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Empirical analysis of the impact of environmental regulation on FDI in China under the background of "double carbon"

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ABSTRACT

Since the reform and opening up, China's economy has developed by leaps and bounds, attracting foreign capital has become an important part of China's opening up to the outside world, and it plays an important role in promoting the rapid economic development of China. However, the inflow of foreign capital is also a "double-edged sword" for China. While promoting China's economic progress, it also brings serious environmental problems and aggravates the difficulty of China's environmental governance work. This paper mainly expounds the impact of environmental regulation on China's foreign direct investment under the "dual carbon" target, then elaborates the role of environmental regulation on FDI and economic development, and then discusses the impact of the intensity of China's environmental regulation on China's foreign direct investment through empirical analysis. In this paper, the comprehensive index of environmental regulation, economic development level, labor cost and infrastructure construction of 30 provinces in China from 2000 to 2020 are included in the theoretical model. Empirical tests on the impact of environmental regulation on attracting foreign direct investment and endogenous tests, robustness tests and regional heterogeneity tests ensure the effectiveness of this study. The conclusion is that the improvement of the comprehensive index of environmental regulation has a certain negative effect on FDI. The smaller the comprehensive index of environmental regulation, the stronger the intensity of environmental regulation, which means that China's high standards of environmental regulation will increase the inflow of foreign direct investment. This proves that the "pollution paradise" hypothesis does not exist in China, and the "Porter hypothesis" has been verified in this paper.

Keywords: Environmental Comprehensive Index, FDI, "Double carbon"

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1. Introduction

The trend of economic globalization is becoming more and more fierce. Since China opened up to the outside world, it has also actively followed the trend of globalization and vigorously developed foreign direct investment. The number of transnational enterprises has greatly increased. The inflow of FDI in China has increased from 40.715 billion dollars in 2000 to 16.3 billion dollars in 2020. In recent years, the total amount of FDI attracted by China has fluctuated significantly due to the impact of the international political and economic environment, but the overall trend is still rising. In the long run, the use of foreign capital has provided capital and technology for China's economic development, effectively promoted the process of industrialization and modernization, and China has become a "world factory". However, the price paid behind the rapid economic growth is the serious damage to the resources and environment. Because some countries' enterprises have transferred their pollution intensive and labor-intensive enterprises to China with loose environmental standards through FDI, thus reducing their environmental pollution and reducing the production costs of enterprises, and enhancing international competitiveness. Moreover, in the early days of China's reform and opening up, in the growth mode characterized by "high growth, high consumption and high pollution", in order to attract more FDI inflows to drive the economy, all regions did not hesitate to damage the ecological environment, so that a large number of pollution intensive enterprises entered China, causing serious environmental problems in China. In the past, the definition of environmental regulation standards was relatively simple, which was limited to government orders to intervene in resources and environment. In recent years, with the continuous improvement of people's awareness of environmental protection and the continuous improvement of the environmental regulation system, the standard strength and control means for environmental regulation are also showing a diversified trend. There are not only government control methods (formal environmental regulation), but also the development of non environmental regulation means based on market incentives. When government control means are insufficient, in order to achieve the goal of pollution prevention and control, regions and their social organizations will negotiate with local pollution intensive enterprises to develop a better regulation method, namely informal environmental regulation. However, because the development of informal environmental regulation is not mature enough and there is less data, this paper focuses on formal environmental regulation. In this process, the standards of environmental regulation in China have been changing, and the situation of foreign direct investment in China has also changed in this process. In 2014, China became the largest FDI inflow country for the first time. With the inflow of FDI and economic growth, China's environment is facing enormous pressure. In order to balance the relationship between economy and environment, China has formulated a legal system on environment, including environmental protection, air pollution, wildlife, mineral resources, forests, oceans, water, fisheries, coal, grassland, circular economy, urban and rural planning, energy conservation, renewable energy, solid waste pollution, sand prevention and control Radioactive pollution, etc. At the National Two Sessions held in 2016, the view that "China is about to introduce environmental taxes" was put forward for the first time. China is becoming more and more strict in formulating environmental regulations, which will have a corresponding impact on the inflow of FDI and thus on the effect of promoting economic growth.

In China's 40 years of economic development, foreign direct investment has become an indispensable part of economic development and has made significant contributions to the rapid development of China's economy. At the same time, the influx of foreign capital has also made China's environmental problems increasingly prominent. The Chinese government is formulating and implementing increasingly strict environmental regulation policies, and pays close attention to how to improve the quality of foreign direct investment while improving the intensity of environmental regulation, so as to optimize the domestic industry structure, promote technological progress, and achieve sustainable development of China's economy. The Fourteenth Five Year Plan for National Economic and Social Development of the People's Republic of China and the Outline of Vision Goals for 2035 for the first time include the goal of carbon peaking and carbon neutralization (referred to as "double carbon") in the economic and social development plan. The optimization and adjustment of China's carbon emission reduction policy has become an important research direction. With the development of the times and the improvement of people's understanding, energy-saving and low-carbon has become an inevitable requirement for economic development. After years of implementing environmental regulations, China's economic development has become less dependent on energy and carbon emissions. In the context of building a new pattern of external development, FDI is of great significance for implementing the "China commitment" of "carbon peak" and "carbon neutral" and promoting high-quality open development strategy. The "double carbon" goal of achieving carbon peak by 2030 and carbon neutrality by 2060 is a big test for China's economic transformation and development.

Since environmental issues have been paid attention to, many scholars have studied the relationship between FDI and the environment, and explored the mechanism and degree of influence between them. By Michel Porter's "Porter Hypothesis" indicates that when appropriate environmental regulations are formulated, the traditional competitive environment of enterprises will change. In order to eliminate the environmental governance costs brought by environmental regulations, enterprises will carry out innovative activities, thereby improving the market competitiveness of enterprises and attracting FDI inflows [1]. According to the research of Davidkson (1980), FDI in pollution-intensive industries mostly flowed into countries with high environmental standards, indicating that the improvement of environmental regulation intensity did not inhibit FDI inflow, but promoted FDI inflow [2]. Li Yanyong et al. (2010) studied the data of cities in Shandong Province from 2000 to 2007 and found that environmental regulation in Shandong province had a significant positive effect on FDI, verifying the "Porter hypothesis" [3]. Zhong Xuesi et al. (2019) took panel data of 30 provinces and cities in China from 2000 to 2014 as samples and showed through empirical analysis that environmental regulation significantly promoted foreign investment [4]. Colin and Kenichi (2008) conducted regression analysis on panel data of five pollution-intensive industries in Japan and found that Japanese pollution-intensive enterprises invested more in countries with strict environmental regulations, indicating that stricter environmental regulations have a more positive effect on FDI inflow [5]. Andrea et al. (2011) focused on the relationship between environmental regulation and enterprise investment behavior based on European industrial level data, and the results showed that the coefficients of the total environmental expenditure of the industry and the variable of national environmental tax

revenue were both positive, indicating that environmental regulation had a positive effect on investment [6].

Jaffe A B and Palmer K later extended the Porter hypothesis on three levels. "Porter hypothesis in narrow sense", "weak Porter hypothesis" and "strong Porter hypothesis" [7]. "Narrow sense Porter hypothesis" mainly emphasizes the promoting effect of certain kinds of environmental regulation on enterprise innovation. Zeng Yi (2016) integrated geographical location into Porter's hypothesis and proved that stricter environmental regulations would promote the innovation input level of polluting enterprises, further verifying the rationality of "Porter's hypothesis in a narrow sense" [8].

The "Weak Porter hypothesis" holds that reasonable environmental regulation can promote innovation. Some scholars, after analysis, agree. Horbach J (2006) concluded that environmental regulation, environmental management tools and general organizational reform can encourage environmental innovation after empirical analysis by establishing panel data model, and verified the "Weak Porter hypothesis" [9]. But at the same time, some scholars who think the Weak Porter hypothesis is not valid have presented their own proofs. Sheng Pengfei and Wei Haohao (2020) found through the construction of global value chain index that environmental regulation is not conducive to the improvement of global value chain in the short term, but has a significant positive impact in the long term [10]. Through the panel data study on the relationship between environmental regulation and industrial technological innovation, Liu Wei et al. (2017) found that the influence trend of environmental regulation on industrial technological innovation showed a U-shaped feature, that is, weak environmental regulation was not conducive to industrial technological innovation, and technological innovation would be promoted only after reaching the U-shaped inflection point [11]. Kneller R and Manderson E found that environmental regulation would increase environmental investment and cost, but had no positive correlation with overall innovation activities [12].

The "Strong Porter hypothesis" says. Jorge et al. (2015) took 481 smes in Spain as samples and analyzed the relationship between environmental regulation and economic performance, showing that environmental regulation can directly and significantly positively affect the competitiveness of smes [13]. Yuan Yijun and Xie Ronghui (2016) analyzed the relationship between environmental regulation and industrial green productivity based on China's provincial panel data from 1999 to 2012, and finally concluded that they were positively correlated [14].

But there are also a number of dissenting voices that question the Porter hypothesis. Some scholars believe that enterprises may not innovate and improve to save costs under environmental regulation, and some enterprises may give up or ignore environmental regulation for profit. Palmer believes that it is difficult to motivate enterprises by environmental regulation in the competitive market, and more enterprises tend to ignore environmental regulation [15]. Christer and Martin (2005) believed that less developed regions in China were more inclined to attract more FDI inflow at the expense of environment [16]. Kahouli and Maktoud (2014) analyzed the relationship between environmental regulation and FDI based on the data of 14 home countries, 39 host countries and 6 regional trade agreements from 1990 to 2011, and the results showed that although environmental regulation promoted FDI inflow, its promoting effect was insignificant [17].

Contrary to Porter's hypothesis, the "polluted paradise" hypothesis holds that environmental regulations will increase the cost of enterprises,

which will lead to capital flows from countries and regions with high environmental standards to countries and regions with relatively loose environmental regulations. Taylor (1996) elaborated the principle of "polluted paradise" in detail in his article "North-South Economy and Environment" [18]. Keller, Levinson (2002) [19] and List, Co (2005) [20] carried out researches on various industries in the United States and finally confirmed the hypothesis of "polluted paradise". Through the analysis of conditional logarithm model, List and Co found that American states would reduce the inflow of FDI with the increase of environmental regulation intensity. Dean and Lovely study and analysis the relationship between industrial environmental regulation and FDI inflow in our country, and the final result proves that there is a consistent result with the "polluting paradise" hypothesis, and concludes that the "polluting paradise" indeed exists in our country [21]. Elliot and Shimamoto (2008) measured the intensity of environmental regulation from the perspective of governance costs, and the results showed that the intensity of environmental regulation would change the amount of FDI outflow from Japan to Indonesia, Malaysia and other Southeast Asian countries [22]. By analyzing the panel data of various provinces from 1998 to 2001, Yang Tao believes that environmental regulations have a negative impact on the inflow of FDI, and the negative correlation is caused by the rise of costs. The stricter environmental regulations are, the higher fixed costs and entry barriers will affect the production of enterprises and further affect the investment decisions of enterprises [23]. Chinese scholar Shi Qing (2013) proved that loose environmental policies can indeed attract FDI inflow from the perspective of government honesty [24]. Jiang Ke et al. (2011) empirically studied 41 investment source countries and showed that the relative strength of environmental regulation was significantly negatively correlated with FDI from developing countries [25]. Kolstand and Xing (2002) selected several representative industries with high and low pollution in the United States, and concluded after research and analysis that loose environmental regulations in host countries were an important factor influencing investment in pollution-intensive industries in the United States [26]. Mulatu and Abay (2017) analyzed 23 industries in the UK from 2002 to 2006 and found that environmental regulation policies significantly affected the UK's OFDI [27].

However, there are great differences among scholars on whether the hypothesis of "polluted paradise" is valid or not. Many scholars believe that environmental regulation is not the key factor affecting FDI. Javorcik and Wei (2005) concluded through analysis that environmental regulation has no significant impact on FDI when government corruption occurs [28]. Friedman et al. (1992) found that environmental regulation was not an important factor affecting FDI location choice [29]. Similarly, Zeng Xiangang (2010), a Chinese scholar, took the panel data of 30 provinces in China from 1998 to 2008 as the research sample and found that environmental regulation did inhibit the inflow of FDI in various regions of China, but the effect was not significant [30].

On the basis of previous studies, this paper has made the following two innovations:

First of all, from the research perspective, this paper uses the comprehensive index calculated by the entropy method from multiple pollutant emission indicators, and few literatures have studied the relationship between the comprehensive index and FDI. This paper studies the relationship between environmental regulation and FDI from this perspective. Secondly, the supplement of the research content. From the existing research, there is no research

combining China's environmental regulation, FDI and "dual carbon". This research enriches this field.

2. Materials and Methods

2.1 Sample selection and data description

The samples selected in this paper are 23 provinces, 4 municipalities and 4 autonomous regions in China. The data selected are panel data of indicators related to regional foreign direct investment for 20 consecutive years from 2000 to 2020.Table 2-2 is the descriptive statistics of variables through Stata15.

All data are from the China Urban Statistical Yearbook, the official website of the State Council and the National Bureau of Statistics of the People's Republic of China.

Table 2-2 Descriptive statistics of main variables

Variable	Obs	Mean	Std.Dev.	Min	Max
lnFDI	630	14.135	1.774	7.99	16.932
lneci	630	0.373	0.316	0	1.277
lnwage	630	10.362	0.769	8.221	12.091
lngdp	630	9.084	1.159	5.575	11.615
lninfra	630	-0.518	0.892	-3.809	0.916
lnlever	630	-4.16	1.107	-9.139	-1.811
$Lneci^2$	630	0.331	0.442	0	2.039
Lnlever	630	-4.16	1.107	-9.139	-1.811

Through descriptive statistics on various indicators of the sample, we can have a certain understanding of the indicator status of the sample. From the table above, we can see that there are 630 observations in total, and there are no obvious outliers in the indicators of the sample cities.

2.2 Model building

The general regression models of panel data mainly include: mixed effect model, fixed effect model and random effect model. The Hausman test method assumes that the estimates of fixed effects and random effects are consistent with the heterogeneity. This paper uses Stata15 econometric analysis software to carry out the Hausman test. According to the results of the Hausman test, the Hausman test is significant at the level of 1%, so the original hypothesis is rejected and the fixed effect model needs to be used. Through the analysis of relevant literature, in order to control the heterogeneity characteristics of the individual level that do not change with time and the heterogeneity characteristics of the time level that do not change with individuals at the same time, this paper adopts a two-way fixed model of the individual level and the time level to ensure the reliability and persuasiveness of the empirical estimation results. On the basis of existing research, the two-way fixed effect model is constructed as follows:

$$LnFdi_{it}=\beta_0+\beta_1 LnEci_{it}+\beta_2 \mathrm{LnControls}_{it}+\gamma_i+\delta_t+\varepsilon_{it} \quad (1)$$

$$LnFdi_{it}=\beta_0+\beta_1 LnEci_{it}+\beta_2 \mathrm{LnControls}_{it}+\beta_3 LnEci_{it}^2+\gamma_i+\delta_t+\varepsilon_{it} \quad (2)$$

In Equation (1), $\mathrm{LnFdi_{it}}$ is the explained variable, which represents the level of foreign direct investment in city i in t year. This paper selects foreign direct investment in 30 provinces of China to measure the level of export. $\mathrm{LnEci_{it}}$ is the core explanatory variable, which is

represented by the comprehensive index of environmental regulation in the t year of city i. Incontrol is a set of control variables affecting the growth of foreign direct investment.γ_i is the individual fixed effect,δ_t is the time fixed effect, and ε_{it} is the random interference term. Considering that there may be short-term and long-term differences in the impact of environmental regulation on foreign direct investment, the quadratic term of the Environmental Comprehensive Index lnEci is added as the independent variable in model 2. β1 as the core to estimate parameters and identify the net effect of environmental regulation, if the coefficient is positive, that strict environmental regulation effect was influenced by foreign direct investment in growth, if the β1 value is negative, then the strict environmental regulation has negative influence on regional foreign direct investment growth, if no significant β1, said the strict environmental regulation can not influence the foreign direct investment.

2.3 Variable Selection

In order to study the impact of strict environmental regulations on the effect of foreign direct investment in China, the variables and Settings of the selected model are as follows:

(1) Explained variable ($\mathrm{LnFdi_{it}}$): The explained variable is the effect of foreign direct investment in each province of China. This paper uses the logarithm of foreign direct investment in each province of China to measure it. The larger the regional foreign direct investment, the higher the level of foreign direct investment in the region. All the original data in this paper are from the statistical yearbooks of various provinces in China.

(2) Core explanatory variable ($\mathrm{LnEci_{it}}$): The core explanatory variable is represented by the comprehensive index of environmental regulation, and the regression coefficient of Lneci reflects the impact of environmental regulation on fdi. The data selected in this paper are the panel data of 21 consecutive years from 2000 to 2020. The composite index of environmental regulation is calculated from industrial wastewater discharge, industrial SO2 discharge and industrial soot discharge.

The specific formula is:

(1) standardize the above three pollutants;

$$\bar{X}=\frac{X-X_{min}}{X_{max}-X_{min}} \quad (3)$$

$$\bar{Y}=\frac{Y-Y_{min}}{Y_{max}-Y_{min}} \quad (4)$$

$$\bar{Z}=\frac{Z-Z_{min}}{Z_{max}-Z_{min}} \quad (5)$$

Wherein, $\bar{X}$ is the standardization of industrial wastewater discharge, X is the industrial wastewater discharge, X_{min} is the minimum industrial wastewater discharge of each province in the same year, and X_{max} is the maximum industrial wastewater discharge of each province in the same year.

$\bar{Y}$ is the standardization of industrial SO_2 emissions, Y is the industrial SO_2 emissions, Y_{min} is the minimum industrial SO_2 emissions of each province in the same year, and Y_{max} is the maximum industrial SO_2 emissions of each province in the same year.

$\bar{Z}$ is the standardization of industrial smoke and dust emissions, Z is the industrial smoke and dust emissions, Z_{min} is the minimum industrial smoke and dust emissions of each province in the same year, and Z_{max} is the maximum industrial smoke and dust emissions of each province in the same year.

(2) To obtain the weight of each pollutant;

(3) The comprehensive index of environmental regulation is obtained by the product of weight and standardization.

$$ECI=\frac{X*\bar{X}+Y*\bar{Y}+Z*\bar{Z}}{3} \quad (6)$$

ECI is the comprehensive environmental regulation index.The greater the ECI is, the weaker the environmental regulation intensity based on pollutant emissions is, and the greater the resource and environmental cost of economic development is; The smaller the ECI is, the stronger the environmental regulation intensity based on pollutant emissions is, and the smaller the cost of resources and environment is. The green GDP can be obtained by adjusting the traditional GDP with this index. This accounting method is based on the original national economic accounting system, and the traditional GDP is adjusted with the environmental comprehensive index. It does not destroy the original accounting system, but also comprehensively incorporates the resource and environmental factors. It is highly operable and has important practical significance.

(3) Control variable ($\mathrm{Ln}\mathrm{Controls}_{\mathrm{it}}$): In order to control and reduce the influence of other variables on fdi effect, based on existing theories and empirical research results, this paper selects three indicators as control variables, including:

Infrastructure construction (lninfra), road network density is an important proxy variable for the level or degree of infrastructure construction, and an important control variable for most macroeconomic problems, which can reflect the impact of infrastructure level on product sales, industrial development and foreign direct investment.

$$Density=\frac{\mathrm{Road}+\mathrm{High}+\mathrm{Inland}}{\mathrm{Area}} \quad (7)$$

Among them, Density represents the density of road network, Road represents the total mileage of railway, High represents the total mileage of highway, Inland represents the total mileage of inland waterway, and Area represents the administrative area of each region.

The labor cost (lnwage) and the comparative advantage of low labor cost are the internal driving factors for the growth of FDI in most Chinese cities. The current rise in labor costs is the erosion of the comparative advantages of foreign direct investment, which will endanger the international competitiveness of foreign direct investment and lead to the dilemma of shrinking the scale of foreign direct investment. In this paper, the average wage of employees is used to express the labor cost.

The level of economic development (lngdp), which determines the direction, mode, scale and quality of foreign direct investment. The economic structure determines the starting point or entry point of foreign direct investment, and the economic scale determines the degree of dependence on foreign trade. This paper uses the provincial GDP to express the level of economic development.

Table 2-1 Main variables and their calculation methods

Variable Type	Variable Name	Variable Meaning	Calculation method
Explained variable	lnFDI	Foreign direct investment effect	Foreign direct investment is taken as logarithm
The core explanatory variable	lneci	level of environmental regulation	logarithm of the comprehensive index of environmental regulation

	lninfra	infrastructure construction level	road network density
The control variable	lnwage	labor cost	average employee wage
	lngdp	Level of economic development	GDP of the whole province

3. Empirical analysis and discussion

3.1 Basic regression

The fixed effect model is applicable to the analysis of panel data. After the Hausman test, it can be known that the P value is less than 0.01, which means that the original hypothesis is rejected. Therefore, the fixed effect model will be selected for the empirical analysis of this article. According to the theoretical analysis and model construction, environmental regulation is taken as the explanatory variable; The explained variable is FDI, and the other variables are used as control variables for model regression. The data analysis results are summarized in Table 3-1:

Table 3-1 Basic regression results

VARIABLES	(1) lnFDI	(2) lnFDI
lneci	-0.401**	0.906
	(0.192)	(0.559)
$Lneci^2$		-0.907**
		(0.364)
lnwage	-0.267	-0.241
	(0.220)	(0.219)
lngdp	0.755***	0.717***
	(0.219)	(0.219)
lninfra	0.617***	-0.621***
	(0.126)	(0.126)
Constant	10.51***	10.40***
	(0.765)	(0.763)
Observations	630	630
Number of id	30	30
R-squared	0.573	0.578

Note: (1) ***, ** and * respectively represent significant at 1%, 5% and 10% levels;

(2) The value in square brackets under the regression coefficient is the corresponding t-test value, the same as below.

The first column is the fixed effect regression result of FDI without adding the quadratic term of the comprehensive index of environmental regulation in model 1. According to the stata benchmark regression result, the P value of lneci is 0.037, which means that it passes the test when the significance level is 5%, and the t value is 0.192. The regression coefficient of the core explanatory variable is negative. When other conditions remain unchanged, every 1% increase in the comprehensive index of environmental regulation will reduce FDI in China by 0.401%, This shows that the improvement of the comprehensive index of environmental regulation has a certain negative effect on FDI. The smaller the comprehensive index of

environmental regulation, the stronger its environmental regulation intensity, which means that China's high standards of environmental regulation will increase the inflow of foreign direct investment, and also means that the "pollution paradise" hypothesis does not exist in China; The second column shows the regression results of the fixed effect of the quadratic term of the comprehensive index of environmental regulation added to the model 2 on FDI. Similarly, according to the stata benchmark regression results, we can see that the P value of lneci2 is 0.013, which means that it passes the test when the significance level is 5%. Then, the t value is 0.364, and the estimation coefficient of the quadratic term of environmental protection β 3 is negative, indicating that the relationship between environmental protection intensity and FDI is inverted "U" to a certain extent. In the short term, the comprehensive index of environmental regulation is positively related to China's attraction of FDI. In the long term, if the intensity of environmental regulation continues to increase, it will have a negative effect on China's attraction of FDI, which is consistent with the verification results of "Porter hypothesis" by Qi Shaozhou and others [31].With the full implementation of environmental protection policies, the cost of enterprises to adapt to environmental regulations will gradually decrease, and the proportion of their R&D, production and operation costs will also decrease. In addition, technological innovation, product differentiation, resource productivity improvement and other measures of enterprises under environmental regulation will eventually promote them to lead the market peers, take the lead in the production of environmentally friendly and efficient environmental protection and energy saving products, and form a competitive advantage in the international market.

The coefficient of control variable is further analyzed. The coefficient of economic development level (lngdp) in Model 1 and Model 2 is significant at the level of 1%, indicating that the level of economic development has a significant role in promoting FDI growth. The labor cost coefficients in Model 1 and Model 2 are not significant, indicating that there is no significant relationship between labor cost and China's FDI attraction. In recent years, domestic scholars have been concerned about the changes in labor costs and their impact on China's FDI. The most direct impact of rising labor costs is that it will lead to rising production costs, which will reduce the direct investment of labor-intensive enterprises in China. Because of the overcapacity of China's labor-intensive low-end products, the overcapacity is digested by competing export prices, and the key factor to maintain low-cost exports is cheap labor [32].

At the same time, the rising labor cost also shows that the quality of labor is improving, which will improve the direct investment of knowledge intensive enterprises in China. The regression coefficient of the index of infrastructure construction level in model 1 is 0.617, and the t value is 0.126, which is significant at the level of 1%, indicating that the level of infrastructure construction has a strong positive effect on China's FDI attraction.

3.2 Unit root test of variables

When studying the impact of environmental regulation on foreign direct investment, in order to prevent the appearance of spurious regression and ensure the stationarity of samples, unit root test should be carried out first. In order to avoid the occurrence of test contingency, this paper uses the econometric analysis software Stata15 to carry out unit root test, and the test result is shown in the figure. Explained variables (Lnfdi) Explanatory variables (Lneci) and control variables in the table are significant, and all variables

are significant at the significance level of 1% under the LLC test and Fisher test. Under HT test, Lncei, Lnwage and Lninfra passed the significance level of 1%. Under IPS test, P values of all variables except the control variable (lnlever) were less than 0.05. It can be seen that all variables selected in this paper have passed the unit root test and have good stationarity.

Table 3-2 Unit root test of variables

Variable	LLC test	IPS test	Fisher test	HT test	stationarity
lnFDI	-7.4391***	-2.1264***	14.1220***	-1.2481*	steady
lneci	-1.7229**	-2.3251***	15.3304***	-5.1104***	steady
lnwage	-10.571***	-9.4889***	36.5851***	-3.3008***	steady
lngdp	-12.678***	-5.0705***	19.7274***	4.8545	steady
lninfra	-5.1503***	-2.5014***	14.8237***	-2.3551***	steady
lnlever	-3.7443***	1.4533	8.7342***	-1.7354**	steady

3.3 Multicollinearity test

In order to test whether the estimation of the regression model is distorted or difficult to be accurately estimated due to the existence of accurate correlation or high correlation between the explanatory variables, this paper applied the measurement software stata15 to carry out the multicollinearity test of the model, and the test results were as follows. VIF value of economic development level is 5.50, labor cost is 2.89, environmental regulation is 2.08, infrastructure construction is 2.09, VIF value of these indicators are less than 6, and their Mean VIF is also less than 4, only 3.14. This means that there is no problem of multicollinearity in the model, and the model setting is effective.

Table 3-3 Multicollinearity test

VARIABLES	VIF	1/VIF
lnwage	2.89	0.346391
lngdp	5.50	0.181874
Lninfra	2.09	0.478078
Lneci	2.08	0.479936
Mean VIF	3.14	

3.4 Endogeneity test

Although the above has demonstrated the impact of environmental regulation intensity on FDI from the perspective of combining theory and empirical evidence, in fact, the increase of foreign direct investment may aggravate the environmental pollution problem and lead to the improvement of the comprehensive index of environmental regulation. Therefore, the possible bidirectional causality between the comprehensive index of environmental regulation and FDI will lead to endogeneity problems, resulting in certain bias in the estimation results of the benchmark regression. In model 1, the comprehensive index of environmental regulation with a lag of one period is taken as an instrumental

variable and estimated by the two-stage least squares method. The estimation results of endogeneity test are shown in Table 3-4. The elasticity coefficient of the comprehensive index of environmental regulations on foreign direct investment reaches -0.507 at the significance level of 1%, indicating that the negative effect of the increase of the comprehensive index of environmental regulations on foreign direct investment still exists significantly after the endogeneity problem is controlled.

Table 3-4 Endogeneity test

VARIABLES	(1) lnFDI
lneci	-0.507***
	(0.154)
lnwage	-0.707***
	(0.0972)
lngdp	1.242***
	(0.0791)
lninfra	0.655***
	(0.0723)
Constant	10.72***
	(0.709)
Observations	600
R-squared	0.722

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

3.5 Robustness test

3.5.1 Change the estimation method of the explained variable

In this paper, the robustness of the estimation results of the above benchmark regression is tested by replacing the estimation method of the explained variable, and the total amount of foreign direct investment of the explained variable is replaced by the level of foreign direct investment (lnlever) to estimate.

Level of foreign direct investment = foreign direct investment (ten thousand yuan)/GDP(hundred million yuan)/ten thousand

The estimation results of the robustness test are shown in the second column (1) of Table 3-5. The comprehensive index of environmental regulation is negative on the level of foreign investment at the significance level of 5%, which again verifies the negative impact of the comprehensive index of environmental regulation on FDI.

Table 3-5 Robustness test

VARIABLES	(1) lnlever	(2) lnFDI
lneci	-0.418**	-0.362**
	(0.192)	(0.170)
lnwage	-0.261	-0.727***
	(0.220)	(0.196)
lngdp	0.253	1.300***
	(0.220)	(0.199)
lninfra	0.621***	0.606***

	(0.126)	(0.112)
Constant	1.320*	10.26***
	(0.766)	(0.663)
Observations	630	564
Number of id	30	26
R-squared	0.120	0.702

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

3.5.2 Exclusion of extreme areas test

Behind the attraction of foreign direct investment in China is the comprehensive strength of a province, which needs a long-term development foundation of a province. From the previous analysis process, due to the large regional difference level ratio in the sample, the existence of highly developed areas and less developed areas may affect the validity of the assessment. Therefore, in order to avoid the impact of the regional development differences between the more developed and less developed regions on the effectiveness of policy evaluation, the less developed cities and the more developed cities in the sample were removed for the exclusion of extreme regions test. In this paper, the relatively backward regional provinces of Qinghai and Ningxia, as well as the two most developed provinces of China, Guangdong and Jiangsu, were excluded from the sample, and the robustness test was re-conducted. The regression results are shown in the third column (2) of Table 3-5. The regression analysis results show that the core explanatory variable is significantly negative at the level of 5%, and the regression results are robust, which further verifies the negative impact of the comprehensive index of environmental regulation on FDI.

3.6 Regional heterogeneity test

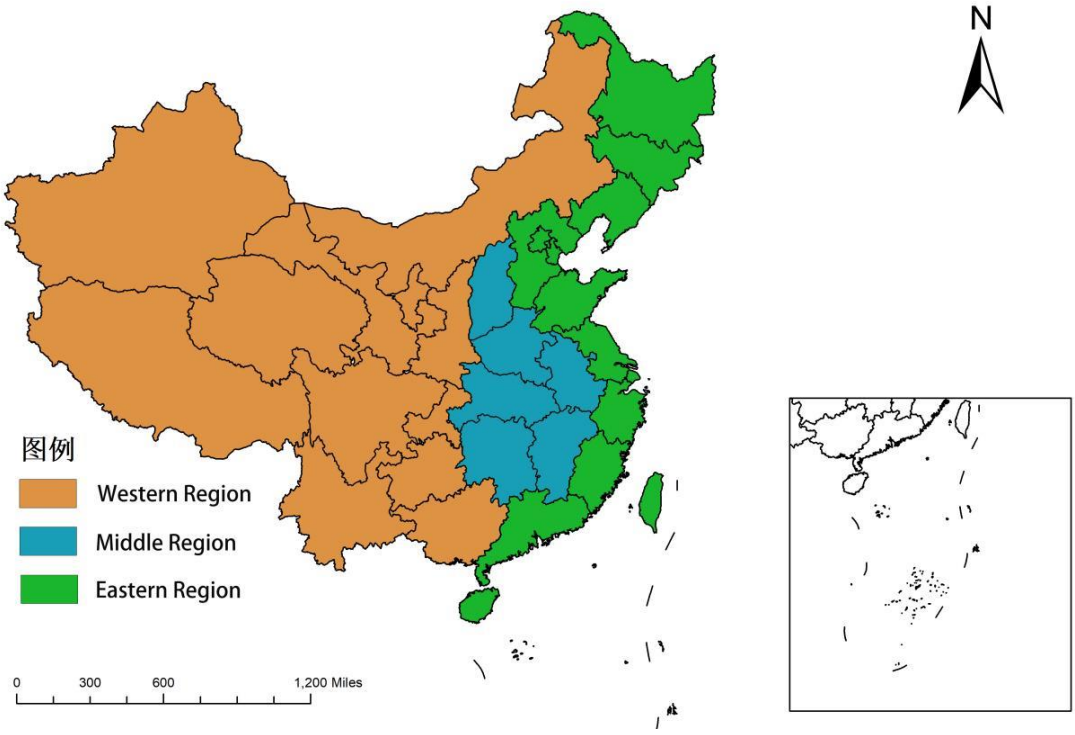

Figure 3-1 Geographical division of Eastern, Western and Eastern China

The previous paper systematically analyzed the growth effect of environmental regulation intensity on attracting foreign direct investment in China. However, because the intensity of environmental regulation is closely related to the overall level of local development, the development of different regions is different, and the intensity of environmental regulation is also different in different regions. In order to test whether there is regional heterogeneity in the impact of environmental regulation intensity on foreign direct investment, this paper divides China into east, middle and west in geographic space, and carries out sub-sample regression based on this. The specific regression results are shown in Table 3-6.

Table 3-6 Estimation results of regional heterogeneity

VARIABLES	(1) lnFDI	(2) lnFDI	(3) lnFDI
lneci	-0.671**	-0.129	0.250
	(0.297)	(0.260)	(0.346)
lnwage	0.0826	1.210***	-1.514**
	(0.194)	(0.497)	(0.656)
lngdp	0.330	-0.206	1.844***
	(0.203)	(0.474)	(0.609)
lninfra	0.406***	0.633***	0.553**
	(0.152)	(0.183)	(0.253)
Constant	11.56***	4.327***	13.15***
	(0.744)	(1.261)	(2.278)
Observations	272	126	232
Number of id	13	6	12
R-squared	0.529	0.895	0.474

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The regression results show that only in the eastern region of China, the estimated coefficient of the core explanatory variables is significantly negative at the level of 5%, which indicates that the improvement of the comprehensive index of environmental regulation has a certain negative effect on FDI. This result is more representative in the eastern region. The greater the intensity of environmental regulation, that is, the smaller the comprehensive index of environmental regulation, the greater the role of China in attracting foreign direct investment. In the central and western regions of China, the core explanatory variables are not significant, which indicates that the intensity of environmental regulation has no impact on foreign direct investment. The reason may be that in the central and western regions of China, infrastructure construction, economic development level, market size and capital intensity are the most important factors that affect FDI. The central and western regions of China lack the main factors that affect FDI. The intensity of environmental regulation is a secondary factor that affects FDI. Therefore, environmental factors have no significant impact on FDI in the central and western regions.

4. conclusions

Since China's reform and opening up, China's economic and social system has also undergone many reforms. From the dual track system of planned economy at the beginning to the reform of exchange rate system adjusted by reference to a basket of currencies in 2005, or the reform of increasingly tightened environmental

regulation. These reform measures have a profound impact on China's absorption of foreign capital. At present, environmental regulation plays an important role in foreign direct investment. Therefore, the study of environmental regulation is of great significance. This paper combs the relevant literature, research background, theoretical significance, purpose and research methods of domestic and foreign scholars on the impact of environmental regulation on FDI, and clarifies the research content and specific framework of the article; On this basis, this paper analyzes how environmental regulation affects FDI growth. Based on panel data from 30 provinces in China from 2000 to 2020, this paper uses the fixed effect model to evaluate the impact of environmental regulation on FDI and conducts variable unit root test, multiple collinearity test, endogenous test, regional heterogeneity analysis and multiple robustness tests. Based on the above analysis, this paper puts forward the following conclusions and suggestions:

From the regression results of the regression model, the core indicator of this paper, the comprehensive index of environmental regulation, is negatively related to the amount of foreign direct investment. The smaller the comprehensive index of environmental regulation, the stronger its environmental regulation intensity. It can be concluded that China's high standards of environmental regulation will increase the inflow of foreign direct investment. From other control variables, the economic development level is significant at the 1% significance level; The regression coefficient of infrastructure construction level is 0.617, which is significant at the 1% significance level, and the regression coefficient is positive. It shows that different from the core explanatory variable environmental regulation, the level of economic development and infrastructure development have a positive impact on attracting FDI; Although the regression coefficients of the above control variables on the level of FDI attraction are different, it shows that they also play a positive role in the level of FDI attraction while maintaining this influence trend.The "pollution shelter" hypothesis is not significant in China. Although the current research in China has proved that there is a phenomenon of pollution shelters, with the continuous maturity and development of China's environmental management and market environment, there will be a "Porter hypothesis" effect. This means that the environmental issues regulated by the government in our country are strictly standardized, which is conducive to the inflow of foreign direct investment.

Under the "dual carbon" goal, we will more accurately introduce policies to adjust the foreign investment structure in China, guide foreign investors to invest more in green and low-carbon industries such as new energy, and promote the development and growth of green and low-carbon markets; Strengthening technological innovation and promoting the vigorous development of the clean industry will reduce the inflow of FDI from polluting industries to China, which will also create a better market environment to attract high-quality industry FDI inflows. Moderately strengthen environmental regulation and improve the system of market incentive environmental regulation; Vigorously develop technology intensive industries, increase innovation effect, and advocate green enterprise development; The government should continue to implement favorable environmental regulation policies to improve the inflow quality of FDI. However, in the process of formulating emission reduction targets, the government should also pay attention to the environmental regulation, otherwise, it will not increase the inflow of FDI, but will be counterproductive; Improve energy-saving and low-carbon regulation policies, and find energy-

saving and low-carbon development methods that are suitable for China's national conditions. Environmental regulation policies need to pay more attention to the encouragement of corresponding technology research and development and institutional innovation at the macro level.

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