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Calculation and Comprehensive Evaluation of China's Tourism High-Quality Development Level and Regional Differences and Dynamic Evolution Based on Entropy Weight Method and TOPSIS Modeling

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ABSTRACT
Achieving high-quality development has become the core essence of tourism industrialization, and is also a necessary step for the construction of ecological civilization to make new achievements. The article establishes the index system of China's tourism high-quality development, and uses the entropy weight-TOPSIS model to measure the tourism high-quality development of China's tourism in each region from 2013 to 2021. On this basis, it comprehensively applies density estimation, Dagum Gini coefficient and convergence modeling methods to analyze the regional differences and convergence of China's tourism development. The study shows that the level of high-quality development of China's tourism industry is gradually rising, and the regional differences in high-quality development of tourism are generally narrowing, with insignificant changes in intra-regional differences and narrowing of inter-regional differences, though. The overall trend of wave height in the central region is increasing, the wave height in the western region is decreasing and the width is increasing, and the wave height in the northeast region is increasing and the width range is decreasing. At the same time, σ convergence coefficient shows that the gap between the level of high-quality development of tourism economy in the eastern, central and northeastern regions shows a trend of convergence, while the western region increases from 0.373 in 2012 to 0.388 in 2021, that there is no trend of convergence.

Keywords: tourism high-quality development, entropy weight-TOPSIS model, Dagum Gini coefficient, regional differences

1. Introduction

China's tourism industry is an important part of economic and social development, and plays an important role in promoting economic growth and improving people's living standards. High-quality development of tourism refers to the pursuit of a higher level of development quality and benefits on

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the basis of guaranteeing the sustainable and healthy development of tourism [1-4]. Its connotation mainly includes the following aspects: first, the requirement to improve the level of tourism services. This includes upgrading the quality of tourism infrastructure such as tourist attractions, hotels, catering, transportation, etc., improving the professionalism and service level of service personnel, and providing tourists with a more convenient, comfortable and safe tourism experience [5-8]. Second, pay attention to the protection of the environment and cultural heritage. In the process of tourism development, it is necessary to pay attention to ecological environmental protection, promote green travel and low-carbon tourism, and avoid overdevelopment and destruction of the natural environment [9-11]. At the same time, it is necessary to strengthen the protection and inheritance of cultural heritage, such as famous historical and cultural cities, ancient buildings, folk customs, etc., to avoid the destruction of cultural landscapes by commercialization. It is also required to improve the management level of the industry [12-14]. Strengthen the supervision of the tourism market, standardize the order of the tourism market, crack down on unreasonable low-priced tours and other behaviors that disturb the market order, and protect the legitimate rights and interests of tourists. At the same time, strengthen the standardization of tourism, enhance the awareness of industry self-discipline, and promote the healthy and orderly development of tourism [15-18].

Realizing the high-quality development of tourism requires increasing investment and talent cultivation, increasing investment in tourism infrastructure construction, improving the quality and comfort of tourism facilities, improving tourism transportation, accommodation, catering and other infrastructure, and enhancing the level of tourism services [19-22]. Strengthen the professional training and quality improvement of tourism employees, cultivate a group of tourism talents who know the industry, service and management, and improve the service quality and level. As of now, China's tourism development as a whole has significantly improved, but there are problems such as regional imbalance and large gap [23-26], and the entropy weight method and TOPSIS model can play an important role in calculating and evaluating the level of high-quality development of China's tourism.

High-quality development of Chinese tourism should not only focus on economic benefits, but more importantly on the protection and inheritance of natural and cultural resources, which aims to provide tourists with a better tourism experience, while respecting and protecting the ecological environment and social culture of the tourism region. Literature [27] constructed an evaluation system for the high-quality development of tourism, which includes the dimensions of the scale of tourism economy and the development speed, and revealed many conclusions, such as “the high-quality development of China's tourism industry is due to the high quality of the tourism supply and the comprehensive benefits of tourism”. Literature [28] used the combination of fuzzy mathematics and clustering model to construct the evaluation index system of China's tourism high-quality development level, pointing out that the level of high-quality development of China's tourism industry has been significantly improved, but the gap between regions is large. Literature [29] defined the concept of high-quality development of tourism (HQDT), constructed the HQDT measurement and evaluation system, and analyzed the spatial and temporal evolution characteristics of China's HQDT, and obtained a number of conclusions, including “HQDT is affected by the government's guidance, innovation driving force, etc.” Literature [30] analyzed the impact of the integration of cultural tourism industry and HQDT on poverty alleviation. Using a spatial panel econometric model, several key results are presented, including “this integration is conducive to promoting tourism consumption, which has a direct impact on poverty alleviation”. Literature [31] evaluates the quality of China's tourism development from the dimensions of innovation, greenness, and sharing, revealing that the economic governance capacity of local governments has a significant impact on the quality of tourism development. Literature [32] describes the significant impact of tourism industry agglomeration on the high-quality development of tourism economy, and puts forward strategic suggestions to promote the coordinated and linked development of tourism industry in different regions, providing insights for promoting the high-

quality development of China's tourism economy.

Although the overall level of tourism development in China has been developing rapidly, tourism revenue and the number of tourists continue to grow. However, there are significant differences in the level of tourism economic development among regions. The tourism economy in the eastern coastal regions is more developed, while the tourism economy in the central and western regions is relatively lagging behind. Literature [33] constructed the dimensions of innovation, coordination, and green as the evaluation index system for the high-quality development of China's tourism economy, and applied the entropy value method. It shows that the value of high-quality indicators of China's tourism economy is relatively low, and there are large regional differences and the distribution of high-level cities is relatively decentralized. Literature [34] compares the potential economic contribution of tourism in Chinese provinces, pointing out that the more economically developed provinces have greater economic benefits from tourism than the inland provinces, while the less developed inland provinces are also expected to benefit from the growth of tourism. Literature [35] examined the imbalance of regional tourism growth and its trend in mainland China by using KDE and Gini, revealing that the difference between the development levels of mainland China and the four major economic zones regions shows a gradually decreasing trend. Literature [36] explored the impact of urbanization on tourism development in four regions of Guangdong Province, revealing that urbanization promoted the development of tourism in Guangdong as a whole, but the regional impact was uneven. Literature [37] constructed a multi-dimensional tourism urbanization index system, adopted state-space and other methods to analyze the spatial and temporal differentiation characteristics of China's tourism cities and the influencing factors, revealed that the distribution direction was northeast-southwest, pointed out that the regional development strategy, the level of economic development and other factors affecting the development of the region, and put forward recommendations. Literature [38] evaluates the spatial differentiation of China's tourism economic high quality development, describes that China's HQTE index is from high to low in the eastern, central and western regions, and its influencing factors are mainly reflected in the degree of governmental attention, the level of economic development and other aspects.

The study constructed a five-dimensional index system for China's high-quality tourism development, and comprehensively used the entropy weight-TOPSIS method, the Dagum Gini coefficient and its decomposition, density estimation, the Moran index, and the σ-convergence method to analyze China's high-quality tourism development and regional differences. Firstly, data research is conducted for China's tourism development level from 2013-2021, and the evolution of high-quality development of China's tourism industry is analyzed using the kernel density method. Finally, an empirical study on the regional differences and convergence of China's tourism from 2011-2021 is carried out.

2. Indicator system construction and data description

2.1. Construction of tourism high-quality development indicator system

2.1.1. Connotation of high-quality tourism development. High-quality tourism development should be a five-in-one coordinated development of economic, political, cultural, social and ecological civilization construction, and must comprehensively implement the new development concept. Innovation is the main driving force of tourism development, and technological innovation and the training of professional talents are the driving force to promote the high-quality development of tourism. Coordination is an important structure of tourism development, and the coordination of industrial structure and economic structure is a comprehensive check and balance to maintain the high-quality development of tourism. Green is the sustainable growth mode of tourism development, and "green water and green mountains" is the foundation and guarantee for realizing "Golden Mountain and silver mountain". Opening up is a new form of tourism development, and regional

cooperation with distinctive features and inclusiveness is a new growth form from "inviting in" to "going out". Sharing the growth fruits of tourism development, social harmony and common prosperity are important manifestations of achieving high-quality tourism development and enhancing people's well-being.

2.1.2. Indicator System for Measuring High-Quality Tourism Development. This paper constructs the evaluation index system of China's tourism high-quality development as shown in Table 1.

Table 1. China tourism high quality development evaluation index system

Target layer	Criterion layer	Subcanonical layer
Tourism high quality development	Innovative development	Technical product
		Talent breeding
		Scientific support
		Institutional mechanism
		Innovative output
	Coordinated development	Rationalization of industrial structure
		Industrial structure height
		Urban and rural income gap
		Urbanization rate
		Market demand
		Industrial coordination
		Economic coordination
	Green development	Resource consumption
		Forest coverage
		Air quality
		Water quality
		Pollution control
		Living environment
	Open development	Dependence of foreign trade
		Foreign dependence
		Regional cooperation
		Open benefit
		Economic development
	Shared development	Medical sharing
		Education sharing
		infrastructure
		Traffic sharing
		Cultural cause
		Social harmony

2.2. Research methodology

2.2.1. Entropy weight-TOPSIS modeling. This paper mainly adopts the entropy weight-TOPSIS model for calculation and analysis, which is actually an improvement of the traditional TOPSIS method, and its main idea is to use the entropy weight method to determine the weights of each index, and then use the TOPSIS method to carry out a comprehensive evaluation [39]. The method also utilizes the idea of objective assignment of entropy weight method and the idea of approximating ideal solution of TOPSIS method, which can effectively eliminate the influence of human subjective factors, and the effect is

better than that of simple entropy weight method and TOPSIS method. The main process of the model is shown below:

1) Entropy weight method to determine the entropy weight. Determine the weights of the j nd indicator value of the i st program:

$$P_{ij} = x_{ij} / \sum_{i=1}^{n} x_{ij} \tag{1}$$

Determine the entropy value of the j st indicator:

$$e_j = -\frac{1}{\ln n} \times \sum_{i=1}^{n} P_{ij} \ln P_{ij} \tag{2}$$

Determine the entropy weight of the j st indicator:

$$w_j = (1 - e_j) / \sum_{j=1}^{m} (1 - e_j) \tag{3}$$

2) TOPSIS method for evaluation. Thus, pooling the entropy weights of each indicator yields a weight vector of $W = (w_1, w_2, \ldots, w_n)^T$.

With m scenarios and n indicators, there is a decision matrix $X = (x_{ij})_{m \times n}$. Normalize the data on the decision matrix to get matrix $Y = (y_{ij})_{m \times n}$

Calculate the weighted normalized decision matrix V:

$$V = (v_{ij})_{m \times n} = (w_j y_{ij})_{m \times n} \tag{4}$$

The weighted normalized decision matrix is used to calculate the positive and negative ideal solutions, which are usually required to be monotonic in the TOPSIS method, and the positive and negative ideal solution formulas are shown below:

Positive Ideal Solution:

$$X^+ = (v_1^+, v_2^+, ..., v_n^+) \tag{5}$$

Negative Ideal Solution:

$$X^- = (v_1^-, v_2^-, ..., v_n^-) \tag{6}$$

where $v_j^+ = \max_{1 \le i \le m} v_{ij}, v_j^- = \min_{1 \le i \le m} v_{ij}$.

The distance between each scheme and its positive or negative ideal solution is obtained by calculation, usually using the Euclidean distance:

$$S_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^+)^2}, i = 1, 2, ..., m \tag{7}$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)^2}, i = 1, 2, ..., m \tag{8}$$

Calculate the relative proximity of each scenario:

$$C_i^+ = S_i^- / (S_i^+ + S_i^-) \tag{9}$$

The relative proximity C_i^+ value of each program is its composite score index, and the larger the C_i^+ value, the better the program.

2.2.2. Kernel density estimation. Kernel density estimation can be based on the data, using the kernel function to construct a kernel density function, and calculating the kernel density function

values for each data point, and performing a weighted average of these function values to obtain an overall kernel density function estimate. The distributional characteristics of the neoplastic productivity can be inferred from the kernel density estimation, given the density function $f(y)$, there is:

$$f(y)=\frac{1}{nh}\sum_{i-1}^{n}K(\frac{y_i-\overline{y}}{h}) \tag{10}$$

where n is the number of data in the sample, y_i denotes the number of observations in the sample, $\overline{y}$ denotes the mean value of the observations, $K(\cdot)$ denotes the kernel density function, which measures the weight of the observations in the development of the new quality of productivity, and h denotes the smoothed bandwidth of the kernel density estimate.

2.2.3. Dagum's Gini coefficient and its decomposition. The Gini coefficient is often used to measure the disparity in income distribution among residents, and Dagum proposed the Dagum Gini coefficient based on the Gini coefficient, which is decomposed into the within-group coefficient G_w, the between-group coefficient G_b, and the coefficient of hypervariable density G_i. In this study, the 30 provinces and regions are divided into four regions, namely, the east, the center, the west, and the northeast, and the Dagum Gini coefficient and its decomposition are used in order to further analyze the differences in the new-quality productivity and its sources. The formula for the overall Gini coefficient G is as follows:

$$G=\frac{\sum_{j=1}^{k}\sum_{k=1}^{k}\sum_{i=1}^{n_j}\sum_{r=1}^{n}|y_{ji}-y_{hr}|}{2n^2\overline{y}} \tag{11}$$

In the formula, k is the total number of provinces and regions, n is the number of all provinces and regions, j and h represent the regions divided, i and r represent the provinces and regions, n represents the number of provinces and regions in the j regions divided, n_h represents the number of provinces and regions within the h regions divided, y_{ji} represents the new quality productivity development index of provinces i in the j regions divided, similarly, y_{hr} represents the new quality productivity development index of provinces r in the h regions divided, and $\overline{y}$ is the Gini coefficient in the mean group of the national new quality productivity development index during the sample period The formula for calculating the Gini coefficient of G_{jj} and between-group G_{jh} is as follows:

$$G_{jj}=\frac{\frac{1}{2\overline{y}_j}\sum_{i=1}^{n_j}\sum_{r=1}^{n_j}|y_{ji}-y_{jr}|}{n_j^2} \tag{12}$$

$$G_{jh}=\frac{\sum_{i=1}^{n_j}\sum_{i=1}^{n_k}|y_{ji}-y_{kr}|}{n_jn_k(\overline{y}_j+\overline{y}_k)} \tag{13}$$

Where $\overline{y}_j$ denotes the mean value of the NPPI for region j and $\overline{y}_h$ denotes the mean value of the NPPI for region h. y_{ii}, y_{ir} denotes the new quality productivity development index of provinces and districts i and r in the divided j region, and y_h denotes the new quality productivity development index of provinces and districts r in the divided h region. n indicates the number of provinces and districts in the divided j region, and n_k indicates the number of provinces and districts in the divided k region.

Setting the contribution of intra-region variance G_w, the net contribution of inter-region variance

G_{sb} and the inter-region hypervariance density G_f, there are:

$$\begin{aligned} G &= \sum_{j=1}^{k} G_{jj} p_j s_j + \sum_{j=2}^{k} \sum_{k=1}^{j-1} G_{jk} (p_j s_k + p_k s_j) D_{jk} \\ &+ \sum_{j=2}^{k} \sum_{k=1}^{j-1} G_{jk} (p_j s_k + p_k s_j)(1 - D_{jk}) \\ G &= G_n + G_{nb} + G_t \end{aligned} \tag{14}$$

In the formula, p_j represents the proportion of provinces included in region j in the whole sample, s_j represents the proportion of the new quality productivity development index of region j in the whole sample, s_h represents the proportion of the new quality productivity development index in the whole sample of region h, p_h represents the proportion of the provinces included in region h in the whole sample, and $\sum p_j = \sum s_j = \sum_{j-1}^{k} \sum_{h-1}^{k} p_j s_h = 1.D_{jh}$ represents the relative impact of new quality productivity between regions j and h, the specific calculation formula is as follows:

$$D_{jk} = \frac{d_{jh} - p_{jh}}{d_{jh} + p_{jh}} \tag{15}$$

$$d_{jk} = \int_0^{\infty} dF_j(y) \int_0^{y} (y - x) dF_h(x) \tag{16}$$

$$p_{jh} = \int_0^{\infty} dF_h(y) \int_0^{y} (y - x) dF_j(x) \tag{17}$$

where d_{jh} denotes the difference in neoplastic productivity between regions j and h, p_{jh} denotes the hypervariable first-order moment between regions j and h, and F_j and F_h denote the cumulative density distribution function of neoplastic productivity in regions j and h, respectively.

2.2.4. Moran's index:

1) Global Moran Index. The global Moran index is utilized to verify whether there is spatial autocorrelation between China's tourism development and regional economy. The global Moran index formula is:

$$I = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij} (x_i - \overline{x}) (x_j - \overline{x})}{S^2 \sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}} \tag{18}$$

Where x_i and x_j denote the attribute values on the geographic units of region i and region j, respectively; x is the average of the attribute values in each region; w_{ij} is the spatial weight matrix, which indicates the proximity relationship between region i and region j; n is the number of measurement regions; and S^2 is the sample variance.

The value of global Moran's index generally ranges from -1 to 1. A value greater than 0 indicates positive correlation, and a value close to 1 indicates that attributes with similarity are clustered together, i.e., high values are neighboring high values, and low values are neighboring low values; a value less than 0 indicates negative correlation, and a value close to -1 indicates that attributes with dissimilarity are clustered together, i.e., high values are neighboring low values. If the global Moran index value is close to 0, it indicates that the spatial distribution is random and there is no spatial autocorrelation.

2) Local Moran Index. The global Moran index examines the spatial clustering of attributes on the whole space, while the local Moran index examines the spatial clustering of attributes in the vicinity of a certain region, which can further distinguish which spatial linkage form a certain region belongs to with its neighboring regions, and the specific spatial linkage forms include high value and high value, low value and low value, high value and low value, and low value and high value [40]. The local Moran index is expressed as:

$$I_i = \frac{(x_i - \bar{x})}{S^2} \sum_{j=1}^{n} w_{ij}(x_j - \bar{x}) \tag{19}$$

A positive local Moran index indicates that a high (low) value is surrounded by surrounding high (low) values; a negative local Moran index indicates that a high (low) value is surrounded by surrounding low (high) values. The significance level of the local Moran's index is tested by using the standardized statistic $Z(1)$, where $Z(1)$ is given by $Z(1) = (1 - E(1)) / \sqrt{\mathrm{var}(1)}$. The local Moran's index is the correlation coefficient between an observation and its spatially lagged variable, and if the observation is plotted against its spatially lagged variable in a scatterplot, i.e., the local Moran's scatterplot, the spatial linkage between a region and its neighbors in form of spatial correlation is clearly demonstrated but it is not possible to judge the local spatial correlation is significant.

2.2.5. Convergence test for σ. As the simplest way to measure the gap, σ convergence fits well with people's intuitive understanding of convergence. σ convergence initially studied the divergence of real GDP per capita among different economic systems, and in this paper, we use the σ convergence index to measure the degree of dispersion of the differences in the quality of foreign trade development among provinces and regions in China, with the following formula.

$$\sigma_i = \sqrt{\frac{\sum_{i=1}^{N} (\ln S_i - \overline{\ln S_i})^2}{N}} \tag{20}$$

Where $i = 1, 2, \cdots, n, t = 1, 2, \cdots, T$. lnS_i is the comprehensive evaluation score of the quality of foreign trade development in each province, and $\overline{\ln S_i}$ is the average of the comprehensive evaluation score of the quality of foreign trade development in each province and region, that is, the standard deviation is used to test σ convergence.

When $\sigma_{i+1} < \sigma_i$, it indicates that there is σ convergence in the inter-provincial differences in the quality of China's foreign trade development, and on the contrary, there is no σ convergence.

2.3. Data sources

Using 2002-2021 as the time window, 30 provinces (cities and districts, hereinafter referred to as “provinces”) in China (excluding Tibet, Hong Kong, Macao and Taiwan) were used as the research objects, and the relevant data were obtained from China Statistical Yearbook 2002-2021, China Tourism Statistical Yearbook 2002-2018, China Culture and Tourism Statistical Yearbook 2019, China Culture, Heritage and Tourism Statistical Yearbook 2020-2021, and the Statistical Yearbook of Culture, Heritage and Tourism of each province. China Environmental Statistics Yearbook, 2002-2018 China Tourism Statistics Yearbook, 2019 China Culture and Tourism Statistics Yearbook, 2020-2021 China Culture, Heritage and Tourism Statistics Yearbook, provincial statistical yearbooks and statistical bulletins of national economic and social development. Among them, the total tourism revenue is the sum of domestic tourism revenue and converted tourism foreign exchange revenue, and the data of A-grade scenic spots in each province come from the list of scenic spots published on the official websites of the Ministry of Culture and Tourism (formerly the National Tourism Administration) and the provincial departments of culture and tourism.

3. Results and analysis

3.1. Measurement results of the level of high-quality development of Chinese tourism

Table 2 shows the level of high-quality development of the tourism industry at the national level, the three major regions and the 30 provinces and its changes from 2013 to 2021. First, at the national level, the level of high-quality development of tourism increased from 0.329 in 2013 to 0.342 in 2021, indicating that the level of high-quality development of China's tourism industry showed a gradual upward trend during the period of study, but there is still much room for improvement. Secondly, at the regional level, the level of high-quality development of tourism shows a ladder-like distribution pattern from east to west, with the average level in the eastern region (0.440) much higher than that in the central region (0.289) and the western region (0.270), and the top five provinces in terms of mean value are all from the eastern region, while the bottom five provinces in terms of mean value are all from the western region. Finally, at the provincial level, the level of high-quality development of tourism in the 30 provinces has both increased and decreased, with significant inter-provincial differences.

Table 2. The development level and sort of high quality of tourism in the provinces (city)

Province	Year									Mean
	2013	2014	2015	2016	2017	2018	2019	2020	2021	
Beijing	0.708	0.694	0.568	0.586	0.629	0.621	0.632	0.603	0.618	0.629
Tianjin	0.434	0.423	0.395	0.399	0.436	0.44	0.444	0.404	0.424	0.422
Hebei	0.274	0.315	0.285	0.301	0.288	0.307	0.293	0.29	0.292	0.294
Liaoning	0.368	0.364	0.311	0.348	0.375	0.37	0.346	0.323	0.335	0.349
Shanghai	0.611	0.58	0.504	0.553	0.633	0.623	0.606	0.611	0.609	0.592
Jiangsu	0.492	0.527	0.454	0.441	0.493	0.503	0.499	0.478	0.488	0.486
Zhejiang	0.511	0.547	0.451	0.465	0.503	0.522	0.484	0.481	0.497	0.496
Fujian	0.399	0.409	0.391	0.38	0.391	0.41	0.431	0.426	0.428	0.407
Shandong	0.399	0.409	0.361	0.366	0.364	0.406	0.404	0.382	0.393	0.387
Guangdong	0.501	0.508	0.475	0.453	0.502	0.501	0.484	0.500	0.492	0.491
Hainan	0.315	0.296	0.260	0.279	0.321	0.265	0.261	0.294	0.278	0.285
Eastern mean	0.456	0.461	0.405	0.416	0.449	0.452	0.444	0.436	0.441	0.440
Shanxi	0.285	0.279	0.259	0.280	0.274	0.295	0.295	0.276	0.286	0.281
Jilin	0.271	0.266	0.239	0.272	0.284	0.292	0.281	0.260	0.270	0.271
Heilongjiang	0.272	0.283	0.262	0.271	0.270	0.286	0.318	0.250	0.284	0.277
Anhui	0.284	0.324	0.297	0.287	0.283	0.324	0.314	0.319	0.316	0.305
Jiangxi	0.251	0.245	0.250	0.276	0.256	0.313	0.295	0.306	0.301	0.277
Henan	0.295	0.310	0.290	0.269	0.251	0.285	0.29	0.276	0.283	0.283
Hupei	0.286	0.304	0.285	0.268	0.274	0.309	0.326	0.300	0.313	0.296
Hunan	0.286	0.309	0.297	0.278	0.375	0.348	0.334	0.341	0.337	0.323
Median mean	0.279	0.290	0.272	0.275	0.283	0.307	0.307	0.201	0.299	0.289
Inner Mongolia	0.317	0.335	0.306	0.327	0.32	0.357	0.337	0.327	0.332	0.329
Guangxi	0.231	0.247	0.242	0.228	0.277	0.268	0.266	0.295	0.281	0.259
Chongqing	0.26	0.282	0.295	0.267	0.305	0.309	0.348	0.324	0.336	0.303
Sichuan	0.294	0.316	0.284	0.29	0.263	0.285	0.3	0.293	0.296	0.291
Guizhou	0.272	0.259	0.232	0.232	0.29	0.324	0.307	0.341	0.324	0.287
Yunnan	0.251	0.259	0.417	0.396	0.294	0.275	0.283	0.371	0.327	0.319
Shaanxi	0.253	0.268	0.276	0.279	0.312	0.344	0.307	0.319	0.313	0.297

Kansu	0.149	0.175	0.202	0.187	0.164	0.204	0.197	0.201	0.199	0.186
Qinghai	0.176	0.215	0.191	0.21	0.21	0.248	0.235	0.222	0.229	0.215
Ningxia	0.217	0.191	0.203	0.209	0.251	0.245	0.25	0.245	0.247	0.229
Xinjiang	0.245	0.276	0.241	0.254	0.247	0.277	0.264	0.25	0.257	0.257
West mean	0.242	0.257	0.263	0.262	0.267	0.285	0.281	0.290	0.281	0.270
National average	0.329	0.341	0.17	0.321	0.336	0.351	0.347	0.311	0.342	0.338

3.2. Regional differences in the level of high-quality tourism development and its decomposition

3.2.1. Overall differences. The overall and intra-regional differences in the level of high-quality development of China's tourism industry from 2013 to 2021 are shown in Figure 1. As can be seen from the figure, the overall difference (G) in the level of high-quality development of China's tourism industry has declined from 0.195 in 2011 to 0.154 in 2019, and the process of change is characterized by the evolution of "declining-rising-declining". This shows that the spatial imbalance in the high-quality development of China's tourism industry has improved significantly during the period under investigation, probably because the quality of tourism development in the central and western regions has improved more than that in the eastern region in recent years due to the support of national policies, and the overall difference between the central and western regions and the eastern region has narrowed as the difference between the central and western regions and the eastern region has narrowed.

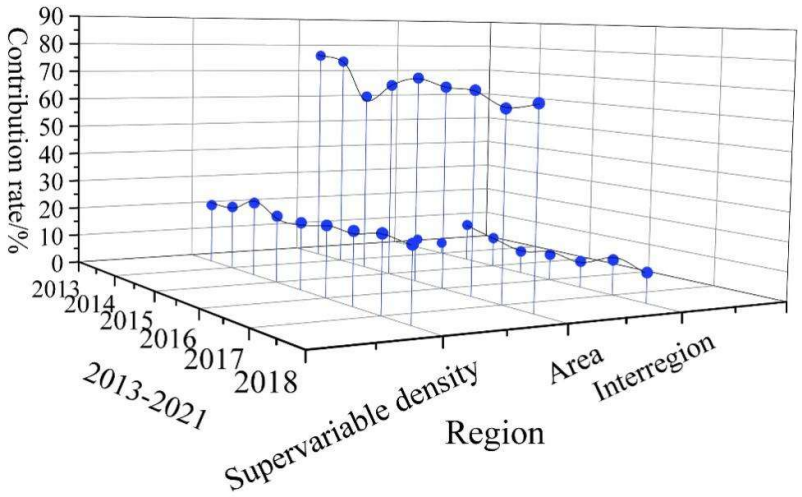


Fig. 1. Overall differences in the development level of tourism and regional **differences**

3.2.2. Intra-regional differences. The inter-regional differences in the level of high-quality development of China's tourism industry are shown in Figure 2. As can be seen from the figure, in terms of intra-regional differences (Gw), the mean values are ranked in the order of eastern region (0.142) > western region (0.103) central region (0.043). It can be seen that the intra-regional differences in the eastern and western regions are much larger than those in the central region.

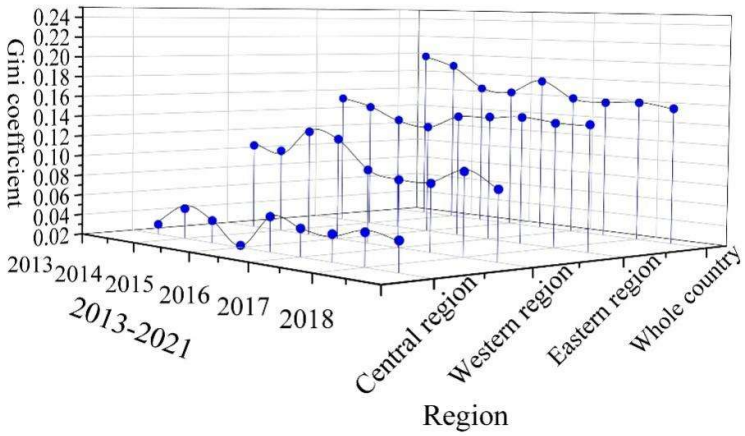


Fig. 2. Regional differences in the level of tourism development

3.2.3. Interregional differences. The interregional differences in the level of high-quality development of China's tourism industry are shown in Figure 3. As can be seen from the figure, in terms of inter-regional differences (Gnb), the mean values are ranked in the order of East and West (0.185) > East and Central (0.164) > Central and West (0.083). It can be seen that the differences between East and West and East and Central are significantly larger than those between Central and West. In terms of evolutionary trends, the Gini coefficient of the difference between the east and the west declined significantly, plummeting from 0.221 in 2011 to 0.177 in 2013, then gradually rising to 0.188 in 2015, and then slowly declining to 0.171 in 2019. The Gini coefficient of the difference between the east and the center showed an overall downward trend, dropping from 0.182 in 2011 to 0.158 in 2019, and has gone through five phases of “decreasing-rising-decreasing-rising-decreasing”. The Gini coefficient for the difference between central and western China has declined, but not by much, from 0.083 in 2011 to 0.071 in 2019.

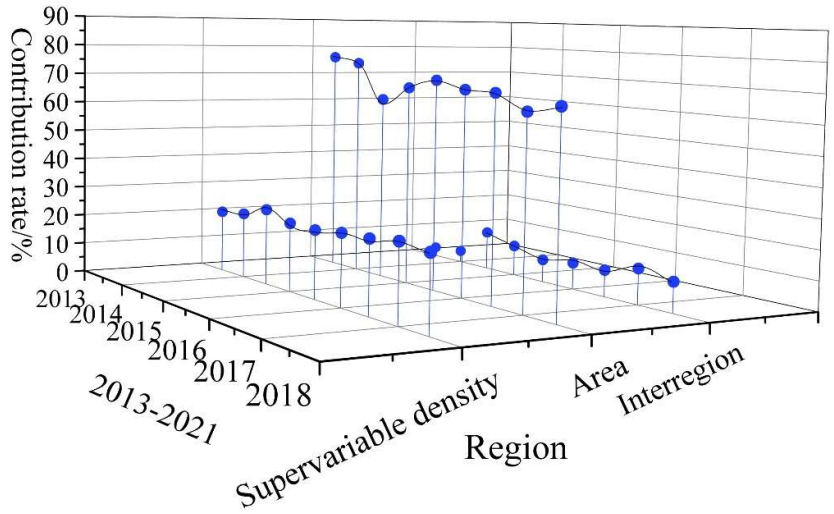


Fig. 3. Regional differences in the level of tourism development

3.3. Spatial and Temporal Dynamic Evolution of China's Level of High-Quality Tourism Development

3.3.1. Dynamic evolution of China's level of high-quality tourism development. The trend of the tourism industry's high-quality development level is shown in Figure 4. From the figure, it can be seen that the curve of national kernel density shifted to the right from 2008 to 2021, which indicates that the level of high-quality development of tourism industry has an upward trend. 4 years have 1 wave peak number, and there is no polarization phenomenon. From different years, compared with 2008, the center of the curve shifted to the right in 2012, and the height of the wave peak decreased and the width increased, which indicates that the level of high-quality development of the tourism industry increased in 2012, and the regional differences increased.Compared with 2021, the center of the curve shifted to the right in 2016, and the height and width of the wave peak were relatively stable, which indicates that the level of high-quality development of the tourism industry further increased in 2016. In 2021, compared with 2016, the center of the curve shifted to the left in 2021, with the height and width of the wave peak increasing and slightly narrowing, indicating that the level of high-quality development of the tourism industry decreased in 2021, and regional differences narrowed.The right trailing phenomenon of the curve exists in all four years, which is caused by the high level of development of the provinces, such as Beijing, Shanghai, Jiangsu, Zhejiang, Shandong, Guangdong, Henan, and Sichuan. provinces caused by the high development level of Beijing, Shanghai, Jiangsu, Zhejiang, Shandong, Guangdong, Henan and Sichuan.

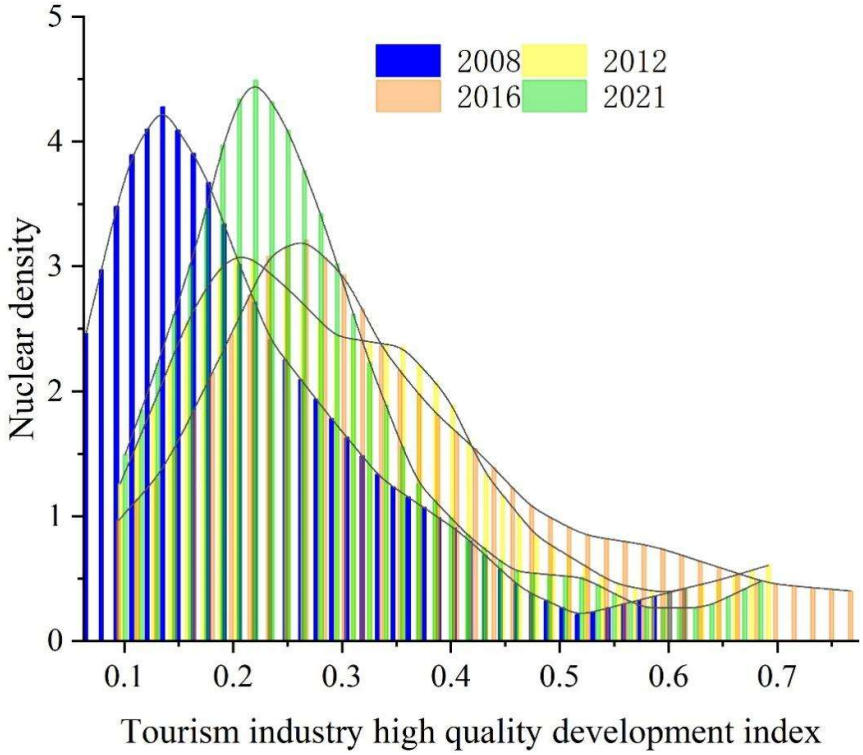


Fig. 4. The trend of development of high quality of tourism industry

3.3.2. Evolution of high-quality dynamics of tourism in the four regions. The trend of high-quality development level of tourism industry in the eastern region is shown in Figure 5. As can be seen from the figure, the center of the kernel density curve in the eastern region moves to the right in 2008-2021, which indicates that there is an upward trend in the level of high-quality development of the tourism industry in the eastern region. 4 years have 1 wave peak number, and there is no polarization phenomenon. From different years, in 2012 compared with 2008, the center of the curve in 2011 shifted to the right, the height of the wave peak decreased and the width increased, which indicates that the level of high-quality development of the tourism industry increased in 2011, and regional differences increased. 2016 compared with 2012, the center of the curve in 2016 shifted to the right, the height of the wave peak decreased and the width increased, which indicates that the level of high-quality development of the tourism industry increased in 2016, and the regional differences increased. Compared with 2016, in 2021, the center of the curve shifts to the left, the height of the wave crest increases and the width decreases slightly, which indicates that the level of high-quality development of the tourism industry decreases in 2021 and the regional differences decrease.

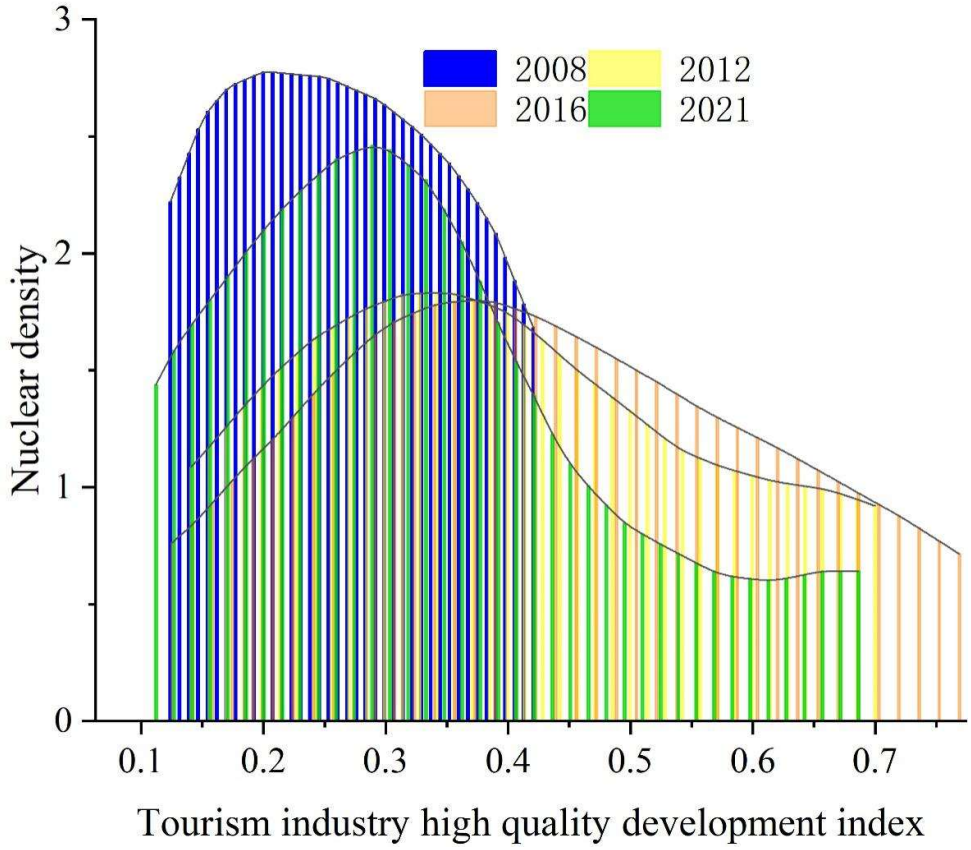


Fig. 5. The development of high quality of tourism industry in the eastern region is changing

The changing trend of the high-quality development level of the tourism industry in the central region is shown in Figure 6. According to the figure, it can be seen that the center of the nuclear density curve in the central region shifted to the right from 2008 to 2021, which indicates that the level of high-quality development of the tourism industry in the central region has increased. All 4 years have 1 wave peak number, without polarization phenomenon. From different years, in 2012, compared with 2008, the center of the curve in 2012 shifted to the right, the height of the wave peak increased significantly, and the width became smaller, which indicates that the level of high-quality development of the tourism industry in 20121 increased, and the regional differences narrowed.In 2016, compared with 2012, the center of the curve in 2016 shifted to the left, the height of the wave peak decreased, and the width increased, which indicates that the level of high-quality development of the tourism industry in 2016 declined, and regional differences increased. The level of high-quality development of tourism industry decreases and regional differences increase. 2021 Compared with 2016, the center of the curve in 2021 shifts to the left, the height of the wave crest increases and the width narrows slightly, which indicates that the level of high-quality development of tourism industry decreases in 2021 and regional differences narrow.

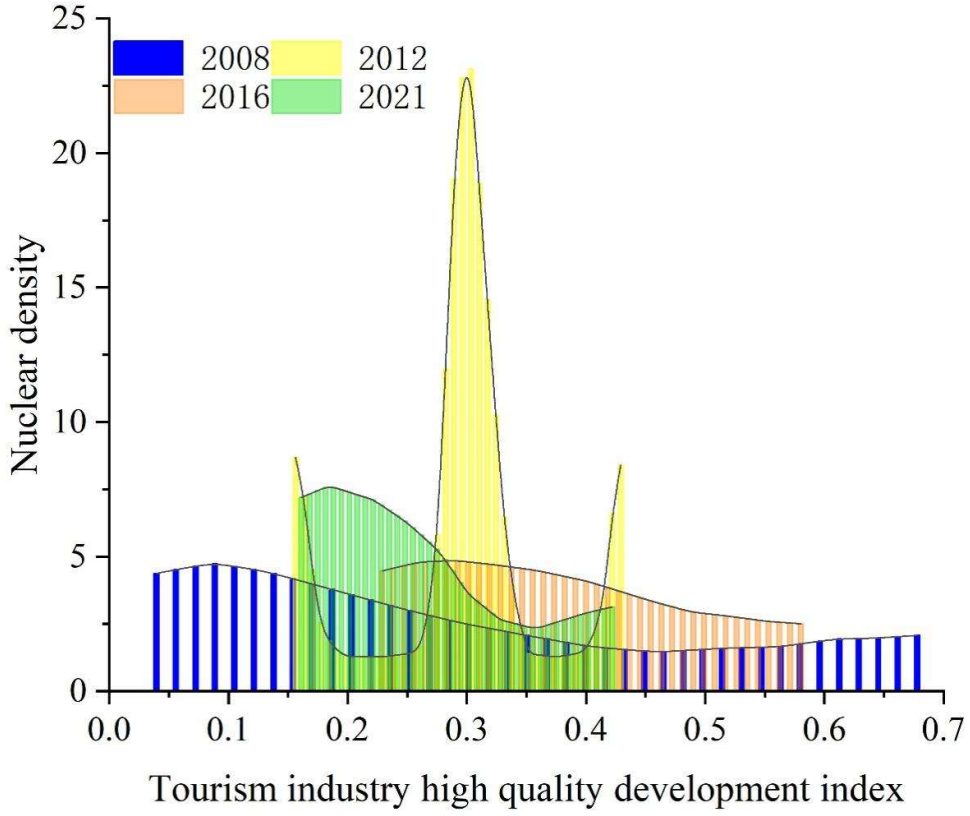


Fig. 6. The trend of high quality development of tourism industry in the central region

The trend of the high-quality development level of the tourism industry in the western region is shown in Figure 7. As can be seen from the figure, the kernel density curve in the western region shifted to the right in 2008-2021, the height of the wave decreased, the width increased, and the number of waves decreased from 2 to 1 wave, which indicates that the level of high-quality development of the tourism industry in the western region increased, and the regional differences increased.The height of the wave gradually decreased in 2008, 2012, 2016 and 2021, width increases, which indicates that the absolute differences in the index of high-quality development of the tourism industry in the western provinces have a tendency to increase.

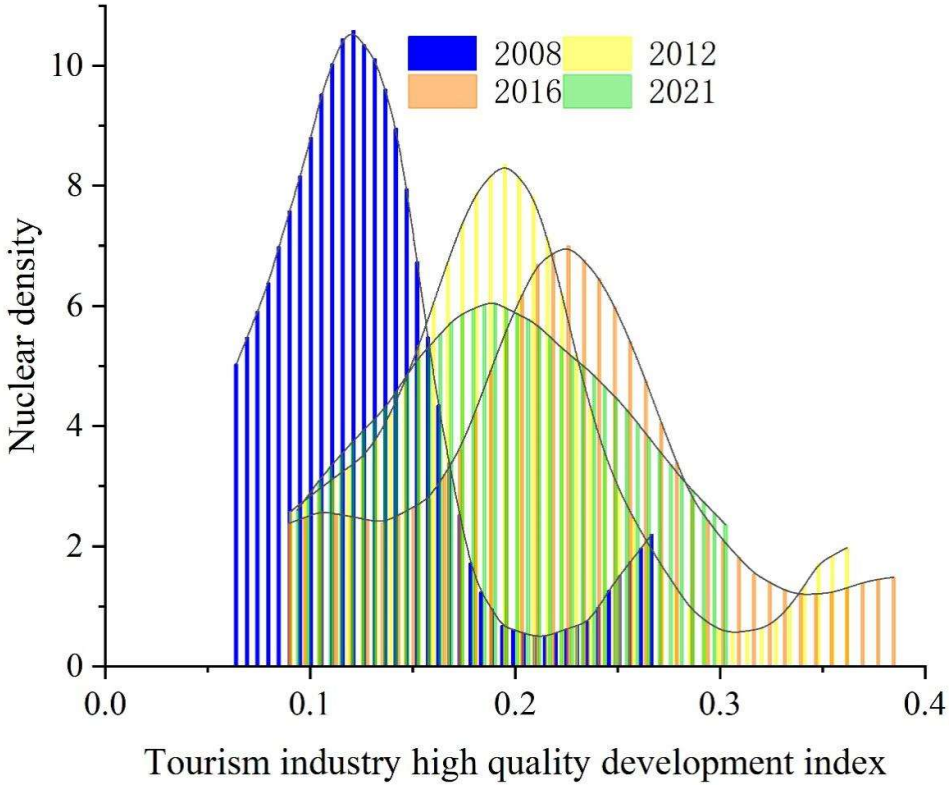


Fig. 7. The development of high quality of tourism industry in the western region is changing

The changing trend of the level of high-quality development of the tourism industry in the northeast region is shown in Figure 8. According to the figure, it can be seen that the kernel density curve of the Northeast region shifted to the right in 2008-2021, the height of the wave peak increased, the width interval decreased, the wave peak kept 1 single peak, and there was no polarization, which indicates that the level of high-quality development of the tourism industry in the Northeast region has increased, and the regional differences have narrowed.The height of the wave peak decreased in 2012 relative to 2008, and the width of the wave peak increased and then decreased in 2016 and 2021 the wave height rose in the situation, the width first increased and then decreased, which indicates that the absolute differences in the index of high-quality development of the tourism industry in the Northeast region became smaller.

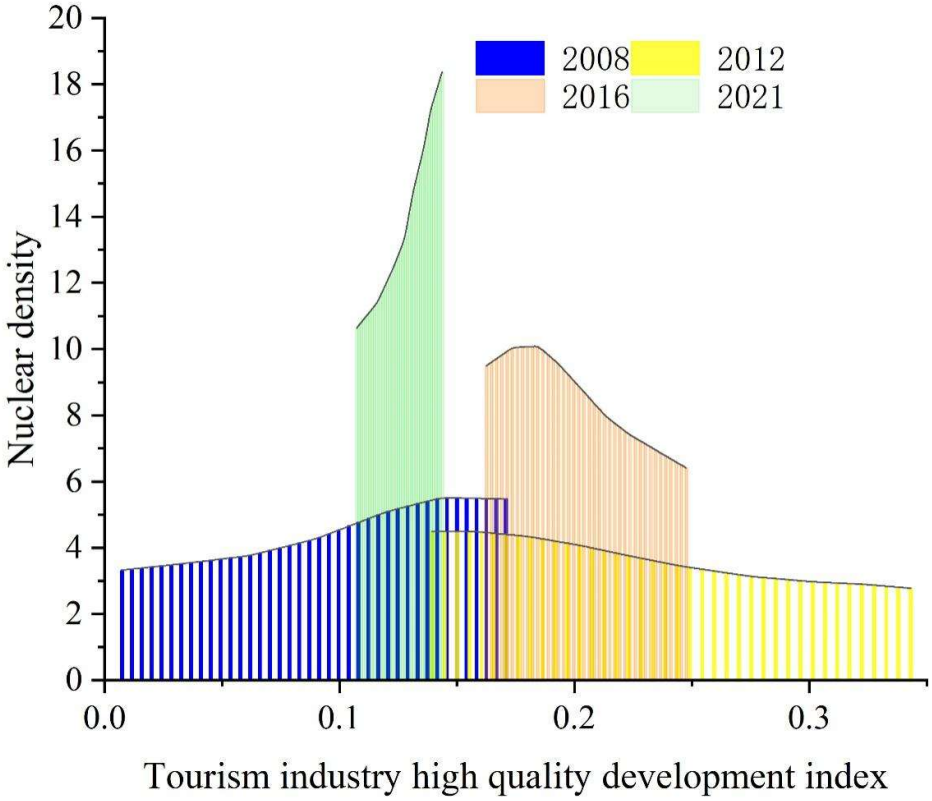


Fig. 8. The development of high quality of tourism industry in northeast China

3.3.3. Analysis of the spatial evolution of China's high-quality tourism development:

1) Global spatial autocorrelation analysis. This paper adopts the Moran index to measure the agglomeration level of high-quality development of tourism economy among provinces. The inverse distance spatial weight matrix is used to construct the spatial weight matrix and normalized to calculate the global Moran index of high-quality development of tourism economy among Chinese provinces from 2012 to 2021, and the results are shown in Table 3.

It can be seen that from 2012 to 2021, the Moran index of China's high-quality development level always stays between 0.178 and 0.253, and all years show a significant positive correlation. In terms of time series change, it shows a fluctuating trend of decreasing, then increasing and then decreasing, reaching a maximum value of 0.253 in 2021 and a minimum value of 0.178 in 2019.This indicates that the high-quality development level of the tourism economy in each province is not independent of each other, and that spatial dependence decreases, then strengthens and then decreases.

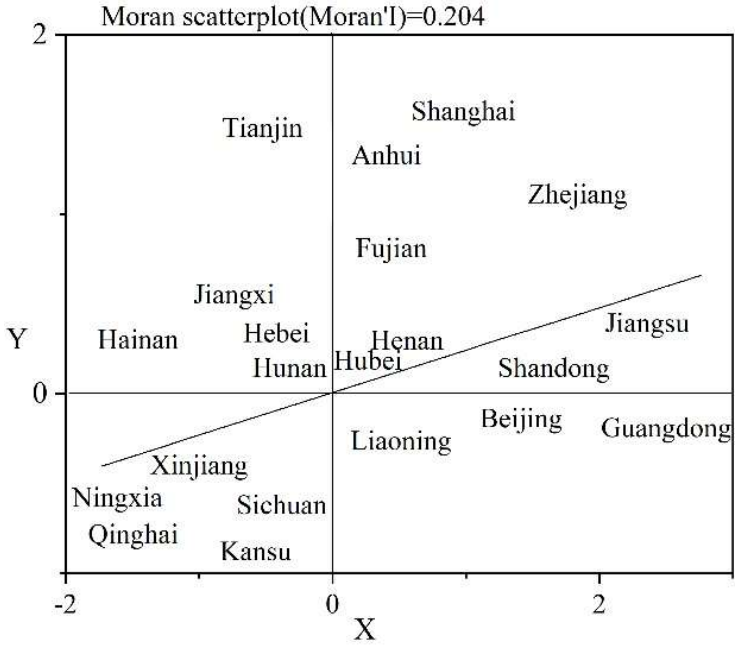
Table 3. China's tourism economy is developing the global blue moon index

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Moran's I	0.204	0.206	0.210	0.197	0.220	0.214	0.203	0.178	0.179	0.252
P value	0.008	0.007	0.007	0.010	0.005	0.006	0.007	0.014	0.014	0.003

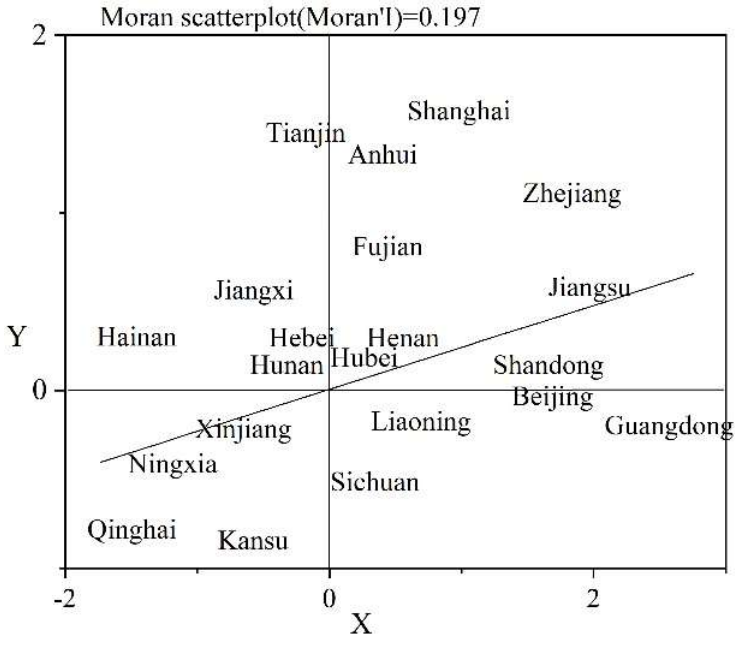
2) Local spatial autocorrelation analysis. In order to study the spatial agglomeration and leapfrog changes in the tourism economy of each province, the years 2012, 2015, 2018 and 2021 were selected as local Moran index scatter plots to analyze the spatial distribution pattern of the level of high-quality development of the interprovincial tourism economy. Figure 9 shows the spatial agglomeration of the high-quality development level of interprovincial tourism economy in different years.

First, the number of provinces with high - high agglomeration and low - low agglomeration is more than the number of provinces with high - low agglomeration and low - high agglomeration, and there is a positive spatial correlation in most provinces. Second, in terms of the distribution of provinces in

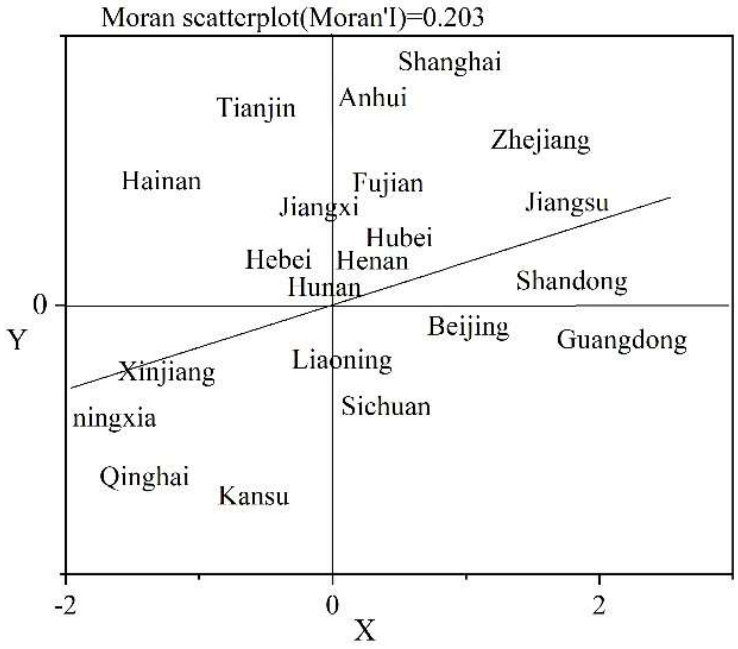
the quadrant, the high-high concentration provinces are mainly located in the eastern part of Shanghai, Zhejiang, Tianjin and Shandong, while the low-low concentration provinces mainly include Gansu, Xinjiang, Liaoning, the western region and the northeastern region. The Beijing-Tianjin-Hebei region has formed a spatial distribution with Beijing as the core, in which Beijing is the political, economic and cultural center and regional transportation hub, but the high-quality development of Hebei's tourism economy has been affected by the "reflux effect" of Beijing and Tianjin, and most of the time it is located in the area of low-high concentration, and has been in the state of marginalization for a long time.



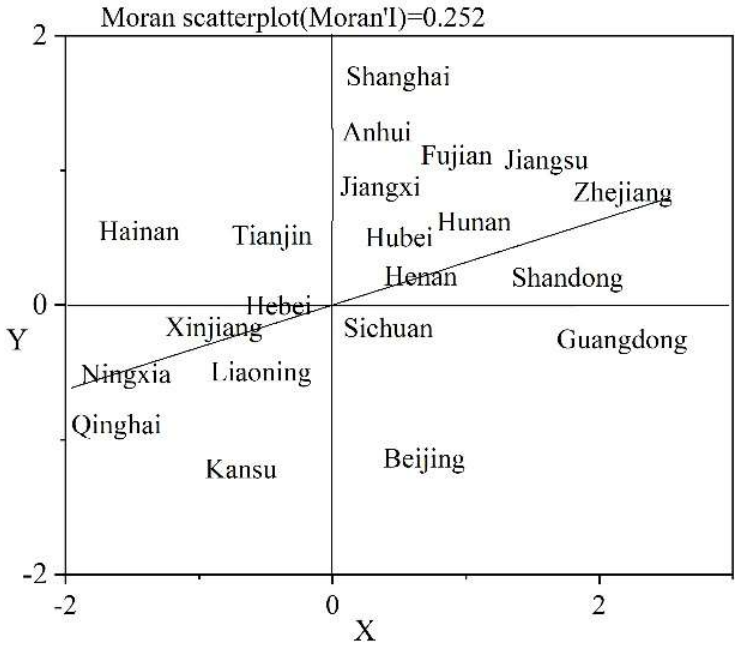
(a) 2012



(b) 2015



(c) 2018



(d) 2021

Fig. 9. Different years of the state of the moran

3.4. Characterizing the σ-convergence of China's high-quality tourism development

In this paper, the σ convergence coefficient is adopted to measure the change trend of inter-regional differences in China. Among them, the σ convergence coefficients of the level of high-quality development of the national and four major regions' tourism economy from 2011 to 2021 are shown in Figure 10. From the national perspective, the national σ convergence coefficient declined from 0.479 in 2011 to 0.406 in 2017; it rose to 0.469 in 2019, and then continued to decline; it reached 0.355 in 2021; it only rebounded around 2018, and showed a trend of convergence at all other times. From a regional perspective, the eastern region shows a continuous downward trend, from 0.357 in 2012 to 0.301 in 2021, but the rate of decline is relatively flat, and the rate of decline accelerates in 2020; the coefficient of the central region fluctuates from 0.111 in 2012 to 0.091 in 2016, and continues to decline from 2016 to 0.037 in 2020, but rebounds and rises to 0.120 in 2021, indicating

the existence of σ-convergence from 2012 to 2020; the northeastern region shows an alternating trend of movement together and down, falling from 0.252 in 2012 to 0.249 in 2015, falling sharply to 0.139 in 2016 before rising to 0.188 in 2017, with 2018, 2019, 2020 years with small fluctuations, and then drops sharply again to 0.138 in 2020. σ-convergence also exists in Northeast China. The western region fluctuates from 0.373 in 2012 to 0.388 in 2021, except for a slight decline in 2015, indicating that σ convergence does not exist in the western region.

Overall, σ convergence exists in the national, eastern, central, and northeastern regions, and σ convergence does not exist in western China. This suggests that the gap in development levels within the western region is gradually increasing, and the differences between the remaining regions are gradually decreasing. At the same time, the western region is at the top of the numerical scale, followed by the eastern, northeastern and central regions, indicating that there are large differences in the level of high-quality development among the provinces in the western region, followed by the eastern region, and the northeastern and central regions are more balanced.

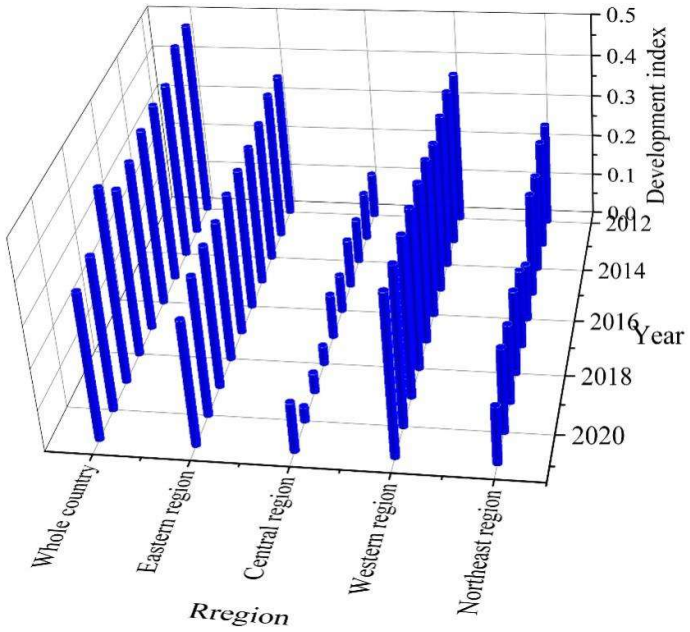


Fig.10. The trend of the development of the high quality of tourism economy

4. Conclusion

Based on the evaluation indexes of China's tourism high-quality development, the study measures the comprehensive level of tourism high-quality development of China's provinces from 2013 to 2021 by using the entropy weight method-TOPSIS model, analyzes the dynamic evolution trend of China's tourism industry and the source of regional differences by using the Kernel density estimation and Dagum's Gini coefficient, and analyzes the convergence of the efficiency of the tourism industry with the help of the convergence model. The main conclusions are as follows:

1) Regional differences in the high-quality development of China's tourism industry have generally declined. In terms of regional differences, the differences in tourism development levels within the eastern and western regions are large, but narrowed during the study period, and the differences within the central region are small but on an increasing trend. In terms of regional differences, the differences between the east and the west, the east and the center are significantly higher than the differences between the center and the west, and the differences between the east and the west, the east and the center and the center and the west are all narrowed during the examination period.

2) From the results of kernel density estimation, the kernel density curve of the whole country and the four major regions shifted to the right in 2008-2021, indicating that the level of high-quality development of the tourism industry has been increasing. The number of wave peaks in the whole country and the eastern, central and western regions is only 1, and there is no polarization phenomenon. The number of wave peaks in the Northeast region has decreased from 2 to 1, but the side peaks are relatively low, showing a weak trend of bipolarization. There is a trailing phenomenon on the right side of the national kernel density curve.
3) Regional differences in the development level of China's tourism economy are gradually narrowing. The analysis of convergence characteristics shows that the eastern, central and northeastern regions show spatial convergence characteristics, and the difference in the level of development between the regions has a tendency to narrow; the coefficient of variation in the western region increases by a small margin, and there is no convergence characteristics.

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