Low Carbon Development Strategy and Corporate Social Responsibility

-- A Quasi-natural Experiment based on Low-carbon Urban Policy

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Abstract

In order to ensure the realization of my country's goal of "carbon peaking and carbon neutrality", the National Development and Reform Commission has implemented the low-carbon city pilot policy in three batches. Will the implementation of this policy help enterprises to assume social responsibilities? By what mechanism? Based on the social responsibility reports of listed companies and the corresponding financial data from 2010 to 2017, this paper uses the progressive double difference model to empirically test the above problems. The research shows that the implementation of low-carbon city policies is beneficial to corporate social responsibility. After the robustness test, it is still established. Further mechanism analysis shows that the improvement of the policy's commitment to corporate social responsibility is mainly achieved through the improvement of investment efficiency and the improvement of R&D investment. In addition, the heterogeneity analysis shows that low-carbon city policies can effectively promote state-owned enterprises to actively undertake environmental responsibilities, and the promotion effect is significantly higher in areas with a high degree of marketization than in areas with a low degree of marketization. The research conclusions of this paper have important policy implications for achieving the goal of peaking carbon neutrality by 2030.

Keywords

Low-carbon City Pilot Policy; Corporate Social Responsibility; Progressive Double-Difference Model.

1. Introduction

Since the reform and opening up, my country's extensive economic development mode has made my country's economy develop rapidly and enter the forefront of the world. However, with the continuous advancement of urbanization and industrialization, this mode of economic development has gradually revealed its drawbacks. The industrial production mode of high input, high energy consumption, high pollution and low added value has made my country pay a huge price of ecological environmental pollution. As the world's largest developing country and the largest carbon emitter, China has actively carried out a number of energy conservation and emission reduction practices in order to reduce carbon emissions, and adopted a series of policies to promote low-carbon economic transformation. The National Development and Reform Commission of the People's Republic of China (NDRC) issued the "Notice on the Implementation of Pilot Policies for Low-Carbon Provinces and Low-Carbon Cities" in 2010, officially launching the pilot policies for low-carbon cities, and carried out pilot policies in 2012 and 2017. Two pilot city-wide expansions were launched to ensure that the goal of controlling greenhouse gases by 2030 is met. The Chinese government promulgated in September 2021

the State Council's Opinions on Completely and Accurately Implementing the New Development Concept and Doing a Good Job in Carbon Reaching and Carbon Neutralization will deeply adjust the industrial structure and accelerate the construction of a clean, low-carbon, safe and efficient energy system. Dafeng's key task of carbon neutralization [1]. The strategic goal of carbon peaking and carbon neutrality has raised my country's green development path to a new level.

Corporate Social Responsibility (CSR) refers to the responsibilities that an enterprise should take towards those who have an interest in it in its business activities. The aspects that an enterprise should be responsible for mainly include taking into account its own profits and business conditions, and should join the upper and lower ranks of employees and supply chains. Consider the responsibilities of enterprises, customer groups, social groups, subsidiaries, investors, shareholders and partners, as well as their responsibilities to the natural environment. For enterprises, whether they can take the initiative to assume social responsibilities, Implementing and promoting the "low-carbon strategy", effectively reducing pollution, and protecting the environment have become an indispensable part of my country's realization of low-carbon cities and enterprises. In recent years, the society has paid more and more attention to the social responsibility of enterprises. The social problems caused by the short-term behavior of enterprises have gradually increased, and problems such as product counterfeiting, environmental degradation, and intensification of social conflicts have emerged one after another, seriously restricting my country's economic and social development. With the development of enterprises, the society begins to realize that only enterprises must undertake corresponding social responsibilities in order to fundamentally solve problems and maintain sustainable development of enterprises. How to promote corporate social responsibility has become a topic of great concern to scholars at home and abroad. Existing research shows that corporate social responsibility (CSR) is closely related to corporate performance, environmental regulation and other factors, but most of the research focuses on the impact of environmental regulation on corporate performance and the impact of corporate social responsibility on corporate performance. The research on environmental regulation on corporate social responsibility is relatively weak.

In this context, this paper first studies the impact of low-carbon policies on corporate social responsibility, and further enriches the empirical evidence that environmental regulatory tools affect corporate social responsibility. Secondly, this paper focuses on the low-carbon city policy, and uses this policy as a quasi-natural experiment to identify causal relationships and evaluate policy effects, expand the research perspective of the economic impact of the "dual carbon" policy, and help the country achieve total carbon emissions by 2030. The work of peaking in quantity has important policy implications.

The rest of this paper is structured as follows: the second part reviews and summarizes the existing research, the third part describes the data and conducts empirical research, and the fourth part analyzes the empirical results, including the parallel trend test and the placebo test, The fifth part is the heterogeneity test.

2. Literature Review

There are different influencing factors for corporate social responsibility. From a micro perspective, the nature of property rights and governance structure of enterprises are the main factors. First, under different property rights, the social responsibility contribution presented by enterprises varies. Huang Sujian (2006) pointed out that for general enterprises, the social responsibility of the enterprise includes the pursuit of economic goals, and economic goals are the main content of corporate social responsibility. It depends on the implementation of the enterprise's economic goals; for state-owned enterprises, social responsibility includes both

economic goals and non-economic goals. On the whole, the social responsibility of state-owned enterprises is more dependent on the non-economic goals. Realization, the realization of economic goals is to serve the realization of non-economic goals [2]. Second, the senior managers of the enterprise control various resources of the enterprise and play a crucial role in the development of the enterprise. The governance structure of the enterprise also affects the undertaking of corporate social responsibility. Zhong Ma and Xu Guanghua (2019) conducted a full sample and propensity score matching sample study on listed companies in Shanghai and Shenzhen, and found that companies with overconfident executives had lower social responsibility performance levels [3]; Lin Liyang and Li Hua (2013) conducted research on corporate social responsibility behavior and financial performance, ownership structure and internal governance structure, and found that an effective governance structure can provide a reliable mechanism for the performance of corporate social responsibility [4].

In addition to the internal influencing factors of the enterprise, the external market environment will also affect the corporate social responsibility. Some scholars also study the impact of the social environment on the corporate social responsibility from a macro perspective. The external competitive market includes product market, manager market, capital market, etc. Chen Zhi (2011) believes that external market competition can help enterprises to enhance their sense of urgency, continuously improve product quality, maintain corporate reputation, and promote corporate responsibility. fulfillment [5].

As an important part of corporate social responsibility, the environment is also one of the main items for evaluating corporate social responsibility. The government's environmental protection and regulatory policies directly affect the undertaking of corporate social responsibility. So, can environmental regulation policies promote corporate social responsibility? Although there is no clear research showing that there must be a positive relationship between the two, some studies have proved that there is a certain relationship between corporate profit rate, environmental regulation, and corporate social responsibility. Long Xiaoning and Wanwei (2017) used the double difference method to empirically analyze the relationship between the implementation of clean production standards and corporate profit margins, and found that the implementation of cleaner production standards significantly improved corporate profit margins [6]. Ye Hongyu (2020) empirically studies the relationship between environmental regulation, corporate social responsibility and corporate performance, as well as the moderating effect of corporate social responsibility between environmental regulation and corporate performance. The results show that: environmental regulation has a negative impact on corporate performance; corporate social responsibility has a positive and significant impact on corporate performance; corporate social responsibility has a significant positive moderating role in the impact of environmental regulation on corporate performance [7].

As one of the important policies of green and low-carbon development policies, the "Notice of the National Development and Reform Commission on Launching the Third Batch of National Low-Carbon Cities Pilot Work" issued in 2017 pointed out that the construction of low-carbon cities should achieve the goal of peak carbon emissions, control the The total amount of carbon emissions, the exploration of low-carbon development models, and the practice of low-carbon development paths are the main lines, and the model innovation, institutional innovation, technological innovation and engineering innovation of low-carbon development shall be explored, and the national low-carbon development shall be led and demonstrated through pilot projects. Numerous studies have shown that the implementation of pilot policies has had a significant impact on the development of cities, regions and enterprises. Xu Jia and Cui Jingbo (2020) conducted a multi-dimensional empirical test on the above problems based on the sample data of A-share listed companies in Shanghai and Shenzhen stock exchanges from 2005 to 2015. The results show that the pilot policy of low-carbon cities is to a certain extent. It can

induce the green technology innovation of enterprises [8]. Zhang Hua (2020) used the panel data of 285 cities in China from 2003 to 2016 to estimate the impact of low-carbon city construction on carbon emissions using the double difference method. It was found that compared with non-pilot cities, the carbon emissions of pilot cities were significantly lower than the sample mean [9]. She Shuo and Wang Qiao et al. (2020) based on the quasi-natural experiment of the promotion of low-carbon pilot city policies in 2010, and found that approved low-carbon pilot cities can directly promote green total factor productivity by combining propensity score matching and double-difference model [10]. Lu Jin and Wang Xiaofei et al. (2020) conducted an empirical study based on PSM-DID on the impact of low-carbon city pilot policies on the industrial structure. The results show that the implementation of the policy has significantly promoted the upgrading of the industrial structure [11]. Su Taoyong (2022) used the multi-period double difference method to estimate the impact of the establishment of low-carbon and innovative dual pilot cities on the urban carbon emission level. It is found that the carbon emissions of dual pilot cities are significantly lower than those of non-dual pilot cities, and low-carbon city pilots and innovative city pilots have a synergistic effect on carbon emission reduction [12].

3. Data, Empirical Design and Variable Description

3.1. Data

There are two data sources for this article. First, the Social Responsibility Report of Listed Companies on Runling Global Network, which provides the scoring data of corporate social responsibility of Chinese listed companies. Second, the financial data of listed companies comes from the Guotai'an CSMAR China Listed Company Database, which is used to construct corporate financing constraints, and to construct a series of control variables based on the financial information of listed companies.

3.2. Institutional Background and Empirical Design

3.2.1. Institutional Background

In the transitional period, China is facing environmental problems such as excessive carbon emissions, environmental pollution, and serious greenhouse effect. In order to coordinate the contradiction between economic growth and environmental problems, energy conservation and emission reduction have become an important strategy for my country's economic development in the new era. In 2020, the Chinese government proposed at the 75th United Nations General Assembly that carbon dioxide emissions should peak in 2030 and achieve carbon neutrality in 2060.

In this context, the Chinese government has proposed a number of low-carbon policies, and the term "low-carbon city" has gradually entered the public's field of vision. What is a low carbon city? As the name suggests, cities with low levels of energy consumption and carbon dioxide emissions. In order to achieve the goal of low-carbon cities, the Chinese government has organized three batches of low-carbon city pilots. In 2010, the National Development and Reform Commission issued the "Notice on Carrying out Low-Carbon Provinces and Low-Carbon Pilot Work". First, five provinces including Guangzhou and Yunnan and eight cities including Shenzhen and Hangzhou were identified as low-carbon pilot cities to carry out energy-saving and low-carbon pilot projects. Pilot projects in cities where emission and reduction of carbon emissions are the main goals. Subsequently, the second and third batch of national low-carbon pilot cities were announced in 2012 and 2017 respectively, and first-tier cities such as Guangzhou and Nanjing were included in the list. Since then, low-carbon pilot work has been rolled out across the country. Each pilot city working group should include industrial structure adjustment, energy adjustment, low-carbon transportation, low-carbon life, etc.; for example:

reducing carbon dioxide emissions in the production field by adjusting the industrial structure and increasing enterprise green technology innovation; through a series of environmental Regulatory systems and incentive policies to promote the development of low-carbon industries. So far, my country's low-carbon pilot policies have achieved remarkable results in reducing carbon emissions.

3.2.2. Empirical Research

Based on the quasi-natural experiment of three batches of low-carbon city pilot work conducted by the National Development and Reform Commission from July 2010 to January 2017, this paper adopts the asymptotic double-difference model for empirical research. The regression equation is shown below.

$$CSR_{it} = \beta * post_t * treated_i + X_{it} * \gamma + u_i + v_t + \varepsilon_{it}$$

Among them, CSR_{it} is the corporate social responsibility of company i in year t; $post_t$ is a time dummy variable, which takes 1 after the policy occurs, otherwise it takes 0; $treated_i$ represents a policy dummy variable, if the city where the company is located is included in the low-carbon city pilot, it takes 1 , otherwise 0; X_{it} is other control variables; u_i is city individual fixed effect; v_t is year fixed effect.

In addition, it should be noted that, first, considering that the three batch lists overlap each other, this paper takes the year when a city was first included in the pilot list as the year in which the policy took place. For example, if a city was included in 2010 The pilot, and then included in the pilot in 2012, then set the city's policy occurrence year as 2010. Second, considering that the second batch of pilots took place in November 2012, which is close to the end of the year, there may be a certain time lag when the policy takes effect. Therefore, this paper sets the policy occurrence time in these cities as 2013.

3.3. Variable Description

1. **Corporate Social Responsibility:** CSR_{it} is the corporate social responsibility score of i company in year t. This paper selects the total score of the MCTI social responsibility report rating of listed companies published by the third-party rating agency Runling Global to measure the level of corporate social responsibility. The indicator includes four zero-level indicators: macrocosm, content, technology, and industry. From these four perspectives, first-level indicators and second-level indicators are established to integrate corporate strategy , stakeholders, fair operation and other aspects are included in the assessment scope, and the contribution of corporate social responsibility is objectively and scientifically assessed.

2. **Core explanatory variable:** The core explanatory variable is the intersection of the time dummy variable and the policy dummy variable. If the city where the enterprise is located is included in the pilot list in that year, this intersection is 1, otherwise it is 0.

3. **Control variables:** Existing studies have shown that the logarithm of total assets, the proportion of cash, the age of the enterprise, and the return on assets of the enterprise have a certain impact on the undertaking of corporate social responsibility, so these four factors are used as control variables.

4. **Enterprise investment efficiency mechanism:** As the main body of value creation, a concept closely related to enterprises is the investment efficiency of enterprises, which is a concept relative to the optimal investment level. The best investment ever made. If the enterprise investment deviates from this level, then it is considered that the enterprise has inefficient investment, and there may be two situations of over-investment and under-investment. At present, there are mainly Wurgler model, marginal Tobin's Q model and Richardson model to measure the efficiency of corporate capital investment. This paper adopts

the method of Richardson (2006) to measure the investment efficiency of enterprises, and refers to Li Yanxi et al. (2015) and Hu Shiyang et al. (2019) to select the variables that affect investment. The specific equation is as follows:

$$Inv_{ift} = \alpha_0 + \alpha_1 Inv_{ift-1} + \alpha_1 asset_{ift-1} + \alpha_1 cash_{ift-1} + \alpha_1 leve_{ift-1} + \alpha_1 roa_{ift-1} + \alpha_1 ficc_{ift-1} + u_i + e_t + \varepsilon_{ift}$$

The idea of this measurement method is to regress the enterprise investment amount on the variables that affect the normal investment of the enterprise, so as to obtain the enterprise investment amount fitted by the model. The difference between the actual investment amount of the enterprise and the fit of the model, that is, the residual term of the model, is the degree to which the enterprise deviates from the optimal investment level. Finally, we take the absolute value of this residual term as a measure of enterprise investment efficiency. In the following, we record it as Eff_{dft} ,the investment efficiency of enterprise f in region d in year t. The larger this indicator is, the worse the investment efficiency of the enterprise is.

Specifically, Inv_{ift} represents the investment level of enterprise f in industry i in year t, which is calculated by the enterprise's expenditure on building fixed assets, intangible assets and other long-term assets minus the enterprise's income from handling fixed assets, intangible assets and other long-term assets, and then divided by The total assets of the enterprise are obtained. Inv_{ift-1} represents the investment level of enterprises with a lag period, $asset_{ift-1}$ is the total assets of enterprises with a lag period of one period, $cash_{ift-1}$ is the monetary funds of enterprises with a lag period of one period, $leve_{ift-1}$ is the asset-liability ratio of enterprises with a lag period of one period, roa_{ift-1} is the return on assets of enterprises with a lag period of one period, and $ficc_{ift-1}$ is the asset-liability ratio of enterprises with a lag period of one period. free cash flow for the period.

5. **Enterprise R&D expenditure mechanism:** In the face of environmental regulation policies, enterprises may adjust the factor structure, adopt technology to replace labor and capital, reduce pollutants and carbon emissions, so as to reduce environmental costs and achieve green production. This paper uses the R&D investment of enterprises as a measure of enterprise technology elements and innovation. When the R&D investment of enterprises increases, it means that enterprises carry out more green technology innovations and use green technology to replace labor and capital. The data related to R&D investment (rd) comes from the financial statements of listed companies.

4. Empirical Results

In this paper, Stata software is used to regress the above equation, and the benchmark regression results are obtained. According to the results, the effect of environmental regulation on corporate social responsibility and the reasons for this effect are analyzed. Then, parallel trend and placebo tests are carried out to ensure the consistency of the results. effectiveness.

4.1. Benchmark Regression Results

According to the benchmark model constructed above, this part examines the impact of the implementation of environmental regulation policies on corporate social responsibility. The regression results are shown in Table 1. Columns (1), (2) and (3) of Table 1 represent the scores of corporate social responsibility, that is, the explained variables in the research question. In column (2), the paper controls the year fixed effect and individual fixed effect; column (3) adds control variables on the basis of column (2). It can be seen from the results in Table 1 that no matter what kind of regression is performed, the coefficient of the double difference term is

significantly positive at the 1% confidence level. It shows that, on the whole, the environmental regulation policy has greatly promoted the enterprises in the pilot areas to undertake social responsibility.

According to the innovation compensation theory [13], we analyze the possible reasons for the above results: in the face of environmental regulations, compared with passively accepting fines, assuming sewage charges and environmental protection costs, enterprises are more likely to take environmental responsibility and take measures to protect the environment. Active measures to respond to the government's mandatory environmental protection policies. For example, companies will increase research and development efforts to develop green products, green processes, etc., which to a certain extent promotes corporate innovation, which allows companies to use raw materials, energy, labor and other production factors more efficiently, thereby offsetting additional Environmental regulation costs and increases business productivity. At the same time, the low-carbon city policy also promotes enterprises to pay attention to environmental protection, and enterprises will pay more attention to the favorable impact of social responsibility on their development and value enhancement.

Further analysis of the impact of control variables on corporate CSR scores, we found that corporate size and corporate age have a significant role in promoting corporate social responsibility. The possible reason is that large companies and companies with a long history often have a good sense of responsibility and attach great importance to corporate reputation and corporate culture. Taking social responsibility helps companies expand their influence and form a good corporate culture. For this reason, large enterprises tend to take social responsibilities more actively in order to expand their influence.

Table 1. Benchmark regression results

	(1)	(2)	(3)
	csrscore	csrscore	csrscore
policy	6.925***	7.427***	1.797***
	(19.16)	(18.06)	(4.71)
cv1			2.076***
			(7.48)
cv2			1.135
			(0.98)
cv3			1.096***
			(24.18)
cv4			-0.0117
			(-1.31)
year fixed effect		control	control
individual fixed effects		control	control
_cons	35.65***	36.08***	-29.33***
	(93.44)	(193.78)	(-4.93)
N	5428	5428	5414

4.2.   DID Specification Validity Test: Parallel Trend Test

The asymptotic difference-in-difference model requires the control group and the treatment group to satisfy a parallel trend to ensure the unbiased estimator. In the benchmark model, the parallel trend is assumed to be that before the implementation of environmental regulation policies, the scores of enterprises in pilot cities and non-pilot cities are basically the same. Therefore, this paper establishes the following regression to test the parallel trend of the benchmark regression results to verify that there is no significant difference between the pre-treatment group and the control group. Taking the first batch of policy pilots as an example, the first batch of policies occurred in 2013. This paper sets before1 and before2 dummy variables to represent dummy variables in 2012 and 2011, that is, one year and two years before the policy occurred. Regression was performed by interacting the defined dummy variable with the treatment group dummy variable. The obtained results are shown in Table 2. The regression results show that there is no significant difference in the social responsibility commitment of listed companies between the treatment group and the control group before the policy occurs, and the change trend is basically the same, which can be considered to have passed the parallel trend test.

Table 2. Parallel trend test results

	2011	2012
	(1)	(2)
	csrscore	csrscore
before2*treated	-0.320	
	(-0.52)	
before2	-1.154***	
	(-3.15)	
before1*treated		-0.445
		(-0.75)
before1		-0.00866
		(-0.03)
cv1	1.387***	1.375***
	(4.40)	(4.35)
cv2	-0.203	-0.398
	(-0.16)	(-0.31)
cv3	1.118***	1.170***
	(22.40)	(23.75)
cv4	-0.000952	-0.00328
	(-0.10)	(-0.33)
_cons	-13.09*	-13.77**
	(-1.94)	(-2.03)
N	4160	4160

4.3. DID Designation Validity Test: Placebo Test

Referring to the practice of previous scholars (Li and WU., 2016; Wang Qi et al., 2021), this paper uses the method of randomly generating policy implementation time as a placebo test to verify whether there will be differences in regression results due to omitted variables [14,15]. Specifically, this paper repeats the random grouping 500 times. Since the "pseudo" treatment group is randomly generated, the coefficient of the policy dummy variable should be around 0, that is, the policy dummy variable will not have a significant impact on the explained variable. As shown in the figure, the coefficients are concentrated around 0, indicating that the policy dummy variables of the pseudo-treatment group have no significant impact on the explained variables, and are far from the benchmark regression coefficient of 1.797. Show that this paper can pass the placebo test.
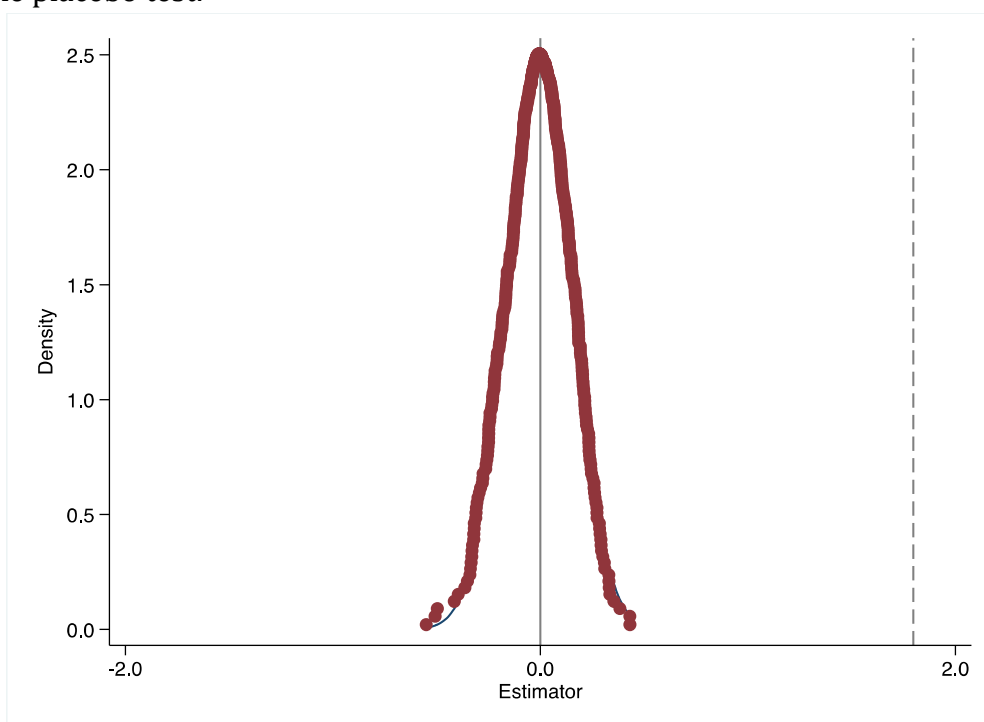

Figure 1. Distribution of placebo test results

5. Mechanism Analysis and Heterogeneity Analysis

The above results show that environmental regulation has a certain impact on the undertaking of corporate social responsibility. This part analyzes the way of action and studies the mechanism by which environmental regulation promotes the undertaking of corporate social responsibility. The effect of enterprises in different regions has certain differences. Therefore, this paper also analyzes the heterogeneity of enterprise ownership and regions.

5.1. Mechanism Analysis: Enterprise Investment Efficiency Mechanism

The regression results of the impact mechanism of environmental regulation policies on enterprise investment efficiency are presented in Table 3. Among them, it can be seen from the columns (1), (2) and (3) that at the 1% confidence level, the coefficient before the core explanatory variables is negative, that is, the impact of environmental regulation policies on the inefficient investment of enterprises is negative , and after controlling for the year fixed effect and the individual fixed effect, the coefficient is still significantly negative after adding the control variable. This shows that environmental regulation policies can effectively reduce the inefficient investment of enterprises and improve the investment efficiency of enterprises.

The possible reasons for the above results are the following two points. First, according to the innovation compensation theory, enterprises will try their best to control pollution through innovation in the process of meeting their own interests and policy goals, so as to prompt enterprises to gradually eliminate backward production capacity and reduce pollution. Short-term blind investment, improve the investment efficiency of enterprises. Second, environmental regulation policies increase the production cost of enterprises and reduce the free cash flow of enterprises, which may alleviate the problem of inefficient investment caused by free cash flow [16]. The improvement of investment efficiency will further affect the social responsibility of enterprises. On the one hand, environmental regulation improves the investment efficiency of enterprises, makes the allocation and utilization of funds more reasonable, and more funds flow into technological reform and innovation, improving enterprises. performance, and promote the transformation of enterprise structure, from polluting enterprises to non-polluting enterprises or low-polluting enterprises, thereby bringing potential value-added to the company. On the other hand, changes in corporate structure will also affect consumers' choices. Consumers' purchase intention for non-polluting companies will gradually increase, while their purchase intention for polluting companies will decrease,Which become the promotion of social responsibility.

Table 3. Analysis results of enterprise investment efficiency mechanism

	(1)	(2)	(3)
	eff	eff	eff
policy	-0.00326***	-0.00718***	-0.00165
	(-2.78)	(-4.12)	(-1.36)
cv1			0.000166
			(0.34)
cv2			-0.0202***
			(-4.19)
cv3			-0.000619***
			(-5.53)
cv4			0.000103***
			(2.60)
year fixed effects		control	control
individual fixed effects		control	control
_cons	0.0324***	0.0338***	0.0416***
	(36.16)	(41.68)	(3.66)
N	3934	3934	3933

5.2. Mechanism Analysis: Enterprise Factor Structure Adjustment Mechanism

The impact mechanism of environmental regulation policy on enterprise R&D expenditure is shown in Table 4. The results shown in columns (1), (2) and (3) show that the implementation of environmental regulation policy has an impact on enterprise R&D expenditure at the level of 1%. played a positive role, and the results were still significant after controlling for the year fixed effect, individual fixed effect, and control variables. It shows that the implementation of environmental regulation policies can help enterprises to increase R&D expenditure and promote the rational allocation of enterprise resources. Enterprises can use more resources to carry out green innovation, thereby improving environmental performance and helping enterprises to undertake environmental responsibility.

Table 4. Analysis results of enterprise factor structure adjustment mechanism

	(1)	(2)	(3)
	rd	rd	rd
policy	0.791***	0.843***	0.159***
	(12.85)	(12.42)	(2.62)
cv1			0.757***
			(17.27)
cv2			-0.0970
			(-0.58)
cv3			0.0887***
			(12.84)
cv4			0.00177
			(1.32)
year fixed effects		control	control
individual fixed effects		control	control
_cons	17.70***	17.92***	-0.880
	(239.72)	(607.00)	(-0.94)
N	4034	4034	4029

5.3. Heterogeneity Analysis: Enterprise Ownership Heterogeneity

This paper further studies the heterogeneity of firm ownership. We collected the actual controller and the nature of the enterprise as of December 30, 2020. If the nature of the enterprise is "local state-owned enterprise", "central state-owned enterprise", "state-owned enterprise", "collective enterprise", or the actual controller of the enterprise is "central SASAC", "local SASAC", "SASAC", " "collectively owned", then we identify the enterprise as a state-owned enterprise and assign a value of 1, and for other types of enterprises, we classify it as a non-state-owned enterprise and assign a value of 0. Group regression is performed on state-owned enterprises and non-state-owned enterprises, and the analysis results are shown in the following table.

Table 5 is analyzed. Columns (1) and (2) of the table indicate the impact of environmental regulation policies on the CSR scores of state-owned enterprises, and columns (2) and (3) indicate the impact of environmental policies on the CSR scores of non-state-owned enterprises. Firstly, the state-owned enterprises are analyzed. From the column (1) of the table, it can be obtained: the impact of environmental regulation policies on corporate social responsibility is positive at the level of 1%, and the impact is relatively large. Add control variables in column (2) After that, the coefficient still shows a positive value at the level of 1%, indicating that the environmental regulation policy has a significant promoting effect on the CSR score of state-owned enterprises; then we analyze the non-state-owned enterprises, from the column (3), we can get: environmental regulation policy The impact on the CSR of non-SOEs is positive at the 1% level. But after adding the control variable in column (4), the results become insignificant. This shows that environmental policy has no obvious effect on the CSR score of non-state-owned enterprises.

The above results are also in line with our theoretical expectations. First of all, from the perspective of the characteristics of state-owned enterprises, their development and operation are not aimed at making profits as the primary goal, but more need to undertake local social development goals and certain political functions, and the management is generally appointed by the government [17]. This makes the relationship between state-owned enterprises and the government closer. When the government issues policies, state-owned enterprises naturally respond quickly compared to non-state-owned enterprises. Second, because state-owned enterprises often enjoy policy subsidies and support, the cost of responding to the policy is relatively small, and enterprises are less adversely affected by environmental policies. Enterprises are more inclined to carry out technological innovation to reduce costs and assume more environmental responsibility.

Table 5. Analysis results of enterprise ownership heterogeneity

	state-owned enterprise		non state enterprise	
	(1)	(2)	(3)	(4)
	csrscore	csrscore	csrscore	csrscore
policy	7.493***	1.909***	5.128***	0.976
	(17.01)	(4.19)	(7.92)	(1.30)
cv1		2.006***		2.398***
		(5.34)		(5.83)
cv2		4.090**		-2.180
		(2.33)		(-1.47)
cv3		1.156***		0.941***
		(20.27)		(12.52)
cv4		-0.0248**		0.00839
		(-2.16)		(0.59)
_cons	36.49***	-28.61***	34.99***	-34.01***
	(67.51)	(-3.47)	(65.80)	(-4.03)
N	3299	3288	2129	2126

5.4. Heterogeneity Analysis: Regional Heterogeneity

In order to study the regional heterogeneity of digital finance on corporate social responsibility, we introduce the marketization degree index, which is an index constructed in the classic literature of Wang Xiaolu and Fan Gang (2004) to measure the difference in the degree of marketization between regions in China. This paper refers to the latest data compiled by Wang Xiaolu et al. (2019) as a measure of the degree of regional marketization [18, 19]. And according to the degree of marketization of the region, if the province is higher than the median of the marketization degree of all provinces in that year, then this province is considered to have a high degree of marketization, and accordingly, the enterprises in this province are classified as Groups with a high degree of marketization. On the contrary, other enterprises are classified into the low marketization group. The results are shown in the table below.

By analyzing Table 6, it can be seen from columns (1) and (2) that in regions with a high degree of marketization, the impact of environmental policies on CSR is significantly positive at the 1% confidence level; while (4) The results in the column show that in regions with a low degree of

marketization, the impact of policies on CSR is negative at the 10% level, which indicates that the implementation of environmental policies is conducive to marketization compared with companies in regions with a low degree of marketization. Enterprises in higher-level regions actively undertake social responsibilities. This is because the innovation ability and talent absorption ability of enterprises in areas with a high degree of marketization are higher than those in areas with a low degree of marketization. Therefore, facing the pressure of environmental regulation, these enterprises tend to improve their innovation ability and develop green products to reduce costs; For enterprises in areas with a low degree of marketization, the cost of technological innovation is relatively high, and they tend to adopt a negative attitude in response to environmental policy measures, such as passively accepting fines and bearing corporate sewage charges [18] .

Table 6. Regional heterogeneity analysis results

	Regions with a high degree of marketization		Areas with a low degree of marketization	
	(1)	(2)	(3)	(4)
	csrscore	csrscore	csrscore	csrscore
policy	7.219***	1.513***	3.145***	-3.008*
	(18.82)	(3.60)	(3.21)	(-1.68)
cv1		2.086***		1.891***
		(4.46)		(4.76)
cv2		3.211*		-0.186
		(1.90)		(-0.11)
cv3		1.287***		1.367***
		(15.65)		(20.60)
cv4		-0.0514***		-0.00578
		(-3.09)		(-0.50)
_cons	35.76***	-31.89***	35.60***	-29.16***
	(68.41)	(-3.18)	(73.07)	(-3.45)
N	2488	2485	2174	2166

6. Conclusions and Policy Implications

Environmental regulation policy is an important policy tool for my country to further promote the goal of "carbon peaking and carbon neutrality". Based on the quasi-natural experiment of three batches of low-carbon city pilot work conducted by the National Development and Reform Commission from July 2010 to January 2017, this paper adopts a progressive double difference model to empirically study the impact of environmental regulation policy on low-carbon cities on enterprises. The impact of social responsibility. The research results show that the environmental regulation policy can improve the enterprise's social responsibility to a certain extent, and this conclusion still holds after the parallel trend test and the validity test. From the perspective of enterprise heterogeneity, environmental regulation has a higher role in promoting social responsibility of state-owned enterprises than non-state-owned enterprises, and it has a higher role in promoting enterprises in regions with a higher degree of marketization than those in regions with a lower degree of marketization. From the perspective

of the mechanism of action, environmental regulation policies can significantly improve the investment efficiency and R&D investment of enterprises, so that in the face of policy pressure, more funds will flow into technological innovation and green product development, and promote enterprises to social responsibility.

The research conclusions of this paper provide the following policy implications for effectively promoting low-carbon city policies and promoting corporate social responsibility: First, the state can expand the scope of low-carbon environmental policy pilots and promote the construction of low-carbon cities and low-carbon enterprises. According to the research results of this paper, my country's current low-carbon environmental policy has a positive effect on corporate social responsibility, which can greatly improve the investment efficiency of enterprises, increase investment in research and development, and further improve corporate social responsibility. Therefore, in order to achieve the goal of peaking carbon emissions in 2030, the pilot scope of the policy should be further expanded in the future, especially in the western region where the economy is relatively backward and the degree of marketization is low. Second, the government should strengthen policy subsidies and technical support for non-state-owned enterprises. The results of the study on the heterogeneity of enterprise ownership in this paper show that the low-carbon environmental policy has a significantly greater role in promoting the social responsibility of state-owned enterprises than non-state-owned enterprises. Most non-state-owned enterprises are profit-oriented enterprises. In response to this phenomenon, the state should increase policy support for non-state-owned enterprises, provide technical subsidies, and actively promote the transformation of non-state-owned enterprises into green enterprises, low-carbon enterprises and innovative enterprises. In addition, the technology subsidies for enterprises in areas with a low degree of marketization will be enhanced, and the technological development and innovation of small and medium-sized enterprises will be encouraged. The results of this study on regional heterogeneity show that when faced with policy pressures, companies in areas with a low degree of marketization will take a negative response due to lack of funds and technical guidance, which is not conducive to the implementation of my country's low-carbon policy in the long run. of. Therefore, certain technical subsidies are given to enterprises with a low degree of marketization, and certain technical guidance is given to encourage the development and innovation of small and medium-sized enterprises. Third, the government should increase the punishment for polluting the environment. It can be seen from the conclusions of this paper that for some non-state-owned small and medium-sized enterprises, the main purpose of operation is to make profits. If the punishment for environmental pollution is too low, these enterprises would rather choose to accept the punishment than invest in R&D and innovative products. On the contrary, the appropriate punishment will promote the system reform and system innovation of enterprises to reduce costs. The integration of low-carbon and green production methods into the enterprise system will further promote the enterprise's commitment to social responsibility.

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