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Effect of Air Pollution on Provincial Fiscal Investment for Environmental Protection in China

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ABSTRACT

The economic transition in China has caused serious air pollution problems despite the rapid economic growth it promotes. Analysis of the air pollution status in 31 provinces in China indicated that positive measures of provincial fiscal investment in environmental protection could relieve the progressive deterioration of financial mechanisms induced by environmental pollution and significantly improve air quality. In this study, a sharp regression discontinuity model was established in accordance with air pollution index (API) grading rules. The model simulated the relationship between API and provincial fiscal investment based on API data obtained from 31 provinces in China from 2001 to 2014. The influence of air pollution on local investments in environmental protection was analysed using the proposed model. The effects of control variables (population density, GDP per capita, proportions of the secondary and tertiary industries, and fixed-asset investment scale) on fiscal investment and robustness of air pollution were subsequently analysed using the McCrary test. Results show that mild air pollution can decrease the proportion of expenditures allocated for environmental protection; however, this effect is not observed under heavy air pollution. Moreover, the “inverse adjustment” response of local government expenditures on environmental protection to air pollution and expenditure proportion allocated for the environmental protection of economically developed provinces shows no discontinuity effect. Meanwhile, the non-model provinces of environmental protection exhibit significant negative discontinuity effect. This study also suggested measures on how Chinese provincial governments can formulate appropriate incentive and constraint mechanisms for air environmental protection, as well as maintain and increase local government investment towards environmental protection. The conclusions obtained in this study can provide practical significance to fully comprehend the heterogeneity in air pollution control of 31 Chinese provinces.

INTRODUCTION

With rapid economic progress, environmental pollution has become one of the important factors hindering sustainable social and economic development in China. Environmental pollution has drawn increasing social interest. In the First Quarter Air Quality Report of 2015 involving cities that have adopted the new air quality standard, China National Environmental Monitoring Center announced that the average number of days with standard air quality in 74 key environmental protection cities account for 59.7% of the year, leaving the remaining 40.3% days with substandard air quality. Days of mild air pollution, moderate air pollution, heavy air pollution, and serious air pollution are 23.3%, 9.4%, 6.4%, and 1.2%, respectively. Although China has achieved rapid economic growth, environmental challenges remain.

Air pollution is present when the concentration of air pollutants or secondary pollutants transformed from air pollutants reaches a level that can damage human health and the natural environment. Air pollution is mainly composed of pollutant release, airborne transmission, and human environment interactions. Before the 1950s, air pollution was mainly caused by smoke and SO_2 from coal combustion. Extensive use of internal combustion engine in subsequent years brought about oil combustion pollution, except for the intensifying coal combustion pollution. In recent decades, air aerosols, SO_2, NO_2, CO, chlorine and photochemical smog have become the main pollutants in the air. Vehicle exhaust and photochemical pollution caused by sunlight intensify air pollution because of automobile production.

The rapid development of China’s national economy, continuous urban expansion, and increasing engineering projects in cities have led to serious challenges threatening urban air quality. People have directed increasing attention towards urban air quality. Rapid economic growth greatly increases the environmental pressure, and the long-term accumulated environmental risk begins to appear. Air quality in some large and middle-sized cities tends to deteriorate. Air pollution sources and environmental pollutants increase continuously, and the pollution range expands gradually. For instance, smoke (dust) discharge from exhaust gas grows in a fluctuating manner (Fig. 1), and its substantial impact on resources and environment threatens the foundation of sustainable development. Meanwhile, with increasing living standard, as well as health and safety considerations, people have higher requirements for environmental quality, accompanied with growing environmental consciousness. Air cleanliness directly influences human activities. The appeal of controlling urban air pollution and improving environmental quality is becoming increasingly strong.

Environmental pollution pertains to negative external public product and belongs to the market malfunction area. To relieve environmental pollution, the government should adjust investments in environmental protection according to pollution levels. The Chinese government has been increasing its investment in environmental protection in recent years, and local government expenditures allocated for environmental protection increase yearly. However, no empirical evidence is yet available as to whether environmental pollution levels can influence provincial governments' investments in environmental protection in China. In an environmental management field dominated by government investment, if the intensifying environmental pollution fails to gain additional government investment, its lack of an internal financial mechanism can relieve environmental pollution. Therefore, in this study, a multiple regression discontinuity model was designed according to air quality grading in China. Based on this model, an empirical analysis of the effect of air pollution [represented by air pollution index (API); pollutants counted in API include SO_2, nitric oxide, and total suspended particulates (TSPs); Table 1] in 31 provinces (cities and municipalities) in China on local government investments in environmental protection were conducted. The model aims to provide a reference for making decisions by relevant departments on environmental investment adjustment strategy.

STATE OF THE ART

Air pollution is one of the main influencing factors affecting economic development. Many Chinese and foreign researches have proven that short-term variation in air pollution concentration is related to economic development.

Most studies have used the API to reflect air pollution. Among studies concerning API and influencing factors, Neha Khanna proposed a new API system on the basis of a comprehensive assessment of multiple pollutants, which can clearly reflect the risks of gas pollution to human bodies (Khanna 2000). Kyrkilis et al. (2007) developed the concentrated API, comparing it with the State Environmental Protection Administration of the United States; they found that it is superior in reflecting the effect of pollution on human health. Grivasa et al. (2008) classified the influencing factors of API into two groups by clustering analysis. They assessed that four regions near downtown are mainly influenced by primary aerosols, fuel combustion, and vehicle exhaust, whereas pollutants (i.e., secondary aerosols) in other regions far from downtown mainly come from heavily polluted areas nearby. Based on daily data on urban air quality from 2001 to 2005, Ranying (2006) described the spatial and temporal air quality distribution of main cities in China (Ranying 2006). Qimin & Jingbo (2007) evaluated air quality in 10 typical cities and determined that cities in South China suffer less air pollution than those in North China; they further concluded that the level of air pollution is closely related to geographic location, meteorological and topographic conditions, energy source structure, and economic development.

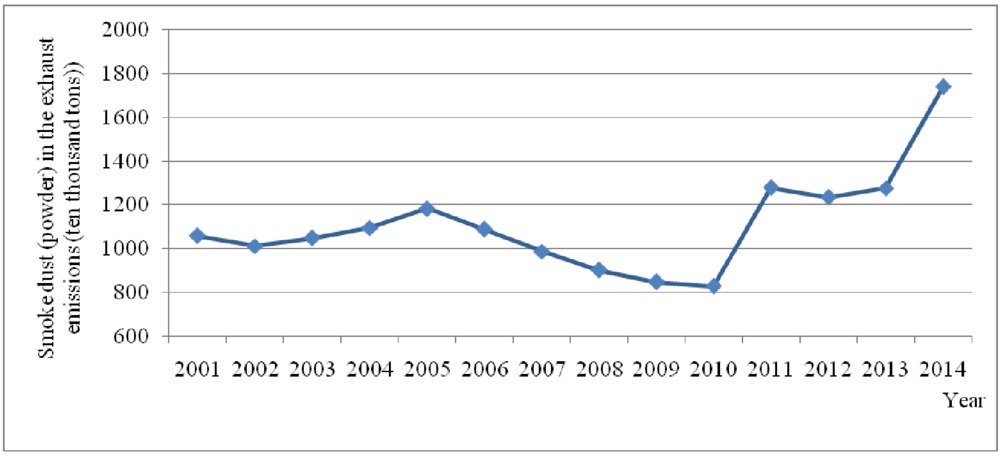

Fig. 1: Trend of smoke (dust) discharge from exhaust gas in China.

However, environmental pollution is a typical public product with non-excludability and non-competitiveness. It has a considerably strong negative externality in market activities. Although local governments generally control pollution through administrative or taxation means, their efforts on pollution management can still be measured by expenditures allocated for energy conservation and environmental protection. As environmental issues become increasingly serious, the relationship of government revenue and expenditure with environmental pollution has received much attention. By analysing the administrative pollution control policies in India, Greenstone & Hanna (2011) found that, policies issued by the Supreme Judicial Court and proposed according to citizen suits significantly and affect pollution control, whereas those issued by the central and local government are almost ineffective. In developing countries focusing on economic development, public finance expenditures inclined toward production and governments can easily neglect the negative effects of environmental pollution on policy-making. Therefore, environmental pollution in developing countries fails to draw sufficient theoretical or practical interest. Yafei Wang (2011) analysed the effects of environmental investment on environmental pollution using provincial panel data and found that environmental investment can facilitate environmental pollution control, but the effect is not outstanding. Sixia & Hongyou (2014) reported that education, science and technology, social welfare relief, and social insurance are conducive to accumulating human capital and technological innovation, thereby improving environmental quality. Kezhong Zhang et al. (2011) found that fiscal decentralization deteriorates environmental quality. Almond & Li (2009) conducted a quasi-natural experiment based on the difference in heating policy between South and North China; they designed the geographical regression discontinuity between north and south of the Huaihe River and reported that North China with heat supply in winter has higher TSP density than South China. Luechinger (2014) used the desulfurization technology applied by power stations as an instrumental variable of SO_2 discharge and demonstrated that SO_2 reduction can decrease the infant mortality rate (IMR). Cesur et al. (2013) conducted a double differential analysis on the basis of aquasi-natural experiment involving natural gas infrastructures in Turkey and found that using natural gas can improve air quality, thereby lowering the IMR.

The majority of these studies analysed the air pollution status, studied API, and discussed the effect of government activity on pollution. However, few studies on the influence of pollution on fiscal expenditures for environmental protection have been reported. Thus, this study analysed the air pollution status in 31 provinces of China from 2001 to 2014. Focus was directed towards the influence of air pollution on fiscal expenditures, environmental protection, and its robustness. This study aimed to provide government sectors several policy suggestions for pollution control.

METHODOLOGY

Provincial government expenditures are generally determined by the financial budget during the early part of the year and adjusted according to social and economic development of the previous year to cope with future development needs. Therefore, the air quality of one region is more likely to affect the financial expenditure structure for the succeeding year. In this study, financial expenditure for the succeeding year was regarded as the explained variable. This method is logical and can weaken the possible reverse causal influence of financial expenditure allocated for environmental pollution.

Sharp regression discontinuity (SRD): In accordance with the method developed by (Brollo et al. 2009), the mean values between two discontinuity points were applied for sample cutting. Assuming that the values of the j-1, j and j + 1 discontinuity points are A_{j-1}, A_j, and A_{j+1}, respectively, then the value range of the treatment group close to A_j is $\left(A_j, \frac{A_j + A_{j+1}}{2}\right)$, and the value range of the control group is $\left(\frac{A_{j-1} + A_j}{2}, A_j\right)$. The value ranges of the control group and treatment group of the head and tail discontinuity points only have to be equal with the value ranges of the corresponding treatment group and control group. According to this discontinuity design, multiple regression discontinuity could be implemented based on equation (1); thus, the overall effect of discontinuity on environmental expenditure structure is given by:

$$y_{it} = \alpha * D_{it} + f(a_{it} - A_j) + D_{it} * f(a_{it} - A_j) \cdot$$
$$+ X\beta + \delta_t + \eta_p + \xi_z + u_{it} \quad \text{...(1)}$$

Where $a_{it} \in (\frac{A_{j-1} + A_j}{2}, \frac{A_j + A_{j+1}}{2})$, $D_{it} = 1\{a_{it} - A_j > 0\}$, y_{it} is the expenditure proportion of province i on environmental protection, a_{it} is air quality index, A_j is the j^{th} discontinuity point, and $a_{it} - A_j$ is the distance from the i^{th} sample to the j^{th} discontinuity point. X is the control variable, including the population density, GD per capita, proportions of the secondary and tertiary industries, as well as the fixed-asset investment scale. These parameters are used to control the possible influences of population and economic variables on the financial expenditure structure. δ_t is the time fixed effect, which controls the time variation trend of variables that do not change with individual differences. η_p is the provincial fixed effect, which controls the provincial difference that does not change with time. ξ_z is the discontinuity fixed effect, which controls the discontinuity difference in overall discontinuity regression. u_{it}, the error item, is for city clustering. Furthermore, $f(a_{it} - A_j)$ is the function of the performance variable $(a_{it} - A_j)$, and $D_{it} * f(a_{it} - A_j)$ controls different function forms that may exist on two sides of the discontinuity point.

The estimated α in equation (1) represents the change in provincial government expenditure proportion allocated for environmental protection when the pollution level increases to the next level, that is, the comprehensive discontinuity effect. To determine provincial government investments in environmental protection under different air quality grades, all discontinuity effects needs to be estimated. Therefore, a dummy variable was determined: when $a_{it} \in (\frac{A_{j-1}+A_j}{2}, \frac{A_j+A_{j+1}}{2})$, $A_J = 1$. Then, the regression discontinuity formula is as follows:

$$y_{it} = \sum_{J=1}^{m} \alpha_J * D_{it} * A_J + (1+D_{it}) f(a_{it} - A_j) +$$

$$- f(a_{it} - A_j) * A_J + X\beta + \delta_t + \eta_p + u_{it} \quad ...(2)$$

Where, the estimated α_J reflects the effect of air quality grade close to the j^{th} discontinuity point in the financial expenditure structure.

Robustness Test

Continuity test of the performance variable: Regression discontinuity assumes that sample points close to the discontinuity point are generated randomly, so missing variables are avoided. Sample manipulation causes regression errors. Therefore, this study employed the McCrary test in reference to test for the continuity of the performance variable (Chen Yuyu et al. 2012). First, sample points close to the discontinuity point were distributed in different equilateral boxes. A considerable jumping frequency density was determined before and after testing the discontinuity point by calculating the frequency density of the different boxes.

Table 1: Grading standard of API.

API	Air quality	Effect on health	Suggested measures
0-50	Excellent	Normal human activities	
51-100	Good		
	Slight		
101-150	pollution	Susceptible population experiences slightly intensified	Populations with heart disease and respiratory dis-
	Mild	symptoms and healthy population is stimulated	ease should reduce physical and outdoor activities.
151-200	pollution		
201-250	Moderate	Populations with heart and lung disease show more serious	The elderly and population experiencing heat re-
	pollution	symptoms, and tolerance to exercise is significantly reduced.	lated conditions and lung disease should stay in
	Heavy	Uncomfortable symptoms are universal among healthy	doors and have reduced physical activity
		populations.	
251-300	pollution	Exercise tolerance of healthy population is reduced,	The elderly and sick should stay indoors and cut
>300	Serious	accompanied with obvious symptoms and some diseases.	down physical activity. Population with normal
			health should avoid outdoor activities.

Table 2: Discontinuity effect of expenditure proportion for environmental protection.

	Standard regression			Bandwidth=20	Bandwidth=15	Bandwidth=10
	First-order function	Second-order function	Third-order function			
Comprehensive discontinuity effect	-0.359	-1.046	-1.498	-1.156	-1.874	-1.963
SD of clustering robustness	0.345	0.519	0.564	0.532	0.678	0.763
API=100	-1.568	-1.562	-5.324	-1.365	-2.545	-4.366
SD of clustering robustness	0.754	1.365	1.485	0.265	0.986	1.487
API=200	-0.689	-1.654	-1.698	-1.069	-0.684	-0.345
SD of clustering robustness	0.398	0.496	0.683	0.456	0.568	0.867
API=300	-0.401	-0.865	-0.765	-0.698	-0.456	-1.974
SD of clustering robustness	0.365	0.698	0.471	0.546	0.964	1.697

Continuity test of the control variables: If the control variable jump is observed at the discontinuity point, the discontinuity effect of air pollution may capture the effect of other characteristic variables. Therefore, these control variables need to be tested. The test model is expressed as follows:

$$x_{it} = \alpha * 1\{a_{it} - A_j > 0\} + (1 + D_{it})$$
$$f(a_{it} - A_j) + \delta_t + \eta_p + \xi_z + u_{it} \quad ...(3)$$

Where, x_{it} represents the control variables. When α is insignificant, no control variable jump is determined at the discontinuity point.

Data Processing and Specification

API: API data were collected from daily air quality report of key cities, which had been published by the State Environmental Protection Administration of China. Maximum API data of 31 provinces in China from 2001 to 2014 were screened as dependent variables. Maximum API could reflect pollution level.

Financial investment: In this study, changes in the financial expenditure structure were expressed by the expenditure proportion for environmental protection in the public financial budget. The explained variable is the expenditure proportion for environmental protection in the general budget expenditure. Meanwhile, to improve the SRD accuracy and reduce the estimation error caused by sample differences, several control variables that may influence the financial expenditure structure were introduced, including the population density, GDP per capita, proportions of the secondary and tertiary industries, and fixed-asset investment scale. The time horizon of these data ranges from 2001 to 2014. The values of all indexes were obtained from China Statistical Yearbook and China City Statistical Yearbook (2001-2014). The GDP per capita, fixed-asset investment and price level in 2001 were processed to eliminate price influences.

RESULT ANALYSIS

This section focuses on the causal effect of API at air quality discontinuity on the finance expenditure structure, mainly including comprehensive discontinuity effects and sub-discontinuity effects. Moreover, robustness of air pollution was tested, which involved different function forms and the processing effect of bandwidth estimation. The presence of data manipulation was evaluated by analysing the continuity of performance variables and the continuity of related control variables.

Standard regression results: According to equation (1), the expenditure proportion for environmental protection was calculated using Stata software (Table 2). Table 2 lists regression estimations of the annual maximum API based on equation (1). To enhance the robustness of results, the first-order, second-order, and third-order functions of API were used as control variables. Controlled by different orders of function forms, the proportion of local government expenditure allocated for environmental protection will decrease by 0.35%-1.49% when air pollution increases to the next level (Table 2).

Viewed from the sub-discontinuity effect, the negative effect was mainly contributed by the first sub-discontinuity effect. When API = 100, the expenditure proportion for the environmental protection of the appropriate cities ranged from 1.56% to 5.64%, which was lower than that of the right cities. This finding indicated that an increase in maximum urban pollution in slightly polluted cities could decrease the expenditure proportion for environmental protection. When API = 200, the sub-discontinuity effect was significantly negative. However, such negative effect exhibited poor robustness, as determined by using the robustness test. Therefore, the local government will not increase investment at all discontinuity levels to cope with intensifying air pollution. Intensifying air pollution will reduce the expenditure proportion for environmental protection, which is mainly influenced by the low-level discontinuity effect. According to the overall regression result, provincial governments did not increase environmental investment according to the deterioration degree of air quality.

Samples near the discontinuity point were distributed randomly so that the regression discontinuity design could be used as the quasi-natural experiment and missing variables could be avoided. Therefore, bandwidth in regression discontinuity may influence regression result, which will be balanced between unbiasedness and effectiveness of estimation. A shorter distance between the sample and discontinuity point can lead to a greater possibility of no difference in related variables and a smaller estimation error. However, a wide bandwidth may cause a difference in related variables and not resolve the missing variable problem. Meanwhile, inadequate bandwidth can cause sample loss, thereby reducing the regression discontinuity efficiency. As depicted in Table 2, the estimation result always remains consistent with the standard regression result on every 5 bandwidth reduction. The comprehensive discontinuity effect of air pollution on environmental investment was significantly negative. The proportion of expenditures allocated for environmental protection in the financial expenditure decreased by 1.15%-1.97% when air pollution increased to the next level, which was similar to the standard regression result. Moreover, a robust negative discontinuity effect on environmental investment at API = 100 was present. In summary, regression sample reduction when bandwidth decreases may sig-

Table 3: Continuity test of control variables.

	Population density	GDP per capita	Secondary industry	Tertiary industry	Fixed-asset investment	First-order function	Second-order function	Third-order function
Comprehensive discontinuity effect	26.851	1568.123	-1.659	0.369	0.036	-0.469	-0.964	-1.345
SD of clustering robustness	56.38	6544.321	1.231	1.564	0.047	0.689	0.578	0.698
API=100	136.254	4201.365	1.765	-5.698	-0.048	-1.698	-1.182	-4.671
SD of clustering robustness	169.354	4873.122	2.698	3.684	0.0697	0.475	0.245	0.541
API=200	1.496	-116.547	-1.687	0.054	0.012	-0.547	-1.685	-5.697
SD of clustering robustness	64.685	4976.651	2.697	0.542	0.542	0.497	0.168	0.544
API=300	28.645	-1974.685	-2.987	0.571	0.064	-0.874	-0.697	-0.832
SD of clustering robustness	59.687	5424.651	2.987	2.674	0.687	0.974	0.587	0.987

nificantly lower the regression result.

Robustness test: The annual maximum API was tested using the McCrary test. Passing the McCrary test indicated no API manipulation. Manipulation of the annual maximum API would be unnecessary and difficult for provincial governments. In Table 3, non-control variables exhibit a comprehensive discontinuity effect and will not result in a regression discontinuity error. Although the discontinuity effect of the second and tertiary industries at API = 100 is significant at the 10% level, it exhibits poor robustness under other function forms. To prove that control variables are insignificant to the regression discontinuity model, regression of different forms of functions without control variables were investigated, which was found in accordance with the standard regression result. The discontinuity point of API = 100 is significantly negatively correlated with the proportion of expenditures for environmental protection. Air quality improvement will significantly reduce the proportion of expenditures allocated for environmental protection, and the proportion of expenditures for environmental protection will decrease by 0.46%-1.34% when air pollution intensifies to the next level. In summary, control variables slightly influence the regression discontinuity result.

POLICY SUGGESTIONS

Establishing a multi-department air pollution coordinated management system: The scope and intensity of air environmental management in China have gradually increased, particularly after 2000. Although environmental protection and public health improvement are important components of the development policy in China, they are two independent goals instead of a unified one. Air environmental changes significantly influence public health. They do not only intensify public health problems but also lead to a series of problems against sustainable social development. Therefore, cooperation among departments, including the environmental protection department, urban construction department, and department of health, is necessary to conduct real-time monitoring of disease information, comprehend changes in the geographical distribution of diseases, enhance environmental management, improve air quality, and strengthen public education on individual behaviours.

Building a national integrated environment and health monitoring system: An integrated air environment and health monitoring system should be built, particularly in rural regions. To provide scientific and technical support for environmental and health protection, the following measures are suggested: develop a unified national monitoring program and norms, continuously replenish and optimize monitoring content, establish and perfect the national environment and health integrated monitoring network that covers both environmental quality monitoring and health influence monitoring, conduct long-term studies on environment and health, and acquire a systematic understanding of main environmental pollutants, public health conditions, and development trends.

Perfecting the early-warning mechanism of air pollution against human health: With social development, environmental health attracts increasing attention from the government and the public. An early-warning mechanism of air pollution against human health should send early warnings of air pollution before it damages human health or an accident occurs. Conventional air environmental monitoring or related information regarding responses to sudden air pollution events should be collected and analysed. Development trends and risks of air pollution should be analysed to allow related departments and the target population to respond promptly, thereby preventing or reducing damage. A scientific and comprehensive early-warning mechanism should be established to help the public understand and treat air pollution correctly, take appropriate self-protection measures, cooperate with professional institutes on air pollution control and maintaining normal social order, and improve government crisis management and prestige in international societies.

Increasing financial expenditure allocated for environmental protection: An appropriate incentive and constraint mechanism should be developed in all provinces to maintain and increase the environmental investment of local government. Ecological environment assessment is recommended as an addition in the officer assessment and promotion system, and green GDP should be advocated. An accountability mechanism of the main responsible officers of local governments with continuously intensifying environmental pollution should be established. Ecological civilization and environmental protection should be regarded as important content of government performance evaluation, and scientific development should be emphasized. Efforts of local official directed toward air pollution control should be enlisted in the annual assessment; those officials with failed efforts should be interviewed by the Ministry of Environmental Protection and Prosecuting Authority. These changes are expected to positively affect air pollution control. Moreover, leaders should pay more attention to air pollution control, particularly focusing and forecasting air pollution situations, initiating air pollution control using various measures, perfecting corresponding management organizations, conducting feasibility plans, establishing target-oriented responsibility systems, and procedurally implementing approved plans.

Expanding regional monitoring scope of air pollution: The basic state policies of resource saving and environmental protection, perfecting the air pollution monitoring system and expanding monitoring scope, establishing an effective decision-making system considering both environment and economy, and protecting the ecological environment with systems must be pursued to accelerate economic development. Furthermore, environmental protection and utility maximization should be associated under market economy conditions to realize the harmonious development of production, consumption, and air environmental protection. The promotion of green development, cyclic development, and low-carbon development is strongly encouraged.

CONCLUSIONS

Commercial and industrial development and rapid population growth in cities will certainly lead to city area expansion and increase in residential houses, vehicle and fuel consumption, as well as man-made heat and steam discharges. Consequently, more pollutants will be discharged into urban air. In accordance with API grading rules, this study established an SRD model of the relationship between API and provincial fiscal investment based on API data of 31 provinces in China from 2001 to 2014. With this model, the influence of air pollution on local investment in environmental protection was analyzed. The effects of control variables (population density, GDP per capita, proportions of secondary and tertiary industries, and fixed-asset investment scale) on fiscal investment and robustness of air pollution were subsequently analyzed using the McCrary test. Five suggestions are presented to control air pollution, namely, establishing multi-department air pollution coordinated management system, building an integrated national environment and health monitoring system, perfecting the early-warning mechanism of air pollution against human health, increasing financial expenditures for environmental protection, and expanding the regional monitoring scope of air pollution. This study aimed to provide relevant departments with references for environmental investment adjustment strategy and environmental protection.

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REFERENCES

Almond, D. and Li, H. 2009. Winter heating or clean air? Unintended impacts of China's Huai River policy. American Economic Review, 99(2): 184-90.

Brollo, F., Nannicini, T. and Perotti, R., et al. 2009. The political resource curse. Working Papers, 67(5): 783-794.

Cesur, R., Tekin, E. and Ulker, A. 2013. Air pollution and infant mortality: evidence from the expansion of natural gas infrastructure. Economic Journal, 1: 28-33.

Chen, Y., Jin, G. Z., Kumar, N. and Shi, G. 2013. Gaming in air pollution data? Lessons from China. The BE Journal of Economic Analysis & Policy, 13(3): 1-43.

Greenstone, M. and Hanna, R. 2011. Environmental regulations, air and water pollution, and infant mortality in India. American Economic Review, 104(10): 1573-1576.

Grivas, G., Chaloulakou, A. and Kassomenos, P. 2008. An overview of the PM10 pollution problem, in the metropolitan area of Athens, Greece. Assessment of controlling factors and potential impact of long range transport. Science of the Total Environment, 389(1): 165-177.

Kezhong, Zhang, Juan, Wang and Xiaoyong, Cui 2011. Fiscal decentralization and pollution of the environment: The perspective of carbon emissions. China Industrial Economy, 10: 65-75.

Khanna, N. 2000. Measuring environmental quality: an index of pollution. Ecological Economics, 35(2): 191-202.

Kyrkilis, G., Chaloulakou, A. and Kassomenos, P. A. 2007. Development of an aggregate air quality index for an urban Mediterranean agglomeration: relation to potential health effects. Environment International, 33(5): 670-676.

Luechinger, S. 2014. Air pollution and infant mortality: a natural experiment from power plant desulfurization. Journal of Health Economics, 37(2): 219-231.

Qimin, Zhang and Jingbo, Zhao 2007. The variance analysis on the status quo and pollution of air pollution in 2004 in China. Journal of Guizhou Normal University (Natural Science Edition), 2: 33-36.

Ranying, Lu 2006. Urban environmental air quality and its evaluation method. Lanzhou University Master's Thesis, 23-29.

Sixia, Chen and Hongyou, Lu 2014. Public expenditure structure and environmental quality: the analysis of Chinese experience. Economic Review, 1: 70-80.

Yafei, Wang 2011. The analysis on influence of public fiscal expenditure on environmental pollution to the environment. Public Finance Research, 2: 38-42.