THE RELATIONSHIP BETWEEN FOREIGN DIRECT INVESTMENT, ECONOMIC GROWTH AND ENVIRONMENTAL POLLUTION IN CENTRAL CHINA

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Abstract - The paper study the relationship between foreign direct investment, economic growth and environmental pollution in central China using time series data from 1992-2017,establishing VAR model with the annual FDI, per capita GDP, the emission of industrial waste gas and industrial solid waste emission as the variables,using co-integration test and impulse response function to study the dynamic relationship between these variables in central China. Central China has continuously strengthened its economic strength and has gradually become a gathering place for China to attract foreign direct investment. The result shows that FDI, economic growth will increase environmental pollution, and environmental pollution will also have a certain negative impact on economic growth. Moreover,the relationship between economic, FDI and environmental evolution does not all conform to the inverted U-shaped curve, but different pollution indicators show different forms of the relationship between the economy, FDI and the environment.Then put forward relevant suggestions to promote the coordinated development of the economy and environment in the central China.

Keywords - FDI, Economic Growth, Industrial Pollution, Central China

I. INTRODUCTION

Foreign direct investment (FDI) plays an increasingly important role, they are even considering as the engine of economic growth and development for a country. China has become the world's second-largest recipient of foreign direct investment. In recent years, FDI in central China has increased rapidly, it increased from 2.9 billion dollars in 2000 to 77.8 billion dollars in 2018. The actual use of FDI accounts for 58% of China in 2018. Central China is gradually becoming a key development area for China to absorb FDI. In 2018, the central region's economic growth rate reached 7.8%, ranking first among China's four major economic regions. The central region has six provinces, four of which are among the top 10 fastest economic growth of China's 31 provinces. However, rapid economic development has also brought great pressure on the environment. In 2017, sulfur dioxide emissions in the central region totaled 1.75 million tons, of which industrial sulfur dioxide accounted for 62%. The total amount of soot emission was 1.62 million tons, of which industrial soot accounted for 80% and industrial solid waste reached 8.7 billion tons, an increase of 7.2% over last year.

The coordinated development of economy and environment has always aroused the close attention of the society. Central China occupies an important position in China's regional development pattern and is also an important carrier of China's ecological green development. As one of China's four major economic sectors, central China has continuously strengthened its economic strength and has gradually become a gathering place for China to attract foreign direct investment. With the continuous improvement of economic strength and the increase of foreign direct investment, it will also affect the local environment to a certain extent. Therefore, it is significant to study the relationship between FDI, economic growth and environmental pollution in central China. Then, we can put suggestions for the government, improving the quality of foreign investment, make corresponding environmental protection measures, and promote the coordinated development of economy and environment in central China.

II. LITERATURE REVIEW

Grossman and Krueger (1991) introduced the Kuznets curve into the study of the relationship between economic growth and environmental pollution, they found that there is an inverted U-shaped relationship between economy and environment. And then Grossman and Krueger (1995) formally proposed the Environmental Kuznets Curve(EKC) hypothesis. Subsequently, Dasgupta et al (2002); Fodha and Zaghdoud (2010); Wang, Zhou, Zhou, and Wang (2011) provided empirical evidence on the validity of EKC hypothesis.

Blanco, L., Gonzalez, F., and Ruiz, I. (2013) used panel Granger causality test with VAR model to examine the relationship between FDI and CO2 emissions in 18 Lain American countries over the period 1980-2007.The author divides the FDI category into pollution-intensive industries (dirty industries) and then focus on testing the impact of these industries on CO2 emissions. The paper found that FDI inflows in pollution-intensive industries can increase in CO2 emissions. The study also recommended that the government should pay close attention to pollution-intensive industries.

Agrawal, G. (2015) empirically examined cointegration and causality among FDI and economic growth in BRICS countries from 1989-2012 by using

panel cointegration test and panel Granger-causality test and error correction model. The findings indicate a long run equilibrium relationship between FDI and economic growth.

Jiang, Y. Q. (2015) investigate the effect of FDI and regional economic growthon pollution by using fixed effect model in China from 1997-2012. The main finding is that FDI contribution to more serious pollution emission.

Tan, B. W., Tang, C. F. (2016) used data from ASEAN-5 countries over the period of 1970-2012 by using Johansen-Juseliuscointegration test and causality test with the VECM to evaluate causal linkage among domestic investment, FDI, trade, interest rate and economic growth. The result show that economic growth Granger-causes FDI. However, more is the existence of a bi-directional long-term causality between FDI and GDP.

Aung, T.S., Saboori,B., and Rasoulinezhad,E. (2017) empirically studied the short-and long-run relationship between GDP and CO2 emissions in Myanmar by using annual time series data from 1970-2014.Through establishing ARDL model to estimate the dynamic relationship among GHG, GDP, Trade, Financial openness in the long-and short-term. The result display that there is positive relationship between CO2 and GDP in both short- and long-run and thus, no evidence of EKC hypothesis is found for CO2 in Myanmar.

Peng, H. F., Hua, Y. (2018) using the panel data to study the impact of FDI and economic growth on CO2 emissions in eastern, central and western China. The author found that FDI has a carbon reduction effect in eastern, central and western regions. And the eastern region is more significant, satisfying the inverted U-shaped of EKC.

Kim, S.(2019) based on panel vector correction model to explore the causal relationship among energy consumption, CO2 emissions, FDI and GDP in 57 developing countries from 1980-2013. It shows a long-term cointegration relationship among CO2 emissions, GDP and FDI, which means sustain the environmental Kuznets curve hypothesis.

III. DATA AND MODEL

Data

Based on the availability of data, industrial solid waste produced in the central region was selected, the total emission of sulfur dioxide, soot and dust in industrial exhaust gas was taken as the indicator to measure industrial exhaust gas.In this paper, industrial solid waste produced and industrial waste gas emission as environmental pollution variables, the unit is 10,000 tons; The FDI data of the central China over the years, with the unit of US$10,000, and the per capita GDP of the central China were selected as the economic growth, which was deflated by the CPI index (1995=100), and converted by the annual average exchange rate, with the unit of US $10,000. Data are derived from the China Statistical Yearbook, China Provincial Statistical Yearbook, and China Environmental Statistics Yearbook. The period of data is from 1992 to 2017.This paper performs a natural logarithmic transformation on the relevant data to avoid the violent fluctuation of the data and reduce the possible heteroscedasticity in the sequence. The basic variables used are: LNPGDP, LNFDI, LNSOLID and LNGAS.

Model

The vector autoregressive (VAR) model was firstproposed by Sims.Granger(1983)and Engle(1987) supplemented by co-integration theory to analyze and explain the short-term adjustment dynamics and long-term equilibrium of variables in the model.The VAR model is suitable for explaining the dynamic relationship between various variables and economic variables. Therefore, the model was established to study the dynamic relationship between foreign investment, the environment and the economy.The general form of the VAR model is:

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots + A_p Y_{t-p} + B X_t + \mu_t$$

Inthis paper,Yt=[LNPGDP,LNFDI, Pollutant]{Pollutant represent environmental pollution indicators which include LNSOLID and LNGAS}. Xt is a d-dimensional exogenous variable vector. A1,...,Ap and B are the matrix of coefficients to be estimated, p is the lag order of the model.μt is a random perturbation vector.

IV. EMPIRICAL ANALYSIS

Stationary Test

In order to avoid the generation of pseudo-regression, it is necessary to perform a stationarity test on the time series.In this paper, PP (Phillips-Perron Test) is used to perform unit root test on four variables of LNSOLID, LNGAS, LNFDI and LNPGDP.According to the result of the unit root test(table 1), all four variables satisfy the first-order, recorded as I (1) and can be co-integrted..

Variables	(c,t,k)	T-stat	Critical value 5%	
LNPGDP	(c,t,0)	-3.596702	-3.6032	Non-stable
LNFDI	(c,t,2)	-3.191609	-3.6032	Non-stable
LNSOLID	(c,t,2)	-2.180814	-3.6032	Non-stable
LNGAS	(c,t,3)	0.753256	-3.6032	Non-stable
DLNPGDP	(c,t,0)	-3.359573*	-3.6122	Stable
DLNFDI	(c,t,1)	-6.939819***	-3.6122	Stable
DLNSOLID	(c,t,2)	-5.453465***	-3.6122	Stable
DLNGAS	(c,t,4)	-3.909381**	-3.6122	Stable

Table 1 Unit Root Test Results (PP-Test)

Note: (1) D represents the first-order difference.(2) The test form (c, t, k) indicates whether the unit root test contains a constant term (c), a time trend term (t), and a lag order (k), respectively, where the lag order is determined by the AIC criterion. (3) ***, ** and * is significant at 1%, 5% and 10% level, respectively.

CointegrationTest and VAR model establishment

In order to determine the optimal lag order of the VAR model, we use information criteria to select it, such as LogL, LR, FPE, AIC, SC and HQ (as shown in Table 2). Therefore,we determine that the optimal lag order of VAR is 2 orders. From the unit root diagram, we can see that the inverses of all the roots are in the unit circle, indicating that the VAR (2) model is stable. It shows that there is a long-term stable relationship among the four selected variables, which can be further analyzed.

Lag	LR	FPE	AIC	SC	HQ
0	NA	3.01E-06	-1.36293	-1.166588	-1.31084
1	129.524	1.28E-08	-6.846649	-5.864938*	-6.586201
2	27.71457*	8.71e-09*	-7.360954*	-5.593873	-6.892147*

Table 2 VAR model lag order test

Note: "*" marks the lag order selected according to the corresponding criteria.

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.8562	98.29421	47.85613	0
At most 1 *	0.758449	53.68961	29.79707	0
At most 2 *	0.467403	21.01405	15.49471	0.0066
At most 3 *	0.24698	6.524266	3.841466	0.0106

Table 3 Co-integration test result

According to LR, AIC and SC criteria, the optimal lag order of the model is 2. Based on the VAR model, the Johansen co-integration test can test the multivariate regression coefficient, and the maximum characteristic root test is adopted.

The results are shown in table 3. Through the co-integration test, we found that there was a long-term stable relationship between per capita GDP, FDI and the production of industrial solid waste, and the emission of sulfur dioxide and soot in industrial gas.

Impulse Response Function Analysis

The impulse response function is the effect of adding a unit of standard deviation on the disturbance term to the current and future values of the endogenous variable. It can visually describe the dynamic interaction between variables. We use the impulse response function of generalized VAR(2) model to analyze the impact response of PGDP, FDI on industrial solid waste and industrial waste gas, describe the long-term and short-term dynamic relationships between variables, and select a response model with a lag period of 10.(Table 4)

Period	LNFDI TO LNGAS	LNPGDP TO LNGAS	LNGAS TO LNFDI	LNGAS TO LNPGDP
1	0	0.012642	0.023384	0
2	-0.000657	-0.007437	0.06244	0.019879
3	-0.057122	0.031331	0.061823	0.003924
4	0.118983	0.083576	0.053553	-0.019519
5	0.162533	0.118115	0.046762	-0.027038
6	0.19824	0.142435	0.034087	-0.024287
7	0.231906	0.165246	0.015281	-0.020681
8	0.260258	0.185203	-0.004671	-0.017892
9	0.280543	0.199494	-0.023008	-0.014777
10	0.292868	0.207926	-0.039555	-0.011258
Total	1.487552	1.138531	0.230096	-0.111649
Curve	U	U	Inverted-U	N

Table 4 Impulse response analysis result

Period	LNFDI TO LNSOLID	LNPGDP TO LNSOLID	LNSOLID TO LNFDI	LNSOLID TO LNPGDP
1	0	0	0.040916	0.0448
2	0.04042	0.015453	0.045545	0.051642
3	0.071228	0.023514	0.047499	0.042311
4	0.082986	0.032281	0.053228	0.029728
5	0.082472	0.042289	0.058057	0.021503
6	0.076634	0.050651	0.060131	0.019531
7	0.070926	0.055241	0.059495	0.021873
8	0.06785	0.055966	0.057369	0.02544
9	0.06739	0.054222	0.055079	0.027943
10	0.068258	0.051746	0.053423	0.028591
Total	0.628164	0.381363	0.530742	0.313362
Curve	Inverted-U	Inverted-U	Inverted-U	N

Table4 Impulse response analysis results(continue)

The impact of FDI and economic growth on industrial waste gas decreases first and then increases, with cumulative values of 1.487552 and 1.138531, respectively. This shows that FDI and economic growth will lead to a decrease in industrial exhaust emissions and then increase.The impact of industrial waste gas on FDI increased first and then decreased. The value of industrial waste gas response to economic growth in the first period is 0, it shows increases first, then decreases, and then increases, the cumulative value is -0.111649. This shows that industrial waste gas has a negative impact on economic growth, that is, restricts economic growth.

The impact of FDI and economic growth on industrial solids first increased and then decreased, with cumulative values of 0.628164 and 0.381363, respectively. This indicates that FDI and economic growth will lead to the increase in industrial solid waste production and then decrease.The response of industrial solid waste to FDI for the first period was 0.040916, which rose first and then decreased, with a cumulative value of 0.530742. The amount of industrial solid waste produced first increased and then decreased, and then increased again, with a cumulative value of 0.313362. This indicates that the economy has grown with the increase of industrial solid waste.

V. CONCLUSION AND RECOMMENDATION

This paper study the dynamic relationship between FDI, economic growth, and environmental pollution in the central China by using VAR model, and impulse response analysis from 1992 to 2017. Then conclusions and recommendations as follow:

1. The shock response trajectories of economic growth and FDI to environmental pollution indicators can be roughly divided into U-shaped (industrial waste gas) and inverted U-shaped (industrial solid waste production). The impact response trajectories of environmental pollution indicators on economic growth show N-shaped (industrial waste gas, industrial solid waste production), and the impact response trajectory of environmental pollution indicators on FDI show inverted U-shaped (industrial waste gas, industrial solid waste production). This shows that the relationship between economic, FDI and environmental evolution does not all conform to the inverted U-shaped curve, but different pollution indicators show different forms of the relationship between the economy, FDI and the environment.
2. FDI inflows and rapid economic growth will increase environmental pollution, and different environmental pollutants will also have different effects on FDI inflows and economic growth.Therefore, in the development process of the central region, the government should pay attention to industrial pollution, change the mode of economic growth, no longer drive economic growth at the expense of environmental resources, and further exert the positive effect of rapid economic growth on environmental pollution. When formulating corresponding environmental pollution control policies, the particularities of different pollutants and the differences in industrial development should be fully considered,so as to improve the effectiveness of environmental pollution control
3. Actively introduce high-quality foreign investment, raise the threshold for industry entry, and avoid foreign investment stimulus that only focuses on economic growth and disregards the ecological environment.At the same time, strengthen the industry-oriented function, guide FDI inflow to high-tech, low-energy, clean production industries through preferential policies, and avoid environmental costs caused by highly polluting resource-intensive industries.

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