

Research on the Impact of Green Finance on Regional Low-carbon Transition in the Context of High-quality Development

-- Based on Provincial Panel Data

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Abstract

The trend and goal of global high-quality development have given new missions to the reform and innovation of the financial sector, and the development of green finance can further optimize the mode of economic development and empower high-quality economic development. Since 2020, when China formally proposed the goal of "carbon peak and carbon neutrality", it is of great theoretical and practical significance to explore the impact of green finance on the low-carbon transformation of the economy, so as to formulate a reasonable carbon emission reduction program and determine the future development direction of green finance in China. Based on the theories of financial development and sustainable financial development, government intervention and market failure, this project analyzes and summarizes the theoretical foundations of green finance, green financial policies and market development; based on the theories of sustainable development, low-carbon economy and regional economic development, it compiles the theoretical basis of low-carbon economic transformation. Using the all-factor non-radial directional distance function and the common frontier (Meta-frontier) non-radial Malmquist index measurement method, we measure the level of economic low-carbon transformation and the dynamic carbon emission performance index at the level of prefecture-level cities in China from 2006-2019, and study the impact of green finance development on regional economic low-carbon transformation from the perspectives of green finance policy and green finance market, and analyze in-depth the regulation and regulation of the development of the green finance policy and market. and deeply analyze the regulating factors, influencing mechanisms and heterogeneous characteristics. Finally, based on the conclusions of the above study, we put forward five policy recommendations to comprehensively promote the low-carbon transformation of regional economy.

Keywords

High-quality Development; Green Finance; Regional Low-carbon Transition; Provincial Panel Data.

1. Introduction

In the face of a century of unprecedented changes in the background, China's development is still in an important strategic opportunity, green low-carbon development is undoubtedly an effective path to maintain economic and social development. Therefore, it is of profound practical significance to extend the study of how finance supports the development of low-

carbon economy to the study of the impact and mechanism of green finance on the low-carbon transformation of the economy. First, based on the fact that the characteristics of economic low-carbon transition for different regions to develop carbon peak program to provide reference. On the basis of the research, government departments can combine the economic foundation, industrial structure and resource endowment of different regions to provide targeted carbon emission reduction programs for different regions to formulate the basis, with a view to promoting the coordinated development of regional economy. Second, it provides research evidence for government departments to choose green financial policies to promote low-carbon economic transformation. This study clarifies the nature and dimensions of the impact of green finance on the low-carbon transformation of the economy, and the conclusions of the study help governments at all levels to make clearer the low-carbon effects of green finance and the paths in which it plays a role, which can help the government formulate corresponding policies to support the development of the real economy by utilizing financial policies, and promote the sustainable development of the real economy. Thirdly, it has practical reference value for financial institutions to develop green finance to help regional economic low-carbon transformation. Not only can it enhance the degree of matching between economic development and green finance in various regions, but also improve the policy system for coordinated regional development, and promote the release of development potential in different regions to form regional synergy.

2. Measurement and Evaluation of Regional Low-carbon Transition

2.1. Variable Selection

Input variables include labor input, capital input and energy input. Among them, labor input (L): the number of urban employment in each prefecture-level city is used. Capital input (K): the capital stock of each prefecture-level city is used. The calculation method of capital stock is based on Zhang Jun et al. (2004), which adopts the perpetual inventory method to estimate the fixed capital stock of each prefecture-level city, and the actual fixed capital investment is deflated based on the fixed asset investment price index of each province with 2000 as the base period. Energy input (E): Unlike some studies that use the annual electricity consumption of cities, this paper uses the energy consumption of prefectural cities to measure energy input, considering that energy consumption can more accurately measure the energy input of each region. Since there is no complete data on energy consumption at the prefecture-level city level, the data are calculated by the formula. Energy consumption is calculated as follows: based on the total amount of natural gas supply, total amount of liquefied petroleum gas (LPG) supply and total electricity consumption of the whole society in each city given in the Energy Statistics Yearbook, the energy consumption of prefectural-level cities is converted and totaled according to the coefficients of natural gas discounted by standard coal, LPG discounted by standard coal and electricity discounted by standard coal to get the energy consumption of prefectural-level cities in the past years.

The output variables include desired output and non-desired output. The desired output variable is the Gross Regional Product (Y) of each prefecture, which is calculated for each prefecture at constant prices for the calendar year 2006 as the base period.

The non-expected output variable is measured by carbon dioxide emissions (C) at the prefecture-level city level. For the CO₂ emission data at the prefecture-level city level, in order to calculate the regional carbon emission level as accurately as possible, this paper relies on the practice of Wu and Huang (2016), which sums up the carbon emissions generated by the consumption of gas and liquefied petroleum gas (LPG), electrical energy and thermal energy in prefecture-level cities. The carbon emissions from gas and LPG are calculated using the carbon conversion factors provided by the United Nations Intergovernmental Panel on Climate Change

(IPCC) 2006, and the carbon emissions from electricity are calculated using the baseline emission factors for the whole society's electricity consumption and the power grid. Carbon emissions from thermal energy were calculated by converting the total heat supply, the low-level heat output of raw coal, the thermal efficiency and the raw coal heat output factor.

2.2. Sample Data

Specifically analyze the low-carbon transition of the economy in each region in time and space. Descriptive statistics of the data for each group of input-output variables are shown in Table 1.

Table 1. Descriptive statistics

variant	number of individuals	average value	(statistics) standard deviation	minimum value	maximum values
Low carbon intensity areas					
Capital stock K (billions of dollars)	1330	8108.134	33164.470	359.638	582862.800
Labor force input L (million)	1330	38.372	30.825	5.670	380.400
Energy consumption E (tons of standard coal)	1330	53.258	61.985	1.0923	578.549
GDP Y (billion dollars)	1330	1179.666	1080.111	70.175	8248.482
Carbon emissions C (tons of standard coal)	1330	261.494	273.454	7.531	3255.207
medium carbon intensity area					
Capital stock K (billions of dollars)	1330	7657.628	7560.860	330.703	49247.170
Labor force input L (million)	1330	61.108	70.343	6.740	649.334
Energy consumption E (tons of standard coal)	1330	163.668	228.216	5.596	1869.846
GDP Y (billion dollars)	1330	1967.283	2467.301	125.593	20094.880
Carbon emissions C (tons of standard coal)	1330	816.139	994.498	36.527	6385.556
High carbon intensity areas					
Capital stock K (billions of dollars)	1330	6680.027	10053.290	390.322	86562.850
Labor force input L (million)	1330	59.807	112.190	4.210	986.870
Energy consumption E (tons of standard coal)	1330	276.121	482.783	2.416	4217.379
GDP Y (billion dollars)	1330	1741.493	3082.306	51.928	29826.090
Carbon emissions C (tons of standard coal)	1330	1364.912	2045.365	12.445	22861.190

As can be seen from Table 1, the mean values of GDP and labor input are relatively low in the low carbon intensity regions, but the mean value of capital stock is high, indicating that some cities in the low carbon intensity regions are still in the stage of large-scale infrastructure construction, with a faster economic growth rate, and the demand for carbon emissions may be

higher in the future. Medium carbon intensity regions have the highest mean values of gross product and labor input, indicating that prefecture-level cities in medium carbon intensity regions are densely populated and have higher levels of economic development. The mean value of GDP is higher in high carbon intensity regions, and the maximum value of GDP is higher than that of the other two groups, while the minimum value of GDP is lower than that of the other two groups, which indicates that there are cities in high carbon intensity regions that have developed economies in China and are in urgent need of industrial restructuring and upgrading, as well as cities that are lagging behind in terms of economic development and whose industries are highly reliant on traditional energy sources, and that the pressure and potential for carbon reduction in high carbon intensity regions are greater in comparison.

2.3. Measurement Results

The level of low-carbon transformation of the economy is measured by the measured Total Factor Carbon Performance Index (TCPI), and the TCPI is measured between 0 and 1, with the closer the result is to 1 indicating a better degree of low-carbon transformation of the economy. As can be seen from the measurement results of the national Total Factor Carbon Emission Performance Index (TCPI), the average value of carbon emission performance from 2006-2019 is 0.2888, which is still at a relatively low level. In terms of the time period, from 2006-2012, the value of carbon emission performance increased steadily, with the mean value rising from 0.233 to 0.316, with an average annual growth rate of 5.21%. There was a small decline in 2012-2013, after which the carbon emission transition performance remained at a relatively stable level, and by 2019, the national mean value of carbon emission performance was 0.299, and the 2006-2019 The average annual growth rate of the carbon emissions performance index in 2019 was 1.94%.

3. Empirical Analysis of Green Finance on Regional Low-carbon Transition

3.1. Modeling

In order to verify hypothesis 5, that is, green credit, as the most important green financial instrument, has a positive promotion effect on the economic low-carbon transition, the proxy indicators of green credit are selected as the explanatory variables, and the performance level of the economic low-carbon transition as the explanatory variables, and in order to alleviate the heteroskedasticity, the logarithmic treatment is done for the relevant variables. The benchmark regression model is constructed as shown in equation 1:

$$\ln TCPI_{it} = \beta_0 + \beta_1 \ln gcp_{it} + \rho X_{it} + \delta_t + \varphi_i + \varepsilon_{it} \quad (1)$$

where $TCPI_{it}$ denotes the economic low-carbon transition performance of prefecture-level city i in year t , gcp_{it} represents the level of green credit, and X_{it} represents the control variables. β_0 is the intercept term, and δ_t is the year fixed effect, φ_i is the prefecture-level city fixed effect, and ε_{it} is the disturbance term.

3.2. Variable Selection and Data Description

3.2.1. Variable Selection

The explanatory variable: the level of low-carbon transition of the economy, still uses the performance data of low-carbon transition of the economy measured in chapter five.

Explanatory variables: Green credit. Therefore, this paper only refers to the idea of constructing the indicator of the amount of interest expense of six high energy-consuming enterprises.

Considering that the structure of China's urban end-use energy consumption is dominated by coal, in which the share of industrial energy is the highest, according to the analysis of data from the China Energy Statistical Yearbook, the six major high-energy-consuming industries in the country (including ferrous metal smelting and calendaring and processing industry, chemical raw materials and chemical products manufacturing industry, non-metallic mineral products industry, petroleum processing, coking and nuclear fuel processing industry, non-ferrous metal smelting and calendaring and processing industry, and electric power, thermal power, gas and water production and supply industry) has long been the main body of industrial energy use, and since the share of energy use exceeded 70% in 2000, it has been fluctuating at a high level, and in 2016, it accounted for 75.1% of the national industrial energy use, which accounted for 50% of the total energy consumption, with a large amount of greenhouse gases emitted from the production process. According to the calculation results of Hu Anjun and Sun Jiowen (2022), the domestic high carbon emission industries and the six major high energy consumption industries basically overlap, so the six major high energy consumption industries are the industries most affected by the development of green finance, and after the implementation of green credit, their lending capacity is limited, and the decline in the scale of financing has led to a decline in the industry's overall interest expense, reflecting the constraining effect of green credit. Based on this, drawing on the practice of scholars such as Jiang Hongli et al. (2020), (1 - the proportion of the interest expense amount/industrial production value of the six major provincial energy-consuming enterprises) is used as a proxy indicator for the level of green credit development. On this basis, the data are further decomposed, drawing on the practice of Li Jiangtao and Huang Haiyan (2022), using the proportion of each city's industrial added value in the industrial added value of the province in which it is located as the allocation weight of green credit, and decomposing the proportion of green credit at the provincial level to each prefecture-level city, so as to obtain the level of green credit development at the prefecture-level city level (gcp).

Control variables: in order to control other factors affecting the level of low-carbon transition of the economy, industrial structure, financial development level, foreign investment intensity, human capital level, environmental regulation level and government intervention are still selected as control variables.

3.2.2. Data Description

Data from 283 prefecture-level cities in China from 2006-2019 are used as the research sample, the interest expenses of the six high energy-consuming industries are from the China Industrial Statistics Yearbook of all years, the data on industrial output value are from the China Urban Statistics Yearbook of all years, and the data on the distribution of the banking industry and branches are from the website of the China Banking and Insurance Regulatory Commission (CBIRC).

3.3. Empirical Results

3.3.1. Baseline Regression Results

By doing fixed and random effects regression on model (1), the chi-square statistic of Hausman's test is 213.89, with a p-value of 0.000, which rejects the original hypothesis, indicating that a fixed effects model should be used. The standard error of the regression estimation is also corrected using the clustering effect at the prefecture level, and the regression results are shown in Table 2.

Table 2. Benchmark regression results

variant	(1)	(2)	(3)
	lnTCPI	lnTCPI	lnTCPI
lngcp	0.192*** (0.0658)	0.140* (0.0658)	
lngcp2			0.132*** (0.0462)
lnstru		0.0882 (0.0592)	0.0222 (0.0164)
lnfinance		-0.0417*** (0.0124)	-0.0414*** (0.0087)
lnFDI		0.0052 (0.0292)	0.0051 (0.0223)
lndeu		-0.0084 (0.0083)	-0.0071 (0.0060)
lnso ₂		-0.0468*** (0.0157)	-0.0469*** (0.0089)
lngi		-0.0027 (0.0063)	-0.0029 (0.0047)
Constant	-1.229*** (0.0514)	-1.001*** (0.312)	-0.678*** (0.116)
Area fixed effects model	containment	containment	containment
time fixed effects model	containment	containment	containment
Observations	3962	3277	3241
R-squared	0.765	0770	0.770

Columns (1)(2) represent the regression results when the green credit variable is calculated with the share of industrial added value of prefecture-level cities as the weight, and it can be seen that the regression coefficients are significantly positive regardless of whether or not the control variables are added, indicating that the increase in the level of green credit development is conducive to the enhancement of the economic low-carbon transition performance. In terms of control variables, the level of financial development reduces the performance of economic low-carbon transition, which is presumed to be mainly due to the fact that China's credit market is driven by profit-making purposes and the influence of the local government, and the funds are invested in more traditional industries capable of increasing the gross local product, but the traditional industries are mostly production sectors with high energy consumption and high levels of greenhouse gas emissions, which is thus detrimental to the realization of a low-carbon transition of the economy, and the level of sulphur dioxide emissions is used to The coefficient is significantly negative when measuring the intensity of environmental regulation, indicating that the higher the intensity of environmental regulation, the more favorable it is for the economy to achieve low-carbon transition.

In addition, in order to improve the robustness of the results, this paper re-runs the regression by replacing the calculation of explanatory variables. Column (3) represents the regression results when the calculated weight of green credit development level is replaced by the ratio of prefecture-level city GDP to the province's GDP, and it can be seen that the regression coefficient of green credit development is still positively contributing, which means that the level of green credit development improves the performance of economic low-carbon transition at the 1% significance level.

3.3.2. Robustness Tests

In order to further determine the reliability of the above regression results of green credit on the performance of low-carbon transition of the economy, this paper conducts a robustness test in terms of considering lag, replacing explanatory variables, and excluding some samples. The results of the robustness test are shown in Table 3.

Table 3. Robustness tests results

variant	(1)	(2)	(3)
	lnTCPI	lnTCPI	lnTCPI
L.lngcp	0.187*** (0.0485)		
lngc		0.127*** (0.0585)	
lngcp			0.156*** (0.0518)
Constant	-1.009*** (0.164)	-1.022*** (0.226)	-1.039*** (0.172)
Area fixed effects model	containment	containment	containment
Time and area fixed effects	containment	containment	containment
Observations	3962	3277	3241
R-squared	0.765	0.770	0.770

First, the explanatory variables are lagged by one period. Considering the possible time lag of green credit investment-related programs in affecting the performance of economic low-carbon transition, the explanatory variables are regressed with one period lag. As can be seen in column (1) of Table 6-3, the impact of green credit on economic low-carbon transition lagged by one period remains significantly positive, controlling for other variables and time and region fixed effects.

Second, the measurement of green credit is replaced. A regression is conducted using the number of green credits (gc), calculated using the regional industrial value added share as a weight, as a proxy for the development of green credits. The test results are shown in column (2) of Table 3. It can be seen that the proxy indicator of green loan balance still has a positive contribution to the performance of low-carbon transition of the economy. And after dealing with endogeneity through instrumental variables as above, the regression results with green loan balance are still significantly positive, further indicating the robustness of the conclusions. Finally, the sample of provincial capital cities is excluded from the analysis. Since the number of banks and financial market maturity are higher in provincial capital cities compared to non-capital cities, to determine the situation in regions other than provincial capital cities, the sample is regressed again after removing 30 provincial capital cities and municipalities, and the results are shown in column (3) of Table 3. The results show that green credit still has a positive impact on the performance of low-carbon transition of the economy after removing the developed areas of financial markets such as provincial capital cities and municipalities. The regression results tested in the above three ways illustrate that green credit can improve the performance of economic low-carbon transition, and the results are robust.

4. Countermeasures Research on the Impact of Green Finance on Regional Low-carbon Transition

4.1. Accelerate the Comprehensive Development of Green Finance and Formulate Programs Targeting the Low-carbon Transition of the Economy

Low-carbon economic transformation is a systematic and all-round transformation of the whole society, and from the financial point of view, finance plays a leveraging effect and an accelerator role, which is a key link that cannot be ignored in realizing low-carbon economic transformation. The "five pillars" proposed by the People's Bank of China include green financial policy and green financial market, etc. The development of green finance in each region should be actively in accordance with the requirements of the "five pillars" to further improve the financial guarantee for the low-carbon economic transformation. In the future, for the low-carbon transformation of the economy, it is necessary to further expand the connotation boundary of green finance. Green finance should support financing activities including ecology, environment, climate, energy, biodiversity, etc., and emphasize the research of green finance in low-carbon technology, energy structure, industrial structure, etc. Especially in energy, through innovative green finance, we can provide financial guarantee for low-carbon economic transformation. Especially in energy, through innovative green financial products, it should promote the cleanliness and decarbonization of the energy supply system and the electrification of terminal energy consumption. According to the local energy endowment, improve the support mechanism of green financial policy, so that green funds focus on wind, solar, biomass, ocean energy, geothermal energy-rich areas, improve the stability and transmission and storage capacity of clean energy, increase the proportion of non-fossil energy in energy consumption, and boost energy security and comprehensively support the low-carbon development of the economy with green finance. China's green financial development is different from that of developed countries in terms of economic situation and development stage. When formulating the development program of green finance to promote low-carbon economic transformation, on the one hand, it should emphasize that the green financing standards should be in line with international standards to improve the international level of financing, and on the other hand, it should be combined with the typical characteristics of China's energy structure, which is dominated by coal, the high proportion of heavy industry in the industrial structure, the high total amount of carbon emission, and low level of per capita carbon emission, to formulate a development program with the following characteristics On the other hand, it should take into account the typical characteristics of China's energy structure, which is dominated by coal, the high proportion of heavy industry in its industrial structure, the high total amount of carbon emissions, and the low level of per capita carbon emissions, etc., and formulate the development plan of green finance with Chinese characteristics, so as to support the development and transformation of the economy in a low-carbon manner with more targeted and efficient measures.

4.2. Enrich Green Financial Product Services to Improve the Match with Carbon Neutral Targets

Sources of financing for the low-carbon transition include government funds, financial institutions, private investment, PPP cooperation, foreign direct investment, international partners and interregional collaboration. Industries and enterprises in the low-carbon transition period have high financial needs, and at present, exogenous financing for green projects in China is still dominated by bank credit, with limited development of other financing methods. In order to improve the match between the supply of financial resources and the capital demand for low-carbon transition, green financial products and services should be further enriched. It should focus on improving the development level of green credit in each

region, especially focusing on the specific investment of green credit in the eastern and central regions, supervising the use of funds in the whole process, and improving the positive impact of green credit on the low-carbon transformation of the economies of the eastern and central regions. At the same time, the scale of green credit in the western and northeastern regions should be increased to strengthen its effect on promoting low-carbon economic transformation. In regions with relatively large green financial markets, the allocation of financial resources should be optimized, the proportion of low-carbon allocation of credit assets should be increased, the proportion of green credit should be increased, and the low-carbon transition effect of green credit development should be enhanced.

4.3. Balancing Green Finance and Transition Finance to Enhance Quality and Efficiency for Low-carbon Economic Transformation

The development experience of green finance reflects that the development of green finance will play a significant role in restricting high energy consumption, high pollution and high emission industries through policies and market mechanisms. However, for China's economy in transition, the promotion of low-carbon transformation of the economy should not be rushed, and excessively stringent investment and financing requirements have exposed a series of problems in reality. From the point of view of China's current stage of economic development, we should emphasize the joint development of green finance and transition finance. Financial support for low-carbon transformation of the economy needs to "walk on two legs", on the one hand, vigorously develop green finance to support green technological innovation and the development of green industry, on the other hand, we should develop transition finance and improve the elements required for the development of transition finance, including the standards of transition finance, the disclosure of information related to transition finance, the financial instruments of transition finance, etc., so as to ensure that the financial instruments closely related to people's lives will not be used in a hurry. On the other hand, it is necessary to develop transition finance and improve the conditions of the elements necessary for the development of transition finance, including the standards of transition finance, the disclosure of information related to transition finance, and the financial instruments of transition finance, etc., so as to ensure that the energy-intensive industries that are closely related to the life of the people realize sustainable development. In order to urge enterprises to implement low-carbon transition strategies, expanding the coverage of the carbon emissions trading market and internalizing externalities are effective measures to promote the low-carbon transition of high-carbon industries.

Although the standards and definitions of green finance and transition finance are different, the development of the two cannot be viewed in isolation, and the limited nature of financial resources determines that green finance and transition finance must be synergized and coordinated in a way that balances the strength of financial support for "greening" and "transitioning". The relationship between the quality of development and the quantity of emission reductions, finance and finance, fairness and efficiency should be handled well, and regions with high energy consumption and emissions should be taken as the anchor point for transformation, so as to promote the convergence of elements such as modern finance, advanced technology, human capital and data and information to the green industry and the traditional energy industry, and to drive the low-carbon transformation of the regional economy by means of new technologies, new products, new forms of business, and new modes of business, and ultimately to promote the high-quality development of the economy.

5. Conclusion

At present, China's economy is facing multiple pressures such as shrinking demand, supply shocks and resource constraints, and is undergoing a long-term transformation of economic

development mode. Continuously improving the level of low-carbon economic transformation is not only a necessary response to the five development concepts of innovation, coordination and green development, but also an important direction and path to promote sustainable development of regional economy. Through theoretical discussion and empirical analysis, this paper shows that the promotion of low-carbon economic transformation cannot be achieved without the guidance and guidance of green finance policy, nor can it be achieved without the resource allocation and targeting of green finance market. The rapid development of green finance in the country benefits from the top-level design norms and the promotion of local pilot experience. By summarizing the above research conclusions, it is proposed to accelerate the comprehensive development of green finance and formulate plans for low-carbon economic transformation. Enrich green financial products and services, and improve the matching degree with the carbon neutral goal; Give consideration to green finance and transformation finance, improve the quality and efficiency of low-carbon economic transformation, and improve the quality and efficiency of low-carbon economic transformation.

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References

- [1] Qi Chang. The impact of pilot zone policy on energy low-carbon transition under the perspective of digital finance[J]. *Times Economy and Trade*,2024,21(05):190-192.
- [2] Wang Family, Wang Haoran. Can low-carbon transition promote coordinated regional development? --Empirical evidence from the construction of "low carbon cities"[J]. *Economic and Management Review*,2024,40(03):31-44.
- [3] Liu Dandan. Research on the green transformation path of iron and steel industry under the goal of "double carbon"[J]. *Business Watch*,2024,10(14):69-73.
- [4] Du Minzhe,Liao Liping. Can Low Carbon Transition Promote Common Wealth? --Evidence from low-carbon city pilots[J]. *Economics Dynamics*,2024,(04):33-48.
- [5] XU Yan,SONG Yijin,SHAO Shuai. Impacts and mechanisms of low-carbon transition policies on environment-social responsibility-corporate governance of listed companies[J]. *China Population-Resources and Environment*,2024,34(04):60-75.
- [6] GUO Jinhua,GUO Leminan. A study on the impact of green low-carbon transition on enterprise de-virtualization[J]. *Journal of Management*, 2024,21(04):517-526.
- [7] ZHOU Jiewen, GAO Xiang, XIE Peipei. Research on the impact of environmental regulation on China's green and low-carbon transformation and development under the "dual-carbon" goal[J]. *Journal of Jiangsu University (Social Science Edition)*,2024,26(02):55-67.
- [8] Zhou Xiaoru. An empirical study on the impact of low-carbon pilot policies on low-carbon economic transition [D]. Shandong University,2023.
- [9] Jingli Wu. Research on the Influence Path of Green Finance on the Low Carbon Transition of Economy [D]. Shanghai University of Applied Sciences,2023.
- [10] KONG Dongmin, SHI Zheng. Optimization study on environmental regulation of green technological innovation of enterprises in China under the goal of "double carbon"[J]. *Taxation and Economy*, 2022, (06):1-7.