Calculation of the Impact of Income Gap on Environmental Pollution

Yaobo Shi 1 and Pengting Zhao*1

1 School of Economics and Management, Xi’an University of Technology, Xi’an, China
Email: 1076823587@qq.com

Abstract. This article uses the panel data of 30 provinces (excluding Tibet autonomous region) from 2000 to 2018, and uses pm2.5 concentration as an indicator to measure environmental pollution. It starts from the traditional EKC curve and adds the Gini coefficient to measure income gap as the key explanatory variable, in order to study the impact of income gap on environmental pollution in China. Regardless of whether it is a static panel model or a dynamic panel instrumental variable model, the results show that China as a whole has an environmental Kuznets curve of pm2.5, and the widening of the income gap is not conducive to the improvement of environmental quality. Among the selected control variables, the increase of industrialization level, energy intensity and foreign direct investment will aggravate the environmental pollution. However, the good news is that the rational advancement of urbanization has played a positive role in the improvement of environmental quality.

1. Research background

Green ecology and narrowing the income gap are the eternal themes of China's sustainable economic and social development under the guidance of Xi Jinping Thoughts on socialism with Chinese characteristics in the new era. Whether the overall improvement of the economic level and environmental quality can develop simultaneously has become one of the most concerned issues both at home and abroad.

It is undeniable that China has achieved world-renowned economic achievements in recent years, but the environmental quality has been damaged to a certain extent in the development and construction process. Various phenomena show that China's environmental pollution is severe and environmental pressures are increasing. This has become a hard constraint affecting my country's overall economic development. At the same time, China is also facing increasingly serious income inequality, but the income gap is gradually widening. Judging from the Gini coefficient published by the National Bureau of Statistics, from 2010 to 2017, the Gini coefficient of Chinese residents' income increased from 0.412 to 0.467. Although the Gini coefficient has slowed down in recent years, it still hovered around 0.46, which has exceeded International cordon 0.4.

It can be seen from this that income gap and environmental pollution are two important issues that urgently need to be resolved in the current economic development of our country. So, is there a "dilemma" between narrowing the income gap and environmental pollution? Whether the widening income gap has significantly aggravated environmental pollution is a question worthy of our attention.

2. Research design

With the increasing status of income distribution gap in the study of environmental pollution, more and more scholars believe that the expansion of income gap will increase the emission of environmental pollution and have a negative impact on the environmental quality. Boyce [1] was the first to conduct research on the relationship between income gap and environmental quality. He used panel data from 54 countries for empirical analysis and PSDM model to analyse and conclude that the
widening income gap tends to damage environmental quality. The analysis of Coondoo and Dinda (2008) [2] from the perspective of political stability shows that the narrowing of income gap is conducive to political stability and prompts the public to pay more attention to pollution control. Baiocchi and Minx (2010) [3] studied the impact of consumption in different regions and sectors on carbon emissions based on input output analysis, and found that consumption preferences in different regions with different income gaps were different, thus affecting carbon emissions, which also supported Boyce's opinion. In China, Li Haipeng (2006) [4] pointed out that excessive income gap stimulates the increase of carbon dioxide emissions, which is specifically reflected in that excessive income gap affects economic growth, then postpones the turning point of inverted U-shaped curve, and finally leads to the increase of emissions. Zhan Hua (2016) [5], from the perspective of countries and regions, believes that China, on the whole, has an environmental Kuznets curve of per capita carbon emissions, and the widening income distribution gap in China is not conducive to improving environmental quality. Subsequently, he (2018) [6] also used the carbon emission data of Chinese provinces from 1997 to 2014 to study the impact of income inequality on environmental quality. Meng Fanjie (2019) [7] considered the spillover effect of space environment and found that the widening of regional income gap would not only lead to the deterioration of local environmental quality, but also lead to the deterioration of surrounding environmental quality.

To sum up, scholars at home and abroad have conducted some meaningful studies on the relationship between income gap and environmental pollution. Considering the characteristics of China's "dual economy" and the imbalance of urban and rural income levels, this paper adopts the income gap between urban and rural areas which can better reflect the impact of income gap on environmental pollution. At the same time, considering the integrity and continuity of data, this paper chooses PM2.5 as an indicator to measure environmental pollution, which is also the innovation of this paper.

3. Data and methods

3.1 Source of data
This paper selects the annual panel data of 30 provinces (municipalities directly under the Central Government and autonomous regions) in China from 2000 to 2018, excluding Xizang Province (some data are missing). The data mainly come from China Statistical Yearbook, China Environmental Statistical Yearbook and statistical yearbooks of all provinces.

3.2 Variable measurement

3.2.1 Dependent variable. The environmental pollution index selected in this paper is PM2.5 concentration. PM2.5 refers to particles in the atmosphere with a diameter of less than or equal to 2.5 microns, also known as fine particulate matter, which is harmful to human health. PM2.5 sources can be divided into two types: natural sources and anthropogenic sources, among which anthropogenic sources are the main sources, including road dust, industrial dust, fossil fuel combustion, etc. [8]. The above characteristics of PM2.5 indicate that PM2.5 is not a single pollutant, but a comprehensive environmental pollution index. PM2.5 concentration, as a proxy indicator of environmental pollution in empirical analysis, is positively correlated with the degree of environmental pollution, that is, the more serious the environmental pollution is. The original PM2.5 data selected in this paper comes from the annual mean value table of global PM2.5 released by the Atmospheric Composition Analysis Group of Dalhousie University in Canada, and the regional statistics of ArcGIS are used to analyse the data of China's provinces.

3.2.2 The independent variables. Gini coefficient is the most commonly used index to measure the income gap of a country or region. The Gini coefficient is between 0 and 1. The larger the coefficient is, the more serious the inequality is. This paper refers to the calculation method of Gini coefficient by Tian Weimin (2012) [9], who put forward the following calculation formula:
\[ G = 1 - \frac{1}{P \times W} \sum_{i=1}^{n} (W_{i-1} + W_i) \times P_i \]  

(1)

Here, \( P \) is the total population, \( W \) is the total income, \( W_i \) is the income accumulated to group I. In this paper, the Gini coefficient of urban and rural residents’ income in each province is calculated by using this method, and then the Gini coefficient of overall residents’ income is calculated by using the "grouping weighting method" proposed by Sundrum (1990):

\[ G = P_c^2 \frac{H}{u} G_c + P_r^2 \frac{H}{u} G_r + P_c P_r \frac{H_r - H_c}{u} \]  

(2)

In the formula, \( G_c, G_r \) respectively are the Gini coefficient of the income gap between urban residents and rural residents, \( P_c, P_r \) respectively represent the proportion of urban and rural population, \( u_c, u_r \) respectively represent the per capita income of urban and rural areas, \( u \) represents the per capita income of the whole province (city and district). Thus, we calculate the Gini coefficient of income at the provincial level.

3.2.3 Control variables.

(1) Level of economic development (pgdp). Real per capita GDP based on the year 2000 is used to represent the level of economic development in each region.

(2) Industrial structure index (str). The index is expressed in terms of the share of total industrial production in GDP.

(3) Urbanization rate (urb). This index is measured by the proportion of urban population in each region in the total population at the end of the year.

(4) Foreign direct investment (fdi). Reflect the amount of foreign direct investment actually utilized.

(5) Energy structure (est). Reflecting energy efficiency, it is the ratio of total energy consumption to GDP per capita.

3.3 Research methods.

Drawing lessons from the traditional EKC curve model, after directly introducing the Gini coefficient into the model as a measure of income disparity, a model of the impact of income disparity on environmental pollution is established [6]. At the same time, multiple control variables are selected, such as urbanization level, industrialization level, foreign direct investment and energy efficiency. The model of the impact of urban-rural income gap on environmental pollution established in this paper is as follows:

\[ PM = \alpha + \beta_1 pgdp + \beta_2 (pgdp)^2 + \beta_3 lnGini + \beta_4 lnurb + \beta_5 lnstr + \beta_6 lnfdi + \beta_7 lnest + \epsilon \]  

(3)

Among them, the regression model uses quadratic to fit EKC curve and adds the above variables. Meanwhile, \( gini, urb, str, fdi, est \) are converted into logarithmic form, and the coefficients of all explanatory variables after taking the logarithm are of strong economic significance and explanatory strength.

Based on the above analysis, in order to make the measurement results robust and reliable, this article first uses the static panel regression model as the benchmark regression result of this article. Taking into account the endogenous nature of the equation, this paper uses the panel instrumental variable method for further analysis, that is, the first-order lag term of the explanatory variable is used as the instrumental variable. The measurement software used in the demonstration is STATA15.0.

4. The results and conclusions

The following table shows the estimated results of the impact of Gini coefficient on environmental pollution. Models (1)-(5) are the results of gradually adding control variables. The Hausman test results show that the P value is <0.01, rejecting the null hypothesis, so this paper uses fixed panel estimation to study.
Table 1. Estimation results of the panel fixed effect model.

| Model Variables | (1) Pm2.5   | (2) Pm2.5   | (3) Pm2.5   | (4) Pm2.5   | (5) Pm2.5   |
|-----------------|-------------|-------------|-------------|-------------|-------------|
| Pgdp            | 0.6518***   | 4.8265***   | 4.9015***   | 4.4650***   | 4.3054***   |
|                 | (0.210)     | (0.000)     | (0.000)     | (0.000)     | (0.021)     |
| Pgdp2           | -0.2014***  | -0.5955***  | -0.4947***  | -0.4785***  | -0.4690***  |
|                 | (0.002)     | (0.000)     | (0.000)     | (0.000)     | (0.002)     |
| Ln(Gini)        | 25.0588***  | 24.3359***  | 19.3448***  | 18.8057***  | 26.1373***  |
|                 | (0.000)     | (0.000)     | (0.000)     | (0.000)     | (0.001)     |
| Ln(urb)         | -17.7773*** | -19.9318*** | -24.2349*** | -26.4833*** |
|                 | (0.000)     | (0.000)     | (0.000)     | (0.000)     | (0.004)     |
| Ln(str)         | 9.3431***   | 7.4041***   | 7.5307***   | 7.5307***   |
|                 | (0.000)     | (0.000)     | (0.000)     | (0.028)     |
| Ln(fdi)         | 1.6991***   | 2.1357***   |
|                 | (0.001)     | (0.012)     |
| Ln(est)         | -5.1299***  |
|                 | (0.003)     |
| Constant        | 57.2667***  | 37.0329     | -2.9244     | -6.9265     |
|                 | (0.000)     | (0.000)     | (0.786)     | (0.518)     |
| Observation     | 570         | 570         | 570         | 570         | 570         |

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

Table 1 is the regression result of the impact of income gap on environmental pollution based on the fixed panel, and the conclusion is basically the same as expected. As it is a basic regression, detailed result analysis is based on dynamic panel regression discussion. Table 2 is a dynamic panel model using instrumental variables. This article draws on general practices and uses the first-order lag term of explanatory variables as the instrumental variables of IV-FE.

Table 2. Estimation results of the IV-FE model.

| Model Variables | (1) Pm2.5   | (2) Pm2.5   | (3) Pm2.5   | (4) Pm2.5   | (5) Pm2.5   |
|-----------------|-------------|-------------|-------------|-------------|-------------|
| Pgdp            | 1.1056***   | 3.8049***   | 3.9170***   | 3.6624***   | 3.4823***   |
|                 | (0.000)     | (0.000)     | (0.000)     | (0.000)     | (0.021)     |
| Pgdp2           | -0.2831***  | -0.5094***  | -0.4397***  | -0.4332***  | -0.4064***  |
|                 | (0.019)     | (0.000)     | (0.000)     | (0.000)     | (0.002)     |
| Ln(Gini)        | 25.2491***  | 24.0525***  | 18.6135***  | 18.0642***  | 17.7673***  |
|                 | (0.000)     | (0.000)     | (0.000)     | (0.000)     | (0.001)     |
| Ln(urb)         | -12.0164*** | -14.3469*** | -17.9940*** | -16.4230*** |
|                 | (0.001)     | (0.000)     | (0.000)     | (0.000)     |
| Ln(str)         | 10.4991***  | 9.0885***   | 10.0488***  |
|                 | (0.000)     | (0.000)     | (0.000)     |
| Ln(fdi)         | 1.3089***   | 1.2201***   |
|                 | (0.005)     | (0.009)     |
| Ln(est)         | 0.9653***   |
|                 | (0.026)     |
| Observation     | 540         | 540         | 540         | 540         | 540         |

Table 2 shows the estimated results of regression using the panel tool variable method. By comparing Table 1 and Table 2, it can be found that the results of the two tables are basically similar. At the same time, the over-identification test is carried out, and the results showed that the P value >0.01 in Sargan test of all models, indicating that the null hypothesis of "there is no overuse of instrumental variables" is accepted, and the selection of instrumental variables was reasonable and in line with expectations. This paper mainly explains the results of the panel instrumental variable econometric model: (1) There is an "inverted U" EKC of PM2.5 in China. With the increase of China's per capita income, PM2.5...
emissions, i.e. environmental pollution levels, in China show a trend of first increasing and then decreasing. (2) According to the significantly positive Gini coefficient, it can be shown that the income gap will aggravate China's environmental pollution. When the income gap increases by 1%, PM2.5 emissions in China will increase by 17.76%, and both pass the significance test at the 1% level, which is the same as the theoretical expectation. (3) Regarding the control variables, the regression coefficient of the impact of industrialization level, foreign direct investment and energy intensity on environmental pollution is significantly positive, indicating that the improvement of industrialization, the increase of foreign direct investment and the expansion of energy intensity will lead to the increase of PM2.5 concentration, thus increasing environmental pollution. Therefore, China needs to reasonably and effectively promote industrialization upgrading, more reasonably introduce foreign direct investment, and improve energy utilization efficiency. (4) In addition, the urbanization level coefficient is significantly negative at the level of 1%, indicating that the improvement of urbanization level plays a positive role in the improvement of environmental quality and can reduce PM2.5 concentration to a certain extent. Therefore, China should reasonably promote the urbanization process to promote the reduction of environmental pollution level.

5. Conclusion
Based on the above research, the following results are obtained in this paper: (1) There is an Environmental Kuznets Curve of pm2.5 in China as a whole, and the widening of income gap is not conducive to the improvement of environmental quality; (2) The results support the ascent of the industrialization level and energy intensity will increase significantly the environmental pollution degree of the typical fact, at the same time, the increase of foreign direct investment will aggravate environmental pollution; (3) The improvement of urbanization level has played a positive role on the improvement of the environmental quality, to a certain extent, can reduce the concentration of pm2.5, reducing environmental pollution.

6. References
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