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The Impact of FDI on Carbon Emission from the Perspective of Environmental Regulation

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Abstract

Based on the panel data of 30 provinces and regions from 2000 to 2015, the panel model and threshold model estimation methods are used to investigate the impact of FDI on carbon emissions under heterogeneous environmental regulations. The following conclusions are drawn: FDI is not conducive to China's carbon emissions under environmental regulations.

Keywords

Foreign Direct Investment; Carbon Emission; Environmental Regulation; Threshold Effect.

1. Introduction

Over the past four decades of reform and opening up, the scale of foreign investment in China has been expanding. From 1984 to 2020, the actual amount of utilized FDI has increased from US $1.258 billion to US $144.4 billion. China has become the largest FDI inflow country in the world. While FDI is filling the financial gap for China's economic development, the country is also facing pressure from environmental degradation and carbon emissions. According to the World Environment Performance Index (EPI), China's comprehensive score was 56.20 in 2006, ranking 94 among 133 participating countries. In 2020, China scored 37.30, ranking 120 out of 180 participating countries. China's environmental quality is deteriorating. In this situation, in September 2020, China made a "3060" commitment to the world, striving to achieve carbon neutrality by 2030 and carbon neutrality by 2060, which will usher in a new aspect of China's carbon emission cause. Then, a practical question is whether the intensity of environmental regulation has changed as the country, society and people's attention to the environment has intensified. And does the impact of FDI on carbon emissions change under heterogeneous environmental regulations? What is the mechanism behind this? This is the question that this article tries to answer.

The mechanism of environmental regulation in the process of FDI's influence on carbon emissions depends on "FDI input influence" and "investment preference". On the one hand, the intensity of environmental regulations can affect FDI entry and exit. If the host country sets high-intensity environmental regulations, it will be difficult for highly polluting FDI to enter the host country, and the FDI that has entered will also be unable to withstand the high-intensity environmental regulations and exit the home country successively. On the other hand, the intensity of environmental regulation can affect FDI investment preference. When the environmental regulation intensity is set high, that is, the environmental protection tax is far greater than the cost of pollution control and emission reduction of enterprises. In order to maximize profits, enterprises will increase the investment in environmental governance, such as purchasing environmental protection equipment and increasing the research and development of clean technology, so as to change the investment preference and development direction of enterprises. In addition, if the environmental regulation and punishment are

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relaxed, enterprises think that the environmental protection tax is far less than the enterprise pollution control investment, enterprises will be willing to accept the environmental protection tax, but not willing to invest in environmental governance. In addition, enterprises will expand the scale of production and factory buildings, and offset environmental taxes through the income from expanding output. Even "small, disorderly, scattered and dirty" FDI will be able to bear small environmental costs, which will make the operation of FDI more extensive, and the final result will be the deterioration of the ecological environment in the host country. Therefore, under the influence of multiple factors, it is difficult to determine the size and direction of FDI influence on carbon emissions from the perspective of heterogeneous environmental regulation only by qualitative analysis. Only by combining qualitative and quantitative methods can we accurately grasp the mechanism and influencing factors between variables.

2. Research Design

2.1. Index Selection

2.1.1. Explained Variable

In this paper, the total amount of carbon dioxide is selected as the explained variable. Carbon dioxide is mainly produced by the consumption of energy fuels, including coal, coke, crude oil, gasoline, kerosene, diesel, fuel oil and natural gas. Due to the lack of direct monitoring data, the method adopted by Tian Jianguo and Wang Yuhai (2018) was used to calculate the total carbon emission (CE) using the carbon emission coefficient provided by IPCC.

$$CE = \sum_{i=1}^{8} E_i \times CEF_i \tag{1}$$

$$CEF_i = H_i \times CH_i \times COR_i \times CEF_i \times 44/12 \times 10^{-6} \tag{2}$$

, CE is the total carbon dioxide emission; E_i represents the total consumption of the first energy,CEF_i is the carbon emission coefficient during the combustion of the first energy, and is calculated from equation (2). H_i ,CH_i and COR_i are the average low calorific value, carbon content per unit calorific value and carbon oxidation rate of the first energy, respectively. The data is from China Energy Statistical Yearbook, and both are from the Guide to Weaving Provincial Greenhouse Gas Inventories.

2.1.2. Core Explanatory Variable

For the index selection of foreign direct investment, refer to the method of Yao and Wei (2007) and use the perpetual inventory method to calculate the stock data. The formula is as follows:

$$FDI_{i,t}^{s} = FDI_{i,t-1}^{s}(1 - \sigma_{i,t}) + FDI_{i,t} \tag{3}$$

In the formula,$FDI_{i,t}^{s}$, and $FDI_{i,t-1}^{s}$ are the stock data of region i respectively. $FDI_{i,t}$ is the amount of foreign investment actually utilized in Region i, and $\sigma_{i,t}$ is the depreciation rate.Finally, the ratio of $FDI_{i,t}^{s}$ to $GDP_{i,t}$ is used as the core explanatory variable.In this paper, according to the research conclusion of scholars Zhang Jun et al. (2004), the value of σ will be 9.6%; The data base period is reduced by 10% to the amount invested in the initial year.

2.1.3. Other Control Variables

According to Li Zihao (2015), Jiang Xinying (2019) and other literatures, the control variables are mainly selected as economic size (ES), industrial structure (IS), energy structure (Estr), opening-up level (Tra), and human capital (Hr).

2.1.4. Threshold Variable

Environmental regulation: Based on the indicators selected in the study of Wu Lei and Jia Xiaoyan (2020), this paper takes the number of employees in environmental institutions as an indicator instead, denoting them as ER.

2.2. Model Construction

2.2.1. Common Panel Model

In order to better compare the role of environmental regulations with carbon emissions, a model excluding environmental regulations was first constructed to study the impact on carbon emissions. Build a model by referring to existing references:

$$CE_{i,t} = \beta_0 + \beta_1 FCP_{i,t} + \beta_2 IS_{i,t} + \beta_3 ES_{i,t} + \beta_4 Estr_{i,t} + \beta_5 Hr_{i,t} + \beta_6 Tra_{i,t} + \mu_{i,t} + \eta_i \tag{4}$$

$\beta_0$is the constant, β_1-$\beta_6$are the regression coefficient of each variable, $\mu_{i,t}$, η_i are respectively the residual and the fixed effect in the non-observed area.

2.2.2. Panel Threshold Model

In this paper, the threshold regression model proposed by Hansen (1999) can overcome the defects of the previous two, and can be tested for significance. The structural threshold regression model is shown as follows:

$$CE_{i,t} = \beta_0 + \beta_1 FCP_{i,t} \times I(ER_1 \le \gamma_1) + \beta_2 FCP_{i,t} \times I(ER_1 > \gamma_1) + \alpha_2 IS_{i,t} + \alpha_3 ES_{i,t} + \alpha_4 Estr_{i,t} + \alpha_5 Hr_{i,t} + \alpha_6 Tra_{i,t} + \mu_{i,t} + \eta_i \tag{5}$$

$$CE_{i,t} = \beta_0 + \beta_1 FCP_{i,t} \times I(ER_2 \le \gamma_2) + \beta_2 FCP_{i,t} \times I(ER_2 > \gamma_2) + \alpha_2 IS_{i,t} + \alpha_3 ES_{i,t} + \alpha_4 Estr_{i,t} + \alpha_5 Hr_{i,t} + \alpha_6 Tra_{i,t} + \mu_{i,t} + \eta_i \tag{6}$$

$$CE_{i,t} = \beta_0 + \beta_1 FCP_{i,t} \times I(ER_3 \le \gamma_3) + \beta_2 FCP_{i,t} \times I(ER_3 > \gamma_3) + \alpha_2 IS_{i,t} + \alpha_3 ES_{i,t} + \alpha_4 Estr_{i,t} + \alpha_5 Hr_{i,t} + \alpha_6 Tra_{i,t} + \mu_{i,t} + \eta_i \tag{7}$$

$I(\cdot)$ is the indicative function. if the expression in parentheses is true, the value is 1; Otherwise, values are 0, β_0, $\mu_{i,t}$and $\eta_i$are constants, residuals, and fixed effects in non-observed areas respectively. Similarly, double and triple thresholds can be similarly extended.

3. Empirical Analysis

3.1. Analysis of the Empirical Results

This paper explores the impact of FDI on carbon emissions without considering the influence of environmental regulations, and the results are shown in Table 4. The FCP coefficient of the core explanatory variable is 1.384, which is significant at the 1% level, indicating that FDI plays a role in promoting carbon emissions. Therefore, without considering environmental regulation factors, the "pollution paradise hypothesis" is not applicable to China's carbon emissions, and the technological innovation and spillover effect brought by FDI is less than the pollution caused by enterprises.

Table 1. Regression result

Explaining variable	Explained variable
FCP	1.384*** (0.405)
IS	0.0525* (0.0266)
ES	1.712*** (0.282)
Estr	4.833* (2.545)
Hr	1.24e-05 (0.00157)
Tra	-0.0194 (0.891)
C	-6.101** (2.309)
N	480
R-squared	0.707

Note: ***, ** and * are significant at 1%, 5% and 10% levels respectively.

3.2. Threshold Model Analysis

According to the estimation results of panel threshold model parameters in Table 7, when ER ≤12.748, FCP coefficient is 1.069374, which is significant at 5% level, that is, FDI promotes carbon emissions. When ER > 12.748, FCP coefficient is 24.02199 and significant at the 1% level. Compared with the previous stage, FDI has a significantly greater promoting effect on carbon emissions. On the whole, in 30 provinces, municipalities and autonomous regions, command-based environmental regulation plays a role in promoting FDI carbon emissions, that is, with the increase of command-based environmental regulation input, there appears a phenomenon of "more control, more pollution".

Table 2. Parameter estimation results of panel threshold model

Threshold variable	interval division	coefficient estimated	T	P
ER	ER ≤12.748	1.069374** (0.3086067)	3.47	0.002
	ER＞ 12.748	24.02199*** (1.835932)	13.08	0.000

4. Conclusion and Policy Recommendations

4.1. Research Conclusions

According to the above empirical results, the following conclusions are drawn: First, without considering environmental regulations, FDI is positively correlated with total carbon emissions; Second, under command-and-control environmental regulation, FDI is not conducive to China's carbon emission industry on the whole. Moreover, at a higher level of environmental regulation, the restriction effect of environmental regulation has completely lost its effect, and the promotion effect of FDI on carbon emission shows a malignant increase.

4.2. Policy Suggestions

First, reasonable enforcement of environmental regulations should be adopted to promote a robust development model. When formulating and implementing policies, the central government should fully take into account the differences among regions and whether the policies fit the economic development model of each province. Local governments should not blindly implement a "one-size-fits-all" system because they cater to the central government, but should test the feasibility and practicability of policies at multiple levels and in various aspects. At the same time, local governments should formulate reasonable trade policies and attract investment to reduce the possibility of high-polluting industries entering the country.Second, accelerate the establishment of a unified carbon emission trading market and promote the diversity of market-based environmental regulations. From the perspective of optimal allocation of resources, market leadership is more dynamic than government intervention, which can give full play to enterprises' enthusiasm for pollution control and emission reduction. Carbon emission trading market is an important regulatory tool for market-inspired environmental regulation, but its popularity is far from reached. Many provinces, regions and industries have not been included in the same market, so that the willing buyers and sellers cannot trade, resulting in the segmentation of the carbon emission market. The government should gradually expand the application field and scope of the carbon emission trading market, establish a sound carbon emission rights market trading system, and promote the diversified development of market incentive environmental regulations. In this way, a variety of measures can be adopted to seek the balance between economic development and environmental governance, and reduce the failure of environmental regulations.

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