

Article

# Enhancing clean energy financial policies: Financing efficiency of new energy industry based on DEA-BCC-Malmquist-Tobit Model

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**Abstract:** The “double carbon” objective presents opportunities for new energy enterprises, though financing efficiency remains a significant challenge. This paper assesses the financing efficiency of 153 new energy enterprises from 2017 to 2021 using DEA-BCC (Differential Evolution Algorithm-Bias Corrected and Accelerated) and DEA-Malmquist models, providing both static and dynamic perspectives. The Tobit model is employed to analyze the factors influencing financing efficiency, with a case study on Shanghai Electric. Key findings include: (1) New energy enterprises and Shanghai Electric show diversified financing channels (internal financing, debt, equity, and financial support) with a positive trend. (2) Despite this, their financing remains inefficient. From 2017 to 2021, only about 15% of new energy enterprises achieved DEA effectiveness, with overall financing efficiency impacted by changes in scale efficiency. Dynamic analysis shows an overall improvement, but low efficiency persists. For Shanghai Electric, while its comprehensive technical efficiency was optimal between 2017 and 2020, it declined in 2021 due to suboptimal scale efficiency. Low technical progress and scale efficiency contributed to this inefficiency. (3) Factors affecting financing efficiency include enterprise size, green technology innovation, capital structure, government support, and employee quality. For new energy enterprises, scale is inversely related to financing efficiency, while the other factors positively influence it. For Shanghai Electric, enterprise size, employee quality, capital structure, and government support significantly impact its financing efficiency.

**Keywords:** new energy enterprises; financing efficiency; evaluate; influencing factor

## 1. Introduction

In 2020, China proposed a “dual carbon” goal, which is an inevitable choice based on the national conditions of the energy industry and development, and actively responds to domestic and foreign challenges [1]. Nevertheless, with respect to the energy consumption structure, China continues to be the world’s biggest energy consumer. Considering the modernization level and the green and low-carbon requirements, there is still a substantial distance to cover for China in adjusting its energy consumption structure. This circumstance, moreover, facilitates the development of new energy enterprises. At present, the development status of China’s new energy enterprises shows a trend of digital development, significant improvement of green technology, and diversified financing channels. Enterprises enjoying financial support are bound to develop in a better and swifter manner. For the purpose of propelling the development of new energy enterprises, it is essential to resolve the financing issues that new energy enterprises encounter.

In recent years, with the gradual tilt of national policies to the new energy field, the internal funds of new energy enterprises are also relatively abundant. From 2017

to 2021, the internal financing of new energy enterprises is shown in **Figure 1**. As can be seen from **Figure 1**, the surplus reserve, undistributed profit, and retained earnings of new energy enterprises have steadily increased from 2017 to 2021. By the end of 2021, the average surplus reserve of new energy enterprises will be about 774,173,500 yuan, the average undistributed profit will be about 288.898533 yuan, and the retained earnings will be about 36,640,900 yuan. From 2017 to 2021, the growth rate of new energy enterprises' surplus reserve is 39.26%, the growth rate of undistributed profits is 59.72%, and the growth rate of retained earnings is 54.91%. The above data shows that with the gradual tilt of national policies toward new energy enterprises, their internal funds are relatively abundant, and the internal financing capacity of new energy enterprises is gradually enhanced. Nevertheless, given that new energy enterprises are currently in the phase of green technology innovation and digital transformation, they still have to set aside a greater amount of internal funds to satisfy certain financing requirements.



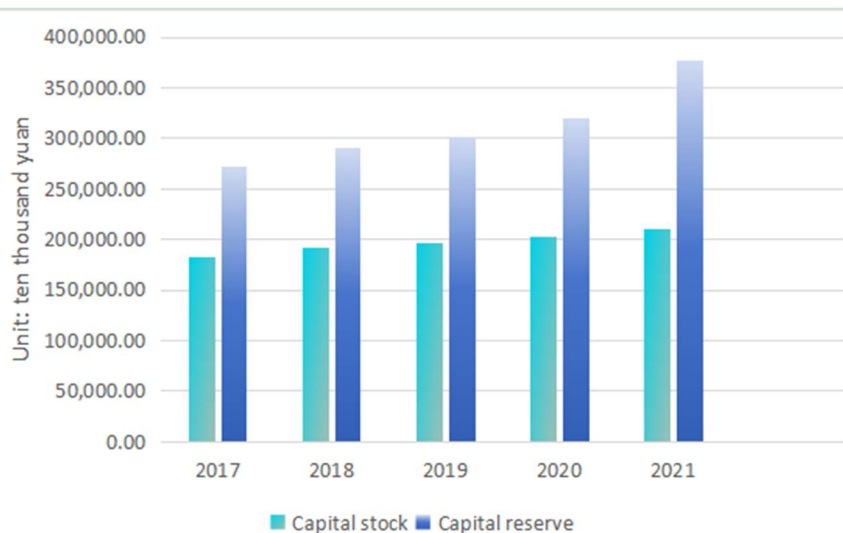
**Figure 1.** Internal financing of new energy enterprises from 2017 to 2021.

Debt financing is a way for new energy enterprises to obtain funds through borrowing, including bank loans, financial leasing, and so on. As can be seen from **Figure 2**, from 2017 to 2021, the long-term borrowing of new energy enterprises shows a steady rise, while the short-term borrowing shows a trend of fluctuation and decline. By the end of 2021, the average long-term borrowing of new energy enterprises is about 641,659,200 yuan, and the average short-term borrowing is about 22,784,660 yuan. The growth rate of short-term borrowing is  $-3.48\%$ . The above data shows that the long-term borrowing capacity of new energy enterprises has increased, while the short-term borrowing capacity has decreased.



**Figure 2.** Debt financing situation of new energy enterprises from 2017 to 2021.

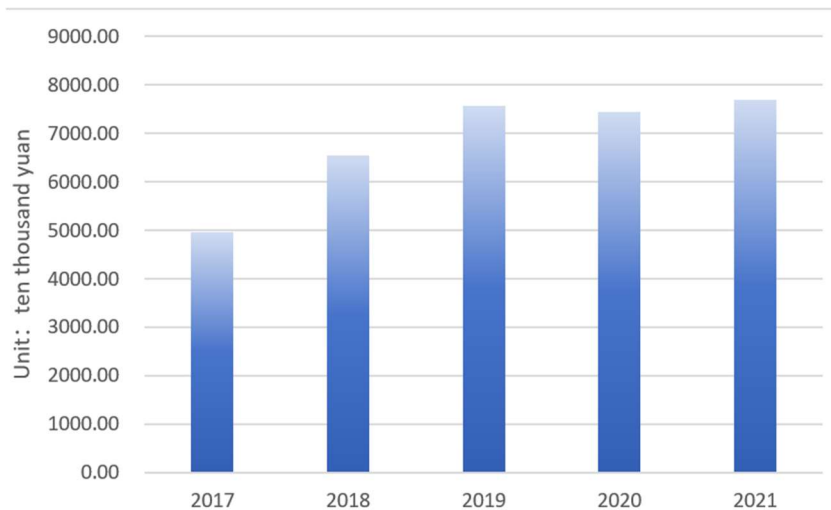
The capacity for equity financing in new energy firms has diminished, especially when compared to debt financing. It has the advantage of less financial risk. However, the use of equity financing means the introduction of new investors, which will not only change the original ownership structure but also increase the risk of decentralization of corporate control. There are three main channels of equity financing: share sending, additional issuance, and conversion. As can be seen from **Figure 3**, by the end of 2021, the average share capital of new energy enterprises is about 2,110,431,800 RMB, and the average capital reserve is about 3,771,424,200 RMB. From 2017 to 2021, the growth rate of equity of new energy enterprises is 15.23%, and the growth rate of capital reserve is 38.42%, indicating that the capacity for equity funding in renewable energy enterprises is gradually enhanced.



**Figure 3.** Equity financing of new energy enterprises from 2017 to 2021.

New energy enterprises are important industries supported by state finance, and government subsidies are the main way to support the development of new energy enterprises. From 2017 to 2021, the financial support of new energy enterprises is

shown in **Figure 4**. As shown in **Figure 4**, from 2017 to 2021, the financial support obtained by new energy enterprises presented a fluctuating trend. By the end of 2021, the average government subsidy for new energy enterprises was approximately 76,812,900 yuan. During this period, the growth rate of government subsidies for new energy enterprises was 55.02%, indicating an enhancement in financial support for these enterprises. Against the backdrop of an increasingly serious environmental crisis driven by the “dual-carbon” goal, China has prioritized the growth of renewable energy companies.



**Figure 4.** Financial support for new energy enterprises from 2017 to 2021.

Overall, the financing landscape of new energy enterprises has demonstrated a promising development trend. However, given that new energy enterprises are currently in the throes of digital transformation, they not only need to set aside more internal funds to meet a portion of their financing needs but also must broaden their financing avenues to acquire more capital for enhanced development. Moreover, during the growth process of new energy enterprises, rationalizing financing funds continues to be an effective approach to propel the expansion of the new energy sector.

Consequently, engaging in an exploration of new energy enterprises and conducting empirical research on the factors influencing their financing efficiency can effectively facilitate the development of new energy enterprises. In this paper, the DEA-BCC model and DEA-Malmquist model are utilized to examine the financing efficiency of new energy enterprises through a combination of dynamic and static methods. Building on this, the Tobit model is utilized to explore the elements influencing the financing efficiency of new energy companies, alongside an examination of the prevailing problems related to their financing efficiency. Additionally, by incorporating the case of Shanghai Electric, this paper authentically reflects the financing circumstances of representative new energy enterprises and endeavors to help address their financing challenges.

Other arrangements for this study are as follows. Section 2 is a literature review. Section 3 is methods and materials. Section 4 is the result and discussion. Section 5 is the conclusion and suggestion.

## **2. Literature review**

A comprehensive understanding of past research results is an important basis for in-depth development of the current topic. Domestic and foreign scholars have carried out a lot of exploration in the research field of financing efficiency and have accumulated rich achievements in the aspects of theoretical definition, influencing factors, and research methods. Combing these literatures not only helps to grasp the research context in this field but also provides a powerful reference for the research perspective, method selection, and model construction of this paper.

### **2.1. Financing efficiency theory**

There are few definitions of corporate financing efficiency in foreign countries, which mainly focus on the study of corporate financing theory. Weston and Brigham [2] systematically elaborated the financial growth cycle theory, dividing the growth cycle of enterprises into six stages. Myers [3] formally proposed the theory of priority financing. Berger and Udell [4] constructed a growth cycle financing model. They believe that the financing method of an enterprise is related to its stage of development. Wu [5] established the Tobit model based on the priority-order financing theory to analyze the influence of robustness on debt financing efficiency. Hao and Wang [6] explored the causes of credit rationing based on the theory of information asymmetry and considered the elements of moral hazard and built an S-W (Strengths-Weaknesses) model to explore the financing situation of enterprises.

Domestic scholars have conducted comprehensive explorations of financing efficiency. Through meticulous and elaborate summarization, they have classified the definition of financing efficiency from the following three perspectives. (1) Ni [7] proposed that financing efficiency refers to whether an enterprise can obtain the required funds at a low cost and make effective use of them. (2) Defined from the perspective of cost, risk, and benefit. Wang and Cheng [8] defined it from the perspective of financing risk. They believe that financing efficiency includes financing cost, income, and risk. In addition, if the risk of financing is too high, then the behavior is inefficient. Wang and E [9] believe that financing efficiency means that the process of obtaining funds is low-cost and low-risk, and the operation of the raised funds can obtain the highest efficiency. (3) Defined from the perspective of efficiency. Song [10] considered financing efficiency as transaction efficiency and allocation efficiency. In other words, it is considered efficient when enterprises can secure funds at a relatively low cost and promptly allocate the acquired funds to the production process.

### **2.2. Research on influencing factors of financing efficiency**

There is quite a lot of literature on the factors affecting financing efficiency. Through combing, it is found that domestic and foreign scholars study the factors affecting financing efficiency mainly from the internal and external aspects of enterprises.

(1) Corporate external conditions affect financing efficiency. Biswas and Koufopoulos [11] propose that there is a “mountain shape” relationship between market power and corporate financing efficiency.

(2) The internal conditions of enterprises affect financing efficiency. Liu and Zhan [12] believe that the turnover rate is an important factor affecting the financing efficiency of listed companies, while the total debt and financial expenses reduce the financing efficiency. Elkins et al. [13] propose that the disclosure of “optimization” of capital structure will have a positive impact on investors’ decision-making and enable enterprises to get more investment, which is ultimately reflected in the improvement of corporate financing efficiency. Shi [14] finds that the main factor affecting the financing efficiency of listed companies in southern Jiangsu is pure technical efficiency. Huo and Li [15] believe that growth ability, operation ability, profitability, enterprise scale, and debt financing are related to financing efficiency. Wang and Cui [16] believe that executive compensation and institutional shareholding ratio positively promote financing efficiency, while cash holding level and accounting information quality will hinder the improvement of financing efficiency.

(3) Financing efficiency is affected by both internal and external factors. Meng [17] believes that, from the internal aspect, corporate structure, corporate nature, financing methods, and corporate scale have an impact on financing efficiency. On the external side, regional economic and system risks will have an impact on financing efficiency. Qin [18] proposes that financing cost, financing structure, corporate nature, and legal system are the main factors affecting corporate financing efficiency. Yao et al. [19] believe that the impact of the external environment on financing efficiency cannot be ignored, and the impact of scale efficiency on industry differentiation leads to changes in corporate financing efficiency. Total asset turnover and R&D (Research and Development) investment intensity have a positive impact on financing efficiency, while the proportion of equity financing and asset-liability ratio have a negative impact. Wang et al. [20] found that corporate capital structure, equity concentration, and macroeconomic development are significantly correlated with corporate financing efficiency.

### **2.3. Research methods of financing efficiency**

Domestic and foreign literature involves a variety of research methods on financing efficiency, such as the DEA, Malmquist model, entropy weight method, and linear regression model to analyze financing efficiency. However, most studies focus on DEA.

(1) Mohtashami et al. [21] used the improved fuzzy DEA model to evaluate the financing efficiency of enterprises. Chang et al. [22] used the DEA method and combined input-output index to study the financing efficiency of enterprises. Fan [23] used the DEA model to explore the efficiency of equity financing of enterprises. Xu [24] measured the financing efficiency of the real estate industry based on the DEA model. Ma [25] evaluated the financing efficiency of enterprises under different financing methods. Zhang [26] calculated the financing efficiency of new energy automobile enterprises based on the DEA model and proposed corresponding countermeasures according to the conclusions.

(2) Linear regression model. Yang et al. [27] studied the relationship between financing methods and financing efficiency by constructing a linear regression

model. Chen et al. [28] studied the relationship between various parameters by establishing a linear regression model. Cao and Du [29] explored various factors affecting financing efficiency by establishing a linear regression model.

(3) Entropy method. Zhao [30] used the entropy method to assign weights to each index and systematically evaluated the financing efficiency of the company. Li [31] objectively weighted the factors affecting corporate financing efficiency based on the entropy method. Multiple methods are combined for evaluation. Liu et al. [32] analyzed the financing efficiency of SMEs (Small and Medium-sized Enterprises) based on DEA and Tobit models. Chen et al. [33] evaluated the financing efficiency of SMEs according to the DEA-Malmquist index method.

### 3. Methods and materials

Scientific and reasonable research methods and accurate and reliable research materials are the keys to ensuring scientific and effective research conclusions. This part will elaborate on the specific methods used to study the financing efficiency of new energy enterprises, including the DEA model, Malmquist index model, Tobit model, and grey correlation degree model, and explain the principle and application of these methods. At the same time, it will also introduce the various materials involved in the research, such as the determination of evaluation indicators, data sources, and data processing processes.

#### 3.1. Methods

##### 3.1.1. DEA model

The DEA model was proposed by Charnes et al in 1978. It uses planning and statistical data to identify relatively efficient production fronts and projects data units onto them to assess their degree of deviation. The specific model of DEA is shown in Equation (1):

$$s. t. \left\{ \begin{array}{l} \min[\theta - \varepsilon(e^T S^- + e^T S^+)] \\ \sum_{j=1}^n x_{ij} \lambda_j + S^- = \theta x_{i_0} \\ \sum_{j=1}^m y_{rj} \lambda_j - S^+ = y_{rj} \\ \sum_{j=1}^m \lambda_j = 1 \\ \lambda, S^-, S^+ \geq 0, r = 1, \dots, s, i = 1, \dots, m \end{array} \right. \quad (1)$$

$\varepsilon$  is the Archimedean infinitesimal quantity,  $\theta$  is the decision unit efficiency value, and  $\theta \in (0,1]$ ,  $\lambda$  are the weight coefficients,  $S^-$  and  $S^+$  are the relaxation variables, and  $e$  is the unit vector. When the calculation result is 1, it means that DEA is valid.

##### 3.1.2. Malmquist index model

Malmquist index model is an economic model to measure the efficiency change of decision evaluation unit in different periods based on dynamic perspective. The

expression of Malmquist index model is shown in Equation (2):

$$M(x^{t+1}, y^{t+1}, x^t, y^t) = \left[ \frac{D_c^t(x^{t+1}, y^{t+1})}{D_c^t(x^t, y^t)} \times \frac{D_c^{t+1}(x^{t+1}, y^{t+1})}{D_c^{t+1}(x^t, y^t)} \right]^{1/2} \quad (2)$$

The Malmquist index measures changes between two periods. When the value of the index is greater than or equal to 1, it indicates progress. Otherwise, there is a recession. The index as shown in Equation (3):

$$\begin{aligned} M(x^{t+1}, y^{t+1}, x^t, y^t) &= \left[ \frac{D_c^t(x^{t+1}, y^{t+1})}{D_c^t(x^t, y^t)} \times \frac{D_c^{t+1}(x^{t+1}, y^{t+1})}{D_c^{t+1}(x^{t+1}, y^{t+1})} \times \frac{D_c^t(x^t, y^t)}{D_c^{t+1}(x^t, y^t)} \right]^{1/2} = TEC \times TC \\ &= \frac{D_v^{t+1}(x^{t+1}, y^{t+1})}{D_v^t(x^t, y^t)} \times \frac{\frac{D_c^{t+1}(x^{t+1}, y^{t+1})}{D_v^{t+1}(x^{t+1}, y^{t+1})}}{\frac{D_c^{t+1}(x^{t+1}, y^{t+1})}{D_v^{t+1}(x^{t+1}, y^{t+1})}}}{\frac{D_c^{t+1}(x^{t+1}, y^{t+1})}{D_v^{t+1}(x^{t+1}, y^{t+1})}}{\frac{D_c^{t+1}(x^{t+1}, y^{t+1})}{D_v^{t+1}(x^{t+1}, y^{t+1})}}} \times \left[ \frac{D_c^t(x^{t+1}, y^{t+1})}{D_c^{t+1}(x^{t+1}, y^{t+1})} \times \frac{D_c^t(x^t, y^t)}{D_c^{t+1}(x^t, y^t)} \right]^{1/2} \\ &= PTEC \times SEC \times TC \end{aligned} \quad (3)$$

### 3.1.3. Tobit model

The Tobit model is a statistical model used to deal with limited, truncated, or restricted variables. It estimates the value of a potential variable by establishing a relationship between a potential variable and an observed variable and further makes predictions and inferences. The Tobit model can help to reveal the true value of a variable in the case of limited or truncated data and analyze and interpret it. The advantage of the Tobit model is that it can handle restricted or truncated variables and can provide estimates and predictions of potential variables. The Tobit model is presented in Equation (4) below.

$$Y_i = \beta_o + \beta^T X_i + \varepsilon(i = 1, 2, \dots, m) \quad (4)$$

To resolve the problem of financing efficiency in new energy enterprises for the protection of the industry, aside from analyzing it, delving deeply into the factors that boost financing efficiency is also imperative. Thus, this paper utilizes the Tobit model to analyze the factors having an impact on the financing efficiency of new energy enterprises so as to offer empirical data for the formulation and development of the new energy industry.

### 3.1.4. Grey relational degree model

The basic idea of the grey relational degree model is to judge the closeness of the relationship by comparing the similarity of the geometric shapes of the series curves. The closer the two curves are, the higher the correlation between the corresponding sequences. In this paper, the pure technical efficiency value is determined as the reference sequence  $y_0$  of the grey relational degree model, and the factors affecting the financing efficiency are determined as the comparison sequence  $x_0$  of the grey relational degree model. The correlation degree between the financing efficiency of Shanghai Electric and the influencing factors is calculated by constructing an evaluation index system.

### 3.2. Materials

#### 3.2.1. Evaluation index determination

In accordance with the principles of comprehensiveness, comparability, and importance of the indicators, this paper determines the input indicators for measuring the financing efficiency of new energy enterprises. These include the ratio of financing cash inflows to outflows, the costs of equity and debt financing, equity financing efficiency, debt financing efficiency, and internal financing efficiency. The financing cost of equity and debt reflects the financing cost of new energy enterprises. Equity financing efficiency, debt financing efficiency, and internal financing efficiency cover the financing methods of new energy enterprises. Among them, the main business profit reflects the level of capital operation of new energy enterprises. Return on equity is used as an indicator to evaluate the profitability of new energy enterprises. It has to be admitted that the outbreak of COVID-19 caused a period of macroeconomic disruption during the study. This study aims to deeply analyze the financing efficiency of new energy enterprises and its key influencing factors. The indicators and models selected for the study have been carefully considered and designed to systematically assess the efficiency of financing and to delve deeper into internal and external influencing factors. Although external factors are not emphasized separately when constructing the research system, various general external factors that may affect the financing efficiency have been comprehensively considered, and the role of external factors on corporate financing has been covered to a certain extent; not the impact of the external environment has been ignored. The growth rate of operating income is an indicator to evaluate the development ability of new energy enterprises. See **Table 1** for details.

**Table 1.** Evaluation indexes of input and output of financing efficiency.

	Name	Formula
Input index	Financing cash inflow and outflow ratio	Financing cash inflows/financing cash outflows
	Equity and debt financing costs	Dividend per share/market price per share + finance charges
	Equity financing efficiency	(equity + capital reserves)/Total assets
	Debt financing efficiency	(long-term loans + short-term loans + bonds payable)/Total assets
	Internal financing efficiency	(surplus reserve + undistributed profit)/Total assets
Output indicator	Main business profit	Main business income – Main business cost – Main business taxes and surcharges
	Earnings per share	-
	Return on equity	Net profit/owner’s equity
	Turnover of total assets	Net income from main business/total assets
	Revenue growth rate	(Current operating income – last year’s operating income)/last year’s operating income

(1) Input indicators are divided into financing cash inflow and outflow ratio, equity and debt financing cost, equity financing efficiency, debt financing efficiency, and internal financing efficiency.

Financing cash inflow and outflow ratio: Financing cash inflow and outflow ratio refers to the ratio between financing cash inflow and outflow [34]. This indicator reflects the financing speed of new energy enterprises. For new energy

enterprises, the greater the value, the faster the financing speed of the enterprise.

Equity and debt financing cost refers to the sum of the enterprise's equity financing cost and bond financing cost, that is, the ratio of dividends per share to the market price per share plus the value of financial expense [35]. This indicator reflects the financing cost of new energy enterprises, that is, the higher the financing cost of equity and debt, the higher the financing cost of new energy enterprises.

Debt Financing Efficiency: Debt financing efficiency is calculated as the proportion of the combined value of long-term loans, short-term loans, and bonds payable to the total assets of new energy enterprises. This metric serves as an indicator of how effectively these enterprises secure funds through debt-based financing methods.

Internal financing efficiency: internal financing efficiency refers to the ratio of an enterprise's surplus reserve and undistributed profits to its total assets, and internal financing efficiency represents the efficiency of new energy enterprises in internal financing.

(2) Output indicators are divided into main business profit, earnings per share, and operating income growth rate.

Main business profit: Main business profit refers to the main business income minus main business costs and main business taxes and additional charges [36]. This index can reflect the operation of new energy enterprises' funds. For new energy enterprises, the greater the value of the main business profit, the better the development of the enterprise at this stage.

Earnings per Share: Earnings per share indicates a company's operational outcomes. The greater the earnings per share value, the more favorable the operating results of the new energy enterprise will be, and the smaller the earnings per share value, the less favorable the operating results of the enterprise.

Return on equity refers to the numerical relationship between the net profit of a business and the owner's equity. The higher the value of this indicator, the greater the return brought by the investment. This index reflects the ability of new energy enterprises to obtain net income from their own capital [37]. The total asset turnover ratio is the value of the net income of the main business divided by the total assets and utilization rate of the assets of new energy enterprises [38].

### 3.2.2. Dimensionless data processing

The DEA model requires the sample value to be non-negative, and some input and output data selected in this paper may be less than 0. For this reason, this paper carries out dimensionless normalization operation on the selected data uniformly, so that all the input and output data are in [0, 1]. As shown in the Equation (5):

$$x'_i(j) = 0.9 \times \frac{x_i(j) - \min[x_i(j)]}{\max[x_i(j)] - \min[x_i(j)]} + 0.1, i = 1,2,3 \dots m, j = 1,2,3 \dots n \quad (5)$$

### 3.2.3. Determination of influencing factors of financing efficiency

There are many factors that affect the financing efficiency of new energy enterprises. Yao and Dai [39] believe that the asset-liability ratio and corporate scale, which represent financing constraints, and the interest burden, which represents financing costs, have significant negative effects on the financing efficiency of

enterprises. Zhang [40] believed that the four indicators of R&D expenses, personnel with a bachelor’s degree or above, enterprise size, and provincial GDP (Gross Domestic Product) index positively promote the financing efficiency of enterprises. After a literature review, this paper selects enterprise scale, digital transformation, green technology innovation, enterprise capital structure, employee quality, and government support as factors affecting its financing efficiency. The influencing factors and definitions are shown in **Table 2**.

**Table 2.** Influence factors and their definitions.

	Name	Symbol	Definition
Explained variable	Financing efficiency	FE	Pure technical efficiency in DEA
	Enterprise scale	SIZE	Take the natural log of total assets
	Digital transformation	DIG	Obtain data through Guotai an database
Explanatory variable	Green technology innovation	GREEN	(Ending intangible assets – beginning intangible assets)/Ending total assets
	Enterprise capital structure	CAPITAL	Equity ratio
	Staff quality	STAFF	The proportion of personnel with bachelor’s degree or above
	Government support	GOVERN	Government subsidy

(1) Enterprise scale

It is generally believed that the larger the scale of an enterprise, the more commodities it produces, the lower the cost, and the stronger its competitiveness, thereby enhancing the enterprise’s financial efficiency. Many scholars have analyzed the influence of enterprise size on enterprise financing efficiency. Wang [41] found a positive correlation between a company’s financing efficiency and its total assets. In this paper, the logarithm of the total assets of an enterprise is used to represent the size of an enterprise. Based on signal theory, this paper believes that the larger the asset scale, the stronger the strength of the enterprise, and the better the external judgment of the development of the enterprise. Based on the above analysis, this paper proposes hypothesis H1: Financing efficiency of new energy enterprises is positively correlated with enterprise scale.

(2) Digital transformation

While outdated technologies, processes, and customer relationship management difficulties are currently holding businesses back, digital transformation simplifies operations and increases efficiency through the adoption of new technologies and processes [42]. Digital transformation is an important strategic decision for enterprises, which can automate production and streamline business processes, saving time and effort [43]. This allows employees to focus more on work that adds value, improving overall productivity and productivity. An important advantage of digital transformation is the ability of businesses to respond quickly to changing market and customer needs [44]. By adopting digital processes and agile approaches, companies can quickly adapt to new developments and opportunities, increasing their flexibility and agility and facilitating improved financing efficiency [45]. Successful digital transformation is bound to bring more powerful development momentum to the enterprise [46]. In this paper, the digital word frequency is searched in the CSMAR database as the basis for enterprises’ digital transformation.

In addition, many scholars have analyzed the significance of digital transformation. Zhang et al. [47] found that enterprises' digital transformation can significantly improve their capital allocation efficiency. Huang et al. [48] asserted that the digital transformation of businesses can enhance their financing efficiency.

### (3) Green technology innovation

Green technology innovation is adapted to the ecological environment of modern technology [49]. Under the increasingly severe constraints of natural resources and the trend of vigorously advocating green development, green technology innovation can help enterprises reduce energy consumption, effectively reduce pollution emissions and production and manufacturing costs, and is an inevitable choice for enterprises to achieve the goal of reducing costs and increasing efficiency [50]. For new energy enterprises, the successful realization of green technology innovation can enable them to obtain more abundant, critical, and important resources by virtue of their unique technological competitive advantages, which will help enterprises improve financing efficiency and promote their future development. Wang [51] believed that technological R&D capability was the main factor restricting the improvement of corporate financing. Xu [52] believed that technological innovation could be used to improve financing efficiency. Zhu and Song [53] believed that innovation and R&D investment should be focused on obtaining more financing opportunities. In this paper, the difference between the end intangible assets and the beginning intangible assets and the ratio of the end total assets represent green technology innovation. Based on the above analysis, this paper proposes hypothesis H3: the financing efficiency of new energy enterprises is positively correlated with their green technology innovation.

### (4) Enterprise capital structure

In this paper, the ratio of property rights represents the capital structure of enterprises. This indicator is the value of liabilities and owners' equity. To some extent, this index can indicate whether the financial structure of the enterprise is stable so as to measure the long-term solvency of the enterprise. Scientific capital structure and moderate debt can improve the financing efficiency of enterprises to a certain extent. This paper proposes hypothesis H4: The financing efficiency of new energy enterprises is positively correlated with the capital structure of enterprises.

### (5) Staff quality

At present, the factors that determine the competitiveness of enterprises have gradually changed from traditional production management to human resources. Therefore, for enterprises, improving the overall quality of employees can effectively improve financing efficiency, thus promoting the development of enterprises. In this paper, staff quality is defined as the proportion of staff with a bachelor's degree or above in the total staff. Based on the above analysis, this paper proposes hypothesis H5: the financing efficiency of new energy enterprises is positively correlated with the quality of employees.

### (6) Government support

First of all, the increase of government support can help enterprises reduce costs, such as financial subsidies and other ways to reduce the operating costs of enterprises and enhance the financial strength of enterprises. Secondly, the increase of government support can promote the innovation and development of enterprises,

for example, through incentive programs and other ways to encourage enterprises to increase research and development investment, launch new products and new technologies, and promote industrial upgrading and transformation and upgrading. Finally, government support can help enterprises solve development problems, for example, through training and skill upgrading, professional services and consulting, improving the management level of enterprises, and enhancing the comprehensive competitiveness of enterprises. Especially for new energy enterprises, government support means access to government funds, resources, services, and policy support so as to enhance the development potential of enterprises and improve financing efficiency. In this paper, government subsidies represent the support of enterprises by the government. Based on the above analysis, this paper proposes hypothesis H6: the financing efficiency of new energy enterprises is positively correlated with government support.

### 3.2.4. Model construction

Based on Equation (5), this paper builds a Tobit data regression model for analysis of factors affecting financing efficiency of new energy enterprises, as shown in Equation (6):

$$FE = \beta_0 + \beta_1 SIZE + \beta_2 DIG + \beta_3 GREEN + \beta_4 CAPITAL + \beta_5 STAFF + \beta_6 GOVERN + \varepsilon \quad (6)$$

where  $\beta_0$  is the constant term and  $\varepsilon$  is the residual value. This paper chooses pure technical efficiency value as the index to measure financing efficiency [54].

### 3.3. Data sources

The Malmquist model requires that the sample data be 5 years or more, so this paper selects the financial data of new energy enterprises from 2017 to 2021 for calculation. This paper conducted a preliminary screening and found that 190 enterprises met the conditions. After eliminating the enterprises with ST (Special Treatment), ST\*, missing data, and insufficient information disclosure, this paper took 153 new energy enterprises as the research object.

## 4. Results and discussion

After rigorous data collection, processing, and model analysis, we obtained a series of results on the efficiency of new energy enterprises. This part will comprehensively display these research results, a comprehensive examination of the financial efficiency of renewable energy companies from both static and dynamic perspectives, and a detailed discussion of various factors affecting the financing efficiency. Through the in-depth interpretation of the results, it is helpful to reveal the current situation, problems, and mechanisms affecting the financing efficiency of renewable energy companies.

### 4.1. Results

#### 4.1.1. Financing efficiency analysis standards

This paper uses DEAP2.1 software to measure the financing efficiency of 153 new energy enterprises from the static and dynamic levels during 2017–2021. According to the input-oriented solving efficiency value, the financing efficiency of

new energy enterprises is analyzed. When analyzing the calculation result of financing efficiency, this paper divides the efficiency value measured by the DEA model into four intervals. The details are shown in **Table 3**.

**Table 3.** Standards for dividing efficiency levels.

The efficiency of interval distribution	$0 < H < 0.5$	$0.5 \leq H < 0.8$	$0.8 \leq H < 0.1$	$H = 1$
Level of efficiency	Low efficiency	Lower efficiency	Higher efficiency	The best efficiency

#### 4.1.2. Static financing efficiency analysis

The static analysis results of financing efficiency of new energy enterprises from 2017 to 2021 are shown in **Table 4**.

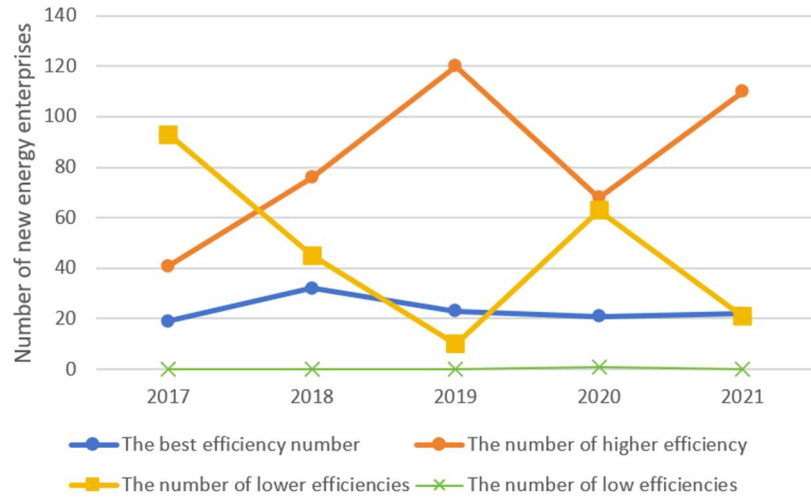
**Table 4.** Static results of financing efficiency of new energy enterprises from 2017 to 2021.

Annual efficiency		2017	2018	2019	2020	2021
Comprehensive technical efficiency	The best efficiency number	19	32	23	21	22
	Best efficiency ratio (%)	12.42%	20.92%	15.03%	13.73%	14.38%
	The number of high efficiency	41	76	120	68	110
	High efficiency ratio (%)	26.80%	49.67%	78.43%	44.44%	71.90%
	The number of lower efficiencies	93	45	10	63	21
	Low efficiency ratio (%)	60.78%	29.41%	6.54%	41.18%	13.73%
	Number of inefficiencies	0	0	0	1	0
	Percentage of inefficiency (%)	0.00%	0.00%	0.00%	0.65%	0.00%
	Mean value	0.792	0.865	0.911	0.832	0.880
Pure technical efficiency	The best efficiency number	35	42	33	27	41
	Best efficiency ratio (%)	22.88%	27.45%	21.57%	17.65%	26.80%
	The number of high efficiency	107	109	120	125	110
	High efficiency ratio (%)	69.93%	71.24%	78.43%	81.70%	71.90%
	The number of lower efficiencies	11	2	0	1	2
	Low efficiency ratio (%)	7.19%	1.31%	0.00%	0.65%	1.31%
	Number of inefficiencies	0	0	0	0	0
	Percentage of inefficiency (%)	0.00%	0.00%	0.00%	0.00%	0.00%
	Mean value	0.919	0.937	0.943	0.930	0.934
Scale efficiency	The best efficiency number	19	32	26	22	23
	Best efficiency ratio (%)	12.42%	20.92%	16.99%	14.38%	15.03%
	The number of high efficiency	82	112	124	117	124
	High efficiency ratio (%)	53.59%	73.20%	81.05%	76.47%	81.05%
	The number of lower efficiencies	52	9	3	13	6
	Low efficiency ratio (%)	33.99%	5.88%	1.96%	8.50%	3.92%
	Number of inefficiencies	0	0	0	1	0
	Percentage of inefficiency (%)	0.00%	0.00%	0.00%	0.65%	0.00%
	Mean value	0.859	0.922	0.966	0.894	0.943

Note: DEAP2.1 software running results calculated.

(1) The importance of comprehensive technical efficiency has become increasingly prominent in the modern economy. At the same time, the overall

technical efficiency can be determined by multiplying pure technical efficiency with scale efficiency. This paper offers a thorough analysis of both pure technical efficiency and scale efficiency. As shown in **Figure 5** below.



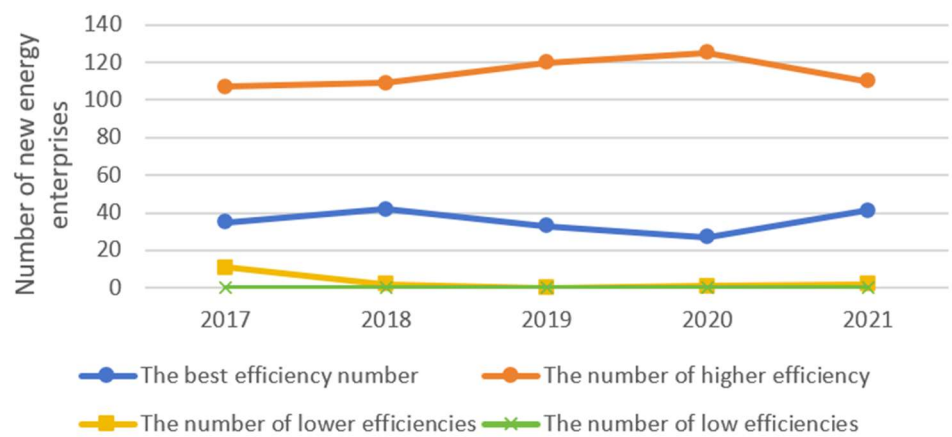
**Figure 5.** Comprehensive technical efficiency interval distribution of new energy enterprises from 2017 to 2021.

**Table 4** and **Figure 5** show that from 2017 to 2021, the number of new energy enterprises with comprehensive technical efficiency in the best efficiency range shows a small fluctuation, and the count of new energy companies in the low-efficiency category is nearly nonexistent. The specific situation is as follows: From 2017 to 2021, the count of new energy enterprises in the best comprehensive technical efficiency range showed a small fluctuation, and the overall trend was stable. The count increased from 19 in 2017 to 32 in 2018, then dropped to 23 in 2019, then to 21 in 2020, and finally to 22 in 2021. From 2017 to 2021, the count of new energy enterprises in the higher comprehensive technical efficiency range fluctuated greatly, and the overall trend was upward. The number increased from 41 in 2017 to 76 in 2018, increased significantly to 120 in 2019, then dropped sharply to 68 in 2020, and finally rose again to 110 in 2021. From 2017 to 2021, the count of new energy enterprises in the lower comprehensive technical efficiency range fluctuated greatly, and the overall trend was downward. The number decreased from 93 in 2017 to 45 in 2018, then to 10 in 2019, then to 63 in 2020, and finally to 21. From 2017 to 2021, the changing trend of the number of new energy enterprises with comprehensive technical efficiency in the low-efficiency range is not significant. There are zero in 2017–2019 and 2021, and only one exists in 2020.

The mean value of comprehensive technical efficiency of new energy enterprises from 2017 to 2021 is 0.792, 0.865, 0.911, 0.832, and 0.880, respectively, showing a curve fluctuation state, indicating that the financing efficiency of new energy enterprises is unstable and does not reach the optimal financing state. Among the 153 new energy enterprises selected, the number of new energy enterprises that can achieve the best comprehensive technical efficiency is relatively small, and there are only 19, 32, 23, 21, and 22 new energy enterprises that can achieve the best comprehensive technical efficiency from 2017 to 2021, respectively. They accounted

for 12.42%, 20.92%, 15.03%, 13.73%, and 14.38%, respectively. Although there has been some improvement by 2018, the number of new energy enterprises with the best comprehensive technical efficiency is 32, which is still low, accounting for only 20.92% of the total. Overall, the financing efficiency of new energy enterprises is unstable and in an inefficient state, and there is still a lot of room for improvement.

(2) Pure technical efficiency plays an important role in the enterprise. It represents the efficiency of enterprises through soft power, such as technical strength and management level, under the existing technical level. When the enterprise can effectively use the invested resources, pure technology can reach 1. As shown in **Figure 6** below.



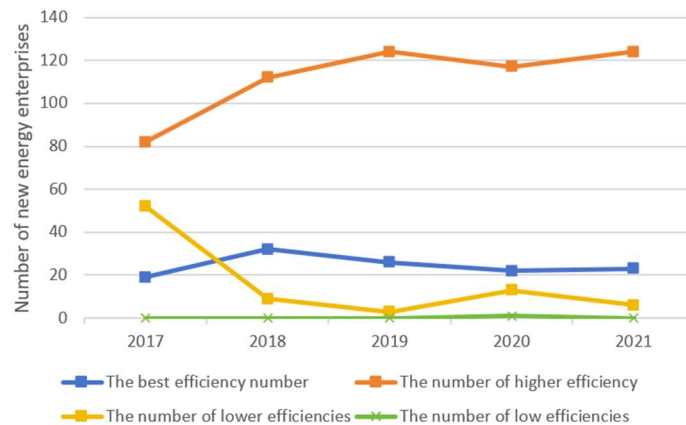
**Figure 6.** Pure technical efficiency interval distribution of new energy enterprises from 2017 to 2021.

As depicted in **Table 4** and **Figure 6**, from 2017 to 2021, the quantity of new energy enterprises with pure technical efficiency within the four efficiency value ranges displays minor fluctuations. The count of new energy enterprises in the best and higher efficiency intervals exhibits an upward trend, while that in the low-efficiency interval shows a downward trend, and there are no new energy enterprises in the lowest efficiency interval. For the best pure technical efficiency range from 2017 to 2021, the number of new energy enterprises fluctuated slightly and had an overall upward trend. It increased from 35 in 2017 to 42 in 2018, then decreased to 33 in 2019 and 27 in 2020, and rose again to 41 in 2021. Regarding the higher purity technical efficiency range during the same period, the number of new energy enterprises also fluctuated slightly and was generally on the rise. It grew from 107 in 2017 to 109 in 2018, 120 in 2019, and 125 in 2020, before falling to 110 in 2021. In the case of the lower pure technical efficiency range from 2017 to 2021, the number of new energy enterprises fluctuated minimally and was in an overall declining state. It decreased from 11 in 2017 to 2 in 2018 to 0 in 2019, rose to 1 in 2020, and finally dropped to 2 in 2021. From 2017 to 2021, the number of new energy enterprises with pure technical efficiency in the lowest efficiency range was consistently 0. In terms of the mean value of pure technical efficiency and the proportion of enterprises, from 2017 to 2021, the mean value of pure technical efficiency of new energy enterprises is 0.919, 0.937, 0.943, 0.930, and 0.934, respectively, showing curve fluctuation. In addition, the pure technical efficiency of

new energy enterprises from 2017 to 2021 is mostly distributed in a higher range, indicating that the overall pure technical efficiency has not reached an effective state and still needs to be adjusted appropriately. They accounted for 22.88%, 27.45%, 21.57%, 17.65%, and 26.80%, respectively. Although there will be some improvement by 2021, the number of new energy enterprises with the best pure technical efficiency is only 41, accounting for only 26.80% of the total.

The above data shows that although new energy enterprises have improved their soft power, by 2021, more than 70% of new energy enterprises have not achieved effective results in terms of pure technical efficiency. This may be due to the fact that China's new energy enterprises are in the initial stage of development, the growth cycle of enterprises is long, and the technical investment takes a certain time to be transformed into results, which will lead to the financing efficiency of new energy enterprises not being high. At the same time, it also shows that the technology and management level of new energy enterprises need to be improved.

(3) Scale efficiency. Scale efficiency refers to the gap between the actual production scale and the optimal production scale under the constant management level. As shown in **Figure 7** below.



**Figure 7.** Scale efficiency interval distribution of new energy enterprises from 2017 to 2021.

As shown in **Table 4** and **Figure 7**, regarding the number of new energy enterprises from 2017 to 2021, the number of those with scale efficiency in the best and low-efficiency ranges shows minor fluctuations, whereas the number of new energy enterprises with scale efficiency in the higher and lower efficiency ranges has relatively large fluctuations. The number of new energy enterprises in the best and higher efficiency ranges is increasing, the number in the low-efficiency range is decreasing, and the number in the low-efficiency range remains stable. Between 2017 and 2021, the number of new energy enterprises in the optimal scale efficiency range exhibits less fluctuation and an overall upward trend. It increased from 19 in 2017 to 32 in 2018, then decreased to 26 in 2019 and 22 in 2020, and rose to 23 in 2021. From 2017 to 2021, the number of new energy enterprises in the higher scale efficiency range has significant fluctuations and is increasing. It grew from 82 in 2017 to 112 in 2018, then to 124 in 2019, 117 in 2020, and finally to 124 in 2021. From 2017 to 2021, the number of new energy enterprises in the lower pure technical

efficiency range fluctuates greatly and shows an overall downward trend. It decreased from 52 in 2017 to 9 in 2018, then to 3 in 2019, 13 in 2020, and 6 in 2021. From 2017 to 2021, the number of enterprises with pure technical efficiency in the low-efficiency range is basically stable, with only 1 in 2020 and 0 in the other years. In terms of the mean value of scale efficiency and the proportion of enterprises, the mean value of scale efficiency of new energy enterprises from 2017 to 2021 is 0.859, 0.922, 0.966, 0.894, and 0.943, respectively, showing a curve fluctuation state. In addition, the scale efficiency of new energy enterprises from 2017 to 2021 is mostly distributed in a higher range, indicating that the overall scale efficiency has not reached the best state and still needs to be adjusted appropriately.

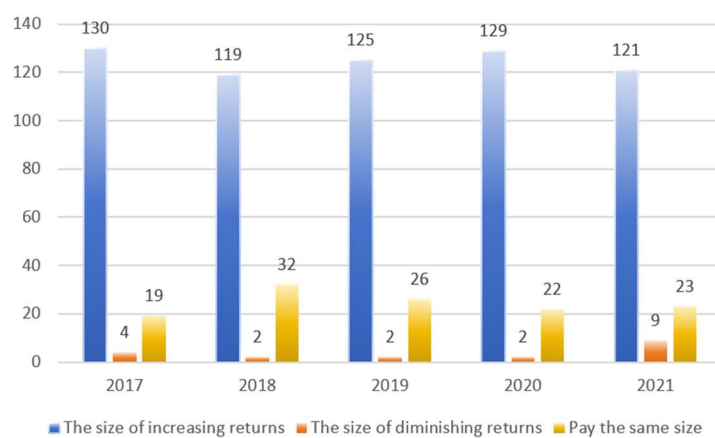
The above illustrates the new energy efficiency of enterprise-scale development imbalance. The reason for this situation may be that the size of the enterprise does not match its operating conditions, does not reach the effective scale of operation, and has the problem of too large or too small scale, resulting in unreasonable resource allocation and poor financing efficiency. New energy enterprises need to improve scale efficiency and scientifically allocate various elements.

(4) Analysis of returns to scale. The return to scale means that under ideal conditions, the output of the firm changes in the same proportion as the amount of input production factors. As shown in **Table 5** and **Figure 8** below.

**Table 5.** Returns to scale of financing of new energy enterprises from 2017 to 2021.

	2017	2018	2019	2020	2021
The number of firms with increasing returns to scale	130	119	125	129	121
Take up a proportion of	84.97%	77.78%	81.70%	84.31%	79.08%
The number of enterprises with decreasing returns to scale	4	2	2	2	9
Take up a proportion of	2.61%	1.31%	1.31%	1.31%	5.88%
The number of enterprises with constant returns to scale	19	32	26	22	23
Take up a proportion of	12.42%	20.92%	16.99%	14.38%	15.03%

Note: DEAP2.1 software running results calculated.



**Figure 8.** Classification of return to scale of new energy enterprises from 2017 to 2021.

From 2017 to 2021, among 153 new energy enterprises, the count of enterprises with unchanged returns to scale shows a fluctuating increase. In 2021, 15.03% of

enterprises achieved the optimal scale of the input-output state, yet 5.88% of businesses remain in a condition of declining returns to scale. This shows that the role of the funds integrated into some new energy enterprises has not been maximized. The above data reflect that the scale of China’s new energy enterprises is generally in a small state, and the existing financing environment and the degree of enterprises themselves have a large gap with expectations. The reason may be that the internal financing environment and system need to be further improved, so the enterprise financing effect is not good.

To sum up, the overall companies exhibited fluctuations between 2017 and 2021, averaging between [0.792, 0.911]. The average pure technical efficiency was recorded at [0.919, 0.943], while scale efficiency averaged between [0.859, 0.966]. These figures indicate that the comprehensive technical efficiency of new energy enterprises is significantly influenced by scale efficiency, and enterprises should operate reasonably according to their actual conditions.

**4.1.3. Dynamic financing efficiency analysis**

The DEA model is limited to assessing efficiency at particular time intervals and does not reflect the fluctuations in financing efficiency of businesses across various periods. To evaluate the funding efficiency of new energy companies more thoroughly, the Malmquist index method is embedded in this paper, which can thoroughly assess the financial efficiency of companies over various periods and examine its evolving patterns. As shown in **Table 6** below.

**Table 6.** Malmquist index and decomposition of financing efficiency of new energy enterprises in different periods.

Period of time	Comprehensive technical efficiency change index	Technological progress index	Index of change in pure technical efficiency	Scale efficiency index	Malmquist index
2017–2018	1.098	1.030	1.021	1.076	1.131
2018–2019	1.057	0.906	1.007	1.050	0.958
2019–2020	0.907	1.073	0.986	0.920	0.974
2020–2021	1.063	1.050	1.004	1.059	1.116
Geometric mean	1.029	1.012	1.004	1.024	1.042

Note: DEAP2.1 software running results calculated.

In 2017–2018, the Malmquist index was 1.131 and 1.131. In 2018–2019, the Malmquist index was 0.958, a value below 1, indicating that the financing efficiency of enterprises showed a downward trend during the period. Through further analysis, it is found that the technological progress index of this period is 0.906, and 0.906 is less than 1. The data above indicate that the low index of technological advancement, or technological decline, caused the decrease in financing efficiency for new energy companies during 2018–2019. The Malmquist index for 2019–2020 is 0.974, indicating that the financing efficiency in this period is still in a declining state. Through further analysis, the comprehensive technical efficiency change index of new energy companies during this period is 0.907, indicating it is below 1. The data above indicate that in 2019–2020, inadequate operation and management contributed to the reduced financing efficiency of new energy companies. The Malmquist index for 2020–2021 is 1.116, indicating that the financing efficiency of new energy enterprises is in an effective state during this period. Therefore, from 2017 to 2021,

only the financing efficiency of 2017–2018 and 2020–2021 achieved an optimal condition, along with the funding efficiency of the rest of the period, which did not reach the effective state. After analysis, it is found that technology regression, insufficient management level, and low scale efficiency all lead to the financing efficiency of new energy enterprises not reaching an effective state. Looking at the average figures, the mean Malmquist index for companies over the entire period stands at 1.042. This suggests that, from 2017 to 2021, the financing efficiency of new energy firms has largely been in a favorable condition. In conclusion, while there has been a noticeable improvement in the financing efficiency of new energy enterprises during these years, some still exhibit relatively low levels of financing efficiency.

## 4.2. Discussion

### Influencing factors of financing efficiency

#### (1) Descriptive statistics

In this paper, Stata16.0 software is used for descriptive statistical analysis of each variable. The results are shown in **Table 7**.

**Table 7.** Descriptive statistics of each variable.

Variable	Sample size	Mean value	Standard deviation	Minimum value	Maximum value
FE	765	0.9326	0.0578	0.7580	1.0000
SIZE	765	23.1629	1.2408	20.7793	26.7385
DIG	765	1.3635	1.1525	0.0000	4.9053
GREEN	765	0.0042	0.0209	-0.0611	0.2678
CAPITAL	765	1.8086	4.9399	0.1041	107.0705
STAFF	765	0.3085	0.1941	0.1829	0.9416
GOVERN	765	0.6868	1.8159	0.0001	22.6300

Note: Stata16.0 software running results calculated.

**Table 7** presents the effectiveness of new energy firms alongside the statistical analysis of several factors. The findings indicate that the financing efficiency of China’s new energy sector is predominantly characterized by inefficiency, and there are obvious differences in various influencing factors. From the results of the explained variables, the average value of financing efficiency is 0.9326, and the new energy companies are currently suboptimal. The minimum value is 0.7580, and the maximum is 1.000. This shows that there are obvious differences in financing efficiency among new energy enterprises and also shows the necessity of studying the factors affecting the financing efficiency of new energy enterprises. In terms of enterprise size, the mean value is 23.1629, the minimum value is 20.7793, and the maximum value is 26.7385. The above data shows that the scale gap between new energy enterprises is large and the development is unbalanced. In terms of digital transformation, the average value is 1.3635, indicating that the digital transformation ability of new energy enterprises is weak at the current stage. The minimum value of digital transformation is 0.000, and the maximum value is 4.9053, and there are still enterprises that have not adopted new technologies and processes to simplify the

operation process. In terms of green technology innovation, the average value is 0.0042, indicating that the green technology innovation ability of new energy enterprises is weak. Indicating a large gap in green technology innovation ability among new energy enterprises. In terms of enterprise capital structure, the average value is 1.8086, indicating that new energy enterprises have more debt and their financial situation is unstable. The minimum value of capital structure is 0.1041, and the maximum value is 107.0705, which indicates that the capital structure gap between new energy enterprises is significant. In terms of employee quality, the average value is 0.3085, the minimum value is 0.1829, and the maximum value is 0.9416, which indicates that the quality of employees in each new energy enterprise is uneven. In terms of government support, the mean was 0.6868, the minimum was 0.0001, and the maximum was 22.6300. This shows that there is a large gap in the intensity of government support among new energy enterprises, and different enterprises have different intensities of government support.

(2) Correlation analysis

It can be seen from **Table 8** that the absolute values of the correlation coefficients of most variables are [0.1, 0.3], so the correlation is weak. In order to get more accurate results, the multicollinearity test operation is carried out in this paper.

**Table 8.** Correlation analysis.

	FE	SIZE	DIG	GREEN	CAPITAL	GOVERN	STAFF
FE	1.0000						
SIZE	-0.1562	1.0000					
DIG	0.0200	-0.0088	1.0000				
GREEN	0.0385	0.1271	0.0559	1.0000			
CAPITAL	0.1354	0.0404	-0.0590	-0.0034	1.0000		
STAFF	-0.0091	0.4173	0.0247	-0.0147	-0.0725	1.0000	
GOVERN	0.0768	0.4353	0.0780	-0.0205	-0.0094	-0.0204	1.0000

Note: Stata16.0 software running results calculated.

(3) Multicollinearity test

The results of multicollinearity test are shown in **Table 9**. The results show that VIF values are all located at [1, 2], and there is no case of more than 10, so there is no multicollinearity problem between independent variables.

**Table 9.** Multicollinearity test.

Variable	VIF	1/VIF
SIZE	1.64	0.6096
GOVERN	1.33	0.7499
STAFF	1.31	0.7641
GREEN	1.03	0.9705
DIG	1.02	0.9808
CAPITAL	1.01	0.9909
Mean VIF	1.22	

Note: Stata16.0 software running results calculated.

(4) Regression analysis

This study utilized Tobit regression analysis on panel data encompassing six influencing factors, with findings presented in **Table 10**.

**Table 10.** Tobit regression results.

Variable type	Coef.	Std. Err.	<i>t</i>	<i>P</i> >   <i>t</i>
SIZE	-0.0146582	0.0020719	-7.07	0.000
DIG	0.0000791	0.0017587	0.05	0.964
GREEN	0.2105611	0.0973886	2.16	0.031
CAPITAL	0.0016628	0.0004082	4.07	0.000
STAFF	0.0349558	0.0118336	2.95	0.003
GOVERN	0.0068720	0.0012765	5.38	0.000
_cons	1.2526030	0.0461344	27.15	0.000

Note: Stata 16.0 software running results calculated.

As can be seen from **Table 10**, except for digital transformation, other indicators suggest that company size, green technology innovation, and enterprise capital structure. Now the regression results of each variable are analyzed in detail.

(1) Enterprise Scale Level: An inverse correlation exists with enterprise scale. The regression coefficient of enterprise size is -0.0146582 and passes the 1% significance test. To some extent, this result shows that a large enterprise scale does not necessarily imply high financing efficiency. The possible reason for this could be that new energy enterprises are in the early to mid-stage of enterprise-scale development, but they have a high technological content, thus possessing strong R & D capabilities, and their financing efficiency may not be lower than that of large-scale enterprises.

(2) At the digital transformation level, the regression coefficient related to digital transformation stands at 0.0000791, failing to meet the criteria for significance. This suggests that digital transformation does not play a meaningful role in enhancing the financing efficiency of new energy companies. China's new energy enterprises are in the initial stage of development, and in the initial stage, a significant amount of digital input is required, and the resulting outputs must undergo a specific process to effectively foster enterprise growth. This can ultimately result in inefficient financing for new energy companies.

(3) Green technology innovation is positively correlated with the financing efficiency of new energy enterprises. The regression coefficient for this indicator is 0.2105611, meeting the 5% significance threshold, showing that green technology innovation notably enhances the financing efficiency of new energy companies. Accelerating green technology innovation can promote the greening of production links of enterprises, reduce carbon emissions, produce more green products, increase business efficiency, and thereby enhance the financial efficiency of businesses.

(4) Enterprise Capital Structure: There exists a positive correlation between enterprise capital structure and the financing efficiency of new energy enterprises. The regression coefficient of enterprise capital structure is 0.0016628, which indicates that the enterprise capital structure has a notably positive effect on the

financing efficiency of new energy enterprises. This reveals that a scientific approach and a certain amount of debt can, in a reverse way, facilitate the development of enterprises.

(5) Employee quality level: Employee quality surpassed the 1% significance threshold, suggesting a notable positive effect on the financing efficiency of new energy companies. The results show that high-quality staff can provide strong manpower support for the development of new energy enterprises, promote better and faster development of enterprises, and help improve financing efficiency. Currently, market competition is intensifying, and new energy companies must employ skilled personnel to secure a competitive edge.

(6) Level of Government Support: The level of government support is positively correlated with the financing efficiency of new energy enterprises. The regression coefficient of government support is 0.0068720 and passes the 1% significance test, indicating that government support has a significant positive impact on the financing efficiency of new energy enterprises. The high-quality development of enterprises requires strong financial backing. When enterprises obtain financial support from the government, they can obtain more startup capital and thereby expand their market. China's new energy enterprises are in the early stage of development, and their foundation is relatively weak. Government support for enterprises can relieve financial pressure, significantly reduce operating costs, and improve financing efficiency.

## **5. Case studies**

In order to reflect the financing situation of new energy enterprises more directly and concretely, it is very necessary to select representative enterprises for case analysis. As a typical enterprise in the new energy industry, Shanghai Electric's financing situation and efficiency have certain representative and reference values. This part will take Shanghai Electric as an example to analyze its financing status and then analyze the existing problems to provide practical reference for new energy enterprises to solve financing problems.

### **5.1. Analysis of current financing situation of Shanghai Electric**

#### **5.1.1. Introduction to Shanghai Electric**

Shanghai Electric Group (stock code: 601727.SH) was founded in 1902; its main business is the production of comprehensive equipment, and it is a comprehensive new energy enterprise. Its business involves four industries and three sectors, namely the modern service industry, industrial equipment, new energy, and environmental protection equipment, focusing on efficient and clean energy equipment. Focusing on the three business segments of smart energy, smart manufacturing, and smart infrastructure, we provide customers with digital green solutions. Products cover machine tools, elevators, environmental protection equipment, nuclear power units, etc., with more than 200 subsidiaries. After the reform and opening up, Shanghai Electric developed a series of innovative products that were ahead of domestic and foreign countries at that time, such as the third and fourth generations of nuclear islands, conventional island main equipment,

large-scale offshore wind power equipment, and the first million-kilowatt ultra-supercritical coal-fired generator set. The company has been committed to green development under China’s “double carbon” goal. The contribution rate of energy equipment to operating income has increased year by year, which is competitive in the industry. In the process of energy reform, Shanghai Electric continues to contribute core products and services with global competitiveness in accordance with the requirements of “product intelligence and service industrialization” two-wheel drive. As a representative enterprise in the new energy industry, the study on the financing efficiency of Shanghai Electric is representative, which is helpful in deepening our understanding.

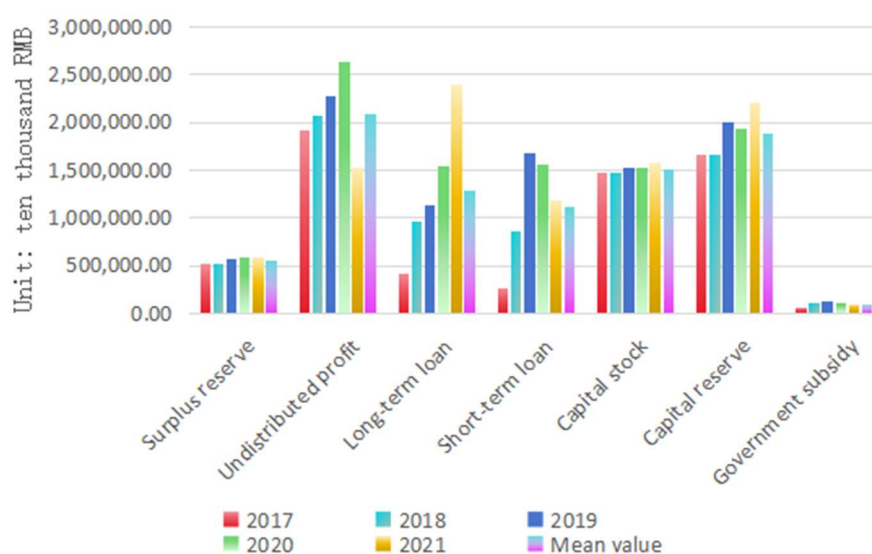
**5.1.2. Analysis of financing situation of Shanghai Electric**

Shanghai Electric comprehensively uses a variety of financing methods for financing, among which equity financing occupies an important proportion in the total financing scale of Shanghai Electric. The financing situation of Shanghai Electric during 2017–2021 is shown in **Table 11** and **Figure 9**.

**Table 11.** Analysis of financing situation of Shanghai Electric from 2017 to 2021.

Year	Unit: ten thousand yuan					Average firm value	Rate of increase
	2017	2018	2019	2020	2021		
Surplus reserve	509,192.70	524,410.00	572,069.50	590,652.40	590,652.40	557,395.40	16.00%
Undistributed profit	1,911,189.90	2,076,683.30	2,280,687.60	2,634,889.70	1,521,842.50	2,085,058.60	-20.37%
Long-term loan	414,544.20	958,883.60	1,126,841.80	1,540,845.20	2,384,541.70	1,285,131.30	475.22%
Short-term loan	255,350.80	858,555.60	1,673,394.40	1,562,738.40	1,183,636.60	1,106,735.16	363.53%
Capital stock	1,472,518.10	1,472,518.80	1,515,246.30	1,518,135.30	1,570,597.10	1,509,803.12	6.66%
Capital reserve	1,653,462.30	1,655,680.70	1,997,591.50	1,933,814.00	2,204,556.00	1,889,020.90	33.33%
Government subsidy	53,060.00	108,500.00	117,800.00	111,900.00	92,920.00	96,836.00	75.12%

Note: Data from WIND database.



**Figure 9.** Analysis of financing situation of Shanghai Electric from 2017 to 2021.

From the viewpoint of the years 2017 to 2021, Shanghai Electric’s financing methods are mainly equity financing. In 2021, the share capital value is 157,059,710

million RMB, and the capital reserve is 220,455,600 million RMB. From the perspective of the mean value of individual indicators, the undistributed profit is the maximum value, which is 208,505,860 million RMB, and the government subsidy is the minimum value, which is 9,683,600 million RMB. In terms of growth rate, long-term borrowing grew the fastest between 2017 and 2021, with a growth rate of 475.22%, while undistributed profit grew negatively, with a growth rate of -20.37%. In short, Shanghai Electric’s financing channels are diversified and mainly equity financing.

## 5.2. Evaluation of financing efficiency of Shanghai Electric

### 5.2.1. Static analysis of financing efficiency of Shanghai Electric

This paper directly compares the comprehensive technical efficiency of Shanghai Electric with the average of sample enterprises to evaluate its financing effectiveness. As shown in **Table 12** below.

**Table 12.** Comprehensive technical efficiency of Shanghai Electric and enterprise average from 2017 to 2021.

Year	2017	2018	2019	2020	2021
Shanghai Electric	1.000	1.000	1.000	1.000	0.928
Average value of new energy enterprises	0.792	0.865	0.911	0.832	0.880

Note: DEAP2.1 software running results calculated.

This paper analyzes the comprehensive technical efficiency of Shanghai Electric from 2017 to 2021, as shown in **Table 12**. From 2017 to 2020, the comprehensive technical financing efficiency of Shanghai Electric was relatively stable, and the value is 1.000, which has reached the effective state. In 2021, the comprehensive technical efficiency of Shanghai Electric is reduced to 0.928, which is in a non-efficient state. In 2017–2019, the average value of new energy enterprises increased by 0.911 from 0.792, decreased to 0.832 in 2020, and rose to 0.880 in 2021. Although the overall trend of fluctuation increases, it has not reached an effective state. By comparing the overall technical efficiency of Shanghai Electric to the average of new energy companies, it is found that from 2017 to 2020, the overall technical efficiency of Shanghai Electric exceeded the average of new energy companies., both in terms of stability and value. In 2021, although the value of Shanghai Electric’s comprehensive technical efficiency is higher than the average of new energy enterprises, it has not reached the effective state.

#### (2) Pure technical efficiency and scale efficiency.

This paper analyzes the pure technical efficiency and scale efficiency of Shanghai Electric from 2017 to 2021, as shown in **Table 13**. In terms of pure technical efficiency, the pure technical efficiency of Shanghai Electric from 2017 to 2021 is relatively stable, and the value is 1.000, which has reached the effective state. The scale efficiency of Shanghai Electric from 2017 to 2020 is relatively stable, and the value is 1.000, which has reached the effective state. However, in 2021, the scale efficiency of Shanghai Electric dropped to 0.928, which did not reach the effective state. In 2021, the scale efficiency of Shanghai Electric did not reach the

effective value, resulting in its financing efficiency did not reach the effective value. This shows that the enterprise scale of Shanghai Electric does not match its operating conditions, does not reach the effective scale of operation, and the allocation of resources is unreasonable.

**Table 13.** Pure technical efficiency and scale efficiency of Shanghai Electric from 2017 to 2021.

Year	2017	2018	2019	2020	2021
Shanghai Electric comprehensive technical efficiency	1.000	1.000	1.000	1.000	0.928
Shanghai Electric pure technical efficiency	1.000	1.000	1.000	1.000	1.000
Shanghai Electric scale efficiency	1.000	1.000	1.000	1.000	0.928

Note: DEAP2.1 software running results calculated.

(3) the scale reward.

As shown in **Table 14**, from 2017 to 2020, the return to scale of Shanghai Electric is in the best state, while in 2021, the return to scale of Shanghai Electric is in a decreasing state. The above data and analysis show that during 2017–2020, the enterprise’s input and production reached an optimal state. In 2021, companies have excess capacity. Enterprises increase capital investment, will not bring more income output, easy to cause the waste of financing funds.

**Table 14.** Returns to scale of Shanghai Electric from 2017 to 2021.

Year	2017	2018	2019	2020	2021
Returns to scale	-	-	-	-	irs

Note: DEAP2.1 software running results calculated.

### 5.2.2. Dynamic analysis of financing efficiency of Shanghai Electric

This paper analyzes the dynamic situation of Shanghai Electric financing efficiency, as shown in **Table 15**.

**Table 15.** Malmquist index and decomposition of Shanghai Electric and enterprise mean value.

	Comprehensive technical efficiency change index	Technological progress index	Index of change in pure technical efficiency	Scale efficiency index	Malmquist index
Shanghai Electric	0.981	0.984	1.000	0.981	0.966
Average value of new energy enterprises	1.029	1.012	1.004	1.024	1.042

Note: DEAP2.1 software running results calculated.

The above data are all less than 1, indicating that the current financing efficiency of the enterprise is in an inefficient state. The Malmquist index is the product of the comprehensive technical efficiency change index and technical progress index. The above data show that the low value of Shanghai Electric’s comprehensive technical efficiency change index and the low technical progress index together lead to the low value of Shanghai Electric’s Malmquist index. Among them, the change index of pure technical efficiency is 1.000, and the scale efficiency index is 0.981. From the comparison of the mean value of Shanghai Electric and new energy enterprises, all values are lower than the mean value of new energy enterprises, and the Malmquist index of Shanghai Electric is 0.966, which is in an

inefficient state, lower than the mean value of new energy enterprises.

From the dynamic analysis of the financing efficiency of Shanghai Electric, the financing efficiency of enterprises has not reached the effective state, and the specific reasons for its low financing efficiency are the low technical progress index and low scale efficiency index.

### 5.3. Analysis of influencing factors of Shanghai Electric financing efficiency based on grey correlation degree

#### 5.3.1. Calculation of grey relational degree

(1) Establish data series

Let the reference sequence and comparison sequence be shown in Equations (7) and (8):

$$y_0 = \{y_0(1), y_0(2), \dots, y_0(n)\} \tag{7}$$

$$x_i = \{x_i(1), x_i(2), \dots, x_i(n)\} \tag{8}$$

In this paper, the pure technical efficiency value of Shanghai Electric from 2017 to 2021 is determined as the reference sequence  $y_0$  of the grey correlation degree model, and the enterprise scale, green technology innovation, enterprise capital structure, employee quality and government support of Shanghai Electric from 2017 to 2021 is determined as the comparison sequence  $x_0$  of the grey correlation degree model. The evaluation index system constructed is shown in **Table 16**.

**Table 16.** Evaluation index system of grey correlation degree.

	Coefficient	Index	Definition
Reference sequence	$y_0$	FE	Pure technical efficiency in DEA
	$x_1$	SIZE	Take the natural log of total assets
	$x_2$	GREEN	(Ending intangible assets – beginning intangible assets)/Ending total assets
Comparison sequence	$x_3$	CAPITAL	Equity ratio
	$x_4$	STAFF	The proportion of personnel with bachelor’s degree or above
	$x_5$	GOVERN	Government subsidy

(2) Data standardization processing

Dimensionless averaging is carried out on the original data, that is, the average value is used as the standard for comparison. The processing method is shown in Equation (9):

$$\frac{x_i(j)}{mean}, i = 1, 2, 3 \dots m, j = 1, 2, 3 \dots n \tag{9}$$

(3) Calculate the correlation coefficient

$$\zeta_i(k) = \frac{\min_i \min_k [y_0(k) - x_i(k)] + \rho \max_k [y_0(k) - x_i(k)]}{[y_0(k) - x_i(k)] + \rho \max_i \max_k [y_0(k) - x_i(k)]}, i = 1, 2, \dots, m, k = 1, 2, \dots, n \tag{10}$$

where,  $\rho$  is the resolution coefficient, which is 0.5 in this paper.

The correlation coefficient represents the correlation between the SIZE, GREEN, CAPITAL, STAFF, GOVERN of the subsequence and the financing

efficiency of the parent sequence. The higher the value, the stronger the correlation. The correlation coefficient results and the correlation coefficient chart are shown in **Table 17**.

**Table 17.** Grey correlation coefficients of Shanghai electric financing efficiency and influencing factors.

Correlation coefficient result					
sequence	SIZE	GREEN	CAPITAL	STAFF	GOVERN
2017	0.9906	0.6514	0.9085	0.9354	0.6253
2018	0.9952	0.7756	0.9999	0.9972	0.8643
2019	0.9996	0.3346	0.9462	1.0000	0.7782
2020	0.9937	0.6697	0.9894	0.9771	0.8307
2021	0.9961	0.3768	0.9449	0.9146	0.9522

Note: SPSS27.0 software running results calculated.

(4) Calculate the correlation degree

The correlation degree between the calculated comparison sequence and the reference sequence is shown in Equation (11), and the correlation results are shown in **Table 18**.

$$r_i = \frac{1}{n} \sum_{k=1}^n \zeta_i(k) \tag{11}$$

**Table 18.** Association results.

Correlation coefficient result		
Evaluation item	Correlation degree	Ranking
SIZE	0.995	1
STAFF	0.965	2
CAPITAL	0.958	3
GOVERN	0.810	4
GREEN	0.562	5

Note: SPSS27.0 software running results calculated.

**5.3.2. Result analysis of influencing factors of Shanghai Electric financing efficiency**

By calculating the grey correlation coefficient between the financing efficiency of Shanghai Electric and the influencing factors, it is found that the correlation degree between the influencing factors and the financing efficiency of Shanghai Electric is between [0.300, 1.000]. According to the correlation results, the correlation between enterprise size and financing efficiency is the highest, with a value of 0.995, ranking first. The correlation between employee quality, corporate capital structure, and corporate financing efficiency is higher than 0.900, the correlation between government support and corporate financing efficiency is 0.810, while the corporate financing efficiency is only 0.597. Therefore, the ranking result of each influencing factor on financing efficiency is *SIZE > STAFF > CAPITAL > GOVERN > GREEN*. It shows that the scale of enterprises, the quality of employees,

capital structure, and government support have a strong impact on the financing efficiency of Shanghai Electric, while the green technology innovation has a weak impact on the financing efficiency of Shanghai Electric. It can be seen that enterprise scale, staff quality, capital structure, and government support are the main factors affecting the financing efficiency of Shanghai Electric. Moderate adjustment of enterprise scale, improvement of staff quality, adjustment of capital structure, and increase of government support are all conducive to improving the financing efficiency of Shanghai Electric. Next, this paper makes a specific analysis of Shanghai Electric's enterprise-scale, staff quality, capital structure, and government support.

(1) Enterprise scale

As can be seen from **Table 19**, the scale of enterprises gradually increases from 2017 to 2020, and slightly decreases in 2021. It shows that Shanghai Electric constantly adjusts the scale of enterprises.

**Table 19.** Analysis of enterprise size.

Year	SIZE	Rate of increase
2017	26.0183	-
2018	26.1102	0.35%
2019	26.3599	0.96%
2020	26.4771	0.44%
2021	26.4297	-0.18%

Note: Data are collected and calculated by individuals.

(2) Staff quality

The staff quality analysis of Shanghai Electric is shown in **Table 20**. In 2017–2018, the quality of employees increased from 0.4608 to 0.4898. In 2020, staff quality dropped to 0.4775. In 2021, the staff quality rose to 0.5229. On the whole, the quality of employees at Shanghai Electric is on the rise. By 2021, employees with undergraduate degrees, indicate that Shanghai Electric is paying more and more attention to the training of its staff.

**Table 20.** Analysis of employee quality.

Year	Bachelor degree or above	Total number of employees	STAFF
2017	13,618	29,552	0.4608
2018	15,121	30,870	0.4898
2019	16,390	33,720	0.4861
2020	18,771	39,312	0.4775
2021	20,402	39,015	0.5229

Note: Data are collected and calculated by individuals.

(3) Capital structure

The capital structure of Shanghai Electric is shown in **Table 21**. In 2017–2018, the capital structure of enterprises increased from 1.8187 to 2.0628. In 2020, the capital structure of enterprises fell to 1.9518. In 2021, the corporate capital structure rose to 2.0649. Overall, Shanghai Electric's corporate capital structure is on the rise,

reaching 2.0649 in 2021.

**Table 21.** Capital structure analysis.

Year	Total liabilities (ten thousand yuan)	Owner's equity (ten thousand yuan)	CAPITAL
2017	12,862,417.20	7,072,158.70	1.8187
2018	14,488,524.50	7,363,662.00	1.9676
2019	18,893,441.70	9,158,917.20	2.0628
2020	20,855,339.20	10,684,934.20	1.9518
2021	20,265,783.70	9,814,435.30	2.0649

Note: Data are collected and calculated by individuals.

#### (4) Government support

The level of government support for Shanghai Electric is shown in **Table 22**. From 2017 to 2019, Shanghai Electric's support from the government gradually increased, from 53,060.00 yuan to 178,000.00 yuan, and from 2019 to 2021, Shanghai Electric's support from the government gradually weakened, from 178,000.00 yuan to 929,200.00 yuan.

**Table 22.** Analysis of government support.

Year	GOVERN (ten thousand yuan)	Rate of increase
2017	53,060.00	-
2018	108,500.00	104.49%
2019	117,800.00	8.57%
2020	111,900.00	-5.01%
2021	92,920.00	-16.96%

Note: Data are collected and calculated by individuals.

### 5.4. Analysis of problems existing in the financing efficiency of Shanghai Electric

From the static analysis of the financing efficiency of Shanghai Electric. However, in 2021, the comprehensive technical efficiency of Shanghai Electric is 0.928, which has not reached the effective state. From the perspective of dynamic analysis, from 2017 to 2021, the financing efficiency of Shanghai Electric has not reached an effective state. The problems in the financing efficiency of Shanghai Electric are analyzed as follows.

#### 5.4.1. Enterprise level

##### (1) The financing structure is not reasonable

Equity financing occupies an important proportion of the total financing scale of Shanghai Electric. As the basis and premise of Shanghai Electric's development of a new energy sector business, the company continues to carry out equity financing to meet its strategic development needs. However, because the proportion of equity financing is too high, the negative impact brought by this excessive dependence on equity financing can not be ignored.

##### (2) The scale of enterprises is not enough to match

From the static analysis of Shanghai Electric's financing efficiency, it can be

seen that in 2021, the scale efficiency of Shanghai Electric has not reached the effective state, which directly leads to Shanghai Electric's financing efficiency has not attained an effective level. In addition, in 2021, Shanghai Electric's return to scale is in a decreasing state. According to the dynamic analysis of Shanghai Electric's financing efficiency, the low scale efficiency index is one of the reasons for the low Malmquist index of Shanghai Electric. The above data shows that there is overcapacity in Shanghai Electric, and the increase of capital investment by enterprises will not bring more income output, and it is easy to waste financing funds. The enterprise scale of Shanghai Electric does not match its operating status and does not reach the effective scale of operation.

### (3) Staff quality is not first-class

In 2021, employees with a bachelor's degree or above in Shanghai Electric account for 0.5229 of the total number of employees, although compared with previous years, the value increases, but there is still a certain gap with the ideal value. The quality of employees directly affects the development of enterprises. If the employees lack basic qualities and skills, it will bring a series of problems and challenges to the enterprise. For example, they may not be competent for the work required by the business, resulting in inefficiency. It may also be due to the lack of professional skills and, the unable to bring high-quality products and services to the enterprise so that customer satisfaction is reduced.

### (4) The capital structure is not scientific enough

Overall, from 2017 to 2021, Shanghai Electric's equity ratio is still on the rise, reaching 2.0649 in 2021. As a new energy enterprise, Shanghai Electric is a high-tech enterprise. The capital structure of Shanghai Electric shows that the capital source of the enterprise is higher from debt than from owners. This shows that Shanghai Electric's moderate liabilities can give full play to the positive role of financial leverage, but the value should be kept within a reasonable range.

## 5.4.2. Government level

Government support is not strong enough. From 2017 to 2019, Shanghai Electric's support from the government gradually increased, from 53,060.00 yuan to 1,178,000.00 yuan, and from 2019 to 2021, Shanghai Electric's support from the government gradually weakened, from 1,178,000.00 yuan to 929,200.00 yuan. Appropriate government subsidies can effectively reduce the operating costs of Shanghai Electric and relieve the operating pressure of Shanghai Electric, thus promoting the improvement of financing efficiency. How the government can promote the improvement of enterprise financing efficiency through multiple channels is an important issue.

## 6. Conclusions and enlightenments

### 6.1. Conclusion

This study examines the financial efficiency of Shanghai Electric and new energy companies, leading to the following conclusions:

(1) Diversified financing channels for new energy enterprises and Shanghai Electric. From the analysis of the financing situation of new energy enterprises, the

current situation of internal financing, debt financing, equity financing, and financial support of new energy enterprises have shown a good development trend. From the analysis of Shanghai Electric's financing situation, Shanghai Electric's financing channels are diversified, and mainly equity financing.

(2) In this paper, the inflow and outflow ratio of financing cash, equity, and internal financing input is selected as input indicators, and the main business profit, earnings per share, return on equity, and DEA-BCC and DEA-Malmquist models are applied. The Shanghai Electric is measured respectively, and both of them have not reached the effective state. From the static analysis of new energy enterprises, from 2017 to 2021, the number of new energy enterprises with DEA effectiveness accounted for only about 15% of the sample enterprises, and the comprehensive technical efficiency of new energy enterprises was greatly affected by the change of scale efficiency. In terms of dynamic analysis, the overall financing efficiency of new energy enterprises from 2017 to 2021 is in the efficiency improvement, but there is also a low financing efficiency. In terms of static analysis, from 2017 to 2020, the comprehensive technical efficiency of Shanghai Electric reached the best state, and in 2021, the comprehensive technical efficiency did not reach the best state, which is caused by the scale efficiency has not reached the best state. In the dynamic analysis, the low technical progress index and scale efficiency index are the specific reasons why Shanghai Electric's financing efficiency has not reached the effective state.

(3) For new energy enterprises, enterprise scale is inversely correlated with financing efficiency, while green technology innovation, enterprise capital structure, government support, and staff quality are positively correlated with financing efficiency; For Shanghai Electric, the scale of enterprises, is the quality of employees. By analyzing relevant literature and combing through it, this paper selects six main factors that affect financing efficiency and conducts regression analysis on the influencing factors of financing efficiency of new energy enterprises through the constructed Tobit model. Among the six influencing factors, digital transformation has no significant impact on the financing efficiency of new energy enterprises, enterprise scale is negatively correlated with the financing efficiency of new energy enterprises, and green technology innovation, enterprise capital structure, employee quality, and government support are positively correlated with the financing efficiency of new energy enterprises. Based on the analysis of the factors affecting the financing efficiency of new energy enterprises, this paper studies the factors affecting the financing efficiency of Shanghai Electric by using the grey relational degree model. For Shanghai Electric, the scale of enterprises is the quality of employees.

## **6.2. Enlightenment**

The new energy enterprises themselves have high risks, and the demand for funds is also relatively large. In this case, how to obtain more funds and how to better allocate these funds to the new energy enterprises' own operations is a problem that both enterprises and the government need to face.

### **6.2.1. Enterprise level**

#### **(1) Improving the financing structure**

With the continuous increase of financing channels, financing methods are gradually increasing. Different financing methods correspond to different financing costs, and excessive financing costs will bring capital and debt pressure to enterprises. Therefore, we should do a good job in financing planning, optimize financing costs, and reduce the costs of enterprises in the financing process through the combination of multiple financing methods while maintaining reasonable liquidity. New energy enterprises should scientifically combine financing methods according to the objective situation of the market and their own conditions, so as to reduce capital costs and risks.

#### **(2) Increase research and development efforts**

After obtaining sufficient financing, new energy enterprises should increase their investment in research and innovation. In terms of capital supply, on the basis of ensuring the normal operation of new energy enterprises, as much as possible should be tilted to scientific and technological research and development. With sufficient funds, new energy enterprises should also make reasonable use of the invested funds. New energy enterprises should focus their research and development on the key aspects of new energy technology supported by China, such as power generation technology, hydrogen energy technology, large-scale new energy storage technology, and so on. In addition, new energy enterprises should innovate and develop new energy green products according to their main business and market demand, extend the industrial chain of new energy products on the basis of green production, and implement traceable process management from research and development, trial, input, production, processing, sales to late peripheral and after-sales service to promote open research and development output of new energy products. Thus, the information is symmetrical, so that consumers can feel at ease to buy, users can feel at ease to use, and finally enable new energy enterprises to obtain economic benefits.

#### **(3) Focus on scale effectiveness**

If the scale of the new energy enterprise does not match its operating status, it will not reach the effective scale, which will lead to a waste of resources and poor financing efficiency. New energy enterprises should pay more attention to scale efficiency and scientifically allocate various elements. First of all, new energy enterprises should implement a professional division of labor. New energy enterprises can divide and distribute each link in the production process according to different professions, skills, or types of work, so that each employee can give full play to their strengths, thereby improving production efficiency and quality. Second, adjust the organizational structure. Strengthen the cooperation between various departments within new energy enterprises, establish a good cooperation mechanism, strengthen the communication and collaboration between departments, and make the cooperation between various departments within new energy enterprises closer. In addition, optimize workflow. New energy enterprises can carry out process reorganization, redesign the work process, eliminate duplication and inefficient links, and make the work process more simple, intuitive, and easy to implement.

#### (4) Strengthen staff training

New energy enterprises should pay attention to the quality training and improvement of employees, to provide them with a good working environment and learning opportunities, only in this way, in order to let employees give full play to their talents and abilities, to create greater value and contribution for the enterprise. At the same time, new energy enterprises should introduce new energy technology-related talents through incentive mechanisms, give talents superior treatment and welfare support at the material level, and provide more development opportunities and space as much as possible at the spiritual level to ensure the sustainable development of new energy enterprises.

#### (5) Adjusting the capital structure

New energy enterprises can optimize their capital structure to achieve the purpose of reducing costs, improving efficiency, and reducing risks. When new energy enterprises optimize their own capital structure, they need to first have a comprehensive understanding of their own financial situation, appropriately adjust the capital structure according to the subjective and objective conditions, improve financing efficiency, and promote the improvement of economic benefits of enterprises.

#### (6) Optimize resource allocation

New energy enterprises can effectively allocate and use various resources of enterprises in a scientific and reasonable way to improve the efficiency and competitiveness of enterprises. There are several methods for new energy enterprises to optimize the allocation of resources: First, fine management. Through data analysis and systematic management, to achieve the optimal allocation and utilization of new energy enterprises' resources, improve production efficiency and profit margins. Second, resource intensification. Optimize the production process, reduce resource waste, and improve resource utilization. Third, rational division of labor. According to the characteristics and advantages of each resource, it will be allocated to the most effective departments or positions. Fourth, information management. Using information technology to realize the sharing and coordination of enterprise resources, improves management efficiency and decision-making level. Optimizing resource allocation of new energy enterprises is a systematic and comprehensive work, which requires enterprises to comprehensively improve their management level and innovation ability to achieve the maximum value of resources.

### **6.2.2. Government level**

The government should further increase support, formulate targeted preferential policies, increase financing support for new energy enterprises, and optimize the financing environment. First, the government should increase financing support for new energy enterprises, solar photovoltaic power generation, and nuclear power and effectively solve the problem of insufficient funds for new energy enterprises. Increase investment in new energy projects, and strengthen the construction of new energy infrastructure. Second, the government should strengthen the tracking, service, and supervision of new energy enterprises. Relevant government departments should take the initiative to establish communication channels with new

energy enterprises, understand the development status and existing problems of new energy enterprises, and take corresponding measures to solve them. At the same time, it is necessary to regularly organize relevant experts to conduct tracking services supervision and inspection. Third, strengthen the supervision of tracking services, take the initiative to establish communication channels with new energy enterprises, understand their development status and problems, and solve them in a timely manner; regularly organize experts to carry out tracking services, supervision, and inspection; improve the guarantee system; standardize guarantee behavior; and timely and accurately provide new energy enterprise development information.

### **6.3. Revelation**

#### **6.3.1. Theoretical enlightenment**

This research employs a thorough approach by utilizing DEA-BCC, DEA-Malmquist, and Tobit models to assess the financing efficiency of new energy companies from both static and dynamic perspectives, while also delving deeply into the factors that influence this efficiency. This multi-model and multi-dimensional research method provides a more systematic and comprehensive analysis framework for the study of corporate financing efficiency and enriches the research perspective in this field.

In the discussion of the influencing factors, not only the internal scale, technological innovation, capital structure, and staff quality of the enterprise are considered, but also the external factor of government support is included, and the direction and degree of each factor's effect on financing efficiency are clarified through empirical research. This will help to further improve the theoretical system of influencing factors of enterprise financing efficiency and provide a more comprehensive theoretical reference for subsequent research.

Through the in-depth analysis of the financing status, efficiency, and influencing factors of new energy enterprises, the uniqueness of new energy enterprises in the financing process is revealed. This provides a targeted empirical basis for the development of new energy enterprise financing theory and promotes the deepening of theoretical research in this field.

#### **6.3.2. Practical inspiration**

The research results clarify the current situation. Enterprises can optimize the financing structure according to this, staff quality improvement, and other aspects of investment to boost their financial capability and increase funding efficiency. The research reveals the important impact of government support on the financing efficiency of new energy enterprises and provides empirical support for government departments to formulate relevant policies. According to the research conclusions, the government can increase financing support for new energy enterprises, improve subsidy policies, strengthen tracking services and supervision of enterprises, and optimize macro-management and regulation measures so as to create a more favorable financing environment and promote the development of the new energy industry. At the same time, it will help financial institutions to more comprehensively understand the financing characteristics and risk status of new energy enterprises. Financial institutions can refer to factors such as enterprise scale, technological

innovation ability, and capital structure to more accurately assess the credit risk of new energy enterprises, reasonably formulate credit policies and product innovation strategies, and ensure the safety and appreciation of their own financial assets while supporting the development of new energy enterprises.

#### **6.4. Deficiencies and prospects**

First, this paper analyzes this study, which evaluates the financing efficiency of new energy companies, including Shanghai Electric, while examining the factors that impact this efficiency. It aims to identify the underlying causes of the suboptimal financing performance of these enterprises and offers sound recommendations for improvement. However, Shanghai Electric is only an example and cannot fully represent new energy enterprises. Second, various elements influence the funding of renewable energy companies, and only six influencing factors are listed in this paper. Finally, although the study identified 153 enterprises as research objects after screening, the sample may not be able to fully cover all types, sizes, and development stages of new energy enterprises. New energy companies across various regions and sectors may have significant differences in financing models, operating characteristics, and other aspects. Only selecting this part of enterprises for research may lead to deviations in the reflection of new energy enterprises, and it is difficult to extend to all new energy enterprises. In future studies, more factors affecting corporate financing efficiency, including the outbreak of COVID-19 and macroeconomic disruption, can be explored. On this basis, subsequent researchers can combine new data and methods to further improve the research.

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