



How Does the Realization Path of "Dual Carbon" Affect the Performance of New Energy Enterprises: Mechanism and Empirical Test

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Abstract. As the key path to the "double carbon" goal, carbon emissions and carbon emission reductions bring opportunities and challenges to new energy companies. In order to provide scientific guidance for new energy companies to make decisions on carbon emissions and carbon reduction, the data of listed new energy companies from 2014 to 2020 was used to examine the impact and mechanism of carbon emissions and carbon reduction on their performance. The results show that reducing carbon emissions will reduce short-term performance of new energy companies and improve long-term performance. Improving carbon emission reductions can improve the short- and long-term performance of new energy companies. Mechanism analysis shows that government subsidies have an inhibitory effect on the relationship between carbon emission reduction and the short-term performance of new energy enterprises due to corporate rent-seeking activities. The research conclusions provide important inspiration for new energy companies to achieve a "win-win" economy and environment.

Keywords: New Energy Enterprise Performance, Carbon Emissions, Carbon Emission Reductions, Government Subsidies.

1 Introduction

In September 2020, China clearly proposed the goals of "carbon peaking" in 2030 and "carbon neutrality" in 2060. In the report to the 20th National Congress of the Communist Party of China (CPC) proposed to further promote the energy revolution and accelerate the planning and construction of a new energy system. This calls for vigorously developing renewable energy. New energy has the characteristics of green, clean, pollution-free and efficient recycling. It has become the key focus of ecological environmental protection, energy structure adjustment and the construction of new energy system, especially the energy conservation and emission reduction work. Therefore, its performance in the process of "dual carbon" target has attracted much attention [1]. It is noteworthy that new energy enterprises need a large amount of capital investment to improve low-carbon technology and develop new clean energy, which has the characteristics of large investment and high risk, and their performance level is facing great

uncertainty. However, the unscientific carbon reduction measures of new energy enterprises will affect the sustainable development of new energy enterprises, and will lead to the decoupling of China and global economic development. Therefore, how to promote carbon emission and carbon emission reduction of new energy enterprises needs scientific guidance, which is of great practical significance for promoting the development of new energy enterprises in China, optimizing the energy structure and economic and social transformation and development.

With the increasing concern of global warming, the impact of carbon emissions on macro economy has attracted the attention of a large number of scholars, but the impact of carbon emissions on the micro enterprise level has received less attention. Some scholars pay attention to the impact of carbon emissions on enterprise performance, mainly through the introduction of carbon emission performance to build enterprise performance evaluation system [2], rarely refining empirical rules [3], and do not pay attention to the key subject of energy conservation and emission reduction, namely new energy enterprises. Companies that reduce carbon emissions have enhanced credibility of low-carbon products [4] and can achieve short-term performance improvements by achieving a relative increase in productivity through reduced resource use [5]. In the long run, carbon emissions are negatively related to asset returns [6]. Companies with high carbon emission reductions have higher market development potential and higher investment value [7]. Their energy consumption shifts from fossil fuels to clean and renewable energy, which improves resource utilization and is conducive to improving the long-term performance of the company [8]. In addition, new energy is a science and technology growth industry, and the development of enterprises needs strong R&D investment and policy support. Some scholars have explored the impact of R&D investment [9] and government subsidies on the performance of new energy enterprises. However, in view of the technological growth attributes of new energy enterprises, the coupling effect of dual carbon interaction path in their performance has not been deeply discussed. Therefore, this paper empirically examines the impact of carbon emissions and carbon emission reduction on the performance of new energy enterprises, reveals the mechanism of impact formation from the aspects of government subsidies, and explores the coupling effect of the dual carbon action path in their performance to fill the gap in this research field, has important academic significance.

New energy enterprises need to invest a large amount of research and development costs in the process of reducing carbon emissions. Therefore, this paper uses the annual panel data of 108 new energy listed enterprises from 2014 to 2020 to empirically analyze the impact of carbon emissions and carbon emission reduction on the performance of new energy enterprises from two dimensions of short and long term.

The contributions of this paper are as follows: firstly, the novelty of the research perspective. This paper empirically examines the impact of carbon emissions and carbon emission reduction on the performance of new energy enterprises, enriches the relevant research on the performance of new energy enterprises, and refines and expands the research of new energy enterprises in the field of green finance. Second, the depth of the research content. This paper analyzes the mechanism of the critical path of "dual carbon" target affecting the performance of new energy enterprises, and reveals the interaction of government subsidy in the relationship between the realization path of

"dual carbon" target and the performance of new energy enterprises. Third, the pertinence of the research content. This paper distinguishes the heterogeneity of the long-term and short-term impact of the "dual carbon" target path on the performance of new energy enterprises, and provides further scientific evidence for enterprises to make accurate decisions on carbon emissions.

2 Research Design

2.1 Sample Selection and Data Sources

We define as new energy enterprises those whose main business and main products in the annual reports are related to new energy such as wind, solar, hydrogen and biomass energy [1]. This paper selects the annual data of 178 new energy enterprises in China's A-share market from 2014 to 2020, including the annual panel data of corporate finance, stock price and other related indicators. The data are from the CSMAR database and the National Bureau of Statistics. In this paper, the data are processed as follows: (1) the enterprises in ST and PT status, new energy business revenue accounting for less than 5% and undisclosed enterprises are excluded; (2) For enterprises that have not clearly disclosed the proportion of new energy business, but have obvious new energy business, such as new energy power generation, this paper calculates the proportion of new energy business revenue of the enterprise according to the proportion of new energy power generation in the total power generation;(3) We winsorize the continuous variables at the 1% and 99% levels to mitigate the effect of outliers, and finally retain 108 listed companies.

2.2 Variable Selection and Definition

Explained variable. According to Luo et al., return on assets (ROA) and Tobin's Q (TBQ) are selected to measure the short-term and long-term performance of enterprises [10]. The former is the ratio of net profit to average assets, and the latter is the ratio of total market value to total assets.

Explanatory variables. Carbon emissions measure the carbon emissions generated by the production and sales of traditional energy businesses, while carbon emission reduction measures the reduction of carbon emissions through new energy, carbon-free or low-carbon equipment or production processes, compared with the creation of the same value products with traditional energy and traditional high-carbon production processes. Since there is no mandatory requirement for enterprises to disclose data related to carbon emissions in China at present, referring to the calculation method [11] of carbon emissions by Pei et al. and based on the information disclosed in the annual report of enterprises. Carbon emission reduction and carbon emission are defined based on operational business as follows:

$$Carbon_R_{it} = \frac{NE_Revenue_{it}}{Ind_Revenue_{it}} \times Ind_E_Cons_{it} \times C \quad (1)$$

$$Carbon_E_{it} = \frac{TE_Revenue_{it}}{Ind_Revenue_{it}} \times Ind_E_Cons_{it} \times C \quad (2)$$

where, $Carbon_R_{it}$ and $Carbon_E_{it}$ respectively represent the carbon emission reduction and carbon emissions of new energy enterprise in year t , $NE_Revenue_{it}$ and $TE_Revenue_{it}$ respectively represent the operating income of new energy business and the operating income of traditional energy business, $Ind_Revenue_{it}$ represent the total operating income of the industry in which new energy enterprise is located in year t , $Ind_E_Cons_{it}$ represent the total energy consumption of the industry measured by standard coal, and C represents the carbon emission factor, which is a fixed number of 0.69. Definitions for the remaining variables are provided in Table 1.

Table 1. Definition and description of variables.

Variable categories	Variable name	Variable code	Variable definition
Explained variable	Return on assets	ROA	Net profit/average assets
	Tobin's Q value	TBQ	Total market value/total assets
	Net earnings per share	EPS	Net profit/total equity
Explanatory variables	Carbon emission reduction	Carbon_R	See Equation (1)
	Carbon emissions	Carbon_E	See Equation (2)
Moderating variables	Government subsidies	Gov_Grant	Government subsidy income charged to current profit or loss
	Innovation ability R&D		R&D investment expenses/operating income
Control variables	Social responsibility disclosure	SR_Dis	Independent disclosure of social responsibility report, yes =1, no =0
	Enterprise size	Size	Total business assets
	Capital structure	Cap_Stru	Total liabilities/total assets

2.3 Model Setting

Referring to the existing research [7], a linear model is established to test the impact of carbon emission reduction and carbon emissions on the long-term and short-term performance of enterprises respectively. The specific model is shown in Equations (3) - (6).

$$ROA_{it} = \beta_0 + \beta_1 Carbon_R_{it} + \beta_2 R\&D_{it} + \beta_3 SR_Disc_{it} + \beta_4 Gov_Grant_{it} + \beta_5 Cap_Stru_{it} + \beta_6 Size_{it} + \varepsilon_{it} \quad (3)$$

$$ROA_{it} = \beta_0 + \beta_2 Carbon_E_{it} + \beta_4 SR_Disc_{it} + \beta_5 Gov_Grant_{it} + \beta_6 Cap_Stru_{it} + \beta_7 Size_{it} + \varepsilon_{it} \quad (4)$$

$$TBQ_{it} = \beta_0 + \beta_1 Carbon_R_{it} + \beta_2 R\&D_{it} + \beta_3 SR_Disc_{it} + \beta_4 Gov_Grant_{it} + \beta_5 Cap_Stru_{it} + \beta_6 Size_{it} + \varepsilon_{it} \quad (5)$$

$$TBQ_{it} = \beta_0 + \beta_2 Carbon_E_{it} + \beta_4 SR_Disc_{it} + \beta_5 Gov_Grant_{it} + \beta_6 Cap_Stru_{it} + \beta_7 Size_{it} + \varepsilon_{it} \quad (6)$$

3 Empirical Research

3.1 Baseline Regression Results

Table 2. Baseline regression results.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Carbon_R	0.023*** (3.33)		-0.291 ** (-2.48)		0.215*** (3.26)	-7.001 *** (-3.79)
Carbon_E		0.006*** (2.77)		0.050 (1.56)		
R&D	0.004*** (8.70)		3.545 ** (2.28)		0.077* (1.74)	0.034** (2.23)
Gov_Grant	0.001 (1.10)	0.001** (1.99)	0.048 *** (5.47)	0.048 * * * (6.06)	0.037*** (5.42)	0.031 (0.73)
SR_Dis	0.000 (0.06)	0.002 (0.24)	0.136 *** (3.07)	0.120 * * (2.28)	0.305 (1.35)	-0.478*** (-3.34)
Cap_Stru	0.102** (2.16)	0.092** (1.97)	0.437 (0.79)	0.426 (0.74)	-1.000 (-1.33)	0.234 (0.55)
Size	0.000 (0.72)	0.001* (1.93)	0.022 ** (2.38)	0.017 (1.47)	-0.056*** (-3.07)	-0.027*** (-3.23)
Constant	0.088** (3.66)	0.068*** (2.96)	1.337 *** (4.41)	1.439 *** (4.58)	1.701*** (3.59)	1.759*** (5.60)
Firm-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	No	No
Adjust R ²	0.343	0.329	0.611	0.605	0.476	0.512
F test	4.289	4.104	10.871	10.709	5.385	6.904
Observations	749	749	749	749	218	531

Note: 1. *, ** and *** indicate that the variable is significant at the levels of 0.1, 0.05 and 0.01, respectively.

In Table 2, the regression coefficient of Carbon_E is 0.006, which is significantly positive, indicating that carbon emissions are significantly positively correlated with the short-term performance of new energy enterprises. The regression coefficient of Carbon_R is 0.023, which is significantly positive, indicating that carbon emission reduction can also significantly improve the short-term performance of new energy enterprises. Actively developing new energy business will improve the reputation of new energy enterprises and the sales of low-carbon products, further improving the short-term performance of new energy enterprises. New energy enterprises improve carbon emission reduction through low-carbon production technology, which can improve the productivity of low-carbon products and resource utilization [5], and ultimately improve the short-term performance of enterprises.

Secondly, carbon emissions are negatively correlated with the long-term performance of new energy enterprises, indicating that higher carbon emissions will reduce the long-term performance of enterprises. Carbon emission reduction negatively affects the long-term performance. Therefore, in order to further explore the impact of carbon emission reduction on the long-term performance of new energy enterprises under different thresholds, this paper sets the threshold effect for verification. The results

show that when the value of Carbon_R is greater than 0.1 (100,000 tons of carbon), Carbon_R will significantly positively affect the long-term performance; when the value of Carbon_R is less than 0.1, Carbon_R will significantly negatively affect the long-term performance of new energy enterprises. This paper argues that carbon emission reduction has a significant positive impact on the long-term performance of new energy enterprises, which requires enterprises to reach a certain scale of new energy related business. On the one hand, scale production indicates higher economic benefits, on the other hand, it also indicates that enterprises have the ability to achieve more carbon emission reduction, and the new energy business is developing well.

3.2 Moderating Effect Analysis

This paper tests whether government subsidies play a moderating role in the path of carbon emissions and carbon emission reduction affecting the short-term performance of new energy enterprises.

Table 3. Moderating effect results.

	ROA	ROA	ROA	ROA
Carbon_R	0.011*** (4.31)	0.024*** (3.44)		
Carbon_E			0.002* (1.70)	0.006*** (2.64)
Carbon_R×Gov_Grant	0.002*** (3.59)	0.002** (2.49)		
Carbon_E×Gov_Grant			0.000*** (3.87)	0.000 (1.56)
Gov_Grant	0.004*** (5.28)	0.004*** (3.84)	0.003*** (5.00)	0.003*** (3.83)
SR_Dis	0.006 (1.21)	0.006 (1.10)	0.006 (1.16)	0.005 (0.72)
Cap_Stru	0.084*** (3.17)	0.098** (2.18)	0.082*** (3.16)	0.094** (2.05)
Size	0.000 (0.05)	0.001 * * (2.53)	0.000 (0.14)	0.000 (0.79)
cons	0.066*** (5.01)	0.077*** (3.40)	0.066*** (5.08)	0.072*** (3.35)
Firm-fixed effects	No	Yes	No	Yes
Year-fixed effects	No	No	No	No
Adjust R ²	0.060	0.327	0.057	0.322
F test	8.995	4.217	8.604	4.139
Observations	749	749	749	749

After adding Carbon_R×Gov_Grant, the positive impact of carbon emission reduction on the short-term performance of new energy enterprises still exists significantly. As shown in Table 3, the coefficients of Carbon_R×Gov_Grant are all - 0.002, which are significantly negative at the significance levels of 0.001 and 0.05, respectively, indicating that a significant moderating effect is observed, and the government subsidy plays a negative moderating role in the path of carbon emission reduction affecting the

short-term performance of enterprises. Similarly, after the addition of Carbon_E×Gov_Grant, carbon emissions still have a significantly positive impact on the short-term performance of enterprises, and the coefficient of the interaction term is negative but the significance is low, indicating that government subsidies play a negative moderating role in the impact path of carbon emissions on the short-term performance of new energy enterprises. According to Yu et al.'s research, in order to obtain government subsidies, enterprises will transfer part or all of the subsidies to officials [12] through rent-seeking activities. Therefore, enterprises will have less funds for carbon emission reduction business and the cost of rent-seeking will be high, which will damage corporate performance.

3.3 Robustness Test

The robustness tests were conducted in this study by replacing the explained variables, grouping the samples based on whether they were in carbon trading pilot areas, and conducting endogeneity corrections. The results were all significant. Due to space limitations, specific results are not presented here.

4 Conclusions and Suggestions

Carbon trading market is one of the core tools to achieve the goal of "dual carbon". Therefore, starting from the two key paths of the "dual carbon" goal, this paper explores the impact of carbon emission reduction and carbon emissions on the short-term and long-term performance of new energy enterprises. The results show that carbon emission reduction can significantly improve the short-term performance of enterprises, the reduction of carbon emissions leads to the decline of short-term performance of enterprises, high carbon emissions are not conducive to the improvement of long-term performance, and the scale of carbon emission reduction can improve the long-term performance of enterprises. The negative moderating effect of government subsidies on the impact of carbon emissions on short-term performance of new energy enterprises may be related to the rent-seeking behavior of enterprises.

In short, the two critical paths of the "dual carbon" target have a significant impact on the short-term and long-term performance of new energy enterprises. Therefore, this paper puts forward the following management suggestions for new energy enterprises: under the "dual carbon" target, new energy enterprises should pay more attention to carbon emission management and increase the proportion of new energy business to improve the performance level of enterprises; Increase investment in research and development, improve the level of energy conservation and emission reduction technology and low-carbon production process, reduce the carbon emissions of enterprises, and improve the long-term performance of new energy enterprises; Attach importance to the interpretation of policies, closely follow the national strategic guidance, obtain and make full use of government subsidies in a reasonable and compliant manner, and contribute to the realization of the "dual carbon" goal. On the other hand, as the formulation and manager of the "dual carbon" goal, the government also needs to help new

energy enterprises achieve energy conservation and emission reduction faster and better: improve the government subsidy mechanism of new energy enterprises, reduce the carbon emissions of enterprises while stabilizing the level of enterprise performance, and achieve reasonable allocation and full use of funds; To promote the development of China's new energy enterprises, optimize the energy structure, and promote the economic and social transformation and development.

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