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Research on the Relationship Between Provincial OFDI And Carbon Emissions Under Dual Carbon Targets

-- Empirical Evidence from China's Provincial Data

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Abstract: With the development of economic globalization and China's continuous high-quality development, China's global status continues to rise, driving more and more companies to "go out" to conduct foreign direct investment overseas in order to seek a larger market, in the face of the two major tasks of "economic development" and "achieving dual carbon goals", studying the impact of foreign direct investment on my country's carbon dioxide emissions has a very important reality for whether our country can achieve economic transformation and fulfill its emission reduction commitments. and guiding significance. Therefore, this article based on the panel data of energy consumption in 30 provinces and regions in China from 2004 to 2019 . At the same time, per capita GDP, technological level, industrial structure, etc. were selected as control variables, a fixed effect model was established, and an empirical analysis was conducted on the carbon emission effects of my country's foreign direct investment by region and time period. Empirical analysis results show that: The increase in the scale of OFDI will promote the increase of carbon dioxide emissions in China, but there are significant differences in the carbon emission effects of various regions. The carbon emission effect of foreign direct investment in the eastern and western regions is significantly higher than that in the central region. Over time, the expansion of foreign direct investment will reduce the increase in carbon dioxide emissions it brings. In addition, the improvement of per capita GDP and industrial structure will increase carbon dioxide emissions, while the improvement of technological level will significantly reduce carbon dioxide emissions. Finally, reasonable policy suggestions are given based on the results of empirical analysis and the current situation of foreign direct investment and domestic carbon dioxide emissions.

Keywords: Foreign direct investment, Carbon emissions, Ordinary panel analysis.

1. Introduction

1.1. Research background and significance

1.1.1. Research background

With the rapid development of China's economy and the advancement of internationalization, China's foreign direct investment (OFDI) has become an important factor in the global economic landscape. Through foreign investment, Chinese enterprises not only expand business globally and enhance international competitiveness, At the same time, we are also faced with a series of environmental and social responsibility issues related to investment. In recent years, as the issue of global climate change has become more prominent, the issue of carbon emissions has gradually become a focus of global concern.

Since the 21st century, especially after the " Belt and Road " initiative was proposed, the scale of China's foreign direct investment (OFDI) has expanded rapidly. According to the " 2019 China Overseas Direct Investment Statistical Bulletin" and the " 2020 China Overseas Direct Investment Statistical Bulletin", China's OFDI flows ranked second in the world in 2019 , and OFDI stocks remained third in the world; in 2020 , China's OFDI Traffic reached US$ 153.7 billion, a year-on-year increase of 12.3% , surpassing other countries in the world for the first time and becoming the first in the world. As of the end of 2020 , China's OFDI stock reached US$ 2.58 trillion. At the same time, however, China's carbon emissions have increased rapidly. In 2017 , carbon emissions exceeded 10 billion tons, and in 2019 they were approximately 10.476 billion tons, accounting for 34% of the total global carbon emissions . As the scale of China's foreign direct investment expands, the flow of domestic production factors accelerates and resources are reallocated, which has raised concerns about how China's OFDI affects domestic carbon emissions.

1.1.2. Research significance

(1) Theoretical significance

In the existing literature, research on the home country effects of foreign direct investment (OFDI) mainly focuses on the economic effects. At the same time, regarding the various influencing factors of carbon emissions, research mainly focuses on key areas such as economic growth level, industrial composition, energy distribution, technological innovation and the pace of urbanization. These studies provide important reference for the development of my country's low-carbon economy, but there are also some shortcomings and flaws. Research on the connection between foreign direct investment and carbon emissions is mainly conducted from the perspective of its impact on the host country , while research on carbon emissions in the home country is relatively limited. In existing research, scholars have not yet reached a consensus on their conclusions, and few scholars have conducted in-depth research on the relationship between the two from the perspective of mechanism analysis. This article aims to deeply explore the direct and indirect carbon emission effects of my country's foreign direct investment by using a multiple intermediary model, in order to provide useful reference for my country's low-carbon green development. Through a review of existing literature, we found that current mainstream research on the

relationship between foreign direct investment and carbon emissions mainly focuses on analyzing the impact on the host country, paying less attention to the impact on carbon emissions in the home country. Moreover, scholars have different conclusions and lack in-depth mechanism analysis. Therefore, the research in this article has important theoretical value in filling this research gap. In terms of research methods, this article adopts a multiple intermediary model and strives to deeply explore the direct and indirect impact mechanisms of foreign direct investment on carbon emissions. The application of this method will provide a more refined theoretical analysis framework for the study of the relationship between foreign direct investment and carbon emissions, and is expected to reveal the potential complex relationships and provide new enlightenment for future research. Through in-depth research in this article, we hope to more comprehensively understand the impact mechanism of my country's foreign direct investment on carbon emissions and provide more accurate and powerful theoretical support for low-carbon green development. This theoretical significance will not only help enrich the research field on the relationship between foreign direct investment and carbon emissions, but will also provide a more scientific basis for relevant decision-making.

(2) Practical significance

With the continuous advancement of global economic integration and the in-depth implementation of China's opening-up policy, China's foreign direct investment (OFDI) has shown a momentum of vigorous development. How to effectively coordinate environmental protection while maintaining rapid economic growth and promote the development of the economy towards a higher level of environmental protection is an important issue that needs to be solved in my country. China has become a major foreign investor in the world. As the scale of foreign direct investment continues to expand, the direction and model of foreign direct investment must be optimized to better promote the high-quality development of our country's economy. On the other hand, facing the challenge of global climate change, our country shoulders major responsibilities for energy conservation and emission reduction. Among them, industrial structure is one of the important driving forces of carbon emissions, while foreign direct investment reduces carbon emissions by promoting technological innovation and improving technological levels of domestic enterprises. As one of the countries with the largest carbon emissions in the world, China must reach its carbon emissions peak before 2030 and strive to achieve carbon neutrality by 2060 .

The outbreak of the epidemic has made economic recovery through green and low-carbon development an international consensus. The United Nations proposed the concept of green and high-quality development in May 2020 . The European Union and the United States have also enacted new policies to promote green growth. So far, 137 countries around the world have set " carbon neutrality " goals in 2050 . Against this background, this article aims to deeply explore the relationship between carbon emissions and foreign direct investment, and put forward corresponding suggestions to help my country achieve its emission reduction goals.

2. Literature Review

2.1. Research on factors affecting carbon emissions

In terms of research on factors affecting carbon emissions, some early and influential theories include the Environmental Kuznets Curve (EKC) hypothesis and the KAYA identity. Grossman and Krueger (1991) showed through empirical analysis that environmental quality has declined during the growth of per capita income, and only when the income level reaches a certain level does environmental quality begin to improve, forming an inverted U - shaped relationship. On the other hand, the KAYA identity was proposed by Yoichi Kaya (1989), which attributes the influencing factors of carbon emissions to four aspects: population size, per capita income, energy intensity and energy structure. This theory is widely accepted and applied. Overall, these theories provide a strong theoretical basis for in-depth research on the relationship between carbon emissions, economic development, population and other factors.

Another widely used theoretical model is the IPAT model proposed by Ehrlich and Holden (1971) , which attributes the influencing factors of a country's pollution emissions to population level, affluence and technological level. Dietz et al. (1994) developed the stochastic regression impact model (STIRPAT) based on the IPAT model. The application of this model in the field of carbon emissions has been widely recognized. The KAYA formula mentioned above is also the basis of the IPAT model in carbon emissions research. an application. On the basis of these theories, Grossman et al. (1995) further studied and proposed that economic scale, technological level and industrial structure are the three main factors affecting the environment. ① From the perspective of economic scale, with the development of the economy, the consumption of mineral resources, fossil energy, etc. is inevitable. With the consumption of resources, the emission of various pollutants will also increase; ② From the perspective of technical level It seems that according to the endogenous growth theory, the improvement of technological level promotes more efficient use of natural resources, which can save resource consumption or realize the recycling of resources in actual production, thus reducing resource consumption and pollution under the same output scale. emission. ③From the perspective of industrial structure, with the development of industrialization and the improvement of economic level, the country's industrial structure will change, such as from energy-intensive resource-intensive industries to technology-intensive or tertiary industries (finance, services) field) changes. With the transformation of industrial structure, it is also expected to reduce the emission of environmental pollution. Antweiler et al. (2001) continued to use the relevant theories proposed by Grossman et al., conducted in-depth research on the influencing factors of environmental pollution under open economic conditions, and constructed a general equilibrium theoretical model . In addition to considering factors such as economic scale effect, technological level effect, and industrial structure effect in the above theory, they also introduced the opening-up effect under open economic conditions. In this model, when a country's export scale expands, similar to the economic scale effect, it will also lead to an increase in the consumption of production resources and fossil energy, thereby increasing environmental pollution emissions; in terms of industrial

structure, a country's trade activities are related to its Comparative advantages are related to factor endowments. For example, if a country has a comparative advantage in technology-intensive products rather than resource-intensive products, the opening-up effect may prompt it to reduce pollution emissions; in terms of technology level, foreign trade may also promote production technology and the transfer of environmental protection technologies, thereby improving resource and energy utilization efficiency, reducing pollution emissions or improving pollution control.

2.2. Research on the relationship between foreign direct investment and carbon emissions

Some scholars believe that the impact of foreign direct investment (OFDI) on a country's carbon emissions is affected by many factors such as regional economic development level, urbanization rate and industry, and the impact of OFDI on the host country includes three types: technology effect, scale effect and structural effect. aspects. These three effects have different directions and degrees of impact on host country carbon emissions, so the final effect after their superposition needs to be considered. Zhou Li and Pang Chenchen (2013) analyzed national and regional data by establishing two simultaneous equations of waste gas and wastewater based on provincial panel data from 1999 to 2010 . They found that the impact of foreign direct investment on the regional environment is affected by the level of local economic development. In economically developed regions, such as East China, the industrial structure effect and reverse technology spillover effect brought by foreign direct investment are significant, so the low-carbon effect in this region is obvious. In economically underdeveloped regions, such as South China and Northwest China, the technical and structural effects of OFDI may not be as good as expected, mainly because OFDI in these regions mainly flows to countries and regions with relatively backward technological levels, resulting in less obvious reverse technology spillover effects, resulting in Negative environmental effects, resulting in environmental damage. On the other hand, Xu and Wang Ying (2015) analyzed panel data from 30 provinces, municipalities and autonomous regions in China by establishing a simultaneous equation model . Different from the views of other scholars, they believe that foreign direct investment will increase China's carbon emissions and have a negative impact on the domestic environment. This is because the industrial structure adjustment caused by foreign direct investment may increase the proportion of the secondary industry, and most high-carbon-emitting industries belong to the secondary industry, thus increasing my country's carbon dioxide emissions. By comparing different regions in the east, west and central China, they found that the carbon emission increase effect of foreign direct investment in eastern China was not obvious, while it had a carbon environment deterioration effect in the central and western parts of the country. This may be due to the industrial adjustment in China. caused.

3. Analysis of the Current Situation of China’s Foreign Direct Investment and Carbon Emissions

3.1. China’s OFDI development history and current situation

3.1.1. Current status of China's total foreign direct investment

Since the reform and opening up in 1978 , China has begun to integrate into the global economic system, actively attracting foreign investment and developing its economy. As a result, foreign direct investment grew rapidly during this stage, which greatly promoted the development of the domestic economy. Although China's economic scale and development level were relatively low at that time, the amount of overseas direct investment activated was still limited and the growth rate was relatively slow. China's foreign direct investment data from the Ministry of Commerce and the National Bureau of Statistics show that China's foreign direct investment continued to increase between 2002 and 2021 . Specifically, it can be clearly seen from Figure 1 below that although growth slowed down in the early stage, since the 2008 Olympic Games, China has begun to make great strides and rapidly promote foreign direct investment. The growth rate of foreign investment stock accelerated from 2016 to 2017 , the growth rate slowed down slightly from 2017 to 2018 , but increased significantly from 2019 to 2021 .

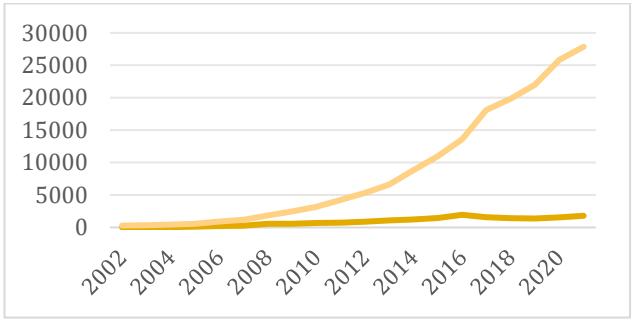

Figure 1 Growth trend of China’s foreign direct investment flows and stocks from 2002 to 2021

As shown in the figures and tables, since 2002-2021 , both the stock of annual outflows and the flow of cumulative outflows have shown an increasing trend year by year . A detailed analysis of the growth trend of China’s foreign investment stock from 2002 to 2021 shows that China’s foreign investment stock in 2002 was US$ 29.90 billion, that in 2010 it was US$ 317.21 billion, and that in 2017 it was US$ 1,809.04 billion . US dollars, until 2021 China has achieved a stock of US$ 2,785.15 billion in foreign investment. Moreover, from 2018 to 2021 , China's foreign investment stock has maintained its third place in the world. Compared with 2002 , China's foreign investment stock has increased by more than 93 times in 2021 . Especially in 2008 , the month-on-month growth rate reached 110.9% . It can be seen that the Beijing Olympic Games will bring more opportunities to China's foreign investment, and more investors will go abroad and enter the world stage.

3.2. China's carbon emission development and current situation

3.2.1. Calculation of carbon dioxide emissions

This article estimates China's carbon emission data based on the method proposed by the United Nations Intergovernmental Panel on Climate Change (IPCC) in 2006. The carbon emissions of China's 30 provinces, autonomous regions and municipalities except Hong Kong, Macao, Taiwan and the Tibet Autonomous Region from 2002 to 2021 are estimated. Emission data are used for estimation. When selecting energy consumption, this article selected the amount of carbon dioxide produced by eight types of energy: coal, coke, crude oil, gasoline, diesel, liquefied petroleum gas, and natural gas based on the data given in the "China Energy Statistical Yearbook " . The specific calculation formula is as follows:

$$CO_2 = \sum_{i=1}^{8} CO_2, i = \sum_{i=1}^{8} E_i \times NCV_i \times CEF_i$$

Among them, CO 2 represents the carbon dioxide emissions in each region; i represents various types of energy fuels, a total of 8 types, including coal, coke, crude oil, gasoline, diesel, liquefied petroleum gas, and natural gas; E i represents the combustion consumption of the i- th type of energy quantity; NCV i is the average low-level calorific value of type i energy, which is suitable for converting all energy consumption into energy units (TJ); CEF i represents the carbon dioxide emission factor of type i energy.

3.2.2. Overall scale of China's carbon emissions

Since China joined the World Trade Organization, China's foreign trade has expanded rapidly and its economy has risen rapidly. At the same time, manufacturing and other high-polluting energy-consuming industries are booming. With the rapid improvement of industrial scale and economic level, energy consumption has also increased significantly, resulting in an upward trend in carbon dioxide emissions. As shown in Figure 4 , in the third year after joining the World Trade Organization, China's carbon dioxide emissions growth rate reached the highest level, indicating that joining the World Trade Organization has greatly promoted China's economic development. China's carbon emissions increased from 3.472 billion tons in 2002 to 10.356 billion tons. From 2002 to 2014 , the growth rate of China's total carbon emissions has been higher than 0 , indicating continued growth. It briefly declined from 2014 to 2016 due to an increasing trend from 2016 to 2021 . Overall, although my country's carbon dioxide emissions are still growing year by year, the growth rate is slowing down year by year. According to current development trends, it is very likely that carbon will peak in 2030 and carbon neutrality will be achieved in 2060 . This also confirms the recognition of the efforts made by our country's enterprises and government in environmental protection, energy conservation and emission reduction.

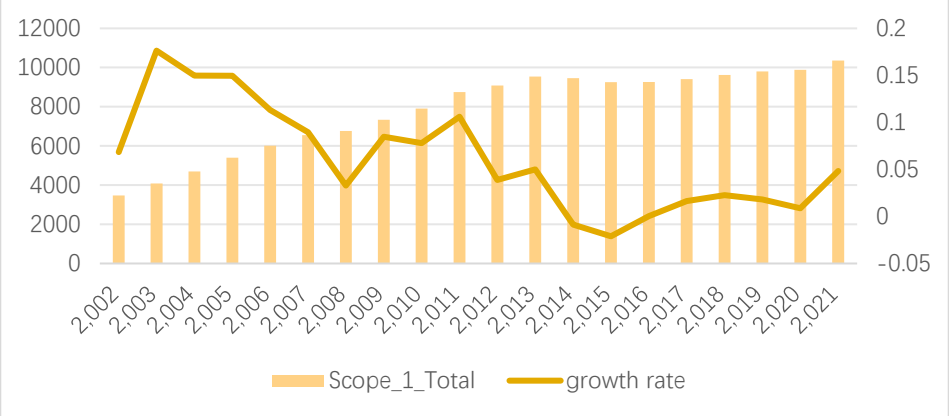

Figure 2 China's total carbon dioxide emissions and growth rate from 2002 to 2021

4. Empirical Research and Analysis of the Impact of China's Foreign Direct Investment on Carbon Emissions

Through the above summary of previous research and the research and analysis of relevant theories on carbon dioxide emissions, we can find that there are many factors that affect CO_2

4.1. Measurement model construction and data selection

4.1.1. Construction of econometric model

Since the main purpose of this study is the impact of OFDI on domestic carbon emissions, this paper mainly draws on the carbon emission driving force decomposition factor model proposed by Richard et al. (2003) and the Kaya identity proposed by Japanese professor Kaya , and sets the model For the following structure:

$$CO_{2it}=\mathrm{F}\left(OFDI_{it}, Z_{it}\right)$$

In this model, $CO_2 CO_2$

$$\ln CO_{2it} = \alpha_0 \alpha_1 lnOFDI_{it} \sum_{j=1}^{n} \gamma_i \, CV_{ijt} \varepsilon_{1it}$$
$$\ln GDP_{it} = b_0 b_1 lnOFDI_{it} \sum_{j=1}^{n} \gamma_i \, CV_{ijt} \varepsilon_{2it}$$
$$\ln Struc_{it} = c_0 c_1 lnOFDI_{it} \sum_{j=1}^{n} \gamma_i \, CV_{ijt} \varepsilon_{3it}$$
$$\ln GT_{it} = d_0 d_1 lnOFDI_{it} \sum_{j=1}^{n} \gamma_i \, CV_{ijt} \varepsilon_{4it}$$

$$\ln CO_{2it} = e_0 e_1 lnOFDI_{it} e_2 \ln GDP_{it} e_3 \ln Struc_{it} e_4 \ln GT_{it} \sum_{j=1}^{n} \gamma_i \, CV_{ijt} \varepsilon_{5it}$$

Models 5.1-5.5 constitute the multiple intermediary effect model of this article, which can be used to analyze the economic scale effect, technology effect and industrial structure effect, and indirectly affect carbon emissions through foreign direct investment. In Models 4.1-4.4 , i represents the province, t refers to the time (year).

4.1.2. Empirical results and analysis

This article uses panel data from 30 provinces from 2004 to 2019. Before conducting empirical analysis, this article first conducts a multicollinearity test. According to Table 5 , it can be seen that the VIF is less than 10 , indicating that there is no serious multicollinearity between variables. Then the Hausman test is used to determine the model that should be

used in this empirical study. According to the results of the Hausman test , the fixed effects model should be used for the benchmark regression in this article.

Table 1. Variance inflation factor

variable	VIF	1/VIF
lnOFDI	4.10	0.243902
lnGreen	3.43	0.291856
lnFDI	1.69	0.593160
lnTRA	2.27	0.441421
lnUrban	3.75	0.266933
lnGT	3.12	0.320058
lnEner	2.37	0.422430
lnStruc	2.09	0.477544
lnGDP	1.23	0.813612
average value	2.67	

Data source: generated by stata16

4.2. Mediation effect test

Secondly, the mediating effects of OFDI on the impact of OFDICO_2

4.2.1. National level

From a national level, the impact of foreign direct investment on carbon emissions is significantly positive.

From the perspective of the impact of foreign direct investment on carbon emissions, the direct effect of foreign direct investment on carbon emissions is 0.04639, and the indirect effect of foreign direct investment on carbon emissions through economic scale effect, technology effect and industrial structure effect is 0.03666 (=0.12865). × 0.28497), -0.00275=0.05625 × (-0.04890), -0.01511=[0.06170 × (-0.24487)], the total indirect effect is 0.0188 . The total effect of foreign direct investment on carbon emissions is 0.06519 (=0.04639+0.0188).

Table 2. National level regression results

variable	lnGDP	lnGT	lnStruc	ln$\boldsymbol{CO_2}$
lnOFDI	0.12865*** (20.16)	0.05625*** (2.94)	0.06170*** (4.65)	0.04639*** (3.99)
lnGDP				0.28497*** (4.49)
lnGT				-0.04890** (-2.35)
lnStruc				-0.24487*** (-8.04)
lnEner	-0.04848** (-2.33)	-0.02393*** (-0.38)	-0.22593*** (-5.23)	0.14355*** (5.18)
lnUrban	0.91584*** (12.52)	0.00252 (0.05)	0.23148 (1.52)	0.13069 (1.19)
lnGreen	0.11011*** (5.97)	0.00252 (0.05)	0.03373 (0.88)	0.13583*** (5.47)
lnTRA	0.18228*** (6.87)	0.16991*** (2.13)	-0.14253*** (-2.58)	0.11018*** (2.96)
lnFDI	-0.00075*** (-0.17)	-0.04016*** (-2.98)	-0.00377 (-0.40)	-0.02399*** (-4.08)
Constant	3.34596*** (14.07)	4.85693 (6.81)	4.22192*** (0.54)	-2.00846*** (-5.07)
$\boldsymbol{R^2}$	0.958	0.131	0.408	0.803

Note: The numbers in brackets in this table are T values. “ *** ”, “ ** ”, and “ * ” indicate the significance levels of “ 1% ”, “ 5% ”, and “ 10% ”.

4.2.2. Regional level

From the eastern region, foreign direct investment will also increase carbon dioxide emissions, but the significance decreases. Foreign direct investment will also indirectly affect carbon emissions through economic scale expansion and industrial structure effects. The direct effect of foreign direct investment on carbon emissions is 0.03839 . The direct external economic scale expansion effect is 0.04904 , and the industrial structure effect is 0.02813 . Since foreign direct investment in the eastern region does not significantly improve technological level, according to the test method proposed by Wen Zhonglin (2004), it is believed that the intermediary effect of technological level does not exist in the eastern region. The reason may be that there are many factors that cause technological innovation in the eastern region, of which foreign direct investment is only one aspect. Therefore, the relationship between foreign direct investment and technological innovation is not significant in the eastern region. Judging from the results, foreign direct investment and economic scale expansion will increase carbon emissions, while technological level improvement and industrial structure adjustment will inhibit carbon emissions.

Table 3. Regression results for the eastern region

variable	lnGDP	lnGT	lnStruc	lnCO_2
lnOFDI	0.13357*** (18.19)	0.02345 (1.34)	0.08950*** (6.52)	0.03839* (1.93)
lnGDP				0.36713*** (2.95)
lnGT				-0.33730*** (-6.35)
lnStruc				-0.31430*** (-4.54)
lnEner	-0.03079 (-1.50)	-0.10230** (-2.09)	-0.11106*** (-2.89)	0.06064* (1.86)
lnUrban	0.91660*** (9.66)	-0.01729 (-0.08)	0.01172 (0.07)	0.57358*** (3.10)
lnGreen	0.08374*** (4.45)	-0.14169*** (-3.16)	-0.00217 (-0.06)	0.06791** (2.15)
lnTRA	0.17613*** (4.13)	0.16991*** (2.13)	-0.14253*** (-2.58)	0.11018*** (2.96)
lnFDI	0.00022 (0.05)	-0.04016*** (-2.98)	-0.00377 (-0.40)	-0.02399*** (-4.08)
Constant	3.86418*** (12.58)	3.974 20***	3.15611*** (5.50)	-1.95575*** (-2.82)
R^2	0.966	0.149	0.698	0.798

Note: The numbers in brackets in this table are T values. " *** ", " ** ", and " * " indicate the significance levels of " 1% ", " 5% ", and " 10% ".

From the perspective of the central region, the relationship between foreign direct investment and carbon emissions is not significant. Because the economy in the central region is underdeveloped and economic development relies heavily on coal and other resources, the increase in foreign direct investment is disproportionate to the increase in carbon dioxide emissions. Foreign direct investment in the central region will significantly promote the expansion of the region's economic scale and thereby increase carbon dioxide emissions. The technological effect and industrial structure effect are not significant in the central region.

Table 4. Regression results in the central region

variable	lnGDP	lnGT	lnStruc	lnCO_2
lnOFDI	0.18804*** (9.92)	0.00358 (0.12)	-0.03715 (-0.96)	0.00118 (0.07)
lnGDP				0.33695*** (5.47)
lnGT				0.04666 (1.30)
lnStruc				-0.17066*** (-5.54)
lnEner	0.00171 (0.02)	-0.21814 (-1.46)	0.12738 (0.65)	0.24394*** (4.31)
lnUrban	0.34018 (1.08)	-0.90044* (-1.84)	2.0594 0***	0.38952** (1.98)
lnGreen	0.17090*** (2.72)	0.22892*** (2.35)	0.14900 (1.16)	0.02220 (0.58)
lnTRA	0.15203** (2.41)	0.29028*** (2.97)	-0.11312*** (-0.88)	0.05076*** (1.26)
lnFDI	-0.02459 (-1.04)	-0.04500*** (-1.23)	-0.12667** (-2.62)	0.01608 (1.14)
Constant	4.31828*** (3.96)	8.342 66***	-1.48109 (-0.66)	-4.79773*** (-6.21)
R^2	0.938	0.177	0.291	0.899

Note: The numbers in brackets in this table are T values. " *** ", " ** ", and " * " indicate the significance levels of " 1% ", " 5% ", and " 10% ".

From the perspective of the western region, foreign direct investment will increase carbon emissions. The direct effect of foreign direct investment on carbon emissions is 0.05396 , and the economic scale effect is 0.04891 . The technological effect and industrial structure effect are not significant. With the in-depth development of the Western Development Strategy, the western region continues to undertake the transfer of industries from the east, so the impact of foreign

direct investment on the upgrading of industrial structure is not significant.

Table 5. Regression results for the western region

variable	lnGDP	lnGT	lnStruc	lnCO_2
lnOFDI	0.07755*** (7.48)	012628** (2.41)	0.03265 (1.36)	0.05396** (2.50)
lnGDP				0.63073*** (4.50)
lnGT				-0.01604 (-0.59)
lnStruc				-0.21158*** (-3.58)
lnEner	-0.27826*** (-5.10)	0.26217 (0.95)	-0.54040*** (-4.29)	0.43379*** (4.07)
lnUrban	0.97418*** (7.78)	-0.16488 (0.26)	0.38824 (1.34)	-0.67394*** (-2.64)
lnGreen	0.22839*** (7.11)	-0.10963 (-0.676)	0.05102 (0.69)	0.08422 (1.34)
lnTRA	0.19526*** (6.27)	0.18485 (1.17)	-0.17035** (-2.37)	0.11332* (1.90)
lnFDI	0.01273 (1.53)	-0.18951*** (-4.50)	-0.07316*** (-3.81)	-0.03101** (-2.01)
Constant	4.19074*** (8.29)	3.28400 (1.28)	6.17389*** (5.30)	-3.35203*** (-2.91)
R^2	0.979	0.300	0.483	0.870

Note: The numbers in brackets in this table are T values. “ *** ”, “ ** ”, and “ * ” indicate the significance levels of “ 1% ”, “ 5% ”, and “ 10% ”.

5. Research Conclusions and Policy Suggestions

5.1. Conclusion analysis

By summarizing and analyzing the theoretical research results related to carbon emissions and foreign direct investment, and conducting an empirical analysis of the common panel model of panel data on carbon emissions and foreign direct investment in each province (region) in China from 2004 to 2017, this article specifically draws the following conclusions : Conclusion:

(1) By analyzing the current situation of China's foreign direct investment and carbon dioxide emissions, it can be seen that both China's foreign direct investment and carbon dioxide emissions are on the rise, and the trends of the two are basically the same. From a regional perspective, the eastern region has the largest foreign direct investment stock and the largest carbon dioxide emissions, followed by the western region, and finally the central region. Judging from the distribution of the three industries, foreign direct investment is mainly concentrated in the tertiary industry, and the secondary industry emits the most carbon dioxide. my country's foreign direct investment has developed rapidly as a whole, but the areas of foreign direct investment are too concentrated, mainly in Asia. The foreign direct investment industry shows a trend of diversification, but the structure is unreasonable and the tertiary industry accounts for a heavy proportion. Carbon dioxide emissions also increased during the study period, but at a slower rate.

(2) According to the empirical results of the ordinary panel model, it is found that China's foreign direct investment has a significant positive impact on carbon emissions, and the impact differs between the eastern, central and western regions. According to the empirical results of the spatial panel model, it is also found that foreign direct investment has a significant positive impact on carbon emissions in the region, but the impact on carbon emissions in surrounding areas is not significant. Analysis of other empirical regression results that control traffic volume found that an increase in affluence (gross product per capita) will lead to a decrease in carbon emissions in the region and an increase in carbon emissions in surrounding areas; an increase in the proportion of the secondary industry in the economic structure will lead to a decrease in carbon emissions in the region. and the surrounding areas’ carbon emissions increased; the improvement in technological level (R&D expenditure) increased the carbon emissions in the region but inhibited the carbon emissions in the surrounding areas: the level of environmental regulation (the increase in the proportion of environmental governance investment did not inhibit the carbon emissions in the region and surrounding areas) carbon emission.

(3) According to the results of the intermediary effect, it is found that the economic scale discount effect, the technological level improvement effect and the reasonable adjustment of industrial structure effect exist at the national level, and the carbon emission growth effect brought by the expansion of economic scale is greater than the improvement of technological level and the reasonable adjustment of industrial structure. The carbon emission suppression effect brought about by this. The intermediary effect of technological level does not exist in the eastern region, the relationship between foreign direct investment and carbon emissions is not significant in the central region, and the intermediary effect of industrial structure in the western region does not exist.

5.2. Relevant policy suggestions

Based on the empirical research results and combined with my country's specific national conditions, the following

suggestions are put forward.

5.2.1. Adjust the structure of foreign direct investment and improve the quality of foreign direct investment

From the perspective of motivations for foreign direct investment, my country's current foreign direct investment accounts for the largest proportion of resource-seeking foreign direct investment and market-seeking foreign direct investment. These two types of direct investment will increase carbon dioxide emissions by increasing domestic production. Therefore, our country can optimize the structure of foreign direct investment, increase the proportion of technology-seeking foreign direct investment, learn energy-saving and emission-reduction technologies through foreign direct investment in countries with high technological levels, and improve domestic energy-saving and emission-reduction technology through reverse technology spillover effects. . From the perspective of the location of foreign direct investment, my country's current foreign direct investment is mainly concentrated in developing countries and regions. It can increase the proportion of developed countries and invest in technology-intensive industries in developed countries. From the perspective of the foreign direct investment industry, China currently invests a large proportion in the tertiary industry, with leasing and commercial services accounting for more than 30% . Our country can increase investment in resource-intensive industries, transfer domestic carbon emissions, and make full use of the world energy market. The government can establish and improve the foreign direct investment guarantee mechanism to protect the interests of enterprises. It can guide the direction of foreign direct investment of Chinese enterprises through policy preferences and optimize the structure of foreign direct investment.

5.2.2. Develop differentiated foreign direct investment strategies based on the conditions of each region

Because my country's eastern, central and western regions have large differences in economic development levels, technological levels and educational levels, the proportions of foreign direct investment are also different. The government can conduct differentiated foreign direct investment according to the environmental characteristics of each region. For the central and western regions with low economic development levels, we should deepen the “Western Development” and “One Belt and One Road” initiatives, improve the economic development level of the western regions, and increase the scale of foreign direct investment. The eastern region has high economic development and high technological level; it can be encouraged to vigorously carry out technology-oriented foreign direct investment, give full play to the technological advantages of the eastern region, and reduce carbon dioxide emissions through the introduction and learning of new technologies.

5.2.3. Promote domestic industrial structure adjustment and optimize industrial structure

The secondary industry is the industry that emits the most carbon dioxide. Adjusting the industrial structure to reduce the proportion of the secondary industry and actively developing the tertiary industry can reduce carbon dioxide emissions. At the same time, as the added value of the tertiary industry increases, my country's economic level will also improve and its position in the global industrial chain will be enhanced. When economic development crosses a turning point, the economic scale effect is negative, which is also conducive to reducing carbon dioxide emissions. The internal structure of the secondary industry must also be optimized, industries with large energy consumption and serious pollution emissions must be eliminated, and environmentally friendly industries based on energy-saving equipment should be developed to reduce carbon dioxide emissions.

5.2.4. Adjust the energy consumption structure and increase the proportion of green and clean energy

my country's current energy consumption is still dominated by coal, and the existing energy consumption structure is positively correlated with carbon emissions, indicating that a coal-dominated structure increases carbon dioxide emissions. Judging from the current situation, coal will be the main energy source for a long time. Our country can reduce carbon emissions caused by the energy structure from the following three aspects. First, our country can improve the utilization efficiency of coal and reduce coal usage through technological development. Second, our country should increase the opening up and utilization of new energy. At present, my country's electricity mainly comes from coal combustion, and solar power generation, wind power generation, hydropower and nuclear power can be fully utilized according to regional characteristics. Third, as the economy develops, residents’ consumption of cars increases and fuel demand increases. Our country should continue to increase support for new energy vehicles, improve charging facilities, and reduce transportation carbon dioxide emissions.

5.2.5. Increase investment in environmental governance and severely punish environmentally damaging behaviors

There are two ways to reduce carbon dioxide emissions. The first is to reduce carbon emissions in production and life. First, the government can improve environmental standards and integrate them with international standards by formulating strict environmental protection systems. High-standard environmental protection requirements can promote energy conservation and emission reduction of enterprises and reduce carbon emissions. We can also increase people's environmental awareness through increased education and publicity, and reduce carbon emissions in our daily lives. On the other hand, the carbon dioxide produced is offset through tree planting and other methods. The government has increased investment in environmental governance, improved the ecological environment, increased forest coverage, and offset carbon dioxide emissions. The government can also support the development of ecological industries, turn environmental advantages into economic advantages, and simultaneously affect carbon dioxide emissions.

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