Analysis of Pollution Industrial Transfer Based on Environmental Regulation and Public Participation: China's Case

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Abstract

Referring to 1995-2011 China's provincial panel data, this paper constructs an econometric model consisting of environmental regulation, public participation and pollution industrial transfer, and mainly focuses on the role of environmental regulation and public participation in the pollution industries transfer using panel data unit root test, co-integration test, granger causality test and panel regression analysis method. The results show that environmental regulation and public participation play an obvious role in promoting the pollution industries transfer both in the long-term and in the short-term. However, their influencing strength varies. The effect from environmental regulation is stronger, while public participation has a comparatively weak effect on the pollution transfer.

1   Introduction

Pollution industrial transfer refers to the movement of technology, equipment, technical or engineering project producing direct or indirect pollutants without management from developed area to underdeveloped area, which features the typical one-direction trend. The development of economic globalization and frequent flow of capital trigger the discussion about pollution industrial transfer. In China, under the double pressures of the

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industrial structure adjustment and rising of business costs, the survival and development space of the large manufacturing group, once having made a significant contribution to the economic growth of Chinese coastal areas, have increasingly been extruded. In contrast, the local governments in Chinese central and western regions have unprecedentedly high enthusiasms for attracting investment in the vigorously prompting the industrialization. In order to attract foreign investment, the local governments conduct loose environment regulation even zero regulation at the expense of the sacrificing ecological environment, which becomes the main appeal to polluting industry transfer. Pollution transfer brought by polluted industry transfer is not only a main manifestation of the environment spatial dimension conflict, but also an important reason for the failure of Chinese ecological environmental promotion as a whole. In case that those local government environmental regulations fail, the public participation gradually emerges as a new force in promoting pollution industrial transfer.

Many researches have been done on the issue of pollution industrial transfer, the most majority of which focus on the effect of government environmental regulation to pollution industrial transfer and a few cover the role of public participation. The main argument is whether the pollution intensive industries tend to transfer from the area with strict environmental regulations to the area with looser regulations. The mainly supporting view is "Pollution Heaven Hypothesis" (Walter and Ugelow, 1979). Baumol and Oates (1998) argued that developing countries which implemented the lower environmental regulation policies would become the pollution concentration areas. Applying the Poisson model, Wei and Bi (2011) verified that China region industrial transfer did exist pollution shelter effect. By constructing the panel data model, Shen et al. (2012) contended that the environmental regulation was the most important driving force for polluting industries' transfer from the Pearl River Delta region to the other areas. At the same time, there were also some opposite viewpoints. Ederington et al. (2006) found that polluting industries in United States did not migrate to other developing countries from 1974 to 1994. While few papers discussed the effect of public participation to pollution industrial transfer. Jia (2007) observes that the establishment of the effective public participation mechanism does good to industrial sustainable and healthy development.

Comparatively, the studies of the influential factors of industry transfer were focused on the environmental regulation. However, the research from public participation perspective is still in exploring stage and has not yet formed a systematic theory, particularly, exploring the interactive influence to pollution industrial transfer combined the environmental regulation with public participation has been ignored. On basis of existing papers, using the 1995-2011 provincial panel data of China, this research studies the issue of the pollution industry transfer under the action of environmental regulation and public participation through panel data unit root test, co-integration test, granger causality test and panel regression analysis method. It attempts to solve the environmental regulation dilemma that partially improved but wholly deteriorated of Chinese ecological environmental quality, and provides a theoretical reference to the healthy and sustainable development of Chinese industry.

2 Data Acquisition and Model Building

2.1 Study Variables

The Sample indexes of this article consist of pollution industry output (PIIGO), environmental regulation(ER), public participation (PC), human capital (WAGE) and infrastructure construction (ROAD). Specifically, the PIIGO is dependent variable, on behalf of pollution industry output; ER and PC are independent variables; WAGE and ROAD are control variables. We measure the level of environmental regulation with the total completed investment of industrial pollution abatement, the level of public participation with the numbers of petitioners about environmental pollution, the level of human capital with the workers' average wage and the level of infrastructure construction with the traffic mileages of unit area.

2.2 Data Source

In order to improve the data quality and accuracy, ensure the empirical analysis reliability, timeliness as well as preciseness, 31 provinces of China are selected as the research object and collect the data from 1995 to 2011. At the same time, the data of Chongqing from Sichuan province before 1997 is separated because Chongqing municipality was set up in1997.
All the data can be acquired from "the China environment yearbook" and "China statistical yearbook" of each year. Besides, it is equivalent to 1990 constant prices to ensure the availability and the consistency of the statistical data. In addition, this empirical analysis adopts natural logarithm value of some variables because logarithmic simplified for the time series data will be a stationary sequence and not change the original sequence features of the data.

2.3 Establishment of Model

Owning to the relationship between the output of pollution industries and capital, labor, resources and technology, this research adopts input-output models. Besides, the factor affecting industrial position selection includes freight, labor, and industry gathering from Weber's industrial location theory. Therefore, we also bring the variables of environmental regulation and public participation into the model refering to the domestic and foreign scholars' researches on the influencing factors of polluted industries transfer. The empirical model of this paper is:

$$PIIGO = f(ER, PC, WAGE, ROAD) \tag{1}$$

Unlike most of the cross-sectional or time series methods of related issues, this paper uses panel data method, which features certain advantages. On the one hand, using panel data would improve the persuasiveness of empirical results by significantly increasing the sample size. On the other hand, we can control individual unobserved heterogeneity, reduce the possibility of multicollinearity with amount of three-dimensional information and estimate the contribution of each factor effectively. So, according to the model (1), we can get the panel data models as follows:

$$LNPIIGO_{it} = \alpha_i + \beta_{1i} LNER_{it} + \beta_{2i} LNPC_{it} + u_{it} \tag{2}$$

$$LNPIIGO_{it} = \alpha_i + \beta_{1i}LNER_{it} + \beta_{2i}LNPC_{it} + \beta_{3i}LNWAGE_{it} + u_{it} \quad\quad (3)$$

$$LNPIIGO_{it} = \alpha_i + \beta_{1i}LNER_{it} + \beta_{2i}LNPC_{it} + \beta_{3i}LNWAGE_{it} + \beta_{4i}ROAD_{it} + u_{it} \quad (4)$$

Where i denotes the province of China, t represents the year, u_{it} is the error term, which reflect the error generated with the factor of individual and cross-sectional. In order to avoid spurious regression and variable endogenous, this article conduct panel unit root test, co-integration test and Granger causality test to each economic variable in the beginning of empirical analysis process, and using OLS estimation method to conduct panel data regression analysis.

3   Empirical Results Analysis

3.1 Stationary Test

To improve the results' credibility, we use LLC, Breitung, IPS, ADF-Fisher and PP-Fisher test methods, whose null hypothesis is the same, to test the original value and first-order difference value of variable LNPIIGO, LNER, LNPC, LNWAGE and ROAD. From table 1, the result show that except the LNPC PP-Fisher test does not exist panel unit root, the original value of variable LNPIIGO, LNER, LNPC, LNWAGE and ROAD exist panel unit root. While the first-order difference value of these variables significantly reject the null hypothesis in the 1% level. In other words, there is no panel unit root for the first-order difference value of each variable, so these variables are integrated of order 1.

Table 1: Panel data unit root test results

Variable	LLC Test	Breitung Test	IPS Test	CH Test	
				ADF-Fisher	PP-Fisher
LNPIIGO	8.41121 (1.0000)	2.77884 (0.9973)	12.0716 (1.0000)	1.16333 (1.0000)	0.65602 (1.0000)
ΔLNPIIGO	-6.62175* (0.0000)	-9.20229* (0.0000)	-3.08615* (0.0010)	88.3041* (0.0158)	220.950* (0.0000)
LNER	-2.12456 (0.1680)	1.40939 (0.9206)	-1.21429 (0.1123)	45.2308 (0.9460)	54.0407 (0.7541)
ΔLNER	-16.6479* (0.0000)	-6.25550* (0.0000)	-8.54221* (0.0000)	339.764* (0.0000)	544.793* (0.0000)
LNPC	-0.90323 (0.1832)	-0.95485 (0.1698)	-1.24144 (0.1072)	74.5146 (0.1324)	126.918* (0.0000)
ΔLNPC	-8.46535* (0.0000)	-7.53764* (0.0000)	-9.41313* (0.0000)	204.090* (0.0000)	521.652* (0.0000)
LNWAGE	4.03370 (1.0000)	-0.48190 (0.3149)	9.94615 (1.0000)	2.60600 (1.0000)	1.72993 (1.0000)
ΔLNWAGE	-9.02852* (0.0000)	-8.06619* (0.0000)	-5.35345* (0.0000)	124.308* (0.0000)	197.259* (0.0000)
ROAD	8.34537 (1.0000)	-1.92633* (0.0270)	6.74119 (1.0000)	3.07526 (1.0000)	2.14871 (1.0000)
ΔROAD	-9.02852* (0.0000)	-8.06619* (0.0000)	-6.18727* (0.0000)	124.308* (0.0000)	197.259* (0.0000)

Note: Δ means first-order difference; the value in bracket is probability; * means rejecting the null hypothesis.

3.2 Panel Granger Causality Test

According to the researches of Engle and Granger (1987), if each variable is integrated of order 1, it is practicable to adopt dynamic error correction model to analyze the short-term and long-term causal relations between two variables. The specific approach is to estimate error correction term (ECM) from a long-term relationship between two variables, and then estimate the following panel dynamic error correction models (5) and (6):

$$\Delta Y_{it} = \alpha_1 + \sum_p \beta_{11ip} Y_{it-p} + \sum_p \beta_{12ip} X_{it-p} + \varphi_{1i} ECM_{t-1} + \varepsilon_{1it} \tag{5}$$

$$\Delta X_{it} = \alpha_2 + \sum_p \beta_{21ip} X_{it-p} + \sum_p \beta_{22ip} Y_{it-p} + \varphi_{2i} ECM_{t-1} + \varepsilon_{2it} \tag{6}$$

Where Δ is first-order difference, P denotes lag phase. Due to all the variables in the model (5) and (6) are stationary series, so we can judge the significance of coefficient with F test statistic, and then test the causal relationship between them.

We can conclude the short-term relationship between X and Y through the value of β_{12ip} and β_{22ip}. $\beta_{12ip} \neq 0$ indicates a short-term causality relationship from X to Y and $\beta_{22ip} \neq 0$ indicates a short-term causality relationship from Y to X. Besides, we can conclude the long-term relationship between X and Y through the value of φ_{1i} and φ_{2i}. $\varphi_{1i} \neq 0$ indicates a long-term causality relationship from X to Y and $\varphi_{2i} \neq 0$ indicates a long-term causality relationship from Y to X. The panel Granger causality test results are shown in table 2, and the following conclusions can be drawn:

Firstly, there is a short-term one-way causal relationship between LNER and LNPIIGO. That's to say, environmental regulation is the Granger reason of the total output of the polluting industries in the short term, but the total output of polluting industries is not the Granger reason of environmental regulation. Besides, environmental regulation is both cause and result of the total output of polluting industries in the long term.

Secondly, there is a long-term bi-directional causality relationship between LNPC and LNPIIGO. That's to say, public participation is both cause and result of the total output of polluting industries in the short term and long term. At the same time, the variable LNWAGE and ROAD also are both cause and result of LNPIIGO.

Table 2: Panel data granger causality test results

Causality Direction	Short-term Test		Long-term Test	
	F-Statistic	Prob.	F-Statistic	Prob.
LNER→LNPIIGO	-2.81819**	0.01927	1.81005**	0.01873
LNPIIGO→LNER	-1.11843	0.06089	47.2192**	0.02169
LNPC→LNPIIGO	7.90176*	0.00029	872.696*	0.00115
LNPIIGO→LNPC	-2.68346*	0.00542	701.152*	0.00143
LNWAGE→LNPIIGO	2.08026**	0.02333	66.6704**	0.01514
LNPIIGO→LNWAGE	1.94393*	0.00979	59.8188**	0.01671
ROAD→LNPIIGO	-0.20746**	0.01563	127.589*	0.00785
LNPIIGO→ROAD	2.11045*	0.00450	104.173*	0.00955

Note：* and ** means rejecting the null hypothesis at 1% and 5% significant level respectively.

3.3 Panel Co-integration Test

3.3.1 Pedroni and Kao Panel Co-integration Test

This research tests the four groups' integrated of order 1 sequence of LNER and LNPIIGO, LNPC and LNPIIGO, LNWAGE and LNPIIGO, ROAD and LNPIIGO with panel co-integration test. From table 3, the results show that all statistics of co-integration relationship Ⅱ reject the null hypothesis at the 5% significance level, the majority statistics of co-integration relationship Ⅰ, Ⅲ and Ⅳ also reject the null hypothesis at the 5% significance level. Therefore, we can conclude the there are long-term stable co-integration relationships between LNER, LNPC, LNWAGE, ROAD and LNPIIGO.

Table 3: Pedroni and Kao Panel co-integration test results

Test Method		Statistics Quantity	Co-integration Relationship Ⅰ	Co-integration Relationship Ⅱ	Co-integration RelationshipⅢ	Co-integration RelationshipⅣ
Pedroni test	Within dimension	Panel v	0.680489 （0.2481）	2.457323* （0.0070）	0.122991 （0.4511）	1.784425** （0.0372）
		Panel rho	-2.429314* （0.0076）	-5.908611* （0.0000）	-0.133528 （0.4469）	-4.058642* （0.0000）
		Panel PP	-4.084608* （0.0000）	-9.565396* （0.0000）	-2.499320* （0.0062）	-5.528361* （0.0000）
		Panel ADP	-7.192068* （0.0000）	-10.74286* （0.0000）	-3.765878* （0.0001）	-5.681203* （0.0000）
	Between dimension	Group rho	-0.658046 （0.2553）	-2.310134* （0.0000）	1.964211* （0.9752）	-0.544064 （0.2932）
		Group PP	-4.946964* （0.0000）	-8.116481* （0.0000）	-1.934424** （0.0265）	-3.915611* （0.0000）
		Group ADF	-8.520400* （0.0000）	-9.817078* （0.0000）	-3.749394* （0.0001）	-4.987002* （0.0000）
Kao test		ADF	-4.877885 （0.0000）	-0.954209** （0.0170）	-11.57657* （0.0000）	-0.163674 （0.4350）

Note: co-integration relationship Ⅰ, LNER and LNPIIGO; co-integration relationship Ⅱ, LNPC and LNPIIGO; co-integration relationshipⅢ, LNWAGE and LNPIIGO; co-integration relationship Ⅳ, ROAD and LNPIIGO; *, ** and *** means rejecting the null hypothesis at 1% , 5% , 10% significant level respectively; the value in bracket is probability.

3.3.2 Johansen Panel Co-integration Tests

Maddale and Wu (1999) built another co-integration test method by uniting the Johansen co-integration test results of the cross-section individuals. Firstly, we conduct the Johansen co-integration test on each cross-section individual i , and replace the probability of its trace statistic and the max-eigen statistic with π_i . Then, we can get the panel data co-integration test results with the theory of Fisher. The conclusion of Fisher theory is as follows:

$$Fisher = -2\sum_{i=1}^{N}\ln(\pi_i)$$

This paper tests the co-integration relationship among all variable sequences with

Johansen co-integration method and selects the sequences without deterministic trend and intercept. From table 4, the results show that the trace statistic and the max-eigen statistic of the null hypothesis "At most 3" respectively are 178.2 and 167.7, and the probabilities of which are both 0. That's to say, the null hypothesis "At most 3" has been rejected at the 5% significance level. Besides, the trace statistic and the max-eigen statistic of the null hypothesis "At most 4" are both 72.25, and the corresponding probabilities of which are both 0.1754. That's to say, the null hypothesis "At most 4" has not been rejected at the 5% significance level. So we can conclude that there is co-integration relationship in the variable sequences.

Table 4: Johansen panel co-integration test results

Hypothesized No. of CE(s)	Fisher Statistics (form trace test)	Fisher statistics (from max-eigen test)
None	1497.0* （0.0000）	941.0* （0.0000）
At most 1	761.6* （0.0000）	542.4* （0.0000）
At most 2	355.2* （0.0000）	258.1* （0.0000）
At most 3	178.2* （0.0000）	167.7* （0.0000）
At most 4	72.25 （0.1754）	72.25 （0.1754）

Note: * means rejecting the null hypothesis at significance level of 5%, the value in bracket is probability.

3.4 Panel Regression Estimated

Due to the existing long-term and stable co-integration relationship among variable sequences, we can conduct the panel regression estimation directly. Before the regression estimation, a right model should be chosen between random effects model and fixed effects model with the Hausman test method (Tie-mei GAO, 2006). The null hypothesis of Hausman test is the coefficient without systemic differences. If the null hypothesis is accepted, it is better to choose random effects model, otherwise it is better to choose fixed effects model. In the case of accepting the null hypothesis, the Hausman test statistic approximatively follows the chi-square distribution. The Hausman test results are shown in the table 5.

Table 5: Hausman test results

	Model（2）	Model（3）	Model（4）
Chi-Sq. Statistic	95.913574	104.721375	142.191064
Chi-Sq. d.f.	2	3	4
Prob.	0.0000	0.0000	0.0000

From table 5, the Chi-Sq. stat. results of model (2), (3) and (4) respectively are 95.91, 104.72 and 142.19, and the corresponding probabilities of which all are 0. That's to say, the fixed effects model is the best chose to conduct panel regression estimation. So we get the panel date models by LS estimation method in table 6.

Table 6:   Panel data regression estimate results

Variable	Dependent Variable: LNPIIGO					
	Model（2）		Model（3）		Model（4）	
	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic
C	9.510552	30.70298 （0.0000）	-0.580988	-3.153134 （0.0017）	-0.390101	-1.767656 （0.0777）
LNER	-0.328652	-4.413050* （0.0000）	-0.188706	-12.11468* （0.0000）	-0.186752	-11.96844* （0.0000）
LNPC	-0.184271	-6.874347* （0.0000）	-0.015448	-1.12585*** （0.0608）	-0.014691	-1.071541** （0.0285）
LNWAGE			0.913542	65.19702* （0.0000）	0.885902	39.33799* （0.0000）
ROAD					0.101897	1.566310** （0.0179）
Adjusted R^2	0.730712		0.971957		0.972039	
F-statistic	45.60303		553.4423		538.8203	
Prob.	0.000000		0.000000		0.000000	
Durbin-Watson statistic	1.862010		1.722011		1.729237	

Note: *, ** and *** means rejecting the null hypothesis at 1% , 5% , 10% significant level respectively; the value in bracket is probability.

From table 6, the t-statistics values of model (2), (3) and (4) respectively are 45.60, 553.44, 538.82, and the corresponding probabilities of which all are 0. It indicates that these three models wholly meet the statistics and econometrics test. Moreover, the adjusted R^2 of model (2), (3) and (4) respectively are 73%, 97% and 97%, which indicates the goodness of fit of the regression equation improved after adding control variables. Besides, the coefficients of LNER and LNPC are still negative after adding the control variables LNWAGE and ROAD, which also indicates LNER and LNPC have a significant inhibition to LNPIIGO whether control variables exist or not. Furthermore, the most majority of independents' coefficients are significant at the 5% significance level, which confirms the robustness of regression results.

In the model (4), the coefficient of LNER is -0.19, which denotes that the total output of pollution industries will decrease 0.19% while the environmental regulation increases 1%. At the same time, the coefficient of LNPC is -0.01, which represents the total output of pollution industries will decrease 0.01% while the public participation increases 1%.

Comparatively, the effect to the total output of pollution industries from environmental regulation is stronger than public participation. Besides, the control variables of LNWAGE and ROAD are positively correlated with the total output of pollution industries.

4   Conclusions

Generally speaking, the pollution industries always tend to transfer to the other countries or areas when their total output decrease. Therefore, with the increase of environmental regulation and public participation, the pollution industries will transfer to the countries and area where environmental regulation and public participation are weaker. From the above research results, both environmental regulation and public participation have a driving force to pollution industrial transfer, and the driving force from environmental regulation is obviously stronger than public participation.

The basic reason why pollution industries choose transfer strategy is the target of pursuing the maximum of economic benefits. In order to achieve certain economic target, pollution industries consume a large quantity of resources and sacrifice the ecological environment. When the "invisible hand" of the market fails in the resources allocation process, environmental regulation and public participation will emerges as a new force in protecting environment. With environmental regulation and public participation increasing, the total of the pollution industrial output will be restrained. Considering their own interests, pollution industries will choose the strategy of transfer.

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