Research Article

Research on Influencing Factors and Early Warning of University Finance Based on Decision Tree Model

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The level and quality of financial management work are directly related to the progress of the work of the university in all aspects, and it is related to the normal operation of the overall mechanism of the university. With the fast development of Chinese universities, the Chinese government has increasingly relaxed its laws, allowing universities to exercise greater autonomy. However, there are many issues in financial management. Therefore, it is critical to solve the problems in the financial management of universities. In this study, the financial survey data of 56 colleges and universities are collected and, based on the detailed analysis of the development and financial situation of these colleges and universities, we summarize and analyze the financial situation of these colleges and universities. Moreover, a decision tree-based early warning system is constructed for early prediction of financial risk of colleges and universities. Finally, in light of the highlighted elements affecting college and university financial management, appropriate countermeasures and solutions are offered from both an external and internal perspective.

1. Introduction

Financial risk refers to the risk that an economy’s financial structure is unreasonable and improper financing may cause insolvency. It is a real problem that an economy must deal with during the financial management process. The key is to establish a preventive mechanism, explore the factors that affect financial risks, and take effective measures to reduce risks. Early warning systems could aid in the prevention of economic and management crises by providing a systematic prediction of unfavorable developments [1].

The financial risk of colleges and universities refers to the possibility and consequences of adverse events or losses caused by capital movement in the operation of colleges and universities. Different from enterprises which are for-profit organizations, colleges and universities are nonprofit institutions, which are different from the purpose of corporate financial funds to achieve corporate value-added [2]. The purpose of college financial funds circulation is to maintain and develop teaching and scientific research. Therefore, colleges and universities have different types of financial risks. The characteristics of the company include the strong policy in the financing, no profitability in products, no compensation in expenditures, and no reproducibility in turnover [3].

University funds are often derived from the different operations of the university, and the risk is usually low [4]. With the expansion of enrollment and the increase of faculty and teaching resources, the capital flow of colleges and universities has become more and more complicated, and therefore, the financial management risks of colleges and universities have gradually increased. At present, domestic scholars’ research on the financial risks of colleges and universities mainly focuses on different aspects.

The first is the study of the causes of financial risks in colleges and universities. Zhou et al. [5] believe that the financial risks of colleges and universities mainly come from the huge loans caused by the excessive scale of infrastructure, the imperfect financing system of colleges and universities, the unreasonable internal distribution system of colleges and universities, and the rigidity of the personnel system [6]. Carmona et al. [7] pointed out that the financial risks of colleges and universities are mainly due to the large development and expansion of the university, the defects of the
system and mechanism, and the ineffective supervision of government departments. Chen et al. [8] explored that the causes of financial risks in colleges and universities include two aspects, external and internal. The external causes are mainly insufficient fund supply from the state and banks, and the internal causes are mainly lack of financial risk management awareness and imperfect management systems. The authors in [9] analyzed the reasons for the financial risks of colleges and universities which include weak management's risk awareness, lack of a systematic monitoring mechanism for college finance, and huge construction pressure caused by expansion and enrollment.

The second is the study of financial risk evaluation and early warning of colleges and universities. Berens et al. [10] selected 19 financial indicators, used factor analysis to construct a financial risk evaluation system, and used the financial data of 25 affiliated universities to conduct empirical studies. Yaccob et al. [11] selected indicators from three aspects of operating cash flow, investment cash flow, and financing cash flow to build a financial risk evaluation system for colleges and universities based on a cash flow model. Based on the two dimensions of risk level and risk management level, Li et al. [12] constructed a comprehensive model of financial risks in colleges and universities and divided the risks into three levels of red, orange, and yellow as the early warning system.

The third is the research on the prevention and control countermeasures of financial risks in colleges and universities. Gertler et al. [13] pointed out that the current financial risks of colleges and universities include debt risk and overall imbalance risk and proposed preventive countermeasures for the two types of financial risks, such as controlling the scale of college debt and establishing a college financial risk early warning system. The author in [14] pointed out that the financial risk prevention strategy of local colleges and universities includes four aspects: perfecting the internal control system, controlling the scale of loans, establishing a financial risk early warning mechanism, and strengthening the education and training of financial management personnel.

This study focuses on identifying possible indicators for universities facing various financial risks and proposes a Chi-Square Automatic Interaction Detection (CHAID) decision tree algorithm and the logistic regression model to analyze the factors influencing universities' financial affairs and provide references for the effective implementation of healthy financial management strategies. The findings of this study will assist institutions in appropriately identifying financial risks and taking effective preventative and control actions.

The rest of the manuscript is organized as follows: Section 2 describes the influencing factors and financial risks in colleges and universities. In Section 3, the proposed financial risk early warning system is illustrated. Section 4 illustrates different results and the conclusion is given in Section 5.

2. Types and Influencing Factors of Financial Risks in Colleges and Universities

Financial risk is a common manifestation of risk. It refers to the possibility of inconsistency between the expected results of a company’s financial activities and the actual financial status and financial results. In most cases, it is manifested as the company's financial losses [15]. Financial risk can usually be divided into broad financial risk and narrow financial risk. The broad financial risk runs through all the financial activities of the enterprise, mainly manifested in the risk of financing activities, investment activities, capital recovery activities, and income distribution activities [16]. In a narrow sense, financial risk refers only to financing risk. The financial risk of colleges and universities refers to the financial risks that are caused by colleges and universities in financial management activities such as fund-raising management, investment management, and ordinary operation management, which may lead to the loss of college education funds. According to the above definition, we can divide the financial risk of colleges and universities into financing risk, investment risk, and daily operation risk [17].

Most scholars consider several aspects of university financial risk, including debt repayment, financing, investment, and overall imbalance [18]. According to each risk type, appropriate indicators are selected to establish an evaluation system. In this study, first, the variables are constructed for the decision tree model, and data samples are selected based on the variables [19]. Based on previous studies, the financial risks of colleges and universities are divided into four aspects: debt repayment risk, financing risk, investment risk, managing risk, and selecting the appropriate one for each financial risk. Indicators are selected to explore the factors affecting the overall financial risks of universities. The selected indicators are shown in Table 1.

There are more or fewer problems in the financial management of colleges and universities. The main manifestations are as follows: First, in terms of financial management, the principal in charge of finance generally assumes the role of a chief accountant. Affected by the leadership's subjective thinking, it seriously hinders the future development of colleges and universities; secondly, in terms of system construction, the accounting system of college financial management is relatively backward. The current financial department of colleges and universities is generally "reimbursement type" [20], and accounting information is often not available, which truthfully reflects the financial situation of the university itself. The design of the accounting system is biased towards the fund revenue and expenditure and daily accounting of various departments; third, the operation and investment are lagging. The social function of education in colleges and universities is increasing, and economic activities are becoming more and more complicated.

In addition to teaching and scientific research, some operations and investments are also carried out. However, there is currently a lack of management and norms in this area, and colleges and universities themselves do not have clear institutional constraints; fourth, the supervision system is relatively lagging, the financial supervision of colleges and universities often focuses on revenue and expenditure auditing, focusing on special fund supervision and ignoring the supervision of daily expenditures. Compared with the supervision system of foreign colleges and universities, the
supervision of Chinese colleges and universities lacks systematicity, standardization, and preventiveness [21].

Financial personnel of low quality is a widespread problem in colleges and universities, referring to financial personnel’s lack of legal principles, service knowledge, and professional skills [22]. First and foremost, financial personnel lacks legal knowledge and a sense of duty. Some financial professionals are unaware of the need of learning financial rules and accounting professional ethics, are unable to grasp national policies quickly, have a limited understanding of the legal system, and lack integrity and self-discipline. In addition, some financial staff lack service awareness, indifferent service attitude, fail to put a proper posture, even treat teachers and students badly, and have disputes with those who come to pay the bills. Finally, the financial staff has a low level of business and lack of professional skills. With the increasing frequency of current economic activities in colleges and universities, their business is becoming increasingly complex, the business requirements for financial staff are gradually increasing, and there is an urgent need for high-quality talents with professional knowledge. However, at present, some financial staff are unable to earnestly learn business knowledge, do not work earnestly, and have insufficient professional skills to perform their duties well [23]. Furthermore, the finance departments of colleges and universities face several issues, including an imbalance in staff proportions and a big share of nonprofessional personnel.

Enrollment growth in colleges and universities has become a common occurrence in recent years [24]. Many colleges and universities do not evaluate their actual conditions, extend their school’s scale blindly, and do not make the necessary financial investments, putting them in significant financial danger. Currently, the majority of schools and universities merely maintain, or essentially maintain, pay. Due to financing issues, many important experiments cannot be carried out, some necessary internships cannot be completed, several academic conferences have been canceled, and teaching and research funding has been cut. It is severely constrained, financial operations are challenging, and long-term development is problematic.

### 3. Financial Risk Early Warning

Early warning systems are mainly applied in three areas: natural disaster risk, macroeconomic risk, and financial risk [25]. Among them, the financial risk early warning system refers to the real-time monitoring and control of possible financial risks by setting up a set of sensitive financial indicator systems and corresponding risk early warning grade evaluation standards based on accounting, financial management, and financial accounting information. The theoretical methods of financial risk early warning systems can be roughly divided into three types: quantitative analysis, qualitative analysis, and quantitative and qualitative comprehensive analysis. Specifically, they include the following four common methods: analytic hierarchy process, Monte Carlo simulation, Bayesian analysis, and fuzzy analysis method.

#### 3.1. Analytic Hierarchy Process

Analytic Hierarchy Process (AHP) is a multicriteria decision-making method for quantitative analysis of qualitative problems [26]. The basic principles of this method are as follows: It first decomposes more complex issues into several constituent factors, then composes these factors into a hierarchical structure according to the dominance and subordination relationship, determines the relative importance of each factor in the hierarchical structure through pairwise comparison, and then combines them. The subjective judgment of the decision-maker ultimately determines the overall order of the entire decision-making plan. The analytic hierarchy process has a wide range of applications and is especially suitable for situations where there are factors in the decision-making plan that cannot obtain sufficiently accurate data for quantitative analysis. Because of the impact on the financial risks of colleges and universities, the factors include not only financial data that can be quantitatively analyzed but also nonfinancial data that need to be qualitatively analyzed through expert discussion and interview methods.

#### 3.2. Monte Carlo Simulation

The Monte Carlo simulation method [27], also known as the stochastic simulation

### Table 1: Selected factors.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Potential</th>
<th>X11</th>
<th>X12</th>
<th>X13</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1 debt service risk</td>
<td>Assets and liabilities</td>
<td>The ratio of short-term liabilities to own funds</td>
<td>Long-term debt to net assets ratio</td>
<td></td>
</tr>
<tr>
<td>R2 financing risk</td>
<td>Interest cost rate</td>
<td>The proportion of loan balance to total surplus</td>
<td>Cumulative loan to total income ratio</td>
<td></td>
</tr>
<tr>
<td>R3 investment risk</td>
<td>Investment cost ratio</td>
<td>School-run for-profit organization performance</td>
<td>Fund investment rate</td>
<td></td>
</tr>
<tr>
<td>R4 manage risk</td>
<td>The educational level of financial staff</td>
<td>Whether to establish a financial system</td>
<td>Risk awareness</td>
<td></td>
</tr>
<tr>
<td>R5 TFR</td>
<td>Teacher allowance payment rate</td>
<td>Financial support</td>
<td>Tuition-to-income ratio</td>
<td></td>
</tr>
</tbody>
</table>
method or statistical experiment method, is stochastic. Its basic idea is to first establish a probability model or random process to make its parameters equal to the solution of the problem, and then obtain the sampling results through computer simulation and calculate the statistical characteristics of the required parameters. As the number of simulations continues to increase, a stable conclusion can be obtained by averaging the parameter estimates obtained from each time. The Monte Carlo simulation method has a wide range of applications, mainly used in many fields such as mathematics, physics, engineering technology, and financial engineering [28]. However, in the process of constructing the financial risk early warning system for colleges and universities, the deficiencies of the Monte Carlo simulation method are that it requires very high data quantity and accuracy and also has a very large amount of calculation and a relatively complicated calculation process. Therefore, this method is not suitable for the construction of the financial risk early warning system model of colleges and universities.

3.3. Bayesian Analysis. Bayesian Analysis is a statistical inference method [29]. The basic idea of this method is to make full use of model information, data information, and prior information, the sampling distribution, and the prior distribution are jointly integrated into the posterior distribution, information, and the sampling distribution, and the prior distribution are the two key concepts of Bayesian analysis, and when using Bayesian analysis to make inferences, all inferences must be derived from the posterior distribution. Because it is more difficult to determine the prior probability and conditional probability of college financial risks, this means that Bayesian analysis is not suitable for the construction of financial risk early warning systems in colleges and universities.

3.4. Fuzzy Analysis Method. The fuzzy analysis method [30] is a method that uses fuzzy set theory to comprehensively evaluate the object to be evaluated. This method is mainly applicable to many fields such as engineering technology systems and social-economic systems. In the process of using the fuzzy analysis method, there are more subjective judgments in the determination of the index weights, and the conclusions drawn from the analysis are also subjective. The competence of personnel presents a greater challenge. Therefore, in most cases, the fuzzy analysis method cannot be directly used to construct the financial risk early warning system of colleges and universities.

4. Analysis of Financial Factors and Decision Tree Model

The decision tree (DT) model can be used to measure the complex relationship between multiple variables, especially the influence of multiple dependent variables on the same variable can be processed at the same time, and the fitting effect of the entire model equation can be tested. The estimation of the model includes four steps including model construction, model fitting, evaluation, and revision. In estimating the structural equation model, it is necessary to test the reliability and validity, and after the model is developed, it is necessary to perform the fitness test. The structural equation model established based on the variables in this study is shown in Figure 1, and the parameters of the corresponding equation are shown in Figure 2.

The debt-to-asset ratio as shown in equation (1) reflects how much of the university’s assets are built on debt and reflects the overall debt status of the university, especially the long-term debt level. The too high or too low asset-liability ratio will have an impact on the financial risks of colleges and universities: Too high asset-liability ratio will put colleges and universities at higher financial risks, and too low indicates that colleges and universities have not fully utilized the financial leverage of liabilities.

\[ D1 = \frac{F}{G} \times 100\%. \]  

Compared with the asset-liability ratio indicator, the proportion of borrowed funds in total assets as shown in equation (2) can more accurately reflect the proportion of college assets that rely on loans. Like the asset-liability ratio, too high or too low, this indicator is not conducive to the sustainable development of universities. Therefore, we set the minimum and maximum value of the proportion of borrowed funds to total assets as 10% and 60%, respectively.

\[ D2 = \frac{J}{G} \times 100\%. \]  

The proportion of borrowed funds in total income as shown in equation ((3)–(7)) reflects the degree to which the total income of the colleges and universities can repay all the loans, and reflects the degree of financial risk that the colleges and universities can bear. The numerator’s balance of borrowed funds uses the average of the beginning and end of the year so that it can match the denominator “total income” for this period. The larger the value of this indicator, the greater the financial risk faced by colleges and universities. We determined the minimum and maximum of the proportion of borrowed money in total income as 0.4 and 0.8, 3.

\[ D3 = \frac{J1 + J2}{G} \times 100\%, \]  

\[ D3' = \frac{\sqrt{J1 + J2}}{G} \times 100\%, \]  

\[ D3'' = \frac{\sqrt{J1^2 + J2^2}}{|G|} \times 100\%. \]  

The income-expenditure ratio reflects the balance of income and expenditure of colleges and universities and reflects how much income is guaranteed for every 1 Yuan of expenditures in colleges and universities that year, which can be calculated by equations (18)–(9). The standard value of this indicator is 1, which means that the income and
expenditure of colleges and universities are exactly balanced and there is no balance; when the ratio is greater than that, it indicates that colleges and universities will not make ends meet and will bear higher financial risk pressure. We determined the minimum and maximum values of the income-expenditure ratio to be 0.8 and 1.2, respectively.

\[
D_4 = \frac{Z}{G} \times 100\% , \quad \text{(6)}
\]

\[
D_4' = \left( \frac{Z}{G} + \left\| Z + G \right\| \right)^2 \times 100\% . \quad \text{(7)}
\]

The purpose of constructing the judgment matrix is to determine the weight of each index in the evaluation index system. The meanings of the scale in the judgment matrix are given in Table 2.

\[
D_5 = \sqrt{\frac{Z}{G}} \times 100\% , \quad \text{(8)}
\]

\[
D_6 = \left\| \frac{J_1 + J_2}{G} \right\| \times 100\% , \quad \text{(9)}
\]

\[
\text{Entropy}(J_1, J_2, G) = - \int G \times \ln \left\| \frac{J_1 + J_2}{G} \right\| dx. \quad \text{(10)}
\]

equations ((1)-(10)) represent the calculation modes of different risks RI, respectively. Based on the given equations and the specific financial level of the experimental universities, the different risk coefficients are shown in Table 3. RI is the average random consistency index, which corresponds to the order of the matrix. Figure 3 shows the change of RI with n graphically.

According to the methods and steps of the proposed financial risk early warning system model for colleges and universities mentioned above, combined with the above balance sheet and income and expenditure schedule, the quantitative indicators are obtained by calculation, and the qualitative indicators are obtained by interview and scoring methods. The specific calculation process is omitted, and the financial risk status scoring results are shown in Table 4. The comprehensive score of the university’s financial risk status is 84.93. Compared with experience, it can be seen that the university’s financial status is relatively stable, and financial risks are relatively small. Most of the financial indicators are normal, but there are also some indicators whose scores are too low, such as payables and temporary payments. The values of different quantity indicators are shown in Figure 4.

By analyzing the balance sheet of Figure 4, we found that the proportion of payables and temporary payments in the university’s current assets is too high, which can easily lead to tight liquidity. In addition, another main reason for the relatively high overall score is that it does not have foreign investment and school-run enterprises, and the influence of the two on the financial status of the university naturally

Figure 1: The results of the function.
does not exist. But for most colleges and universities, the poor return on foreign investment and the poor financial status of school-run enterprises are still some of the main reasons for the financial burden of colleges and universities.

Analyzing existing research it can be concluded that from the fund-raising experience of American colleges and universities that raising education funds through multiple channels is an effective way to effectively reduce financial risks, especially fund-raising risks. In addition, the US government’s tax exemption of social and individual donations to higher education is also worthy of serious study and reference for Chinese tax policymakers. Compared with the United Kingdom, the proportion of financial appropriations in the funding for colleges and universities in China is still relatively low. In particular, the proportion of fiscal expenditures on education in the Heilongjiang province of China has not yet reached 4% of GDP. It seems particularly...
Higher education all over the world is indeed developing in the direction of marketization, but the Chinese government still needs to play an absolute "protagonist" in the development of higher education. The fund-raising experience of British universities is the best example. In addition, the United Kingdom and the United States also have a lot of references for the diversified forms of government funding for colleges and universities. China is similar to Japan in the establishment of colleges and universities and is divided into colleges directly under the central ministries and commissions, local colleges, and private colleges, but Japan’s financial support for colleges and universities is much higher than that of China, even for private colleges and universities. In Japan, the government’s financial appropriation can also reach about 20% of the income of colleges and universities, and at one time it reached 30%. In contrast, not only China’s financial support for private colleges and universities is negligible, even for some provincial and municipal public colleges, budgetary budgets account for less than half of college education expenditures. Therefore, to further strengthen the support of government funds to private colleges and local colleges is exactly what we need to learn from the experience of Japanese education development.

5. Conclusion

The degree and quality of financial management work are closely tied to the progress of the university’s work in all areas, as well as the regular operation of the university’s overall mechanism. This study divides the types of financial risks in colleges and universities at Heilongjiang Province of China from the perspective of the meaning of broad financial risks, which are divided into financing risks, investment risks, and ordinary operating risks. The financial survey data of 56 colleges and universities were collected and the types of college financial risks and influencing factors were

<table>
<thead>
<tr>
<th>Policy</th>
<th>CI</th>
<th>Weighted</th>
<th>Values = CI*weighted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>6.92</td>
<td>5.54</td>
</tr>
<tr>
<td>Economy</td>
<td>C2</td>
<td>2.62</td>
<td>2.10</td>
</tr>
<tr>
<td>Rules</td>
<td>C3</td>
<td>1.53</td>
<td>1.22</td>
</tr>
<tr>
<td>Internal status</td>
<td>D9</td>
<td>16.50</td>
<td>14.85</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quality_Indicators</th>
<th>CI</th>
<th>Weighted</th>
<th>Values = CI*weighted</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>(0.8-D1)/0.65*100%</td>
<td>5.62</td>
<td>5.05</td>
</tr>
<tr>
<td>D2</td>
<td>(0.6-D2)/0.5*100%</td>
<td>21.56</td>
<td>17.94</td>
</tr>
<tr>
<td>D3</td>
<td>(0.8-D3)/0.4*100%</td>
<td>11.59</td>
<td>11.33</td>
</tr>
<tr>
<td>D4</td>
<td>(5.2-D4)/3.6*100%</td>
<td>9.14</td>
<td>8.12</td>
</tr>
<tr>
<td>D5</td>
<td>(0.4-D5)/0.4*100%</td>
<td>10.92</td>
<td>10.92</td>
</tr>
<tr>
<td>D6</td>
<td>(0.8-D6)/0.8*100%</td>
<td>3.64</td>
<td>3.64</td>
</tr>
<tr>
<td>D7</td>
<td>(1.2-D7)/0.4*100%</td>
<td>6.33</td>
<td>394</td>
</tr>
<tr>
<td>D8</td>
<td>(0.8-D8)/0.8*100%</td>
<td>3.63</td>
<td>0.28</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>84.39</td>
<td></td>
</tr>
</tbody>
</table>
summarized based on a detailed analysis of the development status and the financial status of the colleges and universities. In addition, an early risk warning system model is constructed using the Decision Tree algorithm. The use of this model will not only help university administrators enhance their awareness of financial risk prevention, improve financial decision-making levels, and strengthen financial risk management but also help external entities such as governments, banks, and construction companies to better grasp the current financial status of universities and timely measures the financial risks of colleges and universities.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares that he has no conflict of interest.

References


