

Research on the Financing Efficiency of listed Companies in China's Photovoltaic Industry

Qian Zhang ^a, Chen Zhang ^b

Lanzhou University of Technology, Lanzhou 730000, China

^a314984220@qq.com, ^b601257236@qq.com

Abstract. Through sorting out the theory of financing efficiency, the influencing factors and empirical methods of financing efficiency at home and abroad, taking the panel data of 29 listed companies in the photovoltaic industry in China from 2017 to 2021 as the research object, the DEA-Tobit model was used to study the financing efficiency and influencing factors of China's photovoltaic industry. The results show that in recent years, the financing efficiency of listed companies in the domestic photovoltaic industry has fluctuated greatly, and there is a certain downward trend as a whole, and there is still a broad room for improvement; There are significant positive effects on net profit, net profit margin on sales, cost of main business, cash ratio and corporate financing efficiency, while current liabilities and corporate financing efficiency show significant negative effects. Based on this, suggestions are put forward to optimize the scale of listed companies, broaden financing channels, and introduce new financing methods by relevant government departments.

Keywords: Photovoltaic industry; Financing efficiency; DEA-Tobit model.

1. Introduction

The outline of the "13th Five-Year Plan" proposes to further promote the energy revolution, focus on promoting the reform of energy production and utilization methods, and optimize the energy supply structure, of which solar energy uses light energy to generate electricity, which has unique advantages over other new renewable energy sources. However, the domestic photovoltaic industry also has the phenomenon of "overcapacity, high energy consumption, high pollution", excessive dependence on overseas markets, photovoltaic industry investment has the characteristics of long return cycle, high risk and low return, untimely subsidy issuance, abandonment of light and power rationing behavior and "double reverse" investigation in European and American countries also affect the loan decisions of financial institutions, these factors have caused the development of the photovoltaic industry chain uncoordinated. Based on this, by studying the financing status of listed companies in the domestic photovoltaic industry, evaluating the financing efficiency of listed companies in the domestic photovoltaic industry from both qualitative and quantitative aspects, analyzing the main factors affecting financing efficiency, and putting forward scientific and reasonable suggestions for the development of the photovoltaic industry in the post-epidemic era and the development of the domestic photovoltaic industry, the market development, the improvement of the resource allocation structure of the industry, and the acceleration of industrial technology innovation.

2. Organization of the Text

2.1 Research methodology、Construction of indicator system and Data sources

2.1.1 Research methodology

Data envelopment analysis (also known as DEA) is one of the tools to evaluate the efficiency between decision units of the same nature, and American scholars Charles, Coopers and Rhodes first proposed the DEA- C^2R model. The core idea of the DEA method is to evaluate the efficiency of each decision unit through the multi-input data and multi-output data of multiple decision units, and to evaluate the efficiency of each decision unit and determine the effectiveness of the DEA. In 1984, Banker, Charnes, and Cooper proposed a variable B^2C model based on returns on scale, which

exhibited the validity of the pure technique of the decision unit, with its mathematical expression (1) as follows:

$$\begin{aligned}
 & \min \xi \\
 \text{s. t. } & \sum_{j=1}^n \lambda_j X_j + s^- \leq \xi X_o \\
 & \sum_{j=1}^n \lambda_j Y_j - s^+ \geq Y_o \\
 & \sum_{j=1}^n \lambda_j = 1 \\
 & \lambda_j \geq 0, j=1, 2, \dots, n \\
 & \theta, s^+ \geq 0, s^- \geq 0
 \end{aligned} \tag{1}$$

Tobit regression model. The Tobit regression model was proposed by Nobel Laureate Economist James Tobin (1958), and this econometric model is mainly adapted to the situation when the dependent variable is partially continuously distributed and partially discrete. In this paper, using the Tobit regression model, the parameter estimates obtained have the characteristics of unbiased and consistency, which can further analyze the relevant factors affecting efficiency, and its basic structure is as follows (2):

$$\begin{aligned}
 & Y_i = \\
 & y_i^* = \beta x_i + \xi, \text{ if } y_i^* > 0 \\
 & 0, \text{ otherwise}
 \end{aligned}$$

Where β is the unknown parameter estimator vector, x_i is the explanatory vector, and y_i^* is the explanatory vector? The interpreted vector, y_i^* represents the efficiency value binary, $N \sim (0, \sigma^2)$.

2.1.2 Construction of indicator system

The evaluation index system for enterprise financing efficiency is usually divided into two parts: input indicators and output indicators, and the input indicators are mainly from the two aspects of financing scale and financing cost. Consider, and the output indicator mainly indicates the ability of enterprise development, profit, operation and debt repayment. The above are the main factors affecting the financing efficiency of enterprises, and the indicator variables can be further selected in combination with the knowledge of enterprise financial management, and the input indicators are respectively selected for cash flow outflows generated by total assets ($X_1/10,000$ yuan), finance expenses ($X_2/10,000$ yuan), gearing ratio ($X_3/\%$) and operating expense ratio ($X_4/\%$); The output indicators correspond to the selected operating profit growth rate ($Y_1/\%$), return on net assets ($Y_2/10,000$ yuan), total asset turnover rate ($Y_3/10,000$ yuan) and quick ratio ($Y_4/10,000$ yuan).

2.1.3 Data sources

According to the definition guidelines for photovoltaic enterprises in relevant national laws, the number of listed companies involved in photovoltaic industry business in mainland China is currently more than 100 (limited to companies listed in Shanghai and Shenzhen), and the main business scope includes research and development, production and sales of photovoltaic-related equipment and control software, design, installation and sales of photovoltaic engineering, operation and maintenance and related technical services. This paper examines the time period for 2017-2021, considered factors such as corporate performance and stock value instability of listed companies should be screened according to relevant criteria. At the same time, companies with abnormal or incomplete relevant data, such as ST listed companies, are removed to ensure the reliability of data analysis conclusions. Finally, a total of 29 listed photovoltaic companies met the selection criteria and became the subject of the study sample. The number of decision-making units in this paper is 29, and the number of input and output index variables is 8, which meets the requirements of the DEA sample size. When receiving the paper, we assume that the corresponding authors grant us the copyright to use the paper for the book or journal in question. When receiving the paper, we assume

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In this paper, 29 listed photovoltaic companies in China are selected as a sample, and the annual financial data of 2017-2021 is used as the panel data, and the original data of each input-output index variable is derived from the Wind database. To make the data with comparability and rationality, the linear dimensionless method can be used to de-dimension and normalize the data, as shown in the following equation (3):

$$Y_{ij} = \frac{X_{ij} - m_j}{M_j - m_j} * 0.9 + 0.1 \quad (3)$$

$$m_j = \min(X_{ij})$$

$$M_j = \max(X_{ij})$$

$$(i=1,2,\dots,n), Y_{ij} \in [0,1]$$

2.2 Empirical Research

Table 1. Pearson the mean correlation coefficient

Input indicators	X ₁	X ₂	X ₃	X ₄
X ₁	1	0.546973874	0.496178523	0.098412138
X ₂	0.546973874	1	0.435512678	-0.017645958
X ₃	0.496178523	0.435512678	1	0.227846328
X ₄	0.098412138	-0.017645958	0.227846328	1

Table 2. Pearson the mean correlation coefficient

Output indicators	Y ₁	Y ₂	Y ₃	Y ₄
Y ₁	1	0.4416973874	0.196378523	0.008412138
Y ₂	0.4416973874	1	0.535512678	0.517645958
Y ₃	0.196378523	0.535512678	1	0.293846318
Y ₄	0.008412138	0.517645958	0.293846318	1

Table 3. 2017-2021 Financing efficiency results of listed companies in the domestic photovoltaic industry

Year	CRSTE	VRSTE	SCALE	CRSTE effective quantity	VRSTE effective quantity	SCALE effective quantity
2017	0.513	0.706	0.770	3	11	3
2018	0.515	0.707	0.760	3	11	3
2019	0.506	0.701	0.804	2	10	2
2020	0.507	0.697	0.771	3	10	2
2021	0.505	0.696	0.767	2	9	2

The use of DEA model for empirical analysis, the need to meet the input indicators, the correlation between the output indicators is not strong, this paper first of the empirical data for Pearson correlation analysis, in order to make the correlation analysis more accurate, the sample data selected in this paper for 2017-2021, first of the sample data of each year in the input indicators and output indicators for correlation analysis, and then the Five years between the indicators between the Pearson correlation coefficients to average, and finally the results show: In addition to the Pearson correlation coefficient of the indicator and the indicator itself is 1, the mean Pearson correlation coefficient between the input indicators and the Average Pearson correlation coefficient between the output indicators are less than 0.6, which proves that there is no strong correlation between the indicators, and the indicator selection is reasonable. The results are as follows:

This step uses the BCC model to raise financing for 29 listed companies in the photovoltaic industry rates are measured and analyzed, and the results of the model output (see Table 3) include the overall efficiency and its two subdivisions: pure technical efficiency and scale efficiency.

As shown in the table, the comprehensive efficiency of financing of listed companies in the domestic photovoltaic industry fluctuated as a whole during the period from 2017 to 2021, and the highest level was about 0.515. From the perspective of the number of companies with effective comprehensive efficiency, the number of effective companies in recent years has fluctuated around 3, accounting for about 10.3% of the total sample. Since 2017, the number of companies with effective overall efficiency has begun to decline year by year, reaching a decline of 66.7%. This shows that in recent years, the overall level of financing efficiency of the domestic photovoltaic industry has begun to decrease, and some listed companies have the problem of low capital input-output ratio, and financing efficiency has yet to be solved.

From the comparative analysis of pure technical efficiency and scale efficiency, it is found that the overall level of pure technical efficiency of listed companies in the domestic photovoltaic industry is low, indicating that the photovoltaic industry and the wind power industry need to start from the aspect of improving production technology and management capabilities to improve the overall financing efficiency of the industry; The overall level of scale efficiency is high, and the annual average of the scale efficiency of listed companies in the photovoltaic industry is high, indicating that these companies are close to the optimal production scale. However, the number of companies with pure technical efficiency is higher than that of scale efficiency, which may be caused by the unbalanced distribution of financing levels or the large number of listed companies with low financing efficiency, thus forming an instability in the financing efficiency of the photovoltaic industry.

3. Literature References

According to the measurement results of DEA efficiency, the comprehensive technical efficiency represents the financing efficiency of the photovoltaic industry, the DEA comprehensive financing efficiency is taken as the interpreted variable, and the restricted dependent variable is regressed by the balance panel data of each explanatory variable. The explanatory variables of the Tobit regression model are selected from the balance panel data from 2017 to 2021 as the panel regression, and the explanatory variables are divided into macroeconomic part and micro enterprise part. The macro section selects three indicators: GDP growth rate, CPI consumer price index, and M2 money supply growth rate, which are derived from the websites of the National Bureau of Statistics and Chinese Minmin Bank. The micro part selects three financial indicators of 29 listed companies in China's photovoltaic industry as explanatory variables: net profit, sales profit margin, cash ratio, and the data comes from the Wind information database.

Table 4. Tobit regression model analysis results

Variable	Regression coefficients	Standard error	z	P > z	95% confidence interval	
GDP	0.1660	0.0084	11.7400	0.0000	0.1594	0.1826
CPI	-0.2074	0.0173	-9.7800	0.0000	0.2147	-0.7931
M2	0.1258	0.0203	6.1800	0.0000	0.0859	0.1656
NP	0.0817	0.0125	6.3900	0.0000	0.0580	0.1093
NSIR	0.0602	0.0317	1.7900	0.0741	-0.0058	0.1266
CR	0.0376	0.0159	2.4100	0.0160	0.0072	0.0701

GDP growth rate, broad money supply growth rate is positively correlated with the financing efficiency of the photovoltaic industry, and the GDP growth rate has a more significant positive impact on financing efficiency than the M2 growth rate. The development of the photovoltaic industry is inseparable from the macro-economy, in the good economic period, the GDP growth rate is

relatively fast, the financial market is sufficient, investor confidence is high, and the characteristics of the photovoltaic industry with high returns and high returns can absorb more capital investment. Photovoltaic enterprises should actively innovate in the period of sufficient capital, introduce foreign advanced technology, improve independent innovation capabilities, prepare for the rapid and healthy development of enterprises, and actively expand effective financing channels, attract social capital and foreign capital investment, supplement capital sources, and improve financing efficiency.

The growth rate of the consumer price index is significantly negatively correlated with the financing efficiency of the new energy industry. When ordinary individual investors mainly use household funds for daily consumption, the amount of capital converted into investment in the capital market is reduced, and the flow of private capital into the new energy industry is reduced, which will cause the financing channels of the photovoltaic industry to be tightened, the scale of financing can be reduced, and the efficiency of financing will decrease. The photovoltaic industry can predict the future economic trend according to the published macro indicators, prepare for development and risk response measures in advance, and improve the efficiency of enterprise operation and capital allocation.

The net profit, net profit margin of sales and cash ratio of listed companies in the photovoltaic industry are all positively correlated with financing efficiency. Net profit is the basic influencing factor of the amount of investment income obtained, the basis for operational management decisions, and the main indicator of the financing efficiency of listed companies. The higher the net profit, the higher the financing efficiency of listed companies in the photovoltaic industry. Net profit margin on sales is the ability to reflect the after-tax profit obtained through the sale of products by listed companies in the photovoltaic industry, and the larger the value of the net profit margin of sales, the better the financing efficiency of listed companies. If the cash ratio is too high, it shows that the working capital of listed companies in the photovoltaic industry is not fully utilized, and the opportunity cost of capital increases, resulting in a decrease in financing efficiency.

4. Summary

Based on the panel data of 29 listed companies in the photovoltaic industry in China during the inspection period, this paper establishes an index system of influencing factors of the financing efficiency of listed companies in the photovoltaic industry, and then analyzes and measures the financing efficiency of the research objects from both static and dynamic aspects. The research results show that: First, in terms of static, pure technical efficiency and scale efficiency are higher, which together lead to a better comprehensive efficiency level of photovoltaic listed companies in the sample period. However, in recent years, due to the decline in scale efficiency, there has been a small decline in comprehensive efficiency, which has affected the overall financing efficiency level of the photovoltaic industry and needs to be improved urgently; Second, in terms of dynamics, the total factor productivity of listed companies in the domestic photovoltaic industry has fluctuated greatly in the past five years, and the overall trend has shown a downward trend; Third, there is a significant positive impact effect on net profit, net profit margin on sales, cost ratio of main business, cash ratio and corporate financing efficiency, while current liabilities and corporate financing efficiency show a significant negative impact effect. Based on the above empirical results, in order to further improve the financing efficiency of listed companies in the domestic photovoltaic industry and promote the coordinated and sustainable development of the photovoltaic industry, this paper puts forward the following suggestions:

Optimize the scale of listed companies and increase investment in technological construction. Improve the company's internal capital operation management pre-control system, improve the allocation efficiency of capital. Listed companies in the photovoltaic industry should reasonably adjust capital resources, and can coordinate the full investment of various production factors to achieve the best level; At the same time, strengthening capital management and strictly controlling the use of capital can ensure the scientific nature of financing and improve the overall financing

efficiency of the company. Investing in science and technology has a long return cycle and huge risks, enterprises should pay attention to scientific risk control, and set up special risk control and scientific research and innovation institutions within the enterprise; At the same time, we should learn from foreign advanced technologies, introduce advanced scientific and technological talents, increase the independent innovation ability of enterprises, improve scientific and technological investment in basic equipment, and strive to gradually get rid of dependence on foreign technologies and equipment, master the core technologies of production, and improve China's initiative and discourse power in the international new energy market.

Increase the scale of indirect financing and broaden industrial financing channels. To increase financial support for the photovoltaic industry in the actual financing link, it is not only necessary to improve the objective improvement of the financial market financing platform in the external environment, but also to actively expand the financing channels of the photovoltaic enterprises themselves, improve the return on investment of enterprise projects by improving production and operation efficiency, creating brand effects and other positive measures, reduce investment risks, and enhance the ability of enterprises to attract capital. At different stages of the development of the industrial life cycle, direct financing and indirect financing methods have their own advantages and disadvantages, and enterprises of different sizes and characteristics are suitable for different financing models. In the process of the overall development of the photovoltaic industry, most photovoltaic SMEs lack the ability to directly finance. Indirect financing has the advantages of low entry threshold, less restrictions, flexibility and convenience, and tax saving, and is a convenient financing method more suitable for new smes. At this stage, China's photovoltaic enterprises should mainly use indirect methods such as credit from financial institutions to raise funds, strengthen indirect financing, reduce the financing burden of enterprises, broaden the industrial financing platform, and ultimately improve the efficiency of capital use, and promote the photovoltaic industry to enter the road of sustainable development.

Relevant government departments should actively implement the development policies of the photovoltaic industry and actively introduce new financing methods. Commercial banks need to increase credit support for photovoltaic companies, providing innovative financial products and services such as ABS, discounted interest loans and extended lending cycles (15-20 years). The government should also actively explore new financing methods, guide financial institutions to intervene in the investment field through asset securitization, and gradually realize the rationality, extensiveness and universality of the financing efficiency of the photovoltaic industry. The photovoltaic industry can be financed through indirect methods such as bank credit and direct methods such as listing and issuing shares, while innovative financing models such as financial leasing, asset securitization and Internet finance will bring a large amount of private capital into the new energy industry, and venture capital and project financing also provide the best channel for overseas capital inflow. The financial market should continue to improve its own function of capital media and capital appreciation, seek investment opportunities for high-quality capital, and also provide a source of funds for promising projects, create a diversified financing platform based on bank credit and listed financing, supplemented by a variety of innovative financing channels, and create the best external market environment for the financing of the new energy industry.

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