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Fiscal Decentralization, Revenue and Expenditure Policy and Pollution Control

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Abstract

This paper empirically examines the pollution control effects of government fiscal and revenue policies, using provincial panel data from 2007-2017, The analysis is also expanded from the fiscal decentralization perspective. The main findings are shown as follows: First, the fiscal expenditure policy represented by environmental protection expenditure has indeed exerted a better effect on pollution control, while the fiscal revenue policy represented by sewage charges has not been able to realize its positive effect on pollution control for some time in the past. Second, there is some uncertainty about the effect of fiscal decentralization on pollution control, but overall the effect of either revenue decentralization or expenditure decentralization on pollution governance is unsatisfactory. Third, the interaction effect of fiscal decentralization and fiscal expenditure policy currently fails to achieve effective pollution control, while the interaction effect of fiscal decentralization and sewage charges significantly curbs the level of pollution emissions, and this positive effect may be more obvious after the change from sewage charges to environmental protection taxes.

Keywords

Fiscal Policy; Environmental Protection Expenditure; Sewage Charges; Fiscal Decentralization; Pollution Control.

1. Introduction and Literature Review

Along with China's economic shift to a new era of high-quality development, the concept of green development continues to deepen. How to optimize fiscal policies to help the economy achieve green development and thus promote the quality of life of residents has become one of the major strategic issues that the government needs to solve today. At present, China's financial and revenue levels have corresponding policy support for environmental management, At the expenditure level, the national expenditure on environmental protection in 2019 is 744.357 billion yuan, accounting for only 3.12% of the national fiscal expenditure; As for the revenue level, the official introduction of the Environmental Protection Tax in 2018 has further regulated the collection and management of this revenue on the basis of replacing the original emission fee system, with the annual environmental protection tax revenue of 15.138 billion yuan in 2018, accounting for less than 0.01% of the national tax revenue and less than 0.2% of the local tax revenue. Considering that the current share of this tax in the total tax revenue is still low, its specific effect of regulating pollution emissions still needs further analysis. And under the pressure brought by the asymmetrical fiscal revenue and expenditure decentralization in China, local governments' revenue and expenditure behavior inevitably appears to be distorted to some extent, either actively relaxing taxation efforts or actively investing in productive constructive expenditure projects, and can this institutional factor promote the continuous optimization of pollution control? Based on this, this paper attempts to analyze the effects of environmental pollution management in two dimensions of local government revenue and expenditure under the fiscal decentralization system, in order to

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provide theoretical basis and policy reference for building a green economic development model to achieve high-quality economic development.

So far, domestic and foreign scholars have conducted many useful discussions on fiscal policy and environmental protection from both theoretical and empirical dimensions. Foreign scholars mostly agree that fiscal policy is conducive to reducing pollution emissions to achieve green economic growth. For example, a study by López and Palacios (2014) using data from monitoring stations in 12 European countries between 1995 and 2008 verified that fiscal policy and energy taxes are important determinants of pollution, with an increase in fiscal spending as a share of GDP significantly reducing sulfur dioxide and ozone concentrations, while the imposition of energy taxes reduces nitrogen dioxide concentrations. The study by Halkos and Paizanos (2016) on quarterly data for the period 1973-2013 in the United States proves that expansionary fiscal spending policies have a significant mitigating effect on CO2 emissions from both production and consumption, but the relationship between tax reduction policies and CO2 emissions varies with the source of pollution emissions and the context in which the policies are implemented. Freire-González et al. (2018) used a dynamic CGE model to simulate 39 industries related to pollution emissions in Spain and concluded that the environmental fiscal reform achieved a "double dividend" effect of an increase in economic aggregates and a decrease in pollution emissions. The study by Ike et al. (2020) on the relationship between fiscal policy and CO2 emissions in the framework of the environmental Kuznets curve suggests a bidirectional causal relationship between fiscal policy and CO2 emissions. In contrast, domestic scholars are equally rich in addressing the environmental governance effects of fiscal policy. Luo and Zhu (2010) analyzed the problems of China's current fiscal policy for environmental governance at the theoretical level, arguing that the current problems of insufficient financial investment, single means of regulation, imperfect tax system and unregulated fees affect the effect of government pollution control.In contrast, Xia and Li (2019) conducted a study at the empirical level using data on manufacturing listed companies in China during 2013-2017 and concluded that the cross-level moderating effect of policy support is significant, and the greater the policy support the more the companies are able to achieve green development. At the same time, some scholars have also studied the efficiency of local governments' pollution control from the perspective of fiscal decentralization. For example, a study of provincial and municipal panel data by Li and Liu (2019) demonstrates that the decentralization system is an important cause of the dysfunctional fiscal expenditure structure of local governments, and thus the decentralization system significantly affects the level of haze pollution through fiscal expenditure policies.While Sun et al. (2019) study on 27 key cities of environmental protection in and around Beijing, Tianjin and Hebei showed that there are differences in air pollution control efficiency in different cities, but there is a significant negative effect of fiscal decentralization on air pollution control efficiency, i.e., the higher the degree of decentralization the lower the efficiency of pollution control instead.

2. Theory Interpretation

2.1. Analysis of the Effect of Fiscal Policy on Pollution Control

The nature of public goods for ecological protection dictates that the government must play its proper role in this area (Li et al., 2010). The government's instruments to regulate the emission of environmental pollutants include two main dimensions: fiscal expenditure and taxation.

On the one hand, the fiscal expenditure policy can give full play to its pollution control effect from optimizing the economic development environment and directly implementing the pollution control level to achieve green economic development. First, in terms of the investment-oriented effect of fiscal spending policy, fiscal spending can play a positive role in guiding market investment orientation, increasing investment support for eco-friendly

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enterprises, creating a significant development gap between the industries in which these enterprises are located and non-government supported industries, and prompting market participants to take the initiative to change their development mode to low-pollution industries. Secondly, from the perspective of the spillover of ecological environment as a public good, financial expenditure can provide financial support for enterprises to upgrade their infrastructures and compensate for the cost of using pollution treatment equipment, thus reducing the operating cost of eco-friendly enterprises and improving their market competitiveness, which ultimately brings about an overall reduction in the level of emissions of enterprises. Finally, from the level of government functions, it is the duty of local governments to improve the quality of life of residents and create a green development economic environment. The financial environmental protection expenditure can realize the positive effect on the special treatment of pollution emission, so as to achieve the control of pollution management.

On the other hand, fiscal revenue policy can directly control the cost of corporate emissions, reduce corporate pollution emissions, and ultimately achieve green development. First, as opposed to fiscal spending policy, the government can achieve the purpose of raising the cost of pollution emission by enterprises through the collection of taxes and fees, that is, by running the "who pollutes, who is responsible" development model to reduce the incentive of enterprises to emit pollutants, and thus achieve pollution control at the source. Secondly, the pollution tax levied by the government can be used for special treatment of pollution, so that the funds can be used specifically to enhance the government's pollution control capacity by increasing government revenue. However, at the same time, the larger the scale of the pollution tax levied by the government, to a certain extent, also reflects the huge scale of the total local pollution, at this time, under the premise of high local investment returns, the tax paid by enterprises on pollution emissions may be lower compared to their production returns, so the impact effect of the tax on pollution emissions may not be obvious at this time.

2.2. Analysis of the Effects of Local Government Revenue and Expenditure Policies on Pollution Control under the Fiscal Decentralization System

There are both positive and negative possibilities for the effect of fiscal decentralization on local governments' pollution emission management.

In terms of the positive effects of fiscal decentralization, the decentralized system can give full play to local enthusiasm through the transfer payment system and take advantage of local government information to achieve precise management of pollution emissions. First, transfer payments under the decentralized system can play a positive role in regulating the behavior of local governments, which is conducive to improving the level of pollution control expenditures. Local governments under the Chinese fiscal decentralization system are limited to the revenue and expenditure gap dilemma, and environmental pollution control expenditures will be crowded out to a certain extent, while transfer payments can play a positive role in balancing the fiscal relationship between the central and local governments to ensure the level of local pollution control investment. Secondly, fiscal decentralization, by giving local governments more autonomy over revenues and expenditures, can achieve better pollution control efficiency through information advantages. Since local governments are geographically closer to the people in their jurisdictions, they are able to understand the preferences and needs of local residents more comprehensively than the central government, thus achieving efficient supply of public goods. As a result, local governments are able to achieve precise pollution control more effectively than the central government in the field of environmental management. At the same time, local residents can regulate the behavior of local governments through "voting with their hands" and "voting with their feet" mechanisms (Tiebout, 1956), thus forcing local governments to implement more effective pollution control policies more effectively.

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In terms of the negative effects of fiscal decentralization, local governments are in fierce inter-regional horizontal competition under the decentralized system, and under the economic growth-oriented development model, local government revenue and expenditure behavior will be distorted to the detriment of regional pollution control. First of all, local governments are generally in fierce horizontal competition under the decentralized system, and they tend to focus too much on achieving high economic growth to the neglect of ecological environment management and protection in order to realize their own promotion interests and win the top position in the traditional performance evaluation. At the same time asymmetrical revenue and expenditure decentralization system brings a large pressure of revenue and expenditure gap to the local government, in order to alleviate this pressure local government will relax the degree of supervision of enterprise pollution, bringing about the increase of pollution level. Although environmental performance indicators have gradually become another powerful indicator for officials' performance evaluation since the 18th National Congress, it is still difficult to completely eliminate the existence of "face-saving projects" and "performance projects" by government officials (Liu, 2018). Local governments often tend to accomplish goals that can be easily measured by higher levels of government, and thus there is a whitewash of pollution treatment that treats the symptoms but not the root cause (Shen and Wang, 2018).

3. Variable Definition and Model Setting

3.1. Variable Definition

3.1.1. Explained Variables

In this paper, wastewater emissions (liquid), sulfur dioxide emissions (gas), and industrial solid waste emissions (solid) are selected as the explanatory variables to measure the effects of government fiscal and revenue policies and decentralization system on pollution emissions. At the same time, considering that there may be some correlation between different pollutant emissions, this paper draws on the index constructed by Zhu et al. (2011) to weight and combine the above three emissions into a total pollution emission (total) index. Specifically, the ratio of each type of pollution emission to the real GDP of each region is calculated first, and then its per capita value is calculated to.

3.1.2. Core Explanatory Variables

First, environmental protection expenditure (lnenv) and sewage fee income (lnppw). In order to more accurately study the effects of fiscal revenue and expenditure policies on pollution emissions, this paper selects environmental protection expenditure and emission fee revenue as proxy variables for expenditure and tax policies. Firstly, the environmental protection expenditure variable is obtained by calculating the actual environmental protection expenditure per capita in each province and then taking the natural logarithm. Secondly, considering that China has only formally implemented the Environmental Protection Law of the People's Republic of China since 2018, and this tax evolved from the previous emission fee system, this paper is consistent with the existing literature in choosing the emission fee as a proxy variable to carry out the empirical analysis. The caliber of the indicators published in the China Environmental Yearbook changed after 2015, so this paper complements the data of 2015 by searching the environmental yearbooks or statistical bulletins of each province, but there is still a large proportion of missing data in 2016. The specific indicators are obtained by taking the natural logarithm after calculating the actual sewage charges per capita in each province.

The second is fiscal revenue decentralization (fqr) and expenditure decentralization (fqs). Based on the benchmark regression, this paper further examines the effect of the fiscal decentralization system on the pollution governance effect of fiscal revenue and expenditure policies. Among them, the fiscal revenue decentralization index is obtained by calculating fiscal

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revenue per capita in each province/(fiscal revenue per capita in each province + central fiscal revenue per capita), and the fiscal expenditure decentralization is obtained by calculating fiscal expenditure per capita in each province/(fiscal expenditure per capita in each province + central fiscal expenditure per capita).

3.1.3. Control Variables

In this paper, population growth rate, urbanization, the share of tertiary industry output and economic development level are selected as control variables based on existing studies and relevant theories. The population growth rate (peog) indicator is obtained by calculating the year-end resident population growth rate of each province. The urbanization (urban) indicator is obtained by calculating the ratio of the urban population to the year-end resident population in each province. The tertiary sector share (industry) indicator is obtained by calculating the ratio of the value added of the tertiary sector to the GDP of each province in that year. The economic development level (lnpgdp) indicator is first obtained by using the GDP deflator (2007=100) to remove the price factor, and then dividing by the total resident population at the end of the year in each province and taking the natural logarithm.

3.1.4. Variable Sources and Statistical Characteristics

The raw data for all variables appearing in this paper were obtained from the China Statistical Yearbook 2008-2018, the China Environment Yearbook 2015-2016, the official website of the People's Republic of China on ecology and environment, the EPS database, the environmental yearbooks of each province, and the statistical yearbooks, and the relevant variables were excluded from inflation or deflation using the GDP deflator (2007=100). The specific statistical information of each variable is shown in Table 1 below.

Table 1. Statistical information of variables

variables	Sample size	Standard error	Minimum value	Average value	Maximum value
Wastewater discharge(*liquid*)	330	4.2674	0.6278	9.6278	27.4486
Sulfur dioxide emissions (*gas*)	330	0.0060	0.0001	0.0059	0.0415
Industrial solid waste emissions (*solid*)	330	1.0329	0.0295	0.7965	8.1199
Total pollution emissions *(total)*	330	1.5102	0.2420	3.4767	9.3803
Environmental Expenditures *(lnenv)*	330	0.7215	11.0292	13.5568	15.2435
Sewage fee income*(lnppw)*	279	0.6613	0.2536	2.5247	4.5865
Revenue decentralization *(fqr)*	330	0.1342	0.2630	0.4906	0.8349
Expenditure decentralization *(fqs)*	330	0.0539	0.6977	0.8387	0.9370
Population growth rate *(peog)*	330	2.6571	-0.6000	5.3241	11.7800
Urbanization *(urban)*	330	0.1345	0.2824	0.5406	0.8960
Tertiary industry share *(industry)*	330	0.1342	1.9947	2.3106	2.8013
Economic Development Level*(lnpgdp)*	330	0.5297	8.9798	10.3704	11.6152

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3.2. Model Setting

This paper first examines the effects of fiscal revenue and expenditure policies on pollution emissions separately, and includes the quadratic terms of policy variables in the model to determine whether there is a nonlinear effect, so as to examine the effects of policies at the revenue and expenditure levels on total pollution emissions and various types of pollution emissions separately, and thus constructs the benchmark regression models in equations (1) and (2) below.

$$total_{it}(liquid_{it}/gas_{it}/solid_{it})=\alpha_0+\alpha_1 lnenv_{it}+\alpha_2 lnenv_{it}^2+\alpha_3 X_{it}+\mu_i+\lambda_t+\varepsilon_{it} \quad (1)$$

$$total_{it}(liquid_{it}/gas_{it}/solid_{it})=\beta_0+\beta_1 lnppw_{it}+\beta_2 lnppw_{it}^2+\beta_3 X_{it}+\mu_i+\lambda_t+\varepsilon_{it} \quad (2)$$

On this basis, this paper will further examine the impact effect of the fiscal decentralization system, so the regression models shown in equations (3) and (4) below are constructed by introducing the fiscal decentralization and its interaction term with fiscal policy respectively on the basis of the benchmark regression.

$$total_{it}(liquid_{it}/gas_{it}/solid_{it})=\alpha_0+\alpha_1 lnpenv_{it}+\alpha_2 fq_{it}+\alpha_3 lnenv^* fq_{it}+\alpha_4 X_{it}+\mu_i+\lambda_t+\varepsilon_{it} \quad (3)$$

$$total_{it}(liquid_{it}/gas_{it}/solid_{it})=\beta_0+\beta_1 lnppw_{it}+\beta_2 fq_{it}+\beta_3 lnppw^* fq_{it}+\beta_4 X_{it}+\mu_i+\lambda_t+\varepsilon_{it} \quad (4)$$

where X_{it} is a set of control variables, μ_i is a set of individual fixed effects, λ_t is a set of time fixed effects, and ε_{it} is a set of random error terms.

4. Analysis of Empirical Results

Considering that there are differences in order of magnitude and magnitude of each variable, in order to avoid possible estimation errors, the paper standardizes each variable before regression. By conducting Hausman test on the baseline regression, the results verified the selection of random effects, but the model proved to have cross-sectional correlation problems in the follow-up tests, so the xtscc order estimation results reporting Driscoll-Kraay standard errors were finally selected in this paper.

4.1. Analysis of Baseline Regression Results

In this paper, the regressions are conducted separately for environmental protection expenditure and sewage charges, and the specific regression results are shown in Tables 2 and 3.

4.1.1. Analysis of the Effect of Environmental Spending on Pollution Emissions

First, at the level of total pollution, environmental protection expenditure shows a significant non-linear effect on total pollution emissions. The primary term of environmental protection expenditure shows a significant negative correlation with total pollution emissions, i.e., environmental protection expenditure significantly suppresses the amount of total pollution emissions, and for every 1% increase in environmental protection expenditure, total pollution decreases by 1.5540 units. In contrast, the secondary term of environmental protection expenditure shows a significant positive correlation with total pollution emissions, indicating that excessive environmental protection expenditure instead drives the increase in total pollution emissions. This empirical result is similar to that of Cao (2019), indicating that the increase in the level of government environmental protection expenditure does exert a better pollution control effect, which helps to achieve green economic development and promote the continuous improvement of environmental quality. However, it should also be concerned that

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when environmental spending is too high, it has the negative effect of contributing to the rise in total pollution, which suggests that local governments may have adopted a policy of supporting the development of polluting enterprises in order to develop the economy, i.e., paying more for environmental spending and implementing the vicious development model of polluting first and treating later.

Table 2. Regression results of the effect of environmental protection expenditure on pollution emission

variables	Total pollution(*total*)	Wastewater*(liquid)*	Sulfur Dioxide*(gas)*	Industrial solid waste*(solid)*
Environmental expenditure *(lnpenv)*	-1.5540*** (-11.36)	-1.1129*** (-6.29)	1.0541*** (5.23)	-2.2246*** (-4.94)
Environmental protection expenditure secondary items *($lnpenv^2$)*	1.4875*** (9.83)	1.0164*** (4.84)	-0.8119*** (-5.21)	2.3299*** (3.97)
Population growth rate *(peog)*	0.2000*** (3.48)	0.1867** (2.58)	0.3502*** (4.55)	0.1035 (1.40)
Urbanization *(urban)*	-0.1056 (-0.82)	-0.2650 (-1.73)	-1.2440*** (-7.20)	0.6392 (1.44)
Tertiary industry share *(industry)*	0.2976*** (4.38)	0.3374*** (4.52)	0.1347 (1.08)	-0.0891 (-0.61)
Economic Development Level*(lnpgdp)*	-0.2793 (-1.23)	-0.2276 (-1.22)	-0.4789 (-1.42)	-0.2808 (-0.97)
Constant term	-2.2027*** (-5.14)	-1.8601*** (-3.78)	2.6367*** (6.14)	-1.9920** (-2.83)
N	330	330	330	330
R^2	0.8446	0.8310	0.9091	0.7901

Second, in terms of sub-pollution indicators, the effect of environmental spending on wastewater discharge and industrial solid waste discharge shows consistency with total pollution discharge. Specifically, for every 1% increase in environmental spending, wastewater discharge and industrial solids emissions will decrease by 1.1129 and 2.2246 units, respectively, with the effect of environmental spending on industrial solids pollutants being relatively greater. In contrast, the impact of environmental spending on sulfur dioxide emissions is diametrically opposed to total pollution emissions, that is, lower environmental spending is difficult to achieve the treatment of sulfur dioxide pollution, only a certain scale of environmental spending to achieve its treatment effect. However, in a comprehensive comparison, the positive effect of environmental spending on wastewater emissions and industrial solids emissions is greater than the negative effect of sulfur dioxide, so environmental spending still shows a positive effect on the management of total pollution emissions.

Third, the population growth rate shows a positive correlation with pollutant emissions, indicating that the increase in population growth rate significantly contributes to the increase in pollutant emission levels, and the negative effect of population growth rate is mainly realized

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through the increase in wastewater emissions and sulfur dioxide emissions. The increase in population growth rate significantly raises local resource use, which in turn brings about an increase in pollution levels, a result that is consistent with theoretical expectations.

Fourth, the level of urbanization shows a negative correlation with pollution emissions, but this positive effect is not significant overall, and only shows a significant negative correlation with sulfur dioxide emissions. To a certain extent, this indicates that the accelerated urbanization process helps to promote the transformation of economic development from the traditional dependence on resource inputs to the green growth of the economy by taking advantage of the demographic dividend brought about by the population aggregation effect.

Fifth, the share of tertiary industry shows a certain positive correlation with pollutant emissions, and the driving effect on total pollution emissions is mainly achieved by promoting the level of wastewater discharge. This indicates that the current industrial structure upgrading does not achieve good pollution control effect, so we should focus on reasonable guidance of industrial structure transformation and upgrading, and promote the industrial structure to adapt to the local resource endowment structure, so as to achieve industrial structure optimization and upgrading on the basis of green growth.

Finally, the level of economic development and pollution emissions show a negative correlation, but this influence effect is not significant. This reflects to a certain extent the importance of the current shift to a high-quality stage of China's economic development, where development no longer takes the pursuit of growth rate as the main goal, but pays more attention to the environmental effects in the process of economic growth.

4.1.2. Analysis of the Effect of Sewage Fee Revenue on Pollution Emission

Table 3. Regression results of the effect of emission fee revenue on pollution emission

variables	Total pollution(*total*)	Wastewater*(liquid)*	Sulfur Dioxide *(gas)*	Industrial solid waste*(solid)*
Sewage fee income*(lnppw)*	0.0968 (0.97)	0.0659 (0.52)	-0.2153* (-2.20)	0.1534 (1.23)
Sewage fee income secondary items*($lnppw^2$)*	0.0458 (0.32)	0.0472 (0.29)	0.3564*** (3.46)	0.0036 (0.05)
Population growth rate *(peog)*	0.1880*** (3.46)	0.2063** (3.03)	0.3824*** (3.40)	-0.0297 (-0.28)
Urbanization *(urban)*	-0.1903 (-1.48)	-0.3348** (-2.90)	-1.0192*** (-4.01)	0.5542 (1.49)
Tertiary industry share *(industry)*	0.3179** (2.65)	0.3964*** (3.45)	0.0655 (0.48)	-0.2437 (-1.22)
Economic Development Level*(lnpgdp)*	-0.5186 (-1.55)	-0.3834 (-1.57)	-0.9163** (-2.86)	-0.6851 (-1.36)
Constant term	-1.4033*** (-3.15)	-1.4184*** (-3.39)	2.5593*** (3.80)	-0.3101 (-0.61)
N	279	279	279	279
R^2	0.8533	0.8486	0.9220	0.7326

First, the impact effect of emission fee revenue is not significant in terms of total pollution, indicating that the policy instruments at the revenue level do not achieve a good pollution

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regulation effect. In contrast, among the sub-pollution indicators, emission fees significantly curb SO_2 emissions, with each 1% increase in emission fee revenue bringing a 0.2153 unit decrease in SO_2 emissions. At the same time this impact effect of sewage charges shows a significant non-linear characteristic. To a certain extent, it contrasts with the environmental protection expenditure policy. In contrast, the impact effect of sewage charges is not significant at the level of wastewater discharge and industrial solid waste discharge.

Second, by comparing the impact effects of environmental expenditures with those of emission fee revenues, it can be seen that the effects of fiscal policy at the expenditure level to curb pollution emissions are more pronounced, while the effects at the revenue level are relatively small. Theoretically, sewage charges, as a cost expenditure of enterprises, should play a positive effect of curbing pollution emissions at source, while environmental protection expenditure is to some extent more focused on the effect of post-pollution emission treatment, which is more inclined to ex post measures. This empirical result suggests that the current development model of local governments still focuses on ex-post pollution control rather than ex-ante prevention, and thus the impact effect of expenditure policies is more significant.

Finally, the effects of the control variables on each pollution emission did not change significantly, so the analysis is not repeated here and in the following.

4.2. Further Study: The Impact Effects of Fiscal Decentralization

4.2.1. Analysis of the Effects of Environmental Spending and Fiscal Decentralization on Pollution Emissions

Table 4. Regression results of the effects of environmental spending and income decentralization on pollution emissions

variables	Total pollution(*total*)	Wastewater*(liquid)*	Sulfur Dioxide *(gas)*	Industrial solid waste*(solid)*
Environmental Expenditures *(lnpenv)*	-0.3219** (-2.89)	-0.2528*** (-1.89)	0.5219*** (5.29)	-0.3706*** (-4.48)
Revenue decentralization *(fqr)*	0.2324 (0.45)	-0.3291 (0.62)	0.3345 (1.64)	-0.3423 (-1.77)
Interaction items*(lnpenv*fqr)*	0.3306 (1.01)	0.1732 (0.45)	-0.5436*** (-3.50)	0.7412*** (3.42)
Population growth rate *(peog)*	0.0825 (1.61)	0.1000 (1.37)	0.4108*** (4.72)	-0.0536 (-0.61)
Urbanization *(urban)*	-0.3970** (-2.27)	-0.4851* (-2.10)	-1.1948*** (-5.48)	0.2698 (0.99)
Tertiary industry share *(industry)*	0.3154*** (3.73)	0.3667*** (4.22)	0.1420 (1.20)	-0.1324 (-0.79)
Economic Development Level*(lnpgdp)*	-0.8666 (-1.30)	-0.7909 (-1.29)	-0.4677 (-1.66)	-0.5307 (-1.25)
Constant term	-2.0627*** (-3.34)	-1.9011*** (-2.89)	2.6989*** (5.23)	-1.3405*** (-3.21)
N	330	330	330	330
R^2	0.8401	0.8309	0.9077	0.7695

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Table 5. Regression results of the effect of environmental protection expenditure and expenditure decentralization on pollution emission

variables	Total pollution*(total)*	Wastewater*(liquid)*	Sulfur Dioxide *(gas)*	Industrial solid waste*(solid)*
Environmental Expenditures *(lnpenv)*	-2.2586*** (-8.29)	-1.5716*** (-4.80)	1.4320*** (4.49)	-3.4218*** (-7.02)
Expenditure decentralization *(fqs)*	-0.6627** (-2.54)	-0.3050 (-1.10)	0.4193* (2.00)	-1.6494*** (-5.45)
Interaction items*(lnpenv*fqs)*	3.0591*** (7.61)	2.0444*** (4.24)	-1.6652*** (-4.12)	4.9814*** (6.53)
Population growth rate *(peog)*	0.1581** (2.64)	0.1469* (2.00)	0.3686*** (5.07)	0.0846 (1.46)
Urbanization *(urban)*	-0.0979 (-0.51)	-0.3111 (-1.18)	-1.2671*** (-5.02)	0.8632** (2.70)
Tertiary industry share *(industry)*	0.3267*** (4.36)	0.3779*** (4.48)	0.1283 (1.03)	-0.1289 (-0.76)
Economic Development Level*(lnpgdp)*	-0.7780 (-1.61)	-0.7459 (-1.67)	-0.2849 (-0.99)	-0.3295 (-0.90)
Constant term	-2.2786*** (-3.37)	-1.8230*** (-2.58)	2.7054*** (8.16)	-2.4785*** (-4.81)
Sample size	330	330	330	330
R^2	0.8463	0.8327	0.9095	0.7992

First, the relationship between income decentralization and total pollutant emissions is not significant, and there are differences in the effects on different types of pollutants. In contrast, expenditure decentralization exhibits a suppressive effect on total pollution emissions, and this suppressive effect is mainly achieved by reducing industrial solid waste emissions, while it shows a boosting effect on sulfur dioxide emissions. This regression result fully reflects the difference in the impact of fiscal revenue and expenditure out of decentralization on pollution control. On the one hand, the increase in the degree of revenue decentralization means that local governments have more abundant levels of their own revenues, and the increase in overall financial strength brings diversification of spending options for local governments. The local governments in the midst of fierce horizontal competition may not be able to consider pollution control first, and the increase in revenue level will also bring about the relaxation of sewage charges, which in turn leads to the insignificant effect of revenue decentralization on pollution emissions. On the other hand, the increased decentralization of spending allows local governments to more fully exercise their spending autonomy in accordance with local conditions and to choose projects that are conducive to local development for fiscal spending, thus enabling them to better achieve pollution control.

Second, there is a significant effect of income decentralization and environmental protection expenditure interaction term only on sulfur dioxide emissions and industrial solid waste emissions. On the one hand, the increase in revenue sharing can reverse the negative effect of environmental spending on SO2 emissions and instead curb its emission levels. Revenue decentralization, on the other hand, significantly suppresses the effect of environmental spending on industrial solid waste treatment, which instead promotes pollution emissions. The expenditure decentralization and the interaction of environmental expenditures raise the level

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of total pollution emissions overall, but effectively suppress the level of SO2 emissions. This suggests that although both expenditure decentralization and environmental protection spending can curb pollution emissions, the distortion of local government spending behavior brought about by excessive expenditure decentralization will significantly reduce the importance of local government spending on environmental protection, which in turn distorts the original pollution control effect.

4.2.2. Analysis of the Effect of Emission Fee Revenue and Fiscal Decentralization on Pollution Emission

Table 6. Regression results of the effect of emission fee revenue and revenue decentralization on pollution emissions

variables	Total pollution(*total*)	Wastewater*(liquid)*	Sulfur Dioxide *(gas)*	Industrial solid waste*(solid)*
Sewage fee income*(lnppw)*	0.6898*** (3.51)	0.4802** (2.54)	0.9238*** (3.84)	1.0364** (3.02)
Revenue decentralization *(fqr)*	1.0654** (3.00)	0.9040** (2.81)	0.3928*** (4.43)	0.9360** (3.04)
Interaction items*(lnppw*fqr)*	-0.6827** (-3.02)	-0.4749* (-2.15)	-0.9432*** (-3.50)	-1.0270** (-2.95)
Population growth rate *(peog)*	0.1416** (2.66)	0.1682** (2.47)	0.3537** (3.15)	-0.0761 (-0.59)
Urbanization *(urban)*	-0.1977 (-1.69)	-0.3670** (-2.92)	-0.9433*** (-3.94)	0.6546 (1.53)
Tertiary industry share *(industry)*	0.3324** (2.41)	0.4194** (3.18)	0.0114 (0.10)	-0.2749 (-1.46)
Economic Development Level*(lnpgdp)*	-1.4761** (-2.55)	-1.2472** (-2.69)	-0.7668** (-2.44)	-1.3177* (-1.99)
Constant term	-2.2124*** (-4.44)	-2.1600*** (-4.48)	2.8024*** (4.44)	-0.7966** (-2.42)
N	279	279	279	279
R^2	0.8626	0.8557	0.9266	0.7419

First, the impact effects of fiscal decentralization are somewhat different from Tables 4 and 5. On the one hand, income decentralization presents a present promoting effect on the emissions of each pollutant, while expenditure decentralization significantly boosts the emissions of total pollution, wastewater discharge and sulfur dioxide, in addition to significantly suppressing the emissions of industrial solid pollutants. This regression result leads to overall disagreement on the pollution control effect of fiscal decentralization, suggesting that research on the pollution control effect of decentralized systems still needs further refinement. Overall, however, the overall effect of revenue and expenditure decentralization on pollution governance is not satisfactory.

Second, both the revenue decentralization and the expenditure decentralization show significant positive effects of their interaction terms with emission fees to curb pollution emissions.

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Table 7. Regression results of the effect of revenue and expenditure decentralization of sewage charges on pollution emissions

variables	Total pollution(*total*)	Wastewater*(liquid)*	Sulfur Dioxide *(gas)*	Industrial solid waste*(solid)*
Sewage fee income*(lnppw)*	1.7229** (2.74)	1.6277** (2.39)	2.6044*** (3.40)	0.8170* (2.03)
Expenditure decentralization *(fqs)*	0.5318*** (3.35)	0.6549*** (3.75)	0.3550** (2.27)	-0.3751** (-2.77)
Interaction items*(lnppw*fqs)*	-1.6029** (-2.52)	-1.5464* (-2.26)	-2.5125*** (-3.29)	-0.6274 (-1.71)
Population growth rate *(peog)*	0.1266* (1.91)	0.1393* (2.04)	0.3101*** (3.42)	-0.0221 (-0.18)
Urbanization *(urban)*	-0.0975 (-0.57)	-0.3189 (-1.57)	-0.6950** (-2.39)	0.8939* (1.87)
Tertiary industry share *(industry)*	0.3449** (2.67)	0.4393*** (3.36)	0.0599 (0.44)	-0.3022 (-1.66)
Economic Development Level*(lnpgdp)*	-1.0091** (-2.38)	-1.0591** (-3.13)	-0.8803*** (-3.87)	-0.0453 (-0.08)
Constant term	-1.5164*** (-4.00)	-1.3871*** (-3.57)	2.0398*** (7.02)	-0.9327** (-3.19)
N	279	279	279	279
R^2	0.8570	0.8540	0.9264	0.7391

In terms of the degree of revenue decentralization, the formerly implemented sewage charge system provided for a 1:9 revenue split between the central and local governments, i.e., local governments had considerable incentives at this level of revenue capture. Considering the current asymmetric nature of China's revenue and expenditure decentralization, the conversion of emission charges to environmental protection tax, with all revenues going to local ownership, will to a certain extent help boost local governments' motivation to use taxation to combat pollution. In terms of the degree of expenditure decentralization, an increase in the degree of decentralization can reverse the impact effect of sewage charges to curb pollution emissions. This result suggests that increasing the level of expenditure decentralization on the basis of ensuring an adequate level of local government revenue helps to give full play to the local government's incentive to treat pollution and realize the effect of treating pollution emissions.

5. Research Conclusion and Policy Recommendations

Using inter-provincial panel data from 2007-2017, this paper explores the pollution control effects of government fiscal and revenue policies, and the findings show that: First, the fiscal expenditure policy represented by environmental protection expenditure has indeed exerted a better effect on pollution control, while the fiscal revenue policy represented by sewage charges has not been able to realize its positive effect on pollution control for some time in the past; Second, there is some uncertainty about the impact effect of fiscal decentralization on pollution governance, but overall neither revenue decentralization nor expenditure decentralization has a satisfactory impact effect on pollution governance; Third, the interaction effect of revenue and expenditure sharing and fiscal expenditure policy currently fails to achieve effective pollution

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control, while the interaction effect of revenue and expenditure sharing and sewage charges significantly curbs the level of pollution emissions, and this positive effect may be more obvious after the change of sewage charges to environmental protection tax.

Firstly, the positive effect at the level of fiscal expenditure policy should be actively used to raise the proportion of expenditure on environmental protection. Although the empirical results of this paper verify that there is a certain non-linear effect of environmental protection expenditure, the overall expenditure on environmental protection in China is relatively low at present, and there is still some room for improvement, so the proportion of environmental protection expenditure should be gradually increased to give full play to the positive effect of fiscal expenditure policy on pollution control. Also focus on the precise use of environmental protection expenditure, so that the financial funds allocated to various pollution control to show the highest effectiveness, to achieve the efficiency of pollution control.

Secondly, it is important to strictly regulate the collection of environmental protection tax to avoid the decline of the positive effect of this tax due to the implementation of tax incentives by local governments for economic development. The characteristics of environmental protection tax determine that it is difficult to become the main source of tax revenue for local governments, but should focus on collecting as much as possible without affecting the enthusiasm of enterprises in production, so as to give full play to its regulatory role as a behavioral tax without affecting the enthusiasm of micro-economic agents.

Finally, the reform on the division of financial affairs and expenditure responsibilities between the central and local governments should be further promoted. Although the State Council has issued the Reform Plan for the Division of Financial Affairs and Expenditure Responsibilities between the central and local governments in the field of ecology and environment in May this year, enhancing the enthusiasm of local governments in environmental governance cannot be achieved by reforms in a single area. While promoting this reform, we should make use of transfer payments to regulate the income and expenditure behavior of local governments, so as to realize the auxiliary effect on fiscal revenue and expenditure policies and jointly promote pollution control to ultimately achieve green development.

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