

# Study on the Impact of FDI on Environmental Pollution in Hebei Province

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**Abstract:** In recent years, with the further development of economic internationalization, the scale of foreign direct investment continues to expand, and the pace of free flow of global funds is further accelerating. At the same time, FDI has also had many positive effects on the host country, including leading scientific and technological level and leading enterprise management skills. However, at the same time, the impact of foreign direct investment on China's economic development environment has attracted more and more attention. The "pollution paradise" hypothesis points out that foreign direct investment has a serious impact on the natural environment of the host country, while the "pollution halo" hypothesis points out that foreign direct investment has also produced a certain improvement effect on the natural environment of the host country. Based on some data of Hebei Province from 2010 to 2020, this thesis selects FDI, the proportion of tertiary industry and trade openness in Hebei Province as explanatory variables, and selects the intensity of environmental pollution in Hebei Province as explanatory variables. Then through three research methods, the first is literature research, data analysis and empirical analysis. Through the above research methods, this thesis analyzes the impact of FDI on environmental pollution, summarizes and finds that FDI can improve environmental pollution in Hebei Province, and finally puts forward some feasible suggestions.

**Keywords:** Foreign direct investment, Industrial pollution, Sulfur dioxide.

## 1. Background

In 2019, the Ministry of Ecological Environment, the National Development and Reform Commission, the Ministry of Industry and Information Technology, and the Department of Finance issued the Implementation Plan for Comprehensive Treatment of Atmospheric Environmental Pollution in Industrial Production Furnaces. The Implementation Plan also stipulates that by 2022, the comprehensive assessment and management system for environmental pollution of iron and steel production kilns will be comprehensively improved, the target emissions of smelting kilns will be promoted, and the emissions of sulfur dioxide, nitrogen oxides, ultrafine dust and other pollutants from industrial production will be gradually reduced; Reasonably adjust the total carbon dioxide emissions of key industries such as building materials, continuously improve the quality of environmentally friendly air, and promote the effective development of the industry. According to the China Statistical Yearbook and the statistics of the Ministry of Commerce, the amount of foreign direct investment has been increasing in recent years, while the coastal areas of Hebei Province are more likely to attract foreign direct investment. Therefore, through the analysis of the scale of FDI in Hebei Province, this paper obtains the relationship between FDI and environmental pollution in Hebei Province, as well as the correlation between FDI and major pollutants.

The theoretical significance of this paper is to conduct an empirical analysis of FDI in Hebei Province, which provides new evidence for the pollution refuge hypothesis and pollution halo hypothesis. In practical application, FDI is the main form of transnational investment in the world. It can promote the development of domestic enterprises. Investing in various ways can speed up the structural adjustment of domestic enterprises and the transformation of domestic markets. However, if we blindly invest, ignoring other factors, ignoring the impact on the environment, and damaging the

ecological environment, long-term development will not pay off. Through the analysis of the impact of foreign direct investment on environmental pollution in Hebei Province, we can make further research on the policy of attracting foreign investment, especially the policy of environmental protection, which provides some reference for the decision-makers in Hebei Province when formulating new energy and environmental protection policies.

## 2. Literature Review

### 2.1. Research status at home and abroad

#### 2.1.1. Based on threshold effect

Yanling Zhang (2020) selected 30 provinces and cities in China and applied the per capita income, human capital and technological innovation of FDI's impact on China's environment to the threshold panel regression method for analysis. The results show that, in the case of low human capital level, the increase of FDI will cause environmental degradation, while the continuous improvement of human capital level will gradually improve the degree of environmental degradation, and the negative impact of FDI on the environment will also be reduced. However, the negative effects are still obvious [1]. Jie Yang and Ye Xiaorong (2016) conducted an empirical study on the threshold effect of FDI on environmental pollution based on the regional statistical data of China from 2000 to 2011, and found that there was a double threshold effect when the comprehensive assessment index of environmental pollution was used as the explanatory variable; In China, the introduction of FDI is mainly reflected in promoting the environment [2]. Kang Yimin (2019) used the threshold regression model. When the system quality is less than the specified level, the higher the total foreign trade volume, the more serious the pollution problem. But when the system quality exceeds the specified level, the effect of foreign trade on environmental pollution is improved [3].

### 2.1.2. Based on the pollution halo hypothesis

Khan Muhammad Azam et al. The empirical research results show that there is a two-way relationship between carbon dioxide emissions and the inflow of foreign direct investment, and economic policy reform is needed to guide the inflow of foreign capital to a healthier environmental direction [12]. Dujia and Ding Jiayun (2016) used GMM method to discuss the interaction of FDI, environmental pollution and economic growth from the data of provinces from 2004 to 2014. The results show that foreign direct investment can not only promote economic growth, but also improve the environment [4].

### 2.1.3. Based on the pollution shelter hypothesis

Kerry (2020), based on the systematic analysis and research on the scale and structure of FDI, established the theoretical relationship between FDI and the environment, and proposed the negative impact of FDI on the environment [[5]. Qianqian Liu et al. (2018) used global and local spatial autocorrelation measures to study the spatial agglomeration effect and dynamics of 285 cities in China in terms of FDI and environmental pollution from 2003 to 2014. The results show that there is a clear spatial correlation between FDI and pollution level, and there is a clear path dependence in their geographical distribution, that is, the high value concentration area and low amount concentration area of FDI are not consistent with the environmental pollution concentration area. As a result, the inflow of FDI has reduced waste soot and dust pollution to a certain extent, but increased environmental pollution, wastewater and sulfur dioxide pollution [13]. GUO Zheng et al. (2021) took the three continents of the Yangtze River as the study area, and carried out statistical analysis on panel data of 26 cities from 2004 to 2017. The spatial accumulation effect of FDI and SO<sub>2</sub> emissions was analyzed by using relevant international and local indicators. It was found that FDI and SO<sub>2</sub> emissions have significant spatial correlation. FDI has a significant impact on SO<sub>2</sub> emissions, and FDI can promote SO<sub>2</sub> emissions [14].

## 2.2. Literature review

To sum up, there are two viewpoints, one is the pollution halo hypothesis, the other is the pollution shelter hypothesis. There is no unified conclusion either at home or abroad. Because there is no unified definition of the evaluation criteria for environmental pollution in the academic community, different research objects and different variable indicators will produce different results. There are several

views on the above literature.

First, there are more and more studies on the environmental threshold effect of FDI, which has been deeply discussed by scholars and included into the internal factors, and the environmental impact of FDI has been analyzed using the threshold panel regression method. For China, to understand the relationship between foreign direct investment and the environment, we must understand the current development level of China, and we cannot ignore the damage of FDI to the environment. In my opinion, with the progress of science and technology and the improvement of education, attracting foreign direct investment will improve environmental pollution. Of course, environmental pollution is also affected by many factors, and empirical research is needed.

The second aspect is that the selection of some environmental pollution indicators in some literatures is relatively simple. From the selected pollution indicators, most of the data are analyzed by selecting several pollutants, so the conclusions are not representative, because only a few pollutants can hardly reflect the true degree of pollution.

The third aspect focuses on linear analysis, but the nonlinear analysis of threshold effect is relatively rare. Their research focuses on the above two levels, making great contributions to the study of the relationship between the two. In most of the literature, the impact of foreign investment on the environment has been mentioned, but no detailed analysis has been made of other impacts, that is, individuals have their own views.

## 3. Model Settings

Due to the development of economy and society, people's demand for environmental protection is getting higher and higher, and the impact of FDI on environmental protection will become greater and greater. There are many factors that affect environmental pollution, and there is more than one explanatory variable at this time. Therefore, for the model setting, the models used by various scholars are different. This paper adopts the model setting of Curry (2020) and makes some changes.

The specific model settings are as follows:

$$Y = \beta + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + e_t$$

Y represents pollution emission intensity, X<sub>1</sub> represents foreign direct investment in Hebei Province, X<sub>2</sub> represents the proportion of the tertiary industry, and X<sub>3</sub> represents trade openness.

**Table 1.** Variable Measurement Table

Variable Type	Variable name	Variable measures
Interpreted Variable	Environmental pollution intensity Y	Industrial sulfur dioxide emissions/GDP of Hebei Province
Core explanatory variables	Hebei Foreign Direct Investment X <sub>1</sub>	Foreign direct investment in Hebei Province The proportion of actual utilization of foreign direct investment in Hebei Province to GDP of the whole province
	Proportion of tertiary industry X <sub>2</sub>	Proportion of GDP of tertiary industry in GDP of Hebei Province
Explanatory variable	Trade openness X <sub>3</sub>	Hebei's total import and export volume accounts for the regional GDP

## 4. Measurement Result Analysis

### 4.1. Data inspection

#### 4.1.1. ADF inspection

In order to prevent the occurrence of false regression due to the instability of the time series, the conclusion is invalidated. Therefore, in order to make the regression meaningful, before the demonstration, the stability of the selected series should be checked to see whether the series to

be analyzed is stable. If it is not stable, phase 1 difference or phase 2 difference should be implemented. The most common way to check the stability of data is the unit root test. This paper will use the ADF test method to check the stability of data. It is recorded below that  $X_1$  represents the foreign direct investment in Hebei Province,  $X_2$  represents the proportion of GDP in the tertiary industry, and  $X_3$  represents the openness to trade.  $Y$  is the environmental pollution intensity of Hebei Province. The inspection results are as follows:

**Table 2.** Unit root test of time series data

ADF inspection	t-Statistic	Level of significance	critical value	Whether it is stable
$X_1$	-3.103665	1% level	-5.295384	NO
		5% level	-4.008157	NO
		10% level	-3.460791	NO
$X_2$	-1.887024	1% level	-5.295384	NO
		5% level	-4.008157	NO
		10% level	-3.460791	NO
$X_3$	-6.025783	1% level	-2.816740	Yes
		5% level	-1.982344	Yes
		10% level	-1.601144	Yes
$Y$	-3.015426	1% level	-2.816740	Yes
		5% level	-1.982344	Yes
		10% level	-1.601144	Yes

From the results of ADF test, we can see that the proportion of foreign direct investment and the tertiary industry in Hebei Province is a non-stationary series, while  $X_3$  trade openness and pollution emission intensity  $Y$  are stationary series. However, the precondition of cointegration analysis is that after the same difference operation, the result is stable. Therefore, in the later research, we will exclude the variable

trade openness and environmental pollution intensity, and focus on the proportion sequence of foreign direct investment and the tertiary industry in Hebei Province. In the following, we first make a second-order difference on the proportion of foreign direct investment and the tertiary industry in Hebei Province to do a sequence stability test. The inspection results are shown in the following table.

**Table 3.** Unit Root Test of Second Order Difference of Time Series Data

ADF inspection	t-Statistic	Level of significance	critical value	Whether it is stable
$X_1$	-4.213568	1% level	-2.937216	Yes
		5% level	-2.006292	Yes
		10% level	-1.598068	Yes
$X_2$	-5.369617	1% level	-2.937216	Yes
		5% level	-2.006292	Yes
		10% level	-1.598068	Yes

From the results of ADF test, we can see that the proportion of foreign direct investment and the GDP of the tertiary industry in Hebei Province are both second-order single integration series, indicating that there may be a cointegration relationship between the two. Therefore, we can estimate the regression model and analyze the long-term equilibrium relationship of these two variables according to Engel and Granger's cointegration method (i.e. EG test).

#### 4.1.2. Cointegration analysis

In 1987, Granger put forward the concept of cointegration analysis, among which EG test and Johansen test are the most commonly used. This paper will carry out cointegration test on variables  $X_1$  and  $X_2$  through the EG two-step test.

The first step is to make cointegration regression with  $X_1$  as the explanatory variable and  $X_2$  as the explanatory variable. The resulting residual sequence is:

$$X_1=0.712070+0.027066X_2+e_t$$

The second step is to test the stationarity of  $e_t$ , and perform ADF detection without intercept term and trend term for the sequence. It can be seen from the results that under the significance level of 1%, 5% and 10%, the P value of the residual sequence  $e_t$  is 0.0008, and the assumption of unit root is rejected. The residual sequence is stable, so there is a long-term cointegration relationship between variables  $X_1$  and  $X_2$ . Therefore, there is a long-term equilibrium relationship between foreign direct investment and the proportion of GDP in the tertiary industry in Hebei Province, so there is no pseudo regression phenomenon in the regression of this time series.

#### 4.1.3. Result analysis

It can be seen from the above test results that there is no pseudo regression phenomenon in this time series. Next, the least square method (OLS) will be used for overall regression. The regression results are as follows:

**Table 4.** Overall Regression Results of Original Data

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	177.3464	33.41508	5.307375	0.0011
X <sub>1</sub>	-97.0647	22.3902	-4.335141	0.0034
X <sub>2</sub>	0.371412	0.499535	0.743515	0.4814
X <sub>3</sub>	5.524454	1.535773	3.597182	0.0088
R-squared	0.988078	Mean dependent var		35.59909
F-statistic	193.3839	Durbin-Watson stat		1.863812

It can be seen from the above table that the proportion of X<sub>2</sub> tertiary industry is not significant, so the following table

shows the results after removing the variable X<sub>2</sub> and doing a least square regression:

**Table 5.** Final Regression Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	169.4196	30.77084	5.505847	0.0006
X <sub>1</sub>	-84.42783	14.16254	-5.961349	0.0003
X <sub>3</sub>	5.561158	1.491461	3.728665	0.0058
R-squared	0.987137	Mean dependent var		35.59909
F-statistic	306.9579	Durbin-Watson stat		1.594410

According to the above table, the results of parameter estimation and test are as follows:

$$Y = 169.4196 - 84.42783X_1 + 5.561158X_3$$

$$(30.77084) (14.16254) (1.491461)$$

$$t = (5.505847) (-5.961349) (3.728665)$$

$$R^2 = 0.987137 \quad R = 0.983921 \quad F = 306.9579 \quad n = 11$$

The prediction results of the model show that under the condition that other variables remain unchanged, the proportion of the actual use of foreign direct investment in Hebei's GDP will increase by 1%, and the sulfur dioxide emissions in Hebei Province will decrease by 84.42783% on average; The proportion of total import and export of Hebei Province in GDP will increase by 1%, and on average, the sulfur dioxide emission of Hebei Province will increase by 5.561158 percentage points. Among them, the proportion of the tertiary industry is not significant when the significance level is 5%, indicating that the proportion of the tertiary industry has little effect on the emission of environmental pollutant sulfur dioxide.

## 5. Conclusions and suggestions

Through a series of empirical analysis, this paper draws the following conclusions: First, OLS regression analysis shows that the regression coefficient of variable X<sub>1</sub> is -97.06470, and the empirical analysis result is negative, that is, there is a negative correlation between foreign direct investment and the environment of Hebei Province. That is, if the ratio of FDI to GDP in Hebei Province increases by 1%, the SO<sub>2</sub> emissions in Hebei Province will decrease by 97.06470 percentage points. Second, with the increase of openness, it can also reduce the emission of industrial sulfur dioxide and other pollutants, which will reduce the local environmental pollution in Hebei Province. On the other hand, the increase of trade brought about by openness can also promote the development of industry, improve the environmental quality and reduce environmental pollution. Third, from the above regression results, the proportion of the tertiary industry is not significant in this model. The reason may be the political, economic, social and other complex factors that China implements cost control. Although the regression results show that the proportion of the tertiary industry in sulfur

dioxide emissions in Hebei Province has little effect, we still need to optimize the industrial structure if we want to achieve high-quality economic development, or it will still bring a series of environmental pollution problems.

Based on the above conclusions, the following suggestions are put forward: First, in the process of introducing FDI, Hebei Province should be targeted and selective, transfer the amount of foreign capital to the quality, and correctly handle the relationship between attracting foreign capital and stimulating economic development. Second, we can optimize the source structure of foreign direct investment and increase investment in some countries with advanced technology and good technology spillover effects. Third, the specific approach to Conclusion 3 can be to optimize the secondary industry and cultivate a group of enterprises with high science and technology, high pollution treatment technology and high added value. For these enterprises, the government can increase support, and then let these enterprises lead other enterprises to become green and environmentally friendly enterprises.

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