industry development trend; national political and regulatory environment; management quality; experience, records and attitude to risk; management layer structure; enterprise basic operation and competition status; business strategy and philosophy; idiopathic event risk; debt structure; financial status and sources of liquidity. Moody's analysis of the risk factors of key is: First, focus on the long term, analyzed by evaluating the basic factors of the long-term solvency of the object, such as a severe economic downturn; second, it emphasizes that cash flow stability and predictive analysis cash flow effects of predictable and constant factors.

(2) Standard & Poor's corporate credit rating index system

Standard & Poor's corporate credit rating criteria are based on the relevant risk factors, an overall evaluation of information quality of enterprises, mainly evaluated from three aspects of enterprise environment, organization and performance. Wherein: First, assessment of the business environment, including economic environment, industry

conditions, customer requirements and expectations; second, enterprise organizational assessment, including human resources, strategy, production processes, etc.; third, performance evaluation, including financial performance, non-financial performance. Qualitative analysis began in business analysis, enterprise management capabilities and competitiveness in the industry. The quantitative analysis is for financial analysis, the evaluation process is not limited to analyze financial data.

(3) Dun & Bradstreet credit rating index system

Dun & Brad street credit rating business mainly has two modes. One is between the enterprise trade credit rating, another is enterprises to bank loans of credit rating. These two modes in consultation and advisory content have some differences, but the content of credit rating generally include the following aspects: company overview, payment records, financial condition, operating performance and operating condition.

Standard & Poor's and Moody's rating object are mainly enterprises having a share in the capital market, while Dun & Bradstreet emphasizes the enterprises themselves. They all consider business operation and financial condition, holding a view that credit rating is a way of examining enterprises' repayment ability and willingness to pay, but Standard &Poor's and Moody's are taking less consideration of this in their actual rating process compared to Dun & Bradstreet.

(4) Experience from foreign credit rating

There are many aspects of foreign credit rating worth to be learned.

First, the performance analysis of willingness. Credit rating is a comprehensive evaluation for the performance intention, performance capacity and performance consequences in the contract obligations. Among them, the performance ability is a sufficient condition for performance will occur, the willingness is a necessary condition, the lack of performance will even have a higher capacity cannot guarantee the performance of the place. Even with the high performance capabilities, we cannot guarantee the performance behavior occurs.

Second, cash flow analysis. In the judgment of the enterprise performance capability index, we should be based on current and potential profitability analysis of the enterprise, focus on profit quality, which should pay attention to the analysis of cash flow. The performance capability evaluation can not only see the overall scale of the enterprises, the total assets of the enterprise only is the basis of performance ability, only the cash flow size can reflect the enterprise performance capability accurately.

Third, the performance of the contract situation analysis. From the evaluation of enterprise payment arrears accounts and records, and the payment situation of enterprises in the same industry to carry on the comparative analysis, can be directly put on the evaluation of enterprise's ability to pay and risk assessment.

1.3.2 Development of domestic credit rating

The research work of domestic enterprise credit rating index system was started by the end of 1980s. In recent years, with the non-performing loans of the banking system

increased sharply, more and more research scholars focus on enterprise credit evaluation index. In the earlier introduction of enterprise credit index is the study of Wu Shinong and Huang Shizhong (1986). Research of credit rating model are: (1999) Chen Jing takes the 27 ST companies and 27 non ST companies in 1998 as the sample of univariate analysis, found the debt ratio, liquidity ratio, rate of return on total assets and the rate of return on net assets 4 financial indicators, and current ratio is the lowest misclassification rate; Gao Peiye, Zhang Daokui (2000) put the Shenzhen listing Corporation into manufacturing and non-manufacturing, based on financial data for a year to evaluate the financial situation of enterprises; Zhang Ling (2000) using the financial data of 120 listing Corporation in China. Establish a discriminant analysis model of four variables; Zhang Aimin (2001) by using principal component analysis to study the listing Corporation financial distress question method, comprehensive index to find out the impact of the financial situation of enterprises, establish and Altman Z score model comprehensive index similar linear equation.

Research on credit rating index: Wang Jun (2002) summarize the perspective of evaluation and assessment of corporate financial position and operating results and meet the requirements of the modern enterprise starting from, redesign the financial evaluation index system is constructed. This set of index system including profitability, solvency and growth capacity of 12 sub indicators in 3 areas; Zhou Chunxi (2003) defects of methods of enterprise credit evaluation in China based on the establishment of enterprise credit rating evaluation index system from 6 aspects of enterprise quality, economic strength, capital structure, business performance, reputation status Li

Xianguo, Xie Xinyong, development prospects; (2004) to strengthen credit management and put forward a set of enterprise credit evaluation index system, the index system is divided into qualitative and quantitative indicators of 2 parts, including the qualitative index of the organization management, credit status, the main person in charge of the 12 key indicators, quantitative indicators business year, liquidity ratio, capital gains rate of 12 key indicators; Shao Haiqing and Yuan Chunzhen (2005) from the quality of management, financial and business 4 aspects of management and market competition conditions, environmental factors were constructed with 20 quantitative indicators and 30 qualitative indicators of the rating index system; Jiang Zhihua and Zhang Rui (2006), character, ability, based on capital, from the outside evaluation, promised to complete the degree, litigation and arbitration, operation, profitability, growth, liquidity, capital strength the strength of the 8 aspects of the 22 sub indicators, qualitative and quantitative evaluation index system construction of listing Corporation credit: Zhou Baicheng, Li Xiaodong (2006) enterprise basic quality, support of the external environment, the development potential of enterprises based on the enterprise basic quality is divided into enterprise financial status, system construction, continuous operation time, management efficiency, quality of staff and assets the quality of the external environment support for the enterprise product awareness and support of the government, business environment, industry conditions, upstream and downstream manufacturers, enterprises The future development potential for profitability growth rate, research investment average growth rate and the basic quality of growth rate, industry output growth rate and GDP growth rate, a total of 16 analysis of industrial

enterprises credit rating factors.

In our country, the research on the credit rating index mostly extraction processing related accounting statements of the company announced financial index to ST companies as a breach of contract sample for empirical research, avoid the asymmetry of information is difficult to verify validity of evaluation index. The theory and practice have also tried to introduce some non-financial indicators, improve the effectiveness of the evaluation, but the effect is not obvious.

In summary, the credit rating index system of mature market economy countries and its market economic system to adapt, to our country's credit rating index system construction can play a very good reference, but not for the situation of our country. Our existing research results mostly is the product of western developed capital market, the evaluation of enterprise credit level typically focus in performance capabilities, rarely involves the willingness to repay problem, now in the outbreak of the global economic crisis situation, it is need to be combined with the situation of our country, comprehensive and systematic study of China's enterprise credit level evaluation index system and method of, to regulate the institution environment of our country, guiding the healthy development of enterprises.

1.4 Research methodology

Rating model law is a quantitative rating methodology ,which is a kind of mathematical technology-based risk assessment methods, means being on the basis of a

comprehensive analysis of the commentary on the object history data management, through economic analysis indicators with the credit rating models, that is to build a model with variables and parameters, size of the object is the probability of default risk assessment by calculation, in order to determine the result of a credit rating by its measurement methods. Credit rating usually regarded economic indicators to develop a standard value as a basis for comparison with each other. Reached or exceeded the standard value, credit status is good, unattainable, credit status is poor. Most of the existing rating models based on statistical discrimination method is proposed after the basic research Fisher (Fisher 1936) made. Collectively, these models are characterized by financial ratios as explanatory variables, derivation of the standard model established by using the number of statistical methods. Summed up in a linear probability model, Logit, Probit model and discriminant analysis model. Wherein the multivariate discriminant analysis the most popular, Logit model followed. Multivariate discriminant analysis method is based on the statistics characteristics observed, the classification of objective things, to determine the categories of things. It is already mastered several samples of each category in the history, summed up the rules of classification, establish a discriminant formula. When faced with new things, as long as the discriminant formula is summed up, can distinguish the categories of things. Multivariate linear discriminant analysis, discriminant analysis can be specific for the general (not considering variable selection) stepwise discriminant analysis and quantitative data (considering variable selection). But the application of multivariate discriminant analysis there are three main hypotheses: variable data are normally

distributed; each covariance is the same; the mean vector and covariance matrix of each group, and the prior probability of misclassification cost is known.

Logit model is one of the discrete choice model, belonging to multiple variable analysis category. It is a common method used in sociology, biostatistics, clinical, quantitative psychology, marketing and other statistical analysis. It is using a series of financial ratio variables to predict the company's insolvency or default probability, then according to the bank, investor risk preference setting risk warning line, in order on the analysis of the object positioning and risk decision. Logit model and multiple discriminant analysis of the essential difference is that the Logit model does not need to meet the normal distribution or variance, its model using Logistic function. For Logistic regression does not assume that any probability distribution, especially in does not meet the normal distribution, the correct rate is higher than the multivariate discriminant analysis results.

The advantages of rating model method is simple, low cost, staff rating the subjective factors of the doped less, however, rating model prediction effect by different length of time difference, in a short period of time financial ratios changed little, the accuracy rate is high; in the longer term financial ratios may change greatly, forecast accuracy will be reduced. This method is inadequate and must be set up on the assessment by a large number of objects, the history of reliable statistical data base, which is a prerequisite in developing countries such as Chinese difficult to have. At present, honesty and credit in China is generally weak, enterprise financial report of arbitrarily large, real bad, under such an environment for the credibility of the rating of the

financial statements will be greatly reduced, based on financial data, then get the rating results will not be true reflect the enterprise actual situation.

1.5 Research highlights

This paper introduces the concept and the characteristics of credit rating system, describes the credit rating generation, development, causes, changes and rules with asymmetric information theory and transaction cost theory. Making a summary on development of domestic and international credit ratings and on the basis of it to make some development and changes.

This paper has made the comprehensive elaboration to the status of the enterprise in the course of economic development in China and the characteristics of the credit status on the reference to a large number of domestic and foreign advanced literature, and then pointed out that the improvement and vigorously implement the corporate credit rating is an effective solution to solve the enterprise financing difficulties.

This paper established the index system and evaluation model in accordance with the business characteristics on the reference to enterprise credit rating system widely used in China's banking industry. In this paper, a city some pharmaceutical companies empirical analysis using established rating models constructed to evaluate the results and compared and analyzed the ratings.

Chapter 2 Credit rating theory

Credit rating, which is the rating agencies according to the scientific index system, using rigorous analysis methods and simple symbols to fair evaluation an economic responsibility and confidence degree of and determine the credit rating. For the basic concepts of credit rating, we should pay attention to the following four points:

First, the credit rating reveals the specific risk, including specific or related debt credit capacity of the evaluating object according to the contract schedule, instead of all risks of the evaluated object (such as evaluation of investment risk, interest rate risk and exchange rate risk, etc.).

Second, the emphasis of Credit rating evaluation is the solvency of some kind of debt, rather than the object of the performance assessment and market value. Although the latter often is one of the factors for the evaluation of the ability to pay debt.

Third, during the process of credit rating, we often using some theories or models and marked the ability to pay the debt for the object with special symbols to show the reliability of the repayment.

Fourth, customers which in the same level, don't mean that the credit ability exactly same. Because the credit rating results only for a limited number of grade and within the same level of credit will exist some differences.

2.1 An overview of credit rating

Credit is a characteristic form of repayment and interest for the special value movement, through a series of borrowing, repayment and payment process to achieve. It not only refers to the simple credit activity and credit relationship, and contains currency borrowers' solvency, performance record, trustworthy degree, social reputation and so on.

With the continuous development of market economy, credit is becoming more and more mature, the credit rating also came into being and has got rapid development. The concept of credit rating has been more than 100 years history in the international market, but in China it’s only ten years of history still in its infancy. Therefore, in addition to the standard definition of international comparison and the market for it, our country has also made a more comprehensive theory definition according to the actual situation in China.

"Encyclopedia of Banking and Finance" from United States put forward the definition of credit rating as something being based on a relevant index system and showing the values of the ability and willingness of the economy to pay its debts (debt history). Market economic activities will take place all types of debt and credit relations. General speaking, both the bonds of government agency and the finance market of enterprises, or economic organizations and individual business loans, when its debt is loaned to the creditor, which requires to evaluate the ability and willingness to repay, then to assess the possibility of debt maturity. Dong Fuqi , a famous economics professor in China considered that: " credit rating, used by the specialized agencies, to evaluate the market main body repay debt capacity or some kind of financial tools investment risk and use

specific symbols to show the degree of trust, then show the majority of investors. He put the credit rating of the clear content as the main body of market repay debt capacity or financial investment risk. ZouJianPing ,the domestic senior experts in credit put the concept in the book “Securities Rating Conspectus”, Credit rating is "an evaluation or consulting content through the internal and external factors of the comprehensive investigation of the effect of all kinds of economic organizations or various types of financial instruments, using scientific methods to make comprehensive analysis and judgment in their performance of various economic commitments and trusted degree, and apply simple symbol to represent the pros and cons, then announced to the public ". The credit rating object includes both economies organization and financial tools, such as long term corporate bonds, short-term financing coupons; credit evaluation reveals not only is the solvency ability, but the broad meaning of “perform various economic commitments and trust degree". A professor Zhu Baoxian at Tsinghua University in the book “Financial markets” argued that, the credit rating is analyzing and evaluating the debt capacity and social reputation degree of different credit subjects in market economy, which is a special method and system to use some form to represent the quality level of credit.

2.2 Corporate credit rating

Credit rating refers to the independent professional rating agencies or departments according to the scientific index system using scientific rating methods, the principle

of "fair, objective, scientific “strictly, rating credibility of the commitment to economic ability and commitment to the judgment for the object with the premise of comprehensive investigation, examination ,and using intuitive, and using easy to understand the letter symbols (such as AAA, AA and BBB -) to express the results of credit rating, to convey to the vast number of investors, social supervision authorities and other interest related.

Credit rating is an important credit technology. It can assess enterprise credit level fairly and comprehensive, reduce the degree of information asymmetry; also can reduce the cost of bank loans to prevent and control the credit risk effectively. What’s more, it also can help enterprises to obtain bank loans and rise the availability of credit financing.

(1) In terms of enterprise, credit rating makes them easier to get bank loans. The financial information opacity caused by information asymmetry between bank and enterprises(Berger & Uden, 1998); the limitation of asset dues to the mortgage insufficient (Wang & Zhang, 2003) is the main reason for the enterprise in the credit markets suffered credit rationing. Credit rating can reflect the credit rating for a loan applier objectively and accurately by establishing reasonable index system of credit rating. So banks have a clear understanding of the credit risk of the enterprise, reducing the information asymmetry between banks and enterprises. According to the level of credit risk which can be reflected by the credit rating report， banks can adjust the mortgage standard.

(2) In terms of the banks, credit rating will help reduce credit costs and manage the risk of credit assets more efficient. Credit rating can make accurate evaluation for business performance, profitability, solvency of a loan applier by establishing reasonable index system of credit rating, then to determine the degree of credit risk. bank allocate the credit funds reasonable to control loan risk maximize according to the level of various types of borrowers credit risk, so as to improve the efficiency of the risk management of credit assets. In addition, by establishing a reasonable index system of credit rating, credit evaluation will be completed by the computer system automatically. Banks just need to focus on the credit score in the business loan application near the pass line, thereby reducing loan processing time and the human hand, which reduces the cost of bank credit.

2.3 Development of corporate credit rating

2.3.1 Expert evaluation method

Expert evaluation method refers to the analysis of experts to score through management factors which affecting business performance, so that, then draw a weighted average of enterprise to work out the credit rating. The method relies on expert's subjective judgment. The rating results mainly used in credit decisions. The representative expert evaluation method is "5C", "5P", "LAPP" etc.

(1) 5C analysis method: 5C refers to the character, capital, capacity, condition, collateral.

Character, which is used to evaluate the customer initiative conduct credible, the repayment of the loan. For the company, the character refers to the operation ability and the management style of the main leaders, and corporate culture and ethics, including the enterprise’s reputation and status in the same industry.

Capital, which is an important aspect to reflect the financial strength of the enterprise, but also reflects the enterprise's capital accumulation indirectly. Adequate capital and capital accumulation shows good enterprise credit status.

Capacity, including the ability to repay the loan in the economic and borrowing capacity in legal. From the point of view of the economy, the credit evaluation focus on the evaluation of enterprise's solvency, profitability and operation ability, in accordance with the factors that financial ratio analysis method emphasizes completely. From the point of view of the law, credit evaluation focus on evaluating the enterprise whether to have legal qualifications and rights. According to survey analysis of the government regulations and the association of the company can obtain such information.

Condition, including the internal and external environment of enterprise. Internal environment mainly refers to the enterprise's operating characteristics, mode of operation, technology and equipment, labor relations, which enterprises can control; enterprise external environment mainly refers to the condition of the national economy, industry competition, industry trends, market conditions and other. The environmental conditions are favorable, it will improve the level of credit.

Collateral, which is refers to the goods from enterprise can be used for credit guarantee or mortgage. The collateral value is rich and good for credit is relatively high. Once the credit crisis occurs the possibility of loss is less. But it should pay great attention to the ownership of collateral, collateral value status when evaluating.

(2) 5p analysis method: 5p is refers to personal factor, purpose factor, payment factor, protection factor and perspective factor.

Personal factor mainly analyzes the enterprise manager's moral character, ability, honesty and trustworthiness, repayment willingness.

Purpose factor mainly includes three aspects of production management, tax equity, and alternative repayment.

Payment factor has two main sources: one is cash flow, assets is two.

Protection factor including the internal security and external security.

Perspective factor mainly analysis the development of enterprises, including industrial policy and competition ability etc.

(3) The LAPP method evaluate the enterprise credit from the Liquidity, Activity, Profitability, Potentialities.

The method of evaluation have a variety of forms, but all are related to several key aspects on enterprise repayment potential, capital adequacy, the guarantee situation.

The main defects of expert evaluation method is a subjective issue, for the weight factors of the method depends on the subjective judgment of experts and the measure

results are different from man to man. This method will make the evaluation result is unfair according to the expert thinking on evaluation caused by human factors.

2.3.2 Financial ratio analysis

The method was introduced to predict the field of enterprise bankruptcy in 1966, formed a series of financial ratio analysis method after years of development. Generally speaking, the method is making a comprehensive, systematic and comprehensive analysis to the financial index of enterprises. According to the analysis, parsing and evaluating of enterprises operating conditions and financial conditions. In the practical application, this is a simple additive weighting method, which namely to each financial ratios to determine corresponding weight and calculate the standard, after comparing the enterprises with the standard values, given the individual scores. And then sum the weighted to conclude the enterprise credit scores and grading. The main representative of this kind of method is DuPont financial analysis system and Waldo proportion score. The basic principle of Du Pont financial analysis system takes financial indicators as a system, financial analysis and evaluation as a systematic project, to make a comprehensive evaluation of enterprise debt paying ability, operating ability, profitability and the interaction between the relationship. Comprehensive evaluation is based on comprehensive financial analysis. Which makes a deep understanding for the company's financial situation and has an effective decision making. Its basic characteristics is to taking net worth rate as a leader, net assets profit rate as the core,

combining with the solvency, asset operating capacity and profitability to constitute a complete analysis of the system, which reflects the financial situation of the enterprise comprehensive, systematic and intuitively.

Woer method selected seven kind of financial ratios as indicators for analysis, including current ratio, own assets of the proportion of fixed assets, equity to debt ratio, accounts receivable turnover rate, inventory turnover rate, fixed assets turnover rate, equity capital turnover. Taking the advanced index level of industry as the standard value and combining the index by a linear relationship, given their proportion scores, by compared with the actual value and the standard ratios to determine the indicators and overall index score of cumulative score. So we can draw a conclusion that the comprehensive evaluation of the financial condition of the enterprise and then determine its credit rating.

Financial ratio analysis method overcomes the subjectivity of the factor analysis method, which makes evaluation independent evaluators subjective efforts and enable the use of computers as possible, but the index weight and the difference compared with the standard that financial ratios score have obvious subjectivity, causing great discrepancy in the evaluation results and the enterprise actual situation.

2.3.3 Structural model

This model requires the data of the company's assets value in the calculation of credit risk, which is a dynamic management model of credit risk. The structured model has

four kinds of analysis model for example:

The first model is risk measurement model based on option pricing techniques, put forward by Black & Scholes (1973) and Merton (1974) the earliest. Menon discussed the idea of option pricing theory in risk loans and securities valuation, the study provides a practical and efficient analysis method, which used to measure the company default risk. Then, the idea of Merton along the direction develop a lot, many scholars try to measure the application of option pricing theory to credit risk. KMV model is a successful example of this. KMV method in the calculation of every enterprise expected default probability of the use of Merton theory, the probability and the enterprise capital structure, the volatility of asset returns and the asset value relationship. KMV also established the EDF (Expected Default Frequency) and the relationship between enterprise credit rating. KMV method is most applicable to listed companies, because these company's value is determined by the market, the company's share price and balance sheet data can be diagnosed release implied default risk.

The second model is default risk statistical model proposed Jarrow & Turnbull (1995), the default rate is described as a continuous single point movement, but also takes into account the default rate volatility, each credit rating variable risk function estimated based on the credit spreads, Suisse credit bank through the idea to develop a credit risk plus model (credit risk). The idea that in a time paragraph portfolio default the number of times the event described by Poisson distribution, each event of default are independent of each other, by introducing the probability generating function calculated default probability distribution, portfolio credit exposure by single asset risk

exposure, mean of default rate, default rate standard deviation and risk of loss percentage is determined.

The third model is discrete time dynamic macro simulation model proposed by Wilson. This method use the time series data of macroeconomic variables in the historical data and the average default rate to construct a multi factor model for different countries and sectors, the typical model is Credit Portfolio View System

The fourth model is a model of value at risk, taking the use of enterprise credit rating, rating migration matrix, loan default restore rate, risk spreads and yield rate to calculate the enterprise value and volatility. J.P. Morgan and company's Credit Metrics model is takin the changes of asset credit rating as variables to describe the enterprise value distribution, and to predict enterprise credit risk.

2.3.4 Artificial intelligence model

In recent years, artificial intelligence technology is introduced to the credit risk assessment with the development of information technology, mainly including the decision tree, the genetic algorithm, the neural network technology and expert system. The decision tree is in Quinlan in Hunt's concept learning system CLS (concept learning system) developed a bottom-up classification methods, it is constructed the structure of knowledge representation in decision-making through the learning of a set of training samples. The decision tree model is a statistical model which can easy to understand. But in practical application, due to the increase in the complexity of the

problem, decision tree model will happen combinatorial explosion situation. At the same time, the inductive learning approach for modeling is easy to cause the model overfitting, lacking of efficiency in modeling.

Greene and Smith try to use genetic algorithm (GA Generation Algorithm) to solve the problem of credit risk assessment. They represented the risk identification criterion with a fixed length encoding. However this method encountered great difficulties in the practical application, the main problem is that due to the limitations of fixed length coding mechanism, coding appears difficult or too long, the encoding and decoding processes need a lot of time and the lack of efficiency.

The neural network method can be regarded as a nonlinear mapping from input space to output space, which to study and find the relationship between variables by adjusting the weight and domain, classify things. It overcomes the complexity of traditional analysis process and difficulty to choose the appropriate model form. The method applied in the research on credit risk of enterprise, on the one hand by the mapping ability. On the other hand, mainly using the generalization ability, that after training with a certain number of noise samples, the network can be implied by the sample characteristics, and under the new situation number according to inclusion and extrapolation to infer its properties. Although the neural network can solve the non-normal distribution and non-credit evaluation problem effectively, there are still some defects, such as not capable of explaining the difficulty of determining the structure.

Expert system is one of the most widely used in artificial intelligence technology, it can

use domain knowledge in the knowledge base, through reasonable reasoning so as to solve the scope problem effectively. Romaniuk and Hall developed the expert system for credit evaluation for Fuzzynet, used as auxiliary tool for enterprises' judgement for whether applying for loans. But on the one hand, the expert system has the problem of knowledge acquisition. On the other hand, the credit evaluation process contains the noise data processing, which is not suitable for logic processing mechanism from expert system.

2.3.5 Moody's and Standard & Poor's external rating method

Moody and Standard & Poor's are international rating agencies. Nowadays the credit risk assessment models including credit risk measurement technique are applicate on the base of Moody's, Standard & Poor's rating methodology

Moody's rating business categories include: long-term debt rating, short-term debt rating, mutual fund rating, and the insurance company to pay ability rating, preferred stock rating and sovereign rating. Here only making a briefly introduction to Moody's rating methods on the case from industrial enterprise in foreign authority. Moody's corporate credit analysis structure includes eight aspects: industry trends, including the impact of the economic cycle, changes in commodity prices and industry competition and barriers; the influence of national policy and regulatory environment for company cash inflows and debt capacity; the quality in management; the company's basic business and competitive position; financial status and sources of liquidity; the

company's structure and system; the situation of parent company guarantee, maintenance agreement and the risk of unexpected events.

The analysis of the company's financial position become the core of the work in accordance with the above ratings based structural assessment when using the Moody's credit rating in the industrial enterprises, as well as in Moody's rating methodology, the financial analysis is described as the important content for analyzing overall structure credit.

The publicly rating information in rating agencies has the following problems in practical application:

First, the rating object of external credit rating agencies is mainly large companies, as which issuance stocks and bonds in the capital market. But in practical application, such as the rating objects in commercial bank, apart from those external rating of large enterprises, also a number of no external rating of enterprise. Because there are differences in the risk of external rating agencies, the risk analysis of rating agencies information used in commercial bank loan companies may omit borrowers unique risk information.

Second, the rating agencies downgrade the rating for certain securities issuers credit after their risk or operational difficulties appear, which shows the application of rating information and rating method in agencies is also problematic. From the aspect of rating information, rating agencies mainly uses the public information in the market to grasp the borrowers which get less information compared with the commercial banks. And further affecting the effect of the information use in the credit risk model.

Third, the external credit rating agencies rating have many users. Most of the rating methods are public, so it is possible that the rating methods are disclosed for take fake rating materials to improve threating in the process.

Chapter 3 Current situation of corporate credit in China

3.1 Development of credit rating in China

After the reform opening up, China's economy gradually transition from planned economy to market economy system, the enterprises are gradually becoming independent economic subject and benefit main body, and the credit problems gradually aroused people's attention. Commercial credit, bank credit, government credit, consumption credit and credit system have been given a completely different environment. With the content of the planned economy system getting the unprecedented development, enterprise credit construction also experienced changes. The three main changes are as below.

First, credit body began to privatize. Under the condition of market economy Banks, businesses have become independent market main body. Credit transaction as a special deal, transaction object is monetary funds or capital goods, independent banks, is the theme of the trading enterprises. Their goods or of their capital with exclusive property rights.

Second is about the leasing credit system. Credit mainly reflected a kind of social contract relationship, there is no power and threat factors.

Third is the harder relationship constraints. These constraints include interest's mechanism, the market competition, factors such as the moral law. As necessary to maintain the market economic development, meanwhile, laws, regulations and policies,

legal system of creditor's rights, in the maintenance of phenomenon of enforcement, strengthening credit taken many measures, such as in the 1980 s, China has issued and implemented the enterprise bankruptcy law, the regulation ", "contract law", "security law" and so on. Established the industrial and commercial administration, quality supervision and inspection, management, law enforcement and supervision departments, such as consumer society to regulate credit behavior played a role.

But, no country can provide the enterprise credit information institutions before 1987. At that time was awarded over access to foreign trade of hundreds of domestic enterprises, participate in international competition in the market, and when many businesses need to understand these companies abroad background and credit situation, but can't find can provide consulting agency. Until July 1987, the computing center of the ministry of foreign trade and economic cooperated with the United States Dun & Bradstreet to produce the first credit investigation institution in our country, which was the forerunner of ZhongMaoYuanDa. And since then a certain development of credit management is reached in our country.

In the 1990 s, gradually enter the market credit consolidation stage. Government departments in order to improve the of all kinds enterprise credit concept, organized a "contract", "national quality prize" and other activities, also organized a concentrated impact and clean up the "zombie" work. Enterprises to obtain financing support and expand the market, began to pay attention to change the past disorderly competition do not speak credit behavior, gradually improve the credit consciousness, strengthen enterprise credit management. Banking from control the credit risk of loan enterprise

credit evaluation work, strengthen bank credit risk prevention. To provide credit information service, specialized agencies began to appear in the Chinese market, such as Xinhua Commercial Information Consultancy Company established in 1993, and so on. But in this stage, there are still some outstanding problems: one is the credit investigation agency channel block, poor financial institutions of information, is the enterprise credit management there is a huge barrier; Second, many enterprises have not yet form the concept of credit investigation and the system of credit management system, credit risk consciousness; Three is the accounting system in our country there are serious loopholes, lack of authenticity, financial statements audit cannot work properly. Although our country credit regulation work, but on the whole, our country the construction of credit system and credit management system is far behind the development of market economy process. Therefore, social and economic life, breach of contract, fraud, bilk ignored the credit, do not speak credit, destruction of credit still occur in great quantities, become the serious obstacle of the development of the socialist market economy in China.

Since 1999, entered the stage of preliminary construction enterprise credit system in our country. Around the state economic and trade commission organized a pilot work of building enterprise credit guarantee system, and issued a "pilot guidance on setting up enterprise credit guarantee system, etc. By the end of 2000, 13 provinces across the country had been established the credit guarantee institutions at the provincial level, 30 provinces (cities, districts) set up in 203 cities enterprise credit guarantee agencies. In 300 the people's bank of China branches formed a bank loan credit registration

information system, and began to gradually achieve the provincial area system connected to the Internet. Administrative department for industry and commerce registration yearly check of industry and commerce, began to explore the enterprise credit management system. Such as Zhejiang Fuyang city administration for industry and commerce for establishing the enterprise contract credit GongShiZhi typical example. On July 1, 2000, Shanghai form on the basis of the bank credit company, information about the credit and credit reporting, query subsystem. In May 2001, Guangzhou decided to establish a "hukou" is the enterprise for the enterprise credit archives management and the enterprise credit rating, forms the enterprise of "economic account". In July, the Beijing municipal enterprise "bad behavior records management system," open with "315" of the municipal administration website, at the end of 2014 by 381 companies and natural persons for running an illegal is locked into the "blacklist" 1 to 10 years. On December 1, enterprise credit system of Beijing ZhongGuanCun science park pilot work start.

In 2013, the state economic and trade commission and other 10 ministries jointly issued "several opinions on strengthening enterprise credit management, put forward to set up the enterprise credit management system, a sound system of accounting, strict quality management. At the same time, the requirements to perfect enterprise credit system, establish credit intermediary service related norms system, create favorable intermediaries to fair competition market environment, play an intermediary role in the promotion enterprise credit, make enterprise and intermediary institutions, the credit rating system, carry out the credit evaluation of enterprises and intermediary agencies,

credit project implementation, on the existing credit system, to establish the joint credit information collection between government departments. These marks, with emphasis on the enterprise in our country, including personal credit system, establishing social credit system has already started. For the first time in Beijing on September 19 in the same year, BBS "" China's credit economy, the participants initiative this day would be a" good faith, "in our country. These reflects both the government and enterprises in China, the theory and practice are common concerned about the problem of enterprise credit process, and then set about to facilitate the construction of credit mechanism for the development of China's credit economy created the initial conditions.

3.2 Defects of corporate credit rating in China

The study of corporate credit rating in China was started late, but has made great achievement with continuous efforts. But we still should be aware of our shortcomings and limitations, the current rules and regulations of our country's credit rating is not perfect and sound, although the foreign research and the rating model is relatively more and perfect, but considering the actual situation in our country and the actual situation of enterprise development, the research and the model is not suitable for us. At present our country enterprise's credit rating index system is not able to completely objectively reflect the enterprise of credit risk, has yet to be further perfected and developed, so the enterprise faced with the plight of financing difficulties, embodied in the following aspects.

3.2.1 Problems in credit rating index selection

(1) High weight on enterprise scale while other comprehensive factors are having lower weights.

Rating agencies will mostly reactions such as enterprise's total assets and net sales enterprise size variable, be considered as the main rating elements, and the weights and scores given by the larger. And, in fact, enterprise scale is not the bigger the better, the enterprise of the optimal scale, professional production of SMEs, adapt to market changes and produce stable performance, not necessarily than blindly expand the production scale of comprehensive enterprise group do poorly, the credit rating results rather than the larger integrated enterprises. In SMEs credit rating, therefore, should be appropriate to reduce the influence of scale factor to the enterprise rating result.

(2) Focusing on the past of SMEs while development, growth, and evaluation of innovation ability is insufficient.

Current SMEs credit rating index system is set up on the basis of the past financial indicators analysis, it is a kind of static evaluation, historical data and the future of the enterprise correlation is not big, So it is difficult to reflect the flexibility of SMEs management. Information and financial statements do not necessarily reflect the actual operation of the SMEs, more is not enough to reflect the trend of the development of enterprises and the degree of security for debt. SMEs are usually innovative and high growth, compared with large enterprises have grown up with faster growth rates, SMEs

after continuous development, the scale has probably reached the standard of large enterprises, enterprises in the future is likely to enhance ability to repay its debt, but the current rating system based on the analysis of SMEs growth ability insufficient, the evaluation of SMEs development ability were weighted too low, so the credit rating of SMEs must pay more attention to innovation and development capacity evaluation, focusing on the future of the SMEs development prospect.

(3) Lack of the analysis of industries, the analysis of industry characteristics and risk s not enough..

Enterprise industry characteristics are the important factors that affect the enterprise credit risk, the industry standard that enterprise's position in the industry and levels, and can judge the change trend of the enterprise, and the current lack of SMEs credit rating index system of the specific analysis of the industry, to which the enterprise belongs to industry classification are sketchy, some are divided into industry, public utilities, commerce, real estate development, etc., some divided into industrial enterprises and circulation enterprises, the industry is difficult to highlight in the rating system, cannot be accurately reveal the specific risk of specific industry enterprises face weak indicator design targeted, the objectivity and reliability of the result of the ratings.

(4) The analysis of cash flow is neglected as can see from the lack of prediction and application of the cash flow index.

The financial elements of the enterprise cash flow of the most can reflect the actual

operation of the enterprise, is an important factor to determine enterprise future solvency, the cash flow to repay the debts of the enterprise to provide fundamental guarantee, to analysis enterprise solvency has had a huge impact in the future. Under accrual accounting, sometimes book profits but did not increase of cash flow, corporate profitability indicator to evaluate enterprise's financial situation has significant limitations. At present, some institutions set up by the credit rating index system only consider profit ability, but insufficient attention to earnings quality, focus on the profits of debt security, rarely analysis and forecast cash flow adequacy, not to the enterprise's solvency reflect. Therefore, in order to evaluate objectively the solvency of the enterprise, the ratings should be combined with asset-liability ratio and other indicators, to join the cash flow analysis in the index system.

(5) Credit records analysis is in lack as there is insufficient evaluation of default history. In the rating system of institutions, there is no analysis of SMEs credit record, the financial indicators of an enterprise, debt paying ability is strong, does not necessarily have good credit, SMEs to use various methods to examples of debt evasion, so whether can timely performance is also one of the key factors of SMEs credit rating. Therefore, in the SMEs credit rating to handle credit record is analyzed, to evaluate the performance situation, so that it can more accurate judgment of SMEs credit standing.

(6) The influence of external economic environment on SMEs' credit conditions is ignored.

External economic environment has important influence to the development of SMEs, SMEs small, weak ability to resist crisis, once the macro economic situation changes, operating conditions are easy to be affected, but the current SMEs credit rating index system of external economic environment to consider is not much, only emphasis on the micro level of the enterprise. In addition, the regional economic environment differences of the influence of the SMEs operating performance in the current rating index system also does not take into account, due to the regional economic development is very uneven in our country, in different areas, even the same industry, the same form and scale of enterprise, its development degree is not the same. Therefore, the external economic environment this factor the accuracy of the result of the SMEs credit rating influence to a certain extent.

(7) The inner links between various indicators is cut so it is difficult to make accurate judgment as a whole.

There are multiple factors influencing the rating results, between them is not completely independent, connected between each index, some correlation is also very obvious, the analysis of enterprise's credit, not only need to consider the effect of single factor, also need to analyze the internal relations between the factors. While the existing credit rating index system less attention index, the inner link between overall judgments will there is a deviation. Therefore, in the SMEs credit rating, should be combination of qualitative and quantitative analysis, at the same time pay attention to qualitative analysis, integrated all sorts of influencing factors and the result of expert opinion, to

assess the rating object credit rating, such ability for SMEs' credit rating result objectively, scientifically, fairly reflected

3.2.2 Problems in credit rating methodology and system

(1) The rating method needs to be improved.

When for SMEs credit rating, to mainly adopt the method of expert judgment, quantitative indicators for quantitative indicators generally adopt the method of ratio analysis, and then comprehensive score of indicators, existing problems of this method is difficult to determine the qualitative and quantitative analysis of each index in the relationship, is not conducive to ensure that the results of scientific, the ratings have systemic error is more likely. In addition, in the main factors of affecting the enterprise debt paying ability and its correlation coefficient to determine when, due to the insufficient data, can only be judged by the expert's experience and selecting indexes and weights, difficult to use certain statistical analysis techniques to to eliminate duplicate score factors.

(2) Credit rating system is not complete.

Credit rating is influenced by partners who may be the result of the default risk level, the credit rating index system to be whole, in addition to the rating on credit enterprise, also need to is not in conformity with the credit conditions of enterprises, will the system integrity. Generally, according to the score results for SMEs's credit rating level

is divided into 10 to 20, most is the enterprise credit rating is divided into ten risk level: AAA, AA, A, BBB, BB, b. CCC, CC, C, D, etc. Few rating index system for evaluation of enterprise, constantly default make the rating index system of discontinuity, adverse effects on the statistical probability of default and loss rate, is unfavorable to further perfect the credit rating index system, which hindered its role in the whole rating index system.

(3) Rating result inspection is lacked.

Technology, thus establishing in order to evaluate and correct the rating system, needs the special inspection to the rating result. One is due to the rating method and the index system could fundamentally defects, to cause the rating process of overall system deviation; 2 it is due to improper operation or other objective factors caused by deviation in operation. Because at present our country's credit rating is still in its infancy, and easy to affected by macro economic and financial environment changes rapidly, so the deviation in theory it is difficult to eradicate. And the special inspection, the result of the rating can make self rating method and system of development and perfection. So, to continuously improve the rating method and system, and make it more scientific and accurate, and must adjust the corresponding effect mechanism of return inspection.

(4) A scientific and standard evaluation system is in need.

Rating agencies in the financial index of enterprises of different industries with

reference to the same standard, but because of the different industry characteristics, some financial indicators, such as accounts receivable turnover, industry enterprises to use the same reference standard, such as inventory turnover operating efficiency index can make a big difference, the facts right rating result is scientific and fair. In addition, because of non-financial factors, such as part of the system management and willingness of solvency indicators, mainly qualitative indicators, control standards define the fuzzy, there are few quantitative data standards, and these indicators mainly rely on the experience of credit analyst, easy for operation, for the determination of their subjective randomness is too big.

3.3 The importance of establishing corporate credit rating system

In 2007 the us subprime mortgage crisis triggered by the financial crisis influence the entity economy, our country crisis the impact to our country mainly comes from the export sector are greatly influenced by external economy. Particularly worth mentioning is, in China, the international financial crisis triggered by the overseas economic recession is the most serious is that SMEs. In recent years the appreciation of the renminbi, duty drawback rate cut of the profits of export-oriented small and medium enterprises has been falling, coupled with the sharp drop in external demand, weak anti-risk ability of life difficult for SMEs. Our country the most economically developed Pearl River delta, Yangtze River delta and the Bohai rim region, a large number of SMEs face a serious business.

At present of all SMEs in China, up to 98% of SMEs are using indirect financing, and bank credit is the main way of indirect financing of SMEs. But actually SMEs' loan balance accounts for less than 25% of commercial banks' total credit balance. Due to their lack of credit, SMEs' relationship with banks can be summarized as banks are "reluctant to lend, fear is borrowed, which leads to SMEs financing difficulties. And the solution of making through the corporate bond market, second board market does not have realistic feasibility. To this situation, further analysis can start from two aspects, first is from SMEs itself, on a smaller scale of SMEs in China, operating variables is more, average enterprise life cycle is shorter; at the same time, the SMEs internal and external various environment factors change fast, a lot of financial information and non-financial information, such as difficult for banks to grasp, compared to large and medium-sized enterprises exist serious information asymmetry and so on. Is the external environment on the other hand, in our country, in view of the SMEs external credit system has not established effective, lack of SMEs credit data. At the same time, the major commercial Banks based on the analysis of credit risk evaluation of SMEs, there is no specific, advanced risk assessment system construction, SMEs credit business specialized rating system lack of science can be quantified, and the use of large and medium-sized enterprises of objective evaluation criteria will not be able to SMEs credit risk. So, at present, although the average yield of SMEs credit business is higher, but because of the SMEs credit business is faced with the problem of the above, the plight of SMEs financing difficulties still exist.

Therefore, it is necessary to establish for SMEs, especially for growing SMEs credit

rating system to solve the problem of SMEs credit rating level of injustice, the credit rating system should comply with the characteristics of SMEs, and operable.

SMEs in China's economic development has a pivotal position, is China's economic growth, growth and contribution of the most, but credit problems become the important factors affecting SMEs financing, has adverse effects to the normal development of SMEs. Governments, Banks and other credit rating agencies for SMEs lack of evaluation, is one of the SMEs financing credit loss is very important. To establish and perfect the SMEs characteristic, operable index system of credit rating, for SMEs' credit rating assessment of science have the milk also can effectively solve the problem of SMEs' credit. However, the current rating index system did not grasp the characteristics of SMEs, cannot effectively distinguish between SMEs credit conditions, the role of credit rating and weakening. Therefore, further effective construction of SMEs credit rating index system, and solve the problem of financing of SMEs, to regulate the behavior of SMEs credit guarantee the benign development of the national economy has important practical significance.

(1) The influence on SMEs

First, strengthen the credit consciousness of the SMEs. By building SMEs credit rating evaluation index system for SMEs credit status, help enterprise to recognize their own credit, the credit rating of promotion to the enterprise constitutes a credit constraints and the magnitude of the external supervision to strengthen the credit consciousness, accelerate the construction of enterprise credit culture, and thus increase the enterprise's

credit image

Second, reduce the SMEs financing costs. Reasonable analysis and evaluation of SMEs, bank or other financial institutions on corporate lending, may follow the enterprise credit rating, make reasonable financial support. Height is inversely proportional to the credit rating of the cost of financing, if the enterprise's credit rating is high, can obtain funds at a relatively low cost of funding support; If the enterprise's credit rating is low, can through the credit rating results analysis of the problem itself, thus to targeted to improve their credit rating, in order to reduce the financing cost.

Third, improve the level of operation and management of SMEs. The discretion of the SMEs credit rating and the enterprise's internal quality contact close everything, including technology innovation, human resources management, financial management level, etc. SMEs credit rating results would lead to more emphasis on its internal quality, prompt it to improve the level of management, provide the booster for the sustained and healthy development of the SMEs.

(2) The impact on banks and guarantee agencies.

First of all, to reduce the risks of information asymmetry. Due to the number of SMEs, banks and SMEs, there are serious information asymmetry between the credit rating report issued by credit rating agencies, Banks and guarantee agencies can more clearly understand the operation status quo of SMEs, solvency and development trend of various aspects, so as to improve the disadvantage of information, reduce the risk caused by information asymmetry.

Second, related to reduce costs, improve work efficiency. Through the financial statements of the SMEs, and cannot be real reaction of SMEs internal information, need further bank soft enterprise collecting relevant information, this will increase the cost of collecting and organizing information. Rating report released by credit rating agencies and the tracking rating information, Banks and guarantee agencies for SMEs credit record to collect cost can be saved and can more clearly understand the enterprise internal risk, reduce the transfer information to pay the cost of manpower, financial resources, make reasonable credit decisions, more targeted to credit risk management and control, improve efficiency.

Third, is conducive to cultivating potential customers. Through perfect credit rating index system of the bank not only can effectively control the loan risks of its own, can also according to the result of credit rating evaluation to establish a good relationship with good credit, enterprise, and cultivate a batch of potential SMEs, making it the potential customers, thus accelerating the development of SMEs business.

(3) The impact on capital market

First of all, can make optimal allocation of capital. Unlimited in the real society, money demand and money supply limited coexist, between requirements in various departments, various enterprises with as little money as possible consumption, allocation of funds to make the best choice, obtain good economic benefit as much as possible. Through the application of SMEs credit rating index system, can encourage social capital to flow in the high credit rating companies, the optimal selection for

funds, realize the reasonable configuration, to promote the virtuous cycle of national economy.

Second, provide information service for the capital market. Under the condition of market economy, the information on the role of social production, distribution, exchange and consumption is becoming more and more important, information has become a professional industry. SMEs credit rating can exert its advantages, the complex information processed, then the output of information products is easy to understand and to provide information services to the capital market, to promote its healthy development.

Third, guarantee the healthy development of direct financing. To change focus on bank credit institutions that social capital flow pattern, need to develop the direct financing, form a new financing mechanism. Such enterprises can gain social financing in financial market. And SMEs credit rating by evaluation according to the facts of the financing credit conditions, carried out on a normal financing is financing guarantee. Therefore, through the study of the evaluation of SMEs credit rating, can guarantee the healthy development of direct financing.

Chapter 4 Corporate credit rating methods

4.1 A comparative analysis of domestic and foreign credit rating methods

After more than hundred years of development, the rating agencies, financial institutions, and many scholars have built up different angles of credit rating methods. Widely used rating methods can be divided into three categories: model-based rating method, comprehensive rating method and credit scoring method.

4.1.1 Model-based rating method

Model-based rating method belongs to quantitative rating method, which is a kind of the risk assessment method based on mathematical techniques, referring to the evaluated object operating history data, on the basis of comprehensive analysis, through economic analysis indicators, with the help of a credit rating model, namely, build the model variables and parameters, by calculating the probability of default risk evaluated object size, to determine their credit rating results a metering method. In the credit rating, usually develop a standard value, the economic indicators as the basis of comparing each other. Reach or exceed the standard value, credit conditions are good, unattainable, credit conditions are poor. The existing assessment method of rating model mostly based on statistical is Derek fisher (Fisher1936) after basic research. In general, these models are with characteristics of financial ratios as the explanatory

variables, using statistical method is derived and established a number of the standard model. In summary there are linear probability model, Logit and Probit model and discriminant analysis model. Among them, multiple discriminant analysis is the most popular one, and the Logit model is the second one.

Multiple discriminant analysis is based on some statistic characteristics of observed, classifying objective things, in order to determine the category of things. Its characteristic is already mastered several samples of each category in history, summed up the regularity of classification, discriminant formula is established. When meet new things, as long as we devised according to the discriminant formula, can distinguish things belong to the category of the. Multivariate linear discriminant analysis, can be specific to general discriminant analysis (regardless of the variable screening) and stepwise discriminant analysis of quantitative data (considering variable screening). But the application of multiple discriminant analysis has three main assumptions: variable data is normal distribution; Group covariance components are the same; each group's average vector and covariance matrix, the prior probability and miscalculation cost is known.

Logit model is one of the method of discrete choice models, belong to the category of multiple variable analysis, is a clinical, quantity, psychology, sociology, biostatistics, marketing and so on the empirical analysis of the commonly used method of statistics. It is to use a series of financial ratios variables to predict the probability of bankruptcy or default, then according to the bank risk, the degree of investor risk appetite set police line, in order to locate the risk analysis object and decision-making. Logit model and

multiple discriminant analysis the essence of the difference lies in the Logit model need not meet normal distribution or variance, such as its model USES the Logistic function. Regression does not assume any probability distribution, especially in the case of does not meet the normal distribution, the discriminant accuracy higher than that of the multiple discriminant analysis results.

Model rating method has the advantage of simple, low cost, rating personnel's subjective factors doping is less, but the rating model method of prediction effect varies by time length, in a short period of time financial ratios change smaller, accuracy is high; Over a longer period of financial ratios may be larger changes, forecast accuracy will be reduced. The shortcoming of this method is must be based on the evaluation object large, reliable statistics, on the basis of the history of that in developing countries such as China is difficult to have the prerequisite. At present, the integrity is generally weak, optional the gender is big, the authenticity of the enterprise financial report of the poor, under such an environment, for the credible degree of the financial statements of the ratings will be discounted, based on the financial data of the rating results reflect the actual condition of the enterprise will not be true.

4.1.2 Comprehensive rating method

The comprehensive rating method in the 1980 s, used to rely on financial data to evaluate the credit risk evaluation object method cannot adapt to market changes quickly, and this method flexibility is poor, only reflect enterprise operating condition

of the past and present. Comprehensive rating method is given priority to with qualitative analysis and quantitative analysis is complementary, required to make a comprehensive, comprehensive evaluation rating companies.

The comprehensive rating method steps are: first, determine the rating index system, clear the rating content and ways, and the second is to establish evaluation index system, properly according to the systematic analysis of the rating content make, to enterprise's business performance changes to make the forecast of the development trend in the future. Famous Moody’s, a rating companies in the United States, for example, one of the basic principles of the company's credit rating method is combination of qualitative analysis and quantitative analysis, emphasis on the qualitative analysis is given priority to, and the fundamental analysis, quantitative analysis is necessary in addition to financial analysis and part adopts quantitative analysis index prediction, the rating of a large number of USES the qualitative analysis, comprehensive rating results for the various influence factors and expert advice, and comprehensive reflection of risk rating object. Moody's this approach has become a mainstream direction of the development of the current credit rating method, as the world's major rating companies and commercial Banks.

Still exists subjectivity is stronger, the approach of credit risk assessment of the lack of consistency, the rating result of too much depends on the rating personnel's experience, ability of comprehensive evaluation for rating personnel demand is higher, the different rating personnel due to differences in their experience, habits and preferences, may appear different risk assessment results.

4.1.3 Credit scoring method

Credit scoring method and the comprehensive rating method, also using a combination of quantitative analysis and qualitative analysis. But they have the essential difference is that the former will mean quantitative qualitative analysis and quantitative analysis, to different index using expert scoring and standardization, can add and subtract each other between the indexes with different dimensions. Credit scoring method to calculate the total value of the credit, can according to the standards set by rating agencies, find the corresponding credit rating score. 0 more scoring method in our country, namely the highest credit rating at 100 points, such as AAA is 95-100, AA is 85-95 points, and so on. Hundred-mark system method is simple and easy, the maneuverability is strong, and the evaluation process is clear, easy to supervise, won't appear large deviation. Its disadvantage is can't play to the wisdom of the estimators, can only be fully in accordance with the evaluation method to calculate the score, determine the credit rating evaluation object. In order to solve this defect, the general design in this kind of evaluation method, have been increased an adjusted score "experience" as a rating personnel's reference.

Taken together, all three of these methodologies have their own advantages and disadvantages, through the introduction and analysis of three rating methods, combining with the characteristics of our country's actual (enterprise financial data credibility is not high, credit rating personnel quality improvement, etc.), the enterprise credit rating appropriate USES credit scoring method in our country, and our country

commercial bank at present most of the credit scoring evaluation methods, enterprise credit rating using this method to make the rating results comparable, easily accepted by investors and regulators.

4.2 The corporate credit rating system for SMEs in China

4.2.1 Selecting the index

Currently in China, there are seven primary aspects that are generally believed to have impact on corporates' credit status, this paper aims at introduce the corporate credit rating index system in China basing on indicators from these seven aspects.
With reference to previous research, the seven aspects can be summarized as follows.

(1) Business environment of the company

Enterprise basic quality is the foundation of the credit rating elements, is the internal conditions affecting the enterprise credit status, higher quality enterprise is the enterprise constantly develop new products, new business, improve market share and gain greater economic benefits of great security. For enterprises, the quality of enterprise is mainly embodied in the enterprise scale and enterprise staff's quality, so this article chooses the enterprise scale, leadership quality and staff quality these three indicators. Among them, the leadership quality of culture of enterprise leaders and their credit level in the industry, the professional quality of the staff mainly inspects

enterprise technology and management personnel's overall culture level and the education situation.

(2) Leverage / Gearing

Enterprise debt paying ability is the main performance, financial status is also preferred indicator of enterprise credit rating. The discretion of the enterprise debt paying ability is to reflect the operating risk of an enterprise, and reflect the ability of enterprises engaged in business activities using debt. Investigation of enterprise debt paying ability index includes both reflect the enterprise long-term debt paying ability index, asset-liability ratio, also reflect the enterprise short-term solvency indicators such as current ratio, quick ratio, cash ratio, overdue debt ratio, has won the interest ratio, etc. Various target specific meaning is as follows.

Asset-liability ratio = total debt/total assets x100%

Current ratio = total current assets/current liabilities x100%

Quick ratio = (total liquid assets - inventory)/total current liabilities x100%

Cash ratio = total cash/total current liabilities x100%

Overdue debt ratio = overdue debt/total liabilities x100%

The multiple of interest safeguard = EBIT/interest charges

(3) Operating capacity

Operation ability mainly refers to the enterprise the efficiency and effectiveness of the

operation of the asset, it shows that the enterprise management personnel management, ability to use money. The faster the production makes operation of an enterprise capital turnover. Shows that the enterprise funds use, the better effect, and the higher efficiency, and enterprise management personnel management ability is stronger. The size of the operation ability of the continuing growth of profit and the constant improvement of the solvency, have a decisive influence. Reflect the enterprise operation ability indicators mainly include inventory turnover, accounts receivable turnover ratio, current asset turnover, fixed asset turnover and total asset turnover. Its computation formula is as follows.

Inventory turnover ratio = average cost of sales/inventory

Accounts receivable turnover ratio = sales revenue/average balance of accounts receivable

Current assets turnover ratio = sales revenue/current assets average balance

Fixed asset turnover average balance = sales revenue/fixed assets

Total asset turnover = advocate business income/average total assets

(4) Leverage / Gearing

Enterprise's profit ability is the guarantee of enterprise credit, enterprise profit only, is likely to repay debt on schedule. Profitability is refers to the enterprise profit ability, also known as enterprise funds or capital appreciation ability, usually for a certain period of time business income amount of how many and its level of high and low..

Profitability is the foundation of enterprise survival and development. A lot of indicators to measure corporate profitability, usually used are hard Numbers, mainly include sales net interest rate, sales gross profit margin, return on assets and return on equity. Its computation formula is as follows.

Sales net interest rate = net profit/sales net income

Net sales gross profit margin = gross profit/sales revenue

Return on assets = net income/average total assets

Return on equity = net income/average net assets

(5) Innovation ability

Along with the rapid development of science and technology innovation ability of enterprises played an important role for the formation of competitive advantage and is especially important for science and technology enterprises. When evaluating enterprise innovation ability, the main indicators are the new product sales income proportion, the proportion of technical personnel, the new technology and equipment, R&D input intensity. Its computation formula is as follows.

New product sales income proportion = new product sales revenue/sales revenue

Technical personnel ratio = technical personnel/company worker total number

New technology and equipment rate = new technology had cost/price fixed assets

R&D input intensity = R&D cost/sales revenue

(6) Future growth potential

Growth potential is advance ceaselessly, improve the credit condition of force, only the growth potential of the enterprise to guarantee the sustainable profit, its financial status is good. Evaluation of enterprise's growth potential includes three aspects: one is the enterprise industry development prospects, 2 it is national policy support, three is the enterprise's own growth ability. Enterprise own ability can be measured by the following indicators, the growth of net profit growth, sales growth, capital accumulation, business development plan. Its computation formula is as follows.

Net profit growth rate = (net profit a net profit of the previous period in current)/net profit of the previous period

Sales revenue growth rate = (current sales income from sales of the previous period)/sales revenue of the previous period

Capital accumulation rate = owner's equity of the current year growth/owner's equity at the beginning of the forehead

(7) History of credit records

Refers to the credit rating agency, rely on credit from a channel or social parties, to determine the economic subject's credit status information, according to certain criteria and indicators for evaluation, with a certain symbols or words said about economic subject a credit note. Assessment of the creditworthiness of an enterprise, should not only pay much attention to whether companies have the ability to expire repaid, also

cannot ignore the investigation of the history of the enterprise, survey ever history debt or demurrage charges, ever escape financial debts, debit interest owed credit behavior, with objectivity, notarization is analyzed, the ability to make accurate judgment of credit.

Basing on the above analysis, the initial indicators of corporate credit rating system includes 29 indicators, including 22 quantitative indicators, qualitative indicators 7.

4.2.2 Determining weights for the quantitative index

Weight is a relative concept, referring to the calculation in the statistical index, the average value, the role of each variable has a balance weight, the credit rating index weights that weigh the value of the role of credit rating index weight, also called importance coefficient. In order to accurately measure the rating indexes, the size of the role played by the credit standing is for each of the credit rating index weight, a indicates the degree of the role played by the credit rating index, the role of the credit rating index, weight is big; The role of small credit rating index, weight was low. When the credit rating index system for credit rating weight must be attached great importance to, to make it truly reflects the rating the indicators in the role of the rating credit conditions. When the credit rating index system should been first to determine the weight of factors of credit rating, and then determine the weight of each index in the factors of credit rating.

By evaluating the enterprise industry is different, each industry has its own characteristics, in order to improve the reliability and accuracy of enterprise credit rating, the rating needs to classify them according to the national industry standard, within the same category of enterprise use the same standard. DaGong Global Credit Rating Co., Ltd., for example, dividing enterprises into 10 categories, and elements and index weight are all different among the 10 categories, but no matter in which category, the weight of debt paying ability and gain profit ability is always the biggest of all. There are mainly two methods in the determination of index weight.

First is the analytic hierarchy process (AHP) method, which is put forward by American operations research scientist at the University of Pittsburgh Professor Saaty in the 1970s a multi-objective decision analysis method. It is always about the elements of decision-making down into objectives, guidelines, programs and other levels. On this basis of qualitative and quantitative analysis of decision-making method. AHP method, first of all, the effect was rated objects of various complicated factors according to the membership relation is partitioned into an orderly hierarchical structure and according to the objective reality of subjective judgment, relative to the level of a hierarchy of factors for pairwise comparison, and by mathematical calculation and verification and, ultimately, the lowest level relative to the highest levels of relative importance weights, and the method used to determine the weights of the rating indexes has its unique role.

Another widely used method is called open class method, which can identify the difference among the evaluated objects more accurately from the whole, so that the

evaluation object can be classified into different grades, so as to realize the convex dominance of the evaluation result.

Because of the open class method has the advantages of good objective, transparent and order preserving, its application in the credit rating model to determine the evaluation index (attributes) of the weights can be better to highlight all of the credit rating of the main differences, is conducive to investment decisions more effectively identify good credit status of enterprises, can also motivate the evaluated subject to take measures to strengthen the building of the enterprise credit. The specific process is as follows.

The linear function of (x_1, x_2, …, x_m) and the very large scale evaluation index is a comprehensive evaluation function of the system

$$y = \sum_{i=1}^{m} w_i x_i = W^T X$$

……..…(1)

where W = (w_1, w_2, …, w_m) is the weighted coefficient vector of m indicators, X = (x_1, x_2, …, x_m).

If we get the m indicators of the ith observation x_{i1}, x_{i2}, …, x_{im}), into equation (1), then we can have

$$y_i = \sum_{j=1}^{m} w_j x_{ij}, i = 1,2, \dots, n$$

……..…(2)

Suppose that

$$\mathrm{y} = \begin{pmatrix} y_1 \\ \vdots \\ y_\mathrm{n} \end{pmatrix},\ A = \begin{pmatrix} x_{11} & \cdots & x_{1m} \\ \vdots & \ddots & \vdots \\ x_{n1} & \cdots & x_{nm} \end{pmatrix}.$$

……..…(3)

then equation (2) can be written as

$$\mathrm{y} = \mathrm{AW}$$

……..…(4)

To determine the weight vector w criterion is maximally reflect the "essence" of different evaluation differences between objects, namely for index vector x is a linear function of $w^T x$, make the function of N was evaluated object value of the dispersion degree of variance or as large as possible. And the variance of variable $y = w^T x$ basing on the sample of n indicators will be

$$s^2 = \frac{1}{n}\sum_{i=1}^{n}(y_i - \bar{y})^2 = \frac{y^T y}{n} - \bar{y}^2$$

……..…(5)

If we get $\mathrm{y} = \mathrm{AW}$ into equation (5) and due to the standardized processing of raw data we will have $\bar{y} = 0$, thus we can get

$$ns^2 = W^T A^T AW = W^T HW$$

……..…(6)

where $\mathrm{H} = A^T A$ is the real symmetric matrix.

Obviously, when the W is not constrained, equation (6) can have any value. If we constraint $W^T W = 1$, the maximum value of the equation (6), that is, the choice of W, will be

$$y^* = \begin{cases} \max W^T H W \\ \text{s.t.} \; W^T \mathrm{W} = 1 \\ \mathrm{W} > 0 \end{cases}$$

……..…(7)

Therefore we can obtain the following conclusions.

First, if W is the maximum eigenvalue of the H corresponding to the standard feature vector, then the equation (7) to obtain the maximum value.

By this, we can see that the weight coefficient is the characteristic vector corresponding to the maximum eigenvalue of the matrix H, and then it is normalized.

Second if H is a square matrix (i.e. h elements are both greater than 0), only a positive maximum characteristic value lambda max, and only with the lambda max corresponding to the positive characteristic vector (if excluding normal several times).

Third, any two columns (or two rows) in matrix A can be exchanged, with the comprehensive evaluation function value unchanged.

4.2.3 Processing the qualitative index

Usually we can use the traditional expert scoring method to process the qualitative index. According to the scoring criteria for qualitative indicators, experts will score

referring to the rule that a better indicator will be given a higher score and a worse one will be given a lower score. According to the international and domestic standards, Table 4.1 gives the SMEs credit rating qualitative indicator score table, table of qualitative indicators are divided into three levels, namely, the high standard for evaluation in lower level three. The qualitative index weight accounted for 37% of the total, and rating according to percentile calculation, then the qualitative index score was 37. The small and medium-sized enterprise credit rating qualitative indicator score table as shown below.

Table 4.1 Rules of scoring qualitative indicators

No.	Indicators	Senior grade value 3-2.5	Intermediate grade value 2.4-2	Lower score value 1.9-1.5	The worst score value 1.4-0
External environmental indicators					
1	industrial policy	loose	moderation	More strictly	tight
2	macroeconomic policy	economic prosperity	economic downturn	economic recession	depression
3	Stability of industry development	good prospect	Labor Economics	Poor prospects	No prospect
4	Degree of Competition	Degree of weak	Degree of general	Strong degree	Competition cruel
5	enterprise production scale	large	medium	lesser	small
6	product market share	high	medium	low	Very low
Managements' quality indicators					
1	Management	rich	general	little	lack

	experience				
2	Managers management performance	excellent	general	poor	very poor
3	Management of personal credit	excellent	general	poor	very poor
No	name of index	Senior grade value 2.4-2	Intermediate grade value 1.9-1.5	Lower score values 1.4-1	The worst score values 0.9-0
Stakeholders' credit status evaluation indicators					
1	The main cooperation enterprise for its credit rating	Good reputation	Word of mouth in general	bad rap	Word of mouth is poor
2	Bank payment records	Good tracking record	Records of the general	Poor record	Poor record
Enterprise management indicators					
1	rnal control	Good	Internal control	Internal	No internal

	system	internal control system	system sound	control system not sound	control system
2	Enterprise management goal and target system	Target managemen t balanced	Basic implementatio n level	Do not implement managemen t more generally	No target managemen t disorder

According to table 5.4 for small and medium-sized enterprises of the qualitative index scores calculated the score of each index as S_i (i = 1, 2, …, 13), and then calculated according to the type of qualitative index of the total value

$$S_i^* = \sum_{i=1}^{13} W_i^* S_i$$

4.2.4 Calculating the comprehensive score

The index system, the international advanced commercial banks such as the internal rating system of Citibank, Bank of America and other quantitative indexes occupy absolute proportion, about 70% or more. China's authoritative rating agencies believe that corporate credit rating indicator system through six rating module together to build, the module assignment composite proportion: prospects for development 16%, 32% of the financial situation, solvency is 14%, profit ability is 14%, 12% of operating capacity, bank credit 10%. In order to reduce the influence of subjectivity on the model results, making effect of rating is more accurate, while reducing the establishment of the workload of the rating process model, refers to a large number of domestic and foreign more representative of the design scheme, and based on the proportion of the above set enterprises quantitative financial ratios in weight is 62%, qualitative non-financial index weight was 38%. At the same time, according to the credit rating of enterprises in the above set to seven levels, and the scale principle, the proportion will be reset to 63 points, the index weights of quantitative qualitative index 37 points. In order to simplify the calculation model, improve the efficiency of SMEs' credit rating.

On this basis, we can get the comprehensive score value for SMEs by

$$S = S_1^* + S_2^*$$

which is the final score from the corporate credit rating system for SMEs.

And Table 4.2 is a reference of credit level for SMEs.

Table 4.2 Credit level for SMEs

Credit rating	Score	Explanation
AAA	[90,100]	Enterprise credit degree is high, the debt risk is small. AAA level enterprise financial strength is abundant, the short - and long-term debt payments and repay ability strong, strong corporate profitability, broad prospects for development; Operating in a virtuous cycle, uncertainty factors impact on the operation and development of its tiny.
AA	[80,90)	The relatively small enterprise credit degree is higher, the debt risk. AA level enterprise with rich strength in capital, both short-term and long-term debt payments and repay ability is very strong, earnings level is higher, development prospect of relatively broad; Run in a virtuous cycle, uncertainty factors impact on the operation and development of its smaller.
A	[70,80)	Enterprise credit level is good. A-class enterprise financial strength considerations, both short-term and long-term debt payment and repayment ability is stronger; Operating in a state of virtuous cycle, there are some uncertain factors affecting the development of future business with, impact on corporate profitability and solvency.
BBB	[60,70)	Enterprise credit level. BBB corporate assets strength, short - and long-term debt payments and repay ability; Operating in a state of

		virtuous cycle, there are some uncertain factors affecting the development of future business with, profitability and solvency produce the resulting large fluctuations.
BB	[50,60)	Enterprise credit level is poorer. BB enterprise assets and financial condition is poor, short - and long-term debt payments and repay ability is poor, the future development prospect is not clear; Easily affected by internal and external uncertainty, enterprise's profit ability and debt paying ability to produce the resulting sharp fluctuations, the risk is bigger.
B	[40,50)	The poor credit degree of the enterprise. B enterprise assets and financial situation is bad, both short-term and long-term debt payments and repay ability is poor, weak profitability and solvency; Business in a difficult economic environment, the risk is bigger.
CCC	[30,40)	Enterprise credit is very poor, CCC level enterprise assets and financial situation is very poor, short - and long-term debt payment and repayment ability is very poor, profitability and debt paying ability is very weak. The enterprise security investment for investors is lesser, the risk is very big.

Chapter 5 Theoretical explanation of the methodology

The method carried out to estimate and predict the credit ratings in this paper is something called the GHK simulator, which proves to be appropriate for this kind of model which assuming the error term to be a random walk process.

In fact, besides the GHK simulator, another method was carried out as well, which is called the EM algorithm. However, the EM algorithm seems to be inappropriate as the model carrying out this algorithm fails to obtain a convergence result even under the simulation process. Although there is an anticipation that the EM algorithm would act well for stationary models, considering the purpose of this studying to find a proper method for the estimation and prediction of credit ratings, the GHK simulator is adopted instead and the result is quite satisfactory.

5.1 EM algorithm

Precedence researches are usually carried out using maximum likelihood. However, with the goal of obtaining more information, models are getting complex, which accompanies with growing count of parameters and sophisticated shape of the log-likelihood function that are at odds with simplicity of estimation.

EM algorithm is a procedure to maximize the likelihood function when standard procedures are too numerically difficult or infeasible.

The procedures consists of defining an expectation and then maximizing it. And it is introduced as a way of handling missing data, which might be useful in credit rating. First of all let us take a look at the difference between the two methods, maximum likelihood and EM algorithm.

Let y be the dependent variables, z be the missing data, θ be the coefficient to be adjusted to reach the maximization while θ_t known as constant in the maximization. Probability of the observations without missing data can be written as

$P(y|z,\theta)$.

Probability in reality is

$P(y|\theta) = \int P(y|z,\theta)f(z|\theta)dz$.

Probability with missing data conditional on the observations is

$h(z|y,\theta) = \frac{P(y|z,\theta)f(z|\theta)}{P(y|\theta)}$.

When estimated by maximum likelihood, we will have

$LL(\theta) = \log P(y|\theta) = \log(\int P(y|z,\theta)f(z|\theta)dz)$.

When estimated by EM algorithm, we will have

$E(\theta|\theta_t) = \int h(z|y,\theta_t)\log(P(y|z,\theta)f(z|\theta))dz$.

If we define an intermediate as

$E^*(\theta|\theta_t) = E(\theta|\theta_t) + (LL(\theta_t) - E(\theta|\theta_t))$

where $E^*(\theta|\theta_t) = LL(\theta)$ for $\theta = \theta_t$.

Now all the preparation for proof has been completed and the proof will be carried out in two steps.

The first step is to prove that the derivatives with respect to θ are the same for E^* and LL for $\theta = \theta_t$ which we can confirm from the two formulas below.

$$\frac{dE^*(\theta|\theta_t)}{d\theta}$$
$$= \frac{dE(\theta|\theta_t)}{d\theta}$$
$$= \int h(z|y,\theta_t)\frac{d\log(P(y|z,\theta)f(z|\theta))}{d\theta}\,dz = \int h(z|y,\theta_t)\frac{1}{P(y|z,\theta)f(z|\theta)}\frac{d(P(y|z,\theta)f(z|\theta))}{d\theta}\,dz.$$

$$\frac{dE^*(\theta|\theta_t)}{d\theta}|\theta_t$$
$$= \int h(z|y,\theta_t)\frac{1}{P(y|z,\theta_t)f(z|\theta_t)}\left(\frac{d\left(P(y|z,\theta)f(z|\theta)\right)}{d\theta}\right)|\,\theta_t dz$$
$$= \int \frac{P(y|z,\theta_t)f(z|\theta_t)}{P(y|\theta_t)}\frac{1}{P(y|z,\theta_t)f(z|\theta_t)}\left(\frac{d\left(P(y|z,\theta)f(z|\theta)\right)}{d\theta}\right)|\,\theta_t dz$$
$$= \int \frac{1}{P(y|\theta_t)}\left(\frac{d\left(P(y|z,\theta)f(z|\theta)\right)}{d\theta}\right)|\,\theta_t dz$$
$$= \frac{1}{P(y|\theta_t)}\left(\frac{d(\int P(y|z,\theta)f(z|\theta)dz)}{d\theta}\right)|\theta t$$
$$= \frac{1}{P(y|\theta_t)}\left(\frac{d\left(P(y|\theta)\right)}{d\theta}\right)|\theta_t$$
$$= \left(\frac{d\left(\log P(y|\theta)\right)}{d\theta}\right)|\theta_t = \left(\frac{d(LL(\theta))}{d\theta}\right)|\theta_t.$$

While at the second step, suppose $E^* \leq LL$ for all θ, then we can have

$$LL(\theta) = \log P(y|\theta) = \log\left(\int P(y|z,\theta) f(z|\theta) dz\right)$$

$$= \log\left(\int \frac{P(y|z,\theta) f(z|\theta)}{h(z|y,\theta_t)} h(z|y,\theta_t) dz\right)$$

$$\geq \int \log \frac{P(y|z,\theta) f(z|\theta)}{h(z|y,\theta_t)} h(z|y,\theta_t) dz$$

$$= \int h(z|y,\theta_t) \log(P(y|z,\theta) f(z|\theta)) dz - \int h(z|y,\theta_t) \log\left(h(z|y,\theta_t)\right) dz$$

$$= E(\theta|\theta_t) - \int h(z|y,\theta_t) \log\left(h(z|y,\theta_t) \frac{P(y|\theta_t)}{P(y|\theta_t)}\right) dz$$

$$= E(\theta|\theta_t) + \int h(z|y,\theta_t) \log P((y|\theta_t)\, dz - \int h(z|y,\theta_t) \log\left(h(z|y,\theta_t) P((y|\theta_t)\right) dz$$

$$= E(\theta|\theta_t) + \log P((y|\theta_t) \int h(z|y,\theta_t) dz - \int h(z|y,\theta_t) \log\left(h(z|y,\theta t) P((y|\theta_t)\right) dz$$

$$= E(\theta|\theta_t) + \log P((y|\theta_t) - \int h(z|y,\theta_t) \log\left(h(z|y,\theta_t) P((y|\theta_t)\right) dz$$

$$= E(\theta|\theta_t) + LL(\theta_t) - \int h(z|y,\theta_t) \log\left(h(z|y,\theta_t) P((y|\theta_t)\right) dz$$

$$= E(\theta|\theta_t) + LL(\theta_t) - \int h(z|y,\theta_t) \log\left(\frac{P(y|z,\theta) f(z|\theta)}{P(y|\theta)} P((y|\theta_t)\right) dz$$

$$= E(\theta|\theta_t) + LL(\theta_t) - \int h(z|y,\theta_t) \log(P(y|z,\theta) f(z|\theta)) dz$$

$$= E(\theta|\theta_t) + LL(\theta_t) - E(\theta_t|\theta_t)$$

$$= E^*(\theta|\theta_t)$$

where the inequality comes from Jensen's inequality.

Each iteration of EM algorithm raises the value of the LL function until it converges at the maximization of the LL function.

When we apply EM algorithm to an ordered probit model with three categories, let y be the observation variable, x be the state variable and y^* be the categorized y, so we can have

$$y^* = \begin{cases} 0 \text{ if } y < a_1 \\ 1 \text{ if } a_1 < y < a_2 \\ 2 \text{ if } y > a_2 \end{cases}$$

where $y = \beta x + e = \mu + e$ with e being an AR(1) process with a correlation coefficient ρ.

Then we can have a transformation

$$z = \begin{cases} y - a_1 \in (-\infty, 0) \text{ if } y < a_1 \\ \frac{y - a_1}{a_2 - a_1} \in (0, 1) \text{ if } a_1 < y < a_2 \\ y - a_2 + 1 \in (1, +\infty) \text{ if } y > a_2 \end{cases}$$

with

$$z \sim \begin{cases} N(\mu - a_1, 1) \text{ if } y < a_1 \\ N\left(\frac{\mu - a_1}{a_2 - a_1}, \frac{1}{(a_2 - a_1)^2}\right) \text{ if } a_1 < y < a_2 \\ N(\mu - a_2 + 1, 1) \text{ if } y > a_2 \end{cases}.$$

After this transformation, we can utilize z instead of y in estimation which would be easier because no unknown parameter is included in the range of the integral anymore.

5.2 The GHK simulator

5.2.1 An example of the GHK simulator in a three-variable probit model

To get a brief knowledge of what the GHK simulator is, it is quick to start with a three-variable probit model.

(1) The three-variable probit model

Let's take three binary variables, y_1, y_2 and y_3, in our example. So the three-variable probit model can be written as

$$y_1 = \begin{cases} 1, \text{if } X_1\beta + \varepsilon_1 > 0 \\ 0, \text{otherwise} \end{cases}$$
$$y_2 = \begin{cases} 1, \text{if } X_2\gamma + \varepsilon_2 > 0 \\ 0, \text{otherwise} \end{cases}$$
$$y_3 = \begin{cases} 1, \text{if } X_3\theta + \varepsilon_3 > 0 \\ 0, \text{otherwise} \end{cases}$$

……..…(1)

with

$$\begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \end{pmatrix} \sim N(0, \sum)$$

……..…(2)

And the variances, expressed as must equal 1 for the sake of identification.

The computation of three-variable normal integrals is required to evaluate the likelihood function.

For instance, the probability of observing ($y_1 = 0,\ y_2 = 0,\ y_3 = 0$) is

$$P(y_1 = 0, y_2 = 0, y_3 = 0) = \int_{-\infty}^{-X_1\beta} \int_{-\infty}^{-X_2\gamma} \int_{-\infty}^{-X_3\theta} \Phi_3(\varepsilon_1, \varepsilon_2, \varepsilon_3, \rho_{12}\rho_{23}\rho_{31}) d\varepsilon_1 d\varepsilon_2 d\varepsilon_3$$

……..…(3)

where $\Phi_3(.)$ is the three-variable normal population density function and ρ_{ij} is the correlation coefficient between ε_i and ε_j.

While statistical software such as R and Stata can be applied to compute univariate and bivariate normal cumulative density functions directly, nothing is available for the

three-variable case (as a matter of fact, numerical approximations perform poorly in computing high order integrals).

Instead, the GHK (Geweke-Hajivassiliou-Keane) simulator can be applied in a smooth recursive way to approximate these integrals in a three-variable model.

(2) The GHK simulator

We illustrate the GHK simulator in the three-variable case first, so it will be very straightforward for a generalization to higher orders.

What we aim to evaluate is

$$P(\varepsilon_1 < b_1, \varepsilon_2 < b_2, \varepsilon_3 < b_3)$$

……..…(4)

where $(\varepsilon_1,\ \varepsilon_2,\ \varepsilon_3)$ are normal random variables whose covariance structure is given in Equation (2).

Equation (4) can be expressed in a way of conditional probabilities

$$P(\varepsilon_1 < b_1)P(\varepsilon_2 < b_2|\varepsilon_1 < b_1)P(\varepsilon_3 < b_3|\varepsilon_1 < b_1, \varepsilon_2 < b_2)$$

……..…(5)

Suppose L be the lower triangular Cholesky decomposition of $\sum$, such that

$$LL' = \sum,$$

thus we have

$$L = \begin{pmatrix} l_{11} & 0 & 0 \\ l_{21} & l_{22} & 0 \\ l_{31} & l_{32} & l_{33} \end{pmatrix}.$$

And we can obtain

$$\begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \end{pmatrix} = \begin{pmatrix} l_{11} & 0 & 0 \\ l_{21} & l_{22} & 0 \\ l_{31} & l_{32} & l_{33} \end{pmatrix} \begin{pmatrix} v_1 \\ v_2 \\ v_3 \end{pmatrix}$$

……(6)

where v_{i} are independent standard normal random variables.

By Equation (6), we can get

$$\begin{cases} \varepsilon_{1=} l_{11} v_1 \\ \varepsilon_2 = l_{21} v_1 + l_{22} v_2 \\ \varepsilon_3 = l_{31} v_1 + l_{32} v_2 + l_{33} v_3 \end{cases}.$$

Therefore we have

$$P(\varepsilon_1 < b_1) = P\left(v_1 < \frac{b_1}{l_{11}}\right)$$

……(7)

and

$$P(\varepsilon_2 < b_2 | \varepsilon_1 < b_1) = P\left(v_2 < \frac{b_2 - l_{21} v_1}{l_{22}} \middle| v_1 < \frac{b_1}{l_{11}}\right)$$

……(8)

and

$$P(\varepsilon_3 < b_3 | \varepsilon_1 < b_1, \varepsilon_2 < b_2)$$

$$= P\left(v_3 < \frac{b_3 - l_{31} v_1 - l_{32} v_2}{l_{33}} \middle| v_1 < \frac{b_1}{l_{11}}, v_2 < \frac{b_2 - l_{21} v_1}{l_{22}}\right)$$

……..…(9)

Because v_{i} are independent random variables, we can rewrite Equation (4) as a product of univariate cumulative density function conditional on the unobservable v.

Suppose that a random variable v_1^* is drawn from a truncated standard normal density whose upper truncated limit is $\frac{b_1}{l_{11}}$, and another one v_2^* is drawn from a standard normal density whose upper truncated limit is $\frac{b_2 - l_{21}v_1^*}{l_{22}}$, and we insert these two random variables into Equation (8) and Equation (9).

Basing on this, Equation (5) can be rewritten as

$$P\left(v_1 < \frac{b_1}{l_{11}}\right) P\left(v_2 < \frac{b_2 - l_{21}v_1^*}{l_{22}}\right) P\left(v_3 < \frac{b_3 - l_{31}v_1^* - l_{32}v_2^*}{l_{33}}\right)$$

……...(10)

Through a calculation of the arithmetic mean of Equation (10) for D random draws of v_1^* and v_2^*, we can derive the GHK simulator of Equation (4), which can be written as

$$\widetilde{P_{GHK}} = \frac{1}{D}\sum_{d=1}^{D}\left(\Phi\left(\frac{b_1}{l_{11}}\right)\Phi\left(\frac{b_2 - l_{21}v_1^{*d}}{l_{22}}\right)\Phi\left(\frac{b_3 - l_{31}v_1^{*d} - l_{32}v_2^{*d}}{l_{33}}\right)\right)$$

……...(11)

where v_1^{*d} and v_2^{*d} are the d-th draw of v_1^* and v_2^*, and $\Phi(.)$ is the univariate normal cumulative density function.

Equation (11), the simulated probability, can then be used in the maximum likelihood function for further estimation.

5.2.2 A general explanation of the GHK simulator

After the brief example in 5.2.1, it will be somehow easier to absorb a general explanation of the GHK simulator.

(1) The GHK draws from a truncated multivariate normal distribution

Suppose want to draw from

$$\begin{pmatrix} x_1 \\ \vdots \\ x_n \end{pmatrix} \sim TN\left(\vec{\mu}, \sum; \vec{a}, \vec{b}\right) \equiv N(\vec{\mu}, \sum)\ s.t.\ \vec{a} < \vec{x} < \vec{b}$$

……(12)

where the problem is that $\sum$ is not sure to be diagonal, what is to say that elements of $\vec{x}$ may be correlated.

Denote $\vec{u}$ an n-dimension vector of independent multivariate standard normal random variables and suppose $\sum^{1/2}$ the lower-triangular Cholesky factorization of $\sum$ which can be expressed as

$$\begin{pmatrix} s_{11} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ s_{n1} & \cdots & s_{nn} \end{pmatrix}.$$

Basing on this, Equation (12) then can be rewritten as

$\vec{x} = \vec{\mu} + \sum^{1/2}\vec{u} \sim N(\vec{\mu}, \sum)\ s.t.$

$$\begin{pmatrix} \frac{a_1 - \mu_1}{s_{11}} \\ \vdots \\ \frac{a_n - \mu_n - \sum_{i-1}^{n-1} s_{ni} u_{\mathrm{i}}}{s_{nn}} \end{pmatrix} < \begin{pmatrix} u_1 \\ \vdots \\ u_{\mathrm{n}} \end{pmatrix} < \begin{pmatrix} \frac{b_1 - \mu_1}{s_{11}} \\ \vdots \\ \frac{b_n - \mu_n - \sum_{i-1}^{n-1} s_{ni} u_{\mathrm{i}}}{s_{nn}} \end{pmatrix}$$

……(13)

What above suggests that to draw from a truncated multivariate normal distribution, say $\vec{u}$, we should do it recursively.

That is to say, we first draw u_1^s from N (0,1; $\frac{a_1 - \mu_1}{s_{11}}$, $\frac{b_1 - \mu_1}{s_{11}}$), then u_2^s from N (0,1; $\frac{a_2 - \mu_2 - s_{21}\mu_1^s}{s_{22}}$, $\frac{b_2 - \mu_2 - s_{21}\mu_1^s}{s_{22}}$), …, and finally u_n^s from N (0,1; $\frac{a_n - \mu_n - s_{n(n-1)}\mu_{n-1}^s}{s_{nn}}$, $\frac{b_n - \mu_n - s_{n(n-1)}\mu_{n-1}^s}{s_{nn}}$).

With $\vec{u}^s$ being drawn in the above recursive way, we can simply obtain the desired $\vec{x}^s$ by transforming

$\vec{x}^s = \vec{\mu} + \sum^{1/2}\vec{u}^s$.

There is something to be noted.

First of all, we need to know that to draw an n-dimensional vector $\vec{u}$ of independent truncated standard normal random variables with rectangular truncation conditions, say $\vec{c} < \vec{u} < \vec{d}$, is quite easy actually .

The only thing we need to do is to draw a vector of independent uniform variables

$\vec{u} \sim U[\Phi(\vec{c}), \Phi(\vec{d})]$

and then do the transformation like

$u_i = \Phi^{-1}(\tilde{u}_i)$.

The second point is about what is called importance sampling as follows.

$$\int_F sf(s)ds = \int_G S\frac{f(s)}{g(s)}g(s)ds$$

What above tells us that sampling s from $f(s)$ distribution equals to sampling $s * w(s)$ from $g(s)$ distribution, where $(s) \equiv \frac{f(s)}{g(s)}$ is the weight of importance sampling.

And the GHK simulator is actually a method of importance sampling as well, and the density of importance sampling equals to the multivariate normal density N ($\vec{\mu}$, $\sum$) being truncated to the range as shown in Equation (13).

The characteristic of being recursive can be shown from the truncation range, say for example, x_3 depending on the x_1 and x_2, which is different from the multivariate normal density N ($\vec{\mu}$, $\sum$) truncated to a range of $\vec{a} \leq \vec{x} \leq \vec{b}$.

And the importance sampling weight given to each draw $\vec{x}^s$ can be expressed as

$w(\vec{x}^s)$

$$\equiv \left(\Phi\left(\frac{b_1 - \mu_1}{s_{11}}\right) - \Phi\left(\frac{a_1 - \mu_1}{s_{11}}\right)\right)$$

$$\prod_{i=2}^{m}\left(\Phi\left(\frac{b_i - \mu_i - \sum_{j-1}^{i-1} s_{ij}u_j^s}{s_{ii}}\right) - \Phi\left(\frac{a_i - \mu_i - \sum_{j-1}^{i-1} s_{ij}u_j^s}{s_{ii}}\right)\right)$$

Therefore, for an integral such as

$$\int_{\vec{a} \le \vec{x} \le \vec{b}} \vec{x} f(\vec{x}) d\vec{x}$$

where $f(\vec{x})$ is the density of N ($\vec{\mu}$, $\sum$), can be approximated via the GHK simulator as below

$$\frac{1}{S}\sum_{s=1}^{S} \vec{x}^s w(x^s)$$

The last remark is about the weight of importance sampling w^s.

We need to know that even it is an unbiased estimator of the truncation probability, say $P(\vec{a} < \vec{x} < \vec{b})$, we can always get a more precise estimate by averaging over w^s in the way below

$$T_{\vec{a},\vec{b}} \equiv P(\vec{a} < \vec{x} < \vec{b}) \approx \frac{1}{S}\sum_{s} w^s$$

for say S simulation draws.

(2) Monte Carlo Integration by the GHK simulator

As long as we can get draws from truncated multivariate distributions by the GHK simulator, it will not be a problem to apply these draws to calculate integrals of functions of $\vec{x}$.

However there are two important cases here that we must bear in heart.

The first one is about integrating over the untruncated distribution $F(\vec{x})$ with a range of $\vec{a} < \vec{x} < \vec{b}$.

Suppose that we are to calculate

$$\int_{\vec{a}<\vec{x}<\vec{b}} g(\vec{x})f(\vec{x})d\vec{x}$$

with $f(\vec{x})$ denoting the density of N ($\vec{\mu}$, $\sum$), the GHK draws can be applied to derive a Monte-Carlo estimate like

$$E_{\vec{a}<\vec{x}<\vec{b}}g(\vec{x}) \approx \frac{1}{S}\sum\nolimits_s g(\vec{x}^s)w^s$$

For a multinomial probit model with k choices such as

$kU_k = X\beta_k + \varepsilon_k$

The probability that choice k will be picked up equals to the probability that

$v_i \equiv \varepsilon_i - \varepsilon_k < X\beta_i - X\beta_k$, for all $i \neq k$.

For each parameter vector β, we can draw S (K-1)-dimension vectors $\vec{v}^s$ subject to $\vec{v} < \overrightarrow{x\beta}$. So the likelihood function will be

$$P(k) = \int_{\vec{v}} 1(\vec{v} < \vec{x}\beta)f(\vec{v})d\vec{v} = \int_{\vec{v}<\vec{x}\beta} f(\vec{v})d\vec{v} \approx \frac{1}{S}\sum\nolimits_s w^s$$

The other case is integrating over a truncated conditional distribution say

$F(\vec{x}|\vec{a} < \vec{x} < \vec{b})$.

Suppose that we are going to calculate

$$E_{\vec{a}<\vec{x}<\vec{b}}g(\vec{x}) = \int_{\vec{a}<\vec{x}<\vec{b}} g(\vec{x})f(\vec{x}|\vec{a} < \vec{x} < \vec{b})d\vec{x} = \frac{\int_{\vec{a}<\vec{x}<\vec{b}} g(\vec{x})f(\vec{x})d\vec{x}}{P(\vec{a} < \vec{x} < \vec{b})}$$

So we can apply the GHK draws to derive a Monte-Carlo estimate as is done in the last case

$$E_{\vec{a}<\vec{x}<\vec{b}} g(\vec{x}) \approx \frac{1}{T_{\vec{a},\vec{b}}} \frac{1}{S} \sum_s g(\vec{x}^s) w^s$$

Chapter 6 Empirical analysis of the methodology

6.1 Data

(1) Data of the corporate credit ratings

The data of credit ratings are from R&I, which includes 162 public companies' data (excluding financial corporations such as banks, securities, insurance companies and NPOs) from 2005 to 2008.

The original data of credit rating from R&I is divided into 21 categories with AAA being the highest rank and D the lowest one. Taking into consideration that the quantity of companies fall into each category varies a lot, it is better to reclassify the categories to cater to the model.

And the reclassification is as follows. As is shown in Table 6.1, the reclassification of the categories combines some original categories into a new one resulting in a new classification of 8 categories, with AAA and AA+ being the highest rank, following by AA as the second rank, AA- ranking third, A+ fourth, A fifth, A- sixth, BBB seventh and those equaling or less than BBB the lowest rank.

Table 6.1 Reclassification of the credit categories of the 162 companies

Category	Number of observations	Reclassification	Number of observations after reclassification	Original classification
		y^*		y
AAA	55	1	294	0
AA+	239	1		1
AA	297	2	297	2
AA-	378	3	378	3
A+	389	4	389	4
A	764	5	764	5
A-	829	6	829	6
BBB+	603	7	603	7
BBB	602	8	1228	8
BBB-	344	8		9
BB+	132	8		10
BB	50	8		11
BB-	46	8		12
B+	22	8		13
B	11	8		14
B-	2	8		15
CCC+	5	8		16

CCC	4	8		17
CC	5	8		18
C	1	8		19
D	4	8		20
SUM	4782		4782	

(2) Data of the financial indicators

With reference to precedent research and experience from both domestic and abroad, four most basic and most vital financial indicators are finally adopted, which are $\log(asset)$, ROA (return on asset), a special gearing ratio (with long-term debt with interest only taken into consideration so it will be like LT $\mathrm{debt}/asset$) and finally the well-known net asset ratio ($\mathrm{equity}/asset$).

The resource of the data used to calculate the financial indicators are from eol database by Pronexus Inc., which provides free access rights for colleges and universities in Japan through its online database.

However due to the limits of free access, only a small part data from corporates' financial statements are available. So via application of a temporary trial usage of the full online database, the author obtained the necessary data to calculate the four adopted financial indicators.

And Table 6.2 shows the statistical values of the four adopted financial indicators from 2005 to 2007 respectively.

Table 6.2 Statistical values of the 4 financial indicators from 2005 to 2007

2005							
Definition	Variable	Mean	Variance	Maximum	Minimum	Skewness	Kurtosis
$\log(asset)$	x1	12.9743	1.84803	16.41332	9.89873	0.06603	2.38272
ROA	xr1	1.48358	129.176	13.29	-137.09	-2.1129	138.181
LT debt$/asset$	xda1	0.25747	0.0376	0.737798	0	0.49987	2.41903
equity$/asset$	xea1	0.45553	0.03992	0.945227	0.07702	0.29504	2.30577
2006							
$\log(asset)$	x2	13.033	1.80914	16.38288	10.0246	0.06066	2.40775
ROA	xr2	1.88661	134.548	12.45	-137.09	-10.791	129.038
LT debt$/asset$	xda2	0.23433	0.03474	0.728949	0	0.66099	2.71155
equity$/asset$	xea2	0.4718	0.03824	0.911912	0.09769	0.20228	2.0653
2007							
$\log(asset)$	x3	13.0881	1.7996	16.3746	10.0129	0.03652	2.38441
ROA	xr3	2.8934	21.5346	17.33	-26.24	-11.299	15.5368
LT debt$/asset$	xda3	0.23157	0.03402	0.728949	0	0.55434	2.53395
equity$/asset$	xea3	0.46786	0.03583	0.904942	0.10262	0.29905	2.13865

Table 6.3 Correlation among the 4 financial indicators from 2005 to 2007

2005		$\log(asset)$	ROA	LT debt/$asset$	equity/$asset$
		x1	xr1	xda1	xea1
$\log(asset)$	x1	1			
ROA	xr1	0.005567596	1		
LT debt/$asset$	xda1	0.005567596	-0.0245	1	
equity/$asset$	xea1	-0.3789822	-0.0565	-0.7585377	1
2006		$\log(asset)$	ROA	LT debt/$asset$	equity/$asset$
		x2	xr2	xda2	xea2
$\log(asset)$	x2	1			
ROA	xr2	-0.01591384	1		
LT debt/$asset$	xda2	0.2861109	-0.041	1	
equity/$asset$	xea2	-0.3824831	-0.0198	-0.7424881	1
2007		$\log(asset)$	ROA	LT debt/$asset$	equity/$asset$
		x3	xr3	xda3	xea3
$\log(asset)$	x3	1			
ROA	xr3	-0.08671436	1		
LT debt/$asset$	xda3	0.2890509	-0.3592	1	
equity/$asset$	xea3	-0.3870864	0.403933	-0.7290191	1

6.2 Estimation and prediction by GHK simulator

There are several basic assumptions in the estimation and prediction process.

(1) The error term is assumed to be a random walk process.

(2) The coefficients of the 4 financial indicators are assumed to be fixed from 2005 to 2008.

Let y be the original corporate credit rating values from R&I database, y^* be the reclassified one, so there is a relationship between y and y^* as follows.

$$y^* = \begin{cases} 1 \text{ if } y \leq a_1 \\ 2 \text{ if } a_1 \leq y < a_2 \\ 3 \text{ if } a_2 \leq y < a_3 \\ \quad \ldots \\ 8 \text{ if } y > a_7 \end{cases}$$

And let

$y = b_1 + b_2 * x + b_3 * xda + b_4 * xea + b_5 * xr$

The estimation is carried out by applying the GHK methodology to a truncated distribution basing on the model above, and the likelihood function finally converging to 459.7237, as the optimized result.

The estimated coefficients are shown in Table 6.4 as follows.

Table 6.4 Estimated coefficients

b_1	b_2	b_3	b_4	b_5
-16.9241	1.009781	0.754833	3.544284	0.041946

As we can see from Table 6.4 that all estimated coefficients for our four financial indicators have a plus sign, which exactly caters to our assumption of the truncated model that the bigger the coefficients are, the bigger the predicted result will be so there will be a higher probability that the object will fall into a higher credit level.

And then we apply the estimation result to the next step, prediction of corporate credit ratings of the target 162 companies in 2008.

As shown in Table 6.5, compared to the 162 observations of year 2005, the number of predictions that equals the observation is 141, which reaches a high soundness of 87.04%.

Taking another look at Table 6.4, which gives more details about the correctness of the prediction. Table 6.4 compares the prediction with the observation in each category. As we can see from Table 3, there seems to be no relationship between the correctness of prediction and the rank of the category. Both correctness of prediction for Category 1 and Category 6 are 100%, being the top; those for Category 2 and Category 8 are 92.3% and 91.7% respectively, being the second level; next are Category 3's 85% and Category 5's 86.7% as the third level; finally come 77.8% for Category 4 and 56.3% for Category 7, being the poorest level.

Table 6.5 Comparison of the estimation result with the observations in 2008

Categories	Number of observations	Number of prediction equal to observation	Equal or not
1	18	18	1
2	13	12	0.923076923
3	20	17	0.85
4	18	14	0.777777778
5	30	26	0.866666667
6	23	23	1
7	16	9	0.5625
8	24	22	0.916666667

Chapter 7 Comparison by an example SME in China

In Chapter 4, the author introduced the characteristics of SMEs and the actual situation in China and a common method to build up the index system for SMEs in China. On the basis of this, in order to further illustrate the application of the corporate credit rating system for SMEs in China, verifying the effectiveness and practicability of this system, this chapter will cite a specific instance of SMEs in China, using both the widely-used method in China and our GHK simulator.

7.1 The basic situation of the example SME in China

Jiangsu province YongXing electric power equipment co., LTD., located in Zhenjiang, Jiangsu province, is a processing and manufacturing SME. The company was established in 1983, mainly engaged in the valve, bridge device design and production, the main processing and manufacturing all kinds of high, medium pressure instrument valves, valve group, all kinds of tower, tower, various specifications of the ark, bus duct of 22 classes, more than 2500 kinds of specifications products, can also according to the special requirements of customers design and production of various types of valves, bridge. Products are widely used in real estate, petroleum, chemical, thermal power, steel, non-ferrous metal, paper and industrial automation instrument control and other industries, companies also repeatedly won the "high-tech enterprise", "national excellent quality management enterprise", "Chinese famous brand product", "Jiangsu

province contracts and keep promise enterprise" and other honorary titles.

The company has always pursued "unity, progressive, pragmatic, innovative" spirit of enterprise, Bing follow "the user first, quality first, comprehensive services," the purpose, to strengthen internal management, is 09001: 2000 quality system throughout the whole process of product manufacturing, sales and service, initially set up the brand image of the product. In order to provide a better service to the user, has in Shanghai Pudong and Puxi, Nanning, Guangxi set up offices in Guangzhou to set up a branch, to ensure that each user to provide fast, convenient, high-quality, full range of pre-sale, sale, after-sales service.

The company has a total of 698 employees, technical staff of 179 people; Corporation total 438 employees, including technical staff of 126; Guangzhou branch company has a staff of 126 people, including technical staff of 25 people; Wuhan Branch 113 people, including technical personnel 23 people; Shanghai sales company has 21 people, including technical personnel 5.

The company covers an area of 51,360 square meters, construction area of 30,800 square meters. Guangzhou branch covers an area of 8,000 square meters, construction area of 6,000 square meters. Wuhan branch covers an area of 8,600 square meters, construction area of 5,800 square meters; Shanghai sales company has 630 square meters of office space.

Table 7.1 Basic information of Jiangsu YongXing

Company name	Jiangsu Province YongXing Electric Power Equipment Co., LTD
Enterprise property	Stockholding system
Registration time	October 1983
Registered capital	CNY 15,000,000
Registered address	Jiangsu province, Yangzhong city
Main business scope	Series aluminum alloy, steel, glass reinforced plastics, organic flame retardant cable tray; Bus duct, switchgear, power distribution boxes, sliding contact line; High, medium voltage power station valve, instrument valve, the valve group; Instrument pipe, pipe fittings, pressure vessels.

7.1.1 Qualitative information of the cited company

(1) Industrial policy

Of the development of the development of the development of electrical equipment industry with the development of the national economy and the people's living standards improve, national infrastructure construction, electrical equipment, electrical equipment manufacturing depends to some extent, the amount in the installed power generating capacity, the state investment in infrastructure and people's student activities to improve the electrical energy demand. Electrical equipment industry is a national key support industry in recent years, the electrical equipment industry market to grow faster than the industry growth.

(2) Macroeconomic policy

"Fifteen" during the construction of urban and rural power grid renovation continues, the country is going to invest 320 billion of the power grid; and the "western development" "west east" for the electrical equipment industry to create tremendous business opportunities. Is expected to "1025" period, the State Grid Corporation 800kV UHV DC investment of about 208 billion yuan, and 660kV (+ 400kV) DC project investment of about 70 billion yuan. South Network "1025" during the DC project investment 38 billion 700 million yuan. DC line in Xinjiang may be involved in the building, more than expected. The "Twelfth Five Year" period, the national policy to vigorously support the development of the west, the northwest power grid is expected

to achieve rapid development.

(3) Industry development stability

Combined with power equipment enterprise management status analysis, it is concluded that judgment on the future development trend of the power equipment industry: first, competition will gradually produce, cost, unit structure, regional distribution and other factors will constitute the company a competitive advantage. Two, capital spending will decline, the scale of growth slowing, slowing revenue growth; three, cash flow situation will be better, will enhance the ability of profit sharing. Generally speaking, under the influence of the above three aspects, the long-term stability of the power equipment industry profitability will be enhanced.

(1) Industry competition

In the next few years, with the rapid development of industry, electrical equipment in the industry's enterprises will face more intense competition in the market. In the market competition of enterprises will be rapid growth, and the lack of core competitiveness of enterprises will be mergers, restructuring, and face the survival crisis. Domestic small and medium-sized enterprises not only face the fierce competition between domestic enterprises, as China became a member of WTO, foreign companies can join the fight for market of business. International large electrical company has successively in China, such as Schneider, ABB, Siemens, Fuji, etc.

(5) Enterprise production scale

It is understood that since this year, the company to "actively forge ahead, the key breakthrough, full speed" for the general requirements, in accordance with the "around a center, seize the opportunity to achieve four optimization, promote the development of the three," the general idea, actively respond to challenges and try my best to grasp the market, growth, and promoting development. Jiangsu province YongXing electricity in addition to the head office two production bases, also has a Guangzhou, Wuhan, two production base, annual production bridge capacity can reach 12000 tons.

(6) Product market share

In the first half of the group to complete the bridge output of 15000 tons, up 19.77%; complete instrument tube valve parts production up to 50000 sets, year-on-year growth of 10.8%; Complete the bus duct, high and low voltage switchgear production growth of 5.4% and 5.4% respectively over the same period. The group's two big bridge, instrument valve leading products sales indexes and the best level in history, in the same power equipment enterprise occupies the absolute advantage.

(7) Management’s quality

The company's main business consisted of nine people who were university degree or above. Have rich professional knowledge and experience in business management, and has a lot of business experience. The information about the management’s experience, performance and personal credit situation is shown in Table 7.2.

Table 7.2 Information of the management's major members

Name	Education background	Age	Position
XXX	EMBA	39	Chairman of the board
Resume	Party member of CPC, economist. Nearly three years as yet untouched by the administrative punishment and punishment and other relevant departments.		
XXX	Bachelor Degree	45	General manager
Resume	Nearly three years as yet untouched by the administrative punishment and punishment and other relevant departments.		

(8) Stakeholders credit evaluation

At present, the company has established long-term good cooperation relations with financial institutions, to establish good corporate reputation and image, the company has been in the process of financing in this service on time, in 2010 the company balance sheet shows the company from financial institutions in the first half of the actual financing of the company's total assets accounted for only 13.60, that the company use of financial leverage for project investment sources of money and space. And have a long-term partnership between the partners, there is no malicious arrears for a long time. At the same time the company also does not exist for shareholders or shareholders holding subsidiaries or affiliated companies and other related party transaction of holding less than 50% of the company or other entity without legal personality, personal guarantee, in the first half of 2010 the company without any form of guaranty, nor took place during the previous but continue to guaranty matters during the reporting period.

(9) Internal control and corporate governance

Companies in the setting of departments, whether department organization form, system Settings are complete; Starting from the company's own needs at the same time, combining with the relevant legal system, national standard, the strict regulations, and organize the company various departments to carry out the implementation; To establish and improve the company's internal supervision mechanism, the company also organize regular inspection, implement a punishment system on those department

or personal who fail to execute related regulations. The management of the company has passed the ISO9001-2000 quality management system certification.

7.1.2 Quantitative information of the cited company

Table 7.3 gives the quantitative information of the cited company.

Table 7.3 Quantitative information of the cited company

No.	Index name	
1	Quick ratio	0.367
2	Interest earned	0.067
3	Inventory turnover	17.663
4	Accounts receivable turnover	2.918
5	Fixed assets turnover	0.119
6	Total assets turnover	0.045
7	Net profit rate	20.844
8	Return on net assets	2.349
9	Sales of new product to income ratio	0.054
10	Growth of sales	8.059
11	Growth of net profit	0.821
12	Growth of total assets	0.232

Note: data is from the financial statements of the cited company in 2010.

7.2 Credit rating of the cited company by the method in China

(1) Data

11 companies are picked up from a 92-company sample considering their scale and some other characteristics similar to our cited company.

And the basic information of the 11 companies combined with that of the cited company is listed in Table 7.4

Table 7.4 Basic information of the 11 companies and the cited company

No.	Stock code	Total assets (CNY, in ten thousand)	Sales (CNY, in ten thousand)	Number of employee	Scale
1	002074	79,417.81	8,744.17	1080	MS
2	002205	88,431.79	22,054.31	272	S
3	002057	37,520.39	8,596.24	698	MS
4	002218	97,788.35	7,801.82	825	MS
5	002176	53,043.15	7,968.56	1191	MS
6	Cited company	87,233.98	3,533.22	922	MS
7	002322	86,518.30	4,466.66	246	S
8	002323	88,988.25	6,067.50	195	S
9	002339	82,447.20	3,619.11	615	MS
10	002346	88,005.25	4,097.87	531	MS
11	002359	82,383.44	7,882.45	548	MS
12	002389	78,094.78	12,181.83	265	S

(2) Standardizing the 12 companies' financial data

Because of the unit or difference in the magnitude (i.e. different measurement index of magnitude) there may exist incommensurability, evaluation index makes the comprehensive comparison of the selection of the size of a lot of inconvenience. So, in this paper as far as possible in order to reflect the actual situation, excluding as indicators of the units or different due to the difference between numerical magnitude and cause deviation of the rating results, because as possible to avoid the probability of occurrence of unreasonable phenomenon, indicators increase the commensurability, this paper after obtaining the relevant data of index system in the were dimensionless treatment. The so-called dimensionless, i.e. data standardization, standardization, it is by using method of mathematical transform to avoid or eliminate related primitive indexes due to the presence of different units and orders of magnitude and the dimensionless we can increase the comparability between the index data.

Suppose the index set is (x_1, x_2, …, x_m), then the normalization will be

$$x_{ij}^{*} = \frac{x_{ij} - \bar{x}_j}{S_j}$$

where $\bar{x}_j$ and S_j (j = 1, 2, …, m) being the sample mean and sample variance of the observation respectively.

Obviously the sample mean and sample variance will be 0 and 1, known as the standard measurements, respectively.

(3) Calculating symmetric matrix, characteristic values and characteristic vectors

After get the dimensionless matrix A, we can calculate H according to the following formula

$H = A^T \cdot A$

On the basis of the symmetric matrix H, we can get the largest eigenvalue and the corresponding eigenvectors, w, of matrix H.

(4) Determining judgment matrix R

By comparing to the standards of the indicators, matrix R can be calculated for the cited company.

(5) The quantitative index score

By formula

$B = W \cdot R$

we can get quantitative index score of the cited company.

(6) The qualitative index score

Table 7.5 gives the qualitative information of the cited company.

Table 7.5 Qualitative information of the cited company

Ranking criteria	AAA	AA	A	BBB	BB	B	CCC
Industrial policy	3	12	4	0	1	0	0
Macroeconomic policy	0	0	2	6	8	8	1
Stability of industry development	1	2	9	0	1	7	0
Degree of competition	0	1	13	2	3	1	0
Enterprise production scale	1	1	5	6	7	0	0
Product market share	0	0	0	11	5	4	0
Managements' experience	5	1	0	0	7	6	1
Managements' performance	3	7	0	0	3	5	2
Managements' credit status	0	15	4	0	1	0	0
Credit status of business partners	2	8	7	3	0	0	0
Bank loan records	10	6	2	0	2	0	0
Internal control system	17	1	1	1	0	0	0
Enterprise operation system	15	3	2	0	0	0	0

(7) Results and analysis

After we get both the qualitative and quantitative rating score, the comprehensive rating score can be calculated by simply adding them together, and for the cited company, the result is 67.1332.

Referring to Table 4.2 in Chapter 4, the credit rating for the cited company will be BBB. Credit is generally measuring the length of period of debt repayment and the ability to pay, with appropriate protection of principal and interest; business in the virtuous cycle, there are uncertain factors have an impact on the profitability and solvency, the agreed conditions may not enough to protect the safety of principal and interest.

Jiangsu YongXing electric basic quality is good, but short-term debt and long-term debt paying ability is low, the quick ratio is only 0.41, financial statements show the quarter monetary fund of the enterprise, the trading financial assets and accounts receivable amount relative to the same period last year in terms of decreased less, while the current debt levels compared to last year, but increased. The interaction of these two factors make the enterprise quick ratio remained at a low level. But because the solvency for credit rating index system in the proportion is not large, cannot make the company's credit rating changes.

Jiangsu YongXing electric power operating capability indexes during the process of the analysis, we obtained results show that the company's assets operation ability is strong. The receivable turnover rate is 3.734, the turnover rate shows that the company's accounts receivable speed rapidly, aging is short, which can reduce the accounts receivable costs and bad debt losses so the relative increase of current assets investment

income; and from another side improve enterprise short-term solvency. But the company's fixed assets turnover situation is not too optimistic, so as to reduce the turnover rate of total assets. But because of the particularity of business projects, the fixed asset investment cost is huge, so the depreciation period longer, resulting in the turnover rate of fixed assets is relatively low, which is a common phenomenon in the industry. With the index system of operating capacity assignment is smaller, so the index of enterprise credit rating are less affected, which confirmed the scientific index system set up from the side.

The company's profit ability is stronger, the performance in the business on the net interest rate and asset returns, the value of 3.19 and 3.254 respectively. It has a certain degree of growth and income, the influence of the two aspects that the company's earnings over the same period last year has been greatly improved. The rating index weights, the profitability of the business accounted for a larger proportion, which laid the foundation of good corporate credit.

At the same time, the company's new product sales ratio of only 0.193, the technology innovation ability is poor, the problem is almost a common problem facing all the companies in the industry. The particularity of the industry itself is concerned, or more because of its R & D capital investment is not enough. In the credit rating index system of the design of small and medium-sized enterprises, technological innovation capability index accounted for a large weight, the low score would lower the total enterprise credit score.

The company's ability to grow stronger, showed that the accumulation of base is firmer,

sustainable development ability, the development potential is large, the business continued good growth momentum, market expansion ability. The conclusion of the company's external report display content is the same, from the side confirmed the authenticity of the report.

In accordance with the rating of the design of index system and the establishment of the model, the name of the company's credit grades and BBB, and Jiangsu province YongXing electric power is rated as A grade credit enterprise ", in this paper, the ratings by contrast, A low level. The analysis thinks, rating level low a level for the following reasons: first, the company's technology innovation ability score is low. Reality, bank for small and medium-sized enterprise credit rating was not bound to technology innovation index on the index system of rating category, but this article rating index to highlight its comprehensive, scientific nature, its list of index system, and gives the relatively large weight, this part makes YongXing, Jiangsu electric power company's credit rating lower relative bank credit rating is given; Second, the end of May 2010, the company is to undergo division, the cause of the company's cash flow to a certain extent dispersed, and make the most of the financial index value is not ideal. Rating system designed in this paper, based on financial data bits of the quantitative indicators of weight is 63%, occupies the bigger weights of index system. The reference of the rating standard is relatively high, causes the enterprise operation ability and profitability score is not high, directly down the rating value of the enterprise.

The credit rating system designed in this paper a more comprehensive science and specific, first of all, when it establishes an index system of credit rating increased some

predecessors did not consider the qualitative indexes, the qualitative index covers more influence in the key information of small and medium-sized enterprise credit rating, so that small and medium-sized enterprise credit rating index proposed in this paper can reflect the actual credit status of small and medium-sized enterprises. Secondly, this paper adopted a more scientific method to establish the rating model, during the credit rating evaluation for small and medium-sized enterprises, not just only rating object is given a credit rating results, but step by step in the process of credit rating to reveal what are the factors influencing enterprise credit rating, including the favorable factors and unfavorable factors, makes the external investors not only see a single rating as a result, it can be more clearly understand the whole management of enterprises. For enterprise managers, through to the enterprise credit rating, can be more clear understanding of the enterprise in a competitive advantage and disadvantage, could be used in operation and management, promoting the development of enterprises.

7.3 Credit rating of the cited company by GHK simulator

Next step the author plans to carry out is to apply the GHK methodology to the cited company so as to predict its credit rating.

Although the data of the necessary four financial indicators have already been available for the moment, the problem is that considering the different situation in China as well as the difference in currency, measurement and accounting standards of company, a

further research is proposed by the author to obtain a much more accurate result of prediction.

Thus, this part is left temporarily for further studying.

Chapter 8 Suggestions on corporate credit rating system for SMEs

8.1 Suggestions for government

In order to regulate the behavior of SME credit rating, to prevent corporate credit risk, safeguard the legitimate rights and interests of SMEs according to law, to promote the healthy development of economy and society, government departments should be organized to promote the credit evaluation of SMEs in all aspects , improve SME credit awareness, promote economic development of SMEs.

First is to establish the consciousness of corporate credit rating systems for SMEs.

(1) To strengthen the credit rating standards and the construction of the system, SMEs should be gradually incorporated into the institutional, legal and scientific track. The credit rating agency which carrying out the credit rating, should enforce the provisions of the relevant departments strictly; implement the "the people's Bank of China credit rating management views" to the SMEs which involve credit markets and borrowing enterprise's credit rating in order to regulate credit rating of the main credit rating business and management. The practice of credit rating agencies, internal rating system and carry out the business principles and procedures, information release and management mode and content should be strictly in accordance with strict regulations.

By credit rating norms established by current standards, regulating the rating agencies and rating personnel occupation ethics effectively, improve the quality of credit rating agencies. Government departments to guide the establishment of SME credit rating system of scientific and standardized management system, a clear access conditions for credit rating agencies, registration management system, the main rating, the rating objects and methods, content and grade rating, the rating process, rating information rating costs, information disclosure, the use of rating report, rating the supervision and management and other related content. Establish and improve various kind of credit services market entry and exit mechanism, guarantee the impartiality and authenticity of credit products, and promote the credit services develop healthy.

(2) To enhance the credit consciousness of government functional departments, which should take network, television, newspapers and other media as the carrier, and promote the SMEs credit rating for the main content of the credit system construction work vigorously, combined with the SME credit rating evaluation of the pilot work, opening column in a newspaper and website. To introduce the advanced experience and credit rating, carry out credit rating activities in SMEs, promote integrity and the integrity of corporate intermediaries to the society, and carry out the credit exposure activities, disclosure and exposure the credibility of enterprises and credit rating agencies. Through the two aspects of positive and negative publicity, creating a good credit environment and the development environment for SMEs. So guide the SMEs to enhance credit awareness.

Second is to standardize the process of corporate credit rating system for SMEs.

(1) Regulating small enterprises credit rating market.

Small and medium sized enterprises credit rating is the actual operation of the construction of social credit system, government departments change to service functions, which is an important guarantee to improve the credit level and the core competitiveness of SMEs, also is an important part of improving the financial ecological environment. The credit rating of SMEs development is conducive to resolving the political information asymmetry problems, help to improve the efficiency of bank decision. Besides, it's also conducive to SMEs grasping the initiative information in bank credit, economic and trade activities, project contracting, bidding and government funding. Currently, because the national level, laws and regulations on corporate credit rating is not perfect, the SME credit rating market is lacking of effective supervision, so that some assessment agencies which do not have the credit rating qualifications, do not follow standard, professional rating process collect fees arbitrarily, assessment "AAA "grade enterprise arbitrarily and disrupted the normal order of the SME credit rating market, which resulting in a very bad impact on society. Strengthen the guidance and supervision of credit rating of SMEs and the third-party credit rating agencies to further standardize the market order is immediately. Which a long and complicated work for the government, the government departments should take the initiative to deal with these. Establishing a sound management system, organization the supervision and inspection investigation, setting up reporting and

investigation and other work to standardize the enterprise credit rating.

(2) Regulate credit rating models and standards for SMEs credit rating.

Following the "government guidance, market-oriented, strict supervision, to assess and promote use" principle to evaluate the enterprises. The way for rating agencies to rating is including client rating and rating initiative. The rating agencies can be entrusted by SMEs, financial institutions, Guarantee Corporation and industry organizations to carry out the business credit rating; which also can be in the initiative to invite enterprises to rating credit. Enterprise credit rating is based on the principles of objectivity, impartiality, and analysis method for the evaluation of enterprise credit rating by macro and micro, dynamic and static, quantitative and qualitative, history and future combined with science independence, scientific to set index system. Rating agencies shall follow the principle of "legitimate, objective, impartial, scientific", on the base of comprehensive investigation in enterprises 'credit, considered by the expert review committee, and then to make a scientific and reasonable credit evaluation, give corporate credit rating report within the period of validity of corporate credit rating bear legal responsibility. With the credit condition of dynamic adjustment of credit rating. The credit rating agencies shall maintain the legitimate rights of enterprises, abide by the occupation morality, not harm corporate trade secrets, and harm the competitive position of enterprises and other legitimate interests, without prejudice to the public interest and safety.

Third is to set up regulations on corporate credit rating system for SMEs.

(1) The fight against illegal behavior which disrupt the credit rating of SMEs market order.

Strengthen the credit rating agencies regulation and supervision work to study and solve the credit rating agency's own credit problems. credit rating agencies and their assessment personnel in violation of laws, regulations and policies by government regulators ordered rectification shall be held responsible person liability , should also limit the institution within three years shall not engage in SME credit rating, and to cause losses to the parties shall bear civil liability according to law. Government regulators on rating agencies serious dishonesty and illegal behavior, according to the specific circumstances take warning, restricted access, and in accordance with the provisions of the dishonest facts through the website, the media to exposure to social announcement, to give the corresponding punishment. For those agencies who do not have the qualifications and no regulatory departments registration, taking doing for SMEs credit rating, issued false credit certificate, false assessment report， the government departments should crack down. The evaluated corporate fraud defrauding credit rating, government departments will cancel the enterprise evaluation of credit rating, records of bad behavior in the enterprise credit database and according to its violations give corresponding punishment, including records, publicity, warning, cancel the relevant support policies, and in the news media and credit information platform shall be announced and exposure.

(2) Optimizing the credit rating of SMEs market order.

Organize and coordinate the SMEs authorities, industrial and commercial administration, and public security departments to participate to work together to safeguard SME credit rating orderly market order. creating good policy, legal, administrative and service environment from the aspect of social security system, to make the SMEs credit rating to achieve institutionalization, legalization, standardization and scientific, lay a solid foundation for the construction of credit system of SMEs, make contribution for the construction of social credit system.

8.2 Suggestions for credit rating agencies

Credit rating agencies are the subject to the credit evaluation of SMEs, which plays a decisive role in the rationality of SME credit evaluation work. Credit evaluation method based on the proposed in this paper, the credit rating agencies can judge and evaluate the credit status of enterprises. At the same time, according to the actual characteristics of SMEs, the credit evaluation of SMEs credit rating agencies should also pay attention to the following issues.

First is to adjust the emphasis of information.

(1) Increase the analysis of non-financial indicators.

The non-financial index is the driving factor or the key success factors of financial indicators. Anderson (2000) to the customer, the business unit and company survey

data which proved that customer satisfaction is the evaluation of customer's future purchase behavior, customer growth rate, business unit changes in financial performance and recently market value predictive indicators. The study shows that customer satisfaction is the driving factor of financial performance and corporate performance, and empirically the positive relationship between them. The SMEs financial strength is weak which should rely on financial indicators to determine its credit status.

(2) Pay attention to the cash flow analysis.

Cash flow can verified for the verification of bills and tax sheets, the possibility of fraud is low, which can reflect more about the business activities and debt paying ability truly. This is conducive to the quality of corporate financial information and actual operating conditions to make more accurate judgment.

(3) To strengthen the financial index analysis and evaluation.

Because of the low reliable degree of the accounting statements from SMEs, credit rating agencies provide financial advisory and financial help in determining the authenticity of the financial report before the financial evaluation of the SMEs. Five main aspects of evaluation of enterprises: operating capacity, profitability, solvency, development ability and the ability to obtain cash.

Second is to improve the evaluation method.

(1) Pay attention to the field investigation and to obtain information.

The SMEs internal control system is not perfect, is difficult to obtain deep understanding to the actual management situation for enterprise through the review of the data. The rating personnel in the course of the field investigation who can obtain more detailed and true internal soft information through the communication with person in charge of enterprise, self-judgment and some other external channels, including business model, internal system, and office environment should lay the foundation for qualitative evaluation and for providing more efficient materials for the credit evaluation.

(2) Pay attention to reveal the enterprise risk.

SMEs have weak foundation, low market risk and financial risk resilience. Credit evaluation is a prediction and evaluation on the company's future performance risk, while for the reverse of the corporate solvency, profitability, development capacity. But market, supply of raw materials, personnel and other factors will impact on enterprise production, operation and development, thereby affecting the performance of the enterprise ability and willingness. Therefore, for evaluation of the credit of SMEs should pay more attention to enterprise risk factors associated with the investigation, explain and clarify influence of the risks for enterprises' performance capability.

(3) Improve the tracking rating requirements.

Enterprise credit evaluation is in a certain point of time for the level of enterprise credit risk evaluation. After rating structure is determined, pay attention to the changes in

corporate credit risking rating within the period of required validity, because the ability of SMEs to resist the risk is weak.

(4) Pay attention to the risk and advantages of SMEs.

SMEs have a small scale and weak foundation. Therefore, the ability of SMEs to resist risks is worse. In order to evaluate the credit rating of SMEs accurately, we need to make the risk assessment of credit evaluation of SMEs. Risk is an economic category, companies should pay attention to credit rating analysis of risk. In some ways, corporate credit risk analysis is to analyze the risk. If the company has sufficient capacity to prevent, disperse and withstand risks, the business of credit will have no problems. In general, the risk faced by SMEs larger than large enterprises. Therefore, the evaluation of SME credit situation incorporated risk assessment index system is particularly important. Mainly from the business and financial risk to evaluate the risk.

Bibliography

[1] Wang Xifu, Hu Pujuan, Yu Ya Cen (2009). Study on the evaluation information system of China's modern logistics enterprise creditChina's modern logistics enterprise credit [J]. Logistics technology. 01:130-132.

[2] Yuan Li, Li Hongnan, Jiang Shaohua, Wang Xiaohui (2009). Study on construction enterprise credit evaluation based on SVM [J]. Value Engineering, 03:141-144.

[3] JiaRen Fu, ZhangJiong, ShanYinghua, GengYu Gui(2009). Construction and Application of Real Estate Enterprise Credit Evaluation System [J]. Yangzhou University Journal (NATURAL SCIENCE EDITION), 01:61-65.

[4] Tan Zhongming (2009. Research on the Credit Evaluation System of SMEs [J]. Academic Forum, 05:123-127.

[5] Wang Suyi, Zhu Chuanhua (2009). Study on the expanding and selection of the SMEs credit evaluation index [J]. Productivity Research, 11:180-181.

[6]Wang Liang, Wang Zuowei(2009). Study on third party logistics enterprise credit evaluation based on Fuzzy Analytic Hierarchy Process [J]. Logistics Technology, 07:89-91.

[7] Yang Lingzhi, Zhang Chunxia, Li Shuhua(2009),Research on the Evaluation Model of Construction Enterprises' Credit [J]. Low Temperature Construction, 08:127-129.

[8]Liu Guangbin, Guo Fugui (2009). Construction and Screening of Science and Technology for SMEs credit evaluation index [J]. Industry Technical Economiy, 08:51-54.

[9] Dai Fen, Liu Xiyu, Wang Xiaomin (2009). Application of Ant Colony Neural Network of SMEs Credit Evaluation [J]. Computer Technology and Development, 10:218-221.

[10]Bao Shengxiang, Yin Yongfei (2009). Credit Evaluation and Empirical Analysis of SMEs [J]. Science and Technology, 20:143-148.

[11] Tan Qingmei, Wu Jinke, Zhao Liming (2009). Study on Evaluation of SME credit based on BP neural network [J]. Journal of Northwest Agriculture and Forestry University (SOCIAL SCIENCE EDITION), 05:57-62.

[12]Guan Xiaoyong, Song Xinwei (2009).An Empirical Research on the Relationship between Enterprise Credit Ability Evaluation Index [J]. ZhengXin Magazine, 04:25-29.

[13] Liang Xiaojuan (2009). The Construction of SMEs Credit Crisis Evaluation System and Method [J].ZhengXin Magazine, 04:39-41.

[14] Lu Chao, Zhong Wangshu (2009). Exploration on Commercial Bank for SMEs Credit Risk Assessment Method [J]. Financial Forum, 09:13-20.

[15] Li Xiaoyan, Lu Chuang, YouWenLi (2003). Research on the Enterprise Credit Evaluation Model, Credit Rating and Performance Correlation [J]. China Soft Science, 05:81-85.

[16] Zhou Chunxi (2003). Enterprise Credit Evaluation Index System and Evaluation [J]. Science and Technology, 04:124-126.

[17] Cao Shun, Liu Ting (2003). Study on Enterprise Credit Evaluation based on BP neural Network [J]. Control Engineering, 05:404-406.

[18] FanboNai, Zhu Wenbin (2003). Theory Selection and Empirical Analysis of SMEs

Credit Evaluation Index [J]. Research Management, 06:83-88.

[19] Liu Xiaofeng, Qi Ershi (2006). Study on Construction enterprises' credit evaluation system [J]. Journal of Xi'an University of Electronic Science and Technology (SOCIAL SCIENCES EDITION), 02:62-66.

[20] Zhao Jiezhen (2006). Study on the Establishment and Composition of the SME credit evaluation systemT [J]. Gansu Science and Technology, 09:31-34+21.

[21] Yonghua oil (2006). The credit status of the enterprise qualitative evaluation -- Based on logistic regression model analysis [J]. Statistics and Information Forum, 06:85-88.

[22] Wu Jinxing, Wang Zongjun (2004). The AHP method of enterprise credit evaluation based on [J]. Journal of Huazhong University of Science and Technology (NATURAL SCIENCE EDITION), 03:109-111.

[23] Li Xiaoyan, Lu Chuang (2004). The performance of the conception of enterprise credit evaluation model [J]. Accounting Research, 05:71-74.

[24] Wang Yue, Yerry, Guo Jiming (2004). Industrial enterprise credit evaluation method [J]. Journal of Hebei University of Technology, 01:89-92.

[25] Gao Lingyun, Cheng Min, Xu Haijun (2004). Construction of credit evaluation system of SMEs in China [J]. Journal of East China Jiaotong University, 06:90-93.

[26] Li Xiaoyan, QianJianHao (2005).Research on the effectiveness of Credit risk evaluation indicators of enterprises in China [J].Chinese soft science, 09:120-125.

[27] Liu Gaojun, Zhu Yan (2005). Construction enterprise data mining technology based on credit evaluation [J]. Journal of China University of Mining and Technology,

04:494-499.

[28] Zhong Tianli, Jia Liheng (2005). Study on the method of neural network in SMEs credit evaluation [J]. Technology Economy and Management, 05:30-32.

[29] Liang Xiaojuan (2005). Credit evaluation: SMEs financing bottleneck [J]. Financial Theory and Practice, 08:46-48.

[30] Zhang YouTang, Yang Yi. Construction of enterprise credit evaluation criteria system based on the "5C" [J].World Standardization & Quality Management, 09:21-23.

[31] Wu Yan. The establishment of [J]. Technology Management Research of credit evaluation system of SMEs in China, 2005, 09:205-206.

[32] Liu Hang (2005). An empirical study of credit evaluation of SMEs [J]. Journal of Zhengzhou Institute of Aeronautics Industry Management (SOCIAL SCIENCE EDITION), 05:127-129.

[33]Li En, Liu Lixin (2013). Small and micro businesses credit evaluation index system of credit [J]. 01:67-70.

[34] Guo Wei, Tong Knin, Shao Hongyu, Wang Lei, Zheng Qing (2013). RS and AHP model of SMEs cloud manufacturing mode based on multi service credit evaluation system of subject construction [J]. Computer integrated manufacturing systems, 09:2340-2347.

[35] Huang Peng, Liu Yan (2013). Fuzzy comprehensive evaluation method Small and micro businesses comprehensive credit evaluation model for the Internet financial services platform based on [J]. Western Finance, 10:25-29

[36]Song Xiaodong, Han Liyan (2013). A dual membership fuzzy support vector

machine credit evaluation of SMEs based on [J]. Industrial Engineering, 01:93-98+108.

[37] Pan Bao (2012). Solve SME financing a new perspective of SME credit evaluation index system construction [J]. Research productivity, 01:227-228+235+261.

[38] Yang Nan (2012). Financial and credit risk assessment of small and medium-sized high-tech enterprises based on fuzzy comprehensive evaluation method [J]. 02:14-19.

[39] Xia Hong (2012). Construction of credit evaluation system of SMEs in China [J]. Journal of Zhongzhou University, 04:23-26.

[40] Zhou Hongmin, Zhang Xiantang (2014), Ding Lidong. Science and technology Small and micro businesses credit evaluation of [J]. Productivity Research, 02:136-139+157.

[41] Zhou Hongmin, Zhang Xiantang, Wang Ke (2014). The matter-element model of real estate enterprise credit evaluation of credit [J]. 03:48-52.

[42]He Ying, Li Wei (2014). Based on is the normal cloud model of emerging industries of strategic enterprises credit evaluation [J]. Statistics and decision, 12:59-62.

[43]ZhangMu, Huang Chunyan, Li Yan (2014). Based on the relative entropy and the theory of variable fuzzy sets of emerging industries of strategic enterprises credit evaluation [J]. Mathematics in practice and understanding, 13:18-26.

[44] Li Anyu, Zhang Zhao, Wang Zehan, Zeng Wei (2014). The business enterprise credit evaluation system -- Based on the perspective of finance AHP credit [J]. 09:6-10.

[45] Gong Lingling, Chi Guotai, Du Yongqiang (2014). Construction of credit evaluation system of small enterprises -- Based on the method of technical and economic principle of [J]. 05:97-101.

[46]Yang Daguang, Kong Lingxin (2014). Small and micro businesses credit evaluation model comparison and improve [J]. China circulation economy,09:74-79.

[47] Zhang Chao, Zhu Weina (2014). The credit construction of credit evaluation system AHP of Internet Finance for small and medium sized enterprises [J]. 10:25-29.

[48] Zhang Yu (2011). AHP- fuzzy comprehensive evaluation method in the evaluation of small and medium sized enterprises credit application [J]. Accounting Communication, 05:42-44.

[49]Liu Changyi, Sun Gang (2011). Clustering analysis and fuzzy extension of AHP credit evaluation of SMEs of a supply chain finance from the perspective of modern scientific management based on [J]. 05:83-85.

[50]Xu Shengdao, Cheng Shaoqing (2011).Study on The Supply Chain Financing and Improve SME Credit Evaluation Index System of Credit [J].ZhengXin Magazine, 02:13-16.

[51]Guan Xiaoyong (2011). The Empirical Research on the Characterizing of Corporate Credit Quality Evaluation Based on our Cultural Values [J]. Science and Management, 05:156-162.

[52]Dong Rujie (2011). Study on micro enterprise credit evaluation based on logit model [J]. New Financial, 08:54-58.

[53]Luo Lianbu（2011）. Research on China's SME Credit Evaluation System Construction [J]. Modern Commerce Industry, 20:152-153.

[54] Wang Xuan, Guo Weichen（2011). Study on the Development of Third Party Logistics Enterprise Credit Evaluation [J].Development Research, 04:129-133.

[55]Pan JiaQin (2011New Ideas to Solve the Financing Problem of SMEs -- the Construction of SMEs Credit Evaluation Model [J]. Accounting Monthly, 30:29-32.

[56] Cheng YanLan (2011). Study on the Participation of Cooperative Enterprise Credit Evaluation Index System of Real Estate Development Project [J]. Civil engineering and Management Journal, 04:86-90.

[57]Fu Hongyuan, Peng Tianming (2008). Analysis of construction enterprises' credit evaluation system based on BP neural network [J]. Science and Technology Management, 11:159-161+170.

[58] Peng Shufeng, Tian Ying (2008). The Application of Fuzzy AHP in Credit Evaluation of Small Industrial Enterprises [J]. Journal of Chongqing Institute of Technology (NATURAL SCIENCE EDITION), 01:131-133+139.

[59] Zhang Jiaping, Zhuang Peizhang, Zhou Zicheng (2008).Research on Construction of Credit Evaluation Index System of Enterprise [J]. Market Modernization, 16:113-114.

[60] Dong Zhenyu (2008).Study on the Construction of enterprise credit evaluationbased on BP Neural Network [J]. Journal of Water Resources and Construction, 04:115-117.

[61] Xu Hao, Wu Dengsheng, Xie Yangqun (2007). Study on Enterprise Credit Evaluation based on PCA/FCM [J]. Technical and Economic, 03:1-5.

[62] Fan yuan, Yang Lixun, Liu Ming (2007). Research on SMEs Credit Evaluation System Operation [J]. Journal of Huaihai Institute of Technology (SOCIAL SCIENCE EDITION), 02:51-53.

[63] Xie Airong, Tian Ying, YuanYi (2007). Application of Multilevel Grey Evaluation Method in the Evaluation of SMEs Credit [J]. Journal of Chengdu University (NATURAL SCIENCE EDITION), 02:160-162.

[64] Tan Zhongming (2007). The design and application of credit evaluation index system of SMEs [J].Rural Financial Research, 06:43-45.

[65]Yao Yuling, Li Tingting (2007). Evaluation of the Highway Construction Enterprise Credit [J]. Journal of Chang'an University (SOCIAL SCIENCE EDITION), 03:31-33.

[66] Fan Li Fang (2007). Comparative study on enterprise credit evaluation information source [J]. Library Information Knowledge, 06:96-100.

[67] DaiDaShuang, Xiao Min Lei, Song Jiashun (2007).Study on the loss of the SME credit evaluation of the entrepreneur credit evaluation [J]. Dalian University of Technology Journal (SOCIAL SCIENCE EDITION), 04:7-11.

[68] Liu Jinlin, Huang Gang (2010). An empirical study of SME credit evaluation -- a case study of Guangxi [J]. Hebei finance, 01:10-13+20.

[69] ZhangMu, Zhou Zongfang (2010).The Application of ANP in Credit Evaluation of High Tech Enterprises [J]. Modern Property, 05:11-13.

[70] ZhangMu, Zhou Zongfang (2010). Construction of Credit Evaluation Index System of High Tech Enterprises based on Rough Set [J]. Economic research Herald, 25:29-31+41.

[71] Xu Hong (2010). The Selection and Evaluation of Enterprise Credit Policy [J]. Journal of Anhui University of Science and Technology (SOCIAL SCIENCE

EDITION), 03:27-30.

[72] Zhu Xianghua, Cao Lian (2010).Evaluation of SMEs in Commercial Bank Credit based on AGA - CAHP [J]. Science Technology and Engineering, 31:7856-7861.

[73] ZhangMu, Zhou Zongfang (2010).The application of an improve cloud barycenter judgement in credit evaluation of high tech enterprises [J]. Mathematics Practice and Cognitive, 19:37-44.

[74]Zhou Zaiqing, ZhongYi, OuYangGuoliang(2010). The Construction and Empirical Research on Supply Chain SME Credit Evaluation Model [J]. Shanghai finance, 11:100-102+108.

[75]Shen Ruyuan, Pang Deliang(2014). Evaluation of Characteristics of Regional Spatial Association of Enterprise Credit- A Case Study of the Western provinces listed companies [J]. Journal of Yunnan Finance and Economics University, 06:139-145.

[76] Yang Nan (2015). Study on Credit Evaluation of the Growth Science and Technology Ventures [J]. Journal of Chongqing University (SOCIAL SCIENCE EDITION), 02:69-74.

[77] Chen Lu, Niu Xia (2015). Review of China's Small and Micro Enterprises Credit Rating [J]. Inner Mongolia Science and Technology and Economy, 06:23-27.

[78] Sun Yuefan, Yang Chao, Zhang Mengshi(2015). SME Credit Evaluation System Reconstruction era of Big Data [J]. Financial and Accounting, 06:47-48.