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Strategies for Higher Art Education to Enable the Innovative Development of Local Cultural Tourism--Taking Tianmei Art District as an Example

Tingting Li[1,*]

1 School of Film and Media Arts, Tianjin Academy of Fine Arts, Tianjin, 300141, China

SUMMARY: *The study analyzes the cultural and tourism innovation development of Tianmei Art Neighborhood by using the EA-Malmquist model, and integrates the influential relationship between higher art education and the efficiency of local cultural and tourism innovation development by combining the vector autoregressive model. The integrated technical efficiency, pure technical efficiency and scale efficiency of the four areas of Tianmei Art Neighborhood are measured based on the total annual customer consumption data of Tianmei Art Neighborhood from 2015 to 2024, and the VAR model is established on the basis of cointegration test, impulse response and variance decomposition through Granger causality test for variables. The results show that the overall level of comprehensive efficiency of cultural tourism industry innovation in the four regions of Tianmei Art Block is high, but there is obvious variability among the regions. The efficiency of local cultural tourism innovation and development will promote higher art education, and the long-term effect on higher art education is significant (the significance level is 5%), and higher art education has a certain promotion effect on the efficiency of local cultural tourism innovation and development.*

KEYWORDS: *EA-Malmquist model; VAR model; higher art education; cultural tourism innovation development*

1 Introduction

Under the background of intertwined globalization and digitalization, culture and tourism industry has become an important engine to promote the transformation and upgrading of local economy [1]. The Chinese government has clearly put forward the "implementation of the national cultural digitization strategy, the improvement of modern public cultural service system, and the innovative implementation of cultural benefit projects", which elevates the in-depth integration of the cultural and tourism industry and digital technology to the height of the national strategy. At present, the cultural tourism industry in many places is experiencing a paradigm shift from "resource-dependent" to "technology-driven" [2, 3]. In this context, [4] focuses on the theme of tourism and cultural forms and norms in the innovation era, systematically explores how sustainable tourism can promote social development through the multidimensional integration of culture, environment, economy and society, and emphasizes that the protection and innovation of local cultural identity become the key driving force for sustainable tourism development in the wave of globalization and digitalization through cross-border dialogues between academia, industry and policy fields. Based on the theory of industrial integration and value chain theory, literature [5] empirically analyzes the drivers, paths and

*13920657047@163.com
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modes of integration between business and innovative industries and tourism using the data integration method, and finds that the data integration technology can systematically reveal the interaction logic among the innovative subsystems of culture and tourism and portray the process and direction of integration and development of the tourism and creative industries in a more graphic and concrete way. Literature [6] used regression analysis to explore the impact of cultural value, facility capacity, price management and personnel management on cultural tourism innovation, and found that cultural value inheritance, facility improvement, pricing strategy optimization and personnel management enhancement all significantly and positively promote tourism innovation practice.

High-quality cultural and tourism integration products can enable consumers to obtain cultural and artistic enrichment during leisure travel, which is likely to be another function and purpose of cultural and tourism integration development. The international academic community has put forward the idea of "cultural tourists" from a multidisciplinary perspective that includes cultural economics, tourism management, cultural sociology and other disciplines [7-9]. For example, literature [10] points out that existing studies have focused on metropolitan cases and neglected the potential of small and medium-sized towns, so by analyzing the practical cases of five small and medium-sized towns in Europe, it explores how culture and creativity can drive tourism innovations and promote more inclusive and sustainable community development, which is an important complement to local cultural and tourism innovations. Literature [11] found that the "willingness" and "ability" of community members are the key to driving multiple innovations, but they alone are not enough to ensure long-term success, so it is necessary to establish an innovative mindset that takes into account economic, social and environmental sustainability in order to realize the sustainable growth of cultural tourism. Therefore, innovative thinking that takes into account economic, social and environmental sustainability is necessary to achieve sustained growth in cultural tourism. Literature [12] explores the far-reaching impact on the overall development and performance of tourism enterprises by constructing a systematic talent cultivation management model, which not only focuses on talent management efficiency, but also devotes itself to optimizing the talent structure and cultivating a diversified team with both cultural literacy and tourism professional ability to enhance service quality, adaptability and sustainable competitiveness. Literature [13] extracts cultural dimensions through principal component analysis, and combines two-way fixed-effects model, time dummy variable and cluster robust standard error method, and finds that culture has a significant impact on innovation and economic development, in which the three cultural dimensions of hierarchical conception, emotional autonomy and mastery inhibit innovation and economic progress, and the group embeddedness, egalitarianism and harmony have a promotional effect on the two. . Based on the paradox perspective, [14] proposed the concept of "cultural heritage innovation" and systematically developed its measurement tools, extracting the four core dimensions of cultural authentic production, creative dissemination, living display and transformation and creation through the theory of rootedness, which not only provides a scientific tool for evaluating the practice of cultural innovation in heritage tourism sites, but also deepens the understanding of the relationship between cultural innovation and sustainable development. The study not only provides a scientific tool for assessing the practice of cultural innovation in heritage tourism sites, but also deepens the theoretical discussion on the relationship between cultural innovation and sustainable development, which is an important reference value for the promotion of innovation and protection of cultural tourism.

As an important talent support for the innovative development of culture and tourism, higher art majors must shoulder the task of the times and resonate with the development of local culture and tourism industry [15]. This requires higher vocational art majors to recognize and pay attention to the latter's transformation needs, so that the two can match and support each other

[16, 17]. At present, many higher vocational art education has begun to adjust the teaching program and teaching content to meet the needs of the transformation and upgrading of culture and tourism. For example, literature [18] found that government support and knowledge transfer from schools and enterprises both enhance the innovation performance of rural cultural tourism, for this reason, it is emphasized that rural cultural tourism enterprises should strengthen the interaction with the government and colleges and universities to obtain policies, talents and knowledge resources, so as to systematically enhance the innovation effectiveness. Literature [19] discusses the key role of colleges and universities in fostering a sustainable culture and training students to become change agents, and emphasizes the significance of integrating the concepts of environmental and sustainable development education into the curriculum system to promote social transformation. In this context, higher art education, as the main way of art education, can realize the seamless connection between talent cultivation and industrial demand by establishing cooperative relationships with cultural and tourism enterprises to jointly formulate talent cultivation programs, develop curricular resources, and carry out practical teaching, so that the connection between the innovation of art education mode and the innovation and upgrading of cultural and tourism can be closer and the collaboration can be more smooth [20, 21].

This paper specifies the research variables and measurement indexes, and selects the customer consumption data of the four core areas of Tianmei Art Neighborhood from 2015 to 2024. On this basis, the EA-Malmquist model is used to analyze the cultural tourism innovation development in the core areas of Tianmei Art Block, including comprehensive technical efficiency, pure technical efficiency and scale efficiency. Then the VAR model of the efficiency of higher art education and local cultural tourism innovation development is constructed, and the variables are empirically tested by Granger causality test, impulse response and variance decomposition methods.

2 Research design

2.1 Selection of variables

Explanatory variables: higher fine arts education (ZXS) (including graduate students and undergraduate students) is represented by the number of college students per 10,000 people enrolled in colleges and universities.

Explained variable: local culture and tourism innovation development efficiency (ETI), this paper selects 2 first-level indicators of innovation input and innovation output, and obtains the regional innovation efficiency measurement index system as shown in Table 1.

First, innovation input. Innovation input is an important factor in determining innovation output, which is here divided into 3 secondary indicators of innovation funding, R&D organizations, and equipment investment, and further divided into the ratio of R&D (research and experimental development) expenditure to tourism expenditure (X1), the ratio of tourism financial support expenditure to tourism expenditure (X2), the number of tourism planning and qualification units (X3), and the amount of investment in fixed assets in tourism (X4). 4 observable values.

Second, innovation output. The scope of output indicators is wider, and the indicator of new product output is excluded, arguing that it is difficult to obtain effective data under the same standard due to the differences in the definition, understanding, and even certification standards for new products in different regions and fields, and that this paper divides the innovation output into the three secondary indicators of knowledge output, innovation performance, and market development, and further divides them into the number of tourism academic papers published

(Y1), the number of tourism patents filed (Y2), the growth rate of total tourism revenue (Y3), the proportion of international tourists to all tourists (Y4), and tourism foreign exchange earnings (Y5), which are five observable values.

Table 1: Regional Innovation Efficiency Measurement Index

Indicator category	Evaluation field	Evaluating indicator
Innovation investment	Innovation funding	Proportion of expenditure to tourism expenditure(X1)
		Tourism financial support expenditure proportion of tourism expenditure(X2)
	Research and Development Institution	Number of qualified tourism planning units(X3)
	Equipment investment	Fixed investment in tourism(X4)
Innovation output	knowledge output	Number of published academic papers on tourism(Y1)
		Number of tourism patent applications(Y2)
	Innovation performance	Gross revenue growth rate of tourism(Y3)
	Market Development	Proportion of international tourists in total tourist arrivals(Y4)
		Foreign exchange earnings from tourism(Y5)

2.2 Methodology and data sources for measuring the efficiency of local cultural tourism innovation development

2.2.1 Principles of DEA-Malmquist modeling

1. DEA model

Data Envelopment Analysis DEA is a nonparametric method that uses mathematical tools to evaluate the efficiency of the production frontier of an economic system and is suitable for evaluating the performance of decision-making units with multiple inputs, outputs, and objectives.The DEA method evaluates the relative efficiency of the decision-making units and does not need to take into account the relationship between inputs and outputs of each decision-making unit. It relies on determining the vector of weights for the inputs and outputs of the decision-making units (DMUs) as the final evaluation criterion, eliminating the influence of human factors that may affect the final results when determining the weights of the indicators.

Considering that the inputs can be adjusted according to the coverage and substitution rate of the basic pension insurance for urban enterprise workers, this paper first chooses an output-oriented CCR-DEA model to evaluate the output maximization problem under a given input level. That is, if the returns to scale are constant, there is a linear relationship between the increase or decrease in inputs and the increase or decrease in outputs in DMUs. The linear programming model is as follows:

$$\begin{cases} \max\left[\theta_0 - \varepsilon\left(\sum s_j^- - \sum s_r^+\right)\right] \\ s.t.\begin{cases} \sum A_{ji}\lambda_i + s_j^- = A_{j0} \\ \sum B_{ri}\lambda_i - s_r^+ = \theta_0 B_{r0} \\ \theta_0 \geq 0, \lambda_i \geq 0, i = 1, 2, \cdots, n \\ s_j^- \geq 0, s_r^+ \geq 0, j = 1, 2, \cdots, m \end{cases} \end{cases} \tag{1}$$

where $A_i=(a_{1i},a_{2i},\cdots,a_{mi})^T$ denotes the DMU_i vector of input indicators.

$B_i=(b_{1i},b_{2i},\cdots,b_{mi})^T$ denotes the vector of input indicators for the DMU_i vector of output indicators.

s_j^- is the redundancy of inputs.

s_r^+ is the redundancy of outputs.

In general, take $\varepsilon=10^{-6}$.

The efficiency values of different DMUs can be obtained from model (1).

(1) When $\theta\neq 1$, the DMU is DEA inefficient.

(2) When $\theta=1$ and $s_j^-=0$, $s_r^+=0$, the DMU is DEA effective, i.e., at this time, the input-output efficiency is optimal;

(3) When $\theta=1$ and $s_j^-\neq 0$, $s_r^+\neq 0$, this DMU is weakly effective for DEA, i.e., because of too large amount of inputs, resulting in redundancy of resources and failing to reach the optimal state;

2. Malmquist index

This paper adopts the Malmquist index proposed by Fare R et al. to study the dynamic change of the operational efficiency of China's urban enterprise workers' pension insurance in different periods. As shown in formula (2):

$$M_i\left(x^{t+1},y^{t+1};x^t,y^t\right)=\left[\frac{D_i^t\left(x^{t+1},y^{t+1}\right)}{D_i^t\left(x^t,y^t\right)}\frac{D_i^{t+1}\left(x^{t+1},y^{t+1}\right)}{D_i^{t+1}\left(x^t,y^t\right)}\right]^{\frac{1}{2}} \tag{2}$$

where $D_i^t\left(x^{t+1},y^{t+1}\right)$ denotes the distance function to the $(t+1)$ period with reference to the production probability frontier in the i province in the t period, $D_i^t\left(x^t,y^t\right)$ denotes the distance function to the current period with reference to the frontier of production possibilities in the i th province in the t th period. The distance function is inversely related to the efficiency, so the operating efficiency can be obtained by the linear programming of Equation (3):

$$\begin{gathered}\left[D_i^t\left(x^{t+1},y^{t+1}\right)\right]^{-1}=\min\theta^i\\ s.t.\begin{cases}Y_i^{t+1}\le\sum_i z_i^tY_i^t\\ \sum_i z_i^tX_i^t\le\theta^iX_i^{t+1}\\ z_i^t\ge 0\end{cases}\end{gathered} \tag{3}$$

Changes in the Malmquist productivity index can be categorized into technical efficiency change (TEC) and technical change (TC). Where TEC is an index of relative efficiency change between period t and period $t+1$ under constant returns to scale and factor conditions, mainly efficiency gains caused by management, institutional reforms and other efficiency improvements, as shown in equation (4):

$$TEC\left(x^{t+1},y^{t+1};x^t,y^t\right)=\frac{D_i^t\left(x^{t+1},y^{t+1}\right)}{D_i^t\left(x^t,y^t\right)} \tag{4}$$

TC is mainly adopted as a result of technological innovation and technology introduction, which makes the production frontier shift outside the border, as shown in equation (5):

$$TC\left(x^{t+1},y^{t+1};x^{t},y^{t}\right)=\left[\frac{D_i^{t}\left(x^{t+1},y^{t+1}\right)}{D_i^{t+1}\left(x^{t+1},y^{t+1}\right)}\frac{D_i^{t}\left(x^{t},y^{t}\right)}{D_i^{t+1}\left(x^{t},y^{t}\right)}\right]^{\frac{1}{2}} \tag{5}$$

2.2.2 Data sources

Taking the four core tour areas of Tianmei Art Block in Tianjin as an example: Tianwei Road (Area 1), Zhongshan Road (Area 2), Italian Style Street (Area 3), and East Haihe Road (Area 4), the source of data is mainly the total customer consumption of derivatives integrating art and culture and tourism of regional brand merchants from 2015 to 2024.

2.3 Econometric modeling

2.3.1 Vector autoregressive model

The vector autoregressive model, or VAR model for short, is a commonly used econometric model that describes the relationship of dynamic variables better than traditional economic theory. The vector autoregressive model constructs the model by taking all the endogenous variables in the system as a function of the lagged values of the endogenous variables, and is able to dynamically analyze the stochastic perturbation variables, thus extending the univariate autoregressive model into a "vector" autoregressive model consisting of multivariate time series. The mathematical expression of the model is shown in equation (6):

$$\begin{gathered} y_t=\varphi_1 y_{t-1}+\cdots+\varphi_p y_{t-p}+\mu x_t+\varepsilon_t \\ t=1,2,3\cdots\cdots T \end{gathered} \tag{6}$$

where y_t denotes the k -dimensional endogenous variable, x_t denotes the d -dimensional exogenous variable, p denotes the number of lag periods, T is the sample size, the matrices $\varphi_1,\varphi_2,\cdots,\varphi_p$ and μ are the parameter matrices to be estimated, and ε_t is the random perturbation term.

2.3.2 Impulse Response

The impulse response function (IRF) is used to describe the dynamic process by which the endogenous variable is affected in terms of its current and future values after it is subjected to a shock of one standard deviation in size brought about by a random disturbance term. The basic idea of the impulse response function is illustrated below using the VAR (7) model:

$$\begin{cases} x_{it}=a_1x_{t-1}+a_2x_{t-2}+b_1z_{t-1}+b_2z_{t-2}+\varepsilon_{1t} \\ z_{it}=c_1x_{t-1}+c_2x_{t-2}+d_1z_{t-1}+d_2z_{t-2}+\varepsilon_{2t} \end{cases} t=1,2,\cdots,T \tag{7}$$

where a_i,b_i,c_i,d_i are the parameters and the perturbation term $\varepsilon_t=\left(\varepsilon_{1t},\varepsilon_{2t}\right)'$, assumed to be white noise vectors with properties like the following:

$$\begin{aligned} &E\left(\varepsilon_{it}\right)=0 && \text{For } \forall t \quad i=1,2 \\ &\operatorname{var}\left(\varepsilon_{t}\right)=E\left(\varepsilon_{t}\varepsilon_{t}'\right)=\Sigma=\left\{\sigma_{ij}\right\} && \text{For } \forall t \\ &E\left(\varepsilon_{it}\varepsilon_{is}\right)=0 && \text{For } \forall t\neq s \quad i=1,2 \end{aligned} \tag{8}$$

Assume that the above system is active from period 0 and let $x_{-1}=x_{-2}=z_{-1}=z_{-2}=0$, and let also be given the perturbation terms $\varepsilon_{10}=1$, $\varepsilon_{20}=0$ and 0 thereafter, i.e. $\varepsilon_{1t}=\varepsilon_{2t}=0\left(t=1,2,\vdots\right)$, and call this the period 0 to give an impulse to x, and the following is a discussion of the response of x_t to z_t, with $t=0$: $x_0=1, z_0=0$, $z_0=0$.

Substituting the result into Eq. (7), at $t=1$: $x_1=a_1, z_1=c_1$

Substituting this result into equation (8), at $t=2$: $x_2=a_1^2+a_2+b_1c_1, z_2=c_1a_1+c_2+d_1c_1$.

Continuing in this way, let the result be obtained as $x_0, x_1, x_2, x_3, x_4, \ldots$, is called the response function of x induced by an impulse of x.

Similarly the resulting $z_0, z_1, z_2, z_3, z_4, \ldots$, is called the response function of z induced by the impulse of x.

Of course, the impulse of period 0 is reversed, and the response function of x and the response function of z induced by the impulse of z can be found from $\varepsilon_{10}=0, \varepsilon_{20}=1$. Because impulse response functions such as these clearly capture the effects of shocks, they are similar to the shock multiplier analysis used in econometric models.

2.3.3 Analysis of variance decomposition

The variance decomposition describes the dynamics of the system from another perspective, which is the decomposition of the predicted mean-square error of the system into the contributions made by shocks to each variable. Examine the decomposition of the forecast mean square error for any of the endogenous variables in the VAR system. The s-step prediction error of a VAR model consisting of k variables is:

$$\begin{aligned} &Var\left[Y_{t+s}-E\left(Y_{t+s}\left|Y_t, Y_{t-1}, Y_{t-2}, \cdots\right.\right)\right] \\ &=X_{t+s}+J_1X_{t+s-1}+J_2X_{t+s-2}+\cdots+J_{s-1}X_{t+1} \end{aligned} \tag{9}$$

It has a mean square error of:

$$\begin{aligned} MSE &= K+J_1KJ_1'+\cdots+J_{s-1}KJ_{s-1}' = PP'+J_1PP'J_1'+\cdots+J_{s-1}PP'J_{s-1} \\ &=\sum_{j=1}^{K}\left(P_jP_j'+J_1P_jP_j'J_1'+\cdots+J_{s-1}P_{s-1}P_{s-1}'\right) \end{aligned} \tag{10}$$

where P_j is the jth column vector of matrix P, and the expression in parentheses denotes the contribution of the jth orthogonalized shock (or freshman) to the mean squared error of the forecasts at the sth step. The variance decomposition is generally performed using the relative variance contribution (RVC), which measures the extent to which the jth variable affects the ith variable by calculating the relative contribution of the jth variable's variance to the ith variable's variance after the fresh interest shock.

$$RVC_{j\to i}(\infty)=\sum_{s=0}^{\infty}\left(a_{ij}^{(s)}\right)^2\sigma_{ij}\Big/\sum_{j=1}^{k}\left[\sum_{s=0}^{\infty}\left(a_{ij}^{(s)}\right)^2\sigma_{ij}\right],i=1,2,\cdots,k \tag{11}$$

If $RVC_{j\to i}(\infty)$ is larger, it indicates that the j th variable has a stronger influence on the i th variable; conversely, it indicates that the influence is smaller.

3 Empirical analysis

3.1 Analysis of the efficiency of local cultural tourism innovation and development

3.1.1 Analysis of static evaluation of innovation efficiency

(1) Evaluation and analysis of comprehensive efficiency

Comprehensive efficiency refers to the ability of the cultural tourism industry to get the maximum output under certain innovative input elements. When the value of comprehensive efficiency is 1, the comprehensive efficiency is effective, and the innovation output reaches the maximum, which means that the innovation input elements have achieved the due output, and the input elements are not wasted; when the value of comprehensive efficiency is less than 1, the comprehensive efficiency is ineffective, which means that the maximum output is not obtained under the existing level of innovation input elements, and the input elements are wasted.

Table 2 shows the changes in the comprehensive efficiency of innovation in the cultural tourism industry in Tianmei Art Neighborhood, where mean value 1 is the average value from 2015-2024 and mean value 2 is the average value from 2015-2023.

From an overall point of view, during the period of 2015-2024, the average value of the annual average comprehensive efficiency of the four regions is 0.794, and the average annual average comprehensive efficiency value of eight of these years is greater than the average value, indicating that the innovation efficiency of the cultural and tourism industry of the four regions as a whole is at a higher level, and the innovation input elements have been utilized at a higher level. Among them, the annual average comprehensive efficiency level is higher in 2015, 2016, 2022 and 2023, which are 0.971, 0.943, 0.806 and 0.757 respectively; the lowest annual average comprehensive efficiency level is in 2024, which is 0.340. it shows that the regional cultural and tourism industry innovation and development is obviously subject to a huge impact of external influences in 2024, which is the vulnerability of the cultural and tourism industry caused by the vulnerability of the cultural tourism industry.

Table 2: 2015-2024 Comprehensive Efficiency of Cultural Tourism Innovation

Time	Region 1	Region 2	Region 3	Region 4	Mean
2015	0.898	0.985	1.000	1.000	0.971
2016	0.787	1.000	1.000	0.985	0.943
2017	0.742	1.000	0.693	1.000	0.859
2018	0.698	0.935	0.606	1.000	0.810
2019	0.658	0.974	0.53	1.000	0.791
2020	0.615	1.000	0.534	1.000	0.787
2021	0.608	1.000	0.566	0.897	0.768
2022	0.637	1.000	0.592	0.996	0.806
2023	0.582	1.000	0.532	0.913	0.757
2024	0.341	0.203	0.346	0.47	0.340
Mean 1	0.657	0.910	0.640	0.926	0.783
Mean 2	0.692	0.988	0.673	0.977	0.832

(2) Evaluation and analysis of pure technical efficiency

Pure technical efficiency refers to the production efficiency under the influence of factors such as the level of production technology and the level of management, ignoring the influence of scale and analyzing the gap between the actual innovation output and the theoretical innovation output under the premise of an equal amount of innovation input elements in the process of innovation and development of cultural tourism industry.

Table 3 shows the changes in the pure technical efficiency of innovation in the cultural tourism industry in the four regions of Tianmei neighborhood, where mean 1 is the average value of 2015-2024 and mean 2 is the average value of 2015-2023. As a whole, Tianmei Neighborhood's pure technical efficiency effectiveness of cultural and tourism industry innovation is high in the study period of 2015-2024, with a mean value of 0.934, which means that Tianmei Neighborhood pays great attention to the use of existing science and technology in the development of cultural and tourism industry innovation. The highest pure technical efficiency is 0.991 in 2022, and the lowest is 0.681 in 2024, with a difference of 0.301, reflecting that external factors have a greater impact on the region's cultural tourism industry in 2024.

Table 3: Pure Technical Efficiency of Cultural Tourism Innovation from 2015 to 2024

Time	Region 1	Region 2	Region 3	Region 4	Mean
2015	1.000	0.867	1.000	1.000	0.967
2016	1.000	1.000	1.000	0.928	0.982
2017	1.000	1.000	0.936	1.000	0.984
2018	0.936	1.000	1.000	1.000	0.984
2019	1.000	0.972	1.000	0.889	0.965
2020	1.000	1.000	0.941	1.000	0.985
2021	0.757	1.000	0.917	1.000	0.919
2022	1.000	0.963	1.000	1.000	0.991
2023	0.619	1.000	0.894	1.000	0.878
2024	0.331	0.559	1.000	0.836	0.681
Mean 1	0.864	0.936	0.969	0.965	0.934
Mean 2	0.924	0.978	0.965	0.980	0.962

(3) Scale efficiency evaluation analysis

When the scale efficiency is 1, it indicates that the scale of innovation development of cultural tourism industry is reasonable and effective, and there is low input and high output; when the scale efficiency is less than 1, it indicates that the scale of production of innovation development of cultural tourism industry is ineffective. Ineffective scale compensation exists in two cases of increasing scale compensation or decreasing scale compensation, when the scale compensation increases, it is necessary to increase the innovative input elements of cultural tourism industry to play out the scale advantage; when the scale compensation decreases, it is not necessary to consider the impact of the production scale, and it is necessary to improve the efficiency from the other aspects such as technology, management and so on.

1) Changes in scale efficiency

Table 4 shows the changes in the scale efficiency of innovation in the cultural tourism industry in the four regions of Tianmei Art Neighborhood, where mean 1 is the average value of 2015-2024 and mean 2 is the average value of 2015-2023. From an overall perspective, during the period of 2015-2024, the mean value of the innovation scale efficiency of the cultural tourism industry in Tianmei Art Neighborhood is 0.802, which is at a relatively high level overall, indicating that the cultural tourism industry in the individual regions is almost in the most appropriate conditions for the scale of investment in the development of innovation. The highest mean value of the innovation scale efficiency of the cultural tourism industry is 0.966 in 2015, and the lowest mean value is 0.632 in 2024, with a difference of 0.334 between the most values.

Table 4: Innovation Scale Efficiency of Cultural Tourism Industry from 2015 to 2024

Time	Region 1	Region 2	Region 3	Region 4	Mean
2015	0.888	0.977	1.000	1.000	0.966
2016	0.777	1.000	1.000	0.998	0.944
2017	0.732	0.998	0.693	1.000	0.856
2018	0.688	0.927	0.606	1.000	0.805
2019	0.648	0.966	0.53	0.993	0.784
2020	0.605	1.000	0.534	0.989	0.782
2021	0.598	1.000	0.566	0.982	0.787
2022	0.627	1.000	0.592	0.999	0.805
2023	0.572	1.000	0.532	0.548	0.663
2024	1.000	0.346	0.346	0.835	0.632
Mean 1	0.714	0.921	0.640	0.934	0.802
Mean 2	0.682	0.985	0.673	0.945	0.821

2) Changes in returns to scale

Table 5 shows the changes in the returns to scale of the cultural and tourism industry in the four areas of Tianmei Art District. Here, "--" indicates that the returns to scale remain unchanged, "irs" indicates an increasing return to scale, and "drs" indicates a decreasing return to scale. Overall, during the period from 2015 to 2024, in terms of time sequence, each year presents three situations of unchanged returns to scale, increasing returns to scale, and decreasing returns to scale to varying degrees, with significant regional differences.

Table 5: Scale returns of innovation in cultural tourism industry from 2015 to 2024

Time	Region 1	Region 2	Region 3	Region 4
2015	drs	drs	--	--
2016	drs	--	--	drs
2017	drs	drs	drs	--
2018	drs	drs	drs	--
2019	drs	drs	drs	--
2020	drs	--	drs	drs
2021	drs	--	drs	drs
2022	drs	--	drs	drs
2023	drs	--	drs	drs
2024	drs	irs	drs	irs

3.1.2 Analysis of dynamic evaluation of innovation efficiency

According to the Malmquist index model, the total factor productivity and decomposition efficiency of innovation in the cultural tourism industry in the four regions of Tianmei Art Neighborhood in 2015-2024 were measured using DEAP2.1 software, as shown in Table 6. The results show that in the 2015-2024 time interval, although the total factor productivity index of cultural tourism industry innovation in the four regions of Tianmei Art Neighborhood fluctuates slightly, the total factor productivity index is greater than 1, indicating that except for the external influence received in the 2015-2024 period, the efficiency of cultural tourism industry innovation is in a state of improvement in different time intervals. During the study period, the average total factor productivity of cultural tourism industry innovation is 1.043, which means that the total factor productivity of cultural tourism industry innovation in Tianmei Art Neighborhood has increased at an average annual rate of 0.8% from 2015-2024, and the development of cultural tourism industry innovation has been continuously improved.

Table 6: Total Factor Productivity and Decomposition of Time Series Changes

Time	TEC	TC	PTE	SE	TFP
2015-2016	1.021	1.146	1.016	0.999	1.155
2016-2017	0.96	1.159	0.997	0.955	1.099
2017-2018	0.999	1.128	1.008	0.987	1.112
2018-2019	0.996	1.093	0.999	0.989	1.074
2019-2020	1.001	1.113	0.994	0.999	1.104
2020-2021	1.041	1.084	1.021	1.018	1.114
2021-2022	1.061	1.061	1.008	1.051	1.111
2022-2023	1.001	1.105	1.009	0.989	1.092
2023-2024	0.594	0.886	0.752	0.793	0.526
Mean	0.964	1.086	0.978	0.976	1.043

3.2 VAR modeling

3.2.1 Unit root test for data

Unit root test is a criterion to detect whether the time series data is smooth or not, because the variables have trend term and intercept term, this paper mainly uses the ADF unit root test, the test results are shown in Table 7. It is not smooth at the significance level of 0.05, so the variables are differentiated, and the T-value of the differentiated data exceeds the critical value, and both variables pass the test at the significance level of 0.01, so the series are single-integrated.

Table 7: ADF unit root test

Variable	T	probability	stability
ZXS	-0.2245	Unstable	0.9729
DZXS	-7.3056	steady	0.0001**
ETI	-1.5827	Unstable	0.8457
DETI	-4.9361	steady	0.0075**

Note: * indicates significant at the 0.05 confidence level, ** indicates significant at the 0.01 confidence level.

3.2.2 Determination of variable lag order

From Table 7, it can be seen that the two variables are single-integrated series, and the VAR model can be further established to determine whether there is a cointegration relationship between the two variables, mainly through the LR statistic, the PEC, AIC, SC, and HQ, and other five criteria to determine the lag order of the VAR model. By repeatedly testing the lag period criteria on the variables, the test results were finally determined as shown in Table 8. Among the 5 informative criteria for lag period determination, all 5 judgment criteria determined the lag period as 3 periods. Therefore, the lag order of the VAR model of ZXS and ETI can be finally determined as 3, and the VAR(3) model of ZXS and ETI can be established.

Table 8: Determination of Optimal Lag Period of VAR Model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	55.6721	NA	4.14E-05	-9.1863	-9.2148	-9.2121
1	72.8343	29.2105	5.19E-06	-11.1784	-10.5826	-11.2156
2	77.0167	7.1428	5.43E-6	-11.1937	-10.4832	-11.2579
3	91.0138	16.0427*	11.27E-08*	-12.5816	-12.0511	-12.6532*

3.2.3 Cointegration test of variables

In order to test whether there is a long-term stable relationship between ZXS and ETI, this paper adopts the Johansen cointegration test, and the lag order selected for the cointegration test should be equal to the lag order of the unconstrained VAR model minus 1, i.e., the lag order for the cointegration test is 2, and the test results are shown in Table 9.

ZXS and ETI two variables of the cointegration equation test, trace test no cointegration equation number of probability at the 0.05 level of significance through the test, that is, rejected the development of higher art education and local culture and tourism innovation and development of the efficiency optimization and upgrading of the hypothesis of the non-existence of cointegration equations, at least one of the number of cointegration equations is also in the 0.05 level of significance through the test, all the two variables there must be a cointegrating relationship equation.

Table 9: The Co-integration Test Results of ZXS and ETI

Variable	Trace test				
	Hypothesis		Trace	0.05	
	Number of cointegration equations	Characteristic root	Statistics	Critical value	Probability
ZXS and ETI	Not have*	0.713257	32.84351	27.83243	0.01243
	At least one*	0.672142	16.88276	14.21628	0.0214

3.2.4 Determination and testing of VAR models

Combining the above test results, it is determined that the VAR(3) parameter estimation results of the optimization and upgrading of the efficiency of the development of higher art education and local cultural and tourism innovation development with a lag order of 3 are shown in Table 10. From Table 10, the VAR(3) model of ZXS and ETI can be finally obtained as:

$$\begin{bmatrix} ZXS \\ ETI \end{bmatrix} = \begin{bmatrix} -0.3135 \\ 0.21165 \end{bmatrix} + \begin{bmatrix} 0.97245, -0.12467 \\ 0.09654, 0.65163 \end{bmatrix} \begin{bmatrix} ZXS \\ ETI \end{bmatrix} t1 + \begin{bmatrix} -0.32185, -0.10324 \\ -0.15832, 0.45385 \end{bmatrix} \begin{bmatrix} ZXS \\ ETI \end{bmatrix} t$$
$$2 + \begin{bmatrix} 0.1424, \ 0.65163 \\ 0.19243, -0.07931 \end{bmatrix} \begin{bmatrix} ZXS \\ ETI \end{bmatrix} ts + \begin{bmatrix} \xi_1 \\ \xi_2 \\ \xi_3 \end{bmatrix} \quad (12)$$

where t=2015,2016,2017,2018, ... 2024.

Table 10: Model parameter analysis results

	ZXS	ETI
ZXS(-1)	0.9724521	-0.1245735
	0.1314737	0.6112851
	[10.21376]	[-0.22816]
ZXS(-2)	-0.3218461	-0.1032436
	0.6017285	0.3310874
	[-7.08432]	[-0.33842]
ZXS(-3)	0.1424015	-0.0510395
	0.0336584	0.1727526
	[3.86662]	[-0.31129]
ETI(-1)	0.0965415	0.6516328
	0.0874324	0.3874271
	[1.47983]	[1.73193]
ETI(-2)	-0.157322	0.4538451
	0.0812741	0.4467524
	[-1.735923]	[0.89214]
ETI(-3)	0.1924326	-0.0793161
	0.0911673	0.4014826
	[2.42485]	[-0.21652]
C	-0.313475	0.2116435
	0.1774273	0.8517283
	[-1.89382]	[0.25672]

The results of the VAR(3) model test are shown in Figure 1. For the VAR(3) model of ZXS and ETI with 3-period lag, the AR characteristic polynomial has six roots and the inverses of the six roots are in the unit circle, and the adjusted R-squared coefficient of the model estimation results is 0.981237, the model fits the dependent variable well, and the explanatory variables derived from the analysis explain the majority of the dependent variable very well, from which it can be judged that the establishment of ZXS and ETI's VAR(3) model is stable.

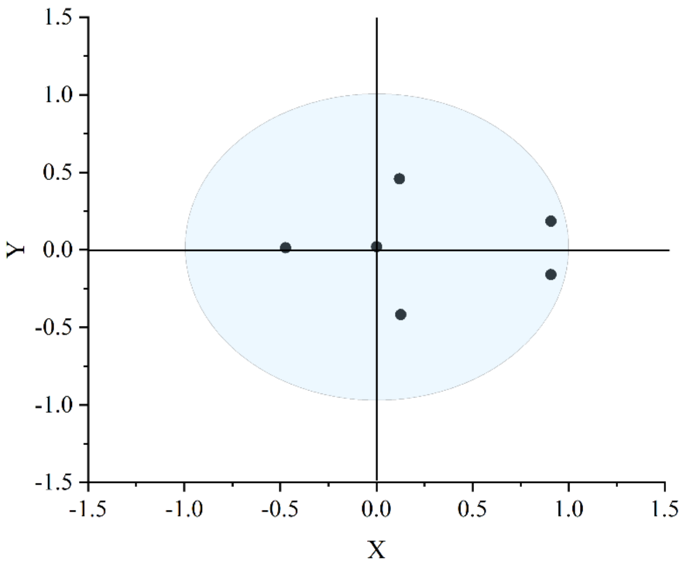


Figure 1: Var(3) Stability test results of the model

3.3 Impulse response and variance decomposition analysis

3.3.1 Causality tests for variables

The results of Granger test on the development of higher art education and the efficiency of local cultural tourism innovation and development are shown in Table 11.

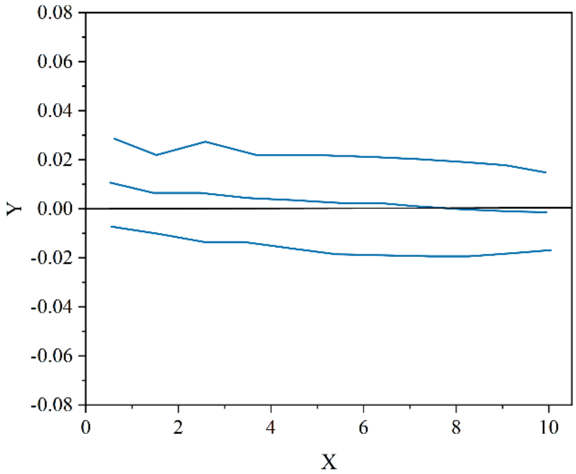
The probability of P-value in the penultimate column is 0.0142, which shows that changes in the efficiency of local cultural tourism innovation and development can cause changes in the development of higher art education, and the effect of upgrading the efficiency of local cultural tourism innovation and development on the development of higher art education is significant (the significance level is 5%); although changes in the development of higher art education are not the Granger cause of the changes in the efficiency of local cultural tourism innovation and development, they have a stronger contributing effect on the development of local cultural tourism innovation and development in terms of the probability (0.1528). 0.1528), it has a stronger and more powerful role in promoting the efficiency of local cultural tourism innovation and development. Thus, it can be verified that there is a mutual influence relationship between the development of higher art education and the efficiency of local cultural tourism innovation and development, and there is a long-term cointegration relationship between the two in the time series.

Table 11: Causality Test Results

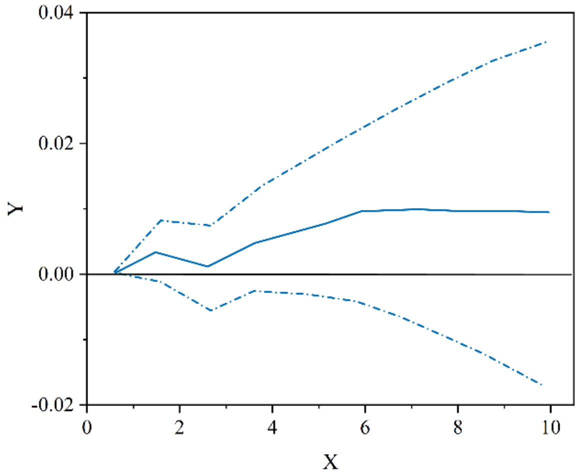
	Dependent variable ETI		
Get rid of	Chi-square test	Free degree	Probability
ZXS	6.01438	3	0.1528
ALL	6.01438	3	0.1528
	Dependent variable ZXS		
Get rid of	Chi-square test	Free degree	Probability
ETI	11.78431	3	0.0142
ALL	11.78431	3	0.0142

3.3.2 Impulse Response Analysis

The response impulse function of higher fine arts education development (ZXS) and local cultural and tourism innovation development efficiency (ETI) is shown in Figure 2. The shocks of higher fine arts education development on local cultural tourism innovation and development efficiency are all positive shocks from period 1 to period 7, indicating that the rapid development of the educational scale of higher fine arts education development and when it reaches the critical point of each institution's hardware and software accommodation, it has a promoting effect on the local cultural tourism innovation and development efficiency. After the 7th period, the effect of the shock slows down, and the role of higher fine arts education development on the efficiency of local cultural and tourism innovation and development is weakened, and the shock is -0.00157 by the 10th period.



(a) Response of ETI to ZXS



(b) Response of ZXS to ETI

Figure 2: Pulse response function of ZXS and ETI

3.3.3 Analysis of variance decomposition

The variance decomposition is to update the contribution of each variable to the impact of the VAR system variables, is a description of the relative effect, this method can estimate the degree of impact of the variables on the VAR model and the role of lagged periods, the test results are shown in Table 12.

In the entire 10-period ZXS and ETI variance decomposition: the efficiency of local cultural and tourism innovation development in addition to the first period does not have any contribution to the development of higher art education, in the 2nd and 3rd period impact effect is relatively not particularly obvious, in the 4th period after the contribution to the degree of impact on the higher art education, the variance of the contribution of the higher art education is constantly enhanced, the lagged impact on the rate of change of the development of the higher art education itself has been on the rise and in the 10th period reached the highest, able to explain the change in the The lagged effect on the rate of change of higher art education development has been rising, and it reaches the highest in the 10th period, explaining 76.09347% of the rate of change, indicating that the rate of change of the efficiency of local cultural and tourism innovation and development has a relatively large contribution to the development of higher art education; although higher art education has a relative impact on the efficiency of local cultural and tourism innovation and development in the first period, but the impact continues to diminish throughout the 10-period variance decomposition until the 10th period when it reaches 6.11772, explaining only 6.11772% of the rate of change. able to explain 6.11772% of the rate of change, much lower than the rate of change explained by the efficiency of local cultural tourism innovation and development on higher fine arts education, although the impact gradually weakened, but still has a contributing effect on the efficiency of local cultural tourism innovation and development.

Table 12: Var(3) variance decomposition results of the model

Lag phase	Variance decomposition of ZXS		Variance decomposition of ETI	
	ZXS	ETI	ZXS	ETI
1	100.0000	0.000001	9.248142	92.117623
2	90.77127	11.24875	9.469726	92.75249
3	91.83596	10.08534	9.510058	93.54947
4	78.78625	23.41272	7.657823	94.27415
5	62.75714	39.45326	7.233215	94.79638
6	49.29172	55.04285	6.59018	95.21794
7	40.51384	61.39247	6.31782	95.57088
8	34.30261	67.62483	6.22753	95.79574
9	29.82008	72.08175	6.10453	95.82091
10	26.75836	76.09347	6.11772	95.81418

4 Conclusion

The study selected the annual consumption of stores in Tianmei art neighborhood from 2015 to 2024 as the data source, and used the DEA-Malmquist model to measure the dynamic efficiency of cultural tourism industry innovation in the four core areas of Tianmei neighborhood from 2015 to 2024. The efficiency of higher art education and local cultural tourism innovation development is empirically tested based on the VAR model. The data results show that the overall level of comprehensive efficiency of cultural tourism industry innovation in the four regions of Tianmei Art Neighborhood is high, and the average value of the annual average comprehensive efficiency of the four regions in 2015-2024 is 0.794, and the average value of the scale efficiency of cultural tourism industry innovation in Tianmei Art Neighborhood in 2015-2024 is 0.802. The test results show that there is an equilibrium between higher fine arts education and the efficiency of local cultural tourism innovation development relationship, and the efficiency of local cultural tourism innovation development can promote the changes in the scale of higher art education, and the effect is significant.

About the Author

Tingting Li was born in Huai'an, Jiangsu China, in 1981. She obtained a master's degree from NanJing Normal University in China. From June 2008 to now, she has been teaching in the Department of Photography Art of Tianjin Academy of Fine Arts, and has been engaged in teaching courses such as Portrait Photography and Photography Investigation and Practice for a long time.

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