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FACTORS INFLUENCING THE GEOGRAPHICAL DISTRIBUTION OF POLLUTION INTENSIVE INDUSTRIES

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Abstract

The paper has verified the hypotheses and theories about the location selection of pollution-intensive industries from various perspectives and explored possible factors influencing the geographical distribution of pollution-intensive industries. Based on the pollution intensity index of each industry, we firstly identified the pollution-intensive industries in China. And the geographical distribution of intensive industries is analysed in terms of the proportion of industry, the industry output value and the number of enterprises. With the regression analysis, the factor endowment, environmental regulation and globalization are proven factors influencing the geographical distribution of pollution-intensive industries.

Keywords: pollution-intensive industries, geographical distribution, pollution intensity index, environmental regulation, globalization.

ФАКТОРЫ, ВЛИЯЮЩИЕ НА ГЕОГРАФИЧЕСКОЕ РАСПРЕДЕЛЕНИЕ ЗАГРЯЗНЯЮЩИХ ПРОМЫШЛЕННОСТЕЙ

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Реферат

В статье проверены гипотезы и теории о выборе местоположения загрязняющих отраслей с различных точек зрения и исследованы возможные факторы, влияющие на географическое распределение загрязняющих отраслей. Основываясь на индексе интенсивности загрязнения каждой отрасли, мы сначала определили отрасли, интенсивно загрязняющие окружающую среду в Китае. Географическое распределение интенсивно загрязняющих отраслей проанализировано с точки зрения доли промышленности, стоимости выпуска продукции отрасли и количества предприятий. Регрессионный анализ показал, что обеспеченность факторами производства, экологическое регулирование и глобализация являются факторами, влияющими на географическое распределение загрязняющих производств.

Ключевые слова: загрязняющие отрасли, географическое распределение, индекс интенсивности загрязнения, экологическое регулирование, глобализация.

Introduction

The other side of rapid economic development is usually resource exhaustion caused by excessive consumption and environmental disruption due to pollution. The tradeoff between economic development and ecological security is a hard one that cannot be avoided in all countries. There has been an evolution from resource-consuming to productivity-driven in the industrialisation in countries around the world. This process manifests itself geospatially in the evolution of a gradient transfer of industrial structure. Therefore, the factors influencing the gradient transfer of industrial structure of pollution-intensive industries in the industrialization have become an important topic in various countries, and many theories and hypotheses already are produced.

The factor endowment hypothesis suggests that comparative advantage arises mainly from relative factor endowment. And pollution-intensive industries are often also capital-intensive or resource-intensive. Therefore, they tend to be located in areas rich in capital and resource. The pollution haven hypothesis believes that environmental regulation exerts an important effect on the geographical distribution of pollution-intensive industries. Regions with lower environmental standards have a comparative advantage. As gross regional product is highly correlated with the intensity of environmental regulation, the pollution-intensive industries, in the process of industrialisation, tend to aggregate in less developed areas with weaker environmental regulation. In addition, there are theories that both transport costs and economies of scale are likely to be factors influencing the geographical distribution of pollution-intensive industries in the context of globalisation.

With the numerous theories and hypotheses, it is clear that a variety of factors could influence the geographical distribution of pollution-intensive industries. The study on factors influencing the geographical distribution of pollution-intensive industries will help to realise the transformation from resource-consuming to productivity-driven in the process of industrialisation, and ultimately to eliminate the contradiction between environmental pollution and resources and economic development. [1-3]

Identification of pollution-intensive industries

In this paper, the pollution intensity index of each industry is calculated by combining two indicators, the discharge intensity of pollution and the discharge scale of pollution. The pollution intensity index is used to classify industries and to define the pollution-intensive industries in China at this stage.

$$I_{ij}=\frac{E_{ij}}{P_i} \quad (1)$$

I_{ij} – the discharge intensity of pollution j in the industry i; E_{ij} – the emission of pollution j in the industry i; P_i – total profit of industry i

$$S_{ij}=\frac{E_{ij}}{E_j} \quad (2)$$

S_{ij} – the discharge scale of pollution j in the industry i; E_{ij} – the emission of pollution j in the industry i; E – the total emission of pollution j

$$P_i=I_{ij}*S_{ij} \quad (3)$$

P_i- the pollution intensity index of industry i

The pollution intensity indices of waste water, waste gas and solid waste for each industry are calculated according to the normalised formulae (1)(2)(3). And weighted sum method was used to obtain the comprehensive pollution intensity index for each industry. [4]

In this paper, 41 industrial sectors in China are studied. The comprehensive pollution intensity index for each sector is calculated based on data on sulphur dioxide emission, nitrogen oxides emission, particulate matter emission concerned with air pollution, COD discharged and ammonia nitrogen discharged concerned with water pollution, and industrial solid wastes generated for each sector in 2019. Based on the mean and the tri-sectional quantiles of the comprehensive pollution intensity index, the categories are classified as high pollution, medium pollution and low pollution. And there are 11 pollution-intensive industries with characteristics of high pollution in China at this stage, as shown in the table 1.

Table 1 – Pollution-intensive industries and their pollution intensity index

Category	Industry	Pollution Intensity Index
High Pollution	Manufacture of Non-metallic Mineral Products	0.4100
	Processing of Food from Agricultural Products	0.2385
	Production and Supply of Electric Power and Heat Power	0.2254
	Smelting and Pressing of Ferrous Metals	0.2221
	Manufacture of Raw Chemical Materials and Chemical Products	0.1472
	Mining and Processing of Non-Ferrous Metal Ores	0.1410
	Manufacture of Paper and Paper Products	0.1266
	Mining and Processing of Ferrous Metal Ores	0.1221
	Smelting and Pressing of Non-ferrous Metals	0.1093
	Manufacture of Textile	0.1055
	Mining and Washing of Coal	0.0537

Geographical distribution of pollution-intensive industries

During the process of industrialisation, the distributional pattern of China's manufacturing industry has evolved from scattered and diversified to concentrated and specialised. Moreover, the geographical distribution of pollution-intensive industries is influenced by a variety of factors such as factor endowment, globalisation and environmental regulations.

From the perspective of the proportion of industry, the geographical distribution of pollution-intensive industries shows unbalanced characteristics. The proportion of pollution-intensive industry is clearly higher in less economically developed and remote regions such as Qinghai, Yunnan, Ningxia or resource-based regions such as Shaanxi, Shanxi, Xinjiang, Inner Mongolia. In contrast, the proportion of pollution intensive industries is significantly lower in economically developed regions or regions without resource endowment, such as Shanghai, Hainan, Beijing, and Tianjin. In addition, some coastal areas also have a high proportion of pollution-intensive industries, such as Shandong, Zhejiang, Jiangsu.

The proportion of pollution-intensive industries in China by province in 2019 are shown in Figure 1. From the figure, it can be tentatively seen that the geographical distribution of pollution-intensive industries is largely consistent with the factor endowment hypothesis, pollution haven hypothesis and the conjecture, that transport cost and international trade in the context of globalisation could influence the geographical distribution of pollution-intensive industries.

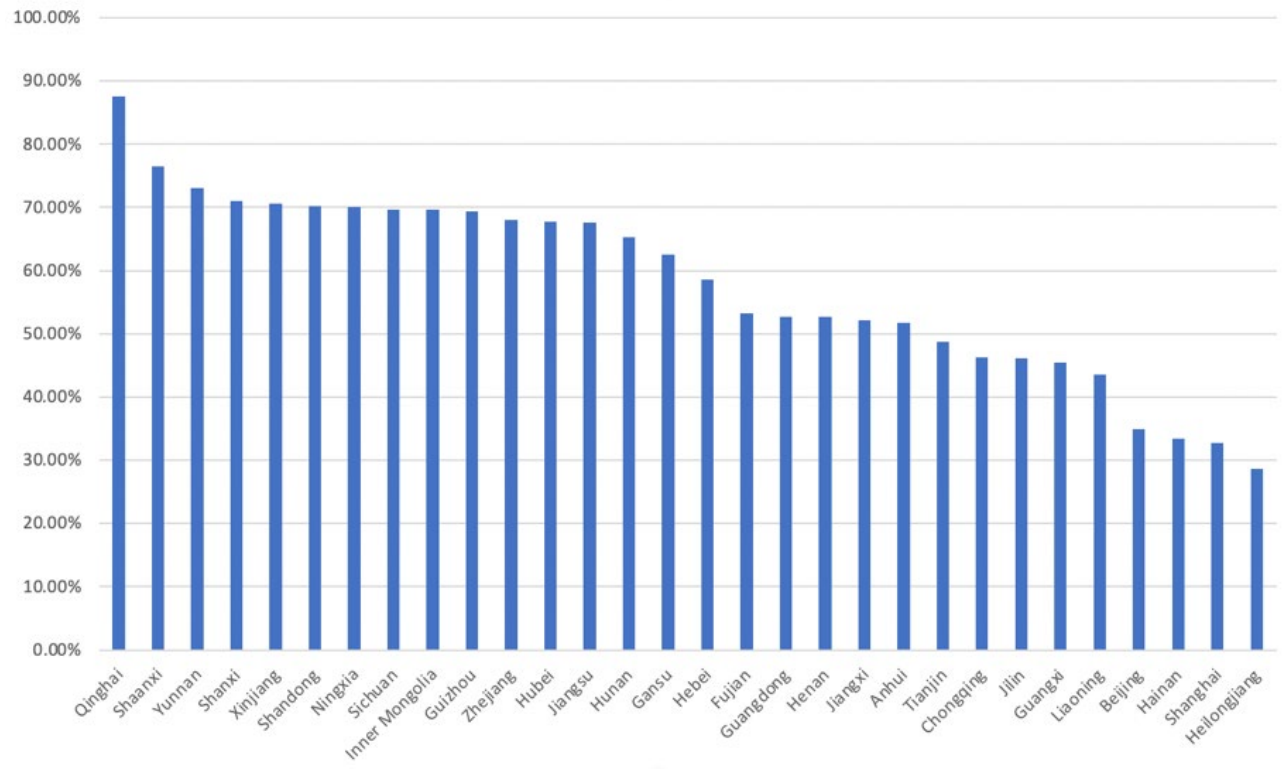

Figure 1 – Proportion of pollution-intensive industries

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From the perspective of industry output value, there exist clear tendency and characteristics in the geographical distribution of pollution-intensive industries. Figure 2 shows a map based on the output value of pollution-intensive industries by province in China in 2019. As we can see, a high output value of pollution-intensive industries come up in most regions in China. Some of the less developed and remote regions such as Qinghai, Yunnan and Ningxia, and resource-based regions such as Shanxi and Xinjiang, which have a high proportion of pollution-intensive industries, in fact do not have a high output value of pollution-intensive industries. Possible reasons for this are their underdeveloped economy and the fact that the secondary industry dominate the industrial structure.

Some of the provinces with resource endowment still rely on their huge resource advantages. The tertiary industry, which causes less pollution and has great potential for output, has not been fully developed in these regions. These have resulted in a large proportion of pollution-intensive industries in these regions but with low gross output. Moreover, pollution-intensive industries intend to be located in central China or coastal areas. As what we learn from the analysis from the perspective of the proportion of industry, the data on industry output value also show that the pollution-intensive industries tend to aggregate in the coastal areas with convenient transportation and developed economy.

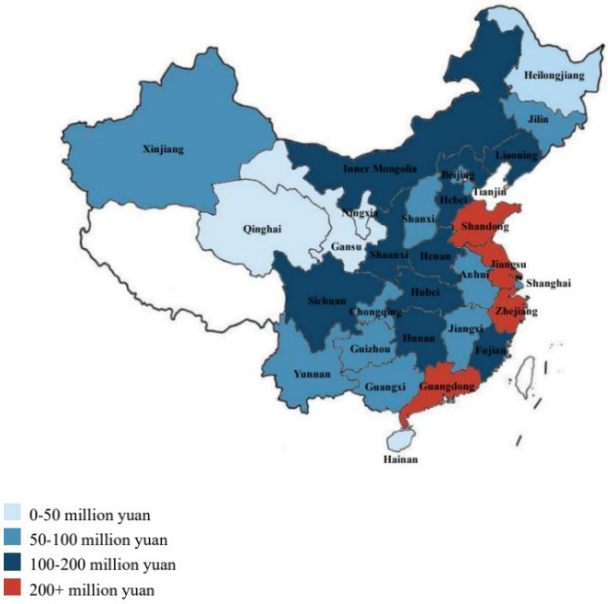

Figure 2 – Output value of pollution-intensive industries

From the perspective of number of the enterprise, the geographical distribution of pollution-intensive industries is highly consistent with the analysis from the perspective of industry output value. Figure 3 shows a map based on the number of enterprises in pollution-intensive industries by province in China in 2019. It shows that the number of enterprises in pollution-intensive industry varies considerably from region to region. A large number of pollution-intensive enterprises are clustered in central China or coastal areas. The marginal provinces and autonomous regions have fewer enterprises in pollution-intensive industries. This is consistent with the results obtained from the above analysis from the perspective of industry output value. Based on the number of enterprises in pollution-intensive industries, a clustering arises in Shandong, Zhejiang, Jiangsu, and Guangdong. As these provinces are economically developed and with strategic location, it is also reasonable to assume that factors such as the capital agglomeration, the convenient transportation and the proximity to external markets in the context of globalisation could be responsible for the concentration of pollution-intensive industries in these areas. [5,6]

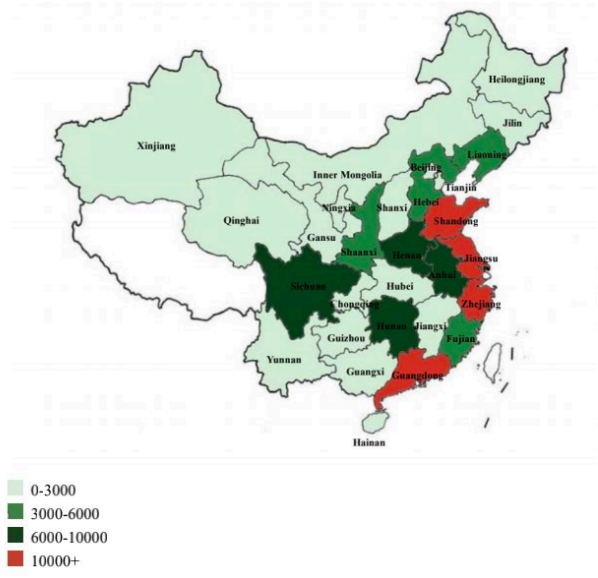

Figure 3 – The number of the pollution-intensive enterprise

Factors influencing the geographical distribution of pollution-intensive industries

To further explore the possible factors influencing the geographical distribution of pollution-intensive industries in China at this stage, the regression analysis is conducted to verify the correlation between factor endowment, environmental regulation, globalization and the number of enterprises in pollution-intensive industries with the data in 2019. The results are shown in Tables 2, 3 and 4.

Table 2 – Regression analysis on factor endowment

Model: Factor endowment	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson	F	Sig.
	.840a	0.706	0.671	2263.91662	1.695	20.01	.000b
Coefficients		Unstandardized Coefficients		Standardized Coefficients	Sig.	Collinearity Statistics	
		B	Std. Error	Beta		Tolerance	VIF
	(Constant)	-2955.983	3741.507		0.437		
	Total Factor Productivity	-14.52	1460.019	-0.001	0.992	0.909	1.1
	Total Investment	0.19	0.026	0.81	0	0.931	1.075
	Average Wage	0.05	0.043	0.13	0.257	0.94	1.063
a Dependent Variable: Number of pollution-intensive industries							

According to the table 2, we prove that the linear regression model between factor endowment and the number of enterprises in pollution-intensive industries holds true. The factor endowment could legitimately explain the location selection of pollution-intensive industries. The location selection of pollution-intensive industries is positive correlation with the total investment.

Table 3 – Regression analysis on environmental regulation

Model: Environmental regulation	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson	F	Sig.
	.750a	0.563	0.490	2818.06939	1.912	7.719	.000b
Coefficients		Unstandardized Coefficients		Standardized Coefficients	Sig.	Collinearity Statistics	
		B	Std. Error	Beta		Tolerance	VIF
	(Constant)	-4095.127	3598.069		0.266		
	Capacity Of Industrial Waste Water Treatment	3.651	0.978	0.567	0.001	0.790	1.266
	General Solid Waste Utilization Rate	8458.968	3119.303	0.358	0.012	0.904	1.107
	Hazardous Solid Waste Utilization Rate	45.485	4117.010	0.002	0.991	0.855	1.170
	Capacity Of Industrial Waste Gas Treatment	.000	0.001	0.046	0.756	0.839	1.192
a Dependent Variable: Number of pollution-intensive industries							

According to the table 3, we prove that the linear regression model between environmental regulation and the number of enterprises in pollution-intensive industries holds true. The environmental regulation could explain to a great extent the location selection of pollution-intensive industries. There is a notable correlation between industrial waste water treatment, general solid waste utilization rate and the number of enterprises in pollution-intensive industries. And the correlations between them are all positive. The industrial waste water treatment has a weaker correlation with the dependent variable than the general solid waste utilization rate. [7]

Table 4 –Regression analysis on globalization

Model: Globalization	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson	F	Sig.
	.758a	0.574	0.541	2672.04294	1.941	17.52	.000b
Coefficients		Unstandardized Coefficients		Standardized Coefficients	Sig.	Collinearity Statistics	
		B	Std. Error	Beta		Tolerance	VIF
	(Constant)	2694.525	876.872		0.005		
	Export Delivery Value	0.166	0.032	0.727	0	0.853	1.173
	Minimum Distance To The Port	-0.521	0.993	-0.073	0.604	0.853	1.173
a Dependent Variable: Number of pollution-intensive industries							

According to the table 4, we prove that the linear regression model between globalization and the number of enterprises in pollution-intensive industries holds true. Globalization can significantly influence the location selection of pollution-intensive industries. And the location selection of pollution-intensive industries is positively correlated with the international market potential included in globalization.

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The above analysis shows that factor endowment, environmental regulations and globalisation are all correlated with the number of enterprises in pollution-intensive industries in a region. In other words, factor endowment, environmental regulations and globalisation could influence the location selection of pollution-intensive industries in China at this stage. Moreover, as industrialisation continues, the preference according to these factors will become the dominant choice for the establishment of new pollution-intensive enterprises. This would, to some extent, result in a geographical concentration of pollution-intensive industries. They will be concentrated in areas with intensive capital factors, weak environmental regulations and huge potential to international markets. Coastal areas with developed economies and frequent external contacts will be popular choices.

Conclusion

This paper verifies the hypotheses and theories about the location selection of pollution-intensive industries from various perspectives and explored possible factors influencing the geographical distribution of pollution-intensive industries.

To ensure the reliability of the study, 11 pollution-intensive industries are identified based on their comprehensive pollution intensity index calculated. On this basis, subsequent analysis was carried out. According to the data from various Chinese provinces, the geographical distribution of pollution-intensive industries follows the same trend from the perspective of the proportion of industry, the industry output value and the number of the enterprise. They tend to be located in the heartlands or coastal areas, in particular in the provinces Shandong, Zhejiang, Jiangsu and Guangdong. These four provinces are the most popular locations for pollution-intensive enterprises from any perspective. In addition, the regression model is applied to further substantiate the possible factors influencing the geographical distribution of pollution-intensive industries. The results prove that factor endowment, environmental regulation and globalization were all identified as important factors influencing the geographical distribution of pollution-intensive industries. Further, the geographical distribution of pollution-intensive industries is significantly correlated with the capital element belonging to the factor endowment, with the industrial waste water treatment and the general solid waste utilization rate in environmental regulation, and with the international market potential contained in globalization. These factors combine to influence the geographical distribution of pollution-intensive industries in China at this stage. It also proves the reliability of the factor endowment hypothesis, the pollution haven hypothesis and the trend of industrial location selection under the effect of internationalisation.

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