Research on the Impact of Carbon Finance on Green Innovation of New Energy Enterprises

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Abstract: The development of green finance, especially the development of carbon finance, can greatly stimulate the green innovation power of enterprises. Green innovation is the key driving force for enterprises to cope with environmental challenges and achieve high-quality development. Under the background of "dual carbon" goal, how to dedicate full attention to guiding role of carbon finance in the development of green innovation of new energy enterprises has become an important topic. New energy enterprises are selected by this paper from 2000 to 2021 to analyze A robustness test is conducted to examine the influence in carbon finance on the green innovation of new energy enterprises. It is found that carbon finance helps to increase the level of green innovation of new energy enterprises, and has the least promotion effect on green invention patents. The mechanism test results show that carbon finance is a suitable environment for green innovation in new energy enterprises by reducing The financial limitations of enterprises. Carbon finance is conducive to improving the businesses' R&D expenditures, so encouraging green innovation in new energy businesses. Lastly, we offer specific policy recommendations and useful takeaways from the research to serve as a helpful resource for advancing green innovation in new energy company ventures.

Keywords: Carbon finance, New energy enterprises, Green innovation, Financial constraints, R&D investment

1. Introduction

Globally, the development of carbon finance markets has benefited from international climate policy changes under the United Nations Framework Convention on Climate Change and the Kyoto Protocol. The implementation of these policies has promoted the value and marketization of carbon emission rights, which has given birth to the carbon trading market with carbon dioxide emission rights as the main commodity. According to the statistics of the World Bank, the total amount of carbon dioxide emission rights traded in the world has increased rapidly in the past few years, which shows the high activity and potential of carbon financial market. In China, with the strategic goal of "carbon peak and carbon neutrality" put forward, the importance of carbon finance has become increasingly prominent [1].

As the global awareness of climate change is increasing day by day, The growth of a low-carbon economy and the encouragement of green innovation are now crucial concerns. As a vital component of the green economy, new energy companies' increasing capacity for innovation is crucial for advancing sustainable development. However, the lack of funding and research and development

resources frequently confront new energy companies during the innovation process, which limits their potential to innovate.

Given this context, carbon finance—a sort of financial model—has emerged as a crucial instrument for advancing the low-carbon economy's transition and is progressively exerting a significant amount of impact [2]. Especially for new energy companies, carbon finance not only for its innovative financing channels, possibly by alleviating financing constraints, increase r&d investment, indirectly promote the enterprise green innovation, in promoting the green technology innovation plays an irreplaceable role. Specifically, carbon finance converts carbon emission rights into tradable financial Thus, the market mechanism facilitates the acquisition of assets. encouraging Businesses are aiming to decrease carbon emissions and increase green investment. For new energy enterprises, which means that they can participate in the carbon market, and gain an additional source of funds, and increase in spending on green technology research and development and product innovation. At the same time, carbon financial market operation also provides the effective risk management tool for the enterprise, help them to better respond to market fluctuations and policy risk. Therefore, carbon financial impact on new energy enterprise green innovation is profound. It not only enhances the enthusiasm and ability of enterprises in green innovation, but also promotes the overall upgrading and transformation of the new energy industry. In the future, with the constant improvement of carbon finance market and expand, the green innovation in promoting the new energy enterprises will become more prominent, the role of contributing to global response to climate change, sustainable development more power.

The marginal contribution of this paper is mainly manifested in the following two aspects: first, based on the innovative financial point of view of carbon financial effect of green The aim of businesses is to decrease carbon emissions. Specifically, this integrates the financing constraints, R&D investment Integrating green innovation of new energy companies into the same analytical framework in order to uncover the way that carbon financing influences green innovation of new energy companies and offer theoretical direction for new energy companies' innovation practices. Enhance the study of green innovation in new energy enterprises as the second step. When it comes to green innovation output types, green patents for inventions that can drastically cut down on pollution and energy use are considered high quality examples. On the other hand, green utility patents, which somewhat mimic government policy regulations by allowing businesses to take advantage of policy arbitrage and innovate, are considered general examples of green innovation. In light of this, this study investigates how carbon financing affects diverse.

2. Theoretical Analysis and Research Hypotheses

2.1. Carbon Finance Green Innovation with New Energy Enterprises

As a financial model with low-carbon economic development as the core, carbon finance plays an important role in promoting green innovation of new energy enterprises. The green innovation activities of new energy enterprises require a large amount of capital investment, and The improvement of their green innovation is directly aided by carbon finance ability by providing capital supply for these enterprises. Specifically, carbon tools such as green credit, green bonds in financial markets for new energy enterprises provides a low-cost source of funds, reduce the threshold, and the cost of financing [3]. These funds not only can be used for the daily operations of the enterprise, more important is can be used for green technology r&d and innovation activities [4]. The carbon financial market also provides incentives for green innovation of new energy enterprises through market mechanisms. In carbon emissions trading, the enterprise can reduce carbon emissions to get additional economic benefits. For example, the enterprise will be reduction results into tradable carbon assets, in order to gain financial returns, these funds can be used for green technology r&d and innovation,

forming a virtuous cycle. These kinds of market incentives to direct businesses promote the development and use of green technology. [5]. At the same time, along with the global pursuit of a low-carbon economy, the increasing demand for green technology, green products and services for new energy enterprises to create a bigger market space, green innovation to improve the new energy sector [6]. In addition, the market-based operation of carbon finance is helpful for new energy enterprises to carry out effective risk management. Enterprises can take advantage of the carbon financial derivatives tools such as hedge risk of fluctuations in the price of carbon emissions, so as to focus more on green innovation activities [7].

Thus, the hypothesis presented in this paper is:

H_1: When the level of carbon finance increases, it is conducive to promoting corporate green innovation.

2.2. Transmission Mechanism of Financial Constraints

Financial constraints are one of the important factors that restrict corporate innovation. For new energy enterprises, due to the uncertainty of their technology and market, they often face higher financing difficulty and cost. The emergence and development of carbon financial markets can alleviate such financing constraints to a certain extent [8]. Specifically, carbon finance provides diversified financing channels for new energy enterprises. Through green bonds, green funds and other financial instruments, provides new energy enterprises with more diversified, low-cost financing options, reducing the threshold, and the cost of financing. Enterprises can more easily obtain low-cost, long-term and stable financial support, reduce the financing difficulty and cost of green innovation projects, and help new energy enterprises to obtain financial support more easily. This not only alleviate the pressure of the enterprise's capital, but also make it more resources for green innovation activities [9]. In addition, carbon finance through carbon emissions trading market mechanisms, such as the enterprise reduction results into tradable financial assets, create new financing channels for the enterprise. New energy enterprises can pledge or sell the carbon assets generated by emission reduction projects to obtain financial support, which effectively alleviates the financial pressure of enterprises in the process of green innovation. Carbon financial markets can also through the provision of credit guarantee and risk management tools, to further reduce the financing risk of the enterprise, and stimulates the more actively into green innovation. This easing of financing constraints can help new energy enterprises overcome financial barriers in the innovation process and promote the smooth development of their green innovation activities. Finally, enterprises that participate in carbon market trading are often regarded as enterprises with environmental awareness and social responsibility, which helps to enhance the brand image and market competitiveness of enterprises, so that it is easier to obtain the favor and financial support of investors, providing a good external environment for enterprises' green innovation.

Therefore, this paper puts forward the following hypothesis:

H_2: Carbon finance is conducive to alleviating the credit constraints faced by enterprises and improving the use of green technologies in new energy companies.

2.3. Transmission Mechanism of R&D Investment

R&d investment is an important guarantee for enterprises to carry out innovation. For new energy enterprises, continuous R&D investment is the key to maintain their competitive advantage and promote green innovation. Through market mechanisms and policy incentives, carbon finance guides new energy enterprises to increase investment in green technology, clean energy and other fields, and promotes the optimization and upgrading of industrial structure and green transformation. This market-oriented mechanism supports enterprise vitality and research promotion. development and

application of green technologies. At the same time, the government provides policy support and preferential treatment to enterprises participating in the carbon financial market and carrying out green innovation, which further encourages enterprises to increase R&D investment and promote the development of green innovation. Therefore, carbon finance can guide new energy enterprises to increase their R&D investment in green technology through various ways [10]. First of all, as mentioned earlier, carbon finance provides a low-cost source of capital for new energy enterprises, part of which can be used for R&D investment. Secondly, investors and financial institutions in the carbon finance market tend to hold a positive attitude towards green technologies and are more willing to invest in projects with environmental protection and sustainable development potential [11]. This market preference can guide new energy enterprises to pay more attention to the R&D and innovation activities of green technologies. Thirdly, the carbon financial market can also promote the cooperation and exchange between new energy enterprises, research institutions, universities and other innovation subjects by providing platforms and mechanisms such as R&D cooperation and technology transfer, so as to promote the R&D and application process of green technology. This guidance effect helps new energy enterprises to clarify the direction of research and development, improve the efficiency of research and development, and thus enhance their green innovation ability. Finally, new energy enterprises are faced with a variety of uncertain factors in the process of green innovation, such as technical risks and market risks. Tools such as carbon financial derivatives can help enterprises effectively hedge these risks and ensure the safety and stability The enthusiasm of can be stimulated by investing in R&D enterprises to increase R&D investment.

Therefore, this paper puts forward the following hypotheses:

H3: Carbon finance is conducive to increasing enterprise R&D investment and promoting green innovation of new energy enterprises.

3. Research Design

3.1. Data Sources and Processing

According to the new concept board classification of Huaxi Securities, this paper selects the new energy enterprises from 2000 to 2021 as research samples, excludes ST shares and enterprises that have been operating continuously for less than 5 years, and finally leaves 2290 effective observations of 173 new energy enterprises as unbalanced panel data [12].

3.2. Measurement of Variables

The ratio of carbon dioxide emissions to GDP is how carbon finance is measured [13]. Based on the vector data of China's administrative divisions in 2021, this paper uses ArcGIS10.7 to mask the ODIAC global carbon emission grid data and obtain the carbon emission data of each province in China from 2000 to 2021. The green innovation of new energy enterprises was obtained from the State Intellectual Property Office of the People's Republic of China, and other control variables were obtained from CSMAR database. Financial constraints are measured by SA index according to the practice of Ren Shuming et al [14].

$$SA = -0.737 \times Siz + 0.043 \times Siz^2 - 0.04 \times Lis \qquad (1)$$

Where, is the size of the enterprise, represented by the logarithm of total assets, is the years of listing. The credit constraints are more severe when SA's value is negative, and the greater the absolute value is, the more serious they are. R&d investment is represented by the logarithm of the amount of R&D investment expenditure.

In addition, referring relating to the current literature, this paper introduces There are multiple control variables that have the potential to influence the green innovation of new energy enterprises [15]. Specifically, it includes sales expenses (sal), net intangible assets (ins), long-term liabilities (term), enterprise Age, year of listing (Age), net profit (net), net profit margin on total assets (ROAA) and Tobin's Q value A (Tob). Variables are defined and measured in Table 1, and descriptive statistics are shown in Table 2.

Table 1: Variable definition and measurement methods

Variable symbols	Variable name	Method of measurement
pat1	Green patent	ln(green patent independent application +1)
pat2	Green invention patent	ln(Independent application for green invention patent +1)
pat3	Green utility model patent	ln(Independent application for green utility patent +1)
Carbon	Carbon Finance	Carbon emissions /gdp
SA	Financing constraints	SA index
Inn1	R&d investment	ln(expensed amount of R&D investment +1)
sal	Selling expenses	ln(selling expenses +1)
ins	Net intangible assets	ln(net intangible assets +1)
term	Long-term liabilities	ln(total long-term liabilities +1)
Age	Age of business Year of listing 1	Year the business was listed
net	Net profit	Log of net profit
ROAA	Net profit margin on total assets	Net profit/average balance of total assets
Tob	Tobin's Q is worth A	Market value of equity + market value of net debt/total assets at the end of the period

Table 2: Descriptive statistical analysis of variables

Variable	N	Mean	SD	Min	Max
pat1	2290	0.390	0.820	0.000	3.784
pat2	2290	0.254	0.640	0.000	3.367
pat3	2290	0.257	0.624	0.000	2.996
Carbon	2290	10.696	0.640	9.308	12.405
ins	2290	18.197	3.437	0.000	23.261
term	2290	17.179	7.090	0.000	25.081
net	2290	18.700	1.659	14.946	22.606
ROAA	2290	0.038	0.030	0.008	0.142
Tob	2290	1.614	0.730	0.843	5.186
Age	2290	11.109	6.932	1.000	29.000
sal	2290	17.224	3.443	0.000	21.670

3.3. Measurement Model Construction

In order to test Hypothesis H_1, this paper constructs the following benchmark econometric model.

$$Pat_{i,t}=\beta_0+cCarbon_{i,t}+\beta X_{i,t}+\mu_t+\varepsilon_{i,t} \tag{2}$$

Where i represents the listed company, j represents the industry, t represents the time, is the green innovation level of the new energy enterprise in the current period, and further distinguishes between green invention patent and green utility model patent; $Carbon_{i,t}$ is Carbon finance level is the variable that is under control. β_0 is the constant term, is the coefficient, is the coefficient of the control variable, is the time fixed effect, is the error term.

In order to test Hypothesis H_2, referring to the practice of Wen et al., a recursive equation is constructed by using the method of mediating effect to test the mechanism of carbon finance affecting green innovation through financial constraints and R&D investment. The measurement model is set as follows [16]:

$$M_{i,t}=\beta_0+aCarbon_{i,t}+\beta X_{i,t}+\mu_t+\varepsilon_{i,t} \tag{3}$$

The measurement model is determined by the following:

$$Pat_{i,t}=\beta_0+cCarbon_{i,t}+bM_{i,t}+\beta X_{i,t}+\mu_t+\varepsilon_{i,t} \tag{4}$$

Where, respectively represents the financing constraints and R&D expenditure of listed company i in year t. The test of mediating effect is divided into three steps: in the first step, regression is conducted on Equation (2) to judge the total effect of carbon finance on green innovation without including mediating variables. If it is significant, it indicates that the total effect of carbon finance on green innovation exists; The second step is to run regression on Equation (3) to judge the effect of carbon finance on mediating variables; The third step is to introduce mediating variables into Equation (2) to form Equation (4) and regression to test the direct effect of carbon finance on green innovation and the effect of mediating variables on corporate green innovation. If a and b are both significant, the mediating effect exists; Under this premise, if c is not significant, it indicates that there is a complete mediating effect; If c significant, it indicates that there is a partial mediating effect; If a and b at least one of and is not significant, the significance of the mediating effect should be tested by Sobel method. If the test result is significant, the mediating effect exists; otherwise, the mediating effect does not exist.

4. Empirical Results and Analysis

Since the fixed effect model is better than the random effect model, this paper chooses the panel fixed effect model for analysis. At the same time, the regression method controlling the time fixed effect is used to verify the previous hypotheses H_1-H_3, so as to control the robustness of the measurement results.

4.1. Benchmark Test

Carbon finance helps new energy enterprises to carry out green innovation. In particular, it is favorable for improving green patents, green invention patents, and green utility models of new energy enterprises. According to the benchmark test, the regression results are shown in Table 3. Columns (1), (2) and (3) are based on the regression of Green patents, green invention patents, and green utility model patents of new energy enterprises are respectively being added to control variables and time-fixed effects. It can be seen that when carbon finance increases by one unit, corporate There was an increase of 0.056, 0.045, and 0.058 units respectively for green patents, green invention patents, and green utility model patents.

The benchmark test results show that carbon finance helps to Encourage the use of green technology in renewable energy businesses, and has the least promotion effect on green invention patents. The reason for this phenomenon may be that the green innovation activities A significant amount of capital investment is necessary for new energy enterprises, and the improvement of green innovation is directly promoted by carbon finance ability by providing capital supply for these enterprises. In addition, the carbon finance market also provides incentives for the advancement of green innovation in new energy companies through market mechanism. Because green invention patents have higher gold content and creativity, they need more capital investment than green utility model patents (Table 3).

Table 3: Regression results of benchmark test

	(1)	(2)	(3)
	pat1	pat2	pat3
Carbon	0.056**	0.045**	0.058***
	(2.23)	(2.28)	(2.96)
ins	0.008	0.006	0.006
	(1.40)	(1.43)	(1.44)
term	0.000	0.001	0.000
	(0.03)	(0.35)	(0.03)
net	0.110***	0.108***	0.069***
	(6.56)	(8.14)	(5.29)
ROAA	2.066	2.449	1.406
	(2.61)	(3.94)	(2.30)
Tob	0.138***	0.127***	0.088***
	(4.89)	(5.75)	(4.02)
Age	0.033	0.023	0.024
	(11.94)	(10.45)	(11.22)
sal	0.039***	0.028***	0.025***
	(7.96)	(7.43)	(6.70)
_cons	2.849	2.709	2.008
	(6.69)	(8.08)	(6.09)
N	2290	2290	2290
r2	0.159	0.147	0.129

Note: ***, ** and * indicate significance levels at 1%, 5% and 10%, respectively. Within () are *t-values*.

4.2. Robustness Test

4.2.1. Add Control Variables That May be Omitted

Considering that company size and asset-liability ratio will also have an impact on the green innovation of new energy enterprises, this paper adds company size and asset-liability ratio to the control variables for empirical analysis to further reduce the possible endogeneity problems caused by key missing variables. The natural logarithm of annual total assets is used to measure the size of the company, as per Si Lijuan et al.'s research [17]. Referring to the study of Sun Le et al., At the end of the year, the asset-liability ratio (Lev) can be calculated by dividing total liabilities by total assets [18]. The regression results are in accordance with the previous ones as shown in Columns (1) to (3) of Table 4.

Table 4: Potentially missing control variables are added in Table 3 as robustness test

	(1)	(2)	(3)
	pat1	pat2	pat3
Carbon	0.043*	0.035*	0.047**
	(1.72)	(1.78)	(2.42)
ins	0.003	0.003	0.003
	(0.59)	(0.60)	(0.62)
term	0.004	0.002	0.004
	(1.49)	(1.05)	(1.68)
net	0.054	0.032	0.051
	(1.65)	(1.26)	(2.03)
ROAA	2.322**	1.114	1.981**
	(2.13)	(1.30)	(2.35)
Tob	0.153***	0.141***	0.098***
	(5.45)	(6.40)	(4.52)
Age	0.036	0.025	0.026
	(12.73)	(11.23)	(12.09)
sal	0.039***	0.028***	0.025***
	(8.04)	(7.50)	(6.78)
Size	0.222***	0.192***	0.159***
	(5.73)	(6.32)	(5.30)
Lev	0.015	0.082	0.106
	(0.13)	(0.91)	(1.20)
_cons	4.606	4.256	3.243
	(8.74)	(10.28)	(7.95)
N	2290	2290	2290
r2	0.172	0.162	0.142

4.2.2. Consider the Impact of the Pandemic

The sample interval of this paper is from 2000 to 2021. Referring to the research of Li et al., in order to eliminate the possible interference caused by the epidemic, the sample observations in 2021 are eliminated and the test is re-conducted [19]. As shown in Columns (1) - (3) of Table 5, there is no significant difference between the regression results and According to the previous ones, the original conclusions are strong.

Table 5: Special years are excluded as robustness test

	(1)	(2)	(3)
	pat1	pat2	pat3
Carbon	0.053**	0.042**	0.055***
	(2.03)	(2.07)	(2.74)
ins	0.008	0.006	0.006
	(1.42)	(1.45)	(1.45)
term	0.001	0.001	0.001
	(0.32)	(0.63)	(0.24)
net	0.104***	0.105***	0.065***
	(6.06)	(7.79)	(4.86)

Table 5: (continued).

ROAA	1.725	2.215	1.166
	(2.12)	(3.48)	(1.84)
Tob	0.143***	0.134***	0.089***
	(4.81)	(5.78)	(3.86)
Age	0.034	0.023	0.024
	(11.60)	(10.13)	(10.84)
sal	0.037***	0.027***	0.024***
	(7.64)	(7.19)	(6.44)
_cons	2.710	2.638	1.920
	(6.19)	(7.71)	(5.63)
N	2169	2169	2169
r2	0.160	0.147	0.129

5. Conduction Mechanism Test

5.1. Test on the Transmission Mechanism of Financial Constraints

Next, the stepwise regression method is used to test H2. In Column (1) of Table 6, the dependent variable is financing constraints for new energy enterprises are revealed in the regression results, and columns (2) - (4) take the regression results of green patents, Green invention patents and green utility model patents are dependent variables for new energy enterprises. Due to the negative financial constraints, the greater the absolute value of the financial constraints is, the greater the financial constraints the enterprises receive. The results show that reducing the financing constraints of enterprises is beneficial to green innovation of new energy enterprises by reducing the financial constraints of enterprises, which verifies Hypothesis H2. Specifically, the carbon finance in Column (1) of Table 5 is significantly positive, which means that higher carbon finance is conducive to reducing the financing constraints faced by enterprises; In columns (2) - (4), both carbon finance and financial constraints are positive. The reason may be that the carbon finance market helps new energy enterprises to obtain financial support more easily by providing diversified financing channels and reducing financing costs. This easing of financing constraints helps new energy enterprises to overcome financial barriers in the innovation process and promote the smooth development of their green innovation activities.

Table 6: Transmission mechanism of financial constraints

	(1)	(2)	(3)	(4)
	SA	pat1	pat2	pat3
SA		0.473***	0.422***	0.337***
		(4.93)	(5.58)	(4.53)
Carbon	0.026***	0.044*	0.034*	0.049**
	(4.69)	(1.75)	(1.73)	(2.51)
ins	0.004	0.009*	0.008*	0.007*
	(3.21)	(1.74)	(1.82)	(1.75)
term	0.003	0.002	0.002	0.001
	(4.93)	(0.54)	(0.92)	(0.50)
net	0.057***	0.083***	0.084***	0.050***

Table 6: (continued).

	(15.55)	(4.74)	(6.05)	(3.64)
ROAA	1.783	1.221	1.697	0.806
	(10.36)	(1.52)	(2.69)	(1.29)
Tob	0.028***	0.125***	0.116***	0.078***
	(4.52)	(4.43)	(5.24)	(3.59)
Age	0.024	0.022	0.013	0.016
	(39.19)	(6.13)	(4.57)	(5.82)
sal	0.002	0.040***	0.029***	0.026***
	(2.06)	(8.21)	(7.71)	(6.92)
_cons	4.584	0.679	0.777	0.464
	(49.40)	(1.11)	(1.62)	(0.98)
N	2290	2290	2290	2290
r2	0.669	0.168	0.158	0.137

5.2. Test on the Transmission Mechanism of R&D Investment

The first column in Table 7 takes the return result of R&D investment of new energy enterprises as the dependent variable, and the second to fourth columns take the return result of green patents as the dependent variable.The regression results show that carbon finance is conducive to improving the R&D investment of enterprises, thus promoting the green innovation of new energy enterprises, which verfies H3. Specifically, the carbon finance in Column (1) of Table 6 is significantly positive, which means that the higher the carbon finance is, the better the enterprise's R&D investment is. In columns (2) - (4), both carbon finance and R&D investment are positive. The reason may be that carbon finance provides a low-cost source of capital for new energy enterprises, part of which can be used for R&D investment. In addition, the carbon finance market can also promote the cooperation and exchange between new energy enterprises and innovation subjects such as research institutions and universities by providing platforms and mechanisms such as R&D cooperation and technology transfer, which helps new energy enterprises to clarify the direction of R&D and improve the efficiency of R&D, thus enhancing their green innovation capacity.

Table 7: Transmission mechanism of R&D investment

	(1)	(2)	(3)	(4)
	inn	pat1	pat2	pat3
inn1		0.099***	0.078***	0.050**
		(3.38)	(3.28)	(2.24)
Carbon	0.171*	0.274***	0.199***	0.219***
	(1.81)	(4.45)	(3.97)	(4.67)
ins	0.019	0.032	0.034	0.001
	(0.51)	(1.30)	(1.71)	(0.04)
term	0.007	0.010	0.004	0.012*
	(0.55)	(1.11)	(0.64)	(1.83)
net	0.434***	0.122***	0.144***	0.034
	(7.06)	(2.91)	(4.22)	(1.07)
ROAA	0.898	3.699	4.183	2.221
	(0.33)	(2.10)	(2.92)	(1.66)

Table 7: (continued).

Tob	0.374***	0.177***	0.151***	0.131***
	(3.83)	(2.75)	(2.88)	(2.67)
Age	0.032	0.036	0.025	0.032
	(3.25)	(5.61)	(4.68)	(6.52)
sal	0.224***	0.040***	0.028**	0.027**
	(10.82)	(2.66)	(2.32)	(2.34)
_cons	3.036**	6.449	5.614	3.967
	(2.05)	(6.66)	(7.14)	(5.39)
N	511	511	511	511
r2	0.504	0.229	0.218	0.193

6. Conclusion

The aim of this paper is to examine the impact of carbon financing on the green innovation of new energy enterprises through the use of research samples from 2000 to 2021, further explores the transmission mechanism of financing constraints and R&D investment, and conducts robustness tests. The results show that: first, carbon finance helps to improve the green innovation of new energy enterprises, also has the least promotion effect on green invention patents; Carbon finance can help companies innovate green by reducing financing constraints; Thirdly, carbon finance is conducive to improving the R&D investment of enterprises, thus promoting the green innovation of new energy enterprises.

Based on the above conclusions, this paper puts forward the following policy recommendations. First, the government should improve laws and regulations to strengthen the construction of carbon trading platform and the supervision of carbon financial market, give full play to the financial function of carbon trading market, encourage the innovation of carbon financial derivatives, guide financial institutions and other institutional investors to actively participate in carbon trading, and strengthen the financial support for low-carbon technology. We should explore new carbon financial trading mechanism, vigorously cultivate carbon trading market players, promote carbon financial product innovation, improve the carbon trading system based on market mechanism, enhance the financialization degree of carbon trading, use market to guide innovative resource allocation. We should also increase tax collection on high emission and high pollution enterprises, and form a positive incentive mechanism for green taxation. Encourage enterprises, scientific research institutions and universities to strengthen cooperation, establish a green technology innovation system integrating industry, university and research, and enhance the international competitiveness of China's new energy industry. Second, we should actively encourage and support new energy enterprises to accelerate green innovation and strengthen their transmission channels. Specifically, in terms of financing constraint channels, we should fully understand the financing needs of new energy enterprises, simplify the financing procedures of new energy enterprises, and reduce the financing costs of new energy enterprises. In the era of digital economy, digital financial means can also be used to open source financing for new energy enterprises. By creating rich digital financial products, financing can be provided to all sectors of society and investors at home and abroad, and the boundary of green innovation financing for new energy enterprises can be broadened. In terms of R&D investment channels, the government should continue to strengthen policy support, reduce production and operation costs, so as to improve the enthusiasm of these enterprises to increase R&D investment.

The government should set up green technology innovation fund to support the investment of new energy enterprises in green technology research and development, product innovation and other aspects. For new energy enterprises that actively participate in the carbon financial market and carry out green innovation, the government should give tax breaks, preferential policies and other support to reduce their operating costs and encourage them to increase their investment in green innovation.

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