Study on the Impact of Environmental Regulation on Environmental Pollution

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\textbf{Abstract.} The Beijing-Tianjin-Hebei, Yangtze River Delta, and Pearl River Delta urban agglomerations were used as experimental groups, and other prefecture-level cities were used as control groups. Based on the annual monitoring values of pm2.5 in various cities in 2008-2016, the double-difference model was used to test the implementation effect of the Air Pollution Prevention Action Plan. The study found that the promulgation of “Ten of the Atmosphere” significantly improved the air quality of the Beijing-Tianjin-Hebei, Yangtze River Delta and Pearl River Delta urban agglomerations, and the emission reduction effect of the northern city pm2.5 was better than that of the southern cities, which may be common with winter heating in northern cities. The environmental pollution is more serious than in the south, and the policy effect is more significant. At the same time, environmental pollution has spatial relevance. It is necessary to strengthen regional collaborative governance, innovative mechanism measures, and play an important role in environmental pollution control in air pollution.

\textbf{Introduction}

The coordinated development of economic growth and environmental protection has always been one of the hot issues that many scholars have been studying. Since the reform and opening up, China has achieved sustained and rapid economic growth at the expense of the environment. At present, China's air pollution situation is very serious, mainly characterized by soot-type pollution. The concentration of total suspended particulate matter in urban atmospheric environment is generally exceeding the standard, and sulfur dioxide pollution is maintained at a high level; the natural environment is the basis for the survival and development of human society. Environmental protection is even more related to the fundamental interests of the people. It is closely related to the sustainable development of China's economy and the realization of the Chinese nation's great rejuvenation. During the "Thirteenth Five-Year Plan" period, China put forward five development concepts of "innovation, coordination, green, openness, and sharing." In 2013, the State Council issued the Action Plan for Air Pollution Prevention and Control, which requires that the concentration of pm2.5 in the Beijing-Tianjin-Hebei, Yangtze River Delta, and Pearl River Delta regions will fall by 25\%, 20\%, and 15\% respectively in 2017, including pm2.5 years in Beijing. The average concentration should be controlled at about 60 μg/m3. The report of the 19th National Congress of the Communist Party of China also clearly stated that it is necessary to speed up the reform of the ecological civilization system and build a beautiful China. In 2018, the State Council issued the "Three-Year Action Plan to Win the Blue Sky Defense War," which required a significant reduction in the total amount of atmospheric pollutants and further reduced the concentration of pm2.5. Although the country has introduced a number of measures to jointly improve environmental pollution, China's environmental pollution is still grim. Therefore, it is of great policy and research significance to explore the effect of environmental regulation on the intensity of air pollution.

\textbf{Literature Review}

Some scholars mainly studied the effectiveness of China's environmental regulation policies on
economic growth and pollution control. For example, Xu Zhiwei (2016) constructed a theoretical model of the “first pollution, post-governance” development model, arguing that industrial pollutant emissions will stimulate output growth. And the increase in output will lead to an increase in the intensity of environmental regulation, which proves that China's industry does have a development model of “first pollution, then governance.” However, due to the lack of investment in environmental regulation, the finishing effect of governance is not satisfactory, and it is only significant in the eastern region [1]. However, Zhu Xiangdong et al. (2018) used the panel data model and the spatial Dubin model to find that the air pollution in the study period has spatial dynamic consistency with polluting enterprises, and both show a trend of shifting to the eastern region. Local government competition will significantly increase the level of air pollution, while government regulation can significantly inhibit air pollution, but local high regulation will cause pollution in the surrounding areas, and technological progress can effectively reduce air pollution, but it has no spatial effect. At the same time, it is found that the inhibitory factor of air pollution is more effective than the aggravating factor, which can explain the development of pollution industry and the degree of air pollution is reduced to some extent [2].

Some scholars have studied the effects of heterogeneous environmental regulation on environmental pollution by classifying environmental regulations: Yan et al. (2017) divided environmental regulations into formal and informal environmental regulations. Using Hansen's “threshold regression” model test, it was found that the effect of formal and informal environmental regulations on pollution intensity is a “U” change. When the threshold value of GDP per capita is higher than the threshold of per capita GDP, the emission reduction effect of environmental pollution will appear, and there is a two-way transmission mechanism between the two major environmental regulations. At the same time, it is also found that when the per capita GDP is more than 6.9545 million yuan, the non-environmental regulation has a "rebound" phenomenon on the pollution reduction effect [3]. Fan Qingquan and Zhang Tongbin (2018) divide environmental regulation into two kinds of regulation policies: environmental tax and emission reduction subsidy. They believe that the optimal policy combination of dynamic environmental taxation and progressively decreasing dynamic emission reduction subsidy rate can increase the enterprise. The motivation for pollution reduction can also control the level of pollution accumulation in the environment. The implementation of only environmental taxes will lead to an “inverted U-type” pollution accumulation path, and excessive emission reduction subsidies may distort the allocation of production factors and thus fail to bring higher welfare levels [4].

In summary, domestic scholars have conducted some theoretical explorations and empirical research on government regulation, environmental pollution and spatial effects. However, the uniqueness of China's national conditions and policy diversity make the research still have a lot of space. The Beijing-Tianjin-Hebei urban agglomeration is one of the most serious areas of air pollution in China. The "Three-Year Action Plan to Win the Blue Sky Defense War" issued by the State Council in 2018 clearly states that it should be Beijing-Tianjin-Hebei, the surrounding Yangtze River Delta, and the Weihe Plain. The key areas are the main battlefields. Through three years of efforts, the concentration of pm2.5 and other pollutants will be significantly reduced, and the number of heavy pollution days will be significantly reduced. Therefore, based on the 2013 “Atmosphere Ten” environmental policy, this paper will further study the policy influence of this policy and the new “Atmosphere Ten” and explore the policies of Beijing-Tianjin-Hebei, Yangtze River Delta, Pearl River Delta and Weihe Plain. The degree of change in air pollution status, spatial correlation and spillover effects.

**Research Design**

**Model Design**

Based on the above analysis, this paper builds the following measurement model:

\[
Pm25it = \beta_0 + \beta_1dum_t + \beta_2dum_a + \beta_3dum_t * dum_a + \alpha Zit + \lambda t + \mu_i + \varepsilon_{it}
\]  

(1)
Among them, the explained variable is \( pm2.5 \), which measures the degree of environmental pollution, and \( i \) and \( t \) represent the prefecture-level city and year. The dummy variables \( dum_t \) and \( dum_a \) indicate whether they are in the policy area and whether they are after 2013. \( Z \) is the control variable, which has the second production ratio (\( \text{second} \)), the third production ratio (\( \text{third} \)), the export level (\( \text{cksp} \)), the gross domestic product (\( \text{gdp} \)), and the foreign direct investment (\( \text{fdi} \)).

**Estimation Method and Data Sources**

This study used the Double Difference-In-Difference Model (DID) to evaluate the implementation effect of the smog synergy measures in the Beijing-Tianjin-Hebei region. In this paper, \( pm2.5 \) is used as the explanatory variable. In the sample, the prefecture-level cities in the Beijing-Tianjin-Hebei, Yangtze River Delta and Pearl River Delta regions are experimental groups, and other prefecture-level cities constitute the reference group, and 2013 is selected as the time dummy variable. In order to ensure the availability of data, this paper selects the prefecture-level data of 2008-2016, and eliminates the observation value of the missing values of some variables, and obtains a total of 1116 sample observations. The data used are mainly from the National Bureau of Statistics, the CEIC database and the China Statistical Yearbook.

**The Measurement Results Analysis**

**Regression Analysis**

Table 1. Regression Estimation Results of Environmental Regulation on \( pm2.5 \) Emissions.

|                     | (1)          | (2)          | (3)          | (4)          |
|---------------------|--------------|--------------|--------------|--------------|
| \([\text{dum}_t \times \text{dum}_a]\) | -0.0416**    | -0.0548***   | -0.0549***   | -0.0473**    |
|                     | (-2.89)      | (-3.64)      | (-3.61)      | (-3.11)      |
| \(\ln \text{fdi}\) | -0.00667     | -0.00241     | 0.00248      |              |
|                     | (-1.35)      | (-0.48)      | (0.48)       |              |
| \(\ln \text{cksp}\) | -0.0335***   | -0.0222**    | -0.0231**    |              |
|                     | (-4.22)      | (-2.69)      | (-2.82)      |              |
| \(\ln \text{third}\) | -0.204***    | -0.227***    |              |              |
|                     | (-4.05)      | (-4.50)      |              |              |
| \(\ln \text{second}\) | -0.237***    | -0.127*      |              |              |
|                     | (-4.31)      | (-2.05)      |              |              |
| \(\ln \text{gdp}\) | -0.163***    |              |              |              |
|                     | (-3.80)      |              |              |              |
| Year dummy variable | control      | control      | control      | control      |
| \[\_\text{cons}\]  | 3.594***     | 3.718***     | 3.282***     | 4.024***     |
|                     | (422.85)     | (114.12)     | (32.52)      | (18.34)      |
| N                   | 1116         | 1049         | 1049         | 1049         |

Note: The \( t \)-values of the regression coefficients are in parentheses, and *, **, and *** indicate the significance levels of 5%, 1%, and 0.1%, respectively.

Using the \( pm2.5 \) emission as the explanatory variable, the DID method was used to test the implementation effect of the environmental policies of the Beijing-Tianjin-Hebei, Yangtze River Delta and Pearl River Delta using robust heteroscedasticity. The results are shown in Table 1. The models (1)–(4) all indicate that the environmental regulation effect is significant. This paper mainly analyzes the model based on (4). It can be seen from the (4) column regression that the coefficient of the DID term is -0.0473, which passes the significance test and is significant at the level of 1%, indicating that the release of the atmosphere ten in 2013 significantly improved the Beijing-Tianjin-Hebei and the Yangtze River Delta. And the environmental quality of the Pearl River Delta region, \( pm2.5 \) emissions significantly decreased. The export level, the proportion of the second production, the proportion of the three productions, and the regional GDP all passed the significant test, and the coefficients were all negative, indicating that to a certain extent, affecting the implementation of environmental policies and reducing the emissions of \( pm2.5 \). However,
foreign direct investment is not significant in the four models, indicating that the degree of influence of foreign investment on the policy is uncertain.

**Triple Difference**

Add the dummy variable dum_f, which is assigned a value of 1 in the northern city and 0 in the remaining cities. The triple difference term coefficient is -0.0793, which is significant at the level of 0.1%. It shows that the emission reduction of pm2.5 in the northern cities in the policy area is larger than that in the southern cities, and the implementation of the ten policies of the atmosphere in the northern regions is more obvious. Hypothesis 2 is verified. This may be related to the general heating in the northern cities in winter, the policy has more impact on the north, and the Beijing-Tianjin-Hebei region is located in the capital economic circle, and the implementation of the policy is relatively large, which makes the level of significance increase.

**Conclusion**

Based on the comprehensive study of the relationship between environmental regulation and air pollution at home and abroad, this paper uses the double difference model to study the effects of the “Atmosphere Ten” policy promulgated in 2013. It was found that with 2013 as the policy node, environmental regulation significantly reduced the emission of pm2.5, and the urban air level of Beijing-Tianjin-Hebei, Yangtze River Delta and Pearl River Delta improved significantly. At the same time, compared with southern cities, policies are more pronounced in northern cities, which is related to winter heating in northern cities. Compared with northern cities, the degree of air pollution in southern cities is relatively light, and the effect of policies is poor.

Based on the above research conclusions, the following policy recommendations are proposed:

Firstly, focus on coordinated measures for air pollution. The effect of a single policy is limited, and in recent years, China has introduced a number of environmental governance policies. Therefore, when dealing with environmental pollution, the region should pay attention to the synergistic effect between policies.

Secondly, compared with southern cities, northern cities are facing stronger environmental pollution pressures. Therefore, we can draw on the experience of other cities to learn from the other, to distinguish the economic structure, demographic characteristics, climatic conditions and geographical conditions of the cities in the north and the south. The local government should introduce corresponding environmental policies to improve the accuracy of the policies.

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