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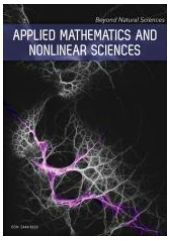

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Power Mechanism and Path of Deep Integration of Cultural Industry and Tourism Industry in the Background of Big Data

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Abstract

This paper extracts the indicators of the power mechanism of the integration of cultural industry and tourism industry in Province A, determines the weights by using entropy value method, substitutes them into the model of coupling coordination degree to measure, and determines the coordination mechanism of the integration of the cultural industry system and the tourism industry system. Through the empirical research method, the comprehensive development level and coupling coordination degree of the culture and tourism industries in province A from 2016-2023 were quantitatively analyzed from a scientific perspective. The results show that the overall development of the culture and tourism industry has maintained a steady upward trend during 2016-2023, but its development is still uneven and synchronized. The degree of correlation between the development of cultural industry and tourism industry is high, and the average value of its coupling degree is at a high level (0.96168).Although the overall level of the coupling coordination degree of province A is low during 2016-2023, it shows a rising trend year by year, and the annual average value grows from 0.23348 to 0.3656.The results of kernel density estimation show that The phenomenon of internal grading is more obvious, and the level of coupled and coordinated development of cultural system and tourism system needs to be further improved. In addition, the polarization of cultural industry and tourism industry in some areas is becoming more and more significant, and the level of coordination is not stable enough, but the level of their coupling and coordination are all moving towards high-quality coordination.

Keywords: Entropy value method; Coupling coordination degree model; Cultural and tourism industry integration; Kernel density estimation.
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1 Introduction

In the integration of culture and tourism, culture industry is the soul of tourism industry and tourism industry is the carrier of culture industry, which have similar nature and natural integration [1-2]. The mutual penetration and integration of culture industry and tourism industry will form the new industry of culture and tourism. The new industry of culture and tourism realizes the optimal allocation of resources and promotes the further development of the two industries of culture and tourism. It can attract more travelers and promote the development of tourism industry, but also can carry culture and find suitable soil for cultural industry [3-6].

The traditional theory of industrial integration divides the power mechanism of industrial integration into three categories, namely, technological innovation, government deregulation, and demand upgrading [7-8]. This is also applicable in the process of cultural and tourism integration, the upgrade of tourism consumption demand is the fundamental motive of cultural and tourism integration [9-10]. Technological innovation is an important driving force for the integration of culture and tourism, which makes the integration of cultural creativity into tourism products a reality, and the integration of scientific and technological elements into cultural tourism products greatly enriches the scientific and technological connotations and forms of expression of cultural tourism products, improves the quality, level and performance of cultural tourism products, and provides technological conditions to meet the needs of consumers for cultural tourism [11-12]. The development of technology is often also the promotion of consumer upgrading. Therefore, it assists tourism enterprises in capturing the overall changes in consumer demand for cultural tourism consumption and the promotion and marketing channels of cultural tourism products [13-15]. Government deregulation is an important guarantee for cultural tourism integration. When the government deregulation, it will greatly improve the efficiency of cooperation between different departments and different enterprises, and give full play to the initiative of enterprises, thus promoting the integration of culture and tourism [16].

Big data has the characteristics of borderlessness, information density and rapid dissemination. In the integrated development of culture and tourism, big data has the natural advantage of integration with tourism industry and culture industry [17]. It is believed that under the addition of big data, it can help the tourism industry to guide the tourism enterprises to change the original mode of corruption, improve the tourism service system, broaden the tourism publicity channels, and also extend the value chain of the cultural industry and expand the scale of the cultural market [18-19]. The integration of culture and tourism under big data will bring different aspects to the development of the two industries.

Nowadays, big data has a great impact on people's life, learning and thinking, and can drive people to make certain decisions, and can in turn understand their decisions. Literature [20] utilizes big data in tourism experience co-design to provide high quality tourism experience services to travelers by analyzing and investigating their needs and interests. Similarly, literature [21] utilized big data and artificial intelligence to conduct an in-depth analysis of travelers from conscious thoughts, field trips, to post-tour evaluations, which provided travelers with high-quality services while increasing scenic area revenues. Literature [22] mentions academic programs that disseminate data through the network, provide usable static and dynamic information about the regional cultural industry, give people an experience with real visual effects, and make travelers have the idea of taking a trip, which promotes the development of cultural and creative tourism. It can be seen that the power mechanism and path of the integration of the cultural industry and tourism industry have been clearly revealed in the context of big data. Literature [23] analyzed three paths affecting the integration of traditional villages' culture and tourism, namely, mature development path, rapid development path and progressive development path, based on the TOPSIS model supported by entropy method using the fuzzy set qualitative comparative analysis method. Literature [24] utilized travelers' action trajectories reacting to social network data to classify cultural tourism attractions, and the analysis found that

tourists from different countries focused on different attractions. Similarly, literature [25] achieved resource replacement by geo-punching attractions during users' trips on social media to provide authentic travel experiences that other users could refer to. Both studies make corresponding layout designs for the preferences of potential customers of attractions and merchants, and also provide an effective reference for the integration path and power mechanism of cultural tourism industry. Under the penetration of big data, the depth and breadth of the integration of culture and tourism have already had remarkable results. However, it is still necessary to study and understand the power mechanism and path of the deep integration of cultural industry and tourism industry, which can provide reference and ideas for the subsequent development of cultural and tourism integration.

This paper focuses on the degree of integration of culture industry and tourism industry (referred to as culture and tourism) in Province A. It mines and analyzes the power mechanism and path of the integrated development of the culture and tourism industry in Province A. The entropy value method is used to calculate the weights of the indicators, so as to construct the coupling coordination degree model. The integrated development of the culture and tourism industry is analyzed in terms of level measurement and coupling coordination degree measurement, and the kernel density estimation of the evolution of culture and tourism development is carried out. Finally, the relative development degree of culture and tourism industry in four cities of Province A is analyzed, which provides a comprehensive understanding of the degree and state of integration of culture and tourism industry in Province A at this stage.

2 The power mechanism and coupling model construction of the deep integration of culture and tourism industry

2.1 Power mechanism of deep integration of culture and tourism industry

2.1.1 A high degree of industrial interconnectedness as a basic condition for industrial integration

Tourism is an industry with a high degree of industrial correlation and strong comprehensiveness, in addition to the close connection with the six core industries of traveling, tourism, housing, food, shopping and entertainment, and also involves the cultural and sports, convention and exhibition, financial and information service industries. Related industries support and coordinate the development of tourism, and the tourism industry in turn drives the development of related industries. The unity of the internal logic, natural coupling, and high-quality development requirements of the tourism industry and the cultural industry have led to a high degree of inter-industry correlation and a high rate of collaborative utilization. Cultural resources through the tourism market to play a role, tourism through the culture to be innovative, the interaction and integration between the two to achieve the optimal allocation of factors, resources to share each other in the construction of the mutual integration of the industrial system, laying a solid foundation for the integration of the development of inter-industry interaction.

2.1.2 Increased Consumer Demand as a Primary Driving Force for Industrial Integration

With the improvement of living standards, people's needs on the material level gradually to the spiritual level, more and more people are willing to choose to travel to relax the body and mind, to relieve the pressure and fatigue of work. And people's travel demand has become more diversified, especially for young people, a single tour of the mountains and water can no longer meet their travel needs, people want to experience life in the process of traveling, knowledge growth, so the emergence

of tourism products rich in cultural connotations. The market demand for consumption levels is increasing, which is becoming the driving force for promoting the process of cultural and tourism integration. The characteristics of tourism activities are inclined to regional and appreciation, and the characteristics of cultural activities are inclined to knowledge and entertainment, which form a complementary relationship between the two, and jointly meet the upgraded needs of personalization and diversification of mass consumption.

2.1.3 Product upgrading and development is the intrinsic thrust of industrial integration

Changes in consumer demand, prompting tourism enterprises to upgrade and transform tourism products, in the process of redesigning products, according to the feedback of tourist data, and constantly explore the cultural connotation of tourism products, iterative upgrading of tourism routes and other cultural and tourism products, from the past a single sightseeing tours to the conversion of the creative fusion of cultural products, to create a series of tourism products suitable for the needs of different groups of customers, to differentiate the cultural and tourism products Shape and strengthen the cultural tourism. The upgrading and development of tourism products provides an internal thrust for industrial integration, promotes the tourism development of historical and cultural relics, accelerates the development and construction of rural tourism, and increases the number of cultural and tourism experience and participation projects, which promotes the integration of cultural and tourism towards the direction of personalization, enrichment and maturity.

2.1.4 Technological progress and innovation as an external driving force for industrial integration

The acceleration of the information age, the continuous development of digital technology, and the era of big data management have made various industries more intelligent. Through data analysis, the preferences and needs of tourists are analyzed and fed back to the cultural and tourism product design department to accurately locate the demand targets, promote the effective integration of cultural and tourism, and accelerate the efficiency of industrial collaboration. Driven by the progress of information technology, the scope of industrial integration has been continuously expanded, i.e., not only in the process of inter-industry resource mutual penetration, but also to the extension and reorganization of inter-industry or internal elements and industry chain. Technological progress and innovation, as the external thrust, accelerate the process of industrial integration, expand the scope of integration of cultural industry and tourism industry, and facilitate the continuous formation of new forms of cultural and tourism industry, which become the bridge and link of industrial integration. The integration mechanism of the culture and tourism industries is shown in Figure 1.

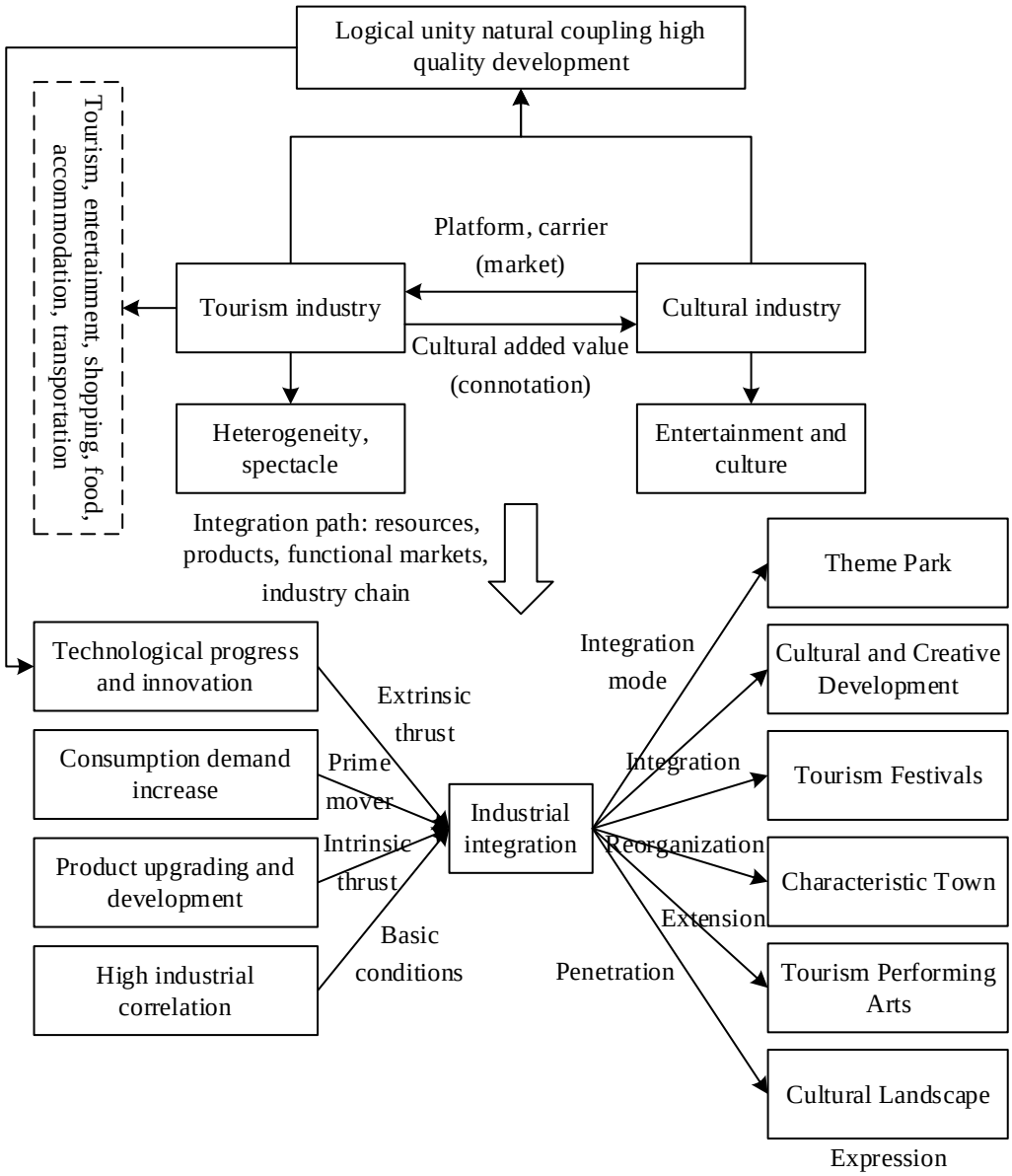

Figure 1. Cultural industry and tourism industry integration mechanism

2.2 Culture and tourism industry coupling coordination degree model construction

2.2.1 Entropy value method to calculate indicator weights

The systematic indicators of the cultural and tourism industries were selected for this study. Due to the different units of measurement of different indicators, in order to facilitate the comparison of the two industrial systems and to avoid the bias of subjective factors on the results of the study, it is necessary to standardize the data and clearly define the proportion of each indicator in the industrial system before evaluating the comprehensive development level. In order to assign weights to the indicators more objectively, we used the entropy value method [26] to calculate the degree of variation of each indicator. The entropy value method is capable of ignoring the impact of subjective factors on the results. In summary, in order to calculate the weights of the indicators, the entropy value method was used in this study. The specific calculation formula and steps are as follows:

1) Construct indicator data matrix

According to the evaluation index system of the development level of industry and tourism industry in Province A, the evaluation indexes therein will construct the initial data matrix:

$$A=\left(A_{xy}\right)_{n\times m}\begin{bmatrix} a_{11} & \cdots & a_{1m} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nm} \end{bmatrix} \tag{1}$$

Where A_{ij} indicates the y rd indicator in the x nd set of data, which in this paper means the value of the y th indicator in the x th year of the cultural industry or tourism industry.

2) Standardized data processing:

$$\text{Positive indicators: } B_{xy}=\frac{A_{xy}-\min\left(A_y\right)}{\max\left(A_j\right)-\min\left(A_y\right)}+0.0001 \tag{2}$$

$$\text{Negative indicators: } B_{xy}=\frac{\max\left(A_y\right)-A_{xy}}{\max\left(A_y\right)-\min\left(A_y\right)}+0.0001 \tag{3}$$

Where A_{xy} indicates the original value of each indicator, $\max A_{xy}$ indicates the maximum value in the data of evaluation indicators, $\min A_{xy}$ indicates the minimum value in the data of each evaluation indicator, and B_{xy} indicates the value of the original data after standardization. In order to avoid 0-value results, 0.0001 is added to all data after processing.

3) Calculate the weight of the y th indicator in the x th year:

$$P_{xy}=\frac{B_{xy}}{\sum_{x=1}^{m}B_{xy}}(y=1,2,\ldots,n) \tag{4}$$

4) Calculate the extracted value of indicator y :

$$e_y=-\frac{1}{\ln N}*\sum_{x=1}^{n}P_{xy}\ln\left(P_{xy}\right)(y=1,2\cdots m) \tag{5}$$

Where e_y is the entropy value of indicator y , $e_y>0$; P_{xy} is the weight of the y th indicator after the standard treatment, $1\mathrm{n}N$ is the natural logarithm, $1nN>0$.

5) Calculate the coefficient of variation of the yth indicator:

$$g_y=1-e_y \tag{6}$$

Where g_y is the coefficient of dispersion of the y nd indicator; e_y is the entropy of the y th indicator. The greater the difference between the indicator values A_{xy} of the y th indicator, the

higher the degree of dispersion, the smaller the entropy. Then the larger the g_y, the more important the indicator is, and the greater the impact on the whole indicator system.

6) Calculate the weight of the y th indicator:

$$w_y = \frac{g_y}{\sum_{y=1}^{n} g_x}, \left(y = 1, 2 \cdots, m\right) \tag{7}$$

7) Calculate the overall score of the level of development of the cultural industry or tourism industry:

$$U_x = \sum_{y=1}^{n} W_y * B_{xy}, (x = 1, 2 \cdots, m) \tag{8}$$

2.2.2 Modeling the degree of coupling coordination

1) Coupling degree model [27-28]

Coupling is a phenomenon of interaction, mutual influence and common development between two systems with similar elements and functions. This phenomenon can be divided into benign and non-benign coupling. The value of coupling degree can reflect the degree of interaction between two systems, i.e., the degree to which they develop with each other. If the degree of coupling between the two is higher, it means that the degree of mutual influence between them is more significant and the development of mutual interaction is smoother; on the contrary, if the degree of coupling is smaller, it means that there is less interaction between the two systems, and there may even be a situation in which they inhibit each other's development.

Set variable $U_x(x = 1, 2 \cdots n)$, which indicates the index of the comprehensive development level of the industry, x indicates the number of industries in the coupling system, when $n = 2$, it means that there are only two industries in the system that are coupled, in this paper, only two major industries are involved in the cultural industry and the tourism industry, so this study involves the formula for calculating the degree of coupling as shown below:

$$C = 2\sqrt{\left(U_1 \times U_2\right) / \left(U_1 + U_2\right)^2} \tag{9}$$

Where U_1 and U_2 denote the value of the integrated development level of cultural industry and tourism industry respectively, which is calculated by the formula (8) listed above. The larger the coupling degree is, the larger the interaction between the two is, and vice versa, the smaller it is.

2) Coupling coordination degree model

Although the coupling degree can reflect the interaction between the two industries, it does not assess the adequacy of the degree of integration of the two industries. In order to prove the degree of integration of the two, this paper proposes a coupling coordination degree model and gives the calculation formula. The model can better coordinate the relationship between the two and reduce their degree of duplication. The specific counting formula is as follows:

$$D = \sqrt{C \times T} \tag{10}$$

$$T = \alpha U_1 + \beta U_2 \tag{11}$$

Where D value is the value of coupling degree of coordination, C value is the degree of coupling, T value is the reconciliation index of the two industries, α and respectively represent the impact weight of the cultural industry and tourism industry, in this paper, it is assumed that the cultural industry and the tourism industry are equally important, so take $\alpha = \beta = 0.5$.

3 Measurement and coupling results analysis of the deep integration development of culture and tourism industry

In this paper, the gains of the cultural and tourism industries in five cities of G province during 2016-2023 are selected as survey objects to investigate the deep integration of their cultural and tourism industries.

3.1 Measurement and analysis of the integrated development of the culture and tourism industry

3.1.1 Determination of weights

The weighting results of the evaluation indicators for the integration and coordination of the cultural industry system and the tourism industry system are shown in Table 1. From the weighting results, the indicators with higher weights in the cultural industry indicator system are the number of cultural institutions, the number of museums, the number of national intangible cultural heritage lists, the amount of investment in the cultural industry, and the number of employees in the cultural industry; and the indicators with higher weights in the tourism industry indicator system are the foreign exchange income from tourism, the number of tourist agencies, the domestic tourism revenue, the number of tourists hosted in the country, and the proportion of the total income from tourism in GDP, respectively. The higher the weight value is, the greater the weight value is. The larger the weighted value, the greater the influence of the indicator in the process of developing this industry. The changes in the data of the indicators above with higher weights can be used to analyze the changes in the development of the cultural industry and tourism industry in Province A to a certain extent.

Table 1. The evaluation index weight of cultural industry and tourism industry

Coupling system	Index name	Entropy	Coefficient of difference	Weighting
Tourism industry system	The number of tourists in the country	0.8353	0.1613	0.0361
	Number of inbound tourists	0.914	0.0794	0.0177
	Domestic travel income	0.828	0.1701	0.0381
	Travel income	0.7188	0.2803	0.0635
	The number of scenic spots	0.8946	0.1082	0.0240
	Number of travel agents	0.7692	0.238	0.0539
	Number of star hotels	0.9044	0.0962	0.0211
	Total room number of star hotel	0.8773	0.1223	0.0270
	Tourism income is the proportion of GDP	0.8595	0.1414	0.0316
	Total annual operating revenue of star hotels	0.9161	0.0846	0.0185
	Number of employees in the catering industry	0.9336	0.0675	0.0149
Cultural industry system	Urban residents' disposable income	0.8625	0.1372	0.0306
	Value-added of cultural industry	0.9071	0.0949	0.0209
	Value-added of cultural industry	0.9081	0.0946	0.0209
	Investment in cultural industry	0.7396	0.2591	0.0585
	Patent number	0.8267	0.1751	0.0392
	Number of cultural pavilions	0.9364	0.0606	0.0130
	Number of public libraries	0.9379	0.0606	0.0130
	Museum number	0.4126	0.5884	0.1340
	The number of art exhibition groups	0.8315	0.171	0.0385
	The number of national intangible cultural heritage sites	0.5715	0.4281	0.0972
	Number of provincial intangible cultural heritage sites	0.9371	0.061	0.0130
	The number of cultural industries	0.9269	0.0712	0.0154
	The number of institutional corporate institutions of cultural industries	0.9156	0.0838	0.0184
	Cultural industry accounts for GDP	0.9294	0.0755	0.0164
	Number of cultural institutions	0.6502	0.3499	0.0792
	Number of cultural practitioners	0.799	0.2006	0.0451

3.1.2 Comprehensive development level measurement and analysis

Through the calculation of the weights in the previous section, the size of the contribution of the influence of each indicator in the process of the development of the cultural industry and tourism industry is understood, so in this section we will further explore the changes in the comprehensive development level of the cultural industry and tourism industry during the period of 2016-2023 according to the weight value of each indicator.

The results of the trend change in the comprehensive development level of the cultural industry and tourism industry during 2016-2023 are shown in Figure 2. From the figure, there are obvious differences in the trend of the comprehensive development level value of the cultural industry and

tourism industry during 2016-2023. First of all, the initial value of the two is farther apart, the value of the comprehensive development level of the tourism industry in 2016, the year of the beginning of the study, is 0.0128, while the value of the comprehensive development level of the cultural industry is 0.0373, which is almost three times as fast as that of the tourism industry, indicating that the degree of development of the cultural industry in province A in the initial year of the study is better than that of the tourism industry. Secondly, from the point of view of development speed, the average annual growth rate of the value of the comprehensive development level of the cultural industry is 26.33% in 2017-2023, and the average annual growth rate of the tourism industry is 22.75% in the same period, which indicates that the development speed of the cultural industry during the period of 2017-2023 is higher than that of the tourism industry. In comparison with the cultural industry, the development of the tourism industry has obviously lagged behind in recent years. Finally, the comprehensive development level index of the culture industry increased from 0.03726 in 2016 to 0.16595 in 2023, while the comprehensive development level index of the tourism industry increased from 0.01278 to 0.10298 from 2016-2023. During this period, the comprehensive development level index of both showed a steady upward trend. In general, there is a phenomenon of unbalanced and unsynchronized development between the cultural and tourism industries, which largely affects the degree of integrated development between them.

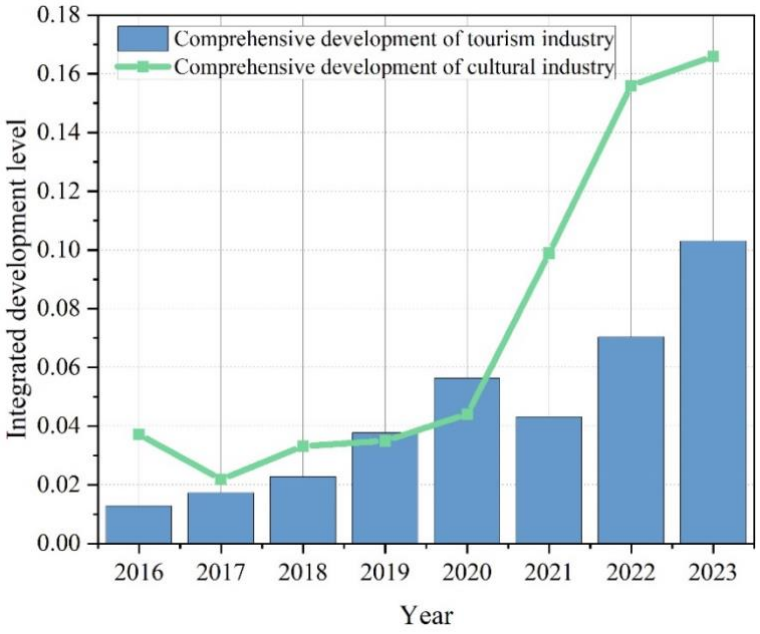

Figure 2. Comprehensive development of cultural industry and tourism industry

3.1.3 Measurement and Analysis of Coupling Degree and Coupling Harmony

1) Measurement and analysis of the coupling degree between cultural industry and tourism industry

Table 2 shows the results of the coupling degree C between the cultural industry and tourism industry from 2016-2023. The degree of coupling can reflect the close degree of connection between the cultural industry and the tourism industry in the process of development, and the size of the degree of coupling C can be used to assess the degree of ordering of various elements within the two industrial systems after mutual influence. From the table, it can be seen that the overall level of the coupling degree C of the cultural industry and the tourism industry during the period of 2016-2023 is high, with an average value of 0.96168, indicating

that the degree of association between the development of the cultural industry and the tourism industry is at a high level. From the development trend point of view during the period of 2016-2023, the coupling degree C shows an inverted "V" trend of rising and then falling, which indicates that although the cultural industry and tourism industry have strong inter-industry interactions during this period, and the development of the degree of correlation is relatively close, the coupling of the two is not stable enough, and has not formed a relatively full and sufficiently stable development. This shows that although the cultural industry and the tourism industry have strong inter-industry interaction during this period, the degree of development is relatively close, but the coupling development of the two is not stable enough, and there is no adequate and stable coupling development mechanism, which leads to large fluctuations in the coupling degree.

Table 2. The cultural industry and the tourism industry coupling value summary

Year	Comprehensive development of tourism industry	Comprehensive development of cultural industry	Coupling C	T value
2016	0.015	0.0393	0.8919	0.015
2017	0.0196	0.0238	0.9956	0.0196
2018	0.0254	0.0343	0.9889	0.0254
2019	0.0416	0.0366	0.9982	0.0416
2020	0.0591	0.0466	0.9932	0.0591
2021	0.0463	0.1084	0.9156	0.0463
2022	0.0762	0.1594	0.9356	0.0762
2023	0.1058	0.1675	0.9744	0.1058

2) Measurement and analysis of the coupling coordination degree between cultural industry and tourism industry

Through the analysis of the coupling degree, the strength of the coupling relationship between the cultural industry and the tourism industry is initially understood, but the coupling degree does not directly reflect the degree of coupling and coordination between the two industrial systems in the process of integration and development, therefore, the coupling degree of coordination will be further analyzed through the measurement of the coupling degree to analyze the coupling coordination situation of the two systems of the cultural industry and the tourism industry in the period of 2016-2023. The integration and coordination of the cultural and tourism industries. The results of the coupling coordination degree and coupling coordination type between the cultural and tourism industries are shown in Table 3.

According to the index of the comprehensive development level of the cultural industry and tourism industry, the types of coupling development are classified, and the years 2016-2018 are tourism lag type, during which the development level of the cultural industry is higher than that of the tourism industry. 2019 and 2020 are cultural lag years, during which the development level of the tourism industry exceeds that of the cultural industry. 2021-2023 are tourism lag type, and the years 2021-2023 are tourism lag type, during which the development level of the tourism industry exceeds that of the cultural industry. 2023 is the tourism lag type, in which the development level of the culture industry once again exceeds that of the tourism industry. From the view of the coupling development type, the coupling development type in 2016-2023 is that although there are some years in which the development of tourism industry is better than the development of culture industry, but from the overall point of view, the

development level of culture industry is higher than that of tourism industry, and the existence of fluctuations may be due to the fluctuations of the year's special tourism events.

From the viewpoint of the value of coupling coordination degree, the overall level of the value of coupling coordination degree of the two industries between 2016-2023 is relatively low, with an annual average value of only 0.23348, and only 0.3656 when it reaches the highest in 2023.From the viewpoint of the development trend, although there is some fluctuation, the overall 2016-2023 maintains the trend of continuous growth. According to the coupling coordination degree classification standard in the previous article, it can be seen that the coupling coordination grade between cultural industry and tourism industry in province A during 2016-2023 is as follows: the coupling coordination grade is seriously out of order during 2016-2019, seriously out of order in 2020 and 2021, and mildly out of order in 2022 and 2023.

Table 3. Coupling coordination and coupling coordination type partition table

Year	Comprehensive development of tourism industry	Comprehensive development of cultural industry	Coupling type	Coupling coordination d	Coupling coordination level
2016	0.015	0.0393	Traveling lag	0.1559	Severe disorder
2017	0.0196	0.0238	Traveling lag	0.1472	Severe disorder
2018	0.0254	0.0343	Traveling lag	0.172	Severe disorder
2019	0.0416	0.0366	Culture lag	0.198	Severe disorder
2020	0.0591	0.0466	Culture lag	0.2297	Moderate disorder
2021	0.0463	0.1084	Traveling lag	0.2667	Moderate disorder
2022	0.0762	0.1594	Traveling lag	0.3327	Mild disorder
2023	0.1058	0.1675	Traveling lag	0.3656	Mild disorder

2016-2023 coupling coordination degree D change trend as shown in Figure 3, during the period of 2016-2023, the comprehensive development level of cultural industry and tourism industry in province A shows a rising trend, at the same time the coupling coordination degree value of the two industries is also growing, which shows the mutual promotion role of the cultural industry and tourism industry in the development process. Obviously, the integration of the two industries has a positive role in promoting both. The figure also shows that during the period of 2017-2020, the development of the cultural industry and tourism industry is more synchronized, and the gap between the comprehensive development level index of the two is relatively small, at this time, the coupling degree of coordination C shows a stable upward trend. And during the period of 2020-2023, when the gap between the comprehensive development level of the cultural industry and the tourism industry increases, the growth of the coupling degree of coordination C also fluctuates, which is manifested in the obvious change of the slope of the fold line. Therefore, it can be assumed that if there is an industry in the two systems whose development level is ahead of the other industry, then the two industries will have insufficient integration and uncoordinated development in the process of integration and coordination.

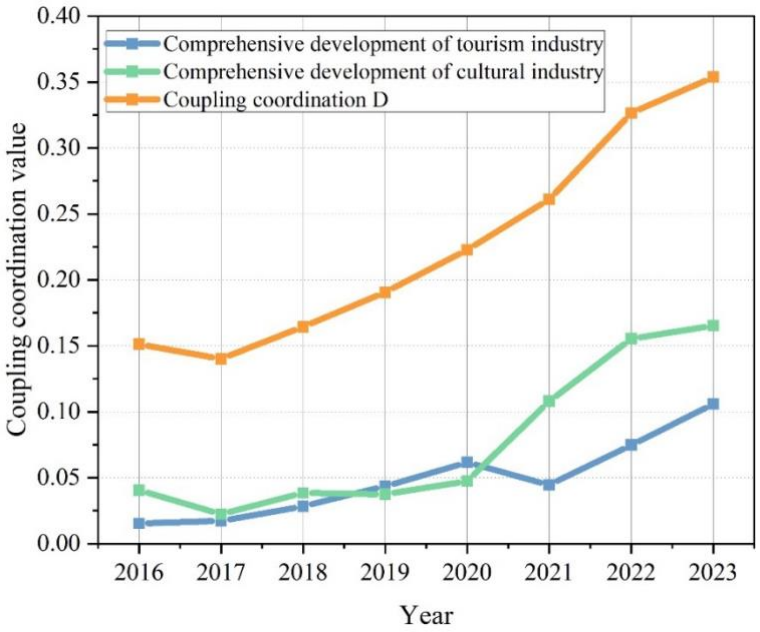

Figure 3. The trend of coupling coordination d in 2016—2023

3.2 Evolutionary characteristics of the coupled and coordinated development of culture and tourism industries

Kernel density estimation is a non-parametric estimation method based on sample data to study and analyze the characteristics of data distribution. Compared with the parametric estimation method, the kernel density estimation method does not need to determine the basic form of the function in advance, which effectively avoids the fitting bias of the sample data, and when no obvious function model is found to correspond to the actual sample data, the model setting is very easy to be biased, which affects the results of the subsequent analysis of the actual problem. Because kernel density estimation does not require prior knowledge of sample data distribution, it has been highly concerned by various research fields. In this paper, it is applied to analyze the time change of the coupling coordination degree of the culture and tourism industries in each city of Province A.

If the sample data $x_1, x_2, x_3, \cdots, x_n$ obeys the continuous distribution $f_n(x)$, the general form of kernel density estimation is:

$$\hat{f}_n(x) = \frac{1}{nh}\sum_{i=1}^{n} K\left(\frac{x - x_i}{h}\right) \tag{12}$$

In the formula, n represents the number of samples, h represents the broadband, the choice of h affects the smoothness of the curve, when the broadband is smaller, the kernel density estimation is more accurate, when the broadband is bigger, the kernel density estimation is more deviated from the accurate; $K(*)$ is the kernel function, which essentially represents the weight function.The kernel density distribution characteristics of the degree of coordination of the coupling of cultural industry and tourism industry in each city of Province A.

The kernel density distribution of the coupling coordination degree of cultural industry and tourism industry is shown in Figure 4. During the study period, some changes occurred in the wave peak and shape of the kernel density curve of the coupling coordination degree of the cultural and tourism industries in various cities in Province A. Specifically: compared with 2016, the main wave peak in

the kernel density curve in 2018 showed a tendency to move to the right, the value of the main peak declined, and the width of the main peak had a slightly larger trend. This indicates that the integration level of the cultural and tourism industries in Province A has increased, while the gap between the coupling coordination degree between cities has widened. Compared with 2018, the main and secondary peaks in the kernel density distribution map in 2020 are increasingly obvious. Both peaks appear to be flattened to the right, and the height of the primary and secondary peaks is increasing, while the width is gradually narrowing. Although it can be shown that both medium coupling coordination and high quality coupling coordination have increased, the pattern of "main and right side peaks" also indicates that there is a certain degree of differentiation between the cities in province A, in which the number of cities at the level of medium coupling coordination is higher, and the number of cities at the level of high quality coupling coordination is lower. At the same time, the distance between the primary and secondary wave peaks shows a gradually increasing trend, indicating that the "polarization" of the cultural industry and tourism industry in each city of Province A is becoming more and more significant. Compared to 2020, the main peak of the kernel density curve in 2023 shifted to the left, the width of the main peak widened, and the value of the side peaks dropped. During this study period, the phenomenon of internal grading has become more apparent, and further improvement is needed in the coupling and coordination of the cultural and tourism systems.

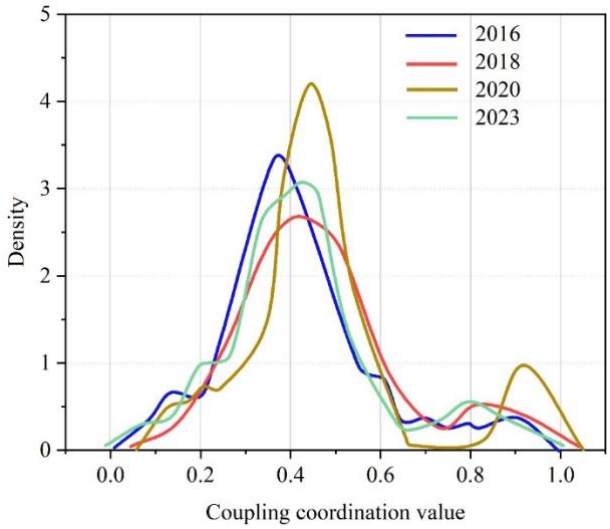

Figure 4. The distribution of coupling coordination of wen brigade industry

3.3 Analysis of the relative degree of development of the regional tourism industry and the cultural industryρ

This paper outlines the tourism and cultural industries, as well as the degree of coordination CV in four areas of province A. The coupling degree C is used to illustrate is the degree of close relationship between the industries, while the coupling coordination degree CV is used to illustrate the index value of the coupling coordination level between the industrial systems, and can not effectively illustrate the relative development level between the two industries. Therefore, this paper takes the ratio between the comprehensive development level of tourism industry and the comprehensive development level of culture industry in different years as a tool to measure the relative development level of the two, assuming that this ratio is ρ, then there is:

$$\rho = \frac{F(x)}{G(x)} \tag{13}$$

In the formula, ρ is the relative development degree between the development of the two industries, $\rho > 0$; $F(x)$ is the comprehensive development level of the tourism industry; $G(x)$ is the development level of the cultural industry.

When $\rho \in (0, 0.9)$, $F(x) < G(x)$, at this time for the type of tourism industry development lag, indicating that relative to the level of comprehensive development of the cultural industry, the level of comprehensive development of the tourism industry is relatively lagging.

When $\rho \in (0.9, 1.1)$, this is the type of synchronous development of tourism and cultural industry, the comprehensive development level of tourism industry and the comprehensive development level of cultural industry exists synchronization.

When $\rho \in (1.1, +\infty)$, $F(x) > G(x)$, at this time is the type of lagging development of the cultural industry, indicating that relative to the comprehensive development level of the tourism industry, the comprehensive development level of the cultural industry is relatively lagging.

The relative degree of development of tourism industry and cultural industry in the regions of Province A from 2016 to 2023 is shown in Table 4, and the change process of the ρ value of the degree of development of tourism industry and cultural industry in the four regions is shown in Figure 5. It can be found that during the eight years from 2016 to 2023, according to the ratio of F/G, in general, the relative degree of development of the tourism and cultural industries in the four regions of "City A, City B, City C, and City D" show fluctuating development. In general, the relative degree of development of tourism and cultural industries in the four regions of "City A, City B, City C and City D" shows a fluctuating development, basically following the line of "lagging in tourism → lagging in culture → synchronized development" with a progressive trend. In particular, from 2020 to 2023, the ρ of the four regions gradually fluctuates around 1, and it can be clearly seen that the frequency of cultural lag is significantly higher than the frequency of tourism lag and synchronized development. For City A, the speed of its development is rapid during the four years from 2016 to 2019, until 2020 when it starts to slow down and begins to show a good synchronized development with the level of development of the cultural industry. For City D, the relative level of development of its tourism and cultural industries compared to the level of development of the cultural industry peaks at three points in time: 2018, 2020 and 2022. For City C, the relative level of tourism industry development peaks in 2020. Compared with the other three regions, the relative level of tourism and cultural industry development in City B begins to rise slowly in 2016 and remains stable between 2021 and 2023, with its ρ-value fluctuating up and down around 1, indicating that City B's tourism industry and cultural industry basically achieve the level of synchronized development in this period.

Table 4. Relative degree of tourism industry and cultural industry

Year	Relative degree of industrial development			
	City A	City B	City C	City D
2016	Tourist lag	Tourist lag	Tourist lag	Tourist lag
2017	Tourist lag	Synchronous development	Tourist lag	Tourist lag
2018	Culture lag	Culture lag	Culture lag	Synchronous development
2019	Culture lag	Culture lag	Culture lag	Synchronous development
2020	Synchronous development	Culture lag	Synchronous development	Culture lag
2021	Synchronous development	Synchronous development	Synchronous development	Culture lag
2022	Culture lag	Synchronous development	Culture lag	Culture lag
2023	Synchronous development	Culture lag	Synchronous development	Synchronous development

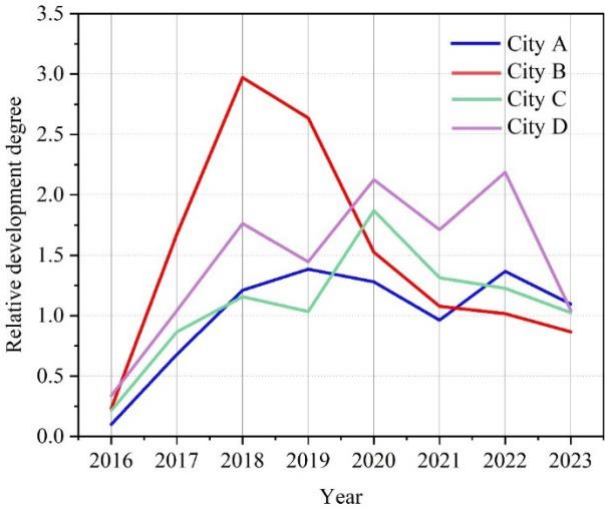

Figure 5. Changes in the development degree of wen brigade industry in 4 regions

4 Conclusion

In this paper, after excavating the power mechanism of the deep integration of cultural industry and tourism entrepreneurship, the entropy value method was used to construct a coupling coordination degree model based on the deep integration of cultural industry and tourism industry, and a research was carried out on the development path of the integration of culture and tourism industry in Province A. The results show that:

1) The overall development of the two industries during 2016-2023 maintains a steady upward trend, but the comprehensive development level of the cultural industry is higher than that of the tourism industry, but its development is still unbalanced and unsynchronized. In terms of coupling degree, the value of the coupling degree between the cultural industry and the tourism industry during 2016-2023 is at a high level, with an average value of 0.96168, indicating that the degree of correlation between the development of the cultural industry and the tourism industry is high. In terms of coupling coordination degree, the coupling coordination degree of culture industry and tourism industry during 2016-2023 shows a rising trend year by year, but the overall level is low, the annual average value is only 0.23348, and when it reaches the highest in 2023, it will be only 0.3656. The cultural industry and tourism industry in A province were seriously unbalanced from 2016 to 2019, severely unbalanced from 2020 to 2021, and slightly unbalanced from 2018 to 2019.

2) The “polarization” of the cultural industry and tourism industry in each city of province A is becoming more and more obvious, the internal grading phenomenon is more obvious, and the coupling and coordinated development of the cultural system and the tourism system needs to be further improved. However, during the period of 2016-2023, although the coordination level of the tourism and cultural industries in the four cities is not stable enough, their coupling coordination level is moving towards high-quality coordination.

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