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Study on the impact of digital economy on the high-quality development of cultural industry: from the perspective of the new development philosophy

Luobu Zhuoga*, Xicang Zhao

School of Finance and Economics, Jiangsu University, Zhenjiang, China

*Corresponding Author. Email: 2212319031@stmail.ujs.edu.cn

Abstract. From the perspective of the new development philosophy, this paper explores the influence mechanism and effect of the digital economy on the high-quality development of the cultural industry. The Entropy Weight Method is adopted to measure the development levels of the digital economy and the high-quality development of the cultural industry in 31 provinces of China from 2012 to 2023, and empirical tests are conducted by using panel regression, threshold model and regional heterogeneity analysis. The results show that: (1) On the whole, the digital economy significantly promotes the high-quality development level of the cultural industry, especially exerting an obvious upgrading effect on the dimensions of innovation, coordination and sharing, but has a negative impact on the opening-up dimension. This suggests that the opening-up mode of the cultural industry may be shifting from the traditional form relying on physical cross-border flow to a new form more dependent on digital platforms and ecological connection. (2) The impact of the digital economy has a single threshold effect based on the level of industrial agglomeration, and its driving effect is significantly enhanced only when the agglomeration degree crosses a certain threshold. (3) The analysis of regional heterogeneity shows that the digital economy has a more prominent promoting effect on the central and western regions, while its impact on the eastern region is not significant. The study suggests that efforts should be made to consolidate digital infrastructure, promote industrial agglomeration and ecological construction, implement regionally differentiated empowerment strategies, and improve the digital cultural governance and opening-up sharing mechanism, so as to systematically promote the deep integration of the digital economy and the cultural industry and achieve high-quality and inclusive development. This paper empirically analyzes the impact of the digital economy on the high-quality development of the cultural industry through panel regression model, threshold effect model and other methods.

Keywords: digital economy, cultural industry, new development philosophy

1. Introduction

At present, under the background of building a strong socialist cultural country, it is of great practical significance to study the digital economy and the high-quality development of the cultural industry. On the one hand, economy and culture are closely linked. Some scholars hold that with the continuous development and

popularization of the internet and digital technologies, the traditional cultural industry has realized digital transformation, and the digital creative industry is accelerating the deep integration of culture and science and technology, driving profound changes in the structure of the cultural industry [1]. On the other hand, other scholars point out that both individuals and enterprises can continuously reduce the search cost of cultural products, give birth to a variety of supply and demand of cultural products, thus promoting the better development of the entire cultural industry [2]. Some scholars have sorted out the role of the digital economy in the development of the cultural industry from the perspectives of output efficiency and industrial chain construction [3]. In addition, some scholars have conducted empirical research and found that Nicola used the data of Italian museums to analyze the digitalization level in the cultural industry, and the results showed that the adoption of digital technologies is to attract more tourists, reduce costs, improve tourist experience and adapt to competitors [4]. Hui Ning et al. found that the digital economy can promote the high-quality development of the cultural industry through three approaches: strengthening the protection of intellectual property rights, promoting the flow of innovative factors and reducing transaction costs [5].

However, Wu Haimin et al. argue that when the development level of the digital economy exceeds a certain threshold, the market structure characteristics of the digital economy such as winner-takes-all and the strong getting stronger may bring about in-depth alienation of the value of the cultural industry, leading the cultural industry to run counter to the goal of high-quality development [6]. What's more, based on the 2017 China Regional Input-Output Table, Ren Wenlong found that there is regional heterogeneity in the integration effect between the cultural industry and the digital economy industry [7]. Through combing the relevant literature, it is found that the existing studies on the digital economy and the cultural industry have laid a good foundation. However, there are relatively few empirical literatures on the impact of the digital economy on the high-quality development of the cultural industry. Most studies on the relationship between the two are based on qualitative empirical analysis, lacking sufficient data support, especially for the cultural industry, and there is a serious lack of in-depth research on its transmission mechanism.

Based on the consistency between the connotation of high-quality development and the new development philosophy, this paper measures the high-quality development level of the cultural industry under the framework of the new development philosophy, and then constructs a panel regression model to explore the influence mechanism of the digital economy on the high-quality development of the cultural industry. At the same time, through heterogeneity analysis, it tests whether the relationship between the digital economy and the high-quality development of the cultural industry has differences due to different geographical locations and resources. On this basis, the threshold regression model is used to test the nonlinear relationship between the two. This study helps to exert the integration and empowerment effect of the digital economy more accurately, and put forward targeted countermeasures and suggestions for developing the digital economy and promoting the high-quality development of the cultural industry.

2. Theoretical analysis and research hypotheses

2.1. The internal mechanism of the digital economy's impact on the high-quality development of the cultural industry

By empowering innovation subjects and reconstructing the innovation process, the digital economy ultimately catalyzes the formation of a data-driven innovation ecosystem, becoming the fundamental driving force for the high-quality development of the cultural industry. Driven by the digital economy, the dynamic system for the high-quality development of the cultural industry is undergoing changes, with science and technology, innovation, talents and other factors becoming the key elements [8]. The core of the digital economy lies in

establishing data as a key production factor [9]. The in-depth integration of data with the original factors of the cultural industry such as talents, capital and technology releases a multiplied innovation effect. As a knowledge-intensive industry, the cultural industry has a strong ability to absorb and transform new forms of knowledge. The liquidity, replicability and analyzability of data break the absolute dependence of traditional cultural creation on individual inspiration and scarce resources, shifting the innovation process from experience-driven to data intelligence-driven, which significantly reduces the trial and error cost and improves the accuracy and sustainability of innovation.

Coordination is an important implication of the high-quality development of the cultural industry [10]. Relying on data flow, platform aggregation and intelligent matching, the digital economy drives the industry to shift from partial and static coordination to overall and dynamic synergy. Specifically, it realizes the precise allocation of policy resources through data driving and improves fiscal efficiency [11]; it bridges the urban-rural digital divide with the help of internet inclusiveness and promotes fairness in cultural consumption; it catalyzes the cross-border development of "culture +" through technological integration and drives the upgrading of industrial structure; and it stimulates the vitality of diverse market players relying on the platform ecosystem to realize the dynamic and precise matching of supply and demand. Therefore, the digital economy is not only a tool, but also a synergy framework that reshapes the relationship within the cultural industry and between the cultural industry and the external social and economic systems. By improving the overall connection efficiency and allocation accuracy of the system, the digital economy lays a new paradigm foundation for the cultural industry to achieve balanced, inclusive and sustainable high-quality development.

Opening-up is the main path for the high-quality development of the cultural industry. The digital economy breaks the temporal and spatial barriers and physical boundaries. First of all, by virtue of the global accessibility of digital platforms and the real-time liquidity of data factors, the traditional "export-oriented" opening-up, which mainly relies on the cross-border flow of physical personnel and goods, is upgraded to an "ecological" opening-up with in-depth multi-level connection of markets, factors and rules [12]. Secondly, through online exhibitions, virtual performances, cross-border cooperative creation and other forms, foreign cultural exchange activities break through physical restrictions and become normalized, popularized and interactive. More importantly, the digital economy has spawned open innovation based on the global creative ecosystem. International talents, capital and creativity are deeply coordinated through digital networks to jointly participate in the creation of cultural value. The digital economy has a more significant driving effect on the export of high-value-added content creation products and can also improve the export technological sophistication [13]. The continuous improvement of the scale and quality of the digital economy has built a new pattern for enhancing the influence of Chinese culture and the international competitiveness of the industry.

Sharing is the fundamental purpose of the high-quality development of the cultural industry. The digital economy optimizes the inclusive and distribution mechanism of cultural achievements, with the core of promoting the upgrading of cultural development from a supply mode relying on limited physical resources to an extensive empowerment mode based on digital connection and replication capabilities, stimulating the motivation of suppliers to provide more comprehensive, diverse and professional products and services to consumers [14]. It effectively breaks the multiple restrictions on the supply volume, accessibility and participation of traditional cultural services. Secondly, the digital economy activates the vitality of diversified social co-creation and sharing, transforming cultural sharing from the one-way delivery of institutional organizations into a living landscape of universal participation and real-time interaction. People are not only consumers but also active disseminators and creators, forming a vibrant participatory cultural ecosystem. To sum up, this paper puts forward the following hypothesis:

Hypothesis 1: The digital economy can promote the high-quality development of the cultural industry.

2.2. The threshold characteristics of the digital economy's impact on the high-quality development of the cultural industry

The impact of the digital economy on the high-quality development of the cultural industry may have threshold characteristics. In the initial stage of the digital transformation of the cultural industry, information barriers, rigidity of departmental organizational structure, complexity of embedded scenarios, high transformation and migration costs of platforms and technologies may all increase the difficulty of digital economy empowerment. This paper holds that such threshold characteristics are regulated by industrial characteristics [15]. In the stage of low agglomeration level, the cultural industry is scattered geographically and in business formats, resulting in high coordination costs among enterprises. At this time, digital technologies are mainly applied as isolated tools by individual enterprises, and their network effects and knowledge spillovers are difficult to realize, so the promotion effect on the overall development of the industry is limited. Once industrial agglomeration crosses the key threshold, quantitative changes lead to qualitative changes. High-density agglomeration brings a pool of professional talents and shared infrastructure, thus improving the empowerment effect of the digital economy. Under such conditions, data factors can flow and integrate efficiently in the region, and digital platforms can connect supply and demand more effectively, promoting collaborative innovation and flexible cooperation among enterprises. Based on this, the following hypothesis is proposed:

Hypothesis 2: The impact of the digital economy on the high-quality development of the cultural industry has a threshold effect, and there is a nonlinear relationship between the two.

3. Research design and variable description

3.1. Variable selection

3.1.1. The high-quality development level of the cultural industry

In academic circles, there are different measurement methods for the high-quality development level of the cultural industry. Fu Caiwu et al. adopted the single indicator method and comprehensive evaluation method with total factor productivity as the single indicator to measure the development of the cultural industry [16]. To make the research conclusions more convincing, this paper draws on the ideas of Yu Lei, Wu Junzhi et al. [17, 18], and constructs an evaluation index system for the high-quality development level of the cultural industry from the four dimensions of coordination, innovation, opening-up and sharing under the high-quality development philosophy, and uses the Entropy Weight Method to comprehensively measure the high-quality development level of the cultural industry, as shown in Table 1.

Table 1. Evaluation index system for the high-quality development level of the cultural industry

Primary Indicator	Secondary Indicator	Tertiary Indicator
Innovation (0.296)	Talent Input	Full-time equivalent of R&D personnel in large-scale cultural manufacturing enterprises
	Capital Income	Internal expenditure on R&D funds of large-scale cultural manufacturing enterprises
	Project Support	Funds for new product development of large-scale cultural manufacturing enterprises (10,000 yuan)
	Achievement Transformation	Number of valid invention patents of large-scale cultural manufacturing enterprises
	New Product Output	Sales income of new products of large-scale cultural manufacturing enterprises (10,000 yuan)
Coordination (0.058)	Policy Coordination	Proportion of cultural undertakings expenditure in fiscal expenditure
	Urban-Rural Coordination	Per capita cultural and entertainment consumption expenditure of urban resident households
		Per capita cultural and entertainment consumption expenditure of rural resident households
	Industrial Coordination	Industrial upgrading
	Supply Coordination	Number of cultural market operation institutions
		Number of employees in cultural market operation institutions
Opening-up (0.549)	Inbound Tourism	Number of inbound tourists
		Foreign exchange earnings from international tourism
	Cultural Exchange	Number of foreign cultural exchange activity projects
		Number of participants in foreign cultural exchange activities
Sharing (0.075)	Services and Facilities	Number of artistic performance institutions
		Number of museum institutions
		Number of literary and artistic activities organized by mass cultural institutions
	Product Sharing	Number of cultural relic collections
		Per capita collection of public libraries

3.1.2. The development level of the digital economy

The *2019 White Paper on China's Digital Economy Development Index* decomposes the indicator system of the digital economy into basic indicators, industrial indicators, integration indicators and environmental indicators. Based on this indicator system and the research of Wang Jun et al. [19], this paper evaluates the development level of the digital economy from four dimensions: digital infrastructure, digital industrialization,

digital innovation and industrial digitalization. Digital infrastructure measures the construction level of information network infrastructure; digital industrialization mainly measures the ability of digital technologies to be transformed into productive forces; digital innovation mainly measures the capital and institutional support for the digital economy; industrial digitalization mainly evaluates the integration degree of traditional industries and the digital economy. The Entropy Weight Method is also used for weight assignment to measure the development level of the digital economy, as shown in Table 2.

Table 2. Indicator system for the development of the digital economy

Primary Indicator	Secondary Indicator
Digital Infrastructure (0.184)	Mobile telephone exchange capacity
	Length of long-distance optical cable lines
	Number of mobile telephones per 100 people
	Number of internet broadband access ports
	Total telecom business volume
Digital Industrialization (0.389)	Proportion of employees in the software and information technology service industry at the end of the year
	Fixed asset investment in the information transmission, software and information technology service industry
Digital Innovation (0.342)	R&D funds of large-scale industrial enterprises
	Number of domestic patent applications accepted
Industrial Digitalization (0.086)	Coverage breadth
	Usage depth
	Digitalization degree

3.1.3. Control variables

Considering other factors that may affect the high-quality development of the cultural industry, this paper selects the following control variables: per capita gross domestic product (eco), measured by the logarithm of regional per capita gross domestic product; cultural industry investment (inv), measured by the logarithm of fixed asset investment in culture and related industries; financial development level (fin), measured by the proportion of regional institutional deposit and loan volume in regional gross domestic product; human capital level (edu), measured by the average years of education of the regional population over 6 years old; marketization level (market), measured by the regional marketization index.

3.1.4. Threshold variable

Considering the nonlinear characteristics of the impact of the digital economy on the high-quality development of the cultural industry, this paper selects the industrial Agglomeration level (AGG) as the threshold variable, measured by the location entropy.

3.2. Data sources and descriptive statistics

The data used in the research are mainly from the *China Culture, Relics and Tourism Statistical Yearbook, China Culture and Related Industries Statistical Yearbook* and *China Statistical Yearbook*. Some missing data are supplemented by linear interpolation. Finally, 31 provinces from 2012 to 2023 are selected as the research objects. The descriptive statistical results of the main variables are shown in Table 3. Among them, the mean value of the high-quality development of the cultural industry is 0.063, the maximum value is 0.418, the

minimum value is only 0.012, and the standard deviation is 0.056, indicating that the overall high-quality development level of the cultural industry is low; the mean value of the digital economy is 0.209, the maximum value is 0.418, the minimum value is 0.031, and the standard deviation is 0.121.

Table 3. Descriptive statistical analysis

Variable Type	Variable Name	Symbol	Sample Size	Mean	Standard Deviation	Minimum Value	Maximum Value
Dependent Variable	High-quality development level of cultural industry	CHQDI	372	0.063	0.056	0.012	0.418
Independent Variable	Development level of digital economy	DIG	372	0.209	0.121	0.031	0.689
Control Variable	Per capita gross domestic product	eco	372	10.938	0.452	9.849	12.207
	Cultural industry investment	inv	372	5.206	1.080	2.083	7.514
	Financial development level	fin	372	3.578	1.144	1.784	8.164
	Human capital level	Edu	372	0.022	0.006	0.008	0.044
	Marketization level	market	372	8.153	2.282	-0.16	13.356
Threshold Variable	Industrial agglomeration level	AGG	372	0.965	0.252	0.209	1.584

3.3. Model setting

3.3.1. Benchmark regression model

To test the impact of the digital economy on the high-quality development of the cultural industry, this paper constructs the following benchmark regression model for testing (Equation (1)):

$$CULTURE_{i,t} = \varphi_0 + \varphi_1 DIG_{i,t} + \sum \varphi Controls_{i,t} + \omega_i + \delta_t + \varepsilon_{i,t} \quad (1)$$

In the formula, the explained variable $CULTURE_{i,t}$ represents the high-quality development level of the cultural industry in province i in year t, the core explanatory variable $DIG_{i,t}$ represents the development level of the digital economy in province i in year t, $Controls_{i,t}$ represents the control variables in province i in year t, ω_i represents the individual fixed effect, δ_t represents the time fixed effect, and $\varepsilon_{i,t}$ represents the random error term of the model.

3.3.2. Threshold regression model

To test the nonlinear characteristics in the process of the digital economy's impact on the high-quality development of the cultural industry, this paper adopts Hansen's panel threshold model [20] and constructs the following threshold effect test model (Equation (2)):

$$CHQDI_{i,t} = \varphi_0 + \varphi_1 DIG_{i,t} \times I(Z_{i,t} \le \theta) + \varphi_2 DIG_{i,t} \times I(Z_{i,t} > \theta) + \varphi Controls_{i,t} + \omega_i + \delta_i + \varepsilon_{i,t} \quad (2)$$

Among them, φ_0 is the intercept term, φ_1, φ_2 and φ are the estimated coefficients, Z is the threshold variable, $I(\cdot)$ is the indicator function, which takes the value of 1 if the condition in the bracket is satisfied,

otherwise 0; θ is the threshold value; Formula (2) is a single threshold case, which will be extended to multiple thresholds according to the sample data situation.

4. Empirical analysis

4.1. Analysis of benchmark regression results

To avoid the estimation bias of multicollinearity, this paper uses the Variance Inflation Factor (VIF) for testing before regression. The test result is 3.01, which is less than 8, indicating that there is no serious multicollinearity problem. Then, through the Hausman test, this paper adopts the two-way fixed effect model to analyze the impact of the digital economy on the high-quality development of the cultural industry. Table 4 shows the benchmark regression results.

Table 4. Regression results of the impact of digital economy on the high-quality development of cultural industry

	(1)	(2)	(3)	(4)	(5)	(6)
	CHQDI	CHQDI	Innovation	Coordination	Opening-up	Sharing
DIG	0.300***	0.293***	1.223***	0.282***	-0.253**	0.440***
	(4.6388)	(3.6664)	(7.0253)	(2.8111)	(-1.9961)	(5.1201)
edu		0.040***	-0.030	-0.092***	-0.043*	-0.030
		(-2.6208)	(-0.9091)	(-3.3464)	(-1.9198)	(-1.0642)
fin		0.010	0.026**	-0.020**	0.009	-0.028***
		(1.0482)	(2.2728)	(-2.0953)	(0.5392)	(-2.7713)
eco		-0.123**	-0.035	-0.016	-0.218**	0.174***
		(-2.0373)	(-0.6523)	(-0.3027)	(-2.0102)	(3.6475)
market		-0.011	-0.006	0.006	-0.019	0.021**
		(-1.2109)	(-0.7781)	(0.4573)	(-1.1436)	(2.1533)
inv		0.001	-0.001	0.004	0.003	-0.008**
		(0.1775)	(-0.2959)	(0.9848)	(0.6051)	(-2.0195)
_cons	-0.004	0.631**	-0.128	0.868***	1.137**	-0.289
	(-0.2808)	(2.1862)	(-0.5110)	(4.0616)	(2.1884)	(-1.3013)
Year,fe	Yes	Yes	Yes	Yes	Yes	Yes
Id fe	Yes	Yes	Yes	Yes	Yes	Yes
N	372	372	372	372	372	372
r2_a	0.820	0.829	0.892	0.896	0.260	0.933

• $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

It can be seen from Model (1) that when the individual and time fixed effects are controlled but no control variables are added, the regression coefficient of the digital economy is 0.3, which is significantly positive at the 1% significance level, initially indicating that the development of the digital economy has a significant promoting effect on the high-quality development of the cultural industry. In Model (2), each control variable is added, and the result is still significantly positive at the 1% level, indicating that for each 1-unit increase in the development level of the digital economy, the high-quality development level of the cultural industry increases by 0.293 units accordingly, which verifies that Hypothesis 1 is valid. From the perspective of control

variables, the regression coefficients of human capital level and industrial structure change rate are both significantly negative, indicating that the current human capital level is not sufficient to provide adequate intellectual support for the high-quality development of the cultural industry; the possible reason for the negative regression of the industrial structure change rate is that the standard of high-quality development does not only emphasize the increase in the proportion of the added value of the tertiary industry in GDP, and pursuing only the expansion of scale while ignoring the particularity of the internal structure of the cultural industry may lead to cultural value being overshadowed by business models.

Models (3) to (6) are the regression results of the two-way fixed effect model with the index of four dimensions: innovation, coordination, opening-up and sharing as the explained variables respectively. Model (3) shows that at the 1% significance level, for each 1-unit increase in the development level of the digital economy, the innovative development level of the cultural industry increases by 1.223 units accordingly. At the same time, the steady development of the financial market level is also a key factor for the improvement of the innovation capacity of the cultural industry. The innovation of digital technologies accelerates the new forms and models of the cultural industry and optimizes the innovation capacity of the cultural industry. Model (4) shows that through data driving, platform empowerment and ecological reconstruction, the digital economy has improved the coordination level of the cultural industry from four dimensions: policy, urban-rural, industry and supply, injecting impetus into promoting the high-quality development of the cultural industry towards a more balanced, efficient and sustainable direction. It can be seen from Model (5) that the digital economy has a significant negative impact on the opening-up level of the cultural industry. The possible reason is that the traditional opening-up form of the cultural industry relies on cross-border mobility such as inbound tourism and physical cultural displays, while the rise of the digital economy has changed the form and path of the cultural industry's opening-up, that is, foreign consumers can consume Chinese cultural products through media platforms, digital games and other channels. Model (6) shows that at the 1% significance level, for each 1-unit increase in the development level of the digital economy, the sharing level of the cultural industry increases by 0.44 units accordingly. At the same time, the improvement of the industrial structure change rate and the marketization level enhance the level of services, facilities and product sharing of the cultural industry, thus promoting the development of the cultural industry for the sharing of all people.

4.2. Threshold effect analysis

With the advancement of the digital economy, there may be nonlinear characteristics between the digital economy and the high-quality development of the cultural industry. Therefore, this paper selects the industrial agglomeration level as the threshold variable from the industrial perspective to test the nonlinear characteristics of the two at different development stages. First of all, before the threshold effect analysis, this paper uses the bootstrap method for 300 times of resampling, and the threshold significance test results are shown in Table 5. The results show that the p-value of the double threshold model test is 0.22, which is greater than 0.1 and fails to pass the test, indicating that the impact of the digital economy on the high-quality development of the cultural industry has only a single threshold characteristic, with the threshold value of 1.3226.

Table 5. Threshold effect test and threshold estimation results

Model Type Single Threshold	RSS	F Statistic	P Value	Threshold Value	Critical Value		
					10%	5%	1%
Double Threshold	0.1789	100.69	0.0000	1.3226	33.4559	47.6901	58.8456
Model Type	0.1692	20.79	0.2200	1.1579	89.4095	146.9738	283.6339

Table 6 shows the regression results of the single threshold model. It can be seen that when the industrial agglomeration level does not exceed the threshold value of 1.3226, the digital economy has no significant positive effect on the high-quality development of the cultural industry. This is because when the industrial agglomeration level is low, enterprises are only simply concentrated geographically, lacking organic connections between each other, and the digital economy is difficult to form a scale effect, thus failing to produce an obvious promoting effect; when the industrial agglomeration level exceeds the threshold value, the regression coefficient of the digital economy passes the test at the 1% significance level. At this time, for each 1-unit increase in the digital economy, the high-quality development of the cultural industry increases by an average of 0.69%. The industrial spatial structure undergoes qualitative changes and is upgraded to an innovation ecosystem, forming a close knowledge spillover network and an efficient factor matching market among enterprises. At this time, the digital economy evolves into an innovation platform, and its potential of technological empowerment, resource allocation and model innovation is systematically activated and amplified, thus producing a strong nonlinear driving effect on the cultural industry. It verifies that the industrial agglomeration level is an important reason for the digital economy to promote the high-quality development of the cultural industry, and the higher the industrial agglomeration level, the more conducive it is to the high-quality development of the cultural industry [21].

Table 6. Regression results of the single threshold model of the digital economy's impact on the high-quality development of cultural industry

Variable	AGG
DIG (Th ≤ 1.3226)	0.089 (3.42)
DIG (Th > 1.3226)	0.690*** (10.98)
Eco	-0.048 (-1.75)
Inv	0.002 (0.73)
Fin	0.024*** (4.87)
Edu	-0.003 (-0.35)
market	-0.014* (-1.92)

4.3. Endogeneity test

Considering the endogeneity problem caused by possible bidirectional causality between the digital economy and the high-quality development of the cultural industry, to obtain more accurate causal effect results, this paper takes the one-period lag of the core explanatory variable as the instrumental variable for endogeneity test, and the estimation results are shown in Table 7.

Table 7. Endogeneity test results

	(1) First Stage	(2) Second Stage
DIG		0.316***
		(0.121)
DIG-t	0.885***	
	(0.034)	
Control Variables	YES	YES
Sample Size	341	341
Province Fixed	YES	YES
Year Fixed	YES	YES
R2		0.389
F		10.737
Kleibergen-Paap rk LM statistic	6.796***	
Kleibergen-Paap rk Wald F statistic	681.686	

Among them, the first-stage regression result of the Two-Stage Least Squares (2SLS) shows that the coefficient of the instrumental variable is significantly positive, which conforms to the relevant criteria; the p-value of the Kleibergen-Paap rk LM statistic is 0.000, indicating the rejection of the original hypothesis of unidentified instrumental variables; the value of the Kleibergen-Paap rk Wald F statistic is 681.686, which is greater than the critical value of 16.68 at the 10% significance level, so it can be inferred that there is no weak instrumental variable in the model, and the selection of instrumental variables is reasonable. In the second-stage regression results, the core explanatory variable is still significantly positive, indicating that after considering the endogeneity problem, the digital economy can still have a positive impact on the high-quality development of the cultural industry, which shows that the benchmark regression results are relatively robust.

4.4. Robustness test

4.4.1. Excluding the samples of municipalities directly under the Central Government

Considering that municipalities directly under the Central Government are quite different from other provinces in terms of economic and social development level and cultural industry scale, which may cause deviations in the study of the impact relationship between the digital economy and the high-quality development of the cultural industry, this paper re-regresses after excluding the sample data of municipalities directly under the Central Government, and the estimation results are shown in column (1) of Table 8. From the regression results after excluding the samples, the sign and significance of the regression coefficient of the digital economy remain unchanged, indicating that the benchmark regression results are robust.

4.4.2. Replacing variables

To avoid the impact of measurement methods on the model regression results, this paper uses Principal Component Analysis (PCA) to re-measure the explanatory variable and the explained variable. The KMO test

results of principal component analysis are 0.78 and 0.835 respectively, and the Bartlett's Test of Sphericity is significant at the 1% p-value level, indicating that it is appropriate to use this method to measure the two variables. Models (2) and (3) in Table 8 are the estimation results of replacing the explanatory variable and the explained variable respectively. The regression result of the digital economy is still significantly positive at the 1% level, indicating that the conclusion that the digital economy can improve the high-quality development level of the cultural industry is robust.

4.4.3. Winsorization

To avoid the impact of outliers on the results, this paper conducts two-way winsorization of the data at the 1% and 99% levels, and the regression results are shown in (4) of Table 8. The regression results show that the coefficient of the digital economy after removing outliers is still significantly positive, which further supports the benchmark regression results.

Table 8. Robustness test results of benchmark regression

	Excluding Municipalities	Replacing Explanatory Variable	Replacing Explained Variable	Winsorization
	CHQDI	DIG	CHQDI	CHQDI
DIG	0.314***	0.060***	1.716***	0.293***
	(0.080)	(3.6489)	(4.9773)	(2.8864)
Year fe	YES	Yes	Yes	YES
Id fe	YES	Yes	Yes	YES
N	324	372	372	372
r2_a	0.861	0.833	0.940	0.360

• $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4.5. Regional heterogeneity analysis

Table 9. Regional heterogeneity

	(1)	(2)	(3)
	CHQDI	CHQDI	CHQDI
DIG	0.115	0.333***	0.523***
	(1.0146)	(4.0934)	(4.7841)
Control Variables	Yes	Yes	Yes
_cons	0.737*	-0.539**	1.115*
	(1.7982)	(-2.2543)	(1.7832)
Year fe	Yes	Yes	Yes
Id fe	Yes	Yes	Yes
N	156	72	144
r2_a	0.702	0.944	0.871

• $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

According to the geographical location of each province, 31 provinces are divided into the eastern, central and western regions to explore the impact degree of the digital economy on the high-quality development level of the cultural industry in different regions, and the estimation results are shown in Table 9.

Among them, the regression coefficient of the digital economy in the eastern region is 0.115 but fails to pass the significance test. This may be because the eastern region has a mature marketization level and complete infrastructure, and the development of the cultural industry has formed an endogenous growth momentum. The decisive role of the market mechanism in resource allocation is strong, and the empowerment effect of the digital economy is covered by the marginal effects of factors such as market-oriented competition and consumption upgrading, leading to the insignificant independent impact of the digital economy on the high-quality development of the cultural industry.

The regression coefficient of the digital economy in the central region is 0.333, which passes the 1% significance test, indicating that the digital economy in the central region can significantly and positively affect the high-quality development of the cultural industry. This is because the cultural industry in the central region is dominated by small, medium and micro enterprises, and its development needs are concentrated on the basic level such as expanding the market and improving efficiency, which is highly consistent with the basic empowerment path of the digital economy in the rapid diffusion period to solve the problems of narrow channels, information asymmetry and high operation costs of the cultural industry, thus promoting the high-quality development of the cultural industry in this region.

The regression coefficient of the western region is 0.523, which is significant at the 1% statistical level. This is because the western region relies on projects such as the East Digital West Calculation Project, with the accelerated improvement of digital infrastructure. Digital technologies have effectively tapped the commercial value of characteristic cultural resources such as intangible cultural heritage and folk customs and transformed them into development advantages. Compared with the eastern and central regions, the empowerment is direct and significant. The low cultural industry investment and low financial development level in the western region are compensated by digital technologies to improve the accuracy and return rate of investment, thus rapidly promoting the transformation of the cultural industry from the traditional model to high-quality development.

5. Conclusion and suggestion

5.1. Conclusion

By combing the relevant literature and theories of the digital economy and the high-quality development of the cultural industry, this paper explores the influence mechanism between the digital economy and the high-quality development of the cultural industry, and then puts forward research questions and hypotheses. Under the framework of the new development philosophy, the Entropy Weight Method is used for weight assignment to measure the provincial-level development levels of the digital economy and the high-quality development of the cultural industry in China from 2012 to 2023, and the impact effects and characteristics of the digital economy on the high-quality development of the cultural industry are empirically analyzed. The main research conclusions are as follows: (1) The effect of the digital economy on the innovation, coordination, sharing and opening-up dimensions of the cultural industry is not balanced. It plays a positive role in the innovation, coordination and sharing of the cultural industry at the 1% significance level, while its effect on opening-up does not meet the expectation. (2) The benchmark regression results show that the digital economy has a promoting effect on the high-quality development of the cultural industry, and this conclusion is still valid under the robustness test. Among the eastern, central and western regions, the digital economy has a strong

driving effect on the high-quality development of the cultural industry in the central and western regions, but its effect on the eastern region is not significant. (3) The impact of the digital economy on the high-quality development of the cultural industry has a single threshold effect based on the industrial agglomeration level. This result indicates that the empowerment effect of the digital economy depends on the innovation ecological foundation constructed by the industrial spatial organization. The networked and ecological environment formed by industrial agglomeration is a key condition for the digital economy to upgrade from an "efficiency tool" to a "systematic innovation architecture". It deepens the understanding of the nonlinear mechanism of the digital economy driving the high-quality development of the cultural industry.

5.2. Suggestion

Based on the research conclusions, this paper puts forward the following suggestions for the digital economy to drive the high-quality development of the cultural industry:

First, consolidate digital infrastructure and ecological agglomeration, and activate the efficiency of systematic innovation. Accelerate the construction of digital infrastructure, focus on the layout of 5G, data centers and cloud platforms, improve the coverage and quality of urban and rural networks, narrow the digital divide, and promote the fair sharing of cultural resources. Promote the spatial agglomeration and ecological construction of the cultural industry, support the construction of digital cultural industry parks and cultural and creative clusters, facilitate data sharing, knowledge spillover and collaborative innovation among enterprises, cross the "threshold effect" of digital economy empowerment, and form a large-scale innovation ecosystem.

Second, deepen the digital transformation of the industry and implement precise regional empowerment. Carry out the special action of "culture + digital" integration, encourage cultural enterprises to apply big data, Artificial Intelligence (AI), Virtual Reality (VR) and other technologies to develop new products and new scenarios, and improve content innovation and user experience; set up transformation support funds to focus on supporting the digital transformation of small, medium and micro enterprises. In view of the regional heterogeneity problem of "effective in the central and western regions and ineffective in the eastern region", the policy focus for the eastern region should shift from promoting the application of digital technologies to encouraging original innovation and ecological construction. Encourage the construction of national-level collaborative innovation centers for digital cultural and creative industries, support leading enterprises to build open-source and open technology and IP platforms, and stimulate the endogenous power of the industrial ecosystem they already have through institutional innovation. For the central and western regions, continue to strengthen the popularization of digital infrastructure and implement the "Industrial Agglomeration Cultivation Plan". By building characteristic digital cultural industry parks and introducing platform-based enterprises, consciously guide the spatial agglomeration of cultural enterprises, talents, data and other factors, laying a foundation for crossing the "industrial agglomeration threshold" and releasing the efficiency of the digital economy.

Third, construct a digital cultural governance system and an opening-up sharing mechanism. Improve the legal and standard system for digital culture, strengthen the protection of intellectual property rights and the supervision of data security and privacy, establish an inter-departmental collaborative governance mechanism, and ensure the healthy and orderly development of the industry. Promote the digital cultural opening-up and sharing, encourage cross-border cultural exchanges and online cultural exhibitions by using digital platforms, and enhance the international communication power of Chinese culture; at the same time, promote the universal sharing of cultural resources through public digital cultural platforms, and improve the inclusiveness and accessibility of cultural services.

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