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Research on Investment Efficiency of Wind Power Industry Based on DEA and Malmquist Index Decomposition

Suli Yan [a], Wenjing Yan [b,*]

School of Economics and Management, North China Electric Power University, Beijing, China

[a]Yysl1207@163.com, [b]18810078190@163.com

Abstract: The blind expansion and overcapacity in the rapid development of the wind power industry have affected the sustainability of its development. Based on the financial data of listed companies in the wind power industry in 2015-2017, this paper uses DEA and Malmquist index to analyze the investment efficiency of companies in different links of the wind power industry chain. The research shows that the overall investment efficiency of the wind power industry is not good, and there are certain non-efficiencies in all links of the industrial chain. This paper proposes targeted suggestions to provide ideas for the healthy development of the wind power industry.

Keywords: Wind power industry, investment efficiency, DEA model, Malmquist index.

1. Introduction

With the increasing emphasis on climate change issues in various countries around the world, the wind power industry has developed rapidly on a global scale. In the "13th Five-Year Plan for Wind Power Development" issued by the Chinese government, it is proposed that by the end of 2020, the cumulative grid-connected installed capacity of wind power should reach over 210 million kilowatts [1]. Under the dual promotion of policy support and technological progress, China's wind power industry has made great progress and has now become a major wind power country in the world. However, the blind investment expansion has made China's wind power industry chain overcapacity in the upstream and middle reaches, and the waste of resources is serious. At the same time, the phenomenon of wind abandonment represented by the Three-North Regions has appeared downstream, which has seriously affected the income of wind power investment and restricted the healthy development of the wind power industry. The data shows that in recent years, the average rate of return of listed companies in China's wind power companies is 18%, lower than the level of the same industry. Therefore, studying the investment efficiency of listed companies in the wind power industry, helping listed companies to make scientific investment decisions, and then rationally controlling the scale of investment is of great significance to promoting the healthy and sustainable development of the wind power industry.

In recent years, the research on investment efficiency at home and abroad has been applied to many fields, and the data envelopment analysis method has been selected as the calculation method mostly. Based on the SFA model and the SVAR model, Zheng et al. (2018) studied the impact of fiscal policy on corporate investment efficiency at different levels of financialization [2]. Sreten and Miloš (2017) used the Monte Carlo method to evaluate the investment efficiency of power systems [3].Wang et al. (2017) used the three-stage DEA method to analyze the green investment efficiency of various provinces and cities in China [4]. Oh and Kim (2018) examined the correlation between experienced stock issuance and investment efficiency [5]. Pan et al. (2016) used the super-efficiency DEA and Malmquist index methods to evaluate the investment efficiency of China's key countries in the "Belt and Road" [6]. Liu and Li (2018) applied the DEA model to study the investment efficiency of the circulation industry under the supply-side reform background, and proposed corresponding development proposals [7].Moriah (2016) discussed the correlation between environmental investment and corporation performance with the network DEA method [8].Qi and Zhou (2018) calculated and analyzed the carbon sequestration efficiency of forestry input and the comprehensive efficiency of forestry investment, and combined with the development history of forestry industry in China, explored the influencing factors of the two types of efficiency [9]. Ge (2015) used the DEA model to study the effectiveness of investment efficiency in China's nuclear power industry, and analyzed the internal and external costs of power generation chains in detail [10]. Gao (2016) analyzed the investment efficiency of China's photovoltaic companies based on Dea-Malmquist method, and explored the influencing factors of investment efficiency by using Tobit model [11]. Cooremans (2012) proposed a new investment decision model and discussed the characteristics of energy efficiency investment [12].

Domestic and foreign scholars have conducted a large number of studies on investment efficiency from various angles, and achieved certain results, but there is a lack of research on investment efficiency taking wind power industry as the object. Based on the financial data of listed companies in the wind power industry in 2015-2017, this paper measures the technical efficiency and Malmquist index of the upstream, midstream and downstream companies in the industrial chain, and analyzes the investment efficiency of the wind power industry from static and dynamic levels, in order to provide reference for the rational development of investment activities in the wind power industry.

2. Research Methods

2.1 Envelopment Analysis

Data Envelopment Analysis (DEA) is a nonparametric method for evaluating the relative effectiveness of multi-input and multi-output decision units. DEA is widely used in efficiency evaluation studies because it has the specific form of not requiring the production function to be set in advance, the dimensionless requirements of data and the weight of indicators are generated by the mathematical programming model. The CCR model and the BCC model are two forms of the DEA model based on whether the scale return is variable or not. Based on the input-output process of the wind power industry, this paper selects the BCC model with variable returns to scale.

There are m decision-making units, h kinds of input variables and l kinds of output variables, the BCC model is constructed as follows [13]:

$$\min\left[\theta-\varepsilon\left(\sum_{u=1}^{h}s_u^-+\sum_{w=1}^{l}s_w^+\right)\right]\begin{cases}\sum_{j=1}^{m}\lambda_j x_{uj}+s_u^-\le\theta x_{u0},u=1,\ldots h\\ \sum_{j=1}^{m}\lambda_j y_{wj}-s_w^+\ge y_{w0},w=1,\ldots l\\ \sum_{j=1}^{m}\lambda_j=1,\\ \lambda_j\ge 0,\ s_u^-\ge 0,s_w^+\ge 0,\ j=1,\ldots,m\end{cases}\tag{1}$$

Among them, ε is infinitesimal; λ_j is the weight of the j-th decision unit; u,w respectively represent the u-th input indicator and the t-th output indicator. s_u^-, s_w^+respectively indicate the amount of redundancy of the u-th input indicator and the deficit of the w-th indicator.

If the optimal solution of the model is θ*, λ*,s+*,s-*, then when θ*=1, s+*= 0 and s-*= 0, DMU is valid for DEA; when θ* =1, s+*≠ 0 or s-*≠ 0, DMU is weakly valid for DEA; when θ*<1, DMU is invalid for DEA.

2.2 Malmquist Index

Malmquist index was put forward by Sten Malmquist (1953) in the study of consumer behavior. After the progressive improvement by Caves (1982) and Fare (1994), it is widely used in the efficiency evaluation of static and dynamic dimensions in combination with data envelopment analysis [14]. The Malmquist index for the period t to t+1 is expressed as follows:

$$M^{t,t+1}=\left[\frac{D^t(X^{t+1},Y^{t+1})}{D^t(X^t,Y^t)}.\frac{D^t(X^{t+1},Y^{t+1})}{D^t(X^t,Y^t)}\right]^{1/2}\tag{2}$$

Further decomposed into:

$$M^{t,t+1}=\frac{D^{t+1}(X^{t+1},Y^{t+1})}{D^t(X^t,Y^t)}\cdot\left[\frac{D^t(X^{t+1},Y^{t+1})}{D^{t+1}(X^{t+1},Y^{t+1})}\cdot\frac{D^t(X^t,Y^t)}{D^{t+1}(X^t,Y^t)}\right]^{1/2}\tag{3}$$

Among them, (X^t, Y^t) and (X^{t+1}, Y^{t+1}) are the input and output vectors of t and t+1 respectively, D^t and D^{t+1} are distance functions of t and t+1 respectively, $\frac{D^{t+1}(X^{t+1},Y^{t+1})}{D^t(X^t,Y^t)}$ is the comprehensive technical efficiency change index, and $\left[\frac{D^t(X^{t+1},Y^{t+1})}{D^{t+1}(X^{t+1},Y^{t+1})}\cdot\frac{D^t(X^t,Y^t)}{D^{t+1}(X^t,Y^t)}\right]^{1/2}$ is the technological progress index.

3. Construction of Evaluation Index System

In this paper, the nature of investment activities and the characteristics of wind power industry are comprehensively considered to select indicators, as shown in Fig. 1. Among them, capital input and labor input constitute input indicators, and capital input is composed of long-term investment and short-term investment. The long-term investment measurement indicators include net fixed assets investment, net intangible assets investment and net long-term equity investment. Short-term investments are measured by operating costs. The labor input index selects the proportion of technicians. Output indicators include operating income, earnings per share, and weighted return on equity to reflect profitability.

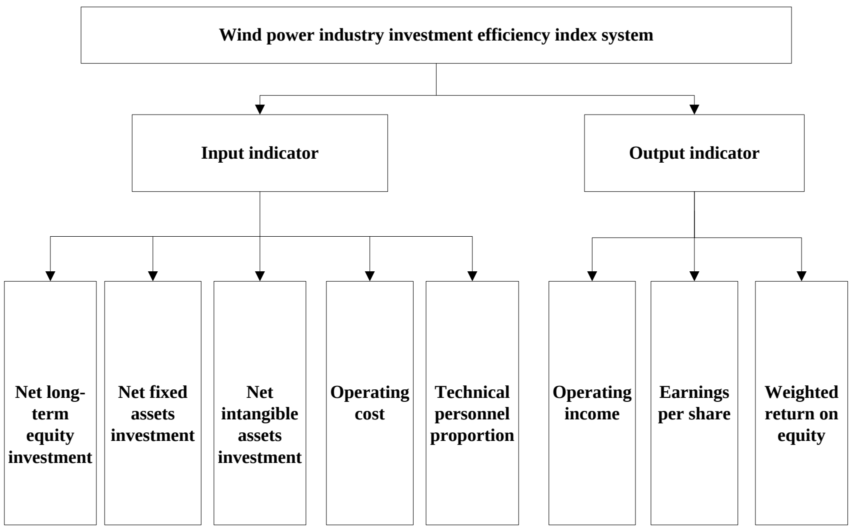

Fig. 1 Wind power industry investment efficiency index system

4. Example study

4.1 DEA Efficiency Static Analysis

The static analysis of efficiency refers to the calculation and analysis of the investment efficiency of listed wind power companies in each year based on the company's one-year cross-sectional data. The specific measurement of efficiency is realized by DEAP2.1 software.

4.1.1 Upstream Efficiency Analysis of Wind Power Industry Chain

The upstream company of the wind power industry chain refers to the suppliers of raw materials, components and equipment for wind power generation. The results of the investment efficiency calculation of the upstream listed companies in the wind power industry chain in 2015-2017 are shown in Table 1.

Table 1 Investment Efficiency Results of Upstream Listed Companies in the Wind Power Industry Chain in 2015-2017

Company Name	TE			PTE			SE					
	2015	2016	2017	2015	2016	2017	2015		2016		2017	
Sinoma Technology	1	1	1	1	1	1	1	-	1	-	1	-
Tianqi Shares	0.904	0.931	0.972	0.914	0.938	0.975	0.99	drs	0.992	irs	0.997	irs
Times New Material	0.993	1	1	0.997	1	1	0.996	drs	1	-	1	-
Taisheng Wind Energy	0.891	1	1	0.906	1	1	0.983	drs	1	-	1	-
Great Wall Electrician	1	0.857	0.922	1	0.875	0.923	1	-	0.979	drs	0.999	irs
Jixin Technology	1	0.921	0.884	1	0.948	0.886	1	-	0.972	drs	0.998	drs
Daikin Heavy Industries	0.825	0.892	0.916	0.846	1	1	0.975	drs	0.892	irs	0.916	irs
Tianshun Wind Energy	0.908	0.972	1	0.913	0.996	1	0.994	drs	0.975	drs	1	-
Jinlei Wind Power	0.895	1	1	1	1	1	0.895	irs	1	-	1	-
Gaolan Shares	1	1	1	1	1	1	1	-	1	-	1	-
Tongyu Heavy Industry	1	1	1	1	1	1	1	-	1	-	1	-
Ningbo Yunsheng	1	1	1	1	1	1	1	-	1	-	1	-
Nantong Forging	1	0.982	0.852	1	1	1	1	-	0.982	irs	0.852	irs

Note: TE indicates comprehensive technical efficiency, PTE indicates pure technical efficiency, and SE indicates scale efficiency. Irs, drs, and - respectively represent increasing returns to scale, decreasing returns to scale, and constant returns to scale.

Comprehensive Technical Efficiency Analysis

The comprehensive technical efficiency refers to the relative efficiency of decision-making unit investment activities when the scale returns are optimal, reflecting the effective utilization of input resources. According to Table 1, there were four decision-making units with effective comprehensive technical efficiency in 2015-2017, including Sinoma Technology, Gaolan Shares, Tongyu Heavy Industry and Ningbo Yunsheng, accounting for 30.77%. The number of effective listed companies of DEA in 2015 and 2016 was seven, which increased to eight in 2017, as shown in Fig. 2. Among them, the comprehensive technical efficiency of six companies increased year by year. Jixin Technology and Nantong Forging experienced a decrease in the comprehensive efficiency value after 2015, indicating that these two companies have room for further improvement in management, technology or scale control.

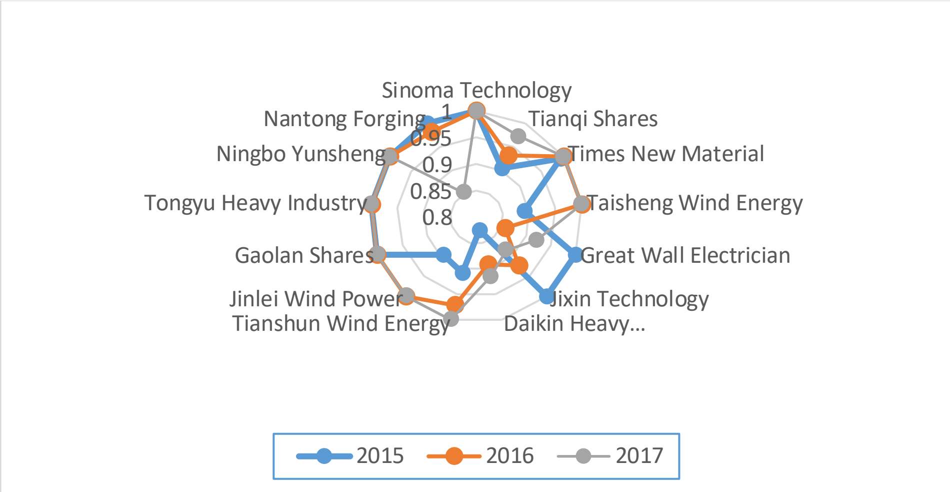

Fig. 2 Comprehensive technical efficiency of listed companies in the upstream of wind power industry chain

(2)Pure Technical Efficiency Analysis

Pure technical efficiency refers to the effect of management and technical factors on investment activities. Within three years, there were six decision-making units with effective pure technical efficiency, indicating that the management and the technology level of nearly half of the companies match the needs of their investment activities. From 2015 to 2017, the number of companies with effective pure technical efficiency increased year by year, increasing to 10 in 2017. Among the decision-making units, only Jixin Technology's pure technical efficiency value decreased year by year, showing that the company's management and technology investment is at a disadvantage in the upstream of the wind power industry chain, and it is necessary to pay attention to the double improvement of quantity and quality.

(3)Scale Efficiency Analysis

Scale efficiency refers to the impact of scale factors on investment activities. The four companies were effective in scale efficiency in three years, which was consistent with companies with effective comprehensive technical efficiency. The scale efficiency of Great Wall Electrician, Jixin Technology, Daikin Heavy Industries and Tianshun Wind Energy decreased from 2015 to 2016, but it increased from 2016 to 2017, indicating that these four companies adjust the investment scale in time according to the input-output situation. From 2015 to 2017, the number of companies with diminishing returns to scale was 5, 3 and 1 respectively, which reflected the effective control of the upstream companies in the wind power industry chain on the scale of investment activities.

4.1.2 Midstream Efficiency Analysis of Wind Power Industry Chain

The midstream company of the wind power industry chain refers to the manufacturer of the wind turbine. Table 2 shows the investment efficiency results of listed companies in the midstream of the wind power industry chain from 2015 to 2017.

Table 2 Investment Efficiency Results of Midstream Listed Companies in the Wind Power Industry Chain in 2015-2017

Company Name	TE			PTE			SE					
	2015	2016	2017	2015	2016	2017	2015		2016		2017	
Goldwind Technology	0.916	1	0.991	0.926	1	1	0.99	drs	1	-	0.991	drs
Shanghai Electric	0.807	1	1	1	1	1	0.807	irs	1	-	1	-
Dongfang Electric	1	1	1	1	1	1	1	-	1	-	1	-
Huayi Electric	0.954	0.885	0.952	1	0.891	0.967	0.954	irs	0.993	drs	0.985	drs
Taiyuan Heavy Industry	1	0.724	0.972	1	0.806	0.997	1	-	0.899	irs	0.975	irs
Xiangdian Shares	0.909	1	1	0.918	1	1	0.99	drs	1	-	1	-

(1)Comprehensive Technical Efficiency Analysis

Table 2 shows that, there were 2, 4 and 3 decision-making units of effective DEA in 2015-2017, accounting for 33.33%, 66.67% and 50% respectively. Among the six companies, only Dongfang Electric had effective DEA within three years, which had advantages in the midstream of the wind power industry chain. In the past three years, the comprehensive technical efficiency of Huayi Electric and Taiyuan Heavy Industry showed a trend of decreasing first and then increasing, while Goldwind Technology showed the opposite trend.

(2)Pure Technical Efficiency Analysis

The companies with pure technical efficiency that were valid for three years were Dongfang Electric and Shanghai Electric. Goldwind Technology and Xiangdian Shares only had invalid pure technical efficiency in 2015, while they reached a valid state in 2016 and 2017, as shown in Fig. 3. The pure technical efficiency of Huayi Electric and Taiyuan Heavy Industry both increased in 2017, but still below the efficiency value of 1, indicating that the two companies should continue to strengthen the control of technology and management inputs.

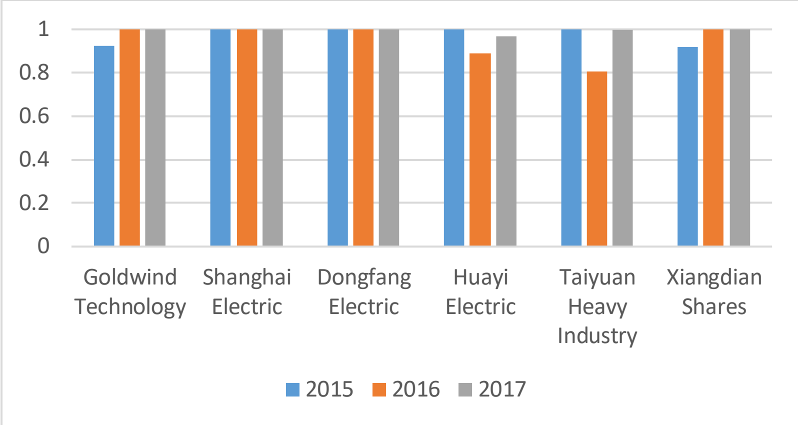

Fig. 3 Pure technical efficiency of listed companies in the midstream of the wind power industry chain

(3)Scale Efficiency Analysis

From 2015 to 2017, except for Huayi Electric, the change trend of scale efficiency of other was consistent with the comprehensive technical efficiency. In 2017, the proportion of companies with efficient scale accounted for 50%, indicating that there were still three companies that need to adjust the investment scale. The number of companies with diminishing returns to scale remained the same in three years. The decreasing returns to scale reflects that the company's investment scale has exceeded the optimal level. Therefore, Goldwind Technology and Huayi Electric should appropriately control the number of input factors.

4.1.3 Downstream Efficiency Analysis of Wind Power Industry Chain

The downstream company of the wind power industry chain refers to the wind farm construction, operation and service providers. The investment efficiency results of the listed companies in the downstream of the wind power industry chain from 2015 to 2017 are shown in Table 3.

Table 3 Investment Efficiency Results of Downstream Listed Companies in the Wind Power Industry Chain in 2015-2017

Company Name	TE			PTE			SE					
	2015	2016	2017	2015	2016	2017	2015		2016		2017	
Silver Star Energy	0.971	0.857	0.779	0.977	0.89	0.862	0.994	irs	0.964	irs	0.904	irs
Energy-Saving Wind Power	1	1	1	1	1	1	1	-	1	-	1	-
Baoxin Energy	0.779	1	0.858	0.804	1	0.871	0.969	irs	1	-	0.985	drs
Huitong Energy	0.985	1	1	0.985	1	1	0.999	drs	1	-	1	-
Zhongmin Energy	1	1	1	1	1	1	1	-	1	-	1	-
Jidian Shares	1	1	1	1	1	1	1	-	1	-	1	-
Datang Power Generation	0.923	1	1	1	1	1	1	irs	1	-	0.998	-
Inner Mongolia Huadian	1	0.949	0.918	1	0.959	0.959	1	-	0.99	drs	0.957	drs

(1)Comprehensive Technical Efficiency Analysis

According to Table 3, DEA had the largest number of effective decision-making units in 2016, accounting for 75%. Baoxin Energy, Huitong Energy and Datang Power Generation were invalid in DEA in 2015, while the comprehensive technical efficiency value reached 1 in 2016, achieving the optimal allocation of input and output. Energy-Saving Wind Power, Zhongmin Energy and Jidian Shares all were effective DEA within three years, indicating that the invested resources were effectively utilized.

(2)Pure Technical Efficiency Analysis

The number of companies with effective pure technical efficiency was five in 2015 and 2017, and six in 2016. After the pure technical efficiency of Inner Mongolia Huadian was reduced in 2016, it remained unchanged in 2017, indicating that the company need to increase its attention and adjustment in technology and management. From 2015 to 2017, there were 4 companies with effective pure technical efficiency, indicating that half of the downstream corporations in the wind power industry chain have better technology and management level.

(3)Scale Efficiency Analysis

The scale efficiency was valid in three of the eight companies for three years, the same as the DEA effective company. In 2015-2017, the number of companies with increasing returns to scale decreased from three to one, accounting for 12.5% of the total number of sample companies (see Fig. 4). More than half of the companies with constant returns to scale in the latter two years. Baoxin Energy and Inner Mongolia Huadian's diminishing returns to scale in 2017 showed that the scale of their investment activities in the year was not properly controlled.

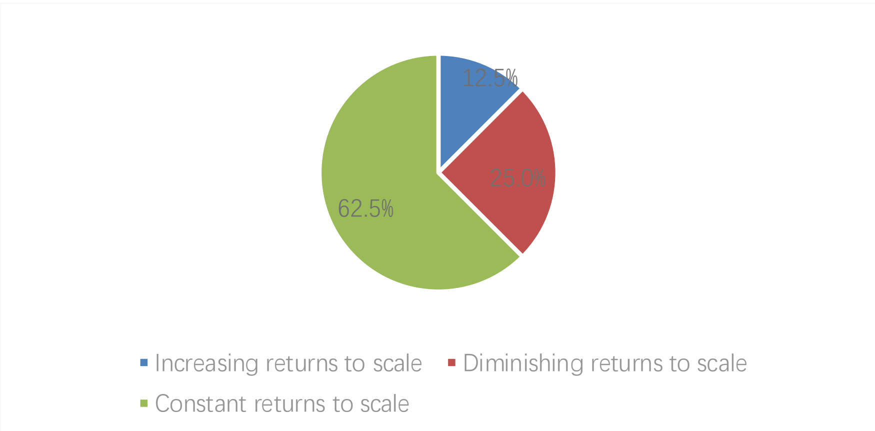

Fig. 4 Changes in scale returns of listed companies in the downstream of wind power industry chain

4.2 Efficiency Dynamic Analysis

The efficiency dynamic analysis refers to the calculation and analysis of the investment efficiency of listed companies in the wind power industry based on the panel data for three years.

4.2.1 Analysis of Upstream Efficiency Changes in Wind Power Industry Chain

Taking the financial data of 13 listed companies in the upstream of the wind power industry chain from 2015 to 2017 as input variables, the change of Malmquist efficiency of the upstream listed companies in the wind power industry chain is obtained, as shown in Table 4.

Table 4 Malmquist Efficiency Change of Upstream Listed Companies in the Wind Power Industry Chain in 2015-2017

Company Name	Effch	Techch	Pech	Sech	Tfpch
Sinoma Technology	1	1.037	1	1	1.037
Tianqi Shares	1.036	1	1.046	0.991	1.036
Times New Material	1.003	1.075	1.001	1.002	1.079
Taisheng Wind Energy	1.045	0.987	1.038	1.007	1.031
Great Wall Electrician	1	1.079	1	1	1.079
Jixin Technology	1	0.961	1	1	0.961
Daikin Heavy Industries	1.057	0.984	1.044	1.012	1.04
Tianshun Wind Energy	0.987	0.986	0.985	1.002	0.974
Jinlei Wind Power	1.012	0.977	1	1.012	0.988
Gaolan Shares	1	0.752	1	1	0.752
Tongyu Heavy Industry	1	0.791	1	1	0.791
Ningbo Yunsheng	1	0.925	1	1	0.925
Nantong Forging	1	0.999	1	1	0.999

Note: Tfpch represents the total factor productivity index, which is equal to the product of the comprehensive technical efficiency change index (effch) and the technological progress index (techch). Pech and sech represent the pure technical efficiency change index and the scale efficiency change index, respectively.

According to Table 5, among the upstream listed companies in the wind power industry chain, there are six companies with annual average total factor productivity growth and seven companies with decrease, accounting for 46.15% and 53.85% respectively. The total factor productivity is affected by both the change of comprehensive technical efficiency and technological progress. Under different circumstances, both of them may become the dominant factor in influencing factors. As far as Taisheng Wind Energy is concerned, its annual average technological progress index has decreased, but the annual average total factor productivity has shown an increasing trend, which indicates that the annual average comprehensive technical efficiency change is the leading factor affecting the annual average total factor productivity in the company. Compared with Great Wall Electrician and Tongyu

Heavy Industry, the annual average comprehensive technical efficiency of both sides has the same change, but the annual average total factor productivity shows two completely different trends, the former increasing while the latter decreasing. It can be seen that in this case, the degree of technological progress has become the dominant factor affecting total factor productivity, which indicates that the above two companies should pay attention to the input effect of core technology in investment activities.

4.2.2 Analysis of Midstream Efficiency Changes in Wind Power Industry Chain

Taking the financial data of 6 listed companies in the midstream of the wind power industry chain from 2015 to 2017 as input variables, the change of Malmquist efficiency of the midstream listed companies in the wind power industry chain is obtained, as shown in Table 5.

Table 5 Malmquist Efficiency Change of Midstream Listed Companies in the Wind Power Industry Chain in 2015-2017

Company Name	Effch	Techch	Pech	Sech	Tfpch
Goldwind Technology	1.045	1.583	1.039	1.005	1.654
Shanghai Electric	1.027	0.942	1	1.027	0.968
Dongfang Electric	0.996	0.935	1	0.996	0.931
Huayi Electric	1.024	1.03	1	1.024	1.054
Taiyuan Heavy Industry	1	1.022	1	1	1.022
Xiangdian Shares	1.024	0.992	1.026	0.997	1.015

Table 6 shows the annual average efficiency changes of listed companies in the midstream of the wind power industry chain. Among the six sample listed companies , there are four companies with an annual average total factor productivity growth, accounting for 66.67%, and two companies with a decrease, accounting for 33.33%. Analysis of the two influencing factors of total factor productivity shows that, except for Xiangdian Shares, which is dominated by the annual average comprehensive technical efficiency changes, the other companies are mainly affected by the annual average technological progress index. By studying the change of the annual average comprehensive technical efficiency of Xiangdian Shares, it can be found that the change of the company's annual average pure technical efficiency increases, while the change of its annual average scale efficiency decreases slightly. Under the combined action of the two factors, the annual average change of the comprehensive technical efficiency of Xiangdian Shares increases as a whole, which indicates that the company should adjust the investment scale in time.

4.2.3 Analysis of Downstream Efficiency Changes in Wind Power Industry Chain

Taking the financial data of 8 listed companies in the downstream of the wind power industry chain from 2015 to 2017 as input variables, the change of Malmquist efficiency of the downstream listed companies in the wind power industry chain is obtained, as shown in Table 6.

Table 6 Malmquist Efficiency Change of Downstream Listed Companies in the Wind Power Industry Chain in 2015-2017

Company Name	Effch	Techch	Pech	Sech	Tfpch
Silver Star Energy	1	1.052	1.01	0.99	1.052
Energy-Saving Wind Power	1	1.037	1	1	1.037
Baoxin Energy	1	1	1.036	0.965	1
Huitong Energy	1.008	0.964	1.007	1	0.971
Zhongmin Energy	0.926	0.965	0.993	0.993	0.894
Jidian Shares	1	1.145	1	1	1.145
Datang Power Generation	1.041	0.96	1	1.041	1
Inner Mongolia Huadian	1	0.819	1	1	0.819

It can be seen from Table 7 that among the listed companies in the downstream of the wind power industry chain, there are three companies with annual average total factor productivity growth and reduction respectively, accounting for 37.5% of the total sample companies. Through the analysis of the two major influencing factors of total factor productivity in the table, it is not difficult to find that when the change of comprehensive technical efficiency tends to be stable, the degree of technological progress will directly affect the company's total factor productivity, such as Silver Star Energy, Energy-Saving Wind Power and so on. However, when the degree of technological progress is similar, the change of comprehensive technical efficiency may not be able to directly affect the total factor productivity. For example, Huitong Energy and Zhongmin Energy have similar annual average technological progress indexes. The former has an increasing change of annual average comprehensive technical efficiency, while the latter annual average comprehensive technical efficiency changes decrease. In the end, the annual average total factor productivities of them both decrease.

5. Conclusion

In recent years, wind energy has developed rapidly as a green energy source in China. The scale of newly installed capacity and the cumulative installed capacity are currently ranked first in the world, and the overall level of technology has also been greatly improved. However, due to the impact of many factors, such as the lack of forward-looking planning layout, unreasonable investment and lagging research and development, the development of the domestic wind power industry is unbalanced, which seriously restricts the sustainable development of the industry. This paper selects the DEA-Malmquist model to analyze the efficiency and its changes of the upstream, midstream and downstream of the wind power industry from the perspective of the industry chain, and draws the following conclusions:

(1) The overall investment efficiency of China's wind power industry is not ideal;

(2)The technological progress index of listed companies in the upstream of the wind power industry chain is lower than the industrial average, and there is a lack of core technology research and development and mastery;

(3)The main factor that the listed companies in the midstream of the wind power industry chain have not achieved effective investment efficiency is the low scale efficiency value. Reasonable adjustment of investment scale is the key to improving efficiency of midstream listed companies;

(4)The performance of the comprehensive technical efficiency and technological progress index of listed companies in the downstream of the wind power industry chain are not good, reflecting that the management and technical level and the scale of the current situation do not meet the actual needs of investment.

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