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Empirical Analysis of the Internal Mechanism of Digital Economy to Facilitate the Integration of Culture and Tourism in Shandong Province

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Abstract: *This study established an evaluation index system for the development level of the digital economy and the efficiency of cultural and tourism integration. By using empirical methods such as benchmark regression analysis, it conducted an empirical analysis of relevant data from eight provinces, autonomous regions and areas including Shandong Province from 2015 to 2023, exploring the internal mechanism by which the digital economy promotes cultural and tourism integration in Shandong Province. The results show that the digital economic development level and the efficiency and effect of cultural and tourism integration in eight provinces and regions including Shandong Province are good, but there is a gap between Shandong Province and provinces such as Henan Province and Guangdong Province. The tourism industry in eight provincial regions has a relatively high promoting efficiency for the cultural industry, but the cultural industry has a relatively low promoting efficiency for the tourism industry. Based on the analysis of empirical results, this study proposes countermeasures and suggestions for further enhancing the integration efficiency of the digital economy and the cultural tourism industry from the perspectives of collaborative mechanisms, the cultivation of compound talents, stimulating the vitality of the main body, and safeguard measures.*

Keywords: *Shandong Province, Digital economy, Integration of culture and tourism, Internal mechanism*

1. Introduction

In April 2021, the Ministry of Culture and Tourism released the *14th Five-Year Plan for Cultural and Tourism Scie*nce and Technology Innovation. And in December 2021, *the State Council issued the 14th Five-Year Plan for the Development of the Tourism Industry*, promoting the significant role of digitalization in upgrading traditional tourism formats and driving the transformation of the tourism industry towards innovation-driven development. In 2021, the General Office of the Shandong Provincial Government also issued the *Digital Shandong 2021 Action Plan* and the *Several Measures for Promoting High-Quality Development of the Cultural and Tourism Industry*, proposing to accelerate the digital transformation of the cultural and tourism industry in Shandong Province. However, in the process of digital economy promoting the integration of culture and tourism in Shandong Province, there are still practical problems such as severe homogenization of cultural and tourism products and data security, and there is a lack of research on the internal mechanism and path of digital economy promoting the integration of culture and tourism. To this end, this study constructs the internal mechanism of digital economy promoting the integration of culture and tourism in Shandong Province, and proposes the path and policy support system. Therefore, this study has significant theoretical and practical significance.

2. Reference review

2.1 Construction of the digital economy indicator system

Sun Aijun et al. (2024) analyzed the impact of the digital economy on the urban-rural gap. In this study, the measurement of the digital economy drew on the research of Guo Feng et al., and constructed a system including the development level of the Internet (Internet penetration rate, employment situation of related industry personnel, output situation of related industries, and mobile phone penetration rate), Digital finance (the breadth of coverage, the depth of application and the degree of digitalization of digital finance). Li Zhiguo et al. (2024) analyzed the aggregation of the digital economy on high-quality development. In this study, the digital economy development level index constructed two first-level indicators of digital industrialization and industrial digitalization, covering six second-level indicators:

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information transmission, service industry development, digital talents, digitalization of the primary industry, digitalization of the secondary industry, and digitalization of the tertiary industry. Chen Xinxin and Duan Bo (2022) explored the relationship between the digital economy and the narrowing of the urban-rural gap. In this study, the development level of the digital economy has established two first-level indicators: digital infrastructure and digital industrial application, as well as seven second-level indicators: the penetration rate of mobile phones, the number of Internet broadband users, the length of optical cables per unit area, the number of websites per thousand people, the average number of Internet broadband access ports per person, the number of web pages per thousand people, and the number of domain names per thousand people.

Table 1 Evaluation index system for the development level of the digital economy

Destination layer	Criterion layer	Indicator layer	Unit
Development foundation	Digital infrastructure	The length of long-distance optical cable lines	Kilometers
		The capacity of mobile phone switchboards	Ten thousand families
		The penetration rate of mobile phones	One device/ hundred people
		Internet broadband access port	Ten thousand
		Number of domain names	Ten thousand
Development momentum	Digital inclusive finance	The breadth of coverage of digital finance	Indicator
		The depth of digital finance usage	Indicator
		The degree of digitalization of digital finance	Indicator
	Digital creation ability	The full-time equivalent of R&D personnel in large-scale industrial enterprises	Person/Year
		R&D expenditure of industrial enterprises above designated size	Ten thousand yuan
		The number of R&D projects of industrial enterprises above designated size	Item
		The total transaction amount of technology contracts	100 million yuan
		Number of patent applications	Piece
		The number of patent applications authorized	Piece
Development achievements	Digital industrialization	The number of enterprises in the information transmission, software and information technology services industry	Item
		Output value of the information service industry	100 million yuan
		Telecommunication business volume	100 million yuan
		Postal business volume	100 million yuan
	Industrial digitalization	The number of websites per 100 enterprises	Item
		The proportion of enterprises with e-commerce transaction activities among the total number of enterprises	%
		E-commerce sales volume	100 million yuan
		Express delivery business volume	Ten thousand pieces

This study is based on the idea of "development foundation—development driving force—development outcome", and draws on the evaluation index system of digital economic development constructed by existing research. The development level of the digital economy in Shandong Province was measured by constructing five first-level indicators, namely digital infrastructure, digital inclusive finance, digital creation capacity, digital industrialization, and industrial digitalization, as well as 22 second-level indicators in three dimensions: the development foundation layer, the development driving layer, and the development achievement layer. For details[1]-[7], see Table 1.

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2.2 Construction of an indicator system for the integration of culture and tourism

Jin Junlong et al. (2023), when analyzing the efficiency of the integrated development of tea and tourism industries in Nyingchi City, constructed input indicators and input indicators, covering five secondary indicators. Yu Kaili (2024) analyzed the efficiency of the integrated development of Shandong's cultural and tourism industry from a digital perspective, using input indicators and output indicators, totaling five secondary indicators. Liu Yingji et al. (2023) explored the relationship between digital economy empowering the high-quality development of cultural and tourism integration, and constructed 4 first-level indicators and 22 second-level indicators. Tang Rui and Wang Yiyuan (2023) conducted a study on the mechanism by which the digital economy drives the high-quality development of the cultural and tourism industry in the Yangtze River Delta. The second-level cover innovation (the number of high-tech enterprises, the number of patent authorizations), coordination (the proportion of tourism revenue in the tertiary industry), green (energy consumption/pollution indicators), openness (the number of inbound tourists), and sharing (the number of cultural institutions, public services). Shi Yan and Zhan Guohui (2021) constructed an index for the high-quality development of cultural and tourism integration in Jiangsu Province. It includes fiscal input (central subsidy funds, per capita operating expenses, the proportion of operating expenses in fiscal expenditure), cultural development (added value of the cultural industry, the number of public libraries/museums/art venues), and tourism development (total tourism revenue, the number of tourists, the number of star-rated hotels/travel agencies). Chen Hongling et al. (2022) analyzed the integration efficiency of China's cultural and tourism industries, and constructed four first-level indicators: cultural industry input, cultural industry output, tourism industry input, and tourism industry output, as well as 19 second-level indicators including museums.

The current research mainly analyzes the efficiency of cultural and tourism integration by using the coupling coordination degree model (Li Hui et al., 2025; Yu Kaili, 2024; Wang Xiuwei, 2020; Shi Yan and Zhan Guohui, 2021; Liu Yinglei et al., 2022), comprehensive evaluation index system (Liu Yingji et al., 2023), industrial integration technology efficiency (Yan Shaohua et al., 2017; Fang Shimin and Li Xiangyang, 2021; Chen Hongling et al., 2022.) Based on the existing literature mentioned above, the index construction of the integration efficiency of the cultural and tourism industry adopts the "input-output" evaluation index system of the integration efficiency of the cultural and tourism industry, as shown in Table 2 for details[8]-[12].

Table 2 Evaluation index system for the integration efficiency of the cultural industry and the tourism industry

Efficiency type	Input indicator	Output indicator
The cultural industry boosts the efficiency of the tourism industry	Number of museum institutions (units), number of public library institutions (units), number of art performance group institutions (units), number of museum staff (persons), number of public library employees (persons), number of art performance group employees (persons)	Total number of tourists (in ten thousand), total revenue of the tourism industry (in hundred million yuan)
The tourism industry promotes efficiency in the cultural industry	Number of travel agencies (units), number of star-rated hotels (units), number of tourist attractions (units), number of tourism practitioners (units)	Cultural market revenue (thousand yuan), museum visitors (ten thousand people), total library circulation (ten thousand people), domestic performance audience of art troupes (thousand people)

3. The internal mechanism of the digital economy facilitating the integration of culture and tourism in Shandong Province

3.1 Measurement of the development level of the digital economy

3.1.1 Evaluation methodology

This study selects the entropy method to evaluate the digital economic development level of Shandong Province from 2015 to 2023, as well as that of highly representative provinces and regions in China such as Beijing, Shanghai, Guangdong, and Jiangsu. Through horizontal comparative analysis, it objectively reflects the objective level of digital economic development in Shandong Province[13].

(1) Digital standardization processing

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Firstly, due to the inconsistency of units, the evaluation index system constructed by the research group needs to standardize the existing data first. The purpose is to avoid the errors caused by the inconsistency of units in the analysis results. In this study, the normalization method was employed to transform the absolute values of each indicator into relative values, unify the heterogeneous indicators, and dimensionless the advanced ones. Then, the value range of each indicator was set between 0 and 1. The specific steps are as follows:

$$x_{ij}^{'} = \frac{x_{ij} - \min(x_{1j,}, x_{2j}, ..., x_{nj})}{\max(x_{1j}, x_{2j}, ..., x_{nj}) - (x_{1j}, x_{2j}, ..., x_{nj})} \tag{1}$$

Among them, $x_{ij}^{'}$ is the standardized indicator value, x_{ij} is the original data of the indicator in item jth of province i, $\max(x_{1j}, x_{2j}, ...x_{nj})$ and $\max(x_{1j}, x_{2j}, ..., x_{nj})$ respectively represents the maximum and minimum values of the indicator in jth item.

(2) Calculating the proportion of the Jth measurement index value of the ith provincial region:

$$y_{ij} = \frac{x_{ij}^{'}}{\sum_{i=1}^{m} x_{ij}^{'}} 0 \le y_{ij} \le 1 \tag{2}$$

(3) Calculating the information entropy of each indicator

Information entropy is the expected amount of information, representing the magnitude of uncertainty[14]. The greater the uncertainty is, the greater the information entropy is. If the information entropy of a certain indicator is smaller, it indicates that the degree of variation of the indicator data is greater, and the weight will be larger.

$$e_j = -k\sum_{i=1}^{m} y_{ij} 1n y_{ij} \quad \left(k = 1/1_{nm}, e_j \ge 0\right) \tag{3}$$

(4) Determining the weights of each indicator

$$w_{ij} = \frac{1 - e_j}{m - \sum_{j=1}^{m} e_j} \tag{4}$$

(5) Calculating the comprehensive score

$$s_i = \sum_{j=1}^{n} y_{ij} w_{ij} \tag{5}$$

3.1.2 Data source

In the index system constructed in this study, the relevant data on the indicators of digital infrastructure in the development foundation, digital creation capacity in the development driving force, and digital industrialization and industrial digitalization in the development achievements are sourced from the EPS database, China Statistical Yearbook, China Science and Technology Statistical Yearbook, China Information Industry Statistical Yearbook, China Industrial Statistical Yearbook, as well as the China Economic Insight Platform and the National Research Network. The GDP deflator with 2015 as the base period is used for deflation treatment. First, obtaining the gross domestic product (GDP) indices of the research subjects-eight provinces and regions including Shandong Province, Beijing, Shanghai, Henan Province, Guangdong Province, Jiangsu Province, Sichuan Province and Zhejiang Province—on the official national data website. Secondly, we need to consider the GDP index of 2015 as 1, and divide the GDP index from 2015 to 2023 by 100, which is denoted as δ_{it}. Finally, taking 2015 as the base period, the base index was calculated by cumulative processing year by year δ_{it}. The actual monetary value of the base period is calculated by multiplying the nominal monetary value of 2015 by 1. Finally,

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the actual monetary values of each province and region from 2015 to 2023 are calculated by multiplying the fixed-base indices of each province and region over the years by the actual monetary values of 2015[15].

3.1.3 Measurement result

The digital economy in the 8 provinces and regions shown in Table 3 is developing well, with an increasing trend year by year. However, there are significant differences among the 8 provinces and regions. The growth rate of the digital economy in Shandong Province has risen from 13% in 2015 to 35% in 2025, with an average annual growth rate of 23.77%. However, compared with Guangdong Province (54%), Jiangsu Province (34%), and Zhejiang Province (32%), there is still a gap. Moreover, the average digital economy development level of the eight provinces and regions studied in this study is 28.15%. The digital economy development level of Shandong Province is lower than the average. The annual growth rate of Beijing is 9.82%, that of Jiangsu is 10.36%, and that of Sichuan is 11.04%. Zhejiang's growth rate was 11.32%. They are all lower than the average growth rate.

Table 3 The comprehensive index of digital economic development in eight provinces and regions

AREA	2015	2016	2017	2018	2019	2020	2021	2022	2023	Mean	Annual average growth rate
Beijing	0.1864	0.2099	0.2232	0.2557	0.2926	0.3067	0.3374	0.3908	0.3944	0.2886	9.82%
Guangdong	0.2986	0.3340	0.3777	0.5082	0.6077	0.6892	0.6327	0.6772	0.7396	0.5405	12.01%
Henan	0.0606	0.0692	0.0889	0.1396	0.1764	0.2053	0.1664	0.1738	0.1914	0.1413	15.46%
Jiangsu	0.2035	0.2198	0.2498	0.3186	0.3799	0.4308	0.4107	0.4313	0.4477	0.3436	10.36%
Shandong	0.1303	0.1445	0.1634	0.2094	0.2376	0.2859	0.2897	0.3229	0.3559	0.2377	13.39%
Shanghai	0.1127	0.1237	0.1382	0.1655	0.1854	0.2072	0.2334	0.2653	0.2963	0.1920	12.84%
Sichuan	0.0923	0.1052	0.1251	0.1664	0.2250	0.2527	0.2170	0.2098	0.2132	0.1785	11.04%
Zhejiang	0.1902	0.2195	0.2439	0.3010	0.3585	0.4189	0.3805	0.4052	0.4486	0.3296	11.32%
Mean	0.1593	0.1782	0.2012	0.2580	0.3078	0.3495	0.3335	0.3959	0.3859	0.2815	

3.2 Measurement of the Efficiency Level of Cultural and Tourism Industry Integration

3.2.1 Evaluation methodology

This study uses the DEA cross-efficiency model to measure the integration efficiency of the cultural and tourism industries in Shandong Province and seven other provinces and regions. The integration efficiency of culture and industry includes two aspects, namely "the efficiency of culture promoting the tourism industry" and "the efficiency of the tourism industry promoting the cultural industry". The calculation steps are as follows:

(1) The efficiency of DMUd is calculated using the DEA model, and the equation is as follows:

$$\theta_d = \max \frac{u^T y_d}{v^T x_d}$$

$$s.t. \frac{u^T Y_d}{v^T x_d} \le 1, i = 1,2,....., n$$

$$u \ge 0, v \ge 0 \tag{6}$$

Among them, u and v are input-output vectors, and the best weights are denoted as θ^*, u_d^*, v_d^*.

(2) Calculating the efficiency of DMUk using the optimal weight and denote it as Edk.

$$E_{dk} = \frac{y_k^T u_d^*}{x_k^T v_d^*} \tag{7}$$

(3) Forming a cross-evaluation matrix

$$E = \begin{bmatrix} E_{11}E_{12}...E_{1N} \\ E_{21}E_{22}...E_{2N} \\ E_{n1}E_{n2}...E_{nm} \end{bmatrix} \tag{8}$$

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(4) Calculating the arithmetic mean of the elements in each row of E to obtain (e1, e2.....) en)T, ei are the efficiency values of the ith decision unit DMUi.

3.2.2 Data source

The data for the evaluation index system of the integration efficiency of the cultural industry and the tourism industry are sourced from the China Statistical Yearbook, China Cultural Relics Statistical Yearbook, China Tertiary Industry Statistical Yearbook, China Cultural Relics and Tourism Statistical Yearbook, as well as the statistical bulletins on national economic and social development published by 8 provinces and autonomous regions in China, including Shandong Province, from 2015 to 2023. In this study, Stata 17 software was used to fill in the missing parts. Finally, we need to restore the logarithmic value after filling to a natural constant.

3.2.3 Measurement result

The analysis results in Table 4 show that the integration efficiency of the cultural and tourism industry in Shandong Province has been developing well, with an average integration efficiency of 145% from 2015 to 2023. However, compared with Henan Province (183%), Guangdong Province (172%), Sichuan Province (149%), and Zhejiang Province (147%), there is still a gap.

Table 4 The integration efficiency of the cultural industry and the tourism industry

AREA	2015	2016	2017	2018	2019	2020	2021	2022	2023	Mean
Beijing	1.0000	1.0000	1.0735	1.0463	1.0000	1.9434	1.3149	2.0396	1.0000	1.2686
Guangdong	1.3210	1.1296	1.0579	1.0000	1.0000	3.0044	1.7449	3.6192	1.5961	1.7192
Henan	2.0392	1.8582	1.6589	1.3963	1.2052	2.2248	1.6781	3.2426	1.1213	1.8250
Jiangsu	1.0367	1.0587	1.1331	1.0433	1.0000	1.7864	1.2360	1.5920	1.0497	1.2151
Shandong	1.6071	1.4050	1.3180	1.1704	1.0539	1.8636	1.4238	1.9326	1.2829	1.4508
Shanghai	1.0480	1.0304	1.0000	1.0000	1.0000	1.6634	1.2876	1.9407	1.0000	1.2189
Sichuan	1.5949	1.4920	1.4099	1.2493	1.1231	1.9070	1.8792	1.7276	1.0000	1.4870
Zhejiang	1.3810	1.3270	1.2024	1.1495	1.1008	1.4875	1.9598	2.1567	1.5005	1.4739

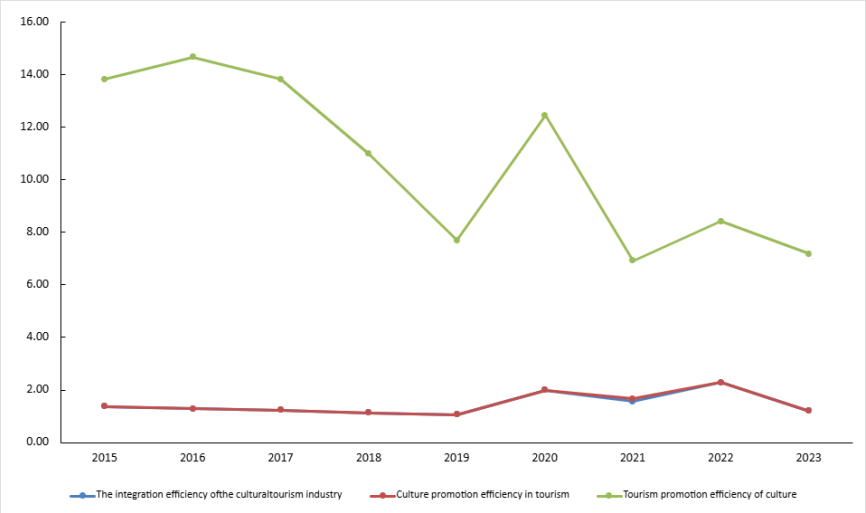

Figure 1 Efficiency change trend chart

Figure 1 shows that during the period from 2015 to 2023, the tourism industry in Shandong Province and seven other provinces and regions had the highest efficiency in promoting the cultural industry, while the efficiency of promoting the tourism industry by the cultural industry and the integration efficiency of the cultural industry and the tourism industry were relatively low and almost overlapped. The efficiency of the integration of the cultural and tourism industries during the sample period is mainly determined by the efficiency of the cultural industry in promoting the tourism industry. That is, the promoting efficiency of the cultural industry to the tourism industry and the integration efficiency of the cultural industry and the tourism industry both show a steady and slightly increasing trend, while the evolution trend of the promoting efficiency of the tourism industry to the cultural industry is relatively unstable, with increase and decrease alternating.

Firstly, the high efficiency of the tourism industry in promoting the cultural industry is attributed to the traffic advantage of tourism. The tourism markets in eight regions are mature. During their visits, tourists naturally come into contact with cultural scenes (such as intangible cultural heritage exhibitions

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in scenic spots and historical districts), which directly drives cultural consumption (purchase of cultural and creative products and viewing of performances). Moreover, the maturity of the tourism industry chain (transportation and accommodation) can rapidly expand the reach of cultural products, forming a direct conversion from "tourism flow to cultural consumption", with more significant efficiency. Secondly, the cultural industry has a low efficiency in promoting tourism due to its insufficient ability to transform cultural resources into tourism attractions. Most cultural resources (such as ancient books and traditional skills) need to be transformed into "experiential and scene-based" ones to become selling points for tourism. However, the current transformation mostly remains at the stage of simple display, lacking innovative forms such as immersive experiences (like escape room games and digital exhibitions), making it difficult to effectively attract tourists to come specifically for culture. The transformation chain is long and weak. Finally, the low integration efficiency stems from the imperfect collaborative mechanism. Tourism and cultural enterprises mostly engage in superficial cooperation (such as scenic spots selling cultural and creative products), lacking integration at the industrial chain level (such as theme parks and tourism routes led by cultural IPs). Meanwhile, the proliferation of homogeneous products (such as the imitation ancient streets in various places) has failed to form a differentiated integration model in line with regional cultural characteristics, resulting in an effect of "1+1<2".

3.3 Analysis of the Impact Mechanism of Digital Economy on the Integration Efficiency of Cultural and Tourism Industries

3.3.1 Panel model setting

This study mainly focuses on conducting an empirical analysis of the direct promoting effect of digital economy development on the integration of culture and tourism in Shandong Province. Here, a benchmark regression model is adopted.

$$ctr_{it} = \partial_0 + \partial_1 dig_{it} + \partial_2 Conrtols_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (9)$$

crt_{it} is the explained variable, representing the efficiency of cultural and tourism industry integration in province i in year t, where i+1, 2,....., 31, t= 2015, 2016, ... 2023, the same below; dig_{it} is the core explanatory variable of the model, representing the comprehensive index of the digital economy of province i in year t, and α0 is the constant term of the model. α1 is the elasticity coefficient of digit.

3.3.2 Descriptive statistics of variables

Table 5 Descriptive Statistics of Main Variables

Stats	TCE	Score
	The integration efficiency of the cultural tourism industry	The development level of the digital economy
Sample size	72	72
Mean	1.457	0.281
Maximum value	3.619	0.740
Minimum value	1.000	0.061
Median	1.316	0.241
Standard deviation of SD	0.523	0.149

The main variables of this study are the integration efficiency of the cultural and tourism industry and the digital economy. Table 5 presents the descriptive statistical characteristics of the above two variables, including the observed values, means, standard deviations, maximum values, minimum values, and median values. The average value of the integration efficiency of the cultural and tourism industries among them is 1.457, the maximum value is 3.619, the minimum value is 1.000, and the standard deviation is 0.523, indicating that there are significant differences in the integration efficiency of the cultural and tourism industries among these provinces. The comprehensive index of the digital economy shows the characteristics of a relatively large average value and a relatively small standard deviation.

3.3.3 Benchmark regression results

When analyzing the direct impact of the digital economy on the integration efficiency of the cultural and tourism industries, the benchmark regression analysis method was used. According to the Hausmann test result, it was significant. This is because this paper examines the influence of the development level of the digital economy on the integration efficiency of the cultural and tourism industries through a

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bidirectional fixed-effect model. According to the model test results, it can be known that the level of digital development shows a positive correlation with the integration efficiency of the cultural and tourism industries at a significance level of 1%, indicating that the level of digital economic development in a region can promote the integration efficiency of the cultural and tourism industries. (Figure 6, Figure 7)

Table 6 Benchmark regression analysis results

	Score	_con	Year	ID	*N*	R^2
Fixed effect model TCE	3.170*** (3.48)	0.873*** (4.99)	YES	YES	72	0.741
Random effects model TCE	1.322** (2.24)	1.168*** (7.23)	YES	YES	72	0.7224

Table 7 Hausmann test

	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	fe_model	re_model	Difference	Std. err.
Score	3.1703	1.3223	1.8480	0.7474
_cons	0.8734	1.1678	-0.2944	0.0855
chi2(2) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 6.11 Prob > chi2 = 0.0470				

4. Specific countermeasures for Promoting the Integrated Development of culture and Tourism in Shandong Province through the Digital Economy

4.1 Breaking regional and data barriers: Strengthening the collaborative mechanism

(1) Establishing a "three horizontal and three vertical" data sharing system

We need to horizontally connect the data of provincial departments, cities and enterprises, and vertically integrate the four-level platforms of national, provincial, municipal and scenic area. By 2025, the "Welcome to Shandong" platform will be connected to 10 types of cross-domain information, including transportation data (such as real-time ticketing for high-speed rail), meteorological data (such as precipitation warnings for scenic spots), and consumption data (such as the flow of people and heat in business districts). We need to establish a "Data Middle Platform Operation Center" led by Shandong Culture and Tourism Group, adopting the "government guidance + enterprise operation" model. It is responsible for data cleaning, desensitization and opening, and implements a free trial policy of data interfaces for small and medium-sized culture and tourism enterprises.

(2) Promoting regional construction in a differentiated manner

Jinan and Qingdao are focusing on developing digital cultural tourism headquarters economy, and are laying out metaverse laboratories and international cultural tourism data ports. The southern Shandong region focuses on the digitalization of rural cultural tourism, developing "digital farmhouses" and "live-streaming bases for intangible cultural heritage". The areas along the Yellow River focus on ecological culture and tourism, and build an integrated platform of "Yellow River ecological monitoring + smart tourism".

4.2 Breaking through technological and innovation bottlenecks: Deepening application scenarios

(1) Establishing a "Digital Culture and Tourism Innovation Fund"

The provincial finance allocates a special fund of 200 million yuan each year to support the in-depth application of VR/AR and artificial intelligence in the cultural and tourism sector, with a focus on funding "culture + technology" integration projects (such as dynamic interactive red education VR systems and AI-based tourist behavior prediction models). For leading digital cultural tourism enterprises that have been recognized, additional deductions for research and development expenses and tax reductions and exemptions will be granted. Enterprises are encouraged to jointly build laboratories with institutions such as Shandong University and the Institute of Oceanology, Chinese Academy of Sciences.

(2) Establishing a "negative list for technology application"

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Blind construction of homogeneous projects (such as VR experience centers with similar content) is prohibited. New digital projects are required to submit a "Cultural Connotation assessment report" to ensure the in-depth integration of technology application and cultural inheritance (for example, the VR project of the Three Confucian Sites in Qufu needs to incorporate the scene interaction of "The Analects of Confucius").

4.3 Solving the problem of talent shortage: Building a cultivation system

(1) Jointly cultivating compound talents by schools and enterprises

Colleges and universities in the province have set up a "Digital Culture and Tourism Major Direction", with courses covering digitalization of cultural heritage, tourism big data analysis, VR content creation, etc. They have jointly established training bases with enterprises such as Shandong Culture and Tourism Group and Qingdao Tourism Group, and aim to cultivate the first batch of 1,000 compound talents by 2025. The "Digital Cultural Tourism Talent Green Card" policy will be implemented. For the AI algorithm engineers, international digital marketing experts and others introduced, a maximum settlement subsidy of 500,000 yuan will be provided, and they will be given priority to be included in the provincial key talent projects.

(2) Enhancing the digital literacy of the industry

Launching the "Digital Training for One Million Cultural and Tourism Practitioners" program, through online courses (such as "Douyin Cultural and Tourism Live Streaming Skills") and offline courses (such as "Practical Operation of Scenic Area Mini-Program Construction"), we need to achieve full coverage of practitioners by 2026. Those who pass the assessment will be issued a "Digital Skills Certification".

4.4 Optimizing the synergy between policies and the market: Stimulating the vitality of entities

(1) Improving the mechanism for policy implementation

We need to implement a "negative list management" for the cultural and tourism development fund to enhance the efficiency of fund utilization (with the budget execution rate raised to over 85% by 2025), and focus on investing in the digital transformation of small and medium-sized cultural and tourism enterprises and rural cultural and tourism projects.

We need to incorporate digital cultural and tourism indicators into the local government assessment system. For cities and prefectures that complete regional coordination and data sharing tasks, we need to provide preferential provincial special funds.

(2) Strengthening the strength of market entities

We need to promote the asset integration of Shandong Culture and Tourism Group, form a trillion-yuan enterprise of "culture and tourism + technology" through mergers and acquisitions and reorganizations, and take the lead in building a provincial digital culture and tourism cloud platform. We need to encourage private capital to participate, establish the "Digital Culture and Tourism Venture Capital Alliance", and provide full-cycle financing services from seed to Pre-IPO.

4.5 Safeguard measures

A "Digital Cultural Tourism Integration Work Task Force" led by the provincial government's deputy leader in charge was established, with tasks assigned to 16 prefecture-level cities and 20 provincial departments, and regular third-party evaluations were conducted. The provincial finance department has set up a 1-billion-yuan "Special Fund for Digital Cultural Tourism Development" and guided social capital to form a "1:5" leverage effect, with a focus on supporting infrastructure and major projects. We need to formulate The Shandong Province Cultural and Tourism Data Security Management Specifications, establish a data classification protection system, and implement "encrypted transmission + off-site backup" for tourists' personal information, cultural heritage data, etc.

5. Conclusion

In recent years, Shandong Province has vigorously promoted the development of the cultural and tourism industry through the digital economy and achieved good results. However, there are still practical

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problems such as data security, as well as theoretical limitations such as the lack of research on the internal mechanism of the digital economy promoting the integrated development of culture and tourism. By exploring the internal mechanism of how the digital economy in Shandong Province promotes the integration of culture and tourism in the province, and proposing countermeasures for the digital economy to promote the integrated development of culture and tourism in Shandong Province in terms of collaborative mechanisms, the cultivation of compound talents, stimulating the vitality of the main body and safeguard measures, it aims to facilitate the high-quality integration of the digital economy and the cultural and tourism industry in Shandong Province.

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