

Research Article

Construction of Credit Assessment Model for International Import and Export Trade Based on Fuzzy Hierarchical Analysis

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With the continuous expansion and development of import and export trade, the problem of credit risk faced by foreign trade enterprises has received increasing attention. This thesis focuses on the credit risk problem in import and export trade based on fuzzy hierarchical analysis; international import and export trade credit risk management risk is measured and evaluated to derive the ranking of key risk factors; the risk factors in the guideline layer are ranked from largest to smallest in order of legal risk, market risk, financial risk, and policy risk. The main purpose of this study is to build a fuzzy AHP international import and export trade credit evaluation model, which can provide reliable credit evaluation when enterprises conduct import and export trade and can better help enterprises to complete the trade. The analysis algorithm implemented in this study is a common and effective algorithm used for credit modeling, and more exploration and research on foreign trade credit modeling using existing modeling techniques are needed. The modeling techniques for credit evaluation of international import and export trade should be based on the credit information available to the enterprise to select the most appropriate modeling techniques and propose the most practical evaluation model. This study uses qualitative and quantitative, theoretical, and empirical comprehensive analysis methods based on fuzzy hierarchical analysis, draws on theories and models of credit risk management of 100 well-known enterprises around the world, and combines the actual situation of import and export trade. The credit evaluation model of international import and export trade based on fuzzy hierarchical analysis is constructed with certain operability and can make the credit evaluation of international import and export trade more accurate and reliable.

1. Preface

In today's world, the process of globalization is deepening, and since China acceded to the WTO, the government has vigorously encouraged import and export trade. Many foreign trade enterprises also actively participate in the import and export trade industry. However, many foreign trade enterprises have suffered huge losses in import and export trade because they are not aware of the existence of credit risk or have not taken effective measures to avoid credit risk [1]. The issue of credit risk is a great concern for foreign trade enterprises. Credit risk management is also a link that foreign trade enterprises always want to strengthen [2].

Credit refers to a social relationship. The grantor trusts the recipient and thus establishes a relationship of trust, in which the judgment of the grantor and the creditworthiness

of the recipient play a decisive role. In economics, it refers to the economic activity in which two parties lend money to one another using a contract and also guarantee in the contract that the money will flow back to the other party.

The concept of credit in economics is the concept of credit in a narrow sense, which generally refers to lending credit. With the deepening of import and export trade, the risks in the import and export trade industry are also diversifying and complicated. The risks in import and export trade mainly include credit risk, foreign exchange risk, contract risk, and so on. And now the international market is a buyer's market based on the market economy, providing credit lines for customers has become a trend and practice, and many foreign trade enterprises are studying how to both expand trade volume and effectively avoid credit risks. Its focus is on credit risk management in import and export

trade, and for the specific situation of foreign trade enterprises, through the analysis of the current situation of credit risk, problems, methods of assessment, effective measures, etc., through a combination of qualitative and quantitative analysis methods, foreign trade enterprises understand the current advanced credit risk management techniques at home and abroad [3]. This study uses the Fuzzy Analytic Hierarchy Process (AHP) to evaluate the credit evaluation model of international import and export trade, which can build the model at a deeper level, and the efficiency is faster.

The fuzzy hierarchical analysis method is to decompose the elements related to decision making into levels such as goal level, criterion level, and indicator level by clarifying the problem, on which qualitative and quantitative analysis is performed. Its calculation steps include constructing a judgment matrix, hierarchical single ranking, checking the consistency of the judgment matrix, and hierarchical total ranking. Among them, the construction of the judgment matrix is the key link of the hierarchical analysis method, and whether the construction of the judgment matrix is scientific or not directly affects the decision-making effect of the hierarchical analysis method. Based on Fuzzy AHP, the credit of international import and export trade can be better evaluated and the construction of the model can be promoted [4]. With the development of many statistical methods such as computers and machine learning methods in recent years, numerous statistical learning methods and machine learning methods have been applied to individual credit assessment models in recent years. Through the research on international import and export enterprises and the study of related literature, it is found that the current credit data present a kind of nonlinearity, high dimensionality, as well a wide distribution of features, and sparse data. The research goal of this study is to build a credit assessment model for international import and export trade, which can make it easier for international trading companies to better assess risks when conducting business transactions and promote trade exchanges.

2. Related Discourses

Earlier credit evaluation models include the 5C model, 5P model, 5W model, etc., which mainly assess the credit-worthiness of individuals or enterprises qualitatively or quantitatively. The 5C factors include asset collateral, business ability, borrower's character, capital, and economic environment; the 5P factors include the business prospect factor, repayment source factor, capital use factor, personal factor, and debt security factor; and the 5W factors are: content analysis, audience analysis, effect analysis, media analysis, and control analysis.

Calabrese et al. [5] argue that the hierarchical analysis method has four shortcomings: first, the consistency test of the judgment matrix is difficult. Second, if the judgment matrix does not pass the consistency test, it needs to be adjusted repeatedly. Third, the criteria of consistency test of judgment matrix lack scientific basis. Fourth, the consistency of the judgment matrix is significantly different from the consistency of human thinking. The

e-commerce credit development index constructed by Zavadskas et al. [6] divides e-commerce credit assessment into online trust risk (security transaction risk, privacy protection risk, service convenience factor), offline trust risk (subject gets qualification, enterprise financial status, operation, and management level, subject honesty and responsibility), and development comprehensive index (industry development background, enterprise development status, development strategic planning). Gnanavelbabu and Arunagiri [7] argue that "Capturing the Political Imagination: Think Tanks and the Policy Process" analyzes the effect of think tanks on influencing policy at the meso-level, laying the foundation for positivist think tank research. Rajasekhar et al. [8] offer a series of insights into the construction of university think tanks through a study of the staffing and management model of the Hoover Institution. They mainly include the mutual reliance on strong research fields and superior disciplines, adherence to research characteristics, attracting and gathering renowned scholars and political and business people, reforming the research organization model, and supporting university talent training. Using literature analysis and comparative analysis, Sirisawat and Kiatcharoenpol [9] analyzed the problems in the construction of university think tanks in China in terms of quantity, composition, and funding, and made suggestions on improving the access mechanism of talents, optimizing funding allocation, and improving the management mode. Taking the background of economic globalization, world multi-polarization, and in-depth development of social informatization, Li et al. [10] elaborated on the achievements of university think tanks in serving the general situation of the Party and the State, promoting healthy economic and social development, guiding correct social opinion guidance, enhancing public diplomacy capability and international discourse, and accumulating experience in the construction of new-type think tanks with Chinese characteristics. On this basis, five suggestions are put forward for the future development of the new type of think tanks in universities, such as ensuring the correct direction, improving research level, enhancing the international influence, strengthening professional development, and improving talent guarantee. Based on the results of previous studies, Karasan et al. [11] comprehensively introduce the basic contents of investment analysis and portfolio management, and the monograph is also used as a textbook by many higher education institutions to elaborate investment principles.

Stanković et al. [12] systematically compose how to manage personal assets to get the most out of their income. It combines investment tools, capital markets, evaluation of investments, and opportunities to meet risk-reward and provides research on how investment practices and theories have been affected by globalization to provide a solid foundation for investment decisions. Bhatt et al. [13] indicate that the problem of siting multiple facilities with capacity is a complex and imprecise decision problem that incorporates both quantitative and qualitative factors. Many objectives for optimizing multiple logistics networks are

described in the literature: first, minimization objectives such as cost, inventory, transportation time, environmental impact, and financial risk; and second, maximization objectives such as profit, customer satisfaction, flexibility, and robustness. However, only a few papers have considered quantitative and qualitative factors and imprecise methods. Unlike traditional cost-based optimization techniques, the approach proposed in the study evaluates these factors in an integrated manner while considering different perspectives. Decision makers have to deal with both factors to simulate complex structures. Suganthi [14] indicates that mimicking biological evolution and exploiting its adaptive capabilities is a problem. This has attracted the interest of computer scientists. Xie et al. [15] elaborate on the problem of gray systems, derive an analytical method, give its geometric meaning, illustrate the solution method, and discuss certain derivatives. Soui et al. [16] studied the stability and stability of gray systems with triangular state matrices, where the displacement operator and the established transfer are indispensable tools for gray systems.

3. Credit Assessment Model of International Import and Export Trade Based on Fuzzy Hierarchy Analysis

3.1. Fuzzy Hierarchical Analysis Method

3.1.1. Hierarchical Analysis Method. Analytic Hierarchy Process (AHP) is an easy-to-apply multi-principled resolution planning approach. When people deal with decision problems [17], they usually need to consider multiple factors. Before a decision can be made, the best solution needs to be selected from a variety of possible solutions, and many elements must be compared. The importance of most of these factors is difficult to quantify precisely, making it difficult for general mathematical approaches to solve such resolution problems explicitly [18]. This method provides a new easy and applicable way to combine qualitative and quantitative approaches to such problems. Hierarchical analysis in practice is mainly used to deal with specific programs, through multi-level, methodical analysis to complete a multi-purpose resolution plan research approach. The method is widely used because it is practical, simple to use, and can analyze problems systematically. The hierarchical analysis contains mathematical principles, but in essence [19], it is a decision-making method. First, a highly complex problem is decomposed and the decomposed components are combined into a hierarchy of progressive relationships with the help of certain dominant relationships; then the importance of each factor is determined by pairwise comparison and analysis, and finally, the importance of the factors is ranked by combining expert judgment. The specific operation steps are shown in Figure 1.

3.1.2. Fuzzy Hierarchical Analysis Evaluation Method. The fuzzy comprehensive evaluation method takes fuzzy mathematics as the theoretical basis, takes the

difficult-to-quantify and fuzzy influencing factors existing in the research object as a collection, constructs the corresponding affiliation function by using the affiliation theory [20], and presents the evaluation results in the form of fuzzy collection. Its principle formula is

$$U = \sum_{i=1}^n X + \frac{1}{n} \sum_{i=1}^n (X_i - \bar{X})^2. \quad (1)$$

This formula principle can better build an evaluation model, with higher accuracy and faster speed. The fuzzy comprehensive evaluation method has the advantages of easy to understand, easy to grasp, and reasonable evaluation indexes. Compared with other mathematical methods, the fuzzy evaluation method can make the evaluation results more objective when studying complex multi-factor and multi-level problems. When using the fuzzy comprehensive evaluation method, the algorithm of taking the larger and smaller amount is generally used because the comprehensive influence of each evaluation index needs to be calculated [21]. However, in the specific operation, using this algorithm will lead to unreasonable evaluation results. Meanwhile, when analyzing the fuzzy comprehensive evaluation result vector, the principle of maximum affiliation is commonly used analysis. However, this principle may lead to the loss of effective information in the case of too many evaluation indicators, thus making the results of fuzzy comprehensive evaluation deviant or even wrong [22]. The specific operation steps are shown in Figure 2.

3.1.3. Fuzzy Hierarchical Analysis Method and Operation Process. Fuzzy hierarchical analysis (FAHP) is proposed based on combining the respective characteristics of hierarchical analysis and the fuzzy comprehensive evaluation method. Its operation steps are the same as those of the hierarchical analysis method, the difference is that when comparing the influencing factors, the hierarchical analysis method usually uses the method of two-by-two comparison to construct a judgment matrix, while the fuzzy hierarchical analysis method constructs a fuzzy consistent judgment matrix more in line with human thinking through two-by-two comparison. This can better reflect the fuzziness of the problem and avoid the influence of subjective factors in the analysis of the evaluation object. Compared with hierarchical analysis and the fuzzy comprehensive evaluation method [23], the fuzzy hierarchical analysis method determines the weights of fuzzy indicators based on the hierarchical analysis method that solves complex qualitative problems layer by layer and then combines the mathematical principles of fuzziness [24]. By combining the use of hierarchical analysis and fuzzy comprehensive evaluation method, the negative impact on the system scoring due to different personal opinions of experts is largely avoided, thus making the process of data collection and collation more flexible and the evaluation process more accurate and realistic.

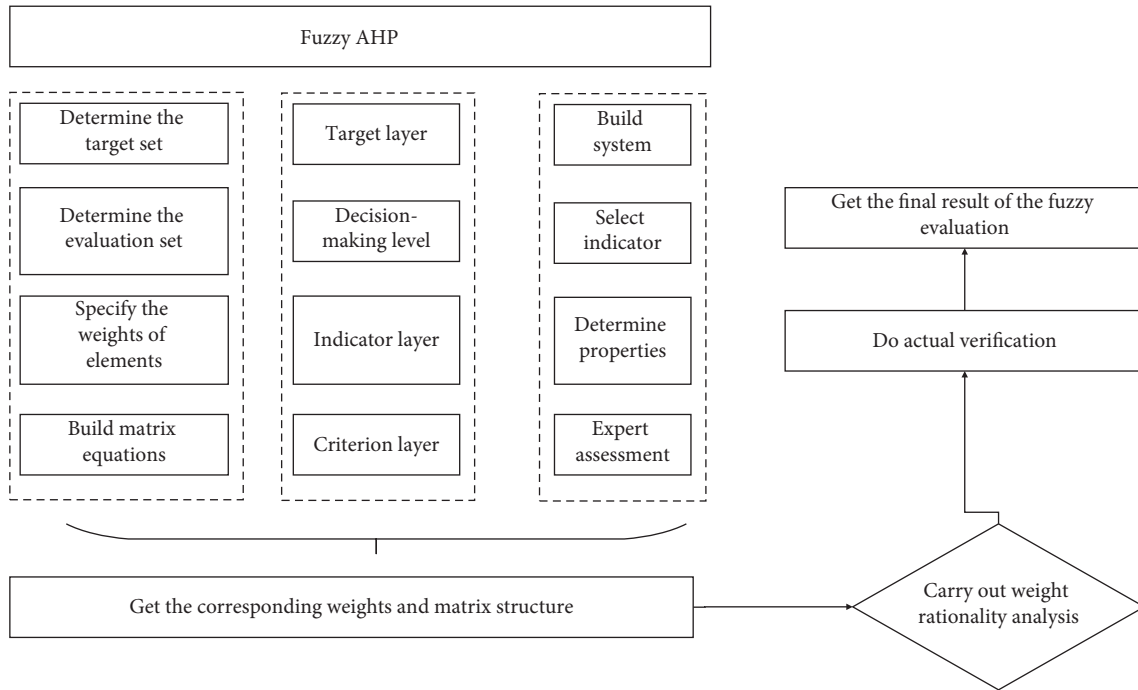


FIGURE 1: Hierarchical model.

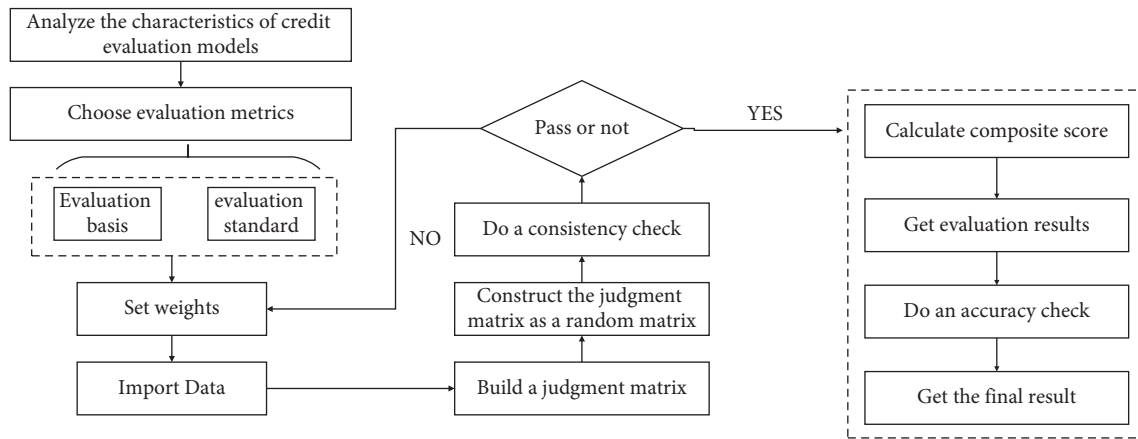


FIGURE 2: Operation steps of fuzzy comprehensive evaluation method.

The general operation process of fuzzy hierarchical analysis is as follows: determine the set of factors. The set of influencing factors of the evaluation object is called the set of factors, which is generally represented by U . We establish the hierarchical structure; decompose the influencing factors layer by layer and construct a bottom-up hierarchical model of evaluation indexes; establish a fuzzy discriminant matrix of influencing factors at each level; distribute expert questionnaires; compare the questionnaire results between two; determine the importance of the influencing factors, used to quantitatively describe the relative importance between two different elements in the same hierarchy; and construct a fuzzy discriminant matrix, fuzzy complementary discriminant matrix A -consistency test and convert to fuzzy consistency matrix R . When comparing two factors, there is

judgment subjectivity and problem complexity influence, so it is necessary to test and discriminate the consistency of the matrix; determine the degree of affiliation and perform the evaluation; develop the evaluation set; use the maximum subordination method; determine the subordination function; evaluate the subject through the single-factor evaluation matrix; and draw the final evaluation results and conclusions.

3.2. *Credit Assessment Model for International Import and Export Trade.* A credit assessment model is a model established for customer credit assessment, based on the analysis of customer credit factors, using expert experience and a large amount of credit data, and employing scientific

credit assessment methods. It is the carrier of the customer credit assessment content and the external expression of the customer's credit status. Credit assessment models are usually designed to predict a certain characteristic of a customer, such as the likelihood of bankruptcy, default rate, performance rate, and ability to perform, or to use knowledge of the customer's credit status to support credit management decisions. So depending on the purpose of the credit assessment model, credit assessment models can be broadly classified into predictive and management models. Credit assessment models are usually designed to make predictions about a customer's characteristics, such as the likelihood of bankruptcy, default rate, performance rate, and ability to perform, or to use knowledge of the customer's creditworthiness to support credit management decisions. Therefore, depending on the purpose of the credit assessment model, credit assessment models can be broadly classified into predictive and management models.

While assessment of credit risk is important, comprehensive and effective credit risk management goes far beyond the concept and scope of assessment. More and more credit risk management experts are realizing the importance of establishing a credit risk management system. This includes not only the identification and assessment of credit risk but also emphasizes the comprehensive and systematic management of credit risk. Assessment is only one aspect of management, what is more, important is how to link the assessment results with the real situation and formulate the right management measures, which means that foreign trade enterprises can effectively avoid credit risks in imports and export.

The main problems of credit risk management of foreign trade enterprises in import and export trade can be analyzed from three aspects: macro-level, meso-level, and micro-level, so the corresponding credit risk management measures are also carried out from these three aspects. The macro-level mainly refers to the management of the national risk of target customers, including preventive, operational, and remedial management methods; the meso-level mainly refers to the management of credit risk in China's foreign trade industry, which is mainly discussed in terms of institutional aspects and personnel training; the micro-level refers to the credit risk management of individual foreign trade enterprises in China, which is mainly analyzed in terms of the construction of internal credit risk department and customer credit risk management system. The micro-level refers to the credit risk management of individual foreign trade enterprises in China, which is mainly analyzed from two aspects: the construction of an internal credit risk department and the customer credit risk management system, as shown in Figure 3.

If a foreign trade enterprise is trading with an overseas company that has a multi-year relationship, its credit risk is much smaller than the credit risk arising from trading with a new company that it does not know. This is precise because through long-term cooperation, there is a relative understanding of the other party's credit situation and a certain degree of trust is generated. Of course, a foreign

trade enterprise cannot judge the credibility of the target customer only by direct experience, which has the disadvantage of high cost and may face the other party's default; it is also because the market needs a group of professional credit risk assessment, management institutions and talents to regulate the foreign trade industry, professional credit risk assessment agencies were conceived and born. The so-called cost of default refers to the benefits received by the fiduciary party because of default not to repay the principal and interest of the grantor, and the cost paid by the fiduciary party to obtain this benefit. China's foreign trade industry generally has the phenomenon of the low cost of a breach of trust. The low cost of a breach of trust will lead to an increase in the probability of credit risk. This is because people will weigh the gains and losses before making a decision. The cost of a breach of trust and the benefit of a breach of trust is a major criterion for whether an enterprise defaults on a contract. A comparison of the cost of a breach of trust (CL) and the benefit of a breach of trust (RL) is shown in Figure 4.

4. Experimental Design

The experiment designed in this study lies mainly in the credit assessment of enterprises engaged in international trade activities, and its credit indicator system is the most important part of the overall credit assessment model. A key factor in the work of the credit assessment model in this study is the base scientific and rational index system, and the construction of this system is what makes the credit assessment effective.

Therefore, the design of an enterprise credit evaluation index system must be guided by the idea of system science according to the background environment in which the enterprise is currently located and the characteristics of its industry to set up a scientific index system in a targeted manner. Credit assessment is ranked according to the overall attributes and utility of the system worthy of comparison, and the stronger the comparability, the greater the credibility of the evaluation effect. Therefore, 100 companies engaged in international trade were selected for analysis in this study, and 100 questionnaires were distributed through the expert survey method, of which one questionnaire was not returned. The questionnaires were mainly filled in by interviewing several e-commerce experts in different positions. After processing the initial questionnaire data, this study uses the basic principles of the method to quantify the importance of each index. The experimental results are analyzed by training the collected dataset using evaluation metrics.

5. Analysis of Results

5.1. Efficiency Analysis of Fuzzy Hierarchy Analysis. The index system for the evaluation of international import and export trade credit services has been constructed in the previous study. For the convenience of calculation, this study chose a 5-point scale to assign values to the evaluation levels. To evaluate the situation of each indicator regarding

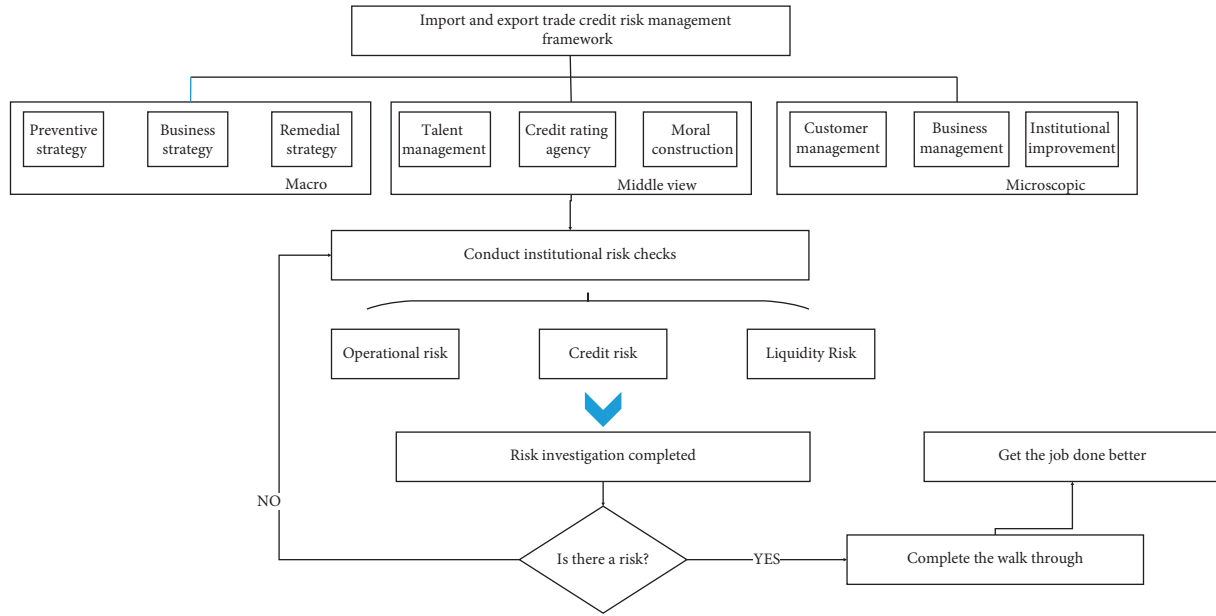


FIGURE 3: Credit risk management structure for import and export trade.

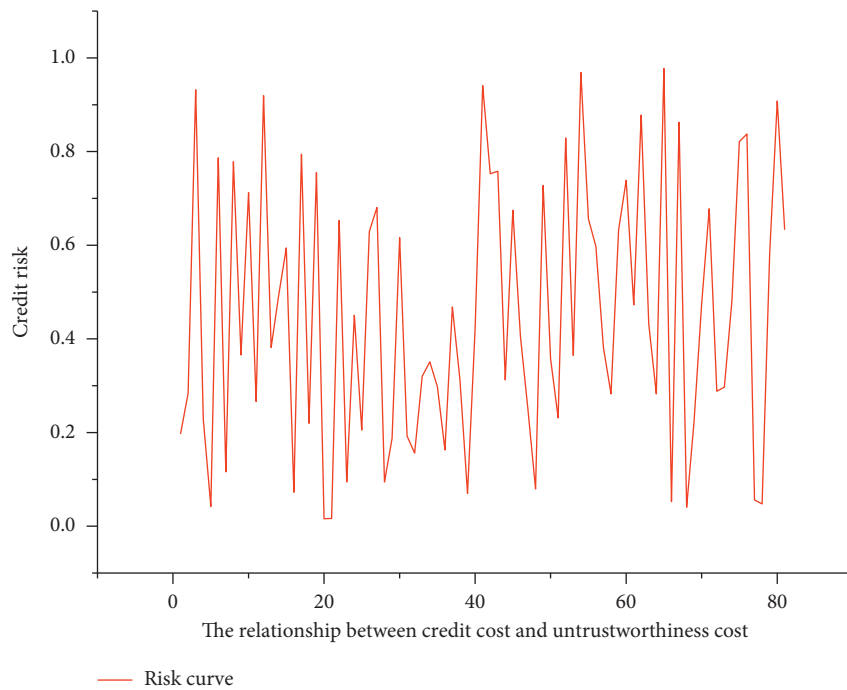


FIGURE 4: Relationship between credit risk and cost of failure to trust.

international import and export, the study invited a total of ten experts and scholars, including relevant researchers, and asked them to score the indicators of the Institute of Credit Assessment Development according to the current situation of the development of information services and their personal experience, and the scores of their relevant companies are shown in Figure 5.

The single-factor fuzzy judgment matrix is established based on the affiliation degree of the index layer (i.e., the affiliation degree of the secondary index) of the credit service quality of international import and export trading companies obtained in the previous section. The vectors are then calculated based on the established single-factor fuzzy judgment matrix, and the specific process is defined as follows:

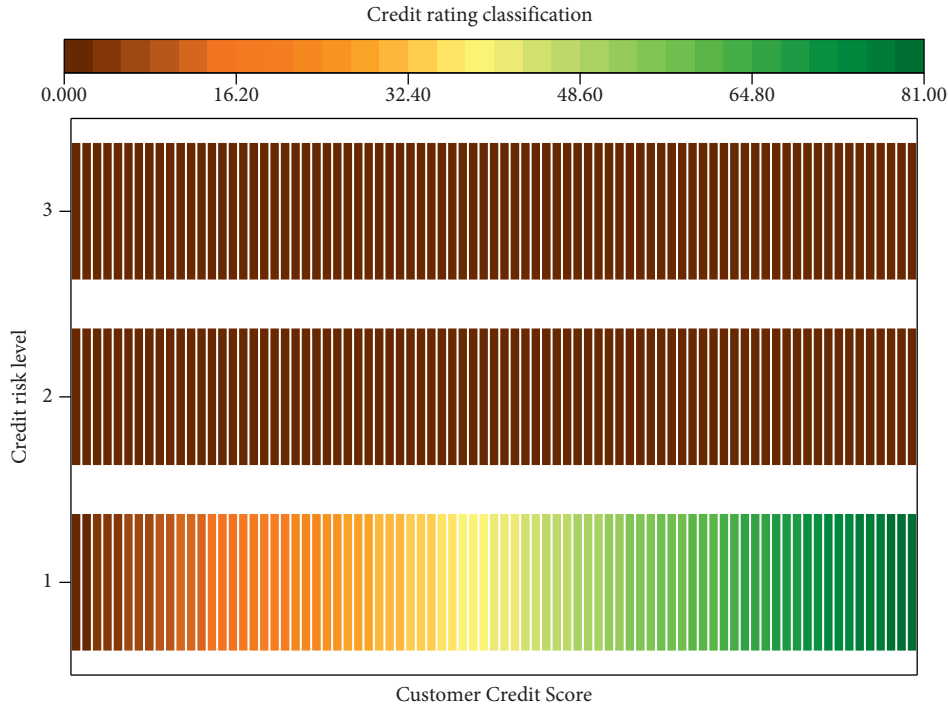


FIGURE 5: International import and export trading companies score.

$$X = \begin{pmatrix} a_1 & 1 & 0 \\ 2 & \cdot & 8 \\ 0 & 7 & a_3 \end{pmatrix}. \quad (2)$$

From this, the evaluation vector of service resources can be calculated.

$$U = \frac{\Delta y}{\Delta x} \frac{\partial^2 \Omega}{\partial u^2}. \quad (3)$$

The overall evaluation vector of Soochow Development Research Institute was compared with the evaluation set, and the maximum value of the overall evaluation vector B was 0.39777 according to the principle of the maximum affiliation method, then the value corresponds to “excellent” in the evaluation set. The comparison of its efficiency with the hierarchical analysis method is shown in Figure 6.

Agencies should use various web service platforms to disseminate their research results, and at the same time, to make the research results better known to the general public, they can use popular language to “transform” the results to enhance the effectiveness of information services. In the context of new media, credit assessment agencies can enhance their social influence by disseminating their results on these electronic network service platforms through social media or by choosing some mainstream media for their speed in the population. Agencies can hire relevant staff for the task of publishing research results, policy evaluations, etc. on such online platforms. Disseminating relevant think tank products online not only saves publicity costs for university think tanks but also makes the speed of dissemination a qualitative improvement.

5.2. Credit Assessment Model Efficiency Improvement Analysis. The more traditional credit assessment methods are subject to many errors, and inaccurate assessment results occur from time to time, which may bring hidden risks for enterprises. After comparing various credit assessment methods, this study chooses to conduct credit assessment for international import and export trade, using fuzzy hierarchical analysis for credit assessment not only has a higher accuracy rate and is easily convincing but also avoids the influence of staff’s subjective consciousness on the assessment results.

In this study, the fuzzy hierarchical analysis neural network method is applied to the credit assessment of cross-border e-commerce enterprises. First, the specific hierarchical institutions of the fuzzy hierarchical analysis method neural network are determined. Second, the sample data are determined, and the sample data are collected from export cross-border e-commerce enterprises according to the index system mentioned above, and the raw data are standardized. Then, make the fuzzy hierarchical analysis method neural network model for training and learning, and the efficiency of its model construction after comparing it with the models constructed by the two algorithms of standard analyze the algorithm structure of Fuzzy AHP and AHP; the obtained figure is shown in Figure 7.

10,000 samples were taken from the dataset in proportion to the positive and negative samples, and after preprocessing the data, the same two sets of models were trained on the training and test sets. The error convergence plots of the algorithms for the four sets were obtained by taking the average of ten experiments as shown in Figure 7. It cannot jump out of the local optimal solution quickly even

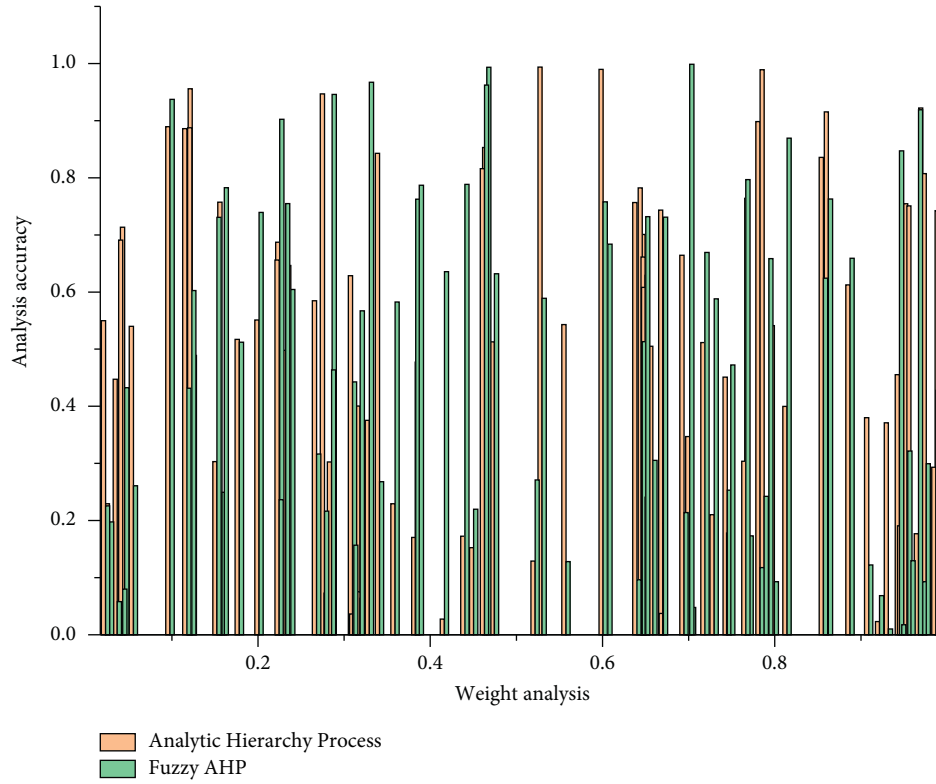


FIGURE 6: Efficiency of fuzzy hierarchical analysis vs. Hierarchical analysis.

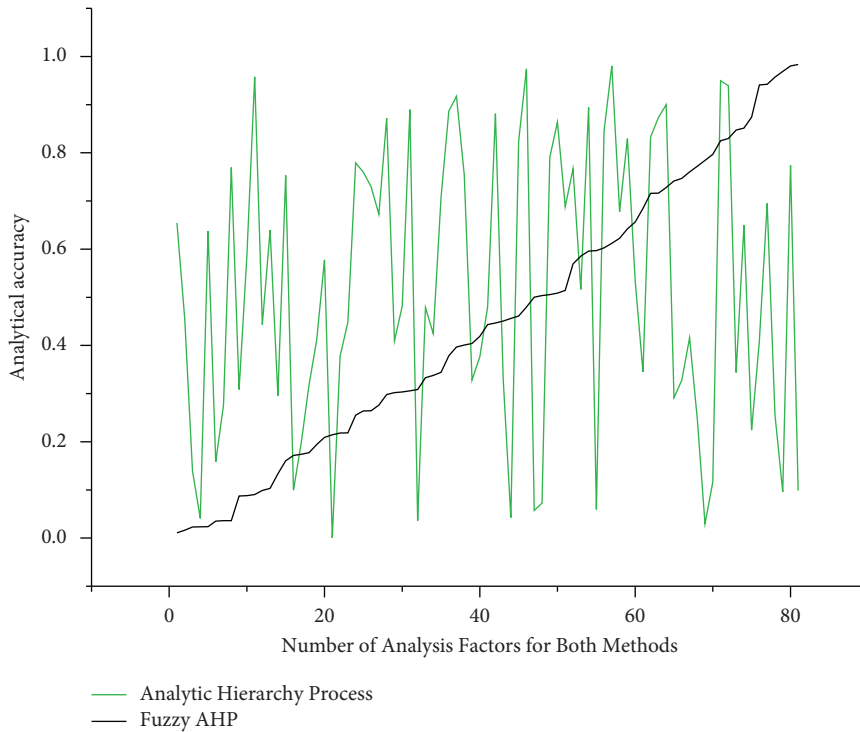


FIGURE 7: The efficiency of credit model construction by fuzzy hierarchical analysis compared with other approaches.

after falling into it, and finally, it also converges to the local optimal solution. The efficiency of the fuzzy hierarchical analysis method has the fastest improvement and is most

capable of making the credit evaluation model more efficient. The prediction correctness of the improved hierarchical analysis evaluation model increases with the number

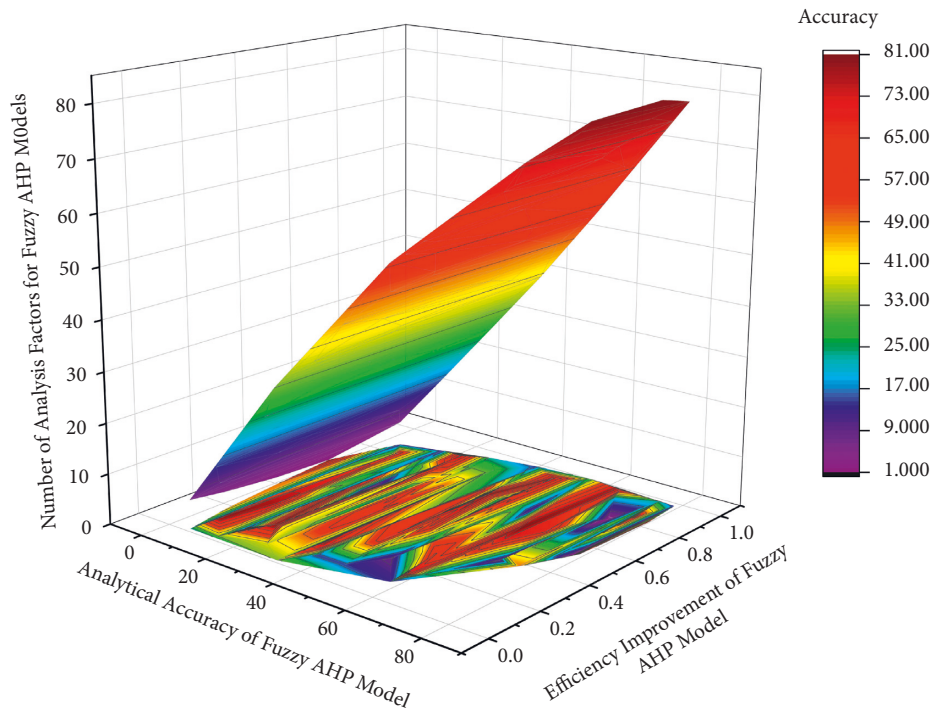


FIGURE 8: The superiority of the fuzzy hierarchical analysis model.

of iterations of about 4000 iterations; the algorithm enters the convergence state and the accuracy rate no longer increases. The accuracy of the model began to stabilize after the first 3,000 iterations and gradually converged in the next 1,000 iterations, with no significant increase in accuracy.

The improved fuzzy hierarchical analysis model proposed in this study is significantly superior to the traditional hierarchical analysis model in all four indicators, indicating that the improved algorithm has better global search capability and better performance of the model obtained through training than the traditional gradient descent optimization algorithm. The algorithm used in this study has better prediction accuracy compared with the logistic regression algorithm, which is commonly used by financial institutions to model personal credit evaluation. The performance is outstanding in various indicators. In the performance of recall rate, which is very important in the credit business, the model in this study performs more outstandingly, and its performance results are shown in Figure 8.

The experimental results show that modeling data from many financial institutions together through a federated learning architecture can effectively improve the accuracy of the model. For the four financial institutions in the experiment, the prediction ability of the model can be effectively improved by increasing the amount of data for the training model.

The models can still maintain a high correctness rate, and machine learning modeling can be performed for those special operations with small amounts of data.

It shows that the personal credit assessment model proposed in this study is more suitable for the credit business and can help the credit market to operate more stably and healthily to a certain extent.

6. Conclusion

This study focuses on the study of credit risk assessment models for international import and export trade. As more and more people use credit consumption, credit consumption products are widely promoted. There is no complete and unified evaluation index for credit risk assessment research status. And most of the methods applied in credit risk assessment of international import and export trade are black-box models, which makes it impossible to interpret the evaluation results reasonably.

To be able to enhance the interpretability of the model, this study completes the application of the fused fuzzy hierarchical analysis model in international import and export trade risk assessment. The fused fuzzy hierarchical analysis model first uses the scoring criteria of experts to assess the company's credit and then uses fuzzy hierarchical analysis to optimize the parameters of the assessment, to obtain the final fuzzy hierarchical analysis model. Through the experimental results, it can be found that the fused fuzzy hierarchical analysis model obtains a high classification accuracy, the model can filter out the important input variables in the data through the flexible neural tree, and the fuzzy hierarchical analysis further optimizes the parameters of the flexible neural tree to improve the classification accuracy of the

model. So the fuzzy hierarchical analysis method model for international import and export trade credit assessment is an important method to better assess the credibility of institutions and promote trade development. The evaluation model constructed in this study is more efficient, can evaluate risks well, avoid certain risks for international trade activities, and has certain use value.

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 there are no conflicts of interest.

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