land

Article

Measurement and Spatial-Temporal Characteristics of Inclusive Green Growth in China

Rui Zhou

School of Economics, Fudan University, Shanghai 200433, China; zhourui@sina.cn

Abstract: In the context of the widely recognized concept of inclusive green growth, it is of great practical significance to study the measurement of inclusive green growth, its temporal characteristics and its spatial heterogeneity. However, it should be noted that most existing studies only consider the situation of China when constructing inclusive green growth indices, and such studies lack international comparators. The index selection dimension is relatively single, and the temporal characteristics and spatial heterogeneity are rarely studied simultaneously. In this study, a spatial correlation analysis method is introduced, and the time series characteristics and spatial heterogeneity of inclusive green growth are deeply analyzed by means of a Moran' I and LISA agglomeration diagram. The results show that: (1) Economic development, fair opportunity, green production and consumption and ecological environment protection are important factors affecting the level of inclusive green growth, but their development is not balanced; (2) Inclusive green growth has obvious time series characteristics, but there are great differences between provinces and regions; (3) The inclusive green growth has significant spatial heterogeneity. From 2010 to 2019, the inclusive green growth level has a dynamic evolution process. Moran's I Index Global Spatial Test results show that inclusive green growth has obvious spatial autocorrelation, that is, it has great spatial differences. Local spatial test results also show that the inclusive green growth in China has obvious spatial aggregation characteristics. Therefore, it is important to coordinate the development of inclusive green growth between provinces and regions and improve the overall level of inclusive green growth in the future.

Keywords: inclusive green growth; time series characteristics; spatial heterogeneity; entropy weight method; Moran' I

check for updates

Citation: Zhou, R. Measurement and Spatial-Temporal Characteristics of Inclusive Green Growth in China. *Land* **2022**, *11*, 1131. https://doi.org/10.3390/land11081131

Academic Editors: Józef Hernik, Karol Król and Barbara Prus

Received: 11 June 2022
Accepted: 20 July 2022
Published: 22 July 2022

1. Introduction

As early as 2012, the United Nations Conference on Sustainable Development proposed the concept of inclusive green growth for the first time, aiming to seek new growth paths and advocate for countries to develop fairer, cleaner and stronger economies [1]. In the same year, the World Bank published a report entitled "Inclusive Green Growth: The Pathway to Sustainable Development", which stressed the importance of integrating economic, social and environmental sustainability issues [2]. Since then, inclusive green growth has become one of the hottest issues for governments and scholars around the world. Inclusive growth, which calls for sustainable economic growth, equity, justice and the sharing of outcomes, is put forward against the backdrop of widespread social inequality and unreasonable income distribution in Asian countries and is getting worse with economic growth [3]. In Europe, Europe 2020 is the European Union's (EU) 10-year strategy to promote smart, sustainable and inclusive growth [4].

Rapid economic growth for more than 40 years has not fully considered environmental protection to a great extent, which is a typical extensive economic growth model, and has also paid a huge environmental price in this process [5–7]. With the increase of environmental costs, this growth mode has exposed many drawbacks, and the extensive economic growth mode is difficult to sustain [8,9]. Since the 11th Five-Year Plan (2006–2010), the Chinese government has actively promoted an environment-friendly and resource-saving society and introduced the development concepts of low-carbon economy and green economy into economic development. China joined the Paris Agreement in 2016. In September 2020, China formally put forward the goal of peak carbon dioxide emissions in 2030 and carbon neutrality in 2060 at the 75th UN General Assembly.

At the same time, the report of the 19th CPC National Congress in 2017 clearly pointed out that China is faced with outstanding problems such as insufficient and imbalanced development, low development quality and efficiency, a large gap between urban and rural regional development and income distribution, and has a long way to go to protect the ecological environment. The root can be attributed to the lack of “inclusiveness” and “green” of traditional growth mode [10,11]. In recent years, China’s environmental quality has improved significantly. According to China’s Atmospheric Environment Meteorological Bulletin 2021, the number of haze days in 2021 declined across the country, with the average number of haze days decreasing by 21.3, 2.9 days less than in 2020 and 16.6 days less than in 2016. China’s steel production capacity of 145 million tons has been upgraded to achieve ultra-low emissions. At the same time, China’s environmental quality has been significantly improved in recent years, and it has been placed in an important position in terms of attaching importance to the quality of economic growth, and the strategy of high-quality economic development has been vigorously promoted, inclusive green growth has achieved initial results [12,13]. The Chinese government has written improving people’s livelihood and advocating green production and consumption into the government work report for many times, and put them in an unprecedented important position. However, it has become a major challenge facing China and the world with regard to how to balance inclusiveness and green transformation in economic growth so as to further improve the level of inclusive green growth [14]. Therefore, the only way for sustainable economic development is to explore an inclusive green economic growth mode that takes into account economic development and environmental protection.

Although many studies have focused on the issue of inclusive green growth in China, most studies only focus on China itself and don’t consider international comparability when selecting indicators. In the construction of the indicator system, the objective basis for the selection of indicators is insufficient, and the dimension of the indicator system is relatively single, which does not fully reflect the inclusive, green and growth aspects of inclusive green growth. In addition, most of the existing studies only use a single method (such as AHP or the entropy weight method) to measure China’s inclusive green growth index, and there are relatively few studies combined with spatial correlation analysis.

The purpose of this study is to build an inclusive green growth indicator system based on international comparability and China’s reality. The entropy weight method based on objective weighting is used to calculate the weight and index of inclusive green growth indicators in China, and the temporal characteristics of various provinces and regions in China are deeply analyzed. At the same time, the spatial correlation analysis method is introduced to further analyze the spatial heterogeneity of inclusive green growth in China so as to characterize the spatial characteristics of inclusive green growth.

In order to analyze the level of inclusive green growth based on international standards (United Nations Development Programme, UNEP) [1] and China’s actual situation, this paper constructs China’s inclusive green growth indicator system. This paper constructs the indicator system of inclusive green growth referring to international standards combined with the reality in China. The entropy weight method based on objective weighting is used to measure China’s inclusive green growth index, and the inter-provincial and regional differences of inclusive green growth are revealed through time series analysis. A Moran’s I and LISA cluster map are used to analyze the spatial correlation of inclusive green growth, and ArcGIS software and GeoDa software are used to depict the global spatial correlation and local spatial heterogeneity of inclusive green growth in order to provide a reference for China and developing countries to improve the level of inclusive green growth. Therefore, the research has important theoretical value and practical significance.

The contributions of this paper are as follows: (1) Different from existing studies, most of which only focus on China's reality while ignoring international comparability when selecting indicators. On the basis of full consideration of international comparability and China's reality, this paper constructs China's inclusive green growth index system from four dimensions, including economic development, equal opportunities, green production and consumption, and ecological and environmental protection; (2) To try to use the entropy weight method based on objective weighting to measure the indicator weight and the indicators of inclusive green growth and reveal the weight differences and time sequence characteristics of each dimension and indicator; (3) Introduce the spatial correlation analysis method. The Moran' I and LISA cluster diagram are used to further study the distribution characteristics of inclusive green growth in order to reveal the spatial heterogeneity; (4) This paper analyzes the temporal characteristics and spatial heterogeneity of inclusive green growth, which makes up for the deficiency of unilateral research in previous studies to a certain extent.

The structure of this paper is as follows: Section 2 is a literature review which collects the literature from four aspects: the connotation of inclusive green growth, inclusive growth, green growth and inclusive green growth. Section 3 outlines the research method, including the entropy weight method and spatial correlation test model. Section 4 includes the calculation of the inclusive green growth indicator, the construction of an inclusive green growth indicator system, and the calculation of indicator weight. Section 5 discusses the time series characteristics of inclusive green growth, including weight analysis and time series analysis. Section 6 reviews the spatial-temporal characteristics of inclusive green growth, which are mainly analyzed from three aspects: thepatial evolution process, global spatial characteristics, and local spatial heterogeneity. Section 7 concludes the paper.

2. Literature Review

Since the issue of inclusive green growth is closely related to climate environment, inclusive growth and green growth, the literature review of this paper will be carried out from these aspects, and research hypotheses will be proposed on this basis.

2.1. Climate, Environment and Inclusive Green Growth

Most countries have embarked on inclusive green growth in order to reduce the risks of climate change and the costs of environmental damage. The relevant research is mainly reflected in three aspects: global warming and climate change, environmental issues and carbon emission reduction policies, and environmental performance and efficiency assessment.

2.1.1. Global Warming and Climate Change

The impact of global warming and climate change on economic development has been recognized by all countries in the world, and the research on relevant issues has become a hot spot of late, especially in developing countries, which has attracted unprecedented attention. In Africa, climate change is also hampering sustainable economic development due to high resource consumption and a lack of inclusive growth. Studies have shown that microfinance can finance climate change projects, so financial inclusion should be incorporated into climate change policies [15]. In India, experts have reached a consensus that the current lack of financial resources and institutional structure, an inefficient subsidy system, limited opportunities for global partnerships, and excessive reliance on regulatory methods to reduce carbon emissions have all limited the success of climate policy measures [16]. In Malaysia, with its commitment to mitigation and adaptation to climate change, they concluded that their experience with extreme weather was that choosing the best time to prepare for prevention and intervention was more important than any wait-and-see approach in managing risk [17]. In the Philippines, due to the attack of super typhoon "Haiyan" in November 2013, how to ensure that cities have access to safe and clean water and sanitation facilities has become an important issue, and climate change is one of the main reasons for these problems, so it can also be attributed to the lack of inclusive green growth [18].

In China, scholars have studied the key energy and climate goals and actions outlined in the 12th Five-Year Plan to gain insight into the nature and scale of medium-and long-term economic and environmental policy challenges and difficulties [19]. The results suggest that China should clearly formulate industrial policies related to global climate mitigation goals in order to avoid long-term carbon lock-in. The study found that growth policies, such as skills investment and access to finance, reduced vulnerability to climate change, but climate change required some adjustments to growth policies. In particular, investments in infrastructure and efforts to stimulate entrepreneurship and competitive markets should be strengthened from a risk management perspective, and climate risks should be recognized. Bowen et al. [20], from the perspective of "pollution paradise", examined the driving mechanism of the impact of economic policy uncertainty on inclusive green growth in China with haze pollution as the intermediary. It reveals how China's inclusive green growth is transforming from "beggar-thy-neighbor" to "good-neighborly" [21].

2.1.2. Environmental Issues and Carbon Policy

India has been pursuing a low-carbon inclusive growth strategy in recent years, but there is an undesirable trade-off between economic growth and climate change mitigation. Some studies have explored the consequences of using carbon tax revenue for investment capacity-building in all sectors, or specifically in the clean energy sector, as well as transferring it to households to improve income distribution [22]. In ASEAN, research results show that there is a significant positive correlation between fossil fuel energy use, electricity use, energy import and economic growth and carbon (CO_2) emissions, and it has an impact on the ecological environment of ASEAN countries [23]. The results show that even if there is no clear climate policy, taking into account resource efficiency, the preference for sustainable production methods and investment in human development, the year 2100 may be more conducive to a renewable energy supply, less land use and lower anthropogenic greenhouse gas emissions than 2010 is [24]. Referring to the data from 1985 to 2011, Green and Stern tested the causal relationship between economic growth, energy consumption and carbon dioxide (CO_2) emissions in high-income and upper middle-income countries by constructing a simultaneous equation framework. The results show that there is a two-way causal relationship between GDP and energy consumption, but it does not support the Environmental Kuznets curve (EKC) hypothesis. In addition, changes in institutional quality may only have a limited impact on energy and environmental policies [25]. In addition, some scholars believe that environmental protection and the availability of natural resources help maintain the sustainability of manufacturing systems. The obtained results indicate that the concerned idea of service facility helps the customer to choose products without hesitation and the supply chain management achieves the maximum profit under green investment [26]. They studied the invalidation of food waste in the supply chain. On the basis of constructing a two-stage supply chain model based on parallel operation, the global optimal solution of the model is obtained by the algebraic method. The effectiveness of the model is verified by cost reduction. Through the sensitivity analysis of the model parameters, the effectiveness of the model and the effectiveness of reducing the carbon emissions and total cost of the two-stage supply chain were verified [27].

With regard to China, Green and Stern review recent changes in the country's economy and energy system since the turn of the century, and looked at the likely trajectory of China's emissions over the next decade. The study suggests that carbon dioxide emissions from energy in China are likely to grow much more slowly, if at all, than under the old economic model, and could peak sometime in the decade before 2025. It also puts forward some important areas that China's policies should focus on to mitigate risks and challenges [28]. Referring to the panel data of 30 provinces in China from 1987 to 2017, the impact of carbon emissions on economic growth was tested. The results show that there is a significant nonlinear relationship between carbon emissions and financial development, openness, innovation and economic growth, and that carbon emissions weaken the role of financial development and innovation in promoting economic growth [29].

2.1.3. Environmental Performance and Efficiency Assessment

Halkos and Tzeremes proposed a conditional directional distance function estimation method to test the correlation between regional environmental efficiency and per capita GDP level. The model is applied to the regional data of the United States, and the inverted u-shaped relationship between regional environmental efficiency and per capita income is revealed. The test results show that regional environmental efficiency has an inflection point when per capita GDP is 49,000 dollars [30]. The relationship between environmental performance, corruption and economic growth is analyzed with reference to panel data from 87 countries selected from 2002 to 2012. The empirical results show that environmental performance is positively correlated with economic growth, especially in non-OECD countries [31]. Some scholars try to study the mechanism between macro environmental variables and environmental performance from the perspective of ethical behavior. Through theoretical model construction and empirical testing, the results show that national culture, economic development and population growth will directly and significantly affect environmental performance. Further research shows that population growth and national culture can significantly affect environmental performance through education [32]. In addition, other studies show that when the uncertainty of supply and demand is large, the performance of highly green innovative products is better than that of low innovative products. New green products should be introduced only when the expected profit of the new product is greater than the loss of the existing product. The new policy innovation through remanufacturing is more cost-effective than the traditional innovation policy [33].

In China, since the reform and opening up, China's economy continues to grow at a high speed while facing the problem of resource conservation and environmental protection. A data envelopment analysis (DEA) method was used to evaluate regional environmental efficiency, and a spatial econometric model was used to empirically test economic growth, environmental efficiency and energy consumption. The results show that the proportion of direct elasticity to total elasticity and the proportion of direct effect to total effect of capital, labor and energy input variables are fixed [34]. Through the study of the impact of environmental regulation efficiency loss on inclusive growth in China and its mechanism. The results show that there is asymmetric strategic interaction between neighboring cities, which intensifies the loss of environmental regulation efficiency. At the national and regional levels, the efficiency loss of environmental regulation in local and neighboring cities can inhibit inclusive growth [35]. By studying the impact of China's renewable energy consumption (REC), non-renewable energy consumption (NREC) and carbon emissions on economic growth in 133 countries under the Belt and Road Initiative from 1996 to 2020. The results show that REC has a positive impact on economic growth, while NREC has a negative impact on economic growth. However, in the long run, there is obvious heterogeneity among different regions [36].

2.2. Inclusive Green Growth

The research on economic growth has expanded from the early labor and capital input as the main factors [37,38] to the influence of natural resources, environment and energy factors on economic growth [39,40]. Inclusive green growth in 2012 was first proposed at the Rio+20 Summit [41], with the aim of combining the interests of industrialized countries with green growth and inclusive growth in developing countries. The World Bank defines inclusive green growth as a sustainable economic growth model with social equity, environmental friendliness and economic sustainability [2]. The Organization for Economic Cooperation and Development (OECD) believes that inclusive green growth provides a realistic way for countries to pursue inclusive and green economic growth [42]. The United Nations Environment Programme (UNEP) considers that inclusive green growth includes the three pillars of social, environmental and economic sustainability [43]. Most scholars believe that inclusive green growth should balance the three subsystems of inclusiveness, green and growth [5,44]. Therefore, it is the continuation and extension of the concept of sustainable development [5], and emphasizes the symbiotic relationship among inclusive, green and growth subsystems. As an organic combination of green growth and inclusive growth, this new development model has enabled more countries to choose a sustainable development model [23,45,46].

With the concept of inclusive green growth put forward and widely recognized, many countries regard inclusive green growth as a long-term development strategy. Many scholars divide inclusive green growth into three aspects: green growth, inclusive growth and inclusive green growth [47–49].

2.3. Green Growth and Its Measurement

In terms of green growth, there is no clear definition of the concept of green economic growth in academic circles at present. The concept of green economic growth stems from the consideration of the relationship between socio-economic development and the ecological environment, and the corresponding terms include sustainable development, green economy, green growth and low-carbon economy [50,51]. The depletion of natural resources and the destruction of the ecological environment have gradually become important factors restricting global economic growth [10,52,53]. Most countries have reached a consensus that economic growth should not be at the expense of the environment and that green development should be vigorously promoted [54,55]. Based on the newly constructed Meta Frontier-Global-SBM super-efficiency DEA (Data Envelopment Analysis) model, this study measures the green economic growth levels of 286 prefecture-level cities in China from 2003 to 2018 and examines their spatiotemporal evolution characteristics and internal influencing mechanisms. The empirical findings highlight that China achieved favorable green economic growth with the most significant improvement in the northeast and eastern coastal cities [56]. Some studies have found that financial technology and green finance significantly promote the growth of green economy, and their impact on green growth has obvious regional heterogeneity, that is, the impact of the eastern region is significantly stronger than that of the central and western regions [57]. Zhao et al. considered artificial intelligence (AI) as the driving force behind the new wave of technological advancement, and it paves the way for a new era of green economic growth. The main findings of this study are that AI has a significant U-shaped effect on GTFP, which was estimated using a nonlinear dynamic panel regression model intelligence (AI) paves the way for a new era of green economic growth [58]. Zhou et al. constructed a comprehensive indicator system to measure green growth, and studied the mediating role of technological innovation on the relationship between energy poverty and green growth. Research showed that eliminating energy poverty and increasing technological innovation can effectively promote green growth, and indirectly affect green growth by accelerating the process of technological innovation [59]. Wang et al. studied the relationship between resource abundance and green economic growth in 40 resource-rich developing countries in Asia, Africa and Latin America. The results showed that an abundance of resources restrains the growth rate of the green economy in developing countries mainly via an innovation effect and a technical leader transfer effect, which promote resource-rich regions to undermine green economic growth [60]. Lin and Zhou constructed a comprehensive indicator system of green economy, and used the entropy weight TOPSIS method to evaluate the green economy growth from 2000 to 2017. Research showed that, since the beginning of the 21st century, the green economy has continuously improved. Ecological civilization and social progress were the main supports for the growth of the green economy. Economic development was in a secondary position, and innovation drive lags behind. There were obvious regional differences in China's green economic growth [61].

2.4. Inclusive Growth and Its Measurement

In terms of inclusive growth, the World Bank first put forward the concept of inclusive growth in 2000. Combining the basic connotation of inclusive growth and sustainable development, the paper holds that inclusive growth, as a more inclusive and flexible growth mode, should fit the theory of sustainable development. From the perspective of anti-poverty, the basic meaning of inclusive growth and pro-poor growth is the same [62]. Research shows that inclusive growth from an open perspective covers both international and domestic inclusiveness [63,64]. Some scholars believe that Developing Asia is embracing inclusive growth as a key development goal in response to rising inequalities and increasing concern that these could undermine the very sustainability of Asia s growth. Them argues that inclusive growth emphasizes creation of and equal access to opportunities; and that unequal opportunities arise from social exclusion associated with market, institutional, and policy failures [65]. Xu and Tao scientifically measured the inclusive growth and explored the factors affecting inclusive growth. It was found that the national level was only "basically inclusive", the economic growth in rural regions was not inclusive, and the economic growth in urban regions was more inclusive [66]. Li and Bian found that although the difference of monetary income growth between different income classes enlarged the wealth inequality of society, the rapid growth of non-monetary welfare among low-income groups narrowed the welfare gap between classes and realized the inclusive growth of China's economy. By discussing the relationship between public housing supply and urban inclusive growth in China [67] Wang et al. concluded that increasing the public housing supply at present was not only beneficial to urban social integration, but also can not hinder urban economic growth [68]. Huang et al. proposed a new empirical framework for inclusive growth estimation by extending the traditional Mincer model. The results confirmed the significant impact of energy poverty alleviation on inclusive income growth [69].

2.5. Inclusive Green Growth and Its Measurement

In terms of inclusive green growth, the related research has attracted wide attention from scholars since inclusive green growth was put forward in 2012. Taking the Yangtze River Basin as an example, Liu et al. constructed an indicator system for measuring inclusive green growth, and described the distribution characteristics and spatial differences within and between urban agglomerations by nuclear density and the Dagum Gini coefficient [70]. Ren et al. studied the impact of digital economy agglomeration on inclusive green growth and its transmission mechanism. The results showed that China's broadband policy was conducive to promoting local inclusive green growth, but not conducive to inclusive green growth in neighboring cities. From the perspective of pollution paradise and smog pollution as an intermediary [71], Gu et al. discussed the driving mechanism of the impact of economic policy uncertainty on inclusive green growth [22]. Sun et al. proposed an improved TODIM method to measure the level of regional inclusive green growth and further revealed the inhibitory effect of various influencing factors on regional inclusive green growth. It was found that from 2008 to 2018 the inclusive green growth level of 30 provinces in China was significantly higher than that of eastern provinces, while the catch-up effect of inclusive green growth in central and western provinces was significant [72]. Wang et al. constructed the functional index of inclusive green growth and dynamically analyzed the spatial-temporal differences of inclusive green growth. It was found that there were significant differences in the absolute level of inclusive green growth in three regions of China, but there was no significant difference in the speed of regional inclusive green growth [73]. Zhao et al. examined the impact of environmental regulation on green economic growth and renewable energy development. The results showed that, as an important part of green economic growth, the development of renewable energy also depended on the implementation of environmental regulation policies, and environmental regulation had made an important contribution to the development of renewable energy [74].

Based on the above analysis, this paper proposes the following hypotheses:

H1. *Inclusive green growth in all provinces and regions of China has obvious temporal characteristics*.

H2. *Inclusive green growth in China has obvious spatial correlation and heterogeneity among different regions*.

In conclusion, the existing studies have drawn unprecedented attention to inclusive green growth, and have formed some valuable research results, which are also the basis of this study. However, there are still some shortcomings. First, when selecting indicators, most of them only consider the situation in China, and rarely consider international comparability, so the conclusions drawn are not applicable in scope. Second, in the process of constructing the indicator system, the selected indicator is too subjective and lacks the necessary basis. Third, the dimensions of the indicator system are relatively single, which does not fully reflect the three connotations of inclusiveness, greenness and growth contained in inclusive green growth. Fourth, the research methods are relatively simple. Most of the existing studies only use a single method (such as AHP or entropy weight method) to measure the inclusive green growth index, and conduct analysis on this basis, while the spatial correlation analysis is relatively lacking, so it is impossible to A good description of the time series characteristics and spatial heterogeneity of inclusive green growth.

In order to better solve the above problems, based on international comparability and China's reality, this paper constructs an inclusive green growth indicator system from four dimensions: economic development, equal opportunities, green production and consumption, and ecological and environmental protection. The entropy weight method based on objective weighting is used to calculate the weight and index of China's inclusive green growth indicators, and the temporal characteristics of China's provinces and regions are analyzed. In order to characterize the spatial heterogeneity of inclusive green growth, the Moran's I and LISA cluster maps are used to further study the distribution characteristics of inclusive green growth in China. At the same time, the temporal characteristics and spatial heterogeneity of China's inclusive green growth are analyzed, which to some extent makes up for the shortcomings of existing studies that only carry out unilateral studies.

3. Research Methods

3.1. Entropy Weight Method

The entropy weight method was first proposed by Shannon in 1951. It is an objective method to determine index weight by the amount of information provided by index entropy [75]. The entropy weight method is used to determine the indicator weight objectively by the information provided by the indicator entropy value. The basic idea is to determine the objective weight according to the variability of indicators. Generally speaking, if the information entropy of an indicator is smaller, the greater the variation degree of the indicator value, the more information it provides, the greater the role it can play in comprehensive evaluation, and the greater its weight. On the contrary, the greater the information entropy of an indicator, the smaller the variation degree of the indicator, the less the amount of information provided, the smaller the role played in the comprehensive evaluation, and the smaller its weight.

Compared with subjective weighting, it has obvious advantages: First, the entropy weight method is an objective method to determine weights, which overcomes the interference of subjective factors to a great extent, and makes the measurement results more realistic and relatively high in accuracy. Second, compared with subjective weighting methods such as the analytic hierarchy process, this method has a wide range of applications, and can be used in any research that needs to determine weights, and can also be used in combination with other methods. This method also has disadvantages, that is, its application range is limited, and it is only suitable for calculating weights. Because the important link of measuring inclusive green growth indicators is the determination of indicator weight, the entropy method is very suitable for this study. The steps of measuring the inclusive green growth index by the entropy weight method are as follows:

(1) Data standardization processing

Because the attributes and meanings of different indexes are different, it is impossible to calculate them directly, so dimensionless processing must be carried out first. According to the positive and negative attributes of the indicator, this paper uses the range standardization method to standardize the original data as follows:

$$\text{Positive indicator } X_{ij} = \frac{X_{ij} - \min(X_{ij})}{\max(X_{ij}) - \min(X_{ij})} \tag{1}$$

$$\text{Negative indicator } X_{ij} = \frac{\max(X_{ij}) - X_{ij}}{\max(X_{ij}) - \min(X_{ij})} \tag{2}$$

In Equations (1) and (2), X_{ij} is the j indicator under the i evaluation object, X_{ij} is a standardized dimensionless indicator with a value between 0 and 1. $\max(X_{ij})$ and $\min(X_{ij})$ are the maximum and minimum values under the j indicator respectively.

(2) Calculate the proportion of the j indicator in the i year

The calculation equation is as follows:

$$P_{ij} = \frac{X_{ij}}{\sum\limits_{i=1}^{n} X_{ij}}, i \in [1, n], j \in [1, m] \tag{3}$$

In Equation (3), P_{ij} is the proportion of the i evaluation object under the j indicator to this indicator.

(3) Calculate the indicator information entropy

The calculation equation is as follows:

$$e_j = -[\ln(n)]^{-1} \times \sum_{i=1}^{n} \left[P_{ij} \times \ln(P_{ij})\right] \tag{4}$$

In Equation (4), information entropy is $e_j \in [0, 1]$, which shows that the smaller the indicator information entropy, the greater the degree of dispersion, and the greater the amount of information provided by the indicator, the greater the indicator weight, whereas the smaller the indicator weight. If specific gravity value $P_{ij} = 0$, define $\lim\limits_{P_{ij} \to 0} P_{ij} \times \ln(P_{ij}) = 0$.

(4) Calculate the indicator weight

$$W_j = (1 - e_j) / \sum_{j=1}^{m} (1 - e_j) \tag{5}$$

In Equation (5), W_j is the weight of the j indicator. The greater the weight, the greater the role of the indicator.

(5) Calculate the evaluation score of single indicators:

$$S_i = \sum_{j=1}^{m} (W_j \times X_{ij}) \tag{6}$$

In Equation (6), S_i is the score of the i evaluation object. According to the weight and standardized dimensionless indicator value, the comprehensive score $S_1, S_2, \cdots S_n$ of each evaluation object is calculated, that is, the inclusive green growth indicator we want to calculate.

3.2. Spatial Correlation Test Model

Referred from the research of Cao et al. [76], this paper constructs the following spatial correlation test model.

3.2.1. Construction of Spatial Weight Matrix

Adjacency rule is selected to construct spatial weight matrix. The specific expression is as follows:

$$w_{ij} = \begin{cases} 0 & \text{Region } i \text{ is not adjacent to } j, \text{ or } i = j \\ 1 & \text{Region } i \text{ is adjacent to } j \end{cases} \tag{7}$$

where, *i*, *j* = *1*, *2* ... *n*, is the research unit; w_{ij} shows the position relationship between observation point *i* and observation point *j* in space. If there is a common edge, the value is 1, and if there is no common edge, or if *i* = *j*, the value is 0.

3.2.2. Global Moran's I

Global Moran's I is a method of global spatial autocorrelation analysis, which mainly studies the overall spatial relations and spatial differences of things or phenomena through spatial positions. The calculation equation is:

$$I = \frac{n \sum\limits_{i=1}^{n} \sum\limits_{j=1}^{n} w_{ij}(x_i - \overline{x})(x_j - \overline{x})}{(\sum\limits_{i=1}^{n} \sum\limits_{j=1}^{n} w_{ij}) \sum\limits_{i=1}^{n} (x_i - \overline{x})^2} \tag{8}$$

$$\overline{x} = \frac{1}{n} \sum_{i=1}^{n} x_i \tag{9}$$

where *n* is the total number of research units. x_j and x_j are the observations of research units *i* and *j* respectively, and w_{ij} is the constructed spatial weight matrix. The value of Moran's I is in the interval of [−1, 1]. If Moran's I > 0, it indicates that there is positive spatial autocorrelation in spatial distribution. If Moran's I < 0, it indicates that there is negative spatial autocorrelation. When Moran's I = 0, it indicates that the observed value presents random distribution in spatial distribution and there is no spatial correlation. The significance level of Moran's I is tested by its standard statistic *Z*, and the calculation equation is as follows:

$$Z = \frac{I - E(I)}{\sqrt{war(I)}} \tag{10}$$

In Equation (10), when Z > 0 and passes the significance test, it shows that there is positive spatial autocorrelation. When *Z* < 0 and passes the significance test, it shows that there is negative spatial autocorrelation. When *Z* = 0, the observed values show an independent random distribution.

3.2.3. Local Moran's I

Local Moran's I is used to study the correlation between provinces in adjacent spatial regions, revealing the heterogeneous characteristics of inclusive green growth level in the study region in spatial distribution, which is usually expressed by Moran's I scatter diagram, and its calculation equation is as follows:

$$I^* = \frac{x_i - x}{S^2} \sum_{i=1}^{n} w_{ij}(x_j - \bar{x}), i \neq j \tag{11}$$

$$S^2 = \sum_{i=1}^{n} (x_j - \bar{x})^2 / n \tag{12}$$

$$\bar{x} = \sum_{i=1}^{n} x_i / n \tag{13}$$

where x_i and x_j are the observed values of spatial units *i* and *j*, and n is the total number of regions and w_{ij} is the spatial weight matrix.

4. Measurement of Inclusive Green Growth Index

4.1. Indicator System and Data Sources

4.1.1. Construction of Indicator System

Inclusive green growth is a comprehensive concept, covering multiple dimensions of economy, society, production, consumption and the environment, which cannot be measured by a single indicator [77]. Therefore, it is necessary to build an indicator system composed of multiple dimensions and indicators for measurement so as to obtain the inclusive green growth indicator. This paper refers to the research of Zhou and Wu [78], Wu and Zhou [11], Zhou et al. [79], and Li and Yin [80]. On the basis of fully considering international comparability and China's reality, we divide the indicator system into three levels: target level (A), dimension level (B) and domain level (C). The indicator system of inclusive green growth is constructed from four dimensions: economic development (B1), fair opportunity (B2), green production and consumption (B3) and ecological environment protection (B4).

(1) Dimension of economic development (B1)

Because economic growth is the core of inclusive green growth, and it is also the material basis and prerequisite for social progress and the improvement of people's livelihood, this paper measures it from two fields: economic output (C1) and income level (C2). Among them, economic output (C1) is measured by GDP growth rate, fiscal revenue proportion and urbanization rate, and income level (C2) is measured by per capita disposable income, per capita net income of rural residents and the per capita disposable income of urban residents.

(2) Opportunity equity dimension (B2)

Opportunity fairness is the premise and foundation of social fairness and justice, and is the basic condition of social harmony. As a realistic social existence, opportunity fairness is the greatest fairness and the primary symbol of fairness. Social equity reflects the value orientation of inclusive green growth, emphasizing increasing social employment, narrowing the gap between rich and poor and sharing public resources, which embodies the inclusiveness of economic growth to equal opportunities, fair process and shared results. This paper measures it from four regions: Employment equity (C3), education equity (C4), social security equity (C5), and infrastructure equity (C6). Among them, employment equity (C3) is measured by two indicators: the urban registered unemployment rate and the employment rate of tertiary industry. Education equity (C4) is measured by two factors: the investment intensity of education funds and the proportion of the population that is illiterate. Social security equity (C5) is measured by two indicators: the proportion of basic old-age insurance fund expenditure and the proportion of basic medical insurance fund expenditure. Fairness of infrastructure conditions (C6) is measured by three indicators: the length of transportation lines per 10,000 people, the ownership of public transport vehicles per 10,000 people and the density of the urban population.

(3) Green production and consumption dimension (B3)

Green production refers to a comprehensive measure that takes energy saving, consumption reduction and pollution reduction as the goal, and takes management and technology as the means to implement pollution control in the whole process of industrial production and minimize the number of pollutants. Green consumption, also known as sustainable consumption, is a general name for various consumption behaviors and modes that meet the ecological needs, take health and ecological environment protection as the basic connotation, and meet the standards of human health and environmental protection. Green production and consumption is an important guarantee for inclusive green growth. It advocates that pollution emissions should be reduced and resource utilization should be improved in the process of production and consumption activities, and green products should be provided to promote the healthy development of human society. Therefore, this paper measures from two fields: green production (C) and green consumption (C8). Among them, green production (C) is measured by four indicators: energy consumption per unit output value, wastewater discharge per unit output value, carbon dioxide discharge per unit output value and sulfur dioxide discharge per unit output value. Green consumption (C8) is measured by four indicators: per capita energy consumption, per capita wastewater discharge, per capita carbon dioxide discharge and per capita sulfur dioxide discharge.

(4) Ecological environment protection dimension (B4)

Ecological environment protection can be reflected by developing the green and low-carbon economy and promoting ecological health and sustainable development. It is the essential requirement of inclusive green growth, and economic growth within the constraints of ecological environment capacity and resource carrying capacity will effectively drive the process of inclusive green growth. This paper measures it from two perspectives: ecological resource endowment (C9) and ecological environment governance (C10). Among them, ecological resource endowment (C9) is measured by three indicators: per capita water resources, the proportion of nature reserves, and the per capita public green space region of cities. Ecological environment control (C10) is measured by two indicators: the investment intensity of environmental pollution control and the proportion of the soil erosion control region.

As a result, we construct the following indicator system of inclusive green growth in China, as shown in Table 1.

4.1.2. Data Sources

China's 12th Five-Year Plan (2010–2015) explicitly calls for promoting green development and building a resource-conserving and environment-friendly society. The 13th Five-Year Plan (2016–2020) further emphasizes the need to firmly establish and implement the concept of innovative, coordinated, green, open and shared development, with the focus on improving the quality and efficiency of development. At the same time, the 12th Five-Year Plan and 13th Five-Year Plan both make coordinated regional development an important part of China's economic and social development. In addition, it seems that China has attached great importance to the development concept of inclusive green growth in the past 10 years. Therefore, samples from 2010 to 2019 are selected in this paper to make the samples more representative.

This paper takes 31 provinces in China from 2010 to 2019 as the research objects, excluding Hong Kong, Macao and Taiwan due to data limitations. Sample data come from the Wind database, the *China Statistical Yearbook*, the *China Energy Statistical Yearbook*, the *China Environment Statistical Yearbook*, the *China Education Statistical Yearbook* and the *China Population* and *Employment Statistical Yearbook* over the years.

4.2. Measurement of the Weight of Inclusive Green Growth Indicators

According to the above calculation method, the weights of inclusive green growth indicators of 31 provincial administrative regions in China are calculated by Stata16.0 software (as shown in Table 2).

Table 1. Indicator System of Inclusive Green Growth in China.

Target Layer A	Dimension Layer B	Domain Layer C	Indicator Name	Unit	Nature
China Inclusive Green Growth Index A	Economic development B1	Economic output C1	GDP growth rate	%	+
			Proportion of fiscal revenue	%	+
			Urbanization rate	%	+
		Income level C2	Per capita disposable income	Yuan/person	+
			Per capita net income of rural residents	Yuan/person	+
			Per capita disposable income of urban residents	Yuan/person	+
	Fair opportunity B2	Employment equity C3	Registered urban unemployment rate	%	−
			Employment rate of tertiary industry	%	+
		Education equity C4	Intensity of investment in education funds	%	+
			Proportion of illiterate population	%	−
		Social Security Equity C5	Proportion of basic endowment insurance fund expenditure	%	+
			Proportion of basic medical insurance fund expenditure	%	+
		Fair infrastructure conditions C6	Length of transportation line per 10,000 people	km	+
			Public transport vehicles per 10,000 people	Vehicles	+
	Green production and consumption B3	Green production C7	Urban population density	Square meters/person	−
			Energy consumption per unit output value	Tons of standard coal/10,000 yuan	−
			Wastewater discharge per unit output value	Tons/10,000 yuan	−
			Carbon dioxide emissions per unit output value	Tons/10,000 yuan	−
			Sulfur dioxide emission per unit output value	Tons/10,000 yuan	−
		Green consumption C8	Per capita energy consumption	Tons/person	−
			Per capita wastewater discharge	Tons/person	−
			Per capita carbon dioxide emissions	Tons/person	−
			Per capita sulfur dioxide emissions	Tons/person	−
	Ecological environment protection B4	C9 Ecological resource endowment C9	Per capita water resources	Cubic meters/person	+
			Region proportion of nature reserves	%	+
			Urban per capita public green space region	Square meters/person	+
		C10 Ecological environment management C10	Investment intensity of environmental pollution control	%	+
			Proportion of soil erosion control region	%	+

Note: "+" indicates a positive indicator, the larger the positive indicator, the larger the index value; "−" indicates a negative indicator. The smaller the negative indicator is, the larger the index value is.

Table 2. Weight of Inclusive Green Growth Indicators in China.

Target Layer A	Dimension Layer B	Domain Layer C	Indicator Name	Nature	Indicator Code	Weight
China Inclusive Green Growth Index A	Economic development B1	Economic output C1	GDP growth rate	+	x1	0.0035
			Proportion of fiscal revenue	+	x2	0.0169
			Urbanization rate	+	x3	0.3816
		Income level C2	Per capita disposable income	+	x4	0.0245
			Per capita net income of rural residents	+	x5	0.0219
			Per capita disposable income of urban residents	+	x6	0.0218
	Fair opportunity B2	Employment equity C3	Registered urban unemployment rate	–	x7	0.0023
			Employment rate of tertiary industry	+	x8	0.0084
		Education equity C4	Intensity of investment in education funds	+	x9	0.0467
			Proportion of illiterate population	–	x10	0.0008
		Social Security Equity C5	Proportion of basic endowment insurance fund expenditure	+	x11	0.0041
			Proportion of basic medical insurance fund expenditure	+	x12	0.0174
		Fair infrastructure conditions C6	Length of transportation line per 10,000 people	+	x13	0.0603
			Public transport vehicles per 10,000 people	+	x14	0.0137
			Urban population density	–	x15	0.0101
	Green production and consumption B3	Green production C7	Energy consumption per unit output value	–	x16	0.0070
			Wastewater discharge per unit output value	–	x17	0.0014
			Carbon dioxide emissions per unit output value	–	x18	0.0038
			Sulfur dioxide emission per unit output value	–	x19	0.0031
		Green consumption C8	Per capita energy consumption	–	x20	0.0070
			Per capita wastewater discharge	–	x21	0.0013
			Per capita carbon dioxide emissions	–	x22	0.0039
			Per capita sulfur dioxide emissions	–	x23	0.0042
	Ecological environment protection B4	C9 Ecological resource endowment C9	Per capita water resources	+	x24	0.2089
			Region proportion of nature reserves	+	x25	0.0566
			Urban per capita public green space region	+	x26	0.0099
		C10 Ecological environment management C10	Investment intensity of environmental pollution control	+	x27	0.0282
			Proportion of soil erosion control region	+	x28	0.0308

4.3. Measurement of Inclusive Green Growth Index

Similarly, according to the calculation of entropy method, the inclusive green growth index, ranking and growth rate can be obtained (see Table 3).

Table 3. China Inclusive Green Growth Index.

Province	2010	2012	2014	2016	2017	2018	2019	Mean	Rank	Average Growth Rate%
Beijing	12.8450	17.2878	17.5655	17.9668	18.4903	18.2902	18.7270	17.2891	1	3.14
Tibet	10.5143	15.8128	16.2299	15.7352	16.1871	16.3742	16.6103	15.5014	2	3.67
Tianjin	16.3073	14.8046	14.3182	15.0983	15.1725	14.1469	15.2241	14.8414	3	−0.71
Hainan	11.8315	14.6524	15.0715	15.3761	15.5521	15.5251	15.8400	14.8350	4	2.53
Zhejiang	12.2462	14.0935	14.8022	15.4707	15.8100	16.0945	16.4081	14.8050	5	2.54
Guangdong	10.8091	14.5254	14.5560	15.2236	15.5114	15.6355	16.6169	14.6423	6	3.50
Shanghai	12.2296	13.9094	14.0771	14.8278	15.2784	15.4681	15.7776	14.3122	7	2.25
Chongqing	12.7450	13.5809	14.1414	15.1162	15.0436	15.2363	15.4229	14.2665	8	1.74
Jiangsu	12.3435	14.0236	14.0991	14.7072	14.9953	15.0698	15.3801	14.2230	9	1.97
Anhui	16.0183	13.1008	13.4267	13.9439	14.2416	14.4972	14.8405	13.9632	10	−0.79
Shandong	10.0686	13.6381	14.0256	14.7786	15.1191	15.1306	15.4523	13.9431	11	3.48
Fujian	10.6833	13.5681	13.9994	14.7754	15.1461	14.9366	15.2364	13.9134	12	2.99
Sichuan	13.8168	13.1025	13.4180	14.0894	14.3960	14.6908	14.9245	13.8379	13	0.74
Jiangxi	12.9823	13.0845	13.3876	13.6203	14.4988	14.5774	13.3824	13.4784	14	0.30
Hunan	12.5282	12.5940	13.1719	13.8222	14.0495	14.5061	14.9081	13.4225	15	1.60
Liaoning	10.6524	13.6556	13.3903	13.4869	13.9791	14.1891	14.4713	13.3761	16	2.64
Hubei	12.1541	12.2591	13.0828	14.0537	14.2882	14.5755	14.8589	13.3305	17	1.82
Yunnan	13.3243	12.1198	12.9291	13.3164	13.9807	14.4152	14.5689	13.2226	18	0.85
Jilin	13.2194	12.7963	12.6908	13.7251	13.6641	14.0477	13.9625	13.2209	19	0.53
Shaanxi	13.3702	12.6286	12.7054	13.5331	13.8388	14.0876	14.1347	13.2068	20	0.54
Guizhou	14.2738	10.8870	12.5736	13.9463	13.9080	14.4423	14.8267	12.9889	21	0.37
Hebei	11.1694	12.3278	12.4695	13.4813	13.8383	13.8188	15.0217	12.9277	22	2.56
Guangxi	9.9624	12.2815	12.8086	13.7443	13.8043	14.0589	14.3433	12.8691	23	3.05
Henan	11.8162	11.7811	12.2233	13.0881	13.9247	14.2014	14.5116	12.7318	24	1.86
Gansu	13.8382	11.4021	12.0797	12.8986	13.3760	13.7467	14.1117	12.6111	25	0.19
Heilongjiang	11.4538	12.2218	12.4556	12.8737	13.1094	13.1254	13.3301	12.6055	26	1.41
Qinghai	13.0384	12.0188	12.3292	12.6634	12.8270	13.1784	13.3320	12.5038	27	0.22
Inner Mongolia	9.6745	11.3298	11.8314	12.9078	12.9030	12.6516	13.0347	11.8873	28	2.58
Xinjiang	11.7134	10.7917	11.1305	12.0958	12.6142	13.2383	13.2681	11.7124	29	1.17
Shanxi	11.8916	10.7405	10.7762	12.5998	12.5539	12.7881	13.0471	11.6915	30	0.89
Ningxia	11.6939	10.3142	11.2517	12.6448	12.6765	12.5089	12.5308	11.5378	31	0.67

5. Time Series Characteristics of Inclusive Green Growth

According to the calculation results, we find that inclusive green growth has the following obvious time series characteristics.

5.1. Weight Analysis

In order to be more intuitive, we made Figure 1 according to the indicator weight. It can be seen from Table 2 and Figure 1 that there are obvious differences in the weights of various dimensions, fields and indicators of inclusive green growth in China. From the indicator level, the weight of urbanization rate (x3) is 38.16%, ranking first among all indicators, indicating that with the rapid increase of urbanization rate in China from 49.95% in 2010 to 62.71% in 2019, it has made the most obvious contribution to economic development. Other indicators, such as the investment intensity of education funds (x9), the length of transportation lines per 10,000 people (x13), the per capita water resources (x24), the proportion of nature reserves (x25), the investment intensity of environmental pollution control (x27) and the proportion of soil erosion control region (x28), all have greater weights and contribute to inclusive green growth.

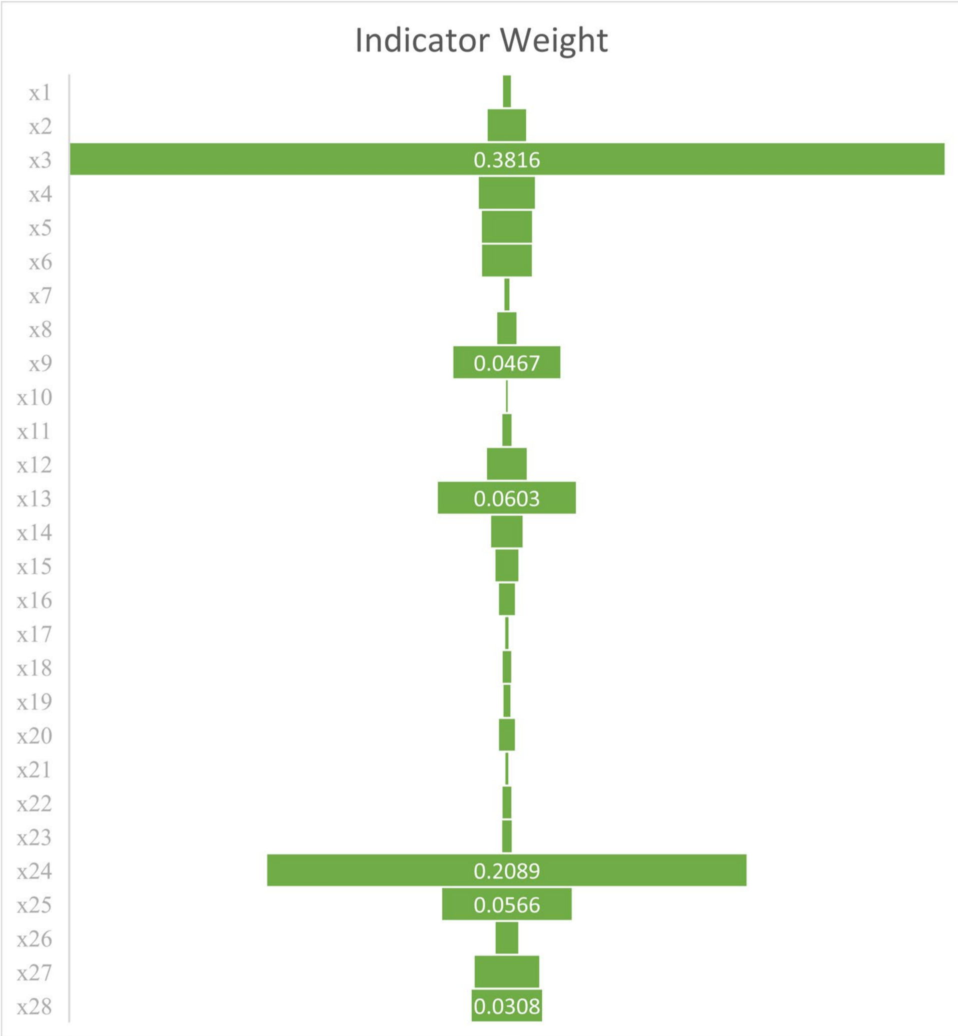


Figure 1. Weight of each indicator.

From the field level, economic output (C1) has the highest weight in all 10 fields, reaching 40.20%, indicating that in China, economic development is mainly achieved through economic output, which greatly promotes inclusive green growth. The weight of income level (C2) is only 6.82%, indicating that China's income level is low, and the role of promoting economic development by increasing income and expanding consumption is not obvious, and the role of income level in promoting inclusive green growth is also limited. The weights of employment equity (C3), education openness (C4), social security equity (C5) and infrastructure conditions (C6) are 1.07%, 4.74%, 2.15% and 8.41%, respectively, and their weights are relatively low, indicating that China's equity of opportunity needs to be strengthened, so the contribution of equity of opportunity to inclusive green growth is relatively small. The weights of green production (C7) and green consumption (C8) are 1.53% and 1.64%, respectively, indicating that green production and consumption in China are still at a low stage of development and that their contribution to inclusive green growth is limited. The weights of ecological resource endowment (C9) and ecological environmental governance (C10) are 27.54% and 5.91%, respectively, and the weight of ecological resource endowment (C9) is second only to economic output (C1), indicating that ecological resource endowment plays an important role in China's inclusive green growth. Overall, however, the level of inclusive green growth in China is uneven, which also shows that there is still much room for improvement.

Figure 2 shows the weight of each dimension, in terms of dimension weight, the weights of economic development (B1), and ecological environment protection (B4) in the inclusive green growth index are 47.2% and 33.45%, respectively. Among them, economic development accounts for about half, while ecological environment protection accounts for about one quarter, with a total of 80.65%, which shows that they play an important role in the whole index weight. This means that economic development and ecological environment protection are important components of China's inclusive green growth, which fully reflects that China has paid more attention to the coordinated development of economic development and environmental protection in the past 10 years. It promotes the improvement of the inclusive green growth level, which also reflects the effect of green and high-quality development strategies to a great extent. What's more, it also shows the rationality of an inclusive green growth indicator system. However, it should be noted that although the weights of fair opportunity (B2) and green production and consumption (B3) dimensions in the inclusive green growth index are only 16.37% and 3.17%, respectively, which are lower than the other two dimensions, it cannot be concluded that they are not important. On the contrary, from another angle, China has not done well enough in fair opportunities and green production and consumption, and there is still great potential and room for improvement. If China further improves the level of fair opportunities and green production and consumption, it will not only increase their weight in inclusive green growth indexes, but also make the four dimensions develop in a balanced way, thus further promoting China's inclusive green growth.

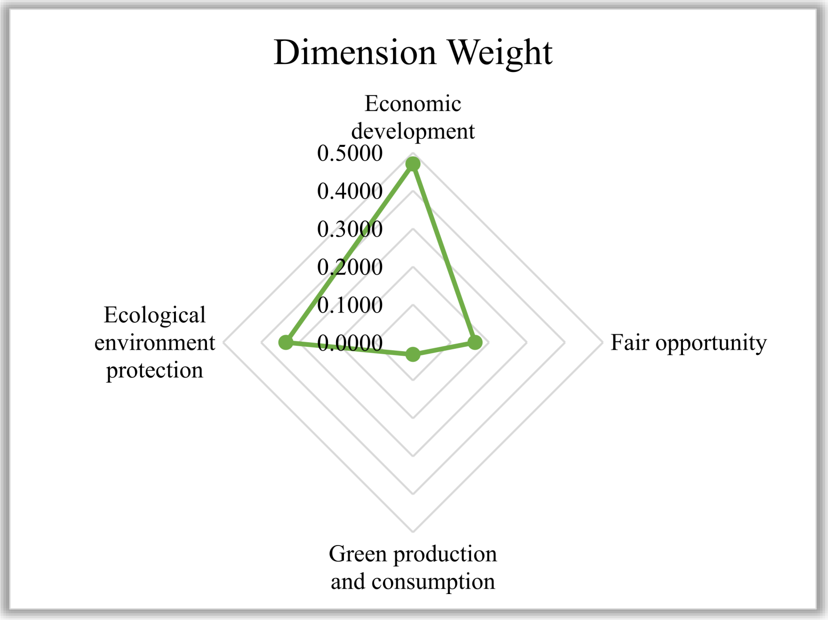


Figure 2. Weights of each dimension from 2010 to 2019.

5.2. Time Series Analysis

It can be seen from Table 3 that the inclusive green growth index showed a fluctuating upward trend from 2010 to 2019, and the comprehensive index increased from 12.2973 in 2010 to 14.7776 in 2019. This shows that the overall level of inclusive green growth in China has steadily increased since 2010, and most provinces have the same trend, but there are obvious inter-provincial and regional differences in the level of inclusive green growth.

From the index ranking of each province (Figure 3), the top 10 are mainly the eastern regions, such as Beijing, Tianjin, Hainan, Zhejiang, Guangdong, Shanghai and Jiangsu, while the bottom 10 are mainly the central and western regions such as Guangxi, Henan, Gansu, Heilongjiang, Qinghai, Inner Mongolia, Xinjiang, Shanxi and Ningxia. From the annual average growth rate, Tibet, Guangdong, Shandong, Beijing, Guangxi, Inner Mongolia, Hebei and Zhejiang have the fastest growth rate, while Sichuan, Ningxia, Shaanxi, Jilin, Guizhou, Jiangxi, Gansu, Tianjin and Anhui have the slower average growth rate, and even

Tianjin and Anhui have experienced negative growth. It can be seen that the development level of inclusive green growth in China is quite different among provinces.

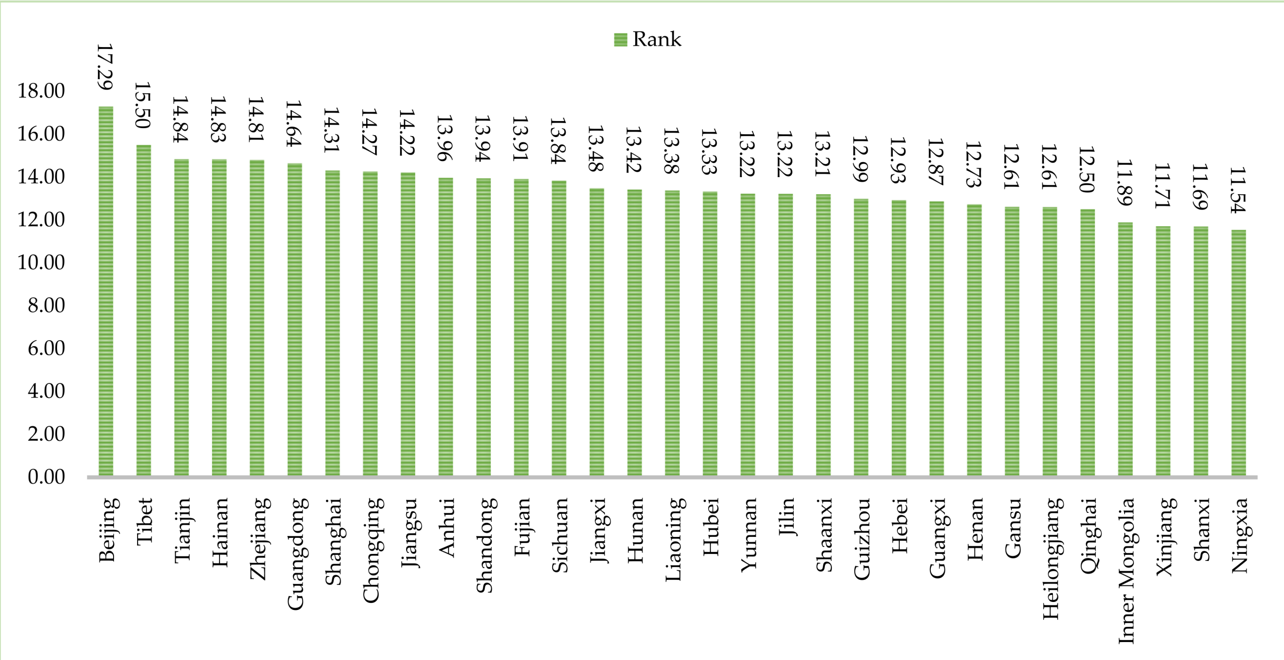


Figure 3. Inclusive green Growth index ranking by province.

The regional differences of inclusive green growth in China are also obvious. In order to better analyze regional differences, this paper makes descriptive statistics on the inclusive green growth index from 2015 to 2019 (see Table 4). The results show that, from a national perspective, the five-year average is 14.2021, the minimum value appears in Xinjiang in 2015 with an index of 10.8085, and the maximum value appears in Beijing in 2019 with an index of 18.727. The difference between them is obvious, which reflects that there is an obvious gap between the inclusive green growth in the east and west to a certain extent.

Table 4. Descriptive statistics of inclusive green growth index from 2015 to 2019.

Year	Mean in 2015	Mean in 2016	Mean in 2017	Mean in 2018	Mean in 2019	Mean in 5 Years	Minimum Value and the Region and Year		Maximum Value and the Region and Year	
National	13.3415	14.0520	14.3477	14.4920	14.7776	14.2021	10.8085	Xinjiang 2015	18.7270	Beijing 2019
Eastern	14.6331	15.1706	15.4913	15.4116	15.9684	15.3350	12.6984	Hebei 2015	18.7270	Beijing 2019
Central	12.7176	13.5080	13.8097	14.0165	14.2356	13.6575	10.9385	Shanxi 2015	14.9081	Hunan 2019
Western	13.2031	13.9296	14.2182	14.3733	14.6542	14.0757	10.8085	Xinjiang 2015	16.6103	Tibet 2019
Northeast	12.4051	13.2868	13.5545	13.7810	14.0505	13.4156	12.3256	Heilongjiang 2015	14.4713	Liaoning 2019

From the eastern region, the five-year average is 15.3350, which is significantly higher than that of the whole country and other regions. The minimum value appears in Hebei in 2015 with an index of 12.6984, and the maximum value appears in Beijing in 2019 with an index of 18.727. This shows that the economically developed regions in eastern China have made remarkable achievements in optimizing industrial structure, transforming economic growth mode and economic growth quality, and promoted the coordinated development of economic development, fair opportunities, green production and consumption and ecological environment, thus improving the level of inclusive green growth.

From the central region, the five-year average value is 14.2356, which is lower than that of the eastern region, the whole country and the western region. The minimum value appears in Shanxi in 2015 with an index of 10.9385, and the maximum value appears in Hunan in 2019 with an index of 14.9081. The possible reason is that in recent years, China has implemented the strategy of the rise of central and undertaken more traditional industries in the east, which has brought great environmental pressure to the central region and dragged down the inclusive green growth level to a certain extent, but this impact is expected to be short-term.

From the western region, the five-year average value is 14.0757, which is obviously lower than that of the eastern region, but higher than that of the whole country and other regions. The minimum value appears in Xinjiang in 2015, with an index of 10.8085, and the maximum value appears in Tibet in 2019 with an index of 16.6103. This shows that the green development strategy implemented by China has played a more obvious role in the western region than other regions. The economic development in the western region is rapid, and the economic development level in the eastern and western regions tends to shrink, thus promoting the inclusive green growth level in the western region. However, the regional differences in the western region are obvious.

From the perspective of northeast China, the 5-year average is 13.4156, which is significantly lower than that of the eastern region, and also lower than that of the whole country and other regions. The minimum value appeared in Heilongjiang in 2015, and the index was 12.3256. The maximum value appeared in Liaoning in 2019, and the index was 14.4713. This shows that the economic growth rate of northeast China has declined in recent years, the traditional industrial dominant position is no longer obvious, and the relationship between economic development and environmental protection needs to be coordinated further. We should give full play to the advantages of resource endowment in the northeast region, tap the potential of green production and consumption, optimize the industrial structure, increase ecological protection, and improve the level of inclusive green growth. However, the advantage of the northeast region is that the differences between regions are not obvious.

In order to observe the changing trend of the inclusive green growth index in different regions more intuitively, this paper makes Table 5 and Figure 4. It can be seen from Table 5 and Figure 4 that the inclusive green growth level not only has obvious differences among provinces and regions, but also has obvious convergence characteristics among regions.

Table 5. National and Regional Inclusive Green Growth Index.

Year	Nationwide	Eastern	Middle	Western	Northeast
2010	12.2973	12.0533	12.2474	12.2801	12.1022
2011	12.7122	13.9701	12.0377	12.5832	11.7527
2012	12.9463	14.2831	12.2723	12.8106	11.9693
2013	13.0970	14.2522	12.4799	12.9715	12.1886
2014	13.3231	14.4984	12.7001	13.1906	12.4097
2015	13.3415	14.6331	12.7176	13.2031	12.4051
2016	14.0520	15.1706	13.5080	13.9296	13.2868
2017	14.3477	15.4913	13.8097	14.2182	13.5545
2018	14.4920	15.4116	14.0165	14.3733	13.7810
2019	14.7776	15.9684	14.2356	14.6542	14.0505

First of all, the inclusive green growth index increased from 12.2973 in 2010 to 14.7776 in 2019, which has a fluctuating upward trend. The trend of each region is basically the same, which means that all regions have made great contributions to the growth of the index. Among them, the eastern region stands out among all regions. Out of the independent trend, which is relatively different from other regions, the inclusive green growth index increased from 12.0533 in 2010 to 15.9684 in 2019, and rapidly increased to a higher level from 2010, which was significantly higher than that of the whole country and other regions, and then showed a steady upward trend, which represented the highest level of inclusive green growth in China; this shows that the eastern region has achieved faster development in terms of economic development, equal opportunities, green production and consumption, and ecological and environmental protection than other regions, and has played the most significant role in promoting inclusive green growth in the eastern region. The western region increased from 12.2801 in 2010 to 14.6542 in 2019, which is basically consistent with the national trend, and the level of inclusive green growth is also equivalent to that of the whole country. This shows that the western region has its own advantages in the process of inclusive green growth, such as the endowment of ecological resources, which promotes inclusive green growth. However, the inclusive green growth index in the central and northeast regions began to decline in 2010, but then returned to the upward channel and maintained the same trend as that of the whole country, which was obviously lower than that in the eastern region, and also lower than that in the whole country and the western region, This may be due to the fact that many provinces in central and northeastern China are traditionally heavy industrial zones with high levels of environmental pollution that are difficult to improve in the short term, thus negatively affecting inclusive green growth, but they still have significant room for improvement.

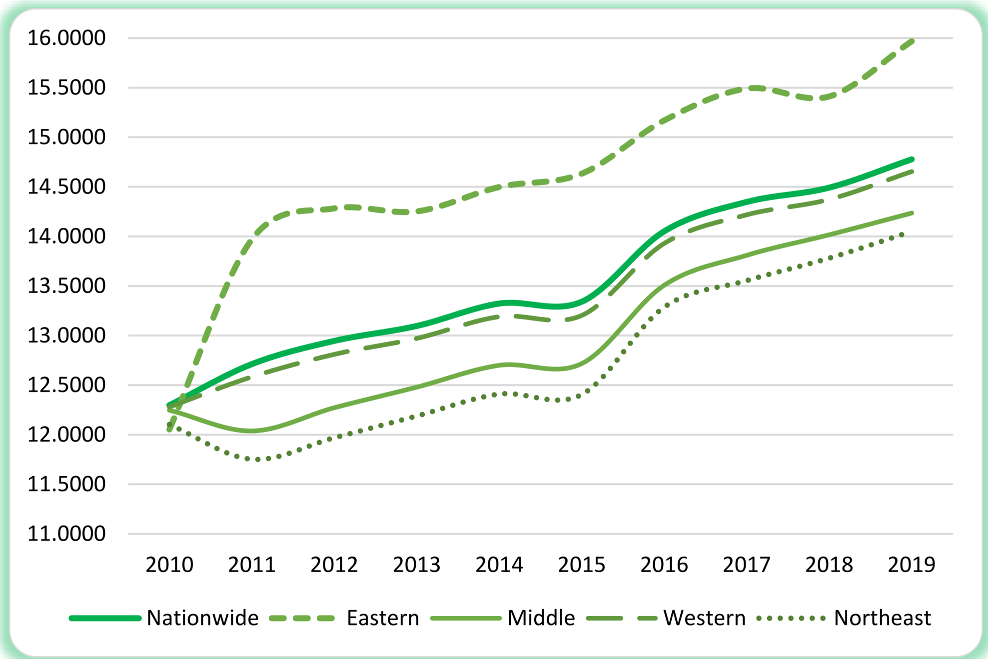


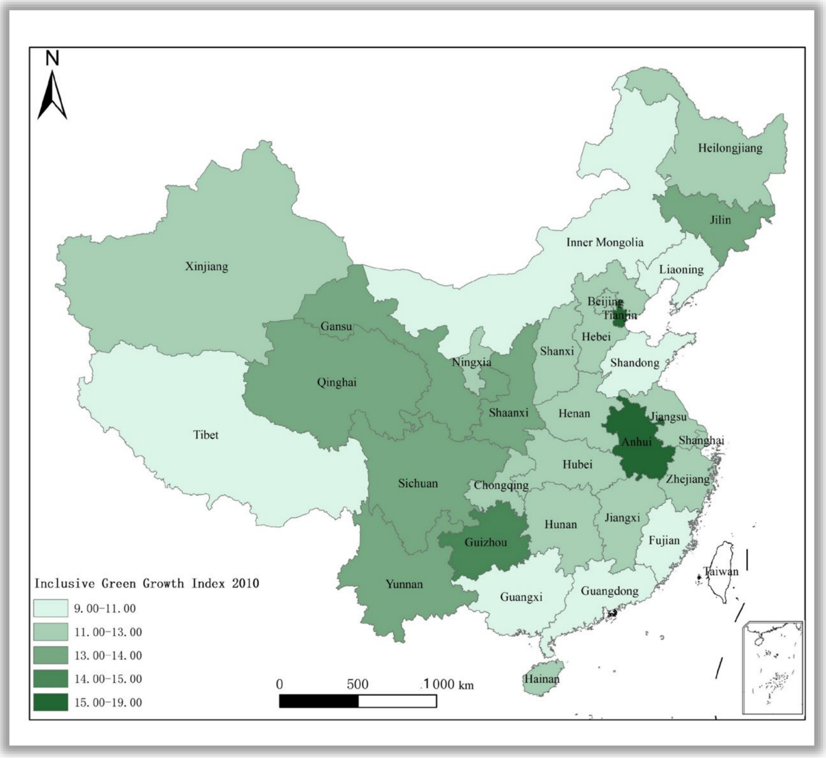
Figure 4. Regional Comparison of the Inclusive Green Growth Index in China.

6. Spatial Characteristics of Inclusive Green Growth

In order to further describe the spatial-temporal characteristics of inclusive green growth, this paper analyzes the spatial evolution process, global spatial characteristics and local spatial correlation of inclusive green growth.

6.1. Spatial Evolution Process

As shown in Figures 5–8, after years of development, China's inclusive green growth experienced a dynamic evolution process from 2010 to 2019. In 2010, Tianjin, Anhui, Guizhou, Gansu and Sichuan ranked in the top five, while Liaoning, Tibet, Shandong, Guangxi and Inner Mongolia ranked in the bottom five, while the eastern provinces did not enter the top five except Tianjin. This shows that there is no obvious regional difference in the inclusive green growth index at this stage. However, since 2011, the inclusive green growth index has entered a differentiated development stage, and the eastern region has sprung up everywhere with a gradual increase in provinces with high index and a tendency of concentration. By 2019, the top 10 provinces were Beijing, Guangdong, Zhejiang, Hainan, Shanghai, Shandong, Jiangsu and Fujian. This shows that from 2010 to 2019, the eastern region benefited from the transformation, upgrading and optimization of industrial structure, and made great progress in economic development, fair opportunities, green production and consumption and environmental protection, which promoted the inclusive green growth level.



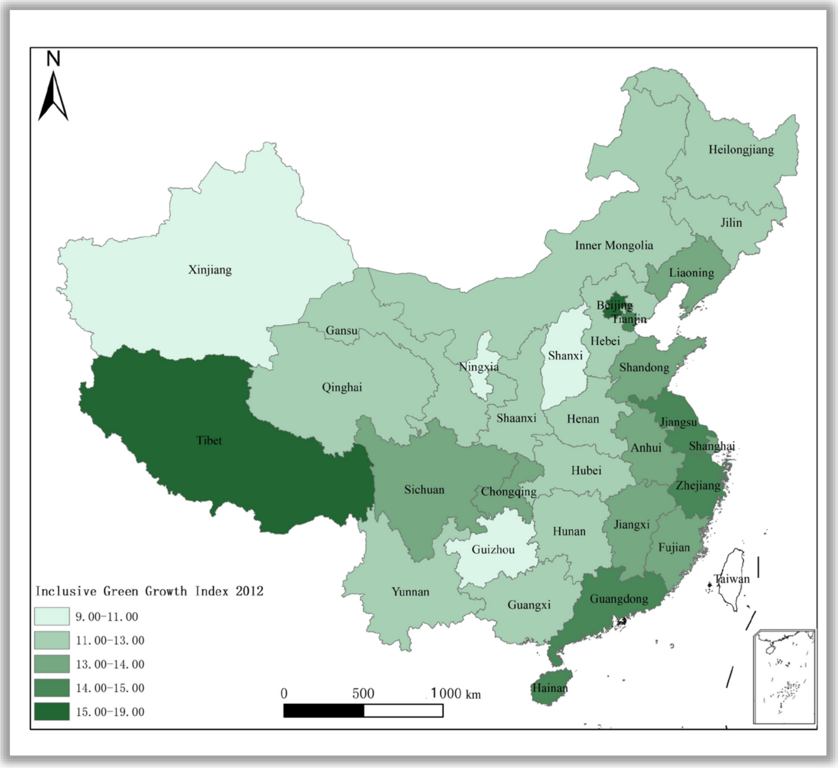


Figure 5. Inclusive Green Growth Level of Provinces for 2010 and 2012.

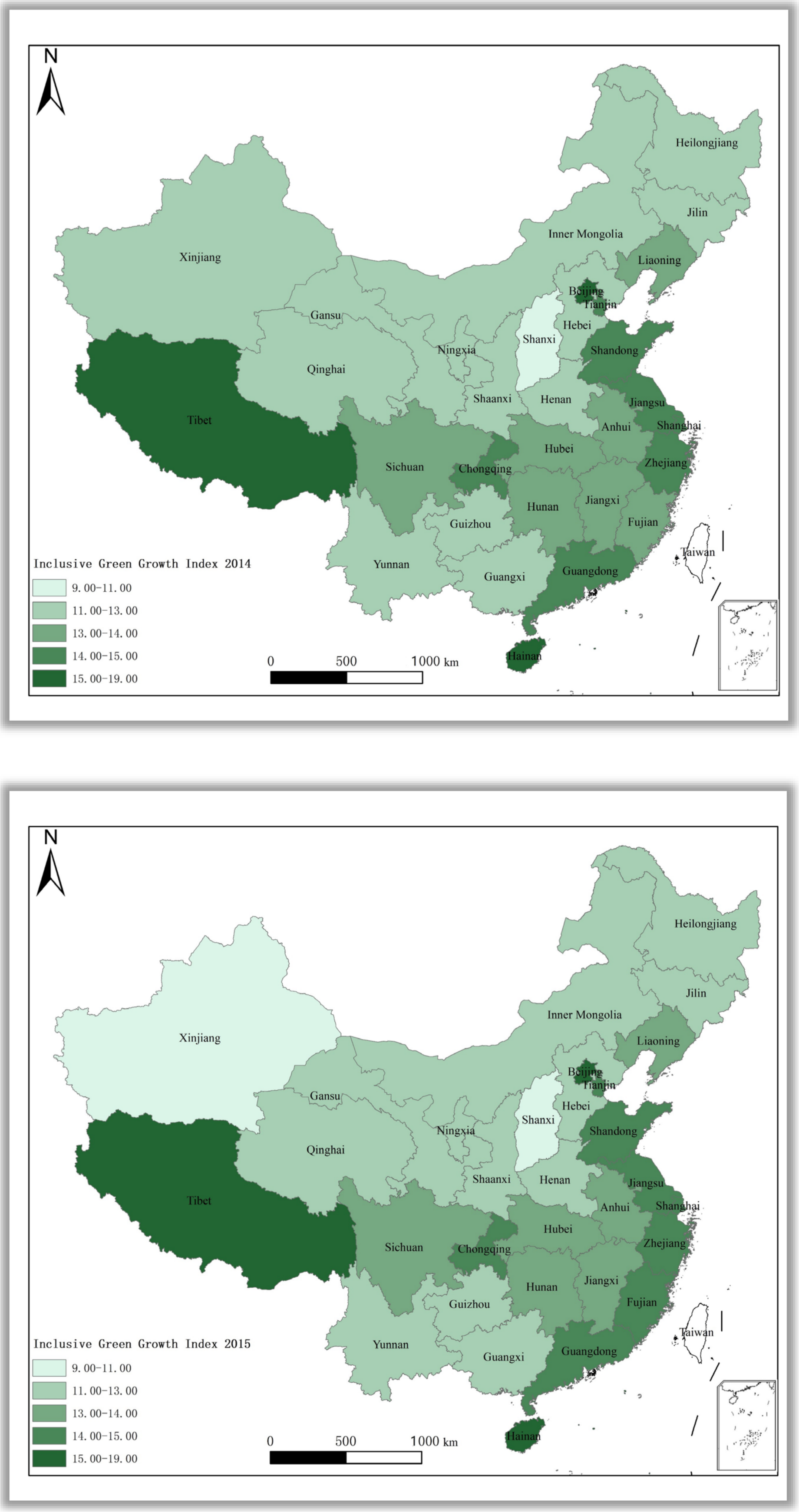
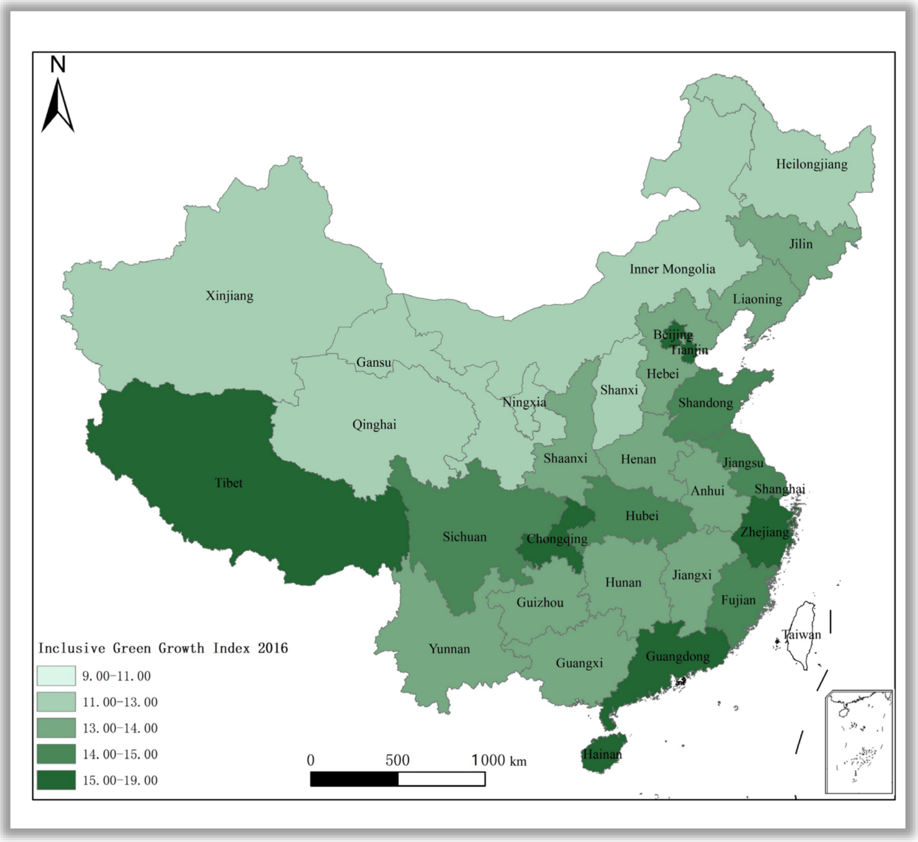


Figure 6. Inclusive Green Growth Level of Provinces for 2014 and 2015.



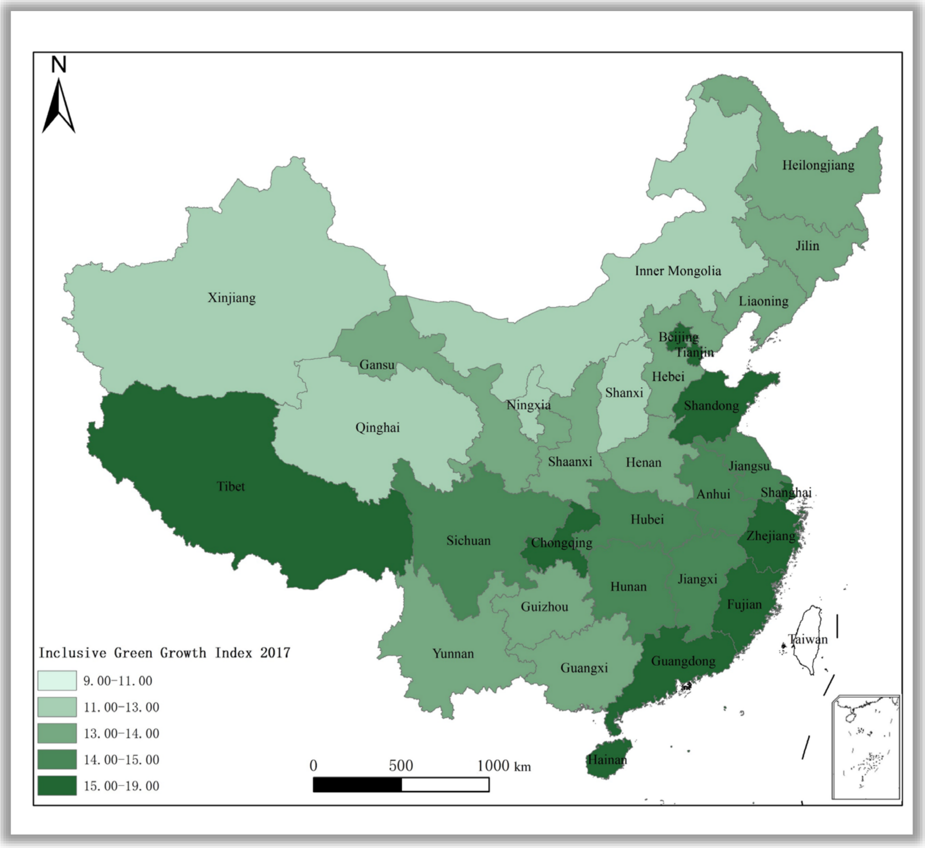
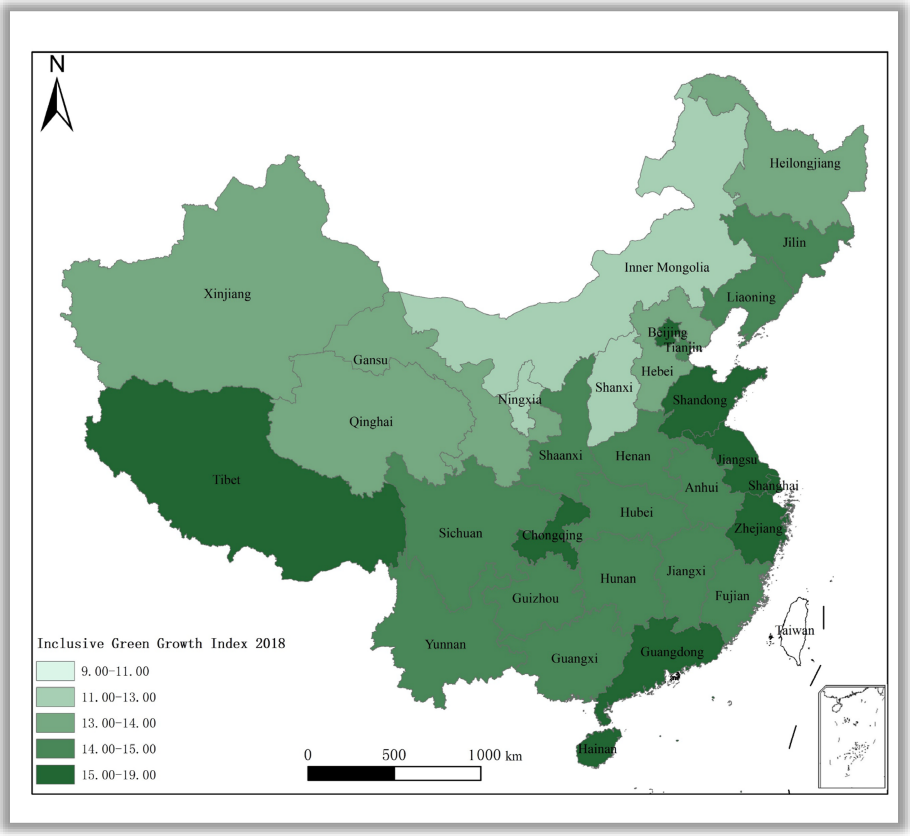


Figure 7. Inclusive Green Growth Level of Provinces for 2016 and 2017.



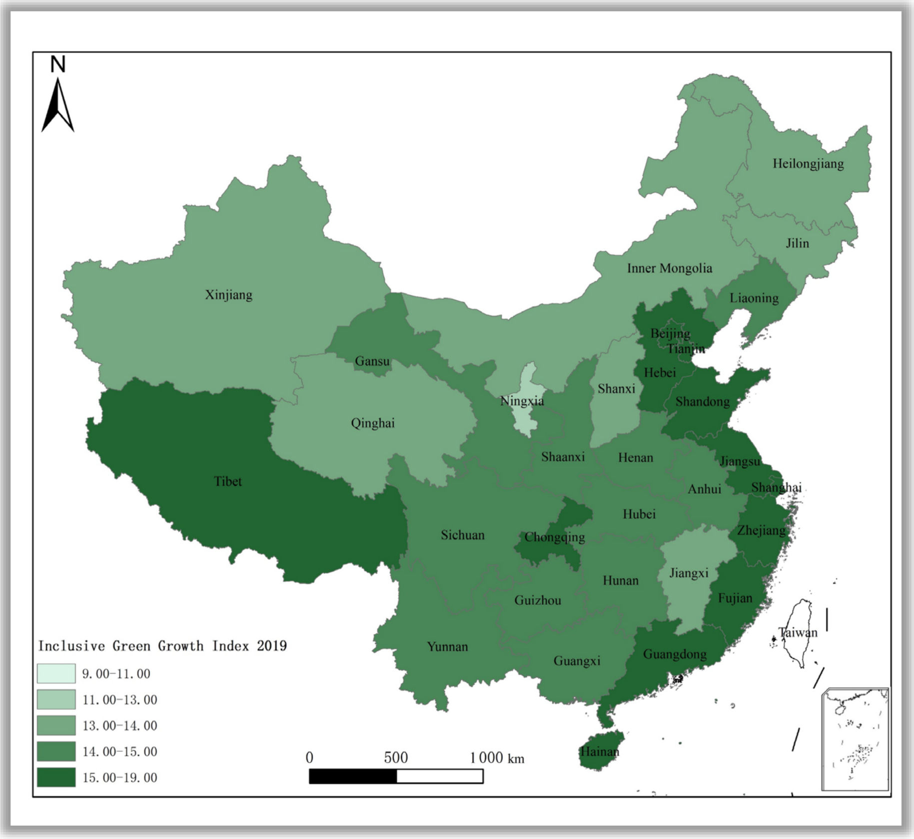


Figure 8. Inclusive Green Growth Level of Provinces for 2018 and 2019.

However, from the comprehensive index of the inclusive green growth from 2010 to 2019 (Figure 9), the top 10 provinces in the central and eastern regions still occupy a major position, mainly including Beijing, Tianjin, Hainan, Zhejiang, Guangdong, Shanghai, and Jiangsu. This also shows that the eastern region is not only the most economically developed region in China in recent years, but also has an irreplaceable position in inclusive green growth with the emphasis on environmental protection. We should also see that Anhui in the central region, and Chongqing and Tibet in the western region also entered the top 10, which also attracted our attention. It is not surprising that Anhui entered the top 10. Thanks to Anhui's proximity to the Yangtze River Delta, it was listed as the Yangtze River Delta Economic Belt in 2018. It has undertaken some industries in Shanghai and Jiangsu, and initially integrated with Shanghai, Jiangsu and Zhejiang. The economy has grown rapidly and has also boosted its level of inclusive green growth. As the only municipality directly under the Central Government in western China, Chongqing is an important economic center in the southwest region. It also benefits from the construction of the Yangtze River Economic Belt and the Chengdu-Chongqing Economic Zone. Since 2010, it has made great progress in economic development and ecological environment protection, thus improving its inclusive green growth level. Surprisingly, Tibet entered the top 10, which is different from previous research conclusions. The possible reason is that although Tibet has a big gap with other regions in terms of economic development, it has unique advantages in ecological and environmental protection, and with the strong support of the Chinese government, Tibet's economy has also developed rapidly in recent years, while there have also been significant improvements in equality of opportunity and green production and consumption, thereby promoting inclusive green growth.

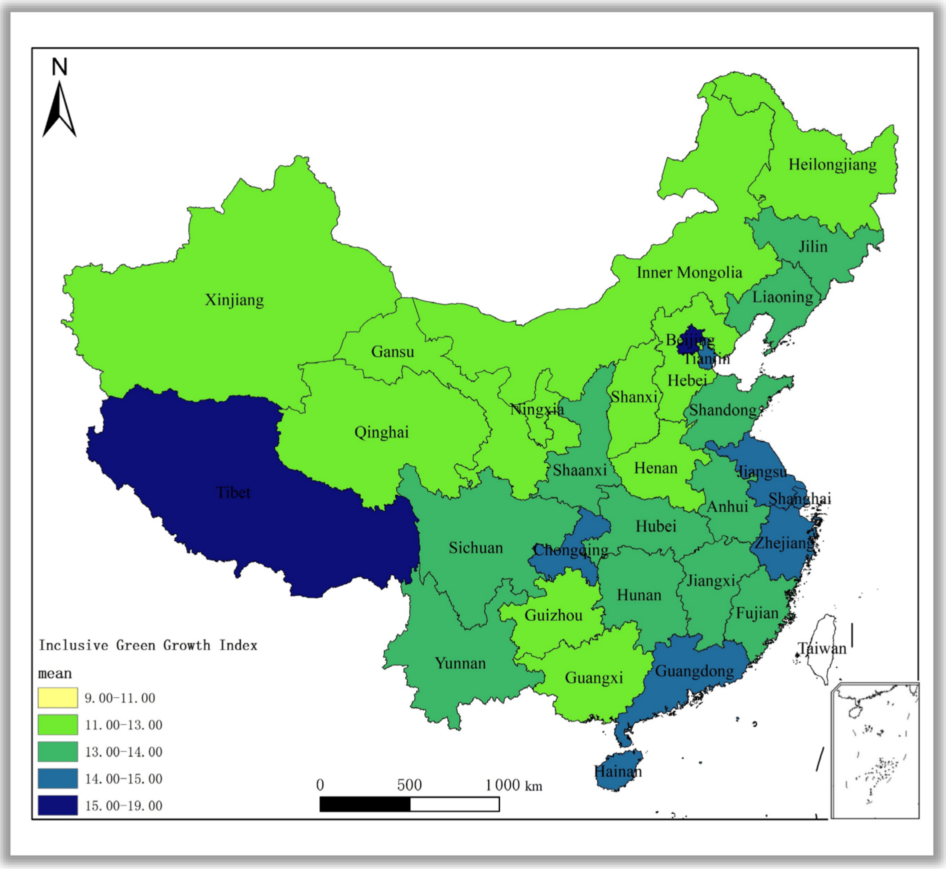


Figure 9. China Inclusive Green Growth Index from 2010 to 2019.

6.2. Global Spatial Characteristics and Pattern

The first law of geography states that everything is related to other things, but things that are close are more closely related. In order to further explore the spatial characteristics and spatiotemporal patterns of inclusive green growth, this paper uses the Moran's I and LISA agglomeration maps to study the spatial correlation of inclusive green growth.

In order to judge whether there are spatial correlations and agglomeration characteristics of the inclusive green growth as a whole, this paper uses ArcGIS 10.8 software to calculate the inclusive green growth index for each year from 2015 to 2019, as well as the Moran index for average comprehensive inclusive green growth in 2010–2019 (Figure 10). Among them, the last figure (mean) is the comprehensive index. The results show that the Moran's I index of inclusive green growth is all negative, indicating that inclusive green growth has a negative spatial autocorrelation relationship, that is, the spatial difference of inclusive green growth is large.

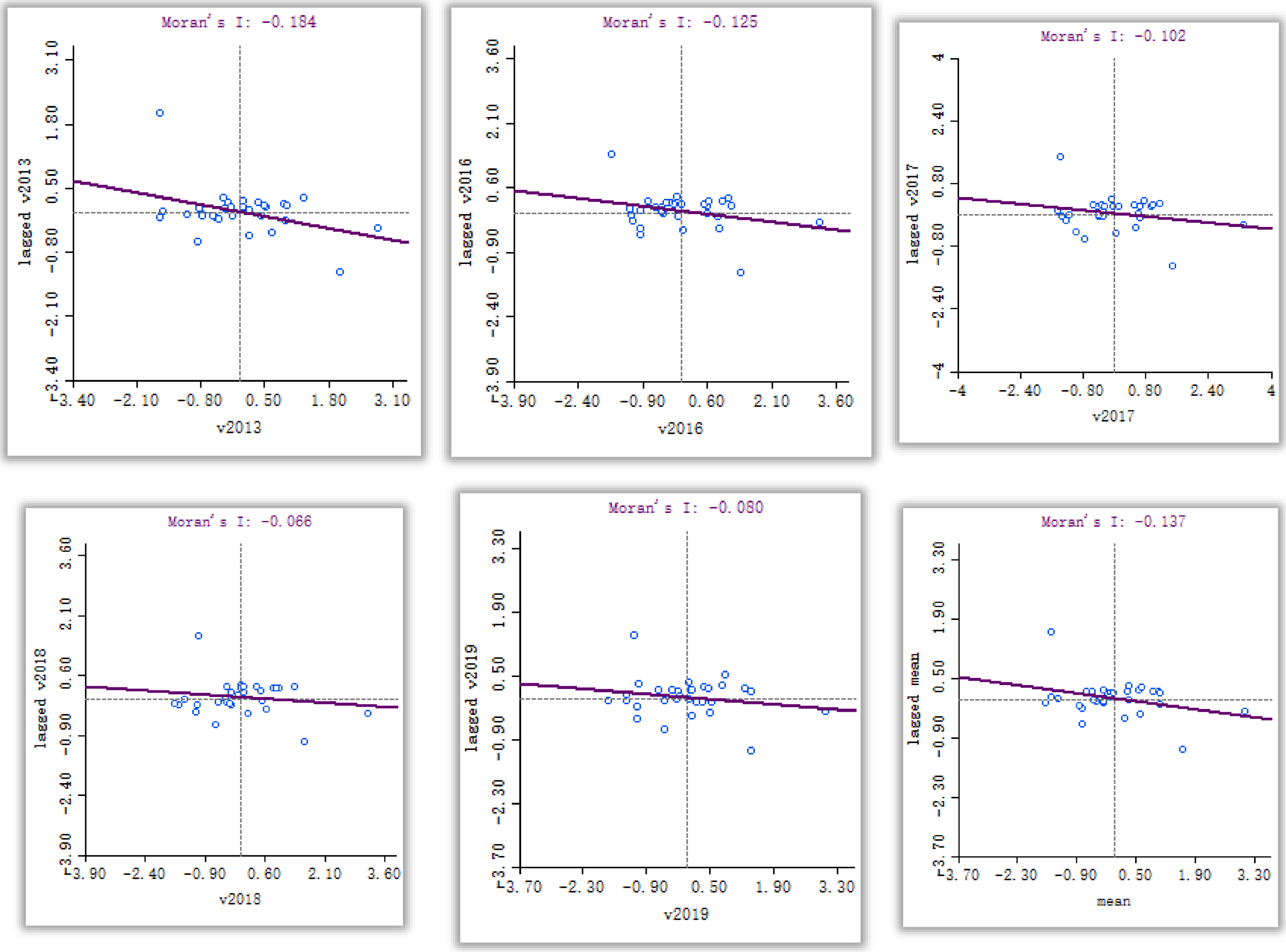


Figure 10. Moran Scatter Plot of Local Autocorrelation.

6.3. Local Spatial Correlation Mode

The global Moran's I index can only judge the spatial distribution of the inclusive green growth index as a whole, but it cannot judge the spatial correlation pattern between regions. This paper uses the Moran scatter plot provided by Geo-Da software combined with LASA to further analyze the local spatial aggregation characteristics of inclusive green growth. The Moran scatterplot includes four quadrants: the first quadrant is the high-high (HH) spatial correlation pattern, the third quadrant is the low-low (LL) spatial correlation pattern, and the spatial units located in the first and third quadrants have positive spatial correlations. The second quadrant Low High (LH) indicates that a region has a low level of inclusive green growth and is surrounded by surrounding regions with higher levels, and the fourth quadrant High Low (HL) is the opposite. These two belong to the negative influence relationship, which is used to indicate the difference between regions. Combined with GeoDa for local spatial analysis, the local spatial clustering relationship was obtained (Figures 11–14).

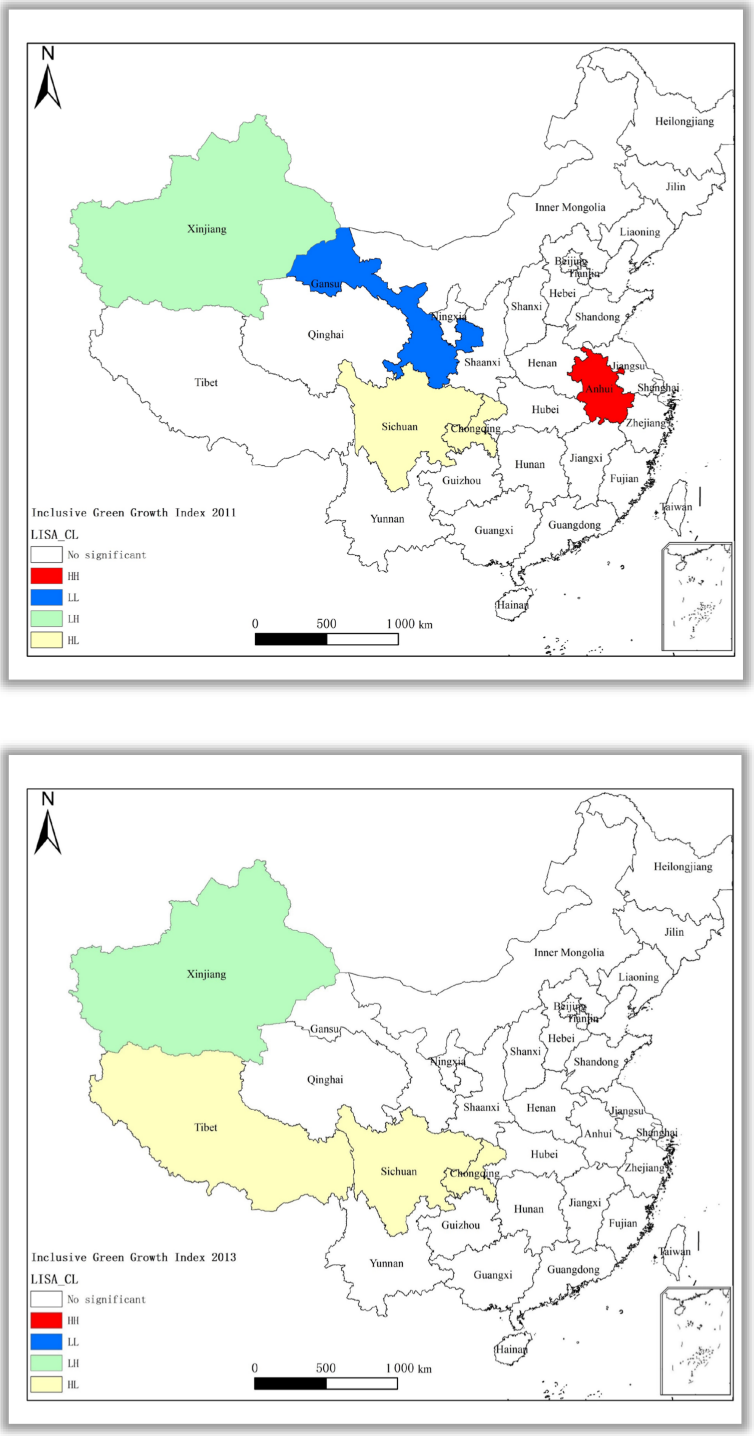
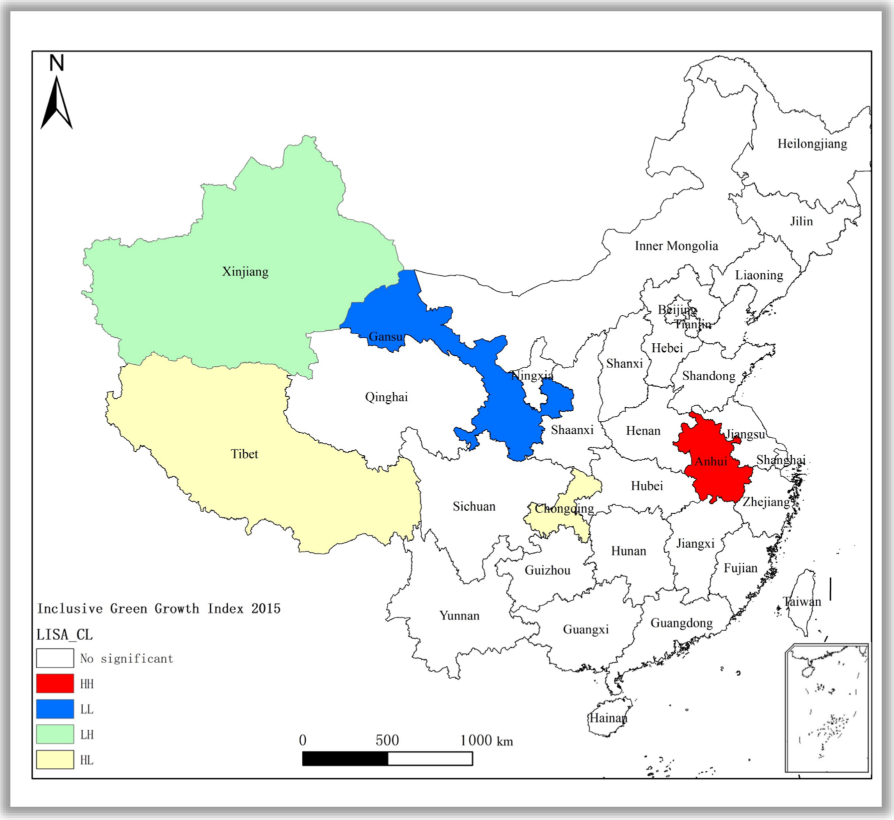


Figure 11. LISA Clustering Diagram of 2011 and 2013.



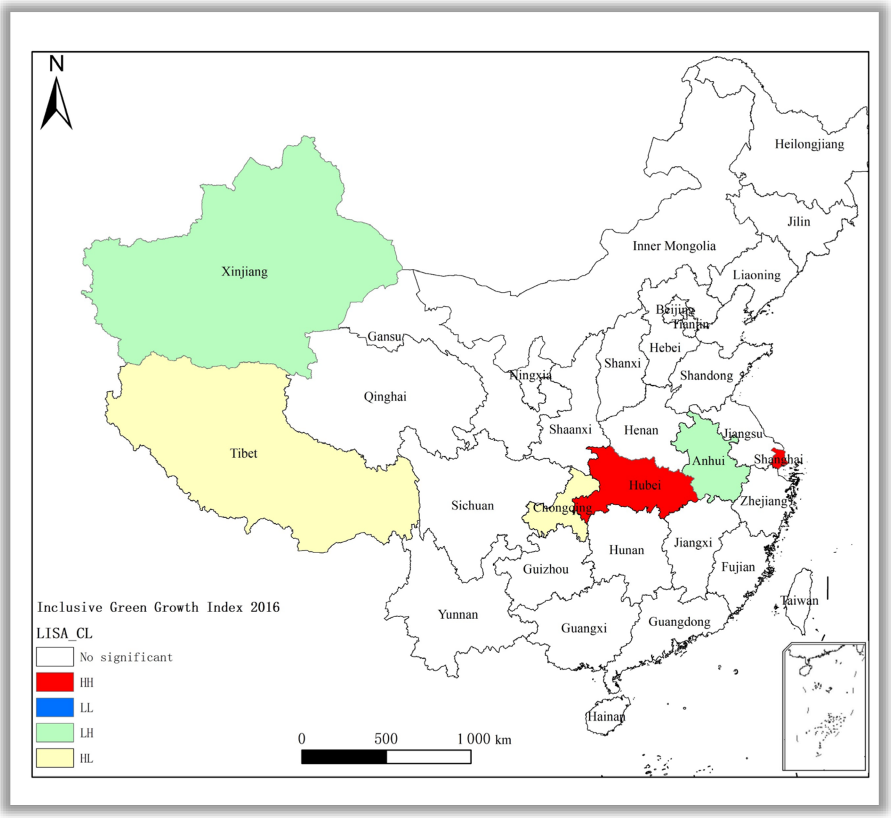
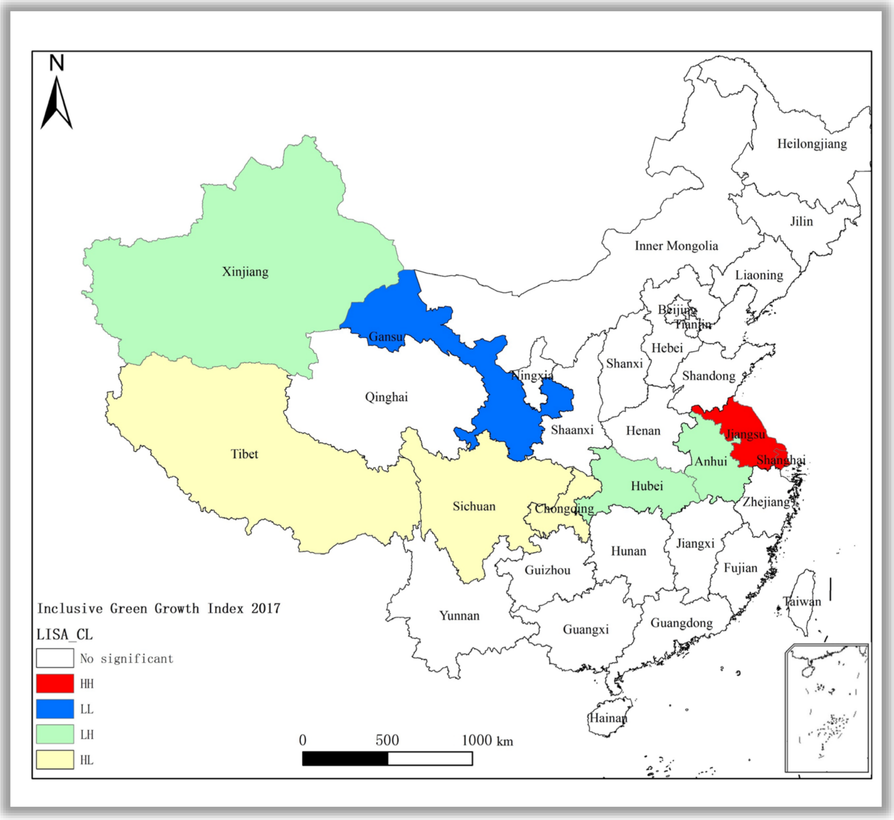


Figure 12. LISA Clustering Diagram of 2015 and 2016.



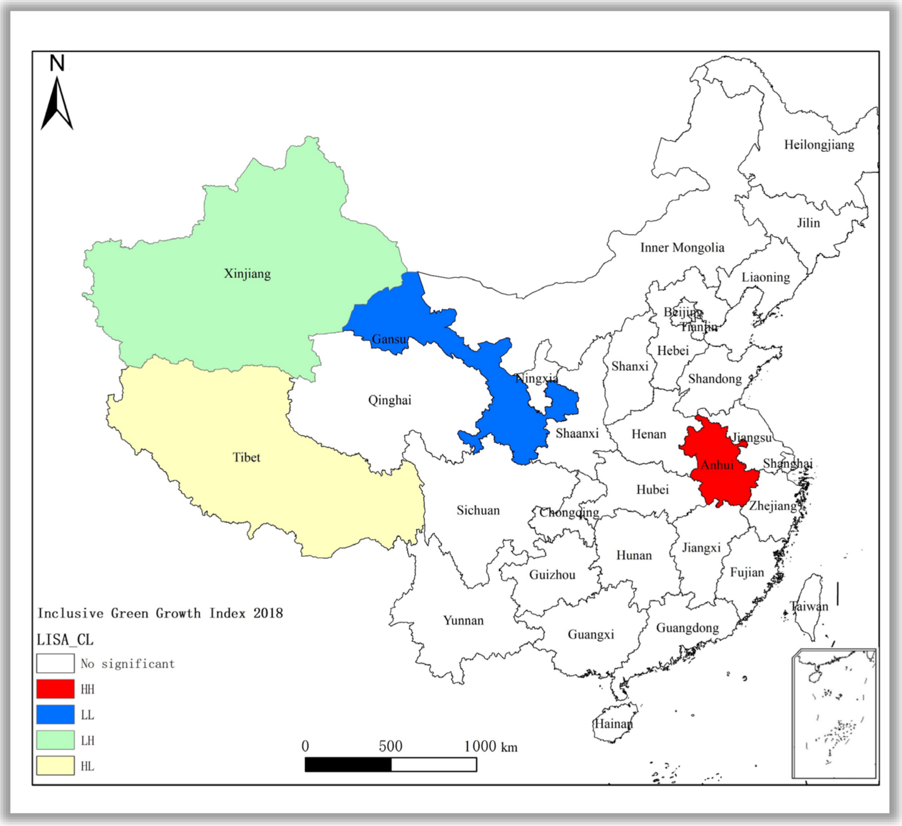
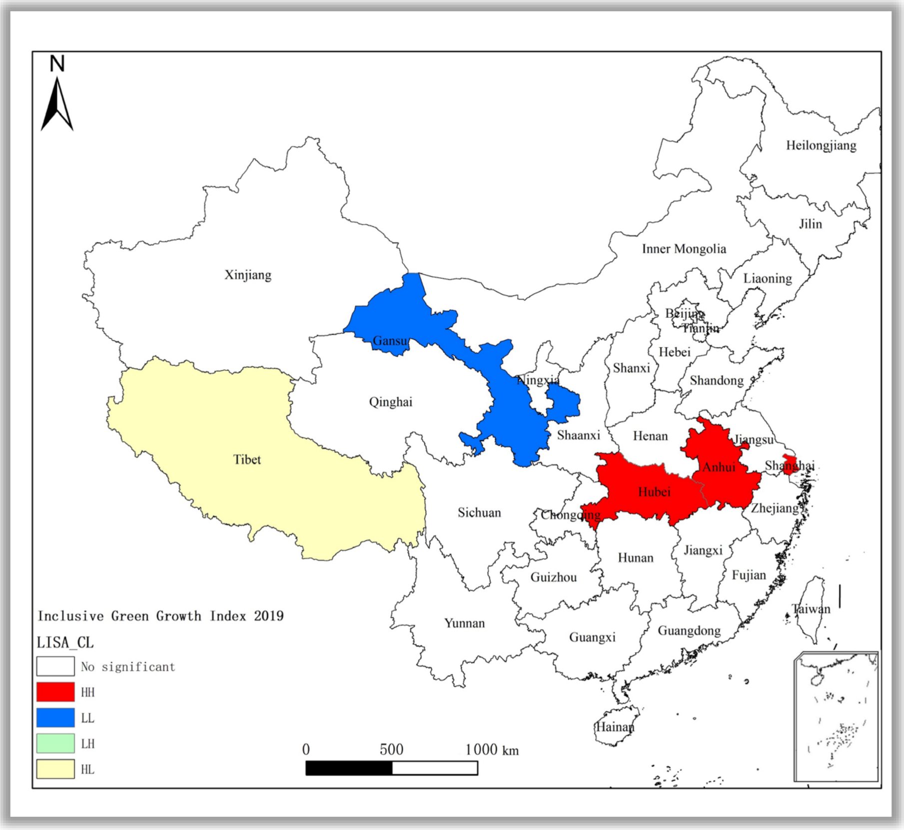


Figure 13. LISA Clustering Diagram of 2017 and 2018.



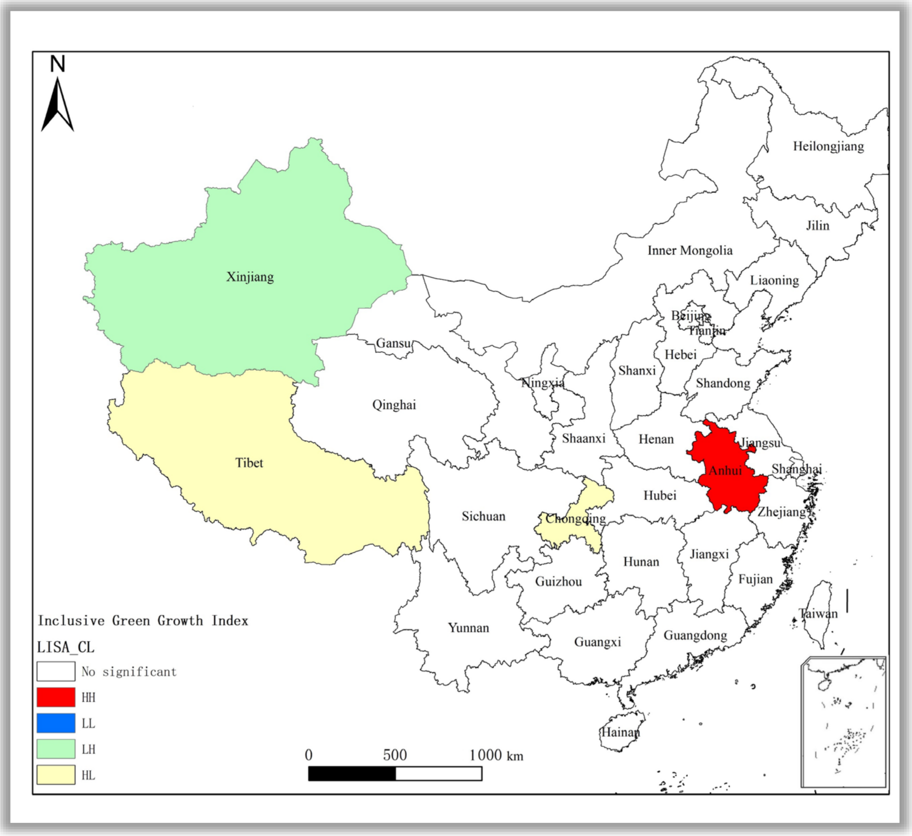


Figure 14. LISA Clustering Diagram of 2019 and Index.

As can be seen from Figure 7, the inclusive green growth index from 2010 to 2019 has obvious spatial heterogeneity characteristics. From 2010 to 2019, Shanghai, Anhui, Jiangsu, and Zhejiang were often in the HH, with a high level of inclusive green growth, and there was a large spatial correlation with the surrounding regions, forming a strong scale agglomeration effect. Among them, Anhui has the most stable status. The reason may be that Anhui is located in the Yangtze River Delta and has received positive spillover effects from Shanghai, Jiangsu, Jiangsu and Zhejiang. In recent years, the level of inclusive green growth has increased rapidly. From 2010 to 2019, most of the years in Gansu and Ningxia were in the LL, indicating that these two adjacent provinces in the northwest are not only similar in geographical location, but also in the level of economic development and ecological environment, thus forming the agglomeration regions represented by them with a low level of inclusive green growth. Xinjiang has been in the LH from 2010 to 2019, indicating that the level of inclusive green growth in Xinjiang is relatively low among all provinces, and is lower than that of the surrounding provinces. The possible reason is that Xinjiang is located in a desert region, has an underdeveloped economy, and the ecological environment is relatively bad, it is more difficult to develop the economy and improve the ecological environment, and it is difficult to achieve in a short period of time. From 2010 to 2019, Sichuan, Chongqing, Hubei, and Tibet have all entered the HL, which shows that the level of inclusive green growth in these provinces is higher than that of the surrounding regions, and they are at the center of regional development. For example, Sichuan and Chongqing are important provinces in the southwest region, and Hubei is an important province in the central region. It should be noted that Tibet has become a region with high inclusive green growth since 2013. The possible reason is that although Tibet's economic development is relatively backward, it has unique advantages in ecological and environmental protection, and the fairness of opportunities and green production and consumption are also improving. Therefore, it is reasonable for Tibet's inclusive green growth level to improve rapidly.

In general, the inclusive green growth has obvious temporal characteristics and spatial correlation. During the period from 2010 to 2019, the level of medium-to-inclusive green growth generally showed a clear upward trend of fluctuation and had the characteristics of convergence. The differences between provinces and regions were large, and the development was extremely unbalanced. The inclusive green growth has obvious agglomeration characteristics. This shows that the level of inclusive green growth and the overall trend has been significantly improved. However, from the perspective of the weight composition of the inclusive green growth index, the improvement of the inclusive green growth level mainly depends on economic development and ecological environment protection, while the weight of fair opportunities and green production and consumption is small and needs to be further improved. In addition, because the long-standing regional differences in economic development are difficult to eliminate in the short term, differences in inclusive green growth between regions would continue to exist. Therefore, China still has a long way to go to achieve the coordinated development of inclusive green growth across regions.

7. Conclusions and Implications

In the process of the economic growth mode changing from extensive to intensive, the Chinese government promotes green growth and high-quality economic development, and achieves the peak carbon dioxide emissions in 2030 and carbon neutrality in 2060. It is of great theoretical and practical significance to study the measurement and spatial-temporal characteristics of China's inclusive green growth in this paper.

This study is different from the existing studies (Xu and Tao, 2017; Zhou et al., 2018; Wu and Zhou, 2018; Zhang et al., 2020; Li and Yin, 2020), most of which only focus on China's reality. This paper not only considers China's reality, but also takes into account international comparability, and constructs China's inclusive green growth index system from four dimensions: economic development, opportunity equity, green production and consumption, and ecological environment protection. In addition, the entropy weight method based on objective weighting is used to calculate the weight and index of China's inclusive green growth index so as to analyze the temporal characteristics of China's inclusive green growth. Meanwhile, Moran's I and LISA clustering maps are used to further analyze the spatial distribution characteristics of inclusive green growth in China, so as to reveal the spatial heterogeneity of inclusive green growth. Thus, to some extent, it makes up for the deficiency of studies that only focus on one aspect of temporal or spatial features.

The innovation or contribution of this paper mainly includes three aspects: One is based on the international comparability and Chinese reality, this paper from the economic development, equal opportunities, green production, consumption and ecological environment protection four dimensions to build inclusive green growth index system, and better make up for the study of existing in the study of Chinese inclusive green growth only consider the situation in China and overlook the defects of the international comparison and index system is relatively single. Second, the entropy weight method based on objective weighting is used to calculate the weight and index of China's inclusive green growth indicators, and in-depth analysis of the temporal characteristics of China's provinces and regions is conducted so that the research results are more objective and reliable. Thirdly, the spatial correlation analysis method is introduced to characterize the distribution characteristics and spatial heterogeneity of China's inclusive green growth. Therefore, it is a major feature of this paper to try to study China's inclusive green growth from two aspects: temporal characteristics and spatial heterogeneity. Therefore, this paper answers and solves some problems that can not be answered and solved by the existing research to a certain extent.

Based on the literature review of inclusive growth, green growth and inclusive green growth, this paper fully considers international comparability and reality and constructs an inclusive green growth indicator system from four dimensions: economic development, fair opportunity, green production and consumption and ecological environment protection. By selecting 28 indicators and inter-provincial panel data of 31 provinces and cities from 2010 to 2019, this paper tries to describe the inclusive green growth level more comprehensively, objectively and accurately. With the help of the entropy weight method based on objective weighting and Stata software, the weights of each dimension and indicator of inclusive green growth are calculated, as well as the inclusive green growth index. The time series characteristics are analyzed. Furthermore, AcrGIS and GeoDa software are used to depict the spatial characteristics of inclusive green growth in China.

The results show that, first, economic development, fair opportunities, green production and consumption and ecological environment protection are important factors affecting the level of inclusive green growth in China. Among them, China has made important progress in economic development and environmental protection, accounting for more than 80% of the overall weight, but it needs to be improved in terms of fair opportunities and green production and consumption. Second, the inclusive green growth has obvious time series characteristics. Since 2010, the overall level of inclusive green growth has steadily increased, and most provinces have the same trend. The level of the inclusive green growth is not only quite different in different years, but also quite different between provinces and regions. Third, the inclusive green growth has significant spatial heterogeneity. From 2010 to 2019, the inclusive green growth level experienced a dynamic evolution process. The overall spatial test results of Moran's I index of inclusive green growth show that inclusive green growth has obvious spatial autocorrelation, that is, the spatial difference of inclusive green growth is large. The results of a local spatial test also show that inclusive green growth has obvious spatial aggregation characteristics. This paper achieve the following two inspirations based on the above research results.

(1) China should strengthen the coordinated development of economic development, fair opportunities, green production and consumption and ecological environment protection. On the basis of maintaining the current achievements of economic development and ecological environment protection, China should fully tap the potential of fair

and green production and consumption, and strive to improve their role in inclusive green growth. Based on further improving people's livelihood and advocating green production and consumption, we achieve coordinated development with economic development and ecological environment, so as to enhance the quality and level of inclusive green growth in China.

(2) Narrowing the inter-provincial and regional differences in inclusive green growth is an important task for China in the future. Although the level of inclusive green growth in all provinces and regions in China has steadily improved from 2010 to 2019, there are still significant gaps between provinces. The development trends of inclusive green growth in the four major regions of the eastern, central, western and northeastern regions are also similar, but the eastern region is significantly higher than other regions, and the gap is still expanding. Therefore, it is still very important for China to coordinate the development of inter-provincial and inter-regional inclusive green growth and narrow the gap between them in the future.

Of course, there are shortcomings in this paper, and future research can be carried out from the following aspects: First, since it is difficult to assess the huge impact of COVID-19 on the global economy, and given that its impact on inclusive green growth is inevitable, it is necessary to select the data after COVID-19 for comparative analysis. Second, on the basis of constructing an inclusive green growth index and analyzing the temporal characteristics and spatial heterogeneity, a spatial econometric model can be used to test the influencing factors and spatial correlation of inclusive green growth. Third, the influencing mechanism and dynamic evolution characteristics of inclusive green growth can also be explored theoretically and mechanistically to make up for the lack of theoretical mechanism studies in the relevant literature.

Funding: The research for this paper was supported by the National Natural Science Foundation of China (No. 71573050).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest: The author declares that they have no conflict of interest.

Abbreviations

Notations	Description
X_{ij}	*j*th indicator in the *i*th evaluation object
$\max(X_{ij})$	the max value in jth indicator
$\min(X_{ij})$	the min value in jth indicator
P_{ij}	The proportion of the *i* evaluation object in the *j* index
e_j	The information entropy
W_j	The weight of item *j*
S_i	The score of the *i* evaluation object
w_{ij}	The position relation between observation point *i* and observation point *j* in space
Moran's I	Moran Index
A	Target layer
B	Dimension layer
C	Domain layer
B1	economic development
B2	Fair opportunity
B3	Green production and consumption
B4	Ecological environment protection

C1	Economic output
C2	Income level
C3	Employment equity
C4	Educational equity
C5	Social security equity
C6	Fair infrastructure conditions
C7	Green production
C8	green consumption
C9	Ecological resource endowment
C10	Ecological environment management
LISA	Local Indications of Spatial Association
HH	High and High
LL	Low and Low
HL	High and Low
LH	Low and High

References

1. UNEP. *Measuring Progress towards an Inclusive Green Economy*; United Nations Environment Program: Geneva, Switzerland, 2012.
2. World Bank. *Inclusive Green Growth: The Pathway to Sustainable Development*; World Bank: Washington, DC, USA, 2012.
3. ADB. *Eminent Persons Group Report*; Asian Development Bank: Manila, Philippines, 2007.
4. Pagliacci, F. Regional paths towards Europe 2020 targets: A spatial approach. *Eur. Plan. Stud.* **2017**, *25*, 601–619. [CrossRef]
5. Sun, Y.; Ding, W.; Yang, Z.; Yang, G.; Du, J. Measuring China's regional inclusive green growth. *Sci. Total Environ.* **2020**, *713*, 136367. [CrossRef] [PubMed]
6. He, Q.; Du, J.T. The impact of urban land misallocation on inclusive green growth efficiency: Evidence from China. *Environ. Sci. Pollut. Res.* **2021**, *29*, 3575–3586. [CrossRef] [PubMed]
7. Guo, J.; Zhou, Y.; Ali, S.; Shahzad, U.; Cui, L. Exploring the role of green innovation and investment in energy for environmental quality: An empirical appraisal from provincial data of China. *J. Environ. Manag.* **2021**, *292*, 112779. [CrossRef] [PubMed]
8. Mao, W.; Wang, W.; Sun, H. Driving patterns of industrial green transformation: A multiple regions case learning from China. *Sci. Total Environ.* **2019**, *697*, 134134. [CrossRef] [PubMed]
9. Shahzad, U.; Ferraz, D.; Nguyen, H.H.; Cui, L. Investigating the spill overs and connectedness between financial globalization, high-tech industries and environmental footprints: Fresh evidence in context of China. *Technol. Forecast. Soc. Change* **2022**, *174*, 121205. [CrossRef]
10. Wu, W.; Zhou, X. Evaluation of inclusive green growth in China and measurement of its influencing factors. *Soc. Sci. Res.* **2018**, *1*, 27–37. (In Chinese)
11. Liu, G.; Wang, B.; Cheng, Z.; Zhang, N. The drivers of China's regional green productivity, 1999–2013. *Resour. Conserv. Recycl.* **2020**, *153*, 104561. [CrossRef]
12. İmrohoroğlu, A.; Zhao, K. Intergenerational transfers and China's social security reform. *J. Econ. Ageing* **2018**, *11*, 62–70. [CrossRef]
13. Cai, M.; Yue, X. The redistributive role of government social security transfers on inequality in China. *China Econ. Rev.* **2020**, *62*, 101512. [CrossRef]
14. Cooper, A.; Mukonza, C.; Fisher, E.; Mulugetta, Y.; Gebreeyesus, M.; Onuoha, M.; Massaquoi, A.-B.; Ahanotu, K.C.; Okereke, C. Mapping Academic Literature on Governing Inclusive Green Growth in Africa: Geographical Biases and Topical Gaps. *Sustainability* **2020**, *12*, 1956. [CrossRef]
15. Chirambo, D. Enhancing climate change resilience through microfinance: Redefining the climate finance paradigm to promote inclusive growth in Africa. *J. Dev. Soc.* **2017**, *33*, 150–173. [CrossRef]
16. Dutta, V.; Dasgupta, P.; Hultman, N.; Gadag, G. Evaluating expert opinion on India's climate policy: Opportunities and barriers to low-carbon inclusive growth. *Clim. Dev.* **2016**, *8*, 336–350. [CrossRef]
17. Ibrahim, K.; Shabudin, A.F.A.; Chacko Koshy, K.; Asrar, G.R. A new framework for integrated climate finance and inclusive responses to sustainable development in Malaysia. *Geomat. Nat. Hazards Risk* **2016**, *7*, 1754–1768. [CrossRef]
18. Raza, T.; Rentoy, F.C.; Ahmed, N.; Khas, A.V.L.A.T.; Raza, S.; Marasigan, K.M.E.; Espinosa, R.I.M. Water challenges and urban sustainable development in changing climate: Economic growth agenda for global south. *Eur. J. Sustain. Dev.* **2019**, *8*, 421. [CrossRef]
19. Li, J.; Wang, X. Energy and climate policy in China's twelfth five-year plan: A paradigm shift. *Energy Policy* **2012**, *41*, 519–528. [CrossRef]
20. Bowen, A.; Cochrane, S.; Fankhauser, S. Climate change, adaptation and economic growth. *Clim. Change* **2012**, *113*, 95–106. [CrossRef]
21. Gu, K.; Dong, F.; Sun, H.; Zhou, Y. How economic policy uncertainty processes impact on inclusive green growth in emerging industrialized countries: A case study of China. *J. Clean. Prod.* **2021**, *322*, 128963. [CrossRef]

22. Ojha, V.P.; Pohit, S.; Ghosh, J. Recycling carbon tax for inclusive green growth: A CGE analysis of India. *Energy Policy* **2020**, *144*, 111708. [CrossRef]
23. Safitri, D.; Fahrurrozi, F.; Marini, A.; Husen, A.; Purwanto, A.; Arum, W.S.A.; Nafiah, M. The role of energy consumption and economic growth on the ecological environment in ASEAN countries. *Environ. Sci. Pollut. Res.* **2022**, *6*, 1–14. [CrossRef]
24. Van Vuuren, D.P.; Stehfest, E.; Gernaat, D.E.; Doelman, J.C.; Van den Berg, M.; Harmsen, M.; Boer, H.S.; Bouwman, L.F.; Daioglou, V.; Edelenbosch, O.Y.; et al. Energy, land-use and greenhouse gas emissions trajectories under a green growth paradigm. *Glob. Environ. Change* **2017**, *42*, 237–250. [CrossRef]
25. Arminen, H.; Menegaki, A.N. Corruption, climate and the energy-environment-growth nexus. *Energy Econ.* **2019**, *80*, 621–634. [CrossRef]
26. Sarkar, B.; Bhuniya, S. A sustainable flexible manufacturing–remanufacturing model with improved service and green investment under variable demand. *Expert Syst. Appl.* **2022**, *202*, 117154. [CrossRef]
27. Sarkar, B.; Debnath, A.; Chiu, A.S.; Ahmed, W. Circular economy-driven two-stage supply chain management for nullifying waste. *J. Clean. Prod.* **2022**, *339*, 130513. [CrossRef]
28. Green, F.; Stern, N. China's changing economy: Implications for its carbon dioxide emissions. *Clim. Policy* **2017**, *17*, 423–442. [CrossRef]
29. Li, G.; Wei, W. Financial development, openness, innovation, carbon emissions, and economic growth in China. *Energy Econ.* **2021**, *97*, 105194. [CrossRef]
30. Halkos, G.E.; Tzeremes, N.G. Economic growth and environmental efficiency: Evidence from US regions. *Econ. Lett.* **2013**, *120*, 48–52. [CrossRef]
31. Chang, C.P.; Hao, Y. Environmental performance, corruption and economic growth: Global evidence using a new data set. *Appl. Econ.* **2017**, *49*, 498–514. [CrossRef]
32. Peng, Y.S.; Lin, S.S. National culture, economic development, population growth and environmental performance: The mediating role of education. *J. Bus. Ethics* **2009**, *90*, 203–219. [CrossRef]
33. Sarkar, B.; Ullah, M.; Sarkar, M. Environmental and economic sustainability through innovative green products by remanufacturing. *J. Clean. Prod.* **2022**, *332*, 129813. [CrossRef]
34. Song, M.; Peng, J.; Wang, J.; Zhao, J. Environmental efficiency and economic growth of China: A Ray slack-based model analysis. *Eur. J. Oper. Res.* **2018**, *269*, 51–63. [CrossRef]
35. Ge, T.; Qiu, W.; Li, J.; Hao, X. The impact of environmental regulation efficiency loss on inclusive growth: Evidence from China. *J. Environ. Manag.* **2020**, *268*, 110700. [CrossRef] [PubMed]
36. Hussain, M.N.; Li, Z.; Sattar, A.; Ilyas, M. Evaluating the impact of energy and environment on economic growth in BRI countries. *Energy Environ.* **2022**, *1*, 1–16. [CrossRef]
37. Harrod, R.F. An essay in dynamic theory. *Econ. J.* **1939**, *49*, 14–33. [CrossRef]
38. Solow, R. A new survey of demand analysis. *Rev. Econ. Stat.* **1954**, *36*, 104–107. [CrossRef]
39. Solow, R.M. Intergenerational equity and exhaustible resources. *Rev. Econ. Stud.* **1974**, *41*, 29–45. [CrossRef]
40. Weitzman, M.L. On modeling and interpreting the economics of catastrophic climate change. *Rev. Econ. Stat.* **2009**, *91*, 1–19. [CrossRef]
41. Cao, J. The dynamic coupling nexus among inclusive green growth: A case study in Anhui province, China. *Environ. Sci. Pollut. Res.* **2022**, *29*, 49194–49213. [CrossRef]
42. OECD. *Inclusive Green Growth: For the Future We Want*; OECD Publishing: Paris, France, 2012.
43. UNEP. *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication*; UNEP publication: Nairobi, Kenya, 2012.
44. Wu, W.; Zhou, X. Construction and application of performance evaluation system of inclusive green growth in China. *Chin. Manag. Sci.* **2019**, *27*, 183–194. (In Chinese)
45. Sohag, K.; Taşkın, F.D.; Malik, M.N. Green economic growth, cleaner energy and militarization: Evidence from Turkey. *Resour. Policy* **2019**, *63*, 101407. [CrossRef]
46. Zhang, X.; Guo, W.; Bashir, M.B. Inclusive green growth and development of the high-quality tourism industry in China: The dependence on imports. *Sustain. Prod. Consum.* **2022**, *29*, 57–78. [CrossRef]
47. Song, M.; Wang, J. Environmental efficiency evaluation of thermal power generation in China based on a slack-based endogenous directional distance function model. *Energy* **2018**, *161*, 325–336. [CrossRef]
48. Maji, I. Impact of clean energy and inclusive development on CO_2 emissions in sub-Saharan Africa. *J. Clean. Prod.* **2019**, *240*, 118186. [CrossRef]
49. Maskin, E. Introduction to mechanism design and implementation. *Transnatl. Corp. Rev.* **2019**, *11*, 1–6. [CrossRef]
50. Khoshnava, S.M.; Rostami, R.; Zin, R.M.; Kamyab, H.; Abd Majid, M.Z.; Yousefpour, A.; Mardani, A. Green efforts to link the economy and infrastructure strategies in the context of sustainable development. *Energy* **2020**, *193*, 116759. [CrossRef]
51. Khan, I.; Zakari, A.; Ahmad, M.; Irfan, M.; Hou, F. Linking energy transitions, energy consumption, and environmental sustainability in OECD countries. *Gondwana Res.* **2022**, *103*, 445–457. [CrossRef]
52. Baniya, B.; Giurco, D.; Kelly, S. Green growth in Nepal and Bangladesh: Empirical analysis and future prospects. *Energy Policy* **2021**, *149*, 112049. [CrossRef]

53. Wada, I.; Faizulayev, A.; Victor Bekun, F. Exploring the role of conventional energy consumption on environmental quality in Brazil: Evidence from cointegration and conditional causality. *Gondwana Res.* **2021**, *98*, 244–256. [CrossRef]
54. Zhang, D.; Mohsin, M.; Rasheed, A.K.; Chang, Y.; Taghizadeh-Hesary, F. Public spending and green economic growth in BRI region: Mediating role of green finance. *Energy Policy* **2021**, *153*, 112256. [CrossRef]
55. Ahmad, M.; Ahmed, Z.; Yang, X.; Hussain, N.; Sinha, A. Financial development and environmental degradation: Do human capital and institutional quality make a difference? *Gondwana Res.* **2022**, *105*, 299–310. [CrossRef]
56. Zhou, G.; Zhu, J.; Luo, S. The impact of fintech innovation on green growth in China: Mediating effect of green finance. *Ecol. Econ.* **2022**, *193*, 107308. [CrossRef]
57. Zhao, X.; Ma, X.; Shang, Y.; Yang, Z.; Shahzad, U. Green economic growth and its inherent driving factors in Chinese cities: Based on the Metafrontier-global-SBM super-efficiency DEA model. *Gondwana Res.* **2022**, *106*, 315–328. [CrossRef]
58. Zhao, P.; Gao, Y.; Sun, X. How does artificial intelligence affect green economic growth? Evidence from China. *Sci. Total Environ.* **2022**, *834*, 155306. [CrossRef]
59. Zhao, J.; Shahbaz, M.; Dong, K. How does energy poverty eradication promote green growth in China? The role of technological innovation. *Technol. Forecast. Soc. Change* **2022**, *175*, 121384. [CrossRef]
60. Wang, S.; Wang, X.; Lu, B. Is resource abundance a curse for green economic growth? Evidence from developing countries. *Resour. Policy* **2022**, *75*, 102533. [CrossRef]
61. Lin, B.; Zhou, Y. Measuring the green economic growth in China: Influencing factors and policy perspectives. *Energy* **2022**, *241*, 122518. [CrossRef]
62. Ravallion, M.; Chen, S. Measuring pro-poor growth. *Econ. Lett.* **2003**, *78*, 93–99. [CrossRef]
63. Basu, K. Globalization, poverty, and inequality: What is the relationship? What can be done? *World Dev.* **2006**, *34*, 1361–1373. [CrossRef]
64. Stiglitz, J.E. The Price of Inequality. *New Perspect. Q.* **2013**, *30*, 52–53. [CrossRef]
65. Ali, I.; Zhuang, J. *Inclusive Growth toward a Prosperous Asia: Policy Implications*; Asian Development Bank: Manila, Philippines, 2007.
66. Xu, Q.; Tao, K. Inclusive Growth Measurement and Analysis of Influencing Factors in China Based on Generalized Bonferroni Curve. *J. Quant. Tech. Econ.* **2017**, *12*, 93–109. (In Chinese)
67. Li, L.; Bing, S. Economic Growth, Income Distribution and Poverty: Identification and Decomposition of Inclusive Growth. *Econ. Res. J.* **2021**, *56*, 54–70. (In Chinese)
68. Wang, W.; Wu, Y.; Choguill, C. Prosperity and inclusion: The impact of public housing supply on urban inclusive growth in China. *Land Use Policy* **2021**, *105*, 105399. [CrossRef]
69. Huang, L.; Zhu, B.; Wang, P.; Chevallier, J. Energy out-of-poverty and inclusive growth: Evidence from the China health and nutrition survey. *Struct. Change Econ. Dyn.* **2022**, *60*, 344–352. [CrossRef]
70. Liu, Z.; Li, R.; Zhang, X.T.; Shen, Y.; Yang, L.; Zhang, X. Inclusive Green Growth and Regional Disparities: Evidence from China. *Sustainability* **2021**, *13*, 11651. [CrossRef]
71. Ren, S.; Li, L.; Han, Y.; Hao, Y.; Wu, H. The emerging driving force of inclusive green growth: Does digital economy agglomeration work? *Bus. Strategy Environ.* **2022**, *31*, 1656–1678. [CrossRef]
72. Sun, H.; Mao, W.; Dang, Y.; Luo, D. What inhibits regional inclusive green growth? Empirical evidence from China. *Environ. Sci. Pollut. Res.* **2022**, *29*, 39790–39806. [CrossRef]
73. Wang, D.; Hou, Y.; Li, X.; Xu, Y. Developing a functional index to dynamically examine the spatio-temporal disparities of China's inclusive green growth. *Ecol. Indic.* **2022**, *139*, 108861. [CrossRef]
74. Zhao, X.; Mahendru, M.; Ma, X.; Rao, A.; Shang, Y. Impacts of environmental regulations on green economic growth in China: New guidelines regarding renewable energy and energy efficiency. *Renew. Energy* **2022**, *187*, 728–742. [CrossRef]
75. Shannon, C.E. Prediction and entropy of printed English. *Bell Syst. Tech. J.* **1951**, *30*, 50–64. [CrossRef]
76. Cao, L.; Yang, H.; Li, L. Spatial and temporal differentiation characteristics and dynamic evolution of industrial green innovation efficiency. *Stud. Sci. Sci.* **2022**, *3*, 1–18. (In Chinese)
77. Resnick, D.; Tarp, F.; Thurlow, J. The political economy of green growth: Illustrations from southern Africa. *Wider Work. Pap.* **2012**, *32*, 215–228.
78. Zhou, X.; Wu, W. The Measurement and Analysis of the Inclusive Green Growth in China. *J. Quant. Tech. Econ.* **2018**, *8*, 3–20. (In Chinese)
79. Zhou, X.; Wu, W.; Liao, D. Research on the Measurement and Difference of Regional Inclusive Green Growth in China. *Sci. Technol. Prog. Policy* **2018**, *35*, 42–49. (In Chinese)
80. Li, S.; Yin, H. The Measurement and Spatial-Temporal Features Analysis of Provincial Green Economy Progress Index in China: From a Perspective of Inclusive Green Growth. *Ecol. Econ.* **2020**, *36*, 44–53. (In Chinese)