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Empirical Analysis of China's Atmospheric Control and Environmental Pollution

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Abstract: Since the reform and opening up of the Chinese economy, the average annual growth rate of GDP has exceeded 9%, and the total number of economies has now jumped to the second place in the world. The rapid development of China's industrialization and modernization, its economic achievements are obvious to all. However, in recent years, environmental pollution has become more and more serious, which has seriously affected the daily activities of local residents. However, after maintaining rapid growth for many years, the Chinese economy has gradually slowed down its growth rate, and the Chinese economy has fully entered the new normal of economic growth. Since the "18th National Congress of the Communist Party of China", the central and local governments have attached great importance to environmental issues and have actively carried out environmental governance and achieved certain results, but they have not fundamentally reversed the problem of environmental degradation. Environmental management has been strengthened in all regions, but the effects of environmental governance are not optimistic, and industrial pollution continues to increase. This paper constructs a mediation effect model of public finance, governance equipment and pollutants, and it uses the latest monthly data of 2013-2018 to draw empirical conclusions that are consistent with China's national conditions. The Chinese government's public finance expenditure has played an obvious role in promoting the upgrading of China's industrial pollutant plastics production. China's environmental regulation and air pressure equipment investment has played a significant part of the intermediary effect in this process.

Keywords: Environmental Governance, Environmental Pollution, Mediating Effect

1. Introduction

Since the reform and opening up of the Chinese economy, the National Bureau of Statistics of China announced the average annual growth rate of GDP has exceeded 9%, and the total number of economies has now jumped to the second place in the world. However, after maintaining rapid growth for many years, the China economy has gradually slowed down its growth rate. The National Bureau of Statistics of China (2017) announced that China's GDP growth rate in 2017 was 6.9%. The Chinese economy has fully entered the new normal of economic growth. The economy of most provinces in China at this stage continues to grow. However, along with China's economic development, while environmental resources are gradually being developed, more and more industrial pollutants are discharged into the atmosphere. In recent years, many large and medium-sized cities in China have experienced smog. According to the national AQI index issued by China Central Meteorological Observatory, from December 16 to 21, 2016, more than 10 provinces and cities in North China, Central China and Northeast China suffered from smog weather. The concentration in the Beijing-Tianjin-Hebei region is more than 500 μg/m3, and Shijiazhuang City in Hebei Province is

as high as 1000 μg/m3 for several consecutive days. During this period of time, China's large-scale environmental pollution problem did not happen by chance. Its emergence is directly related to China's rapid economic growth, environmental governance, and industrialization. There are many reasons for air pollution, and one of the important reasons is directly related to industrial pollution. The massive discharge of industrial pollutants has caused serious pollution to the local environment and has adversely affected the normal life of local residents. The "Nineteenth National Congress" of the Chinese Communist Party clearly put forward the five-in-one construction of "ecological civilization", and the Chinese environmental department has also formulated corresponding environmental regulation policies. However, China has implemented strict environmental protection policies and serious environmental problems, indicating that there is a serious reaction to environmental governance and environmental pollution.

2. Literature Review

In the 1970s, the western scholars began to pay attention to the contents of industrial pollution and environmental protection, and summarized many theories of environmental governance, but the research progress was slow. Until the 1990s, the issue of environmental regulation caused a lot of scholars' attention. Environmental regulation began to change from the theoretical level to the practical level, and many important achievements were made. Most of the results were from the "Porter Hypothesis" and "Pollution Shelter". While advancing the theoretical analysis of environmental research, scholars have also improved the methods of environmental regulation. However, the research on environmental regulation and measurement has been slow to date, and there is no unified standard for the academic community of environmental governance measurement in a region. At present, there are three main models for environmental governance measurement: qualitative index measurement method, quantitative index measurement method, and comprehensive index measurement method.

2.1. Qualitative Indicator Measurement Method

Walter, IW, & Ugelow, (1979) used the survey data of the United Nations Organization for Trade and Development (UNCTD) to score environmental assessments in the form of expert scoring questionnaires, obtained environmental governance rankings from multiple countries, and constructed an ordinal environment Governance index [1]. Based on this, Tobey (1990) and Susmita (1995) used qualitative indicators to construct a multi-country environmental governance index [2, 3].

2.2. Quantitative Index Measurement

The quantitative indicator measurement method mainly focuses on the specific data of the local government to reduce the pollution discharge index of the industrial sector in the region. For quantitative indicators to measure environmental governance, scholars mainly focus on the following three aspects.

(1) Pollutant discharge standards and compliance standards. The local government will formulate emission standards according to the technical level and performance level of the enterprise, and limit the emission limit of the enterprise through order-controlled environmental regulation. Some scholars believe that one area can reflect the pollution discharge limit of a certain pollutant specified by the local environmental governance. Mcconnell (1990) measures US environmental governance by using the upper limit of organic volatiles in automotive paints as a proxy variable for environmental regulation [4]. Matthe & Fredriksson. (2009) determines environmental management using the lead content of gasoline as defined in local laws. Some scholars have pointed out that environmental governance depends not only on the development of standards, but also on the strength of corporate implementation standards [5].

(2) Indicators related to pollutants. Environmental governance is mainly measured from three aspects: sewage discharge tax, pollutant treatment expenditure and pollutant discharge. Ménière (2011) uses different fuel taxes in each region as an indicator of environmental governance in the region [6]. Cole & Elliott (2007) set the cost of pollution treatment investment and pollutant treatment facilities as a UK environmental governance indicator and measured [7]. Aiken et al. (2009) conducted a comparison of environmental governance in Germany, Japan and the United States, and they used the proportion of pollution reduction capital expenditures and total investment expenditures as indicators of multinational environmental governance [8]. Javorcik & Wei (2001) used the ratio of lead, sewage and carbon dioxide emissions to GDP as a measure of environmental governance when conducting research on pollution shelters [9].

2.3. Comprehensive Indicator Measurement Method

A single indicator is highly targeted, but does not reflect the overall strength of environmental regulation policies. Later, some scholars have composed multiple single indicators to form a composite indicator. Beers et al. (1997) used seven indicators reflecting environmental quality to obtain the ranking values of sub-items in each country through the ranking assignment method, and sorted the individual numerical values to obtain the national environmental regulation ranking values of each country. Subsequent scholars have studied from a comprehensive perspective of the entire process of environmental regulation [10]. Dam & Scholtens (2012) uses the factor analysis method to construct environmental indicators for environmental policy, environmental management, environmental improvement and environmental performance according to the policy from the formulation, implementation and functioning process [11]. Cao&Wang. (2017) further measured environmental governance issues in a region from the perspectives of inputs, processes, and outcomes of environmental governance, and concludes that environmental regulation is an input-output

process [12]. Wang & Sun (2018) used a new comprehensive indicator to measure the efficiency of the global system environmental assessment system [13]. Smulders (2012) pointed out that there is a "green paradox" in national environmental regulation [14]. Strand (2007) research on the application of clean energy instead of fossil energy policy found that the large-scale application of new energy in advance will accelerate the exploitation of petrochemical energy by energy developers, making the environment worse [15]. Walker (2011) pointed out that environmental regulation has an uncertain impact on various industries, and the labor force will flow according to the compensation of different industries [16]. For this reason, environmental regulation has different development and employment for different industries. Wang et al. (2003) under the background of the strict environmental regulation system of the Chinese government, the overall displacement of China's actual pollutants continued to grow, and the study of China's regulation and environmental pollution from the decentralized structure found that 1994 After the tax-sharing system, local governments still take economic development as the main target under the condition that GDP is the main assessment indicator. In order to attract investment and solve local problems, the implementation of environmental regulations will be reduced [17].

3. Method

In order to empirically examine the impact of China's public finance on environmental protection expenditure (Exp) on industrial plastics production (Pla) and the role of atmospheric management equipment input (Equ) in this mechanism, this paper constructs the following two empirical studies. model. First, in order to examine whether public finances have an impact on the amount of environmental protection expenditure on industrial plastics production, the structural model is shown in formula (1).

$$Pla = c + \gamma Exp + \delta Z + \varepsilon \tag{1}$$

Secondly, in order to further study whether public finances exert influence on the output of industrial plastics through the important intermediary channels of the amount of environmental protection expenditures of domestic listed companies, this paper extends formula (1) to equation (2). Shown.

$$Pla = c_1 + \gamma Exp + \delta_1 Z + \varepsilon_1 \tag{2}$$

$$Equ = c_2 + \alpha Exp + \delta_2 Z + \varepsilon_2 \tag{3}$$

$$Pla = c_3 + \gamma' Exp + \beta Equ + \delta_3 Z + \varepsilon_3 \tag{4}$$

This paper uses the mediation effect test to examine the relationship between public finances on environmental protection expenditures, industrial plastics production, and the amount of atmospheric management equipment invested by domestic listed companies. The concept of mediating effect originated from the study of psychology to measure the degree of influence of the independent variable indirectly on the dependent variable through the mediating effect variable. As the empirical approach to mediation becomes more mature, this concept has gradually been introduced into a wider range of fields.

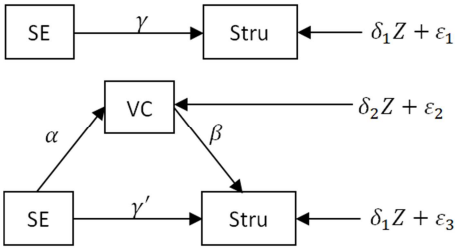

Figure 1. *Schematic diagram of the mediation effect path.*

Among them, γ is the total effect, γ' is the direct effect, and α*β is the mediating effect.

There are many methods for testing the mediating effect, and each has its advantages and disadvantages in terms of statistical test errors and test powers. Therefore, the single test method has low applicability. Based on the existing research, this paper constructs a comprehensive mediation effect test program, which can control the first type of error rate (ie, reject the true error rate) and the second type of error rate (ie, save the higher statistical power). Therefore, this paper will use this test procedure to test the mediating effect.

Sobel test statistic is

$$z = \hat{\alpha}\hat{\beta}/s_{\alpha\beta} \tag{5}$$

Where $\hat{\alpha}$and $\hat{\beta}$ are the estimated values of the parameters α and β, respectively, and $s_{\alpha\beta}$ is the standard error of $\hat{\alpha}\hat{\beta}$, and the approximate formula is obtained according to the first-order Taylor expansion:

$$s_{\alpha\beta} = \sqrt{\hat{\alpha}^2 s_{\beta}^2 + \hat{\beta}^2 s_{\alpha}^2} \tag{6}$$

Due to the product distribution involving the parameters, even if the overall stock-earnings ratio (Exp), industrial plastics production (Pla), and atmospheric processing equipment input (Equ) follow a normal distribution and are large samples, the Sobel test statistic may be normal. The problem of large is distribution deviation. In this regard, this paper draws on the same statistic from previous studies but uses different thresholds for testing. In their threshold table, the 5% confidence level corresponds to a threshold of approximately 0.97 instead of the usual 1.96.

4. Empirical Analysis

4.1. Data and Variable

After years of development, China's environmental governance has become increasingly mature, and China's environmental regulation has become increasingly sophisticated. Among them, the industrial plastics output (Pla) index of China's environmental industrial pollutants, the

government's use of public finance environmental expenditure (Exp) indicators for environmental pollution control, and the atmospheric pollution control equipment (Equ) indicators. The control variables of this model are China's economic development indicators and pollutant emission indicators. The bond issuance indicates the government's China Economic Development Index (KQ), and the sulfur dioxide emissions expenditure indicates the pollutant emission index (SO2). Considering the timeliness and availability of data, this paper selects the monthly data of China's environmental regulation market from March 2003 to August 2018. The data comes from the National Bureau of Statistics of China and the Wind database.

4.2. Descriptive Statistics

Table 1 shows descriptive statistics for the variables.

Table 1. *Variable descriptive statistics.*

Variable	Mean	Std. Dev.	Min	Max
Exp	366.2	158.1	135.4	918.5
Equ	28517	12410	6232	60483
Pla	627.0	68.0	502.0	748.1
KQ	7.146	3.997	0.180	15.490
SO2	20.08	8.67	9.00	48.00

The Pearson correlation coefficient between variables is shown in Table 2:

Table 2. *Pearson's correlation coefficient.*

	Exp	Equ	Pla	KQ	SO2
Exp	1.0000				
Equ	0.6046*** (0.0000)	1.0000			
Pla	0.4861*** (0.0003)	0.7651*** (0.0000)	1.0000		
KQ	0.3050** (0.0295)	0.3296** (0.0182)	0.0546 (0.7037)	1.0000	
SO2	-0.3533** (0.0110)	-0.6188*** (0.0000)	-0.4204*** (0.0021)	-0.2487* (0.0785)	1.0000

Note: P values are in parentheses, and * and *** indicate significant at the confidence level of 10% and 1%, respectively.

5. Empirical Research Results and Analysis

5.1. Stationarity Test

Perform an ADF test on indicators.

Table 3. *Augmented Dickey-Fuller test.*

Variable	confidence level	Test critical Value	ADF test statistic	P Value
Exp	1% level	-3.5966		
	5% level	-2.9332	-0.4029	0.8994
	10% level	-2.6049		
Equ	1% level	-3.5683		
	5% level	-2.9212	-2.1199	0.2380
	10% level	-2.5986		
Pla	1% level	-3.6010	-1.8675	0.3438
	5% level	-2.9350		
	10% level	-2.6058		
	1% level	-3.5683		
KQ	5% level	-2.9212	-1.5702	0.4902
	10% level	-2.5986		
	1% level	-3.5966		
SO2	5% level	-2.9332	-4.1182	0.0024
	10% level	-2.6049		

As can be seen from the above table, except for the monthly average concentration of sulfur dioxide (SO2), the other variable sequences are not stable. Therefore, the first-order difference is made to these variables and the stationarity test is performed. The test results are shown in the following table.

Table 4. *Variable stationarity test.*

Variable	confidence level	Test critical Value	ADF test statistic	P Value
Exp	1% level	-3.5966		
	5% level	-2.9332	-6.3885	0.0000
	10% level	-2.6049		
Equ	1% level	-3.5744		
	5% level	-2.9238	-7.0729	0.0000
	10% level	-2.5999		
Pla	1% level	-3.6010		
	5% level	-2.9350	-0.4768	0.8855
	10% level	-2.6058		
KQ	1% level	-3.5713		
	5% level	-2.9224	-6.9821	0.0000
	10% level	-2.5992		

As can be seen from the above table, except for the first-order difference instability of the plastic product yield (Pla) sequence, the first-order difference of other variables is stable, so the second-order difference is performed on Pla and the stationarity test is performed. The test results are as follows: As shown, the sequence is shown to be stationary.

Table 5. *Pla variable stationarity test.*

Variable	confidence level	Test critical Value	ADF test statistic	P Equ
Pla	1% level	-3.6010		
	5% level	-2.9350	-6.1599	0.0000
	10% level	-2.6058		

5.2. Mediation Effect Test

Based on the previous studies, this paper proposes an improved mediation effect test method. Whether public finance input in environmental regulation exerts an influence on the output of industrial plastics through the important intermediary channel of atmospheric management equipment input. First, a mixed regression model is used for empirical testing.

Table 6. *Mediating effect of public finance expenditure on plastics production through the input of atmospheric treatment equipment.*

Variable	Pla (2-1)	Equ (2-2)	Exp (2-3)
Constant	1.5897	-1898.5570	7.5728
	(24.9285)	(2216.9550)	(24.3962)*
Exp	0.1281***	12.3404***	0.0892
	(0.0474)	(4.2145)	(0.0502)

Variable	Pla (2-1)	Equ (2-2)	Exp (2-3)
Equ			0.0032*
			(0.0016)
SO2	-0.1388	118.9607	-0.5137
	(1.1959)	(106.3562)	(1.1770)
QK	1.7562	-99.6008	2.0701
	(5.1456)	(457.6090)	(4.9978)
Obvious	49	49	49
F Value	2.45	3.41	2.89

Note: Standard deviations are shown in parentheses, and *, **, and *** indicate significant levels of confidence at 10%, 5%, and 1%, respectively.

Specifically, regression (1) first verifies whether public financial environmental expenditure can promote industrial plastics production upgrade. The coefficient of Exp in the regression result is estimated to be 1.6619, and is significantly positive at the 1% confidence level, and there is a change in the same direction between the two. The regression (2) results show that the public fiscal environmental expenditure (Exp) and the atmospheric management equipment input (Equ) are positively correlated at a confidence level of 5%, indicating that the increase in China's environmental regulation public financial environmental expenditure can increase the atmosphere of the Chinese environmental regulation ticket market. Governance equipment input. In regression (3), after adding the variables of atmospheric management equipment input to the model of public finance environmental expenditure affecting industrial plastics production, the coefficients of public finance environmental expenditure (Exp) and atmospheric treatment equipment input (Equ) are significantly positive. And the public financial environmental expenditure (Exp) coefficient decreased from 1.6619 without intermediation variable to 0.7232, which indicates that the amount of atmospheric treatment equipment input played a partial mediating effect in the process of public finance environmental expenditure to promote industrial plastics production.

Overall, the public financial environmental expenditure (Exp) estimate of the coefficient of industrial plastics production (Pla) γ and the amount of atmospheric treatment equipment (Equ) to the industrial plastics production Pla coefficient β are at a confidence level of 5%. Significantly, the public financial environmental expenditure (Exp) coefficient estimate α for the atmospheric management equipment input (Equ) did not pass the t test at the 5% confidence level, so the Sobel-Goodman mediation significance test was required. This paper draws on the test methods of previous studies, and the results of the mediation effect test are shown in the following table:

The amount of further calculation of the mediation effect is shown in the following table:

Table 7. *Effect of mediation effect.*

Indirect effect	0.0389
Direct effect	0.0892
Total effect	0.1281
Proportion of total effect that is mediated:	0.3036
Ratio of indirect to direct effect:	0.4359
Ratio of total to direct effect:	1.4359

In order to ensure the robustness of the empirical results, the sample bootstrap method is further used to calculate the mediation effect. The empirical results are shown in the following table:

Table 8. *Bootstrap mediation effect.*

Variable	Observed Coef.	Bias	Bootstrap Std. Err.	95% Conf. Interval		
Indirect effect	0.0389	0.0043	0.0223	0.0091	0.0974	(P)
				0.0072	0.0905	(BC)
Direct effect	0.0892	0.0002	0.0488	-0.0046	0.1840	(P)
				-0.0031	0.1862	(BC)

Note:(P) percentile confidence interval; (BC) bias-corrected confidence interval

The sample self-sampling results are basically the same as the mixed regression results, and after the deviation correction, the mediation effect effect is significant at the 95% empirical confidence level, and the empirical results are robust. Combined with the empirical results, it can be seen that the amount of atmospheric treatment equipment used for environmental governance is not related to the public financial environment input and industrial pollutant production. On the contrary, the three have a mutual influence relationship.

6. Conclusion

This paper analyzes the current situation of environmental governance in China, sorts out domestic and foreign literature research on environmental pollution, conducts a preliminary analysis of the development of environmental governance in China, and briefly summarizes the relationship between environmental pollution and industrial pollution in China. Secondly, from the perspective of government public finance expenditure under the conditions of China's environmental regulation, the impact of environmental regulation industrial plastics production in China is studied. The time series data of China's environmental regulation market in 2013-2018 was selected, and the mediation effect model was used to test the mediating role of China's environmental regulation air control equipment input in promoting the environmental regulation of industrial plastics production under China's current environmental regulation market. The inspection found that the Chinese government's public finance expenditure has a significant role in promoting the upgrading of China's industrial pollutants plastics production. China's environmental regulation of atmospheric treatment equipment input has played a significant part of the intermediary effect in this process. Finally, this paper provides new empirical experience in order to further promote the optimization and

adjustment of China's environmental regulation market, accelerate the development of China's environmental regulation market, and enhance the effective development of China's environmental regulation.

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