

# The Impact of Foreign Direct Investment on Green Innovation: Taking Urbanization Level as The Threshold

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**Abstract:** At present, China's manufacturing industry is in a critical period of industrial upgrading, but it also needs to maintain a good ecological environment during industrial upgrading. In the context of China's proposal to achieve "carbon peak" in 2030 and "carbon neutrality" in 2060, it is necessary to study whether the knowledge spillover of foreign direct investment can have a positive impact on China's green innovation level, so as to make more efficient policy countermeasures for high-quality development. This paper uses China's provincial panel data from 2007 to 2021 and uses a double fixed effect model to explore the impact of foreign direct investment on China's green innovation. The results verify that foreign direct investment has a negative impact on China's green innovation. Further, taking the urbanization level as the threshold variable, it is concluded that there is a nonlinear relationship between foreign direct investment and the level of green innovation, and at a certain critical point, FDI can have the smallest negative impact on green innovation. The inspiration from the experimental results is to be vigilant about the low-end technology transfer of foreign-funded enterprises and their technological dependence. Developing countries, as host countries, need to establish a more comprehensive innovation incentive system and improve sustainable industrial chain clusters. At the same time, they should adhere to sustainable development, continue to pay attention to environmental protection, and set up environmental regulations for foreign investment entry.

**Keywords:** Green innovation; foreign direct investment; carbon emission reduction; industrial upgrading.

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## 1. Introduction

For developing countries, the entry of foreign direct investment (FDI) will not only directly bring in international capital and provide strong support for local economic development, but it is also more likely to have a positive impact on local industrial upgrading due to the additional knowledge spillovers. Since 2020, China has become the world's largest recipient of foreign direct investment, surpassing the United States and the United Kingdom. FDI has played an important role in China's regional development. However, since developed countries have completed industrial transformation, they tend to keep high value-added industries in their own countries and transfer high-pollution, low-value-added production to developing countries, which has caused irreversible damage to the environment of developing countries. Against the backdrop of global warming and the deteriorating global environment, countries have proposed the concept of carbon trading, and developing countries are more concerned about achieving sustainable development by establishing environmental regulations and encouraging green innovation.

Since China proposed its sustainable development strategy, domestic and foreign scholars have conducted a series of studies on foreign direct investment and China's environment, mainly focusing on the impact of FDI from developed countries on pollution emissions, and have mainly produced two viewpoints: the "pollution halo" hypothesis and the "pollution paradise" hypothesis. With the further deepening of the research, some scholars have gradually begun to explore the impact of technology spillovers from foreign direct investment on local corporate innovation. It is known

that regional factors such as corporate technological investment and human capital, government environmental regulation, etc. are closely related to green innovation. Is there a significant correlation between foreign direct investment and green innovation in the host country? This paper will start with China's provincial panel data and use a two-way fixed effect model to study the relationship between foreign direct investment and green innovation from 2009 to 2021, and use the urbanization level as a threshold to study the nonlinear relationship between the two.

## 2. Literature Review and Theoretical

The earliest viewpoint on the impact of foreign direct investment on the environment of the host country was the "pollution haven" hypothesis, which was first proposed by Leonard (1984). It holds that in order to reduce the pollution level of their own environment, developed countries will make foreign direct investments to transfer polluting enterprises or sunset enterprises to developing countries with relatively low environmental regulations, thereby reducing environmental pollution in the home country while aggravating pollution in the host country. The second is the "pollution halo" hypothesis. Contrary to the "pollution haven" view, it holds that the investment of foreign-invested enterprises in host countries can form technology spillovers and improve the production efficiency of the host country, thereby having a positive impact on the environment of the host country.

At present, domestic scholars analyze the knowledge spillover effect of FDI on the host country mainly through the following three ways: from the perspective of technological progress, measuring the effect of FDI knowledge spillover on

the total factor productivity or labor productivity of the host country; from the perspective of output growth, measuring the impact of FDI knowledge spillover on the economic growth of the host country; from the perspective of independent innovation, examining the effect of FDI knowledge spillover on the innovation capacity of the host country. Among them, independent innovation is an important indicator of industrial upgrading, and green technology innovation in innovation is closely related to total factor productivity.

Green innovation, also known as green technology innovation, refers to new technologies generated to avoid environmental pollution. With the continuous deepening of relevant research, some scholars have gradually studied the relationship between foreign direct investment and green innovation. Cross border capital deconstructs the green technology system into a core patent group and peripheral application technology packages through a "modular technology segmentation" strategy. This selective transfer model has led the host country into a 'low-end technology trap'. The deepening of this technological dependence has given rise to the phenomenon of "decreasing elasticity of innovation substitution". Studies have shown that foreign technology transfer can lead to a decrease in the marginal substitution rate of host countries' independent research and development investment.

Combined with existing research, it can be seen that there are few studies on the direct impact of foreign direct investment on green innovation. Most of them are analyzed from a macro perspective, and environmental regulation is not used as a mediating variable to study the regulatory role of the host country's environmental policy on foreign direct investment inflows. This paper will directly use the green innovation level as the explained variable and foreign direct investment as the explanatory variable to study the impact of knowledge spillovers from FDI inflows on the green innovation level, which is closely related to the host country's environmental protection level, and conduct an in-depth study of the nonlinear relationship between foreign direct investment and green innovation level with urbanization level as the threshold variable.

### 3. Empirical Research

#### 3.1. Research methods

The model of this article is mainly based on the research of Liu Chuanjiang (2016), and the model is as follows:

$$\ln GTI_{ij} = \alpha_0 + \alpha_1 \ln FDI_{i,j} + \alpha_2 X_{i,j} + \omega_i + \eta_t + \mu_{i,j}$$

In the formula: the explained variable  $\ln GTI_{i,j}$  represents the green innovation level of region  $j$  at time  $i$ ,  $CP_{i,j}$  is the number of green innovations.  $\ln FDI_{i,j}$  is the level of foreign direct investment funds obtained by the  $j$  region and invested in production at that  $i$  time. The control variables  $X_{i,j}$  include industrial structure IS (the proportion of secondary industry output in regional GDP in that year), technology input RD (regional research and experimental development funding investment), environmental intensity ER (regional environmental pollution control investment), and external openness OD (the proportion of foreign trade volume in GDP).  $\alpha_1$ 、 $\alpha_2$  represent the autocorrelation coefficients of the core explanatory variables and control variables,  $\omega_i$   $\eta_t$  is the province fixed effect,  $\mu_{i,j}$  is time fixed effect, is the random disturbance term.

#### 3.2. Variable setting

1. Core explanatory variable: The core explanatory variable of this paper is foreign direct investment FDI (lnFDI). This paper selects the actual total investment of foreign-invested enterprises in 30 provinces in China (excluding Tibet, Hong Kong, Macao and Taiwan) from 2007 to 2021 (million US dollars).

2. Explained variable: The explained variable of this paper is the green innovation number (lnGTI). The green innovation number refers to the research of Han Xianfeng (2023). With the data of green utility patents and green invention patents as reference, A-share listed companies from 2007 to 2021 are selected as research samples, and the samples are screened according to the following standards: ① Eliminate financial and ST companies; ② Eliminate samples with missing key variables. Finally, all continuous variables are subjected to a two-way 1% tail shrinkage treatment.

#### 3.3. Data Source and Descriptive Statistics

The data used in this paper mainly come from the China Statistical Yearbook, China Carbon Accounting Database. Table 1 shows the descriptive statistics of the data. All data in this paper come from publicly available databases.

**Table 1.** Descriptive statistics of variables

	Number	Mean	Standard Deviation	Max	Min
lnGTI	450	5.3053	1.0874	10.1392	0.0000
lnFDI	450	11.1229	1.4766	14.4850	7.8240
IS	450	0.4206	0.0832	0.6196	0.1597
lnOD	450	7.2521	0.9676	9.3618	4.0795
lnER	450	13.1898	13.0949	110.3387	0.0855

### 4. Empirical Results and Analysis

#### 4.1. Model selection and result analysis

This paper first conducts F test and LM test. The test results are shown in Table 3. The F test results show that the 1% significance level test is passed, indicating that the null hypothesis is rejected, and it is believed that the FE fixed

effect model is due to the OLS ordinary least squares method. Then the LM test is performed, and the display is 0, that is, the null hypothesis is rejected, and the alternative hypothesis is selected, which supports the selection of the random effect model. The Hausman test results pass the 1% significance test. According to the econometric analysis method, the null hypothesis of selecting the random effect model is rejected. Combined with the data, a two-way fixed effect model with

fixed time and fixed province is selected. Based on the above,

this paper finally selects the two-way fixed effect model.

**Table 2.** Model selection test results

	Statistics	P-value
F test	21.21	0.00***
LM test	653.33	0.00***
Hausman test	19.70	0.00***

Note: \*\*\*, \*\*, \* respectively indicate passing the significance test at 1%, 5%, and 10% levels, the same below.

## 4.2. Benchmark regression results

The benchmark regression results are shown in Table 2, which lists the regression estimation results of OLS regression, FE model and RE model. The significance and size of the regression coefficients are similar. The null hypothesis is rejected at least at the 10% confidence level and the coefficient is negative, indicating that FDI will significantly reduce local green innovation. Under the fixed effect FE model, for every 1% increase in the level of foreign direct investment, the green innovation level of the province will decrease by 0.119%. Therefore, the core conclusion is that the entry of foreign direct investment will have a negative impact on China's green innovation. The reason for this may be due to the limited knowledge spillover effects brought by foreign direct investment, or its indirect impact on environmental protection related innovation. Moreover, its entry may to some extent damage the competitiveness of local

industrial markets, leading to insufficient innovation momentum. Among the control variables, the negative coefficient of the level of opening to the outside world further verifies the stability of the experiment, that is, excessive foreign investment will reduce the green innovation level of the host country; the positive correlation of the industrial structure can explain that green innovation is mainly related to industries with high pollution levels. Therefore, to achieve high-level industrial transformation, the focus should be mainly on resource-intensive industries; the environmental regulation coefficient is positive and significant at a confidence interval of 5%, indicating that environmental regulation can effectively increase the number of green innovations. Therefore, more environmental regulations targeting foreign direct investment should be formulated to help its knowledge spillovers have a more positive impact on the technology level of the host country.

**Table 3.** Model Selection Test Results

VARIABLES	OLS	FE	RE
lnFDI	-0.116* (0.070)	-0.119* (0.070)	-0.119* (0.070)
lnOD	-0.167** (0.077)	-0.159** (0.073)	-0.159** (0.073)
lnER	0.007** (0.003)	0.007** (0.003)	0.007** (0.003)
IS	6.182*** (0.928)	6.299*** (0.867)	6.299*** (0.867)
Constant	7.163*** (1.586)	2.343*** (0.881)	7.616*** (0.941)
Observations	450	450	450
Number of id	30	30	30
R-squared		0.883	

## 5. Main Conclusions and Policy Implications

In the context of "dual carbon", China pays more attention to carbon productivity in industrial production processes, and the impact of foreign direct investment on carbon productivity is highly concerned at this time. This article is based on data from 30 provinces in China from 2007 to 2021, using a double fixed effects model to study the impact of FDI on green innovation, and further using a threshold model to explore the non-linear relationship between urbanization level and FDI towards green innovation. The main conclusion drawn from this article is that the entry of foreign direct investment in urbanization will reduce the level of green innovation in the host country, and there is also a strong correlation between the local industrial structure and the level of green innovation. When using level as the threshold, it is found that there is a non-linear relationship between foreign direct investment and the level of green innovation. When the level of urbanization reaches a certain equilibrium value, the negative impact of

foreign direct investment on the local level of green innovation can be minimized to the greatest extent. Digging deeper into the underlying reasons, it may be that foreign investment transfers low-end technology and the host country relies on domestic technology, reducing its own investment in independent research and development, leading to a decline in local green innovation capabilities. At the same time, controlling for the positive impact of variable environmental regulations on green innovation proves that foreign-funded enterprises will choose host countries with relatively relaxed environmental regulations to transfer high polluting industries, or the implementation of relatively relaxed environmental regulations in host countries will also have a negative impact on the domestic environment.

Based on the conclusions of this article, the following inspirations can be summarized: firstly, be vigilant about the technological dependence and low-end technology transfer of foreign-funded enterprises, maintain investment and research and development in high-tech, increase the attraction of high skilled talents, and increase education and research

institutions. Independent innovation has always been an important engine for achieving industrial upgrading. The Chinese government should increase research and development investment in green innovation, actively improve its own innovation capabilities, and break the dilemma of low levels of independent innovation; Secondly, maintaining the coordination of urbanization level, improving the level of supporting infrastructure, improving local transportation and communication facilities, establishing a more complete industrial chain cluster, accelerating the research and promotion of green innovation, and implementing differentiated strategies based on parameters such as industrial technology complexity and environmental sensitivity; Establish a sound environmental regulatory system, adhere to the maintenance and protection of the ecological environment, prevent the destruction of green ecological balance for short-term low value-added production, pay attention to the new regulatory framework represented by "carbon trading" internationally, and achieve new breakthroughs in green innovation; Establish a healthy and sustainable market environment, increase protection of intellectual property rights, avoid foreign enterprises from squeezing local enterprises with technological and management advantages, and enhance the competitiveness of local enterprises; Establish a domestic and international dual circulation system, expand the domestic market demand and market size, while enhancing international influence.

## References

- [1] Lenonard H J. Are Environmental Regulations Driving US industries Overseas?IML.Washington D C: Conservation Foundation. 1984:226-297.
- [2] Friedman J.What attracts foreign multinational corporations? Evidence from branch plant location in the United States [J]. *Journal of Regional Science*,1992(32):403-418.
- [3] Dinda S. Environmental Kuznets curve hypothesis: a survey[J]. *Ecological economics*, 2004, 49(4): 431-455.
- [4] Hansen B E. Threshold Effects in Non-dynamic Panels: Estimation, Testing, and Inference[J]. *Journal of Econometrics*, 1999, 93(2): 345-368.
- [5] Chang Dunhu, Miao Qi, Yuan Jiaqian, etc Carbon emissions of countries along the "the Belt and Road": analysis of the joint impact of foreign direct investment and development factors [J]. *Environmental Science Research*, 2022,35 (07): 1556-1563.
- [6] Pan Wenqing The spillover effects of foreign investment on China's industrial sector: an analysis based on panel data [J]. *World Economy*, 2003 (06).
- [7] Dinda S. Environmental Kuznets curve hypothesis: a survey[J]. *Ecological economics*, 2004, 49(4): 431-455.
- [8] Zhang Wenbin, Deng Ling Research on the Impact of China's Outward Foreign Direct Investment on Carbon Productivity [J]. *East China Economic Management*, 2019, 33 (11): 78-85.
- [9] Liu Chuanjiang, Hu Wei Has foreign direct investment improved China's carbon productivity—— Empirical analysis based on spatial panel Durbin model [J]. *World Economic Research*, 2016 (01): 99-109+137.
- [10] Deng W, Meng T, Kharuddin S, et al. The impact of renewable energy consumption, green technology innovation, and FDI on carbon emission intensity: Evidence from developed and developing countries[J]. *Journal of Cleaner Production*, 2024, 483: 144310.