EDUCATION AND SUSTAINABLE DEVELOPMENT

A CAUSALITY ANALYSIS OF PUBLIC PARTICIPATION, GOVERNMENT REGULATION AND ENVIRONMENT POLLUTIONS USING REGIONAL PANEL DATA

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Abstract: Utilizing the regional data of China covering 29 provinces and municipalities during 1990-2009, this article outlines a systematic approach to investigate the relations between public participation, government regulation and environment pollutions. Results show that government regulation influences environment pollutions while environment pollutions have no influence on government regulation in the short term. Besides, environment pollutions and public participation have no influence on each other. In the long term, there exists the Granger causality among public participation, government regulation and environment pollutions. Our results also show that improving the public participation's ability in environmental protection and strengthening government regulation's intensity are the basic measures to improve China's environmental pollution in the long run.

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Introduction

Since the reform and openness, along with the rapid economic development, China's regional air pollution incidents, water pollution incidents and solid waste pollution incidents emerge in endlessly. Environmental deterioration becomes more and more serious. We think it is necessary to discuss the relationship among public participation, government regulation and environmental pollution. The paper begins with government regulation and public participation in environmental protection issue, employing Chinese provincial area panel data and using panel cointegration method to test whether there are long-term stable relationships among regional public participation, government regulation and environmental pollution. We also set up a panel error correction model to analyze short-term and long-term Granger causality among public participation, government control and environmental pollution.

Index selection and stationarity test

Index selection and data description

The sample data in this paper is a panel data which covers China's 29 provincial administrative areas between 1990 and 2009. In order to keep the consistency of the data, this paper merges Chongqing and Sichuan the two provincial areas' data. Due to lack of data, Tibet is not contained in this sample. Considering the data availability, we use environmental petition visit number (unit: people) to represent public participation (PUB) variables, the pollution control investment complete frontal (unit: million) to represent government regulation (ER) variables, and use "three wastes" total emissions to represent environmental pollution (PUL) variables. All the data are from the "China environment yearbook", "China statistical yearbook". Except for the environmental pollution (PUL) variable, the other public participation (PUB) variables and government regulation (ER) variables are natural logarithm.

Panel data unit root test

The panel data unit root test refers to put each panel data of variable cross section sequence as a whole unit root test. According to the same (different) homogeneity assumption, there are two kinds of different assumptions of unit root test. One representative test is LLC examination. The other type has eased homogeneity assumption and allows change in different panel unit, this kind of inspection is closer to reality; representative tests include IPS inspection, ADF-Fisher and PP-Fisher inspection.

In order to make inspection results more credible, we conduct unit root test of level values and first-order differential scores of INPUB, INER PUL, using LLC, IPS, ADF-Fisher, and PP-Fisher tests; inspection results are listed in Table 1. The results

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shows that variables PUL, INPUB and INER have panel unit root, and their first-order differentials do not show panel unit root, and the three variables sequence is one-order integration sequence.

TABLE 1. UNIT ROOT TEST OF PANEL DATA

Variable	LLC test	IPS test	CH test	
			ADF-Fisher	PP-Fisher
PUL	-13.1684 (1.0000)	-11.0673 (0.9946)	232.931 (1.0000)	284.975 (0.8675)
ΔPUL	-28.2212* (0.0000)	-25.5251* (0.0000)	535.9* (0.0000)	4872.84* (0.0000)
INPUB	-5.71289 (1.0000)	-6.90337 (0.9670)	155.252 (0.8625)	176.455 (0.9835)
ΔINPUB	-21.7113* (0.0000)	-20.4442* (0.0000)	425.663* (0.0000)	1359.27* (0.0000)
INER	-1.24699 (0.1062)	1.39875 (0.9191)	43.886 (0.9149)	52.8395 (0.6670)
ΔINER	-25.207* (0.0000)	-21.3259* (0.0000)	428.118* (0.0000)	1016.02* (0.0000)

Note: Δ represents difference items, bracket contains P value, according to graphics ,to determine whether or not each variable has a constant item and time trend , and according to the Schwarz principle, automatically determine lag periods, * says denying the null hypothesis of existing panel unit root.

The panel data cointegration test

As INPUB, PUL and INER satisfy first-order cointegration, we can further inspect whether there is cointegration relationship between variables. We first put PUL as dependent variable, construct regression equations (1), and then test steadiness of equations (1) residuals. If residuals are smooth, then there is cointegration relationship between INPUB and INER, PUL. In order to guarantee the robustness of results, we place INPUB and INER as the dependent variables respectively, construct regression equation (2) and (3), and test residual steadiness of the regression equation (2) and (3) to find if results were consistent. Because we assume that the residuals sequence do not have characteristics of having intercept item and trend items, there do not include intercept items trend items in residual unit root test model choice.

$$PUL = \delta_0 + \lambda_0 INPUB_{it} + \gamma_0 INER_{it} + \varepsilon_{it} \quad (1)$$

$$INPUB = \delta_1 + \theta_1 PUL_{it} + \gamma_1 INER_{it} + \varepsilon_{it} \quad (2)$$

$$INER = \delta_2 + \theta_2 PUL_{it} + \lambda_2 INPUB_{it} + \varepsilon_{it} \quad (3)$$

Cointegration test results are shown in Table 2. LLC test, Breitung test, ADF-Fisher test and PP-Fisher test of residuals of equations (1), (2) and (3) in 1% level rejected zero hypothesis of containing unit root. This shows there exists cointegration relationship between INPUB and PUL, INER.

TABLE 2. COINTEGRATION TEST OF PANEL DATA

	LLC	Breitung	ADF-Fisher	PP-Fisher
PUL as dependent variable	-7.3812*	2.2501*	45.4580*	45.4670*
INPUB as dependent variable	-6.6702*	-1.6516*	30.7750*	31.4890*
INER as dependent variable	-4.3031*	-0.4699*	13.2530*	13.9740*

Note: * denotes the 1% significance level.

Because there exists cointegration relationship between INPUB and PUL, INER, we conduct panel regression of INPUB, PUL and INER and get long-term equilibrium equation (4), (5) and (6). In panel regression we must first find out which is more effective among random-effect model and fixed effects model; Hausman test is usually made to make a judgment. The original hypothesis of Hausman test is H0: no systematic difference in random effects. If the test rejects null hypothesis, it means fixed effects model is better; if it accepts null hypothesis, then it shows that the random effects are better. Under the assumption of original hypothesis, Hausman test statistic asymptotically obeys k degrees of freedom of Chi square distribution. According to the above methods, it is known that card square value of the equation (4), (5) and (6) is 24.126598, 48.182367, and 28.876460 respectively, concomitant probability is 0, 0, 0, respectively; therefore, we select fixed effects model.

$$PUL = 4.834041 - 0.324089 INPUB + 0.056108 INER \quad (4)$$
$$(5.65)* \qquad (-4.09)* \qquad (0.98)***$$

$$INPUB = 7.893678 - 0.092151 PUL - 0.000115 INER \quad (5)$$
$$(24.24)* \qquad (-4.09)* \qquad (-0.01)***$$

$$INER = 10.38339 + 0.031412 PUL - 0.000227 INPUB \quad (6)$$
$$(21.37)* \qquad (0.98)*** \qquad (-0.01)***$$

From the equations (4), (5) and (6), it is known that government regulation strength increases 3.14% and public participation - 1% when environment pollution increases 1%; environment pollution degree decreases 32.41% when public participation increases 1% , and public participation is stronger than government regulation in influencing the environmental pollution.

Panel data causality test

Due to the environmental pollution PUL, public participation INPUB and government regulation INER are first order cointegration I (1) variables, and there exists cointegration relationship. According to the research of Engle and Granger (1987), we can use dynamic error correction model to analyze short-term and long-term causality of variables. First, we need to estimate the residual error correction terms $\hat{e}_{ip}$ (ECT) of equation (4), (5) and (6), then respectively estimate panel dynamic error correction model (7), (8), (9).

$$\Delta PUL = \alpha_2 + \sum_p \beta_{21ip}\Delta PUL_{it-p} + \sum_p \beta_{22ip}\Delta INPUB_{it-p} + \sum_p \beta_{23ip}\Delta INER_{it-p} + \varphi_{2i}ECM_{t-1} \quad (7)$$

$$\Delta INPUB = \alpha_1 + \sum_p \beta_{11ip}\Delta PUL_{it-p} + \sum_p \beta_{12ip}\Delta INPUB_{it-p} + \sum_p \beta_{13ip}\Delta INER_{it-p} + \varphi_{1i}ECM_{t-1} \quad (8)$$

$$\Delta INER = \alpha_3 + \sum_p \beta_{31ip}\Delta PUL_{it-p} + \sum_p \beta_{32ip}\Delta INPUB_{it-p} + \sum_p \beta_{33ip}\Delta INER_{it-p} + \varphi_{3i}ECM_{t-1} \quad (9)$$

Δ represents first-order difference, P represents lag periods. If the difference term is significant, it indicates on the short-term Granger causality; If the error correction term (ECM_{t-1}) is significant, it indicates on forming of long-term Granger causality. Granger causality test results are shown in Table 3. Then, we can draw the following conclusions:

First, error correction terms (ECM_{t-1}) in the three models are - 0.738653, - 0.740783, - 0.211377, meaning error correction mechanism happened, and there exists a long Granger causality between public participation, government control and environmental pollution. This also means that in the long term, public participation and government regulation is Granger reason of the environment pollution change; public participation and environmental pollution is Granger reason of government regulation change; meanwhile, government regulation and environmental pollution is Granger reason of public participation change.

Second, according to the significance of difference term, in the short term the government control is the Granger reason of environment pollution change; conversely, environment pollution is not Granger reason of government regulation change; and there does not exist Granger causality between environment pollution and public participation.

TABLE 3. GRANGER CAUSALITY TEST OF PANEL DATA

	ΔPUL(-1)	ΔPUL(-2)	ΔINPUB(-1)	ΔINPUB(-2)	ΔINER(-1)	ΔINER(-2)	ECM_{t-1}
ΔPUL	-0.051341	-0.034463	-0.052663	0.105433	0.179271*	0.196500**	-0.738653***
ΔINPUB	-0.005129	-0.023203	-0.002678	0.073104	0.082898	0.078140	-0.740783***
ΔINER	-0.003948	-0.004898	0.049430	-0.025932	-0.106057	-0.038688	-0.211377***

Note: * * *, * *, *denotes the results are significant at the 1%, 5% and 10% level respectively.

Conclusion

The results of the study indicate that: in the short term, the government control is the Granger reason of environment pollution change, but environment pollution is not the Granger reason of government regulation change. And there does not exist Granger causality between environment pollution and public participation. In addition, in the long term, public participation and government regulation affect environmental pollution. Public participation and environmental pollution also influence government regulation. Meanwhile, government regulation and environmental pollution also have long-term influence on public participation. The stronger the public participation is, the smaller the environment pollution intensity is, and the smaller the government regulation degree is.

Based on the above results, this paper suggests three ways to solve China's environmental problems:

First, the public as stakeholders must participate in policy making and environmental management, to make up for the government failure cases as government regulation was insufficient;

Second, the government as regulator must undertake major responsibility of environmental management, weighting the environment as important as economic development;

Finally, industrial enterprises as the main source of environmental pollution, should constantly conduct technology innovation, improving the industrial structure, transforming from pollution maker to environment operator.

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