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Research on Investment Strategy and Evaluation Mechanism of Power Enterprises Considering Local Development Characteristics

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ABSTRACT

The investment in developing industries with local characteristics is an essential link in the industrial investment chain of power enterprises. Reasonably selecting industries worthy of investment will significantly improve the income of power enterprises. Firstly, this paper constructs an investment project benefit evaluation system including economic benefit indicators and social environment indicators. Secondly, the combination of the analytic hierarchy process and grey correlation method is used to determine the index weight, and the comprehensive evaluation method is used to calculate the score of each index. Finally, the corresponding investment proportion allocation model is established to calculate the relevant industries worthy of investment.

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1. Introduction

With the development of power energy worldwide, power enterprises pay more and more attention to the investment benefits of their projects. The investment in characteristic local industries is an indispensable part of the project construction investment of power enterprises, and its construction investment has a great impact on the development of power enterprises. The investment planning and actual investment objectives of power enterprises are not only limited by their own investment capacity but also closely related to the investment amount of each place and the investment significance of characteristic industries in the region. Therefore, how to reasonably allocate the investment proportion of power enterprises, establish a sound investment evaluation benefit mechanism, and realize the investment with maximum economic benefits and optimal social and environmental benefits is the primary task for power enterprises.

At present, the research on the allocation and evaluation of investment and construction projects of power enterprises has achieved some results. The main evaluation methods include subjective evaluation methods such as the analytic hierarchy process and Delphi method and objective evaluation methods such as grey correlation method and coefficient of variation method. Researchers have also conducted extensive research on different project investment allocation methods. Literature [1] starts from the current distribution network investment distribution and constructs a comprehensive evaluation index system of distribution network development level according to economic and social conditions, distribution network development status, distribution network investment structure and the operation status of urban power enterprises. Through the distribution of power grid investment proportion and empirical analysis, the rationality of the model is verified. However, the literature lacks the rationality analysis of the industry's investment itself, and the data calculation and selection of the investment allocation model lacks typical characteristics. Literature [2] proposes a decision-making optimization method for grid infrastructure investment allocation based on entropy weight method, which can realize the fairness evaluation and optimization of investment allocation index and further improve the rationality and scientificity of power supply enterprises' grid investment allocation index. However, this method only includes the mode of objective empowerment, lacks the help of subjective empowerment, and is not easy to distinguish various situations. Literature [3] established the evaluation system of network investment benefit, which can be used as the basis for quantitative evaluation of network companies; At the same time, the proposed distribution network investment allocation strategy can avoid the blindness of investment and invest in effective places, so as to improve the efficiency of the distribution network in the whole province. However, the perspective considered in this literature is too single. It only analyzes the impact of power and can not judge the investment decision comprehensively. Reference [4] proposed an accurate investment project selection model considering risk measurement and designed a two-tier index system for investment benefit evaluation of distribution network projects. However, it lacks the analysis of profit growth after investment, so it is impossible to accurately judge which projects are more worthy of investment.

The current research generally adopts a single weighting model, such as a separate analytic hierarchy process, which lacks an objective evaluation basis and may produce deviation under certain circumstances, or a separate entropy weight method, which can not reflect the importance of decision-makers to different indicators, or even contrary to the actual situation. Therefore, we need a combination of subjective and objective methods to make up for the shortcomings brought by single empowerment.

According to the above literature analysis, there are few studies on investment distribution for characteristic local industries, and the investment distribution mode is single, one-sided, and the practicability can not be guaranteed without considering the current situation of local industrial development and the actual situation of investment scale. Taking the investment situation of a local characteristic industry as the main body, this paper comprehensively analyzes the investment scale of some characteristic industries in recent years and puts forward a set of subjective and objective evaluation index systems to achieve the goal of maximizing the economic benefits of power enterprises based on the optimal social and environmental benefits, so as to establish the investment distribution proportion model; Based on the comparison between the annual investment trend of power enterprises and the development of various industries in the region, a corresponding project investment

proportion distribution model is proposed to realize the accurate investment of power enterprises in the characteristic industries of a region.

The rest of this paper is as follows: Section 2 is the project benefit evaluation index system, section 3 is the construction of the project benefit evaluation system, section 4 is the construction and example verification of the investment proportion allocation model, and section 5 is the conclusion of this paper.

2. Construction of the Benefit Evaluation Index System of Local Characteristic Industrial Investment Projects

The scientific and reasonable index system is the basis of investment benefit evaluation of characteristic local industries. In this paper, establishing the project investment benefit evaluation system is based on the investment level of power enterprises and the output value of characteristic local industries to objectively evaluate the investment income and investment trend.

In this paper, the economic benefit evaluation and social and environmental benefit evaluation index are established to maximize the investment income.

2.1. Economic Benefit Index

The evaluation index system is established with reference to the analytic hierarchy process. The economic benefit evaluation indicators are shown in Table 1.

Table 1: Economic Benefit Evaluation Index of the Project.

Target Layer	Criterion Layer	Index Layer
Economic benefit index A1 of the enterprise investment project	Financial benefit index B1	Financial internal rate of return C1
		Financial investment payback period C2
		Financial net present value C3
		The financial return on investment C4
		Financial benefit-cost ratio C5
	National economic benefit index B2	Economic internal rate of return C6
		Economic net present value C7
		Economic benefit-cost ratio C8

The rate of return on investment refers to the ratio of the average annual total pre-tax profit (EBIT) to the total investment (TI) in the year of normal production after the project operation reaches the design capacity. The calculation formula of the rate of return on investment is as follows:

$$ROI = \frac{EBIT}{TI} * 100\% \quad (1)$$

Where: EBIT-average annual EBIT of the project in the year of production

TI-total project investment

2.2. Social and Environmental Benefit Indicators

Per capita net income is generally regarded as the ratio of net income to a population in a certain period in a region; The total employment effect is the sum of direct and indirect employment effects. Total employment effect is the ratio of the total effect of direct employment and indirect employment brought to the society after the

project's construction to the total investment of the sum of direct investment and indirect investment in related projects.

Table 2: Social and Environmental Benefit Indicators of the Project.

Target Layer	Criterion Layer	Index Layer
Social and environmental benefits index A2	Social contribution index B3	Increase in per capita net income C9
		Improvement of labor productivity C10
		Adjustment of industrial structure C11
		Employment effect C12
	Environmental impact index B4	Total pollutant discharge C13
		Pollution control degree C14
		Environmental protection effect C15
		Environmental quality C16

Sum of pollution emissions in each year during the project's life cycle: total emission of the project = annual planned output × Project life cycle × Pollution per unit output.

The rest of this paper is as follows: Section 3 is the construction of the project benefit evaluation system, section 4 is the construction and example verification of the investment proportion allocation model, and section 5 is the conclusion of this paper.

3. Investment Benefit Evaluation System of Local Characteristic Industrial Projects

3.1. Determination of Subjective Index Weight by Analytic Hierarchy Process

Analytic hierarchy process [5] refers to taking a complex multi-objective decision-making problem as a system and decomposing the objectives into multiple objectives or criteria. It is then decomposed into several levels of multiple indicators (or criteria and constraints), and the single hierarchical ranking (weight) and total ranking are calculated by the fuzzy quantitative method of qualitative indicators (multi-index) and multi-scheme optimization decision-making system method. The analytic hierarchy process decomposes the decision-making problem into different hierarchical structures according to the order of the general objective, sub-objectives of each layer, evaluation criteria, and specific standby investment schemes. The analytic hierarchy process (AHP) is to decompose the decision-making problem into different hierarchies according to the order of the general objective, sub-objective of each level, evaluation criterion, and even specific backup project, and then obtain the priority weight of each element in each level to an element in the next level by solving the characteristic vector of a judgment matrix. Finally, the method of the re-weighted sum is used to recursively merge the final weight of each alternative scheme to the total goal, and the one with the highest final weight is the optimal scheme. It is more suitable for decision-making problems with hierarchical and staggered evaluation indexes, and the target value is difficult to describe quantitatively.

Its basic principle: the analytic hierarchy process decomposes the problem into different constituent factors according to the nature of the problem and the overall goal to be achieved, and aggregates and combines the factors according to different levels according to the correlation, influence, and subordinate relationship between the factors to form a multi-level analysis structure model. Thus, the problem is finally attributed to determining the relatively important weight of the lowest level (schemes and measures for decision-making) relative to the highest level (overall goal) or the arrangement of the relative advantages and disadvantages.

Basic steps: (1) Establish hierarchical structure model;(2) Construct judgment matrix; (3) Hierarchical single

ranking; (4) Consistency test of judgment matrix; (5) Hierarchical total ranking.

3.2. Determination of Objective Index Weight by Grey Correlation Degree Method

The theory and method of grey correlation degree [6] the measure of the correlation of the factors between two systems that change with time or different objects is called correlation degree. In the process of system development, if the changing trend of the two factors is consistent, that is, the degree of synchronous change is high, it can be said that the degree of correlation between the two is high; On the contrary, it is lower. Therefore, the grey correlation analysis method is a method to measure the correlation degree between factors according to the similarity or difference of development trend between factors, that is, "grey correlation degree." The grey system theory puts forward the concept of grey correlation analysis of each subsystem, which intends to seek the numerical relationship between each subsystem (or factor) in the system through certain methods. Therefore, grey correlation analysis provides a quantitative measure for the development and change trend of a system, which is very suitable for dynamic process analysis.

The specific calculation steps of grey system correlation analysis are as follows: (1) Determine the reference sequence reflecting the characteristics of system behavior and the comparison sequence affecting system behavior; (2) Dimensionless process the reference sequence and comparison sequence; (3) Calculate the grey correlation coefficient of the reference sequence and comparison sequence; (4) Calculate the correlation degree; (5) Arrange the correlation order.

3.3. Determination of Evaluation System by Comprehensive Evaluation Method

Using the linear weighted average method to calculate the combination weight between the index weight obtained by the analytic hierarchy process and the index weight obtained by the grey correlation degree method, the combination weight vector $W = (w_1, w_2, \dots, w_M)$ of each layer of the evaluation model, and the w_i expression is:

$$w_i = \alpha w_{1i} + (1 - \alpha) w_{2i} \quad (2)$$

Where: w_{1i} is the index weight obtained by analytic hierarchy process; w_{2i} the index weight obtained by grey correlation method; α is the combination weight distribution coefficient, $0 \leq \alpha \leq 1$, comprehensive evaluation of local industrial investment, selection $\alpha = 0.5$.

The comprehensive evaluation method [7] gathers various indicators to obtain a comprehensive balance. The formula is as follows:

$$D = \sum_{i=1}^n w_i d_i \quad \sum_{i=1}^n w_i = 1, 0 \leq w_i \leq 1 \quad (3)$$

Where: D is the comprehensive score value of the system, and d_i is the evaluation index value.

3.4. Weight Calculation of Influencing Factors of Investment in typical characteristic Industries

Select the influencing factors of three typical characteristic industries for weight calculation, and the results are shown in Figure (1).

The comprehensive evaluation values of historical indicators of various characteristic industries are shown in Table 3.

The rest of this paper is as follows: Section 4 is the construction and example verification of the investment proportion allocation model, and section 5 is the conclusion of this paper.

The main processes of sections 2 and 3 are shown in Figure (2).

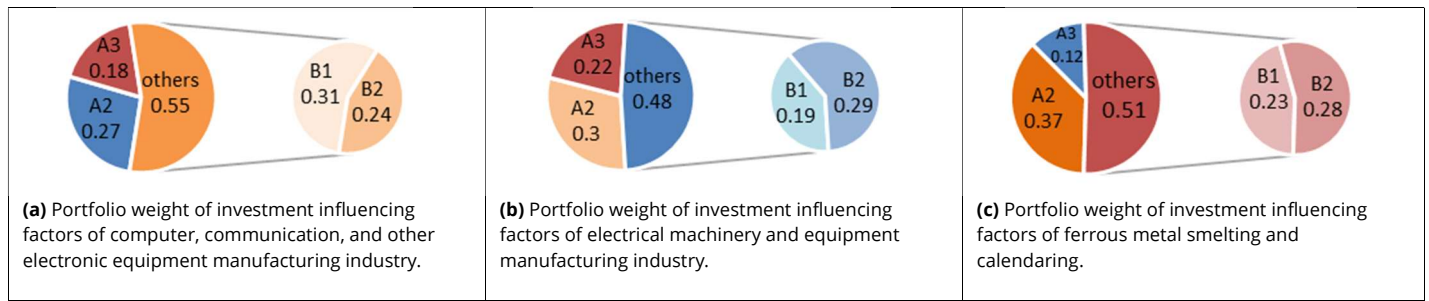


Figure 1: Combination weight of influencing factors of investment in each industry.

Table 3: Comprehensive Evaluation Value of Various Industrial Indicators.

Industry	Total Score	Primary Index	Score	Secondary Index	Score
Computer, communication, and other electronic equipment manufacturing	87	A1	90	B1	90
		A2	82	B2	94
		A3	85	B3	93
				B4	89
Electrical machinery and equipment manufacturing	84	A1	86	B1	89
		A2	92	B2	90
		A3	81	B3	84
Ferrous metal smelting and calendaring	81	A1	85	B4	85
		A2	84	B1	88
		A3	78	B2	92
				B3	87
				B4	79

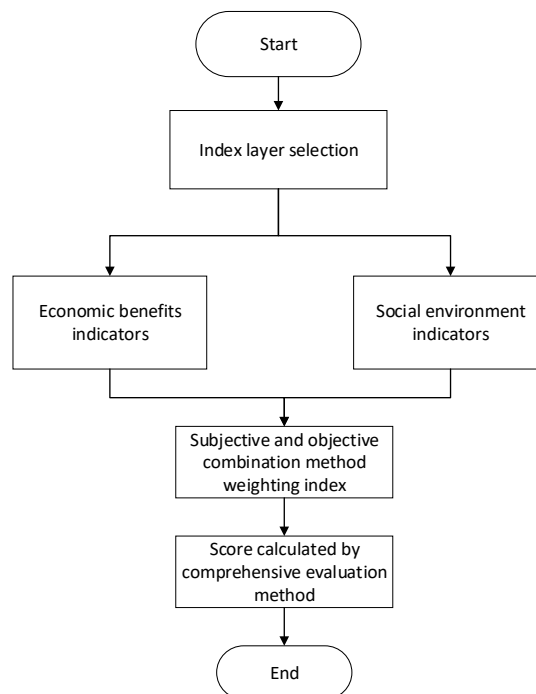


Figure 2: Section 2 and 3 flow chart.

Firstly, according to the current research direction, this paper finds out several key measurement indicators (economic benefits and social environment), calculates the weight of each indicator through analytic hierarchy process and grey correlation method, and finally calculates the index score of the industry through comprehensive evaluation method to facilitate investment analysis of the industry.

The rest of this paper is as follows: Section 4 is the construction and example verification of the investment proportion allocation model, and section 5 is the conclusion of this paper.

4. Investment Allocation Model of Power Enterprises

4.1. Relationship between Comprehensive Evaluation and Investment Scale

By calculating the comprehensive evaluation value of power enterprises, the development of investment projects can be obtained. Combined with the actual total investment data of power enterprises in a particular area, the relationship between the comprehensive evaluation value and the existing total investment can be observed, and the shortcomings of the existing distribution methods can be corrected. Assuming that the comprehensive evaluation value is x and the investment scale of characteristic industries is I , the comprehensive evaluation value of characteristic industry investment from 2020 is calculated by using the above method, and the relationship between the value and the total investment is shown in Figure (3).

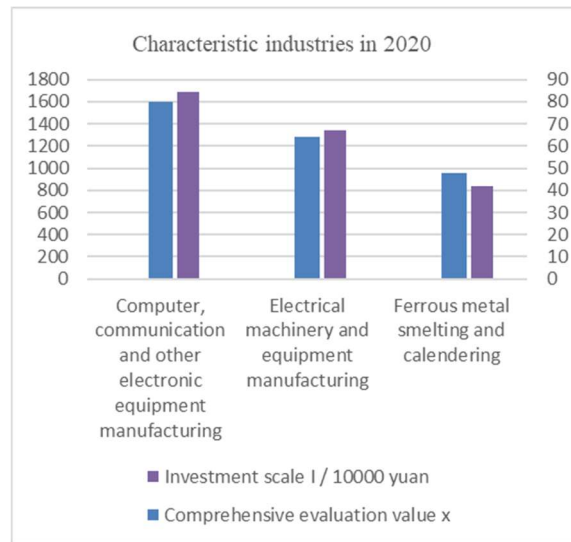


Figure 3: Investment scale and the evaluation value of characteristic industries in 2020.

Using the previous traditional way of investment, there is an approximately linear relationship between the total investment and the comprehensive evaluation value, but the total investment in characteristic industries in individual years still deviates from the law. The correlation coefficient can determine the correlation between the comprehensive evaluation value and the total investment, and the calculation formula is shown in formula (4). The closer the value of $|R|$ is to 1, the better the linear relationship between comprehensive investment evaluation and total investment. The closer the value of $|R|$ is to 0, the worse the linear relationship is. At the degree of freedom $n-2$ (n is the number of samples) and significance level α (general $\alpha= 0.05$), if r is greater than the critical value $r\alpha(n-2)$, then the linear relationship between variables X and Y is established; Otherwise, there is no linear

relationship between the two variables, where $r\alpha(n-2)=\sqrt{\frac{F_{\alpha}(1,n-2)}{F_{\alpha}(1,n-2)+n-2}}$.

$$r = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2 (y_i - \bar{y})^2}} \tag{4}$$

$$r_{\alpha}(n-2) = \sqrt{\frac{F_{\alpha}(1, n-2)}{F_{\alpha}(1, n-2) + n-2}} \tag{5}$$

Where: x_i is the comprehensive evaluation value of the i th investment project; y_i is the total investment of the i th investment project; 25 investment projects in characteristic industries are selected as the research object, i.e. $n = 25, i = 1, 2, \dots, 25$. The calculated result $|r| = 0.978$, greater than the critical value $r_{\alpha}(n-2) = 0.3248$, which is very close to 1. It can be judged that there is a high linear correlation between the comprehensive evaluation value and the total investment scale.

4.2. Establishment of Investment Allocation Model [8]

This model not only considers the previous operation status of various industrial projects but also considers future development. In the modeling process, the project investment prediction coefficient of power enterprises is introduced. Finally, the regression analysis is used to formulate the model of the investment scale of various industrial projects. So as to strengthen the comprehensive management of enterprises, optimize the investment planning of power enterprises, and improve the profitability and economic benefits of enterprises. This model uses the regression analysis method to analyze the mechanism of the comprehensive evaluation value of the investment index system of power enterprises in a region and constructs the investment scale model. When the comprehensive evaluation value x and investment scale y are random variables, if x is taken as the independent variable, the regression model is

$$Y = a + bX + \varepsilon, \varepsilon \sim N(0, \sigma^2) \tag{6}$$

The regression equation of y versus x can be obtained from the scatter points $(x_1, y_1), (x_2, y_2), \dots, (x_n, y_n)$. Where a is the regression constant, b is the regression coefficient, ε is the random variable of the error term, which is not affected by x and y . Through the above analysis, let $y_c = ax + b$, y_c represents the estimated value of y , and x and y represent variables. The key problem to be solved is to determine the coefficients a and b , which generally adopts the least square method:

$$Q = \sum_{i=1}^n (y_i - y_{ic})^2 = \sum_{i=1}^n (y_i - a - bx_i)^2 = \text{minimum} \tag{7}$$

According to the knowledge of calculus, to minimize the value of Q , the necessary condition is that the first partial derivative of Q to a and b is equal to 0, that is

$$\begin{cases} \frac{\partial Q}{\partial a} = -2 \sum_{i=1}^n (y_i - a - bx_i) = 0 \\ \frac{\partial Q}{\partial b} = -2 \sum_{i=1}^n (y_i - a - bx_i)x_i = 0 \end{cases} \tag{8}$$

The algebraic expressions of coefficients a and b are obtained:

$$\begin{cases} b = \frac{\sum_{i=1}^n x_i y_i - \bar{x} \sum_{i=1}^n y_i}{\sum_{i=1}^n x_i^2 - \bar{x} \sum_{i=1}^n x_i} \\ a = \bar{y} - b\bar{x} \end{cases} \tag{9}$$

Where: x_i and y_i are the observed values of independent variable comprehensive evaluation value x and dependent variable investment scale y , respectively. The average value of x and y is as follows:

$$\bar{x} = \frac{\sum_{i=1}^n x_i}{n}, \bar{y} = \frac{\sum_{i=1}^n y_i}{n} \tag{10}$$

Substitute the data of the investment scale index system of power enterprises in a certain region into the expression to obtain the coefficient value of the regression model:

$$\bar{x} = 67.52, \bar{y} = 6123.85, a = 437.97, b = 84.21 \tag{11}$$

The initial investment scale model is

$$Y' = 437.97 + 84.21X \tag{12}$$

Since the development progress of each unit is different, the constraints are applied to the formula to obtain the final calculation results. The change of constraints is based on the initial investment scale. The following is the investment scale model of power enterprises:

$$Y = (1 \pm \varepsilon)Y' = k(1 \pm \varepsilon)(437.97 + 84.21X) \tag{13}$$

4.3. Investment Model Calculation Based on Local Development Characteristics

According to the advantages of industries in the region, the potential of future development of power enterprises is judged, and the investment prediction coefficient K of each industry is determined through the investigation of investment projects of power enterprises. The constraint coefficient is determined according to the development of characteristic industries in the region and the actual data ε . The change of constraint condition coefficient is obtained through investigation. The above data are shown in Table 4.

Table 4: Investment Prediction Coefficient and Constraints.

Characteristic Industry	Investment Prediction Coefficient K	Constraint Condition	ε Value
Computer, communication, and other electronic equipment manufacturing	1.102	Investment income ratio > average level of investment projects of power enterprises	+2%
Electrical machinery and equipment manufacturing	1.463	The net cash flow of the electrical machinery and equipment manufacturing industry is higher than the average level of investment projects of power enterprises	+1%
Ferrous metal smelting and calendering	0.891	Net cash flow < average level of investment projects of power enterprises	-1%

By substituting the values into the above investment allocation model, the investment scale of each characteristic industry in 2021 and the comparison with the historical actual investment scale are shown in Figure (4).

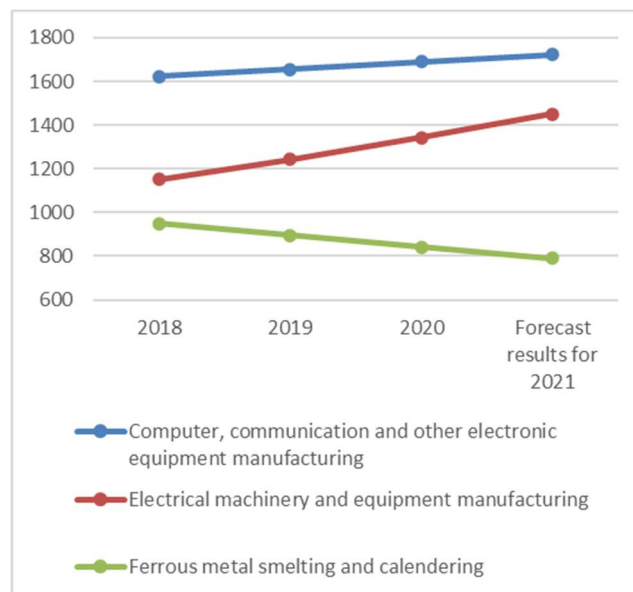


Figure 4: Investment scale of each industry (unit: 10000 yuan).

4.4. Investment Strategy Evaluation Results

According to the calculation results of the investment scale model proposed in the previous section, the weight of each index is calculated by the analytic hierarchy process and grey correlation method, and the obtained index weight is calculated by the linear weighted average method [9]. Finally, the weight of the investment strategy evaluation index is calculated, as shown in Figure (5).

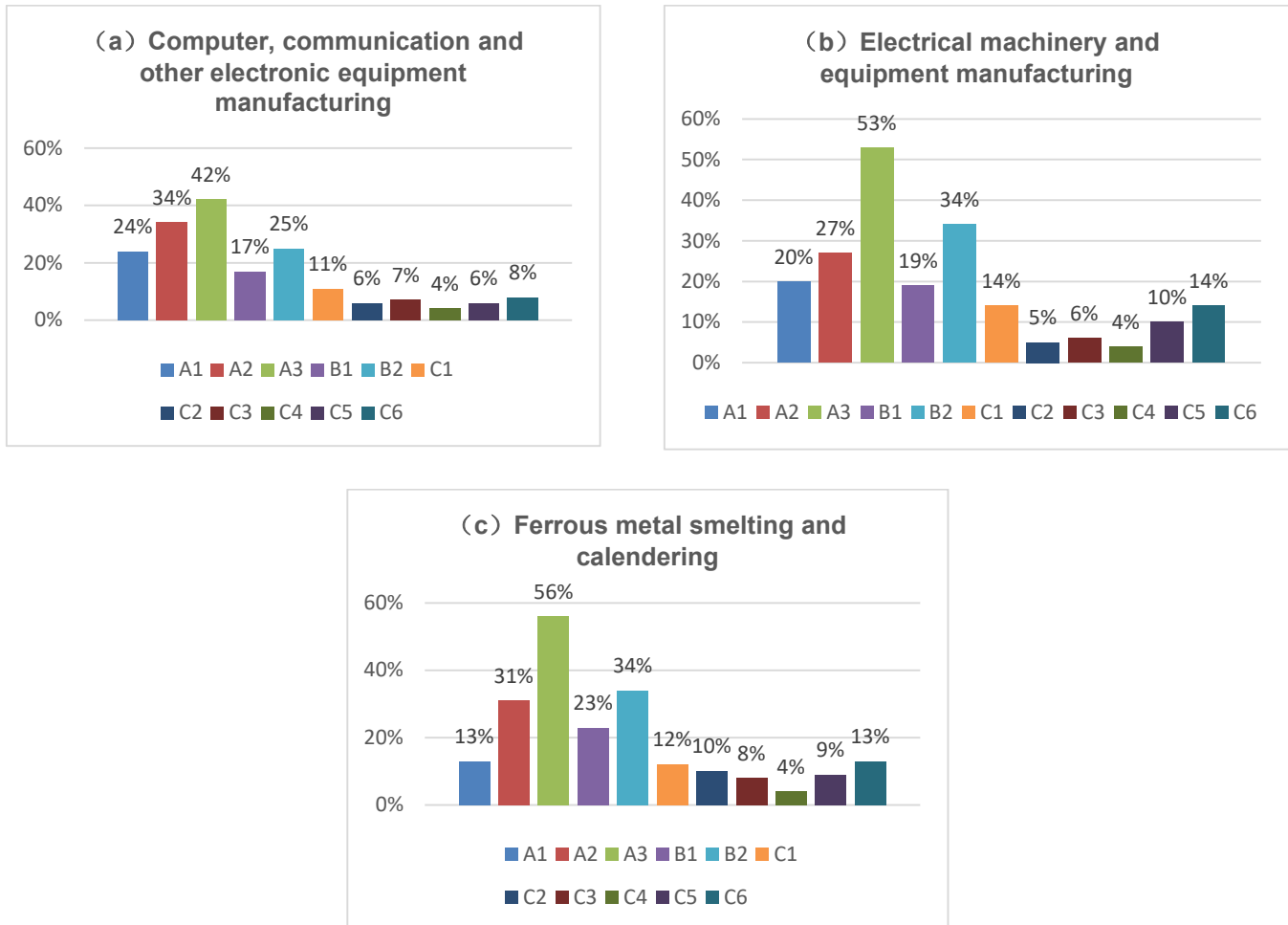


Figure 5: Evaluation index weight of investment strategy of each characteristic industry.

The comprehensive evaluation method summarizes all indicators to obtain the comprehensive score, and calculates the comprehensive score of the investment scale model of each characteristic industry, as shown in Table 5.

Compared with the comprehensive score of the investment scale of each characteristic industry calculated from the historical investment data, it can be seen that the investment scale model proposed by the project has improved the investment score of each industry, which proves that the model proposed by the project is feasible.

4.5. Comparison of Investment Models

(1) Index value. The calculation results of the model represent the investment distribution proportion of the distribution network in the next year. Therefore, the improvement effect of the distribution network is determined by the evaluation index of the project group selected in the next year. The scale, operation status, and profitability of the distribution network are mainly affected by the current value of the current year.

Table 5: Comprehensive Score of Investment Scale Model of Each Characteristic Industry.

Characteristic Industry	Computer, Communication, and other Electronic Equipment Manufacturing					
Total score	90					
Itemized score	A1	A2	A3			
	89	78	91			
			B1		B2	
			86		93	
			C1	C2	C3	C4
84	89	95	90	87	88	
Characteristic Industry	Characteristic Industries Electrical Machinery and Equipment Manufacturing					
Total score	86					
Itemized score	A1	A2	A3			
	89	78	91			
			B1		B2	
			86		93	
			C1	C2	C3	C4
84	89	95	90	87	88	
Characteristic Industry	Ferrous Metal Smelting and Calendering					
Total score	85					
Itemized score	A1	A2	A3			
	89	78	91			
			B1		B2	
			86		93	
			C1	C2	C3	C4
84	89	95	90	87	88	

(2) Index evaluation criteria. The evaluation standard adopts the percentage system, which is sorted according to the index value of each company in all index values, which makes it comparable between different power grid companies to determine the evaluation standard [10]. It is set that the index value x^k and the Evaluation Index Y^k are linear, and the evaluation indexes of all companies range from 0 to 100. The evaluation standard function is as follows:

$$y^k = \frac{x^k - \min(x^k)}{\max(x^k) - \min(x^k)} \times 100 \tag{14}$$

(3) Calculation of investment distribution proportion. Based on the comprehensive index value, index weight, and evaluation criteria, the investment distribution decision value s can be calculated, and the investment distribution proportion can be calculated δ . The calculation formula is as follows.

$$\delta_1 : \delta_2 : \dots : \delta_l = S_1 : S_2 : \dots : S_l \tag{15}$$

Where: l refers to the number of all Prefecture and municipal power grid companies.

The distribution network investment allocation model focuses on investment demand and investment capacity and comprehensively considers many factors. All indicators are combined to reflect the characteristics of power grid companies. However, it has great subjective influence and is easy to produce great errors.

Table 6: Actual investment and error.

Name of County-Level Power Grid Enterprise	Actual Investment /10000 Yuan	Actual Proportion /%	Calculated Proportion /%	Error /%
A	15971	34.5	23.2	11.2
B	5902	12.7	13.4	-0.8
C	7042	15.2	24.6	-9.6
D	6185	13.3	26.9	-13.7
E	7779	16.8	11.9	4.8

It can be seen that the accuracy of the single index evaluation method still needs to be improved.

Table 7: The investment error of the model is calculated in this paper.

Name of County-Level Power Grid Enterprise	Actual Investment /10000 Yuan	Actual Proportion /%	Calculated Proportion /%	Error /%
A	15971	34.5	29.3	5.2
B	5902	12.7	13.1	-0.4
C	7042	15.2	18.6	-3.4
D	6185	13.3	19.3	-6.0
E	7779	16.8	14.2	2.6

It can be seen that the current index evaluation methods still need to improve the accuracy, and the method in this paper can just make up for this.

The rest of this paper is as follows: Section 5 is the conclusion of this paper.

5. Conclusion

This paper mainly studies the influencing factors and their scoring values of power enterprise investment and weighs them by the analytic hierarchy process and grey correlation method. It then obtains the comprehensive scoring values of each factor by the comprehensive evaluation method. The investment strategy and rating mechanism of power enterprises are established. Considering the past operation status and future development of various industrial projects, the project investment prediction coefficient of power enterprises is introduced in the modeling process. Combined with the incentive theory, the basic investment demand of loss-making projects is given priority, and the investment scale is appropriately controlled according to the change of constraint indicators. Finally, regression analysis is used to formulate the investment scale model of each industrial project. The comprehensive economic benefit analysis points of investment planning are identified, and the economic evaluation factors of investment income are selected to evaluate the investment distribution model established by the project, which proves the model's effectiveness.

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