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Regional Economic Growth and Environmental Harmonization Development

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Abstract: The problem of air pollution is becoming more and more prominent in all regions in parallel with economic growth. Shenyang, Dalian, Changchun and Harbin, as the capital cities of the three northeastern provinces and separately listed cities, the development of heavy industry on the one hand has brought about the high-speed development of the regional economy, while on the other hand, the emission of exhaust gas has caused great pressure on the environment. The contradiction between economic growth and air pollution is deepening, hindering the implementation of the national sustainable development strategy. Therefore, how to make the coordinated development between economic growth and environmental protection has become its urgent problem. In this paper, on the basis of describing the current situation of economic growth and air pollution in Shenyang, Dalian, Changchun, and Harbin, relevant data reflecting the economic growth and air pollution in these four cities from 2009 to 2020 are selected to construct an econometric model for empirical research. The results show that there are different curvilinear relationships between GDP per capita and three air pollution indicators: industrial wastewater emissions, industrial sulfur dioxide emissions, and industrial dust emissions. Based on the results, corresponding countermeasures are proposed.

Keywords: Air pollution, economic growth, northeastern provinces.

1. Introduction

Since China's reform and opening up more than 40 years ago, the economy has been growing rapidly, but the air environmental quality has been continuously deteriorating. Due to China's long-term adoption of the economic development model of "pollution first, treatment later", air pollution problems have become increasingly serious, endangering the health of residents and restricting economic development, becoming a bottleneck factor hindering economic growth. For a long time, China's one-sided pursuit of GDP growth has encouraged resource and environmental consumption behaviors at any cost, leading to the continuous deterioration of environmental quality, which in turn has inhibited economic development. China has also rapidly become one of the countries with the most serious environmental deterioration, especially atmospheric environmental deterioration, in the process of world economic growth. The goal of economic development requires not only quantitative expansion but also qualitative improvement. Transforming the extensive economic development model into an intensive one and avoiding the continuous deterioration of air quality have become the key links for the coordinated and sustainable development of the economy and environment in all provinces and cities across the country.

As the provincial capital cities and separately listed cities in the three northeastern provinces, the high-speed economic development and accelerated industrialization process of Shenyang, Dalian, Changchun and Harbin have continuously expanded the city scale and dramatically increased the population. Human production and daily life discharge a large amount of air pollutants, such as sulfur dioxide, waste water and dust, etc., and air pollution has thus intensified, leading to a series of environmental problems, which in turn restricts the improvement of residents' living standards and the development of the city. Based on the data of air pollutant emissions and per capita GDP in Hebei Province, Du Ying et al. [1] empirically analyzed and found that the relationship between economic growth and air pollutants does not entirely conform to the trend of the traditional EKC curve. With the growth of the economy, industrial sulfur dioxide emissions are gradually decreasing, while industrial soot emissions are becoming more and more serious. It is found that Hebei Province needs to optimize the industrial structure, control the scale of economic development and so on to achieve the goal of coordinated development of economic growth and the atmospheric environment. Based on the data of air pollutant concentrations and per capita GDP in 112 cities in China from 2003 to 2010, Wang Min and Huang Ying [2] empirically analyzed and found that the relationship between economic growth and air pollution shows a U-shaped curve trend. However, rapid economic growth does not necessarily lead to high pollution. It is possible to achieve a high-growth and low-pollution development model through technological improvement and industrial structure optimization.

In summary, this article selects the provincial capital cities and separately listed cities in the three northeastern provinces as the research objects, focuses on the interactive influence relationship between the atmospheric environment and economic growth, and on the basis of studying the changing relationship between economic growth and air pollution, hopes to reveal the deep-seated reasons affecting air pollution in Shenyang, Dalian, Changchun and Harbin, and provide a basis for proposing countermeasures.

2. Theoretical Understanding of The Coordinated Development of Economy and Environment

In the coordinated development of the economy and the environment, the economic system and the environmental system are regarded as two aspects that are interconnected, interactive, and mutually based in the process of regional

development, emphasizing the synergy, integrity, sustainability, and spatial fairness between the two. The core is to maintain the sustainable growth of the regional economy while protecting and improving the regional sustainable development capacity to meet people's growing ecological and environmental needs and promote the comprehensive, coordinated, and sustainable development of human society. There is a mutual restriction and mutual promotion between the economy and the environment. The rapid development of the economy, especially in economically backward areas, due to its resource-based industrial structure and economic layout, low-tech, high-consumption growth mode, to undertake the transfer of high-polluting industries from external developed areas, etc., while promoting the growth of material wealth, has greatly increased the demand for natural resources, increased the emission of waste, and damaged the structure and function of the ecological environment.

The deterioration of the investment environment hinders the sustainable growth of the economy; the rapid growth of the economy also further enhances the ability of environmental governance. By increasing investment in environmental protection, on the one hand, the technical level can be improved to reduce pollutant emissions. On the other hand, the governance of existing pollutants can be increased to promote the continuous optimization and improvement of the environment. Improving the environmental capacity provides for economic growth, creates a good environmental resource base and investment environment. The adjustment and optimization of the industrial structure, and the transformation of the economic growth mode have strengthened this trend, thus promoting the sustainable development of the economy [4]. The coordinated development of the economy and the environment is to seek the best dynamic balance in the dynamic evolution of the system of economic development and environmental protection. Its essence is to study and explore the mechanism of action between the regional economy and the environment, and strive to avoid the very abrupt inverted "U" relationship between economic growth and the environment that has occurred in developed countries, and to promote the transformation of environmental quality in developing regions to occur in advance. A "flat" type, inverted "U" type relationship between the economy and the environment is formed to achieve the sustainable development of human society [5].

3. Empirical Analysis

3.1. Data Sources

Most of the studies on the relationship between economic growth and environmental quality at home and abroad use the environmental Kuznets curve for analysis, and the pollution index data corresponding to environmental quality mainly selects the emission of pollutants. Therefore, this paper selects industrial wastewater discharge, industrial second, sulfur oxide emission and industrial dust emission as pollution indicators. The data are based on the "China Urban Statistical Yearbook" from 2010 to 2021 and the statistical yearbooks of various cities.

The selection of economic indicators, for GDP, per capita GDP can better reflect the development level and economic strength of a region than GDP, so this paper selects the per capita GDP of Shenyang, Dalian, Changchun, and Harbin from 2009 to 2020 as an economic indicator to fit the environmental Kuz-Nez curve. GDP per capita is obtained by dividing GDP by the permanent population. The data of GDP is derived from the "China Urban Statistical Yearbook". Table 1 shows the general statistical characteristics of the relevant variables.

Table 1. Descriptive analysis of each variable

Indicators	Mean	Standard Deviation	Min	Median	Max
Per capita GDP	27267.65	8417.534	15089.06	22850.88	46833.89
Industrial wastewater discharge	9896.272	10226.84	1660.1	5555.5	40150
Industrial SO_2 emission	54686.91	37433.27	6598	53184.5	132003
Industrial dust emission	47808.7	29566.73	4178	50499.5	130401

3.2. Regression Analysis

Table 2. Economic development and environmental level of pollution measures the analysis results

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	Per capita GDP	Per capita GDP	Per capita GDP	Per capita GDP	Per capita GDP	Per capita GDP
Ln (Industrial wastewater discharge)	0.198***	0.208***				
	(6.001)	(4.780)				
(Industrial wastewater discharge)^2		-2.83E-11				
		(-0.353)				
Ln (Industrial SO_2 emission)			0.109***	0.068***		
			(7.595)	(2.728)		
(Industrial SO_2 emission)^2				0.000		
				(1.979)		
Ln (Industrial dust emission)					0.109***	0.142***
					(6.422)	(5.534)
(Industrial dust emission)^2						-1.01E-11
						(-1.679)
Constants	8.424***	8.342***	9.010***	9.405***	9.018***	8.705***
	(28.929)	(22.336)	(58.828)	(37.844)	(50.180)	(33.915)
Hausman P value	0.0579	0.0000	0.0074	0.0205	0.0173	0.0000
R^2	0.456	0.457	0.573	0.609	0.490	0.522

Note: Parentheses contain t values; ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively

3.2.1. Economic growth and water pollution Interaction between

Models 1 and 2 in Table 2 and Figure 2 show the relationship between per capita GDP and industrial wastewater discharge in Shenyang, Dalian, Changchun, and Harbin. The regression coefficient of the first term is 0.198, the fitting coefficient R ^ 2 is 0.456, and the regression coefficient of the second term is -2.83E-11. The fitting coefficient R ^ 2 is 0.457. The curve fitting effect is better, indicating that the relationship between the two is first positive promotion and then inhibition, and the overall inverted "U" shape. This shows that there is a strong interaction between the economic growth of Shenyang, Dalian, Changchun, and Harbin and the discharge of industrial wastewater. In the early days, due to its own resource advantages, Northeast China vigorously developed traditional industries, increasing industrial wastewater emissions, but at the same time, the development of industry also drove the growth of the local economy. With the implementation of the Scientific Outlook on Development, environmental remediation was put on the agenda, which made the three northeastern provinces increase again, increasing the control and treatment of wastewater discharge. Annual investment in water pollution treatment accounts for more than 1% of GDP, which to a certain extent curbs the deterioration of the environment and improves the water environment. However, at the same time, some industries have also withdrawn with the development of the times, and their driving force for economic growth has weakened.

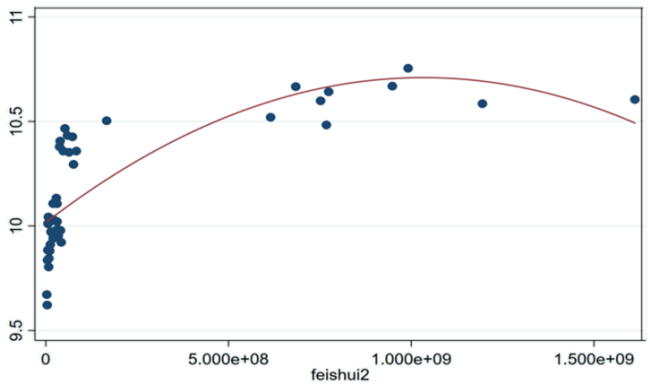

Figure 1. The relationship between the letting amount of the industrial waste water and the GDP per capita

3.2.2. Economic growth and air pollution Interaction between

Models 3 and 4 in Table 2 show the relationship between per capita GDP and industrial sulfur dioxide emissions in Shenyang, Dalian, Changchun, and Harbin. Among them, the regression coefficient of the first term is 0.109, the fitting coefficient R^2 is 0.573, and the regression coefficient of the quadratic term is 0.000. It is not significant, and the fitting coefficient R^2 is 0.609. The curve fitting effect is better, indicating that the relationship between the two is first positive promotion and then the promotion effect is no longer significant. The appearance of this phenomenon is due to the fact that the country is in a period of governance and rectification during this period. Although the economy has grown, the industrial development has declined. The environment Kuznets, the curve shows that industrial exhaust emissions gradually decrease with the development of the economy. With the development of the circular economy and the government's strengthening of the control of industrial waste gas emissions, industrial waste gas emissions have shown a decreasing trend, and the environmental Kuznets curve has shown a downward trend. This is related to the dual regulation of the resource-based industry by the market and the government.

Models 5 and 6 in Table 2 show the relationship between per capita GDP and industrial dust emissions in Shenyang, Dalian, Changchun, and Harbin. The regression coefficient of the first term is 0.109, the fitting coefficient R^2 is 0.490, and the regression coefficient of the quadratic term is -1.01E-11. The fitting coefficient R^2 is 0.522. The curve fitting effect is better, indicating that there is an inverted U-shaped relationship between the two that is first positively promoted and then suppressed. In 2001, with the development of the circular economy and the government's strengthening of the control of industrial waste gas emissions, industrial waste gas emissions showed a decrease, and the trend environmental Kuznets curve showed a downward trend.

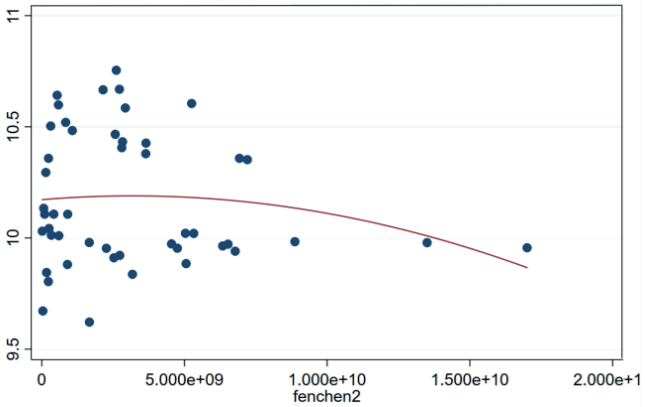

Figure 2. The relationship between the letting amount of the industrial dust emissions and the GDP per capita

4. Conclusions

Through analyzing the interactive effects between the economic development and the ecological environment in Shenyang, Dalian, Changchun, and Harbin, it is found that there is an inverted U-shaped relationship between the per capita GDP and the industrial wastewater emissions and the industrial dust emissions. The inverted U-shaped relationship between the per capita GDP and the industrial sulfur dioxide emissions is not obvious, but after adding the quadratic term, its coefficient has significantly decreased. On the one hand, the impact of economic development on the ecological environment is mainly reflected in the influence of the economic development level on the total pollutant emissions, the influence of the industrial structure on the pollutant composition, the influence of the industrial layout on the regional ecological environment quality, and the influence of the economic growth mode and the regional industrial transfer on the ecological environment state, etc. [8]; on the other hand, the ecological environment also has a feedback effect on the industrial structure adjustment, the industrial layout, and the economic growth rate [9]. This dialectical relationship of mutual restriction and interactive development between the regional economic development and the ecological environment indicates that the degree of coordinated development between the regional economy and the environment is the prerequisite and guarantee for the regional

sustainable development.

5. Suggestions

Based on the previous analysis, it can be seen that as an important strategic base for industrial development, the three northeastern provinces have achieved rapid economic growth. At the same time, the environmental pollution problem has become increasingly prominent. Therefore, measures should be actively taken and relevant policies should be implemented to coordinate the relationship between economic development and air pollution.

Adopting the traditional extensive economic development mode will inevitably lead to atmospheric environmental pollution. The fundamental of scale control lies in the transformation of the economic growth mode from extensive to intensive [10], which specifically includes the following three points: (1) Effectively save non-renewable resources. Strongly implement measures such as energy conservation, comprehensively recycle and reuse energy, and gradually form an intensive development mode to promote the preferential and rapid development of enterprises with high energy utilization efficiency and good benefits [11]. (2) Promote the innovation of science and technology. Encourage more enterprises to use advanced science and technology to transform and upgrade traditional enterprises, thus changing the economic development mode and continuously improving the technical level to achieve the goals of energy conservation and emission reduction.

With the development of the economy, the industrial structure is also constantly changing, but heavy industrialization still accounts for a large proportion. Therefore, optimizing the industrial structure is to accelerate the green development and upgrading of industry, make the development of the industrial economy coexist with environmental protection, reduce the emissions of air pollutants and improve air quality [12]. (1) Vigorously develop the energy conservation and environmental protection industry. Use high-tech to research and develop environmental pollution treatment equipment, especially the research and development of air pollution treatment equipment [13]. Use preferential policies such as taxation to support and cultivate a batch of energy conservation and environmental protection industries with leading positions, develop leading enterprises, and drive small and medium-sized enterprises to vigorously develop the environmental protection industry. (2) The traditional industries should be upgraded in a green way. For traditional industries such as metallurgy, chemical industry, and electricity that follow the development mode of high investment, high consumption, and high emission, a new development mode of cleaning, low-carbon, and recycling should be implemented [14]. Give full play to the demonstration role of high-tech industrial development zones, implement the green development and upgrading of traditional industries, and achieve the goals of energy conservation, emission reduction, and environmental protection.

Strengthen the control of urban dust and vehicle exhaust pollution. Excessive emissions of dust and vehicle exhaust will lead to an increase in fine particulate matter in the air, thus causing the haze phenomenon. Therefore, corresponding emergency treatment measures should be taken for dust emission reduction: dust reduction treatment should be carried out for construction sites, such as subway construction sites and real estate construction sites. For vehicle emission pollution: government departments should implement relevant purchase restriction, traffic restriction, and quota restriction policies to control the number of motor vehicles within the range allowed by environmental protection; the vehicle exhaust emission standards should be improved, and unqualified gasoline should be excluded from the market by legal means, and vehicles that do not meet the exhaust emission standards should be eliminated [15]; the state should increase its support for the electric vehicle industry, and use preferential policies such as taxation and subsidies to attract consumers to purchase, so as to achieve the goals of energy conservation and emission reduction and make the growth of residents' consumption demand coexist with the improvement of air quality.

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