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Retraction

Retracted: Analysis of the Coupled and Coordinated Relationship between Emission of Carbon: International Growth of Economy-Conservation of the Environment in China

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] Z. Lan, "Analysis of the Coupled and Coordinated Relationship between Emission of Carbon: International Growth of Economy-Conservation of the Environment in China," *Mobile Information Systems*, vol. 2022, Article ID 9373389, 11 pages, 2022.

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Research Article

Analysis of the Coupled and Coordinated Relationship between Emission of Carbon: International Growth of Economy-Conservation of the Environment in China

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The coordinated and orderly development of both growth of economy and conservation of the environment is an important part of enhancing regional support capacity and achieving sustainable development. However, at the same time, the problem of environmental pollution and ecological damage in the province cannot be ignored more and more because of the lower resource utilization efficiency. The relationship between the emission of carbon and the growth of economy is a complex one. Energy, as an inherent driving factor of growth of economy, inevitably leads to the generation of emission of carbon while promoting the growth of economy. In such a context, how to reconcile energy consumption, emission of carbon, and economic growth is particularly important on the road to developing a low-carbon economy in China. The coordination of energy, economic, and environmental systems has a great impact on economic and social development, and only the coordinated development of energy, economic, and environmental systems is an important prerequisite to achieve sustainable economic and social development. This article frames the coupled coordination of emission of carbon international growth of the economy conservation of the environment in China and builds a theoretical foundation by defining relevant concepts and theories, summarizing the current situation of development, analyzing existing problems, and sorting out related mechanisms. The experimental results show that the results of lnc, lngdp, and lngdp2 are all at the 3% confidence level, so the coupled coordination model is very feasible. Therefore, this study can better play the role of the promotion between the two and use the coupled coordination model to quantitatively measure and analyze the coupling state of the emission of carbon and ecological environment in China, and deeply analyze the coupling state of growth of economy and ecological environment, so as to better realize the win-win situation of sustainable development of international growth of economy and protection of ecological environment.

1. Introduction

The dramatic increase in the energy emission of carbon driven by the growth of economy has led to global warming and caused a series of environmental problems [1]. The contradiction between energy conservation and emission reduction with the growth of economy and conservation of the environment is becoming increasingly prominent [2]. The long-term crude model of using material resource consumption to drive economic growth has not only distorted the economic structure and weakened the momentum of long-term growth of economy, but also polluted the environment, making environmental problems increasingly prominent [3]. The most important and dominant greenhouse gas that affects temperature change is carbon dioxide, so the main task to stop global warming is to reduce the emission of carbon dioxide [4]. However, fossil energy consumption accelerates a country's economic growth and also brings a series of serious problems such as energy depletion, high foreign dependence, irrational consumption structure, environmental pollution, and ecological degradation [5]. This has become a bottleneck for economic growth to some extent and threatens the sustainable growth of a country's economy [6].

As an important material basis for the existence and development of human society, the strategic development of energy has been related to the stability of national economy and society [7]. However, the dramatic increase in the energy emission of carbon driven by the growth of economy has led to global warming and caused a series of environmental problems [8]. The rising world sea level, the sharp decrease in species diversity, and the frequent occurrence of extreme weather pose a great threat to the living environment with human beings [9]. The intensification of the warming trend brings a series of ecological disasters, such as causing sea level rise, which directly threatens the survival and development of coastal and island countries [10]. International growth of economy and ecological environment are complex systems that are interconnected, mutually influencing, and mutually constraining, and the accelerated process of international growth of economy and the increasing level of growth of economy make the ecological environment face increasingly obvious pressures such as population, economy, and resources [11]. Therefore, how to coordinate the orderly development of growth of economy, emission of carbon, and environment is a problem worth studying.

The coordinated and orderly development of emission of carbon, growth of economy, and conservation of the environment is an important precondition for enhancing the comprehensive support capacity of the region as well as achieving sustainable regional development [12]. At the same time, the emission of carbon is also the key to achieve regional growth of economy and conservation of the environment and sustainable development [13]. Fossil energy consumption promotes high economic growth on the one hand, and on the other hand, there are problems such as supply and demand conflicts and energy security in the process of fossil energy consumption [14]. At the same time, the utilization process emits a large amount of carbon dioxide, causing a serious greenhouse effect, which in turn has a constraining effect on economic growth and threatens the economy to grow sustainably [15]. The first task to promote the construction of low-carbon international growth of economy is to correctly understand the coupling relationship between the two systems, and the correct understanding of this relationship includes two connotations. We construct an emission of carbon productivity and industry growth of economy index system, explore the coupling coordination degree of emission of carbon and industry growth of economy in China through the coupling coordination degree model and spatial exploratory analysis, and seek the influencing factors with greater correlation between the coordinated development of the two systems in each province and urban area. It provides theoretical basis and reference for each region to formulate differentiated and regionalized policies on low-carbon growth of economy and emission of carbon reduction.

The innovative points of this article are as follows:

(1) This article first takes China's emission of carbon as the research object, and uses the coupling degree and coupling coordination model to make an overall evaluation and spatial and temporal difference analysis on the coordination level between China's economy and environment.

(2) This article selects fossil energy consumption, which dominates the energy consumption structure, and carbon dioxide emission, which causes climate change and is of global concern, as the object of the study, together with economic growth.

(3) From the perspective of industry, the relationship between emission of carbon and industry structure is studied by using the Kuznets curve of emission of carbon, which is a novel perspective to take industry structure as the research object.

The research framework of this article contains five major parts, which are organized as follows.

The first part of this article introduces the background and significance of the study, and then introduces the main work of this article. The second part imports the work related to the coupled coordination model with China's emission of carbon, international growth of economy, conservation of the environment coordination relationship. In the third part, the research methodology and the construction of the coupled energy-economic-environmental coordination model are reviewed, so that the readers of this article can have a more comprehensive understanding of the analysis of the coupled emission of carbon, international growth of economy, conservation of the environment relationship in China. The fourth part is the core of the thesis, which completes the description of the Kuznets curve of the emission of carbon and the weighting analysis of the indicators of the coupled coordination model from two aspects. The last part of the article is the summary of the full work.

2. Related Work

2.1. China's Emission of Carbon International Growth of Economy Conservation of the Environment Coordination Relationship. Eco-conservation of the environment seeks to achieve harmonious development between society, economy, resources, and conservation of the environment, changing the previous single development concept of GDP above all else and integrating the concept of development into economy, society, resources, and environment. More and more scholars are focusing on the harmonious relationship between the growth of economy and ecological environment. Because of the limitations of the social development stage, and economic and technological development level at that time, the research focus of different scholars also differs, and the conclusions reached will naturally be different.

Zhang et al. empirically analyzed the relationship between economic growth and environmental issues and concluded that the most important factors that play a role in the inverted U-shape are structural, technological, and scale effects [16]. Jiang et al. constructed an economic growth model including pollution factors to examine the negative effects of energy consumption under the assumption of endogenous technological progress, analyzed the impact of technological progress and environmental pollution on economic growth, and examined the optimal economic growth path in the presence of the dual constraints of technological progress and environmental pollution [17]. Han et al. empirically investigated the Granger causality and cointegration of the relationship between the emission of carbon, economic income, and export trade, and the analysis resulted in the existence of a one-way Granger causality from economic income to the emission of carbon in Turkey [18]. Jia et al. found in their study of the relationship between energy consumption and GNP in the United States that when they used annual data from 1947 to 1979, they found no causality between energy consumption and GNP, while when the data were replaced with quarterly data, they concluded that there was only a one-way causality from GNP to energy consumption [19]. Zhang et al. measured the effect of economic income, energy intensity, and energy mix on the emission of carbon changes in Greece using the LMDI factor decomposition method and concluded that economic income has the greatest influence among these factors and that changes in economic income have a positive effect on the emission of carbon changes [20].

Global climate change and its impact on social and natural systems have been increasingly concerned by governments and the general public around the world, and the world is entering a new era of energy conservation and emission reduction. This is of great significance for the harmonious development of the growth of economy, emission of carbon, and environment.

2.2. Coupling Coordination Model. Integrating the development between economy, energy, and environment is necessary for China to take active measures to deal with the problem. Constructing a scientific and reasonable evaluation index system for the coupling and coordination degree of emission of carbon, economic, and environmental systems, and gaining an in-depth understanding of the current coupling and coordination degree of carbon, economic, and environmental systems in the western region can effectively assess the overall sustainable development status of the western region. To study the relationship between the emission of carbon and the growth of economy in China, carefully analyze the current situation and characteristics of China's carbon dioxide emissions, and identify the main problems and difficulties faced in developing a low-carbon economy. It is beneficial to deepen the understanding of theoretical issues related to the relationship between the emission of carbon and the growth of economy and the importance of development.

Xie et al. proposed the dualistic economic structure theory and pioneered the construction of an analytical framework for the interrelationship between industry and agriculture [21]. Wang et al. used the input-output model to analyze the relationship between energy policy and the environment and added influencing factors such as technology level variables and prices to the input-output model to study about variables related to energy policy such as energy consumption [22]. Zhang et al. studied that both energy and environment are important determinants of growth of economy and it is only by changing the structure of growth of economy that the quality of the environment can be improved in a real sense [23]. Su proposed the concept of the impact of the growth of economy on the environment and studied the mechanism of the impact of the growth of economy on environmental factors [24]. Niyonzima et al. studied the relationship between energy consumption and GDP in the Philippines and Thailand. Niyonzima et al. used cointegration tests and error correction models to obtain a two-way causal relationship between the two [25].

Greening is a figurative expression to accelerate the construction of ecological civilization under the guidance of scientific development concept, which provides new ideas and new requirements for solving the resource and environmental problems encountered in the development of China's industrialization, informatization, urbanization, and agricultural modernization. The growth of economy needs to be built on the basis of sustainable development of the environment, and the special characteristics of the western region better reflect the importance of studying the degree of coupling and coordination of carbon, economic, and environmental systems in the western region.

3. Analysis of the Coupling Coordination Relationship among China's Emission of Carbon, International Growth of Economy, and Conservation of the Environment

3.1. Coupling Research Method. Energy is a material resource that provides power for human production and energy for life, thus ensuring the normal development of the national economy and the normal operation of people's lives [26]. Therefore, on the basis of following the principles of index system construction, the evaluation index system of the emission of carbon and growth of economy coordination is constructed [27]. Research based on the perspective of the coupled and coordinated relationship of the emission of the carbon growth of economy conservation of the environment triad system is important to promote the sustainable development of regional society and economy. The mechanism diagram of the emission growth of the economy conservation of the environment interaction is shown in Figure 1.

First, the growth of economy provides financial and technical support for the emission of carbon, which is conducive to improving the efficiency of the emission of carbon, increasing carbon productivity and thus promoting energy conservation and emission reduction. It must be objective, clearly defined, and also representative, and can truly reflect China's economic and environmental conditions, and can be effectively quantified. The coupled coordination degree model of the emission of carbon-economy-environment system is

$$G_{123} = f(X, Y, Z) = \sqrt{E_{123} \times (\alpha F_1 + \beta F_2 + \gamma F_3)}, \quad (1)$$

where α, β, γ are the undetermined coefficients.

Emission of carbon, as an undesired output of this study, is not directly available in the respective statistical yearbooks

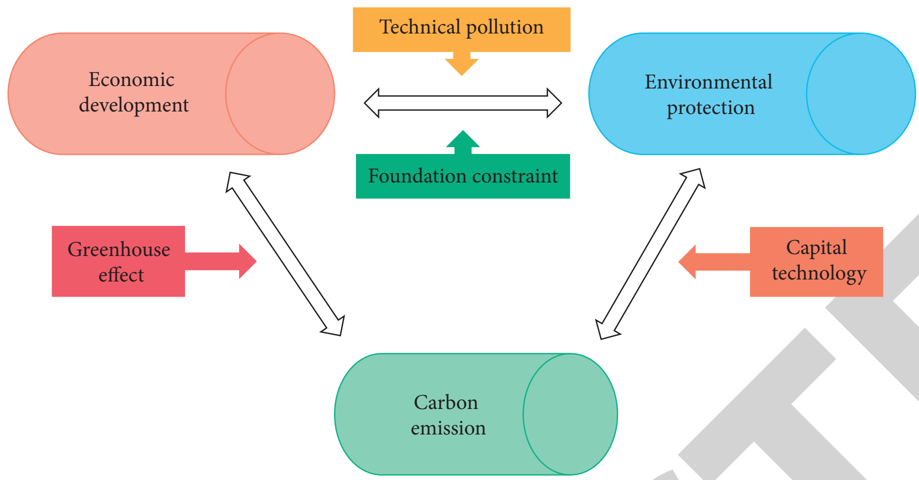

Figure 1: Interaction mechanism diagram of the emission growth the of economy conservation of the environment.

[28]. Therefore, it is necessary to calculate the emission of carbon of each region based on the values of the emission of carbon coefficients published by the United Nations Intergovernmental Panel on Climate Change. For the calculation of the degree of coordination borrowed the concept of fuzzy affiliation function, using real numbers between 0 and 1 to describe the coordinated development relationship between emission of carbon, growth of economy, and conservation of the environment in industrial areas, and its calculation formula is shown as follows:

$$D = \frac{\sum W_T \cdot W_J \cdot W_H}{\alpha \cdot k \cdot \mathrm{COE}}, \quad (2)$$

where D is the coordination degree of emission of carbon, growth of economy, and conservation of the environment in industrial areas. α is the actual value of comprehensive level of growth of economy in industrial areas. K is the coordination coefficient of the emission of carbon, growth of economy, and conservation of the environment.

National energy supply data were used to calculate CO_2 emissions from the combustion of major fossil fuels [29], that is, by the apparent consumption of various fossil fuels in a country. Developed countries have achieved the inverted U-shaped path with the fastest speed by consciously or unconsciously going to restructure their economies as well as their energy consumption structures, which led to a situation where the environmental quality showed a low start to a later improvement while the economy kept growing [30]. Using the synergy theory spontaneously emerges as an orderly structure in time, space, and function through synergy within itself, thus improving the overall efficiency of the system. The principle of the synergy theory is shown in Figure 2.

Secondly, the emission of carbon counteracts the economy, as shown by the following: the higher the GDP output per unit of emission of carbon, the less constraint on growth of economy and the more beneficial to growth of economy. The emission of carbon per unit of energy consumption refers to the amount of carbon dioxide produced per unit of standard coal after converting the actual consumption of various energy sources into standard coal usage and adding up. Based on the principles of data availability and representativeness, energy use efficiency, external dependence, industrial structure, and the degree of government intervention are selected as the main environmental factors that affect the efficiency of regional emission of carbon. The final formula of the coupled coordination degree of emission of carbon, growth of economy, and conservation of the environment in industrial areas is as follows:

$$CDH = \sqrt{C \bullet D}. \quad (3)$$

To construct the indicator system, it is necessary to ensure the operability of the selected indicators and to ensure that the selected indicators are simple and easy to collect for data calculation and analysis. The essence of the environmental Kuznets curve is to study the impact of the rapid growth of economy on environmental quality or resource consumption; that is, resource consumption or the environment is a function of growth of economy. The larger the emission of carbon per unit of energy consumption, the more the total emission of carbon, and vice versa, the smaller. The primary industry is chosen as the base value to calculate the industrial structure diversification coefficient, which is calculated as follows:

$$\mathrm{ESD} = \sum\left(\frac{P}{P}, \frac{S}{P}, \frac{T}{P}\right), \quad (4)$$

where ESD is the industrial structure diversification coefficient. P, S, T is the output value of primary, secondary, and tertiary industries.

Finally, the ecological environment provides natural resources and material security for growth of economy and is the basis for the growth of economy, but the higher cost of environmental treatment increases the economic burden when the environment is polluted. The production possibility set is determined from the original data, and the relative efficiency of the decision unit is calculated by comparing the individual decision unit with the determined

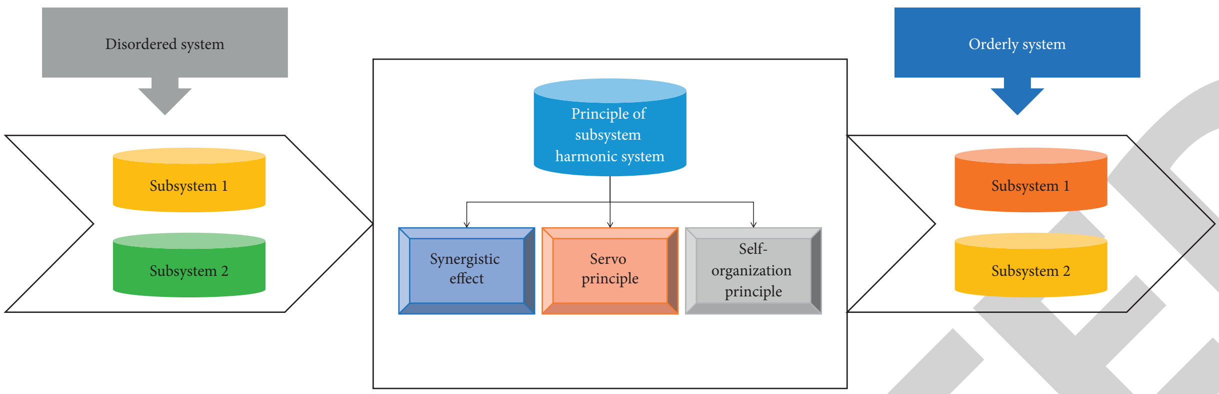

FIGURE 2: Principle of the synergetic theory.

optimal production frontier surface. The factor decomposition method is proposed according to the IPCC emission of carbon guidelines to calculate the emission of carbon from industrial zones with the following formula:

$$\mathrm{COE} = \sum k \cdot \mathrm{COEF} \cdot E \cdot V \cdot S, \tag{5}$$

where COE is the emission of carbon. $k$is the carbon dioxide emission coefficient of energy. COEFis the average low calorific value of energy. $E$is the content value of the unit calorific value of energy. $V$is the carbon oxidation rate of energy. S is the energy consumption.

There should be a certain logical relationship between the systems and between the indicators, and they should be able to reflect the characteristics of both economic and environmental systems in a comprehensive way, while the indicators should be constructed in a hierarchical way, and the indicators should be independent of each other and interconnected, reflecting the inner connection between the economic and environmental systems. When fossil fuels are used for nonenergy purposes, that is, as raw materials or materials, the carbon inside them is not emitted into the air in the form of CO_2, as is the case with fuel combustion, which is what is meant by carbon sequestration. Since the “environment-economy” system is a large and complex system, its interactions are influenced by many other factors, such as geography, trade, technology, population, income distribution, and policy incentives.

3.2. Construction of the Energy-Economy-Environment Coupling Coordination Model. Energy consumption is used as an energy indicator, emission of carbon represents an environmental indicator, and gross domestic product (GDP) is used as a measure of growth of economy to simplify the study of the relationship between energy consumption, emission of carbon, and GDP. Coupling degree refers to the strength of system interaction, which is a measure of the degree of intersystem association and the interrelationship among the internal elements of the system, and can reflect the level of coordination between the economy and the environment of a country or a region. This article constructs a theoretical model of the interaction between economy and ecological environment, as shown in Figure 3.

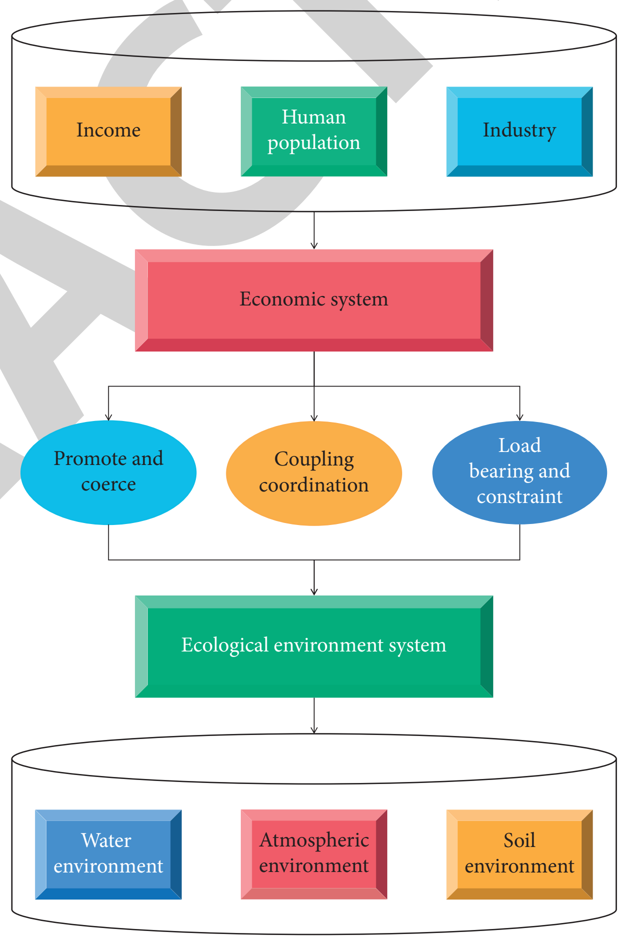

FIGURE 3: Theoretical model of interaction between economy and ecological environment.

The first is the macroeconomic module. The main applied to indicators includes gross domestic product, total population, industrial structure, and social fixed asset investment. Due to the interlocking and complex role of international growth of economy and ecological environment, the coupling degree and coordination degree models between two subsystems of international growth of economy and ecological environment are constructed by borrowing the capacity coupling coefficient model in physics. The coupling coordination degree model between the carbon-economy system, carbon-environment system, and economic-environment system both can be written as

$$\begin{aligned} G_{12} &= f(X,Y) \\ &= \sqrt{E_{12}\times(\mu F_1 + \nu F_2)}, \\ G_{13} &= f(X,Z) \\ &= \sqrt{E_{13}\times(\mu F_1 + \omega F_3)}, \\ G_{23} &= f(Y,Z) \\ &= \sqrt{E_{23}\times(\nu F_2 + \omega F_3)}. \end{aligned} \tag{6}$$

Time series data and cross-sectional data are used for the study. The cross-sectional data are used to summarize whether different economic behaviors are correlated by showing the correlation between each variable through the estimation results of model parameters. Assuming that the contribution of each of the x subsystems to the overall system's integrated development level is the same, the overall system's integrated development level F is calculated by the following formula:

$$F = \frac{F_1 + F_2 + \cdots + F_x}{x}. \tag{7}$$

The primary, quadratic, and cubic GDP per capita are usually used, and sometimes, some control variables are included, which mainly contain influencing factors such as population size, technology level, foreign trade, policies to protect the environment, and economic structure. The global spatial autocorrelation can test whether there is spatial dependence of regional emission of the carbon growth of economy conservation of the environment coupling coordination, and analyze the spatial correlation pattern and spatial clustering pattern of China's emission of carbon growth of economy conservation of the environment coupling coordination from a regional perspective as a whole. According to the classification of primary energy sources, the energy sources at the beginning of industrialization are mainly coal, so the consumption of coal is used as the base value to calculate the energy structure diversification coefficient, and the calculation formula is

$$\text{ECSD} = \sum\left(\frac{C}{C}, \frac{O}{C}, \frac{G}{C}, \frac{E}{C}\right), \tag{8}$$

where COE is the energy diversification coefficient. C is the coal consumption. O is the oil consumption. G is the natural gas consumption. E is the hydropower consumption.

Next is the energy demand module. Mainly applied to the indicators' total energy consumption, energy structure and energy intensity focus on the geospatial effect, that is, the detailed presentation of the geospatial nature of the data of the research object on the geospatial performance. Therefore, the coefficient of variation is used for the derivation of the economic and environmental coupling degree calculation model. When comparing the dispersion of two groups of data, it is not appropriate to use the standard deviation directly for comparison if the metric scale of the two groups of data is too large or the data outline is different. The concept of capacity coupling is used as the theoretical basis to calculate the coupling degree of the emission of carbon, growth of economy, and conservation of the environment in industrial areas, and its calculation formula is shown as follows:

$$C = \frac{W_T W_J W_H}{\text{COE}}. \tag{11}$$

where C is the coupling degree of emission of carbon, growth of economy, and conservation of the environment in industrial areas. W_T is the weight value of the emission of the carbon index. W_J is the weight value of the growth of the economy index. W_H is the weight value of the conservation of the environment index. COE is the emission of carbon.

The global spatial autocorrelation only describes the spatial distribution pattern in general, but it averages out the differences between regions and cannot specifically reflect the high and low distribution status of values and the degree of spatial differences in each region. Therefore, based on the static coordination measure of emission of carbon and growth of economy, the continuity of the coordination state of emission of carbon and economy is considered.

Finally, there is the environmental module. The main indicator used is the emission of carbon, where the data underlying the measurement of emission of carbon are obtained from the database of the energy demand module. The Moran index is used to analyze whether the ternary coupling of coordination produces significant differences between the central and peripheral regions. Emission of carbon indicates energy use and consumption. As the basis of sustainable development of industrial base, it is necessary to improve the emission of carbon efficiency as much as possible in the process of energy development, processing, and use and consumption, which includes the emission of carbon technical efficiency and emission of carbon scale efficiency. Therefore, the hot spot analysis method is needed to reflect more comprehensively the distribution status of high and low values of the coupled emission of carbon growth of economy conservation of the environment coordination in each province and the change trend of spatial differences, and to reveal the local spatial distribution characteristics. By quantifying the magnitude of the comprehensive economic and social efficiency function and the comprehensive energy and environment efficiency function of developing countries on the degree of coupled coordinated development, the degree of coupled coordination between the economic and social development subsystem and the energy and environment subsystem can be reflected more intuitively and the calculation results of the model can be more objective and credible.

4. Emission of Carbon Kuznets Curve and Model Index Weight Analysis

4.1. Analysis of Emission of Carbon Kuznets Curve. The complexity of economic phenomena and the development needs of economic theories, zhi'shi simply applying cross-sectional data or time series data to illustrate economic problems has been somewhat inadequate. The basic idea of environmental Kuznets curve is that in the early stage of growth of economy, achieving economic growth is the main goal people pursue, and in order to obtain more social wealth, they will ignore or even sacrifice the environment to promote economic growth. Therefore, a quadratic function is chosen here to verify whether there is a Kuznets curve hypothesis between the emission of carbon and economic growth, that is, whether there is an inverted U-shaped relationship between the two. The coal-based energy consumption structure and rapid growth of economy jointly determine the characteristics of China's emission of carbon, the value of China's total emission of carbon between 2011 and 2021, and the output is shown in Figure 4.

First, the analysis of the emission of carbon Kuznets curve is performed to test which model forms the sample data fits in order to avoid model setting errors and thus improve the validity of the parameter estimates. When dissecting the energy consumption factors, industrial structure, fixed asset investment, energy production, total population, total economy, and emission of carbon are considered. Because the nature of each indicator and data units are different, it is necessary to dimensionless the indicators, that is, to standardize or normalize the indicators that cannot be directly integrated, so that the influence of the units of measurement of the indicators is eliminated. The structure of the three major industries has changed significantly, and the national economic growth has shifted from being driven by the primary and secondary industries to being driven mainly by the secondary and tertiary industries, and the heavy-duty industrial structure is not conducive to China's goal of energy conservation and emission reduction. The change in the structure of the three major industries in China between 2012 and 2021 is shown in Figure 5.

At the same time, the comprehensive technical level is treated as a variable, which is expressed by the comprehensive level of labor quality index and technology market turnover. This is because the comprehensive technical level is regarded as a constant, which has its limitations.

Secondly, the constant parameter model, variable intercept model, and variable coefficient model are used to regress the sample data to obtain the residual sum of squares, and then, the residual sum of squares is used to construct the F test statistic. In order to make the analysis results more objective and accurate, we need to convert the GDP data to the real GDP calculated by the GDP deflator in constant prices. No longer limit the analysis of the impact of economic growth and emission of carbon on energy consumption, but also make the analysis of the impact factors more reasonable. In the analysis of emission of carbon factors, based on the operability of the research method, the paired sample test is applied to test whether there is a significant difference between the emission of carbon efficiency, pure technical efficiency, and scale efficiency measured by the traditional DEA model and the emission of carbon Kuznets curve, and the test results are given in Table 1.

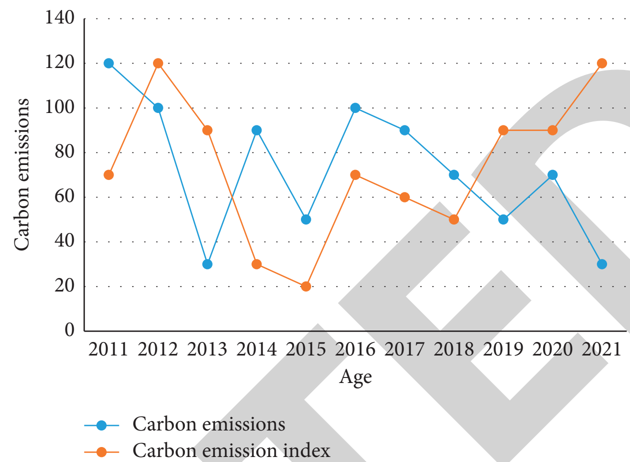

FIGURE 4: Trends of emission of carbon in China.

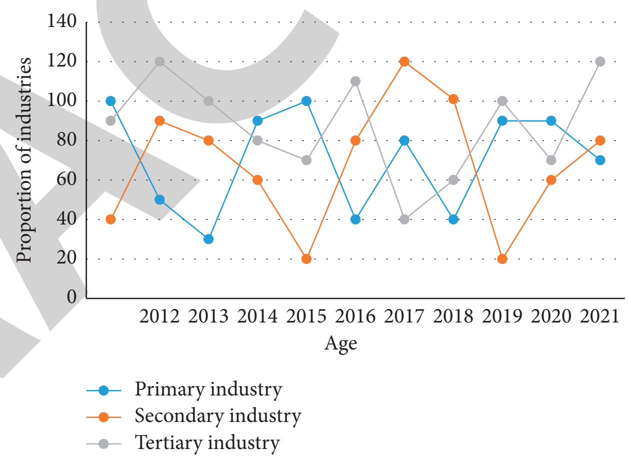

FIGURE 5: Changes of three major industrial structures.

The main purpose is to analyze the factors influencing the emission of carbon per capita and further examine the impact of energy consumption and economic growth on the emission of carbon. The apparent consumption calculation can determine whether there is a long-term equilibrium relationship between GDP and variables such as coal consumption, human capital, fixed capital, and integrated technology level in the western region. The data on international route bunkering and inventory changes in apparent consumption are omitted because they are relatively small, so some scholars directly simplify the definition as production plus imports minus exports, or refer to production plus net imports or production minus net exports. The coefficient of variation and Gini coefficient are used to explore the time variation pattern of China's overall emission of carbon efficiency, and the results are shown in Figure 6.

Finally, considering the effect of the cross-sectional heteroskedasticity problem due to different regions of the sample and the contemporaneous correlation on the estimation validity, the corresponding generalized least squares

Table 1: Test results of paired samples.

	Emission of carbon efficiency	Pure technical efficiency	Scale efficiency
T value	3.227	4.293	5.184
Test of significance	0.178	0.093	0.051

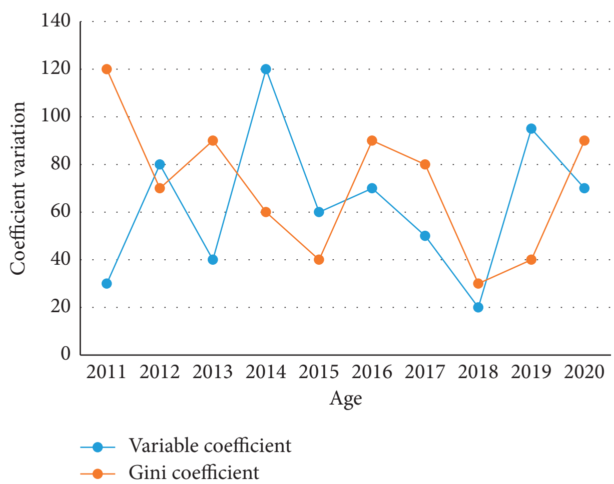

Figure 6: Changes of Gini coefficient and variation coefficient of emission of carbon efficiency.

method is chosen to estimate the model in order to eliminate the cross-sectional heteroskedasticity and contemporaneous correlation. The panel analysis takes into account the effect of regional heterogeneity on the interrelationship between the three. The panel data for its analysis are obtained from the corresponding database. Since Chinese authorities do not explicitly give potential emission of carbon factors for the various fuels used in the country, they are usually specifically tested experimentally or use internationally common parameters that are recommended for use. Therefore, the upstream industry is mainly responsible for the supply of raw materials for water projects. Price fluctuations directly affect the industry costs and profits, and changes in the downstream investment vane directly affect the industry market size.

4.2. Index Weight Analysis of the Coupling Model. Assigning weights by the subjective assignment method is easy to affect the true accuracy of indicators. In the evaluation of ecological environment and other fields, the entropy method is much applied, so the entropy method is used to determine the weights. According to the basic principle of information theory, information is used to measure the orderly degree of the system, while entropy is used to measure the disorderly degree of the system. If the degree of variation of an indicator in the system is greater, the more effective information it carries, and the greater its weight. The results of the calculation of the integrated development level of the economic system and the integrated development level of the environmental system are analyzed by using the scatter diagram to analyze the trend of the three terms, and the obtained trend diagram is shown in Figure 7.

First, since some data are zero, a positive number slightly greater than zero needs to be added to the processing results of such data, using the addition of 0.01 for processing, which can avoid the meaningless number of assignments. Because the original values of each index not only differ greatly in size but also have different units of measurement and are not comparable, it is not scientific to judge them directly. The coupling degree reflects the quantitative degree of coordination between green finance and green industry, and it can be seen from the model that the value of coupling degree is between 0 and 1, and the larger the value, the better the coupling, and vice versa, the worse the coupling. Therefore, the indicators must be dimensionless to make them comparable and dimensionless, so that they can directly reflect the effect on the growth of economy and ecological environment system. The trapezoidal area method is used to obtain the Gini coefficients of energy consumption distribution and environmental consumption distribution, and the area under the Lorentz curve is approximated as a number of trapezoids for calculation. According to the properties of indicators, there are two types of indicators: positive indicators, that is, the larger the value, the more beneficial to the system development, and negative indicators, that is, the smaller the value, the more beneficial to the system development. The positive indicator refers to the indicator whose system state level becomes better as the value of the indicator increases, and the negative indicator refers to the indicator whose system state level becomes better as the value of the indicator decreases. Considering that there may be spatial differences and spatial correlations among the panel data, LLC test, Fisher-PP test, and Fisher-ADF test are selected to determine whether the coupled coordination model is smooth. The test results are given in Table 2.

Although the results obtained by the various tests are different, the results of the tests indicate that the coupled coordination model is feasible at the 3% confidence level when the level values of lnc, lngdp, and lngdp2 are tested, whether the constant term is included in the test equation or the time trend term and the constant term are included.

Secondly, SPSS software was used to conduct factor analysis on the first-level indicators to derive the contribution rate and cumulative contribution rate of each first-level indicator, and the top *n* factors were extracted as the analysis factors according to the contribution rate. The coupling coordination degree is applicable to the quantitative evaluation and comparison of the coordinated development of green finance and green industry in different periods in the same region, which has strong practical significance. Therefore, the coupling coordination degree

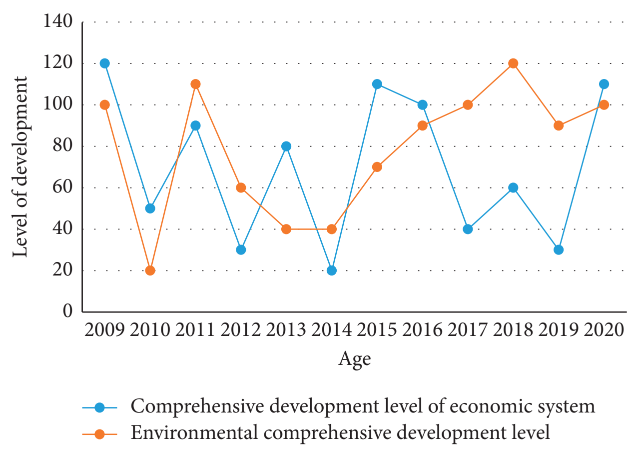

FIGURE 7: Trend line of comprehensive development level of the economic-environmental system.

TABLE 2: Panel unit root test results.

	Inc	Lngdp	Lngdp2
LLC test	−2.1866	−2.0051	−1.9832
Fisher-PP test	−1.7823	−1.6349	−0.7841
Fisher-ADF test	−1.5642	−0.9842	−0.7648

function was created to calculate the energy consumption or water consumption per unit of output value, the emission of three wastes, and the comprehensive energy and environment consumption, and to rank each industry from the smallest to largest accordingly. To determine the similarity of the curve of each index series, the degree of correlation among the factors is determined, and the main factors affecting the target value in the system are sought to promote the benign development of the system. The actual value of the coupled emission of carbon-economy-environment system was selected as the input value, and the actual value of the coupled emission of carbon-economy-environment system was selected as the output value for the training test, and the test results are shown in Figure 8.

Finally, the scores of each secondary indicator in the three indicator systems of emission of carbon, growth of economy, and conservation of the environment are then derived from the scores of the analyzed factors and then synthesized to derive the primary indicator weights. Based on the ranking, the cumulative percentage of output value and the cumulative percentage of energy consumption or water consumption, three waste emissions, and combined energy and environment consumption are calculated and plotted as the horizontal and vertical coordinates of the Lorentz curve, respectively. The evaluation of coupled economic-social-energy-environmental coordination in developing countries takes economic-social and energy-environmental subsystems as subsystems, and defines the degree of coordinated development between economic-social subsystems and energy-environmental subsystems and between system elements as the degree of coupled economic-social-energy-environmental coordinated development.

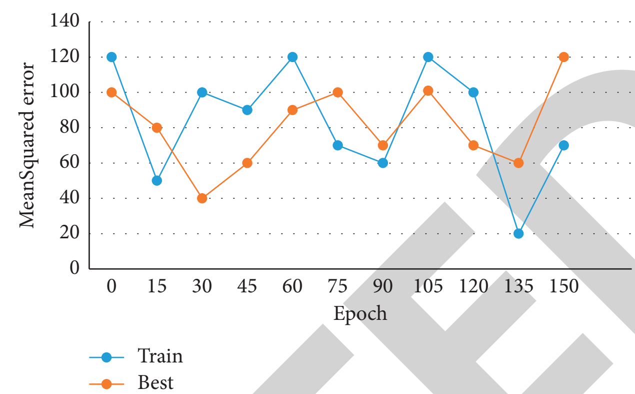

FIGURE 8: Relationship between error and specific training times.

When comparing the degree of variation of multiple targets, if the units or mean values are the same, their standard deviation can be directly used to compare; if the units or mean values are different, the ratio of the standard deviation to the mean value should be used to compare the degree of variation.

5. Conclusions

Along with the global warming climate and the deteriorating resources and environment, it has become a broad consensus in the international community to improve carbon productivity and develop a low-carbon economy. On the issue of climate change, a large number of studies and meteorological observation facts show that the total amount of carbon dioxide in the atmosphere is increasing, the concentration is rising, and the global climate is warming. Climate warming has seriously threatened the survival of human beings and at the same time seriously affected the continuous development of economy, society, and environment. The world has started to pay much attention to the problem of climate warming among environmental issues, and people have started to take various measures to cope with the problem of climate warming. Nowadays, most studies focus on analyzing the relationship between energy, economy, and environment, but few studies at the national level consider the three factors in one system and few in-depth studies at the industry level. In this article, on the basis of combing related research literature and theoretical borrowings, a simplified coupled energy-economy-environment coordination model is constructed as the theoretical mechanism for the empirical study of this article, which argues that energy-environment-economy is a system of mutual influence, and the mutual influence relationship between energy consumption, emission of carbon, and economic growth in China should be systematically. This study can provide a theoretical and decision-making basis for the policy and system formulation of governmental departments in the synergistic strategy of industrial zones, which is conducive to joint actions in the conservation of the environment, growth of economy, and emission of carbon in industrial zones, and provides a reference basis for coping with the infinite environmental pollution and limited economic resource possibilities to show better coupling and coordination.

Data Availability

The data used to support this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest.

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