Enterprise User Credit Evaluation Model Based on Hierarchical Analysis Method

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Abstract

In the daily work of electric power marketing, for all kinds of risks in the electric power marketing business to carry out systematic sorting and in-depth analysis, can effectively reduce the production and operation risks of electric power enterprises. At present, power companies still use more traditional power marketing model, the lack of lean analysis of business data and business risk control, enterprise production and operation there are more problems. For example, in terms of management, the current management system and management level is relatively backward. Electricity marketing work directly affects the operating efficiency of electric power enterprises, and the above-mentioned issues have increased the operating risks of electric power enterprises to a certain extent, bringing more uncontrollable factors to the production and operation of electric power enterprises. For the current situation of power marketing risk control work, this paper uses AHP hierarchical analysis and power data to analyze business users. By constructing the judgment matrix and calculating the affiliation degree, the credit scoring rating system of enterprise users is built and a new credit management model for enterprise users is proposed. The experimental results show that our method can effectively evaluate the credit of corporate users.

Keywords-*electric power marketing; AHP; hierarchical analysis method; power data*

1. INTRODUCTION

With the gradual advancement of China's power system reform work [1], market-oriented power trading centers have been set up one after another, creating a new type of power marketing pattern of "multiple buyers" and "multiple sellers". Buyers and sellers choose to conduct transactions independently, and the power trading center is responsible for market supervision of buyers and sellers, gradually liberalizing the business access scope of power sales companies. Grid enterprises only retain the original transmission and distribution and guaranteed electricity supply services, and the electricity sales companies under the grid enterprises should be separated from the original enterprises. The reform was carried out to achieve the objectives of lowering feed-in tariffs, reducing over-grid charges, benefiting from price reductions on the customer side, improving efficiency and quality services, and optimizing the business environment.

The French electricity system reform adopted a reform strategy of competitive feed-in tariffs for power generators and stepwise liberalization of the electricity sales market. Before the reform was implemented, Electricite de France (EDF) [2], as a state-owned enterprise, was responsible for the whole process of "generation, transmission, distribution and sale" of electric energy in the country. After the reform was implemented, France gradually liberalized the rules of access to the electricity sales market, introduced market-oriented competition mechanism, and permitted social capital to participate in the "power generation" and "electricity sales" business. The original Electricite de France, on the other hand, is responsible for regulating the electricity sales market, retaining a small portion of its transmission and distribution and marketing business, and providing guaranteed electricity supply services to the market.

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After the liberalization of the power sales market, customers and power sales companies conduct transactions independently in both directions, both need to make accurate judgments on the credit of each party to control the settlement risk of both parties, and power market credit management comes into being. To ensure the efficient operation of the electricity market and to realize sustainable electricity trading, a reliable credit evaluation system for power sales companies/power consumers is required first. At present, Chinese power companies have the following types of problems in user credit evaluation management: inadequate supporting laws, insufficient policy support, lack of quantitative power user credit management system, unclear division of management functions, etc. In response to different issues, research and adjustment are needed in several aspects: to analyze the risk of different types of users' transactions, to establish a credit evaluation mechanism for both “power sales companies/users” in line with China's national conditions, and to classify and stratify the management of power trading market participants.

We make the analysis of enterprise user credit status as the research theme, selects enterprise electricity users as the research object, and establishes a quantitative enterprise user credit evaluation model based on mathematical calculation methods. This paper adopts the hierarchical analysis method and electric power data to evaluate the credit of enterprise users, and uses the combination of expert survey and data analysis to classify the characteristic factors such as basic information of users, the length of bill payment, high price and low connection, and the risk of electricity theft, which affects the electricity bill recovery and causes potential default electricity consumption hidden danger, and analyzes them one by one. According to the analysis conclusion, a hierarchical evaluation system is built, two-by-two comparison of indicators is made, the importance judgment matrix is calculated, and the weights of each factor are obtained after passing the consistency test. The experimental results show that our method can effectively evaluate the credit of enterprise users and is important for the prevention and control of user default risk.

2. RELATED WORK

2.1. Foreign Enterprise Credit Evaluation System

Overseas research on enterprise credit evaluation [3] began early, and the corresponding theoretical system is more perfect. Moody's Investors Service, Fitch International Credit Rating and Standard & Poor's are the internationally recognized credit evaluation agencies with high authority. In the early days, credit evaluation of enterprises was mainly based on experts' empirical judgments, and the development of subjective empirical evaluation was relatively short, and credit evaluation methods shifted to a more scientific direction. After the 1990s, along with the wide application of computer technology, people began to favor the use of artificial intelligence and computer technology methods for credit evaluation, and the evaluation methods mainly include neural network method and expert system, etc. The evaluation methods turned from objective to scientific. The enterprise credit evaluation method shifted from the initial empirical judgment to the use of mathematical models, and finally developed to the period of system synthesis. The foreign enterprise credit evaluation system develops continuously and gradually becomes mature and perfect, the evaluation index system develops from univariate index at the beginning to multivariate index, the multivariate index analysis develops from the initial analysis mainly based on the basic financial index to the inclusion of the index reflecting the cash flow of the enterprise, and finally to the index reflecting the market revenue status of the enterprise is also considered.

2.2. Domestic Enterprise Credit Evaluation System

The domestic research on enterprise credit evaluation methods started late, generally on the basis of foreign research results, combined with the characteristics of Chinese enterprises [4] and economic conditions, and has achieved certain results. [5] used literature method, interview method and questionnaire method to select 44 qualitative and quantitative indicators, and formed a credit risk assessment model including financial strength factor, management strength factor and social strength factor by using item analysis and principal component analysis. Based on the state-of-the-art performance evaluation approaches and the roles of the commonly used performance metrics, [6] proposed an alternative direct technical route embedded in a cyber-physical-social system framework. The Chinese scholars have different perspectives on the selection of evaluation indexes and different attempts on the selection of evaluation methods. However, most of the scholars' research is generated on the basis of foreign research results. In the construction of evaluation indexes, non-financial indexes are selected rather arbitrarily and lack a certain theoretical basis. In this paper, we use the analytic hierarchy process and power data to evaluate the credit of enterprise users, and use the means of combining expert survey and data analysis to analyze different types of data.

3. ENTERPRISE USER CREDIT EVALUATION MODEL BASED ON HIERARCHICAL ANALYSIS AND POWER DATA

3.1.Introduction to the Principles of Hierarchical Analysis

Hierarchical analysis [7], first proposed by American operations researcher Professor Sadie, uses a combination of qualitative analysis and quantitative expression means to express the subjective human judgment and thinking process quantitatively. According to the logical hierarchy of influencing factors, complex problems in production practice are analyzed and a hierarchical structure model is established. The factors in each layer are compared two by two, their relative importance is judged, and the judgment matrix is obtained, and after consistency testing, the weights of each indicator are calculated. In this section, the hierarchical analysis method is applied, and the means of integrating quantitative and qualitative are adopted in order to build a systematic, comprehensive and hierarchical credit analysis structure for small and micro electricity users and calculate the credit rating of users. The basic steps of the hierarchical analysis method include: building a hierarchical structure model, constructing a "two-by-two comparison judgment matrix" and calculating the weights of each lower-level element for the criterion level elements.

3.2.Building a Hierarchical Model

Combined with the actual situation of electricity marketing work, according to the logic law, the enterprise user credit influence factors are decomposed into different levels. Each factor of the same level is subordinate to the previous level and is influenced by each factor of the next level at the same time. By defining different factors accurately, it can be clearly delineated whether a lower-level factor will have an impact on the factor when it is used.

3.3.Constructing a "two-by-two Comparison Judgment Matrix"

Different evaluation indicators have different degrees of influence on the evaluation target, and each of them occupies a certain proportion in the mind of decision makers. The judgment matrix is constructed by comparing each evaluation index at each level and the relative importance of each sub-evaluation index by the "9-quantile ratio method".

3.4.Calculating the Weights of Each Lower-level Element for the Criterion Level Elements.

In order to determine the weights of the elements of the judgment matrix, the calculation can be performed by various algorithms: geometric mean method (root method) [8], normative column average method (sum method) [9], eigenvector method [10], and least squares method [11].

3.4.1.Geometric mean method (square root method).

a) Multiplying the elements of each row in the judgment matrix.

b) Root the product result n times square.

c) After normalization process, get the weight vector value.

3.4.2.Normative column averaging method (summation method)

a) Add up the elements of each row in the judgment matrix.

b) After normalization process, get the weight vector value.

3.4.3.Eigenvector method

a) Let the weight vector be W. For the judgment matrix A, we have $AW=l_{max}W$, where l_{max} is the maximum characteristic root of the judgment matrix A and W is the corresponding characteristic vector.

b) Normalize W to obtain the weight vector value.

3.4.4.Least squares method

a) The weight vector is determined by fitting method so that the residual sum of squares is minimum.

3.5.Checking the Consistency of the Judgment Matrix

The logical relationship of objective things is often not single, and it is not always possible to maintain objectivity and impartiality when making a two-by-two comparison of importance, and one-sided judgments are difficult to avoid, which can bring about logical self-contradiction. With the increase of judgment indicators at the same level, two comparisons are regularly difficult to decide. For example, if A is slightly more important than B, B is very important than C, and C is slightly more important than A, there is a conflict in logic. If the judgment matrix is logically confused and does not meet

the requirement of consistency, it will trigger the evaluation inaccuracy. Therefore, it is very significant to check the consistency of the judgment matrix of each layer. After getting the judgment matrix, the weights of each index are calculated. A consistency test is necessary to ensure that the importance of each element conforms to the logical relationship. If the judgment matrix deviates from the consistency target too much, the importance of each element does not conform to the logical relationship, and the matrix needs to be reconstructed or adjusted. Therefore, it is indispensable to perform consistency check on the judgment matrix. When the consistency test is passed, the evaluation model can begin to be built.

4. APPLICATION OF CORPORATE USER CREDIT EVALUATION MODEL BASED ON HIERARCHICAL ANALYSIS AND POWER DATA

4.1.Data Normalization Processing

A pilot application is conducted for 530,000 enterprise users in a region, and the basic information, electricity consumption behavior, power tariff and payment situation of this group of users from August 2016 to December 2017 are taken as the basic data to carry out research and analysis. First, the value fields, missing fields and abnormal fields of each factor should be analyzed based on the uniqueness characteristics of the electricity account number, and invalid fields should be eliminated, and then the data should be normalized. The normalization of data includes the following three steps. In the first step, invalid information is eliminated. If the user does not have any historical electricity consumption data, newly installed unenergized electricity, has carried out cancellation, and has been forced to execute power outage, etc., the evaluation results will be affected due to the lack of valid field information and need to be eliminated. The second step is to classify each evaluation index. Individual indicator types, because they contain a very small number of users and a very small probability, it is not meaningful to quantify the value of their sub-boxes. These indicators can be deleted or combined with other indicators. The third step is to quantify each indicator in separate boxes.

4.2.Model Construction

With reference to the current customer management mode of power supply enterprises, the AHP hierarchical analysis method is used as the basis to build the enterprise customer credit evaluation model through various power data. The AHP hierarchical analysis method has the characteristics of clear logical levels, comprehensive evaluation indexes and easy to adjust flexibly. The analysis method can truly and comprehensively reflect the credit status of small and micropower users. The research object of this paper is corporate power users in a region, and the credit evaluation system is divided into three levels: target level, criterion level and program level according to the risk points of power marketing business. The credit rating of corporate electricity users is included in the target layer as a decision target; three major indicators of basic information, bill payment behavior and electricity consumption behavior is included in the guideline layer. Refined indicators such as accuracy of basic information, timely rate of information update, average bill payment time, number of electricity theft, and amount of electricity theft are included in the scheme layer.

When the importance is compared two by two, the marketing business experts are surveyed and the final judgment matrix is obtained after centralized discussion and correction of the data with large deviations and controversies, and then the weights of each indicator can be calculated. Consistency test is performed on the judgment matrix. The consistency ratio CR of the three indicators in the criterion layer is 0.0000, which is less than 0.1, and the consistency test is passed. In the consistency test of the scheme layer, the consistency ratio CR of “payment behavior” is 0.00892, the consistency ratio CR of “basic information” is 0.00856, the consistency ratio CR of “electricity consumption behavior” is 0.00743, all of which meet the requirement of CR<0.1, so the judgment matrix is logically consistent, and the test is passed. The weight of each factor was calculated by using the pooled average method. The evaluation model was applied to all small and micropower users in the region, and the credit rating of users was divided according to the calculation results of each tier index and the distribution of user credit scores. As shown in Table 1, the credit score is divided into 5 bands from 0 to 1000, where the band of [701, 1000] is defined as “very good”, the band of [601, 700] is defined as “excellent”, the band of [501, 600] is defined as “good”, the band of [401, 500] is defined as “medium”, and the band of [0, 400] is defined as “poor”. The credit rating label is used to show the credit situation of users, and different risk control measures and service modes are adopted for users with different credit ratings.

TABLE 1.CREDIT SCORE RATING TABLE

Different Intervals	[0,400]	[401,500]	[501,600]	[601,700]	[701,1000]
Rating Label	Poor	Medium	Good	Excellent	Very Good

4.3.Promotion and Use

According to the credit evaluation model built for enterprise power users, enterprise power users in a

certain region were selected for testing. The electricity consumption information of the test users from August 2016 to December 2017 is included in the credit calculation scope for credit evaluation calculation. We use the eXtreme Gradient Boosting (XGB) method [11] to compare with the method proposed in this paper，the test results are shown in Table 2. From the table, we can see that the analysis results of our method are closest to the real results, two predictions are the same, and the other three prediction results page are not much different, and the effect is much better than XGB. Therefore, our method is used to score corporate power customers eat credit to predict the potential default risk of corporate power customers and help power companies take pre-control measures in advance. In addition, the use of different management methods for different credit levels of corporate electricity users can help power companies optimize the allocation of service resources and provide marketing services that meet the value level of users.

TABLE 2.PERCENTAGE OF MODEL ANALYSIS RESULTS IN DIFFERENT INTERVALS

Different Intervals	[0,400]	[401,500]	[501,600]	[601,700]	[701,1000]
Our Method	2%	3%	85%	7%	3%
XGB	3%%	6%	82%	6%	3%
Label	2.5%	3%	85%	6%	3.5%

5. CONCLUSION

According to the problems of enterprise customer credit evaluation, this paper builds a scientific and reasonable hierarchical structure model of customer credit risk, calculates the judgment matrix by comparing two by two, tests the logical consistency of the matrix and calculates the weights of each index. The hierarchical structure model is used to score and calculate the credit risk of customers' electricity bills, and practice shows that the judgment matrix meets the requirements of consistency test. We apply the credit evaluation model in practice and implement different risk prevention and control measures and adopt differentiated service modes for customers of different grades according to the rating results, so as to realize lean classification management of enterprise customers. It is convenient for the power marketing staff to carry out the identification work efficiently and take measures to reduce the risk of electricity bill recovery in advance, which is of great significance to the prevention and control of enterprise customers' default risk.

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