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Original Research

Fiscal Decentralization and Atmospheric Environmental Pollution: Evidence from Chinese Panel Data

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Abstract

Fiscal decentralization, as a model of distributing power and resources between the central and local governments, has complex and profound implications for the governance and control of atmospheric environmental pollution. The article explores the relationship between fiscal decentralization and atmospheric environmental pollution, utilizing panel data from 31 provinces in China from 2009 to 2021 to construct fixed-effect models for empirical analysis. The findings reveal a significant positive correlation between fiscal decentralization and atmospheric environmental pollution, which suggests that fiscal decentralization leads to environmental pollution. Robustness tests, including considerations for the COVID-19 pandemic shock, consistently validate the accuracy of the regression conclusions. The article further analyzes whether there are regional differences in the impact of fiscal decentralization on atmospheric environmental pollution in China by introducing the cross-multiplier terms for directly administered municipalities and autonomous regions, and the results show that there are regional differences in the impact of fiscal decentralization on atmospheric environmental pollution in directly administered municipalities, and that an increase in fiscal decentralization is conducive to the improvement of environmental quality in the directly administered municipalities. In contrast, autonomous regions exhibit the opposite trend, as their fiscal decentralization has a more significant adverse impact on atmospheric environmental pollution compared to other provinces. In conclusion, the article suggests that for the key and difficult areas of air pollution in China, it is necessary to rationalize the fiscal allocation of local governments and strengthen the mechanism of local environmental governance responsibility, in order to promote the coordinated development of regional economy and environment.

Keywords: fiscal decentralization, atmospheric environmental pollution, regional differences, environmental governance, coordinated development

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Introduction

Globally, atmospheric environmental pollution has become a crucial challenge affecting public health, ecological security, and sustainable development. With the acceleration of industrialization, the increase in the level of urbanization, and the growing population, the problem of atmospheric environmental pollution has become increasingly severe. Since 1978, China's economic growth has been on an upward trend of high-speed development, but this has been accompanied by pollution of the environment, especially atmospheric environmental pollution, which is closely related to people's lives. China's Ministry of Environmental Protection 2023 released the "2022 China's Environmental Situation Bulletin", stating that in recent years China's environmental protection work has achieved a series of results, and the quality of the environment has improved more significantly compared to the previous years, but as people's demand for quality of life improves, the problem of environmental pollution is still a very serious problem, especially atmospheric environmental pollution.

For a long time, China's economic development has been driven by crude traditional industries, with traditional production methods relying on resource and environmental depletion sources, and this kind of development through the sacrifice of the environment and resources has been caused in many cases by the "Chinese-style decentralization" of local governments [1]. Theoretically, fiscal decentralization policy as a mode of distribution of power and resources between the central and local governments will have a complex and profound impact on the governance and control of atmospheric environmental pollution. The essence of fiscal decentralization is that it aims to improve the efficiency and effectiveness of government services by decentralizing the decision-making power of certain fiscal revenues and expenditures from the central government to local governments. Theoretically, this institutional arrangement helps to create a competitive mechanism among governments and promotes innovation and motivation among local governments in the provision of public services, including environmental governance.

In practice, the relationship between fiscal decentralization and environmental governance is complex. First, from the perspective that fiscal decentralization may lead to a "race to the bottom" in environmental standards, local governments may relax environmental management and regulatory standards to promote economic growth and attract foreign investment. Such local protectionism not only has a direct negative impact on the atmospheric environment but also undermines an equitable and sustainable economic development model. For example, in order to support local employment and tax revenues, some local governments may provide financial subsidies or relax regulations for heavily polluting industries, so that the environmental costs of these industries are borne by the community and other regions, creating a "free rider" phenomenon of environmental protection. However, fiscal decentralization may also have a positive impact on environmental governance. When local governments are given more autonomy and resources, they have greater incentives and ability to address local environmental problems. Local governments have a more direct understanding of the environmental situation and the needs of the people in their region and are able to formulate and implement environmental policies more flexibly and effectively. In addition, healthy competition among local governments is not limited to economic development but also includes the effectiveness of environmental protection. This means that, with the help of fiscal decentralization, some regions may be able to form a development model featuring environmental governance, attracting enterprises and talents that value sustainable development, and gradually creating a virtuous circle.

This complex two-way interaction requires us to have a more detailed and profound understanding of the relationship between fiscal decentralization and environmental governance. Firstly, empirical research is needed to analyze how different degrees of fiscal decentralization affect the policy formulation and implementation of local governments in environmental protection. Secondly, exploration is required within the fiscal decentralization framework on how to encourage local governments to find a reasonable balance between economic development and environmental protection through institutional design and policy guidance. For example, by establishing environmental performance assessments and fiscal incentive mechanisms, there can be incentives for local governments to increase investment and efforts in environmental protection. More fundamentally, optimizing the integration of fiscal decentralization and environmental governance requires the collective participation and efforts of the entire society, especially government, businesses, and citizens. Governments need to formulate scientific and fair policy frameworks at the macro level, businesses need to take on social responsibility and pursue green development, and citizens need to raise awareness of environmental protection and actively participate in environmental activities.

Since 1978, China has actively implemented a series of decentralization systems to promote local economic development, guiding local governments in their economic endeavors. Under the incentives of fiscal decentralization, governments at all levels have actively promoted economic development, attracted foreign investment, provided corresponding infrastructure conditions, and enticed businesses to establish themselves. Although China consistently emphasizes avoiding the " polluting first and then addressing" approach, based on local GDP as a condition for promotion, local government officials, in pursuit of political advancement, may continually attract investment, increase tax revenue, and even introduce highly polluting enterprises, engaging in intense "political competitions" that vigorously promote economic development [2]. Therefore, under the conditions of local

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fiscal decentralization, does this further contribute to regional atmospheric environmental pollution? Will there be different outcomes among provinces due to regional disparities? Only by exploring these questions can we better address atmospheric environmental pollution issues in different regions within the existing institutional environment. This article takes this perspective to explore the impact relationship between fiscal decentralization and atmospheric environmental pollution, with the hope of providing valuable insights for academia and policymakers.

Literature Review

Fiscal Decentralization and Environmental Pollution

Traditional environmental economics, starting from the perspective of welfare economics, posits that the government should bear the entire responsibility for environmental protection. However, it overlooks the fact that the formulation and execution of environmental policies do not solely rely on the central government. Fiscal decentralization is considered the most effective means of addressing environmental issues. Scholars refer to the theoretical framework linking fiscal decentralization to environmental pollution as "Environment Federalism". Fiscal decentralization is also understood as "Fiscal Federalism" [3], granting local governments certain taxation powers and expenditure responsibilities. This approach allows local governments to autonomously determine the scale and structure of their budget expenditures, emphasizing the essence of providing local governments with appropriate and agreed-upon fiscal autonomy for decision-making [4]. Tiebout [5] employs the theory of "voting with their feet" to explain that the fiscal decentralization system can motivate local governments to offer more and better basic public infrastructure in order to secure additional citizen votes, including the enhancement of environmental quality. However, Qian and Weingast [6] argue that this traditional theoretical assumption overlooks the fact that local government officials, in pursuit of their own interests and development, may make decisions that contradict the expectations of local residents. Therefore, from the perspective of fiscal decentralization, some researchers support the idea that since environmental protection is a part of social public services, it should be the responsibility of local governments. Moreover, due to regional differences, delegating this responsibility to local governments can achieve tailored solutions [7]. However, there is still no consensus on whether fiscal federalism should entail decentralization or centralization. Although Aidt and Dutta [8] suggest granting more rights to local governments, some researchers find that environmental regulations in various regions are still uniformly formulated by the central government [9]. Furthermore, fiscal decentralization not only contributes to environmental pollution but also exerts additional influence on environmental quality through political quality.

The fiscal decentralization in China differs from that of other countries because it simultaneously brings about political decentralization. Under the conditions of promotion incentives for officials, this has led to more local governments prioritizing economic development in their regions while overlooking environmental pollution issues. Chinese scholars have primarily focused on two perspectives in their research on fiscal decentralization and environmental pollution. On one hand, using foundational theories such as game theory, researchers examine the incentive changes for local governments from the perspective of fiscal decentralization. They explore how these changes lead to local environmental pollution and gradually improve regional environmental quality through transformations in government behavior [10]. On the other hand, from the perspective of environmental pollution, fiscal decentralization is treated as an explanatory variable. Through empirical studies, researchers confirm the impact of fiscal decentralization on environmental pollution and subsequently propose measures to address the issues [11-13].

Fiscal Decentralization and Atmospheric Environmental Pollution

After the 1930s, with the acceleration of industrialization and the in-depth study of environmental issues, environmental pollution was delineated into aspects such as water pollution, soil pollution, and air pollution. Especially, following a series of severe atmospheric pollution incidents, including coal smoke pollution, light pollution, and acid rain, research on atmospheric environmental pollution garnered widespread attention from Western scholars [14-16]. The existing research on the impact of fiscal decentralization on atmospheric environmental pollution can be categorized into two perspectives.

The first perspective contends that an increase in the degree of fiscal decentralization will exacerbate the current state of atmospheric environmental pollution. Firstly, fiscal decentralization gives local governments more control over the formulation of environmental policies, and some local governments may deregulate environmental protection for the purpose of economic growth, thus leading to an increase in atmospheric environmental pollution. Secondly, as each local government pursues its own economic interests, they may be unwilling to cooperate on environmental protection. This scenario could result in resource wastage and unresolved environmental issues, further worsening atmospheric environmental pollution. Many researchers have conducted relevant studies. Sun et al. [17] studied the relationship between fiscal decentralization and the efficiency of atmospheric environmental pollution control. They employed a panel Tobit model, regressing fiscal revenue decentralization and fiscal expenditure decentralization indicators separately against the

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efficiency of atmospheric pollution control. The regression coefficients were negative, leading to the conclusion that fiscal decentralization prompts local governments to attract investment by introducing highly polluting enterprises, directly resulting in increased emissions of pollutants. Wu and Wang [18] used panel data from 2008 to 2015 for 73 key monitoring cities in China, employing both static and dynamic models to empirically test the impact of fiscal decentralization on haze pollution. The study found a significant positive correlation between fiscal decentralization measured by different indicators and haze pollution. In addition to comprehensive studies on atmospheric pollutants, some scholars have focused on specific pollutants. For instance, Zhang et al. [19] utilized provincial carbon emission data from 1998 to 2008 and concluded that fiscal decentralization can affect carbon emissions by influencing the second and third industries, with the increased degree of fiscal decentralization exacerbating carbon emissions.

The second perspective posits that an increase in the degree of fiscal decentralization restrains atmospheric environmental pollution. Firstly, fiscal decentralization can enhance the ability of local governments to formulate environmental policies that are more in line with actual local needs, thereby improving the efficiency of resource allocation and the effectiveness of environmental protection. Secondly, fiscal decentralization is conducive to enhancing policy transparency and public participation and promoting local governments to take more effective pollution control measures through social supervision. However, the actual effectiveness of fiscal decentralization in curbing air pollution depends on a variety of factors, such as the financial situation of local governments and the strength of environmental policy implementation. Jiang et al. [20] suggest that hierarchical supervision by government departments, with pollution control efficiency enhanced through layers of regulation, results in improved pollution governance. In other words, the cooperation among different levels of government in fiscal decentralization enhances the level of pollution control. Yang et al. [21] found that fiscal decentralization can effectively reduce the rent-seeking behavior of local governments and promote technological innovation, thereby achieving a situation where there is less environmental pollution coexisting with economic growth. Tan and Zhang [22] using the comprehensive environmental pollution index as the dependent variable and the environmental input-output model as the econometric model, empirically found that under fiscal decentralization in China, local governments can obtain more sufficient funds for environmental protection to govern pollution. Thus, there is an inverse relationship between the degree of fiscal decentralization and atmospheric environmental pollution.

Summary

In summary, the conclusions from existing literature on the relationship between fiscal decentralization and atmospheric environmental pollution are not consistent. This inconsistency is primarily due to the different political systems and national conditions across countries. Research on this topic in China started relatively late, and although some studies suggest that fiscal decentralization leads to local environmental pollution, there are also findings indicating that fiscal decentralization is beneficial for the governance of atmospheric environmental pollution. Therefore, in this article, based on panel data from 31 provinces in China from 2009 to 2021, empirical research is conducted on the impact of fiscal decentralization on atmospheric environmental pollution. The aim is to further identify the relationship between the two in theory and provide a theoretical basis for the formulation of relevant policies.

Method and Data

Panel Regression Model

Based on the existing literature [23], this article chooses to empirically test the impact of fiscal decentralization on atmospheric environmental pollution using data from 31 provinces in China (excluding Hong Kong, Macao, and Taiwan) from 2009 to 2021. The basic model for empirical testing adopts a dual fixed effects benchmark regression controlling for both regional and time effects. The benchmark econometric model is presented as Equation (1).

$$lnpollutant_{i,t} = \alpha_0 + \alpha_1 FD_{i,t} + \alpha_x Controls_{i,t} + \mu_i + \gamma_t + \varepsilon_{i,t} \quad (1)$$

In the expressions, the subscript i represents the region, and t represents time. The dependent variable $lnpollutant_{i,t}$ stands for atmospheric environmental pollution, the explanatory variable $FD_{i,t}$ represents fiscal decentralization, $Controls_{i,t}$ denotes control variables, μ_i represents regional fixed effects, γ_t represents time fixed effects, $\varepsilon_{i,t}$ is the random disturbance term, and α_0, α_1, α_x are the regression coefficients for the variables.

Variable Selection

(1) The atmospheric environmental pollution $lnpollutant_{i,t}$ is the dependent variable representing the status of the natural logarithm of per capita emissions of atmospheric pollutants in region i in year t. The pollutant emissions include the sum of sulfur dioxide emissions, nitrogen oxide emissions, and soot emissions.

(2) Fiscal decentralization $FD_{i,t}$ is the independent variable, and the article measures the fiscal decentralization status of region i in year t. The international mainstream calculation of fiscal decentralization mainly adopts 2 ways to measure the degree of decentralization by the ratio of fiscal revenues and expenditures of lower-level governments and the marginal increment of own revenues. Based

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on China's national conditions, this article adopts the decentralization index carved out by Li and Hu [24] to measure, as shown in Equation (2).

$$FD_{i,t} = \frac{areaexpend_people_{i,t}}{allexpend_people_{i,t}} \quad (2)$$

Where $areaexpend_people_{i,t}$ represents the regional per capita environmental expenditure in year t in region i, and $allexpend_people_{i,t}$ represents the national per capita environmental expenditure in year t.

(3) The article further controls for a range of characteristics at all levels of government, including GDP per capita, level of urbanization, and trade openness. Firstly, the natural logarithm of GDP per capita *lnpgdp* and its square term *lnpgdp2* are added to avoid the existence of the Environmental Kuznets Curve (EKC) [25]. Secondly, the article selects the ratio of urban population to resident population as a proxy variable for the urbanization level in the region, so as to control the impacts of atmospheric environmental pollution due to the change of urbanized population. Finally, the article controls the degree of local trade openness. The degree of trade openness will have an impact on the local environmental quality through pollution-intensive enterprises. Chinese scholars have also shown that, in the case of the high-speed development of foreign trade in China situation, it produces adverse side effects such as excessive resource consumption and further deterioration of atmospheric environmental pollution [26], therefore, through the ratio of the total amount of imports and exports of each region to the GDP as a proxy variable for the degree of trade openness, it is conducive to avoiding the impacts on atmospheric environmental pollution caused by different degrees of trade in each region.

Descriptive Statistics

The sample data in this paper are obtained from the China Environmental Yearbook, China Statistical Yearbook, CNRDS China Research Data Service Platform, and statistical yearbooks of various provinces in China, etc. Some of the missing data are filled in by interpolation, and a total of 403 sample observations are obtained. Descriptive statistics of the main variables are shown in Table 1.

According to the results in Table 1, it can be observed that the dependent variable, atmospheric environmental pollution *lnpollutant*, has a mean of 5.656, a median of 5.663, and a standard deviation of 0.741. The small difference between the mean and median, as well as the relatively small standard deviation, indicates a relatively low level of data dispersion. Thus, the statistical characteristics are within a reasonable range, suggesting a uniform distribution of atmospheric environmental pollution overall. Table 1 also presents descriptive statistics for other variables, including *FD*, *lnpgdp*, *lnpgdp2*, *urbanization* and *trade*. It can be observed from Table 1 that the statistical characteristics of these variables are also within reasonable ranges.

Table 1. Descriptive statistics of the variables.

Variable	Obs	Mean	Std.Dev.	Min	Median	Max
lnpollutant	403	5.656	0.741	2.526	5.663	7.423
FD	403	1.230	0.797	0.358	0.992	5.208
lnpgdp	403	1.572	0.639	-0.026	1.520	4.206
lnpgdp2	403	2.879	2.569	0.001	2.311	17.691
urbanization	403	0.555	0.166	0.018	0.557	0.938
trade	403	0.272	0.299	0.001	0.140	1.484

Results and Discussion

Benchmark Regression

Based on Equation (1), the article conducts a benchmark OLS regression of the impact relationship between fiscal decentralization and atmospheric environmental pollution. Table 2 Column (1) does not include any control variables and controls only for region and year fixed effects, while columns (2) to (4) put in the control variables of *lnpgdp* and *lnpgdp2*, *urbanization*, and *trade* sequentially while controlling for region and year fixed effects. As shown in Table 2, the *FD* results of columns (1) to (4) are all positive and all pass the 1% significance test, which indicates that fiscal decentralization has a significant positive effect on atmospheric environmental pollution, and the coefficients of fiscal decentralization in the four columns are 0.224, 0.255, 0.264, and 0.261, respectively.

In column (1), controlling for region and year, for every unit increase in fiscal decentralization, atmospheric environmental pollution increases by 0.224 units. Meanwhile, in column (2), controlling for per capita GDP and its square, as well as region and year, for every unit increase in fiscal decentralization, atmospheric environmental pollution increases by 0.255 units. This indicates that an increase in fiscal decentralization is detrimental to local atmospheric environmental quality. Even when controlling for urbanization in column (3), the result still passes a 1% significance test with a positive coefficient. Similarly, when controlling for trade openness in column (4), the result still passes a 1% significance test with a positive coefficient. This regression result suggests that increased fiscal decentralization grants greater autonomy to regional governments. Consequently, local governments, seeking greater benefits, sacrifice current environmental quality to promote regional economic development. Since local atmospheric environmental pollution, including pollutant emissions, exhibits negative externalities, while active improvement of atmospheric environmental pollution governance has positive externalities, government "free-riding" behavior exacerbates atmospheric environmental pollution

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problems without any benefits to pollution control. In summary, fiscal decentralization significantly alters government behavior, prompting governments to seek greater self-interest, thereby exerting a greater impact on atmospheric environmental issues and exacerbating atmospheric environmental pollution.

Robustness Test

To further assess the robustness of empirical results, this study employs a GMM estimation on the benchmark regression with lagged terms as additional instrumental variables, and the estimation results are shown in columns (1) and (2) of Table 3. To mitigate potential endogeneity issues, all control variables are lagged by one period, and regression is conducted anew, with empirical results presented in column (3) of Table 3. Further, the regression is re-run with the independent variable *FD* lagged by one period, and the empirical results are shown in column (4) of Table 3. Additionally, considering the impact of the COVID-19 pandemic, which had a profound global impact starting in 2020, and to ensure robustness, the sample period is selected as 2009–2019. The empirical results under this consideration are shown in column (5) of Table 3. Finally, considering the impact of green policy shocks, the 2015 Overall Program for Reform of Ecological Civilization System has a complex impact on environmental protection and green finance, in order to further identify whether the green policy shocks affect the empirical study, the dummy variable *Policy* is set up, with *Policy* = 1 when the year is 2015, and *Policy* = 0 when the year is any other year. The interaction term between *Policy* and *FD* is set as *Policy*FD*, and the empirical results are shown in column (6) of Table 3.

From columns (1) and (2) of Table 3, it can be observed that the two columns are generally consistent with the results of the benchmark regression. The signs and significance of the regression coefficients are almost identical, indicating that the empirical conclusions of this study appear to be robust. From columns (3) and (4), it can be seen that the sign and significance of the coefficients are basically consistent with the results of the benchmark regressions with one period lag in the control and independent variables, which also verifies the robustness of the conclusions of this article. In column (5), considering the impact of the COVID-19 pandemic, the coefficient signs and significance align closely with the benchmark regression results. In column (6), the *FD* and the interaction term *Policy*FD* are significant at the 1% statistical level and do not differ significantly, indicating that the impact of green policy shocks on the empirical results is relatively insignificant. In summary, the empirical results of this article exhibit strong robustness.

Location Difference Analysis

Due to variations in environmental conditions, geography, and government policies among different regions, these diverse influencing factors may lead to differential effects of fiscal decentralization on atmospheric environmental pollution. Therefore, this part focuses on regions within China with relatively high autonomy, conducting a sample-based analysis of heterogeneity. Building upon the general results presented earlier, this part incorporates cross-multiplier terms

Table 2. Benchmark regression results.

	(1)	(2)	(3)	(4)
	lnpollutant	*lnpollutant*	*lnpollutant*	*lnpollutant*
FD	0.224***	0.255***	0.264***	0.261***
	(3.852)	(4.068)	(4.326)	(4.320)
lnpgdp		-0.617**	-0.446	-0.433
		(-2.584)	(-1.615)	(-1.590)
lnpgdp2		-0.0121	-0.0497	-0.0493
		(-0.168)	(-0.650)	(-0.657)
urbanization			-0.321	-0.104
			(-1.171)	(-0.351)
trade				-0.188
				(-1.429)
Constant	6.109***	6.323***	6.329***	6.244***
	(27.135)	(27.861)	(28.275)	(28.111)
Province	YES	YES	YES	YES
Year	YES	YES	YES	YES
R^2	0.262	0.294	0.297	0.300
N	403	403	403	403

*Note: Standard errors are in parentheses; *, **, *** indicate significance at the 10%, 5%, and 1% levels.*

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Table 3. Robustness test results.

	(1)	(2)	(3)	(4)	(5)	(6)
	Differential GMM	System GMM	Lagged Control Variable	Lagged Independent Variable	COVID-19 Pandemic Shock	Green Policy Impact
L. lnpollutant	0.523***	0.566***				
	(0.054)	(0.053)				
FD	0.194**	0.148**	0.260***		0.241***	0.239***
	(0.078)	(0.061)	(0.062)		(0.064)	(0.062)
L. FD				0.252***		
				(0.063)		
*Policy*FD*						0.189***
						(0.085)
Constant			6.400***	6.671***	6.013***	6.275***
			(0.219)	(0.257)	(0.232)	(0.223)
Control	YES	YES	No	YES	YES	YES
L.control	No	No	YES	No	No	No
Province	YES	YES	YES	YES	YES	YES
Year	YES	YES	YES	YES	YES	YES
R^2			0.314	0.322	0.279	0.307
N	310	310	372	372	341	403

*Note: Standard errors are in parentheses; *, **, *** indicate significance at the 10%, 5%, and 1% levels.*

Table 4. Location difference analysis results.

	(1)	(2)	(3)
	Benchmark Regression	Directly Administered Municipalities	Autonomous Regions
FD	0.261***	0.438***	0.112***
	(4.320)	(8.168)	(2.313)
FD Municipalities*		-0.443***	
		(-7.784)	
*FD*Regions*			0.566***
			(11.223)
Control	YES	YES	YES
Constant	6.244***	5.761***	6.072***
	(28.111)	(28.359)	(29.812)
Province	YES	YES	YES
Year	YES	YES	YES
R^2	0.300	0.384	0.475
N	403	403	403

*Note: Standard errors are in parentheses; *, **, *** indicate significance at the 10%, 5%, and 1% levels.*

indicating whether a region is a directly administered municipality or an autonomous region, and the empirical results are shown in Table 4. In Table 4, column (1) still shows the results of adding the existing control variables, and as can be seen from the table, the results are exactly the same as above. In column (2), the article adds the cross-multiplier term between fiscal decentralization and whether it is directly administered by municipalities. For directly administered municipalities (Beijing, Tianjin, Shanghai, and Chongqing), there are obvious differences in their fiscal decentralization status with other provinces, based on which the corresponding factors are added to column (2) to further test whether fiscal decentralization on regional environmental pollution differs between directly administered municipalities and other provinces. From the results in column (2) of Table 4, we can see that the result of the cross-multiplier term of fiscal decentralization with municipalities is negative at the

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1% significance level, which indicates that there is a significant difference between municipalities and the rest of provinces in terms of the adverse effect of fiscal decentralization on atmospheric environmental pollution. For provinces in general, the increase of fiscal decentralization is not conducive to the management of environmental pollution in the region, while for directly administered municipalities, the negative impact of fiscal decentralization on regional environmental pollution is much smaller, and even the increase of fiscal decentralization is conducive to the improvement of environmental quality in the region.

Apart from directly administered municipalities, there are also 5 ethnic minority autonomous regions in China, including Inner Mongolia, Guangxi, Tibet, Ningxia, and Xinjiang. These autonomous regions similarly possess a high degree of autonomy in government decision-making and economic development. Therefore, in Table 4, column (3) introduces the cross-multiplier terms between fiscal decentralization and autonomous region status to verify if these areas exhibit results similar to directly administered municipalities. From the results in column (3) of Table 4, we observe that the cross-multiplier terms between fiscal decentralization and autonomous regions are positive at the 1% significance level, with a coefficient value of 0.566, higher than the benchmark regression coefficient of 0.261. This suggests that the adverse effects of fiscal decentralization on atmospheric environmental pollution are more pronounced in autonomous regions. A possible explanation is that autonomous regions may be relatively less developed economically and politically. High fiscal decentralization could lead to an uneven distribution of local financial resources in these regions. Some areas may struggle to invest sufficiently in environmental protection and air pollution control due to a lack of adequate financial resources. Additionally, uneven resource distribution may result in regional disparities in environmental governance capacity and efficiency, further exacerbating air pollution issues. Therefore, the management of autonomous regions should not be generalized with other provinces, and specific development policies and measures need to be formulated accordingly.

Conclusions

The article empirically examines the impact of fiscal decentralization on atmospheric environmental pollution. Using panel data from 2009 to 2021 for 31 provinces in China, the study employs a fixed-effects regression model to explore the relationship between fiscal decentralization and atmospheric environmental pollution. The empirical results indicate a significant positive correlation between fiscal decentralization and atmospheric environmental pollution, suggesting that fiscal decentralization leads to atmospheric environmental pollution. Robustness tests, including GMM regression, lagged control and independent variables, and consideration of COVID-19 pandemic shocks and green policy impacts, confirm the accuracy of the regression conclusions. The article further analyzes whether there are regional differences in the impact of fiscal decentralization on atmospheric environmental pollution in China. Cross-multiplier terms for directly administered municipalities and autonomous regions are introduced. The results reveal regional differences in fiscal decentralization for directly administered municipalities, where economically developed ones outperform other provinces in environmental governance. Increased fiscal decentralization in directly administered municipalities is conducive to improving environmental quality. In contrast, autonomous regions show the opposite pattern, with fiscal decentralization exerting a greater adverse impact on atmospheric environmental pollution compared to other provinces.

Based on the conclusions above, in order to accelerate the transformation and upgrading of economic development, local governments should not only focus on factors such as local economic growth, but also pay further attention to the governance of regional environmental pollution. Firstly, the central government should establish a comprehensive assessment system for local governments, including environmental protection indicators, so that the promotion and performance of local officials depend not only on economic growth data but also on the improvement of environmental quality. Secondly, support and encourage local governments to invest in green industries and clean energy projects. For example, by providing startup capital and policy guidance, promote the development of renewable energy, energy conservation and emission reduction technologies, and low-carbon economy, thereby optimizing and upgrading the economic structure. Thirdly, strengthen public supervision and reporting mechanisms on environmental issues to form a governance system in which the government, enterprises, and society participate together. Fourthly, use technological innovation to address environmental pollution and reduce economic development constraints caused by pollution control. Finally, encourage the establishment of environmental protection cooperation mechanisms among local governments to effectively control and reduce regional environmental issues.

In conclusion, to prevent atmospheric environmental pollution caused by fiscal decentralization, it is recommended to implement comprehensive measures including establishing and improving incentives and penalties for environmental protection, strengthening environmental laws and emission standards, promoting regional collaborative governance among localities, increasing financial support and technological investment, enhancing public participation and environmental awareness, and optimizing fiscal allocation mechanisms. Through these measures, effective supervision and incentives can be provided to local governments within the framework of fiscal decentralization to reduce air pollution, while also promoting cooperation and technological innovation among local governments to ensure sufficient resources are allocated for environmental governance and improvement.

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Conflict of Interest

The authors declare no conflicts of interest.

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