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A Study on The Impact of Economic Development and Environmental Pollution Relationship in Jiangsu Province

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Abstract. This paper selects per capita GDP of Jiangsu Province from 2000 to 2020 as the indicator of economic development, and uses chemical oxygen demand (COD) emissions, sulfur dioxide (SO2) emissions, general industrial solid waste generation, and hazardous waste generation as indicators of environmental pollution. Based on the theoretical foundation of the Environmental Kuznets Curve (EKC), the paper conducts an empirical analysis of the relationship between economic development and environmental pollution using Eviews software. The results show that:(1) The EKC for SO2 emissions fits an inverted N-shaped curve and has surpassed the second inflection point of this curve.(2) The EKC for general industrial solid waste generation fits an inverted U-shaped curve and has not yet reached its inflection point.(3) The EKC for hazardous waste generation fits a U-shaped curve and has surpassed the inflection point of this curve.

Keywords: Jiangsu Province; Environmental Pollution; Environmental Kuznets Curve.

1. Introduction

Over the past two decades or more, China's economic development has achieved a series of remarkable accomplishments, but at the same time, it has also given rise to numerous environmental issues. Jiangsu Province, as a developed coastal province, has witnessed increasingly severe environmental problems along with its continuous economic growth. Harmonizing the relationship between economic development and environmental pollution is a crucial foundation for Jiangsu to achieve sustainable development. Conducting research on the economic and statistical relationship between the two can provide a clearer understanding of their changing dynamics, which will be conducive to promoting green and sustainable development in Jiangsu Province.

1.1 Research significance

The empirical analysis conducted in this paper focuses on the economic model, aiming to explore a sustainable development path that harmonizes economic growth and environmental protection in Jiangsu Province.

From a theoretical perspective, Granger causality analysis enables a static examination of the causal relationships among variables based on statistical indicators, thereby enhancing our qualitative understanding of the interplay between economic growth and environmental pollution. By utilizing Eviews 12.0 software, this paper quantitatively analyzes economic indicators and environmental pollution data from Jiangsu Province to identify the Kuznets Curve reflecting the relationship between economic development and environmental pollution, thereby transforming theoretical value into practical application.

From a practical standpoint, identifying the specific quantitative relationship between economic development and environmental pollution in Jiangsu Province allows for policy adjustments and optimized resource allocation. This ensures that severe environmental pollution can be avoided while economic growth continues, thus truly achieving green and sustainable economic development.

1.2 Research Pathway

Starting from the perspectives of economic growth and environmental pollution in Jiangsu Province, this paper utilizes time-series data related to economic growth and environmental pollution at the provincial level in Jiangsu to achieve its research objectives through the following steps:1. Review and summarize relevant domestic and international literature on the Environmental Kuznets Curve (EKC).2. Explain the basic theory and form of the Environmental Kuznets Curve.

3.Introduce the economic development status and environmental pollution situation in Jiangsu Province.4. Conduct Granger causality tests for environmental pollution variables.5. Establish a model of the Environmental Kuznets Curve for Jiangsu Province.6. Analyze the impact of economic growth on environmental quality in Jiangsu Province through the model.7. Propose policy recommendations.

2. Literature review

As environmental issues continue to deteriorate, an increasing number of economists have begun to focus on the actual mechanisms through which economic growth and environmental pollution interact across various economies, and have embarked on exploring the specific quantitative relationships between the two. Due to differences in the selected economic statistical variables and the utilization of varying economic statistical data, the conclusions drawn regarding the specific quantitative relationship between economic growth and environmental pollution vary as well [1].

The exploration of the specific quantitative relationship between economic growth and environmental pollution originated from the research conducted by Grossman and Krueger, who used data analysis to quantify the specific extent to which the North American Free Trade Agreement (NAFTA) impacted environmental quality [2]. Bangdyopadhyay and Shafik conducted related research using panel data, selecting data samples from 149 countries spanning the years 1986 to 1990. Their study found that environmental pollution indicators such as carbon emissions per unit of GDP, nitrogen dioxide concentrations, suspended particulate matter (SPM) concentrations, and annual deforestation rates all adhered to the relevant hypotheses of the Environmental Kuznets Curve [3].

Since then, a large number of scholars from both domestic and international backgrounds have begun to investigate the quantitative relationship between environmental pollution and economic growth through similar methodologies. Markandya's research supports the inverted U-shaped relationship of the Environmental Kuznets Curve (EKC), arguing that the per capita income turning point of the EKC does exist in most of the 12 Western European countries he studied [4]. Mao Hui and Wang Li used panel data on provincial industrial pollutant emissions in China from 1998 to 2010 to test the EKC and found that the shapes of the EKC for different pollutants were inconsistent, and there were significant regional variations in the EKC [5]. Wang Min and Huang Ying examined the relationship between economic growth and environmental pollution in China using data on air pollution concentrations from 112 cities between 2003 and 2010. They found that all air pollution concentration indicators exhibited a "U-shaped" curve relationship. After considering the specific time trend variables for each city, they discovered that high growth does not necessarily lead to high pollution. Their comparative analysis of emission data and atmospheric concentration data for the same pollutants revealed diametrically opposed regression results [6]. Wang Shuwen and Wang Jingcheng found that the relationship between urban household waste and economic growth in China follows an inverted "S"-shaped pattern, with two inflection points approximately at per capita GDP of 36,890 yuan and 107,450 yuan. In economically developed eastern regions, enterprises and residents have stronger environmental awareness, and governments have achieved better results in managing urban household waste. In central and western regions, the environmental awareness of enterprises and residents needs to be improved. Governments should strengthen the management of urban household waste and raise the environmental awareness of enterprises and residents, especially in the western regions where environmental awareness is still relatively weak [7]. Based on statistical data from 1997 to 2017 and considering spatial effects, Zhao Xiaoman constructed an extended spatial econometric test model of the Environmental Kuznets Curve. The research revealed an inverted "N"-shaped long-term relationship between carbon dioxide emissions from the transportation sector and industrial economic development. The inflection points of this relationship were identified as (116.283, 8471.580). In the foreseeable future, the total carbon emissions from transportation are still expected to show an increasing trend. Both the optimization of energy structures and advancements in energy-saving technologies can inhibit the increase in total carbon emissions from transportation, but the role of transportation structures is not significant [8].

3. Theoretical foundation

In 1950, Kuznets conducted an analysis of the correlation between economic growth and income disparity, and he made hypotheses about the correlation between the two. He believed that in the initial stages of economic growth, income disparities tend to gradually widen with economic growth. However, as the economy continues to grow, income disparities gradually narrow. This typical inverted U-shaped relationship between per capita income and income disparity in a coordinate system came to be known as the Kuznets Curve in later years. This type of relationship is also likely to emerge when studying the relationship between economic development and the degree of environmental degradation, and the curve representing economic growth and the degree of environmental degradation in a coordinate system is called the Environmental Kuznets Curve.

The typical inverted U-shaped Environmental Kuznets Curve is represented by Equation (1) as follows:

$$y_t = a_0 + a_1 x_t + a_2 x_t^2 + \varepsilon \quad (1)$$

In Equation (1), y_t is the dependent variable, typically representing a measure of environmental pollution, while x_t is the independent variable, generally representing a measure of economic growth. When a_2 is negative and a1 is positive, the Environmental Kuznets Curve takes the shape of a typical inverted U-shaped curve. However, in practical research, it has been observed that the Environmental Kuznets Curve for different pollutants or the same pollutant in different regions often exhibits different shapes.

4. Current Situation Analysis

4.1 Current Economic Development Situation in Jiangsu Province

Located in the core area of the Yangtze River Delta, Jiangsu Province boasts a developed economy and affluent populace, with its per capita GDP ranking first among all provinces. Even in recent years, despite facing significant downward economic pressures, Jiangsu Province has not slowed down its pace of development. Figure 4.1 illustrates the regional GDP of Jiangsu Province from 2000 to 2020, while Figure 4.2 shows the per capita regional GDP of Jiangsu Province over the same period.

As shown in Figure 4.1, Jiangsu Province's economy has maintained a rapid development trajectory, with its regional GDP surpassing the 10 trillion-yuan mark in 2020. In terms of growth rate, from 2000 to 2019, Jiangsu sustained a relatively high growth pace. However, in 2020, due to the impact of the COVID-19 pandemic, the growth rate declined. From the perspective of industrial structure, in 2020, the proportions of Jiangsu's three primary industries were 4.4% for the primary industry, 43.1% for the secondary industry, and 52.5% for the tertiary industry, indicating a relatively developed manufacturing and service sector.

As can be seen from Figure 4.2, except for a slight decline in per capita regional GDP in 2020 due to the impact of the COVID-19 pandemic, there has been a steady growth in per capita regional GDP over the past two decades. Both 2019 and 2020 saw the per capita regional GDP surpass the 120,000-

yuan mark. The upward trend in per capita regional GDP reflects, to a certain extent, the remarkable economic development achievements of Jiangsu Province over the past two decades.

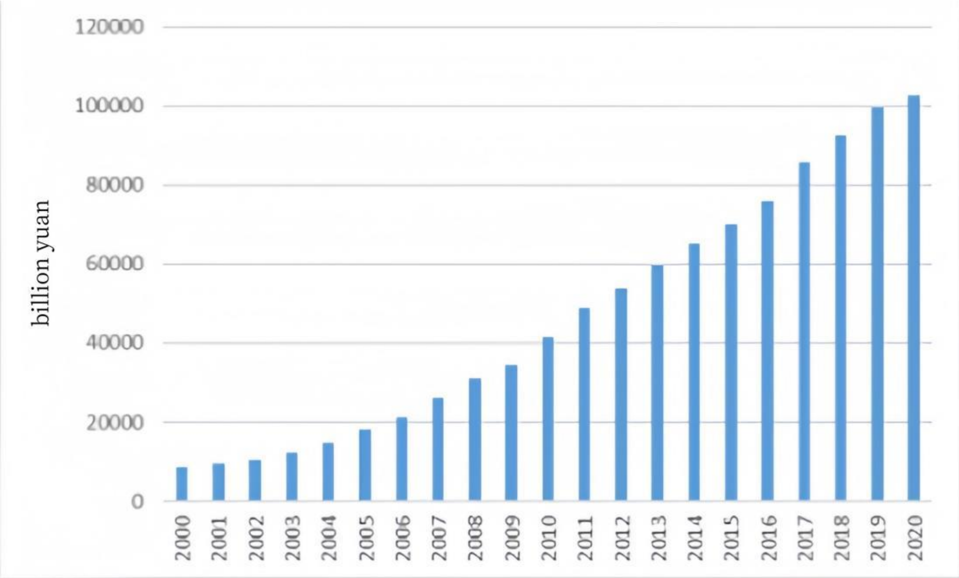

Figure 4.1 Regional GDP of Jiangsu Province from 2000 to 2020

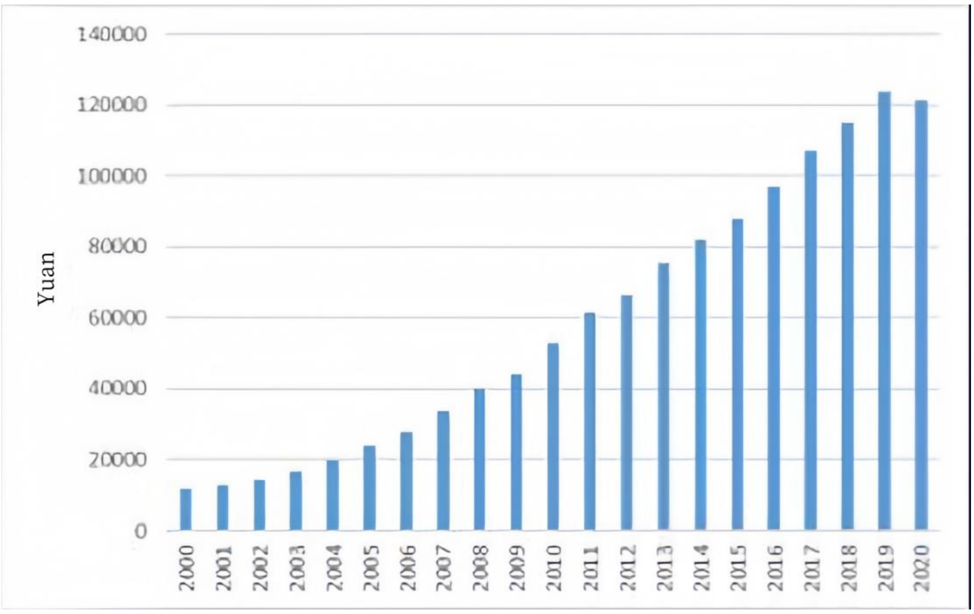

Figure 4.2 Per Capita Regional GDP of Jiangsu Province from 2000 to 2020

4.2 Environmental Development Status of Jiangsu Province

In terms of environmental quality, according to the "2020 Annual Report on the Ecological Environment of Jiangsu Province" released by the Jiangsu Provincial Government, there was a significant improvement in the environmental quality of Jiangsu Province in 2020. The ratio of days with good air quality was 81%, an increase of 9.6 percentage points year-on-year. The annual average concentration of PM2.5 was 38 micrograms per cubic meter, a decrease of 11.6% year-on-year. Both the ratio of days with good air quality and the PM2.5 concentration met the national annual assessment targets. The concentrations of other major pollutants such as O3, PM10, SO2, NO2, and CO also decreased by varying degrees year-on-year. Among the 104 sections assessed for surface water quality in accordance with national standards, 87.5% achieved or exceeded the Grade III standard specified in the "Environmental Quality Standards for Surface Water," an increase of 8.7 percentage points year-on-year, with no sections falling below Grade V. For the 380 sections assessed under the provincial "13th Five-Year Plan" water quality standards, 91.5% achieved or exceeded

Grade III, an increase of 7.2 percentage points year-on-year, with no sections falling below Grade V. The Taihu Lake treatment initiative achieved the "two guarantees" for the thirteenth consecutive year. Among the 204 national risk monitoring points, 195 (95.6%) were below the risk screening values specified in the "Soil Environmental Quality Risk Control Standards for Agricultural Land Soil Pollution (Trial)," while 9 (4.4%) exceeded the risk screening values but did not exceed the risk control values.

Based on the data from the "China Environmental Statistics Yearbook," the following charts have been compiled: Figure 4.3 depicting sulfur dioxide emissions in Jiangsu Province from 2000 to 2020, Figure 4.4 showing major chemical oxygen demand (COD) emissions in Jiangsu Province from 2000 to 2020, and Figure 4.5 illustrating the generation of major solid pollutants in Jiangsu Province from 2000 to 2020.

From Figure 4.3, we can observe that sulfur dioxide, a major air pollutant, exhibited a trend of first increasing and then decreasing over the past two decades. It reached a peak of 1,373,400 tons in 2005 and then declined annually thereafter. Especially during the "13th Five-Year Plan" period, sulfur dioxide emissions showed a steep decline, reflecting Jiangsu Province's active response to the central government's call for "green development" and its outstanding achievements in atmospheric pollution control.

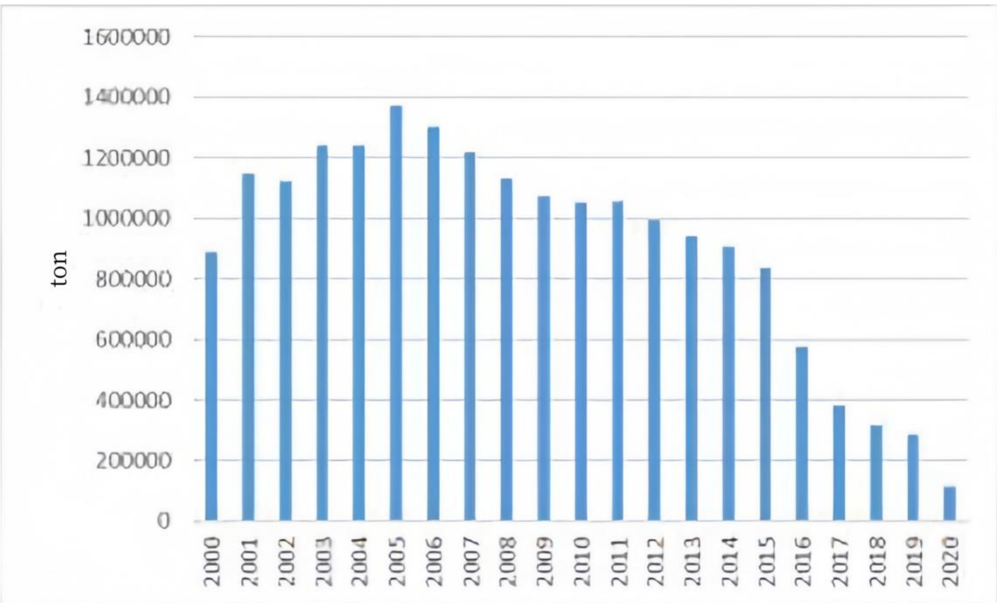

Figure 4.3 Sulfur Dioxide Emissions in Jiangsu Province from 2000 to 2020

From Figure 4.4, we can see that over the past two decades, the emissions of chemical oxygen demand (COD), a major water pollutant, also demonstrated a trend of first increasing and then decreasing. Especially during the "13th Five-Year Plan" period, Jiangsu Province responded to the central government's call by setting higher standards for the treatment of water pollution and issuing a series of related policies. Consequently, COD emissions experienced a steep decline in 2016. However, due to the impact of the COVID-19 pandemic in 2020, there was a noticeable increase in water pollutant emissions.

From Figure 4.5, we can observe that over the past two decades, the generation of both general industrial solid waste and hazardous waste, the two types of solid pollutants, has shown an increasing trend year by year. During the period of rapid economic growth over the past two decades, the manufacturing industry in Jiangsu Province has also developed swiftly. This development in the manufacturing industry has led to an increase in solid pollutants, posing higher demands on environmental protection. Therefore, Jiangsu Province should attach importance to the disposal of solid pollutants in its future development process.

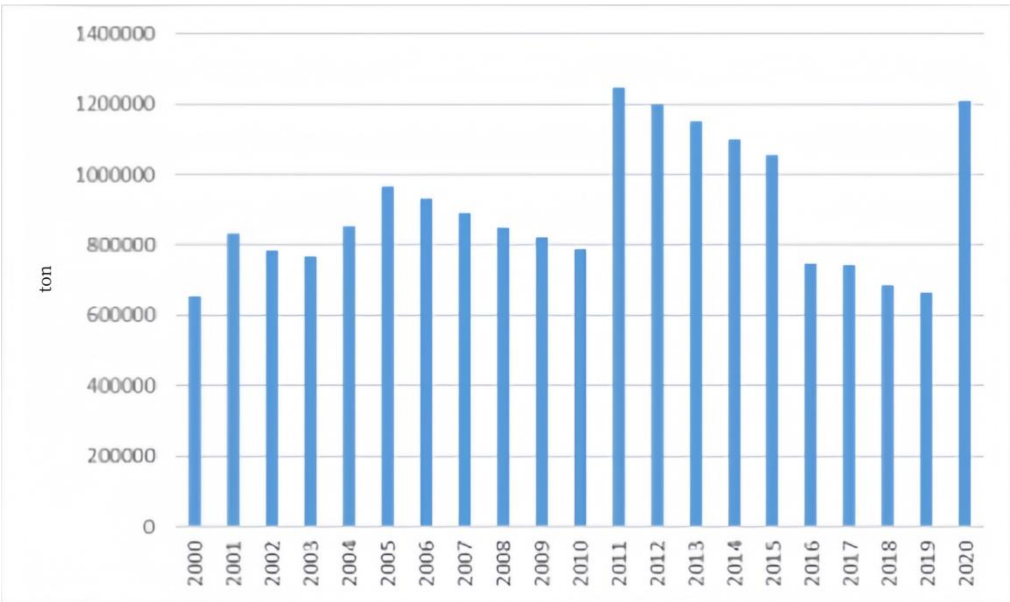

Figure 4.4 Chemical Oxygen **Demand (**COD) Emissions in Jiangsu Province from 2000 to 2020

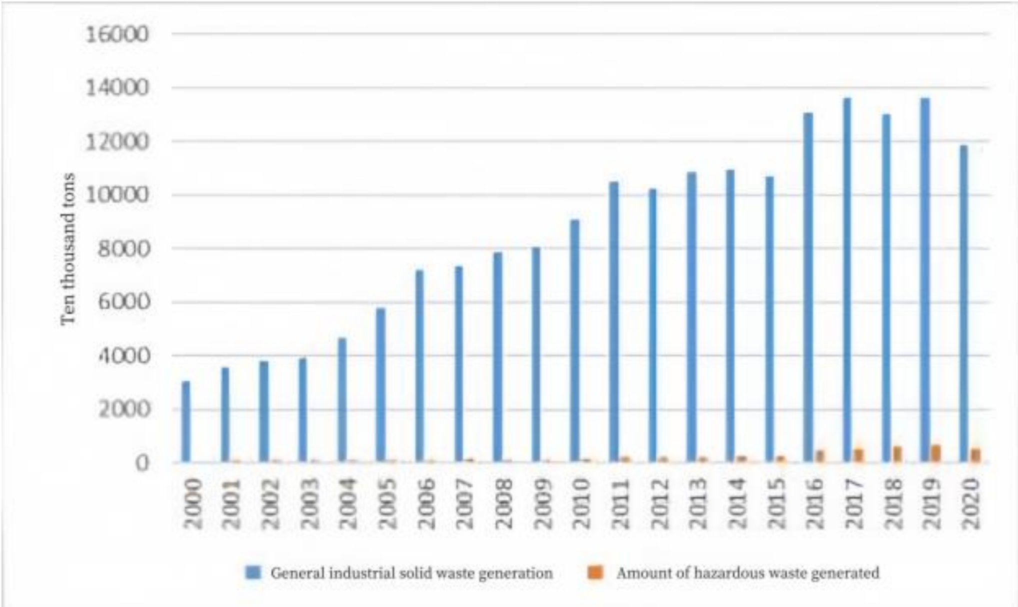

Figure 4.5 Major solid waste generation in Jiangsu Province from 2000 to 2020

5. Empirical analysis

5.1. Variable selection and data sources

This paper chooses per capita GDP as a measure of economic growth, sulfur dioxide emissions as a measure of air pollution, chemical oxygen demand (COD) emissions as a measure of water pollution, and the generation of general industrial solid waste and hazardous waste as measures of solid pollution.

The data type adopted in this paper is time series data. Time series data can easily lead to spurious regression when analyzed directly due to its non-stationarity. Therefore, to enhance the stationarity of the data, this paper performs logarithmic transformation on the corresponding variable data before conducting data analysis.

The data sources for this paper are the "China Statistical Yearbook," the "China Environmental Statistical Yearbook," and the "Jiangsu Statistical Yearbook," covering a time span from 2000 to 2020.

5.2. Unit root test

The premise of conducting a Granger causality test using time series data is that the variables are stationary, as non-stationary variables can lead to spurious regression and inaccurate conclusions. Therefore, before performing the Granger causality test, a unit root test is first conducted to determine whether the variables being studied are stationary sequences. If they are not stationary, they need to be transformed into stationary sequences through differencing or other methods before model analysis can be carried out. In this paper, the Augmented Dickey-Fuller (ADF) test method is used to test the stationarity of the time series.

In this paper, LnPGDP represents the logarithm of per capita regional GDP in Jiangsu Province, LnCOD represents the logarithm of chemical oxygen demand emissions in Jiangsu Province, LnSO2 represents the logarithm of sulfur dioxide emissions in Jiangsu Province, LnGT represents the logarithm of general industrial solid waste generation in Jiangsu Province, and LnWX represents the logarithm of hazardous waste generation in Jiangsu Province.

DLnPGDP denotes the first-order difference of LnPGDP, DDLnPGDP denotes the second-order difference of LnPGDP, DLnCOD denotes the first-order difference of LnCOD, DDLnCOD denotes the second-order difference of LnCOD, DLnSO2 denotes the first-order difference of LnSO2, DDLnSO2 denotes the second-order difference of LnSO2, DLnGT denotes the first-order difference of LnGT, DDLnGT denotes the second-order difference of LnGT, DLnWX denotes the first-order difference of LnWX, and DDLnWX denotes the second-order difference of LnWX.

Using Eviews 12.0, the Augmented Dickey-Fuller (ADF) test method was employed to conduct unit root tests on LnPGDP, DLnPGDP, DDLnPGDP, LnCOD, DLnCOD, DDLnCOD, LnSO2, DLnSO2, DDLnSO2, LnGT, DLnGT, LnWX, and DLnWX. The test results are presented in Table 5.1 below:

Table 5.1 Summary Table of Unit Root Tests for Each Variable

Variable	ADF Statistic	Critical Values (at 5% significance levels)	Conclusion
LnPGDP	1.625182	-3.658446	Non-stationary
DLnPGDP	-2.894325	-3.673616	Non-stationary
DDLnPGDP	-5.086363	-3.710482	Stationary
LnCOD	-3.401660	-3.733200	Non-stationary
DLnCOD	-3.001335	-3.673616	Non-stationary
DDLnCOD	-5.332847	-3.690814	Stationary
LnSO2	2.313847	-3.733200	Non-stationary
DLnSO2	-0.186873	-3.759743	Non-stationary
DDLnSO2	-1.084374	-3.759743	Non-stationary
LnGT	-1.809836	-3.733200	Non-stationary
DLnGT	-6.053702	-3.733200	Stationary
LnWX	-0.673257	-3.733200	Non-stationary
DLnWX	-4.091462	-3.759743	Stationary

Based on the results of the unit root tests mentioned above, it can be concluded that LnPGDP becomes stationary after second-order differencing, indicating that it is a second-order integrated series. Similarly, LnCOD also becomes stationary after second-order differencing, indicating that it is a second-order integrated series. LnGT becomes stationary after first-order differencing, indicating that it is a first-order integrated series. LnWX becomes stationary after first-order differencing, indicating that it is a first-order integrated series.

The analysis reveals that both LnPGDP and LnCOD are second-order integrated, suggesting the possibility of a long-term stable relationship between these two variables. To further analyze the long-term relationship between these variables, a cointegration test can be conducted. This test will help to determine whether the linear combination of LnPGDP and LnCOD is stationary, thereby providing insights into the nature of their long-term equilibrium relationship.

5.3. Cointegration test

The prerequisite for a cointegration test is that the variables being tested are of the same order of integration. In the research presented here, both LnPGDP and LnCOD are second-order integrated. Using Eviews 12.0, a Johansen cointegration test was conducted on these two variables, and the test results are shown in Table 5.2.

Table 5.2 Results of the Johanson cointegration test

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. Of CE(s)	Eigenvalue	Trace Statistic	Critical Values (at 5% significance levels)	Prob.**
None *	0.525883	19.46088	15.49471	0.0120
At most 1 *	0.242669	5.281149	3.841465	0.0216

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level

* Denotes rejection of the hypothesis at the 0.05 level

According to the cointegration test results shown in Table 5.2, there are two cointegrating relationships between LnPGDP and LnCOD. This finding indicates that a Granger causality test can be further conducted to investigate the direction of causality between these two variables.

5.4. Granger causality test

It was found through cointegration tests that there are two cointegration relationships between Jiangsu Province's chemical oxygen demand (COD) emissions per capita GDP. In order to further explain the causal relationship between Jiangsu Province's COD emissions and per capita GDP, the Granger causality test was conducted DDLnCOD and DDLnPGDP using Eviews12.0. The test results are shown in Table 5.3.

Table 5.3 The Granger causality test results between DDLnCOD and DDLnPGDP

Null Hypothesis:	Obs	F-Statistic	Prob.
DDLNCOD does not Granger Cause DDLNPGDP	18	5.49095	0.0333
DDLNPGDP does not Granger Cause DDLNCOD		3.48041	0.0818

According to the Granger causality test results in Table 5.3, it can be seen that the null hypothesis that DDLn is not the Granger cause of DDLnPGDP is rejected at the 3.33% level, and the null hypothesis that DDLnPG is not the Granger cause of DDLnCOD is rejected at the 8.18% level. At the 5% confidence level, this can conclude that there is a unidirectional causal relationship between the second-order difference of chemical oxygen demand emissions in Jiangsu Province and the second-order difference of per GDP in Jiangsu Province.

5.5. Analysis of the Environmental Kuznets Curve in Jiangsu Province

We select Jiangsu Province's per capita GDP from 2000 to 2020 as the measure of economic growth, sulfur dioxide emission from 2000 to 2020 as the measure of air pollution, and the general industrial solid waste and hazardous waste generation 2000 to 2020 as the indicators of solid pollution. Using Eviews12.0 software, we fit the model with linear quadratic, and cubic curves, respectively, to derive the most suitable environmental Kuznets curve for Jiangsu Province.

The Kuznets curve equation for SO2 emissions and per capita GDP in Jiangsu Province is shown in equation (2):

$$\underset{}{LnSO2} = \underset{(2.57)}{568.05} - \underset{(-2.62)}{168.32LnPGDP} + \underset{(2.75)}{16.40LnPGDP^2} - \underset{(-2.89)}{0.54LnPGDP\text{^}3} \tag{2}$$

$$R^2 = 0.87 \qquad F = 38.8 \qquad DW = 1.19$$

As can be seen from the results of equation (2), the model fits well, and all the coefficients pass the T test. The Knets curve for sulfur dioxide emissions in Jiangsu Province is an inverted N-shaped curve, and it has already passed the second turning point of the inverted N-shaped curve As per capita GDP in Jiangsu Province continues to grow, sulfur dioxide emissions will continue to decline, which is highly consistent with the actual situation. This indicates that growth in Jiangsu Province is transforming towards lower air pollution, and it shows that Jiangsu Province has made great achievements in air pollution control

The Kuznets curve equation for the generation of general industrial solid waste and per capita GDP in Jiangsu Province is as shown in (3):

$$LnGT = \underset{(-4.12)}{-13.14} + \underset{(5.91)}{3.58LnPGDP} - \underset{(-4.92)}{0.14LnPGDP\text{^}2} \tag{3}$$

$$R^2 = 0.99 \qquad F = 594.88 \qquad DW = 1.62$$

Based on the results of Equation (3), the model fits well, and all data have passed the T-test. The Kuznets curve for the generation of general industrial solid waste in Jiangsu Province conforms to an inverted U-shaped curve, but as of 2020, the inflection point of the inverted U-shaped curve has not yet been reached. According to the model predictions, when the per capita GDP of Jiangsu Province reaches 335,000 yuan, the Kuznets curve for the generation of general industrial solid waste will reach its inflection point. After reaching this inflection point, with the increase in per capita GDP, the generation of general industrial solid waste will decrease accordingly.

Similarly, the Kuznets curve equation for the generation of hazardous waste and per capita GDP in Jiangsu Province is as shown in Equation (4):

$$LnWx = \underset{(8.05)}{55.35} - \underset{(-7.96)}{10.38LnPGDP} + \underset{(8.60)}{0.53LnPGDP\text{^}2} \tag{4}$$

$$R^2 = 0.97 \qquad F = 277.86 \qquad DW = 1.34$$

Based on the results of Equation (4), the model fits well, and all data have passed the T-test. The Kuznets curve for the generation of hazardous waste in Jiangsu Province conforms to a U-shaped curve, and the sample points have already surpassed the inflection point of the U-shaped curve. With economic growth, there is a gradual increasing trend in the generation of hazardous waste. The reason for this is inadequate government supervision, low illegal costs for enterprises, and ease in evading regulatory penalties.

In summary, the governance of sulfur dioxide emissions in Jiangsu Province is satisfactory. The generation of general industrial solid waste has not yet surpassed the Kuznets inflection point. With the continuous development of Jiangsu's economy, technological advancements, and optimization of industrial structure, it is expected that the inflection point will be reached within the next 10 years. After that, the environmental conditions in Jiangsu Province will further improve. However, there is an increasing trend in the generation of hazardous waste, and efforts to manage hazardous waste need to be strengthened in the future.

6. Policy recommendations

Through empirical analysis, this paper finds a one-way Granger causality between the second-order differences of chemical oxygen demand (COD) emissions and per capita GDP in Jiangsu Province. The Kuznets curve for sulfur dioxide emissions in Jiangsu Province exhibits an inverted N-shape and has already surpassed the second inflection point. The Kuznets curve for general industrial solid waste generation in Jiangsu Province presents an inverted U-shape and is still on an upward trend, indicating that the issue of solid pollutants will continue to intensify with economic growth. Based on these analytical conclusions, this paper proposes the following policy recommendations.

Firstly, optimize the industrial structure and accelerate industrial transformation and upgrading. Jiangsu Province's industrial structure is gradually shifting towards the tertiary industry, but the proportion of the secondary industry remains high overall, and the secondary industry belongs to high-energy consumption and high-pollution industries. To reduce the negative impact of environmental pollution, the economic proportion of the secondary industry should be appropriately reduced, and the tertiary industry should be vigorously developed. At the same time, it is necessary to actively promote industrial optimization and upgrading, vigorously develop the new energy industry, actively seize market and technological commanding heights, achieve new breakthroughs in the development of key technologies and high-end products, and form industrial agglomeration areas with distinctive features and influence nationwide.

Secondly, optimize energy consumption and promote energy conservation and emission reduction. Jiangsu Province has always been a major energy consumer, especially with high consumption of coal resources. The massive use of fossil energy poses a heavy burden on the ecological environment and is not aligned with China's current goals of "carbon peaking and carbon neutrality." In its future development, Jiangsu Province should further increase the use of renewable and clean energy, reducing the dependence of economic development on fossil energy such as coal. At the same time, the environmental protection system should be further improved, starting from the source, excluding projects with high energy consumption, high material consumption, and high pollution. Priority should be given to the development of green industries and the introduction of large-scale, intensive, and high-tech industries. Additionally, the promotion of the green economy should be intensified, the current environmental protection system should be improved, and the environmental protection level of enterprises should be enhanced.

Thirdly, increase the illegal costs for enterprises and strengthen the government's supervisory functions. Currently, relevant environmental protection regulations are not yet complete, and the main legal basis for environmental protection is the "Environmental Protection Law of the People's Republic of China." Clear and feasible laws and regulations for different types of enterprises and different types of environmental violations have not yet been formulated, and many environmental protection departments face practical issues such as difficulty in law enforcement. This has led many highly polluting enterprises to have a lucky mindset, developing high-pollution enterprises in defiance of the law, and the penalties for illegal emissions are still insufficient. For these highly polluting enterprises, the current environmental illegal costs are still relatively low. In the future development process, Jiangsu Province should strengthen the government's supervisory functions, promptly introduce various policies, clarify the division of responsibilities among different departments, strengthen supervision and management of enterprises, increase the illegal costs for enterprises, and avoid permanent ecological damage due to inadequate supervision.

References

[1] Tian Y J. Study on the relationship between environmental pollution and economic growth in Hebei Province. 2019.Yanbian University,MA thesis.

[2] Grossman,GeneM,Krueger,AlanB. Environmental Ipacts of a North American Free Trade Agreement,NBER working Paper,1991,No.3914.

[3] Shafik,N,BandyoPadhyay.Eeonomic Growth and Environmental Quality:Time Series and Cross-county Evidence,Background Paper for world Development Report,1992.

[4] Markandya, Anil,Golub,Alexander,Pedros-Galinato,Suzette.Empirical Analysis of National Income and SO2 Emissions in Selected European Countries. Environmental &Resource Economies,2006, vol.35:221-257.

[5] Mao Hui, Wang Li. Testing the Environmental Kuznets Curve for Industrial Pollution: An Empirical Study Based on Provincial Panel Data in from 1998 to 2010[J]. Studies in Macroeconomics, 2013, No.172(0):89-97.

[6] Wang Min, Huang Ying. Environmental Pollution and Economic Growth in China[J]. Economic Quarterly, 2015, 14(0):557-578.

[7] Wang Shuwen, Wang Jingcheng. Nonlinear relationship between urban household waste and economic growth: Empirical analysis based on the environmental Knets curve[J]. China Population, Resources and Environment, 2022, 32(02): 63-70.

[8] Zhao Xiaoman, Zhang Shuai, Yuan Changwei. Spatial Econometric Test of the Environmental Kuznets Curve for China's Transportation SectorJ]. Statistics and Decision, 2021, 37(04): 23-26.