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Research Article

An Empirical Analysis of Jiangxi Province's Financial Development, Economic Growth, and Environmental Pollution

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Since the reform and opening up in 1978, the economic development in China has experienced a rapid growth stage. Statistics show that annual GDP has grown at an average rate of nearly 10%, and the annual per capita GDP growth rate has also approached 9%. With the rapid economic growth, the problem of environmental pollution across the country has become increasingly serious, and the environmental quality has been deteriorating, which has attracted the attention of many parties in the whole society. The relationship between economic growth and environmental quality has become a hot issue in various fields. First of all, this article introduces basic concepts such as economic development, environmental quality, environmental Kuznets curve, and the relationship between economic development and environmental quality. Afterwards, it analyzes the current situation of Jiangxi Province's economy and environment from the aspects of Jiangxi Province's economic aggregate, industrial structure, development mode, overall law of environmental quality, and industrial waste release. Secondly, this study constructs the evaluation index system of the economic and environmental relationship in Jiangxi Province and uses the principal component analysis method to screen the primary economic and environmental indicators, providing evaluation criteria for the establishment of the economic development and environmental quality relationship model of Jiangxi Province. Third, the relationship between the main economic environment indicators after the principal component analysis is simulated, and the EKC model of Jiangxi Province is established. The research results show that the environmental Kuznets curve in Jiangxi Province is not all the typical inverted U shape in developed countries, that is, environmental pollution does not necessarily show a trend of first rising and then falling with the increase of per capita income, but it appears as N-shaped, half of the inverted U shape, and even repeated fluctuations.

1. Introduction

The rapid development of social economy has improved people's living standards to a large extent. People are paying more attention to improving their own quality of life while paying attention to the improvement of their material living standards. The quality of the environment is also a standard for measuring the quality of life [1]. At this time, the people pay more attention to the problems of environmental pollution and ecological damage, and the desire to improve the environmental quality is also stronger with the higher the degree of economic development. The problem of increasingly degraded environmental resources is an important problem that hinders the sustainable development of the future economy, and it is directly related to the future development of all countries [2, 3]. Coordinating the relationship between economic development and environmental quality is a key issue that countries all over the world must take seriously and properly handle now.

Western scholars' empirical research on the relationship between economic growth and environmental quality began in the early 1990s [4]. Grossman and Krueger (1991) first conducted a groundbreaking empirical study on the relationship between the economy and the environment. They analyzed the changes in 14 air pollutants and water pollutants in 66 countries from 1979 to 1990 and found that the long-term relationship curve between economy growth and environmental quality changes has an inverted U-shaped characteristic [5, 6]. When the level of economic development is low, the degree of environmental pollution is relatively light, but as the economy further grows, the degree of environmental degradation intensifies. When the economic development reaches a certain level, the degree of environmental pollution will decrease with the further economic growth. As a result, the environmental quality has gradually improved [7, 8].

Some scholars have found that in the early stages of economic development, the extent of forest damage has deteriorated with the increase in per capita income [9]. However, with the further development of the economy, the extent of forest damage will be improved with the increase in per capita income, further confirming that the relationship between changes in environmental quality and per capita income level presents an inverted U-shaped curve [10, 11]. They considered that this inverted U-shaped curve is similar to the Kuznets curve proposed by economist Kuznets when he studied the relationship between per capita income and the degree of fairness of distribution [12]. The inverted U-shaped curve presented by the relationship is called environmental Kuznets curve (EKC). Since the environmental Kuznets curve (EKC) theory was put forward, many scholars at home and abroad have tested and verified the EKC theory [13, 14]. Usually, people use cross-section, time series, and panel data to study whether the relationship between economic growth and environmental quality in a specific country or region has an inverted U-shaped shape feature or other shapes such as positive U [15, 16].

Since China only started to collect statistics and release data on environmental pollution late, the domestic understanding and research on the relationship between economic growth and environmental quality also started late. The research of domestic scholars is mainly reflected in two aspects: the first is to use China as the research object, using time series data or panel data to conduct empirical analysis; the second is to use various regions and provinces, cities, and autonomous regions as the research object, using cross-sectional data or time series data for empirical research [17–19]. Located in Southeast China, it is a traditional agricultural province with good natural conditions and resource distribution. From a geographical point of view, Jiangxi Province has a geographical advantage. It is connected to the Yangtze River in the north and the three developed coastal provinces of Zhejiang, Fujian, and Guangdong to the southeast [20–22]. It could have used this advantage to undertake the transfer of coastal industries and develop the regional economy. The actual situation is not. Jiangxi Province did not make full use of its location and resource advantages to enhance its own economic strength. On the contrary, the economic gap between Jiangxi Province and the developed regions has widened. In terms of improving environmental quality, Jiangxi Province is still facing greater pressure. At present, there are few empirical analysis documents on the relationship between economic growth and environmental quality in Jiangxi Province [23–25]. This article takes Jiangxi Province as the research object and intends to use relevant data from Jiangxi Province to explore the relationship between economic growth and environmental quality in Jiangxi Province.

2. Materials and Methods

2.1. EKC Curve. In the early 1950s, when U.S. economist Kuznets studied the relationship between per capita GDP and the degree of income distribution, he used a lot of data to conduct statistical analysis and found that changes in income distribution would show up in different stages of economic development [26–28]. That is, in the initial stage of economic development, the gap in national income distribution is small, but as the economy continues to develop, the gap in income distribution gradually widens, and finally, the gap decreases. The relationship between the two shows an inverted U-type curve shape on the number axis. Later, Grossman and Krueger and Panayotou Gen Zheng analyzed their respective experiences and put forward the hypothesis of the environmental Kuznets curve (EKC), pointing out that the relationship curve between economic growth and environmental quality has an inverted U-shaped characteristic [29–31].

First of all, when the level of economic development is low, most countries are in the stage of poverty alleviation or the economy is just beginning to take off, the level of technology is low, and the degree of environmental pollution is relatively light. However, with the increase of national income, the proportion of high-pollution and high-energy-consuming industries in the national economy has continued to increase, the intensity of pollution emissions has increased, the investment in pollution control has been limited, the rate of energy consumption has accelerated, and the environmental quality has been declining [16, 32, 33]. This is because the economic growth method at this time is extensive, paying more attention to economic development, resource consumption is greater than the benefits brought by economic growth, and environmental quality is deteriorating day by day. Secondly, when the economy develops to a certain level, that is, a specific turning point, the deterioration of environmental quality also reaches its peak, and then as the economy further grows, the environmental quality gradually improves [34, 35]. This is because the industrial structure has been adjusted at this time, technological progress has reduced the intensity of pollution emissions, and the proportion of low-polluting industries in the national economy has increased. Humans have become increasingly demanding on environmental quality, and their environmental awareness has strengthened, and they have begun to manage the environment [36]. While paying attention to economic development, all countries also pay attention to improving the quality of the environment. The development of the economy no longer comes at the expense of the environment, but to gradually improve the environmental quality through multiple channels and channels [37].

2.2. Principal Component Analysis. When analyzing the overall status of each subsystem, the overall evaluation result is generally seriously interfered by the calculation of the index data weight and other factors, which leads to increased errors. As each subsystem selects a large number of indicators, there is a certain connection between the indicators [38, 39]. In order to eliminate the relevant indicators of each subsystem, comprehensive evaluation and selection were made between statistical analysis methods such as fuzzy comprehensive evaluation, principal component analysis, gray cluster analysis, and factor models [40]. It was found that the principal component analysis method is an effective method to solve the overlap of indicator information in the comprehensive evaluation of indicators. Because principal component analysis can use the Z-score function of a modern statistical software SPSS to achieve the standardization of indicator data, the eigenvalues and cumulative variance contribution rates obtained from the table are clear at a glance, which is very intuitive [41].

The principal component analysis method has its own unique advantages: simple and quick simplification of indicators, removing redundant and miscellaneous information irrelevant to the research content. It is easy to operate and is suitable for those who are new to statistical analysis methods to conduct research and study [42]. Principal component analysis of a selected category of indicators can rearrange a large number of interrelated original indicators to obtain an independent overall indicator. While well eliminating the impact of the correlation between indicators, the new indicator retains the main information of the original indicator [43]. At the same time, according to personal research needs, the threshold of the cumulative contribution rate of the selected principal components can be set, and the dimensionality reduction can make the research goals and directions more accurate and clearer. In this way, the index data that removes the complex and redundant information selects the most targeted research data, which not only ensures that the research content is not distorted but also converts multiple indicators into a few comprehensive indicators, making the research more prominent.

2.3. Evaluation Index System. According to the previous evaluation index system, it is generally divided into economic system and environmental system. The economic system usually contains the following indicators, namely, the overall economic situation, industrial structure, production vitality, economic efficiency, and development speed. There are four environmental subsystems: atmospheric environmental index, water environmental index, solid waste environmental index, and ecological protection and destruction index. According to the research needs, this paper selects 12 economic development and environmental quality indicators. Through these indicators, the relationship between economic development and environmental quality in Jiangxi Province is studied, and the indicator system is constructed as shown in Table 1.

Table 1: Index evaluation system table.

Indicator system	Specific index content
Economic development system	$X1$ GDP per capita
	$X2$ fiscal revenue
	$X3$ investment in fixed assets
	$X4$ gross industrial output value
	$X5$ per capita consumption level of residents
Environmental subsystem	$Y1$ industrial wastewater discharge
	$Y2$ industrial waste gas emissions
	$Y3$ amount of solid waste generated
	$Y4$ sulfur dioxide emissions
	$Y5$ total smoke and dust emissions
	$Y6$ output value of comprehensive utilization of three wastes (waste water, waste gas, and solid waste)
	$Y7$ comprehensive utilization of solid waste

3. Results

3.1. Current Situation of Economic Development in Jiangxi Province. Figure 1 shows that from 2004 to 2018, the total GDP of Jiangxi Province has been on the rise. The GDP of Jiangxi Province in 2004 was 349.594 billion yuan. By 2018, the GDP of Jiangxi Province reached 2198.478 billion yuan, an increase of more than 500%.

Figure 2 shows that the proportion of primary, secondary, and tertiary industries in GDP has changed from 20.4%, 45.6%, and 34% in 2004 to 8.6%, 44.6%, and 46.8% in 2018, respectively. The proportion of primary industry keeps getting smaller. With the economic growth of Jiangxi Province, the adjustment of the industrial structure has been continuously rationalized, and the industrial layout structure has been continuously optimized. With the advancement of agricultural industrialization policies, traditional agriculture is gradually transforming into modern agriculture, and the industry-led pattern has accelerated. The secondary industry is still a pillar industry for economic growth. Jiangxi Province is still in the process of rapid industrialization. The tertiary industry has accelerated its development, its share of GDP has gradually increased, and the gap with the share of the secondary industry has gradually narrowed. In 2018, the share of the tertiary industry was greater than that of the secondary industry. Overall, the secondary and tertiary industries jointly promote economic development.

3.2. Current Situation of Environmental Quality in Jiangxi Province. It can be seen from Figure 3 that from 2004 to 2010, wastewater discharge showed a slow growth trend. In 2011, wastewater discharge increased rapidly. In 2011, the discharge of wastewater reached 1944.32 million tons, more than twice that of 2010. Since 2012, wastewater discharge has shown a slow growth trend. In 2018, the discharge of wastewater has decreased.

It can be seen from Figure 4 that from 2004 to 2018, solid waste emissions in Jiangxi Province showed an overall upward trend. In 2004, the amount of solid waste discharged in Jiangxi Province was 65.24 million tons. By 2018, the amount of solid waste discharged was 123.41 million tons, which was nearly twice that of 2004.

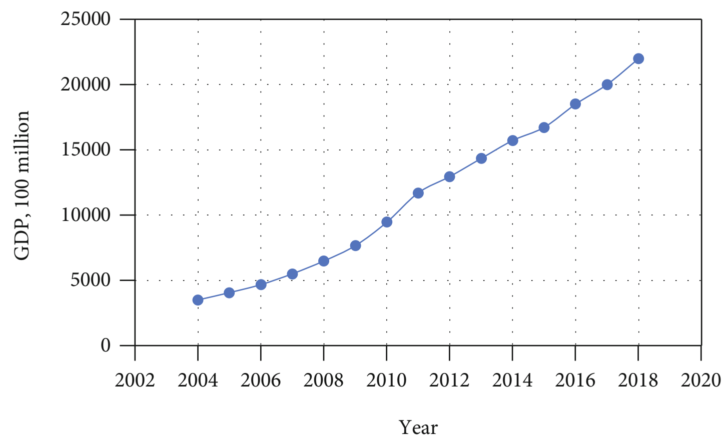

Figure 1: The GDP of Jiangxi Province from 2004 to 2018.

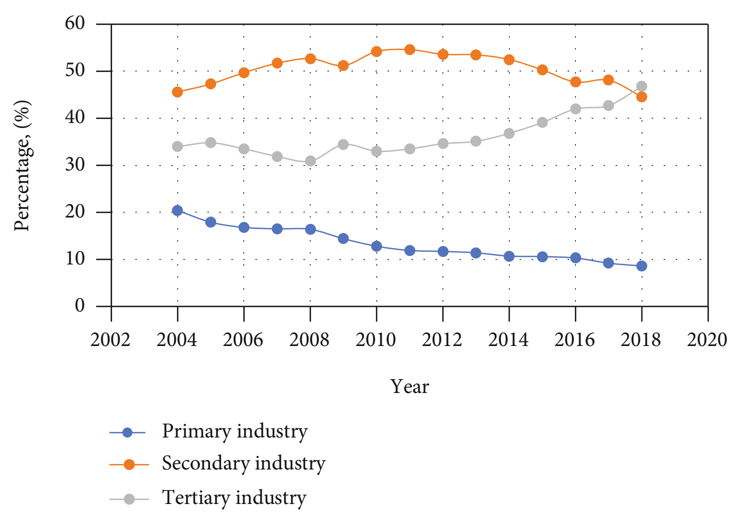

Figure 2: The proportion of the three major industries in 2004-2018.

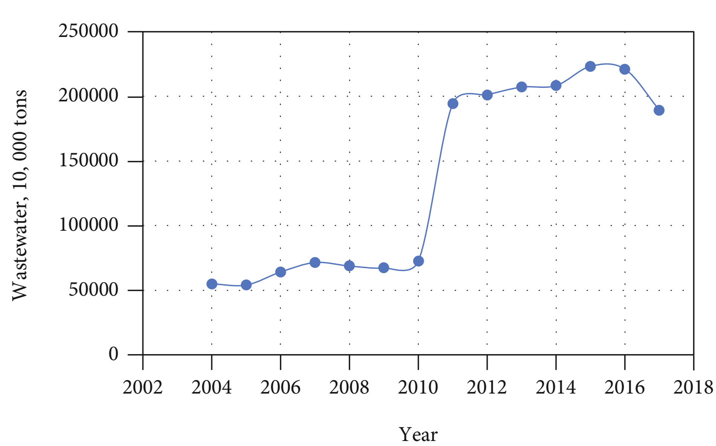

Figure 3: Wastewater discharge in Jiangxi Province from 2004 to 2018.

Air pollution mainly includes sulfur dioxide, smoke and dust emissions, and metallurgy, nonferrous metals, and building materials industries are the main sources of pollution. Jiangxi Province is relatively rich in natural resources, especially nonferrous metals and metallurgy, which have become the main sources of waste gas emissions. With economic development, exhaust emissions have basically continued to rise year by year and occasionally only drop a

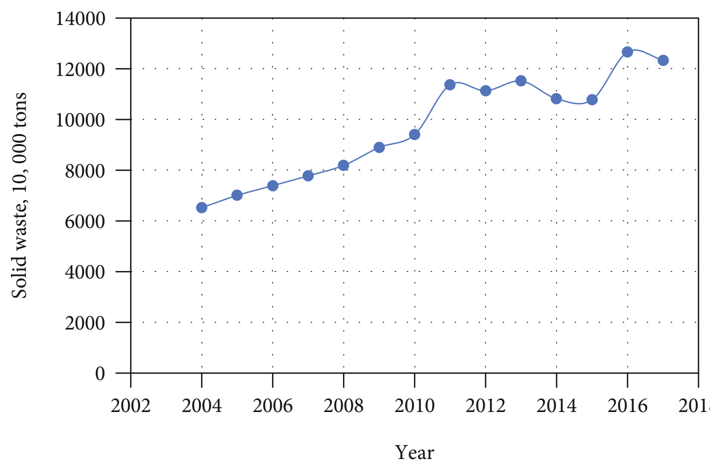

FIGURE 4: Solid waste emissions in Jiangxi Province from 2004 to 2018.

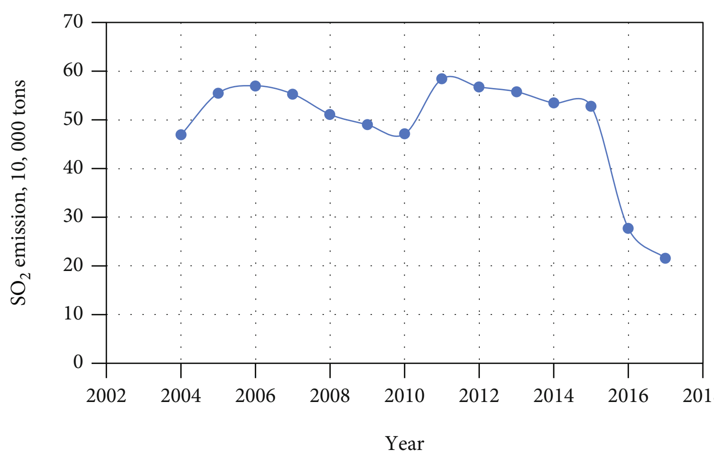

FIGURE 5: SO_2 emissions in Jiangxi Province from 2004 to 2017.

little in a few years. The rapid development of the traditional three-high industry has put a lot of pressure on the environment. It can be seen from Figure 5 that SO_2 emissions increased slowly from 2004 to 2006 and then began to slowly decrease. In 2011, SO_2 emissions increased. From 2011 to 2015, SO_2 emissions declined slowly. After 2015, SO_2 emissions fell sharply. Industrial smoke and dust emissions in Jiangxi Province have shown a downward trend overall (Figure 6).

3.3. Principal Component Analysis. The selection of the number of principal components can be determined according to the characteristic roots of the correlation coefficient matrix. The characteristic roots of the correlation coefficient matrix are just equal to the variance of the principal components, and the variance is one of the important criteria for judging the information contained in variable data. There are three criteria for determining the number of principal components according to the value of the principal component score: one is to take only the principal components whose initial characteristic root score is greater than that. The second is the principal component corresponding to the characteristic value whose cumulative percentage reaches more than 95%. The third is to determine the number of principal components according to the mutation point of the characteristic root value change.

3.3.1. Selection of Principal Components-Economic Indicators. After entering five economic development indicators using statistical software SPSS17.0, the results are summarized in Table 2.

It can be seen from Table 2 that only the eigenvalue corresponding to the first principal component is greater than 1, which means that the variance of the principal component score is greater than 1. This article extracts the principal component based on this criterion. The cumulative score value corresponding to the first principal component reaches 98.8%, which is far greater than the set 95%, which implies that as long as the first principal component is selected, the amount of information is sufficient.

3.3.2. Selection of Principal Components-Environmental Quality Indicators. After using the statistical software SPSS17.0 to enter the seven environmental quality indicators of the preliminary selection, select the corresponding

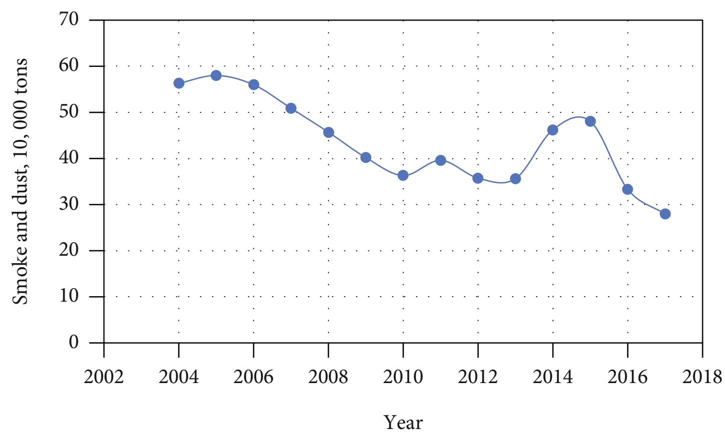

FIGURE 6: Industrial smoke and dust emissions in Jiangxi Province from 2004 to 2017.

TABLE 2: Summary table of characteristic roots of economic development index correlation coefficient matrix.

Component	Total	Initial Eigen values of variance, %
*X*1	4.863	98.800
*X*2	0.052	1.100
*X*3	0.004	0.100
*X*4	0.002	0.000
*X*5	0.000	0.000

TABLE 3: Summary table of characteristic roots of correlation coefficient matrix of environmental quality indexes.

Component	Total	Initial Eigen values of variance, %
*Y*1	5.253	73.284
*Y*2	1.315	18.345
*Y*3	0.308	4.297
*Y*4	0.148	2.065
*Y*5	0.105	1.465
*Y*6	0.032	0.446
*Y*7	0.007	0.098

options for statistics according to the needs of principal component analysis, and the results are shown in Table 3.

The data in the above table is the characteristic root value of the correlation coefficient matrix obtained by the principal component analysis of the selected environmental quality indicators. It can be seen that the eigenvalue corresponding to the first two principal components is greater than 1, that is, the variance value of the principal component score is greater than 1, and combined with the comprehensive cumulative contribution rate, it is not until the third cumulative contribution rate reaches our setting target of 95%. Thus, if wastewater, waste gas, and solid waste are selected as the main components, the amount of information is sufficient. After the above analysis, the main component indicators of Jiangxi Province's environmental system are selected from industrial wastewater emissions, industrial waste gas emissions, and industrial solid waste generation with a large cumulative contribution rate. This is also in line with the reality of environmental pollution in Jiangxi Province.

3.4. EKC Model Analysis. The SPSS software was used to obtain the EKC fitting curves of Jiangxi Province's GDP, industrial wastewater, waste gas, and solid waste, to describe the relationship between the economic development level and environmental quality level of Jiangxi Province.

3.4.1. Analysis of the Relationship between GDP Per Capita and Wastewater Pollution. It can be observed from Figure 7 that the relationship between per capita GDP and industrial wastewater discharge in Jiangxi Province exceeds the turning point of the EKC curve. The theoretical calculation value of per capita GDP corresponding to the turning point is about 36,000 yuan (per capita GDP in 2016 was 36,724 yuan), indicating that industrial wastewater discharge is basically under control in the short term and is beginning to develop towards a benign state. It shows that with the increase of income in Jiangxi Province, the degree of environmental pollution has intensified. When the economic development reaches a certain level and reaches the critical point, namely, the per capita GDP of 36,000 yuan, the environmental pollution situation will improve with the continuous increase of per capita income, and the environmental quality will be improved. However, it is found from the figure that the wastewater discharge volume did not drop continuously afterwards but showed a state of repeated fluctuations. After analysis, the emergence of the inflection point of EKC in Jiangxi Province is due to the increase in sewage treatment in recent years and the continuous increase in wastewater treatment investment.

3.4.2. Analysis of the Relationship between GDP Per Capita and Waste Gas Pollution. By simulating the relationship between per capita GDP and industrial waste gas in Jiangxi Province from 2004 to 2017, it is found that the SO_2 curve of Jiangxi Province conforms to the typical EKC curve of developed countries (Figure 8). This shows that with the continuous deepening of economic development in Jiangxi

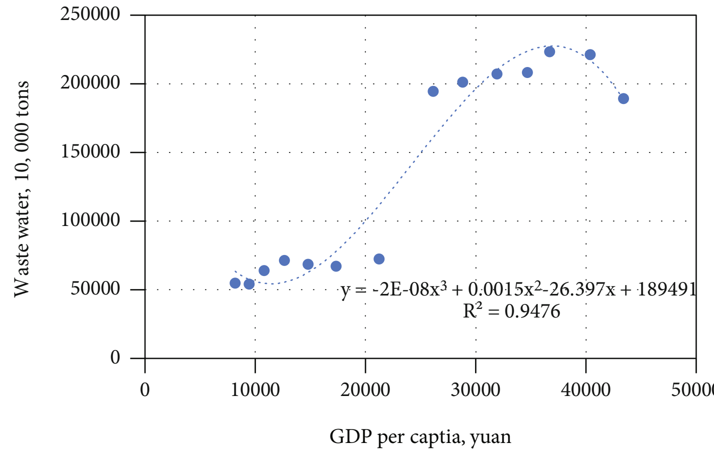

Figure 7: The EKC curve of per capita GDP and industrial wastewater discharge in Jiangxi Province.

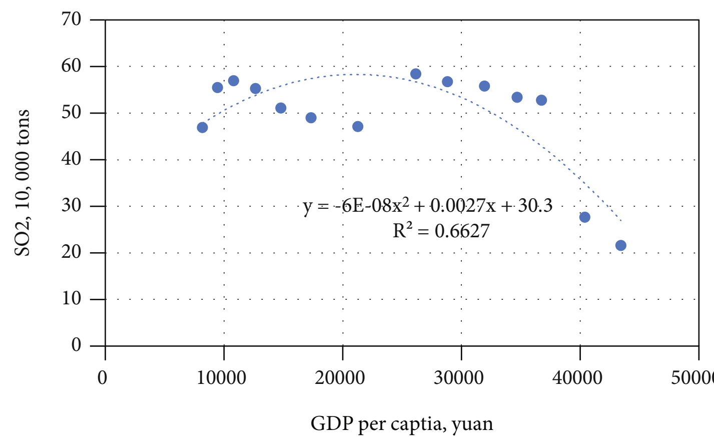

Figure 8: The EKC curve of per capita GDP and industrial SO_2 emissions in Jiangxi Province.

Province and the continuous increase of per capita income, SO_2 emissions have a relatively downward trend. Figure 9 shows that the EKC curve of industrial smoke and dust emissions and per capita GDP do not conform to the typical EKC curve of developed countries. With the increase of GDP per capita, the emissions of industrial smoke and dust will first decrease, then increase, and then decrease.

3.4.3. Analysis of the Relationship between GDP Per Capita and Solid Waste Generation. Through the simulation of the relationship between per capita GDP and industrial solid waste in Jiangxi Province from 2004 to 2018, it is found that the solid waste curve of Jiangxi Province is specifically expressed as the left half of the typical EKC curve, that is, the relationship between industrial solid waste and per capita GDP is shown in Figure 10. Figure 10 depicts the relationship between GDP per capita and the amount of industrial solid waste generated from 2004 to 2018. The relationship between the two is still in the left half of the inverted U shape, that is, in the rising stage of the typical EKC curve, and failed to cross the curve. This shows that with the economic growth in recent years, the amount of solid waste generated has not been effectively controlled and even has an increasing trend. Judging from this sign, there is still a long way to go before the relationship between per capita GDP and the EKC curve of solid waste production reaches an inflection point and goes to a decline stage.

3.5. Suggestions

3.5.1. Optimize the Industrial Structure and Transform the Development Mode. It took China several decades to complete the process of industrialization in Western countries that required hundreds of years. The law of industrial structure changes in the process of industrialization in Western countries is not entirely suitable for the actual conditions in China. China should formulate corresponding industrial structure policies based on its own conditions and optimize the industrial structure. As the tertiary industry has the characteristics of low pollution, low consumption, high output, and high employment, the tertiary industry should be vigorously developed to provide opportunities for green development. According to the situation in Jiangxi, we should continue to advance the process of industrialization, adjust the industrial structure, accelerate the technological transformation of traditional industries, and vigorously develop tertiary industries such as ecological agriculture and tourism.

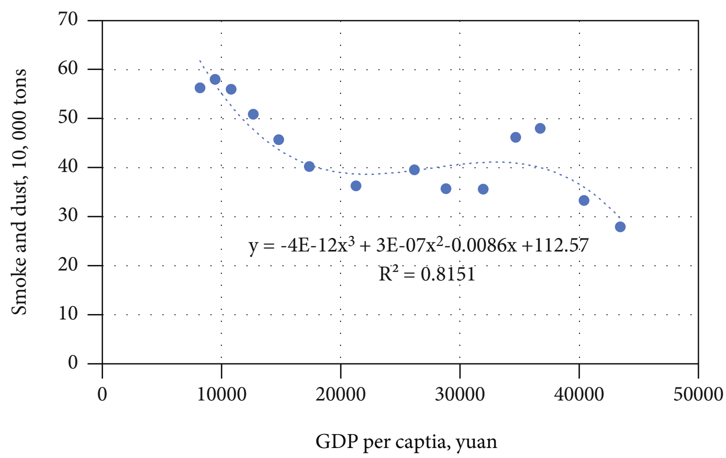

Figure 9: EKC curve of per capita GDP and industrial smoke and dust emissions in Jiangxi Province.

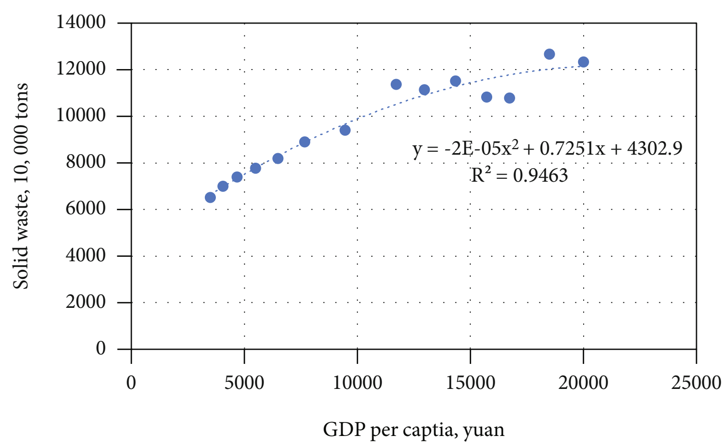

Figure 10: The EKC curve of per capita GDP and industrial solid waste emissions in Jiangxi Province.

3.5.2. Improve the Legal System. The government's promulgation of laws, regulations, and policies related to environmental protection has created a good foundation for improving environmental quality and helped to improve environmental quality. We need to improve the laws, regulations, and standards for energy conservation and emission reduction, strengthen the responsibility assessment of energy conservation and emission reduction targets, and improve the accountability system for major environmental incidents and pollution accidents. We should give governments at all levels the responsibility to protect the environment and strictly hold the responsible person of the government responsible for destroying the environment. Through environmental laws, regulations, and policies, the government can supervise, motivate, and guide enterprises to improve resource utilization efficiency and protect the surrounding ecological environment, improve enterprise production efficiency, and promote economic growth. We should improve the price formation mechanism of resource products and the resource and environmental tax and fee system, optimize the energy structure, and reasonably control the total energy consumption. We also need to strengthen the construction of environmental supervision, monitoring, early warning and emergency response capabilities, increase environmental protection law enforcement, implement strict environmental access, and establish an environmental protection social supervision mechanism.

3.5.3. Improve the Level of Technological Innovation. We need to increase capital investment in scientific and technological research and development, improve the efficiency of the use of research and development funds, encourage enterprises to improve the level of scientific and technological innovation, and save and recycle resources, so that resources can be used more effectively. Technological progress can promote the application of environmental protection technology and cleaner production technology, increase the technological content of production equipment, reduce the intensity of pollution emissions per unit of product, and reduce the amount of pollutant emissions. We need to improve the energy-saving and emission-reduction restraint and incentive mechanism, stimulate the internal green innovation mechanism of enterprises, encourage enterprises to strengthen communication and exchanges with domestic and foreign universities and scientific research institutions, integrate production, research and development, and improve the level of enterprise production technology. We need to promote the development of circular economy and make the economy develop in a sustainable and healthy way towards a resource-saving and environment-friendly form.

4. Conclusion

(1) By simulating the relationship between the main economic development indicators and environmental quality indicators after the principal component analysis, it is concluded that EKC curves between the per capita GDP of Jiangxi Province and the three environmental of industrial wastewater, industrial waste gas, and industrial solid waste do not fully conform to the typical inverted U shape of developed countries, that is, the amount of environmental pollution does not necessarily show a trend of rising first and then falling with the increase of per capita income. This is due not only to the single reason that the selected countries and regions are different but also to other factors such as nature, history, social development stages, government policies, environmental investment costs, and the public's environmental awareness

(2) The positive interaction between the economy and the environment in Jiangxi Province has not really formed. Economic development should formulate corresponding solutions based on specific key environmental problems. At present, research on the relationship between economy and environment has achieved certain results, but there are still many problems. For example, the selected year of economic and environmental indicator data is relatively short. Compared with the research results made by developed countries using long-term monitoring data, it cannot observe problems well and predict future trends

Data Availability

The figures and tables used to support the findings of this study are included in the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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