

Article

The Impact of Foreign Direct Investment on China's Carbon Emissions

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Abstract: China is world renowned for its significant achievements in several fields. China's economic growth has been prominent, with the country's GDP ranking second globally. China's Foreign Direct Investment (FDI) inflows have been significant, with the country now known as the second largest economy in the world. FDI however does have some negative consequences on China's environment. While attracting FDI promotes economic growth through industrial upgrading, the deleterious impacts of the latter on the environment cannot be ignored. The current study analyses the actual use of FDI and carbon emissions in China from 1997 to 2018. Quantitative analysis was employed to analyze the trends of FDI and carbon emissions in China as a whole and in the respective regions, namely the eastern, central and western regions. Regression analysis was then conducted to analyze the impact of FDI on carbon emissions in China on the national level and regional levels, i.e., in the eastern, central and western regions. The conclusion of this article is that FDI will play a positive role in China's overall carbon emissions. The study has important implications for policy. We recommend that the corresponding investment policies need to be formulated according to the different levels of economic development among the regions.

Keywords: FDI; China's carbon emissions; impact



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1. Introduction

China is now the second largest economy in the world, which is the fruit of decades of continuous development. China has experienced steady growth and has attracted a huge inflow of foreign direct investment (FDI). China's actual use of FDI has increased from USD 40.7 billion in 2000 to USD 131 billion in 2017 since the reform and opening up in 1978 and China's accession to the World Trade Organization in 2001. This is double the FDI in a period of less than 20 years.

However, FDI does not only inject vitality into the host country's economy and promotes industrial upgrading, but some countries may also transfer their highly polluting industries to the host country. This is a hot issue which will have detrimental impacts on the host country if it is not well managed. With the gradual expansion of China's use of FDI, the total amount of carbon emissions has also increased. From 1,182,904,870 t in 1997 to 3,723,989,462 t in 2018, the growth rate of carbon emissions exceeded that of FDI. This has more than tripled in almost 20 years. Nowadays, China's carbon dioxide emissions are still increasing and are far higher than that of the world on average. The increase in carbon emissions has led to the increasing greenhouse effect and the frequent occurrence of acid rain and haze. The latter will not only endanger the life and health of every Chinese person, but it will also have a negative impact on China's sustainable development. So, in this paper we try to explore the impact of FDI on China's carbon emissions in order to

put forward some policy implications related to attracting FDI while reducing the negative effect on the environment at the same time.

Our academic marginal contributions are as follows: (1) Drawing on provincial panel data, this paper analyses and compares the differences in carbon emissions caused by the differences in FDI between the eastern and western regions of China. It explores whether FDI brings the “pollution paradise” or “pollution halo” effect to all parts of China to make more scientific use of FDI to provide policy advice; (2) Pollution halo hypothesis argue that multinational companies through FDI transfer their greener technology to the host country. Technology transfer might involve green technologies such as pollution abatement technologies and renewable energy technologies and it might involve advanced energy efficient technologies, reducing the demand for conventional energy sources [1] (Güvercin). It demonstrates that FDI supplies advanced technology to countries and accordingly causes lower carbon emissions. The specific objective of our study is to analyze the impact of FDI on China’s carbon emissions [2,3] (Gök; Aydemir and Feyyaz). We conduct an analysis based on the provincial panel data and compare the differences in carbon emissions caused by the differences in FDI between the eastern and western regions of China. We provide some policy recommendations on carbon emission reduction.

The remainder of the paper proceeds as follows: Section 2 presents the literature review, Section 3 describes the data and the variables, Section 4 introduces the theory and the hypothesis, Section 5 reports the model setting and results and Section 6 includes the conclusion and presents discussions and policy implications.

2. Literature Review

The environmental impact of FDI may be very different in different regions of a country. FDI can have a positive or negative impact on the environment [4] (To AH, Ha DT, Nguyen HM, Vo DH.). FDI flowing into low- and middle-income countries degrades the environment, while flows to high-income countries benefit the environment and support a halo effect [5] (Nadia and Merih). In explaining the relationship between FDI and carbon emissions, the premise that FDI will bring environmental pollution or improve the environmental problems of host countries is not enough. An increase in trade might not be conducive to the reduction in per capita carbon emissions in China as argued by Zhan et al. [6]. Liu et al. [7] through their research on two-way FDI concluded that IFDI can significantly promote regional carbon emissions through the scale effect, while OFDI can significantly inhibit regional carbon emissions through the scale effect. Wang et al. [8] used the systematic GMM method to verify the different effects of FDI on carbon emissions in different regions of China. Their findings show that the scale effect can reduce the carbon emission level in the East, while it will increase the carbon emission level in the middle and West. Further, their findings show that technology effect has a negative effect on the carbon emissions in the East and the middle. This implies that while it can reduce carbon emissions, this is not the case in the West. Their study further reflects that the structural effect has a negative effect on carbon emissions in the East but has a positive effect on carbon emissions in the middle and the West. In conclusion, they note that the environmental regulation effect on the carbon emissions in three regions decreased. This may suggest that some effects of FDI can reduce environmental pollution, while others might increase environmental pollution.

With FDI, the deleterious impacts on the environment significantly increased [9]. Drawing on the quarterly data from 1980 to 2010 in China, a study by Wang et al. [10] concluded that an increase in economic growth and trade openness will increase carbon dioxide emissions. Wang et al. [11] used the data from 1992 to 2016 in China to explore the associations between FDI and China’s total carbon emissions. The Granger causality test was used and the findings reflected that there was a positive correlation between the total amount of foreign investment and carbon emissions. Wang et al. however failed to consider the impact of unbalanced development between regions. FDI is seen as a

significant contributor to environmental pollution in China, as reflected in the above-mentioned studies which the authors justified using different data sets.

In contrast to the above however, some studies show opposite findings. For instance, the study of Grossman and Krueger [12] proposed that are three effects of economic activity on the environment, namely, the scale effect, the structure effect and the technology effect. The scale effect relates to the impact of change on the host country's economic scale that has been caused by an inflow of foreign capital on the environment. The scale effect will have a negative impact on the host country's carbon emissions when technological progress is stagnant. FDI will also mean hosting different industries in the country; this is referred to as the structural effect. The technology effect refers to the role of technology spillover in the process of foreign capital inflow. In general, foreign capital injected in the country will tend to improve the technology level to some extent, which may imply having more advanced technology with a reduced impact on the environment. Advanced technology can improve the energy utilization rate and reduce carbon emissions. Several Chinese scholars have a keen interest in this line of research. For instance, Liu et al. [13] conducted a dynamic study on the impact of trade openness and FDI on China's carbon dioxide emissions by estimating the Kuznets curve of China's carbon dioxide environment. They concluded that the impact of trade openness on carbon emissions still needs to be fully considered to obtain more conclusive findings, although their findings reflect the degree of trade openness and show that the impact of FDI is not as obvious as the impact of per capita GDP on carbon dioxide emissions. Drawing on panel data from 1986 to 2016, Peng et al. [14] investigated the relationship between China's FDI and carbon emissions in different regions. Their findings show that due to the imbalance of regional economic and social development in China, the impact of FDI on carbon emissions has a very significant regional difference. Their findings suggest that the increase in FDI in Eastern, Central and Western China will lead to a reduction in carbon emissions; however, the carbon emission reduction effect of FDI in Central and Western China is not significant. Their model only considers the impact of FDI and GDP on carbon emissions. It does not include the impact of other indicators such as trade openness. Drawing on previous studies as discussed above, we argue that as FDI brings new technology to the host country, there might be a significant reduction in China's environmental pollution.

Drawing on the above discussion, the relationship between FDI and carbon emissions is very complex. We may be biased with the thought that FDI will aggravate environmental pollution or reduce environmental pollution. More research is warranted for conclusive findings. To date, no study to the best knowledge of the authors has reached a unified conclusion on this issue both in the national and international context.

3. Characteristics of China's FDI and Carbon Emissions

China has been adhering to the policy of opening up and has attracted investors from all over the world to invest in China since its reform and opening up in 1978. China has attracted FDI actively in the last 40 years and promoted the process of marketization and this has played an important role in China's economic development. According to the statistics released by the National Bureau of Statistics over the years, China's scale of attracting FDI has continued to grow, with an overall upward trend but not an annual increase. Statistics reflect an increase of USD 45.2 billion in foreign investment in 1997 to USD 135 billion in foreign investment in 2018. In 1998–1999, 2008–2009 and 2011–2012 there was a slight decline (See Figure 1 below). However, in these stages, the proportion of the total amount of FDI actually utilized in China to the total amount of FDI inflows in the world was still in the forefront. This suggests that China has a huge advantage in attracting foreign investment.

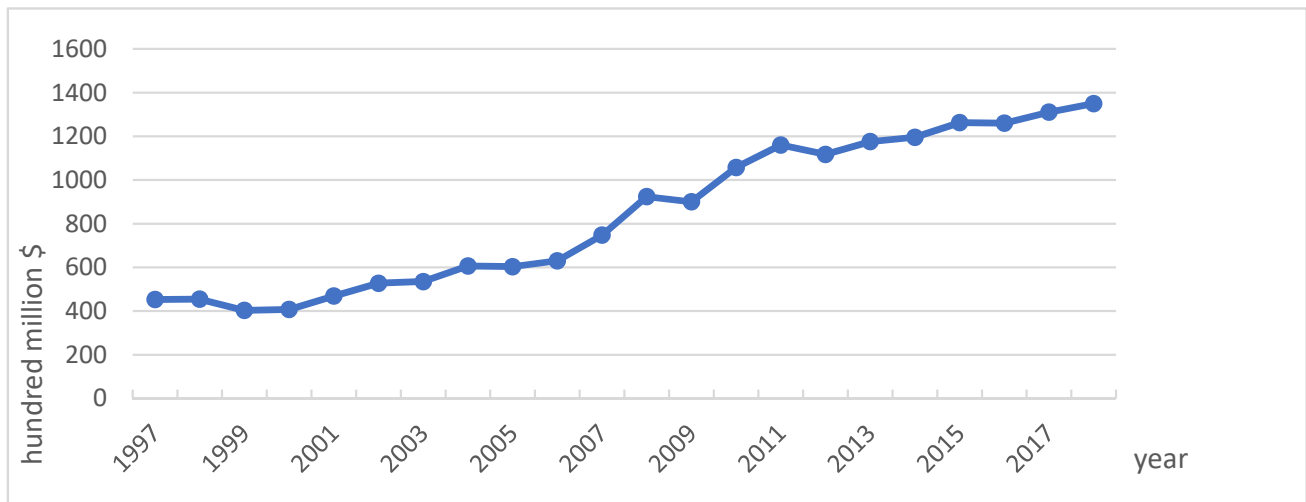


Figure 1. China's Actual Use of Foreign Direct Investment from 1997 to 2018.

We draw on the carbon dioxide emissions of all provinces, autonomous regions (except the Tibet Autonomous Region) and municipalities directly under the central government to calculate the carbon dioxide emissions of China. The change in trend is shown in Figure 2 below.

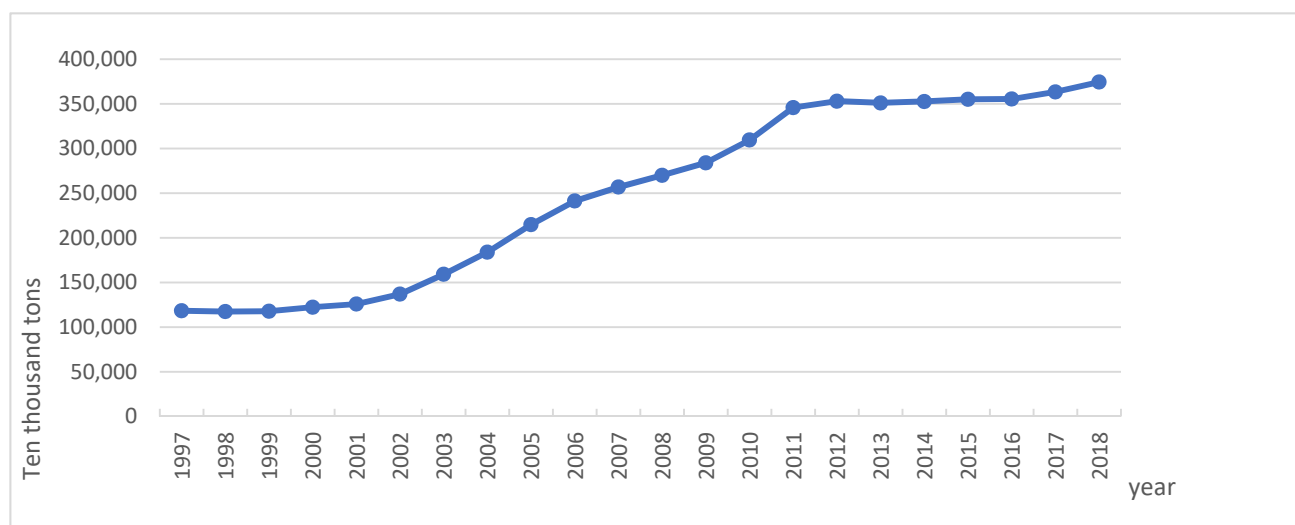


Figure 2. China's 1997–2018 Carbon Emissions.

Figure 2 shows the trend of China's total carbon dioxide emissions from 1997 to 2018. During the study period, the total amount of carbon dioxide emissions in China increased significantly, from 1182.9 million t in 1997 to 3744.16 million t in 2018. This is illustrated in Figure 3. This process can be divided into two stages, before and after China's accession to the World Trade Organization (WTO) in 2001. The growth of carbon emissions was slow prior to China's accession to the WTO. Following China's accession to the WTO in 2001, with the deepening of China's economic opening up, the growth rate of carbon emissions also accelerated. As an increase of about 173% was noted, from 1369.61 million t in 2002 to 3744.16 million t in 2018, it can be argued that to some extent China's carbon emissions since 1997, especially since 2002, tend to be consistent with the changes in the degree of opening up.

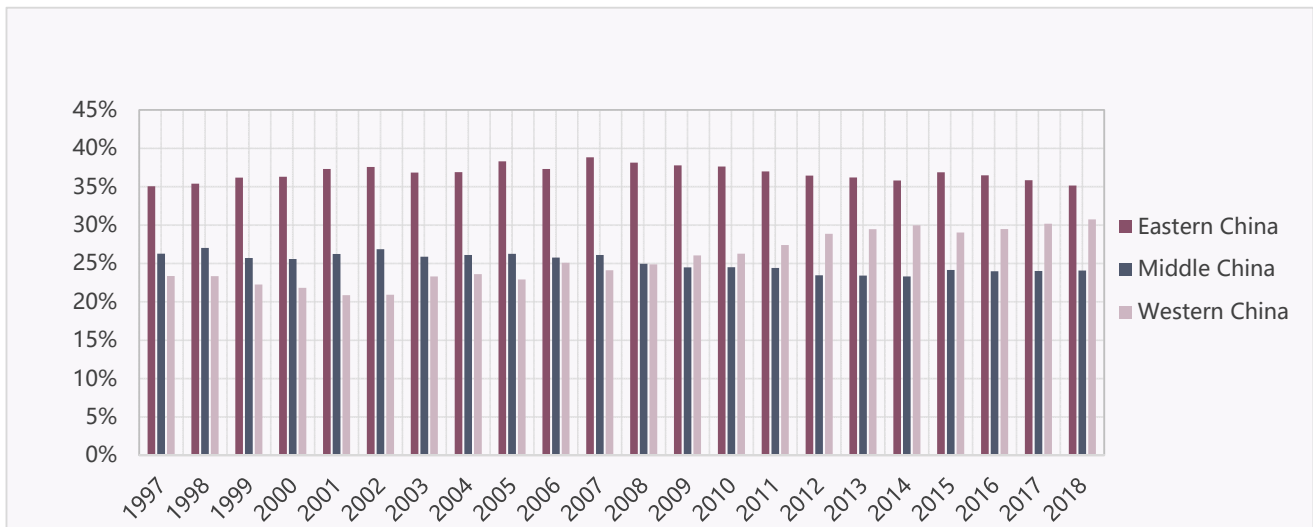


Figure 3. China’s Eastern, Central and Western Carbon Emissions Accounted for the Proportion of National Carbon Emissions from 1997 to 2018.

The proportion of carbon emissions from Eastern, Central and Western China in the national carbon emissions from 1997 to 2018 is shown in Figure 3. The latter illustrates that the proportion from Eastern China is basically stable and Western China has had an obvious upward trend since 2007, while Central China has had a downward trend. In addition, it can be found that compared with the scale of FDI, the difference in carbon emissions between the East, the middle and the west is not so large. The East is higher than the middle and the west but the gap is not very large.

4. Theory and Hypothesis

There are two classical theories about FDI and environmental pollution in host countries at home and abroad. The first is referred to as the “pollution heaven” hypothesis. Copeland and Taylor [15] put forward the “pollution paradise” hypothesis which was also known as the “pollution shelter” hypothesis, for the first time in combination with the North–South trade model. This draws on the premise that enterprises will choose to invest and produce in countries with weak environmental regulations when planning their layout. This hypothesis mainly refers to the “pollution heaven” hypothesis that postulates that when enterprises in large, industrialized countries set up factories overseas, they often choose the countries with the cheapest resources and labor. Unfortunately, this comes with a heavy cost on the environment, depleting our planet’s resources. These deleterious environmental impacts are often irreversible. It has been observed that this most often happens in developing countries. Monica and Neha’s [16] study showed that FDI has a significant positive impact on environmental degradation, especially in developing countries. Samuel Asumadu Sarkodie and Vladimir Strezov [17] studied the impact of foreign direct investment inflows on energy consumption and greenhouse gas emissions in developing countries between 1982 and 2016 and found that energy consumption has a strong positive effect on greenhouse gas emissions. This also proves the validity of the polluted paradise hypothesis. Cole et al. [18] reviewed the theoretical and empirical literature on the relationship between FDI and environmental regulations and then focused on the impact of environmental regulations on the choice of FDI location and the impact of FDI on the increase in pollution in the host country. Developing countries with cheap resources and labor often lack strict environmental regulations. Investors seek developing countries, mostly in search of natural resources and take advantage of weak governance and ineffective regulatory regimes (Cole et al.). Lax environmental regulations are more attractive to foreign direct investment in order to become the country of choice for foreign direct investment, so developing countries choose to relax the policy requirements of

environmental regulations (Santos and Forte [19]). On the contrary, companies need to pay a lot of costs to meet their own strict environmental regulations. As a result, companies that choose to invest in foreign countries tend to have the lowest environmental standards or the weakest enforcement. The other hypothesis is known as the “pollution halo” hypothesis. Birdsall and Wheeler [20] and Copeland and Taylor [15] have successively proposed the hypothesis of the “pollution halo”, which is contrary to the hypothesis of the “pollution paradise”. They believe that the investment of multinational enterprises in the host country can bring more environmental protection production standards and technologies. This can have a positive impact on the environmental protection of the host country through technology diffusion.

The current study analyzes the impact of FDI on carbon emissions. This paper analyzes the impact of foreign direct investment on carbon emissions from the east, middle and west regions by collecting and measuring data from each province, autonomous region and municipality directly under the central government in China.

We propose the following hypothesis: Although the scale of FDI has a positive effect on carbon emissions on the national level, it can reduce the intensity of carbon emissions in China to a certain extent. As for each region in the East, the middle and the West, the effect of FDI on carbon emissions may not be the same. This study will test the “pollution heaven” hypothesis and “pollution halo” hypothesis through the relationship between China’s FDI and carbon emissions.

In the third section of this paper, we argue that the changing trend of China’s FDI scale and carbon emissions is roughly the same. This suggests that in the years when the scale of FDI is large, the carbon emissions are relatively large. However, the amount of FDI actually used in China is opposite to the changes in carbon emissions per unit. From our analysis of Eastern, Central and Western China, we conclude that the scale of FDI in Eastern China is much larger than that in Central and Western China. However, we note that its carbon emissions are not significantly higher than those in Central and Western China. In addition, the use of FDI in the central region is also significantly higher than that in the western region, but the growth rate of carbon emissions in the central region is lower than that in the western region. Since 2009, carbon emissions in the western region have been higher than those in the central region. However, the use of FDI in the central region has always been greater than that in the western region.

Based on the above analysis, we propose the following hypothesis: although on the national level, the scale of FDI has a positive effect on carbon emissions, it can reduce the intensity of carbon emissions in China to a certain extent. Specific to each region, the effect of FDI on carbon emissions may not be the same. This implies that the pure “pollution paradise” hypothesis or the “pollution halo” hypothesis are not enough to fully explain the impact of FDI on China’s carbon emissions.

To test the hypothesis, we use the linear regression model and Stata 15 to analyze the relationship between FDI and carbon emissions in Eastern, Central and Western China, respectively.

5. Model Setting and Result Analysis

5.1. Model Setting

Due to the availability and accessibility of the data set, this paper takes the data of 30 cities from 1997 to 2018 into consideration. Data are derived from the China Statistical Yearbook, the China Urban Statistical Yearbook and the China Energy Statistical Yearbook. Model 1 is a regression at the national level including all cities, Model 2 is a regression that includes 9 cities in Eastern China, Model 3 is a regression that includes 6 cities in Central China and Model 4 is a regression that includes 10 cities in Western China.

Table 1 provides some brief descriptive statistics for the variables at the national level. Table 2 provides some brief descriptive statistics for the variables of Eastern China. Table 3 provides some brief descriptive statistics for the variables of Central China. Table 4 provides some brief descriptive statistics for the variables of Western China.

Table 1. The Descriptive Statistics of the Variables in All Countries.

Variable	Obs.	Mean	Std.Dev.	Min	Max
CO ₂	660	8172.653	7090.362	0	38,097.44
FDI	660	48.94976	64.40514	0.03942	357.6

Table 2. The Descriptive Statistics of the Variables in Eastern China.

Variable	Obs.	Mean	Std.Dev.	Min	Max
CO ₂	220	9065.861	8560.383	0	38,097.44
FDI	220	92.33874	76.37357	4.31	357.6
GDP	220	20,069.51	20,720.12	411.16	97,277.77
EX	220	1.06×10^8	1.51×10^8	551,180	7.45×10^8
POP	220	4884.455	3342.961	743	12,348

Table 3. The Descriptive Statistics of the Variables in Central China.

Variable	Obs.	Mean	Std.Dev.	Min	Max
CO ₂	132	10,251.81	7182.159	1902.437	35,897.59
FDI	132	45.83333	49.41691	0.9	179.02
GDP	132	12,826.08	10,943.52	1480.13	48,055.86
EX	132	1.16×10^7	1.18×10^7	892,350	5.79×10^7
POP	132	5949.955	1939.939	3141	9864

Table 4. The Descriptive Statistics of the Variables in Western China.

Variable	Obs.	Mean	Std.Dev.	Min	Max
CO ₂	242	6019.926	5510.189	0	32,571.71
FDI	242	11.81472	20.09317	0.03942	102.88
GDP	242	6635.953	7161.774	202.79	40,678.13
EX	242	5,998,121	9,229,152	117,290	5.19×10^7
POP	242	3277.471	2045.937	496	8550

China's overall carbon emissions in the model are represented by TC at the national level and the actual amount of FDI is represented by FDI. We establish the following measurement model:

$$TC = \beta FDI + \mu \quad (1)$$

Drawing from the China Energy Statistics Yearbook [21], we note that China's overall carbon emissions are calculated according to the consumption of coal, crude oil and natural gas. The actual amount of FDI in China comes from the website of the National Bureau of Statistics [22]. Stata 15 software is used for the regression analysis of data in the current study. The regression results are shown in Table 5.

The model estimates are: $TC = 388.1899 + 4.61634FDI$ (please see Table 1).

In this model, the decision coefficient $R^2 = 0.0072$. The results indicate that the model has a good fitting effect on the sample. The explanatory variables can explain the 95% deviation of the explained variable.

Parameter $\beta = 4.61634$, indicating that for every USD 10,000 increase in FDI, China's overall carbon emissions will increase by 4,616,340 t. This is consistent with our previous conclusion that the increase in FDI will lead to an increase in carbon emissions.

We used multiple regression models to more accurately study the impact of FDI on carbon emissions in Eastern, Central and Western China. Drawing on the models used by Song et al. [23], Peng et al. [14], the following models were established:

$$\ln CO_{2it} = \mu + \beta_1 \ln FDI_{it} + \beta_2 \ln GDP_{it} + \beta_3 \ln EX_{it} + \beta_4 \ln POP_{it} \quad (2)$$

where i represents each region and T represents each year.

Table 5. National Level Regression Analysis Results.

Variable	National Level
	Model 1
FDI	55.99722 *** (3.375515)
_cons	5545.575 *** (1024.629)
N	660
R ²	0.1792
T	16.59
F	275.20 ***
p	0.000

*** denotes significance at the 1%.

CO₂ represents the regional carbon emissions, unit: 10,000 t. According to the consumption of coal, crude oil and natural gas in the China Energy Statistical Yearbook, the specific calculation method is introduced in the first section of the third chapter [24].

The core explanatory variable is FDI, which indicates the scale of FDI used by the region. The data were obtained through the statistical yearbook of each province over the years, unit: USD 10,000.

Other explanatory variables: ① GDP refers to Gross Domestic Product, which is used to measure the development of regional economy. The data come from the National Bureau of Statistics, unit: 10,000 yuan; ② EX represents the total export volume, which is used to indicate the degree of regional opening to the outside world. The data are collected from the statistical yearbook of each province, unit: USD 10,000; ③ POP refers to the population scale, measured by the total population at the end of the year. The data come from the National Bureau of Statistics and provincial statistical yearbook, unit: 10,000 people.

5.2. Results

The regression analysis results of three regions are shown in Table 6 below.

Table 6. Regression Analysis Results in Eastern, Central and Western China.

Variable	Eastern China	Central China	Western China
	Model 2	Model 3	Model 4
lnFDI	−0.2261237 *** (0.727792)	−0.6299075 *** (0.065534)	0.0578584 *** (0.0212881)
lnGDP	0.2472562 *** (0.0875031)	0.8514942 *** (0.161761)	0.5994643 *** (0.0367483)
lnEX	0.4036403 *** (0.0719587)	0.3777088 *** (0.1058582)	−0.1179097 *** (0.0361622)
lnPOP	−0.1131644 (0.1875521)	−0.3500363 ** (0.1531674)	0.8175113 *** (0.1993769)
_cons	1.132521 (1.521621)	0.3366603 (1.678603)	−1.291065 (1.549539)
N	219	132	240
R ²	0.5667	0.6404	0.4977
F	406.14 ***	226.15 ***	1450.05 ***

*** and ** denote significance at the 1% and 5% levels, respectively.

Table 6 above reflects the fact that although the determinability coefficients of the three regions are very high, they also pass the F test. This shows that the combination of “FDI”, “Gross Regional Product”, “total export”, “population” and other variables do have a significant impact on “regional carbon emissions”.

It can be seen from Table 6 above that in the three models, the determination coefficients in Model 1, Model 2 and Model 3 are $R^2 = 0.5667$, $R^2 = 0.6404$ and $R^2 = 0.4977$,

respectively. It shows that the fitting effect of the three models is good and the explanatory variable can explain about 95% of the deviation in the explained variables.

Given the significance level $\alpha = 0.05$, the critical value $f_{0.05} = 3.26$ was found in the F distribution table $F_1 = 406.14$, $F_2 = 226.15$, $F_3 = 1450.05$, all of which are higher than the critical value $f_{0.05} = 3.26$. This indicates that the regression equation is significant, implying that “FDI”, “regional GDP”, “total exports”, “population” and other variables combined do have a significant impact on “regional carbon emissions”.

Therefore, we can draw the conclusion that the model estimation results of the eastern region are:

$$CO_{21} = 1.132521 - 0.2261237FDI_1 - 0.2472562GDP_1 + 0.4036403EX_1 - 0.1131644POP_1 \quad (3)$$

The estimated results of the model in the central region are as follows:

$$CO_{22} = 0.3366603 - 0.6299075FDI_2 + 0.8514942GDP_2 + 0.3777088EX_2 - 0.3500363POP_2 \quad (4)$$

The model estimates for the western region are:

$$CO_{23} = -1.291065 + 0.0578584FDI_3 + 0.5994643GDP_3 - 0.1179097EX_3 + 0.8175113POP_3 \quad (5)$$

The parameter $\beta_1 = -0.2261237$ in the eastern region indicates that the carbon emissions in the eastern region will be reduced by 226,123.7 t for every USD 10,000 increase in FDI under the same other conditions.

The parameter $\beta_2 = -0.6299075$ in the central region indicates that the carbon emission in the central region will be reduced by 629,907.5 t for every USD 10,000 increase in FDI under the same other conditions.

The parameter $\beta_3 = 0.0578584$ in the western region indicates that the carbon emissions will increase by 57,858.4 t for every USD 10,000 of FDI increase in the western region under the same other conditions.

6. Conclusions, Discussion and Policy Implications

6.1. Conclusions

We can see from the country level that FDI and carbon emissions always move in the same direction. The growth trend in the FDI scale is roughly the same as that of China’s carbon emissions. This implies that the introduction of FDI will continue to have a negative impact on China’s environment. There is a need for China to pay attention to the type of industries to which foreign investment is directed and to technological improvement when introducing foreign capital in the country. Drawing on the above arguments, we can conclude that the pure “pollution paradise” hypothesis and “pollution halo” hypothesis are not enough to fully explain the impact of FDI on China’s environment. The inflow of FDI does have a negative impact on China’s environment. However, due to advanced technology and its preference for the use of clean energy, it has played a positive role in the reduction in carbon emissions per unit in China.

Our findings suggest that for the eastern and central regions at the regional level, it can be considered that FDI has played a reverse role in carbon emissions. This implies that the increase in FDI brings a reduction in carbon emissions. This result also verifies the research of Deng et al. [25]. FDI has a double threshold effect on China’s regional carbon emission intensity. When the environmental regulation degree is low or high, FDI inflow will be detrimental to regional carbon emission reduction. When the intensity of environmental regulation is appropriate, FDI will have a favorable impact on regional carbon emission reduction. Under the current environmental regulation intensity, the inflow of FDI reduces the carbon emission intensity in most regions of China. This could be related to the early economic development of the eastern and central regions and the flow of foreign capital to high-tech industries. Guo et al. [26] concluded that the carbon emission intensity value in the northwest region was higher, while the carbon emission intensity value in the southeast region was lower. Scientific and technological innovation and per capita GDP have a significant inhibiting effect on local carbon emission intensity, which can prove the conclusion. Further, this could also be related to the outward transfer of some industries

to the eastern and central regions. We also conclude that for the western region, the entry of FDI has played a positive role in carbon emissions. This suggests that an increase in FDI has brought an increase in carbon emissions. A possible explanation is that this could be due to the poor geographical environment and lagging economic development of the western region as compared with the eastern and central regions. Zhao et al. [27] studied the effect of financial development in carbon emissions points region and showed that in the east and the west, financial development promotes the carbon emissions, but both also are different. The progress of the eastern region's environment technology has had a diluting effect and the progress in the western region's technology selection has had a mediating effect on carbon emissions. Extensive modes of economic development are bad for low-carbon development.

6.2. Discussion

The popular view that foreign direct investment affects the environmental quality of the host country mainly includes the "pollution paradise" hypothesis and the "pollution halo" effect. However, the potential mechanism of FDI's impact on a country's carbon emissions has not yet been systematically explored and relatively unified. This article focused on the impact of foreign direct investment on China's carbon emissions, analyzed this based on inter-provincial panel data and compared the differences in carbon emissions brought about by the differences in foreign direct investment between the eastern, central and western regions. In fact, our data show that in the eastern and central regions, the impact of foreign direct investment on China's environment can be explained by the "pollution paradise" hypothesis, while for the western region, it can be explained by the "pollution halo" effect. This is different from other attempts to study the impact of FDI on China's provincial carbon emissions. Wang et al. [28] used data from provinces in mainland China from 2004 to 2016 and concluded that FDI was one of the reasons that forced China to increase emissions at this stage. However, there is an "inverted U"-shaped non-linear relationship between FDI and emissions, that is, as the proportion of FDI in GDP increases, the promotion of FDI on emissions first increases and then decreases. Song et al. [29], based on panel data from 30 provinces in China from 2007 to 2018, used a two-layer stochastic frontier model to analyze the opposite side effects of FDI on carbon emission performance and concluded that FDI has an existing effect on carbon emission performance. The promotion effect also has an inhibitory effect and the overall effect is that the inhibitory effect is smaller than the promotion effect, forming a positive driving characteristic of the compound effect. Based on the STIRPAT model, Zhou et al. [30] concluded that China's urban carbon emissions did not follow the upside-down model. The U-shaped hypothesis of the traditional EKC curve theory presents an inverted N shape. Zhang et al. [31] conducted empirical research and an analysis of the long-term relationship between CO₂ emissions and income, energy consumption, trade opening and urbanization. The study revealed two main findings: First, it is not the traditional U-shaped EKC assumption, but the N-type relationship between carbon dioxide emissions and real gross domestic product (GDP) per capita. Second, if energy consumption increases by 1%, in the long run, carbon dioxide emissions will increase by 0.9%.

6.3. Policy Implications

As discussed, FDI brings along a range of negative environmental consequences leading to serious concerns about China's future. These concerns cannot be ignored. It is recommended that the state can choose and have the appropriate guidance when introducing FDI. This will help to assess industries and enterprises entering China. This approach will help in mitigating environmental pollution in China. As discussed, technology can help greatly in this process. We need to have policies in place to encourage FDI through technology-intensive industries to make use of their advanced technology and production methods. Further, there is a need to have more scientific and reasonable laws and

regulations on environmental protection. These laws need to be enforced as a guide for enterprises to use cleaner energy.

Another important policy implication is for the eastern and central regions to pay more attention to the “quality” rather than “quantity” of foreign investment in the future. This is especially required mostly for eastern regions due to their rapid economic development. Foreign-funded enterprises with high pollution levels need to be refused access to China. In contrast, there is a need for high-quality foreign investment with which technological reforms and progress can be brought. This can amplify FDI benefits in China and protect its environment from further degradation. The economic development in the western region is lagging behind due to its poor physical and geographical conditions. There is a need to focus on how to further develop the infrastructure to accommodate industries and enterprises and hence promote economic development. This will require the western region to formulate relevant policies drawing on the needs of their local context and to ensure the fostering of economic development through FDI while keeping environmental pollution to its minimum.

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