Construction of Overseas Asset Operation Indicator Model Adapting to the Monitoring System of Power Grid Enterprises

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Abstract. Currently, the world's unprecedented major changes are accelerating their evolution, and the uncertainty of overseas asset operations for power grid enterprises is increasing. The responsibility and difficulty for power grid enterprises to steadily improve their overseas asset management performance are significant, and there is an urgent need to study indicator management methods applicable to enterprise operation monitoring systems. This paper fully considers the current operation status and improvement needs of the power grid enterprise operation monitoring system, distinguishes between existing indicators and new indicators, and designs the construction process of the overseas asset operation indicator model for power grid enterprises. The process of constructing an index model mainly includes four steps: indicator screening, normalization processing, weight calculation, and index calculation. Empirical research shows that the index model provides a standard for evaluating the level of overseas asset operation of power grid enterprises, and can describe the situation of overseas asset operation from multiple dimensions. It has good applicability in the operation monitoring system of power grid enterprises.

Keywords: Power grid enterprise, overseas assets, monitoring system, operation index, model construction

1 Introduction

Under the unprecedented changes in international power, the geopolitical and economic landscape has undergone profound changes, leading to a significant increase in instability and uncertainty in the international operation of power grid enterprises[1]. The global industrial and supply chains are tense, the global market is sluggish, and the economy is severely declining. Many countries have adopted stricter foreign investment policies and industry development policies to boost their economy[2]. The external resistance to the internationalization of power grid enterprises has significantly increased. On the other hand, with the accelerated evolution of a new round of technological revolution, China has gradually emerged in fields such as the digital economy[3]. The empowering role of digital technology and data elements in the international operation of power grid enterprises is becoming increasingly prominent.

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The differences in asset operations among different regions of power grid enterprises are still prominent, and regulatory policies in the energy industry in various countries are becoming increasingly strict[4]. The difficulty of internal control over overseas asset operations has increased. To carry out overseas operation quality and efficiency improvement work at a deeper and higher level, it is necessary to continue to make efforts in the transformation from "stock tapping" to "mechanism incentive"[5], optimize project CAPEX and OPEX investment, and strengthen the degree of lean management of key operational indicators. At present, there is still room for optimization and improvement in key operational indicator tools in terms of hierarchical classification, analysis, maintenance and management[6].

This article will build an index model based on the overseas asset operation indicators of power grid enterprises, integrate various detailed indicators into a comprehensive index, and describe the overall situation of overseas asset operation and the situation of overseas assets in certain aspects such as operational efficiency, operational management, internal risk, etc. through the index.

2 Construction of overseas asset operation index model

2.1 Indicator screening

Focusing on the two main needs of benefit contribution and risk control, select three categories of indicators: operational efficiency, operational management, and internal risk.

The operational efficiency index selects indicators such as net operating income[7], net profit[8], owner's equity, annual return on investment, RAP deduction rate, CAPEX, OPEX, etc. The operation management index selects indicators such as average asset income, unit asset profit contribution rate, unit asset CAPEX, unit gross profit OPEX, unit asset OPEX, and EBITDA profit margin. The internal risk index selects indicators such as the amount of litigation involved[9].

2.2 Normalization processing

To comprehensively measure the level of overseas asset operation of power grid enterprises, the indicators are normalized year-on-year, and the values of all indicators X are converted into a dimensionless score S to describe the changes in indicators across periods. In the actual work of indicator management in power grid enterprises, it is necessary to maintain existing indicators and design new ones. This article will distinguish between stock indicators and newly added indicators. Considering that the overseas asset operation indicator system includes quantitative indicators, index indicators, and rating indicators, this article will design differentiation rules based on the characteristics of various indicators.

2.2.1 Inventory indicators

(1) Quantitative and exponential categories

Dimensional or non dimensional numerical indicators, such as total income, line loss rate, GDP, climate index, etc. The normalization of such data is based on the idea of setting the acquisition period as the base period and assigning a score of 100. Each period after the acquisition period is compared with the base period to determine the normalized score. The greater the positive deviation, the higher the score. The greater the reverse deviation, the lower the score.

Step 1: Solve the problem of different statistical frequencies for each indicator. Drawing on the idea of data rolling statistics, the calculation formula for quarterly or monthly indicators on an annual basis is as follows:

$$X_t = \begin{cases} \text{Annual value}, & \text{Statistical frequency is annual} \\ \text{Last 4 quarterly values}, & \text{Statistical frequency is quarterly} \\ \text{Last 12 monthly values}, & \text{Statistical frequency is monthly} \end{cases} \tag{1}$$

Step 2: Solve the problem of determining the reference standard values of indicators. The indicator value for determining the acquisition date is the reference standard Z, and the calculation formula is:

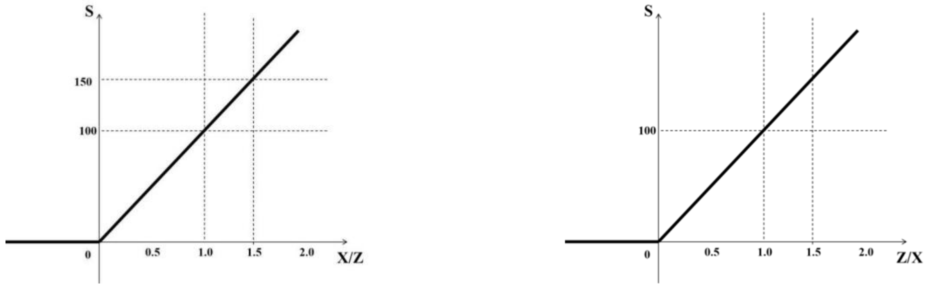
$$Z = X_0 \tag{2}$$

Where, X_0 is the indicator value during the acquisition period.

Step 3: Solve the calculation problem of normalizing indicator values.For positive indicators, divide the actual value of the indicator by the reference standard value. For reverse indicators, divide the reference standard value by the actual value of the indicator and convert it into a normalized score S. The calculation formula is:

$$S = \begin{cases} X_t/Z, & Z \text{ is the standard value}, X \text{ is a positive indicator} \\ Z/X_t, & Z \text{ is the standard value}, X \text{ is a reverse indicator} \end{cases} \tag{3}$$

The function diagram of normalized scores are shown in Figure 1.



(a) Positive indicator (b) Reverse indicator

Fig. 1. Normalized Score Function of Indicators

In addition, different overseas projects have different acquisition dates. If horizontal comparisons are needed, the historical indicator values of multiple projects in the same year need to be determined as standard reference values, and then the impact of benchmark differences on the time dimension needs to be divided.

(2) Rating category

Including sovereign rating, corporate rating, etc. The idea of normalizing such data is to convert the grade into scores within the [0, 100] range based on the grade evaluation criteria, and then convert the converted scores into year-on-year scores. The calculation formula for grade conversion is:

$$S=\begin{cases}\frac{\text{Number of levels below X}}{\text{Total number of levels}}\times 100, & \text{X is not adjusted with " $-$ "}\\ \frac{\text{Number of levels below X}-0.5}{\text{Total number of levels}}\times 100, & \text{X is adjusted with " $-$ "}\end{cases} \quad (4)$$

Where, "-" is used to indicate the evaluation between two adjacent rating levels. The method for converting rating indicators into year-on-year normalized scores is the same as for quantity indicators.

2.2.2 New indicators

The newly added indicators do not have historical values to construct reference standard values. To ensure the continuity of normalized scores in each period of the index model, the normalized score of the newly added indicators is equal to the comprehensive score of the index model. By adding normalized scores for new indicators, the year-on-year reference standard value Z^* is calculated, and the normalized score S will be calculated based on the calculated reference standard for future periods.

$$S_t = \text{comprehensive score of the index model} \quad (5)$$

$$Z^* = X_t/S_t \quad (6)$$

$$S_{t+1} = X_{t+1}/Z^* = X_{t+1} \times S_t/X_t \quad (7)$$

Where, S_t and S_{t+1} are the normalized scores for the current and future periods, X_t and X_{t+1} are the indicator values for the current and future periods, and Z^* is the theoretical reference standard value for calculation.

2.3 Weight calculation

Considering the differences in the amount of data resources accumulated during different periods of overseas project operation and operation supervision system construction. Here, the calculation of indicator weights can be divided into two situations: new projects and inventory projects. Considering the core goal of highlighting benefit contribution, net profit or income is used as the proxy variable for benefit contribution, and supervised machine learning algorithms are used to calculate weights. Using the XGBoost model, which has performed well in various data modeling competitions, as the basic model, the objective weights of the indicators are determined using the variable importance judgment method attached to the model.

(1) Inventory project situation

In the case of inventory projects, the amount of information provided by the data is relatively sufficient, and the sample size required for machine learning model modeling can be met. The XGBoost model can be directly used to model and determine weights. Therefore, based on the XGBoost model, the following weight iteration calculation process is designed:

Step 1: Using net profit as the dependent variable and other indicators as independent variables, construct the XGBoost model and calculate the relative number of frequency indicators for evaluating the importance of independent variables.

Step 2: Set the relative number of frequency indicators for the dependent variable net profit, which is equal to the maximum value of the relative number of frequency indicators in this round.

Step 3: Perform proportional processing on the relative number of frequency indicators for each indicator, so that the total weight sum is 1.

(2) New project situation

In the case of new projects, the amount of information provided by the data is very limited, and the sample size required for modeling the vast majority of machine learning models cannot be met. Therefore, based on the XGBoost model, the following weight iteration calculation process is designed:

Step 1: Using net profit as the dependent variable and other indicators as independent variables, construct an XGBoost model to calculate the relative number of frequency indicators for evaluating the importance of independent variables. Take the first n ($n \leq 3$) variables with the highest frequency values and retain the relative number of frequency indicators.

Step 2: Using net profit as the dependent variable, delete the n independent variables selected in the previous round, construct the XGBoost model, and calculate the relative number of frequency indicators to evaluate the importance of the independent variables. Take the first n^* ($n^* \leq 3$) variable with the highest frequency value, and retain the relative number of frequency indicators.

Step 3: Repeat the above modeling process until all indicators participate in the modeling and obtain the relative number of frequency indicators.

Step 4: Set the relative number of frequency indicators for the dependent variable net profit, which is equal to the maximum value of the relative number of frequency indicators in the first round.

Step 5: Set the total weight to decay at a rate of 1/2 for each round, and the initial indicator weight is:

$$W_0 = F \times (1/2)^{p-1} \tag{8}$$

Where, W_0 is the initial weight, F is the relative number of frequency indicators, and p is the order of rounds in which the independent variable participates in modeling.

Step 6: Perform proportional processing on the initial indicator weights to sum the total weights to 1.

2.4 Index Calculation

The operational index of an overseas project that includes p operational evaluation indicators is:

$$I_j = \sum_{i=1}^{p} (S_i \times W_i) \tag{9}$$

Where, I_j is the operational index of the project j, S_i is the normalized score of the indicator i, and W_i is the indicator weight.

Furthermore, based on the different contributions of n projects to the benefits of power grid enterprises, the weight of the overseas project operation index is set, and the overseas asset operation index of power grid enterprises is obtained as follows:

$$I = \sum_{i=1}^{n} (I_j \times \frac{R_j}{R}) \tag{10}$$

Where, I is the overseas asset operation index of power grid enterprises, I_j is the operational index of the project j, R_i is the net profit of the project j, and R is the total net profit of all projects.

The minimum value of the overseas production and operation index of power grid enterprises is 0, and there is no limit to the maximum value. The higher the score, the better the operation effect. If the index value is greater than 100, it indicates that the asset operation of the current power grid enterprise is better than the base period level. The higher the score, the better the overall operation situation.

3 Empirical research

Taking the C project of a certain power grid enterprise as an example, based on data from 2018 to 2021, calculate the overseas asset operation index of the project in 2021. Normalize the indicators and select 2020 as the benchmark year to obtain the year-on-year normalized scores of each indicator in Project C in 2021. Using net profit as the dependent variable and each indicator as the independent variable, establish an XGBoost model to calculate the weights of each indicator in Project C. The results are shown in Table 1.

Table 1. Normalization and Weight Calculation Results of Various Indicators for Project C

Type	Indicators	Normalized score	Weight	Subindex	Total index
Operational benefits	Net operating income	127.77	0.34	126.44	111.56
	Net profit	130.94	0.34		
	Owners' equity	118.09	0.17		
	Annual return on investment	130.94	0.09		
	RAP deduction rate	85.86	0.01		
	CAPEX	132.53	0.03		
	OPEX	90.14	0.02		
Operation management	Average asset income	91.84	0.26	101.28	
	Contribution rate of unit asset profit	97.30	0.12		
	Unit Asset CAPEX	98.48	0.29		
	Unit gross profit OPEX	115.06	0.19		
	EBITDA profit margin	109.31	0.14		
Internal risk	Amount involved in litigation	90.90	1.00	90.90	

The operating index of Project C is 111.56, which is higher than the standard line (100 points), indicating that the overall operation of the project is better than the 2020 level. Specifically, the operational efficiency index is 126.44, which is better than the level in 2020, indicating that the project's revenue situation was good that year. The operation management index is 101.28, slightly higher than the level in 2020, indicating an improvement in the project management level. The internal risk index is 90.90, which is lower than the level in 2020, indicating that the project has a significant potential internal risk. Similarly, the overall operational index is most driven by the improvement of operational efficiency, less driven by the improvement of operational management level, and influenced by internal potential risk factors.

4 Conclusion

This article focuses on the benefits contribution and risk control of overseas asset operations of power grid enterprises, selecting three categories of indicators: operational efficiency, operational management, and internal risk. Distinguishing between inventory indicators and newly added indicators, we have designed normalization and weight calculation methods for each indicator. Empirical research based on the C project of a certain power grid enterprise shows that the index model provides a standard for evaluating the level of overseas asset operation of power grid enterprises, and can describe the situation of overseas asset operation from multiple dimensions, with good applicability.

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