ISSN: 2472-3703 DOI: 10.6911/WSRJ.202005_6(5).0008

The Study About the Effect of Environmental Regulation on Carbon Emission

Guanyu Chen[1, a]

[1]Faculty of Economics, Jinan University, Guangzhou, China.

[a]774320981@qq.com

Abstract

The global economy has developed rapidly since 21st century. However, due to the fact that more and more countries chose high-energy consumption economic pattern, the environment has gone worse and worse. As the biggest country in carbon emissions, China has marvellous pressure in reducing carbon emission and achieving low-carbon economy. How the Chinese government achieve sustainable and low-carbon development becomes one of most important studies in our country. The article will introduce environmental regulation, which is the way of solving problem about carbon emission. After that the article will take the relationship between environmental regulation and carbon emission as the empirical research object. Results show that environmental regulation can reduce carbon emission directly.

Keywords

Environmental regulation; Carbon emission intensity; Direct effect.

1. INTRODUCTION

Environmental regulation refers to regulatory measures taken by government aimed at achieving goals, such as protecting environment and reasonable allocation of resources. Recently, there are many researchers who focus on the relationship between environmental regulation and carbon emission. A heated debate concerning the direct effect of environmental regulation on carbon emission is arouse in academia.

On one hand, some scholars argue that environmental regulation is good for boosting carbon reduction. Sarah Najm (2019) [1] compared crude oil production of Saudi Arabia and America, and found that considered the difference of state system, environmental regulation might promote carbon reduction. Applying Granger causality test, Lee (2010) [2] found that environmental regulation is the one-way Granger reason of carbon emission. Yang (2018) [3], using the panel data from 2004 to 2015 in China, proved that there is the threshold effect of environmental regulation on carbon emission. Environmental regulation could inhibit carbon emission, but with the enhancement of regulation, this inhibition would gradually decrease. On the other hand, some experts hold an totally different view about the relationship between environmental regulation and carbon emission. Sinn (2008) [4] found that the implementation of environmental regulations may lead to green paradox. The definition of green paradox is that strict enforcement of environmental regulation not only fails to curb carbon emissions, but also promotes the increase of carbon emissions intensity, that is, "good intentions do not always bring good results." Sinn's dissertation concluded two reasons which cause green paradox. First, the government levied carbon taxes without considering adverse effect. Second, there is time lag between the promulgation and implementation of the policy. The research of Quentin Grafton (2012)[5] reinforces sinn's conclusion. Based on the 1995 American acid rain project,

ISSN: 2472-3703 DOI: 10.6911/WSRJ.202005_6(5).0008

Corrado Di Maria (2014)[6] verified the theory of green paradox through empirical research. By constructing a threshold panel model, Lan Hong (2019) [7] analyzed the threshold effect of environmental regulation on carbon emission. The result showed that there was a double threshold effect on the relationship between environmental regulation and carbon emission in China.

2. METHODOLOGY

2.1. Mechanism Analysis

Environmental regulation is one of the most important measure used by government to solve ecological problem and achieve the goal of energy conservation and emission reduction. There are two totally different views concerning the effect of environmental regulation on carbon emission. First, many people agree that environmental regulation can boost carbon emission reduction. In the past, to maximize their own benefit, many companies chose to pollute indiscriminately without considering the damage to environment. The government levied taxes and fees on polluting enterprises which used fossil fuels. This measure could effectively increase the cost of sewage discharge, reduce these companies' revenue from using fossil fuels, and internalize the negative externalities caused by polluting enterprises to the environment. Besides, the government could subsidize companies that use clean and renewable energy, which stimulate the heavy-polluting enterprises to using non-fossil energy instead of fossil fuels. These measure mentioned above can prove that environmental regulation can boost carbon emission reduction. However, those who support the theory of green paradox claim that due to the more stringent environmental regulations implemented by government in the future, the supplier of fossil energy expect that the cost of fossil fuel will become higher and higher. As a consequence, the supplier will accelerate the exploitation of fossil fuel, which causes the decrease of current fossil fuel price. Industrial enterprises will increase the purchase of fossil energy, which leads to the fact that the current carbon emission intensity will eventually increase.

2.2. Variable Selection and Sample Selection

(1) Explained variables. Carbon emission intensity (CEI)has been selected as indicator which can measure carbon emission. As we all known, the source of carbon emission includes coal, tar, kerosene, gasoline, diesel, natural gas, fuel oil and cement. Each energy resources has its individual coefficients. The coefficients are shown in Table 1.

Table 1. The carbon emission coefficients of different energy resources

	Coal	Tar	Kerosene	Gasoline	Diesel	Fuel oil	Natural gas	Cement
Coefficient (tc/tce)	0.7599	0.855	0.5714	0.5538	0.5921	0.6815	0.4483	0.527

Data source: the Guidelines for National Greenhouse Gas Inventories

Using the coefficients mentioned above, these energy resource consumption can be converted into carbon emission. The converted process is shown in Eq.(1):

$$CO2=\sum 44/12*\alpha i*Ei + Q*\beta \quad (1)$$

Where αi is the carbon emission coefficients of i-type energy resource(excluding cement).Ei means the quantity of i-type energy consumption (excluding cement) in different area. Q is the

ISSN: 2472-3703 DOI: 10.6911/WSRJ.202005_6(5).0008

quantity of cement in various regions and β is the carbon emission coefficients of cement.CO2 is the quantities of carbon emission in different area.

(2) Explanatory variables. Environmental regulation (ER)is the explanatory variable of the paper. The proportion of industrial polluting treatment investment to industrial added value is selected as an indicator to measure environmental regulation. There are many ways to measure environmental regulation in academia. Li (2017) divided environmental regulatory indicators into three categories: qualitative index, quantitative index and comprehensive index. Many scholars choose quantitative index as their research variable, including cost of polluting reduction, government environmental protection expenditure, investment in polluting treatment, sulfur dioxide removal rate, and sewage discharge compliance rate. Considering the indicator suitability and availability, the proportion of industrial polluting treatment investment to industrial added value will be selected as the indicator for environmental regulation measuring. The higher proportion of industrial polluting treatment investment to industrial added value means greater environmental regulation.

(3) Control variables. Energy consumption structure (ENER)is one of the most significant factors to measure carbon emission. Normally we choose the proportion of coal consumption to total energy consumption as the indicator for energy consumption measurement. The larger proportion of coal consumption to total energy consumption means higher carbon emission. Industrial structure (INDU), affecting carbon emission, is measured by the proportion of output value of secondary industry to GDP. The carbon dioxide emissions produced by the secondary industry are about seven times that of the tertiary industry. It's necessary to upgrade the industry and promote the reduction of carbon emission. Technological innovation (TECH) is direct and important factor which influences carbon emission deeply. As we all known, advanced green innovation and production equipment are beneficial for carbon emission reduction. Therefore, we try our best to improve green technology. The proportion of R & D expenditure to GDP is used to measure technology innovation. Foreign direct investment (FDI) is measured by the proportion of foreign direct investment to GDP. There are two different views about foreign direct investment. First, some people agree that FDI will boost carbon emission, which we call "pollution refuge effect". However, other people hold an opposite views. They agree that FDI can promote carbon emission reduction, which is "pollution halo effect". The impact of FDI on carbon emission remains a mystery. Besides, control variables include population and economic development. The former will be expressed by the total population of each region and the latter will be expressed by per capita GDP of each province.

2.3. Model Construction

The intensity of carbon emission is a dynamic data. Obviously, there is a time lag in China's carbon emission changes, which means the current carbon emission is not only affected by the current factors, but also by the carbon emission intensity of the previous period. In view of this, the lag term of the explanatory variable will be added in the econometric model to better control the lag effect of carbon emission. The econometric model is shown in Eq.(2):

$$C_{i,t} = \beta_0 + \beta_1 C_{i,t-1} + \beta_2 ER_{i,t} + \beta_3 ENER_{i,t} + \beta_4 INDU_{i,t} + \beta_5 TECH_{i,t} + \beta_6 FDI_{i,t} + \xi X_{i,t} + \varepsilon_{i,t} \quad (2)$$

Where C is the explained variable, which is expressed by CEI.X is the control variables excluding ENER, INDU, TECH and FDI.i is the time dimension and t is regional latitude. There is no doubt that $C_{i,t-1}$ means the carbon emission intensity of the previous period.β_i is regression coefficient excluding β0. ξ is the regression coefficient of control variable X.β0 is the intercept term. $E_{i,t}$ is the error term. Equation (2) is mainly used to verify the impact of environmental regulation on carbon emission.

ISSN: 2472-3703 DOI: 10.6911/WSRJ.202005_6(5).0008

2.4. Sources of Data and Descriptive Statistics

The panel data of thirty provinces (excluding Tibet) in China from 2007 to 2016 are used to analyze the impact of environmental regulation on carbon emission. What's more, the data of energy resources and energy consumption are from the 2007-2016 China Energy Statistical Yearbook, and other data including industrial polluting treatment investment, industrial added value, the output value of secondary industry, R & D expenditure, foreign direct investment, total population and GDP are from the 2007-2016 China Statistical Yearbook, the China Environmental Yearbook, the China Environmental Statistics Yearbook, the China Statistical Yearbook on Finance and the China Statistics Yearbook on Science and Technology. Besides, considering the influence of inflation, all price data in this paper will been processed.

STATA12.0 is used for regression analysis in this paper. And the descriptive statistics of variables are shown in Table 2.

Table 2. descriptive statistics of variables

variables	mean	Standard deviation	Minimum value	Maximum value
CEI	3.696	2.999	0.481	16.886
ER	3.88	3.335	0.359	28.039
GDP	3.435	1.895	0.755	10.101
POP	4467.49	2677.044	552	10999
ENER	95.498	38.179	12.175	199.17
INDU	0.602	0.137	0.23	0.979
TECH	11.007	6.071	0.367	25.888
FDI	0.524	0.674	0.079	6.526

Table 3. The regression results of environmental regulation on carbon emission

Variable	Regression coefficient
CEIt-1	0.538***
	(3.48)
ER	-0.0302*
	(-2.51)
lnPOP	0.369
	(0.32)
lnGDP	-0.797**
	(-2.86)
ENER	0.0151**
	(2.85)
INDU	1.548*
	(2.55)
TECH	0.0166
	(1.17)
FDI	-0.0331
	(-1.05)
Cons	-3.062
	(-0.33)
Observation	240
AR(2)	0.2578
Sargan test	0.1489

ISSN: 2472-3703 DOI: 10.6911/WSRJ.202005_6(5).0008

Note: *** ,** , and * indicate significance levels of 1%, 5%, and 10%.The Sargan test is the p-value of the Sargan statistic which tests for the existence of an over-identified instrument variable. If the p-value is greater than 0.1, the zero hypothesis of the validity of the instrument variable will not be rejected.

3. EMPIRICAL ANALYSIS

DIF-GMM is used to obtain the regression results of environmental regulation on carbon emission and it can effectively eliminate the endogenous and individual effects of the econometric model. The regression result is shown in Table 3. It can be known from Table 3 that the model has passed AR test and sargan test. The AR (2) results show that there are no hypotheses of second order sequence correlation for the error terms, which are estimated by the model. And the sargan test results show that the null hypothesis of the validity of the instrumental variables cannot be rejected. In a word, the model is reasonable and the empirical results are reliable.

Several relevant conclusions can be drawn from the empirical results of environmental regulation on carbon emission.

The current carbon emission intensity will be affected by the carbon emission intensity of the previous period, and there is a lag effect of the carbon emission intensity. The carbon emission intensity estimated coefficient of the lagging period is significant at the statistical level of 1%. When the carbon emission intensity of the previous period increases by 1 unit, the carbon emission intensity of the current period will increase by 0.538 units, which illustrates the cumulative effect of carbon emission intensity.

According to the empirical results, there is a negative correlation between environmental regulation and carbon emission. When the environmental regulation increases by 1 unit, the carbon emission intensity will decrease by 0.0302 units, which proves that environmental regulation can promote carbon emission reduction effectively.

The energy consumption structure is significant at the statistical level of 5%. And its regression coefficient is positive, which confirms that an increase in coal consumption will promote the increase of carbon emission. The industrial structure has a positive correlation with carbon emission intensity at a significant level of 10%, which means the current industrial structure in China is still unreasonable. Further efforts are needed to achieve the goal of advanced industrial structure. Technological innovation increase by 1 unit, and carbon emissions increase by 0.0166 units. However, the result is not significant. The regression coefficient of foreign direct investment is -0.0331. Although it's not significant, it still prove that foreign direct investment can promote carbon emission reduction.

4. CONCLUSIONS

The following conclusions have been obtained by studying the empirical results of the econometric model mentioned above. First, environmental regulation can effectively boost carbon emission reduction. There is no "green paradox". Second, the current energy consumption structure dominated by coal consumption and the current industrial structure mainly made up by secondary industry are obviously unreasonable in China. Third, in the field of scientific and technological innovation, China has not achieved the balance between economic development and ecological protection. Our country ignore the research and development of environmental-friendly and low-carbon technologies. Forth, foreign direct investment restrains the growth of carbon emissions. Foreign companies with advanced technologies can bring more advanced green production technologies and production equipment to the host country.

ISSN: 2472-3703 DOI: 10.6911/WSRJ.202005_6(5).0008

Based on the conclusions, this paper makes the following points: First, improving the intensity of environmental regulation and choosing appropriate environmental regulation tools. Second, it's necessary to establish a scientific government performance evaluation mechanism. Government should increase the performance weight of ecological protection, and reduce the performance weight of economic development. At present, in order to attract more foreign investment, many local governments are endlessly weakening environmental regulations and law enforcement, causing serious damage to the ecological environment. A good evaluation mechanism is good for guiding regional governments to attach importance to ecological protection. Third, adjusting the energy consumption structure. Government should shift from a high-carbonized energy consumption structure dominated by coal consumption to the energy consumption structure dominated by renewable energy such as wind energy, water energy and solar energy. Besides, government should improve the efficiency of energy use, especially the use of coal energy. Some technologies such as coal-burning catalytic combustion technology, coal washing technology, clean coal technology, and coal liquefaction technology are worth promoting and applying. Forth, accelerating the upgrading of industrial structure. A preferential policy for companies which actively implement carbon emission reduction should be adopted by government and the proportion of tertiary industries should be increased. Fifth, boosting enterprises' technologies and creativity. The government should guide enterprises to invest and innovate green technologies by adopting fiscal and tax policies. Domestic enterprises should strengthen their abilities to learn and imitate so that they can absorb foreign enterprises' experience and skills. Sixth, foreign companies should be supervised and regulated by our country. The government must strictly investigate the criminal responsibilities if these foreign companies violate environmental law and constitute illegal act.

This paper studies the impact of environmental regulation on carbon emission. However, considering the availability of data, we select the proportion of industrial polluting treatment investment to industrial added value as our indicator of environmental regulation, which doesn't reflect the overall situation of Chinese environmental regulations. Thus, we should try using other types of environmental regulation indicators in the future.

REFERENCES

[1] Sarah Najm,The green paradox and budgetary institutions, Energy Policy, Volume 133 (2019), 110846.

[2] Lee,The Empirical Analysis of Relationship between low-carbon economy and environmental regulation. Economic Research Guide,Vol.13(2010),163-165.

[3] Yang,The Research on the Threshold Effect of Environmental Regulation on Carbon Emissions based on Industrial Structure[J]. Finance Theory and Teaching,Vol.04(2018):94-96+99.

[4] Sinn H W,Public Policies Against Global Warming: A Supply Side Approach, International Tax Public Finance, Vol.15(2008): 360 — 394.

[5] R. Quentin Grafton,Tom Kompas, Ngo Van Long,Substitution between biofuels and fossil fuels: Is there a green paradox?,Journal of Environmental Economics and Management,Volume 64(2012), Issue 3,Pages 328-341.

[6] Corrado Di Maria,Ian Lange, Edwin van der Werf,Should we be worried about the green paradox? Announcement effects of the Acid Rain Program,European Economic Review,Volume 69(2014),Pages 143-162.

[7] Lan,The Study on Regional Carbon Emission Performance and Threshold Effect of Environmental Regulation under Green Development——Based on SE-SBM and Double Threshold Panel. Soft Science,Vol.33(2019)No.08,73-77+97.