An empirical study on the impact of economic Agglomeration on environmental pollution

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Abstract. In the context of China's vigorous promotion of economic transformation to the green economy, economic agglomeration is one of the main economic activities that promote economic development, it is necessary to study the impact of economic agglomeration on the environment. In this paper, we used the spatial adjacent weight matrix SDM econometric model for empirical analysis. The study found that the regression coefficient of economic agglomeration is a positive significant level of 1%, that is, there is a positive correlation between economic agglomeration and environmental pollution. As the level of economic agglomeration increases, so does the pollution effect.

1. Introduction

From the regional economic school to the new economic geography school, the external scale economic effect and spillover effect of economic agglomeration have been widely and profoundly demonstrated. With its unique advantages, the spillover of technological innovation, the sharing of infrastructure and the reduction of logistics and transportation costs, economic agglomeration has greatly reduced the production costs of manufacturers in the agglomeration area, and promoted the technological innovation and production efficiency of manufacturers. At the same time of high-speed economic growth brought by economic aggregation, what price did we pay? Since the reform and opening up, China's economic development has made remarkable achievements. In just a few decades, China has completed the development process of "one hundred year development"in other countries, and economic agglomeration areas such as industrial parks have also emerged on a large scale in many places. But on the other hand,with the rapid development， It is the rapid depletion of natural resources, the sharp decline of air quality, and the irreversible damage to the environment caused by industrial waste water and exhaust gas. Since the 18th National Congress of the Communist Party of China, China's economic development has ushered in a new topic-----high-quality development replacing high-speed development has become the most urgent theme of the current economic development. The content of high-quality development covers all aspects. Among them, environmental pollution is the most closely related and most concerned important indicator to measure high-quality economic development. In this paper, the most common and prominent phenomenon in economic activities-----Industrial Agglomeration as a starting point, to study the impact of industrial agglomeration on environmental pollution and the mechanism of its impact. Without doubt,It is of theoretical and practical significance to study these problems for the sound and rapid development and transformation of China's economy in the new era.

2. Domestic and foreign literature reviews

Economic agglomeration, with its unique advantages, has become an important choice for economic development, but also a hot topic for academic discussion and Research. Many scholars at home and abroad have studied the impact of economic agglomeration on environmental pollution, and achieved fruitful results. On this issue, some scholars think that economic agglomeration has a negative relationship with environmental pollution, which is the same as the expansion of production scale. for example, Zhang Ke and Dou Jianmin (2013) found that if the output efficiency brought by agglomeration is only to expand the output scale and reduce the cost rather than optimize the environmental performance of the product, it will aggravate the environmental pollution. Zhang Ke and Wang Dongfang (2014) obtained the two-way effect of between economic agglomeration and environmental pollution through the simultaneous equation model. While economic agglomeration aggravates environmental pollution, environmental pollution also inhibits economic agglomeration .

Another part of scholars think that the expansion of industrial agglomeration scale improves the ecological environment of agglomeration area. for example, Zhu Yingming, Peiyu and Ying Hengfei (2019) use the generalized moment model and threshold regression method to verify that with the improvement of industrial agglomeration level, the pollution emission shows a marginal decline phenomenon, and the marginal pollution of industrial agglomeration emission decline law leads to the environmental pollution mitigation effect of industrial agglomeration. Pei Yu（2019) combine Copeland -Taylor model idea with spatial Doberman model, construct Copeland Taylor spatial model, and demonstrate the improvement effect of industrial specialization agglomeration and industrial diversification agglomeration on environment from two aspects of direct environmental pollution effect and indirect environmental pollution effect. Some scholars also think that the mechanism of economic agglomeration on environmental pollution is complex, and its impact is difficult to determine or generalize. for example, Menglu Xie and Yingming Zhu (2019) adopted the STIRPAT model and found that there was an inverse N between industrial agglomeration and environmental pollution When the level of industrial agglomeration is lower than a certain value, the environmental pollution decreases with the increase of the level of industrial agglomeration; when it is between two values, the environmental pollution increases with the increase of the level of industrial agglomeration. Lu Fengzhi and Yang haochang (2020) adopted two-way fixed effect and spatial panel Doberman measurement methods, and considered that there was a stable inverted U-shaped relationship between agglomeration and environmental pollution. In this paper, SDM model is used to analyze the pollution level of economic agglomeration from direct connection effect and indirect effect.

3. Theoretical mechanism and research hypothesis

The impact of economic agglomeration on environmental pollution is complex, among which the most important way of positive impact is the expansion of production scale. Whether it is the expansion of production scale due to the pursuit of scale effect by agglomeration enterprises or the increase of production efficiency due to the spillover of innovative technology in the economic agglomeration, the expansion of production scale is under the condition that the environmental protection process of product production has not been improved.

Will bring a lot of pollution emissions. Scientific and technological innovation is also one of the factors that affect the effect of agglomeration on the environment. To some extent, the level of scientific and technological innovation in an economic agglomeration reflects the industrial structure of the region. For regions with low level of scientific and technological innovation, the agglomeration industries are mostly labor-intensive Industry.this kind of industry is characterized by low efficiency of resource utilization, backward industrial environmental protection technology, large environmental pollution effect and low spillover of clean technology, while the economic agglomeration area with high level of scientific and technological innovation is the opposite. In addition, the level of regional development and policies and regulations are also important influence mechanisms. There are some underdeveloped economic areas that are eager to develop. In order to speed up the establishment of economic agglomeration areas to attract manufacturers to settle down and accelerate the development of regional economy, and to reduce the environmental protection standards for enterprises settled in, there are more vicious competitions among regions for enterprises settled in order to reduce the

standard, It makes the monitoring mechanism of environmental protection virtual, and the vicious competition aggravates the damage of regional natural resources.thus hypothesis 1 is proposed.

Hypothesis 1: in general, economic agglomeration has a positive impact on environmental pollution.

The negative effect of economic agglomeration on environmental pollution is mainly reflected in the spillover of clean technology and the sharing of infrastructure. Industrial agglomeration also facilitates the centralized treatment of waste water and exhaust gas, reduces the cost of enterprise environmental protection and facilitates the unified monitoring and strict management of government departments. The highly competitive economic agglomeration area promotes enterprises to speed up technological innovation and develop more environmentally friendly and competitive products or cleaner and efficient production mode. Therefore, hypothesis 2 is proposed.

Hypothesis 2: in general, economic agglomeration has a negative impact on environmental pollution.

4. Empirical research

4.1 variable explanation and data source

In this paper，we select the data of 31 provincial administrative regions in China from 2009 to 2018 as samples, and the data are all from China Statistical Yearbook and China urban statistical yearbook. Because there is no unified indicator for environmental pollution, the availability and representativeness of comprehensive data, we uses the per capita sulfur dioxide emissions of major urban industrial enterprises as the explanatory variable to show the level of environmental pollution in each prefecture level city. The core explanatory variable is the aggregation of economic sets. The indicators of describing economic agglomeration include Gini index, total economic output per unit area, etc. in this paper ,we select location by reference Entropy, as an index to evaluate economic agglomeration, is calculated as follows:

$$\mathrm{LQ_{ij}} = \frac{\frac{q_{ij}}{q_j}}{\frac{q_i}{q}}$$

In this formula, q_{ij} represents Output value of manufacturing industry i in region j; q_j represents output value of all industries in the region j; q represents output value of all industries in the whole country.

The higher the value of location entropy is,the higher the level of the regional manufacturing agglomeration is.

The location entropy method of manufacturing industry is simple and easy to use, which can reflect the concentration level of industry at the regional level to a certain extent. for other explanatory variables, the number of patent applications and authorizations of the province in that year is taken as the indicator of scientific and technological innovation; the proportion of total import and export trade to GDP is taken as the indicator of foreign trade openness; the proportion of urban population is taken as the indicator of urbanization process; and the labor force level is taken as the indicator of per capita education years. The descriptive statistics of variables are shown in table 1:

Table 1. The descriptive statistics of variables

Variable		Mean	Std. Dev.	Min	Max
SO_2	overall	59.50355	40.86209	0.2	182.74
	between		36.82242	0.4122222	148.2078
	within		18.78399	-18.94201	99.26688
Years of education per capita	overall	8.844953	1.164107	4.222	12.502
	between		1.119576	4.946111	11.81578
	within		0.371167	7.909287	9.531175
Total regional import and export	overall	1.20E+07	2.04E+07	40210	1.09E+07
	between		2.01E+07	118773.1	9.38E+07
	within		4684058	-2.07E+07	5.66E+07
Proportion of urban population in the region	overall	54.3662	13.82323	22.3	89.6
	between		13.61699	25.34222	88.76667
	within		3.315914	45.91287	62.04287
Number of regional patent applications	overall	68493.42	102589.9	162	627834
	between		93120.23	373.222	401423.8
	within		45856.72	-158601.4	392279.7
Regional GDP	overall	19960.61	16703.74	441.36	89705.23
	between		15723.85	831.2111	63270.13
	within		6236.219	-5278.461	46395.71
Location entropy	overall	1.047442	0.181068	0.469136	1.302273
	between		0.173945	0.4959666	1.217412
	within		0.583052	0.7788356	1.233258

4.2 Selection of regression model

First, by calculating the regression equation of fixed effect panel data model, we found that the F-statistic for the combined parameter test was 58.55, and the p-value was 0.0000, which means that the parameter was significant as a whole,F statistic for whether fixed effect is significant is 42.20 and P value is 0.0000.

In this paper, so,we use fixed effect model instead of OLS mixed model.

Secondly, the Hausman test is used to compare the fixed effect model with the random effect model assuming that the individual effect is not related to the explanatory variables, and the result usually is used to reject the original hypothesis. Therefore, SDM model with fixed effect should be used. In order to estimate accurately, the spatial random effect model is calculated as a comparison, and the estimation results are shown in Table 2.

Table 2. Estimation results of spatial Doberman model

Spatial Fixed Effects				Spatial Random Effects			
Variable	C	z	P	variable	C	z	P
Education years of human settlements:	6.310106	2.05	0.041**	Education years of human settlements:	7.847542	2.63	0.008***
Total import and export volume of the region	1.62E-07	1.13	0.259	total import and export volume of the region	2.45E-07	1.68	0.093*
Proportion of urban population of the region	-1.204826	-2.51	0.012**	proportion of urban population of the region	-1.226117	-3.07	0.002***
Number of patent applications of the region	-4.48E-06	-0.17	0.866	number of patent applications of the region	-3.04E-05	-1.07	0.283
Regional gdp	-0.001036	-3.82	0.000***	regional GDP	-0.000612	-2.09	0.037**
Regional entropy	3.00E+01	2.90	0.004***	regional entropy	33.87736	3.19	0.001***
				The constant terms	-25.14684	-0.91	0.363

Note: *, * *, ***, represent significant at the level of 10%, 5%, and 1%, respectively.

4.3. Empirical result analysis based on SDM model

In this paper, SDM model based on spatial adjacent weight matrix is used , the regression coefficient of per capita education years in Table 2 is positive, which is significant at the level of 5% and 1%, that is, the regional per capita education years are positively correlated with environmental pollution; the regression coefficient of urban population proportion is negative, which is significant at the level of 5% and 1%, which is negatively correlated with pollution effect; the regression coefficient of regional GDP is negative, which is significant at the level of 1%, 5%, negative correlation with pollution effect; location entropy regression coefficient is positive, significant level is 1%, positive correlation with pollution effect; regional patent applications authorization number regression coefficient is negative, not significant, which may be Because the level of scientific and technological innovation in China is still in short supply. Utility models account for the majority of patent applications, while invention patents are less. On the other hand,may be because most of the current scientific and technological innovation is centered on improving the industrial production efficiency, while is not concerned about the environmental improvement and upgrading of products or production processes. The return coefficient of regional total import and export is positive, not significant, that is, the promotion effect of Regional Opening-up on pollution is not significant. This may be because other countries are closed to their own core technologies and scientific and technological innovations, and refuse to introduce their own technological achievements of high-tech innovation, which makes it difficult for regions to introduce green science and technology to upgrade their industrial production processes, and sometimes can only undertake the backward production capacity eliminated by developing countries. Since the reform and opening-up, China's economy has been developing rapidly, and the ability of independent innovation has been improving year by year. It has long been unnecessary to undertake the production capacity eliminated from developed countries by which leads to the fact that the enhancement of the opening-up level no longer significantly promotes the pollution effect.

4.4 Direct effect and indirect effect analysis

The direct effect and indirect effect of SDM model under spatial random effect and spatial fixed effect are calculated respectively, as shown in Table 3.

When a variable of a region changes. The direct effect is the effect on other variables in the region when one variable changes. Indirect effect refers to the influence on the surrounding area

The SDM model of two effects shows that the correlation coefficient of pollution is significantly positive, that is, there is a positive correlation effect between the regional pollution level and the pollution level of the surrounding areas , and the two values are often similar.

Next, the total effect of solution explanatory variable on the explanatory variable is divided into indirect effect and direct effect.

In Table 3, we can find that no matter in SDM model of spatial fixed effect or spatial random effect, the years of education per capita in the region, the proportion of urban population in the region, and the regional GDP and location entropy are significant. In the two effects, the regression coefficient of location entropy is positive and significant at the level of 1%, indicating that economic agglomeration has a positive effect on environmental pollution to a certain extent, and environmental pollution increases with the improvement of agglomeration level, agglomeration improves production efficiency and also aggravates the environmental pollution to agglomeration area.

The regression coefficient of urban population proportion is significantly negative at the level of 1%, and the regression coefficient of regional GDP is also significantly negative at the level of 1% and 5% , respectively. Both explanatory variables reflect the level of urban economic development. The lower the proportion of urban population is, the lower the GDP of the area is, the lower the level of economic agglomeration is, which further shows that the gathering of economic agglomeration has a positive correlation with environmental pollution.

Table 3. The direct effect and indirect effect and total effect of SDM model

SDM model direct, indirect and total effect analysis results							
Spatial Fixed Effect				Spatial Random Effect			
Direct Effect							
variable	C	z	P	variable	C	z	P
resident education years	7.209072	2.29	0.022**	resident education years	8.538386	2.84	0.004***
total import and export volume	1.44E-07	1.02	0.306	total import and export volume	2.49E-07	1.68	0.092*
proportion of urban population of the region	-1.306807	-3.01	0.003***	proportion of urban population of the region	-1.342803	-3.62	0.000***
number of patent applications of the region	-3.83E-06	-0.14	0.890	number of patent applications of the region	-0.0000308	-1.05	0.294
regional GDP	-0.0010615	-4.02	0.000***	regional GDP	-0.0006458	-2.27	0.023**
location entropy	3.86E+01	3.49	0.000***	location entropy	42.74285	3.83	0.000***
Indirect Effect							
variable	C	z	P	variable	C	z	P
resident education years	10.01282	1.40	0.162	resident education years	7.425426	1.14	0.253
total import and export volume	-9.20E-08	-0.14	0.886	total import and export volume	1.34E-07	0.21	0.833
proportion of urban population of the region	-1.881544	-1.79	0.074*	proportion of urban population of the region	-1.906364	-1.91	0.056*
number of patent applications of the region	5.31E-06	0.06	0.952	number of patent applications of the region	-6.45E-06	-0.07	0.945
regional GDP	-0.0003196	-0.37	0.712	regional GDP	-0.000455	-0.52	0.604
location entropy	1.06E+02	2.84	0.005***	location entropy	108.0109	3.18	0.001***
total effect							
variable	C	z	P	variable	C	z	P
resident education years	17.22189	2.16	0.031**	resident education years	15.96381	2.26	0.024**
total import and export volume	5.57E-08	0.08	0.936	total import and export volume	3.83E-07	0.55	0.582
proportion of urban population of the region	-3.177351	-3.06	0.002***	proportion of urban population of the region	-3.249167	-3.21	0.001***
number of patent applications of the region	1.48E-06	0.01	0.988	number of patent applications of the region	-0.0000372	-0.35	0.723
regional GDP	-0.0013811	-1.47	0.143	regional GDP	-0.0011008	-1.16	0.245
location entropy	144.9379	3.30	0.001***	location entropy	150.7537	3.79	0.000***

Note: *, * *, ***, represent significant at the level of 10%, 5%, and 1%, respectively.

The number of years of education per capita represents the level of labor force, and the coefficient is significant at the level of 5% and 1%. The level of labor force is closely related to the industrial structure of the land, which is determined by the characteristics of different industries. The traditional labor-intensive industries or sunset industries have low requirements for the level of labor force, in the high-tech industries characterized by technology intensive. Therefore, it can be concluded that the industrial structure of agglomeration is one of the factors affecting the level of pollution

In addition, the total import and export volume of the region and the number of patent application authorization of the region are not significant

According to the indirect effect calculated in Table 3, it is found that the regional entropy in the two spatial effect models is significantly positive at the level of 1%, that is, the level of industrial agglomeration in the region is positively related to the pollution effect in the surrounding areas. From the above direct effect analysis, we can draw the conclusion that the improvement of industrial agglomeration level and the expansion of production scale brought by industrial agglomeration will increase the pollution effect of the region. In many cases, the pollution produced by the region is not

limited to the region. On the one hand, the flow direction of waste water and waste gas pollution is difficult to be controlled. the economic development has never been isolated, and its development effect will have a radiation like impact on the surrounding areas. For example, as the world's fastest-growing large-scale economy, China's development achievements will benefit the neighboring areas and more people through trade exchanges. In the same way, a city with a high level of economic development agglomeration will promote the surrounding areas to improve the level of economic agglomeration and promote the economic development, which will further cause the improvement of pollution level in the surrounding areas. The regression coefficient of regional urban population level is negative, and the level of 10% is significant in both spatial effect models, which is lower than that of direct effect and total effect. The proportion of urban population in the area represents the urbanization level of the area, and the pollution level of surrounding area decreases with the increase of urbanization level. This reflects the improvement of the infrastructure related to pollution control in the process of regional urbanization. And with the increase of urban residents, the most concerned problem is no longer the level of regional development, but the level of air quality, pollution and other issues related to the quality of life of residents. The environmental monitoring, prevention and treatment system is more perfect, effectively reducing the environmental damage caused by waste water and exhaust gas, thus reducing the spillover of regional pollution effect to adjacent areas effect. The years of education per capita and the GDP of regions are significant in the direct effect, but not in the indirect effect. The total import and export volume of regions and the number of patent applications and authorizations of regions are not significant.

5. Conclusion and suggestion

Based on the above studies, we can find that the economic agglomeration causes the damage of the ecological environment in the region, and the pollution effect increases with the increase of the level of economic agglomeration, and the indirect effect on the pollution of the surrounding areas, and the impact of economic agglomeration on the region and the surrounding areas environmental pollution is extremely significant, the level and capacity of labor force only have a positive correlation with the pollution of the region, but no indirect effect on the surrounding areas; the proportion of urban population in the region has a positive correlation with the pollution of the region and the surrounding areas.

Compared with the surrounding areas, the correlation is more significant; the total regional production has a significant negative correlation to the pollution of the region area, but not to the surrounding areas.

China is in a critical period of economic transformation from high-speed development to high-quality development. The "green mountain and green water is the golden mountain and silver mountain" and "supply side reform" all reflect the determination of China's economic transformation. In this paper, several suggestions are put forward:

(1)The government should pay attention to the independent innovation of domestic invention, especially the Production technology is a clean, improved and innovative scientific and technological innovation project, which promotes the upgrading of industrial production process.

(2)The government should strictly enforce the environmental protection,monitoring standards, and punish unqualified enterprises by publicity, rectification and banning.

(3)We will improve the environmental monitoring mechanism and urban pollution treatment infrastructure, establish a set of effective pollution treatment mechanism

(4)We should increase support for high-tech industries and promising high-quality sunrise industries, and gradually upgrade or eliminate backward production capacity.

References

[1]Ma Qi: Quantitative analysis of spatial agglomeration of e-commerce industry [J]. Business economic research, 2019 (24): 81 -83;

[2] Zhu Wentao, LV Chengrui, Gu Naihua. Research on the impact of OFDI and reverse technology spillover on green total factor productivity[J]. China's population, resources and environment, 2019,29 (09): 63-73;

[3] Su Qin, Meng Nana. How does local government intervention affect regional financial inclusion? -- Spatial econometric analysis based on Provincial Panel Data[J]. International financial research, 2019 (08): 14-24;
[4] Wan Li-juan, Liu Min, Yin Xiguo. Fiscal decentralization, economic agglomeration and environmental pollution: An Empirical Study Based on Provincial Panel number[J]. Journal of Chongqing University (SOCIAL SCIENCE EDITION): 1-11 [2020-03-04];
[5] Xu -Rui. The impact of industrial agglomeration on urban environmental pollution [J]. Urban issues, 2019 (11): 52-58;
[6] Lu Xing. Study on the influence mechanism of industrial agglomeration heterogeneity on economic growth [D]. Jiangxi University of Finance and Economics, 2019;
[7] Lu Fengzhi, Yang haochang. Industrial collaborative agglomeration and environmental pollution control: power or resistance [J]. Journal of Guangdong University of Finance and economics, 2020 (01): 16-29;
[8] Zhang Ke, Dou Jianmin A study on the mechanism of agglomeration on environmental pollution [J]. China Population Science, 2013 (05): 105-116 + 128;
[9] Zhang Ke, Wang Dongfang. The interaction between economic agglomeration and environmental pollution and spatial spillover [J]. China Industrial Economics economy, 2014 (06): 70-82.