Environmental Regulation, Tax Greening and Regional Carbon Emission

Based on the Empirical Study of 41 Cities in the Yangtze River Delta

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Abstract. Exploring the impact of environmental regulation and tax greening on regional carbon emissions has important practical guiding value for accelerating the green and low-carbon development of the Yangtze River Delta. On the basis of grasping the current situation of carbon emissions in the Yangtze River Delta region, the driving mechanism and effects of environmental regulation and tax greening on carbon emissions in the Yangtze River Delta region are revealed from multiple perspectives by using the dual fixed effect model, the regulating effect model, the intermediary effect model and the threshold model.

Keywords: Yangtze River Delta; Environmental regulation; Greening of tax system; Carbon emissions; Driving mechanism.

1 Introduction

Implementing the concept of green development and strengthening the intensity of environmental regulations is considered to be an important starting point to alleviate the contradiction between economic development and environmental protection. With the deepening of the reform of the modern fiscal and taxation system, the greening degree of the tax system also plays an important role in reducing pollution and carbon, and the cooperation of the above "combination" will help accelerate the realization of the "double carbon" goal. The Yangtze River Delta region is an important demonstration area that takes the lead in exploring the realization of carbon peaking and carbon neutrality. In the process of promoting the integration of the Yangtze River Delta region, studying the impact mechanism and effect of tax greening and environmental regulation on carbon emissions in the region has important theoretical significance and practical guiding value for further accelerating the development of green and low-carbon transformation and taking the lead in realizing carbon peaking and carbon neutrality in the Yangtze River Delta region.

2   Literature Review

The main task of this paper is to explore the multiple impacts of environmental regulation and tax greening on carbon emissions in the Yangtze River Delta region on the basis of measuring carbon emissions in the Yangtze River Delta region. Previous studies focused on the following three aspects:

2.1   Relevant Research on Carbon Emission Measurement

When studying carbon emissions in the existing literature, there are many methods to estimate carbon emissions. Cong Jianhui et al. (2014) sorted out the boundary definition methods of urban carbon emission accounting from different perspectives, such as "direct emission and indirect emission", "transportation emission and industrial emission" [1]. Zhou Li and Xia Yuhui et al. (2020) analyzed the relationship between China's overall CO2 emission, energy structure, industry, agriculture and transportation, and analyzed the factors affecting the level of CO2 emission [2].

2.2   Relevant Studies on the Impact of Environmental Regulations on Carbon Emissions

First, there is a "forced emission reduction" relationship between environmental regulation and carbon emissions. Second, there is a "green paradox" relationship between environmental regulation and carbon emissions. That is, environmental regulations will promote regional carbon emissions to a certain extent. Sinn (2008) first proposed the concept of "green paradox", in which environmental policies have restrictive conditions for climate, and enterprises may accelerate the exploitation of fossil energy in response to environmental policies, but will promote carbon emission. Combined with China's practical experience, some scholars have verified the existence of the "green paradox" [3].

2.3   Related Research on the Impact of Tax Greening on Carbon Emissions

The greening of the tax system is a variety of taxes levied by the government in order to protect the environment. The existing literature on the impact of tax greening on the environment mainly focuses on two aspects. Liu Fangxiong et al.believe that the tax scope of green taxation should be expanded and the reform of green taxation such as resource tax and consumption tax should be promoted at the same time [4]. The second is to use the empirical research method to analyze the impact of tax greening on the environment. Most scholars believe that levying green tax can play a role in protecting the environment. Theoretical analysis and research hypothesis

How should environmental regulation and tax greening affect carbon emissions in the Yangtze River Delta region? Based on the above theoretical basis, this paper will carry on the theoretical analysis and put forward the research hypothesis. Research hypothesis H1: Environmental regulations inhibit carbon emissions in the Yangtze River

Delta region. The greening of tax system to curb carbon emissions is mainly based on the theory of negative externalities. For example, enterprises over-exploit resources and carry out production and operation with low efficiency for their own interests, resulting in environmental pollution. H2 [5]: Greening the tax system can promote the reduction of carbon emissions. Low-carbon economy attempts to improve energy efficiency through technological innovation, industrial structure adjustment and other ways, while expanding new carbon utilization paths, its purpose is to reduce CO_2 emissions while improving fuel efficiency. H3: The interaction between environmental regulation and tax greening has a negative inhibition effect on carbon emissions.

3   Empirical Research Design

3.1   Model Setting

Benchmark Model. According to the above theoretical analysis, environmental regulation and tax greening can inhibit carbon emissions in the Yangtze River Delta region. In order to verify this hypothesis, Li Yongyou et al. [6] (2008) supported this hypothesis.

$$DOC = \alpha_0 + \beta_1 ER_{it} + \beta_k X_{it} + \varepsilon_{it}$$

$$DOC = \alpha_1 + \xi_1 TAX_{it} + \xi_k X_{it} + \varepsilon_{it}$$

$$DOC = \alpha_2 + \eta_1 ER_{it} + \eta_2 TAX_{it} + \eta_k X_{it} + \varepsilon_{it}$$

Modulating Effect Model. The above theoretical analysis points out that environmental regulation and tax greening may have an interactive impact on carbon emission reduction. The study of Wang Jun and Li Ping (2018) also verified this view [7]. Therefore, in order to capture this mechanism, based on the existing research practices, and on the basis of baseline regression, the interaction term between environmental regulation and tax greening is introduced to test the regulatory effects of environmental regulation and tax greening on carbon emissions. The model is set as follows.

$$DOC = \alpha_3 + \delta_1 ER_{it} + \delta_2 TAX_{it} + \delta_3 ER_{it} \times TAX_{it} + \delta_k X_{it} + \varepsilon_{it}$$

Intermediary Effect Model. Green technology, as the main carrier of green innovation, can improve production efficiency. Under the premise of improving production efficiency, the negative impact on the environment is relatively small when enterprises produce the same products, and the goal of environmental protection is further achieved.

3.2   The Meaning and Descriptive Statistics of Variables

Meaning of Variables. Carbon emissions (DOC). At present, the calculation of China's total carbon emissions is mainly based on the "2006 IPCC National Greenhouse Gas Guidelines".Environmental Regulation (ER).including the discharge of industrial wastewater. The higher the value of ER, the greater the intensity of environmental regulation. On the contrary, the smaller the value of ER, the smaller the intensity of environmental regulation.Greening the TAX system (TAX). Tax system greening is measured by the sum of resource tax, vehicle and ship tax, environmental protection tax, urban maintenance and construction tax, urban land use tax and farmland occupation tax [8]. The result is Table 1.

Descriptive Statistics

Table 1. Descriptive statistics

varible	N	mean	sd	min	max
DOC	574	4.86	7.84	0.17	56.86
ER	574	3.17	0.98	0.42	6.60
TAX	574	1.84	2.98	0.11	41.25
PGDP	574	6.62	3.99	0.65	19.90
FDI	574	1.38	2.86	0.02	34.26
TEC	574	25.29	53.96	0.13	426.37
EDU	574	9.45	12.51	0.49	103.95
FINC	574	0.08	0.16	0.00	1.64

4   Analysis of Empirical Results

According to the dual fixed effect model was subjected to baseline regression. The result is Table 2.

Table 2. Baseline regression results

	model (1) DOC	model (2) DOC	model (3) DOC	model (4) DOC
ER	-0.113***		-0.107***	0.276**
	(0.023)		(0.023)	(0.107)
TAX		-0.743***	-0.598**	-0.398
		(0.280)	(0.277)	(0.279)
ER*TAX				-0.131***
				(0.036)
PGDP	0.276***	0.263***	0.248***	0.287***
	(0.054)	(0.056)	(0.055)	(0.056)
FDI	-0.029	-0.008	-0.020	-0.019
	(0.030)	(0.031)	(0.030)	(0.030)

TEC	0.037***	0.037***	0.038***	0.045***
	(0.005)	(0.005)	(0.005)	(0.005)
EDU	0.424***	0.422***	0.426***	0.433***
	(0.038)	(0.038)	(0.038)	(0.037)
FINC	-14.189***	-13.581***	-14.284***	-15.456***
	(2.105)	(2.136)	(2.098)	(2.098)
_cons	0.038	1.719**	1.494**	0.823
	(0.275)	(0.740)	(0.727)	(0.741)
N	574	574	574	574
adj. R^2	0.8343	0.8286	0.8354	0.8393

4.1   Analysis of Benchmark Regression Results

Under the premise that the production efficiency of enterprises can be improved, enterprises can obtain more profits and benefits, which exceeds the cost of increasing research and development investment for the purpose of protecting the environment. Verify hypothesis H1model4 shows that the regulatory effects of environmental regulation and tax system greening have a synergistic effect on carbon emission reduction.

4.2   Intermediary Effect

Environmental regulation can promote the technological innovation of enterprises, optimize the allocation of enterprise resources, and improve the production efficiency of enterprises, so as to achieve the purpose of carbon reduction. Green taxation plays an incentive role in solving the problem of market failure caused by externalities and uncertainties. Preferential tax policies and tax greening policies can increase the available funds of enterprises, which can increase the R&D investment of enterprises, improve the degree of innovation investment of enterprises, and then affect the overall technological innovation level of enterprises [9]. The result is Table 3.

Table 3. Regression results of intermediary effects of technological innovation

	model5) DOC	model6) GRE	model7) DOC
ER	-0.113***	0.023***	-0.095***
	(0.023)	(0.006)	(0.023)
GRE			-0.769***
			(0.167)
TAX			
PGDP	0.276***	-0.059***	0.224***
	(0.054)	(0.014)	(0.054)
FDI	-0.029	0.003	-0.028
	(0.030)	(0.008)	(0.030)
TEC	0.037***	0.001	0.038***

	(0.005)	(0.001)	(0.005)
EDU	0.424***	-0.040***	0.394***
	(0.038)	(0.010)	(0.038)
FINC	-14.189***	1.561***	-13.023***
	(2.105)	(0.546)	(2.079)
_cons	0.038	7.256***	5.680***
	(0.275)	(0.072)	(1.241)
N	574	574	574
adj. R^2	0.8343	0.8548	0.8405

5　　Conclusion

From the perspective of baseline regression, environmental regulation and tax greening significantly inhibited carbon emissions in the Yangtze River Delta region; From the perspective of regulatory effect, environmental regulation and tax greening synergistically inhibit carbon emissions in the Yangtze River Delta region; From the perspective of mediating effect, green technology innovation plays an important mediating role in the carbon emission of the Yangtze River Delta region. Environmental regulation and tax greening have regional heterogeneity in restraining carbon emissions in the Yangtze River Delta.

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