

# *The Impact of Economic Environmental Regulations on Industrial Firms' Technological Innovation - An Empirical Study Based on the Eastern Region*

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**Abstract:** While enterprises continue to develop, they have caused certain damage to the ecological environment, and studies have shown that technological innovation is beneficial to the protection of the ecological environment. Can environmental regulations promote technological innovation? And does heterogeneity exist among different environmental regulations on technological innovation? These two questions are of great academic importance for guiding enterprises to achieve their technological innovation goals and promoting the government to formulate a unified and effective environmental regulation strategy. In this paper, based on the panel data of 13 provinces and cities in the eastern region of China from 2012-2021, regression analysis is conducted using STATA software to study the impact of economic-type environmental regulations on industrial enterprises' conducting technological innovation. The results show that: cost-based environmental regulations have a relatively obvious hindering effect on industrial enterprises to carry out technological innovation, and cannot effectively promote enterprises to sustain product and technological innovation within the system; investment-based environmental regulations have long-term benefits on industrial enterprises to carry out technological innovation, and can enhance the motivation of enterprises to carry out technological innovation.

## **1. Introduction**

After the reform and opening up, all kinds of enterprises have flourished, and the market vitality of enterprises has become stronger and stronger. In the whole process of promoting the sustainable development of China's enterprises, the traditional economic development model has been followed, which has caused certain damage to the ecological environment. On the one hand, with the complicated and severe international ecological environment situation, environmental problems are becoming more and more serious constraints on the future economic development of China, and even become a strategic issue for the long-term development of China. On the other hand, enterprises discharge all kinds of pollutants in their development, which seriously damage the ecological environment of our country. Therefore, environmental issues have also become a major common challenge for our enterprises, forcing our enterprises to pay attention to the environmental

governance inside and outside the enterprise. How to protect the environment and at the same time enhance the ability of enterprise technology innovation has become an important issue that the government and enterprises need to solve together at present.

## 2. Literature Review

Traditional economics argues that environmental protection increases manufacturers' production costs and reduces firms' incentives for technological innovation<sup>[1]</sup>. Numerous scholars have taken a static perspective in which they argue that environmental regulations lead to higher production costs and hinder firms' technological innovation. However, the American scholar Porter (Porter) and others have challenged the traditional economics view of environmental protection from a dynamic perspective. Porter, who advocated environmental protection in 1991, argued that strict environmental protection policies can enhance the ability of firms to innovate technologically and make them more competitive in the marketplace<sup>[2]</sup>.

The proposal of Porter's theory has attracted the attention of many scholars at home and abroad. They have carried out careful and systematic research on the aspects of environmental regulation and technological innovation. The findings of the existing literature can be broadly divided into the following three views. First, environmental regulation can enhance the technological innovation ability of enterprises<sup>[3-6]</sup>. Second, in a market environment, environmental regulations have a significant inhibitory effect on firms' participation in various independent R&D and autonomous innovation activities<sup>[7-9]</sup>. Third, the impact of environmental regulations on firms' technological innovation is uncertain.<sup>[10-13]</sup>

The literature has provided a comprehensive analysis of the relationship between environmental regulation and technological innovation based on different research perspectives. Environmental regulation is usually studied as a whole, and there is no careful division of environmental regulation. Silvia et al. (2017) classified environmental regulation into market-based and command-and-control environmental regulation<sup>[14]</sup>. Xiong Hang et al. (2020) classified government environmental regulation into market-based incentive and command-and-control type<sup>[15]</sup>. Zhang Guoxing et al. (2021) added public participation type environmental regulation to this<sup>[16]</sup>. Chen, Liza (2021) classified environmental regulation into economic, regulatory and administrative punishment types<sup>[17]</sup>. Lu, Mengci (2021) classified environmental regulation into formal and informal environmental regulation<sup>[18]</sup>. Yuan, Yijun et al. (2013) studied economic-type environmental regulation from the macro perspective of investment in environmental protection and classified it into cost-type and investment-type<sup>[19]</sup>. Zhang et al. (2016) argue that cost-based regulatory instruments inhibit technological innovation of enterprises, while investment-based environmental regulations have social and environmental protection benefits and can enhance the innovation capacity and market competitiveness of enterprises<sup>[20]</sup>.

## 3. Research Design

### 3.1. Research Subject

This paper focuses on the impact of environmental regulations on technological innovation in the eastern region. The division of the eastern region is referred to Wang Mingyue et al. (2022), and 13 provinces and cities, including Heilongjiang, Jilin, Liaoning, Hebei, Beijing, Tianjin, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong, and Hainan, are considered as the eastern region.

### 3.2. Data sources and variable selection

The data selected in this paper are panel data of eastern provinces and cities in China for a total of 10 years from 2012-2021, and are obtained from the China Statistical Yearbook (2012-2021), China Environmental Statistical Yearbook (2012-2021), and Wind database.

(1) Explained variables.

Technological innovation: the higher the number of patent applications, the higher the innovation ability of the enterprise is represented. In this paper, the number of patent applications of industrial enterprises above the scale is used to measure technological innovation.

(2) Explanatory variables.

Environmental regulation: cost-based environmental regulation (FEE) is measured by the amount of sewage charges levied; investment-based environmental regulation (EINV) is measured by the total investment in industrial pollution control.

(3) Control variables.

According to the existing literature, technological innovation is not only influenced by environmental regulations, but also by other external factors. Therefore, three control variables are introduced in this paper, which are GDP per capita, industrial structure, and foreign direct investment.

### 3.3. Model Construction

This paper investigates the relationship between different types of environmental regulations and technological innovation in industrial firms. In order to avoid the effects of anomalous terms and heteroskedasticity on data smoothness, all variables are logarithmically treated and the final model is established as follows.

$$\ln Y_{it} = \alpha + \beta_1 \ln FEE_{it} + \beta_2 \ln EINV_{it} + \beta_3 X_{it} + \varepsilon_{it}$$

where  $i$  represents 13 different provinces and  $t$  denotes time,  $\alpha$  is a constant term,  $X_{it}$  is a control variable, and  $\varepsilon$  is a random disturbance term.

### 3.4. Descriptive statistical analysis

Table 1: Results of descriptive statistics for each variable

Variables	Sample size	mean	standard deviation	minimum	maximum
lnY	130.00	9.77	1.54	5.96	12.63
lnFEE	130.00	10.78	1.12	7.95	12.79
lnEINV	130.00	11.96	1.32	6.17	14.16
ln LnPer capita GDP	130.00	11.04	0.45	10.17	12.01
LnIndustry Structure	130.00	-0.99	0.31	-1.83	-0.64
lnFDI	130.00	12.23	1.20	9.95	14.83

## 4. Empirical Analysis

This paper uses STATA software to estimate the relationship between environmental regulation and technological innovation using a panel model. the Hausman test indicates that this paper should use a panel fixed effects model for multiple regressions, and the regression results are presented in

Table 2.

Table 2: Regression results

	<b>Technology Innovation</b>
LnFEE	-0.115** (-3.18)
LnEINV	0.0680* (2.51)
LnPer capita GDP	1.350*** (8.48)
LnIndustry Structure	0.888*** (3.45)
LnFDI	0.176** (3.29)
_cons	-5.973*** (-4.18)

\* Note: t statistics in parentheses, \*p<0.05, \*\*p<0.01, \*\*\*p<0.001

From the results of the empirical tests, the technological innovation of industrial enterprises is affected by environmental regulations. Among them, the regression coefficient of cost-based environmental regulations is -0.115. the regression coefficient of investment-based environmental regulations is -0.068. among the control variables, the regression coefficients of GDP per capita, industrial structure, and foreign direct investment are 1.35, 0.88, and 0.176, respectively.

For industrial enterprises above the scale, Emission levy is a short-term action implemented by the government to protect the environment, which can reduce the pollution emission of enterprises in the short term. However, the emission levy increases the production cost of enterprises to a certain extent, and enterprises are likely to be willing to pledge penalties to avoid investing in short-term technology research and development funds. Over time, cost-based environmental regulations will have a serious negative impact on enterprise technological innovation. Investment-based environmental regulation is a long-term governmental action to combat environmental problems. Investment-based environmental regulation is a long-term government action to combat environmental problems. With the strengthening of government environmental regulation, the methods and means for enterprises to cope with government environmental regulation will gradually become ineffective and eventually promote enterprise technological innovation.

## 5. Conclusions and Recommendations

This study illustrates that when formulating environmental regulation policies, the state and relevant governments should consider the differences between different types of environmental regulation policies and effectively formulate and implement relevant environmental regulation policies. In the comprehensive formulation of environmental regulation policies, on the one hand, we should continue to emphasize investment-based environmental regulation policies and encourage various types of environmental protection investments. On the one hand, it is necessary to establish a system of investment in environmental protection that can both fully realize environmental protection and continuously promote technological innovation. On the other hand, it is necessary to create a healthy and favorable economic environment for cost-based environmental regulation, to scientifically set standards for sewage charges, to refine the types of sewage charges for enterprises, and to standardize the management of the collection and use of various types of

sewage charges. In addition, strict environmental regulations by the government alone cannot fully realize environmental protection, and the society and enterprises need to strengthen scientific environmental awareness. The government should promote environmental protection in the whole society, but also encourage enterprises to actively carry out technological innovation to reduce pollution emissions, stimulate the sense of social responsibility and ownership of enterprises, and encourage the majority of enterprises to work together to build a beautiful home.

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