PROBLEMY EKOROZWOJU – PROBLEMS OF SUSTAINABLE DEVELOPMENT
2019, vol. 14, no 2, 63-70

Looking at the Impacts of Income Inequality on Environmental Governance in China

Analiza wpływu nierówności dochodowych na zarządzanie środowiskiem w Chinach

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Abstract

This research investigates the impacts of income inequality (proxied by the Gini index) on environmental governance (proxied by per capita government investments on industrial pollution prevention) by employing the panel fixed effect model, system generalized method of moments and bias-corrected least-squares dummy variables model for 23 provinces from 1995 to 2014. The results indicate that income inequality exhibits significantly positive impacts on government environmental governance investment in China, which reveals that an increase in income inequality may help to improve environmental governance in China; we thus offer several remittable implications for those policy makers in Chinese provinces as well as governments of emergent economies like China.

Key words: income inequality, environmental governance; SYS-GMM; LSDVC, JEL codes: Q56, Q58, O15

Streszczenie

W niniejszym artykule zbadano wpływ nierówności dochodów (wykorzystując przez indeks Giniego) na zarządzanie środowiskiem (uwzględniając inwestycje rządu per capita na zapobieganie zanieczyszczeniom przemysłowym) poprzez zastosowanie modelu o stałych efektach panelowych, uogólnionej metody systemowej momentów i skorygowanego odchylenia modelu zmiennych pozornych najmniejszych kwadratów dla 23 chińskich prowincji w latach 1995-2014. Wyniki wskazują, że nierówność dochodów może wywierać znaczny pozytywny wpływ na rządowe inwestycje w zarządzanie środowiskiem w Chinach, co pokazuje, że wzrost nierówności w dochodach może przyczynić się do poprawy zarządzania środowiskiem w Chinach; oferujemy zatem kilka wymiernych rozwiązań dla decydentów w chińskich prowincjach, a także dla rządów wschodzących gospodarek, takich jak Chiny.

Słowa kluczowe: nierówność dochodowa, zarządzanie środowiskiem, SYS_GMM, LSDVC

1. Introduction

It cannot be denied that China has gained world-famous achievements in economic growth in recent years. However, together with the economic take-off, problems over environmental degradation have gradually become stumbling blocks to economic development, presenting China with a negative image in the world (Zhang and Hao, 2016). For example, carbon dioxide emissions have increased from 1495 million tons in 1980 to 8,287 million tons in 2010.[1] In 2015, CO_2 emissions in China hit even higher at 9154 million tons, accounting for more than 25% of the world's output (British Petroleum, 2016). In the Outline of the 13th Five-Year Plan, China aims to reduce energy consumption by 15% (per 10,000 RMB of GDP) compared to 2015.[2] Around the same time, an income distribution reform plan was introduced in 2013, with the reform of the country's income distribution system entering into a new stage. Policy-level concerns indicate that reducing environmental pollution and narrowing the income gap are significant issues that China should focus on in the next decade or more; for purposely achieve sustainable development then build a harmonious society, Chinese government needs to reconcile the phenomena such as income inequality, environmental governance and economic growth currently.

The most existing literature has written about the impact of income inequality on environmental pollution (Golley and Meng, 2012; Baek and Gweisah, 2013). Some scholars hold the view that unfair income distribution has a significant effect on the increase of environmental pollution, Boyce (1994) analyzed the relationship between income distribution and environmental quality, proving that greater income and power inequality lead to more serious environmental pollution; Yang et al. (2011) found that there is a negative relationship between income inequality and environmental quality. Magnani (2000) and Hao et al. (2016) have also proposed similar arguments, whereas a few scholars stated that the nexus between income inequality and environmental quality is uncertain (Wolde-Rufael and Idowu, 2017).

Most studies up to now have analyzed the effects of income inequality on environmental pollution by using relevant indicators such as CO_2 or SO_2 emission to measure the pollution (Berthe and Elie, 2015), however, very little of existing research has carried out the linkages among income inequality and environmental governance. However, we believe that when the income gap widens, government spending falls more on people's livelihood and social issues, with less investment into environmental governance (Panayotou, 2011). Some scholars have raised the opposite view; for example, Zhao et al. (2015) argued that there is a positive relationship between pollution control expenditure and emissions. Thus, researching environmental issues must consider the relationship between income inequality and environmental governance.

Our paper contributes to the previous studies in several aspects. First of all, this is the first empirical study to analyze the relationship between income inequality and environmental governance in China. Second, we focus on the provincial level and verify the relationship between income inequality and environmental governance using static panel and dynamic panel estimations, respectively, employing 23 provinces over the period 1995-2014. We initially use the panel fixed effect (FE) model to verify the impact of income inequality on environmental governance, but since this model provides inconsistent estimation results, to solve the problem and allow for dynamics we then propose the System Generalized Method of Moments (SYS-GMM) to further investigate the impact of income inequality on environmental governance. However, SYS-GMM estimates may cause a weak instrumental variable problem, and we hence use the bias-corrected Least-Squares Dummy Variables (LSDVC) model for solving the problem arising from the SYS-GMM model. Third, we use the Gini coefficient to measure income inequality and consider governance investments on industrial pollution as the main measurement of environmental governance. Our empirical results show a positive relationship between income inequality and environmental governance, indicating that an increase in income inequality improves the investment of environmental governance in China.

The rest of the paper is: Section 2 presents a brief account of the relevant literature. Section 3 lists the methodology and data. Section 4 shows the empirical findings. Section 5 summarizes conclusions and offers policy implications.

2. Literature review

Boyce (1994) first studied the relationship between income inequality and environmental pollution, stating that greater power and income inequality cause more environmental degradation. He showed as the income gap widens that the poor tend to overexploit natural resources and damage the environment, while the rich do not necessarily increase investment to improve the environment. Adopting 7 indicators to reflect environmental quality and using cross-country data to conduct empirical analysis, Torras and Boyce (1998) reached the conclusion that income inequality has a significantly negative effect on environmental quality in low-income countries.

[1] Data from the *World Bank World Development Index* (WDI) database.

[2] Please see the details at: http://www.gov.cn/zhengce/content/2017-01/05/content_5156789.htm.

Boyce et al. (1999) got a similar conclusion by using empirical data from all 50 states in the United States. Some scholars' researches also supported Boyce's (1994) theory from different perspectives. Martinez-Alier (1995) classified environmental goods into environmental luxury and environmental necessities and analyzed the impact of income inequality on environmental quality from the perspective of demand and supply, concluding that income equalization is conducive to environmental quality improvement due to the fact that the expansion of the income gap increases the demand for environmental luxury goods under other conditions. From the political economic perspective, Magnani (2000) noted that income inequality to a large extent reduces the relative income and the willingness to pay for environmental goods of "income middlemen", thus weakening the demand for a clean environment. Marsiliani and Renstrom (2000) obtained similar conclusions as Magnani (2000). Vornovytskyy and Boyce (2010) used the Russia Statistical Agency's data and adopted the fixed-effects model to explore the effects of income distribution within and between regions of Russia on air pollution, proving that greater inequality of income between regions induces greater air pollution. More evidence is proposed by Hao et al. (2016) as well as Ali et al. (2016) by using panel data of 23 Chinese provinces and Africa. To our knowledge, few in the literature have looked into the influence of income inequality on environmental governance.

We overall can say that the literature has ignored the impact of income inequality on environmental governance. The only existing papers studying the relationship between the two have some limitations, such as data sample source and methods. Therefore, in order to overcome the limitations of previous studies, we use provincial panel data from 1995 to 2014, take the Gini index as an indicator of income inequality and governance investment of industrial pollution as the measurement of environmental governance, and utilize the panel fixed effect model, system GMM regression, and LSDVC estimator to verify the relationship between income inequality and governance investment on industrial pollution.

3. Data and methodology

3.1. Data and variables

We analyze the relationship between income inequality and environmental governance for a panel database on 23 Chinese provinces from 1995 to 2014.[3] Most of the data are from *China Statistical Yearbooks*, *China Environmental Yearbooks*, *China Compendium of Statistics.*

(1) The dependent variable: Following recent studies like Zheng and Zhao (2014) and Yan (2012), we take per capita government investments on industrial pollution prevention (*Investment*) in China's provinces as a measure of environmental governance.

(2) Explanatory variables: We adopt the provincial Gini index to measure income inequality as the key independent variable, and Gini index calculation method proposed by Tian (2012) as follow:

$$G = 1 - \frac{1}{PW}\sum_{i=1}^{n}(W_{i-1} + W_i) * P_i \quad (1)$$

P represents the total population, W is the total income, and W_i stands for the accumulated income to the *Group i*. We hence use the *group weighting method* proposed by Sundrum (1990) to calculate the overall Gini coefficient:

$$G = P_c^2 \frac{u_c}{u} G_c + P_r^2 \frac{u_r}{u} G_r + P_c P_r \frac{u_c - u_r}{u} \quad (2)$$

G_c stands for the Gini index of urban residents and G_r represents the Gini index of rural residents. Moreover, P_c and P_r respectively are the ratios of urban population and rural population, while u_c and u_r respectively stand for per capita incomes of urban and rural residents. Finally, u is the per capita income of the whole province.

The following control variables are also included in this study.

GDP: Luo and Deng (2012) demonstrated that economic growth gives the government more financial resources to invest in environmental governance. We thus follow previous literatures and adopt the logarithmic form of per capita GDP to assess the economic growth of various provinces. *Urbanization:* Urbanization brings about an increase in the scale of the economy, which may affect environmental governance investment. Therefore, we adopt the proportion of the urban population to the total population to measure the urbanization rate. *Industry:* The change in industrial structure affects the degree of environmental pollution, therefore, we follow Hao et al. (2016) and utilize the secondary industry value divided by GDP to measure industrial structure.

Education: The rise in education level helps increase the public's environmental attention to a certain extent (Brasington and Hite, 2005; Jalan et al., 2007). We thus adopt the years of education per capita to represent the education level of various provinces.[4] *Revenue:* Fiscal revenue directly influences the amount of government spending on environmental projects. Following Guo and Yang (2014), we adopt provincial fiscal revenue to represent *Revenue. Openness:* The degree of openness may reflect the full utilization of local governments' resources in international trade (Jayanthakumaran and Liu, 2012), this paper utilize total export-import volume divided by GDP to represent the economic openness of various provinces in China. *Competition:* Local govern-

[3] Other provinces are not included because their data are not be obtained.

[4] The criteria for years of education per capita is as follows: illiterate for 0 years, primary school for 6 years, junior high school for 9 years, high school for 12 years, and university and above for 16 years. According to this standard, the total years of education in each provinces are divided by the total years of education for total population.

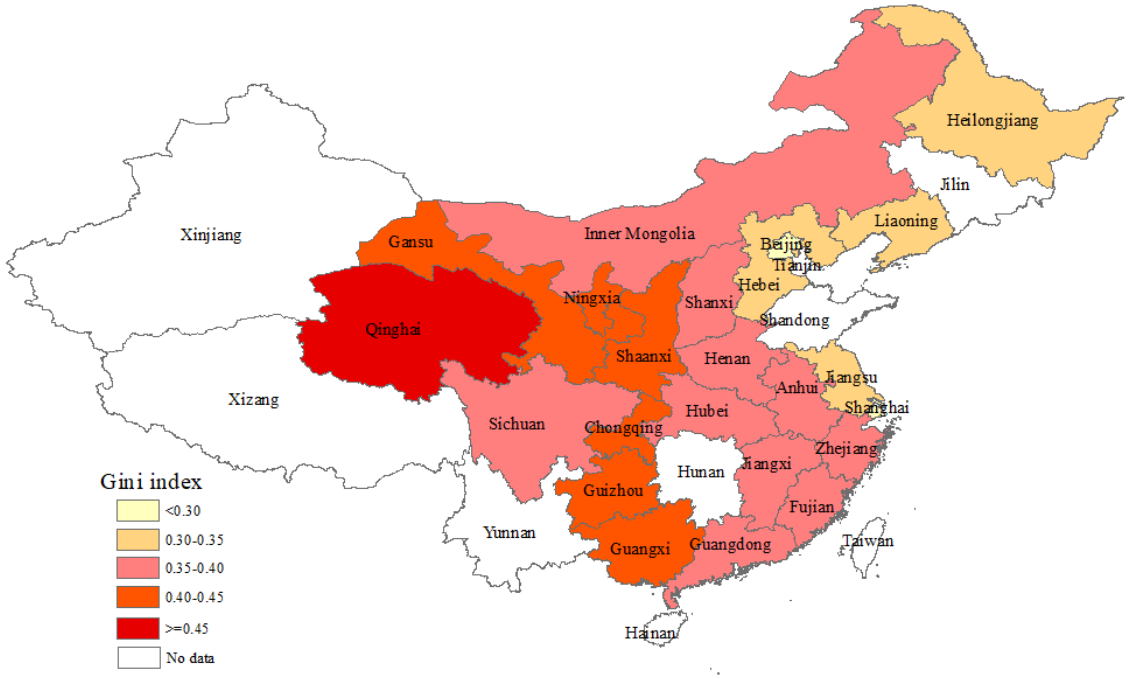

Figure 1. Mean of the Gini coefficient from 1995-2014

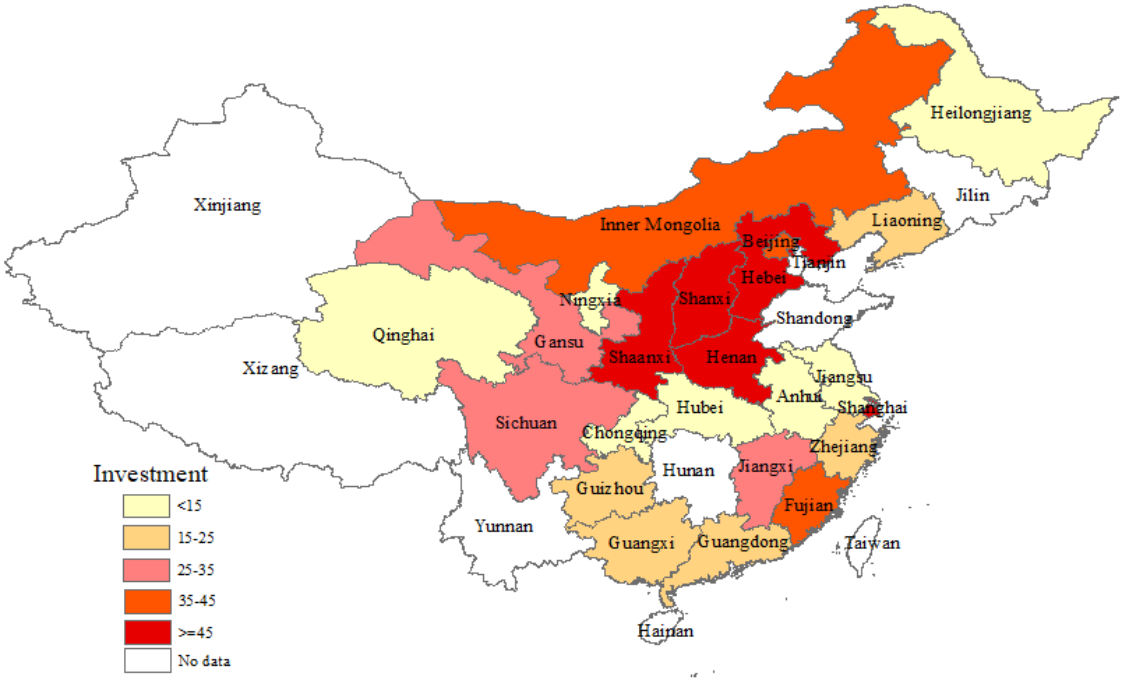

Figure 2. Mean of the per capita government investments on industrial pollution prevention from 1995 to 2014

ments often compete to attract foreign direct investment to promote their own regional economic growth. This study chooses the amount of Foreign Direct Investment (FDI) in each province divided by China's total FDI to stand for government competition.

Figure 1 shows the mean of the Gini coefficient in different provinces from 1995 to 2014. Here, the income gaps in the eastern, central, and western provinces are sorted from small to large, presenting that the eastern province has the smallest income gap, the western province has the largest, and the central province is in the middle. In Figure 2, we see that central provinces of Hebei, Henan, and Shanxi have the largest governance investment on industrial pollution. The potential reason is that industry there is the backbone of economic development, and vigorous development of industry will inevitably increase environmental pollution and along with it investment on environmental governance.

3.2. Empirical methodology

Considering the huge difference in the value of different variables, in the actual estimation process we take the logarithm of the dependent variable $Investment$ and some independent variables such as GDP per capita, fiscal revenue, and openness. Therefore, we set the following model in this study:

$$\log(Investment_{i,t}) = \propto_0 + \propto_1 Gini_{i,t} + \gamma Z_{i,t} + \mu_i + v_i + \varepsilon_{i,t} \quad (3)$$

In equation (3), $Investment$ represents governance investments of industrial pollution as a measure of environmental governance. $Gini$ is the main independent variable, standing for the Gini index. Z is a vector of control variables that may affect environmental governance. μ_i and v_i are the fixed effect variables of time and region, respectively, and $\varepsilon_{i,t}$ is the error term.

The panel fixed effects model does not consider the potential endogeneity of some independent variables and the dynamic specification of the dependent variable, potentially making the estimation results still be inconsistent. To solve the problems of the fixed effects model, Arellano and Bond (1991) proposed the difference GMM estimator. In order to solve the problem of weak instruments, Arellano and Bover (1995) and Blundell and Bond (1998) developed another GMM estimator, called system GMM. Bond et al. (2001) argued that two-step GMM estimation can better deal with autocorrelation and heteroscedasticity problems under finite sample conditions. Therefore, adopting the two-step GMM estimate method, we add the dynamic variable to better analyze the impact of income inequality on environmental governance. The system GMM estimate is as follows:

$$log(Investment_{i,t}) = \propto_0 + \propto_1 Ln(Investment_{i,t-1}) + \propto_2 Gini_{i,t} + \gamma Z_{i,t} + \varepsilon_{i,t} \quad (4)$$

However, the dynamic system GMM also has some limitations. For example, there is a relatively large variance when the data sample is finite in this estimator method. The Least-Squares Dummy Variables (LSDVC) method proposed by Kiviet (1995) is able to correct bias and ensure the consistence of the empirical results. In order to test the robustness of the empirical results, we use the bias corrected Least-Squares Dummy Variables models of LSDVC (AB, by Arellano and Bond (1991) and LSDVC (BB, developed initially by Blundell and Bond (1998). Moreover, bootstrapped standard errors can be used to test the significance of estimation coefficients (Bruno, 2005).

4. Empirical results

4.1. The panel fixed effect model

This study first presents the results of the panel fixed effect model in Table 1. As indicated in Table 1, the estimation results confirm that the coefficient of the Gini index is positive and significant at 1% level regardless of adding any control variables, proving that environmental governance rises with the expansion of income inequality in the sample provinces. In some sense, when environmental pollution increases, the government's investment in pollution control rises accordingly (Xin and Zhou, 2018). The argument that income inequality has a positive impact on environmental pollution is proposed by some scholars, such as Boyce (1994), Hao et al. (2016), and Ali et al. (2016). The reason is that income inequality shows a negative relationship with public attention demand for environmental quality, which may lead to environmental degradation to a certain degree. Some scholars also held the same view (e.g., Bimonte, 2002; Zhang and Zhao, 2014), and thus from another viewpoint this means that when income inequality increases, the government raises investment in environmental pollution control.

In terms of control variables and using the estimation results in columns (1) and (2), we find that the coefficient of the logarithm of GDP per capita is positive and significant at the 5% level, implying that investment in environmental governance will increase when GDP per capita is improved. Our empirical results are consistent with Luo and Deng (2012), who believed that economic growth provides the government with more funds to invest in environmental governance.

In column 2 the coefficient of urbanization is positive and significant at the 5% level. The coefficient is not significant, but is positive in other columns, indicating that the improvement of urbanization increases the investment of environmental governance to a small extent (Yang et al., 2011; Shahbaz et al., 2014). A government inevitably increases investment in order to manage a degraded environment. The coefficient of the financial revenue variable is significantly positive at the 5% level, suggesting that revenue positively correlates to environmental governance. The empirical estimation results also reveal that other control variables have no significant relationship with environmental governance in any other columns of Table 2.

4.2. Estimation results: SYS-GMM

In order to solve the problem of potential endogeneity and the dynamic specification of the dependent variable in the panel fixed effect model, we use the system GMM estimate to discuss the impacts of income inequality on environmental governance. The estimation results in Table 2 reveal that AR (2) for most models is not significant at the 10% level. The P values of the Hansen test judging the over-identification problem of the instrumental variable are also well above 0.1, meaning the GMM estimate is valid overall. From the Table 2, we can conclude the following points. First, in the regression estimates of all columns, the coefficient of the lagged industrial pollution investment per capita is significantly negative at the 5% level, which implies that environmental governance investment is persistent and dynamic.

Table 1. Estimation results of the panel fixed effect model

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Gini	5.474***	4.386***	5.125***	5.279***	5.345***
	(0.824)	(0.782)	(0.881)	(0.870)	(0.853)
log (GDP)	0.720***	0.478**	-0.258	-0.226	-0.195
	(0.073)	(0.179)	(0.397)	(0.393)	(0.382)
Urbanization		0.021**	0.015	0.016	0.016
		(0.009)	(0.011)	(0.011)	(0.011)
Industry		0.683	1.904	1.797	1.733
		(1.939)	(1.798)	(1.749)	(1.720)
Education			-0.093	-0.100	-0.094
			(0.159)	(0.158)	(0.157)
log (Revenue)			0.622*	0.619*	0.579*
			(0.328)	(0.327)	(0.318)
log (Openness)				-0.106	-0.132
				(0.144)	(0.152)
Competition					1.142
					(1.795)
Constant	-5.913***	-4.388***	-0.868	-0.568	-0.608
	(0.728)	(1.177)	(1.659)	(1.745)	(1.625)
Observation	460	460	460	460	460
R^2	0.633	0.647	0.659	0.660	0.661
F	80.06	68.20	63.04	51.82	48.44

Notes: The values in parentheses denote the standard errors. *, **, and *** denote significance at the 1%, 5%, and 10% levels, respectively.

Table 2. Estimation results of the SYS-GMM model

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
L.log (Investment)	0.387**	0.391**	0.373***	0.363***	0.338***
	(0.146)	(0.153)	(0.119)	(0.106)	(0.103)
Gini	8.534*	8.864*	8.176**	9.396***	11.332***
	(4.342)	(4.561)	(3.031)	(2.910)	(2.880)
log (GDP)	0.385***	0.304	-0.515	-0.570	-0.602*
	(0.129)	(0.315)	(0.394)	(0.360)	(0.361)
Urbanization		0.005	-0.015	-0.020	-0.027
		(0.017)	(0.019)	(0.021)	(0.023)
Industry		0.451	1.689	1.971*	2.551**
		(1.415)	(1.178)	(0.079)	(1.093)
Education			0.703**	0.757***	0.784***
			(0.255)	(0.252)	(0.225)
log (Revenue)			0.321	0.323	0.361*
			(0.222)	(0.213)	(0.195)
log (Openness)				0.118	0.451
				(0.188)	(0.264)
Competition					-4.769*
					(2.605)
Constant	-4.947**	-4.736*	-3.895**	-4.809*	-7.125**
	(1.869)	(2.331)	(1.677)	(2.477)	(3.147)
Observation	437	437	437	437	437
AR (1)	0.000	0.001	0.000	0.000	0.000
AR (2)	0.092	0.109	0.113	0.107	0.087
Hansen test	0.181	0.209	0.316	0.448	0.485

Notes: Same as Table 1.

Second, in all models of Table 2, the income inequality variable *Gini index* is significantly positive at the 10% level, which is consistent with the results in Table 1, suggesting that the rise of environmental governance is associated with an increase in the income gap.

4.3. Robustness test: LSDVC (AB) and LSDVC (BB)

To further test the reliability and robustness of the estimation results, we report LSDVC (AB) and LSDVC (BB) in Table 3 and Table 4, respectively. The LSDVC estimation approach is regarded as the most appropriate for dynamic panels. Consistent with the logic of the regression results presented in Table 2, we present the regression results of the

lagged value of the environmental governance variable, income inequality variable, and economic growth variable as the basic explanatory variables. As indicated in Table 3 and Table 4, almost all the explanatory variables are consistent in different models. We again support the estimation result that income inequality presents significantly positive impacts on environmental governance in China at the present time.

5. Conclusion and policy implications

Existing studies have been dedicated to the relationship between environmental pollution and income inequality, but there is little research on the impact of income disparity on environmental governance. We therefore use 23 Chinese provincial panel data from 1995 to 2014, taking the Gini index as an indicator of income inequality and governance investment on industrial pollution as the measurement of environmental governance, and perform the panel fixed effect model, system GMM regression, and LSDVC (AB, BB) estimator. The results of this study show that there is a significantly positive correlation between income inequality and environmental governance, indicting that an increase of income inequality improves environmental governance.

The Chinese government needs to further increase investment in environmental pollution control and implement relevant market-oriented environmental protection policies to increase environmental protection investment. Another issue that the government needs to pay attention is the inequality of income distribution. In order to solve this problem, the government should deepen the income distribution reform system, as to reform the tax adjustment system, introduce an estate tax system as soon as possible and improve its social security system and so on. Similar implications are offered to those governments of emergent economies like China.

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