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Accounting of Financial Evaluation Indicators Based on Fuzzy Mathematics

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Abstract. *Based on the theoretical knowledge of fuzzy mathematics, fuzzy mathematics is introduced into the feasibility analysis of financial evaluation index system, and the principles and construction steps of optimizing the current financial evaluation index system are discussed. Combining the fuzzy comprehensive evaluation model with the financial comprehensive evaluation, the current financial evaluation index system is optimized. A set of financial fuzzy comprehensive evaluation model is established to evaluate the comprehensive financial strength of listed companies. This model is used to analyze the profitability, solvency, operating ability, growth ability and non-financial indicators of listed companies in household electrical appliances industry. In addition, the model before and after optimization is compared and analyzed.*

Keywords: *Fuzzy mathematics, Feasibility analysis, Optimization principle*

1. Introduction

With the establishment and perfection of China's market economic system, the number of companies is increasing, and the risk of investment is bigger and bigger. The development of knowledge economy makes the resource allocation and the nature of work in modern enterprises changed. The traditional financial evaluation index system cannot meet the needs of comprehensive analysis or evaluation of enterprises. However, with the gradual improvement of the market economic system, investors need to make timely and accurate use of the information of listed companies for financial comprehensive evaluation. Nevertheless, due to the complex relationship between financial indicators, investors are at a loss in financial evaluation. Therefore, improving the financial evaluation index system of listed companies is the trend.

The financial evaluation index system is optimized from the perspective of fuzzy mathematics, and the ideas of fuzzy clustering analysis and non-parametric test are applied to the whole process of financial evaluation. The purpose is to make up for the deficiency of the current financial evaluation system and make the

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comprehensive financial evaluation more comprehensively use relevant financial data to reveal the comprehensive financial strength of enterprise more comprehensively and intuitively. Moreover, non-financial indicators are introduced to optimize the financial evaluation method, so that financial evaluation is more effective and practical and financial evaluation is conducive to the decision-maker's judgment, making it possible for the promotion and application of financial evaluation.

2. Theoretical basis

In general, fuzzy mathematics is a new branch of mathematics that takes the phenomenon of fuzziness in the objective world as the research object, to find out the law from it, and then use the accurate mathematical method to deal with it. It provides a simple and effective method for us to study those complicated problems that are difficult to be described by exact mathematics. Fuzzy mathematics does not mean to turn mathematics into vagueness. It also has the general character of mathematics, which is clear-cut and meticulous. In the objective world, the things that people encounter can be divided into two categories quantitatively: deterministic quantity and uncertain quantity, and uncertain quantity can be divided into randomness and fuzziness. The method to study these quantities is different. Classical mathematics is used for deterministic quantities, probability theory is applied for random and uncertain quantities, and fuzzy mathematics is adopted for fuzzy and uncertain quantities.

Definition of fuzzy mathematics: supposing that there is a given mapping in the domain U: μ_A :U $\rightarrow$[0,1] $\mu \mapsto \mu_A(\mu) \in$[0,1], then it is considered that μ determines a fuzzy subset in U, recorded as A. μ is called the membership function of fuzzy subset A, μ_A is the membership function of A, $\mu_A(\mu)$ appearing at u$\in$U is called the membership degree of u to A, and it belongs to the degree or "qualification" that u belongs to A. For convenience, fuzzy subsets are usually referred to as fuzzy sets, and μ_A and $\mu_A(\mu)$ are both abbreviated as A(u).

Fuzzy set A is completely described by its membership function, that is, as long as the membership function A(u) is given, then fuzzy set A is completely determined, different membership functions determine different fuzzy sets, and the same domain U can have more than one fuzzy set. For fuzzy set in $\forall u \in U$ and U, generally, it cannot say that whether u subordinates to A. It can just say that to what extent u belongs to A, which is the essential difference between fuzzy set and common set. Especially when A(u) only takes the two endpoints of [0, 1], that is, the two values of 0 and 1, the membership function is reduced to the characteristic function, and the fuzzy set A is reduced to a common set, which indicates the special state of the ordinary subset. In addition, if A(u) =0 , then A is known as an empty set Φ ; if $\forall u \in$U and A(u) =1, then A is called the complete set U.

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When the object is directly identified, it is based on the principle of maximum membership: supposing that $A_i \in F(U)$ (i =1, 2,…, n), if $\exists j \in \{1, 2,\ldots, n\}$ makes $A_j(u_0) = \max(A_1(u_0), A_2(u_0), \ldots, A_n(u_0))$, then u_0 is considered to be relative to belong to A_j, namely, the element u_0 should be attributed to fuzzy pattern A_j. This method directly judges the specific object membership by calculating the subordinate function values of elements is called the direct method of fuzzy pattern recognition. This method is suitable for dealing with the following problems: (1) the pattern used for comparison is fuzzy; (2) the object itself recognized is determined. Direct recognition method is a mathematical model that simulates the thinking process of human brain processing problems. Although its form and classification method are simple, it can effectively deal with many problems.

3. Optimization process

In practical problems, it is necessary to compare different things and choose the best ones. If only a single factor is considered, then the problem is relatively simple. Just giving the object an evaluation score, according to the level of the score, the order of the objects can be determined. However, the same thing often has a variety of attributes, and some attributes have fuzziness. People's evaluation of such things is not simply "good" and "bad", but using fuzzy language to divide it into different degrees of evaluation. At this time, in the comparison, it is supposed to take into account all aspects and pay attention to their difference in degree. In this case, to order them out and find the best one, it needs to consider comprehensively, which requires fuzzy comprehensive decision-making. Simply speaking, fuzzy comprehensive decision-making is the application of fuzzy mathematics method to for single decision-making of the factors involved in the matter, and then a comprehensive decision-making of the matter is given by considering all aspects.

In production, scientific experiments and daily life, we are often asked to divide the objects (areas) that we contact and research into several categories according to their nature and use. The method of classifying things according to certain requirements and rules is called cluster analysis. Cluster analysis is a mathematical method to classify things according to their different characteristics, degree of intimacy, and similarity. Its mathematical basis is multivariate analysis in mathematical statistics. However, the boundaries between things in real life are often not very clear, and many classification problems are often accompanied by ambiguity. In terms of weather, there is no absolute limit between sunny and cloudy. For this kind of problem, the ordinary clustering analysis is powerless, but the use of fuzzy mathematics language and methods for clustering analysis will be more natural and realistic, which is where the strong vitality of fuzzy clustering analysis. The steps of fuzzy clustering analysis are as follows:

Select statistical indicators: according to the actual problems, select those features with clear meaning, strong resolution and representativeness as the

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statistical indicators of classification. The choice of statistical indicators has a direct impact on the classification effect.

Conduct data normalization: because the dimension and magnitude of m characteristic indices are not necessarily the same, they may highlight the role of a special large order of magnitude in classification, and reduce or even exclude the role of some very small order of magnitude, resulting in the lack of a unified scale for the classification of each characteristic index. In cluster analysis, in order to eliminate the difference of characteristic index units and the influence of different magnitude of characteristic index, data normalization must be carried out on each index value, so that each index is unified in a common range of numerical characteristics, and the purpose of converting data is to make these variables comparable. The following normalization method is adopted:

For *j*th column of characteristic index matrix *U*, calculate $\overline{u_j} = \frac{1}{n}\sum_{i=1}^{n} u_{ij}$ and $\sigma_j^2 = \sum_{i=1}^{n}(u_{ij} - \overline{u_j})^2$ ($_j$=1,2,…,m), and the transform $u_{ij} = \frac{u_{ij} - \overline{u}_j}{\sigma_j}$, (*i*=1,2,…,n; *j*=1,2,…,m).

After transformation is implemented, the average value of each index is $\mu = 0$ and variance is $\sigma = 1$.

Construct fuzzy similarity matrix: assuming that data u_{ij} (i= 1,2,…,n;j= 1,2,… ,m) are all normalized, multivariate analysis is used to identify the similarity between objects $u_i=(u_{i1},u_{i2},\ldots,u_{im})$ and $u_j=(u_{j1},u_{j2},\ldots,u_{jm})$: $r_{ij} = R(u_i , u_j) \in [0,1]$(i,j=1,2,…,n). Thus, a fuzzy similarity matrix between objects is constructed.

$$R = \begin{matrix} r_{11} & r_{12} & \ldots & r_{1n} \\ r_{21} & r_{22} & \ldots & r_{2n} \\ \ldots & \ldots & \ldots & \ldots \\ r_{n1} & r_{n2} & \ldots & r_{nn} \end{matrix}$$

r_i is determined by adopting subjective evaluation. In some practical problems, the characteristic index of the classified object is a qualitative index, that is, the characteristic index is difficult to be expressed by numerical value. At this point, the experts concerned and those with relevant practical experience are invited to use the method of grading to assess the similarity between the classified objects.

Perform fuzzy clustering: The result of classification can be obtained by selecting a suitable clustering method. After determining the distance between samples, we can classify the samples. There are many methods to classify the samples, among which the most widely used is the system clustering method. It first classifies several samples into a category, then merges the two classes with the smallest distance into one class, and then recalculates the distance between the classes until all the samples are classified into one class.

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For the screening of financial indicators, a dynamic screening method combining fuzzy clustering analysis and non-parametric test is applied. The specific steps are as follows:

Step 1: four kinds of financial indicators are conducted with fuzzy clustering analysis. n_k indicates the number of indicators corresponding to the result of clustering analysis.

Step 2: when $n_k = 1$, it indicates that if there is only one index in clustering results, then this index is selected.

Step 3: according to the clustering results of the first step, the subclasses with obvious differences will be decomposed into smaller classes, and then the second step test will be carried out.

Step 4: when $n_k = 2$ and there is no obvious difference between the two indicators, because they are the same to r_{ij}^2 of another indicator, according to the actual significance of the indicators, the more representative one is selected.

Step 5: combine the financial indicators and non-financial indicators selected from the four categories of financial indicators to form a new financial evaluation index system.

4. Conclusion

The result of classification can be obtained by selecting a suitable clustering method. After determining the distance between samples, the samples can be classified. There are many methods to classify the samples and the most widely used is the system clustering method. It first classifies several samples into a class, then merges the two classes with the smallest distance into one class, and then recalculates the distance between the classes until all the samples are classified into one class.

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