An Empirical Study on Fiscal Policy's Promoting Environmental Protection Based on Pollution Spills

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Abstract. Environmental quality has always been the focus of China's economic and social development. China puts forward that environmental protection and economic development should complement each other, but in practice economic development has been relatively fast, meanwhile, China has paid a serious environmental cost. This paper will take into account the characteristics of pollution spills, and do the research on the environmental governance effects of fiscal policy by establishing the spatial econometric models. The results show that the best environmental governance effects of fiscal policy are industrial sulfur dioxide emission reduction, followed by industrial solid waste reduction, and finally the industrial waste reduction. The research output will have a positive effect on China's financial reform, and further will help to improve the environment quality of China.

Keywords: Fiscal policy; spatial lag model; pollution spills; effects.

1. Introduction

Due to the impact of natural geographical conditions and other objective factors, the environmental quality of a region of China is bound to be affected by neighboring areas' pollution, that is, environmental pollution has spill feature. Meanwhile, the pollution produced by industrial transfer and the policy spillover generated by public investment make it impossible that the amount of environmental pollutants in a region is independently. In view of the mutual spatial impact of environmental pollution, this paper will do the spatial econometric analysis of China's environmental governance effects of fiscal policy according to space-related factors.

2. Literature Reviews

It has been more than twenty year from the first foreign research on the environmental policy's governance effects. Magat and Viscusi (1990) studied the impact of environmental policy on the paper products business and the results showed that environmental policy can reduce about 20 per cent pollutant emissions [1]. Nadeau (1997) had a conclusion that environmental protection policy and strategy could make it decline the duration of the pollutant emissions of pulp and paper company in the United States [2]. Hettige et al. (2000) found that the strict environmental regulations could cause the discharge of industrial waste water cut back with increasing income through the industrial discharges empirical data of Brazil, China and other 12 countries [3]. Dasgupta et al. (2001) through the data from the industry in Zhenjiang of China to detect the impact of supervision and sewage charges on the enterprises, got a conclusion that government regulation was more effective than the sewage charges [4]. Through data of 23 countries in 1960-1995 year, Tzouvelekas (2007) regarded carbon dioxide emissions as production input factors, and found that when the environment factor was introduced into the production, the traditional total factor productivity's growth is overestimated, and environment played a key role in the output growth and technological advances [5]. Ray and Mukherjee (2007) regarded fossil fuels and non-fossil fuels as input and studied on the data of 110 countries in 2005 to do empirical study, and found that 70 countries' score of efficiency is greater than 0.33, indicating that these countries at least could increase 33% per capita GDP, and reduce carbon dioxide emissions[6].

3. Model Construction and Data Sources

3.1 Model Construction.

The most commonly used spatial econometric models are the spatial lag model (SLM) and spatial error model (SEM). Two models are as follows:

The spatial lag model is:

$$Y = \rho WY + X\beta + \varepsilon \tag{1}$$

The spatial error model is:

$$Y = X\beta + \mu \tag{2}$$

Among them $\mu = \lambda W_{\mu} + \varepsilon$. Dependent variable is interpreted as $n\times 1$ dimensional vectors, explanatory variables are $n\times k$ dimensional vector, is for the $k\times 1$ dimensional vectors. W is the spatial weights matrix of order n, and the space weights of adjacent areas is assigned to one, and of non-adjacent area is assigned to zero. ρ is the spatial lag regression coefficients, λ is spatial error regression coefficients. ε and μ are random error terms.

3.2 Variable Selection and Data Sources.

The paper's data are from "China Environment Statistical Yearbook", "China Statistical Yearbook" and CEI database in the years 2007 to 2012 in China's 30 provinces (autonomous regions and municipalities, excluding Tibet). The paper uses Geoda software and Matlab7.0 to do the empirical research.

The dependent variables. The dependent variables y_{it} is the decrease of pollution emissions to reflect environmental governance effects, and the dependent variables y_{it} includes industrial wastewater emissions (*fs*), industrial emissions of sulfur dioxide (*so2*) and industrial solid waste (*gf*) emissions.

The explanatory variables. Given the availability and selection of data, the paper selects the 2007-2012 China's environmental protection expenditure (*hbzc*) as explanatory variables xit. It is expected that its coefficient is negative.

The control variables. The paper selects the economic development level, population size, social investment in fixed assets as the indicators of control variables. The level of economic development is signed by a per capita GDP (*rjgdp*) and its coefficient symbol is expected to be positive. Population size (*rkgm*) is represented by the population of the region at the end of the year and its symbol is expected to be positive. Total fixed asset investment (*gdzc*) is respected by the fixed assets investment of the whole society and its coefficient symbol is expected to be positive.

3.3 Spatial Correlation Analysis and Empirical Results.

Spatial Autocorrelation Analysis.

Spatial autocorrelation test is a very important step in spatial econometric analysis. Moran's I index is interpreted by using Geoda software, in order to verify whether there is spatial correlation among the dependent variables, and the variables among which spatial correlation exist could be regressed using spatial econometric models.

Test results show that industrial wastewater Moran's I index is 0.067, and the probability is 0.135 not passing significance tests, so it isn't suitable for the establishment of spatial econometric model. Industrial sulfur dioxide Moran's I index is 0.2475 passing the 0.01 level of significance test. This shows that the industrial sulfur dioxide emissions in Chinese provinces exist spatial dependence, and there is a positive correlation among the provinces. Industrial solid waste Moran's I index is 0.291 passing 0.01 level of significance test indicating that the provincial industrial solid waste discharge among the provinces has positive correlation.

In summary, in the analysis of environmental governance effects of each area in china, the paper should select the spatial econometric model to establish an empirical study on industrial sulfur dioxide and industrial solid waste. Since each variable's Moran's I index is more significant, therefore, this paper does select the raw data. Next, the paper will do the Lagrange multiplier test of industrial sulfur dioxide and industrial solid wastes, and then decide if we should establish spatial lag model or the spatial error model (Table 1).

Table 1 Space Variable Lagrange Multiplier Test Results

Objects	Industrial sulfur dioxide		Industrial solid waste	
	Statistical value	P values	Statistical value	P values
LM test-spatial lag	29.548	0.000	18.742	0.000
Robust LM test-spatial lag	14.908	0.000	4.306	0.038
LM test-spatial error	19.604	0.000	14.701	0.000
Robust LM test-spatial error	4.963	0.026	0.265	0.607

As can be seen, Robust LM test of spatial error model of industrial solid wastes can not reject the null hypothesis, and the remaining variables are very significant. It suggests that industrial sulfur dioxide and industrial solid waste have significant spatial dependence, and can be analyzed by the spatial econometrics model. After spatial correlation test the paper selects the spatial lag model.

Empirical Results.

Through Hausman test, the models of industrial sulfur dioxide and industrial solid waste as explanatory variables should choose the fixed effects model of spatial lag model. Seen from Table 2, the spatial weight amount of pollution emissions of sulfur dioxide and solid waste are highly significant at the 0.01 level, indicating that the pollution emissions do have spillover feature. By the spatial weighting coefficient 0.3850> 0.3810 it can be obtained, compared with the industrial solid wastes, industrial sulfur dioxide emissions are more spatial clustering and have more spills.

Table 2 Regression Results of Spatial Lag Models

Variable	Industrial sulfur dioxide		Industrial solid waste	
	Model 1	Model 2	Model 3	Model 4
hbzc	-0.15^{***}	-0.13^{***}	-28.61^{**}	-8.71
	(-3.2393)	(-3.4224)	(-2.1203)	(-0.7854)
rkgm	0.0107	0.0106^{***}	4.9186^{*}	0.1726
	(1.1175)	(5.3535)	(1.7493)	(0.4421)
gdzc	0.0004	0.0005	0.5765^{***}	0.5680^{***}
	(0.8994)	(1.3065)	(4.8089)	(4.8090)
rjgdp	0.0003^{*}	0.0002	-0.0355	-0.0818^{**}
	(1.9445)	(1.1479)	(-0.8260)	(-2.1994)
W*dep.var.	0.3850^{***}	0.3780^{***}	0.3810^{***}	0.4360^{***}
	(4.8097)	(4.9016)	(4.7822)	(5.7678)
R-sq	0.9599	0.9516	0.8983	0.8768
Model type	FE	RE	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.

According to Model 1 and Model 3 regression results it can be seen that the coefficients of environmental protection expenditure have passed the significant test. In Model 1, the per capita GDP is significant at 0.1 levels, indicating that the more economic development the more industrial sulfur dioxide emissions. In Model 3, the coefficient symbol of the population size variable is positive, indicating as the provincial population expanding, industrial sulfur dioxide emissions continue to increase. Total fixed asset investment coefficient is positive, indicating that the companies continue to buy new equipment, resulting in an increase in emissions of sulfur dioxide. Fully visible, environmental governance effects of China's fiscal policy is very significant.

4. Conclusion

Considering spill feature, the best environmental governance effects of fiscal policy is industrial sulfur dioxide reduction, followed by industrial solid waste reduction, and finally the industrial waste reduction, indicating that China's current fiscal policy mainly focuses on air pollution control, which has a relationship with a strong appeal to the public.

Meanwhile, the government and relevant agencies give more environmental concerns on fog and haze than other contaminants, because other emissions have concealed feature, for example, water quality is very difficult to find. So China should give more emphasis on promoting water environment and solid waste governance when continuing to increase governance of the air in the future.

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