

Financing Model Analysis and Risk Management of Supply Chain Finance Based on Gray Evaluation

Hualiang Chen¹, Jianbo Wen²

¹ School of Economics, Huazhong University of Science and Technology, Wuhan 430074, China

² School of Foreign Studies, Central University of Finance and Economics, Beijing 100081, China

Abstract

This paper mainly studies the financing mode of supply chain finance and its credit risk management. Firstly, it investigates the financing mode of supply chain finance, then focuses on analysis of operation mechanism, credit risk and function of accounts receivable financing mode, FTW(finance-transportation and warehouse)Financing and confirming warehouse financing mode, thereby revealing the potential financing advantages of supply chain finance. Then analyzes the influence factors of credit risk of supply chain finance and evaluates the credit risk of supply chain finance by using the multi-hierarchy gray comprehensive evaluation method. Finally, on the basis of this, this paper further analyzes credit risk of supply chain finance, puts forward the thought that to transfer and manage credit risk of supply chain financial by application of credit spread option method.

Key words: Risk management, supply chain finance, financing model analysis, gray evaluation

1. INTRODUCTION

Since the 1990s, some unique functions of small and medium-sized enterprises (SMES) in the economic operation, such as the engine of economic growth, job creation and the optimization and adjustment of industrial structure, have recognized by all walks of life in China. <2004 National Economic and Social Development statistical bulletin>, said China's collective enterprises, private enterprises realized profits of 51.2 billion yuan and 123.7 billion yuan, with a year-on-year growth of 31.3% and 40.1%(Grani et al.,2015). At present, China's small and medium-sized enterprises accounted for 99% of the total number of enterprises, the total output value, total profits and taxes and total exports accounted for 60%, 40% and nearly 60% of the national enterprises, creating 75% of urban employment opportunities, play as the main force in regional economic development, also play an important role in China's economic construction. However, the financing of small and medium-sized enterprises is disproportionate with its position and role in the national economic and social development(Zhang et al., 2013). According to the National Social Science Fund Project (01BJY052)<Research on the Transformation and Upgrading of Small and Medium-sized Enterprises in China>, more than 2,000 surveys on small and medium-sized enterprises found that 53.8% of the enterprises to choose the lack of funds as the most unfavorable problem in enterprise development. Financing difficulties have become the biggest bottleneck which restricting the development of small and medium-sized enterprises in China.

At present, the research on the financing problem of small and medium-sized enterprises mainly concentrates on three aspects: (1) The perspective of the fund supplier (bank), mainly research on information asymmetry of the supply and demand and the scale of bank. Information asymmetry leads to the adverse selection and moral hazard problems; in terms of bank size, large banks have more options for enterprises, thus loans rarely to small and medium-sized enterprises, while for small and medium-sized financial institutions because of their own disadvantage is difficult to meet loan demand the small and medium-sized enterprises(Zhang et al., 2011). (2) The perspective of intermediary institutions, mainly research from the credit guarantee, credit evaluation. The existence of credit guarantee institutions enhances the marginal credibility of small and medium-sized enterprises, enhance the ability of small and medium-sized enterprises to bargain, and reduce the information asymmetry between banks and enterprises. However, the market-oriented operation of credit guarantee institutions in our country is not strong, and the credit guarantee has little effect on the contribution of small and medium-sized enterprises(Diebold and Tay, 1998). (3) Social credit system perspective, mainly because the

social credit system is not perfect, weak credit awareness, resulting in small and medium-sized enterprises is difficult to obtain financing support. Although these studies have played a certain effect on improving the financing environment for small and medium-sized enterprises, due to the particularity of the development of small and medium-sized enterprises in China and the domestic social credit environment will not be much improvement in the short term, therefore it is difficult to fundamentally alleviate the current financing difficulties of small and medium-sized enterprises. In addition, non-core assets collateral, no effective third-party sponsor are key problems of small and medium-sized enterprises when facing with financing difficulties, the current studies did not fundamentally solve the problem.

This paper is from the perspective of the supply chain to study the financing problem of small and medium-sized enterprises, breaking the limitations of the above studies. Supply chain finance is a kind of new financing model tailored specifically for small and medium-sized enterprises in recent years (Bjorgan et al., 1999). It is closely linked with the structure and trading characteristics of supply chain, by using of the credit power of core enterprises or the degree of self-indemnity of a single transaction and value of goods circulation, provides comprehensive financial services for the single or multi-upstream and downstream small and medium-sized enterprises on supply chain. The supply chain finance is helpful to weaken the restriction of the bank to the small and medium-sized enterprise and to alleviate the information asymmetry of the bank, to reduce the transaction cost of the bank, then to stimulate the enthusiasm of the bank to lend the loan, to improve the credit support of the bank to the small and medium-sized enterprise. Relieve the Financing Dilemma of China's small and medium-sized Enterprises. At present, domestic research on this area is still relatively lacking.

2. CONSTRUCTION OF SMES CREDIT RISK EVALUATION INDEX SYSTEM OF SUPPLY CHAIN FINANCE

In order to convenient to the following comparative study, to highlights the effectiveness of supply chain finance, this paper also design SMES credit risk evaluation index system of supply chain finance. Due to there already have many literatures researched and discussed the evaluation system, and tented to mature, so this paper will not repeat them here. Conducting the correlation analysis and discriminability analysis on the basis of the above influence factors, combining with the characteristics and content of SME credit risk of supply chain finance, and eliminating the index of supply chain operation status, the paper eventually constructs SMES credit risk evaluation index system of supply chain finance, as shown in Figure 1 below.

The comprehensive strength of SMEs includes the basic quality of enterprises, solvency, operating capacity, profitability, innovation ability, growth potential and credit history. These seven elements scientific and comprehensive reflect the SME's own business ability and credit status.

(1) The basic quality of enterprises

The basic quality of enterprises is the internal conditions that affect the credit status of enterprises, and the higher enterprise quality can ensure that the enterprises develop new products and new business continuously, increase the market share and obtain more economic benefits. For SMES, the basic quality of enterprises is mainly reflected in the enterprise scale, the quality of leaders, the quality of the workforce and management level.

(2) Enterprise solvency is the most important performance of enterprises credit status, but also the primary index of corporate credit evaluation. Enterprise solvency not only reflects the level of business risk, but also reflects the ability of enterprises to use debt to engage in business activities. The indexes which reflecting the solvency mainly are: asset-liability ratio, liquidity ratio, quick ratio, cash ratio, overdue debt ratio, the interest coverage ratio and so on (Christoffersen and Diebold, 2000).

(3) Operating capacity

High Operating capacity refers to the efficiency of funds utilization reflected by relevant indexes such as the turnover rate of production and operation of enterprises. It indicates the ability of enterprise management personnel to manage and use funds. The faster the turnover rate of production and operation of enterprises, indicating that the better the use of enterprise funds, the higher the efficiency, the stronger the management capacity of enterprise management personnel (Millo and Mackenzie, 2009). The size of the operating capacity has a decisive impact on the continued growth of profitability and continuous improvement of solvency, The

indexes which reflecting the operating capacity of enterprises include inventory turnover rate, accounts receivable turnover rate, current asset turnover rate, fixed asset turnover rate and total asset turnover(Millo and Mackenzie, 2009).

(4) Profitability

Enterprise profitability is the foundation of enterprise credit, only profitable enterprises, will it be possible to repay debt on schedule. Profitability refers to the ability of enterprises to obtain benefits in the course of business, is the concentrated expression of enterprise management level and operating performance, is one of the important aspects that reflect the enterprise can realize the process of funds restructuring. Profitability is the basis for the survival of enterprises, there have many indexes to measure the enterprise profitability, mainly are: sales net profit margin, sales gross margin, return on assets and net assets income rate.

(5) Innovation ability

With the rapid development of science and technology, the enterprise's technological innovation ability plays a decisive role in forming the competitive advantage, especially for the small and medium-sized enterprises of science and technology. The indexes of evaluating the innovation capability of enterprises are: the proportion of new product sales revenue, the proportion of technical personnel, the rate of new technology equipment, the intensity of R & D investment and so on.

(6) Growth potential

Growth potential is the acting force to promote enterprises to move forward as well as to improve the credit status, only with the large growth potential, can enterprises to ensure the sustainability earnings, the credit status will be good. Reflecting the growth potential of the enterprise indexes include three aspects: First, the development prospects of the industry where the enterprise is in, and second, national policy support, third is enterprises own growth capacity. Main evaluation indexes of enterprises own growth capacity are net profit growth rate, sales revenue growth rate, fund accumulation rate, enterprise development planning

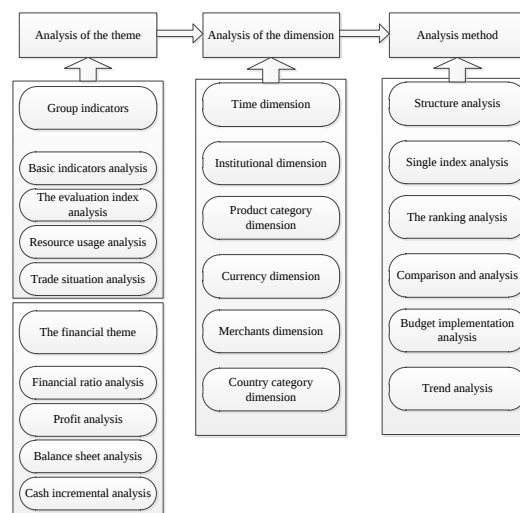


Figure 1 SMES credit risk evaluation index system based on supply chain finance

3. GRAY MULTI-HIERARCHY ANALYSIS METHOD

The basic principle of the gray multi-hierarchy analysis method is as follows: Firstly, the hierarchy structure of the index system is constructed, and the hierarchy is divided into the target layer, the criterion layer and the index layer. Then the gray evaluation method is used to evaluate the index layer(Pongsakdi et al., 2006). Furthermore the evaluation results of index layer are used in gray evaluation of each index in criterion layer, evaluate the indexes from the bottom to top, the comprehensive evaluation results of the target layer are obtained, and the evaluation results are sorted at last. It is a non-mathematical statistical method combining

analytic hierarchy process and gray system theory. This method is mainly aimed at the situation that the data is less or not complete, usually it is used to solve the problem of evaluation of "small data", "Poor information" and other uncertain issues. The specific procedures of gray multi-hierarchy analysis method are as follows:

3.1 Determine scoring criteria of the multi-hierarchy gray evaluation index

Evaluation class is set to nine scoring criteria, as shown in Table 1

Table 1 The scoring criteria of evaluation index

Scoring criteria	meaning
9	Very high
7	High
5	General
3	Poor
1	Very poor
2, 4, 6, 8	Between adjacent indicators

3.2 Determine gray class of evaluation index

Select the five classes of "excellent", "good", "general", "poor" and "very poor", respectively. The first gray class, that is, "excellent" gray class function is (since the evaluation class is 9)

$$\varphi_1(f_{ijr}) = \begin{cases} 1 & f_{ijr} \geq 9 \\ \frac{f_{ijr}}{9} & 0 < f_{ijr} < 9 \\ 0 & f_{ijr} \leq 0 \end{cases} \quad (1)$$

The second gray class, that is, "good" gray class function is (since the evaluation class is 7)

$$\varphi_2(f_{ijr}) = \begin{cases} \frac{f_{ijr}}{7} & 0 < f_{ijr} < 7 \\ \frac{14 - f_{ijr}}{7} & 7 < f_{ijr} < 14 \\ 0 & f_{ijr} \leq 0 \end{cases} \quad (2)$$

The third gray class, that is, "general" gray class function is (since the evaluation class is 5)

$$\varphi_3(f_{ijr}) = \begin{cases} \frac{f_{ijr}}{5} & 0 < f_{ijr} < 5 \\ \frac{10 - f_{ijr}}{5} & 5 < f_{ijr} < 10 \\ 0 & f_{ijr} \leq 0 \end{cases} \quad (3)$$

The fourth gray class, that is, "poor" gray class function is (since the evaluation class is 3)

$$\varphi_4(f_{ijr}) = \begin{cases} \frac{f_{ijr}}{3} & 0 < f_{ijr} < 3 \\ \frac{6-f_{ijr}}{3} & 3 < f_{ijr} < 6 \\ 0 & f_{ijr} \leq 0 \text{ or } f_{ijr} > 6 \end{cases} \quad (4)$$

The fifth gray class, that is, "very poor" gray class function is (since the evaluation class is 1)

$$\varphi_5(f_{ijr}) = \begin{cases} 1 & 0 < f_{ijr} < 1 \\ 2-f_{ijr} & 1 < f_{ijr} < 2 \\ 0 & f_{ijr} \leq 0 \text{ or } f_{ijr} > 2 \end{cases} \quad (5)$$

(2) Calculate the number of gray evaluation, the formula is $X_{ijr} = \varphi_1(f_{ij1}) + \varphi_2(f_{ij2}) + \dots + \varphi_n(f_{ijn})$

(3) Calculate gray evaluation weight vector and weight matrix

(4) Calculate the comprehensive score value

Using the formula $B_i = w_i R$ to calculate the scoring vector B_i of criterion layer, the weight of criterion layer is w_i ,

$B = w_i \begin{bmatrix} B1 \\ B2 \\ B3 \\ B4 \end{bmatrix}$, transform the evaluation class value to vector C , $C = [9, 7, 5, 3, 1]$, $Z = BC^T$, then obtain value of Z .

4. CASE STUDY

4.1 Case background introduction

A pharmaceutical company approved by the Changchun City Restructuring Committee in 1993, is a joint stock limited company established in directional raise way, with registered capital of 32 million yuan. 2000, the company launched to legal entity kuancheng pharmaceutical factory and natural person additional 800 million shares, the company registered capital increased to 40 million yuan. The company is mainly engaged in production, sales of Chunyan brand Chinese medicine and western medicine and the production, sales and research and development of traditional Chinese medicine, biochemical medicine and western medicine (Dias, 2009). At present, the company has obtained the relevant laws and regulations and the various approvals and permits, obtain production right for a total of 95 products, including 12 Chinese medicine, 80 Western medicine and three biochemical drugs, are all with five forms of production, namely infusion, capsules, tablets, granules and liquor, It is a high-tech enterprise recognized by Changchun City Science and Technology Commission.

The company has total of 291 employees, including 39 management and administrative staffs, 25 technical staffs, 95 production staffs, 221 market personnel.

At present, the company is facing financial difficulties. As the higher occupation of company's run funds, the flow is not smooth, among them the finished products and net account receivable account for about 30%-40% of the total circulating fund, which seriously affected the enterprise's capital flow and economic benefits; The high cost of sales, accounting for about 17% of the business, offset some of the economic benefits; the company has many overdue accounts receivable and bad debts, it is difficult to recover. Therefore, the company needed financing to solve the current financial predicament badly, and to maintain the company's continued production operations.

4.2 Multi-hierarchy gray comprehensive evaluation

We have constructed the credit risk evaluation index system of the supply chain finance, and used the combination weight method to determine the weights for the corresponding indexes respectively (Greuning and Bratanovic, 2003). The following will use the multi-hierarchy gray method to evaluate the credit risk of the company based on supply chain finance.

(1) Construction of evaluation sample matrix

According to the evaluation index system constructed above, and according to the scoring criteria of the evaluation index U_{ij} , five experts are organized to score the credit status of the pharmaceutical company, and the evaluation sample matrix D is obtained.

$$D = \begin{bmatrix} 4, 3.5, 4, 4, 3.5 \\ 4.5, 3, 4, 4, 3 \\ 4, 4, 4.5, 3.5, 4 \\ 3.5, 3, 2.5, 4, 4.5 \\ 2, 3.5, 4, 4, 3.5, 2 \\ 4, 5.5, 3, 2.5, 4, 3 \\ 2, 3.5, 2.5, 4, 4 \\ 2.5, 4, 4.5, 4, 3, 2 \\ 3.5, 4.5, 5, 4, 3, 2.5 \\ 4, 3, 2.5, 2.5, 5, 5 \\ 4.5, 3, 4, 3, 3.5, 4 \\ 4, 4, 4.5, 4.5, 3.5, 3 \\ 2, 2, 3.5, 4, 4, 3.5 \\ 4, 4.5, 4.5, 3, 4.5, 3 \\ 3, 3.5, 4.5, 5, 5, 4.5 \\ 2.5, 3, 3.5, 4, 4, 3.5 \\ 5.5, 3, 2, 2.5, 3, 4.5 \\ 3.5, 4, 4, 4.5, 5, 2 \\ 3.5, 2.5, 4.3, 5, 3, 4 \\ 4.5, 4, 4, 4, 3.5, 2.5 \\ 3, 3, 4.5, 4.5, 4, 5 \\ 2.5, 3.5, 4, 4, 3.5, 4 \\ 3, 4.5, 3, 4, 3.5, 2 \\ 5, 4, 3.5, 3.5, 4, 4.5 \\ 5.5, 3, 3, 4.5, 4, 3 \\ 4, 5, 4.5, 3.5, 3, 3 \\ 3.5, 4, 4, 4.5, 3, 2.5 \end{bmatrix} \quad (6)$$

(2) Calculation of the gray evaluation coefficient and weight matrix

The gray evaluation coefficient of the evaluation index U_{ijx} is calculated according to the weight function of the evaluation gray indexes (Alexander, 2005). For the evaluation index u_{111} , the gray evaluation coefficient q of the company belongs to the e -th evaluation gray class is:

$$e=1 \quad q_{111} = \sum_{k=1}^5 f_1(d_{111k}) = f_1(3.5) + f_1(4) + f_1(3.5) + f_1(3) + f_1(4) = 3.6 \quad (7)$$

$$e=2 \quad q_{1112} = \sum_{k=1}^5 f_2(d_{111k}) = f_2(3.5) + f_2(4) + f_2(3.5) + f_2(3) + f_2(4) = 4.5 \quad (8)$$

$$e=3 \quad q_{1113} = \sum_{k=1}^5 f_3(d_{111k}) = f_3(3.5) + f_3(4) + f_3(3.5) + f_3(3) + f_3(4) = 4 \quad (9)$$

$$e=4 \quad q_{1114} = \sum_{k=1}^5 f_4(d_{111k}) = f_4(3.5) + f_4(4) + f_4(3.5) + f_4(3) + f_4(4) = 1 \quad (10)$$

$$e=5 \quad q_{1115} = \sum_{k=1}^5 f_5(d_{111k}) = f_5(3.5) + f_5(4) + f_5(3.5) + f_5(3) + f_5(4) = 0 \quad (11)$$

For the evaluation index u_{111} , the total gray evaluation coefficient of the pharmaceutical company belongs to each evaluation gray class is q_{111} ,

$$q_{111} = \sum_{t=1}^5 q_{111e} = q_{1111} + q_{1112} + q_{1113} + q_{1114} + q_{1115} = 13.5 \quad (12)$$

For the indexes u_{111} , experts advocated the gray evaluation weight of the e -th evaluation gray class of the company is r_{111e} , then:

$$e=1 \quad r_{1111} = \frac{q_{1111}}{q_{111}} = \frac{3.6}{13.5} = 0.256 \quad (13)$$

$$e=2 \quad r_{1112} = \frac{q_{1112}}{q_{111}} = \frac{4.5}{13.5} = 0.326 \quad (14)$$

$$e=3 \quad r_{1113} = \frac{q_{1113}}{q_{111}} = \frac{4}{13.5} = 0.302 \quad (15)$$

$$e=4 \quad r_{1114} = \frac{q_{1114}}{q_{111}} = \frac{1}{13.5} = 0.085 \quad (16)$$

$$e=5 \quad r_{1115} = \frac{q_{1115}}{q_{111}} = \frac{0}{13.5} = 0 \quad (17)$$

Therefore, the evaluation weight vector r_{111e} of the company's evaluation index u_{111} to each gray class is:

$$r_{111} = [0.256, 0.326, 0.302, 0.085, 0]$$

Similarly, we can calculate the gray evaluation weight vector r_{ijx} of each evaluation index belongs to the index u_{ij} , furthermore to get evaluation weight matrix of the index U_i of the pharmaceutical company to each evaluation gray class.

$$R_{11} = \begin{bmatrix} r_{111} \\ r_{112} \end{bmatrix} = \begin{bmatrix} 0.285 & 0.326 & 0.307 & 0.085 & 0 \\ 0.325 & 0.324 & 0.214 & 0.022 & 0 \end{bmatrix} \quad (18)$$

$$R_{12} = \begin{bmatrix} r_{121} \\ r_{122} \\ r_{123} \end{bmatrix} = \begin{bmatrix} 0.256 & 0.325 & 0.245 & 0.065 & 0 \\ 0.254 & 0.326 & 0.412 & 0.003 & 0 \\ 0.269 & 0.352 & 0.198 & 0.051 & 0 \end{bmatrix} \quad (19)$$

$$R_{21} = \begin{bmatrix} r_{211} \\ r_{212} \\ r_{213} \end{bmatrix} = \begin{bmatrix} 0.174 & 0.185 & 0.285 & 0.362 & 0 \\ 0.265 & 0.315 & 0.314 & 0.114 & 0 \\ 0.265 & 0.354 & 0.314 & 0.098 & 0 \end{bmatrix} \quad (20)$$

$$R_{22} = \begin{bmatrix} r_{221} \\ r_{222} \\ r_{223} \end{bmatrix} = \begin{bmatrix} 0.206 & 0.545 & 0.103 & 0.003 & 0 \\ 0.352 & 0.415 & 0.112 & 0.005 & 0 \\ 0.229 & 0.198 & 0.269 & 0.285 & 0 \end{bmatrix} \quad (21)$$

$$R_{23} = \begin{bmatrix} r_{231} \\ r_{232} \\ r_{233} \end{bmatrix} = \begin{bmatrix} 0.145 & 0.194 & 0.269 & 0.301 & 0.003 \\ 0.142 & 0.198 & 0.265 & 0.302 & 0.085 \\ 0.165 & 0.174 & 0.256 & 0.269 & 0.121 \end{bmatrix} \quad (22)$$

$$R_{24} = \begin{bmatrix} r_{241} \\ r_{242} \end{bmatrix} = \begin{bmatrix} 0.215 & 0.156 & 0.145 & 0.285 & 0 \\ 0.202 & 0.265 & 0.360 & 0.215 & 0 \end{bmatrix} \quad (23)$$

$$R_{25} = [r_{25}] = [0.221 \quad 0.265 \quad 0.369 \quad 0.142 \quad 0] \quad (24)$$

$$R_{31} = \begin{bmatrix} r_{311} \\ r_{312} \\ r_{313} \\ r_{314} \end{bmatrix} = \begin{bmatrix} 0.265 & 0.328 & 0.342 & 0.048 & 0 \\ 0.213 & 0.254 & 0.298 & 0.140 & 0 \\ 0.256 & 0.315 & 0.325 & 0.113 & 0 \\ 0.262 & 0.362 & 0.285 & 0.036 & 0 \end{bmatrix} \quad (25)$$

$$R_{32} = \begin{bmatrix} r_{321} \\ r_{322} \end{bmatrix} = \begin{bmatrix} 0.218 & 0.269 & 0.363 & 0.185 & 0 \\ 0.205 & 0.548 & 0.102 & 0.005 & 0 \end{bmatrix} \quad (26)$$

$$R_{33} = \begin{bmatrix} r_{331} \\ r_{332} \end{bmatrix} = \begin{bmatrix} 0.296 & 0.396 & 0.247 & 0.069 & 0 \\ 0.269 & 0.698 & 0.102 & 0.003 & 0 \end{bmatrix} \quad (27)$$

$$R_{34} = \begin{bmatrix} r_{341} \\ r_{342} \\ r_{343} \end{bmatrix} = \begin{bmatrix} 0.298 & 0.357 & 0.255 & 0.025 & 0 \\ 0.295 & 0.339 & 0.365 & 0.107 & 0 \\ 0.215 & 0.254 & 0.324 & 0.112 & 0 \end{bmatrix} \quad (28)$$

(3) First grade gray comprehensive evaluation

Gray comprehensive evaluation for indexes belongs to U_{ij} , the evaluation results recorded as B_{ij} , then:

$$B_{11} = W_{11} \cdot R_{11} = [0.412, 0.526] \cdot \begin{bmatrix} 0.236 & 0.354 & 0.301 & 0.074 & 0 \\ 0.365 & 0.314 & 0.241 & 0.026 & 0 \end{bmatrix} \\ = [0.306 \quad 0.359 \quad 0.214 \quad 0.014 \quad 0] \quad (29)$$

Similarly obtained:

$$B_{12} = W_{12} \cdot R_{12} = [0.215 \quad 0.236 \quad 0.036 \quad 0.084 \quad 0] \quad (30)$$

$$B_{21} = W_{21} \cdot R_{21} = [0.265 \quad 0.248 \quad 0.302 \quad 0.175 \quad 0] \quad (31)$$

$$B_{22} = W_{22} \cdot R_{22} = [0.247 \quad 0.222 \quad 0.304 \quad 0.141 \quad 0] \quad (32)$$

$$B_{23} = W_{23} \cdot R_{23} = [0.145 \quad 0.154 \quad 0.326 \quad 0.214 \quad 0.141] \quad (33)$$

$$B_{24} = W_{24} \cdot R_{24} = [0.213 \quad 0.265 \quad 0.321 \quad 0.211 \quad 0] \quad (34)$$

$$B_{25} = W_{25} \cdot R_{25} = [0.220 \quad 0.238 \quad 0.374 \quad 0.162 \quad 0] \quad (35)$$

$$B_{31} = W_{31} \cdot R_{31} = [0.285 \quad 0.315 \quad 0.114 \quad 0.274 \quad 0] \quad (36)$$

$$B_{32} = W_{32} \cdot R_{32} = [0.215 \quad 0.245 \quad 0.141 \quad 0.362 \quad 0] \quad (37)$$

$$B_{33} = W_{33} \cdot R_{33} = [0.265 \quad 0.334 \quad 0.317 \quad 0.085 \quad 0] \quad (38)$$

$$B_{34} = W_{34} \cdot R_{34} = [0.284 \quad 0.315 \quad 0.362 \quad 0.122 \quad 0] \quad (39)$$

(4) Second grade gray comprehensive evaluation

From the above calculation, the gray evaluation matrix of second grade evaluation index U_i is $R_i = [B_{i1}, B_{i2}, \dots, B_{ij}]^T$, Gray comprehensive evaluation for indexes belongs to U_{ij} , the evaluation results are recorded as B_i , then:

$$B_1 = W_1 \cdot R_1 = [0.352 \quad 0.648] \cdot \begin{bmatrix} 0.362 & 0.314 & 0.248 & 0.044 & 0 \\ 0.214 & 0.333 & 0.304 & 0.098 & 0 \end{bmatrix} \\ = [0.202 \quad 0.315 \quad 0.328 \quad 0.047 \quad 0] \quad (40)$$

$$B_2 = W_2 \cdot R_2 = [0.285 \quad 0.124 \quad 0.352 \quad 0.205 \quad 0.014] \quad (41)$$

$$B_3 = W_3 \cdot R_3 = [0.251 \quad 0.362 \quad 0.125 \quad 0.241 \quad 0] \quad (42)$$

(5) Third grade gray comprehensive evaluation

From the above calculation, total gray evaluation matrix of first grade index U is $R = [B_1 B_2 B_3]^T$, then:

$$B = W \cdot R = \begin{bmatrix} 0.205 & 0.415 & 0.336 \end{bmatrix} \cdot \begin{bmatrix} 0.258 & 0.315 & 0.248 & 0.041 & 0 \\ 0.252 & 0.247 & 0.362 & 0.241 & 0 \\ 0.285 & 0.254 & 0.526 & 0.004 & 0 \end{bmatrix} \quad (43)$$

$$= \begin{bmatrix} 0.252 & 0.365 & 0.301 & 0.018 & 0.006 \end{bmatrix}$$

(6) Calculate the comprehensive evaluation value V

The comprehensive evaluation value V of the credit status of the pharmaceutical company is:

$$V = B \cdot C^T = \begin{bmatrix} 0.269 & 0.232 & 0.317 & 0.284 & 0.003 \end{bmatrix} \cdot \begin{bmatrix} 100 \\ 80 \\ 60 \\ 40 \\ 20 \end{bmatrix} = 73.2 \quad (44)$$

According to the credit evaluation index system of SMEs based on supply chain finance, we make multi-hierarchy gray comprehensive evaluation of the credit status of the pharmaceutical company. The evaluation results show that the credit rating of the pharmaceutical company is 73.2 points based on the credit status of the supply chain finance, which indicates that the credit is good, there is no problem to repay the debt under normal conditions, and the company's financial strength and asset quality are acceptable, the economic indexes are at the upper level, operating in a virtuous circle, the bank can consider providing credit support for the company.

The results show that: the comprehensive strength of the pharmaceutical company in general, the credit status is low, but place it in the background of the supply chain to overall consideration, through the analysis and study of the entire supply chain operation and cooperation between upstream and downstream enterprises, the credit rating has been improved as well as the credit status, the financing condition of the bank can be basically satisfied. Thus, the financing dilemma of the company can be alleviated, which quantitatively proves the effectiveness of supply chain finance to improve the financing environment of small and medium-sized enterprises and the advantages of enterprise financing.

5. CONCLUSION

The main contents and conclusions of this paper can be summarized as follows:

(1) Based on investigation of the general financing model of supply chain finance, this paper introduces and analyzes accounts receivable financing mode, FTW(Finance-Transportation and Warehouse)financing mode and confirming warehouse financing mode, and discusses its operation mechanism, credit risk and function separately. To reveal the potential financing advantages of supply chain finance.

(2) On the analysis of the credit risk influence factors of supply chain finance, the paper constructs a small and medium-sized enterprises credit risk comprehensive evaluation index system based on supply chain finance, and comprehensive evaluates the case by using multi-hierarchy gray evaluation method. The result is 73.4 points. Through comparative analysis of the results, we can quantitatively prove the financing advantage of supply chain finance and the effectiveness of improving the financing dilemma of China's small and medium-sized enterprises, and provide scientific and objective judgment basis for credit decision of banks and other financial institutions.

(3) On the basis of the former researches, this paper proposes to transfer and circumvent the financing risks of supply chain finance by using the method of credit spread options, and designs the basic trading model and parameters of the spread options, so as to provides some ideas for banks and other financial institutions to manage the credit risk of small and medium-sized enterprises based on supply chain finance, and at the same time improves the enthusiasm of banks to provide credit support for supply chain finance.

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