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Article

Economic Effect and Quantitative Modeling of the Integration of Cultural Industry and Tourism Industry under the Conditions of Digital Economy

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Abstract: In the context of the rapid development of digital economy, the deep integration of cultural industry and tourism industry has become an important engine to promote the high-quality development of the economy. This paper constructs an evaluation index system for the development of cultural industry and tourism industry based on the panel data of 31 provincial-level administrative regions in China from 2015 to 2024. The coupling coordination degree model is used to quantify the integration level of the two, combined with the spatial econometric model to analyze their economic effects and influencing factors. During the period of 2015-2024, the coupling coordination degree of China's cultural and tourism integration shows an overall upward trend, but is subject to the epidemic impact showing phased fluctuations. Spatially, the level of cultural and tourism integration shows the clustering characteristic of “East high, West low”. The spatial spillover effect of the integrated development of culture and tourism significantly reduces the income gap between urban and rural areas, and the direct and indirect effects both converge negatively, with coefficients of -0.1863 and -0.0756 respectively.

Keywords: cultural industry; tourism industry; industrial integration; coupled coordination model; spatial measurement model

1. Introduction

With the rise in consumption levels and the diversification of social demands, the deep integration of the cultural industry and the tourism industry—two key service sectors—has become a critical pathway to enhancing economic competitiveness [1]. The cultural industry, which centers on creativity and cultural content, aims to promote the diversity and richness of social culture [2-3]. The tourism industry, meanwhile, leverages its unique spatial and experiential characteristics to meet people’s diverse needs for leisure, vacation, and cultural experiences [4-5]. The tourism industry and the cultural industry share inherent complementary characteristics, mutual benefits, and external factors that drive their integration. Strengthening the deep integration of the two industries can help meet tourists' spiritual needs while accelerating the development of the cultural industry and promoting the optimization and upgrading of the tourism industry [6-9]. According to industry integration theory, cross-industry integration can effectively optimize resource allocation and create new market demands and development opportunities [10-11]. Therefore, promoting the deep integration of the cultural industry and the tourism industry can help optimize and upgrade the local economic structure while also promoting the comprehensive development of the regional economy [12-13]. Additionally, by studying the economic benefits and evaluation methods of the integrated development of the cultural industry and the tourism industry, we can not only enrich the connotation, extension, and theoretical foundation of their integrated development but also help explain the basis and inevitability of their integration from a theoretical perspective [14-17].

Numerous scholars have pointed out that the integration of the cultural industry and the tourism

industry is inevitable for regional economic development. Kalvet, T. et al. have shown that data analysis results on the impact of cultural tourism not only demonstrate the numerous values of cultural heritage for regional tourism, but also play an important role in policy planning, implementation, and evaluation. Therefore, it is necessary to use innovative tools and data to conduct an assessment of the benefits of cultural tourism [18]. Gómez-Zapata, J. D. et al. pointed out that the value of cultural heritage tourism ecosystems is a driving factor in tourism appeal, so implementing economic valuation of cultural tourism integration industries will help manage and protect regional ecological culture and brand strategies [19]. Torre, A. and Scarborough, H. used expenditure multipliers and cost-benefit analysis (CBA) to assess the economic benefits of cultural tourism activities in a certain area, parameterizing the benefit function to achieve accurate assessment under conditions of limited data [20]. Liu, G. and Chen, J. S. constructed a model of interest group development conflicts in the cultural tourism integration industry, which accurately analyzes the asset returns and investment ratios of cultural tourism managers and participants, thereby promoting the sustainable development of cultural tourism [21]. Zhang, R. et al. established a comprehensive evaluation model for the sustainable development of regional tourism economies based on the analytic hierarchy process. Given the stable and rapid growth of urban nighttime tourism economies characterized by cultural immersion, this comprehensive evaluation structure provides important reference value for the development of urban cultural tourism economies [22]. Zeng, M. et al. found that the integration of the cultural industry and the tourism industry based on Internet communication technology can enhance the added value of the tourism value chain and further strengthen the agglomeration effect of regional tourism activities. However, this regulatory effect has certain thresholds, and it is necessary to design corresponding measurement models to analyze its impact mechanism [23]. Therefore, establishing relevant economic benefit evaluation standards is a key means of measuring the integration standards and integration stages of the regional cultural tourism industry, which is of great significance.

In this paper, we first construct a three-dimensional development evaluation index system containing resource base, service team, and industrial effect, and quantify the integration level of China's culture and tourism industry from 2015 to 2024 by using the coupled coordination degree model. The spatial correlation test identifies the spatial agglomeration pattern of the integration of culture and tourism industries, and analyzes its economic effect by combining with the spatial econometric model. Decompose the direct and indirect effects through the spatial Durbin model, and explore the influence mechanism of key factors such as financial investment, human capital, and infrastructure on the integration of culture and tourism.

2. Empirical Research on the Coupling and Coordination of Cultural Industry and Tourism Industry

As the core driving force of global economic growth, digital economy is profoundly reshaping the development pattern of culture and tourism industry. On the one hand, digital technology breaks through the time and space limitations of the traditional culture and tourism industry, and promotes resource integration, product innovation and service upgrading; on the other hand, the intrinsic correlation between the culture industry and the tourism industry is further strengthened under the catalytic effect of the digital economy, and the in-depth fusion of the two has become a key path to cultivate new productivity and promote the coordinated development of the regional economy.

In this paper, 31 provincial-level administrative regions from 2015 to 2024 are selected as samples for the study, and the data are mainly from China Statistical Yearbook, China Cultural Relics and Tourism Statistical Yearbook, and statistical bulletins of national economic and social development of each region, etc. The interpolation method is used to make up for the individual missing values.

2.1. Construction of Evaluation Index System for the Development of Cultural Industry and Tourism Industry

Following the principles of scientific, systematic and reachability, this paper selects a total of 17 evaluation indicators from 3 dimensions to measure the development level of China's cultural and tourism industries, and the evaluation indicator system is shown in Table 1. Resource base is the foundation for the development of culture and tourism industry, service team is the intellectual guarantee and service base for the functioning of culture and tourism industry, and industry effect is an important aspect reflecting the scale and output level of culture and tourism industry.

Table 1. Development evaluation index system.

Target layer	Factor layer	Indicator layer	Unit
Cultural industry system	Resource basis	The number of libraries	Piece
		The number of museums	Piece
		The number of mass cultural institutions	Piece
		The number of art performance groups	Piece
	Service team	Practitioners in the cultural and related industries	Ten thousand people
	Industrial effect	Art performance sessions	Time
		Audience of art performance groups	Ten thousand people
		Fixed asset investment in culture and related industries	Ten thousand yuan
Tourism industry system	Resource basis	The number of travel agencies	Piece
		Number of star-rated hotels	Piece
		The number of A-level tourist attractions	Piece
	Service team	Accommodation and catering industry practitioners	Ten thousand people
	Industrial effect	Domestic tourist visits	Ten thousand people
		Number of inbound tourists	Ten thousand people
		Domestic tourism revenue	Billion yuan
		Tourism foreign exchange earnings	Ten thousand dollars
		Business turnover of accommodation and catering services above the designated size	Ten thousand yuan

2.2. Measurement Model Construction of the Integration Level of Cultural Industry and Tourism Industry

The development level score of China's cultural industry and tourism industry is obtained by multiplying and summing each year's dimensionless processed data with its corresponding weight:

$$U_i = \sum_{j=1}^{n} \omega_j \times x'_{ij} \tag{1}$$

where U_i is the evaluation index of the comprehensive development level of China's culture and tourism industry in the ith year, ω_j is the weight of the ith indicator, and x'_{ij} is the data after the dimensionless processing.

The coupling coordination degree model is an important method in the field of physics to study the degree of synergistic development among multiple systems, and is now widely used in economic and social fields. There is a natural coupling relationship between the culture and tourism industries, so this study adopts this model to quantify the level of integration between China's culture and tourism industry systems, and its multi-system coupling model is as follows:

$$C_n = \left[(u_1 * u_2 * \ldots u_n) / \Pi(u_i + u_j) \right]^{1/n} \quad (2)$$

Based on the previous formula, the coupling degree model of the binary system of culture and tourism can be constructed:

$$C_2 = \left\{ (u_1 \times u_2) / \left[(u_1 + u_2) \times (u_1 + u_2) \right] \right\}^{1/2} \quad (3)$$

where C_2 represents the coupling degree index; u_1 and u_2 denote the evaluation indexes of the cultural industry system and the tourism industry system. When the development level of both systems is at a low level, the level of coupling degree shows a high level. Since the coupling degree better reflects the degree of mutual influence between systems or elements, but cannot accurately measure the level of integration and development between systems with coupling relationship, the coupling coordination degree model is further introduced to objectively reflect the integration relationship between culture and tourism industries, i.e.:

$$D = (C \times T)^{1/2} \quad (4)$$

$$T = \alpha u_1 + \beta u_2 \quad (5)$$

where D is the coordination index; T is the sum of the evaluation indexes of the cultural industry system and the tourism industry system; α and β are the coefficients to be determined to reflect the relationship between the two and $\alpha + \beta = 1$, this study considers that the cultural and tourism industries are equally important for the development of the Yellow River Basin, so α and β are assigned to 0.5, so $T = 0.5u_1 + 0.5u_2$.

2.3. Measurement Results

Using SPSS and excel software, the original data found in each statistical yearbook were substituted into the model to obtain the measurement results of each index. Specifically, it contains: the comprehensive development level of China's tourism industry (U1), the comprehensive development level of China's cultural industry (U2), as well as the synchronization (P), coupling (C), coupling coordination (D), coordination index (T), synchronization type, and coupling type of the two major systems, and the results of the measurement are summarized as shown in Table 2. It can be seen that in 2015~2018, China's cultural and tourism development belongs to the cultural lag type, and reaches the synchronous development in 2019. 2020~2022 by the impact of the epidemic, China's cultural and tourism development turns to the tourism lag type, until after 2023, it resumes the state of synchronous development again.

Table 2. Summary of Calculation Results.

Year	U_1	U_2	C	T	D	Coordination level	P	Coupling coordination degree	Type
2015	0.3075	0.2199	0.9867	0.2637	0.5102	6	0.68	Barely coordinated	Cultural lag type
2016	0.3882	0.2846	0.9880	0.3364	0.5765	6	0.69	Barely coordinated	Cultural lag type
2017	0.4536	0.3289	0.9876	0.3913	0.6217	7	0.74	Primary coordination	Cultural lag type
2018	0.5521	0.4019	0.9876	0.4770	0.6863	7	0.85	Primary coordination	Cultural lag type
2019	0.5838	0.5718	1.000	0.5778	0.7599	8	0.91	Intermediate coordination	Synchronous development type
2020	0.3929	0.4829	0.9952	0.4379	0.6603	7	1.16	Primary coordination	Tourism lag type
2021	0.3211	0.4905	0.9780	0.4058	0.6293	7	2.07	Primary coordination	Tourism lag type
2022	0.4175	0.5003	0.9960	0.4589	0.6760	7	1.05	Primary	Tourism lag type

								coordination	
2023	0.5264	0.5194	1.000	0.5229	0.7231	8	0.96	Intermediate coordination	Synchronous development type
2024	0.5018	0.5022	1.000	0.5020	0.7085	8	0.99	Intermediate coordination	Synchronous development type

2.4. Analysis of Measurement Results

2.4.1. Analysis of the Comprehensive Development Level of the Cultural Industry and Tourism Industry

Analyzing the comprehensive development level of the cultural industry and tourism industry is conducive to clarifying the development status of China's cultural industry and tourism industry. Therefore, it is particularly important to analyze the comprehensive development level of the two industries, and this paper measures the comprehensive level of the development of the two industries through the calculation of relevant data indicators in China from 2015 to 2024, and compares the data between different years, and the specific results are shown in Figure 1.

From the systematic evaluation value of the tourism industry, it can be seen that the development level of China's tourism industry from 2015 to 2019 is in a steadily rising trend, which also reflects the steady and rising development trend of China's tourism industry. 2015 was the lowest value of 0.3075 in the calendar year, and the highest value appeared in 2019, reaching 0.5838. The tourism industry, since 2015's primary stage, has successfully transformed and upgraded to the middle level development stage in 2019. However, subsequently affected by the epidemic, the development of the tourism system in 2020 was hindered and declined at a faster rate. As can be seen from the evaluation value of the cultural industry system, the comprehensive development level of China's cultural industry from 2015 to 2019 has been substantially improved, and the growth rate is faster. 0.2199 in 2015 and 0.5718 in 2019, but its overall level is still low due to the low starting point. Affected by the epidemic, it declined significantly in 2020.

By comparing the comprehensive development level between the two industries, the comprehensive development level of the tourism industry is higher than the comprehensive development level of the cultural industry before 2019, but it almost overlaps in 2019. After 2020 the comprehensive development level of the culture industry exceeds the comprehensive development level of the tourism industry and there is a new intersection of the two folds in 2023.

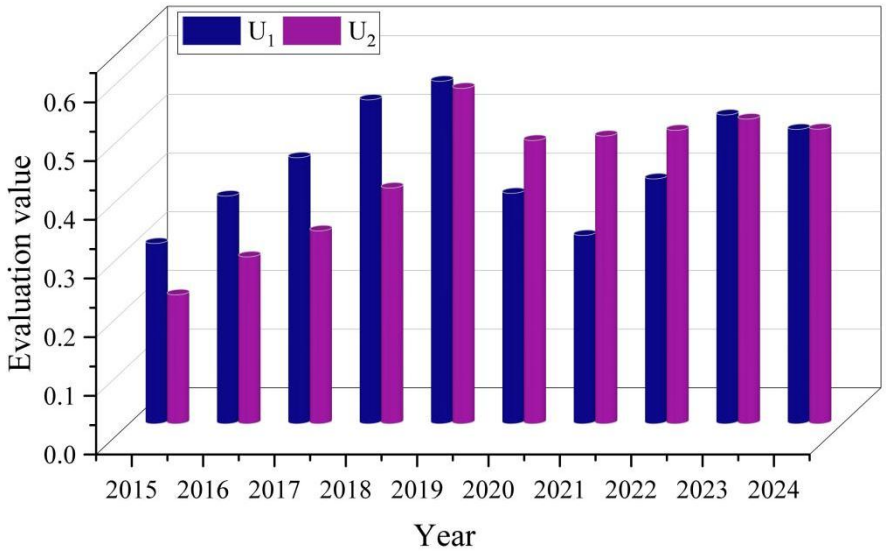

Figure 1. Comprehensive development level of cultural industry and tourism industry.

2.4.2. Analysis of the Degree of Coupling and Coordination between Cultural Industry and Tourism Industry

Analyzing the coupling and coordination degree between culture industry and tourism industry is of great research significance for the common progress of the two. The coupling relationship between the

two can be explored from the coupling degree (C), and the coupling coordination degree (D). Firstly, analyzing the value of coupling coordination degree of culture industry and tourism industry can determine whether there is an interaction relationship between them. Second, the degree of coupling coordination is an important criterion to measure the consistency of the development of China's cultural industry and tourism industry. If the consistency of the two systems is weak, it will seriously affect their joint development. In order to more clearly and accurately obtain the coupled and coordinated development status between China's cultural industry and tourism industry, the specific research results are shown in Figure 2.

During 2015-2024, the overall fluctuation of the coupling degree between China's cultural industry and tourism industry is small, and the extreme difference is not obvious, and the coupling degree between the cultural industry and tourism industry tends to be stable as a whole, and the values of the coupling degree are all above 0.9. The coupling and coordination degree of the cultural industry and the tourism industry is in a rising trend from 2015-2024, and the development is in the state of medium coordination until 2019. However, it shows a decreasing trend from 2020 to 2021, until it rebounds in 2022, and resumes the medium coordination level after 2023.

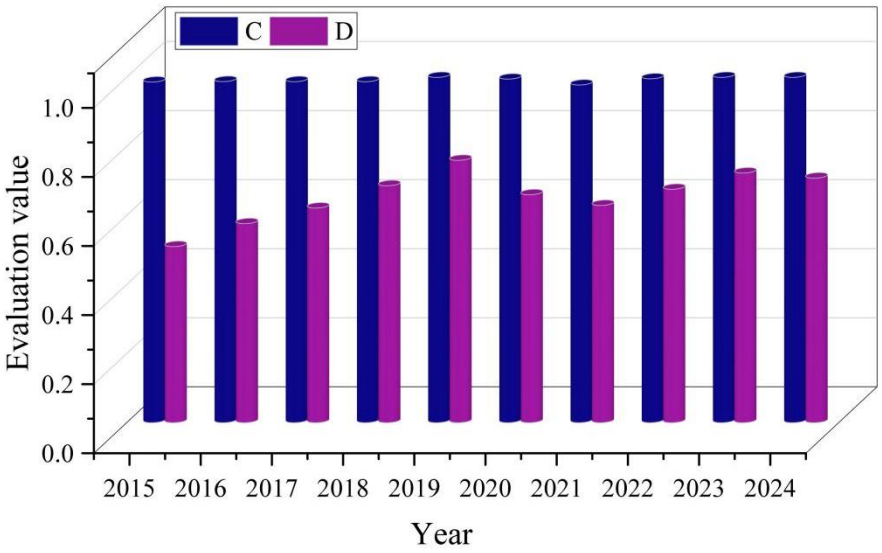

Figure 2. Coupling degree and coupling coordination degree.

3. Analysis of the Economic Effect of the Integration of Cultural Industry and Tourism Industry under the Conditions of Digital Economy

3.1. Spatial Correlation Test

3.1.1. Spatial Weighting Matrices

Conducting spatial correlation tests first requires constructing a spatial weight matrix to measure the spatial distance of the research object. Here, based on the actual situation of the study and to enhance the robustness of the results, the economic-geographical nested matrix and the economic distance matrix are selected to analyze the spatial effect of digitalization on the integrated development of culture and tourism in China.

(1) Economic-geographic nested matrix

With the development of digitalization, digital technology has been widely used, telecommuting, online transactions and other ways to make the impact of geographic distance on economic activities is weakening, the traditional geographic weighting matrix focuses more on the actual geographic distance, the economic geographic nesting matrix also takes into account the characteristics of economic activities in the era of digitization, so this paper adopts the economic geographic nesting matrix. The specific formula is as follows:

$$w_{ij} = \begin{cases} \frac{1}{2}\frac{1}{d_{ij}} + \frac{1}{2}\frac{1}{\left|GDP_i - GDP_j\right|}, & i \neq j \\ 0, & i = j \end{cases} \tag{6}$$

where d_{ij} denotes the spherical distance derived from the latitude and longitude of province i and province j, and GDP_i and GDP_j denote the per capita gross regional product of province i and province j, respectively.

(2) Economic distance matrix

The economic distance matrix is based on the gap of economic development as a distance indicator, the specific formula is as follows:

$$w_{ij} = \begin{cases} \dfrac{1}{\left|GDP_i - GDP_j\right|}, & i \neq j \\ 0, & i = j \end{cases} \tag{7}$$

where GDP_i and GDP_j denote the per capita gross regional product of province i and province j, respectively.

3.1.2. Global Spatial Autocorrelation Test

The global autocorrelation model can determine the spatial correlation of the relevant variables, and the economic-geographical nested matrix is used to calculate the Moran's I index of the digitization level and the development level of cultural-tourism integration of the 31 provincial-level administrative regions in China from 2015-2024 to analyze the global spatial correlation of the two. The specific formulas are as follows:

$$\text{Global } Moran's\ I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \bar{X})(x_j - \bar{X})}{S^2 \sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \tag{8}$$

where n is the number of provinces studied, $S^2 = \dfrac{\sum_{i=1}^{n}(x_i - \bar{X})}{n}$ is the sample variance, X_i and X_j are the study variables associated with province i and province j, and w_{ij} is the space weight matrix. The value of Moran index is between $[0,1]$, greater than 0 means positive correlation, less than 0 means negative correlation, the closer to ± 1, the stronger the spatial correlation; if it is equal to 0, it means there is no obvious spatial correlation.

In this paper, using stata17.0 software, the global autocorrelation test is carried out on the level of cultural tourism integration and digitalization in China respectively, and the results of the Moran index test are shown in Table 3. From the global autocorrelation test results, it can be seen that the p-value of each year in the study period is less than 0.05, rejecting the original hypothesis, indicating that the level of cultural and tourism integration development and the level of digitization have significant spatial clustering characteristics in the study period, and the Moran's I indexes are greater than 0, which indicates that the level of cultural and tourism integration development and the level of digitization show positive spatial correlation, and it is suitable for the use of spatial econometric modeling to analyze the The relationship between the two.

Table 3. Global Moran's I indices of Cover and Dig.

Year	Cover			Dig		
	Moran's I	z value	p value	Moran's I	z value	p value
2015	0.081	2.084	0.018	0.083	2.197	0.009
2016	0.070	2.011	0.029	0.080	2.083	0.018
2017	0.073	2.063	0.022	0.085	2.287	0.012
2018	0.062	1.568	0.028	0.082	2.255	0.015
2019	0.057	1.472	0.037	0.090	2.464	0.007
2020	0.068	1.793	0.029	0.086	2.587	0.011

2021	0.081	2.019	0.016	0.089	2.596	0.008
2022	0.085	2.278	0.022	0.087	2.578	0.006
2023	0.084	2.186	0.019	0.088	2.591	0.009
2024	0.082	2.084	0.021	0.089	2.584	0.005

3.1.3. Local Spatial Autocorrelation Test

In order to further study the polarized development characteristics of spatial agglomeration of provinces, conduct local spatial autocorrelation test, in order to visualize the development of local spatial correlation, here we take 2015 and 2024 as an example, and number the 31 provinces as A1~A31, and the results of their local Moran's I index for the level of development of cultural and tourism integration are shown in Figure 3.

The first quadrant is the “high high” agglomeration type, mainly distributed in the eastern coast of the Yangtze River Delta and Pearl River Delta, which are the most economically developed and active regions in China, and therefore form a high value agglomeration of the level of cultural and tourism integration. The reason may be that the eastern region has a natural advantage in terms of cultural and tourism resources with rich tourism resources and huge market demand, which provides a broad space for cultural and tourism integration.

The second quadrant is the “low-high” agglomeration type, which is mainly distributed in the central and western regions, and the cultural and tourism industries in these regions may have deficiencies in resource integration, product development, marketing, etc., which make it difficult to form effective cooperation and linkage with neighboring high-value regions. At the same time, due to the more mature development of the cultural tourism industry in neighboring high-value regions, a large number of capital, talents and other factors are attracted to gather, which puts the central and western regions, which were relatively backward, in an even more unfavorable position in the competition of factors. This siphon effect further exacerbates the difficulty of the deep integration of cultural tourism development in these regions.

The third quadrant is the “low-low” agglomeration type, dominated by the western and some northeastern regions. Among them, Qinghai, Gansu, Ningxia, Xinjiang and other regions have magnificent natural scenery, profound cultural heritage and unique ethnic customs, and are endowed with unique tourism resources, but the backwardness of transportation and communication infrastructure largely affects the experience of tourists and the effective development of cultural and tourism resources, resulting in a low level of cultural and tourism integration. The government and enterprises should increase investment, accelerate infrastructure construction, improve transportation, communication and other public services to provide effective support for the development of culture and tourism industry.

The fourth quadrant is the “high and low” agglomeration type, these areas show unique advantages in the process of cultural and tourism integration and development, on the one hand, they have rich cultural and tourism resources, which lay the foundation for the development of cultural and tourism industry, and they also have huge market demand, which provides a strong impetus for the sustainable development of cultural and tourism industry, such as Henan, Shaanxi, Yunnan and other provinces. On the other hand, backed by developed economic circles, such as Sichuan Province in the Chengdu-Chongqing Economic Circle, Shandong Province, the three major economic circles, which provides a broad market as well as more opportunities for development, so in the process of the development of cultural and tourism integration, and gradually to the surrounding areas of the cultural and tourism resources elements of the siphon effect, inhibit the development of neighboring provinces, and exacerbate the imbalance between the region.

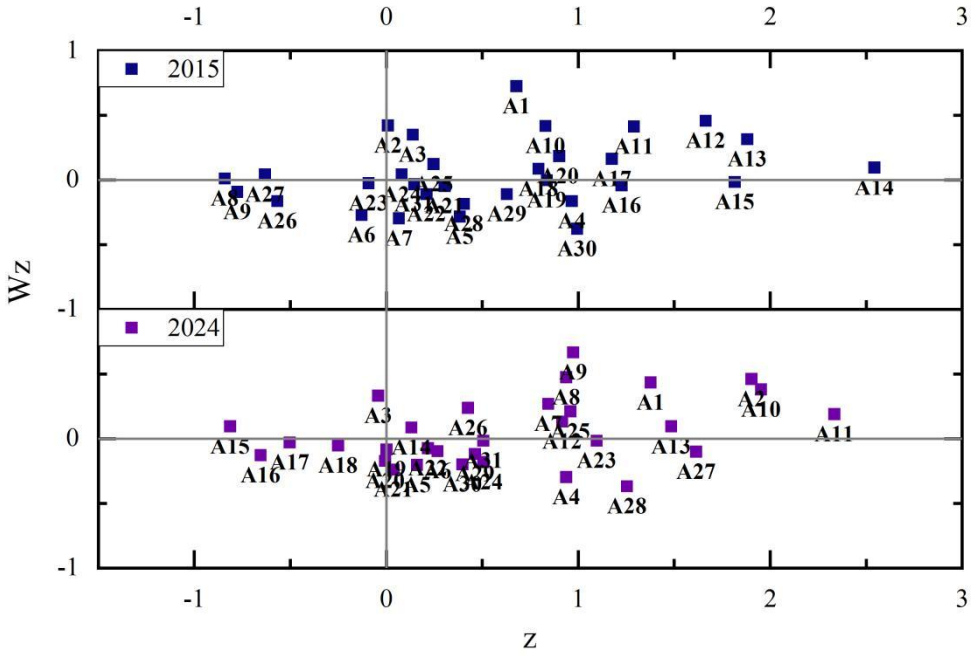

Figure 3. Local Moran's I index results.

3.2. Classification of Spatial Measurement Models

Spatial lag and autocorrelation errors should be incorporated in the model, and the type of spatial dependence in the statistical model should be determined based on the LM test. In panel data analysis, SLM, SEM and SDM form the basis of spatial econometric models.The SLM model exhibits interactions between spatial variables, the SEM model assumes that these effects originate from random perturbations, and the SDM model combines these two effects.

$$y_{it} = \rho_1 \sum_{j=1}^{N} w_{ij} y_{ij} + \beta x_{it} + \delta cont_{it} + \mu_i + \varepsilon_{it} \tag{9}$$

Eq. (10) is a spatial lag model whose core parameter ρ is the spatial autoregressive coefficient, where w_{ij} is an element in the spatial weight matrix W. $\rho_1 \sum_{j=1}^{N} w_{ij} y_{ij}$ reflects the spatial interactions of industries between neighboring regions, and when $\rho > 0$, it indicates that the industrial integration of the neighboring regions has a spillover effect; If $\rho < 0$, it means that there is a siphon effect in the industrial integration of neighboring regions, i.e., the industrial development of one region may suck away the resources and opportunities of other regions, leading to the inhibition of the development of these regions. x_{it} denotes the agglomeration location of the cultural and tourism industries, $cont_{it}$ is the set of control variables, and δ is the coefficient of the impact of these control variables on industrial integration; in addition, the model includes the spatial effect of μ_i and the error term of ε_{it} to ensure that unobserved factors in the model are Controls.

$$y_{it} = \beta x_{it} + \delta cont_{it} + \mu_i + \varepsilon_{it} \tag{10}$$

$$\varepsilon_{it} = \lambda \sum_{j=1}^{N} w_{ij} \varepsilon_{it} + v_{tt} \tag{11}$$

Eq. (11) is the spatial error model, w_{ij} is the element in the spatial weight matrix W, and ε_{it} affects the surrounding areas through shocks. λ is the spatial error correlation coefficient, which measures the spatial dependence of variable observations hidden in the perturbation error term, the degree of influence of error shocks from industrial integration in neighboring regions on local industrial integration, $\lambda > 0$, indicating that the shock is positive, and the error shocks from industrial integration in neighboring

regions lead to inter-regional spillovers of the components; on the contrary, $\lambda < 0$, indicating that the shock is negative and the error shock in neighboring regions' industry writing statistics bureau leads to inter-regional siphoning component. $cont_{it}$ is the set of control variables, and δ is the coefficient of the local set of control variables on convergence.

$$y_{it} = \rho_1 \sum_{j=1}^{N} w_{ij} y_{it} + \beta x_{it} + \gamma \sum_{j=1}^{N} w_{ij} x_{it} + \delta cont_{it} + \kappa \sum_{j=1}^{N} w_{ij} cont_{it} + \mu_i + \varepsilon_{it} \quad (12)$$

Eq. (12) is the spatial Durbin model, γ is the spatial autoregressive coefficient of the independent variables, $\gamma > 0$, indicating that the local explanatory variables have a positive spillover effect on the neighboring regions; on the contrary, $\gamma < 0$, indicating that the local explanatory variables have a negative one-place effect on the neighboring regions to produce siphoning effect. w_{ij} is the element in the spatial weight matrix W, β and γ are the regression coefficients of the explanatory variables with the spatial interaction effects of the explanatory variables, δ is the coefficient of the local set of control variables on the convergence, and κ is the coefficient of the set of control variables in the neighboring region on the convergence of this region. Impact.

3.3. Analysis of the Impact Effect of the Integrated Development of Culture and Tourism Industry in Narrowing the Urban-Rural Income Gap

3.3.1. Regression Results

The urban-rural income gap (Gap) is used as an explanatory variable, and the urban-rural income gap is measured with the help of the Thiel index. The level of integrated development of culture and tourism industry (Tour) is taken as the explanatory variable, and transportation infrastructure (Trans), financial development level (Fina), industrial structure upgrading (Struc), and education development level (Edu) are selected as the control variables. The spatial Durbin model under random effect is chosen to measure the spatial spillover effect of the integrated development of culture and tourism industry on the urban-rural income gap. In order to avoid the homogeneity of the empirical results, the spatial error model, spatial lag model and spatial Durbin model based on the neighbor weight matrix are regressed, and the specific regression results are shown in Table 4. The spatial autoregressive coefficients under the spatial error model, spatial lag model and spatial Durbin model are 0.2058, 0.3087 and 0.3974 respectively, and all of them pass the 1% significance test. It further verifies that China's urban-rural income gap has significant spatial autocorrelation, and the selection of spatial econometric model is reasonable. At the same time, it indicates that China's urban-rural income gap has a significant positive spillover effect. In addition, the influence coefficient and spatial interaction term coefficient of Chinese tourism industry integration development in the spatial Durbin model are negative but do not pass the significance test. Therefore, this paper chooses the spatial lag model based on time fixed effects for subsequent empirical analysis.

Table 4. Empirical regression results of spatial panel model.

Variable	SEM	SLM	SDM
Con	-0.1375***	-0.1537***	-0.0397
	(0.0228)	(0.0298)	(0.0586)
Trans	-0.1364***	-0.1175***	-0.0209
	(0.0275)	(0.0254)	(0.0635)
Fina	0.0201**	0.0211*	0.0294
	(0.0183)	(0.0137)	(0.0287)
Struc	-0.0112	-0.0186	0.0186

	(0.0135)	(0.0147)	(0.0102)
LnEdu	0.1186*** (0.0337)	0.1270*** (0.0325)	-0.0587 (0.0406)
W*Con	/	/	-0.0839 (0.0845)
W*Trans	/	/	-0.3018 (0.2017)
W*Fina	/	/	0.0068 (0.0415)
W*Struc	/	/	0.0044 (0.0206)
W*LnEdu	/	/	0.2018*** (0.0739)
Rho	0.2058** (0.1196)	0.3087*** (0.0904)	0.3974*** (0.0648)
Sigma2_e	0.0015*** (0.0000)	0.0011*** (0.0001)	0.0004*** (0.0000)
Observed value	508	508	508

3.3.2. Decomposition of Spatial Effects

Although the spatial autoregressive coefficient can reveal the trend of the role of cultural and tourism industry integration development on the urban-rural income gap and its statistical significance, it cannot accurately reflect the specific effects between variables. Therefore, by applying the partial differentiation method to decompose the spatial effects, the direct effect, indirect effect, and overall effect of cultural and tourism industry integration can be calculated. The results of the decomposition of spatial spillover effects are shown in Table 5. The direct effect refers to the impact of the development of cultural and tourism industry integration in the region on the urban-rural income gap in the region, the indirect effect refers to the impact of the development of cultural and tourism industry integration in the region on the urban-rural income gap in the neighboring regions, and the total effect is the sum of the direct and indirect effects, i.e., all the impacts of the development of cultural and tourism industry integration on the impact of the urban-rural income gap in the region and in other regions.

Through the spatial effect decomposition of the spatial lag model, it is found that the direct effect indirect effect and total effect of the integrated development of cultural and tourism industry are negative and passed the significance test, that is, the integrated development of cultural and tourism industry has spatial spillover effect in narrowing the urban-rural income gap. The integrated development of culture and tourism industry in this region can not only reduce the urban-rural income gap in this region, but also have a convergent effect on the urban-rural income gap in neighboring regions. The direct and indirect effects of the integrated development of cultural and tourism industries on the urban-rural income gap are -0.1863 and -0.0756, which pass the significance test at the 1% and 5% levels, respectively, indicating that every 1% increase in the level of the integrated development of cultural and tourism industries will contribute to the narrowing of the urban-rural income gap between the local and neighboring regions by -0.1863% and -0.0756%.

Table 5. Spatial spillover effect decomposition results.

Variable	Direct effect	Indirect effect	Total effect
Con	-0.1863*** (0.0426)	-0.0756** (0.0385)	-0.2619*** (0.0711)
Trans	-1375***	-0.0636***	-0.2011***

	(0.0186)	(0.0248)	(0.0305)
Fina	0.0211** (0.0103)	0.0116 (0.0094)	0.0327*** (0.0192)
Struc	-0.0186 (0.0112)	-0.0092 (0.0073)	-0.0278 (0.0221)
LnEdu	0.1745*** (0.0208)	0.0636*** (0.0318)	0.2381*** (0.0533)

3.4. Analysis of Factors Influencing the Development of Cultural and Tourism Industry Integration

3.4.1. Regression Results

Considering the complexity of the data, the explanatory variables selected in this paper are: general budget expenditure (GOV), manpower input (L), basic input (FND), fixed input (K), and education (EDU), which are all the five indicators that are closely connected with the cultural tourism industry and the bottleneck of the cultural tourism industry coupling. In this paper, the related model will be used to estimate, and the results of spatial Durbin SDM analysis are shown in Table 6.

The time-fixed local influence coefficient and spatial spillover coefficient are greater than individual fixed and time-fixed, so the time-fixed model is chosen for analysis. Under the time-fixed model, the regional correlation of general budget expenditure is 0.271 at the significant level of 0.01, the regional correlation of human capital is 0.042 at the significant level of 0.01, the regional correlation of infrastructure construction is 0.091 at the significant level of 0.01, the regional correlation of investment in fixed assets is 0.096 at the significant level of 0.01, and the regional correlation of education investment has a correlation of 0.099 for the region at the 0.1 level of significance, which is overall more significant than random effects, individual fixed effects, and two-way fixed effects. Next, this paper will compare the direct and indirect perspectives. The direct impact aspect refers to the effect of the evidence-seeking factors on the city itself, and the indirect impact aspect refers to the effect of the evidence-seeking factors on neighboring cities.

Table 6. Spatial Durbin SDM Analysis Results.

VAR	Random effect		Fixed time		Individual fixation		Bidirectional fixation	
	RIC	SSC	RIC	SSC	RIC	SSC	RIC	SSC
LnGov	0.071*** (0.022)	-0.011 (0.029)	0.271*** (0.051)	0.283*** (0.062)	0.056*** (0.021)	0.009 (0.025)	0.045** (0.022)	-0.052* (0.031)
LnL	0.033*** (0.011)	-0.033* (0.021)	0.042*** (0.022)	0.083*** (0.045)	0.031*** (0.002)	-0.031** (0.026)	0.009* (0.012)	0.061*** (0.022)
LnFND	-0.042 (0.032)	0.038 (0.055)	0.091*** (0.033)	-0.010 (0.056)	-0.083** (0.045)	0.082 (0.057)	0.103*** (0.042)	-0.056 (0.052)
K	0.012* (0.009)	-0.001 (0.009)	0.096*** (0.012)	0.007 (0.032)	0.011 (0.007)	-0.003 (0.024)	0.007 (0.009)	-0.018 (0.021)
EDU	0.041* (0.024)	0.092*** (0.033)	0.099* (0.055)	0.196* (0.099)	0.042*** (0.021)	0.095*** (0.033)	0.033** (0.018)	0.042 (0.033)

3.4.2. Decomposition of Spatial Effects

In order to further explain the impacts brought about by the other cities, the partial differential method was used to further decompose the model in the following form:

$$\ln Y_{it} = \alpha_{0t}\tau_n + \rho\sum_{j=1}^{N} W_{ij}\ln Y_{it} + \beta_{it}\ln X_{it} + \theta_{it}\sum_{j=1}^{N} W_{ij}\ln X_{it}\theta + \varepsilon_{it} \tag{13}$$

$$\left(I_n - \rho\sum_{j=1}^{N} W_{ij}\right)\ln Y_{it} = \alpha_{0t}\tau_n + \beta_{tn}\ln X_{it}\rho + \theta_{it}\sum_{j=1}^{N} W_{ij}\ln X_{it} + \varepsilon_{it} \tag{14}$$

$$\ln Y_{it} = \sum_{r=1}^{k}\left[S_r(W_{ij})\ln X_{it}\right] + V(W_{ij})\alpha_{0t}\tau_n + V(W_{ij})\varepsilon_{it} \tag{15}$$

$$\frac{\partial y_i}{\partial x_{jr}} = S_r(W_{ij}) \tag{16}$$

$$\frac{\partial y_i}{\partial x_{ir}} = S_r(W_{ij}) \tag{17}$$

$$S_r(W_{ij}) = V(W_{ij})(I_n\beta_r + W_{ij}\theta_r) \tag{18}$$

$$V(W_{ij}) = (I_n - \rho W_{ij})^{-1} = I_n + \rho W_{ij} + \rho^2 W_{ij}^2 + \cdots \tag{19}$$

Y_{it}, X_{it} denote the explanatory and interpretive variables, respectively; τ_n is the unit matrix; θ_{it} is the weight coefficient; ρ is the influence coefficient; $V(W_{ij})$ is the inverse matrix; W_{ij} is the matrix; r is the number of the justifying factors, β_{it} is the coefficients of the proof factors; ε_{it} is the perturbation factor; I_n is the n-order unit matrix; β_r is the regression coefficient; θ_r is the regression coefficient; α_{0t} is the normality; and $S_r(W_{ij})$ reflects the influence.

The effect decomposition results of the influence factors of the coupled and coordinated development of culture and tourism industry are shown in Table 7. The general budget expenditure is positively related to the level of cultural and tourism industry, and the coefficient of this region is 0.271. In the direct effect, for every one point increase in the general budget expenditure, the level of cultural and tourism industry in this province increases by 0.206 points. It is not significant in the indirect effect.

The coefficient of the positivity between human input and the level of cultural and tourism industry in the region is 0.042. In the direct effect, one point of human capital leads to an increase of 0.041 points in the level of the province. In the indirect effect, the coefficient of human capital is -0.091, which indicates that human capital has a clustering effect, the more the talents gather, the more they are attracted, and the siphoning effect on the neighboring provinces has a negative impact.

The coefficient of infrastructure investment and the level of cultural and tourism industry is positive, and the coefficient of this region is 0.091. In the direct effect, for every point of GDP per capita, the level of this province increases by 0.094 points. In the indirect effect, the coefficient of infrastructure is 0.031, the p-value is not significant, and the spatial diffusion effect is not obvious.

Fixed asset investment is positively related to the level of cultural and tourism industry, and the coefficient of the region is 0.096. In the direct effect, for every one point increase in the whole society's fixed assets, the level of coupling coordination in this province increases by 0.096 points. In the indirect effect, the coefficient of the whole society's fixed assets is 0.053, which indicates that for every point increase in the whole society's fixed assets, the level of coupling coordination for neighboring provinces grows by 0.053 points.

Education expenditure is positively related to the level of cultural and tourism industry, and the coefficient of this region is 0.099. In the direct effect, for every point increase in education expenditure, the level of coupled coordination of this province increases by 0.112 points. In the indirect effect, the coefficient of education expenditure is 0.286, indicating that for every point increase in education investment, the level of coupled coordination for neighboring provinces grows by 0.286 points.

Table 7. Effect Decomposition results of influencing factors.

VAR	RIC	SSC	Direct effect	Indirect effect	Total effect
LnGov	0.271***	0.283***	0.206***	-0.311***	-0.105
	(0.051)	(0.062)	(0.044)	(0.092)	(0.103)
LnL	0.042***	0.083***	0.041**	-0.091***	-0.050
	(0.022)	(0.045)	(0.025)	(0.027)	(0.042)
LnFND	0.091***	-0.010	0.094***	0.031	0.125
	(0.033)	(0.056)	(0.018)	(0.077)	(0.082)
K	0.096***	0.007	0.096***	0.053	0.149***
	(0.012)	(0.032)	(0.021)	(0.047)	(0.042)
EDU	0.099*	0.196*	0.112**	0.286**	0.398***
	(0.055)	(0.099)	(0.051)	(0.119)	(0.143)
Observed value	502	502	502	502	502
R-Squared	0.702	0.702	0.702	0.702	0.702
Number of id	31	31	31	31	31

In summary, China's coupled and coordinated development level of culture and tourism industry is not only affected by the factors in the region, but also by the neighboring provinces due to the spatial spillover effect and indirect effect, so it is necessary to take the spatial factors into account while studying the coupled and coordinated development level of China's culture and tourism industry. General budget, fixed inputs, human inputs, education inputs, and basic inputs all have obvious positive direct effects, and basic inputs, fixed inputs, and education inputs have positive effects on their neighboring regions.

4. Conclusion

This paper focuses on the economic effect and quantitative modeling of the integration of culture industry and tourism industry in the context of digital economy, and the main conclusions are as follows:

First, the coupling and coordination degree of China's culture and tourism industry as a whole shows an upward trend, but by the impact of the epidemic presents phased fluctuations. 2015~2018, China's culture and tourism development belongs to the culture lag type, and reaches the synchronous development in 2019. 2020~2022 by the impact of the epidemic, the development of China's culture and tourism turns to the tourism lag type, until after 2023, it resumes the state of synchronous development once again.

Second, the spatial heterogeneity of cultural and tourism integration is significant. The eastern coastal areas (such as the Yangtze River Delta and the Pearl River Delta) rely on their economic and resource advantages to form "high-high" agglomeration areas; Due to the weak infrastructure and the siphon effect of factors, the central and western regions have fallen into the dilemma of "low-high" and "low-low" agglomeration, and it is necessary to strengthen regional linkage through policy tilt.

Thirdly, the integrated development of culture and tourism has a significant spatial spillover effect, and can promote common prosperity by narrowing the urban-rural income gap. The direct and indirect effects of the integrated development of culture and tourism industry on the urban-rural income gap are -0.1863 and -0.0756, which pass the significance test at the 1% and 5% levels respectively, indicating that every 1% increase in the level of the integrated development of culture and tourism industry will promote the reduction of the urban-rural income gap between the local and the neighboring areas by -0.1863% and -0.0756%.

Fourth, factors such as financial investment, human capital, and infrastructure have a positive driving effect on cultural and tourism integration. Among them, the cross-regional spillover effect of investment in education is prominent, with an indirect effect coefficient of 0.286, while excessive concentration of talent may inhibit the development of neighboring regions.

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