International Journal of Global Economics and Management
ISSN: 3005-9690 (Print), ISSN: 3005-8090 (Online) | Volume 2, Number 1, Year 2024
DOI: https://doi.org/10.62051/ijgem.v2n1.16
Journal homepage: https://wepub.org/index.php/IJGEM/index

Will Environmental Regulations lead to China's outward Foreign Direct Investment?: A Quasi Natural Experiment Based on China's Carbon Emission Trading Pilot Policy

Yanzhihui Cao[1, a], Siyu Yin[1], Jiabao Luo[2], Deyu Li[3, *]

[1] School of Accountancy, Anhui University of Finance and Economics, Bengbu 233030, China

[2] School of International Trade and Economics, Anhui University of Finance and Economics, Bengbu 233030, China

[3] School of Economics, Anhui University of Finance and Economics, Bengbu 233030, China

*Corresponding Author: Deyu Li (Email: ldy0048@163.com), [a] 2051185314@qq.com

ABSTRACT

Foreign direct investment (OFDI) is an important part of China's "going global" strategy. With the continuous expansion and rapid development of OFDI in China, domestic environmental problems are becoming increasingly severe. Therefore, China has established a pilot policy of Carbon Emission Trading System (ETS) to address environmental issues. This article takes the implementation of ETS pilot policies as a quasi natural experiment, uses the double difference method (DID model) to empirically test whether ETS pilot policies will lead to OFDI, and uses the composite control method for robustness testing to supplement and expand the conclusions of the DID model. In addition, incorporate the "Pollution Shelter Hypothesis" and "Porter Hypothesis" into the same framework to explore the impact mechanism of ETS pilot policies on OFDI. Based on the conclusions drawn, it is recommended to further improve the design of carbon trading systems in pilot areas and establish a national carbon emission trading system to enhance the quality of China's outward foreign direct investment.

KEYWORDS

Carbon emission trading system; Foreign direct investment; Double difference estimation (DID); Triple Difference Estimation (DDD).

1. INTRODUCTION

With the increasingly serious environmental problems caused by global greenhouse gas emissions, the international community is gradually realizing the urgency of taking action to address climate change. The concept of using market mechanisms to reduce greenhouse gas emissions based on the framework of the Kyoto Protocol is gradually being promoted globally. As the world's largest developing country, China bears the responsibility and obligation to address climate change. To achieve the action goal of peaking carbon emissions before 2030 and achieving carbon neutrality before 2060, China has formulated a series of carbon reduction policies, among which the establishment of a carbon emission trading system (ETS) pilot is one of the important measures. In 2011, China issued a notice on carrying out carbon emission pilot policies and approved seven provinces and cities, including Beijing, Shanghai, Guangdong, Shenzhen, Chongqing, Tianjin, and Hubei, as pilot areas to start preparing for carbon emission trading markets. Subsequently, these regions successively launched carbon emission trading markets, including Guangdong, Shenzhen, Beijing, Shanghai, Hubei, and Chongqing. In addition, China's foreign direct investment (OFDI) also maintained a rapid growth, especially since the implementation of the "the Belt and Road" initiative in 2013, China's non-financial OFDI flows to countries and regions along the Belt and Road grew rapidly. However, it is worth noting that the environmental regulations in most developing countries and regions are not strict. Under the condition that the constraints of carbon emission reduction in the home country are constantly strengthened and the design of emission reduction policies needs to be improved, whether the industrial enterprises in the ETS pilot provinces and cities will transfer production through OFDI, which may lead to the risk of "carbon leakage", which is not conducive to achieving the sustainable development goal of building a green "the Belt and Road". Therefore, it is necessary to closely monitor this issue and take corresponding measures to solve it.

The construction of a carbon emission trading market is of great significance for promoting China's transition to a low-carbon economy and promoting global climate change governance. However, compared with developed countries in Europe and America, China started relatively late in the construction of the carbon emission market, and its understanding of the laws of CO2 emissions is not sufficient. In addition, there are relatively few entities covered in the carbon emission market, and most of them are state-owned enterprises. At the same time, there are also problems such as lagging legislation and weak market mechanisms. Although carbon trading has been carried out nationwide, it is still necessary to conduct in-depth research on the impact mechanism and action mechanism of carbon trading policies on CO2 emissions and production efficiency. With the rapid advancement of new industrialization and the increasingly prominent contradiction between environmental protection and economic development, clarifying the impact of carbon emission trading policies on CO2 emissions and production efficiency will help better achieve the "dual carbon" goals. Therefore, this article starts from the perspective of carbon emission trading pilot, studies the impact of environmental regulations on OFDI, evaluates the implementation effect of current ETS pilot policies, and provides new ideas for the comprehensive development of the carbon emission trading market. By supplementing and expanding relevant research on ETS pilot policies, improving the design of ETS pilot policies, promoting the construction of a national carbon market, improving the quality of OFDI, promoting the development of ETS pilot policies, achieving greenhouse gas emissions reduction, and ultimately promoting sustainable development of the Chinese economy.

2. THEORETICAL ANALYSIS AND RESEARCH HYPOTHESES

2.1. Definition of relevant concepts

2.1.1. Foreign Direct Investment (OFDI)

Foreign direct investment is an economic activity carried out by investors to obtain lasting benefits or management rights of overseas enterprises. Foreign direct investment can be divided into two forms: mergers and acquisitions and green space investment. Merger and acquisition is the process of acquiring existing foreign enterprises in order to carry out production and business activities. Green space investment refers to investors engaging in production and business activities by establishing subsidiaries or new factories in the host country. Through outward direct investment, various resources of the host country can be fully utilized, and advanced technological and management experiences of the host country can be learned and mastered. Through learning effects and internal technology transfer between enterprises, the development of the home country's enterprises can be promoted.

2.1.2. Market incentive based environmental regulation

Market incentive environmental regulation refers to policy measures for environmental protection and management through market mechanisms and economic means. Under this regulation, the government has taken a series of incentive measures, such as introducing environmental subsidies and tax incentives, encouraging enterprises to take environmental protection measures, develop environmental protection technologies, and reduce pollution emissions. The government can also establish a carbon emission quota trading market to guide enterprises to actively reduce emissions and improve resource utilization efficiency through carbon emission trading. In addition, market driven environmental regulations can also introduce market competition mechanisms to drive companies to improve their environmental performance through competition. The government can prioritize selecting environmentally friendly enterprises as partners through bidding and procurement, environmental certification, and other methods, encouraging other enterprises to consciously strengthen environmental protection work.

The advantage of market incentive based environmental regulation is that it can fully leverage the role of market mechanisms, making environmental protection a necessity and driving force for the development of enterprises themselves. At the same time, this regulation can also reduce the cost of government regulation, stimulate the innovation vitality of enterprises, and promote the development of green economy. It should be noted that market driven environmental regulations do not necessarily mean a relaxation of environmental regulation. The government still needs to establish necessary laws, regulations, and standards to ensure that enterprises comply with environmental protection requirements and punish violations in accordance with the law. At the same time, the government also needs to monitor and evaluate to ensure the effectiveness and fairness of market incentive mechanisms.

2.1.3. Carbon Emission Trading System (ETS)

The Carbon Emission Trading System (ETS), also known as the Carbon Market, is an effective policy that encourages the reduction of greenhouse gas emissions. Generally speaking, the government or other designated authoritative institutions determine the greenhouse gas emission quotas for carbon market participants within a specified time period and allocate them to various companies. Carbon market participants who exceed their emission quotas can purchase emission rights from those with excess quotas. Correspondingly, companies with emissions below their quotas can sell their quotas in the carbon market. This cap and trade mechanism provides an effective fiscal incentive to encourage companies to reduce their carbon emissions below the limit as much as possible.

The quota and trading mechanism, as a model for reducing pollution, originated in the United States in the 1980s and 1990s. At that time, the model was successfully applied to eliminate lead, sulfur dioxide (SO2), and hydrogen monoxide (N2O) in gasoline to address acid rain issues. Nowadays, this quota and trading mechanism is widely applied in greenhouse gas emissions reduction in many key industries. Although carbon emission trading mechanisms are commonly referred to as carbon markets, carbon dioxide is far from the only greenhouse gas included in the calculation. There are many types of greenhouse gases emitted into the atmosphere, most of which have much higher global warming potential (GWP) than carbon dioxide. For example, methane (CH4) is another greenhouse gas with more common emissions, and its global warming potential is 28 times that of carbon dioxide. In other words, the consequence of emitting one unit of methane is equivalent to emitting 28 units of carbon dioxide. Therefore, carbon markets typically trade in carbon dioxide equivalents (CO2e), converting the greenhouse effects of other gases into carbon dioxide to include multiple greenhouse gases in their calculations.

In discussions about climate policy, people often equate carbon taxes with carbon markets. Both methods price carbon emissions with the aim of reducing greenhouse gas emissions and stimulating investment and development in low-carbon technologies. If the carbon market allocates carbon emission rights to enterprises through auctions, this carbon market, like carbon taxes, can generate additional income for the government and be invested in more green development projects.

Although carbon tax and carbon market sound very similar, there are key differences between the two. Carbon tax is a government led strategy where authoritative authorities set a fixed price for greenhouse gas emissions and charge companies based on each unit of emissions. Under this approach, the market will adjust carbon emissions based on this additional cost. Therefore, the final emissions under the carbon tax policy are determined by the market and difficult to predict. On the other hand, the carbon market allows government departments to determine the expected final annual emissions and allocate emission quotas accordingly based on this expectation, allowing the market to determine the price of greenhouse gas emission rights. Therefore, in the carbon market, the price of greenhouse gas emissions is fluctuating, but the total amount of emissions is relatively more controllable. These two policies can be combined to more effectively incentivize different industries. Overall, carbon taxes are more suitable for managing emissions from smaller industries, while carbon markets are more suitable for managing larger and more polluting industries.

2.2. Theoretical Basis

2.2.1. Hypothesis of "Pollution Shelter"

In the early 1980s, American economists Walter and Ugelow (1979) proposed the "Pollution Shelter" hypothesis while studying the correlation between trade and the environment, which was subsequently widely validated and recognized by scholars. The main idea of this hypothesis is that fossil fuels and other fuels such as solid biomass serve as effective driving forces for economic development, stimulating rapid global economic growth while also deteriorating the ecological environment on which people rely for survival by emitting large amounts of pollutants. Therefore, consider the sustainable evolution of the economy and society, governments around the world aim to strengthen environmental supervision to achieve coordinated development of the economy and environment, which inevitably increases the costs for enterprises producing pollution intensive products. With the continuous deepening of international trade, pollution intensive enterprises will gradually shift the production and operation of this product to countries and regions with relatively loose environmental supervision in order to reduce costs and maximize their profits. And these countries or regions are usually developing countries with relatively backward economies, urgently in need of foreign investment and technology to drive economic growth, which will gradually reduce corresponding environmental regulatory standards. The transfer of polluting industries will lead these countries to become pollution havens for developed countries. That is to say, the differences in economic development levels, resource endowments, and environmental pollution conditions among countries around the world lead to heterogeneity in their environmental regulatory policies, thereby promoting the free flow of capital between economies to seek the optimal allocation point. Developing economies with relatively backward development and relatively low environmental standards need to bear corresponding environmental costs, which in turn leads to continuous degradation of their environmental quality and forms a vicious cycle.

2.2.2. Porter hypothesis

In 1990, American scholar Michael Porter conducted a study in his book "National Competitive Advantage" on four countries: the United States, Germany, Japan, and Switzerland. He found that these four countries not only had competitive advantages in their products, but also ranked among the top in terms of environmental quality globally. Porter's research on these four countries became the basis for his proposal of the Porter hypothesis in 1995. The Porter Hypothesis first elucidated that environmental regulation can promote technological innovation, challenging the view in neoclassical economics that environmental regulation policies will increase production costs for businesses.

The Porter hypothesis has two main ways of affecting carbon emissions in the home country. The first approach is to invest in developing countries. With the development of the host country's economy and the increasing awareness of environmental protection, the host country's parliament is gradually raising environmental standards. Multinational corporations continuously develop clean products and innovate green technologies in order to maintain profits. The utilization of green technologies is beneficial for reducing carbon dioxide emissions. The second approach is to invest in developed countries, which have high environmental standards. Investing in these countries can learn advanced technologies and transfer them to their home countries through technology spillovers, achieving low-carbon and green development for home country enterprises. The Porter hypothesis proves that outward foreign direct investment is beneficial for improving the green technology level of the home country and reducing carbon dioxide emissions.

2.3. Propose research hypotheses

2.3.1. The implementation of ETS pilot policies will lead to outward direct investment from industrial enterprises in pilot provinces, cities, and regions

Generally speaking, the industrial industry can be divided into two categories: clean and polluting. The differences in production technology, cost structure, and pollution intensity in the industry to which a company belongs will affect its sensitivity to environmental regulations. The impact of environmental policies on the total factor productivity of the industry's environment varies depending on the level of industry pollution. Simone et al. found that, especially in trade intensive sectors, the EU ETS has a significant impact on the production of Italian foreign subsidiaries. In the implementation plan of China's ETS pilot policy, eight high carbon emission industries, including steel, electricity, petrochemical, chemical, construction, papermaking, non-ferrous metals, and aviation, are mainly constrained by carbon emissions. On the one hand, due to the dual lock-in effect of technology and equipment, enterprises in high carbon emission industries are unable to meet the emission reduction requirements of ETS in a short period of time and face higher compliance costs. When the carbon compliance costs caused by ETS exceed the profits obtained from continuing production in the home country, in order to avoid being eliminated by the market under strict regulatory requirements, these carbon intensive industries are more inclined to transfer polluting industries to cross-border production. On the other hand, facing significantly increased production costs and emission reduction costs, high carbon emitting industries need to improve their competitiveness through directional technological changes. Environmental policies also have a stronger incentive for their green technology innovation. Compared with clean industries, they can better promote the improvement of their production capacity and competitiveness, and the induced effect of outward direct investment is also more significant. Based on this, this article proposes a second hypothesis to be tested: under the constraints of ETS pilot policies, enterprises in high carbon emission industries in pilot provinces and cities are more likely to conduct OFDI.

2.3.2. Under the constraints of ETS pilot policies, enterprises in high carbon emission industries in pilot provinces and cities are more likely to engage in OFDI

The imbalance of regional economic development is one of the characteristics of China's economy. The ETS pilot program in China covers seven provinces (municipalities directly under the central government) in the three major regions of the East, Central, and West. There are significant differences in the speed and degree of ownership and marketization reforms among different regions. In areas with high levels of marketization, markets operate well with minimal government intervention, and businesses in these areas face less uncertainty and lower transaction costs. Although ETS is an environmental policy based on the market, and the government does not directly intervene in corporate behavior, but guides companies to make decisions to achieve emission reduction goals through market signals, the signal transmission effect may vary depending on the degree of marketization in the region. The outward foreign direct investment decisions of inland enterprises with lower levels of marketization are still significantly influenced by the characteristics of command economy, such as regulatory power and close ties with the government. In areas with lower levels of marketization, facing increasingly tight emission reduction constraints, on the one hand, the government has a greater impact on corporate strategic decision-making, and companies are more inclined to respond to the "going out" policy through OFDI in order to obtain policy dividends. On the other hand, some companies may encounter financing constraints and other problems in the process of emission reduction investment financing due to incomplete systems, which may lead to the phenomenon of "institutional escape", By transferring production through OFDI, we aim to gain more funding sources and market opportunities in the international market. Therefore, this article proposes a third hypothesis to be tested: provinces with lower levels of marketization are more sensitive to the investment transfer effects of pilot policies.

3. ANALYSIS OF THE CURRENT SITUATION OF CHINA'S OUTWARD FOREIGN DIRECT INVESTMENT

3.1. Current Situation of China's Total Outbound Direct Investment

Since the reform and opening up in 1978, China has been integrating into the global economic system, actively absorbing foreign investment, and developing the economy. As a result, foreign direct investment has grown rapidly during this stage, greatly promoting the development of the domestic economy. Although China's economic scale and development level were relatively low at that time, there were still limitations on the volume of activated outward foreign direct investment, and the growth rate was also relatively slow. The data on China's outward foreign direct investment from the Ministry of Commerce and the National Bureau of Statistics shows that from 2002 to 2021, China's outward foreign direct investment continued to increase. Specifically, although growth has slowed down in the early stages, since the 2008 Olympics, China has made significant strides and rapidly promoted outward foreign direct investment. The growth rate of outbound investment stock accelerated from 2016 to 2017, slightly slowed down from 2017 to 2018, but significantly increased from 2019 to 2021.

Since 2002 to 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 outbound investment stock from 2002 to 2021 reveals that China's outbound investment stock was 29.9 billion US dollars in 2002, 317.21 billion US dollars in 2010, and 1809.04 billion US dollars in 2017. By 2021, China had achieved a total outbound investment stock of 2785.15 billion US dollars. And from 2018 to 2021, China's outbound investment stock has consistently ranked third globally, with a more than 93 fold increase in 2021 compared to 2002. Especially in 2008, the month on month growth rate reached 110.9%, indicating that the Beijing Olympic Games have brought more opportunities for China's foreign investment, and more investors have gone abroad and entered the world stage.

3.2. Current situation of China's outward foreign direct investment in different regions

In 2021, central enterprises and units invested 64.29 billion US dollars in non-financial direct investment, accounting for 42.3% of non-financial flows, an increase of 30.7% compared to the previous year, with over 60% coming from reinvestment of income. Local enterprises reached 87.73 billion US dollars, an increase of 3.4% from the previous year, accounting for 57.7%. As shown in Table 2, the eastern region accounted for 71.81 billion US dollars, accounting for 81.9% of local investment flow, an increase of 0.6% compared to the previous year; The central region reached 10.03 billion US dollars, accounting for 11.4%, an increase of 44.6% compared to the previous year; The western region reached 4.51 billion US dollars, accounting for 5.1%, a decrease of 23.8% from the previous year; The three northeastern provinces reached 1.38 billion US dollars, accounting for 1.6%, an increase of 126.2% compared to the previous year. As shown in Table 3, Guangdong, Zhejiang, Shanghai, Jiangsu, Beijing, Shandong, Fujian, Anhui, Hebei, and Tianjin ranked among the top ten in terms of local outward foreign direct investment flows, with a total of 73.84 billion US dollars, accounting for 84.2% of local outward foreign direct investment flows. Shenzhen has a foreign direct investment flow of 8.72 billion US dollars, ranking first among the planned cities and accounting for 61.5% of Guangdong Province.

From the above data, it can be concluded that there is a regional imbalance in China's outward investment. The eastern coastal cities, due to their relatively developed economy and convenient transportation, have lower costs and more opportunities for outward investment; The outward investment flow in the central region is 7 times smaller than that in the eastern region, which is the result of comprehensive factors. Firstly, the central region is mostly agricultural, and secondly, the economic development in the central region is lower than that in the eastern region; The western region and the three northeastern provinces have the least outward investment flow, which is also a reflection of the uneven regional development in China. At present, China is also vigorously carrying out the Western Plan and the Revitalization Plan for the Three Eastern Provinces, in order to eliminate and alleviate the problem of regional development imbalance as much as possible.

3.3. Distribution status of China's outward foreign direct investment industry

The proportion of China's three forms of outward investment has been fluctuating, and there is no fixed trend or pattern of change in the proportion of bond instrument investment, income reinvestment, and new equity.

In 2021, China's outward foreign direct investment covered 18 major industries of the national economy, with investments flowing into leasing and business services, wholesale and retail, manufacturing, finance, transportation/warehousing, and postal industries all exceeding 10 billion US dollars. The leasing and business services industry remains at the top, while wholesale and retail rank second.

The investment flowing into the leasing and business services industry was 49.36 billion US dollars, an increase of 27.5% compared to the previous year, accounting for 27.6% of the total flow. The investment is mainly distributed in countries (regions) such as Hong Kong, Cayman Islands, British Virgin Islands, Singapore, and Australia.

The investment in wholesale and retail industry was 28.15 billion US dollars, an increase of 22.4% from the previous year, accounting for 15.7% of the total flow. The investment mainly flows to countries (regions) such as Hong Kong, Singapore, the United States, Macau, Germany, Malaysia, the United Kingdom, the Netherlands, and Australia. The investment in the manufacturing industry was 26.87 billion US dollars, an increase of 4% from the previous year, accounting for 15% of the total flow. The investment mainly flows into the automobile manufacturing industry, computer/communication and other electronic equipment manufacturing industry, metal products industry, specialized equipment manufacturing industry, non-ferrous metal smelting and rolling processing industry, chemical raw materials and chemical products industry, pharmaceutical manufacturing industry, other manufacturing industry, rubber and plastic products industry, electrical machinery and equipment manufacturing industry, textile industry, papermaking and paper products industry, general equipment manufacturing industry, non-metallic mineral products industry, food manufacturing industry Chemical fiber manufacturing industry, railway/shipping/aerospace and other transportation equipment manufacturing industry, black metal smelting and rolling processing industry, furniture manufacturing industry, etc. The investment flowing into the equipment manufacturing industry was 14.12 billion US dollars, an increase of 18.7%, accounting for 52.5% of the manufacturing investment.

The investment in the financial industry was 26.8 billion US dollars, an increase of 36.3% from the previous year, accounting for 15% of the total flow. In 2021, domestic investors in China's financial industry directly invested 25.57 billion US dollars in overseas financial enterprises, accounting for 95.4%; Domestic non-financial investors in China invested 1.23 billion US dollars in overseas financial enterprises, accounting for 4.6%. Financial enterprises invested 1.23 billion US dollars, accounting for 4.6%.Financial enterprises invested 1.23 billion US dollars, accounting for 4.6%. The investment in transportation/warehousing and postal industry was 12.23 billion US dollars, an increase of 96.3% compared to the previous year, accounting for 6.8% of the total flow. The total investment in the above five areas is 143.41 billion US dollars, accounting for 80.2% of the total flow. In addition, the investment flowing into the mining industry in 2021 was 8.41 billion US dollars, an increase of 37.2% from the previous year, accounting for 4.7% of the total flow. The investment in information transmission/software and information technology services industry was 5.13 billion US dollars, a decrease of 44.2% from the previous year, accounting for 2.9% of the total traffic. The investment in scientific research and technology services industry was 5.07 billion US dollars, an increase of 35.9% from the previous year, accounting for 2.8% of the total flow. The investment in the construction industry was 4.62 billion US dollars, a decrease of 42.9% from the previous year, accounting for 2.6% of the total flow. The investment in the production and supply of electricity, heat, gas, and water was 4.39 billion US dollars, a decrease of 23.9% from the previous year, accounting for 2.5% of the total flow.

4. RESEARCH ON THE CARBON EMISSION EFFECTS OF CHINA'S FOREIGN DIRECT INVESTMENT FROM A POLICY PERSPECTIVE

4.1. Econometric models and variable settings

The double difference method (DID) is a representative research method currently used both domestically and internationally to test the effectiveness of policy implementation. The advantage of this method is that it can avoid endogeneity issues that exist when policies are used as explanatory variables and obtain unbiased estimates of policy effectiveness. Therefore, this article uses the DID model to empirically test the OFDI induced effects of ETS pilot policies.

4.1.1. Measurement Model Setting

This article takes 32 provinces as the research objects, with 7 ETS pilot provinces including Beijing, Shanghai, Tianjin, Chongqing, Hubei, Guangdong, and Shenzhen as the experimental group, and the remaining 25 non pilot provinces as the control group. Based on their non-financial OFDI flows from 2004 to 2015, the implementation of ETS pilot policies is used as an impact event for quasi natural experiments, and the DID method is used to analyze the induced effects of ETS pilot policies on OFDI in pilot provinces. The specific econometric model is set as follows:

$$\mathrm{OFDI}_{jt}=\beta_0+\beta_1 ETSj \times POST_t + X_{jt} + \delta_j+\gamma_t + \varepsilon_{jt} \quad (1)$$

Where, OFDI_{jt} is the outward direct investment flow of province j in the t-th year; POST represents the year when the ETS pilot policy officially begins to be implemented; ETS represents whether the sample province is a pilot region. If so, the value is 1, and if not, the value is 0. This article uses the coefficient of attention β_1. Measure the OFDI induced effects of ETS pilot policies, where X_{jt} represents the control variable. Based on previous relevant research, including per capita GDP, population, urbanization level, marketization index, industrialization level, the proportion of imports and exports to GDP, the proportion of actual utilization of foreign funds to GDP, and the level of human capital, all variables are analyzed

Logarithmic processing. δ_j and γ_t represents the fixed effects of capturing provinces and years, respectively, ε Jt is a random perturbation term.

4.1.2. Variable Setting and Data Sources

(1) The dependent variable. Due to the inability to obtain OFDI traffic data by province and industry, the dependent variable in this article is the number of new OFDI projects created by province and industry each year during the sample period. According to Yu et al.'s research, the changes in outward foreign direct investment flows and the number of newly established overseas branches in 17 host countries are consistent, and there is a positive correlation between the number of new projects and OFDI flows. Referring to Gao et al.'s industry classification, this article reclassifies the top 50 industries in the national economy industry code into 26 major industries, and counts the number of OFDI projects in each province each year by industry. The specific method is to calculate the total number of OFDI projects for each industry in each province, and the data required for OFDI is from

the relevant year's China Overseas Investment Enterprise Directory China's Foreign Direct Investment Bulletin.

(2) Core explanatory variables. ETS represents the experimental variable in the double difference method, with a distribution value of 1 in the 7 pilot provinces and 0 in other regions. POST represents a time dummy variable used in the double difference method to measure the exogenous impact of the carbon emission trading system. Although the ETS pilot program was officially implemented in 2013, the National Development and Reform Commission issued a notice on conducting carbon emission trading pilot work at the end of 2011. Relevant enterprises in each pilot province will make corresponding preparations and adjust their emission reduction strategies. Therefore, this article selects 2012 as the year of impact, The variable POST is assigned a value of 1 in 2012 and later, and 0 in previous years.

(3) Control variables. The level of economic development, with the continuous improvement of regional economic development, enterprises in the region usually begin to try to internationalize. This article uses per capita GDP to measure the level of economic development in each province. Drawing inspiration from Gao et al.'s research, this article selects population (POPU, total population of each province at the end of the year), urbanization level (UL, ratio of urban population to total population), and foreign trade dependence (FD, ratio of total import and export to GDP) as control variables. We also measure the degree of openness to the outside world (OD) by the proportion of actual utilization of foreign investment to GDP, measure the level of human capital (HCL) by the proportion of higher education to labor force, and measure the degree of marketization (MI) by the marketization index of each province. Among them, Shenzhen uses data from Guangdong Province, which reflects the systematic development and gradual improvement of various aspects of the market system. The control variable data is sourced from the China Statistical Yearbook, China Urban Statistical Yearbook, and China Provincial Marketization Index Report 2016. The descriptive statistics of the relevant variables are shown in Table 1.

Table 1. Descriptive Statistics of Variables

Variables	Sample size	Mean	S.D.	Min	Max
ODFI	9984	0.899	3.087	0	74
lnUL	9984	-0.721	0.310	-1.586	-0.110
lnMI	9984	1.749	0.469	-2.813	2.391
lnIL	9984	-0.962	0.372	-2.687	-0.634
lnFD	9984	-1.588	1.066	-3.332	1.180
lnOD	9984	-3.746	1.373	-7.887	-0.831
lnHCL	9984	-2.577	0.683	-4.923	-0.860
lnINPERGDP	9984	10.23	0.691	8.370	12.00
lnPOPU	9984	8.003	0.956	5.107	9.292

4.2. Empirical Results Analysis

4.2.1. Benchmark regression

The regression results of the impact of ETS pilot policies on OFDI in pilot provinces are shown in Table 2. The regression results in column (5) with all control variables included show that ETS × The coefficients of POST are significantly positive, and China's ETS pilot policy will indeed lead to industrial enterprises in pilot provinces conducting OFDI. Hypothesis 1 is confirmed. Faced with market-oriented emission reduction constraints, some companies are concerned about insufficient free quotas and do not want to reduce production. They will use the "going out" platform to transfer production outward through OFDI. These companies may be more inclined to go to areas with less strict environmental regulations, which poses a risk of carbon leakage. Another group of enterprises have certain green technology innovation capabilities and can improve productivity and reduce carbon emissions by using or introducing clean technologies. At the same time, trading surplus quotas in the secondary market can also provide them with funding sources and enhance OFDI capabilities. These enterprises may go to developed countries and regions with higher technological levels and strict environmental constraints.

Table 2. Impact of Carbon Emission Trading System on Investment Transfer

Variables	(1)	(2)	(3)	(4)	(5)
ETS×POST	0.322 4*** (0.002)	-0.328 1** (0.000)	0.024 1 (0.835)	0.027 2 (0.817)	0.309 3** (0.013)
lnUL		-3.531 3*** (0.000)	-2.113 6 (0.835)	-2.258 0*** (0.000)	- 1.145 1 (0.101)
lnMI		0.291 0*** (0.007)	0.224 0** (0.040)	0.278 7** (0.013)	0.326 6*** (0.006)
lnIL			-0.973 7*** (0.000)	-0.984 0*** (0.001)	0.160 2 (0.624)
lnFD			0.398 7*** (0.000)	0.421 0*** (0.000)	-0.515 4*** (0.000)
lnOD				0.013 0 (0.795)	-0.099 2* (0.053)
lnHCL				0.268 3 (0.241)	0.187 0 (0.201)
lnINPERG- DP					-3.215 0*** (0.000)
lnPOPU					-3.900 4*** (0.000)
_Cons	0.076 5 (0.274)	-3.438 7*** (0.000)	-3.727 5*** (0.000)	-3.451 6*** (0.000)	59.415 3*** (0.000)
Provincial fixed effects	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes
observations	9 984	9 984	9 984	9 984	9 984

Note: The superscripts * *, * *, and * respectively indicate significance at the 1%, 5%, and 10% statistical levels, as shown in the following table.

In the controlled variables, the marketization index (MI) of the pilot provinces and cities were significantly positive at the 1% level, and hypothesis 3 was not confirmed. This article speculates that in areas with high levels of marketization, the Porter effect may play a role, resulting in relatively weak carbon leakage risks associated with OFDI. In addition, areas with high levels of marketization in pilot areas have already accumulated experience with OFDI in the early stages, and the information cost of new investment by enterprises is relatively low. Therefore, further exploration is needed after grouping.

4.2.2. Robustness testing of DID

(1) Parallel trend test. The assumption of double difference is that before the policy event occurs, the trend of changes in the treatment group and the control group should be consistent. There are two methods to verify this hypothesis: drawing parallel trend graphs and conducting parallel trend tests. In the ETS pilot policy, the industries constrained by carbon emissions are mainly eight high carbon

emitting industries, including steel, electricity, chemicals, construction, papermaking, non-ferrous metals, and aviation. Under the impact of ETS policies, the growth rate of OFDI in high carbon emitting industries in pilot provinces has been faster, which to some extent confirms hypothesis 2. In addition, this article sets the following regression equation to test the trend changes in the first 8 years of the 2012 shock year:

$$\mathrm{OFDI_{jt}}=\beta_0+\beta_k\sum_{k>-8}^{0} ETS_j\times POST_{2012+K}+X_{jt}+\delta_j+\gamma+\varepsilon_{\mathrm{jt}} \quad (2)$$

The first column of Table 3 shows the parallel trend regression test results of carbon trading pilot policies on outward foreign direct investment of Chinese provinces. It can be intuitively reflected that before 2012, except for 2009 and 2011, the coefficient of the double interaction term was not significant, and the carbon trading pilot policy overall conforms to the parallel trend assumption. The negative significance of the interaction coefficient in 2009 may be due to the 2008 financial crisis, which led Chinese companies to temporarily adopt a wait-and-see conservative attitude when formulating OFDI strategies. However, the negative significance of the interaction coefficient in 2011 may be due to the lag effect of domestic investment in infrastructure construction of 4 trillion yuan. Due to the inclusion of many companies related to infrastructure in the ETS pilot program, stimulated by domestic investment, companies may pay more attention to the domestic market, And it delayed going out.

Table 3. Robustness test of the impact of carbon trading pilot policies on China's OFDI

Variables	(1)	(2) ETS×t2009	(3) ETS×t2010	(4) ETS×t2011
ETS × POST		-0.129 6 (0.217)	0.031 0 (0.783)	0.019 2 (0.885)
ETS×t2004	0.006 7 (0.977)			
ETS×t2005	0.012 5 (0.956)			
ETS×t2006	-0.106 6 (0.623)			
ETS×t2007	-0.292 0 (0.165)			
ETS×t2008	-0.302 7 (0.136)			
ETS×t2009	-0.427 2* (0.030)			
ETS×t2010	-0.288 2 (0.134)			
ETS×t2011	-0.331 0* (0.083)			
Provincial fixed effects	YES	YES	YES	YES
Time fixed effect	YES	YES	YES	YES
Observations	9 984	6 656	6 656	6 656

(2) Placebo test. Placebo test one: columns (2) to (4) in Table 3, assuming that the policy time occurred before 2012 (fictitious policy time). The premise of the double difference method is that there is no significant difference in the investment behavior of enterprises before the policy event

occurs. Therefore, if the policy time is set to a certain period before 2012, the estimated coefficient of the core variable will not be significant. Select the sample interval from 2004 to 2011 without policy implementation, and set 2009, 2010, and 2011 as virtual implementation years for ETS policies. According to columns (2) to (4) of Table 3, the estimated coefficients of the core variables are not significant, thus excluding the influence of other potential unobservable factors on the outward direct investment behavior of the pilot provinces in this article.

Placebo test two: Column (1) in Table 3, randomly selected experimental group (fictional treatment group). In order to further test whether the changes in the treatment group and control group were influenced by other policies during the same period, this study conducted a placebo test by randomly assigning pilot provinces. Specifically, this article randomly selected 7 provinces from 25 non pilot provinces as the treatment group, assuming that these 7 provinces have implemented carbon emission trading policies, and other regions are the control group. This article conducted 500 random sampling and conducted benchmark regression according to equation (1), and found that all ETS × The mean estimation coefficient of POST is almost zero, and the distribution of 500 estimation coefficients and their related P-values are plotted, all concentrated around zero. The P-values of most estimation values are greater than 0.1, indicating that most estimation coefficients are not statistically significant at the traditional level, providing further evidence for the conclusion that the increase in outward investment in pilot provinces is indeed brought about by ETS policies.

(3) Analysis of differences in industry characteristics. In order to further investigate the differences in industry characteristics, this article added the carbon intensity (CO2i) of the industry to the benchmark model, forming a triple difference model to test hypothesis 2. The model is set as equation (3):

$$\mathrm{OFDI_{ijt}}=\beta_0+\beta_1 C0_{2i}\times ETS_j\times POST_t+X_{jt}+\delta_j+\gamma_t+\varepsilon_{jt} \quad (3)$$

In the formula, CO_{2i} is a dummy variable, assigned a value of 1 when the sample enterprise belongs to the top 50 industries in CO_2 emissions ranking, and 0 when it belongs to the top 50 industries in non CO2 emissions ranking. The definition of other variables is the same as the equation. This article focuses on the triple difference sub item the coefficient β_1 of $CO_{2i} \times ETS_j \times POST_t$. if β_1 is significantly positive, it indicates that the inducing effect of ETS on outward direct investment in pilot provinces is more significant in high carbon emission industries. if β_1 is significantly negative, the conclusion is opposite, indicating that the inducing effect of low-carbon industries is stronger than that of high carbon emission industries.

The industry differential regression results of the investment transfer effect of ETS pilot policies are shown in Table 5. OLS and FE regression models show that the triple difference item coefficient $CO_{2i} \times ETS_j \times POST_t$ is significantly positive at the 1% level in columns (1) and (3), and remains significant even after adding control variables. There are industry differences in the effect of ETS pilot policies on OFDI in pilot provinces, which is more significant in high carbon emission industries. Hypothesis 2 is validated. Under the constraints of ETS, enterprises in high carbon emission industries belong to traditional heavy industry enterprises, with relatively backward technological levels and inflexible management systems. If the extensive production mode is not changed, there is a high possibility of quota shortage. However, the research and introduction of clean technologies required by changing the production mode will also increase production costs for enterprises. Therefore, enterprises will consider transferring production through OFDI, But it may also come with the risk of carbon leakage.

Table 4. Impact of Carbon Emission Trading System on Investment Transfer

Variables	OLS		FE	
	(1)	(2)	(3)	(4)
ETS×POST	3.050 5*** (0.000)	2.131 4*** (0.000)	2.028 7*** (0.000)	1.840 2*** (0.000)
lnUL		1.125 1*** (0.009)		-0.961 0 (0.161)
lnMI		0.383 5*** (0.000)		0.320 6*** (0.006)
lnIL		- 1.804 9*** (0.000)		0.100 0 (0.758)
lnFD		-0.365 6*** (0.000)		-0.498 2*** (0.000)
lnOD		-0.034 9 (0.368)		-0.104 0** (0.039)
lnHCL		0.204 7** 0.039)		0.204 1 (0.161)
lnINPERGDP		0.583 1*** (0.000)		-3.031 8*** (0.000)
lnPOPU		0.705 5*** (0.000)		-3.900 4*** (0.000)
_Cons	0.842 4*** (0.000)	- 12.582 4*** (0.000)	0.076 9 (0.269)	55.724 0*** (0.000)
Control variable	No	Yes	No	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes
observations	9 984	9 984	9 984	9 984

5. CONCLUSION AND SUGGESTIONS

5.1. Conclusion

As a major global greenhouse gas emitter, the Chinese government has always attached great importance to climate change and made positive contributions to addressing global climate change. As an important measure to achieve the action goal of "carbon peaking by 2030, carbon neutrality by 2060", the pilot carbon emission trading system will lead to the risk of production transfer, economic growth and "carbon leakage" of the included enterprises through OFDI, which is not conducive to achieving the sustainable development goal of building a green "the Belt and Road", It has important theoretical and practical significance for promoting the construction of a national carbon market. This article is based on data from 32 provinces in China from 2004 to 2015, using China's carbon emissions trading pilot policy as a natural experiment to examine the impact of China's ETS on the OFDI of pilot provinces. The benchmark regression results of the double difference method show that the carbon emissions trading pilot policy can to some extent induce outward direct investment activities in pilot provinces. This conclusion is based on the parallel trend hypothesis The placebo test and PSM-DID test still hold true. At the industry level, through triple difference estimation, it is found that compared to low-carbon emission industries, carbon trading pilot policies have more significantly promoted investment transfer in high carbon emission industries, as they face greater pressure to reduce costs and increase production transfer through outward direct investment, making them more prone to carbon leakage problems. At the regional level, provinces with lower levels of marketization are more sensitive to the investment transfer effects of pilot policies due to the lack of clean technology and institutional factors.

5.2. Suggestions

The research conclusion of this article provides the following insights for improving the design of ETS pilot policies, promoting the construction of the national carbon market, improving the quality of OFDI, and preventing the risk of carbon leakage:

Firstly, optimize the design of ETS pilot policies, reasonably determine quota issuance, trading prices, report verification, and punishment mechanisms based on the industry structure and regional characteristics of each province. Following the principle of common but differentiated, design differentiated carbon emission trading market systems based on the economic development characteristics of different pilot areas, and further explore carbon trading market rules that are consistent with China's national conditions and reflect regional differences, Strengthen the constraints on overseas social responsibility of Chinese enterprises and promote high-quality foreign investment by Chinese enterprises.

Secondly, accelerate the process of marketization in relatively backward provinces as soon as possible, improve the market economy system, ensure the decisive position of the market in resource allocation, promote the free flow of resource elements, enhance the vitality of carbon trading markets, promote the formation and improvement of quota trading and price systems, and achieve enterprise emission reduction. Due to the significant differences in economic development, technological level, and education level among the three regions of East, Central, West, and East China, there are differences in the proportion of outward foreign direct investment. The government can make differentiated outward direct investment based on the environmental characteristics of each region. For the central and western regions with low economic development level, we will deepen the "Western Development" and the "the Belt and Road" initiatives, improve the economic development level of the western region, and increase the scale of foreign direct investment. The economic development and technological level in the eastern region are high; We can encourage the eastern region to vigorously engage in technology driven outward foreign direct investment, fully leverage the technological advantages of the eastern region, and reduce carbon dioxide emissions through the introduction and learning of new technologies.

Thirdly, the government should provide corresponding emission reduction technology subsidies to enterprises in high carbon emission industries, compensate for the cost of investment in emission reduction technology, enhance the motivation of enterprises to innovate low-carbon technology, reduce the transfer of production activities by polluting enterprises through OFDI, and thereby improve the quality of China's OFDI and reduce the risk of carbon leakage. The current energy consumption in our country 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. From the current situation, coal will be the main energy source for a long time. China can reduce carbon emissions caused by energy structure in the following three aspects. Firstly, China can improve the efficiency of coal utilization and reduce coal consumption through technological development. Secondly, China should increase the openness and utilization of new energy. At present, China'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. Thirdly, with the development of the economy, the consumption of cars by residents has increased, leading to an increase in fuel demand. China should continue to increase support for new energy vehicles, improve charging facilities, and reduce transportation carbon dioxide emissions.

Fourthly, the government should promote domestic industrial restructuring and optimize the industrial structure. The secondary industry is the industry with the highest carbon dioxide emissions. 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, the added value of the tertiary industry increases, and China's economic level can also improve, enhancing its position in the global industrial chain. When economic development crosses a turning point, the economic scale effect is negative, which is also beneficial for reducing carbon dioxide emissions. The internal structure of the secondary industry also needs to be optimized, eliminating industries with high energy consumption and severe pollution emissions, developing environmental protection industries mainly focused on energy-saving equipment, and reducing carbon dioxide emissions.

Fifthly, the government should increase investment in environmental governance and severely punish behaviors that damage the environment. Reducing carbon dioxide emissions can be approached from two aspects. The first is to reduce carbon emissions in production and daily life. Firstly, the government can establish strict environmental protection systems, improve environmental standards, and align with international standards. High standard environmental protection requirements can promote energy conservation and emission reduction for enterprises, and reduce carbon emissions. We can also increase education and publicity to raise people's environmental awareness and reduce carbon emissions in daily life. On the other hand, it is to offset the carbon dioxide generated through afforestation and other methods. The government is increasing investment in environmental governance, improving the ecological environment, increasing forest coverage, and offsetting 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.

ACKNOWLEDGMENTS

This work is supported by 2023 Anhui University of Finance and Economics Undergraduate Research and Innovation Fund Project (XSKY23036ZD).

REFERENCES

[1] Dong Kangyin, Zhao Jun, Dong Xiucheng Research on the Carbon Emission Effects of China's Foreign Direct Investment on Host Countries: Based on Spatial Spillover Perspective [J]. Industrial Technology and Economics, 2023,42 (07): 133-142.

[2] Gong Haoxi. Research on the Carbon Emission Effect of China's Foreign Direct Investment [D]. Shanxi University of Finance and Economics, 2023.

[3] Zhai Chaoying, Huang Ruoyun A Study on the Carbon Emission Effects of China's Foreign Direct Investment: Based on the Spatial Durbin Model [J]. Contemporary Financial Research June 2023 (01): 30-46.

[4] Yan Yunfeng The carbon emission effect of China's outward foreign direct investment: based on a multi regional input-output model [J]. Resource Science 2022, 44 (11): 2222-2232.

[5] Liu Rui Research on the Impact of China's Foreign Direct Investment on Domestic Carbon Emissions [D]. Tianjin Normal University, 2022.

[6] Tu Zhengge, Chen Renjun Can the emission trading mechanism achieve the Porter effect in China? [J] Economic Research, 2015 (7): 160-173.

[7] Ren Shenggang, Zheng Jingjing, Liu Donghua, et al Does the emission trading mechanism improve the total factor productivity of enterprises: Evidence from Chinese listed companies China Industrial Economy, 2019 (5): 7-25.

[8] Jia Yunyun Does carbon emissions trading affect economic growth? [J] Macroeconomic Research, 2017 (12): 72-81.

[9] Zhou Chaobo, Qin Yun Has the carbon emissions trading pilot policy promoted China's low-carbon economic transformation-- Empirical research based on the double difference model [J] Soft Science, 2020 (10): 36-42, 55.

[10] Hu Jun, Huang Nan, Shen Hongtao Can market driven environmental regulations promote technological innovation in enterprises-- A Natural Experiment Based on China's Carbon Emission Trading Mechanism [J] Financial Research, 2020:171-189.

[11] Hu Jiangfeng, Huang Qinghua, Pan Xinxin Carbon emissions trading system and corporate innovation quality: inhibiting or promoting [J]. China Population, Resources and Environment, 2020 (2): 49-59.

[12] Liu C, Ma C, Xie R. Structural, innovation and efficiency effects of environmental regulation: Evidence from China's carbon emissions trading pilot [J]. Environmental and Resource Economics, 2020, 75: 1-28.

[13] PorterM E, Vander Linde C. Toward a new conception of the environment - competitiveness relationship [J]. Journal of Economic Perspectives, 1995, 9: 97-118.