Study on the relationship between industrialization level, economic development and environmental pollution in China

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Abstract

With the development of economy, environmental problems gradually outstanding in China. This article adopts the method of empirical study, have collected the data of China's industrial added value, per capita GDP and emissions of the three major pollutants from 2004 to 2015. The VAR model was established on the basis of the logarithm values of the three factors mentioned above, so as to conduct impulse-response analysis to discuss the relationship between industrialization level, economic development and environmental pollution. The conclusion is as follows: (1) At present, the increase of China's industrial added value can promote the decline of China's environmental pollution emissions to a certain extent; (2) China is now at the left of the turning point of the Environmental Kuznets Curve, and the increase of per capita GDP will aggravate environmental pollution.

Key words: Environmental pollution; Economic development; Level of industrialization; The VAR model

1. Introduction

In the past 40 years of reform and opening, China's industrialization process has been accelerating, driving the rapid economic development. However, we should also realize that there are many hidden dangers behind the rapid economic development, and environmental problems are one of them. Over the past 40 years, China has been adhering to the basic national policy of "economic construction as the center" and embarked on a road of pollution first and treatment afterwards. Now environmental problems are being forced to solve, and the severe smog in the Beijing-Tianjin-Hebei region, appalling cancer villages and "white pollution" pose a serious threat to people's health. President Xi Jinping's important statement that "green water and green mountains are mountains of gold and silver" indicates that the CPC has paid great attention to the construction of ecological civilization in recent years, and China's economy will follow a path of coordinated development between man and nature.

2. Literature review

The relationship between environmental pollution and economic development has drawn worldwide attention. Grossman and Krueger (1995), two American economists, believed that the relationship between economic development and environmental pollution presented an inverted u-shaped curve statistically.

Then Panayotou and Theodore (1997) proposed the famous Environmental Kuznets Curve (EKC) hypothesis, confirmed that there is an inverted u-shaped relationship between environmental pollution and economic development level. The theory holds that, on the left side of the inflection point, the degree of environmental pollution will increase with the level of economic development, while on the right side of the inflection point, the level of economic development will reduce environmental pollution. Zhang Peng and He Qingrong (2014) concluded with empirical research that China has not reached the turning point of EKC curve, and the increase of per capita income will aggravate environmental pollution. Tian Shizhong (2017) used the "Vertical and Horizontal" method to measure China's environmental pollution index, believing that the degree of environmental pollution in China is decreasing from the east to the west, meanwhile, SPSS software was used for regression analysis, the result showed that the higher fiscal decentralization was, the more serious the environmental pollution would be. Wang Shanshan and Qu Xiaoe (2012) calculated China's environmental pollution index by using the vertical method and added foreign trade and foreign direct investment. Based on the ARDL model established by these three variables, they concluded that the total export volume and foreign direct investment could reduce China's environmental pollution to some extent. On the basis of previous studies, this paper attempts to establish a vector autoregressive model with industrialization level, environmental pollution level and economic development level as variables to study the relationship among the three. On the basis of previous studies, this paper attempts to establish a vector autoregressive model to study the relationship among industrialization level, environmental pollution level and economic development level.

3. Empirical analysis

3.1 Data source and variable design

This paper collected the data during year 2004 to 2015 from the website of the national bureau of statistics of China and <China statistical yearbook>. The three variables studied in this paper are the level of industrial development, the level of economic development and the level of environmental pollution, which are respectively measured by the three indicators of industrial added value, per capita GDP and the total emissions of the three pollutants. In order to make the three indicators in the same order of magnitude to reduce the influence of heteroscedasticity, this paper takes the logarithm of the above three indicators and then applies the Eviews8.0 software to build the VAR model. The specific variable design is shown in table 1:

Table 1 Variable design

Variable	Name	Meaning
lnIAV	The natural logarithm of industrial added value	Industrial development level
lnPGDP	The natural logarithm of GDP per capita	Level of economic development
lnDEP	The natural logarithm of the total emissions of the three pollutants	Degree of environmental pollution

3.2 ADF test

The ADF test is used to test the stationarity of variables. Only when the time series is stable, can the occurrence of pseudo-regression be avoided. In this paper, the ADF test is conducted on variables lnIAV, lnPGDP and lnDEP at the significance level of 5%. The ADF test results are shown in table 2:

Table2 Results of ADF test

Variable	ADF value	Test critical values			Results
		10%	5%	1%	
lnIAV	-3.5908	-2.7290	-3.1754	-4.2001	stable
lnPGDP	-3.8555	-2.7711	-3.2598	-4.4206	stable
lnDEP	-3.7887	-2.7290	-3.1754	-4.2001	stable

Table 2 shows that the three variable sequences selected in this paper are all zero-order single integral sequences, that is, they are all stationary sequences, and no difference processing is required.

3.3 Model construction

In this paper, the five criteria of LR, FPE, AIC, SC and HQ are applied to determine the optimal lag order. The results are shown in table 3. It can be seen that the five methods all determine the optimal lag order of the model as order 2. Therefore, VAR (2) model is proposed:

$$y_t=A_1y_{t-1}+A_2y_{t-2}+Bx_t+\mu_t \quad (1)$$

y_t is an endogenous variable vector of dimension k. x_t is an exogenous variables vector of dimension d; μ_t is the k-dimensional error vectors A_1 and A_2; B is the coefficient matrix to be estimated.

Table 3 Results of optimal lag order test

Lag order	LR	FPE	AIC	SC	HQ
0	NA	3.57E-08	-8.637818	-8.547042	-8.737398
1	55.49606	2.39E-11	-16.08716	-15.72406	-16.48548
2	18.50000*	7.17e-13*	-20.45383*	-19.81840*	-21.15089*

3.4 Granger causality test

The Granger causality test was carried out when the lag order was 2.As shown in table 4,the results showed that at the significance level of 5%, lnIAV was the Granger cause of lnDEP, lnPGDP was the Granger cause of lnDEP, but there was no significant Granger causality between lnIAV and lnPGDP.

Table 4 Results of Granger causality test

Hypothesis	F-Statistic	Probability	Causal relationship
lnIAV does not Granger Cause lnDEP	8.5103	0.0246	yes
lnDEP does not Granger Cause lnIAV	0.3080	0.7479	no
lnPGDP does not Granger Cause lnDEP	8.3937	0.0252	yes

lnDEP does not Granger Cause lnPGDP	0.8576	0.4784	no
lnPGDP does not Granger Cause lnIAV	0.3563	0.7167	no
lnIAV does not Granger Cause lnPGDP	0.2504	0.7877	no

3.5 VAR model analysis

The VAR (2) model established in this paper is as follows:

lnDEP=0.1547*lnDEP(-1)+0.0249*lnDEP(-2)-0.9675*lnIAV(-1)+0.0284*lnIAV (-2) + 0.8426*lnPGDP(-1) + 0.0892*lnPGDP(-2) + 15.7439 (2)

lnIAV=0.0997*lnDEP(-1)-0.0640*lnDEP(-2)+0.1211*lnIAV(-1)+0.9919*lnIAV (-2) + 0.9430*lnPGDP(-1) - 1.2014*lnPGDP(-2) + 0.7626 (3)

lnPGDP=0.2014lnDEP(-1)-0.1115*lnDEP(-2)-0.3700*lnIAV(-1)+0.5278*lnIAV(-2)+1.3388*lnPGDP(-1)-0.5975*lnPGDP(-2)-0.6604 (4)

The robustness test results of the VAR model are shown in fig.1. All unit roots of the model fall into the unit circle, which indicates that the VAR model is stable and can be used for impulse response analysis.

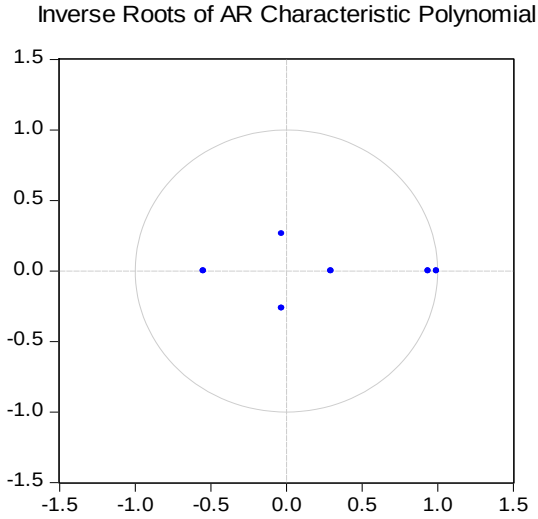

FIG. 1 AR root graph

3.6 Impulse response analysis

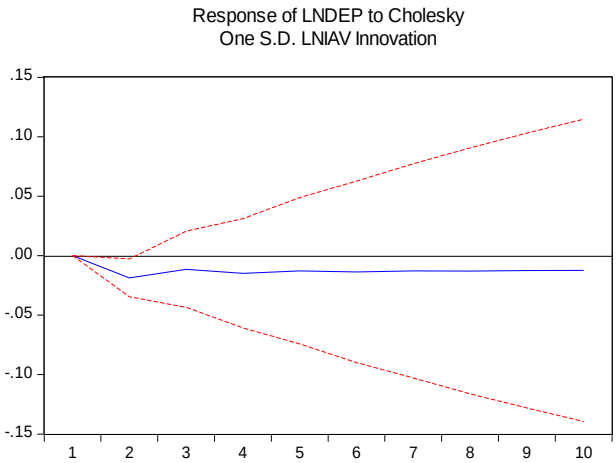

FIG. 2 Impulse response curve of industrial added value to environmental pollution degree

According to the impulse response function curve in FIG.2, In this period, a positive impact is given to the industrial added value, and the degree of environmental pollution will react negatively after 0.5 period, It reaches the lowest point in the 1.5 period, and then gradually converges and becomes stable, which indicates that the external impact on industrial added value will bring a reverse impact on environmental pollution. From the macroscopic aspect, the reason for this result may be due to the government's policy on environmental protection has shown initial results, improving the level of industrialization can promote the green development of the economy. From the micro perspective, the reason for this result may be that the increase of benefits of industrial enterprises will make enterprises more inclined to assume corporate social responsibility and pay more attention to environmental protection.

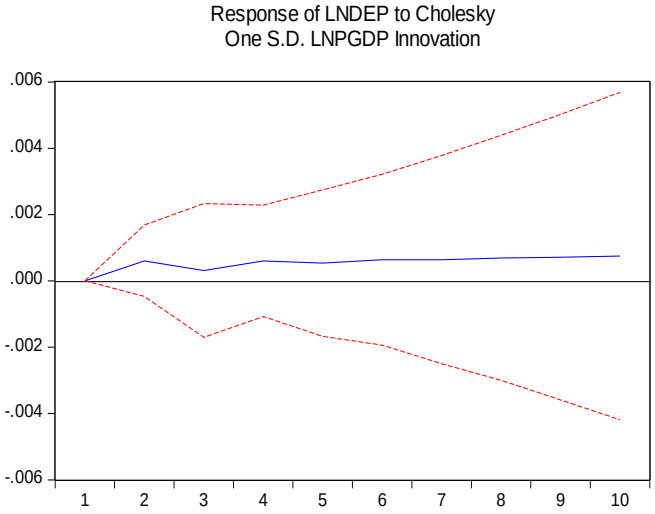

FIG. 3 impulse response curve of per capita GDP to environmental pollution degree

According to the impulse response function curve in FIG.3, In this period, give per capita GDP a positive impact, the level of environmental pollution will have a positive reaction after the 0.5 period. in period 1.5, the pollution reached the highest point, and then gradually converged. In period 2.5, there was a small fluctuation and an increase, but eventually it leveled off. In general, the increase of China's per capita GDP will aggravate environmental pollution, and China's economic development stage has not reached the inflection point of EKC curve, which is consistent with the conclusion reached by Zhang Peng and He Qingrong (2014) when they used the entropy method to measure the degree of environmental pollution.

4 Research conclusions and suggestions

In this paper, VAR model was established based on the natural logarithm of China's industrial added value, per capita GDP and the sum of the emissions of the three pollutants from 2004 to 2015, and the impulse response analysis was carried out. The conclusion is as follows :(1) The increase of industrial added value in China at the present stage can promote the decline of environmental pollution emissions in China to a certain extent; (2) China is now at the left of the inflection point of the Environmental Kuznets Curve, and the increase of per capita GDP will aggravate environmental pollution.

In view of the above conclusions, this paper believes that (1) The government should control industrial pollution and at the same time pay attention to protecting the profits of industrial enterprises. The government can emphasize the importance of industrial enterprises' transformation and upgrading, encourage cooperation and merger between small and micro enterprises, and promote the complementary advantages of small and micro enterprises. (2) China is still in the stage of developing economic at the cost of the environment. China must adhere to the transformation of economic development mode, drive the development of green economy with technological innovation, and coordinate the relationship between economy and environment. So as to achieve the goal of healthy development of China's economy

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