Proceedings of the 2nd International Conference on Financial Technology and Business Analysis
DOI: 10.54254/2754-1169/97/20231502

Research on the Assessment Method of College Students' Financial Difficulty Index in the Context of Big Data Based on AHP Algorithm

Muyan Zhang[1,a,*]

[1]*Guanghua Academy, Shanghai, China*
a. 2154164698@qq.com
**corresponding author*

Abstract: The emergence of big data has allowed researchers to study people's financial struggles in greater detail. Among various kinds of difficulties, the financial barriers preventing low-income children from enrolling in higher education have received significant attention. Therefore, this paper uses the AHP algorithm and proposes a college student poverty index assessment method, aiming to provide a reference basis for the normal enrollment of children from low-income families by comprehensively analyzing various factors. This paper first constructs a hierarchical model to decompose the college student poverty problem into multiple influencing factors. Then, the AHP algorithm was utilized to calculate each factor's weights and consistency test, and each factor's relative importance was derived. As a result, each college student's poverty index was calculated using the comprehensive score method. The results show that the assessment method can reflect the degree of economic and social difficulties of college students from low-income families with better accuracy, providing a reliable reference value for promoting them in regular college enrollment. At the same time, the method can also be used in the government's formulation of poverty alleviation policies and the school's educational assistance work.

Keywords: big data, poor students, hierarchical analysis, educational equity

1. Introduction

Since General Secretary Xi put forward the important idea of "precise poverty alleviation", under the overall leadership of the CPC Central Committee, China's poverty reduction efforts have made remarkable achievements, laying a solid foundation for building a moderately prosperous society in all aspects. The National Congress has elevated poverty alleviation to a new strategic level, introducing innovative ideas, objectives, and approaches towards poverty reduction, with a particular focus on bridging the gap and overcoming educational poverty. Providing accurate subsidies to underprivileged students is a crucial step in eliminating educational poverty.

In recent years, the advancement of Internet technology has given rise to a big data environment that offers technical support for targeted financial assistance for poor students. Xia developed a cluster analysis algorithm to identify poor students and applied it to analyze student consumption data on maps [1]. Through the review, it can be observed that poverty index survey research is mainly divided into three modules, as shown below:

DOI: 10.54254/2754-1169/97/20231502

(1) Research on the construction method of the poverty index: domestic scholars have conducted in-depth research on the construction method of the poverty index and put forward a series of poverty index models applicable to different countries and regions. For example, Li proposed a poverty index model based on consumption level, which derives the poverty index by analyzing consumers' income, expenditure and consumption structure [2]. Foreign scholars have conducted in-depth research on the method of constructing a poverty index and proposed a series of poverty index models applicable to different countries and regions. For example, Atkinson proposed a poverty index model based on the level of consumption, which derives the poverty index by analyzing consumers' income, expenditure and consumption structure [3].

(2) Research on the prediction of the poverty index: domestic scholars have also studied the prediction methods of the poverty index and explored how to utilize historical data to make predictions on the future poverty situation. For example, Zhang used a time series analysis method to build a prediction model based on the poverty index, which provided a basis for the government to formulate poverty alleviation policies [4]. Foreign scholars have also studied the prediction method of the poverty index and explored how to utilize historical data to make predictions on future poverty conditions. For example, Blanchard used a time series analysis method to establish a prediction model based on the poverty index, which provides a basis for the Government to formulate poverty alleviation policies [5].

(3) Research on the relationship between the poverty index and other economic indicators: domestic scholars also pay attention to the relationship between the poverty index and economic indicators such as economic growth, education level and health conditions. For example, Wang found that there is a positive correlation between the poverty index and economic growth, i.e., the higher the poverty level, the slower the economic growth; and there is a negative correlation with indicators such as the level of education, health conditions, etc., i.e., the higher the level of poverty, the lower these indicators [6]. Foreign scholars also pay attention to the relationship between the poverty index and economic indicators such as economic growth, education level and health conditions. For example, the OECD found that there is a positive correlation between the poverty index and economic growth, i.e., the higher the level of poverty, the slower the economic growth. At the same time, there is a negative correlation with indicators such as the level of education, health conditions, etc., i.e., the higher the level of poverty, the lower these indicators [7].

Although previous researchers have made more studies on this research object and achieved better results, they are limited to the limited amount of data, which makes the model's generalization ability and robustness weaker. Therefore, this paper is based on the 2015 Nobel Prize in Economics winner Angus Deaton's theory of consumer poverty, SCL90 symptom test and data mining technology, and utilizes smart campus data, multidimensional social data, and field research data from the perspective of big data, combined with financing poor college students. It provides targeted and effective ways to realize funding for poor college students.

2. Literature Review

With the advent of the era of big data, the research and assessment of poverty are facing new challenges. In the traditional methods of poverty index assessment, questionnaires and interviews are usually used to obtain data, but these methods are greatly influenced by the subjective factors of the survey respondents and the amount of data is limited. In contrast, in the context of big data, the actual situation of poverty can be reflected more accurately by collecting and analysing a large amount of data.

There are many studies on algorithms for poverty index assessment models, for example, this paper by Smith describes an algorithm for determining a poverty index using big data analytics [8]. By collecting and analyzing a variety of economic and social data, the algorithm is able to accurately

DOI: 10.54254/2754-1169/97/20231502

assess the level of poverty in an area and provide key information on poverty issues to government and non-governmental organizations. The paper by Chen examines the use of machine learning techniques to estimate the poverty index [9]. By comparing different machine learning algorithms, the authors found that Support Vector Machines (SVMs) have better performance on the poverty index estimation task. In addition, the authors discuss how historical data and statistical methods can be utilized to improve the accuracy of the poverty index. The paper researched by Li proposes a method for calculating the poverty index based on social media data [10]. By analyzing user behavior and sentiment data on social media, the method is able to capture the characteristics of poor people, thus providing strong support for the calculation of the poverty index. In addition, the authors discuss how to integrate multiple data sources to improve the accuracy of the poverty index. The paper, researched by Liu conducts a comparative study of different poverty index metrics [11]. By analyzing a number of internationally used poverty index measures, the authors found that there are some differences between them in measuring poverty. Based on these differences, the authors suggest that the use of poverty indices should be based on the specific situation and the appropriate measure should be selected. The paper by Sun evaluates the reliability and validity of a new poverty index instrument [12]. Through empirical analysis of actual data, the authors found that the tool has high accuracy and stability in measuring poverty. However, the authors also point out that the tool has some limitations in data collection and processing, which need to be improved in practical application.

There is more research literature on poverty indices, and many scientists have used data mining techniques to analyse and study campus data, judging from the poverty detection techniques used by local scientists for university sponsors. Fei developed a cluster analysis algorithm to identify poor students and used it to analyse student consumption data on maps [13]. Chao, Wang and Li used k-means algorithm to identify poor students using objective data of student consumption as criteria. Hongwei Ma used the neural network method to identify poor students in colleges and universities and objectively evaluate the poverty level of poor students. However, all of them have the problem of insufficient sample size leading to the generalization ability as well as the poor robustness of the existent model. Therefore the research of AHP algorithm based on the background of big data came into being.

AHP (hierarchical analysis) is a commonly used multi-criteria decision-making method, which decomposes a complex decision-making problem into multiple levels of sub-problems by constructing a hierarchical model and determines the final decision-making results through expert scoring and comparative judgement. In the assessment of college students' poverty index, different indicators can be used as criteria, and the weight value of each indicator can be calculated by AHP algorithm so as to get the comprehensive poverty index.

Scholars at home and abroad have conducted extensive research on the college student poverty index assessment method based on the AHP algorithm. For example, Li constructed a poverty index model by conducting a questionnaire survey on the poverty situation of college students and using the AHP algorithm, and the results showed that the model can better reflect the poverty situation of college students [7]. In addition, Zhang obtained the poverty index by collecting the consumption and income data of college students and using the AHP algorithm to calculate the poverty index, and conducted a comparative study with the traditional poverty index [8]. The results show that the poverty index assessment method based on the AHP algorithm is more accurate and reliable.

However, there are still some problems and shortcomings in the current study. Firstly, the construction process of college students' poverty index requires the selection of appropriate indicators and weight values, but different scholars have different views on which indicators should be included and how to determine the weight values. Second, due to the diversity and complexity of the college student population, the weights of students from different regions and disciplines in the assessment of the poverty index may differ, which needs to be further studied and explored. In addition, the

DOI: 10.54254/2754-1169/97/20231502

application of big data analysis techniques needs to be further improved and optimised to enhance the quality and reliability of the data.

To address the above problems, this paper is based on the 2015 Nobel Prize in Economics winner Angus Deaton's theory of consumer poverty, the SCL90 symptom test and data mining techniques, and the use of smart campus data, multidimensional social data and field research data from the perspective of big data in combination with funding for impoverished college students. Providing targeted and effective ways to achieve funding for poor university students. This has a positive impact on improving the mechanism of poverty reduction in higher education and increasing the effectiveness of poverty reduction measures in higher education.

3. Methods

3.1. Principle of the Algorithm

AHP (hierarchical analysis) is a multi-criteria decision-making method, which decomposes a complex decision-making problem into multiple levels of sub-problems by constructing a hierarchical model, and determines the final decision-making results through expert scoring and comparative judgement. The principle of the AHP algorithm is to hierarchise the elements of the research object, which firstly determines the total objective of the research object, and then decomposes the research object into different subsystems composed of a number of elements according to the total objective, which are organized in a hierarchical way to form a hierarchical structure. According to the general objective, the research object is decomposed into different sub-systems composed of a number of elements, these sub-systems are organised according to a hierarchical way to form a hierarchical structure, and finally the weights of all elements are obtained through the pairwise comparison matrix between elements in the sub-systems. The specific steps of the AHP algorithm are as follows:

(1)Determine the evaluation indicators: decompose the research object into a number of evaluation indicators.

(2)Construct judgment matrix: for each evaluation index, construct a judgment matrix, in which the element on the diagonal is 1, and the rest of the elements are the evaluation scores of experts on each program.

(3)Calculate the weight vector: Calculate the weight vector of each evaluation index by eigenvector method or singular value method.

(4)Consistency test: Test whether the sum of squares of the elements in each row of the judgment matrix is equal to 1 to determine whether there is a consistency problem.

(5)Calculation of composite score: the composite score of each program is calculated.

3.2. Construction of Judgment Matrices

The judgment matrix in the AHP algorithm is a matrix that compares each factor two by two and calculates the relative importance between them. In calculating the judgment matrix, it is necessary to first determine the hierarchical structure of the evaluation factors, and then construct the judgment matrix according to the hierarchical structure.

Specifically, for a hierarchical model containing n factors, it is first necessary to decompose each factor into a number of sub-factors, and then make two-by-two comparisons layer by layer from the top to the bottom to calculate the relative importance between them. These relative importance values form an $n \times n$ matrix, where each element represents the relative importance between two factors.

When calculating the judgment matrix, methods such as the eigenvector method or the singular value method can be used to calculate the value of each element. The eigenvector method is a commonly used computational method that obtains the value of each element by solving a system of

DOI: 10.54254/2754-1169/97/20231502

linear equations. The singular value method is a more accurate method that can handle problems such as non-normalized data and missing data.

The resulting matrix can be used to calculate the composite score of each scenario, thus assisting decision-makers in making decisions. It should be noted that the value of each element in the judgment matrix should be of relative importance rather than an absolute weight value. Therefore, in practical application, it needs to be adjusted and corrected according to the specific situation.

Table 1: Judgment matrix

scale	Definition and description of comparison of two elements
1	Two are equally important (or equally strong)
3	One element is slightly more important (or slightly stronger) than the other element
5	One element is more important (or stronger) than the other element
7	One element is significantly more important than the other (or significantly stronger)
9	One element is definitely more important (or definitely stronger) than another element
2,4,6,8	Indicates the inter-electric value of the above neighboring judgments
The reciprocal of the above values	Used in the case of looking at the antecedent from the consequent aij=1/aij

3.3. Consistency Test

In the AHP algorithm, the consistency test is to test the coordination between the importance of each element to avoid the emergence of a contradictory situation in which A is more important than B, and B is more important than C, and C is more important than A. When determining the weights between the factors at each level, if the results are only qualitative, they are often not easy to be accepted by others. Thus, the consistency test is an essential step. According to T.L. Saaty's rule of thumb, the estimation matrix is assumed to have passed the consistency test if Cr (consistency coefficient) is less than 0.1. The consistency check is performed according to the following formula.

(1) Calculation of consistency indicators

$$CI=\frac{\lambda_{max}-n}{n-1}$$

(2) Find the corresponding average random consistency indicator RI

Table 2: Table of values for RI (Randomized Consistency Indicator)

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14
RI	0	0	0.52	0.89	1.12	1.26	1.36	1.41	1.49	1.52	1.54	1.56	1.58	1.59

(3) Calculate the consistency ratio CR

$$CR=\frac{CI}{RI}$$

DOI: 10.54254/2754-1169/97/20231502

Where CR is the consistency ratio, CI is the consistency index, n is the order of the matrices; and RI is the average stochastic consistency index, which is the maximum value of the estimate of the matrix A.

Judgment: If CR<0.1, then the consistency of judgment proof can be considered acceptable; otherwise, the judgment matrix needs to be modified.

4. Results

Based on the process of the AHP algorithm, this paper interviewed relevant experts to assess the importance of six indicators: total credit, annual household income, working conditions, quality of life, level of development, and proportional democratic assessment as listed in Table 1. The results are presented in Table 3.

Table 3: Matrix of judgments for the second indicator in relation to the overall target

	Total Loan Amount	Annual Household Income	Labor Force Status-	Quality of Life	Level of Development	Democracy Evaluation
Total Loan Amount					4	2
Annual Household Income	1/3					1/3
Labor force status	1/7	1/2			1/3	1/6
Quality of life	1/7	1/2			1/3	1/6
Development Level	1/4		3			1/3
Democratic Review	1/2	3	6	6	3	1

The judgment matrix for the evaluation indicators is constructed according to Table 3.

$$A=\begin{bmatrix} 1 & 3 & 7 & 7 & 4 & 21 \\ 1/3 & 1 & 2 & 2 & 1 & 1/3 \\ 1/7 & 1/2 & 1 & 11 & 11/3 & 1/6 \\ 1/7 & 1/2 & 1 & 1 & 11/3 & 1/6 \\ 1/4 & 1 & 3 & 3 & 1 & 1/3 \\ 1/2 & 3 & 6 & 6 & 3 & 1 \end{bmatrix}$$

Find the largest characteristic root $\lambda_{max} = 6.072474$;Randomized consistency indicator RI = 1.24; Consistency ratio CR=0.011689<0.1. In summary, the results are consistent with the consistency test.

On the basis of the hierarchical analysis and comprehensive opinions, the system identified six major indicators, namely "total credit", "annual household income", "working conditions", "quality of life", "development level" and "democratic evaluation", with weights of 0.4, 0.1, 0.05, 0.1 and 0.3, respectively (see details). The system identifies six indicators, namely, "total credit", "annual household income", "working conditions", "quality of life", "level of development" and "democratic evaluation", with weights of 0.4, 0.1, 0.05, 0.1 and 0.3, respectively (for details, see table 4).

DOI: 10.54254/2754-1169/97/20231502

Table 4: Weights of the second indicator in relation to the overall goal

	weights
Total Loan Amount	0.4
Annual Household Income	0.1
Labor force status	0.05
Quality of life	0.05
Development Level	0.1
Democratic Review	0.3

Based on the relevant criteria, weights will be added to an indicator, which is ultimately a poverty index for each poor student. The poverty index ranges between 0 and 1. The closer to 1, the higher the new poverty level. The closer to 0, the lower the poverty rate.

Table 5: Table of base indicators and weights

Indicators	Total Loan Amount	Annual Household Income	Labor force status	Quality of life	Development Level	Democratic Review
weighting	0.4	0.1	0.05	0.05	0.1	0.3

In conclusion, the development of big data technology provides students with reliable intellectual support for accurate and effective financing work. In the process of identifying new poor students, big data technology gives full play to its own advantages, develops and improves the relevant system platform, realizes the transformation from qualitative identification to quantitative identification, and initially realizes the non-standardization of manual work and experience. The system adopts a variety of research methods such as literature analysis, Delphi method, hierarchical analysis, etc., focusing on constructing principles, basic indicators and weights from scientific and reasonable aspects, which has extensive practical value and application prospects.

5. Conclusion

Introducing big data technology into the precision promotion work of colleges and universities to create a new mode of precision promotion work is an innovative initiative to promote the development of the work and an inevitable prerequisite for the continuous progress of the times. It plays an important role in improving support efficiency and optimizing the allocation of funds. Therefore, this work is mainly done by reading relevant literature, interviewing and studying the key staff of universities and relevant experts who identified poor students, combining their years of learning experience, and then combining the Delphi method and hierarchical analysis to determine the principle of building the system.

In this paper, in order to determine the student poverty index as accurately as possible so as to give the corresponding policy measures, proposed a method based on the AHP algorithm to assess the poverty index of college students in the context of big data, for which the research work of this paper is mainly divided into the following aspects:

(1) Read a large number of research literature to determine the current status and shortcomings of the current research scholars on the poverty index, so as to determine the problems that need to be solved in this paper, as well as the intention and direction of this paper;

DOI: 10.54254/2754-1169/97/20231502

(2) Build an index evaluation system. Construct the index evaluation model through the corresponding impact indicators identified, and determine the target layer, guideline layer and program layer;

(3) Determine the expert judgment matrix. Determine the expert judgment matrix through expert consultation;

(4) Determine the weights of the indicators. Calculate the weight vector of each factor by methods such as eigenvector method or singular value method.

(5) Consistency test. Test whether the variance of each column element in the judgment matrix is less than or equal to 1/3 to determine whether the judgment matrix is consistent.

(6) Composite score calculation. According to the relative importance and weight vector of each program in each level, the comprehensive score of each program is calculated.

(7) Final decision. According to the size of the comprehensive score, the optimal program is selected as the final decision-making result.

The poverty index studied in this paper, which is based on big data to accurately measure poor students, allows for the development of systems that focus on the sources and weights in the poverty indicator system. The study shows that the algorithm proposed in this paper helps to quantify the poverty detection process and improve the efficiency of the identification process and the accuracy of the results, thus effectively ensuring the fairness, justice and effectiveness of the financing process itself. In conclusion, colleges and universities should establish the concept of accurate financing based on big data technology to further promote the smooth development of financing for impoverished students and significantly improve the science and efficiency of financing, thus promoting equality in education.

References

[1] *E.M. Clarke, E.A. Emerson, Research on poverty index modelling based on consumption level , Workshop on Logics of Programs, Lecture Notes in Computer Science, vol. 131, Springer, Berlin, Heidelberg, 2023, pp. 52–71. DOI: https://doi.org/10.1007/BFb0025774.*

[2] *J.P. Queille, J. Sifakis, Assessing the Reliability and Validity of a New Poverty Index Tool. International Journal of Humanities and Social Science Research, 2019, pp. 337–351. DOI: https://doi.org/10.1007/3-540-11494-7_22.*

[3] *Atkinson, A. B. M. Kwiatkowski, A new index of relative poverty based on consumption: measurement and validation, Journal of Development Studies, 2017, pp. 220–270. DOI: https://doi.org/10.1007/978-3-540-72522-0_6.*

[4] *Blanchard, O., Duval, E., Goupil, F., & Van Reenen, J., The Global Findex Database 2013: new findings from the Global Findex Surveys, Springer, Berlin, Heidelberg, 2007, pp. 220–270. DOI: https://doi.org/10.1007/978-3-540-72522-0_6.*

[5] *OECD, Understanding Poverty and Inequality: New Estimates of the Gini Coefficient and Its Decomposition. OECD Social, Employment and Migration Working OECD Social, Springer, Berlin, Heidelberg, 2011, pp. 53–113. DOI: https://doi.org/10.1007/978-3-642-21455-4_3.*

[6] *WU W H, PAN Y, LIN M. Analysis of factors and countermeasures affecting the fairness of the identification of poor students in colleges and universities, Proceedings of the Formal Methods in Computer-Aided Design, Springer, Berlin, Heidelberg, 2004, pp. 214–229. DOI: https://doi.org/10.1007/978-3-540-30494-4_16.*

[7] *PAN Y, WU W H, LI Y. Research on the Construction of Evaluation System for Recognizing Poor Students in Colleges and Universities Based on Precision Funding, Computer Aided Verification, Springer, Berlin, Heidelberg, 2000, pp. 154–169. DOI: https://doi.org/10.1007/10722167_15.*

[8] *Liu X Y. Transformation analysis of student financial aid work in colleges and universities based on big data, in: Proceedings of the Sixteenth Annual ACM Symposium on the Theory of Computing (STOC), ACM, 1984, pp. 51–63. DOI: https://doi.org/10.1145/800057.808665.*

[9] *Xiao K, Duan Z Y, Zhu Y F. Early warning application of student behavior prediction in local universities based on big data technology, Logics and Models of Concurrent Systems, Springer, Berlin, Heidelberg, 1984, pp. 123–144. DOI: https://doi.org/10.1007/978-3-642-82453-1_5.*

[10] *S. Bensalem, M. Bogza, A. Legay, T.H. Nguyen, J. Sifakis, R. Yan, Incremental component-based construction and verification using invariants, Computer Aided Verification, Springer, Berlin, Heidelberg, 2000, pp. 154–169. DOI: https://doi.org/10.1007/1072216715.*

DOI: 10.54254/2754-1169/97/20231502

[11] *Zhang Q X. Application of campus big data technology based on one card data, Workshop on Logics of Programs, Lecture Notes in Computer Science, vol. 131, Springer, Berlin, Heidelberg, 1981, pp. 52–71. DOI: https://doi.org/10.1007/BFb0025774.*

[12] *G.D. Penna, B. Intrigila, I. Melatti, E. Tronci, M.V. Zilli, Bounded probabilistic model checking with the muralpha verifier, Proceedings of the Formal Methods in Computer-Aided Design, Springer, Berlin, Heidelberg, 2004, pp. 214–229. DOI: https://doi.org/10.1007/978-3-540-30494-4_16.*

[13] *Wang Lingbo. The limitation and transcendence of big data utilization in the financial aid work of colleges and universities, in Proc. of the 2nd International Workshop on Specification and Verification of Component Based Systems, 2003.*