

# *A Research about the Relationship between Environmental Protection, FDI, R&D and the Progress of the Secondary Industry Based on Panel Data*

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**Abstract:** This research explores how the investments in environmental pollution treatment influence the local industry development, considering both the foreign and the scientific research, the two important factors to use data from 2009 to 2018 to establish econometric model, and draws the following conclusions: in general, this paper argues that environmental regulation has a promoting effect to regional industrial development; in the east and the middle of China, investment in scientific research plays a significant role in promoting industrial development, but has an inhibitory effect in the west; foreign investment encourages industrial development only in the western region; investment in environmental protection and governance in the western region is negatively correlated with foreign investment, and investment in environmental protection and governance and scientific research in the central region are also negatively correlated. Finally, policy suggestions are proposed based on the conclusions.

## 1. Introduction

### 1.1. The Research Background

Over the four decades since the reform and opening up in 1978, China's economy has grown by leaps and bounds. According to the data of TRADING ECONOMICS (2018), the gross domestic product (GDP) of China was 13608.15 billion US dollars in 2018. This value of China have occupied 21.95% of the world economy. Industries have contributed a lot to the GDP in China, the industry sector occupy 40.7% of the total GDP in China in 2018. However, When the economy and industry develop rapidly, the environment suffers from pollution. China's environmental pollution problem has gone hand in hand with industrialization. With the continuous expansion of industrialization and the rapid development of heavy industry, environmental pollution spread from cities to rural areas, such as vegetation destruction, land degradation, air pollution and so on. According to the 2018 Environmental Performance Index (EPI) data, China's EPI ranks 120th in the world. This shows that

China's environmental quality needs to be improved. As we pursue a high-quality life, we should not only have material satisfaction, but also protect the environment.

## 1.2. Significance of Research

As we pursue the high quality of life, we also need to protect our environment, so that we can achieve sustainable industrial development. When implementing environmental regulation, the regulated party (in this case, industrial factories) may be affected either positively or negatively. Good environmental policies can achieve win-win results in industrial development and environmental governance. Therefore, in order to find the appropriate intensity of environmental regulation, it is necessary to explore the relationship between environmental regulation and industrial development. At the same time, the two factors of scientific research investment and foreign investment are taken as the factors influencing industrial development, and the correlation between the two factors and environmental regulation is explored to provide a basis for formulating policies in different regions. Currently, there are many literatures exploring the influencing factors of industrial development, focusing on foreign trade, capital accumulation, innovation investment, financial development and fixed asset investment. There are also literatures on environmental regulation on industrial development, which are mainly divided into three categories: inhibition theory, promotion theory and uncertainty theory. But few literatures consider environmental regulation, foreign investment and research investment at the same time. Therefore, this paper will evaluate the effect of environmental regulation by studying the relationship between environmental regulation and industrial development. Based on the inter-provincial data from 2009 to 2018 (except Hong Kong, Macao and Taiwan), the effects of environmental regulation on industrial development were measured through empirical analysis. The effects of environmental regulation, foreign investment and scientific research investment on industrial development and foreign investment and scientific research investment on environmental regulation were also investigated vertically. Horizontal exploration of the impact of different regions to different degrees, based on the conclusions of different regions to formulate policies for each region and provide suggestions.

## 2. Literature Review

### 2.1. Relationship between Environmental Regulation and Economic Growth

The research of the impact of environmental regulation on economic development are mainly divided into three categories: "the theory of promotion", "the theory of inhibition" and "the theory of uncertainty". Firstly, the "the theory of promotion". Porter's "Porter Hypothesis" proposed that reasonable environmental regulation can encourage enterprises to innovate constantly and improve scientific and technological innovation, thus promoting the improvement of productivity and supply. Such long-term profits can offset short-term costs, known as "innovation compensation theory". Carnegie Mellon University (2017)[1] investigated through county-level economic indicators, pollution levels and population data, figured out that reasonable and well-designed environmental regulation policies can not only avoid hindering economic growth and innovation, but also effectively reduce pollution.

The second is the "inhibition theory". Neoclassical economists believe that stronger environmental regulation policies will increase the production cost of enterprises and increase the price of products, thereby reducing the market price advantage, reducing competitiveness and bringing negative impact on economic growth. This is called the "compliance cost theory". Other studies have shown that environmental regulation has a negative impact on economic growth.

The third is “uncertainty”. Xia Haili (2019)[2], by studying the time dimension of environmental regulation, showed that environmental regulation would reduce economic output and national savings in the short term, thus reducing social fixed capital and adversely affecting economic growth. But in the long run, as enterprises continue to carry out scientific and technological innovation, improve production efficiency and promote economic growth. Zhang Tongbin (2017)[3] found that high-intensity environmental regulation can promote enterprise innovation and shift from short-term cost loss to long-term benefit.

## **2.2. Factors Influencing Industrial Growth**

There are some literatures about factors of influencing industrial growth, they are mainly about capital investment, FDI, labour force, imports and exports. Taking Zhundong development zone in Xinjiang as the research object, Zhou Yamin[4] found that amount of coal mining, amount of electricity, tax revenue, budget revenue and fixed asset investment all promoted industrial economic growth. Xu Rui and Liu Jun (2015)[5] found that inputs of physical capital, such as machinery or equipment, promote economic creativity.

## **2.3. Relationship between Environmental Regulation and Industrial Development**

Research conclusions can be divided into three categories: inhibition, promotion and uncertainty. Firstly, the theory of inhibition, according to the research of Ji Yongjie and Xu Jintao (2006)<sup>6</sup>, they found that for small businesses, environmental regulations are bad for industrial growth. Due to the strong pressure of environmental regulation, small enterprises cannot cope with the cost of environmental regulation. Gray (2001)[7] found that because of environmental regulations, factories spend some of their money on pollution control, which studies show reduces TFP growth rate. Secondly, the theory of uncertainty. Li Ying et al. (2019)[8] showed that there was a ‘u-shaped’ relationship between the intensity of environmental regulation and industrial TFP. This is because, when the intensity of environmental regulation is low, it causes less pressure on enterprises. When the intensity of environmental regulation increases, the cost of pollution control is higher, leading to a decline in profits. Hence industries need to improve production techniques to increase TFP.

## **2.4. The Literature Review**

In the above researches on environmental regulation and industrial development, the theoretical basis is very plentiful, the model establishment and empirical analysis are very rigorous, and the conclusions obtained are very convincing. But there are still some drawbacks. First of all, most of the literatures come to a unified conclusion or only analyze the situation of one region, while few literatures analyze different regions separately and set up conclusions and suggestions for different regions. Because the development degree and technology degree of different regions are different, the conclusion of classification discussion is very convincing and comprehensive. Secondly, most of the literatures directly studies the relationship between environmental regulation and the factors influencing industrial development. There are few literature studies on the correlation between research investment, foreign investment and environmental regulation. Therefore, this paper will discuss the influence of environmental regulation, foreign investment and scientific research investment on industrial development, as well as the correlation among foreign investment, scientific research investment and environmental regulation.

## **3. Data Analysis and Specification of Model**

### 3.1. Variable Selection and Descriptive Statistics

Su Hui (2011) [9] used the gross regional industrial product to reflect the growth of industrial economy. Guan Chao (2019)[10] uses industrial economic development to reflect industrial development by measuring the production capacity and profitability of industrial economy in each region. Du Chuanzhong (2010) used system productivity as the measurement index, and lv Yuye (2013) used the growth rate of industrial added value to measure industrial growth. The data from CNKI China hownet scale of economic and social development statistical database - more than gross value of industrial output (unit: ten thousand yuan) The higher the index means the industry to develop more rapidly.

Wang hao (2015) [11] used amount in emission of different pollutants in different industries to measure environmental regulation intensity. Yang Baibing and Yao Xiaoming (2019)[12] mainly calculated the emissions of industrial wastewater, industrial SO<sub>2</sub> and industrial soot. Zha Jianping (2014) and Li Pengyu (2014) considered sulfur dioxide, waste water, solid waste, dust and other indicators comprehensively.

For the measurement of foreign capital power, foreign direct investment (FDI) is used in most existing literatures. Considering the completeness of the research data in terms of region and year, the total investment (FDI) of foreign-invested enterprises registered in each province at the end of the year is used to reflect the strength of the foreign capital power. The data comes from CSMAR National tai 'an database (unit: us \$100 million), the larger the index, the stronger the regional foreign capital.

Most literatures have used is funding research and experimental development (R&D), so this article also use funds research and experimental development (RD) as a measure of scientific research factors affecting industrial index. The data from the national bureau of statistics (unit: one hundred million yuan), the indicator, the greater the industrial scientific research strength, the greater the representative area.

By considering the regional differences, 31 provinces are divided into eastern and western regions according to the classification of economic and social development statistical database of cnki in this essay. Panel data are used in this essay. In the empirical process, more accurate model types are determined according to the redundant fixed effect test (LR) and Hausman test. Because using exponential can improve the stability of the data and also the probability of multicollinearity and heteroscedasticity will decrease and will not change the correlation data. The purpose of this essay is to explore the relationship among environmental regulation, foreign investment, scientific research and also how these three factors influence on the development of the industry. In order to measure the relationship of the three, the introduction of two cross terms, eventually establish metrological multivariate regression simultaneous equation, the specific equation is as follows:

$$\ln Y_{it} = C + \alpha_1 \ln EPI_{it} + \alpha_2 \ln FDI_{it} + \alpha_3 \ln RD_{it} + \alpha_4 \ln EPI_{it} * \ln FDI_{it} + \alpha_5 \ln EPI_{it} \quad (1)$$

$$* \ln RD_{it} + \alpha_6 \ln FDI_{it} * \ln RD_{it} + \alpha_7 \ln IEAA_{it} + \alpha_8 \ln IEA_{it} + \varepsilon_{it} \quad (2)$$

### 4. The Empirical Results

On the selection model effect, taking the national data as an example, the P value of the redundancy fixed effect test was 0.0000, so FE was selected. Further Hausmann test found that the P value was 0.0000, and it was more accurate to continue to select FE. Table 1 directly presents the most accurate model regression results after the test:

Table 1: Empirical Results

	National data	Data in the east	Data in the middle	data in the west
Model	FE	FE	FE	FE
LOG(EPI)	0.073451*** (2.860230)	-0.279345 (- 1.923342)	0.875849* (1.658258)	0.147015** (3.0154170)
LOG(FDI)	0.196627*** (2.759899)	0.006270 (0.0150102)	-0.654849 (-1.233278)	0.523015** (1.996343)
LOG(RD)	0.166862*** (0.860082)	0.621627** (1.514161)	0.932834** (2.532191)	-0.297198*** (-1.775069)
LOG(IEEN)	0.570684* (6.619760)	0.483134* (- 3.401328)	0.399652* (3.746387)	0.029299 (0.193360)
LOG(IEA)	0.678684* (12.44924)	0.587957* (- 6.294037)	0.752844* (5.994492)	0.852522* (6.372371)
LOG(EPI)*LOG(FDI)	-0.010252 (-0.712543)	0.029957 (1.021249)	-0.001957 (-0.021678)	-0.072520*** (-1.647145)
LOG(EPI)*LOG(RD)	0.011578 (1.044296)	0.016784 (0.621365)	-0.182339* (-4.381658)	0.032521 (2.913664)
LOG(FDI)*LOG(RD)	-0.083445 (0.1008)	-0.064835** (-2.298398)	0.172167* (3.948426)	0.057667* (3.013647)
C	2.677727* (3.750394)	5.828727* (- 3.253336)	-0.341415 (- 0.126499)	4.171251* (3.291730)
LR Test (P Value)	21.811429 (0.0000)	19.841836 (- 0.0000)	34.101255 (0.0000)	7.848231 (0.0000)
Hausman Test (P Value)	72.813219 (0.0000)	37.803668 (- 0.0000)	246.434437 (0.0000)	54.269275 (0.0000)
R-squared	0.881416	0.819218	0.967784	0.902914
Adjusted R-squared	0.912161	0.912410	0.945570	0.869133

Note: the corresponding t value is shown in brackets. \*, \*\*, and \*\*\* represent passing the significance test at the levels of 1%, 5%, and 10%, respectively.

According to the model, LOG(EPI) is positive and prominent in both midland and western which means increasing environmental regulation investment will increase the total regional industrial output. It can be concluded that environmental regulation and industrial development play a promoting role in the central and western regions. However, LOG(EPI) is negative in eastern which means environmental regulation inhibit the industrial development. This maybe because in eastern industry is in a short period, and the environmental regulation has not been effective to reduce the environmental protection cost of enterprises according to the cost theory.

As for the impact of foreign direct investment on industrial gross product, according to the data, LOG(FDI) is positive for both eastern and western regions. The effect was not significant in the eastern part of the country due to the small number. For the western region, the value was significant, indicating that FDI had a positive effect on the gross industrial product. The reason may be that the natural environment and transportation in the western region restrict the introduction of foreign resources, so the increase of FDI can play a significant role in promoting the industrial gross product of the western region.

As for research & development, from the model, RD has a significant impact on the east, the

middle and the west. For the east and west, LOG (RD) is positive, so RD promotes the growth of industrial output in the east and west. However, for the west, LOG (RD) is negative, so RD has an inhibitory effect on the industrial output in the west. The reason may be that the eastern and central regions have a higher degree of scientific and technological development, and it is useful to use RD to promote industrial development, while the western regions lag behind in development, the infrastructure has not yet been improved, and the investment in scientific research is temporarily ineffective for the western regions.

As for the cross terms, for the LOG(EPI)\*LOG(FDI), the data of the whole country shows a negative value. In the western region, the negative value is more significant, which indicates that the combined effect of EPI and FDI will have a negative effect on the gross industrial product. Although both have negative effects, EPI and FDI separately promote industrial gross product. Therefore, the separate promotion effect of EPI and FDI offset the inhibition effect brought by foreign investment and environmental regulation, hence it won't have a big impact on the whole.

For LOG(EPI)\*LOG(RD), the values are positive in the west and east, and negative in the middle. This shows that the combined action of EPI and RD has a negative effect on the industrial development of the central region. The reason may be that the 'porter hypothesis' is not true in the middle of the country. The porter hypothesis refers to the fact that proper environmental regulation can encourage enterprises to conduct more scientific innovation, which will increase the productivity of enterprises and thus offset the cost of environmental protection. Through the data of the central region, it is shown that environmental regulation cannot promote the innovation of scientific research in enterprises. The second reason is the representative index of "research and experimental development expenditure" is general, which is not specific enough to the environment-related industries.

By analyzing the data of LOG(FDI)\*LOG(RD) in the eastern, central and western regions, we conclude that the combined effect of FDI and RD has a significant impact on the three regions, negatively affecting the eastern region, but promoting the central and western regions. This may be because the eastern region has more foreign investment than the central region and the western region, and too much foreign investment may make enterprises rely on the introduction of technology so as to be satisfied with the current circumstances and reduce the investment in scientific research. Foreign investment may also stifle innovation through market competition or resource grabs. For the central and western regions, the economic development is relatively backward compared with that in the east, so the investment in scientific research and foreign investment complement each other, promote each other and boost the development of regional industry. Moreover, foreign investment can relieve the capital difficulties of enterprises in the central and western regions to a great extent.

## 5. Conclusion

This paper is based on panel data from 2009 to 2018, studies the relationship between environmental regulation and industrial growth. At the same time, it also explores the relationship among foreign investment, scientific research investment and environmental regulation. The following conclusions are drawn:

In terms of the whole country, investment in environmental regulation can promote industrial growth which means the total industrial output value of the region will increase with the increase of investment in regional environmental pollution control. However, there are great differences in different regions, such as the negative impact between the two in the eastern region. Foreign direct investment plays an important role in promoting industrial growth in the eastern and western regions, especially in the western regions. That is to say, with the increase of foreign investment, the total

industrial output value of the region will increase accordingly. However, for the central region, foreign investment plays a restraining role in the growth of industrial output value. There is a negative correlation between environmental governance investment and foreign investment in the western region, which shows that both of them work together to restrain the growth of industrial output value.

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