Research on the Impact of Environmental Regulation on the Level of Urban Innovation ——Based on Dynamic GMM Regression

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Abstract—As environmental protection and innovation are the basis and motivation of high-quality development, how to improve environmental quality and innovation level has attracted wide attention from the society. To further explore the relationship between environmental regulation and innovation, this paper selects the Yangtze River Delta urban agglomeration, which is one of China's innovative urban agglomerations, as the research object, and constructs a comprehensive index for three pollutant emissions of wastewater, sulfur dioxide and smoke. Taking into account the lag of the city's innovation, this paper uses the one-period lagging dynamic generalized method of moments (GMM) to solve the endogenous problem. The empirical results show that there is a significant positive lag effect in the level of urban innovation, and the impact of environmental regulations on the level of urban innovation is inconsistent. At the same time, a good innovation environment and extra fixed asset investment will play a very significant positive role in promoting urban innovation.

Keywords- environmental regulation; urban innovation; GMM regression

1 INTRODUCTION

Since the reform and opening up, China's economy has developed. The ensuing environmental problems are becoming more serious and are restricting the sustainability of economic development. The investment-based development model with high energy consumption and high pollution is in urgent need of transformation. The report of the 19th National Congress of the Communist Party of China stated that “stop and punish behaviors that damage the ecological environment” and advocate a new concept of green development. At present, China is in a critical stage of turning to high-quality development, and the new development concept provides the right direction for China's economic development. Innovation, as a powerful driving force leading the country's development, is an important factor in improving economic quality. How to further stimulate the driving force of innovation on the basis of protecting the ecological environment is of great significance for China to build a strong modern socialist country.

Environmental regulation is a policy measure for the government to reduce energy consumption and pollution emissions to protect the environment through compulsory means [1]. At present, there are three main viewpoints about the research on environmental regulation and innovation ability. The first view is that when local governments adopt certain environmental regulations, which will increase the pollution cost of enterprises, and some enterprises will move out to

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other places, thus reducing the gathering and exchange of knowledge, and has a negative impact on innovation ability. So, environmental regulation has an extrusion effect on innovation [2]. The second view is that environmental regulation puts forward new requirements for the production of enterprises, forcing enterprises to increase investment in green technology research and development, which is conducive to the improvement of the innovation capability of the locality [3]. Reasonable environmental regulation can produce an innovation compensation effect [4], so the innovation effect of regulation is the key to achieve win-win economic development and environmental protection. The third view is that the relationship between environmental regulation and innovation is dynamic and non-linear, and environmental regulation policies will have an inverted U-shaped effect on local green innovation capabilities [5].

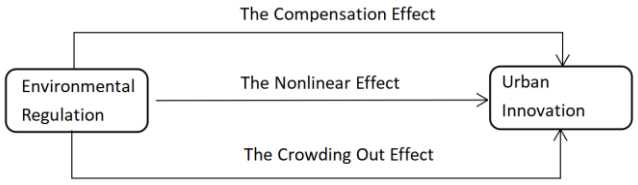

Figure 1. Influence of environmental regulation on urban innovation

Through combing the literature, we can find that different types of environmental regulation have different impacts on technological innovation [6] [7] [8]. Environmental regulation will have different effects on the level of technological innovation due to the different nature of their regions, industries and property rights [9]. At present, most of the research focuses on the interprovincial level, and the selection of relevant indicators has a certain one-sided nature. So, this paper will take 26 cities in the Yangtze River Delta to explore the impact of environmental regulation on urban innovation. As an important intersection area of "Belt and Road" and the Yangtze River Economic Belt, the development of the Yangtze River Delta urban agglomeration is of great reference significance for the construction of China's urban agglomeration.

2 MODEL SETTING AND VARIABLE DESCRIPTION

2.1 Specification of the Model

Because the innovation has a certain lag, the current innovation ability will have a certain impact on the future innovation activities. This paper will construct a dynamic panel regression model with a one-period lag. As the following formula (1):

$$\text{Innovation}_{i,t} = \alpha + \alpha_1 \text{Innovation}_{i,t-1} + \beta_1 \text{ER}_{i,t} + \beta_2 \text{X}_{i,t} \quad (1)$$

In formula (1), ER represents environmental regulation, Innovation represents urban innovation and development index, X represents other variables, including economic development level, human capital, innovation environment, fixed asset investment, degree of marketization, i represents city and t represents time.

About the measurement of environmental regulations, this paper chooses the comprehensive index of wastewater, sulfur dioxide and smoke dust as the proxy variable. The higher the comprehensive index of pollutants, the more serious environmental pollution, the stricter environmental regulations are needed. Drawing on the method of Ye Qin (2018), the index calculation method is as follows:

First, standardize the unit pollutant discharge of each city (formula 2):

$$UE'_{ij,t_{ij,t}} = \frac{UE_{ij,t} - \min(UE_{ij,t})}{\max(UE_{ij,t}) - \min(UE_{ij,t})} \quad (2)$$

Then, use the weighing coefficient w, the proportion of j pollutants in i cities accounts for all urban j pollutants, to roughly reflect the difference in pollutant characteristics (formula 3):

$$W_{ij,t} = UE_{ij,t} / \sum_{i=1}^{26} UE_{ij,t} \quad (3)$$

Finally, calculate i city's the comprehensive index of pollutant emissions (formula 4):

$$ER_{i,t} = \sum_{j=1}^{3} W_{ij,t} UE'_{ij,t} \quad (4)$$

In formula (2) (3) (4), UE represents contaminant, UE′ represents pollutants after linear normalization, ER represents the pollutant comprehensive index; i represents city, j represents pollutant type, and t represents time.

2.2 Variable description

The datas in this paper are obtained from *China Urban and Industrial Innovation Report*, EPS database and *the China City Statistical Yearbooks*. The descriptions of the individual variables are shown in the Table 1 below. From the standard deviation, maximum value and minimum value, we can know that the economic development level of the Yangtze River Delta urban agglomeration is balanced, but there are significant differences in the urban innovation level. Different cities have a large gap in human capital investment.

Table 1 Descriptive statistics of the main variables

Variable	illustration	type	observed	mean	st	min	max
Innovation	Urban innovation	explained variable	338	20.802	55.132	0.005	541.332
ER	Environmental regulation	Core explanatory variables	338	0.102	0.125	0	1.175
P_gdp	The level of economic development	Other explanatory variables	338	0.549	1.000	0	2.396
P_cap	human capital		338	21.337	45.810	0.002	401.805
I_environment	Innovation environment		338	0.990	0.942	0.029	5.543
F_invest	investment in the fixed		338	0.995	0.911	0.0216	4.017

	assets					
Market	The degree of marketization	338	0.765	0.296	0	2.160

3 EMPIRICAL ANALYSIS

First, this paper uses Hausman method to test the endogeneity of the variables, and the results are as followed the Table 2. (1) is the fixed effect endogenous test, and (2) is the random effect endogenous test. The results showed that environmental regulation, population number and human capital are all somewhat endogenous. Thus, to eliminate the autocorrelation between variables, this paper will use the GMM method.

Through the (1) (2) in the Table 3, we can know that there is a significant lag in urban innovation, and the current innovation level will have a significant positive effect on the next period; there is also a significant positive relationship between environmental regulation and innovation. There is also a significant positive relationship between environmental regulation and innovation. By gradually introducing relevant explanatory variables, the impact of environmental regulation on urban innovation becomes negative, while the level of urban innovation always has an obvious positive lag. This shows that the impact of environmental regulation on innovation is not consistent. Different urban development levels and the level of innovation accumulated in the previous period will affect the relationship between environmental regulation and urban innovation.

At the end, according to (9) in the Table 3 by introducing all variables, the result shows that both the innovation environment and fixed asset investment have a positive impact on urban innovation, but the environmental regulation, per capita gdp, population, human capital and the degree of marketization have no significant impact on the level of urban innovation. This shows that a good innovation environment is an important basis for improving the urban innovation level. Once the city's innovation capacity rises, the corresponding economic development level will also be improved, so as to improve the per capita gdp.

In recent years, with the rapid development of the Yangtze River Delta urban agglomeration, more and more people choose the Yangtze River Delta urban agglomeration to find jobs, etc. The corresponding population and human capital investment are increasing, but this increase requires an effective transformation method that can Better improve the level of urban innovation. At the same time, although the Yangtze River Delta urban agglomeration has a high degree of marketization, it is mostly small and medium-sized enterprises that are attached to large enterprises, lacking innovation and motivation to a certain extent.

Table 2 The hausman test

VARIABLES	(1) innovation	(2) innovation
er	-13.10	-11.01
	(11.53)	(11.19)
p_gdp	-50.30***	-55.83***
	(5.185)	(5.362)

peo	10.83	5.954
	(8.863)	(25.42)
h_cap	0.00554	0.00591
	(0.0353)	(0.0344)
i_environment	-21.90***	-26.00***
	(2.955)	(3.063)
f_invest	68.92***	71.75***
	(3.826)	(4.164)
market	-11.99*	-12.07**
	(6.130)	(6.062)
Constant	23.63**	35.15
	(10.60)	(24.40)

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 3 Gmm regression results

VARIABLES	(1) innovation	(2) innovation	(3) innovation	(4) innovation	(5) innovation	(6) innovation	(7) innovation	(8) innovation	(9) innovation
L.innovation	1.263***		1.259***	1.246***	1.245***	1.243***	1.247***	1.223***	1.222***
	(0.0191)		(0.0180)	(0.0124)	(0.0175)	(0.0186)	(0.0183)	(0.0114)	(0.0111)
er		77.05***	4.664***	-2.221**	-2.317	-2.223	-1.756	-1.540	-0.975
		(26.05)	(1.530)	(0.904)	(1.531)	(1.469)	(1.287)	(0.961)	(0.786)
p_gdp				1.849***	1.787***	1.714**	1.748**	0.254	0.514
				(0.475)	(0.619)	(0.672)	(0.683)	(0.378)	(0.552)
peo					0.104	0.286	-1.233	-2.008*	-1.589
					(0.797)	(0.875)	(1.230)	(1.129)	(1.011)
h_cap						-0.00606	-0.00153	0.00320	0.00387
						(0.00463)	(0.00330)	(0.00457)	(0.00357)
i_environment							1.183**	0.905***	0.976**
							(0.477)	(0.318)	(0.382)
f_invest								2.605***	2.351***
								(0.547)	(0.624)
market									-0.723
									(0.673)
Observations	338	364	338	338	338	338	338	338	338
Number of City	26	26	26	26	26	26	26	26	26

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

4 CONCLUSIONS AND INSPIRATION

Environmental protection and innovation, as the basis and driving force of high-quality development, have attracted wide attention from the society. The research on the impact of environmental regulation on enterprise technological innovation, green production factors and the number of patents has gradually increased, but most of them focus on enterprises and industries or at the provincial level, and the conclusions obtained are not the same. To further explore the relationship between environmental regulation and city innovation, This paper selects the Yangtze River Delta urban agglomeration as a sample, and conducts a dynamic GMM regression analysis. The results show that there is a significant positive lag effect, while the influence of environmental regulation on the urban innovation level is inconsistent. At the same time, a good innovation environment and extra fixed asset investment will play a very significant positive role in promoting urban innovation.

Based on the above research conclusions, this paper puts forward the following suggestions: First, continue to promote the innovative development strategy of the Yangtze River Delta urban agglomeration is critical. Innovation is the first driving force for development, and the improvement of urban innovation level will help to transform the economic structure and achieve high-quality development. Realize the continuous positive impact of innovation through innovation incentives and policy support. Second, The government should plan appropriate environmental regulations and some other ways. The government of the Yangtze River Delta urban agglomeration and environmental management departments should consider the influence of other factors to promote the innovation initiative of the actors, so on improve the level of urban innovation. Third, improve infrastructure construction and strive to build a good environment for innovation. By attracting elite talents and enterprises, convenient communication and high-level demand will further promote innovation.

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