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Research on supply chain risk evaluation based on the core enterprise-take the pharmaceutical industry for example

Zhang Ling

Business School, Hohai University, Nanjing, Jiangsu, P. R. China

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ABSTRACT

In recent years, the financing problems of SMEs (small and medium sized enterprises) have become the focus of attention, including the pharmaceutical industry. With the rapid growth of economic development, the financial services of pharmaceutical industry become more and more diversification, which has become the effective method to solve financing problems of SMEs on the supply chain. However, there exists much risk in the pharmaceutical industry, so we need to construct a specific risk evaluation of pharmaceutical industry financial service. According to the characteristics of supply chain finance, paper build the risk assessment of pharmaceutical industry financial service model based on FAHP (fuzzy analytic hierarchy process), and the method is applied to the A Medical Corporation, the data shows that the evaluation method can effectively evaluate the risk in the financial services, and the model is universal to some extent.

Keywords: FAHP; supply chain; pharmaceutical industry; risk evaluation

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INTRODUCTION

Pharmaceutical industry as one of the key industries in the livelihood of the people planning, occupies a large proportion in the total output value of our country. With the rapid development of pharmaceutical industry in China, financing difficulties about pharmaceutical industry supply chain of SMEs have become increasingly prominent. The people's Bank of China has held a number of related financial forums to support the development of pharmaceutical industry, ask the banking system to do comprehensive medical and financial services, through a variety of ways to ensure the long-term stability of the pharmaceutical industry, which, is beneficial to the people's livelihood support. All of those have provided a vast prospect for the pharmaceutical industry financial services. The pharmaceutical industry financial services mainly refers to the financing activities among medical drugs , equipment production, sale, and purchase, including activities of stocks and bonds in the capital market and so on, which features in the amount of money, long period of turnover, capital increment etc[1]. It is a cross system related to laws and regulations, policy and finance insurance.

1 CURRENT SITUATION OF THE DEVELOPMENT OF PHARMACEUTICAL INDUSTRY OF FINANCIAL SERVICES IN CHINA

The well-known manufacturers in a strong position on Pharmaceutical industry supply chain were commonly known as the core enterprises. Upstream supply chain including parts suppliers, raw material suppliers[2]; the lower reach including dealers at all levels, although there is some difference between the supply chain, the general structure is basically same. As shown in Figure 1

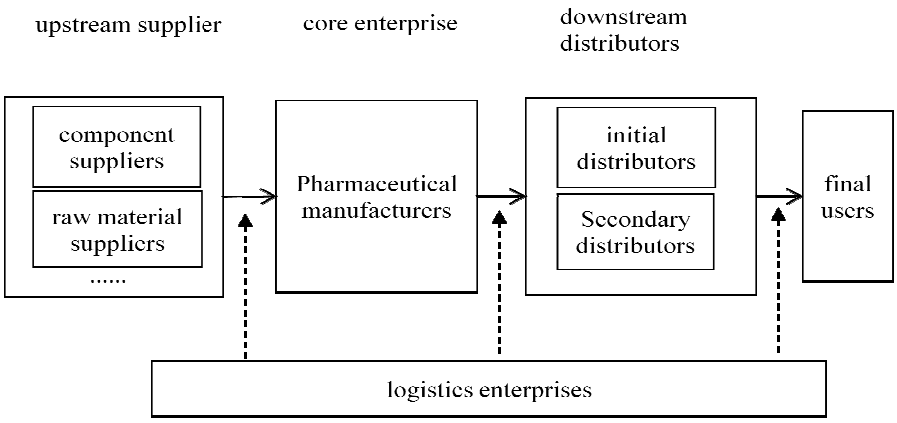

Fig.1 The figure of pharmaceutical industry supply chain

Generally, there will be a period of time from the pharmaceutical manufacturing enterprises received upstream supplier shipments to the pharmaceutical manufacturing enterprises pay the purchase, and dealers are generally pay the deposit at first, and then to take the goods after payment. The strong position of pharmaceutical manufacturing enterprises cause stress to the upstream and downstream enterprises on the funds.

The core enterprise usually has strong profit ability and a higher visibility and scale. Characteristics of these enterprises overall presentation stands for capital strength, sufficient cash flow; strong bargaining power, control right and the right to choose the lower reaches. It is the biggest part of the profit income in the supply chain, has the strong financing ability and financing channels, and is in a strong position in the negotiations of banks or financial institutions; the amount of bank credit is high, and financing conditions and the cost is low. The core enterprise is less dependent on banks in daily management, however, as to the evaluation system, the company is an excellent customer. To relieve this paradox, bund the upstream and downstream enterprises which have greater demand for funds to core enterprise, which not only guarantee the supply and demand of funds agreed, but also ensure the risk control requirements. The upstream and downstream suppliers of pharmaceutical industry mainly include the raw material suppliers, components suppliers, initial distributors and secondary distributors. Most of these firms are not large, with the limited profitability, and intense market competition. Generally, its popularity, scale and profitability are relatively weak. Once the financial companies of pharmaceutical industry opened in the domestic, it is likely to be a trend which cannot be halted[3]. As shown in Figure 2

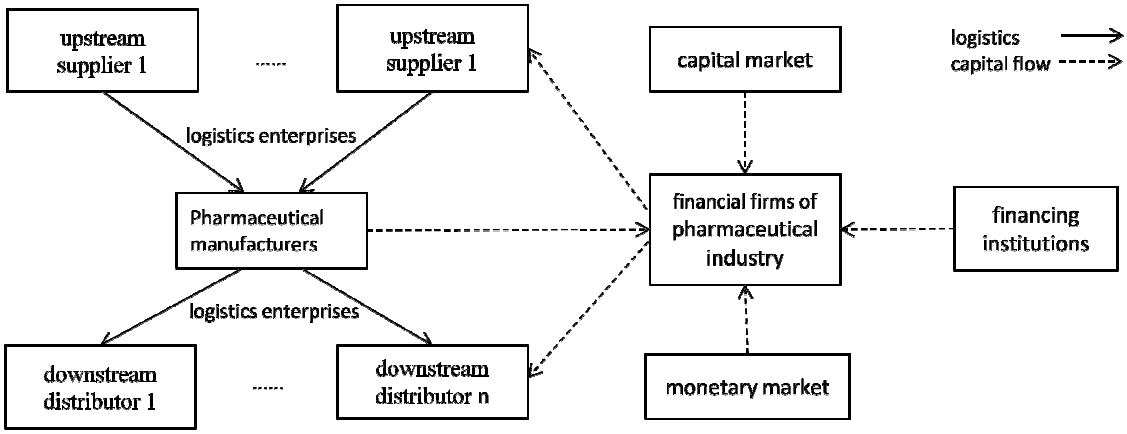

Fig.2 financial firms of pharmaceutical industry

2 RISK EVALUATION BASED ON FAHP

In recent years, the pharmaceutical industry financial business develops during practice. As the financing link and participant growing, the relevant business management becomes very complex and the following financing risk is becoming bigger[4]. Therefore, how to conduct risk management and control and avoid the adverse consequences coming from the risks is the key to financial success of supply chain in pharmaceutical industry. This article embarks from the supply chain core pharmaceutical manufacturing enterprises. It constructs the corresponding risk evaluation index system and fuzzy analytic hierarchy evaluation model by standing in the height of the supply chain. And put the risk evaluation method into practice by combining the example application[5].

2.1 THEORY OF FAHP

FAHP is an integrated use of analytic hierarchy process and fuzzy comprehensive evaluation method. Saaty puts forward the Analytic Hierarchy Process (AHP) which is a systematic and hierarchical analysis method combined with qualitative and quantitative in the 1970. Fuzzy mathematics is to study and deal with the fuzziness of mathematics. And it is a branch of mathematics developed based on the fuzzy set theory which was suggested by a US cyberneticist A.Zadeh in 1965. The basic idea of fuzzy comprehensive evaluation model is: on the basis of determining the rank and evaluation level of evaluation factors, uses the fuzzy set transform principle and the membership degree to describe fuzzy boundaries of factors, construct the fuzzy matrix, and then finally decide the rank of the evaluation object by multilayer compound operation[6]. This case uses MATLAB6.0 software to help calculate the related evaluation index.

2.2 STEPS OF FAHP

(1) Establish a hierarchy structure

Including destination layer U, criterion layer U_i, project layer U_{ij}. As shown in Figure 3

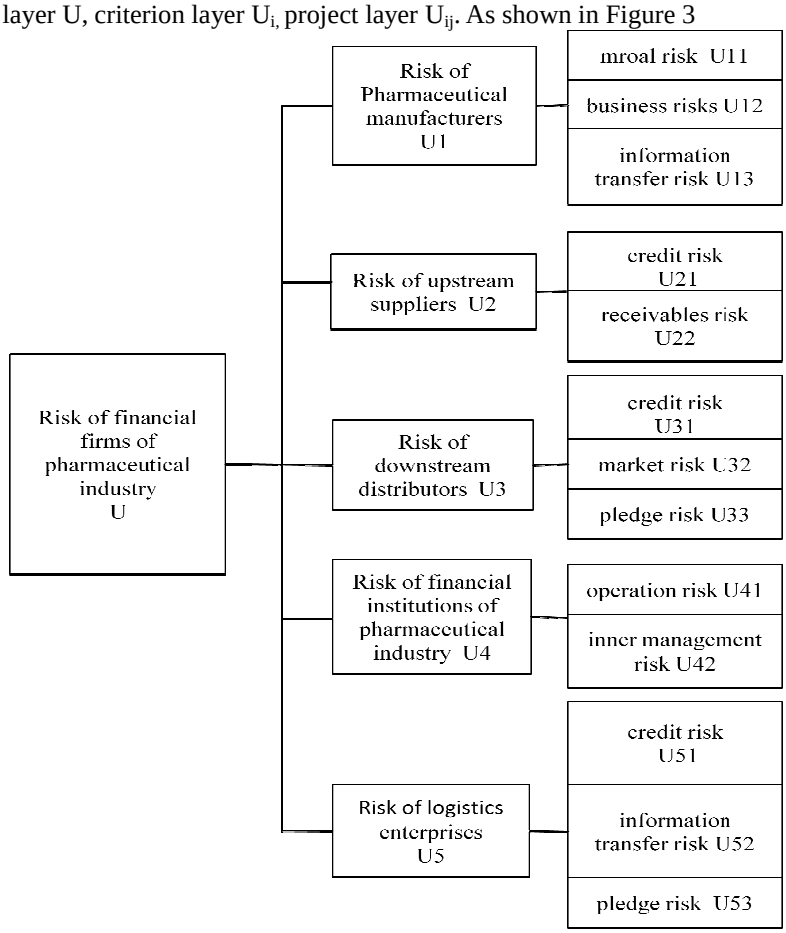

Fig.3 hierarchy structure

(2) Determine the weight of evaluation index

① constructs pairwise comparison matrices

Set on a layer of index A, the next layer of indicators B, B_i : $B_j \sim a_{ij}$, a_{ij} stands for effects ratio of B_i, B_j to A. The comparing scale currently used 1~9 scale proposed by Saaty et al. The value of a_{ij} is 1, 2, 3…9, and its reciprocal 1, 1/2, 1/3…1/9. As shown in table 1

Table.1 meaning of scale method

scale aij	1	2	3	4	5	6	7	8	9
the importance of Bi：Bj	equal		slightly strong		strong		obviously strong		absolutely strong

Note: Usually psychologists believe that should not be more than 9 factors of paired comparison. Through the 1~9 scale integration method, we can get a 5 dimensional matrix.

② Calculation of weight and the consistency check

Calculate the maximum eigenvalue λ_{max} and corresponding feature vector W of A, $AW=\lambda_{max} \times W$. The feature vectors

are normalized to get the weight vector w[7]. In order to keep the rationality and logic consistency evaluation before and after the weighting calculation results, we need to check the consistency of matrix A. When the consistency ratio CR is less than 0.1, we often think the consistency of the judgment matrix can be accepted; otherwise we need to re adjust the judgment matrix to meet the consistency test. Consistency index CI= λ -n/n-1 (n refers to the dimensions of the matrix, the bigger CI stands for the serious of inconsistency), the consistency ratio CR=CI/RI. Random consistency index RI as shown in table 2

Table.2 RI table from Satty

n	1	2	3	4	5	6	7	8	9	10	11
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51

(3) Construction of the fuzzy comprehensive evaluation model

①Determine the evaluation factors. According to the graph hierarchy above medical financial evaluation factors set, this paper divides into two layers of indexes to construct the factor set U, the first layer of index is denoted as U_i, second layer index is denoted as U_{ij}, so the factors set denoted as U=｛U_1, U_2, U_3, U_4, U_5｝.

②To calculate the index weight set, means the proportion weight of each index of U, expressed as B_i=｛w_{i1}, w_{i2}…w_{in}｝.

③ Establish the evaluation set. According to the risk of pharmaceutical supply chain finance, establish a appropriate evaluation set, usually divide to five levels, namely Z= { slightly risk, low risk, normal risk, high risk, obviously risk}, in order to facilitate the evaluation comparison, usually make the comment set digital, as shown in table 3

Table.3 evaluation set Z

evaluation set Z	slightly risk	low risk	normal risk	high risk	obviously
scale set	0-20	20-40	40-60	60-80	80-100
mark set	10	30	50	70	90

④ Calculate the fuzzy relationship matrix. Expert group rank the index U_i, and then count the frequency U_i fall in each Z levels, frequency / total number of experts =membership grade of each index, and then obtain the fuzzy relation matrix R_i.

⑤ Build a sub objective evaluation matrix. The sub goal evaluation vector $D_i=W_i*R_i$, sub objective evaluation matrix D= [D_1, D_2…D_i].

⑥ Calculate the comprehensive evaluation vector D, D=W*R

⑦ Calculate each factor score S_i, and comprehensive evaluation score S, $S_{i=}D_i*Z$, S=D*z

3 A CASE OF RISK EVALUATION

To assess the risk of professional financial company in the principle of professional and fairness, we distributed and recovered 60 valid questionnaires, the survey person including pharmaceutical manufacturing manager, financial institutions manager, the pharmaceutical industry association member, logistics manager and so on. Steps of risk evaluation are as follows:

(1) Build the risk evaluation index system. U_{ij} in judgment matrix equals to the mean of 60 experts' judgment.

Table.4 Risk evaluation matrix of financial firms of pharmaceutical industry

U	U_1	U_2	U_3	U_4	U_5	w
U_1	1	3	3	4	4	0.4302
U_2	1/3	1	1/4	4	3	0.1561
U_3	1/3	4	1	5	2	0.2808
U_4	1/4	1/4	1/5	1	1/2	0.0563
U_5	1/4	1/3	1/2	1/2	1	0.0766

λ_{max}=5.5826, CR=0.0631, Pass the consistency test.

Table.5 Risk evaluation matrix of Pharmaceutical manufacturers

U_1	U_{11}	U_{12}	U_{13}	w_1
U_{11}	1	4	5	0.6738
U_{12}	1/4	1	3	0.2255
U_{13}	1/5	1/3	1	0.1007

λ_{max}=3.0858, CR=0.0739, Pass the consistency test.

Table.6 Risk evaluation matrix of upstream suppliers

U_2	U_{21}	U_{22}	w_2
U_{21}	1	3	0.7500
U_{22}	1/3	1	0.2500

λ_{max}=2, CR=0, Pass the consistency test.

Table.7 Risk evaluation matrix of downstream distributors

U_3	U_{31}	U_{32}	U_{33}	w_3
U_{31}	1	3	5	0.6370
U_{32}	1/3	1	3	0.2583
U_{33}	1/5	1/3	1	0.1047

λ_{max}=3.0385, CR=0.0332, Pass the consistency test.

Table.8 Risk evaluation matrix of financial institutions of pharmaceutical industry

U_4	U_{41}	U_{42}	w_4
U_{41}	1	2	0.6667
U_{42}	1/2	1	0.3333

λ_{max}=2, CR=0, Pass the consistency test.

Table.9 Risk evaluation matrix of logistics enterprises

U_5	U_{51}	U_{52}	U_{53}	w_5
U_{51}	1	5	3	0.6370
U_{52}	1/5	1	1/3	0.1047
U_{53}	1/3	3	1	0.2583

λ_{max}=3.0385, CR=0.0332, Pass the consistency test.

(2) Determine the fuzzy comprehensive evaluation factor set. U=｛U_1, U_2, U_3, U_4, U_5｝.
(3) Calculate w_i, w_i=｛w_{i1}, w_{i2}…w_{in}｝,as in the last row in tables,
w_1= [0.6738 0.2255 0.1007]
w_2= [0.7500 0.2500]
w_3= [0.6370 0.2583 0.1047]
w_4= [0.6667 0.3333]
w_5= [0.6370 0.1047 0.2583]
w= [0.4302 0.1561 0.2808 0.0563 0.0766]

(4) Calculate the fuzzy relationship matrix R_i

$$R_1 = \begin{bmatrix} 0.2667 & 0.1667 & 0.1667 & 0.2333 & 0.1667 \\ 0.2 & 0.2333 & 0.2 & 0.2 & 0.1667 \\ 0.2 & 0.2333 & 0.2667 & 0.2 & 0.1 \end{bmatrix}$$

$$R_2 = \begin{bmatrix} 0.1667 & 0.1333 & 0.2 & 0.2667 & 0.2333 \\ 0.1 & 0.1667 & 0.2333 & 0.2 & 0.3 \end{bmatrix}$$

$$R_3 = \begin{bmatrix} 0.1 & 0.2 & 0.2333 & 0.2 & 0.2667 \\ 0.1333 & 0.1667 & 0.2 & 0.2667 & 0.2333 \\ 0.1333 & 0.1333 & 0.2333 & 0.2333 & 0.2667 \end{bmatrix}$$

$$R_4 = \begin{bmatrix} 0.2667 & 0.2333 & 0.1667 & 0.2 & 0.1333 \\ 0.2333 & 0.2667 & 0.2333 & 0.1333 & 0.1333 \end{bmatrix}$$

$$R_5 = \begin{bmatrix} 0.1333 & 0.2333 & 0.2667 & 0.2 & 0.1667 \\ 0.2 & 0.2667 & 0.1667 & 0.2 & 0.1667 \\ 0.1667 & 0.3 & 0.2 & 0.1333 & 0.1333 \end{bmatrix}$$

(5) Take the Risk of pharmaceutical manufacturers U_i for example. Calculate the sub goal evaluation vector $D_1=w_1*R_1$.

$$R_1 = \begin{bmatrix} 0.2667 & 0.1667 & 0.1667 & 0.2333 & 0.1667 \\ 0.2 & 0.2333 & 0.2 & 0.2 & 0.1667 \\ 0.2 & 0.2333 & 0.2667 & 0.2 & 0.1 \end{bmatrix}$$

w_1= [0.6738 0.2255 0.1007]

so, $D_1=w_1*R_1$= [0.2449 0.1884 0.1843 0.2225 0.1600]

in a similar way, D_2=[0.1500 0.1417 0.2083 0.2500 0.2500]

D_3= [0.1121 0.1844 0.2247 0.2207 0.2581]

D_4= [0.2556 0.2444 0.1889 0.1778 0.1333]

D_5= [0.1489 0.2540 0.2390 0.1828 0.1581]

$$R = \begin{bmatrix} D_1 & D_2 & D_3 & D_4 & D_5 \end{bmatrix}^T$$

The comprehensive evaluation vector D=W*R

D= [0.1860 0.1882 0.2038 0.2207 0.1999]

(6) Calculate each factor score S_i, and comprehensive evaluation score S, $S_i=D_i*Z$, S=D*z.

Z= [10 30 50 70 90]

S_1=47.2910, S_2=56.1660, S_3=56.5660, S_4=43.7760, S_5=48.0840, S=51.1360.

CONCLUSION

According to the results, the comprehensive evaluation score Z=51.1360, the evaluation results: normal risk. Through the evaluation scores it is obviously that the risk of the upstream suppliers and downstream distributors is relatively high, the evaluation scores were 56.1660 and 56.5660. may be it's due to the upstream and downstream enterprises are mostly in small and medium size, we have not established a SME credit system yet, the credit consciousness is not strong in SMEs, they are prone to credit crisis compared with large enterprises. Secondly, funds are not sufficient in SMEs, ability of anti risk is weak, and once the risk occurs it will directly affect the capital turnover, thus affecting the pharmaceutical industry financial company's funds chain. So it is necessary to pay attention to risk control of upstream and downstream enterprises in the supply chain, during the development of the pharmaceutical supply chain financial services, so as to make it coordinated and orderly. At last, the data also shows that model which based on pharmaceutical industry has effective practicality.

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