Evaluation of China's Tourism Quality Development Level Based on Entropy Value Method and Exploration of Its Regional Differences

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Abstract China's tourism industry has gradually transformed towards quality development in its rapid development in recent years. The traditional evaluation system is often interfered by subjective factors, which cannot reflect more accurately the level of quality development and differences among regions of tourism. This study evaluates and analyzes the level of quality development of China's tourism industry and its regional differences based on the entropy value method, Dagum's Gini coefficient, and kernel density estimation. First, the entropy value method is used to objectively assign weights to 22 indicators in order to assess the quality development level of tourism across the country and provinces. Second, the regional and internal differences were analyzed by Dagum Gini coefficient decomposition, and it was found that the level of quality development of China's tourism industry showed a rising trend year by year, with the national score increasing from 21.42 to 37.13 from 2013 to 2023, with an increase of 15.71 points. Finally, the kernel density estimation method reveals the spatio-temporal dynamic evolution of the distribution of the national tourism quality development level, showing that there are large development differences among provinces. The eastern region is the highland of quality development of tourism, while the gap between the central and western regions is still obvious, but the inter-regional differences are gradually narrowing with the passage of time. Through the convergence analysis, it is found that there is a significant β-convergence phenomenon in the whole country and in all regions, indicating that regions with low levels of development are gradually narrowing the gap with regions with high levels of development. The study suggests that further strengthening of the institutional environment and economic development is needed to promote balanced regional development and quality development of tourism.

Index Terms quality development of tourism, entropy method, Dagum Gini coefficient, kernel density estimation, regional differences, convergence analysis

I. Introduction

In recent years, with the improvement of people's living standards, the demand for domestic tourism in China has been growing, and the number of domestic tourists and tourism revenue have continued to grow significantly [1]. In addition, China, as a country with rich tourism resources, has attracted a large number of foreign tourists, promoting the development of the international tourism market [2]. This development trend shows us the great potential of tourism. However, with the continuous promotion of economic and social reforms, China's tourism industry is also facing some new problems and challenges, especially the overall low level of high-quality development of the tourism industry and the existence of large regional disparities [3]-[5].

At present, China's tourism in the "quality development level" mainly exists in the supply-side structural reform is not perfect, the level of service is low, etc. [6], [7]. In terms of regional differences, the eastern region has active economic development and the best tourism development situation [8]. Among them, the Pearl River Delta (PRD) region, the Yangtze River Delta (YRD) region and the Beijing-Tianjin-Hebei (BTH) region are one of the most developed regions in terms of tourism, especially the most representative of the Pearl River Delta (PRD) region, which is characterized by unique historical and geographic advantages, abundant tourism resources, and mature tourism development [9]-[11]. The central region is more backward in tourism development, but in recent years the central and western regions began to focus on the development of tourism, through policy guidance and financial support, has made remarkable achievements [12]-[14]. However, there is still a big gap between the tourism development in the western region and other regions, and the tourism attractiveness and tourism facilities and service level need to be improved [15], [16]. In order to better promote the sustainable development of China's

tourism industry tourism quality development level evaluation, and its regional differences are of great significance to explore.

China's tourism industry has experienced rapid growth over the past decades, becoming one of the most attractive destinations in the world. However, with the ever-changing demand for tourism and the limitations of environmental carrying capacity, the traditional growth model has gradually failed to meet the current demand for high-quality development of tourism. Therefore, it is particularly important to explore and establish a new assessment system for quality development. Previous studies on tourism have mostly focused on single dimensions such as tourism revenue and the number of tourists, neglecting more comprehensive evaluation indicators such as green, sharing and innovation. In order to evaluate the quality development level of tourism more objectively and scientifically, this paper adopts various methods such as entropy method, Dagum Gini coefficient, kernel density estimation, etc., and comprehensively takes into account the influence of economic development, social environment, technological innovation and other factors. In this study, 22 evaluation indicators were first constructed from five dimensions, and the entropy value method was used to determine the weight of each indicator, which provided basic data for further analysis. Then, regional difference analysis using Dagum's Gini coefficient reveals the differences in the level of tourism development between different regions and their changing trends. Further, the spatial distribution of tourism development was analyzed by kernel density estimation, which explored the agglomeration effect and polarization trend among different regions. Finally, convergence analysis was applied to test whether the level of quality development of tourism in each region tends to equalize and to study its long-term convergence trend. China's tourism industry has experienced rapid growth over the past decades, becoming one of the most attractive destinations in the world. However, with the ever-changing demand for tourism and the limitations of environmental carrying capacity, the traditional growth model has gradually failed to meet the current demand for high-quality development of tourism. Therefore, it is particularly important to explore and establish a new assessment system for quality development. Previous studies on tourism have mostly focused on single dimensions such as tourism revenue and the number of tourists, neglecting more comprehensive evaluation indicators such as green, sharing and innovation. In order to evaluate the quality development level of tourism more objectively and scientifically, this paper adopts various methods such as entropy method, Dagum Gini coefficient, kernel density estimation, etc., and comprehensively takes into account the influence of economic development, social environment, technological innovation and other factors. In this study, 22 evaluation indicators were first constructed from five dimensions, and the entropy value method was used to determine the weight of each indicator, which provided basic data for further analysis. Then, regional difference analysis using Dagum's Gini coefficient reveals the differences in the level of tourism development between different regions and their changing trends. Further, the spatial distribution of tourism development was analyzed by kernel density estimation, which explored the agglomeration effect and polarization trend among different regions. Finally, convergence analysis was applied to test whether the level of quality development of tourism in each region tends to equalize and to study its long-term convergence trend.

II. Research design on the level of quality development of China's tourism industry

II. A.Research methodology

II. A. 1) Entropy method

Entropy value method [17] is an objective assignment method to determine the weight of indicators by calculating the degree of data discrete, which can avoid the interference of subjective factors. The smaller the entropy value of an indicator is, the larger its objective weight is, and the more important its status is in the evaluation index system. This study adopts the entropy value method to evaluate the level of quality development of China's tourism industry.

The polar deviation method is used to standardize the indicator values in the evaluation index system to eliminate the influence of the scale. The standardization methods for positive and negative indicators are respectively:

$$X_{ij} = \frac{x_{ij} - \min(x_{1j}, x_{2j}, \cdots, x_{nj})}{\max(x_{1j}, x_{2j}, \cdots, x_{nj}) - \min(x_{1j}, x_{2j}, \cdots, x_{nj})} \tag{1}$$

$$X_{ij} = \frac{\max(x_{1j}, x_{2j}, \cdots, x_{nj}) - x_{ij}}{\max(x_{1j}, x_{2j}, \cdots, x_{nj}) - \min(x_{1j}, x_{2j}, \cdots, x_{nj})} \tag{2}$$

where, X_{ij} and x_{ij} denote the standardized and actual values of the j th indicator in year i, respectively. n denotes the number of years.

The standardized data are all increased by 0.01 in order to avoid the influence brought by the appearance of 0 value.

The information entropy of each evaluation index is:

$$E_j = -\frac{1}{\ln n} \sum_{i=1}^{n} \left(\frac{X_{ij}}{\sum_{i=1}^{n} X_{ij}} \ln \frac{X_{ij}}{\sum_{i=1}^{n} X_{ij}} \right) \tag{3}$$

The weights of the evaluation indicators are:

$$W_j = \frac{1 - E_j}{\sum_{j=1}^{m} (1 - E_j)} \tag{4}$$

where, m denotes the number of indicators.

The quality development index of China's tourism industry is:

$$Y_i = \sum_{j=1}^{m} W_j X_{ij} \tag{5}$$

The value of Y_i is in the range of $[0,1]$, and the larger its value is, the higher is the quality development index of China's tourism industry.

II. A. 2) Dagum Gini coefficient

In this study, the Dagum Gini coefficient [18] was used to decompose regional differences into intra-regional differences, inter-regional differences, and hypervariable density. The overall Gini coefficient was calculated as:

$$G = \sum_{j=1}^{k} \sum_{h=1}^{k} \sum_{i=1}^{n_j} \sum_{r=1}^{n_h} \frac{\left| y_{ji} - y_{hr} \right|}{2n^2 \overline{y}} \tag{6}$$

where, G is the overall Gini coefficient. $\overline{y}$ is the score mean. n is the number of districts. k is the number of dividing regions. y_{ji} and y_{hr} are the quality development level of Chinese tourism in $j(h)$ region $i(r)$. n_j and n_h are the number of districts in $j(h)$ region. In this study, China's coastal areas are divided into the northern, eastern and southern oceanic economic zones with reference to the 14th Five-Year Plan.

The overall Gini coefficient can be further decomposed into intra-region Gini coefficient, inter-region Gini coefficient and hypervariable density, and the corresponding formula is:

$$G_w = \frac{\sum_{i=1}^{n_j} \sum_{r=1}^{n_h} \left| y_{ji} - y_{hr} \right|}{n_j n_h (\overline{Y}_j + \overline{Y}_h)} \tag{7}$$

$$G_b = \sum_{j=2}^{k} \sum_{h=1}^{j-1} G_{jh} (p_j s_h + p_h s_j) D_{jh} \tag{8}$$

$$G_t = \sum_{j=2}^{k} \sum_{h=1}^{j-1} G_{jh} (p_j s_h + p_h s_j)(1 - D_{jh}) \tag{9}$$

where, G_w is the intra-regional Gini coefficient. G_b is the inter-regional Gini coefficient. G_t is the hypervariance density. $\overline{Y}_{j(h)}$ is the average value of quality development water of Chinese tourism industry in $j(h)$ region. $p_j = n_j / \overline{Y}$, $s_j = n_j \overline{Y}_j / n\overline{Y}$. D_{jh} is the relative impact of the quality development level of Chinese tourism between j and h regions.

The formula for D_{jh} is:

$$D_{jh} = \frac{d_{jh} - p_{jh}}{d_{jh} + p_{jh}} \tag{10}$$

$$d_{jh} = \int_0^\infty dF_j(y) \int_0^y (y-x) dF_h(x) \tag{11}$$

$$p_{jh} = \int_0^\infty dF_h(y) \int_0^y (y-x) dF_j(x) \tag{12}$$

where, F_j and F_h are the cumulative density distribution functions of j and h regions, respectively. d_{jh} is the difference between the quality development levels of Chinese tourism between regions, i.e., the mathematical expectation of the sum of all $y_j - y_h > 0$ sample values of the 2 regions. p_{jh} is the hypervariable first-order moment, i.e., the mathematical expectation of the sum of all $y_h - y_j > 0$ sample values of the 2 regions.

G, G_w, G_b, and G_t are satisfied:

$$G = G_w + G_b + G_t \tag{13}$$

II. A. 3)　Kernel density estimation

Kernel density estimation [19] is one of the important tools to study the spatial distribution of non-equilibrium, through the curve horizontal position, the height and width of the peaks, the number of peaks, etc. intuitively demonstrated that the tourism industry in various regions of the level of high-quality development of the growth of the level of high and low, degree of agglomeration, the trend of polarization and the degree of intra-regional disparities, which is an important significance for the in-depth analysis of the absolute differences in the level of high-quality development of the growth of the tourism industry in the various areas of the descending. This paper is based on the more commonly used Gaussian kernel function for estimation, assuming that the density function of the random variable x is $f(x)$, then the kernel density is estimated as:

$$f(x) = \frac{1}{Nh} \sum_{i=1}^N K\left(\frac{X_i - \overline{x}}{h}\right) \tag{14}$$

$$K(x) = \frac{1}{\sqrt{2\pi}} e^{\left(-\frac{x^2}{2}\right)} \tag{15}$$

where, $K(\cdot)$ is the kernel function. N is the number of observations. X_i is the independent identically distributed observations. $\overline{x}$ is the mean. h is the wide window of the kernel density estimate, which determines the smoothness and accuracy of the kernel density curve.

II. A. 4)　Convergence model

(1) σ convergence model

The σ convergence model is used to analyze whether the differences in the level of quality development of the tourism industry in each province have narrowed over time, and this paper applies the coefficient of variation to analyze the σ convergence characteristics of the level of quality development of the tourism industry. The model expression is as follows:

$$S = \sqrt{\frac{\sum_{i=1}^n (x_{it} - \overline{x}_t)^2}{n}} \tag{16}$$

$$CV = \frac{S}{\overline{x}_t} \tag{17}$$

where x_{it} denotes the tourism quality development level of province i in the t th year, n denotes the number of provinces in the region, $\overline{x}_t$ denotes the average of the tourism quality development level in the t th year, S denotes the standard deviation of the tourism quality development level in the t th year, and CV denotes the coefficient of variation.

(2) β convergence model

The β convergence model is used to test whether the provinces with lower level of quality development of tourism can narrow the gap with the provinces with higher level of quality development with a certain speed of convergence. Absolute β convergence model is to examine its β convergence characteristics without considering the regional heterogeneity factor. The conditional β convergence model, on the other hand, introduces a series of control variables on the basis of absolute β convergence, which is used to explore whether there is a β convergence trend in the level of high-quality development of the tourism industry under the condition of considering control variables. The model expression is as follows:

$$\ln\left(\frac{y_{i,t+1}}{y_{it}}\right) = c + \beta_1 \ln y_{it} + \beta_2 Controls + \mu_i + v_{it} + \varepsilon_{it} \qquad (18)$$

where c is a constant term, β_1 denotes the parameter to be estimated for the level of quality development of tourism, y_{it} is the level of quality development of tourism in i provinces in year t, β_2 denotes the parameter to be estimated for the control variables, $Controls$ denotes the control variables, μ_i is the spatial effect, v_t denotes the random error term, and ε_{it} denotes the random perturbation term. When the model does not contain control variables, the model is an absolute β convergence model, and vice versa is a conditional β convergence model. According to the research idea and data availability of this paper, while referring to the practices borrowed from different literatures, the framework of factors influencing the level of quality development of tourism is constructed from four aspects, namely, economic development, science and technology, institutional environment, and digital economy development. For economic development (Gdp), the gross domestic product (GDP) is chosen as the measure. Science and technology (Tec), the number of mobile Internet users to measure. Institutional environment (Env), the proportion of local general public budget expenditure to GDP after deducting education expenditure and science and technology expenditure. Digital economy development (Eco), measured by the overall development score of the digital economy.

Table 1: China tourism quality development level evaluation index system

Target layer	Criterion layer	Index layer	Weight
China's tourism quality development level	Innovate	The number of colleges and universities for tourism management	0.045
		Tourism labor productivity	0.062
		Tourism capital productivity	0.048
	Coordinate	Tourism revenue variation coefficient	0.044
		Tourism revenue growth volatility	0.002
	Green	Tourism effluent discharge	0.017
		Tourism emissions	0.017
		Tourism solid waste emissions	0.008
		Per capita park	0.035
		Construction zone greening coverage	0.016
		Life waste harmless treatment rate	0.012
		Environmental pollution governance investment accounts for GDP	0.027
	Open	Number of inbound tourists	0.144
		Tourism foreign exchange income	0.112
		Number of travel agents	0.053
		Number of star hotels	0.053
	Sharing	The number of scenic spots above	0.082
		Number of museums	0.088
		The ratio of road mileage to area	0.030
		The ratio of railway business mileage to area	0.053
		Every 10,000 people have public toilets	0.032
		Every 10,000 people have a bus number	0.020

II. B. System of evaluation indicators

Based on the new development concept, from the five dimensions of innovation, coordination, greenness, openness and sharing, combined with the indicator settings and data availability of existing studies, this study selects a total of 22 indicators to construct the evaluation index system of China's tourism industry's high-quality development level, and adopts the entropy method to calculate the weights of each indicator, and the evaluation index system of

China's tourism industry's high-quality development level is shown in Table 1. Among them, the indicator of the number of inbound tourists has the largest weight, which is 0.144.

II. C. Data sources

The data of this study mainly come from the "China Tourism Statistical Yearbook", "China Statistical Yearbook", "China Urban Statistical Yearbook", "China Environmental Statistical Yearbook", and the statistical bulletins of the tourism industry in each coastal region, and some missing values are made up by linear interpolation method. Among them, the labor productivity and capital productivity of tourism are the ratios of the total income of tourism to the number of direct employment in the tourism industry and the amount of fixed capital investment in the whole society, and the emission of three wastes in tourism is the product of the emission of three wastes in the industry and the ratio of the total income of tourism to the GDP, and the emission of three wastes in the industry is the product of the total income of tourism to the GDP of the whole region. Tourism "three wastes" emission is the product of the ratio of industrial "three wastes" emission and total tourism income and regional GDP, tourism foreign exchange income is measured by converting the average interest rate of the US dollar to the Chinese yuan in each year into the Chinese yuan unit, and all the amount of data are deflated to the real price with 2006 as the base period using the corresponding deflator, so as to eliminate the influence of price fluctuations on the results of the empirical demonstration.

III. Evaluation of China's tourism development level and analysis of regional differences

III. A. Analysis of the overall level of quality development of the tourism industry

Table 2 shows the comprehensive score and ranking of the high-quality development of tourism in 20 representative provinces in China from 2013 to 2023, and in general, except for the decline in the score affected by the novel coronavirus infection epidemic from 2020 to 2021, the comprehensive score of China's tourism high-quality development level from 2013 to 2023 showed an upward trend. From 21.42 in 2013 to 37.13 in 2023, an increase of 15.71 in the past 10 years, reflecting the continuous improvement of the quality development level of China's tourism industry with the process of China's high-quality development. Especially after 2016, with the issuance of documents such as the Outline for the Development of Tourism Quality (2013-2023) and the State Council's Opinions on Accelerating the Development of the Tourism Industry, which put forward the need to promote the transformation of the development mode of the tourism industry, improve the overall level of tourism quality, and push forward the construction of a strong country with tourism quality, China's provinces have actively implemented the State Council's guiding opinions and advocated the protection of tourism resources and environment, strengthening the inheritance and protection of cultural resources, optimizing the structure of the tourism industry, and shifting the tourism industry from factor-driven to innovation-driven, with the level of quality development of the tourism industry markedly improved.

Table 2: China tourism development comprehensive score

City	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Mean	Rank
Guangdong	30.76	33.02	36.06	36.17	39.28	41.29	45.13	48.78	52.05	50.53	54.01	42.46	1
Jiangsu	32.26	34.16	34.92	36.54	39.83	41.32	43.85	47.55	52.51	47.55	50.22	41.88	2
Zhejiang	28.53	31.28	32.60	34.53	37.93	39.47	41.84	45.49	47.19	44.30	47.69	39.17	3
Shandong	25.99	27.30	30.10	31.55	34.14	37.80	40.23	43.82	47.46	42.63	45.53	36.96	4
Beijing	29.64	32.05	32.47	33.62	34.66	35.39	38.26	38.12	41.55	41.01	42.26	36.28	5
Sichuan	22.23	24.01	28.03	29.64	31.19	34.88	35.85	39.66	40.77	38.82	41.38	33.31	6
Shanghai	25.43	29.36	29.92	29.88	30.63	32.34	34.84	33.18	35.27	37.36	38.44	32.42	7
Hhenan	22.23	23.08	24.75	26.30	28.94	30.43	33.49	37.38	38.89	37.05	39.99	31.14	8
Anhui	21.01	22.25	21.65	22.66	26.98	28.57	35.92	32.49	35.63	36.03	36.96	29.10	9
Hupei	18.70	20.78	22.92	24.73	26.55	27.58	29.35	30.47	33.27	31.37	33.34	27.19	10
Hebei	18.70	20.01	22.52	22.35	25.60	26.77	29.25	30.69	32.23	31.37	34.71	26.75	11
Hunan	18.43	19.03	20.77	22.38	24.45	26.60	29.47	33.31	32.65	31.55	34.95	26.69	12
Shaanxi	17.54	19.03	20.82	22.17	25.41	26.66	29.51	28.09	29.71	31.00	33.30	25.75	13
Yunnan	16.32	17.71	19.79	21.03	22.60	24.66	27.81	27.89	28.81	30.15	33.93	24.61	14
Fujian	18.63	19.99	21.43	21.45	22.86	24.24	25.71	28.00	28.51	28.62	30.76	24.56	15
Shanxi	17.81	19.30	19.91	20.36	22.39	23.95	26.17	26.04	27.00	29.02	31.58	23.96	16
Xinjiang	19.21	19.48	21.01	21.42	22.73	21.17	21.54	23.61	24.46	25.36	25.72	22.34	17
Liaoning	18.72	19.76	21.08	22.58	21.60	22.06	22.75	22.12	23.06	24.33	26.04	22.19	18
Jiangxi	13.37	14.52	15.49	17.47	19.73	21.94	24.19	27.88	30.22	27.79	30.69	22.12	19
Guizhou	12.90	14.29	16.04	17.42	18.94	21.70	24.49	25.00	26.53	27.71	31.19	21.47	20
China	21.42	23.02	24.61	25.71	27.82	29.44	31.98	33.48	35.29	34.68	37.13	29.52	

By province, the comprehensive score of quality development of tourism in 20 provinces in China increased year by year from 2013 to 2023, but the level of development, the magnitude of change and the speed of change varied greatly. Guangdong, Jiangsu and Zhejiang are in the top three in terms of quality tourism development, with scores of 42.46, 41.88 and 39.17 respectively, while Liaoning, Jiangxi and Guizhou are in the bottom three, with scores of 22.19, 22.12 and 22.47 respectively, with Guangdong having the highest score and Guizhou having the lowest score, with a difference of nearly two times, which is a significant regional difference.

III. B. Spatial differences and sources

The Dagum Gini coefficient of China's tourism quality development and its decomposition results according to the four regions are shown in Table 3, with E, M, W, and N as the abbreviations of east, center, west, and northeast, and G_w, G_{cb}, and G_t as the intra-region variation, inter-region variation, and hypervariable density, respectively. As the quality of tourism development in central and western China has a greater degree of increase, the interprovincial relative differences in the quality development of China's tourism industry show a fluctuating downward trend during 2013-2023, the Dagum Gini coefficient of 0.270 at the end of the examination period in 2023 compared to the beginning of the period of 0.430 in 2013 has decreased by 37.21%, and with the boundary of 2018, the decrease in the early part of the examination period is is significantly higher than that of the later period, and there is a certain degree of spatial equalization trend in the quality development of tourism within the whole region. Cross-sectional comparison shows that, except for the Northeast region in 2016-2017, the Dagum Gini coefficient of tourism quality development in each region in each year of the examination period is smaller than the value of the whole region, i.e., the differences in the quality of tourism development within each region are smaller than the overall relative differences in the whole region. The regional Dagum Gini coefficient means intuitively show that differences within the eastern and northeastern regions are the most pronounced, which is related to the polarization of Beijing, Shanghai, and Liaoning within the region, while differences within the western region are relatively small. There is a downward trend in the Dagum Gini coefficient for quality tourism development in all regions over the examination period, and the relative differences in the quality of tourism development within each region have narrowed over time.

As can be seen from Table 3, there is a significant difference pattern in the quality development of tourism between regions, in which the mean value of Dagum Gini coefficient in the east and other regions is higher than the average value of the whole region. The eastern region is the highland of China's tourism quality development, and it is of great significance to play the spillover and driving role of the eastern region to promote the quality development of tourism in the central-western and northeastern regions. Cross-sectional comparison shows that the mean values of Dagum Gini coefficients of East-Northeast, East-Central, and East-West are decreasing in order.

Table 3: Tourism quality development space differences and sources

| Year | Full | Region gini coefficient | | | | Regional gini coefficient | | | | | | G_w | G_{cb} | G_t | Contribution rate/% | | |
		E	M	W	N	E-M	E-W	E-N	M-W	M-N	W-N				G_w	G_{cb}	G_t
2013	0.430	0.367	0.230	0.240	0.393	0.536	0.487	0.577	0.247	0.366	0.376	0.112	0.232	0.082	25.35	55.14	19.49
2014	0.385	0.348	0.258	0.220	0.373	0.517	0.468	0.567	0.252	0.366	0.355	0.100	0.236	0.079	25.27	54.50	18.43
2015	0.372	0.331	0.249	0.188	0.372	0.488	0.423	0.543	0.246	0.355	0.341	0.099	0.221	0.071	24.66	58.64	18.27
2016	0.363	0.292	0.242	0.187	0.352	0.473	0.401	0.535	0.235	0.345	0.321	0.084	0.218	0.069	24.19	58.55	17.34
2017	0.343	0.284	0.233	0.195	0.351	0.426	0.390	0.505	0.239	0.336	0.331	0.082	0.188	0.060	24.60	55.80	19.61
2018	0.320	0.294	0.262	0.172	0.380	0.358	0.360	0.476	0.249	0.356	0.327	0.086	0.161	0.075	26.27	50.40	23.21
2019	0.334	0.290	0.209	0.158	0.263	0.447	0.361	0.458	0.213	0.255	0.255	0.078	0.194	0.044	25.29	59.67	14.97
2020	0.299	0.255	0.234	0.138	0.203	0.411	0.326	0.420	0.221	0.250	0.222	0.079	0.178	0.056	24.74	58.34	17.05
2021	0.274	0.269	0.193	0.098	0.122	0.403	0.302	0.326	0.176	0.183	0.126	0.071	0.163	0.029	25.55	60.64	13.72
2022	0.284	0.269	0.211	0.106	0.136	0.422	0.325	0.355	0.182	0.191	0.140	0.075	0.183	0.027	25.75	61.75	12.54
2023	0.270	0.247	0.140	0.136	0.125	0.372	0.311	0.309	0.166	0.158	0.135	0.069	0.165	0.034	25.52	63.99	10.42
Mean	0.334	0.295	0.224	0.167	0.279	0.441	0.378	0.461	0.221	0.287	0.266	0.085	0.194	0.057	25.20	57.95	16.82

The results of Dagum Gini coefficient decomposition show that the mean value and contribution rate of intra-regional differences, inter-regional differences and hypervariable density of tourism quality development during 2013-2023 are 0.085 and 25.20%, 0.194 and 57.95%, and 0.057 and 16.82%, respectively, and that the inter-regional differences have always constituted the most important source of intra-regional differences in promoting the quality development of the whole region. The most important source of intra-regional differences is always the inter-regional differences, and to promote the quality development of tourism in the whole region, it is necessary to

pay in-depth attention to the inter-regional development gap. The time-series characteristics show that the Dagum Gini coefficient, which portrays the intra-regional differences, shows a fluctuating and narrowing trend during the period of examination. The trend of the contribution rate of intra-regional differences is not obvious. The value of inter-regional differences shows a fluctuating upward trend. The value of hypervariance density shows a "minus plus minus" trend, with a decrease at the end of the period compared with the beginning of the period. The interaction of intra- and inter-regional relative differences has a relatively small impact on inter-provincial differences in the quality development of tourism.

III. C. Kernel density estimation results

The dynamic evolutionary trend of the distribution of the quality development of the tourism industry in the whole region during the examination period is shown in Figure 1. In terms of distribution position, the center of the overall distribution curve of the whole region in the examination period has a tendency to shift to the right over time, which indicates that the quality of tourism development in the whole region has been continuously improving, and is relatively consistent with the description of the typical facts of China's tourism quality development. The height of the main peak shows a fluctuating upward trend, while the width of the main peak tends to narrow, which indicates that the degree of dispersion of the quality of tourism development within the whole region has weakened, and there is a trend of narrowing the absolute differences. From the perspective of distribution extension, the distribution curve of the quality development of the tourism industry in the whole region has a significant right trailing phenomenon, and the quality of tourism development in some provinces and regions is significantly ahead. The convergence of the distribution curve implies that the gap between the provinces with high quality tourism development and the average level has narrowed. From the evolution of wave peaks, the overall distribution curve of the whole region has a tendency to evolve from "single peak" to "multiple peaks", and the overall tourism quality development of the whole region in the early stage of the study did not show obvious polarization, but the peaks of the later stage of the lower side of the peaks imply the emergence of weak gradient effects and differentiation. The reason for this phenomenon is partly that although the quality of tourism development in all provinces and regions has improved to different degrees during the survey period, the differences in basic endowments and development environments among different provinces make it difficult for provinces with relatively low quality of development to catch up with the leading provinces in the short term, and their absolute differences may even expand to a certain extent in part of the period.
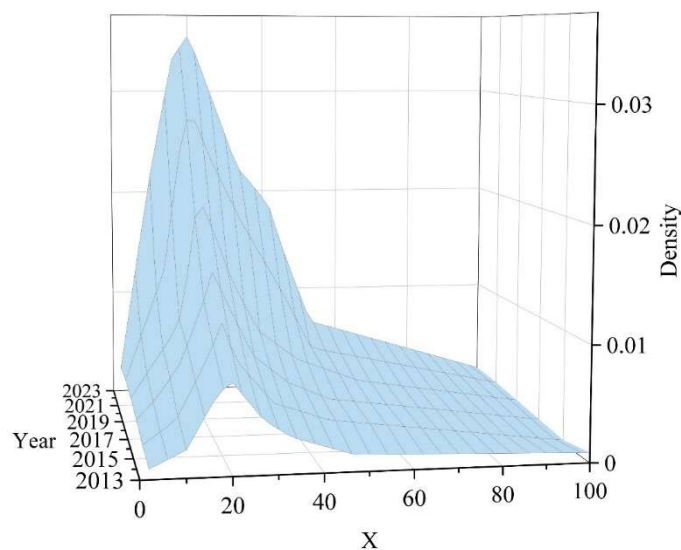

Figure 1: China's tourism quality development distribution dynamic

III. D. Convergence analysis of quality tourism development

III. D. 1) Analysis of σ-convergence

The coefficient of variation of the level of quality development of tourism in the country as a whole and in the eastern, central and western regions is shown in Table 4. The coefficient of variation of the whole country shows a fluctuating downward trend, slightly decreasing in 2013-2014, then increasing to 0.948 in 2015, then decreasing and then increasing to 0.926 in 2018, and then fluctuating and decreasing to 0.885 in 2019-2023, with an overall decrease of the coefficient of variation of the whole country of 8.20% in the period of 2013-2023. The coefficient of variation

in the eastern region shows the trend of "slight decrease - significant increase - decrease", and the overall coefficient of variation in the eastern region increases by 2.80% from 2013 to 2023. The coefficient of variation in the central region shows an m-shaped trend of "fluctuating upward-declining-upward-downward-declining", and the coefficient of variation in the central region rises by about 8.22%. The coefficient of variation in the western region shows a fluctuating downward trend, with a change of about 19.27% from 2013 to 2023. Overall, the coefficient of variation at the national level and in the western region shows a decreasing trend, indicating that there is a σ-convergence of the quality development of the tourism industry at the national level and in the provinces in the western region, suggesting that there is a trend of convergence in the quality development of the tourism industry. The coefficients of variation in the eastern and central regions both show a fluctuating upward trend, and there is no σ-convergence in the development of quality development of tourism, and the degree of imbalance in these two regions has increased.

Table 4: Development level variation coefficient

Year	Whole country	Eastern region	Central region	Western region
2013	0.964	0.642	0.365	0.711
2014	0.942	0.633	0.377	0.665
2015	0.948	0.664	0.385	0.643
2016	0.922	0.665	0.354	0.611
2017	0.935	0.683	0.382	0.598
2018	0.926	0.694	0.386	0.593
2019	0.911	0.683	0.377	0.599
2020	0.895	0.668	0.389	0.582
2021	0.891	0.667	0.390	0.580
2022	0.890	0.664	0.392	0.577
2023	0.885	0.660	0.395	0.574

III. D. 2) β-convergence analysis

Absolute β-convergence of tourism quality development. The absolute β-convergence of the development of quality development of tourism in the whole country and in the eastern, central and western regions is analyzed through Haus-man test, fixed effect test and random effect test. The test results are shown in Table 5. The results show that it is more appropriate to choose the fixed effect model. From the test results, the convergence coefficients β of the whole country and the three regions are negative, and all of them passed the 5% significance test, indicating that there is a trend of absolute β convergence in the quality development of tourism in the whole country and the three regions.

Table 5: Test results of absolute β convergence test

	Whole country	Eastern region	Central region	Western region
β	-0.227	-0.202	-0.212	-5.623
	5.44	3.11	3.05	4.59
R^2	0.142	0.125	0.144	0.289
Sample size	230	84	70	81
F value	29.56	9.56	9.10	23.55

Conditions for quality development of tourism β convergence. Analyze the conditions and convergence of the development of quality development of tourism in the country and the eastern, central and western regions. The test results are shown in Table 6. The values in parentheses are t-statistics. From the test results, it can be found that the convergence coefficients β of the whole country and the three regions are negative, and there is a trend of conditional β convergence.The regression coefficients of the level of digital economic development in the four regression equations are all positive, which indicates that the level of digital economic development has a facilitating effect on the development of high-quality development of the tourism industry.

Specifically, the regression coefficients of economic development, science and technology, and institutional environment in the eastern region are 1.34E-06 and -1.45E-06 respectively, indicating that economic development and institutional environment have a promotional effect on the quality development of the tourism industry, and that the improvement of the economic level and the optimization of the institutional environment can enhance the level of quality development of the tourism industry, while the regression coefficients of science and technology are

negative, indicating that the existing level of science and technology is not conducive to the quality development of the tourism industry. The regression coefficient of science and technology is negative, indicating that the existing level of science and technology is not conducive to the quality development of tourism and the level of science and technology in the eastern region should be further improved. The regression coefficients of economic development, science and technology, and institutional environment in the central region are 1.11E-07, -1.06E-05, and 0.213, respectively. Similar to the eastern region, the improvement of the economic level and the optimization of the institutional environment can enhance the level of high-quality development of the tourism industry, and the existing science and technology level is not conducive to the high-quality development of the tourism industry, so the central region should also strengthen the development of the region's Therefore, the central region should also strengthen the development of the region's science and technology level. The regression coefficients of economic development, science and technology, and institutional environment in the western region are 2.77E-06, -2.56E-06, and 0.058, respectively, and the western region also needs to further develop the level of science and technology in order to promote the quality development of tourism.

Table 6: Conditional β convergence test results

	Whole country	Eastern region	Central region	Western region
β	-0.302	-0.335	-0.255	-0.578
	7.41	5.46	3.47	5.48
InGdp	1.23E-06	1.34E-06	1.11E-07	2.77E-06
InTec	1.08E-06	-1.45E-06	-1.06E-05	-2.56E-06
InEnv	0.062	0.155	0.213	0.058
InEco	0.085	0.103	0.546	0.385
R^2	0.277	0.398	0.258	0.486
Sample size	230	84	70	81
F value	13.56	8.06	3.36	10.22

IV. Conclusion

This study provides an in-depth analysis of the comprehensive evaluation and regional differences in the level of quality development of China's tourism industry.Between 2013 and 2023, the level of quality development of China's tourism industry has risen as a whole, with the score increasing from 21.42 to 37.13, an increase of 15.71 points, showing a strong potential for growth. From a regional perspective, the eastern region has always led in the level of quality development of tourism, and the gap is gradually widening. In contrast, there is a large gap in the central and western regions, especially in Guizhou, Jiangxi and other provinces, where the score is low. The Dagum Gini coefficient analysis shows that inter-regional differences are the main source of promoting the quality development of the tourism industry in the whole region, and such differences show a decreasing trend on the whole. The results of kernel density estimation show that although the level of quality development of tourism has improved in general, there is still a significant gap between different provinces. The results of the convergence analysis show that there is an absolute β-convergence in the quality development of the tourism industry in the whole country and in all regions, and that the gap between the low level regions is gradually narrowing, especially in the western region. By further analyzing the influencing factors, it is found that economic development, institutional environment and the enhancement of digital economy are the key factors to promote the quality development of tourism.

References

[1] Zhao, J., & Li, S. M. (2018). The impact of tourism development on the environment in China. Acta Scientifica Malaysia, 2(1), 1-4.
[2] Xue, L., Kerstetter, D., & Hunt, C. (2017). Tourism development and changing rural identity in China. Annals of Tourism Research, 66, 170-182.
[3] Haibo, C., Ayamba, E. C., Udimal, T. B., Agyemang, A. O., & Ruth, A. (2020). Tourism and sustainable development in China: A review. Environmental Science and Pollution Research, 27, 39077-39093.
[4] Cornet, C. (2015). Tourism development and resistance in China. Annals of Tourism Research, 52, 29-43.
[5] Luo, J. M., Qiu, H., Goh, C., & Wang, D. (2016). An analysis of tourism development in China from urbanization perspective. Journal of Quality Assurance in Hospitality & Tourism, 17(1), 24-44.
[6] Wang, L., & Yotsumoto, Y. (2019). Conflict in tourism development in rural China. Tourism Management, 70, 188-200.
[7] Wang, X., Zhen, F., Tang, J., Shen, L., & Liu, D. (2022). Applications, experiences, and challenges of smart tourism development in China. Journal of Urban Technology, 29(4), 101-126.
[8] Li, R., Guo, Q., Wu, D., Yin, H., Zhang, H., & Zhu, T. (2014). Spatial characteristics of development efficiency for urban tourism in eastern China: A case study of six coastal urban agglomerations. Journal of Geographical Sciences, 24, 1175-1197.
[9] Zhang, Y., Li, S., Zhou, Q., & Wu, F. (2024). The economic benefits and environmental costs of trans-eastern tourism in China. Environmental Impact Assessment Review, 108, 107603.

[10] Bo, Z., Bi, Y., Hengyun, L., & Hailin, Q. (2017). The spillover effect of attractions: Evidence from Eastern China. Tourism Economics, 23(4), 731-743.

[11] Jin, S., & Liu, T. (2017, May). Study on tourist carrying capacity of sustainable tourism---by taking Qingliang Mountain in the south-eastern china as an example. In IOP Conference Series: Earth and Environmental Science (Vol. 64, No. 1, p. 012052). IOP Publishing.

[12] Wang, K., Wang, M., Gan, C., Chen, Q., & Voda, M. (2021). Tourism economic network structural characteristics of national parks in the central region of China. Sustainability, 13(9), 4805.

[13] Liu, J., Yue, M., Yu, F., & Tong, Y. (2022). The contribution of tourism mobility to tourism economic growth in China. Plos one, 17(10), e0275605.

[14] Pratt, S. (2015). Potential economic contribution of regional tourism development in China: A comparative analysis. International Journal of Tourism Research, 17(3), 303-312.

[15] Keyim, P. (2016). Tourism and rural development in western China: A case from Turpan. Community Development Journal, 51(4), 534-551.

[16] Li, W. B., Zhang, L., & Guo, R. L. (2020). The measurement of tourism environmental pollution and tourism efficiency in Western China. Journal of Coastal Research, 104(SI), 660-664.

[17] Hui Wang. (2025). Regional ecological risk assessment for Guangxi (China) based on entropy method and the pressure-capital-vulnerability-response model. Ecological Indicators,175,113542-113542.

[18] Ma Tian,Liu Yisheng & Yang Meng. (2022). Spatial-Temporal Heterogeneity for Commercial Building Carbon Emissions in China: Based the Dagum Gini Coefficient. Sustainability,14(9),5243-5243.

[19] Liang Yusheng,Zhang Fan,Yang Kun & Hu Zhenqi. (2022). A Surface Crack Damage Evaluation Method Based on Kernel Density Estimation for UAV Images. Sustainability,14(23),16238-16238.