The impact of Income Gap on Environmental Pollution: empirical evidence from China's energy producing regions

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Abstract. Previous studies have suggested that the widening of the income distribution gap usually leads to the delay of the turning point of the environmental Kuznets curve. As far as an energy producing area in the western region is concerned, this paper argues that the rich have a strong ability to pay for the cost of mobility. This gap in income distribution leads the rich to emigrate to areas of higher environmental quality to reduce their demand for environmental governance in the region. At the level, in the case of the total supply of environmental governance, the lower demand for environmental governance in the region will lead to the lack of environmental governance and the deterioration of environmental quality in the region. This paper proves the above point by establishing a two-region spatial flow model, and the test results of time series data of environmental governance investment in northern Shaanxi also support this conclusion. Therefore, from the perspective of rich immigrants, this paper expounds the internal mechanism that the widening income distribution gap will lead to the decline of environmental quality in the region. Finally, some policy suggestions are put forward, such as raising the tax rate of resources and environment or reducing the tax rate of individual income, combining the principle that who pollutes and governs with the principle of using environmental products and who pays.

1. Introduction
The energy intensity of China's production unit GDP is significantly higher than the international average. The rich oil and gas resources in the western region provide the necessary energy support for China's GDP growth. However, the western energy producing areas are also facing the phenomena of rich mineral resources, high incidence of poverty, widening income gap and environmental deterioration. In the western region, because the mining is controlled by a small number of large-scale state-owned enterprises, the income related to energy is in the hands of the monopoly state-owned enterprises and private investors, and relatively few local employees are employed, so most people do not have direct access to the rich economic benefits from the region (Sachs and Warner, 2001; Ross, 2003; Collier, 2007). With the increase in demand for energy brought about by GDP growth, most ordinary rural residents are unable to benefit from resource exploitation, but also bear higher prices in energy-producing areas. Real income has not increased significantly, and the income distribution gap in energy-producing areas has widened (the Gini coefficient in the western provinces is significantly higher than that in the eastern region). This means that the poor (low-income class) in the society is expanding, and the poor have a lower preference for environmental quality (Ravallion, 2000). Therefore, the overall environmental preferences formed by the aggregate environmental preferences of all members of society will be reduced, then, if the income gap in energy-producing areas continues to widen, how will the overall environmental preference decrease lead to further deterioration of the
regional environment? The research on the widening of the income gap brought about the deterioration of the environment in the region, which was first proposed by Boyce (1994), and verified the hypothesis that the income gap is the influencing factor of environmental degradation; the unfair distribution of income affects the social demand for environmental quality, and then affects the environmental policy. Subsequently, the literature explores the impact of income gap on environmental degradation, while the exploration of the mechanism of environmental pollution affected by income gap is relatively rare. The resource-rich area in western China provides a special case for studying this mechanism of influence. The case of environmental degradation in the western energy-producing areas is a problem with Chinese characteristics, which is convenient for us to analyze the mechanism and process of environmental degradation in the region caused by the widening income gap. In the western energy-producing regions of China, from the perspective of environmental supply, the formulation process of environmental regulation pays attention to economic development while neglecting environmental governance. The source of local government investment in environmental governance depends on the cumulative output, which is manifested in the sewage tax and charge system collected according to a certain proportion of output.

As a result of the accelerated exploitation of resources, the increase in GDP is accompanied by a widening income distribution gap and an increasing number of low-income groups, while the beneficiaries associated with the exploitation of resources move through the relocation or migration to leave the region. The departure of the rich has led to insufficient investment in environmental governance in the region and a negative impact on policy development. Local governments use the development of local economy as the main indicator of appraisal officials, and the “championship” competition among local governments is reflected in GDP competition. The environmental governance in this region cannot receive the attention of local government officials, and there is a trend of gradual deterioration of the environment.

Therefore, this paper makes an empirical analysis on the influence mechanism of energy income gap on environmental pollution in western China. By constructing a theoretical model to analyze the internal mechanism and logic of environmental protection demand and supply in reality, this paper puts forward that the focus of environmental protection problem is crucial to improve the demand for local environment. Improving the income gap of local residents will increase the demand for the local environment, thereby improving the quality of the environment. The first part is the introduction. In the second part, through the establishment of a two-region spatial flow model, it is proved that the low demand for environmental governance in this region will result in the lack of environmental governance and the deterioration of environmental quality. The third part is empirical analysis using the time series data of environmental governance investment in northern Shaanxi. The fourth part clarifies the internal mechanism that widening income distribution gap will lead to the decline of environmental quality in the region from the perspective of rich migrants. Finally, some policy suggestions are put forward, such as raising the tax rate of resources and environment. Or reducing the tax rate of individual income, combining the principle that who pollutes and governs with the principle of using environmental products and who pays.

2. An empirical Analysis of income Gap and Environmental Governance

2.1 Sample Selection and Data Source

The center of this paper is to demonstrate that the restriction of migration cost on the poor is different from that of the rich, the shortage of environmental governance demand in this region will be caused by the migration of the rich, and the environmental governance demand will be allocated among regions under the condition that the total demand is fixed. When the total supply is determined by the national average environmental level, the total supply is equal to the total demand, and the decline of environmental management demand in the region will lead to a decline in the environmental quality. This paper holds that, assuming that other conditions remain unchanged, when the migration cost is established, the larger the income gap, the lower the demand for environmental governance in the
region; and when the income gap is established, the greater the migration cost, the higher the demand for environmental governance in the region. Therefore, after controlling other influencing factors, we expect that the income gap of independent variables has a negative impact on dependent environmental governance investment, while the migration cost has a positive impact on dependent environmental governance investment.

Choosing appropriate independent variables to reflect income gap and migration cost will be more accurate to experience and measure the theory proposed in this paper. In empirical tests, when the income gap is interpreted as a dependent variable, we often encounter the problem of lack of time series data or poor data quality. Most researchers use Gini coefficient to measure the degree of inequity in income distribution. Gini coefficient is a statistical index to measure social and economic development stipulated by the United Nations, which is used to compare the inequality between social income and wealth distribution among countries or regions, and is widely used in policy analysis and academic research.

Due to the limitation of data, this paper uses the Gini coefficient values GINI of Shaanxi Province to reflect the income distribution in northern Shaanxi. The coefficient does not specifically distinguish the differences between urban and rural areas, and adopts the overall Gini coefficient. The Gini coefficient values of Shaanxi Province come from the official website of the National Bureau of Statistics.

New Economic Geography holds that there are two forms of decentralization in economic activities: individual differences in labor force and price gaps among non-tradable commodities dominated by real estate (Ottaviano and Puga, 1998).

Mobility cost is mainly composed of migration cost and environmental rent to maintain living in areas with high environmental quality. Relative to the cost of relocation, higher environmental quality in Beijing, Shanghai and Hangzhou leads to higher demand (without considering other factors leading to higher real estate). This makes the cost of purchasing commercial housing in Beijing, Shanghai and Hangzhou become the main part of the current cost. Therefore, we choose the index of P-gap between the total commodity house price in Shaanxi and the national average to reflect the current cost rate. This data comes from China Statistical Yearbook and Shaanxi Statistical Yearbook.

Whether the expenditure on environmental governance will increase with the per capita GDP in northern Shaanxi, or whether the environmental quality will automatically improve with the increase of economic growth, we expect that the increase of per capita GDP will increase the expenditure on environmental governance, but this view should be considered in combination with the Gini coefficient. Because of the availability of data, this paper uses the investment of environmental governance in Shaanxi Province to express the expenditure on environmental governance in northern Shaanxi Province, and uses I to express the per capita GDP in northern Shaanxi Province as PGDP.

This paper also chooses industrialization rate and urbanization rate as control variables. The industrialization rate is expressed by the proportion of secondary industry to total GDP, and the urbanization rate is expressed by the proportion of urban population to total population at the end of the year. The level of industrialization determines the level of pollution in the region, which largely affects the demand and expenditure of investment in environmental governance, while the level of urbanization affects people's demand for environmental quality. Because of the limitation of statistical data, the data of urbanization rate is from 2005 to 2014. Detailed descriptions of variables and data are presented in Tables 1 and 2.

| Variable | Variable meaning | data sources |
|----------|------------------|--------------|
| I        | Investment in Environmental Pollution Control | China Environmental Yearbook |
| GINI     | Gini Coefficient of Shaanxi Province | Official Website of the National Bureau of Statistics |
| P-gap    | The Difference of Commercial Housing between China and Shaanxi | China Statistical Yearbook, Shaanxi Statistical Yearbook |
2.2 Econometric model

In addition to the substitution effect of per capita GDP growth, the factors influencing regional environmental governance expenditure should be considered comprehensively, such as Gini coefficient, real estate price gap between the region and the whole country, Gini coefficient and per capita GDP multiplier. Therefore, this paper uses the time series data from 2003 to 2014, using stata13 software for quantitative analysis. The logarithmic-linear econometric model in this paper is as follows:

\[
\ln(I_t) = \alpha + \beta_1 \text{GINI}_t + \beta_2 \ln(PGD_t) + \beta_3 \ln((\text{GINI} \times \text{PGDP})_t) + \beta_4 \ln(P - \text{gap}_t) + \beta_5 \text{industry}_t + \beta_6 \text{Urban}_t + \epsilon_t
\]

In equation (1), \(\alpha\) is a constant, \(\epsilon_t\) means a random error term, and \(t\) is a time factor. PGDP uses two urban per capita GDP reduction indices to reduce the per capita GDP, and obtains the fixed price based on 2003. The dependent variable \(I_t\) is the amount of investment in environmental governance in Shaanxi, and the same year is based on 2003. \(\beta_1\) is the regression coefficient of Gini coefficient, \(\beta_2\) is the regression coefficient of per capita GDP, it measures the elasticity of GDP increasing investment in environmental governance. \(\beta_3\) is the multiplier of Gini number and GDP per capita, which is used to measure the elasticity of investment in environmental governance under the combined action of Gini number and GDP per capita. \(\beta_4\) is the regression coefficient of the real estate price difference between the two regions. With the increase of the price of commodity house per square meter in the whole country, the number of people who can buy and settle in other areas is decreasing, and the higher income left in this area is more. It is expected that the demand for environmental governance in this area will increase. That is to say, the real estate price difference between the two regions is positively correlated with the natural logarithm of investment in environmental governance in this area, \(\beta_4\) measures the elasticity of investment in environmental governance when the liquidity cost rises. The regression coefficients of industrialization rate and urbanization rate are \(\beta_5, \beta_6\) respectively.

2.3 Analysis of Inspection Result

| Table 3. Regression Estimation Results of the Model |
|-----------------------------------------------|
| \(\ln(I)\) | 1    | 2    | 3    | 4    | 5    | 6    |
| GINI       | -21.69** | -24.27** | -2.752 | -28.29*** | -29.30*** | -38.98*** |
Regression model 1 to 3, gradually adding variables for regression, model 4 to 6 added the multiplier of GDP per capita and Gini number, gradually adding variables for regression. In model 1 and 2, there is a significant negative correlation between environmental governance investment and Gini number. In model 3, there is a significant positive correlation between investment in environmental governance and per capita GDP at the level of 1%. That is to say, the increase of per capita GDP can significantly promote the increase of investment in environmental governance, but the Gini number has a negative correlation with the amount of environmental governance, but it is not statistically significant. Therefore, in model 4-6, the multiplier of GDP per capita and Gini number is added to explore their mutual effect on investment in environmental governance.

The regression results show that the regression coefficient of environmental governance investment and Gini number is -21.69, which is negatively correlated at the level of 5%. From the overall regression results of model 1-6, the Gini number has a significant negative correlation with investment in environmental governance. That is to say, the larger the Gini number, the smaller the investment in environmental governance. That is to say, the larger the income distribution gap, the smaller the expenditure on environmental governance, the smaller the income distribution gap and the larger the expenditure on environmental governance. The existing research literature shows that the widening of income gap aggravates environmental pollution. Combined with the empirical results of this paper, the widening of income gap aggravates pollution. The income of most residents is low, and the demand for environmental quality is small. On the contrary, the investment expenditure on environmental governance is reduced.

There is a positive correlation between the price difference of commodity house and the investment in environmental governance. At the level of 5% in model 5 and 6, the increase elasticity of investment in environmental governance is 0.415 in model 5 and 0.219 in model 6. That is to say, the bigger the gap with the national housing price, the bigger the investment in environmental governance. Positive correlation supports our argument that an increase in the ratio of liquidity cost to total income will keep more people in the region, increase the demand for environmental governance in the region, and then improve and improve the environment in the region. Industrialization rate has a positive correlation with investment in environmental governance in model 5. When urbanization rate is added to model 6, it has a negative correlation and is significant at the level of 5%. This shows that the increase of urbanization rate and industrialization rate reduces investment in environmental governance, which is contrary to the existing conclusions.

|                | (-2.47) | (-2.45) | (-1.07) | (-12.55) | (-16.43) | (-9.12) |
|----------------|---------|---------|---------|----------|----------|---------|
| Ln(P-gap)      | 0.421   | 0.28    | 0.28    | 0.415**  | 0.209**  |         |
|                | (-0.65) | (-2.06) | 1.69    | 3.17     | (-2.94)  |         |
| ln(PGDP)       | 1.165***|         |         |          |          |         |

|                | 2.489***| 2.546***| 3.280***|          |          |         |
|----------------|---------|---------|---------|----------|----------|---------|
| Ln(GINI*PGDP)  |         |         |         | (12.98)  | (17.04)  | (-7.64) |
|                | 4.647** | -8.153**|         | (2.54)   | (-3.13)  |         |
| Urban          | -0.00753|         |         |          |          |         |
| Urban          | -0.37   |         |         |          |          |         |
| _cons          | 14.30***| 12.58** | -7.691**| 4.492*** | 1.435    | 9.942***|
| Urban          | (-3.59) | (-2.58) | (-4.35) | (3.55)   | (0.93)   | (-5.62) |

| N              | 12      | 12      | 12      | 12       | 12       | 10      |

Notes: t statistics in parentheses, * p < 0.1, ** p < 0.05, *** p < 0.01
Economic growth is positively correlated with environmental governance, which is accepted by most scholars and verified by regression results of model 3-6. In model 3, the regression coefficient of per capita GDP and investment in environmental governance is 1.165, which is positively correlated at 1% level, indicating that with the increase of per capita GDP, investment in environmental governance increases. In model 4, 5 and 6, the multiplier of per capita GDP and Gini number is introduced. The regression results show that Gini number has a significant negative correlation with environmental governance investment at 1%, while the multiplier has a significant positive correlation with environmental governance investment at 1%. It shows that per capita GDP and Gini number have a positive correlation with investment in environmental governance, and per capita GDP plays a greater role in promoting investment in environmental governance than the inhibition of Gini number. The rich can easily migrate to areas with higher environmental quality through lower mobility cost ratio, while the poor cannot achieve cross-regional family migration or migration due to the large proportion of mobility cost in their income. This kind of cross-regional mobility of the rich is universal, especially in the western energy producing areas. High-income people who can enjoy the huge benefits of energy rent have migrated to the eastern developed cities with high environmental quality and full urbanization development. Therefore, this kind of cross-regional migration of the rich avoids the consumption and demand of local public goods. The main demand body of local environmental products is the poor with weak ability to pay. If the environmental tax and fee are borne by the local environmental tax, it can be seen that the environmental tax and fee borne by the poor is larger, which will make the environmental tax and fee more regressive. The consumption tendency of private goods in this region is greater than that of public goods such as environmental quality, so the demand level of environmental governance in this region will decline.

3. Research Conclusions and Policy Implications

For a long time, the related studies have focused on the relationship between economic growth and environmental pollution, but ignored the impact of Income Distribution on environmental pollution in economic development.

From the point of view of supply and demand of environmental governance, because the mobile cost of the rich accounts for a low proportion of total income, but the poor just the opposite; The income gap has led the rich to allocate the demand for good environmental quality through emigration, and the poor have become the main demanders of environmental governance in the region. This makes the total demand for environmental treatment in this area smaller than the total supply of environmental products, the local environmental pollution cannot be completely controlled. The supply of environmental pollution exceeds the demand, so the environmental demand should be increased from the point of view of narrowing the income gap. Therefore, if want to improve the quality of the regional environment, we must increase the demand for regional environmental governance. In order to improve the demand for regional environmental governance, It is necessary to carry out the reform of income distribution, narrow the income gap in energy producing areas in western China areas, and learn from the experience of environmental governance in countries with equal income.

Based on the reality and data of western energy, this study confirms the basic view of Boyce that the widening income gap will result in Inter-regional Migration and a decline of environmental quality in the region. While paying attention to the change of environment caused by economic growth, we must pay attention to the impact of Income Distribution on the environment. Therefore, the policy implications of this study are as follows:

First, increase the tax rate of resources and environment, reduce the tax rate of individual income, and improve environmental governance by increasing the fairness of Income Distribution. This policy is particularly applicable in the western energy producing areas, improving the income status of most low-income people and narrowing the income gap can reduce the low demand for environmental governance in the region caused by the excessive mobility of the rich.
Second, from the point of view of strong regional mobility of the rich, more rich people should be urged to stay in the region, so that people who enjoy energy rents are willing to provide more funds for local environmental governance. To enhance the public's awareness of environmental protection and improve litigation compensation, we should promote public awareness of participation in environmental protection, promote the openness and transparency of law enforcement procedures, reduce litigation costs, attract public participation and reducing the supervision costs of environmental protection departments.

Third, focus on the environmental effects of pro-poor and development policies. In order to improve the status of income distribution and to adjust the gap between the regions and the urban and rural areas, the direct poverty alleviation and development measures adopted by the State should take full account of the environmental effects of the policies.

Fourth, to examine the index of local government officials to improve the weight of environmental factors, such as the green GDP index, so that local government officials also have the power to increase the expenditure of environmental governance, so that the environmental governance level is close to the optimal equilibrium point.

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