Study on the existence of Environmental Kuznets Curve in China

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Abstract. Environmental Kuznets Curve is one of the important indicators to measure environmental pollution and economic growth. This paper USES panel data of environment and economy of 31 provinces, municipalities and autonomous regions in China to analyse the relationship between environmental pollution and economic growth. The results have showed that the relationship between waste water and economic growth is "inverted U-shape", and the inflection point is about 27,000 ¥ per capita income, but the relationship between exhaust gas and economic growth is also "inverted U-shape", and the inflection point is about 88,000 ¥ per capita income. It shows that China's waste water treatment is early and the technology is mature, but the exhaust gas treatment still needs to be strengthened.

Keywords: Environmental Kuznets Curve, Panel data, Environmental pollution.

1. Introduction

In recent years, our government has paid more and more attention to environmental improvement. In 2015, Minister Chen jining used the concept of "Environmental Kuznets Curve (EKC)" in a response to a reporter's question. In the 2016 government report, he also proposed specific plans for the ecological environment in the next five years, such as reducing water consumption, energy consumption and carbon dioxide emission per unit of GDP by 23%, 15% and 18% respectively. They will work hard to control haze and water pollution. This year, they will reduce chemical oxygen demand, ammonia nitrogen emission by 2 percent, sulfur dioxide and nitrogen oxide emission by 3 percent, and continue to reduce the concentration of fine particulate matter (PM2.5) in key areas. So for governments to balance between economic growth and environmental governance, academic circles often use "Environmental Kuznets Curve" to measure the change between the two.

2. Literature review

Panayotou [1] took emissions of SO2, NO2 and SPM as indicators of environmental pollution and measured their relationship with per capita national income, and pointed out that the EKC turning points of the three are around $3000, $5,500 and $4,500, respectively. Grossman and Kreuger [2] found that the relationship between environmental pollution and per capita national income in many countries is mostly "inverted U-shape", and also pointed out that when the per capita national income is between $4000-5000, it is the inflection point of the relationship between them. This relationship was also confirmed by Iwata et al [3]. However, the study of Kaufma [4] found that the relationship between two is "positive U-shape", and Moomaw [5] found that the relationship between the two is "positive N-shape" in developed countries. Akbostanci et al [6] delineated the relationship between the two with cubic polynomial, and found that the relationship between the two is "inverted N-shape". Different empirical results may benefit from differences in the selection of indicators and time intervals, which indicates that the relationship between the two is uncertain.

In China, the relationship between them arose after 2000. Shen manhong and Xu yunhua [7] showed the relationship between the per capita industrial "three wastes" and per capita GDP in Zhejiang province, which is "inverted U-shape" first and then "positive U-shape", which is also found in the study of Liaoning province by Wang weiguo and Xia yanqing [8]. Wang ruiling [9] found in her study of China's EKC that the two is in an inverted S-shape relationship. Deng zhiqiang et al. [10] respectively studied the EKC relationship in Changsha, Zhuzhou and Xiangtan, and found that there is an "inverted U-shape" relationship in Changsha and a "positive U-shape" relationship in Zhuzhou and Xiangtan. Zhu pinghui et al. [11] used the spatial panel model to test the relationship between industrial pollution emission and economic growth in China, and found that the EKC curve is "inverted N-shape" when the industrial waste water emission and industrial waste gas are studied as environmental pollution variables. Li zhiguo and Zhou detian [12] studied the EKC relationship in Shandong province with the VAR model, and found that the relationship between them depends on the selection of indicators and intervals. Chen xiangyang [13] used panel model to study the relationship between environmental pollution and economic growth in China, and found an "inverted U-shape" relationship between sulfur dioxide emission, industrial solid waste discharge and economic growth. There is an "N-shape" relationship between industrial waste water discharge and per capita GDP. It is found that there are differences in the results of studying the relationship using different samples and different methods in China.

Based on the panel data of 31 provinces, municipalities and autonomous regions (except Taiwan) from 2004 to 2015, this paper makes an empirical study of the relationship between environmental pollution and economic growth in China, adds empirical cases for the study of the relationship between the two, and provides suggestions for the state to adjust environmental regulatory policies.

3. Theoretical analysis and data selection

People try to explain the relationship between economic growth and environmental pollution from different angles. Endogenous growth theory holds that technological progress promotes the improvement of enterprise resource utilization efficiency and environmental quality. The theory of economic structure holds that economies of scale lead to the increase of environmental pollution, and also promote economic restructuring and industrial upgrading. This explains the "inverted U" relationship between the two. Cost theory argues that economic growth leads to the scarcity of resources. It also allows the government to improve environmental regulation, pushing up the cost of resources. In this way, enterprises are forced to use new technologies to improve efficiency and reduce costs. International trade theory argues that international trade leads to international division of labour, allowing low-income countries to produce highly polluting products, and high-income countries to consume highly polluting products. The theory of industrial transfer holds that economic growth is accompanied by industrial upgrading and transfer, so that high-polluting enterprises are transferred to backward areas. Referring to the model of Grossman & Krueger, this paper introduces environmental governance investment and builds a fixed panel model as follows:

$$yit=\gamma i+\alpha 1*pgdpit+\alpha 2*pgdp2it+\alpha 3*pgdp3it+\beta*pinvit+\varepsilon it \quad (1)$$

Where i=1,2,…,n represents region,t=1,2,…,m represents time,and yit represents the unit environmental pollution indicator at time t in region i. pgdpit refers to the per capita GDP of region i at time t,and pinvit represents the unit environmental governance input at time t in the region i. γi is the individual effect parameter,and εit is the random error term.β represents the relationship between environmental governance input and environmental pollution indicators, the two are negative. $\alpha 1$, $\alpha 2$, α3 are used to measure the relationship between per capita economic growth and environmental pollution. Specifically speaking:

If α1=0, α2=0, α3=0, there is no relationship between per capita economic growth and environmental pollution;

If α1≠0, α2=0, α3=0, there is a linear relationship between per capita economic growth and environmental pollution;

If α1≠0, α2≠0, α3=0, there is a U-shape relationship between per capita economic growth and environmental pollution;

If α1≠0, α2≠0, α3≠0, there is an inverted S-shape relationship between per capita economic growth and environmental pollution.

Data are collected from the “national statistical yearbook” and “China environmental yearbook” from 2004 to 2015. In this paper, waste water discharge and SO2 emission are selected as indicators of environmental pollution. The investment of waste water treatment project and exhaust gas treatment project are the environmental governance indicators. Per capita national income represents economic growth.

4. Empirical analysis

In this paper, Hausman test is adopted to find that the modelling of waste water and exhaust gas emission as pollution indicators is suitable to establish a fixed effect model. The specific regression results are shown in table 1.

When waste water is used as the proxy variable of environmental pollution discharge, it is found that α1=1.4, α2=0.0000175, α2=-1.85E-10, the relation between per capita economic growth and environmental pollution is "inverted S-shape". However, when the per capita income is greater than zero, there is only a maximum value greater than zero, that is, when the per capita national income is about 27,000 ¥, the relationship between the two is reversed, actually presenting an "inverted U-shape" relationship, and the investment in environmental pollution control has obvious effects .When exhaust gas is used as the proxy variable of environmental pollution discharge, the coefficient of national income cube per capita is negative and significant. Under the constraint that the per capita income is greater than zero, when the per capita national income is about 885,146,000 ¥, the relationship between the two is turning, generally presenting an "inverted U-shape". However, the relationship between air pollution control and environmental pollution is not significant, which indicates that China still needs to strengthen air pollution control.

Table 1. Panel regression table of pollution and per capita national income

	Waste water coefficient estimation term	Waste water coefficient estimation term
Constant term	147695(＊＊＊)	1308520(＊＊＊)
Per capita national income	1.400529(＊＊＊)	-22.7314(＊＊＊)
Per capita national income square	1.75E-05(＊＊＊)	0.000221(＊＊＊)
Per capita national income cubic	-1.85E-10(＊＊＊)	-8.32E-10(＊＊＊)
Pollution control input	-0.08913(＊＊)	0.053691
Adjust the goodness of fit	0.9895	0.9869
DW	2.23	1.51
Hausman	30.155155	82.075463
Number of samples	360	360
The turning point	27770.7(¥)	88514.6(¥)

Note: ＊＊＊represents 1% confidence level, ＊＊ represents 5% confidence level and ＊ represents 10% confidence level

5. Conclusion

Based on the above analysis, it is found that the inflection point of China's sewage pollution appears earlier, and the waste water pollution is sensitive to the impact on Chinese residents' life, the treatment technology of enterprises is mature, and the country regulates the waste water earlier. Therefore, the inflection point occurs when the per capita income of residents is 27,000 ¥. Treatment of sulfur dioxide pollution started late. In recent years, the country has only increased its input, so the inflection point came late, reaching around 88,000 ¥ in per capita national income. However, China's per capita national income was only 50,251 ¥ in 2015, so exhaust gas pollution and economic growth are still in the same phase of change, which also explains the serious haze in recent years, and exhaust gas pollution treatment has a long way to go.

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