Spatial Econometrics Analysis of Environmental Governance Effects of China's Taxation Policy

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Abstract. China is increasing emphasis on environmental governance, and puts the construction of ecological civilization as an important development strategy. The environmental pollution is more and more serious in China, especially, the pollution caused by the pollution overflow across provincial boundaries. This paper will establish spatial panel regression models to research from the perspective of environmental taxation policy. The paper selects the taxes related to the environmental governance and sewage charges as explanatory variables, and further analyzes their influence on the industrial pollutant emissions. The research's results show that the environmental governance effects are general, so the taxation system should be further revised to improve the environmental quality.

Keywords: Taxation policy; spatial panel regression model; environmental governance effects.

1. Introduction

China's environmental pollution is increasingly serious. Due to the impact of natural geographical conditions and other objective factors, the environmental quality of a region will inevitably be affected by neighboring areas' pollution overflow. So the research on China's environmental problems can not only be confined to the one region, but also be considered to including the impact of pollution overflow of the adjacent areas. This paper use spatial econometrics to do the research, in order to explicitly show the spatial effects of environmental pollution.

In this paper, it should be taken into account that the existence of the mutual impact of environmental pollution has influence on the environmental governance effects of taxation policy when establishing the econometric models. So this paper will introduce space-related factors to establish spatial analysis panel models to study the effects of China's environmental governance of taxation policy.

2. Literature Reviews

An Empirical Study of Foreign Policy Effect on the environment began in the 1990s. Nadeau (1997) found that environmental policy can also reduce the duration of the US pulp and paper manufacturing company emissions [1]. Dasgupta et al. (2001) through detecting Zhenjiang polluters in China put forward the results that the government regulation is more effective than the charges sewage [2]. Conrad, Wastl (1995) examined the impact of environmental policy on pollution-intensive industries' total factor productivity, and the results show that environmental policy can reduce the level of total factor productivity of the pollution-intensive industries and limited their development [3].

Rauscher (2005) pointed out that the presence of government competition resulted in the deterioration of the local environment quality [4]. Potoski (2001) compared the situation of air pollution in the United States, and found that there was no "bad trend Competition" among the states, and even some states showed "increasingly excellent competition" (Race to the Top, RTP) [5].

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3. Model Construction

3.1 Spatial Correlation.

The Moran's I index is generally used to do the whole field spatial correlation analysis. Moran's I index is calculated as follows:

$$Moran's \quad I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}(Y_i - \bar{Y})(Y_j - \bar{Y})}{S^2 \sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}} \tag{1}$$

Among them, $S^2 = \frac{1}{n}\sum_{i=1}^{n}(Y_i - \bar{Y})$, $\bar{Y} = \frac{1}{n}\sum_{i=1}^{n} Y_i$. In this paper, Y_i represents the i province (autonomous region and municipality) observations, W_{ij} is binary adjacent space weight matrix, representing the relationship between the adjacent provinces (autonomous regions and municipalities), usually considering the existence of a common border as a standard. If two regions are adjacent, then W_{ij}'s value is 1, otherwise, the value is 0. The value range of Moran's I is -1≤Moran's I≤1. Moran's I is greater than zero, indicating that the variable spatial distribution has a significant positive correlation; if equal to 0, indicating that the variable is randomly distributed; less than 0, showing a negative correlation between the variables.

3.2 Spatial Panel Regression Model.

Space panel regression model is the amendment of the general panel regression model through establishing spatial weights matrix, including spatial error model and spatial lag model.

Spatial lag model is expressed as:

$$y = \rho W\text{y} + \beta X + \delta C\text{ontrol} + \varepsilon \tag{2}$$

Wherein, y is the dependent variable, X is the explanatory variable matrix, ρ is for spatial regression coefficient, and W is the spatial weight matrix. Space lagged dependent variable W_y is endogenous variable, reflecting the role of spatial distance to regional actors. Control is the control variable, ε is the random error term vector.

Spatial error model is expressed as:

$$y = \beta X + \delta C\text{ontrol} + \varepsilon \tag{3}$$

$$\varepsilon = \lambda W \varepsilon + \mu \tag{4}$$

Among them, ε is the random error term vector, λ is the special error coefficient of the cross-section dependent variable vector. Parameter λ is to measure spatial dependence among the sample observations. yj is the adjacent areas' influence direction and extent to the observed value yi (i≠j), and μ is the random error vector.

4. Variable Selection and Data Sources

4.1 Variable Selection.

Explained variables. In this paper, industrial wastewater emissions (fs, ten thousand tons), industrial sulfur dioxide emissions (so_2, ten thousand tons) and industrial solid waste emissions (gf, ten thousand tons) is the dependent variables, because the decline in pollutant emissions is the best governance effects of environmental taxation policies.

Explanatory variables. This paper mainly researches the environmental governance effects of levying taxes considering the overflow pollution, so the explanatory variables are environmental taxes and sewage charges. Specifically: sewage charges (pwf, ten thousand yuan), resource tax (zys, 100 million yuan), urban maintenance and construction tax (cjs, 100 million yuan), land use tax (tds, 100 million yuan) and farmland occupation tax (gds, ten thousand yuan).

Control variables. In order to obtain more robust estimates, the paper introduces three control variables: the first is the level of economic development, measured by per capita gross domestic product (rjgdp, yuan per person). The second is government competition, which is measured by tax

revenue accounted for the proportion of local GDP (jz, %). The third is spatial weights. If the regions have a common border, the weight value is considered to be 1, and 0 otherwise. Spatial weights are normalized after row, in order to each element of each line is equal to one.

4.2 Data Sources.

The paper's data include China mainland's 30 provinces (autonomous regions and municipalities, excluding Tibet) in the years of 2003 to 2012, and the data are from "China Environment Statistical Yearbook", "China Statistical Yearbook" and CEI statistical databases.

5. Spatial Correlation Analysis and Empirical Results

5.1 Spatial Correlation Test.

Variable spatial correlation test is the premise of the space panel regression. First of all, every variable should be tested, and the results show that only industrial sulfur dioxide and industrial solid waste passed the significant test, and Moran's I index is positive indicating that there is a positive correlation between the two variables. Meanwhile, it is found in the inspection that every variable's raw data are more significant than the logarithm data through Moran's I index, therefore, this paper uses the raw data. Using lagrange multiplier test to select the spatial econometric model, and the results are shown in Table 1.

Table 1 Lagrange Multiplier Test Results of Spatial Variables

Project	Industrial sulfur dioxide		Industrial solid waste	
	Statistics	P values	Statistics	P values
LM test-spatial lag	41.264	0.000	10.667	0.001
Robust LM test-spatial lag	12.224	0.000	33.244	0.000
LM test-spatial error	30.179	0.000	0.133	0.715
Robust LM test-spatial error	1.139	0.286	22.710	0.000

It can be seen that industrial sulfur dioxide and industrial solid waste are significantly spatial dependence, so spatial panel econometric model can be established for further analysis. According to the spatial correlation test results, LM test-spatial lag test and robust LM test-spatial lag are more significant than in the spatial error model checking, so the paper uses spatial lag model. Panel data needs to be through some test to choose establishing a fixed effects model tested or random effect model. The results show that the fixed effects are better than random effects. Therefore, the paper choose the panel fixed effect model of environmental taxes.

5.2 Result Analysis.

After spatial lag regression, it is found that weighting variables of space industrial sulfur dioxide and industrial solid waste were 0.01 level significant, and the coefficients were respectively 0.41 and 0.30. The spatial weighting variable's significance shows that environmental pollution has obvious overflow feature, and industrial sulfur dioxide's overflow feature is significantly higher than industrial solid waste. The spatial panel regression results of environmental governance effects of environmental taxes and charges are shown in Table 2.

Through the table 2, the fitting Optimization of industrial sulfur dioxide spatial panel model is 0.9601, and the result is very good. Resource tax, urban land use tax and urban maintenance and construction tax have passed the test of significance. From the coefficient symbol, it can be found that urban land use tax and city maintenance and construction tax play an active role in reducing industrial sulfur dioxide emissions. Government competition as a control variable passes the significance test on the level of 0.1, and the coefficient is 1.34, indicating that the local governments always only pursue more GDP resulting in increased emissions of sulfur dioxide. Therefore, in the process of the sulfur dioxide discharge reduction, it is necessary to consider the environment quality into local government's assessment indicators.

The fitting optimization of spatial panel regression model of industrial solid waste is 0.8565. Among them, the sewage charges and resource tax pass the significant test, and their coefficients are 0.05 and 112.16. The coefficients are positive indicating that sewage charges and resource tax should

not play the role in the constraints to the industrial solid wastes. This is primarily related to system design of the sewage charges and resource tax, collection standards and collection efforts.

Table 2 Spatial Lag Regression Results

Values	Industrial sulfur dioxide	Industrial solid waste
pwf	0.01	0.05***
	(0.21)	(96.56)
zys	0.48***	112.16***
	(6.79)	(5.62)
tds	-0.08*	-4.07
	(-1.92)	(-0.32)
cjs	-0.07**	5.10
	(-2.47)	(0.65)
gds	-0.05	16.75
	(-1.26)	(1.39)
rjgdp	0.01	-0.03
	(-0.22)	(-1.07)
jz	1.34*	-94.26
	(1.67)	(-0.47)
W*dep.var.	0.41***	0.30***
	(6.77)	(4.91)
R-sq	0.9601	0.8565
Type of the models	FE	RE

Note: *, **, *** represent coefficients on 0.1,0.05,0.01 significance level. The numbers in parentheses indicate the regression coefficient t statistics. FE is for the fixed effect model, RE is for the random effect model.

6. Summary

To sum up, China Environmental taxes have a role in terms of environmental governance effects, but the effects are not obvious. Through the econometric models, farmland occupation tax, urban land use tax and urban maintenance and construction tax have played a positive role. However, environment management function of the sewage charges and resource tax is not significant. Therefore, in the future China should do a series of tax reform, design the taxes considering the environmental governance as the main purpose, to further promote environmental governance effects.

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