The Research of Third-party B2B Supply Chain Finance Credit Risk Identification & Evaluation System

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Abstract. With the development of Internet technology, many banks in China launched the “Internet+” supply chain financial services. The optimizing of Supply chain financial structure not only solves the problem that small and medium-sized enterprises financing of convenience and high threshold of loan, but also improves the loan efficiency of the supply chain financial services which achieves a new level and the degree of the participants of the supply chain collaboration. Due to Third-party B2B cooperation mode of supply chain financial services emerging in endlessly, Banks take advantage of the cumulative credit data from Third-party B2B e-commerce platform to issue credit loan and dynamically monitor the credit conditions of small and medium-sized enterprises. Which provide a new solution to long-term information asymmetry problem of supply chain finance service. But the credit risk identification and evaluation change a lot in new service mode. According to analyzing the supply chain finance credit risk changes as result of the evolution from supply chain financial to third-party B2B supply chain finance, this paper contract and analyze the traditional and modern credit risk assessment model. On the basis of above contraction and following the principle of credit risk evaluation index system, this paper build the index system of electronic warehouse financing mode and select the grey evaluation model as the third-party B2B supply chain finance business credit risk assessment model. Multi-level grey credit risk assessment method based on Theil disequilibrium index is used to make comprehensive evaluation on enterprise credit. It can get the evaluation value of the enterprise to judge the enterprise credit rating. This method provide more detailed evaluation method of the third-party B2B supply chain finance business for the banks.

Introduction

With the development of Internet technology, China's Banks have launched the Internet + supply chain financial services leading to the optimization of the structure of the supply chain finance. It not only solves the problem of the small and medium-sized enterprise financing of convenience and high threshold, but also improves the degree of the participants of the supply chain collaboration leading to the supply chain financial efficiency to a new level.

Although the supply chain financial model reduces the credit risk of the financing party to a certain extent, the traditional mode in the Internet era is obviously not able to control credit risk. And in the new model, the credit risk of Banks has changed a lot. The previous research of supply chain finance more focused on the concept and the description of operation mechanism and the credit risk control and management, etc. A small amount of literatures refer to the supply chain finance credit risk assessment. There are less literatures on the credit risk assessment of Internet + supply chain finance. Therefore, it is of great significance to study the credit risk assessment of this new business model.
Credit Risk of Third-Party Supply Chain Finance

The Definition of the Credit Risk

Credit risk as the traditional risk of banks was born and exists with its loan business at the same time. Customer's loan is the most fundamental source of credit risk that all banks must face. It mainly refers to the risks which make bank lose money due to the borrower's bank loans or debt failing to repay timely or full specified for a variety of reasons. The credit risk of the third-party B2B supply chain is the credit risk of the new business model of the bank based on the third-party B2B supply chain financing business model.

The Characteristics of Credit Risk

Endophytism of Credit Risk

Endogeneity is the most characteristic of credit risk. Endogeneity means that there is a direct relation between whether debt default and the lenders. Therefore, the lender's credit status and repayment willingness and repayment ability are necessary information that the Banks must keep accurate tracking and control in detail. The methods of bank tracking the credit status of small and medium-sized enterprises mainly include two types: 1 obtaining the financial information of enterprises; 2 using the credit rating system established within the bank. But these two channels of access to information require a certain amount of human, material and financial resources and lack of timeliness, reliability and effectiveness.

Asymmetry of Risk and Benefit

According to the hypothesis, the probability distribution of market risk is normal distribution. In fact, however, the probability distribution of market risk necessarily don't obey the standard normal distribution, and likely rush thick tail shape. So the basic characteristics of the credit risk on the market can’t be fully reflected by the hypothesis. The probability distribution of credit risk is biased (as showed by Fig. 1). It is because of that the asymmetry between the risk and the benefit. It means that banks have higher probability to get a certain amount small profit and the smaller probability will cause a great loss in the loan business.

![Figure 1. Distribution’s character of credit risk probability.](image)

Unsystematic Feature

Not only the systemic risks, such as the economic crisis and macro-economic cycle so on, will affect the credit risk, in general, but also the unsystematic micro factors will affect the credit risk largely such as the lender's financial position, management ability, the reimbursement ability and willingness of repayment of some of the enterprise itself. But in the practice of the bank services,
senior customers with high credibility are more likely to get loans from Banks, while small and medium-sized enterprises are virtually impossible to obtain financing through bank loans.

**The Difficult of Getting Credit Risk Information**

When evaluating the credit risk, the more difficult part is the objective evaluation of credit risk. The main reason is that Banks’ loan services don’t have thorough secondary market. Because of that, there are less transaction records as loan business information provided to database. So it’s so hard too banks to get credit risk information.\(^2\)

**The Evolution of Third-party B2B Supply Chain Financial Credit Risk**

**Warehouse/Inventory Pledge Financing Mode to Electronic Warehouse Financing Mode**

Decrease credit risk: The electronic warehouse financing mode adopts the third-party B2B supply chain financing platform to credit the "e-business credit" as the supplement of "financial credit", and reduces the credit risk more effectively.

Increased credit risk:

1. The small and medium-sized enterprises on the third-party B2B supply chain financing platform are in different places. It is difficult for banks to take field investigation and inspection. Which result in certain credit risk.
2. Compared to the small and medium-sized enterprises in supply chain finance, the small and medium-sized enterprises on the third-party B2B supply chain financing platform have smaller size and lower stability of the supply chain. These make more defaults in their loan services.
3. Because of the more complex and diversified participating subjects, the participating subjects are more complex and diversified, and the Banks should face the moral hazard of logistics enterprises and third-party B2B e-business enterprises and small and medium-sized enterprises.
4. Due to the development and application of internet technology, banks turn the credit business process into credit process based on third-party B2B supply chain financing platform. Financing enterprises could be in unusual ways improve credit grade of the members from platform higher to defraud the bank to loan money beyond their financial condition limit. It finally caused a certain degree of credit risk.

**Accounts Receivable/Prepayment Financing Mode to Electronic Order Financing Mode**

Decrease credit risk: The electronic order financing mode adopts the third-party B2B supply chain financing platform. Regarding "e-business credit" as the supplement of "financial credit" reduces the credit risks more effectively, consistent with the credit risk of electronic warehouse receipt financing model change.

Increased credit risk:

1. Electronic order seller financing mode increases the credit risk as electronic warehouse financing mode having above. More than that there are new credit risk as follow:
   i. There are false trades between buyers and sellers and false electronic orders used to defraud the financing;
   ii. It’s difficult for the banks to control logistic and fund flow because loan approval execute before cargo transaction. And the banks face various unsure factors in financing party productive processes.
2. Electronic order seller financing mode has not only the risks of electronic warehouse financing mode but also addition risks as follow:
   i. There are false trades between buyers and sellers. The financing parties cheat the banks with logistic enterprise and take advantage of false electronic orders to defraud the financing;
   ii. The credit risk result from poor regulation. The small and medium-sized enterprises on the third-party B2B supply chain financing platform have the characteristics of geographical dispersion that the parties are often in different places. The bank has difficulty in strict supervision of the warehousing and inspection of the collateral. Besides, the bank also has to cooperate with various
logistics warehousing enterprises in different areas, which brings great challenges to the bank's field investigation and supervision.

The Evaluation Method of Credit Risk

With the development of the financial industry, the financial institutions faced the multiplying increasing risks. Therefore, higher technical requirements are proposed for the credit evaluation model. Currently, mainly Credit Risk Evaluation Model mainly include: Risk Metrics Risk control model used for calculating VaR by J.P. Morgan, Credit Monitor Model from KMV, Credit Metrics from J.P. Morgan and so on. These models are based on a large number of market and bank credit data.

(1) VaR Model
In 1993, the G30 group presented a VaR (Value at Risk: Risk Value) approach to measure market Risk. On the basis, the Risk control model of Risk Metrics used for calculating VaR is widely adopted by many financial institutions. VaR (Value at Risk) refers to the maximum possible loss of a financial asset or portfolio Value in a particular period of time at a certain probability level (confidence level)\(^3\).

(2) KMV Model
In 1997, KMV in San Francisco established a KMV model to estimate the default probability of borrowers. The KMV model is a default prediction model established using the modern option pricing theory, which is a remedy for the deficiency of traditional credit risk evaluation methods \(^4\).

(3) Credit Metrics Model
The Credit Metrics model is a 1997 risk management product launched by J.P. Morgan to quantify Credit risk. To evaluate the risk value measurement model of enterprise assets, the most important feature of this model is to propose that the risk change of enterprises should be evaluated in the futures market \(^5\).

The Influence Factors Analysis of the Credit Risk of Third-party B2B Supply Chain Finance

To establish evaluation index system of credit risk need to regard the influence factors analysis of credit risk as the foundation. In this paper, therefore, the analysis is taken respectively from four aspects: industrial factor, small and medium-sized enterprise strength, credit and strength analysis of the supply chain, according to the characteristics of the third-party B2B supply chain finance and the actual situation of small and medium-sized enterprises.

Industrial Factor
In the course of operation, small and medium-sized enterprises may encounter two risks: non-systemic risk and systemic risk. Systemic risks result of the change of macro-economic cycle or industry development elements. In the credit risk identification based on third-party B2B supply chain finance, industry risk is the most important aspect that must be taken seriously. For an enterprise, the macro environment is very important. We can obtain relevant information about the enterprises development, such as the macro-economic policies. If the macro economy is not very good, the loan risk of small and medium-sized enterprises will rise to a certain extent, and the bank will need to pay close attention to the loans and take corresponding risk control measures. At the same time, the price stability of pledge property and the processing channel of pledge property in the whole industry can also clearly represent the stability and development degree of the whole industry \(^6\).

Small and Medium-sized Enterprises Strength
In the third-party B2B supply chain finance, small and medium-sized enterprises can enhance their credit rating by virtue of the strength of core enterprises and supply chain. But each index and comprehensive strength of small and medium-sized enterprises, the loan borrower, affect the small and medium-sized enterprises repayment willingness and repayment ability. Therefore when the bank take credit rating, the internal various risk factors of the small and medium-sized enterprises is
particularly important. Among them, the internal factors affect the credit rating of small and medium enterprises mainly includes: foundation quality, operation ability, profit ability, innovation ability, development ability, solvency and credit quality, etc[7].

**Basic Quality of Small and Medium-sized Enterprises**

The basic quality of small and medium-sized enterprises is one of the important factors affecting its strength. The quality indicators that can reflect the strength mainly include: the quality of staff and management, the management level, enterprise size, small and medium-sized enterprise development level, technology level and resource conditions, etc.

**Operational Capacity**

In the process of operation profit of small and medium-sized enterprises, only with the cooperation of various departments, the capital can be effectively configured and operated. Therefore, the operation ability of small and medium-sized enterprises is directly proportional to the credit of the enterprise. The size of the operating capacity can be measured by the following indicators(1),(2),(3):

\[
\text{Accounts receivable turnover} = \frac{\text{operation revenue}}{\text{the average amount of accounts receivable}} \quad (1)
\]

\[
\text{Rate of stock turnover} = \frac{\text{operating costs}}{\text{the average amount of stock occupied}} \quad (2)
\]

\[
\text{Current asset turnover} = \frac{\text{operation revenue}}{\text{the average amount of current asset}} \quad (3)
\]

**Profitability**

The small and medium-sized enterprises through normal operation and good development obtain profits. Only good profitability can repay the loan. Therefore, the bank can assess its risk level by analyzing its profitability. The indicators reflecting the profitability of enterprises mainly include the following indicators (4),(5):

\[
\text{Rate of main business profit} = \frac{\text{main business profit}}{\text{main business income}} \quad (4)
\]

\[
\text{Rate of return on total assets} = \frac{\text{retained profits}}{\text{average total assets}} \quad (5)
\]

**Debt Paying Ability**

If the small and medium-sized enterprises fail to pay their debts on time, there are problems in operations possibly. The banks should do well to control their risks. Therefore, solvency can reflect the ability of enterprises to continue operation from the side. The indicators reflecting the ability to pay debt mainly include the following indicators (6),(7),(8):

\[
\text{Turnover rate} = \frac{\text{current assets}}{\text{current debts}} \quad (6)
\]

\[
\text{Asset debts rate} = \frac{\text{total indebtedness}}{\text{total assets}} \quad (7)
\]

\[
\text{Interest coverage rate} = \frac{\text{earnings before interest and tax}}{\text{interest expenses}} \quad (8)
\]

**Credit Record**

**Financial Credit**

Corporate reputation is generally the focus of bank reviewing, reflecting the repayment ability and willingness of enterprises. Because our country's credit evaluation system is not perfect, and small-and -medium enterprises default cost is low. Which may cause the enterprise deliberately default and damage to the bank. Banks will focus on the enterprise's credit history on reviewing credit.
E-commerce Credit Level

The biggest difference between supply chain finance with internet and supply chain finance is the use of Internet technology. Cooperating with the electric business enterprise and founding the third-party B2B supply chain financing platform for taking advantaging the electricity business enterprise electronic commerce credit system of credit data make up for the incompleteness of bank financial credit data and find high quality potential small and medium-sized enterprises more efficiently. The measures include online application time, online transaction times, online trading volume, online credit level and customer evaluation of the enterprises.

Credit Record on Financing Platform

There are many data on internet supply chain finance platform which the banks use to take data mining. Combining the different segment business model, the solvency indicators mainly include the following: platform member enterprise financing amount, number of financing, the percentage of the draw a line of credit, etc.

Supply Chain Strength

The core of the third-party B2B supply chain finance is instead of a separate investigation of small and medium-sized enterprises financial risk by investigating the overall operation of enterprises in the supply chain and trading conditions. The banks confirm credit limit by combining with other aspects of influence factors of comprehensive evaluation of the enterprise credit rating.

Core Enterprise Strength

Core enterprise strength plays a role of stealth guarantees for small and medium-sized enterprises. The production level and management ability of these enterprises of the production level and management ability by this factor can be reflected. The core enterprise strength can be measured by the indicators as follow: the core enterprise industry status, asset-liability ratio, the core enterprise core enterprise main business profit margins.

Supply Chain Competitiveness

The competitiveness of small and medium-sized enterprises is judged by the overall strength of the supply chain. If competitiveness is stronger, it can keep long time cooperation with the core enterprise and access to credit more easily. It can be evaluated by the two aspects, the consumer satisfaction of products and the quality of the product competitiveness.

Cooperation of Supply Chain

The degree of cooperation between the upstream and downstream enterprises of supply chain will affect the bank's credit rating. The closer the relationship among the enterprise is, the more cooperation there is. Then they will establish a long-term and stable relationship between supply and demand. The shortage of the small and medium-sized enterprises can reduce with the relationship becoming more intimate. Information sharing directly reflects whether the communication between each enterprise on the supply smoothly and the degree of enterprise information sharing. It can impact directly on the enterprise in the supply chain. Its measure mainly including sustainability trading, upstream and downstream enterprise's close cooperation degree, upstream and downstream information sharing, etc[8].

The Third-Party B2B Supply Chain Financial Credit Risk Assessment System Construction

The Construction Principle of the Credit Risk Evaluation Index System

Comprehensive Principle. The evaluation index system should reflect all factors that affect the credit status of small and medium-sized enterprises. The secondary and tertiary indicators could be determined one by one after determining the enterprise itself factors, industry factors, supply chain and bank credit record, electricity enterprises, financing platform based on third-party B2B supply
chain financing mode such as credit risk factors. Only the indicators are comprehensive and reasonable, the development level and size of small and medium-sized enterprises can be reflected. At the same time, considering the past performance of enterprises is equal to give attention to the future growth of enterprises development. However, the evaluation index can neither too much nor too little. Too many indicators can cause high correlation between indicators. Too few indicators can't comprehensively reflect the credit risk situation of the enterprises.

Scientific Principle. Since the researchers' credit evaluation of the small and medium-sized enterprises is affected by the scientific setting of evaluation indexes, it is necessary to set up evaluation indexes according to theoretical and practical science. The indicators in the indicator system setting not only need to take into account the whole situation of the research question of the comprehensive and integrated, but also need to be able to satisfy the rationality of the existence of single index. The indicators should be combined organically. Therefore, we should consider the characteristics of small and medium-sized enterprises together and supply chain factors and the Internet when building the enterprises based on the third-party B2B supply chain financial evaluation index system of credit risk.

Fairness Principle. The construction of index system should be based on impartiality. To reflect the credit situation of small and medium-sized enterprises, it need construct the index system fairly according to the actual situation. In addition, it need to maintain a fair attitude and principles for the enterprise credit assessment without doping personal emotion in the process of evaluation and unable to change the evaluation methods and evaluation standards easily.

Maneuverability Principle. When setting indicators, maneuverability principle shows that it should choose evaluation index which has the following characteristics: get the data conveniently, understand easily, simple calculation process, avoid choose indicators too complicated. Only in this way, indicators are operable and practical rather than from actual only based on the theory.

Establish indicator System. Screening the indicator to guarantee the indicator system of comprehensive, impartiality, scientific nature and operability and avoid overlapping index content through the expert scoring method and correlation analysis method of index screening.

Expert Scoring Method. Using the experts to score the questionnaire result preselect indicator through distributing the index screening questionnaire to the Internet+ supply chain finance related practitioners. Summarize the results of the questionnaire and exclude the less influential indicators. Evaluation indicators such as staff quality, personnel stability, core enterprise sales profit and other effects are eliminated.

Correlation Analysis. Economic indicators often have a certain correlation, eliminating the subjective defects of expert analysis and eliminating highly relevant indicators. Using SPSS software for bilateral correlation analysis based on the data of enterprises in the third-party B2B supply chain financing platform, the calculation formula of correlation coefficient is (9) shown below:

\[
\rho = \frac{\sum_{i=1}^{n}[(X_i-\bar{X})(Y_i-\bar{Y})]}{\sqrt{\sum_{i=1}^{n}(X_i-\bar{X})^2} \times \sqrt{\sum_{i=1}^{n}(Y_i-\bar{Y})^2}}
\]

The Credit Risk Evaluation Indicator System of Electronic Warehouse Financing model Construction. According to the setting principle of the index system, the credit risk evaluation index system of small and medium-sized enterprises is constructed based on the electronic warehouse financing mode as. Dividing the index system into four levels: goal layer \( u \), primary criterion layer \( u_i \), secondary criterion layer \( u_{ij} \) and Three level indicator layer \( u_{ijk} \).
Credit Risk Measurement Model

Model choice. The bank credit risk management method mainly includes rating method, classification method and expert system. In business practice, the Credit rating methods include used widely include: financial ratio analysis, Logit model, fuzzy comprehensive evaluation method, Grey theory evaluation method, KMV model, Credit Metrics model, etc. The credit risk assessment of third-party B2B supply chain finance needs to adopt various quantitative and qualitative indexes, such as the company's financial credit, e-commerce credit and supply chain stability, etc. In addition, due to the irregular financial data of small and medium-sized enterprises in China and insufficient data of the credit database, many evaluation models are not applicable to the situation in China. So the credit risk assessment of third-party B2B supply chain finance is a typical grey problem. And the grey evaluation model will be applied to the credit risk assessment of third-party B2B supply chain finance business in China.

Multi-level Grey Credit Risk Assessment Method Based on Theil Disequilibrium Index

Theil Disequilibrium Index. Using discriminant ability of Theil disequilibrium index measure discriminant ability, the index weight calculation, is based on the difference of parameter values as a starting point to determine the index weight method. The size of the index reflects the size of the degree of income inequality. The greater the index is, the greater the inequality is what means the income gap is greater. In the process of evaluation of small and medium-sized enterprises credit risk, Theil disequilibrium index used to calculate the evaluation index of disequilibrium degree reflect the discrete degree of indexes between different enterprises and the size of the characterization of the indicators on the result of comprehensive evaluation. Then using disequilibrium degree of the evaluation index calculates the index weight and make comprehensive evaluation to index weight. The significance of Theil index is not regard as an index in evaluation of the important coefficient of practical significance, but reflects in the sense of the relative competitive level of the indexes after the evaluation object all kinds of indexes and are determined\textsuperscript{[11]}.

The Basic Principle of Hierarchical Grey Analysis. AHP, analytic hierarchy process, was first proposed by American scholar Saaty in the 1970s. AHP skillfully combine qualitative research and quantitative research. The core idea is quantifying multiple goals or solution and getting index weight by mathematical model analysis and prediction to provide quantitative basis for policymakers to solve the problem. This method is suitable for problem that the analysis of the structure is more complicated and uneasy to get the data. Therefore, since the analytic hierarchy process was proposed, it quickly accepts the welcome of people, also is applied to the fields in the field and obtained the good application result\textsuperscript{[12]}. The steps of AHP applied in this paper as follow:
(1) Index weight calculation

1) Preprocessing of index values:

Since the standard units of different indicators are different, the corresponding index values should be normalized.

First, the type of evaluation index is uniformly processed: Usually, index values may include “very large” type (the expected value is better to be large), “minimal type” index (the expected value is better to be small), “central” type (the expected value is better to be centered) and “interval” type (the expected value falls within a certain range). For index set $v = (v_1, v_2, v_3, v_4)$ can divide like that, for $u = (u_1, u_2, u_3, u_4)$ and $u_a \cap u_b = \emptyset$, $i \neq j (i, j = a, b, c, d)$. Among $u_1, u_2, u_3, u_4$, the four indexes respectively means “very large” type index set, “minimal type” index set, “central” type index set and “interval” type index set. If there are four types in an index system, it need to be standardized.

For “minimal type” $U$, for $v_1 = \min \{v_i\}$, $v_2 = \max \{v_i\}$, $v_3 = \frac{v_1 + v_2}{2}$, $v_4 = \frac{v_1 + v_2 + v_3}{3}$.

And, Evaluating the dimensionless treatment of index value, as (10), (11), (12) shown:

$$u_{ij}^* = \frac{u_{ij} - m_j}{M_j - m_j} \quad \text{(10)}$$

$$M_j = \max_i \{u_{ij}\}, \quad m_j = \min_i \{u_{ij}\} \quad \text{(11)}$$

$$u_{ij}^* \in [0, 1] \quad \text{(12)}$$

2) Index weight calculation:

Hypothesis, Take credit rating for $n$ supply chain financing enterprises. There are $m$ indexes $G_s$ ($s=1,2,...,m$). And evaluation value of every index $G_s$ is $g_{ts}$ ($t=1,2,...,n; \ s=1,2,...,m$). These indexes are qualitative and quantitative, and the actual observations of quantitative indexes are taken. For qualitative indexes, the evaluation index score criteria can be set according to the characteristics of the indicators, and the quantitative indexes of qualitative indexes can be achieved by rating expert grades.

(2) Multi level gray evaluation

The index weight of the indicators calculated by Theil disequilibrium index will be the weight of all levels in the multi-level grey evaluation system. According to the different of credit risk profile, determining the, the evaluation indexes are divided to five grading standards as before: “excellent”, “suboptimum”, “normal”, “range”, “terrible” and the evaluation are 1, 2, 3, 4, 5. If the risk is somewhere in between two standards, the evaluation are 0.5, 1.5, 2.5, 4.5, 4.5. Numbering the experts in the evaluation process, assume that the credit rating experts of $p$ should be invited to grade the credit status of a small and medium-sized enterprise. $Y$ is the number of credit rating experts, $y=1, 2, 3, ..., p$. According to their own experience and the actual situation of the enterprise, the experts grade the evaluation indexes. When Expert $Y$ grade index $u_{ijk}$, he will accept the grade of the index $u_{ijk}$ from $p$ experts$^{[13]}$. The grade matrix D as follow:

$$D = \begin{bmatrix}
  d_{1111} & d_{1112} & \ldots & d_{111p} \\
  d_{1121} & d_{1122} & \ldots & d_{112p} \\
  d_{1211} & d_{1212} & \ldots & d_{121p} \\
  \vdots & \vdots & \ddots & \vdots \\
  d_{2111} & d_{2112} & \ldots & d_{211p} \\
  \vdots & \vdots & \ddots & \vdots \\
  d_{4111} & d_{4112} & \ldots & d_{411p} \\
  \vdots & \vdots & \ddots & \vdots \\
  d_{4331} & d_{4332} & \ldots & d_{433p} 
\end{bmatrix} \begin{bmatrix}
  u_{111} \\
  u_{112} \\
  u_{121} \\
  \vdots \\
  u_{211} \\
  \vdots \\
  u_{411} \\
  \vdots \\
  u_{433} 
\end{bmatrix} = (d_{ijk})_{(2+2+3+3+3+2+5+5+6+3+2+3)\times p}$$

After the experts make the evaluation, in order to determine that the white value belongs to a specific classification, we need to use the white function to determine the evaluation of gray classes and the level, grey number and white function of the gray classes.
Hypothesis, there are h evaluations of gray classes and level number is e(e=1,2,.....,h). The evaluation of gray classes of Third party B2B supply chain financial loan enterprise is 5, so h=5. And these five class are named “excellent”, “suboptimum”, “normal”, “range”, “terrible”, and the according classification are 5,4,3,2,1. On this basis, we determine the threshold value of the white function and describing gray classes function by using comparison value. It means that the maximum and minimum values of the matrix are the upper and lower limits of the threshold. Then the grey evaluation coefficient and gray evaluation weight vector and weight matrix are calculated. Based on this, take comprehensive evaluation and confirm matrix of gray evaluation weight of secondary index set $u_i$. Take comprehensive assessment, the result record as $B_{ij}$, then $B_{ij} = W_{ij} \cdot R_{ij}$.

Build evaluation weight matrix $R_i$ of upon index $u_i$ of index $u_{ij}$. Then confirm matrix of gray evaluation weight of primary index set R. Take comprehensive evaluation to $u_i$, the results record as $B_i$. On the base of $B_i$, confirm evaluating weight moment of upon index u of index $u_i$. Finally, the result of comprehensive assessment is shown as B, $B = W \cdot R$.

Complete the distribution of gray class based on gray value and determine the rating at all levels: first species d1, second species d2, ..., the h species d0. In this paper, h is 5, d1=5, d2=4, d3=3, d4=2, d5=1. Each grey evaluation classification value is a vector C(C=5,4,3,2,1). Name evaluation value of small and medium-sized enterprises index as $g_{ijk}$, $g_{ijk} = r_{ijk} \cdot C^T$.

Using a similar approach: The comprehensive evaluation value (after standardization) of the first level index (after standardization) determines the weight distribution of the index.

To facilitate inspection and decision-making, the results of evaluation need to be further standardized. After standardization, the evaluation value of small and medium-sized enterprises is $S = B \cdot C^T$.

<table>
<thead>
<tr>
<th>Comprehensive assessment</th>
<th>Credit level</th>
<th>Credit condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-5</td>
<td>AAA</td>
<td>excellent</td>
</tr>
<tr>
<td>4-4.5</td>
<td>AA</td>
<td>excellent</td>
</tr>
<tr>
<td>3.5-4</td>
<td>A</td>
<td>suboptimum</td>
</tr>
<tr>
<td>3-3.5</td>
<td>BBB</td>
<td>suboptimum</td>
</tr>
<tr>
<td>2.5-3</td>
<td>BB</td>
<td>normal</td>
</tr>
<tr>
<td>2-2.5</td>
<td>B</td>
<td>normal</td>
</tr>
<tr>
<td>1.5-2</td>
<td>CCC</td>
<td>range</td>
</tr>
<tr>
<td>1-1.5</td>
<td>CC</td>
<td>range</td>
</tr>
<tr>
<td>0.5-1</td>
<td>C</td>
<td>terrible</td>
</tr>
<tr>
<td>0-0.5</td>
<td>D</td>
<td>terrible</td>
</tr>
</tbody>
</table>

Table 1. Credit rating scale.

Summarize
Credit risk is one of the main risks of third-party B2B supply chain finance business. According to analyzing on the evolution of third-party supply chain finance risk and comparing the traditional and modern credit risk assessment model, we find that the grey evaluation model is applicable to the credit risk assessment of third-party B2B supply chain in China. At the same time, this paper analyzes and elaborates the main influencing factors of credit risk in the third-party B2B supply
chain financing mode. And it screen and confirm index used to establish credit risk evaluation system from industrial factors, enterprise strength, credit records and supply chain strength. On this base, it build a financial credit risk evaluation system based on third-party B2B supply chain finance. Which provide more detailed evaluation method of the third-party B2B supply chain finance business for the banks to provide professional services for variety customers more efficiently and safely.

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