Research on Comprehensive Evaluation Model of Investment Benefits of Transmission and Transformation Projects

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Abstract. With the rapid development of our country's economy, the demand for electric energy from the whole society is constantly increasing. As the infrastructure supporting power supply, the level of investment and construction efficiency is particularly important for supporting social and economic development and supporting the operation and development of power grid companies. Under these conditions, the comprehensive evaluation of the investment and construction benefits of power transmission and transformation projects is of great practical significance to enhance the management level of China's power transmission and transformation projects, improve the quality of project construction, and improve the level of utilization of project investment funds.

1. Introduction
With the rapid development of China's economy, the demand for electrical energy in the entire society has been increasing. As the infrastructure supporting the power supply, the level of investment and construction efficiency of grid engineering is particularly important to support social and economic development and the operation and development of grid companies. Especially with the continuous advancement of China's power system reform and the introduction of market competition mechanisms, the pressure on investment costs facing grid companies is increasing. In this context, research on comprehensive evaluation technology of investment benefits of power grid projects is of great significance for improving the level of investment benefits and construction levels of projects.

Based on the DEA theory, this paper constructs a comprehensive evaluation index system and evaluation model for investment benefits of power grid projects, and selects 2016-2017 Z province power grid investment projects for empirical analysis, so as to provide a reference for power grid companies to reasonably carry out grid project investment benefit evaluation work.

2. The basic principles of DEA theory
Data Envelopment Analysis, or DEA for short, is a new cross-cutting field in mathematics, operations research, mathematical economics, and management science. It was created by the famous American operations researcher A. Charnes and W.W. Cooper, etc., and named DEA.
Data envelopment analysis is a non-parametric statistical method based on the concept of relative efficiency, which is used to evaluate whether the same type of multi-input, multi-output decision unit is technically effective. The basic idea is to treat each evaluated unit as a decision unit, and then to form an evaluated group by a number of decision units. Through a comprehensive analysis of the input and output ratio, the weight of each input and output indicator of the decision unit is used as a variable. Perform evaluation operations to determine the effective production frontier, and determine whether each decision unit is effective according to the distance between each decision unit and the effective production frontier. At the same time, the reason and The direction and extent of improvement. Because the DEA method does not need to estimate parameters in advance, it has the advantage that cannot be underestimated in avoiding subjective factors, simplifying operations, and reducing errors. In recent years, this method has been widely used in various fields such as technological and productivity advancement, cost-benefit issues, resource allocation, financial investment, non-productivity, etc., to carry out effectiveness analysis to make evaluation decisions.

3. Construction of the evaluation index system for investment benefits of power grid projects

Through investigating the investment situation of regional power grid construction; at the same time, based on the research content of domestic and foreign literature and consulting the opinions of relevant experts, combined with the "universal applicability principle" and "easy accessibility principle", the final selection includes total assets and fixed assets amount, capacity-to-capacity ratio, GDP growth rate, line loss rate, and other comprehensive investment indicators that describe the state of investment. According to the economic efficiency of various types of investment as the target value, the direct increase of electricity per unit of assets to measure economic output as an output index. The details are shown in Table 1 below:

| Indicator category | Evaluation index |
|--------------------|------------------|
| Input indicators   | Total assets     |
|                    | Investment in fixed assets |
|                    | Capacity to load ratio |
|                    | Line loss rate    |
|                    | GDP growth rate   |
| Output indicators  | Unit investment increases power supply |

4. Empirical analysis

The analysis is based on the index data of 11 provinces and cities in Z province from 2016 to 2017, as shown in Table 2:
Table 2 Statistics of basic data of indicators.

| Years | DMU   | (I) Total assets (100 million yuan) | (I) Investment in fixed assets (10,000 yuan) | (I) Capacity to load ratio | (I) Line loss rate | (I) GDP growth rate (%) | (O) Unit investment increases power supply |
|-------|-------|-----------------------------------|---------------------------------------------|---------------------------|-------------------|-------------------------|------------------------------------------------|
| 2016  | Company H | 115.89                             | 187093.68                                   | 2.25                      | 3.23              | 10.47                   | 1.85                                                                 |
|       | Company J | 65.18                              | 103014.20                                   | 2.12                      | 3.57              | 7.83                    | 1.89                                                                 |
|       | Company N | 79.86                              | 136303.21                                   | 1.87                      | 3.44              | 7.62                    | 2.51                                                                 |
|       | Company Q | 26.72                              | 40819.43                                     | 2.31                      | 3.70              | 6.3                     | 0.45                                                                 |
|       | Company W | 75.52                              | 112327.75                                   | 2.22                      | 4.76              | 7.26                    | 1.23                                                                 |
| 2017  | Company K | 63.69                              | 89224.53                                     | 2.09                      | 2.78              | 6.89                    | 2.09                                                                 |
|       | Company M | 27.32                              | 44839.31                                     | 1.9                       | 3.70              | 7.98                    | 2.58                                                                 |
|       | Company L | 36.96                              | 78269.03                                     | 2.88                      | 5.56              | 7.49                    | 1.17                                                                 |
|       | Company S | 44.39                              | 69041.70                                     | 2.27                      | 2.78              | 7.07                    | 1.81                                                                 |
|       | Company T | 61.29                              | 95418.79                                     | 2.07                      | 5                 | 7.29                    | 2.51                                                                 |
|       | Company K | 10.32                              | 7935.56                                      | 3.24                      | 5                 | 6.32                    | 0.82                                                                 |
|       | Company H | 123.96                             | 200107.68                                    | 2.41                      | 3.03              | 11.2                    | 1.98                                                                 |
|       | Company J | 68.35                              | 108020.95                                    | 2.22                      | 3.45              | 8.21                    | 1.98                                                                 |
|       | Company N | 86.79                              | 148138.89                                    | 2.03                      | 3.13              | 8.28                    | 2.73                                                                 |
|       | Company Q | 28.44                              | 43444.97                                     | 2.46                      | 3.45              | 6.7                     | 0.48                                                                 |
|       | Company W | 78.03                              | 116059.04                                    | 2.29                      | 4.55              | 7.5                     | 1.27                                                                 |
| 2017  | Company K | 65.79                              | 92170.08                                     | 2.16                      | 2.7               | 7.12                    | 2.16                                                                 |
|       | Company M | 28.55                              | 46860.17                                     | 1.99                      | 3.57              | 8.34                    | 2.7                                                                  |
|       | Company L | 38.46                              | 81444.09                                     | 3                        | 5.26              | 7.79                    | 1.22                                                                 |
|       | Company S | 45.96                              | 71485.56                                     | 2.35                      | 2.70              | 7.32                    | 1.87                                                                 |
|       | Company T | 67.28                              | 104746.57                                    | 2.27                      | 4.55              | 8                       | 2.76                                                                 |
|       | Company K | 11.27                              | 8663.19                                      | 3.54                      | 4.55              | 6.9                     | 0.9                                                                  |

According to the principle of the model, the input and output numbers of the regions with a comprehensive efficiency of 1 are the most effective use, and the lower the comprehensive efficiency score is, the lower the relative efficiency is. At least one input has a target value that is not equal to the actual value. The difference between the actual value and the target value is the space that can be improved by the relatively inefficient unit resources, which can be used as a reference for the adjustment of fixed asset investment. The results of input-output analysis by region are as follows:

Table 3 DEA calculation of input and output efficiency of various companies.

| Years | DMU   | Comprehensive efficiency | Pure technical efficiency | Scale efficiency |
|-------|-------|--------------------------|---------------------------|------------------|
| 2016  | Company H | 0.768                   | 0.907                     | 0.847            | irs               |
|       | Company J | 0.738                   | 0.936                     | 0.789            | irs               |
|       | Company N | 1                       | 1                         | 1                | -                 |
|       | Company Q | 0.219                   | 1                         | 0.219            | irs               |
|       | Company W | 0.495                   | 0.946                     | 0.523            | irs               |
|       | Company K | 1                       | 1                         | 1                | -                 |
|       | Company M | 1                       | 1                         | 1                | -                 |
|       | Company L | 0.474                   | 0.877                     | 0.540            | irs               |
|       | Company S | 0.895                   | 1                         | 0.895            | irs               |
|       | Company T | 1                       | 1                         | 1                | -                 |
|       | Company K | 1                       | 1                         | 1                | -                 |
|       | average value | 0.781                  | 0.970                     | 0.801            | -                 |
|       | Company H | 0.749                   | 0.895                     | 0.837            | irs               |
|       | Company J | 0.731                   | 0.937                     | 0.780            | irs               |
|       | Company N | 1                       | 1                         | 1                | -                 |
| 2017  | Company Q | 0.220                   | 1                         | 0.220            | irs               |
|       | Company W | 0.491                   | 0.948                     | 0.518            | irs               |
|       | Company K | 0.967                   | 1                         | 0.967            | irs               |
|       | Company M | 1                       | 1                         | 1                | -                 |
The following evaluation conclusions can be drawn from Table 3 above:

(1) The comprehensive efficiency of N, M, T, and K companies in 2016 and 2017 is 1, which is at the forefront of efficiency, indicating the number of inputs and outputs of N, M, T, and K companies in 2016 and 2017. All of them make the most effective use, and the overall efficiency of H, J, Q, W, L, and S companies in 2016 and 2017 was not 1, indicating that there is room for improvement in their resource utilization and technology investment.

(2) In 2016, the comprehensive technical efficiency of Company J was 1, but due to the decline in scale efficiency in mid-2017, the comprehensive efficiency was not 1 and it was an increase in scale returns (irs), indicating that its scale needs to be increased, thereby increasing scale efficiency and upgrading. Comprehensive efficiency.

(3) In 2016 and 2017, the pure technology efficiency of Q and S companies was 1, the scale efficiency was not 1, and they were increasing returns to scale (irs), indicating that their scale needs to be increased to increase scale efficiency and overall efficiency.

(4) In 2016 and 2017, the pure technology efficiency of H, J, Q, W, L, and S companies is not 1, the scale efficiency is not 1, and they are increasing returns to scale (IRs), indicating the technology and scale of these regions. Mismatch, there may be redundancy in scale investment in these regions. After eliminating the redundant scale, pure technology efficiency will increase and comprehensive efficiency will also improve.

(5) The model calculates that there is a redundant input or insufficient output in the area where the comprehensive efficiency is not 1. Through calculation, it is found that the redundancies of the fixed asset investment of Company H in 2017 are the largest, reaching 53.2%, and the fixed asset investment of Company J in 2017 The amount of redundancy has reached 34.37%.

5. Conclusion
This paper first combines the characteristics of power grid project investment construction and DEA theory principles to construct a comprehensive evaluation index system and evaluation method for power grid project investment benefits. Then it conducts an empirical analysis with China’s Z province power grid project investment construction as the research object, and draws an analysis and evaluation problems in grid investment in Z province provides technical support for grid companies to carry out similar project investment benefit evaluations.

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