# Application of the Fuzzy AHP Model Based on a New Scale Method in the Financial Risk Assessment of the Listing Corporation

Xinhui Cui*, Zhiqiang He

Hebei Finance University, Baoding, Hebei, China, 071051.
cui_xinhui@126.com

Enterprises are facing a variety of risks, both financial risk and non-financial risk. But no matter what kind of risk, the final performance will be for the financial risk. The financial risk is the most significant and comprehensive reflection of enterprise risk. Only by doing a good job for financial risk assessment, the overall risk of the enterprise can be better evaluated. According to the characteristics of listing Corporation financial risk assessment, this paper proposes an improved fuzzy -AHP method aiming at the shortcomings of the traditional fuzzy -AHP method. We propose the 1-9 scaling method, which preserves the advantages of the original AHP method. We compare the various types of 1-9 scaling method, select the optimal scaling method, and calculate the weight of each factor of the financial risk of the listing Corporation. At the same time, we increase the security of the scope of the evaluation. This measure can avoid the division of the scope of the evaluation of fuzzy comprehensive evaluation method too absolute. Finally, we analyze the changeable trend of financial risk in the framework of the financial risk index system of listing Corporation. The trend of the financial risk index of the Listing Corporation is increasing, which shows that the financial risk of the Listing Corporation is decreasing. Meanwhile, we believe that the financial management of the Listing Corporation has become increasingly mature. The risk control ability of the mature listing Corporation has been able to resist all kinds of financial risks.

## 1. Introduction

Enterprises are facing a variety of risks, both financial risk and non-financial risk. But no matter what kind of risk, the final will be for the financial risk. The financial risk is the most significant and comprehensive reflection of enterprise risk. Only by doing a good job for financial risk assessment, the overall risk of the enterprise can be better evaluated. Financial risk is one of the most common risks in enterprises. In recent years, with the improvement of the socialist market economic system, especially the rapid development of the capital market, business management of part of the listing Corporation and the large group of Companies gradually from asset management to capital management, and they take the first effort in the financial guidance business management stage.

In the study of the financial risk of the listing Corporation, many scholars have made fruitful contributions. In the control of investment risk, Chen Y X (2008) pointed out that the investment risk is the product of the negative deviation of the actual net cash flow and the expected target value. Liang J H (2003) believed that the use of investment risk identification model can have a general and objective understanding of the effect of the company's investment. Zhang M H (2007) pointed out that the investment risk decision-making method that including weighted average cost of capital method and adjusted net present value method. At the same time, in the investment risk decision-making, we not only should pay attention to quantitative analysis, but also do not neglect the qualitative analysis. In terms of financial risk, Wei M W (1996) pointed out that the key to effectively inhibit the financial risk of enterprises is to study the formation mechanism of corporate financial risk. As far as possible to avoid the obvious financial risk factors. Zhang Y B and Peng S X (2002) used a series of monitor indicators of financial statements to achieve the purpose of financial risk monitoring. Huang j L and Bai F (2004) considered that the control of financial risk in the narrow sense mainly through the index analysis method and the financial leverage coefficient method. They measured the size of an enterprise's financial risk by calculating the coefficient of financial leverage. Wu S N and Meng L M (2000) pointed out that the financial risks of high-tech

investment projects potentially a great threat. They believe that improving the financial structure is the main way to reduce the financial risks of high-tech investment projects. Zhang B R (2009) believes that the main measures to prevent financial risk is the establishment of enterprise financial risk identification and warning system, and comprehensively improve the overall quality of financial personnel. In terms of market risk, Viney (2003) considered that market risk is the risk factor of the market which causes the enterprise to be lost. Wilmott (2001) considered that the market risk is the uncertainty of the expected return of the stock market. Melicher (2008) defined the market risk as the uncertainty of the future earnings of the investment. Tsay (2005),
Pan Z B (2008), Wang C F (2003) and Zhang H P (2010) believed that the market risk is the possibility of financial asset loss that due to the volatility of interest rate, exchange rate, stock price and other factors. Xu S (2003) defined the market risk as a possibility that will affect the price of the securities market. Volatility in the stock market prices will lead to asset devaluation.

In this paper, we develop an improved fuzzy -AHP method aiming at the shortcomings of the traditional fuzzy -AHP method. We propose the 1-9 scaling method, which preserves the advantages of the original AHP method. We compare the various types of 1-9 scaling method, select the optimal scaling method, and then calculate the weight of each factor of the financial risk of the listing Corporation. At the same time, we increase the security of the scope of the evaluation. This measure can avoid the division of the scope of the evaluation of fuzzy comprehensive evaluation method too absolute.

## 2. The basic model of fuzzy AHP

Fuzzy set as a famous method has been widely used to express fuzzy concepts. In the fuzzy sets, we use a relative vague language to describe a certain state of character. In this way, we can avoid to use "yes" and "non" to describe the nature of things. In general, fuzzy set includes three representations that are vector method, Zadhe method and membership function method. Among them, the vector method uses two tuples to describe the fuzzy set. In the vector method, $U$ is the object space, $x$ is the element of $U$, and there is a set of $A \subseteq U$. $x \in A$ can be expressed as $(x,1)$, and $x \notin A$ can be expressed as $(x,0)$. The membership function is established by using fuzzy membership function method to measure fuzzy sets. In the fuzzy set, the value between 0 to 1 is used to describe the elements of membership.

**Definition 1:** in the set $X$, element $x$ can be expressed as the following sequence

$$A = \{(x, f_A(x) | x \in A)\}$$

(1)

Among them, $f_A(x)$ is the membership function of the $X$. The membership function is a numerical value in the interval $[0,1]$, which we call the value of membership.

**Definition 2:** fuzzy set $X$, in the domain of the set of all points $x$ of the membership function $f_A(x) > 0$ is a support set of fuzzy set $X$:

$$Support(A) = \{x | f_A(x) > 0\}$$

(2)

**Definition 3:** in the fuzzy set $X$, all points $x$ that meet the conditions $f_A(x) = 0$ which is the kernel of fuzzy set $A$

$$Core(A) = \{x | f_A(x) = 0\}$$

(3)

**Definition 4:** the kernel of the set $A$ is non-empty, then the set $A$ is also non-empty.

$$\exists x \in X, f_A(x) = 1$$

(4)

## 3. Scale method and weight optimization

The traditional AHP method uses the 1-9 scale method, but we have found that the scale method has some differences with the human's thinking. For example, we compare the two metrics $x_1$ and $x_2$, when $x_1$ is slightly more important than $x_1$, their scaling is 4:1. It means that $x_1$ is 4 times more important than $x_2$, which is a gap in our thinking. When the index of the problem is more and the scale is large, the 1-9 scale method is prone to problems. Aiming at the problem of 1-9 scale method, many domestic scholars have carried on the research, and proposed the improvement method. For example, some researchers put forward the index scaling method that is the exponential scaling method, 9/9-9/1 fractional scaling method, and the index

scaling method, etc.. In the study of 1-9 scaling method, we find that when $x_1$ is more important than $x_2$, the importance of $x_1$ is probably 4 times $x_2$. Based on this, we use a new scale method: $In(\frac{9}{9}e) \sim In(\frac{17}{1}e)$ scaling method.

## 4. Scale uniformity.

When we use the scale, we first calculate subtraction or division of two scales. Then we compare the results of the calculations. If we find results of the comparison are very different. We say that the uniformity of the scale is not very good, the scale is not reasonable. Therefore, in order to verify the uniformity of the scale, we use the mean value of the distance between the scaling value to carry out the test, and the calculation formula is as follows:

$$b = \max\left(d/D, D/d\right) \tag{5}$$

$$d = \max\left(d_{ij}\right)\big/\min\left(d_{ij}\right), j = i+1; i = 1, 2, \cdots, 8 \tag{6}$$

$$D = \max\left(D_{ij}\right)\big/\min\left(D_{ij}\right), j = i+1; i = 1, 2, \cdots, 8 \tag{7}$$

$$d_{ij} = s_j - s_i, j = i+1; i = 1, 2, \cdots, 8 \tag{8}$$

$$D_{ij} = s_j\big/s_i, j = i+1; i = 1, 2, \cdots, 8 \tag{9}$$

Among them, $s_j$ and $s_i$ are adjacent values to the same scale.

According to the above formula, we calculate the mean value of the distance of the scale value. The results are shown in table 1:

*Table 1: Average value of the distance of the scale value in different scale method*

|   | 1-9 | 9/9- 9/1 | $9^{0/9} - 9^{8/9}$ | $In(e) \sim In(\frac{25}{1}e)$ |
|---|---|---|---|---|
| d | 1 | 36 | 6.14 | 3.65 |
| D | 1.78 | 1.78 | 1.02 | 1.12 |
| b | 1.78 | 20.25 | 6 | 2.53 |

From the above table, the 1-9 scale method and $In(e) \sim In(\frac{25}{1}e)$'s scale uniformity are better, the scaling of 9/1- 9/9 scale is generally, and the uniformity of the $9^{0/9} - 9^{8/9}$ scale method is poor. So we chose the $In(e) \sim In(\frac{25}{1}e)$ scaling method as the standard method for improving the fuzzy AHP.

## 5. Simulation and result analysis

First of all, we give the financial evaluation index system of listing Corporation in china:

*Table 2: Financial evaluation index system of China's listing Corporation*

| First level index $F$ | Second level index $C$ | Financial index $B$ | Variable |
|---|---|---|---|
| Financial risk | Financing risk | quick ratio | $X_1$ |
| | | current ratio | $X_2$ |
| | | Asset liability ratio | $X_3$ |
| | Investment risk | Main business cost ratio | $X_4$ |
| | | Operating expense ratio | $X_5$ |
| | | Management expense ratio | $X_6$ |
| | | Financial expense ratio | $X_7$ |
| | | Total assets turnover rate | $X_8$ |
| | | Net assets yield | $X_9$ |
| | | Return on assets | $X_{10}$ |
| | | Net interest rate | $X_{11}$ |
| | | Main business revenue growth rate | $X_{12}$ |
| | | Pre-tax profit growth rate | $X_{13}$ |
| | | Net profit growth rate | $X_{14}$ |
| | | Total asset growth rate | $X_{15}$ |
| | Income distribution risk | Shareholder's equity growth rate | $X_{16}$ |
| | | Total assets ratio of retained earnings | $X_{17}$ |
| | Cash flow at risk | Cash Debt Coverage Ratio | $X_{18}$ |

In this paper, we evaluate the financial risk of the listing Corporation as the evaluation object, and then evaluate the financial risk index of the listing Corporation for three years. Firstly, according to the method of calculating the weight of the above, we find the weight of all levels:

Due to the limited space of the article, we only take the second grade index as the example

The first step is to find the bottom evaluation matrix $R$:

$$R_a = \begin{bmatrix} 0 & 0 & 0.210 & 0.790 & 0 \\ 0 & 0 & 0.130 & 0.870 & 0 \\ 0 & 0 & 0.120 & 0.880 & 0 \end{bmatrix}$$

$$R_b = \begin{bmatrix} 0 & 0 & 0.251 & 0.749 & 0 \\ 0 & 0 & 0.062 & 0.838 & 0.1 \\ 0 & 0 & 0.195 & 0.805 & 0.2 \end{bmatrix}$$

$$R_c = \begin{bmatrix} 0 & 0.111 & 0.357 & 0.532 & 0 \\ 0 & 0.035 & 0.222 & 0.743 & 0 \\ 0 & 0.042 & 0.106 & 0.852 & 0 \end{bmatrix}$$

The second step, the evaluation results of the third level indicators $B$ are calculated:

$$B_a = w_a{}' \cdot R_a = (0.3213, 0.3487, 0.33) \cdot \begin{bmatrix} 0 & 0 & 0.210 & 0.790 & 0 \\ 0 & 0 & 0.130 & 0.870 & 0 \\ 0 & 0 & 0.120 & 0.880 & 0 \end{bmatrix}$$

$$= (0, 0, 0.1524, 0.8476, 0)$$

According to the same method, we can get $B_b = (0, 0, 0.1604, 0.7721, 0.0675)$, $B_c = (0, 0.0825, 0.2352, 0.6827, 0)$.

So as to calculate the evaluation matrix of the two level index $C_1$.

The third step, in accordance with the same method, we get the listing Corporation risk indicators $F$ in 2011

$$F = (w_1, w_2, w_3, w_4, w_5) \cdot [C_1, C_2, C_3, C_4, C_5]$$

$$= (0.301, 0.247, 0.181, 0.196, 0.075) \cdot \begin{bmatrix} 0 & 0 & 0.252 & 0.705 & 0.043 \\ 0 & 0.016 & 0.064 & 0.500 & 0.420 \\ 0 & 0.034 & 0.163 & 0.783 & 0.020 \\ 0 & 0.081 & 0.343 & 0.576 & 0 \\ 0 & 0 & 0.288 & 0.512 & 0.300 \end{bmatrix}$$

$$= (0, 0.026, 0.209, 0.628, 0.137)$$

*Table 3: Comprehensive evaluation results of the financial risk index of listing Corporation*

|      | Bad | Poor  | General | Good  | Excellent |
|------|-----|-------|---------|-------|-----------|
| 2011 | 0   | 0.026 | 0.209   | 0.628 | 0.137     |
| 2012 | 0   | 0.017 | 0.204   | 0.633 | 0.146     |
| 2013 | 0   | 0.012 | 0.191   | 0.669 | 0.148     |

From the table we can see the results of comprehensive evaluation, evaluation of excellent or good results showed an upward trend, while the general and poor evaluation results declined. It shows that the evaluation results of the evaluated object are steadily rising, which is consistent with the actual situation. In addition, from the bottom of the evaluation matrix we can see that the financial level of the listing Corporation's evaluation matrix and not too big change. This shows that the financial management capabilities of the listing Corporation

has become more mature, the financial management of the listing Corporation has been better to resist all kinds of risks.

## 6. Conclusions

In this paper, we propose an improved fuzzy -AHP method aiming at the shortcomings of the traditional fuzzy -AHP method. We propose the 1-9 scaling method, which preserves the advantages of the original AHP method. We compare the various types of 1-9 scaling method, select the optimal scaling method, and then calculate the weight of each factor of the financial risk of the listing Corporation. At the same time, we increase the security of the scope of the evaluation. This measure can avoid the division of the scope of the evaluation of fuzzy comprehensive evaluation method too absolute. Finally, we analyze the change trend of financial risk in the framework of the financial risk index system of listing Corporation. The trend of the financial risk index of the listing Corporation is increasing, which shows that the financial risk of the listing Corporation in reducing. At the same time, we analyze the change of the underlying evaluation matrix. Then, we believe that the financial management of the listing Corporation has become increasingly mature. The risk control ability of the mature listing Corporation has been able to resist all kinds of financial risks.

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