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FINANCIAL RISK ASSESSMENT OF LISTED TOURISM COMPANIES BASED ON EVIDENTIAL REASONING ALGORITHM

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Abstract. *In recent years, tourism industry in China has developed rapidly. Tourism enterprises are facing financial risks as well as opportunities. How to accurately evaluate financial risk of the listed tourism companies is of great practical significance. This paper first chooses the representative financial index to establish the financial risk index system of the listed tourism companies. Then the entropy weight method is used to determine the index weight. Finally, the evidence reasoning algorithm is used to evaluate the financial risk of the listed tourism companies, and the satisfactory results are obtained.*
Keywords: Financial risk assessment, Listed tourism companies, Entropy weight method, Evidence reasoning algorithm

1. **Introduction.** With the rapid development of China's tourism industry, tourism has become a strategic pillar industry of the national economy and a happy industry closely related to the people. For many years, China has maintained the status of the world's largest outbound tourist country and the fourth largest inbound tourist host countries in the world. According to the data provided by the National Tourism Bureau Data Center, the total tourism revenue of China was 5.4 trillion yuan in 2017, which has an average annual growth of 15.83% since 2012. The domestic tourism market is 5 billion people in 2017, an average annual growth rate of 11.08% since 2012. In 2017, domestic tourism revenue was 4.57 trillion yuan, an average annual growth rate of 15% from 2012. China's tourism industry has achieved rapid development in a short period of time, making great contributions to the development of the national economy. However, the market competition is intensifying day by day. At the same time, the tourism enterprises are facing a lot of financial risk problems which will affect the efficiency of the enterprises. Under such circumstances, accurately assessing the financial risks of China's listed tourism companies will help to avoid risks and benefit the healthy development of China's listed tourism companies.

An early study of the financial risk of enterprises was done by foreign academics. Fitzpatrick carried out the earliest financial early warning research – single variable bankruptcy prediction [1]. Altman used a multivariate linear model to analyze the possibility of financial risk in an enterprise [2]. Altman et al. proposed ZETA model based on the z-score model, adjusted the annual report data of the company, and created a research method that could clearly reflect the company's bankruptcy risk [3]. Ohlson and Zavgren provide financial risk early warning by introducing logistic and probit regression methods [4,5]. Odom and Sharda proposed the artificial neural network method to warn the financial situation [6]. Altman et al. used artificial neural network to warn enterprises of financial situation [7]. Mariekede constructed a cash flow model to introduce cash flow

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into early-warning research on corporate financial risk [8]. Purwanto et al. integrated the multivariate financial ratio index analysis, multivariate linear judgement model and cash flow model on the basis of previous research experience, forming a new financial risk early warning system [9].

In view of the financial risks of tourism enterprises, some scholars in China have explored and applied different models and methods. Han used the qualitative analysis method in finance and accounting, and discussed several measures of the financial risk control of the tourism enterprise [10]. Yin and Zhou used the extenics model to make a quantitative study on the financial risk of different aspects of the listed tourism companies [11]. Chen and Zhang used the grey relational evaluation model to study the financial risks of hotel listed tourism companies [12]. Wang used the principal component analysis to make an early warning analysis of the listed tourism companies finance [13]. Wu made a quantitative analysis and research on the profit model of the theme tourism enterprises in his Master Thesis [14]. Hu adopted the empirical research method to study the risk of rural tourism industry in China in his Master Thesis [15]. The above domestic and foreign research process and research results have certain reference value for this paper.

This paper proposes the D-S evidence reasoning algorithm, to calculate the confidence level of each financial risk assessment index in the evaluation set, then to determine the financial risk situation of each sample, so that the company can take corresponding measures to manage the risks. There are advantages to use the evidence reasoning algorithm to carry out the financial risk assessment of listed tourism companies. When we evaluate the financial risks of listed tourism companies, although the established financial risk index system is representative, it cannot cover all the financial risk factors. However, the evidence reasoning algorithm has the unique ability and advantage to solve the multiple criteria decision-making problems with incomplete information. Therefore, the use of evidence reasoning to carry out financial risk assessment can reflect the enterprise financial risk level more scientifically.

2. Construction and Weight Calculation of Financial Risk Assessment Index of Listed Tourism Companies.

Listed tourism company is listed on the Shanghai and Shenzhen two exchange trading of securities market, its main business includes tourism catering, hotel services, scenic spot tourism services, tourism transportation, tourism information, tourism product sales business and main business income accounted for the proportion of total income is not lower than 50% shares of the listed company [16].

2.1. Construction of financial risk assessment index system for listed tourism companies.

Tourism industry has strong dependence on natural resources and human resources. It is comprehensive, seasonal and sensitive, and is vulnerable to external influences. It faces many constraints, big risks and great potential [17]. Therefore, the financial risk of the listed tourism companies has the characteristics of persistence, dynamics, volatility and complexity. The solvency, operating capability and profitability of tourism enterprises have great influence on the financial risk of the enterprises. In this paper, based on the relevant theory of enterprise financial risk assessment and the characteristics of the financial risk of listed company, also the reference related literature of the scholars at home and abroad, financial risk assessment index system of listed tourism company is established from financial perspective in Table 1.

2.2. The entropy weight method to determine the weight of financial index.

Entropy weight method is an objective weighting method to collect the values of specific indexes of each research sample and construct the judgment matrix. In order to eliminate the influence of dimensionality, the original judgment matrix needs to be treated with dimensionless treatment. Then use MATLAB computer language to calculate the corresponding entropy and entropy weight [18].

TABLE 1. Financial risk assessment index system of listed tourism companies

Financial risk of listed tourism companies (A)	Solvency (B_1)	Asset-liability ratio	C_1
		Liquidity ratio	C_2
		Quick ratio	C_3
		Equity ratio	C_4
		Interest coverage ratio	C_5
	Operating capability (B_2)	Inventory turnover ratio	C_6
		Receivable turnover ratio	C_7
		Total asset turnover ratio	C_8
		Cash flow ratio	C_9
	Profitability (B_3)	Total asset profit ratio	C_{10}
		Return on assets ratio	C_{11}
		Sales profit ratio	C_{12}

(1) Construct the pending matrix. The existing research sample size m, index number n, which forms the original matrix $R = (R_{ij})$, $i = 1, 2, \ldots, m$, $j = 1, 2, \ldots, n$.

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}$$

(2) Calculate the proportion of the index value of the i item under the j index p_{ij}:

$$p_{ij} = r_{ij} \Big/ \sum_{i=1}^{m} r_{ij}$$

(3) Calculate the entropy of the j index e_j:

$$e_j = -k \sum_{i=1}^{m} p_{ij} * \ln p_{ij}, \quad k = 1/\ln m$$

(4) Calculate the entropy weight of the j index w_j.

The size of entropy weight directly reflects the role of each financial index in influencing the financial risk of the enterprise.

$$w_j = (1 - e_j) \Big/ \sum_{j=1}^{n} (1 - e_j)$$

(5) Determine the comprehensive weight of the index β_j.

It is assumed that the evaluator determines the weight of the index to be α_j, $j = 1, 2, \ldots, n$. According to its purpose and requirements, combined with the entropy weight w_j of the index, the comprehensive weights of the index j can be obtained.

$$\beta_j = \alpha_j w_j \Big/ \left(\sum_{j=1}^{n} \alpha_j w_j \right)$$

3. Empirical Study on Financial Risk Assessment of Listed Tourism Companies of Scenic Spots Based on Entropy Weight Evidence Reasoning Algorithm.

3.1. **Selection of sample data.** The listed tourism companies in Shanghai and Shenzhen are divided into three categories: scenic spots, hotels and comprehensive category. This paper selects Tibet Tourism (600749), Dalian Sun Asia (600593), Beibu Gulf Brigade (603869), Oct A (000069), Yunnan Tourism (002059), Jiuhua Tourism (603199), Lijiang Tourism (002033), Guilin Tourism (000978), Changbai Mountain (603099), Zhangjiajie (000403), Mount Huangshan B (900942), Xi'an Tourism (000610), Qujiang Cultural Tourism (600706), Sante Cableway (002159), Mount Emei A (000888) total 15 listed tourism companies of scenic spots as the research sample, which are with complete financial index data. According to the annual financial data of 2012∼2016, the company financial risks are evaluated (source: NetEase Finance) [19].

3.2. **Determination of the weight of financial risk index.** According to the principle of entropy weight, considering the continuity and stability of company financial index, combined with the financial index values of 15 selected listed tourism companies, the paper averages the original data of 12 financial indicators (2014-2016). The original matrix is constructed as follows:

$$\begin{pmatrix}
58.82 & 0.51 & 0.46 & 146.34 & -216.30 & 4.34 & 7.08 & 0.10 & -1.99 & -3.28 & 3.26 & -32.44 \\
39.92 & 1.21 & 1.20 & 63.60 & 482.15 & 66.17 & 132.15 & 0.42 & 60.81 & 5.40 & 42.46 & 12.98 \\
23.68 & 2.06 & 1.90 & 30.40 & 1184.68 & 17.01 & 18.84 & 0.43 & 72.94 & 6.55 & 9.95 & 18.31 \\
65.51 & 1.65 & 0.58 & 185.03 & 1133.41 & 0.29 & 70.90 & 0.31 & -1.50 & 5.15 & 3.37 & 18.36 \\
51.31 & 1.46 & 0.61 & 89.62 & 914.90 & 0.73 & 3.62 & 0.34 & -0.25 & 2.29 & 13.97 & 7.26 \\
22.12 & 1.44 & 1.38 & 30.71 & -3193.03 & 28.56 & 182.53 & 0.41 & 127.27 & 6.98 & 36.11 & 17.39 \\
20.37 & 5.29 & 5.23 & 13.37 & 1015129.57 & 12.73 & 58.51 & 0.30 & 132.91 & 9.15 & 21.39 & 32.24 \\
44.66 & 0.84 & 0.69 & 79.81 & 114.04 & 3.43 & 3.26 & 0.23 & 45.51 & -0.07 & 23.18 & -1.07 \\
10.00 & 7.94 & 7.81 & 11.10 & -2939.08 & 19.92 & 618.21 & 0.37 & 208.44 & 9.01 & 32.80 & 27.32 \\
41.25 & 0.52 & 0.49 & 87.07 & 1308.14 & 69.74 & 247.70 & 0.68 & 73.21 & 8.28 & 32.92 & 13.19 \\
25.99 & 2.05 & 1.11 & 32.91 & 3585.72 & 1.00 & 36.29 & 0.42 & 60.14 & 7.16 & 28.31 & 18.71 \\
30.38 & 1.80 & 1.49 & 42.69 & 3634.79 & 69.62 & 45.36 & 0.89 & -15.45 & -0.74 & 15.51 & -0.24 \\
52.25 & 1.01 & 0.94 & 107.96 & 278.08 & 14.70 & 3.15 & 0.59 & 16.30 & 2.39 & 19.58 & 4.05 \\
52.64 & 0.58 & 0.41 & 116.41 & 164.74 & 2.46 & 44.52 & 0.20 & 7.05 & -0.05 & 18.66 & -0.63 \\
20.25 & 2.34 & 2.10 & 18.38 & 2700.96 & 8.81 & 53.86 & 0.45 & 78.37 & 7.79 & 47.34 & 18.26
\end{pmatrix}$$

According to the steps of entropy weight method in 2.2, the weights of 12 financial indicators are determined as follows.

TABLE 2. Financial risk index weights with entropy weight method

Standard layer	Weight (W_b)	Sub index		Weight (W_c)
B_1	0.63	Asset-liability ratio	C_1	0.0303
		Liquidity ratio	C_2	0.0892
		Quick ratio	C_3	0.1134
		Equity ratio	C_4	0.0570
		Interest coverage ratio	C_5	0.3369
B_2	0.29	Inventory turnover ratio	C_6	0.0947
		Receivable turnover ratio	C_7	0.1221
		Total asset turnover ratio	C_8	0.0294
		Cash flow ratio	C_9	0.0512
B_3	0.08	Total asset profit ratio	C_{10}	0.0245
		Return on assets ratio	C_{11}	0.0376
		Sales profit ratio	C_{12}	0.0137

3.3. **Evidential reasoning algorithm.** Evidence reasoning (Dempster-Shafer reasoning), is referred to as D-S reasoning. D-S theory can treat the hypothesis as a set and introduce trust function to describe the trust degree of proposition. The basic idea is: (a) Establish the recognition framework and use the set method to study the propositions;

(b) Establish the initial trust allocation. According to the information provided by the evidence, the support degree for each set by the evidence is allocated; (c) Calculate the trust degree of proposition [20].

3.4. **Empirical research.** Company financial risk assessment is a comprehensive, hierarchical and dynamic system analysis. Therefore, we need to take account of the company's solvency, operation ability and profitability. In this paper, according to the state-owned capital performance evaluation rules policy papers and the operating conditions of enterprises evaluation, on the basis of literature review, the financial risk evaluation system of listed tourism company is constructed. The financial risk level is divided into "excellent", "good" "middle" and "bad".

Set: $U_\eta = \{U_1, U_2, U_3, U_4\}$ is the evaluation level of financial risk.

(Note: U_1 – excellent; U_2 – good; U_3 – middle; U_4 – bad)

$B_i = \{B_1, \ldots, B_i\}$, B_i is the ith first level index of financial risk, $i = 1, 2, 3$.

$C_j = \{C_1, \ldots, C_j\}$, C_j is the jth secondary level index of financial risk; $j = 1, \ldots, 12$.

$\lambda_{cj} = \left[\lambda_{cj}^L, \lambda_{cj}^H\right]$. It indicates that each secondary index corresponds to the corresponding score interval of the ith evaluation level, and the interval is determined by the evaluation of various indicators standard values by several experts.

$0 \le \lambda_{cj}^L \le \lambda_{cj}^H \le 1$, $j = 1, 2, 3, \ldots, 12$.

$H = (U_\eta, R_j)$: R_j is the confidence of each secondary level index on the evaluation level U_η.

$0 \le R_j \le 1$, $j = 1, \ldots, 12$.

$W_i = (W_1, \ldots, W_i)$, W_i is the relative weight of the first level index. $0 \le W_i \le 1$, $i = 1, 2, 3$.

$W_{ix} = \{W_{i1}, \ldots, W_{ix}\}$, W_{ix} is the weight of the xth secondary level index at the ith first level index, and meets $0 \le W_{ix} \le 1$, $i = 1, 2, 3, 4$; $x = 1, 2, \ldots, 12$.

R_j is obtained from the following two formulas:

When $x_j > \frac{\lambda_{cj}^L + \lambda_{cj}^H}{2}$, $R_j = \frac{x_j - \lambda_{cj}^L}{\lambda_{cj}^H - \lambda_{cj}^L}$, $R_{j-1} = 1 - R_j$;

When $x_j < \frac{\lambda_{cj}^L + \lambda_{cj}^H}{2}$, $R_{j-1} = \frac{\lambda_{cj}^H - x_j}{\lambda_{cj}^H - \lambda_{cj}^L}$, $R_j = 1 - R_{j-1}$.

x_j is the secondary level index data of each sample.

According to the data x_j obtained from the financial statements of 15 sample enterprises in 2016, the confidence level of each indicator in different evaluation levels is calculated $H = (U_\eta, R_j)$ and the basic credibility distribution function of each secondary index is established. Then the mass function of each secondary index is synthesized by the rule of evidence inference. On this basis, the confidence of the sample in each evaluation level is obtained. The financial risk level of the evaluated object is judged according to the confidence of evaluation degree so as to take corresponding measures.

Steps:

Determine the mass function of each secondary level index, with the data x_j obtained for each secondary level index, calculate the confidence of each secondary level index in different evaluation degree $H = (U_\eta, R_j)$. The mass function of each secondary level index is calculated according to the weight of the confidence and the secondary level index W_{ix}. Calculate the mass function of each secondary level index.

$$m(U_\eta/x_j) = W_{ix}R_j, \quad \eta = 1, 2, 3, 4.\ i = 1, 2, 3;\ j = 1, 2, \ldots, 12. \tag{1}$$

$$m(U/x_j) = 1 - \sum_{j=1}^{n} m(U_\eta/x_j) = 1 - W_{ix}\sum_{j=1}^{n} R_j \tag{2}$$

$$\overline{m}(U/x_j) = 1 - W_{ix} \tag{3}$$

$$\widetilde{m}(U/x_j) = W_{ix}\left(1 - \sum_{j=1}^{n} R_j\right) \tag{4}$$

$$m(U/x_j) = \overline{m}(U/x_j) + \widetilde{m}(U/x_j) \tag{5}$$

Among them, $m(U/x_j)$ represents the global basic probability distribution assigned to the secondary index, which is composed of unknown $\overline{m}(U/x_j)$ due to the weight and unknown $\widetilde{m}(U/x_j)$ due to the judgement.

According to the above steps, after calculation, the following results are obtained.

TABLE 3. Confidence level on the evaluation set of each two level index

Confidence of the secondary index	U_1	U_2	U_3	U_4
C_1	0.064	0.106	0.053	0.041
C_2	0.308	0.148	0.077	0.160
C_3	0.175	0.487	0.016	0.204
C_4	0.122	0.101	0.153	0
C_5	0.559	1.807	0.592	0.600
C_6	0.163	0.170	0.150	0.350
C_7	0.177	0.230	0.193	0.381
C_8	0.043	0	0	0.068
C_9	0.086	0.278	0.07	0.100
C_{10}	0.043	0.032	0.043	0.044
C_{11}	0.066	0.099	0.060	0.083
C_{12}	0.021	0.026	0.023	0.044

TABLE 4. 15 sample firms's probability distribution on the evaluation set

Sample Firms	U_1	U_2	U_3	U_4
Tibet Tourism	0.099	0.052	0.071	0.112
Dalian Sun Asia	0.099	0.205	0.089	0.135
Beibu Gulf Tourism	0.275	0.094	0.086	0.086
Oct A	0.119	0.205	0.089	0.135
Yunnan Tourism	0.091	0.133	0.164	0.103
Jiuhua Tourism	0.107	0.320	0.078	0.121
Lijiang Tourism	0.179	0.109	0.080	0.123
Guilin Tourism	0.103	0.163	0.174	0.116
Changbai Mountain	0.107	0.173	0.078	0.128
Zhangjiajie	0.116	0.196	0.086	0.131
Mount Huangshan B	0.194	0.115	0.085	0.130
Xi'an Tourism	0.123	0.014	0.092	0.139
Qujiang Cultural Tourism	0.111	0.185	0.082	0.126
Sante Cableway	0.124	0.018	0.094	0.141
Mount Emei A	0.207	0.187	0.083	0.127

4. **Analysis.** Select the evaluation set with the maximum probability value as the financial risk assessment results of each sample. The empirical study can get the results: Beibu Gulf Tourism, Lijiang Tourism, Mount Huangshan B, Mount Emei A the financial risk levels are "excellent"; Dalian Sun Asia, Oct A, Jiuhua Tourism, Changbai Mountain, Zhangjiajie, Qujiang Cultural Tourism the financial risk levels are "good"; Yunnan Tourism, Guilin Tourism the financial risk levels are "middle"; Tibet Tourism, Xi'an Tourism, Sante Cableway the financial risk levels are "bad".

Through the data from NetEase finance and Cninfo website information disclosure, the net profit of Beibu Gulf Tourism, Lijiang Tourism, Mount Huangshan B, Mount Emei A is superior to other scenic spot listed tourism companies, verifying the conclusion of this paper. Dalian Sun Asia, Oct A, Jiuhua Tourism, Qujiang Cultural Tourism risk level "good", financial statement data also showed their better development trends. Yunnan Tourism, Guilin Tourism in line is with the truth. Net profits of Tibet Tourism, Xi'an Tourism, Sante Cableway are negative. In this empirical study, the financial risk levels of Changbai Mountain and Zhangjiajie are "good", but the operating profits of these two listed companies are in the middle state from the financial statement data, seemingly contradictory, in fact the financial risk of a business is actually affected by many factors, such as government policy, market conditions, and non-financial indicator factors within an enterprise. Therefore, the data of a single financial index cannot fully represent the financial risk level of the enterprise.

5. **Conclusion.** The accuracy of enterprise financial risk assessment directly influences the decision-making of managers, which is of great significance to the risk management. This paper applies the evidence reasoning algorithm to financial risk assessment, so that managers can systematically evaluate the financial risk of enterprises, thus improving the manager's decision-making level.

On the basis of establishing the financial risk assessment index system of listed tourism companies, the objective weight of each index is determined by entropy weight method. Then, the financial data of 15 scenic spots listed companies from 2014 to 2016 are analyzed by using evidence reasoning algorithm (the sample data for 2017 are not available for the time being). The process herein is feasible, and the results are practical and scientific. While this article is based on scenic spot listed tourism company as an example to carry on the empirical research, this method also can be applied to other enterprise financial risk assessment. According to the financial risk assessment information, managers can take corresponding measures so as to make the enterprise more healthy and sustained development. In fact, in terms of financial risk assessment method and data selection, the new progress of intelligent computing, management evaluation model and big data should be considered, continuously improving the financial risk assessment system of listed tourism companies.

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