Financial Performance Evaluation Approach based on Compound AHP and Boston Matrix Classification: Evidence from China

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Abstract

The logistics industry in China remains in its infancy. Since the service level can not satisfy the demand of individuals, the logistics enterprises urgently need to enhance the core competitiveness. This paper aims to strengthen the objective empirical factors of Analytic hierarchy process and construct a reasonable financial performance evaluation approach to provide basic decision for business managers. First of all, after considering the financial characteristics of listed logistics enterprises, this paper constructs a financial performance evaluation index system based on AHP. After the indexes standardization and missing data processing, a compound correlation coefficient method is delivered to construct the pairwise comparison matrix in AHP, and the dynamic coefficient is given. Finally, combining with the empirical ranking of 75 listed logistics enterprises and integrating Boston matrix method, these enterprises were divided into Stars, Cash cows, Question marks and Thin dogs. Through analyzing the changes of each enterprise category from 2016 to 2017, it is proved that the variation of each firm category over time in the Boston matrix accords with the development law of most enterprises and the change of AHP rank has a explanatory power to the category changes, which respectively verifies the validity of our evaluation approach.

Keywords

Compound AHP; correlation coefficient; Boston matrix classification; enterprise performance evaluation; listed logistics enterprises.

1. Introduction

Since March 2006, The Eleventh Five-Year Plan put "vigorously develop the modern logistics industry" in a separate section, emphasizing the industrial status of the logistics industry in China, then the logistics industry has a great boom at an unprecedented rate. Logistics industry has become the basic industry to support the development of national economy in China. Enterprise financial performance evaluation is an effective way to increase the core competitiveness of enterprises, and financial performance evaluation can fully reflect the financial situation of enterprises, which will provide an important decision-making basis for managers and interest-related personnel. Therefore, through making performance evaluation for the listed logistics enterprises, we can find the malpractice of the enterprise in time and speed up the construction of the enterprise, which will promote the sustainable development of China's overall logistics market as well.

Research of logistics performance abroad began earlier. In the 1970s, T.L.Saaty[1] established a multi-objective evaluation and decision-making method——analytic hierarchy process (AHP). Each factor of analysis system is divided into several levels according to different properties, then combined with the qualitative judgment and quantitative calculation of the evaluator, several Paired comparison matrix are determined, next the weight vector is obtained, which is synthesized to get the

comprehensive performance evaluation. Kaplan and Norton [2] advanced the Balanced Scorecard, which is built on four aspects: finance, customer, internal business and improved learning. Fotini Voulgaris[3]proposed a methodological framework for developing evaluation models for estimating SMEs' performance, based on financial ratio analysis, which involved the application of a multiple criteria decision aid method, namely the UTADIS method (UTilités Additives DIScriminantes). Baoyou Zhang(2008) [4] put forward the performance evaluation of listed logistics enterprises based on AHP/DEA (analytic hierarchy process/data envelopment analysis) model. Firstly, financial indexes were selected and the non-financial indexes were obtained by the method of 1/9 scale. Secondly, the performance judgment matrix of AHP was constructed by DEA model for the evaluation object. Finally, the author used AHP to calculate the value of logistics enterprise performance superiority and inferiority. Suyan Li(2009) [5] utilized clustering analysis, correlation analysis and principal component analysis to screen the indexes objectively. Under the guidance of performance evaluation theory, 65 actual listed enterprises of A-share transportation industry in Shanghai and Shenzhen stock markets from 2005 to 2007 were selected to make a demonstration analysis. Yiyi Xiao(2012) [6] combined principal component analysis (PCA) with analytic hierarchy process (AHP) to design weighted component analysis (WPCA), a comprehensive two-level index system, which took profitability, operational capability, solvency and development capacity into consideration. Eleven listed logistics enterprises in China were selected as the research samples. The research showed that the method mentioned above can objectively and reasonably evaluate the overall performance level of listed logistics enterprises. Gregory Yom Din [7] proposed a method of project evalution by profit sensitivity to risk criterion, in which the approximate formula for profit sensitivity to risk (when basic production and market assumptions change simultaneously) is derived using a cost-volume-profit model. Madjid Tavana[8]propose da hybrid fuzzy multi-criteria decision making method that helps investors choose a proper portfolio of stocks in the presence of environmental turbulence and uncertainties. Hyun-Bae Kim[9] develop performance indices capable of measuring the R&D performance quantitatively in private construction enterprises. This paper established development direction of performance indices through the analysis on current R&D measurement standards in major Korean private construction enterprises and through carrying out questionnaire survey. Meysam Shaverdi[10] developed a new financial performance evaluation framework to rank the enterprises in Iranian petrochemical industry based on fuzzy MCDM approach. Martin Dörnhöfer[11] developed a logistics PMS which allows for assessing the effectiveness and efficiency of current logistics processes.The authors took the attitude that while being generic in terms of its definition, it can be seen as specific enough to be applicable in industry with limited adjustments. Suhaiza Zailani[12] tap into the field of strategic management to help clarify the mechanisms underlying the links between factors influencing, logistics outsourcing practices and outsourcing performance.

Combined with the existing research methods and achievements, this paper advances a performance evaluation system based on compound analytic hierarchy process and Boston matrix classification. We put forward a new analytic hierarchy process based on compound correlation coefficient. First and foremost fifteen financial indexes are obtained from five aspects: investment income, profitability, management ability, debt paying capacity and capital structure. Then with the fiscal data of 75 listed logistics enterprises from 2016 to 2017, we get the company's specific score and comprehensive ranking. Next through constructing Boston matrix based on the score and the growth rate of operating income each year, we divide the enterprises into four categories and research the changes of categories. Finally we verify the rationality of this method and put forward effective helpful suggestions to related enterprises.

2. Brief introduction of the main research methods

2.1 Analytic Hierarchy Process

The section headings are in boldface capital and lowercase letters. Second level headings are typed as part of the succeeding paragraph (like the subsection heading of this paragraph). All manuscripts

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This is a mathematically-based technique for analyzing complex situations which was sophisticated in its simplicity[13]. This method synthesizes each index weight, through weighting each object total score and sorting, mainly applies in the decision-making problem which has a multitude of evaluation factors, its main operational steps are:

The establishment of system hierarchy

This step aims to break down the factors involved in a complex problem into several levels, resulting in a hierarchical structure consisting of a target layer, a criterion layer and a scheme layer. The target layer is usually the predetermined goal or the ideal result of an exact analysis, and there is only one element. The criterion level can have many levels, including the criterion and sub-criterion which is taken into account relative to the realization of the goal level. The purpose of the structure is to make it possible to judge the importance of the elements in a given level with respect to some or all of the elements in the adjacent level above[14]. The scheme layer consists of a single layer of alternative measures, decisions and programmes to achieve the goals.

2) Constructing two-to-two Comparison Judgment Matrix

This step is the most critical step of the analytic hierarchy process (AHP). Experts with considerable knowledge are usually invited to make a quantitative judgment on the relative importance of the elements compared with the upper elements[15]. If factors i and j are assigned to the importance on a scale of 1-9 and constitute a judgment matrix, see Table 2.1.

Table 2.1 1-9 scaling assignment rules

the relative weight of alternative i to j (a_{ij})	definition
1	Element i is as important as j
3	Element i is slightly more important than j
5	Element I is more important than J
7	Element I is strongly more important than J
9	Element I is extremely more important than J
2、4、6、8	The intermediate value of adjacent judgment two elements
reciprocal	the relative weight of alternative j to i

Obviously, the judgment Matrix has the following properties:

$$a_{ij} = \frac{1}{a_{ji}}, \ a_{ij} > 0, a_{ii} = 1, \ i, j = 1,2,3 \cdots, \ n \tag{1}$$

3) Consistency checking

Because of the complexity of things and the diversity of individuals' subjective knowledge, the construction of judgment matrix does not require the complete consistency of judgment matrix. The scale of 1-9 also determines that the judgment matrix with more than three stages is sometimes difficult to satisfy the complete consistency. But there is a general consistency to be met. For example, A is more important than B, B is more important than C, thus C can't be more important than A [16]. If the judgment matrix deviates too far from consistent, it is not desirable. To avoid that, we need to run a consistency checking. The consistency ratio (CR) is used to check whether a criterion can be used for decision-making[17]. The pass condition is: CR=CI/RI<0.1. CI is the Consistency Index, there are

$$CI = (\lambda_{max} - n)/(n - 1) \tag{2}$$

λ_max is the maximum eigenvalue of the Matrix, and the random consistency index RI is determined by the matrix order n, as shown in Table 2.2.

Table 2.2 Query table for the same-order average random consistency index (part)

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

4) Weighted computation and sorting

After calculating the weight of each level of each element, the weighted integral of the reprocessed data is obtained, and the comprehensive sorting of each object in the scheme layer is derived. In this paper, 75 enterprises in the field of logistics in 2016 and 2017 were calculated the score and comprehensive ranking.

2.2 The Boston Matrix.

The Boston Matrix or, as it is sometimes called, the Boston Box is a vehicle for classifying and characterizing an organization's activities in relation to the markets in which it operates[18]. Depending on the Boston Matrix, there are two basic factors that generally determine the product structure: market gravity and enterprise strength. Getting these two factors as horizontal and vertical axes, we can get four different product categories: Stars, Cash cows, Question marks and Thin dogs, which are in the four quadrants.

In the process of this study, we take the growth rate of business revenue as the market gravity, and the score of AHP as the strength, and construct the Boston Matrix. According to the change of enterprise category in 2016 and 2017, combined with the comprehensive sort fluctuation of hierarchical analysis, the nature, development status and the prospect of an enterprise are judged. Classification rules are shown in Table 2.3 (the standard point for judging low or height is the matrix origin):

Table2.3 Boston matrix classification rules

Type	Operating income growth rate	Overall rating
Thin dogs	low	low
Question marks	low	high
Cash cows	high	low
Stars	high	high

2.3 Application in this article.

Analytic Hierarchy Process(AHP), using the combination of qualitative and quantitative analysis methods, can achieve the multi-objective decision-making effectively[19]. The limitation of this method is that the judgment matrix is completely determined by the evaluator and is often subjective. We expect to get a matrix that combines the experience of experts and numerical analysis, so we utilize the combination of expert assignment method and data correlation assignment method to construct the judgment matrix, which is called the compound correlation Coefficient dynamic examination AHP method, abbreviation compound AHP method. On the basis of the research with the method of compound AHP and the method of Boston Matrix Classification, this paper completes the empirical analysis of the data of 75 enterprises in 2016 and 2017, so as to evaluate the company's financial performance.

3. Establishment of index system

When establishing the index system, each evaluation index is required to be representative, comparable, quantifiable and operable. Furthermore, each evaluation index should have a certain logical relationship, which can reflect the financial status and characteristics of the enterprise from different aspects. We start with five aspects: investment income, profitability, management ability, debt paying capacity and capital structure. The basic earnings per share, net assets per share and other 15 small indicators were taken into account, and the evaluation index system was constructed as follows. See Fig 3.1.

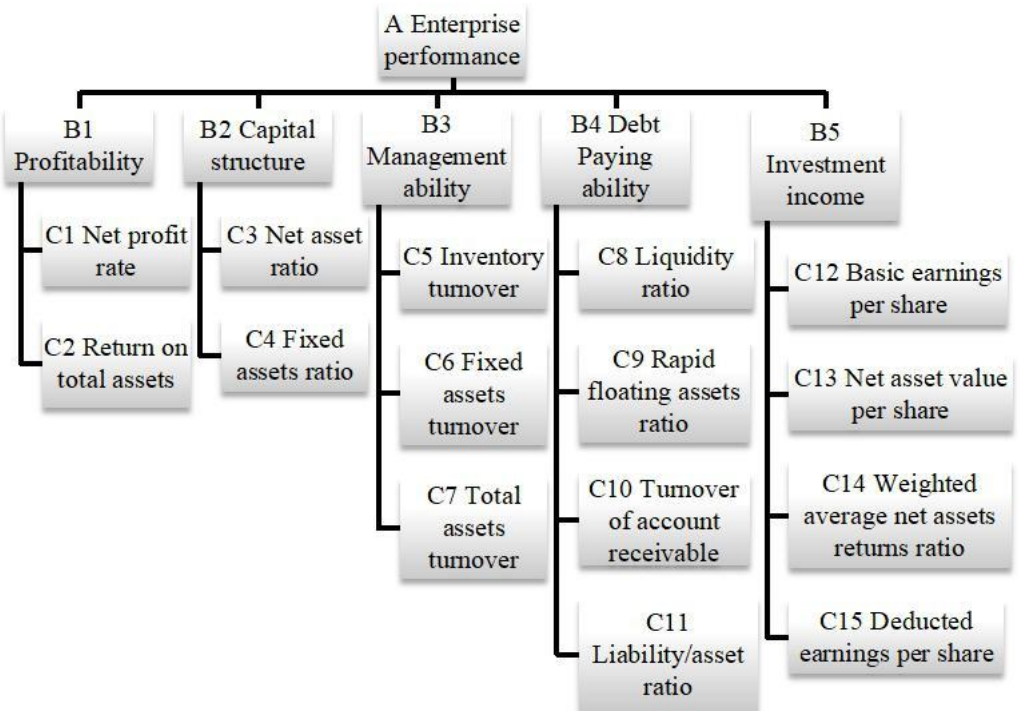

Fig 3.1 financial evaluation index system of Logistics Enterprises

4. Data Collection and Preprocessing

4.1 Data collection and collation

The data in this paper are all from the Deep Authentication Data Service platform. (http://webapi.cninfo.com.cn/#/databrowse) Collected annual reports from 75 enterprises in 2016 and 2017 for the express delivery, road transport, water transport, air transport, loading and unloading and transportation agents, respectively. According to the evaluation system of Figure 3.1, two original datasets were obtained. For instances, the raw data for each logistics company for 2016 are as follows. See Fig 4.1.

N0.	Enterprise Name	Securities code	Investment income				Profitability				Management ability				Paying ability				Capital structure	
			Bas	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1	Yunda Holding Co., Ltd.	002120	1.3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	S.F. Holding Co., Ltd.	002352	1.1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3	STO Express Co., Ltd.	002468	1.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4	YTO Express Group Co., Ltd.	600233	0.6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
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.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
72	Jiangsu Aucksun Co., Ltd.	002245	0.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
73	Antong Holdings Co., Ltd.	600179	0.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
74	Sinotrans Air Transportation	600270	1.1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
75	CTS International Logistics C	603128	0.3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Fig 4.1 Partial magnification of data from 75 Logistics Enterprises in 2016

4.2 Standardization

The 15 indexes involved in the index evaluation system can be divided into three categories: most of them are positive indexes, and the general expectation on them is to increase their value; the ratio of assets to liabilities, and the ratio of fixed assets is negative, and the general expectation is to reduce their value; the rapid floating assets ratio is a special index, which is generally expected to be close to 1.

For positive index X, it can be standardized directly and calculated according to the following formula:

$$x_p = x\ ;\ x_z = \frac{x_p - \mu}{\sigma} \tag{3}$$

For negative index Y, its reciprocal must be calculated firstly and then standardized according to the following formula:

$$y_p = \frac{1}{y}\ ;\ y_z = \frac{y_p - \mu}{\sigma} \tag{4}$$

For the special index W, calculate the absolute difference from 1 and treat this difference as a negative index, using the following formula:

$$w_p = \frac{1}{|w-1|};\ w_z = \frac{w_p - \mu}{\sigma} \tag{5}$$

μ is the average value of the data under the index and σ is the standard deviation of the data under the index.

4.3 Process of missing values

In this study, we used SPSS 25 software to fill in the missing data by multiple interpolation. The multiple interpolation method first simulates a random distribution of missing values, which can reflect the uncertainty caused by missing data, and then samples the missing values from the distribution. According to the statistical characteristics of each group of data after interpolation, the group with the smallest standard deviation is selected as the final interpolation value. This method is appropriate for many kinds of missing cases, and has obvious advantages over the single interpolation.

The 2016 and 2017 data were standardized and filled in the missing values, that is, the pre-processing of the data was carried out.

5. Weighted the index by AHP method with comprehensive correlation coefficient

5.1 Structure model of analytic hierarchy process

In attempt to put suggestions to these enterprises, the target layer, criterion layer and scheme layer of AHP are established. See Fig 5.1.

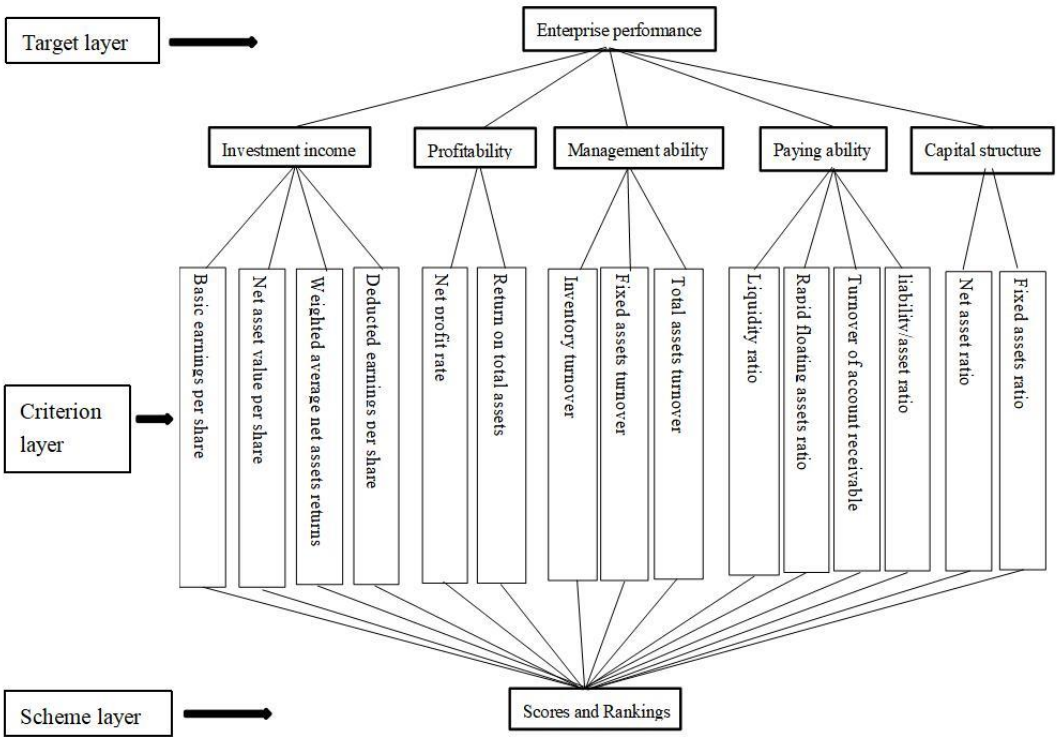

Fig 5.1 Structure model of analytic hierarchy process

5.2 Paired comparison matrix combining correlation matrix and expert evaluation matrix

5.2.1 Paired comparison matrix determined by expert valuation

In order to obtain some more accurate pairwise comparison matrix, three experts in logistics performance research were requested to assign value. The following is the pairwise comparison matrix which averagely weighted these experts.E is the pairwise comparison matrix that represented the importance of the five indexes including profitability, capital structure, management ability, debt paying ability and investment and income ability in comparison to the target layer. E_1, E_2, E_3, E_4, E_5 respectively represent the importance of sub-index under these five indexes.

$$E=\begin{bmatrix} 1 & 5 & 4 & 4 & 2.11 \\ 1/5 & 1 & 1.28 & 0.78 & 0.34 \\ 1/4 & 1/1.28 & 1 & 2.07 & 0.71 \\ 1/4 & 1/0.78 & 1/2.07 & 1 & 0.39 \\ 1/2.11 & 1/0.34 & 1/0.71 & 1/0.39 & 1 \end{bmatrix},$$

$$E_1=\begin{bmatrix} 1 & 3.67 \\ 1/3.67 & 1 \end{bmatrix}, \quad E_2=\begin{bmatrix} 1 & 3 \\ 1/3 & 1 \end{bmatrix}, \quad E_3=\begin{bmatrix} 1 & 4.33 & 3.67 \\ 1/4.33 & 1 & 1.28 \\ 1/3.67 & 1/1.28 & 1 \end{bmatrix},$$

$$E_4=\begin{bmatrix} 1 & 0.34 & 1.44 & 3.33 \\ 1/0.34 & 1 & 3 & 5 \\ 1/1.44 & 1/3 & 1 & 3 \\ 1/3.33 & 1/5 & 1/3 & 1 \end{bmatrix}, \quad E_5=\begin{bmatrix} 1 & 4.67 & 2.11 & 1.44 \\ 1/4.67 & 1 & 0.39 & 0.30 \\ 1/2.11 & 1/0.39 & 1 & 0.78 \\ 1/1.44 & 1/0.30 & 1/0.78 & 1 \end{bmatrix}$$

5.2.2 Paired comparison matrix of relativity

In order to eliminate the errors caused by the subjective evaluation of some experts, the final analytic hierarchy process (AHP) will adopt the index weight derived from the combination of expert evaluation matrix and correlation coefficient matrix. R_1^{16}, R_2^{16}, R_3^{16}, R_4^{16}, R_5^{16} respectively represents the correlation coefficients of in the sub-index in the five indicators of profitability, capital structure, management ability, debt paying ability and investment and income ability in 2016. Similarly, R_1^{17}, R_2^{17}, R_3^{17}, R_4^{17}, R_5^{17} respectively represents the correlation coefficients in 2017.

$$R_1^{16}=\begin{bmatrix} 1 & 0.209 \\ 0.209 & 1 \end{bmatrix}, \quad R_2^{16}=\begin{bmatrix} 1 & -0.094 \\ -0.094 & 1 \end{bmatrix}, \quad R_3^{16}=\begin{bmatrix} 1 & -0.073 & -0.064 \\ -0.073 & 1 & 0.551 \\ -0.064 & 0.551 & 1 \end{bmatrix},$$

$$R_4^{16}=\begin{bmatrix} 1 & -0.008 & -0.022 & 0.568 \\ -0.008 & 1 & -0.021 & 0.013 \\ -0.022 & -0.021 & 1 & -0.076 \\ 0.568 & 0.013 & -0.076 & 1 \end{bmatrix}, \quad R_5^{16}=\begin{bmatrix} 1 & 0.686 & 0.602 & 0.941 \\ 0.686 & 1 & 0.030 & 0.600 \\ 0.602 & 0.030 & 1 & 0.606 \\ 0.941 & 0.600 & 0.606 & 1 \end{bmatrix}$$

$$R_1^{17}=\begin{bmatrix} 1 & 0.259 \\ 0.259 & 1 \end{bmatrix}, \quad R_2^{17}=\begin{bmatrix} 1 & -0.089 \\ -0.089 & 1 \end{bmatrix}, \quad R_3^{17}=\begin{bmatrix} 1 & -0.106 & -0.119 \\ -0.106 & 1 & 0.467 \\ -0.119 & 0.467 & 1 \end{bmatrix},$$

$$R_4^{17}=\begin{bmatrix} 1 & -0.199 & 0.065 & 0.730 \\ -0.199 & 1 & -0.033 & -0.118 \\ 0.065 & -0.033 & 1 & 0.006 \\ 0.730 & -0.118 & 0.006 & 1 \end{bmatrix}, \quad R_5^{17}=\begin{bmatrix} 1 & 0.737 & 0.688 & 0.955 \\ 0.737 & 1 & 0.158 & 0.706 \\ 0.688 & 0.158 & 1 & 0.681 \\ 0.955 & 0.706 & 0.681 & 1 \end{bmatrix}$$

It is assumed that the correlation coefficient of the factor i and factor j is r_{ij}, and correspondingly p_{ij} is assigned in the pairwise comparison matrix. If the factor i is more important, $0 < r_{ij} \le 0.2$, $p_{ij} = 9$; $0.2 < r_{ij} \le 0.4$, $p_{ij} = 7$; $0.4 < r_{ij} \le 0.6$, $p_{ij} = 5$; $0.6 < r_{ij} \le 0.8$, $p_{ij} = 3$; $0.8 < r_{ij} \le 1$, $p_{ij} = 1$;

By using the method above, we can get the P_j^i corresponding R_j^i:

$$P_1^{16} = \begin{bmatrix} 1 & 7 \\ 1/7 & 1 \end{bmatrix}, P_2^{16} = \begin{bmatrix} 1 & 9 \\ 1/9 & 1 \end{bmatrix}, P_3^{16} = \begin{bmatrix} 1 & 9 & 9 \\ 1/9 & 1 & 5 \\ 1/9 & 1/5 & 1 \end{bmatrix},$$

$$P_4^{16} = \begin{bmatrix} 1 & 1/9 & 9 & 5 \\ 9 & 1 & 9 & 9 \\ 1/9 & 1/9 & 1 & 9 \\ 1/5 & 1/9 & 1/9 & 1 \end{bmatrix}, P_5^{16} = \begin{bmatrix} 1 & 3 & 3 & 1 \\ 1/3 & 1 & 1/9 & 1/3 \\ 1/3 & 9 & 1 & 1/3 \\ 1 & 3 & 3 & 1 \end{bmatrix},$$

$$P_1^{17} = \begin{bmatrix} 1 & 7 \\ 1/7 & 1 \end{bmatrix}, P_2^{17} = \begin{bmatrix} 1 & 9 \\ 1/9 & 1 \end{bmatrix}, P_3^{17} = \begin{bmatrix} 1 & 9 & 9 \\ 1/9 & 1 & 5 \\ 1/9 & 1/5 & 1 \end{bmatrix},$$

$$P_4^{17} = \begin{bmatrix} 1 & 1/9 & 9 & 3 \\ 9 & 1 & 9 & 9 \\ 1/9 & 1/9 & 1 & 9 \\ 1/3 & 1/9 & 1/9 & 1 \end{bmatrix}, P_5^{17} = \begin{bmatrix} 1 & 3 & 3 & 1 \\ 1/3 & 1 & 1/9 & 1/3 \\ 1/3 & 9 & 1 & 1/3 \\ 1 & 3 & 3 & 1 \end{bmatrix},$$

5.2.3 Synthetic pairwise comparison matrix

There was no specific data between the target layer and the criterion layer, so instead of using the synthetic pairwise comparison matrix to determine the weight, it was determined directly according to the result of the expert evaluation, that was the matrix E. Among the criterion layers, after many tests, the comprehensive ratio of experts and correlation coefficients was adjusted to meet the first basis namely to pass the consistency test of significance and the second level basis namely to acquire the largest proportion of correlation coefficients. The final determination was that the ratio of expert;s assignment: correlation coefficient assignment = 0.9 / 0.1, which was as follows:

$$\Sigma_i = 0.9E_i + 0.1P_i \tag{6}$$

The matrices in 2016 and 2017 are as follows:

$$\Sigma_1^{16} = \begin{bmatrix} 1 & 4 \\ 1/4 & 1 \end{bmatrix}, \quad \Sigma_2^{16} = \begin{bmatrix} 1 & 3.60 \\ 1/3.60 & 1 \end{bmatrix}, \quad \Sigma_3^{16} = \begin{bmatrix} 1 & 4.80 & 4.20 \\ 1/4.80 & 1 & 1.65 \\ 1/4.20 & 1/1.65 & 1 \end{bmatrix},$$

$$\Sigma_4^{16} = \begin{bmatrix} 1 & 0.32 & 2.20 & 3.50 \\ 1/0.32 & 1 & 1.80 & 5.40 \\ 1/2.20 & 1/1.80 & 1 & 3.60 \\ 1/3.60 & 1/5.40 & 1/3.60 & 1 \end{bmatrix}, \quad \Sigma_5^{16} = \begin{bmatrix} 1 & 4.50 & 2.20 & 1.40 \\ 1/4.50 & 1 & 0.36 & 0.30 \\ 1/2.20 & 1/0.36 & 1 & 0.73 \\ 1/1.40 & 1/0.30 & 1/0.73 & 1 \end{bmatrix};$$

$$\Sigma_1^{17}=\begin{bmatrix}1 & 4\\ 1/4 & 1\end{bmatrix},\quad \Sigma_2^{17}=\begin{bmatrix}1 & 3.60\\ 1/3.60 & 1\end{bmatrix},\quad \Sigma_3^{17}=\begin{bmatrix}1 & 4.80 & 4.20\\ 1/4.80 & 1 & 1.65\\ 1/4.20 & 1/1.65 & 1\end{bmatrix},$$

$$\Sigma_4^{17}=\begin{bmatrix}1 & 0.32 & 2.20 & 3.30\\ 1/0.32 & 1 & 1.80 & 5.40\\ 1/2.20 & 1/1.80 & 1 & 3.60\\ 1/3.30 & 1/5.40 & 1/3.60 & 1\end{bmatrix},\quad \Sigma_5^{17}=\begin{bmatrix}1 & 4.50 & 2.20 & 1.40\\ 1/4.50 & 1 & 0.36 & 0.30\\ 1/2.20 & 1/0.36 & 1 & 0.73\\ 1/1.40 & 1/0.30 & 1/0.73 & 1\end{bmatrix};$$

The feature vector, characteristic value and consistency check values of each matrix were obtained by calculating the pairwise comparison matrix. See Table 5.1.

Table 5.1 Feature vector, characteristic value and consistency check values of each level

	Feature vector	λ_{max}	CR
Σ_1^{16}	$\omega_1=(0.8000,0.2000)$	2	0
Σ_2^{16}	$\omega_2=(0.7826,0.2174)$	2	0
Σ_3^{16}	$\omega_3=(0.6676,0.2070,0.1254)$	3.0721	0.0622
Σ_4^{16}	$\omega_4=(0.2746,0.4075,0.2454,0.0725)$	4.2684	0.0994
Σ_5^{16}	$\omega_5=(0.4132,0.0\ 830,0.2175\ ,0.2864)$	4.0097	0.0036
Σ_1^{17}	$\omega_6=(0.8000,0.2000)$	2	0
Σ_2^{17}	$\omega_7=(0.7826,0.2174)$	2	0
Σ_3^{17}	$\omega_8=(0.6676,0.2070,0.1254)$	3.0721	0.0622
Σ_4^{17}	$\omega_9=(0.2698\ ,0.4101,0.\ 2472,0.072\ 9)$	4.2697	0.0999
Σ_5^{17}	$\omega_{10}=(0.4132,0.0\ 830,0.2175\ ,0.2864)$	4.0097	0.0036
E	$\omega_{11}=(0.4497,0.0966,0.1392,0.0889,0.2257)$	5.1517	0.0339

CR<0.1. We can make the conclusion that the pair comparison matrix was reasonable.

After the consistency check of single level is passed, the consistency of the level total sorting is verified. If the element j of layer k is obtained as the consistency index of the criterion CI_j^k, and the average random consistency index is RI_j^k, then the calculation formula of the total ranking consistency index CR is as follows:

$$CR=\frac{CI}{RI}=\frac{\sum_{j=1}^{n_{k-1}}\omega_j^{k-1}\times CI_j^k}{\sum_{j=1}^{n_{k-1}}\omega_j^{k-1}\times RI_j^k} \tag{7}$$

Table 5.2 Consistency check of hierarchical total sort in 2016

Weight(ω_j^{k-1})	0.4497	0.0966	0.1392	0.0889	0.2257	
	Profitability	Capital structure	Management ability	Debt paying ability	Investment income	CR
CI	0	0	0.0361	0.0895	0.0032	0.01370391
RI	0	0	0.58	0.9	0.9	0.363876

$CR=\frac{CI}{RI}=0.0377$, CR<0.1. We can make the conclusion that the overall ranking of the levels was reasonable. The weight table of the indicators of each level in 2016 is as shown in Table 5.3.

Table 5.3 Index weights for each layer in 2016

First evaluation index	Second evaluation index	Weight	Third evaluation index	Weight
Enterprise performance	Profitability	0.4497	Net profit rate(%)	0.3598
			Return on total assets(%)	0.0899
	Capital structure	0.0966	Net asset ratio(%)	0.0756
			Fixed assets ratio(%)	0.0210
	Management ability	0.1392	Turnover of inventory(%)	0.0929
			Turnover of fixed assets(%)	0.0288
			Turnover of total asset	0.0175
	Debt paying ability	0.0889	Liquidity ratio(times)	0.0244
			rapid floating assets ratio (times)	0.0362
			Turnover of account receivable(times)	0.0218
			Balance sheet ratio(%)	0.0064
	Investment income	0.2257	Basic earnings per share(￥)	0.0933
			Net asset value per share(￥)	0.0187
			Weighted average net assets returns ratio(%)	0.0491
			Deducted earnings per share	0.0646

Similarly, verify the consistency in 2017. See Table 5.4.

Table 5.4 Consistency check of hierarchical total sort in 2017

Weight(ω_j^{k-1})	0.4497	0.0966	0.1392	0.0889	0.2257	
	Profitability	Capital structure	Management ability	Debt paying ability	Investment income	CR
CI	0	0	0.0361	0.0895	0.0032	0.0137
RI	0	0	0.58	0.9	0.9	0.3639

$CR = \frac{CI}{RI} = 0.0377$, CR<0.1. We can make the conclusion the overall ranking of the levels was reasonable. The weight table of the indicators of each level in 2017 is as shown in Table 5.5.

Table 5.5 Index weights for each layer in 2017

First evaluation index	Second evaluation index	Weight	Third evaluation index	Weight
Enterprise performance	Profitability	0.4497	Net profit rate(%)	0.3598
			Return on total assets(%)	0.0899
	Capital structure	0.0966	Net asset ratio(%)	0.0756
			Fixed assets ratio(%)	0.0210
	Management ability	0.1392	Turnover of inventory(%)	0.0929
			Turnover of fixed assets(%)	0.0288
			Turnover of total asset	0.0175

	Debt paying ability	0.0889	Liquidity ratio(times)	0.0240
			rapid floating assets ratio (times)	0.0365
			Turnover of account receivable(times)	0.0220
			Balance sheet ratio(%)	0.0065
	Investment income	0.2257	Basic earnings per share(￥)	0.0933
			Net asset value per share(￥)	0.0187
			Weighted average net assets returns ratio(%)	0.0491
			Deducted earnings per share	0.0646

5.3 Comprehensive ranking of weighted score

According to the index weight of the above levels, 75 listed logistics enterprises in 2016 and 2017 were ranked synthetically, as showed in Table 5.6, Table 5.7.

Table 5.6 Comprehensive ranking of 75 listed logistics enterprises in 2016

Ranking	Enterprises	Scores	Ranking	Enterprises	Scores
1	Shenzhen Yan Tian Port Holdings Co., Ltd.	2.01770	41	Jilin Expressway Co., Ltd.	-0.1435
2	Xiamen International Airport Co., Ltd.	1.47651	42	Antong Holdings Co., Ltd.	-0.1461
3	Chongqing Road and Bridge Co., Ltd.	1.39555	43	Dazhong Transportation (Group) Co., Ltd.	-0.1524
4	STO Express Co., Ltd.	1.23345	44	China Railway Tielong Container Logistics Co., Ltd.	-0.1718
5	Shanghai International Airport Co., Ltd.	1.18942	45	COSCO Shipping Energy Transportation Co., Ltd.	-0.2179
6	Dongguan Development (Holdings) Co., Ltd.	1.03175	46	Guangshen Railway Company Limited	-0.2542
7	Yunda Holding Co., Ltd.	0.91197	47	Hainan Airlines Holding Co., Ltd.	-0.3007
8	Sinotrans Air Transportation Development Co., Ltd.	0.88770	48	Guangxi Wuzhou Communications Co., Ltd.	-0.3047
9	Guangdong Provincial Expressway Development Co., Ltd.	0.72209	49	Shanghai Jiao Yun Group Co., Ltd.	-0.3145
10	Heilongjiang Transport DEV. Co., Ltd.	0.64908	50	Jiangsu Aucksun Co., Ltd.	-0.3311
11	Shandong Hi-speed Company Limited	0.61887	51	Hainan Haiqi Transportation Group Co., Ltd.	-0.3319
12	Jiangsu Expressway Co., Ltd.	0.58955	52	Yingkou Port Liability Co., Ltd.	-0.3327
13	Guangzhou Baiyun International Airport Co., Ltd.	0.55388	53	Air China Limited	-0.3672

14	Anhui Expressway Co., Ltd.	0.53780	54	Henan Zhongyuan Expressway Co,. Ltd.	-0.3809
15	China Merchants Port Group Co., Ltd.	0.49963	55	Shanghai Ya Tong Co., Ltd.	-0.4151
16	YTO Express Group Co., Ltd.	0.47187	56	Shanghai Shentong Metro Co., Ltd.	-0.4178
17	Hainan Strait Shipping Co., Ltd.	0.32805	57	Sichuan Fulin Transportation Group Co., Ltd.	-0.4238
18	S.F. Holding Co., Ltd.	0.20922	58	Hubei Yichang Transportation Group Co., Ltd.	-0.4256
19	Nanjing Port Co., Ltd.	0.17579	59	China Southern Airlines Co., Ltd.	-0.4630
20	Juneyao Airlines Co., Ltd.	0.17497	60	CITIC Offshore Helicopter Co., Ltd.	-0.4689
21	Hubei Chutian Smart Communication Co., Ltd.	0.11060	61	Xiamen Port Development Co., Ltd.	-0.4723
22	Shenzhen Expressway Co., Ltd.	0.10787	62	Shanghai Qiangsheng Holding Co., Ltd.	-0.5054
23	Tangshan Port Group Co., Ltd.	0.10595	63	Anhui Wanjiang Logistics (Group) Co., Ltd.	-0.5254
24	Shenzhen Airport Co., Ltd.	0.09660	64	Zhuhai Port Co., Ltd.	-0.5343
25	Daqin Railway Co., Ltd.	0.07186	65	China Eastern Airlines Corporation Limited	-0.5758
26	Xinjiang Tianshun Supply Chain Co., Ltd.	0.04355	66	Ningbo Marine Co., Ltd.	-0.5829
27	Spring Airlines Co., Ltd.	0.01702	67	Chang Jiang Shipping Group Phoenix Co., Ltd.	-0.5849
28	Shandong Airlines Co., Ltd.	0.00844	68	Longzhou Group Co., Ltd.	-0.5881
29	Shanghai International Port (Group) Co., Ltd.	-0.04239	69	Ningxia Western Venture Industrial Co., Ltd.	-0.6079
30	Hunan Investment Group Co., Ltd.	-0.04718	70	Chongqing Gangjiu Co., Ltd.	-0.6222
31	Hengtong Logistic Co., Ltd.	-0.05690	71	Rizhao Port Co., Ltd.	-0.6297
32	Tianjin Port Co., Ltd.	-0.06388	72	Jinzhou Port Co., Ltd.	-0.6968
33	Fujian Expressway Development Company Limited	-0.07513	73	Henan City Development Environment Co., Ltd.	-0.7214
34	Shanghai Jin Jiang International Industrial Investment Co., Ltd.	-0.07671	74	COSCO Shipping Specialized Carriers Co., Ltd.	-0.7544

35	Y.U.D.Yangtze River Investment Industry Co., Ltd.	-0.07695	75	Jiangxi Changyun Co., Ltd.	-1.1951
36	Jiangxi Ganyue Expressway Co., Ltd.	-0.08211			
37	Xiandai Investment Co., Ltd.	-0.11459			
38	Sichuan Expressway Company Limited	-0.12359			
39	CTS International Logistics Corporation Limited	-0.12748			
40	Beibu Gulf Port Co., Ltd.	-0.12788			

Table 5.7 Comprehensive ranking of 75 listed Logistics enterprises in 2017

Ranking	Enterprises	Scores	Ranking	Enterprises	Scores
1	Shenzhen Yan Tian Port Holdings Co., Ltd.	1.7028	41	Chang Jiang Shipping Group Phoenix Co., Ltd.	-0.1567
2	Chongqing Road and Bridge Co., Ltd.	1.6351	42	Antong Holdings Co., Ltd.	-0.1604
3	Shanghai International Airport Co., Ltd.	1.6080	43	Guangxi Wuzhou Communications Co., Ltd.	-0.1717
4	Guangdong Provincial Expressway Development Co., Ltd.	1.2856	44	COSCO Shipping Energy Transportation Co., Ltd.	-0.2057
5	Dongguan Development (Holdings) Co., Ltd.	1.1457	45	CTS International Logistics Corporation Limited	-0.2113
6	Xiamen International Airport Co., Ltd.	1.0209	46	Sichuan Expressway Company Limited	-0.2284
7	Sinotrans Air Transportation Development Co., Ltd.	0.9354	47	Jiangsu Aucksun Co., Ltd.	-0.2392
8	Yunda Holding Co., Ltd.	0.8923	48	Shanghai Jiao Yun Group Co., Ltd.	-0.2568
9	STO Express Co., Ltd.	0.6987	49	Xiandai Investment Co., Ltd.	-0.2632
10	Anhui Expressway Co., Ltd.	0.5992	50	Henan Zhongyuan Expressway Co,. Ltd.	-0.2889
11	Jiangsu Expressway Co., Ltd.	0.5745	51	Shanghai Ya Tong Co., Ltd.	-0.3214
12	Daqin Railway Co., Ltd.	0.5204	52	Guangshen Railway Company Limited	-0.3234
13	Shandong Hi-speed Company Limited	0.4676	53	Ningxia Western Venture Industrial Co., Ltd.	-0.3313

14	Spring Airlines Co., Ltd.	0.3637	54	Tianjin Port Co., Ltd.	-0.3394
15	Guangzhou Baiyun International Airport Co., Ltd.	0.3394	55	Yingkou Port Liability Co., Ltd.	-0.3443
16	Hainan Strait Shipping Co., Ltd.	0.3165	56	Zhuhai Port Co., Ltd.	-0.3695
17	Shanghai International Port (Group) Co., Ltd.	0.2609	57	China Railway Tielong Container Logistics Co., Ltd.	-0.3723
18	S.F. Holding Co., Ltd.	0.2425	58	Hainan Haiqi Transportation Group Co., Ltd.	-0.3757
19	China Merchants Port Group Co., Ltd.	0.2191	59	Air China Limited	-0.3837
20	Dazhong Transportation (Group) Co., Ltd.	0.2070	60	Sichuan Fulin Transportation Group Co., Ltd.	-0.3845
21	Shenzhen Expressway Co., Ltd.	0.1919	61	Longzhou Group Co., Ltd.	-0.3922
22	Heilongjiang Transport DEV. Co., Ltd.	0.1893	62	China Southern Airlines Co., Ltd.	-0.4393
23	YTO Express Group Co., Ltd.	0.1229	63	Shanghai Shentong Metro Co., Ltd.	-0.5004
24	Shenzhen Airport Co., Ltd.	0.0664	64	China Eastern Airlines Corporation Limited	-0.5041
25	Jilin Expressway Co., Ltd.	0.0311	65	Ningbo Marine Co., Ltd.	-0.5254
26	Hengtong Logistic Co., Ltd.	0.0088	66	CITIC Offshore Helicopter Co., Ltd.	-0.5267
27	Tangshan Port Group Co., Ltd.	0.0058	67	Rizhao Port Co., Ltd.	-0.5574
28	Hubei Chutian Smart Communication Co., Ltd.	0.0048	68	Hainan Airlines Holding Co., Ltd.	-0.6208
29	Xinjiang Tianshun Supply Chain Co., Ltd.	-0.0174	69	Shanghai Qiangsheng Holding Co., Ltd.	-0.6441
30	Juneyao Airlines Co., Ltd.	-0.0279	70	Anhui Wanjiang Logistics (Group) Co., Ltd.	-0.6596
31	Hunan Investment Group Co., Ltd.	-0.0713	71	Xiamen Port Development Co., Ltd.	-0.6640
32	Henan City Development Environment Co., Ltd.	-0.0727	72	COSCO Shipping Specialized Carriers Co., Ltd.	-0.6653
33	Shanghai Jin Jiang International Industrial Investment Co., Ltd.	-0.0839	73	Jinzhou Port Co., Ltd.	-0.7350
34	Shandong Airlines Co., Ltd.	-0.0987	74	Jiangxi Changyun Co., Ltd.	-0.8858

35	Jiangxi Ganyue Expressway Co., Ltd.	-0.1188	75	Y.U.D.Yangtze River Investment Industry Co., Ltd.	-1.1710
36	Nanjing Port Co., Ltd.	-0.1218			
37	Fujian Expressway Development Company Limited	-0.1326			
38	Beibu Gulf Port Co., Ltd.	-0.1436			
39	Hubei Yichang Transportation Group Co., Ltd.	-0.1543			
40	Chongqing Gangjiu Co., Ltd.	-0.1555			

6. Enterprise Classification based on Boston Matrix

On taking the growth rate of business income as the longitudinal axis and the compound AHP score as the lateral axis, draw the Boston bubble diagram. Taking into account the overall development of the market economy, the origin of the two-year matrix was appropriately adjusted to make it in the center of the matrix which reflected the relative operation of enterprises in the market. See Fig 6.1.

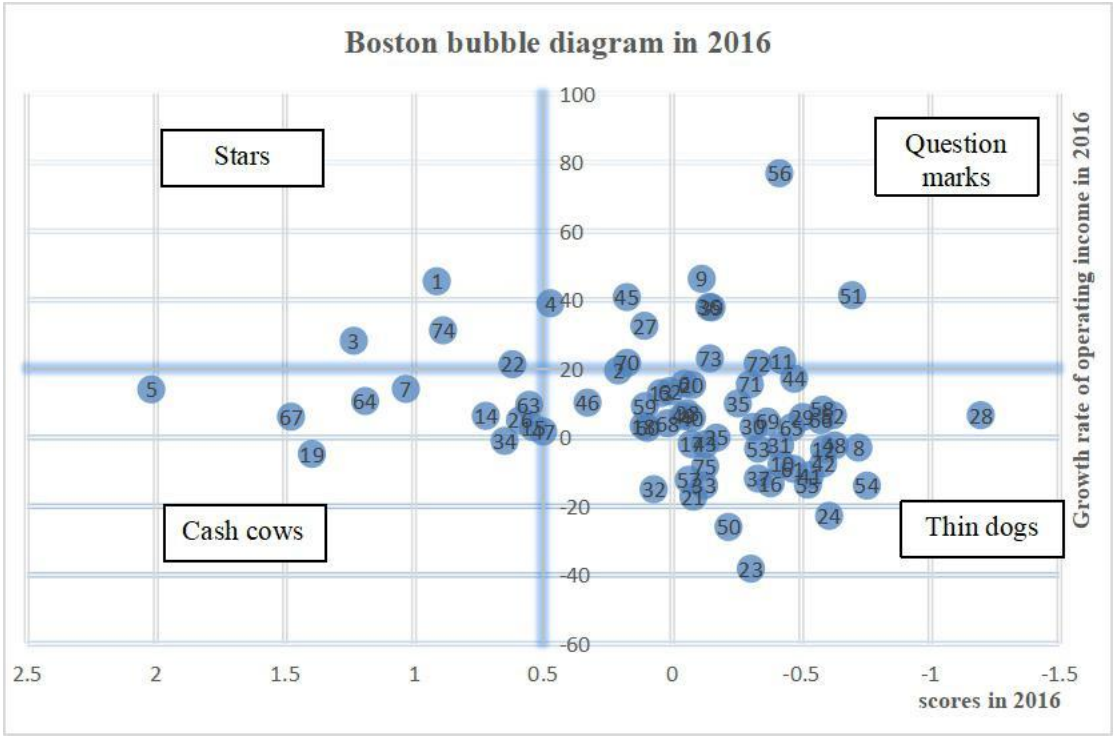

Fig 6.1 Boston bubble diagram in 2016

The concrete classification in 2016 was shown in Table 6.1.

Table 6.1 Concrete category in 2016

Type	Enterprises	Ranking	Type	Enterprises	Ranking
Stars	Yunda Holding Co., Ltd.	1	Thin dogs(49)	Guangxi Wuzhou Communications Co., Ltd.	23

(4)	STO Express Co., Ltd.	3		Ningxia Western Venture Industrial Co., Ltd.	24
	Shandong Hi-speed Company Limited	22		China Railway Tielong Container Logistics Co., Ltd.	25
	Sinotrans Air Transportation Development Co., Ltd.	74		Jiangxi Changyun Co., Ltd.	28
Cash cows(10)	Shenzhen Yan Tian Port Holdings Co., Ltd.	5		Shanghai Qiangsheng Holding Co., Ltd.	29
	Dongguan Development (Holdings) Co., Ltd.	7		Shanghai Jiao Yun Group Co., Ltd.	30
	Guangdong Provincial Expressway Development Co., Ltd.	14		Shanghai Shentong Metro Co., Ltd.	31
	Anhui Expressway Co., Ltd.	15		Daqin Railway Co., Ltd.	32
	Chongqing Road and Bridge Co., Ltd.	19		Sichuan Expressway Company Limited	33
	Jiangsu Expressway Co., Ltd.	26		Guangshen Railway Company Limited	35
	Heilongjiang Transport DEV. Co., Ltd.	34		Hainan Haiqi Transportation Group Co., Ltd.	37
	Guangzhou Baiyun International Airport Co., Ltd.	63		Hengtong Logistic Co., Ltd.	38
	Shanghai International Airport Co., Ltd.	64		Shanghai Jin Jiang International Industrial Investment Co., Ltd.	40
	Xiamen International Airport Co., Ltd.	67		Zhuhai Port Co., Ltd.	41
Question marks(12)	YTO Express Group Co., Ltd.	4		Chang Jiang Shipping Group Phoenix Co., Ltd.	42
	Xiandai Investment Co., Ltd.	9		Beibu Gulf Port Co., Ltd.	43
	Hubei Yichang Transportation Group Co., Ltd.	11		Xiamen Port Development Co., Ltd.	44
	Shenzhen Expressway Co., Ltd.	27		Hainan Strait Shipping Co., Ltd.	46
	Jilin Expressway Co., Ltd.	36		China Merchants Port Group Co., Ltd.	47
	Dazhong Transportation (Group) Co., Ltd.	39		Rizhao Port Co., Ltd.	48
	Nanjing Port Co., Ltd.	45		Shanghai International Port (Group) Co., Ltd.	49
	Jinzhou Port Co., Ltd.	51		COSCO Shipping Energy Transportation Co., Ltd.	50
	Shanghai Ya Tong Co., Ltd.	56		Chongqing Gangjiu Co., Ltd.	52
	Juneyao Airlines Co., Ltd.	70		Yingkou Port Liability Co., Ltd.	53

	Jiangsu Aucksun Co., Ltd.	72		COSCO Shipping Specialized Carriers Co., Ltd.	54
	Antong Holdings Co., Ltd.	73		Anhui Wanjiang Logistics (Group) Co., Ltd.	55
Thin dogs(49)	S.F. Holding Co., Ltd.	2		Tianjin Port Co., Ltd.	57
	Hunan Investment Group Co., Ltd.	6		Ningbo Marine Co., Ltd.	58
	Henan City Development Environment Co., Ltd.	8		Tangshan Port Group Co., Ltd.	59
	Sichuan Fulin Transportation Group Co., Ltd.	10		Shenzhen Airport Co., Ltd.	60
	Longzhou Group Co., Ltd.	12		CITIC Offshore Helicopter Co., Ltd.	61
	Xinjiang Tianshun Supply Chain Co., Ltd.	13		Shandong Airlines Co., Ltd.	62
	Henan Zhongyuan Expressway Co,. Ltd.	16		China Southern Airlines Co., Ltd.	65
	Fujian Expressway Development Company Limited	17		China Eastern Airlines Corporation Limited	66
	Hubei Chutian Smart Communication Co., Ltd.	18		Spring Airlines Co., Ltd.	68
	Y.U.D.Yangtze River Investment Industry Co., Ltd.	20		Air China Limited	69
	Jiangxi Ganyue Expressway Co., Ltd.	21		Hainan Airlines Holding Co., Ltd.	71
				CTS International Logistics Corporation Limited	75

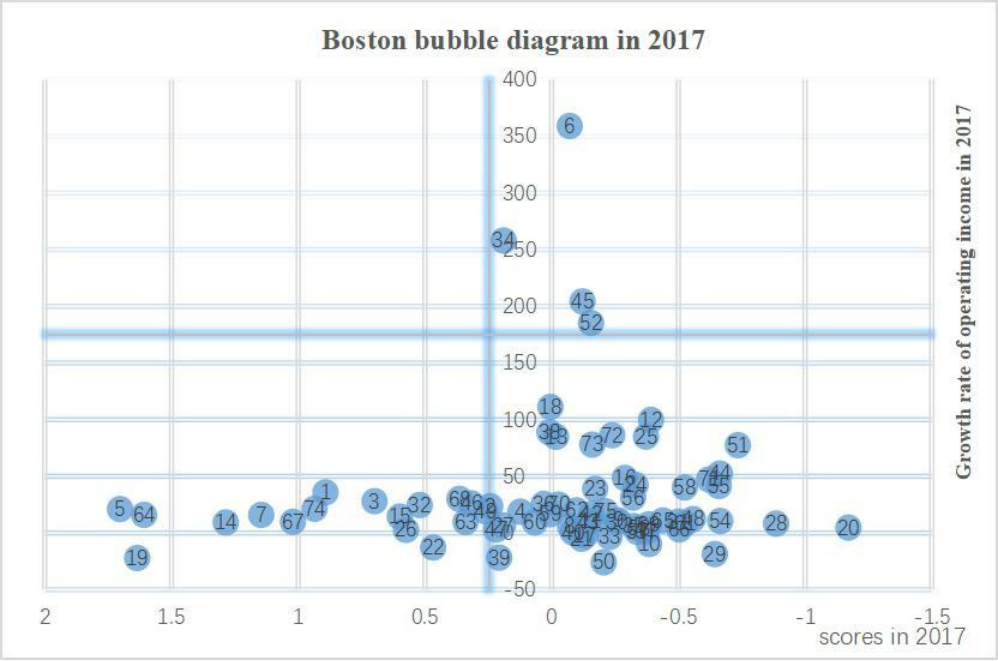

Fig 6.2 Boston bubble diagram in 2017

The concrete classification in 2017 was shown in Table 6.2.

Table 6.2 Concrete category in 2017

Type	Enterprises	Ranking	Type	Enterprises	Ranking
Cash cows(17)	Yunda Holding Co., Ltd.	1	Thin dogs(54)	Shenzhen Expressway Co., Ltd.	27
	STO Express Co., Ltd.	3		Jiangxi Changyun Co., Ltd.	28
	Shenzhen Yan Tian Port Holdings Co., Ltd.	5		Shanghai Qiangsheng Holding Co., Ltd.	29
	Dongguan Development (Holdings) Co., Ltd.	8		Shanghai Jiao Yun Group Co., Ltd.	30
	Guangdong Provincial Expressway Development Co., Ltd.	14		Shanghai Shentong Metro Co., Ltd.	31
	Anhui Expressway Co., Ltd.	15		Sichuan Expressway Company Limited	33
	Chongqing Road and Bridge Co., Ltd.	19		Guangshen Railway Company Limited	35
	Shandong Hi-speed Company Limited	22		Jilin Expressway Co., Ltd.	36
	Jiangsu Expressway Co., Ltd.	26		Hainan Haiqi Transportation Group Co., Ltd.	37
	Daqin Railway Co., Ltd.	32		Hengtong Logistic Co., Ltd.	38
	Hainan Strait Shipping Co., Ltd.	46		Dazhong Transportation (Group) Co., Ltd.	39
	Shanghai International Port (Group) Co., Ltd.	49		Shanghai Jin Jiang International Industrial Investment Co., Ltd.	40
	Guangzhou Baiyun International Airport Co., Ltd.	63		Zhuhai Port Co., Ltd.	41
	Shanghai International Airport Co., Ltd.	64		Chang Jiang Shipping Group Phoenix Co., Ltd.	42
	Xiamen International Airport Co., Ltd.	67		Beibu Gulf Port Co., Ltd.	43
	Spring Airlines Co., Ltd.	68		Xiamen Port Development Co., Ltd.	44
	Sinotrans Air Transportation	74		China Merchants Port Group Co., Ltd.	47

	Development Co., Ltd.				
Question marks(4)	Hunan Investment Group Co., Ltd.	6		Rizhao Port Co., Ltd.	48
	Heilongjiang Transport DEV. Co., Ltd.	34		COSCO Shipping Energy Transportation Co., Ltd.	50
	Nanjing Port Co., Ltd.	45		Jinzhou Port Co., Ltd.	51
	Chongqing Gangjiu Co., Ltd.	52		Yingkou Port Liability Co., Ltd.	53
Thin dogs(54)	S.F. Holding Co., Ltd.	2		COSCO Shipping Specialized Carriers Co., Ltd.	54
	YTO Express Group Co., Ltd.	4		Anhui Wanjiang Logistics (Group) Co., Ltd.	55
	Henan City Development Environment Co., Ltd.	8		Shanghai Ya Tong Co., Ltd.	56
	Xiandai Investment Co., Ltd.	9		Tianjin Port Co., Ltd.	57
	Sichuan Fulin Transportation Group Co., Ltd.	10		Ningbo Marine Co., Ltd.	58
	Hubei Yichang Transportation Group Co., Ltd.	11		Tangshan Port Group Co., Ltd.	59
	Longzhou Group Co., Ltd.	12		Shenzhen Airport Co., Ltd.	60
	Xinjiang Tianshun Supply Chain Co., Ltd.	13		CITIC Offshore Helicopter Co., Ltd.	61
	Henan Zhongyuan Expressway Co,. Ltd.	16		Shandong Airlines Co., Ltd.	62
	Fujian Expressway Development Company Limited	17		China Southern Airlines Co., Ltd.	65
	Hubei Chutian Smart Communication Co., Ltd.	18		China Eastern Airlines Corporation Limited	66
	Y.U.D.Yangtze River Investment Industry Co., Ltd.	20		Air China Limited	69
	Jiangxi Ganyue Expressway Co., Ltd.	21		Juneyao Airlines Co., Ltd.	70

	Guangxi Wuzhou Communications Co., Ltd.	23		Hainan Airlines Holding Co., Ltd.	71
	Ningxia Western Venture Industrial Co., Ltd.	24		Jiangsu Aucksun Co., Ltd.	72
	China Railway Tielong Container Logistics Co., Ltd.	25		Antong Holdings Co., Ltd.	73
				CTS International Logistics Corporation Limited	75

7. Analysis and Conclusions

The categories of 75 enterprises in 2016 and 2017 can be broken down into four categories:

1）The Stars in 2016, with a total of 4 enterprises, whose business growth rate and financial indicators analysis scores were both high, they belonged to the growing enterprises. The next year they all evolved into Cash cows, indicating that these four enterprises had spent their upgrade period and matured in 2017. Thus operating income began to stabilize and the growth rate of operating income became lower, so they turned into Cash cows with high scores and low growth rate.

2）The Cash cows in 2016, with a total of 10 enterprises, were mature, successful businesses with relatively little need for new investment[20]. Next year, 9 enterprises were still Cash cows, which showed that they were mature and stable. And they need to be managed for continued profit so that they could continue to generate the strong cash flows which will lead to next phase of development[20]. Another company, Sichuan Expressway Company (serial number 34), turned from Cash cows to Question marks, and dropped its overall ranking by 12 as well. Its internal financial situation began to decline, being likely to be unable to support the current high income growth rate in the future. It was recommended that the company to pay extra attention to avoid the decline of the Thin dogs enterprises.

3）The Question marks in 2016, with a total of 12, had a high growth rate of operating income, but their compound AHP scores were so average that it would be difficult to maintain the advantage of the growth rate in the future. In fact, the following year, 11 became Thin dogs, suggesting that low financial scores did have a negative impact on future revenue growth. The other was Nanjing Port Co., Ltd.(serial number 45), remaining Question marks in 2017, but its overall ranking dropped 17. If no more attention could be given to the improvement of corporate financial performance, the company was likely to follow the footsteps of another 11 enterprises.

4）The Thin dogs in 2016, with a total of 49, was about to have the future growth ratio of business income remaining low if they did not try to improve financial performance. In fact, categories of 43 business remained unchanged the following year, in a state of subsequent weakness. And 4 enterprises were transformed into Cash cows, namely Daqin Railway Co., Ltd. (serial No. 32), Hainan Strait Shipping Co., Ltd. (serial No. 46), Shanghai International Port (Group) Co., Ltd. (serial No. 49) and Spring Airlines Co., Ltd. (serial number 68), whose comprehensive rankings increased by 13, 1, 12, 13, respectively. It was quite clear that their financial performance compared with other enterprises had been improved. If maintaining this benign trend, this positive tendency could be reflected in the enterprise's business income growth indicators, which meant the performance of star-like enterprises. Two of the forty-nine were transformed into Question marks, namely Hunan Investment Group Co., Ltd.(serial number 6), Chongqing Gangjiu Co., Ltd.(serial number 52), the financial performance score was still low while the business growth rate was leading in 75 enterprises, which seemed not reasonable. After observing two enterprises' two-year growth rate of business income, it was found that the former had soared from 15.639 in 2016 to 359.08 in 2017 and the ranking had increased from

19th to 1st; the latter had soared from 6.454 in 2016 to 185.297 in 2017 and the rate of growth had increased from 34th to 4th. So it was clear that this two enterprises had experienced some kind of emergency, leading to its performance out of the general company's development rules.

The analysis of the above four cases proved that the change rule of each company's category in Boston Matrix with time is accorded with the development law of most enterprises. This improved analytic hierarchy process combined with the Boston Matrix can help those in need to understand the current financial situation of an enterprise and put forward some valuable suggestions as well as making the general forecast to the future enterprise's financial condition development tendency. Therefore, the improved analytic hierarchy process method and the Boston Matrix established by us are of research value.

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Competing interests

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