Research on the application of hierarchical analysis method in the construction of financial risk evaluation system of colleges

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Abstract. In recent years, along with the continuous promotion of China's education and teaching reform, colleges have invested a large amount of education expenses for education work, and their financial management problems have become one of the important work. As an important part of financial management, financial risk in colleges plays an important role in the normal operation of financial system and long-term sustainable development of colleges. Based on this, this paper analyzes its application in the financial risk evaluation system of colleges by using hierarchical analysis method, which is a reference and reference for colleges to improve and strengthen the construction of financial risk system.

Keywords: financial management; financial risk evaluation; hierarchical analysis method.

1. Introduction

With the education reform and the expansion of the autonomy of colleges, the source of school funding has gradually changed from relying mainly on government funding to raising funds in various ways to make up for the shortage of funds required by colleges[1]. Rational financing and prevention of financial risks have gradually become an important task of financial management in colleges. In this paper, we make a case study of colleges and establish a financial risk evaluation model based on hierarchical analysis to make a comprehensive evaluation of their financial risks.

2. Financial risk evaluation model of colleges based on hierarchical analysis method

2.1 Introduction of hierarchical analysis method

Hierarchical analysis (AHP), a combination of qualitative and quantitative methods used to determine hierarchical weights and guide decision-making[2]. The method can be used to rank specific indicators in order of priority to provide decision makers with a basis for their decisions.

2.2 General steps of hierarchical analysis method

The specific steps of the hierarchical analysis method are as follows:

In the first step, the hierarchical matrix is constructed. We usually divide the sample indicators into target layer, criterion layer and indicator layer. The highest level is the target layer, and the middle layer is the criterion layer, where specific indicators are classified according to the attributes of each indicator and certain criteria, and each attribute is an item in the criterion layer; below the criterion layer is the indicator layer, which is the specific indicator selected.

The second step is to construct the judgment matrix. Starting from the criterion layer, the M elements of the same level are compared with each other, and the relative importance of the elements is assigned to them, so as to establish a judgment matrix. Each element of the matrix represents the horizontal index $X$, the relative importance degree value of the index $X_j$ for each vertical axis, often expressed as 1, 2, 3, 4, 5, 6, 7, 8, 9 or its inverse.

The third step is to calculate the indicator weight coefficients[3-4]. The indicator weight coefficients are the eigenvectors of the matrix, denoted by $I$. The value of the weight coefficient of each indicator is the ranking vector of the weight of each indicator.
Calculate the product of the elements of each row of each judgment matrix with the formula \( Z_i = (i = 1, 2, 3, \ldots, m) \), the formula is:

\[
Z_i = X_{ij}^m b_j
\]

(2) Calculate the \( m \) secondary root of each line of \( Z_i \), the formula is:

\[
\overline{W} = \sqrt[\overline{Z}]{Z_i}
\]

(3) Normalize the vector \( W \), the formula is:

\[
W_i = \frac{\overline{W}_i}{\sum_{j=1}^{n} \overline{W}_j}
\]

The fourth step, consistency test. In the judgment matrix, especially in the multi-order judgment matrix, since the determination of scores and the given values of scores are subjective judgments of several experts, it is inevitable that there will be subjective judgments or some important judgments[5-6]. In order to reduce the influence of human factors and make the assessment of importance more scientific and reasonable, we need to conduct consistency tests.

(1) The judgment matrix \( X \) is multiplied by the column vector \( W \) to obtain the formula for each row of values \( XW_i \):

\[
XW_i = \begin{pmatrix}
X_{11} & \ldots & X_{1i} \\
\ldots & \ldots & \ldots \\
X_{mi} & \ldots & X_{mi}
\end{pmatrix}
\]

(2) Find the maximum characteristic root, formula as:

\[
\lambda_{\text{max}} = \frac{1}{n} \sum_{i=1}^{n} XW_i
\]

(3) calculate the consistency index \( CI \) (\( m \) is the order of the judgment matrix), the formula is:

\[
CI = \frac{\lambda_{\text{max}} - m}{m - 1}
\]

(4) Calculate the consistency ratio \( CR \), the formula is:

\[
CR = \frac{CI}{RI} (m > 2)
\]

The fifth step is to calculate the synthetic weights of individual indexes[7-8]. The value is the ordinal number of the total ranking of each index in the whole target. The obtained ranking of index weights can locate the key aspects of financial management of local colleges, guide the optimization and reform of the index system of local colleges, and analyze the expert opinions and make the basis for decision making due to the ranking, making it more scientific and convincing. In addition, it can be combined with standardized index values to comprehensively assess the financial performance of local colleges.

3. Selection of financial risk evaluation indexes of colleges

3.1 Debt-servicing ability

Solvency refers to the ability of colleges to pay various debts due[9-10]. The basic goal of financial risk control is to guarantee solvency, and only by guaranteeing solvency can we ensure the smooth reproduction. The evaluation indexes of solvency mainly include: asset-liability ratio, current ratio, realistic payment ratio, potential payment ratio and income debt ratio.
### 3.2 Operation performance

Operation performance refers to the ability of colleges to use educational resources reasonably and effectively to accomplish expected goals. This indicator reflects the daily management level and ability of colleges. If the operation performance index is unsatisfactory, it indicates that there are problems in the management of colleges. Its evaluation indexes include: the ratio of self-sufficiency of funds, the ratio of average income and expenditure of students, the ratio of public expenditure, the ratio of growth of fixed assets and the ratio of self-financing revenue capacity.

### 3.3 Profitability

Profitability reflects the ability of colleges to obtain economic benefits[11]. The supply of funds and the development of school business has always been a problem of outstanding contradiction between supply and demand. The size of the school's profitability directly affects its development speed and competitiveness in the same industry. The indicator is too low, which indicates that the development funds of colleges are not guaranteed enough. The evaluation indexes of profitability mainly include: asset income ratio, net asset income ratio, investment income ratio, net contribution per employee, and non-financial contribution per student.

#### 3.4 Development ability

Development ability reflects the ability of sustainable development of colleges. Its evaluation indexes mainly include: asset equity ratio, ratio of own funds utilization, ratio of other funds utilization, ratio of money fund expenditure.

#### 3.5 Budget management ability

The budget management ability is related to the school's business plan and business tasks, and its good or bad will directly affect the completion of the college's business plan and the efficiency of the use of funds. Financial budget management of higher education institutions includes budget formulation, execution, control and evaluation. The analysis of this part includes actual income, actual expenditure and budget variances, income budget completion rate, and expenditure budget completion rate[12]. These indicators are used to analyze the actual completion of budget revenue and expenditure, the differences arising from the budget and the reasons.

### 4. Construction of financial risk evaluation index system of colleges based on hierarchical analysis method

#### 4.1 Design of financial risk evaluation index system of colleges

According to the index design principles and other factors, the model for the financial risk evaluation index system of colleges is shown in Table 1:

<table>
<thead>
<tr>
<th>Level 1 indicators</th>
<th>Level 2 indicators</th>
<th>Level 3 indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>College financial risk evaluation system</td>
<td>Debt paying ability</td>
<td>Asset-liability ratio</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Current ratio</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reality payment ratio</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Potential payment ratio</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Income and liability ratio</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Self-sufficiency ratio of funds</td>
</tr>
<tr>
<td>Operation performance</td>
<td>Eper capita income and expenditure ratio</td>
<td>Public expenditure ratio</td>
</tr>
<tr>
<td></td>
<td>Growth ratio of fixed assets</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Self-raised income capacity ratio</td>
<td></td>
</tr>
<tr>
<td>Profitability</td>
<td>Assets income ratio</td>
<td>Net asset income ratio</td>
</tr>
</tbody>
</table>

Table 1 Financial risk evaluation index system model of colleges
4.2 Application of hierarchical analysis method in the construction of financial risk evaluation system of colleges

4.2.1 Establishing multi-level recursive structure

For the risk evaluation index system designed in this paper, the progressive level is shown in Table 1. After several stages of investigation and research, the indicators of each level in the element index system have been basically established, and 5 primary indicators and 24 secondary indicators have been obtained through analysis and generalization[13-14]. Now, to calculate the weight of each indicator by AHP method, we need to compare two indicators in the same level and construct a judgment matrix.

4.2.2 Establishment of judgment matrix and consistency test

Firstly, the relative importance of each element should be compared between two, i.e., the college financial risk evaluation index should be used as the criterion, and each element should be used as the sub-criterion to determine the degree of mutual influence between the elements and construct the judgment matrix. In practice, the relative importance of each factor in the judgment matrix of element-level indicators and target-level indicators is investigated in depth through expert questionnaires, and this paper derives the judgment by consulting nine senior financial personnel of colleges[15]. As Table 2, the judgment matrix of criterion level.

<table>
<thead>
<tr>
<th></th>
<th>Investment in come ratio</th>
<th>Pure contribution per staff</th>
<th>Students are not making financial contributions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development ability</td>
<td>Assets equity ratio</td>
<td>Use ratio of its own funds</td>
<td>Other fund utilization ratio</td>
</tr>
<tr>
<td>Budget management ability</td>
<td>Net cash growth ratio</td>
<td>Monetary capital expenditure ratio</td>
<td>School-run industrial asset-liability ratio</td>
</tr>
<tr>
<td></td>
<td>Budget revenue implementation rate</td>
<td>Implementation rate of budget expenditure</td>
<td>Implementation rate of special government appropriations</td>
</tr>
</tbody>
</table>

Similarly, the two-two judgment matrices of solvency, operational performance, profitability, development capability and budget management capability at sub-criteria level are obtained. In order to ensure that the conclusions of the hierarchical analysis method are basically reasonable, the
formed judgment matrix must also be tested for consistency, after checking Table 3, the average random consistency index $R_I$, we get Table 4, the consistency test results.

Table 3 Average random consistency index $R_I$

<table>
<thead>
<tr>
<th>n</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_I$</td>
<td>0</td>
<td>0</td>
<td>0.58</td>
<td>0.90</td>
<td>1.12</td>
<td>1.24</td>
<td>1.32</td>
<td>1.41</td>
<td>1.45</td>
</tr>
</tbody>
</table>

Table 4 Results of the consistency test

<table>
<thead>
<tr>
<th>The standard layer</th>
<th>Debt paying ability</th>
<th>Operation performance</th>
<th>Profitability</th>
<th>Development ability</th>
<th>Budget management ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum eigenvalue $\lambda_{max}$</td>
<td>5.060</td>
<td>5.021</td>
<td>5.017</td>
<td>5.039</td>
<td>6.072</td>
</tr>
<tr>
<td>coincidence indicator CI</td>
<td>0.015</td>
<td>0.005</td>
<td>0.004</td>
<td>0.010</td>
<td>0.014</td>
</tr>
<tr>
<td>Average stochastic consistency index $R_I$</td>
<td>1.12</td>
<td>1.12</td>
<td>1.12</td>
<td>1.24</td>
<td>0.58</td>
</tr>
<tr>
<td>consistency ratio CR</td>
<td>0.013</td>
<td>0.005</td>
<td>0.004</td>
<td>0.009</td>
<td>0.012</td>
</tr>
</tbody>
</table>

From the table, it can be seen that when $CR < 0.10$, the consistency of the judgment matrix is considered acceptable and satisfactory.

4.2.3 Determination of index weights and importance causal analysis chart

The magnitude of the influence of each element corresponding to the total target level college financial risk evaluation indicators is calculated by the AHP method, and the weights of these indicators can be ranked. After collation, the weights and rankings of key factors of college's financial risk as follows.

4.2.4 Evaluation and conclusion

From the weights and rankings of key factors of financial risk of colleges, it can be seen that:

① The degree of financial risk of the college affects five major categories of factors in order: budget management ability, operation performance, development ability, profitability, and solvency.

② In terms of budget management capability, the degree of influence is the execution rate of financial special allocation, the execution rate of budget expenditure, and the execution rate of budget revenue in order[16]. And the three execution rates occupy the top three important positions in the ranking of secondary indicators, which shows that college should pay special attention to the indicator of budget management capability.

③ In terms of operational performance, the ratio of self-financing, the ratio of self-financing revenue capacity, and the ratio of public expenditure occupy the fourth, fifth, and sixth positions. college should pay some attention to the risks caused by them. The operational performance reflects the daily management level and ability of the college, and the unsatisfactory index indicates that there are problems in the management of the college.

④ Development ability and profitability rank the third and fourth positions with little difference in weight, 0.1332 and 0.1317 respectively. Net asset income ratio, non-financial contribution per student and own fund utilization ratio rank the seventh, eighth and ninth positions among the secondary indicators. Net assets are the economic basis for the school's existence and...
development, and affect the net assets available for future use, which affects the school's sustainability and represents the maximum tolerance of debt risk the school can bear.

⑤ In terms of solvency, its weight is ranked last, and it is easy to see that since the work of college to resolve its debt was fully completed at the end of 2012, there is no bank loan problem, so there is not much attention in its aspect. This is also the reason for the low impact indicators.

5. Conclusion

Hierarchical analysis, as one of the important methods of system analysis, uses a comprehensive index to calculate the financial risk index situation of colleges by combining qualitative and quantitative analysis methods. This paper analyzes the application of hierarchical analysis method in the construction of financial risk evaluation system of colleges and confirms that it can better evaluate and measure the actual situation of financial risks of colleges, so as to provide some reference for the effective control of financial risks of colleges.

References