Multivariate Statistical Analysis on Competitiveness of Environmental Listed Companies in China

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Abstract: Taking 12 companies as an example, we evaluate the competitiveness of Environmental Listed Companies in China by multivariate statistical methods of AHP and Principal Component Analysis, on base of which these companies were ranked and classified by Cluster Analysis method, according to the advantages and disadvantages of each indicator. Investors may choose stocks which are more competitive, in order to reduce risk and make profits.

Key words: Environmental Listed Companies; Competitiveness; Multivariate statistical analysis

1. INTRODUCTION

Enterprise competitiveness is the comprehensive capabilities of a company to develop its own resources and ability, at the same time, obtain external resources, both of which are made multiple use, so as to create value for customers and to realize their own value in a competitive market conditions. It is an abstract concept, containing multiple levels, which includes competitiveness of the surface, of those to support the platform, as well as the core competitiveness. Each industry has its own key abilities, one shall conduct specific analysis aimed to specific questions. In addition, indicators for evaluating competitiveness are very complex, and so far, there is no uniform index system for it, researchers must establish one system directly towards different sectors of the economy.

With wind energy and solar energy put into use, the human race has stepped into an age of industrial civilization and agricultural civilization. However, more attention has been paid to environmental problems caused by usage of energy, which is the result of rapid development of global economy. Now people are advocating a so-called Low-Carbon Economy, and are cognizing environmental problems more deeply. With such a background, Environmental Listed Company is faced with opportunities and challenges at the same time. They shall try to improve their competitiveness, so as to meet challenges and seize opportunities, and stand out in the competitive market.

So it is of great necessary to investigate into the competitiveness of Environmental Listed Companies, not only can it provide references to make competitive strategy for companies, but also can it give advice for investors.

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2. COMPREHENSIVE EVALUATION OF ENVIRONMENTAL LISTED COMPANIES

2.1 Index System for Evaluation

Taking data availability and existing research into consideration, an indicator system for evaluation of environmental listed companies may be comprised of profitability, development ability, management ability, debt-paying capacity, and financing ability. Indicators reflecting a company’s profitability includes profit margin (let it be X1), all capital earnings rate (X2). Those reflecting development ability may be growth rate of main business income (X3) and that of net asset (X4). And management ability, turnover of account receivable (X5), fixed asset turnover (X6), debt-paying ability, asset-liability ratio (X7) and number of times interest earned (X8), financing ability, gross profit (X9) and earnings per share (X10).

2.2 Choice of Weights

There exit many methods to weight indicators. In this paper, we employ AHP and the Principal Component Method.

2.2.1 Sort indexes according to importance

We extract four principal components on base of principal component analysis, and divide ten indicators into 4 grades by their degrees of importance, which are important, more important, very important, most important, respectively denoted as 1, 2, 3, 4. The result of Principal Component Analysis by SPSS15.0 show that the first principal component includes X6, X8, X10, the second principal component, X4, X7 and X9, and the third, X1, X2, the fourth, X3,X5, variance contribution rate progressively decreasing. This means that fixed asset turnover, number of times interest earned and earnings per share are the most important indicators, growth rate of net asset, asset-liability ratio and gross profit are very important indicators, profit margin and all capital earnings rate are more important indicators, and growth rate of main business income and turnover of account receivable, important indicators.

2.2.2 Establishing comparison matrix and calculating weights vector

On base of the result of rank above, we may establish the comparison matrix, normalize each column of the matrix, and add them by the line to get vector M. The normalized vector is the feature vector, which we denote with W. Then by the formula \( \lambda = \frac{\sum (AW)}{nW} \), we calculate the largest eigenvalue of comparison matrix, the data given in Table 1.

\[
A = \begin{bmatrix}
1 & 1 & 2 & 2/3 & 2 & 1/2 & 2/3 & 1/2 & 2/3 & 1/2 \\
1 & 1 & 2 & 2/3 & 2 & 1/2 & 2/3 & 1/2 & 2/3 & 1/2 \\
1/2 & 1/2 & 1 & 1/3 & 1 & 1/4 & 1/3 & 1/4 & 1/3 & 1/4 \\
1/2 & 1/2 & 1 & 1/3 & 1 & 1/4 & 1/3 & 1/4 & 1/3 & 1/4 \\
2 & 2 & 4 & 4/3 & 4 & 1 & 4/3 & 1 & 4/3 & 1 \\
2 & 2 & 4 & 4/3 & 4 & 1 & 4/3 & 1 & 4/3 & 1 \\
2 & 2 & 4 & 4/3 & 4 & 1 & 4/3 & 1 & 4/3 & 1 \\
\end{bmatrix}
\]

\( \lambda = \frac{\sum (AW)}{nW} \)

Table 1-a: The Weights Vector for Evaluation Index System

<table>
<thead>
<tr>
<th>indicators</th>
<th>eigenvector W</th>
<th>vector AW</th>
<th>( AW / nW )</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1</td>
<td>0.0741</td>
<td>0.7407</td>
<td>0.99965</td>
</tr>
<tr>
<td>X2</td>
<td>0.0741</td>
<td>0.7407</td>
<td>0.99965</td>
</tr>
<tr>
<td>X3</td>
<td>0.0370</td>
<td>0.3704</td>
<td>1.001001</td>
</tr>
<tr>
<td>X4</td>
<td>0.1111</td>
<td>1.1111</td>
<td>1.0001</td>
</tr>
<tr>
<td>X5</td>
<td>0.0370</td>
<td>0.3704</td>
<td>1.001001</td>
</tr>
<tr>
<td>X6</td>
<td>0.1481</td>
<td>1.4815</td>
<td>1.000325</td>
</tr>
</tbody>
</table>
Table 1-b: The Weights Vector for Evaluation Index System

<table>
<thead>
<tr>
<th>indicators</th>
<th>eigenvector W</th>
<th>vector AW</th>
<th>(AW / nW_i)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X7</td>
<td>0.1111</td>
<td>1.1111</td>
<td>1.0001</td>
</tr>
<tr>
<td>X8</td>
<td>0.1481</td>
<td>1.4815</td>
<td>1.000325</td>
</tr>
<tr>
<td>X9</td>
<td>0.1111</td>
<td>1.1111</td>
<td>1.0001</td>
</tr>
<tr>
<td>X10</td>
<td>0.1481</td>
<td>1.4815</td>
<td>1.000325</td>
</tr>
</tbody>
</table>

2.2.3 The consistency test of judgement matrix

It can be concluded that \(\lambda_{max} = 10.00258\) on base of table 1. According to test coefficient formula, it is drawed that test coefficient is:

\[
CR = \frac{CI}{RI} = \frac{(\lambda_{max} - n)/(n-1)}{RI} = 0.0019 < 1
\]

so the judgement matrix has satisfactory consistency. The comprehensive evaluation index weights of most important, very important, more important, important are 0.1481, 0.1111, 0.0741, and 0.0370.

2.3 Comprehensive Evaluation of Competitiveness of Environmental Listed Companies

2.3.1 Non-dimensional treatment of the indexes

We uses the function method to treat dimensionless problem for index, the formula is as follows:

\[
G_i = \frac{x_i - x_{ai}}{x_{ai} - x_{bi}} \times 40 + 60 \quad i = 1,2 \ldots n \quad (2)
\]

Where \(G_i\) is evaluation score for the ith item; \(x_i\) the actual value for the ith indicator; \(x_{ai}\) the highest level for the whole industry and \(x_{bi}\) the lowest level; \(40 + 60\) is to make the results not equal to 0. The calculated results is shown in Table 2.

Table 2: Non-Dimensional Treatment of the Indexes

<table>
<thead>
<tr>
<th>enterprise</th>
<th>profitability</th>
<th>development capacity</th>
<th>management capacity</th>
<th>solvency capacity</th>
<th>financing capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>IWT</td>
<td>65.6123</td>
<td>72.7148</td>
<td>82.3432</td>
<td>80.0721</td>
<td>60</td>
</tr>
<tr>
<td>FL</td>
<td>67.0069</td>
<td>76.2141</td>
<td>68.7506</td>
<td>60.0902</td>
<td>60</td>
</tr>
<tr>
<td>ZFEST</td>
<td>60.0000</td>
<td>60.0000</td>
<td>72.2779</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>TCEPG</td>
<td>84.2050</td>
<td>73.1823</td>
<td>75.007</td>
<td>60.1062</td>
<td>60</td>
</tr>
<tr>
<td>ZYEPE</td>
<td>88.8511</td>
<td>100.0000</td>
<td>75.9988</td>
<td>60.0162</td>
<td>60</td>
</tr>
<tr>
<td>CXRGI</td>
<td>100.0000</td>
<td>98.2570</td>
<td>73.0115</td>
<td>60.4355</td>
<td>60</td>
</tr>
<tr>
<td>TEDIH</td>
<td>64.5369</td>
<td>65.1836</td>
<td>100.0000</td>
<td>60.411</td>
<td>60</td>
</tr>
<tr>
<td>SER</td>
<td>81.4829</td>
<td>85.1386</td>
<td>80.9141</td>
<td>60.5881</td>
<td>60</td>
</tr>
<tr>
<td>BWBD</td>
<td>84.9527</td>
<td>78.4476</td>
<td>60.0000</td>
<td>60.0000</td>
<td>60</td>
</tr>
<tr>
<td>XSEI</td>
<td>72.6108</td>
<td>88.7460</td>
<td>78.7543</td>
<td>64.2558</td>
<td>60</td>
</tr>
<tr>
<td>BOWT</td>
<td>87.7421</td>
<td>77.6617</td>
<td>93.1010</td>
<td>66.9954</td>
<td>60</td>
</tr>
<tr>
<td>DENED</td>
<td>72.6024</td>
<td>90.5985</td>
<td>86.0230</td>
<td>83.1329</td>
<td>60</td>
</tr>
</tbody>
</table>

2.3.2 Calculation of composite index

Here we try Weighted Average Method to calculate composite score, the calculating formula is:

\[
\overline{G_i} = \frac{\sum G_i W_i}{\sum W_i} \quad (3)
\]

Where \(\overline{G_i}\) is the composite score of the indicators, \(W_i\) indexes’ weights. According to the formula and relevant data, we get composite score of each enterprise and competitiveness rankings in Table 3.
3. CLUSTER ANALYSIS OF ENVIRONMENTAL LISTED COMPANIES

3.1 What is Clustering Analysis?
Cluster analysis is a collection of statistical methods, which identifies groups of samples that behave similarly or show similar characteristics. It is an approach of studying "birds of a feather flock together", aimed at finding some statistics that can measure the similarity between different levels' sample or indicators (variables) being investigated and classify them into different types by these statistics. Generally, samples or indicators of more similarity are clustered together step by step, until each sample has a class which it attributed to.

3.2 Cluster Analysis of Companies
On based of Hierarchical Clustering Method and the result of rank for comprehensive competitiveness of 12 listed companies, we classify the 12 listed companies.

It shows that the 12 listed companies can be divided into three categories according to pedigree chart.

The first category includes Fujian Longking, Chengdu Xing Rong Group and Sound Environmental Resources. Their profitability, operating ability, development ability, financing ability and debt-paying ability develop in a more balanced way and top out. So these companies have quite doughty competitiveness and good momentum of development.

The second category includes Tianjin Capital Environmental Protection Group and TEDA Investment Holding. They have higher asset-liability ratio, number of times interest earned and gross profit, which indicates that they have better debt-paying ability and financing ability, as well as profitability. However, growth rate of these enterprises’ net assets is lower, showing weaker development ability.

The third category includes Interchina Water Treatment, Xiamen Savings Environmental Industrial, Zhejiang Feida Environmental Science & Technology, Zhong Yuan Environmental Protection, Beijing Origin Water Technology, Dalian East New Energy Development and Beijing Water Business Doctor. They have better profitability, development ability and management ability, but bear weaker debt-paying ability and financial ability than other enterprises, showing smaller number of times interest earned and gross profit, which may lead to higher financial risk, so investors shall be cautious with them.

4. CONCLUSION
Involving a wide range of factors and indicators, comprehensive evaluation of competitiveness of the Listed Companies is a very complex process. This article employs multivariate statistical methods such as AHP, Principal Component Analysis and Cluster Analysis to comprehensively evaluate competitiveness of Environmental Listed Companies, and classify them by their superiors and inferiors.
REFERENCES
