Research on Investment Distribution Technology of Power Grid Enterprise Overhaul Based on Gini Coefficient Theory

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Abstract. Equipment overhaul is one of the core businesses of power grid enterprises. The scientific and rational allocation of overhaul funds plays an important role in improving the lean management of power grid enterprises. In view of this, this paper is based on the current situation of overhaul fund allocation of 11 municipal power supply companies under the provincial-level power grid companies in China, and based on the relevant theory of Gini coefficient, starting from improving the level of investment efficiency and improving the reliability of equipment operation. The sub-quota degree has been optimized and designed to improve the reasonable level of the over-allocation of funds of Z-provincial power grid companies and improve the level of business operation efficiency.

1. Introduction
With the development of economy and society, the development of power grid enterprises faces a new form, and the investment management method faces new requirements. It is urgent to implement the grid investment strategy and improve the efficiency and efficiency level [1]. Equipment overhaul is one of the core businesses of power grid enterprises. The scientific and rational allocation of overhaul funds plays an important role in improving the lean management of power grid enterprises [2]. However, at present, China's provincial power grid companies have an imbalance in the allocation of equipment overhaul funds, which has an adverse impact on the operation and development of enterprises. Therefore, based on the current situation of the overhaul investment allocation of 11 municipal power supply companies under the Z Power Grid Company of China, combined with the relevant theory of Gini coefficient, this paper studies the improvement of investment efficiency level and the reliability of equipment operation. The technology has improved the reasonable level of investment in the overhaul of the Z provincial power grid company and improved the level of business operation efficiency.

2. The basic principle of Gini coefficient theory

2.1. Lorenz curve
The Lorenz curve is proposed to solve the problem of the distribution of national income. It first queues the population of a country according to the income from low to high. After considering the
percentage of income from any percentage of the population with the lowest income, the corresponding relationship between the cumulative percentage of the population and the cumulative percentage of income is plotted on the graph to form the Lorenz curve. The Lorenz curve can be used to compare and analyze the wealth inequality of a country in different eras or in different countries in the same era. It is widely used as a convenient graphical method to summarize the information of income and wealth distribution [3].

The figure below shows the manifestation of the Lorentz curve. In the figure, the horizontal axis OH represents the cumulative percentage of the population (grouped by income from low to high), the vertical axis OM represents the cumulative percentage of income, and the arc OL is the Lorenz curve. As shown below:

The degree of curvature of the Lorentz curve reveals important information. It reflects the degree of inequality in income distribution, the greater the degree of curvature indicates the more unequal income distribution. Usually a country’s income distribution does not reach complete fairness or unfairness, but is somewhere in between. The corresponding Lorentz curve is represented by an arc between the 45° line OC and the broken line OXC, such as the arc LC.

2.2. Gini coefficient
The Gini coefficient is a ratio indicator defined by the Lorenz curve, the absolute equality curve, and the absolute inequality curve to quantitatively analyze the inequality of income distribution [4]. The formula for calculating the Gini coefficient (G) is as follows:

\[ G = \frac{S_A}{S_A + S_B} \]

As shown in FIG. 1 above, SA represents the area enclosed between the absolute equality curve OC and the Lorenz curve LC, and SB represents the area enclosed between the Lorenz curve LC and the absolute inequality curve OXC. Among them, when SA=0, the Gini coefficient is zero, indicating that the income distribution is completely equal, that is, the person who occupies the first percentage of the population receives the same percentage of income; when SB=0, the Gini coefficient is 1, indicating that the income distribution is absolutely unequal. That is, a very small number of people account for the vast majority of income. The more the income distribution tends to be unequal, the greater the curvature of the Lorenz curve, the value range is 0 to 1, and 0.4 is usually used as the warning line for the income distribution gap.
3. Empirical analysis

In this study, combined with the main features and main objectives of the overhaul project, the unit's investment efficiency technology improvement level index (the unit investment increase in electricity and unit investment power supply reliability rate increase rate of 0.2 and 0.8 respectively), for the overhaul investment efficiency, technology upgrade. The situation is calculated comprehensively. As shown in the following table:

Table 1. Table of cumulative percentage of unit investment efficiency technical level improvement indicators.

| Serial number | Municipal unit | Cumulative percentage (increased level of unit investment power supply reliability rate) | Cumulative percentage (sold sales) | Unit investment efficiency technology improvement level | Overhaul investment | Cumulative percentage of overhaul investment |
|---------------|----------------|---------------------------------------------------------------------------------|-----------------------------------|-----------------------------------------------------|-------------------|-------------------------------------------|
| 1             | Z company      | 24.96%                                                                          | 14.04%                            | 22.78%                                               | 2.46%             | 2.46%                                     |
| 2             | Q company      | 33.94%                                                                          | 16.23%                            | 30.40%                                               | 3.30%             | 5.76%                                     |
| 3             | S company      | 37.41%                                                                          | 40.00%                            | 37.93%                                               | 7.40%             | 13.16%                                    |
| 4             | H company      | 52.18%                                                                          | 41.75%                            | 50.09%                                               | 7.60%             | 20.76%                                    |
| 5             | L company      | 60.04%                                                                          | 46.84%                            | 57.40%                                               | 7.85%             | 28.61%                                    |
| 6             | T company      | 73.61%                                                                          | 66.66%                            | 72.22%                                               | 8.81%             | 37.42%                                    |
| 7             | J company      | 78.72%                                                                          | 71.66%                            | 77.31%                                               | 10.85%            | 48.27%                                    |
| 8             | W company      | 87.24%                                                                          | 74.12%                            | 84.62%                                               | 10.89%            | 59.16%                                    |
| 9             | G company      | 94.35%                                                                          | 75.61%                            | 90.60%                                               | 11.42%            | 70.58%                                    |
| 10            | N company      | 97.59%                                                                          | 95.08%                            | 97.09%                                               | 13.34%            | 83.92%                                    |
| 11            | H company      | 100%                                                                            | 100%                              | 100.00%                                              | 16.09%            | 100.00%                                   |

The cumulative percentage of the investment improvement technology level of each city-level company based on the control index unit is the abscissa, and the cumulative percentage of the newly added investment in the initial 2017 after the adjustment of the power supply enterprises in each city is the Lorenz curve on the ordinate, and the power supply enterprises in each city according to the slope size. Incremental sorting on the Lorenz curve.

The Lorenz plot, based on the data shown in Table 3, is shown in Figure 2:
In order to ensure the fairness and rationality of the allocation of overhaul investment, from the perspective of asset size, municipal units with large asset scales should allocate more funds for overhaul; from the perspective of economic benefits of overhaul investment, municipal units with high unit investment and high power supply should allocate more overhaul funds; from the perspective of safe and reliable power grids, units with lower power supply reliability rates should allocate more funds for overhaul. Combining various influencing factors, combining the basic process of Gini coefficient optimization analysis, determining the optimal target and constraints for comprehensive optimization planning analysis, the optimized Gini coefficient is 0.3384.

Table 2. Table of cumulative percentage of technical level improvement indicators of unit investment benefit after optimization.

| Serial number | Municipal unit | Cumulative percentage (increased level of unit investment power supply reliability rate) | Cumulative percentage (sold sales) | Unit investment efficiency technology improvement level | Overhaul investment |
|---------------|----------------|---------------------------------------------------------------------------------|-----------------------------------|-------------------------------------------------------|---------------------|
| 1             | Z company      | 24.96%                                                                          | 14.04%                            | 22.78%                                                | 8.46%               |
| 2             | Q company      | 33.94%                                                                          | 16.23%                            | 30.40%                                                | 15.76%              |
| 3             | S company      | 37.41%                                                                          | 40.00%                            | 37.93%                                                | 21.16%              |
| 4             | H company      | 52.18%                                                                          | 41.75%                            | 50.09%                                                | 26.76%              |
| 5             | L company      | 60.04%                                                                          | 46.84%                            | 57.40%                                                | 38.61%              |
| 6             | T company      | 73.61%                                                                          | 66.66%                            | 72.22%                                                | 46.42%              |
| 7             | J company      | 78.72%                                                                          | 71.66%                            | 77.31%                                                | 52.27%              |
| 8             | W company      | 87.24%                                                                          | 74.12%                            | 84.62%                                                | 59.16%              |
| 9             | G company      | 94.35%                                                                          | 75.61%                            | 90.60%                                                | 67.58%              |
| 10            | N company      | 97.59%                                                                          | 95.08%                            | 97.09%                                                | 88.92%              |
| 11            | H company      | 100%                                                                            | 100%                              | 100.00%                                               | 100.00%             |

The Lorentz plot of the optimized control index plotted against the data shown in Table 2 is shown in Figure 3:

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Combined with the optimized Gini coefficient, it can be concluded that the optimization plan for the overhaul investment of each municipal unit in 2018 is as follows:

Table 3. Table of the 2018 overhaul investment allocation of each municipal unit after optimization.

| Serial number | Municipal unit | 2018 overhaul plan investment(100 million yuan) | Optimized investment in 2018 after overhaul(100 million yuan) |
|---------------|----------------|-----------------------------------------------|---------------------------------------------------------------|
| 1             | H company      | 12.34                                         | 6.49                                                          |
| 2             | N company      | 10.23                                         | 5.60                                                          |
4. Conclusion
In this paper, the Gini coefficient theory is used to optimize the overhaul funds of 11 municipal units in Z province of China, and the optimized investment allocation plan is obtained, which not only satisfies the demand for electricity (i.e., benefit) in economically developed regions, but also guarantees the completion of various regions. The possible balanced development (i.e., fairness) reflects the optimization concept of “optimizing investment, scientific investment, focusing on efficiency and sustainable development”.

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