The Comprehensive Evaluation Method of Supervision Risk in Electricity Transaction Based on Unascertained Rational Number

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Abstract. For the uncertain problems in the comprehensive evaluation of supervision risk in electricity transaction, this paper uses the unidentified rational numbers to evaluation the supervision risk, to obtain the possible result and corresponding credibility of evaluation and realize the quantification of risk indexes. The model can draw the risk degree of various indexes, which makes it easier for the electricity transaction supervisors to identify the transaction risk and determine the risk level, assisting the decision-making and realizing the effective supervision of the risk. The results of the case analysis verify the effectiveness of the model.

1. Introduction
With the establishment of the united and mutual power market[1-2], the objects and methods of electricity transaction are more complicated, and there is greater uncertainty in market behaviors, resulting in increasing supervision risk in electricity transaction. In order to avoid the deteriorating supervision risk in electricity transaction, affect the market order and bring more risk to the electricity transaction, it is urgent to research the supervision risk in electricity transaction.

At present, fuzzy comprehensive evaluation method [3-4]is widely used to evaluate the supervision risk in electricity transaction[5-6]. However, the evaluation objects of the method are most the power market operation efficiency, the power market operation rules and so on which are highly certainty. Relative to the supervision risk in electricity transaction with greater uncertainty, the fuzzy comprehensive evaluation method does not exactly reflect the uncertainty in the evaluation which is embodied in two aspects. Firstly, uncertainties in market behaviors lead to greater uncertainty in the comprehensive evaluation of supervision[7] risk in electricity transaction. Secondly, when determining
the true state of things and the number relation, policy makers are with uncertainty in purely subjective understanding due to insufficient information.

In fact, the information which is provided by any system has both state factors and behavioral factors is mainly all essentially unidentified information. For the information, we must consider its uncertainty and can not simplify it to the determining information to deal with it. Therefore, aiming at the uncertainty of supervision risk in electricity transaction, this paper constructs the comprehensive evaluation method of supervision risk in electricity transaction based on unascertained rational number[8].

2. The comprehensive evaluation model of supervision risk in electricity transaction based on unascertained rational number

This paper builds the warning index system for transaction supervision risk that is applicable to the united and mutual power market. It contains 4 first class indexes namely market synergies, trading plans, contracts and settlements and energy efficiency including 10 second indexes which are shown in table 1.

| The first class index      | The second class index                                                                 |
|----------------------------|---------------------------------------------------------------------------------------|
| Market coordination        | Provincial trading volume                                                             |
|                            | The ratio of transaction volume in the total electricity                                |
|                            | Clean energy efficiency                                                               |
| Trading plan               | The completion rate of base electricity plan                                           |
|                            | The implement balanced rate of base electricity plan                                   |
| Contract and settlement    | The rate of contract record                                                            |
|                            | The rate of settlement completion                                                     |
|                            | The rate of settlement prompt                                                         |
| Energy efficiency          | The rate of clean energy consumption                                                 |
|                            | The year-on-year growth rate of coal saving calculation                               |

Table 1. The warning index system for transaction supervision risk that is applicable to the united and mutual power market

(1) the overall thinking
1) Conduct a comprehensive credibility model for power market experts, drawing the comprehensive credibility of the experts involved in the evaluation;
2) The second class index are marked by each expert;
3) According to the credibility of experts and the grade, calculate the scores of the two class index and the score is belong to unascertained rational number;
4) Finally, combining the weight of second class indexes and the scores, calculate the scores of first class indexes. By that analogy, calculate the score of the general goal.

(2) Conducting the comprehensive credibility model for power market experts

According to the expert title, academic qualifications and working years, determine the credibility of the experts which is shown in table 2.
Table 2. Expert Credibility Assessment Standard Classification

| Item  | Job title | Education | Working-age (year) |
|-------|-----------|-----------|-------------------|
| Category | Senior Title | Intermediate Title | Junior Title | Master's degree | Undergraduate | Specialist | High school | ≥20 | 20~10 | <10 |
| Confidence interval | [8,10] | [4,7] | [1,3] | [8,10] | [7,10] | [3,6] | [1,3] | [8,10] | [4,7] | [1,3] |

$\varepsilon_i (i = 1, 2, 3)$ is the job title, education, working-age respectively, and then the credibility of experts is $\beta_i$ that can be expressed by the formula (1).

$$\beta_i = \frac{\sum_{i=1}^{3} \varepsilon_i}{30}$$  \hspace{1cm} (1)

The closer the value of $\beta_i$ is to 1, the more trustworthy this expert is and the more accurate the judgment is. Conversely, the smaller $\beta_i$ is, the less likely it is to believe this expert.

The credibility of experts $B_1, B_2, \ldots, B_n$ involved in comprehensive evaluation are $\alpha_1, \alpha_2, \ldots, \alpha_n$.

The comprehensive credibility of expert $B_i$ for expert group $B_1, B_2, \ldots, B_n$ is $\alpha_i$.

$$\alpha_i = \frac{-\alpha_i}{\sum_{k=1}^{n} \alpha_k} \hspace{1cm} (i = 1, 2, \ldots, n)$$  \hspace{1cm} (2)

The comprehensive credibility of expert group $B_1, B_2, \ldots, B_n$ is $\alpha$.

$$\alpha = \frac{1}{n} (-\alpha_1 + \alpha_2 + \ldots + \alpha_n)$$  \hspace{1cm} (3)

(3) The uncertainty quantization of expertise

This paper uses the unascertained rational number to quantify the evaluation information of experts. $A_1, A_2, \ldots, A_m$ are the assessment of $A$, and the experts $B_1, B_2, \ldots, B_n$ use the percentile system to rate the indicator factors, drawing the scoring table.

The scores of factor $A$ are $C_{i1}, C_{i2}, \ldots, C_{in}$ respectively, and the comprehensive credibility of experts are $\alpha_1, \alpha_2, \ldots, \alpha_n$. Now, arrange the $C_{i1}, C_{i2}, \ldots, C_{in}$ into $C_{ij1}, C_{ij2}, \ldots, C_{ijn}$, then the paper draws the unascertained rational number of the factor $A$.

$$f_i(x) = \begin{cases} \alpha_{i1}, & x = C_{ij1} \\ \alpha_{i2}, & x = C_{ij2} \\ \vdots & \vdots \\ \alpha_{ijn}, & x = C_{ijn} \end{cases} \hspace{1cm} (4)$$

In the formula, $f_i(x)$ is the unascertained rational number of the factor $A$.

$i = 1, 2, \ldots, m$;
\[ A_{i1}, A_{i2}, \ldots, A_{ik} \] are the sum of experts' comprehensive credibility which the score are \[ C_{i1}, C_{i2}, \ldots, C_{ik} \].

The weight of factor \( A_i \) is \( w_i \), so the uncertain quantizer of object \( A \) is \( C \).

\[
C = \sum_{i=1}^{m} w_i f_i(x)
\]  

(5)

3. The analysis of case

The paper supposes that there are three power market experts involved in the evaluation. Through the model of experts' comprehensive reliability, the comprehensive reliability of experts are 0.5, 0.3, 0.2 respectively. The scores of second class index in market coordination index are shown in table 3.

Table 3. The scores of second class index in market coordination index

|                      | Expert 1 | Expert 2 | Expert 3 |
|----------------------|----------|----------|----------|
| provincial trading volume | 75       | 80       | 78       |
| the ratio of transaction volume in the total electricity | 65       | 60       | 66       |
| clean energy efficiency       | 40       | 50       | 35       |

The scores of market coordination index are shown in table 4.

Table 4. The scores of market coordination index

|         |        |        |        |
|---------|--------|--------|--------|
| score   | 40.43  | 52.33  | 61.63  |
| credibility | 0.105  | 0.270  | 0.365  |
|         | 0.260  |

The higher the score, the greater the risk. Table 4 shows that the probability of 60 or more is 62.5%, indicating that in the electricity market transaction at this stage, the market coordination that the first class index has certain risks. So the relevant person should strengthen the supervision of market coordination, make early warning response to the indicator and put forward countermeasures to avoid greater risks.

4. Conclusion

The comprehensive evaluation method of supervision risk in electricity transaction based on unascertained rational number in this paper solves the problem of uncertainty in the current supervision risk evaluation in power transaction. At the same time, the model facilitates the risk supervisor to identify and judge the risk level, avoiding the ever-worsening of trading risk, and instruct power supervisors to take appropriate measures to effectively monitor the risks.

5. References

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