Financial Analysis of Photovoltaic Energy Listed Companies Based on Factor Analysis

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Abstract—In recent years, some photovoltaic enterprises expanded crazily, leading to serious overcapacity. Scientific and reasonable financial analysis and evaluation can provide reasonable and effective suggestions to stakeholders of listed PV Energy Enterprises. Therefore, this paper adopts the method of factor analysis to analyze and evaluate the profitability, development ability, operation ability and debt-paying ability of the listed companies in the photovoltaic energy industry, in order to reflect the photovoltaic energy industry listed companies operating and management status and provide reference with investors and other stakeholders.

Keywords-Photovoltaic Energy Enterprise, Factor Analysis, Financial Analysis

1 INTRODUCTION

In recent years, the problem of environmental pollution has become more and more serious. Countries around the world are looking for cleaner energy to replace primary energy to improve environmental pollution. Photovoltaic power generation has significant energy benefits, environmental protection and economic benefits which is one of the best green energy.

China's photovoltaic industry has developed rapidly. Especially since 2013, with the issue of a series of favorable policies, the photovoltaic industry in China has shown explosive growth. A series of problems have emerged, such as overcapacity of photovoltaic industry, excessive expansion, which is extremely detrimental to the sustainable development of the field.

At present, the development of photovoltaic energy technology in China is facing the bottleneck, and many photovoltaic energy enterprises are in the process of industry transformation or inferior in industry competition. Dong Xiaoning (2017) adopted the method of factor analysis to analyze the data of the sample companies in order to make an effective financial evaluation of the listed companies in the photovoltaic energy industry and have a clear understanding of its development status. It is considered that the development of PV energy industry is fast and the profitability of enterprises is good, but the growth ability is not enough [1]. Chen Ying (2014) took the solar cell LDK as an example which was in the dilemma and

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constructed a factor analysis model, considered the main factor affecting LDK's financial position is profitability. In the future, enterprises should vigorously develop the domestic market to increase market share and improve the debt situation and operating conditions [2]. In the same context, Feng Baonian (2015) used factor analysis to analyze the financial data of 83 PV Energy Enterprises, and found that the current PV industry is in a depressed state [3]. Zhu Wenjing (2021) evaluated the competitiveness of listed companies in Sichuan province by factor analysis, and analyzed the influence of each capability on the comprehensive competitiveness of enterprises [4]. Wang Chunzhi (2014) analyzed and compared three extraction methods of factor analysis, and explained the applicable conditions and application notes of these methods [5].

2 PRINCIPLES AND PROCEDURES OF FACTOR ANALYSIS

2.1 Principles of factor analysis

Factor analysis is a technique to reduce dimension and simplify data. It explores the basic structure of the observed data by studying the internal dependence of many variable, and expresses the basic data structure by a few “Abstract” variables. These abstract variables are called “Factors” and can reflect the main information of many variables. The original variables are observable explicit variables, while the factors are generally unobservable latent variables.

2.2 The steps of factor analysis

1) Testing the correlation between indicators; 2) KMO test and Bartlett spherical test; 3) Calculating of eigenvalues, variance contribution rate and cumulative variance contribution rate; 4) Naming and explaining the factors; 5) Calculating the factor score; 6) Calculating the common factor comprehensive score and making a comprehensive evaluation.

3 EMPIRICAL ANALYSIS

This paper takes the financial reports of 35 listed companies in the photovoltaic energy industry in 2020 as the research sample, we choose 11 indexes as the study variables: operating profit rate, cost and expense profit rate, return on equity, net profit growth rate, total assets growth rate, receivable turnover rate, inventory turnover rate, current ratio, quick moving ratio, cash ratio, and asset liability ratio. These indicators reflect the photovoltaic energy industry listed companies’ profitability, development capacity, operating capacity and debt-paying capacity. SPSS25.0 software was used for the above sample data to the main cost analysis method for the extraction of factor analysis, and the following results were obtained.

3.1 Correlation test

Figure 1 is a graph of correlation coefficient. It can be seen from the graph that there is a strong correlation coefficient among each index.

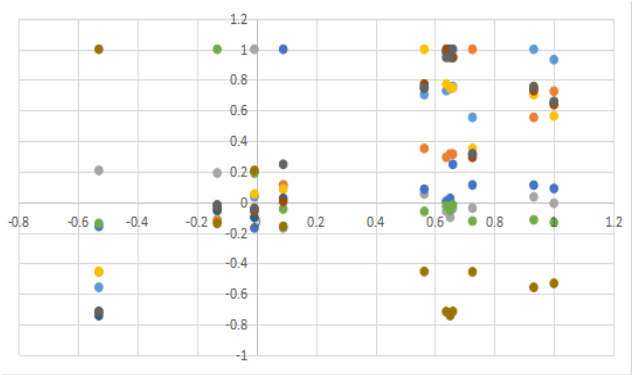

Figure 1. Correlation coefficient diagram.

3.2 KMO test and Bartlett Spherical Test

The common KMO metrics: 0.9 represents that the result is extremely appropriate to do a factor analysis; 0.8 is appropriate; 0.7 is fairly appropriate; 0.6 is mot appropriate; and 0.5 below is extremely not appropriate. The KMO statistic takes a value between 0 and 1. When the sum of simple correlation coefficients between all variables is much larger than the sum of partial correlation coefficients, the KMO value approaches 1. The closer the KMO value is to 1, the stronger the correlation between variables, and the more suitable the original variables are for factor analysis. The closer the KMO value to 0, the weaker the correlation between variables, and the less suitable the original variables are for factor analysis.

According to table 1 KMO and Bartlett test, KMO value is 0.685 and greater than 0.5, which is more suitable for factor analysis. It is better that the number of statistics of Bartlit Sphericity testis more. The significance is far less than 0.05, which shows that factor analysis can be done.

Table 1. KMO and Bartlett tests.

KMO and Bartlett Test		
Number of sampling suitability for KMO.		.685
Bartlit sphericity test	Approximate chi-square	404.719
	Degree of freedom	55
	Salience	.000

3.3 Determine factor variance contribution rate and extract common factor

According to table 2, the cumulative variance contribution rate of the first four factors is 83.404%, which shows that the information contained in the original variables can be explained effectively and the loss of information is less. The result of factor analysis is more ideal. Therefore, M = 4. It is used to replace the original 11 financial indicators with 4 main factors, which account for 83.404% of the information.

Table 2. Table of characteristic roots and variance contribution rate.

Total variance interpretation									
	Initial eigenvalue			Extract the square sum of the loads			Square sum of rotating loads		
Composition	Total	Percentage of variance	Cumulative%	Total	Percentage of variance	Cumulative%	Total	Percentage of variance	Cumulative%
1	5.684	51.673	51.673	5.684	51.673	51.673	4.718	42.890	42.890
2	1.306	11.876	63.549	1.306	11.876	63.549	2.087	18.968	61.859
3	1.183	10.751	74.300	1.183	10.751	74.300	1.236	11.240	73.099
4	1.001	9.104	83.404	1.001	9.104	83.404	1.134	10.305	83.404
5	.856	7.779	91.183						
6	.416	3.783	94.967						
7	.342	3.110	98.077						
8	.153	1.390	99.467						
9	.026	.234	99.700						
10	.020	.179	99.879						
11	.013	.121	100.000						
Extraction method: principal component analysis.									

3.4 Factor naming

Table 3 shows the factor load matrix after rotation, the first common factor has a greater load on variable quick ratio, current ratio, cash ratio, total asset growth rate, asset liability rate, cost and expense utilization rate. This shows that these six variables are highly correlated and fall into one category, which is called the solvency factor. And the second public factor, which has a greater load on the return on equity and operating profit margin, puts the two variables into the same category. The third public factor has a greater load on the turnover rate of accounts receivable and the growth rate of net profit, which is named as the development capacity factor. It's called the operational capability factor.

Table 3. Factor load matrix after rotation.

The rotational composition matrix A				
	Composition			
	1	2	3	4
Quick ratio	.978	.131	.024	-.029 - . 029
Flow ratio	.973	.146	-.018 - . 018	-.058 - . 058

Cash ratio	.931	.209	-.140 - . 140	.040
Growth rate of total assets	.777	.274	.104	-.037 - . 037
Ratio of assets to liabilities	-.726 - . 726	-.226 - . 226	.338	-.168 - . 168
Cost, expense, profit margin	.687	.629	.039	-.071 - . 071
Return on equity	.169	.877	-.132 - . 132	-.061 - . 061
Operating Margin	.550	.770	-.001 - . 001	-.099 - . 099
Turnover rate of accounts receivable	-.010 - . 010	.206	-.789 - . 789	.138
Growth rate of net profit	-.112 - . 112	.229	.670	.471
Inventory turnover	.035	-.156 - . 156	-.023 - . 023	.916

3.5 Factor score

The factor score is calculated as follows:

$Y_1 = X_1 * (- 0.034) + X_2 * 0.051 + X_3 * (- 0.194) + X_4 * (- 0.071) + X_5 * 0.181 + X_6 * (- 0.106) + X_7 * 0.036 + X_8 * 0.273 + X_9 * 0.281 + X_{10} * 0.234 + X_{11} * (- 0.149)$

$Y_2 = X_1 * 0.400 + X_2 * 0.262 + X_3 * 0.584 + X_4 * 0.244 + X_5 * (- 0.017) + X_6 * 0.151 + X_7 * (- 0.053) + X_8 * (- 0.168) + X_9 * (- 0.178) + X_{10} * (- 0.105) + X_{11} * 0.029$

$Y_3 = X_1 * 0.050 + X_2 * 0.086 + X_3 * (- 0.081) + X_4 * 0.517 + X_5 * 0.137 + X_6 * (- 0.098) + X_7 * (- 0.688) + X_8 * 0.046 + X_9 * (- 0.078) + X_{10} * (- 0.066) + X_{11} * 0.254$

$Y_4 = X_1 * (- 0.040) + X_2 * (- 0.032) + X_3 * 0.021 + X_4 * 0.386 + X_5 * (- 0.036) + X_6 * 0.208 + X_7 * 0.814 + X_8 * (- 0.058) + X_9 * (- 0.036) + X_{10} * 0.046 + X_{11} * (- 0.184)$

The composite score is calculated as follows:

$Z_1 = (Y_1 * 42.890\% + Y_2 * 18.968\% + Y_3 * 11.240\% + Y_4 * 10.305\%)/83.404\%$

Table 4. Component score coefficient matrix.

Component score coefficient matrix	
	Composition

	1	2	3	4
Operating Margin	-.034 -.034	.400	.050	-.040 -.040
Cost, expense, profit margin	.051	.262	.086	-.032 -.032
Return on equity	-.194 -.194	.584	-.081 -.081	.021
Growth rate of net profit	-.071 -.071	.244	.517	.386
Growth rate of total assets	.181	-.017 -.017	.137	-.036 - .036
Turnover rate of accounts receivable	-.106 -.106	.151	-.668 -.668	.208
Inventory turnover	.036	-.053 -.053	-.098 -.098	.814
Flow ratio	.273	-.168 -.168	.046	-.058 -.058
Quick ratio	.281	-.178 -.178	.078	-.036 -.036
Cash ratio	.234	-.105 -.105	-.066 -.066	.046
Ratio of assets to liabilities	-.149 -.149	.029	.254	-.184 -.184

According to the coefficient matrix of component score, the scores of 13 enterprises with comprehensive score greater than 0 in figure 2 can be obtained by SPSS calculation. The top five overall scoring companies are Jinbo Shares, Deer Laser, Weichuang Extronics, Dreamnet Technology, and Tongde Chemical.

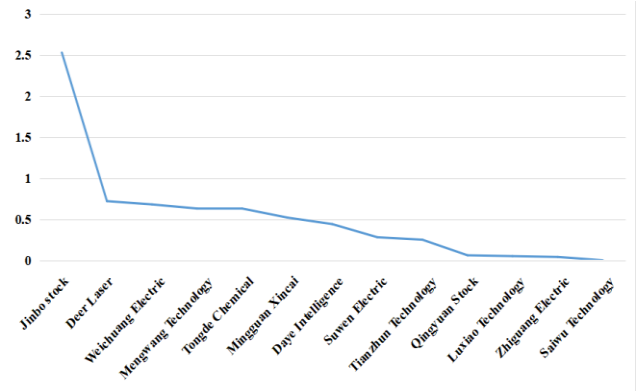

Figure 2. Composite score chart.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusion

1)In factor analysis with principal component analysis as extraction method, the top five companies in the comprehensive score are Jinbo Shares, Deer Laser, Weichuang Extronics, Dreamnet Technology, and Tongde Chemical.

2)In factor analysis with principal component analysis as extraction method, the variance contribution rate of solvency factor is the largest, followed by profitability factor. These two factors have the greatest influence on the calculation of the composite score.

3)By analyzing the data of the 35 listed companies in the photovoltaic energy industry in 2020, it can be known that one third of the enterprises have a positive overall score, accounting for a small proportion, indicating that most of the listed companies in the photovoltaic energy sector financial competitiveness is weak, and facing higher risk.

4.2 Advice

In order to optimize the capital structure of PV energy industry, promote the green development and sustainable development of PV energy industry, the following suggestions are proposed:

1)While paying attention to the improvement of debt-paying ability and profit-making ability, PV energy enterprises should focus on the improvement of their own development ability and operation ability.

2)Photovoltaic energy industry enterprises should pay more attention to technological reform and technological innovation, reduce the cost of technology, reduce or even get rid of the dependence on government subsidies to form their own independent brand.

3)Photovoltaic energy industry enterprises should introduce more advanced management experience, focus on product quality and cost management, improve financial competitiveness.

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