Credit ability evaluation system of power selling enterprises based on big data

Xudong Wang[1, a], Chang Liu[2, b], Yongchao Liu[2, c], Yuan Lu[2, d], Jialu Zhang[2, e]

[1.]State Grid Shandong electric power company marketing department Shandong Jinan 250001

[2.]State Grid Shandong electric power company marketing service center Shandong Jinan 250001

[a]wangxudong1985@126.com, [b]liuchang1994@126.com, [c]1621128751@qq.com, [d]1509547797@qq.com, [e]1879982703@qq.com

Abstract. With the gradual relaxation of the electricity market access threshold, the development pattern of market-oriented electricity sales has brought great challenges to the power grid business development. It is of great significance to select the right electricity selling enterprises in the market-oriented electric power marketing mode to ensure the practical demand of electricity customers and the operating efficiency of power grid enterprises. First, the basic characteristics of power big data are analyzed. Secondly, it classifies and analyzes the important factors that affect the performance credit of electricity selling enterprises under the new electricity transformation environment. By normalizing different types of key index data and assigning index weights, a credit ability evaluation model of electricity selling enterprises based on matter-element extension-TOPSIS is established. Finally, taking eight electricity selling enterprises in a province as an example, the credit ability evaluation model is applied to analyze and calculate the performance ability of different electricity selling enterprises. The results prove the practicability of the evaluation system proposed in this paper.

Keywords: big data; Key indicators; Credit ability evaluation; Performance ability.

1. Introduction

With the development of a new wave of electricity reform, the nature of electric power enterprises has changed gradually. In the transition from a production-oriented enterprise to a service-oriented enterprise, its business focus is also gradually moving to the practical needs of customers as the center, and it continues to optimize the business capability of the enterprise [1-3]. How to better match the power demand of different power users and do a good job in electricity service is the key to improve the core competitiveness of electric power enterprises [4-5].

The application of big data in the field of electricity market has achieved certain research results. Based on the analytic hierarchy process (AHP) and factor analysis method, Literature [6] proposes an improved fuzzy comprehensive evaluation model applied to the credit evaluation of small and medium-sized enterprises. The feasibility of the algorithm is confirmed by the application results of the example. In the reference [7], considering the contradictions of the evaluation results of a single evaluation algorithm, the combination weight was calculated based on the range maximization method, and the rural microcredit credit evaluation system was established. In reference [8], a cloud user credit evaluation model is established to calculate the credit rating value of cloud users based on the combined weighting method of relative entropy and the weight information of subjective and objective weighting method. In reference [10], relevant factors affecting the distribution network planning scheme were analyzed, cost optimization was taken as the control objective, and the design scheme was evaluated based on the analytic hierarchy process.

Based on the above research basis, this paper through the data mining technology in-depth analysis of different power customers' needs, to maximize the satisfaction of customer needs and improve the enterprise's operating efficiency. Based on the analysis of the basic characteristics of power big data, this paper classifies and analyzes the important factors that affect the performance credit of electricity selling enterprises under the new power transformation environment. By normalizing different types of key index data and assigning index weights, a credit ability evaluation model of electricity selling

enterprises based on matter-element extension-TOPSIS is established. Finally, the performance capacity of different electricity selling enterprises is analyzed and calculated.

2. Basic characteristics of power big data

Each industry contains a large amount of data information, which has gradually formed the key factors of production [11] For the power system, power big data is the collection of production, transportation, marketing and management data of power enterprises. By mining the data value can predict the industry development situation. Making full use of the core value of big data helps to continuously optimize the service concept, promote the transformation and upgrading of enterprise management mode, and adapt to the external situation and environment of constantly innovating. Power big data mainly has the following four basic characteristics [12]:

1. Large amount of data. With the continuous advancement of electric power information construction, the growth rate and scale of electric power data show an exponential development trend.

2. Wide variety. The power grid operation data includes structured and unstructured data such as equipment operation state data under normal working conditions and fault working conditions, system operation data, diagnostic data, noise interference data and so on.

3. Fast speed. Power grid operation data is generated all the time. Similarly, the data information is also collected synchronously and sent to the main station for analysis and processing, which puts forward higher requirements on the collection and processing speed.

4. High value. Various operating parameters and operating states of the power grid have been shown in the form of data, which is the embodiment of the value of the data era.

3. Analysis of credit characteristics of electricity selling enterprises

3.1. Analysis of credit influencing factors of electricity selling enterprises

The main factors that determine the credit rating of electricity selling enterprises include: internal factors and external factors. Internal factors refer to the factors which are determined by the behaviors of electricity selling enterprises and affect the credit of electricity selling enterprises. It mainly includes: the basic conditions of the enterprise, the willingness to abide by the credit, the financial situation of the enterprise, the credit status of the enterprise; External factors refer to the environment of the existing electricity market and the dynamic influence of competitors. It mainly includes: the performance of credit compliance, etc[13-14].

3.2. Selection of credit evaluation index of electricity selling enterprises

This paper selects relevant indicators from six aspects: the basic conditions of enterprises, the ability to abide by credit, the willingness to abide by credit, the performance to abide by credit, the financial situation and the credit status of enterprises. These constructs the credit evaluation index system of electricity selling enterprises as shown in Table 1.

Tab. 1 Credit evaluation levels and indicators of electricity selling enterprises

Level of evaluation	Index of evaluation
Basic conditions	Integrity of information
	Annual electricity sales
	Completeness of various professional qualifications
Ability to keep one's word	Implementation of quality safety and environmental protection
	Proportion of technicians
	Achievements of various honors of the enterprise
	Business scope
	Equipment loss rate
	Proportion of R&D investment
Willingness to keep promise	Management's credit status
	Tax credit rating

	Construction of enterprise credit system
Performance of trustworthiness	Implementation of trading standards
	Timeliness of account settlement
	Contract execution capability
	Implementation of dispatching management measures
Financial situation	Turnover rate of accounts receivable
	Return on assets
	Gross profit margin
	Net profit value
	Profit growth rate
	Income ratio with top enterprises in the same industry
	Return on net assets
	Quick asset ratio
	Asset liability ratio
	Enterprise income growth rate
Enterprise credit status	Enterprise good credit record entries
	Enterprise bad credit record entries

4. Credit evaluation model of electricity selling enterprises

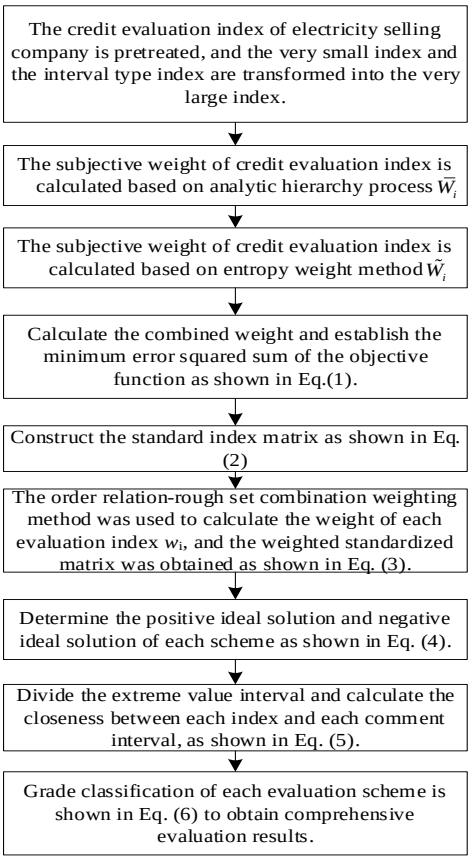


Fig. 1 Credit evaluation model based on matter-element extension-TOPSIS method

As shown in Figure 1, it is a credit evaluation model based on matter-element extension-TOPSIS method.

$$\begin{cases} \min \sum_{t=1}^{m} [(W_i - \bar{W}_i)^2 + (W_i - \tilde{W}_i)^2] \\ W_i = \alpha \tilde{W}_i + \beta \tilde{W}_i \end{cases} \tag{1}$$

Where, W_i is the combined weight; $\bar{W}_i$ is the weight calculated based on analytic hierarchy process. $\tilde{W}_i$ is the weight calculated based on entropy weight method; α is the proportion of weight; β is the proportion of weight $\tilde{W}_i$.

$$C = (c_{ij})_{m\times n} = \begin{bmatrix} c_{11} & c_{12} & \cdots & c_{1n} \\ c_{21} & \cdots & \cdots & c_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ c_{m1} & c_{m2} & \cdots & c_{mn} \end{bmatrix} \tag{2}$$

Where, $M = (M_1, M_1, ..., M_m)$ is the scheme set participating in the evaluation; $D = (D_1, D_1, ..., D_n)$ is the evaluation indicator set; C is the standard index matrix of Scheme M to Index D.

$$X = (x_{ij})_{m\times n} = \begin{bmatrix} w_1c_{11} & w_2c_{12} & \cdots & w_1c_{1n} \\ w_1c_{21} & w_2c_{22} & \cdots & w_1c_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ w_1c_{m1} & w_2c_{m2} & \cdots & w_1c_{mn} \end{bmatrix} \tag{3}$$

Where, X is the weighted normalized matrix. The positive ideal solution and negative ideal solution X^+ and X^- obtained by further calculation are:

$$\begin{cases} X^+ = \{\max\limits_{1\le i\le m} x_i(j) \mid j \in J^+, \min\limits_{1\le i\le m} x_i(j) \mid j \in J^-\} \\ X^- = \{\min\limits_{1\le i\le m} x_i(j) \mid j \in J^+, \max\limits_{1\le i\le m} x_i(j) \mid j \in J^-\} \end{cases} \tag{4}$$

$$E(N_i = \left| x_{ij} - \frac{h_{it}^1 + h_{it}^2}{2} \right|) \tag{5}$$

$$Q_j(N_i) = 1 - \sum_{j=1}^{n} w_j E(N_i) \tag{6}$$

Where, N is the extreme value interval division section; $H_{it} = (h_{it}^1, h_{it}^2)$ is the interval of each layer; $E(N_i)$ is the closeness between each index of the standardized decision-making matrix and each comment interval; $Q_j(N_i)$ is the weighted closeness of each evaluation scheme.

5. Analysis of examples

The relevant data of eight electricity selling enterprises in a certain province were collected and sorted, and the credit evaluation model based on matter-element extension-TOPsis method was used to demonstrate and analyze the credit evaluation. First of all, according to the data preprocessing method, the original data of credit evaluation index of electricity selling enterprises are processed uniformly and dimensionless, and the combined weight of credit evaluation index of electricity selling enterprises is obtained as shown in Table 2.

Tab. 2 Weight coefficients of each evaluation index

Index of evaluation	Index weight
Integrity of information	0.0351
Annual electricity sales	0.0673
Completeness of various professional qualifications	0.0595
Implementation of quality safety and environmental protection	0.0025
Proportion of technicians	0.0581
Achievements of various honors of the enterprise	0.0036
Business scope	0.0287
Equipment loss rate	0.0342
Proportion of R&D investment	0.0174
Management's credit status	0.0621
Tax credit rating	0.0360
Construction of enterprise credit system	0.0667
Implementation of trading standards	0.0391
Timeliness of account settlement	0.0066

Contract execution capability	0.0177
Implementation of dispatching management measures	0.0161
Turnover rate of accounts receivable	0.0047
Return on assets	0.0314
Gross profit margin	0.0564
Net profit value	0.0299
Profit growth rate	0.0355
Income ratio with top enterprises in the same industry	0.0137
Return on net assets	0.0325
Quick asset ratio	0.0361
Asset liability ratio	0.0651
Enterprise income growth rate	0.0031
Enterprise good credit record entries	0.0508
Enterprise bad credit record entries	0.0671

It can be seen from Table 2 that the index weights of factors such as annual electricity sales, complete degree of various professional qualifications, proportion of technical personnel, credit status of management, construction of enterprise truth-keeping system, implementation of trading rules, profit growth rate, entries of enterprise good credit record, entries of enterprise bad credit record, and asset-liability ratio are relatively large. In other words, these factors will have a great impact on the credit rating of electricity selling enterprises in the process of market trading. Therefore, we should focus on these factors and try our best to ensure the completeness and authenticity of the collection of these evaluation indicators, so as to ensure that the evaluation results are as close as possible to the actual credit rating of the electricity selling enterprises.

After the combined weight of each index is obtained, the weighted standardized matrix is further obtained, and the positive ideal solution and negative ideal solution are calculated, as shown in Table 3.

Tab. 3 Positive ideal solutions and negative ideal solutions of each evaluation index

Index of evaluation	Positive ideal solution	Negative ideal solution
Integrity of information	0.00102	0.0057
Annual electricity sales	0.1914	0.0107
Completeness of various professional qualifications	0.0165	0.0092
Implementation of quality safety and environmental protection	0.0065	0.0035
Proportion of technicians	0.0172	0.0088
Achievements of various honors of the enterprise	0.0013	0.0006
Business scope	0.0081	0.0041
Equipment loss rate	0.0101	0.0055
Proportion of R&D investment	0.0051	0.0028
Management's credit status	0.0185	0.0099
Tax credit rating	0.0111	0.0058
Construction of enterprise credit system	0.0203	0.0107
Implementation of trading standards	0.0107	0.0066
Timeliness of account settlement	0.0021	0.0011
Contract execution capability	0.0051	0.0031
Implementation of dispatching management measures	0.0047	0.0024
Turnover rate of accounts receivable	0.0013	0.0009
Return on assets	0.0091	0.0049
Gross profit margin	0.0167	0.0088
Net profit value	0.0087	0.0044
Profit growth rate	0.0105	0.0057
Income ratio with top enterprises in the same industry	0.0039	0.0022
Return on net assets	0.0091	0.0053
Quick asset ratio	0.0105	0.0063
Asset liability ratio	0.0189	0.0097
Enterprise income growth rate	0.0013	0.0005
Enterprise good credit record entries	0.0153	0.0078
Enterprise bad credit record entries	0.0197	0.0101

The extreme value interval composed of the positive ideal solution and the negative ideal solution is divided into four levels equally, and the corresponding credit rating of the electricity selling enterprise is A level, 2A level, 3A level and 4A level respectively. After calculating the close degree $E(N_i)$ between each index of the standardized decision matrix and the four comment intervals as well as the weighted close degree $Q_j(N_i)$ of each evaluation scheme, the corresponding evaluation level of the evaluated electricity selling enterprise is found according to the maximum value $Q_j(N_i)$, as shown in Table 4.

Tab. 4 Evaluation levels of each electricity selling enterprise

Power sale enterprise	The maximum value of weighted closeness	Subordinate evaluation level
Power sale enterprise1	0.99969	4A
Power sale enterprise2	0.99915	3A
Power sale enterprise3	0.99722	A
Power sale enterprise4	0.99897	3A
Power sale enterprise5	0.99939	3A
Power sale enterprise6	0.99865	2A
Power sale enterprise7	0.99871	2A
Power sale enterprise8	0.99697	A

Based on the rating results in Table 4, the factors affecting the credit rating of electricity selling enterprises are analyzed. For 4A-level electricity selling enterprises, the main evaluation indicators are: annual electricity sold, the proportion of technical personnel, the degree of complete professional qualifications, the credit status of management, the construction of enterprise trustworthy system, the implementation of transaction rules, the entry of enterprise bad credit record, the growth rate of profits, the rate of return on assets and the asset-liability ratio, etc. Especially the annual sales of electricity, management credit status, the construction of the enterprise trustworthy system and the implementation of trading standards. For the electricity selling enterprises with 3A and 2A credit ratings, the main factors affecting their credit ratings are the annual electricity sold and the items of bad credit records of the enterprises. This has improved the company's credit rating to some extent. The main reasons for the worst credit rating of the A-grade electricity selling enterprises are the poor evaluation results of the management's credit status, the construction of the enterprise's truth-keeping system, the implementation of the trading rules and the bad credit record entries of the enterprises.

6. Conclusion

The credit evaluation model based on matter-element extension-TOPSIS method constructed in this paper can objectively and truly reflect the credit rating of electricity selling enterprises, which has certain reference significance for the enterprise access and daily assessment of electricity selling enterprises in the process of electricity market trading. Among them, the ability to abide by credit, the willingness to abide by credit and the financial situation are the factors that need to be focused on in credit evaluation.

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