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Modeling Research on the Interaction Relationship between Tourism Culture and Local Economy Based on Network Analysis

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Abstract The organic combination of culture and tourism can promote the effective dissemination of tourism culture, and the enhancement of cultural popularity can lead to the increase of local economic income. The article adopts the tourism economic data of 10 tourism provinces in China, analyzes the correlation relationship between tourism culture and local economy based on MS-VAR model and regression model, and then uses the network analysis method to portray the spatial correlation network between tourism culture and local economy. The final conclusions are: the promotion effect of local economy on tourism culture is smaller than the promotion effect of tourism culture on local economy, and for both of them, the biggest promotion effect is still their own factors. The change trend of local economy for the promotion of tourism culture is weaker, and the promotion of tourism culture for the local economy is more obvious.

Index Terms MS-VAR model, network analysis, tourism culture, local economy

I. Introduction

Tourism is a complex of commercial investment and consumption, and its development is closely related to culture [1]. Culture carries the material and spiritual dimensions of human beings, is the form of life elements of regional human beings, and is the product of human spiritual activities and their activities [2]. Combining culture and tourism, and at the same time, broadening the depth and breadth of integration, so that it can become a practicable symbiosis to promote the sustainable and effective development of the local tourism economy [3]-[5].

The development of tourism and cultural industries can promote scientific and technological and cultural exchanges, and have a positive effect on the promotion of local economic development [6], [7]. As tourism has a very prominent role in linkage, the development of tourism can bring a large number of people, logistics, information flow, capital flow, not only directly to the transportation, food and beverage, business, scenic spots to bring sources of customers and markets, but also through the tourism to bring the latest technology, information and advanced management concepts, drive and influence the development of local economy [8]-[11]. Tourism culture construction is the modern tourism industry to maximize the effectiveness of the effectiveness of the new business management ideas, cultural tourism will be the characteristics of personal experience in tourism and the connotation of culture in the depth of the integration, to create a valuable form of consumption [12]-[14]. At the same time, along with the development of tourism and culture industry, the inter-regional tourism links are getting closer and closer, forming a complex spatial correlation of tourism economy [15], [16]. Therefore, it is necessary to explore the changes of spatial association network between tourism and culture industry and local economy from the perspectives of “association network” and “intensity of association”, so as to provide reference for formulating relevant policies, optimizing the network structure, and promoting the synergistic development of regional tourism and culture industry [17]-[19].

The article firstly constructs the MS-VAR model and regression model, and identifies the data sources. Then it introduces the related concepts of network analysis, analyzes their respective statistical properties, and briefly introduces some basic usages of UCINET. Subsequently, an empirical study is conducted with 10 Chinese tourism provinces as an example, and the smoothness of the data is tested to ensure the smoothness of the data, and the accuracy of the model is ensured by determining the optimal lag order. The spatial correlation between tourism culture and local economy is further investigated by Granger test and network analysis. Finally, the impulse response function and variance decomposition are used to explore whether there is a long-term or short-term cointegration relationship between tourism culture and local economic development and the process.

II. Modeling of interactions based on network analysis theory

II. A.MS-VAR model

The Markov Chain Transition Vector Autoregressive (MS-VAR) model is a model for time series analysis, which is usually used to describe discrete time series data with different states. The model combines the features of autoregressive model and Markov chain model, so it can be used to predict the future state of the series, and can also be used for the determination and study of the cycle. The advantages of the model are:

(1) The introduction of regional system transition variables better describes the movement law and transition process of the economic cycle.

(2) It has more realistic economic significance for the nonlinear fitting of the model.

The model mainly contains:

(1) State variable: indicates which state the time series is in.

(2) Transfer probability: indicates the probability that the time series will transfer to another state in one state.

(3) State equation: Indicates how the state variable changes over time.

(4) Observation equation: Indicates how the time series produces different observations in different states [20].

II. B.Study design

II. B. 1) Research ideas

In this study, the MS-VAR model is first used to measure the overall local economy and tourism culture, and to observe the cycles of both. After that, the economic stability of each period of the sample is measured, aiming to capture the fluctuation characteristics of the local economy in different cyclical states. After determining the stability of the sample period, the panel regression model is used to further analyze the relationship between the local economy and the development of tourism and culture, and to explore the role of tourism and culture in promoting the stable operation of the local economy. After that, the group regression model is used to analyze the different regions and periods in detail, in order to reveal the existence of regional and temporal heterogeneity, and further illustrate the differences in the influence of tourism culture on the stability of the local economy.

II. B. 2) MS-VAR Model Setting

In this study, the autoregressive Markov zone transition model with two zones system is adopted, and the upper value of the state is set as low growth zone system and high growth zone system, and the expression of this model can be shown as follows:

$$Tour_t - \mu_{st} = \sum_{k}^{q} = \varphi_k (TRG_{t-k} - \mu_{s_{t-k}}) + \sigma_{st}\varepsilon_t \tag{1}$$

$$\mu_S = \mu_0(1-S_t) + \mu_1 S_t, \sigma_S = \sigma_0(1-S_t) + \sigma_1 S_t \tag{2}$$

Equation (1) exhibits the mean form, where $Tour_t$ represents the state of the local economy at moment t, available per capita income. Equation (1) is an AR(k) model, where φ_k represents the coefficients of lagged order k, and ε_t represents the white noise in the form of $\varepsilon_t \sim i.i.d.N(0,1)$, $S_t = \{0,1\}$, representing the regional system of local economic cycle, in other words, whether the local economic cycle is in low or high growth, and μ_s and σ_s represent the mean and variance of different regional systems, i.e., the mean and variance of the local economic situation in the case of low and high growth. The transition probability matrix for the district system is shown below:

$$P = \begin{pmatrix} P_{11} & P_{12} \\ P_{21} & P_{22} \end{pmatrix} \tag{3}$$

where: P_{11} denotes the probability that the current period is in the 1-zone system and the next period is in the 1-zone system. P_{12} denotes the probability that the current period is in the 1-region system and the next period is in the 2-region system, and the rest of the probabilities denote and so on. The stability of the economic cycle can be measured by P_{11} and P_{22}. In this paper zone system 1 represents the economic cycle in a low growth state and zone system 2 represents the economic cycle in a high growth state. The selection of the optimal lag order of the model is judged by the Akashi-Information Criterion (AIC) and the Schwartz Criterion (SBC), when the smaller the value of the following function is taken, it means that the model fitting state is better. Namely:

$$AIC = N * \log(SSR) + 2K \tag{4}$$

$$SBC = \log(SSR) + K * \log(N) \tag{5}$$

where: the SSR represents the residuals of the model, N represents the number of samples, and K represents the number of explanatory variables in the model. The final model results are presented as the likelihood of the sample being in a certain zone system in each period.

II. B. 3) Regression modeling

In this paper, a fixed effects model is used to construct a lower base regression model:

$$Tst_{it} = \alpha_0 + \alpha_1 DigE_{it} + \alpha_2 Control_{it} + \mu_i + \sigma_i + \varepsilon_{il} \tag{6}$$

where: $DigE_i$ is the core explanatory variable, representing the level of tourism and culture development of the i th province at t time, constructing the evaluation index system of the level of tourism and culture development in terms of industrialization, digitization, and the related infrastructure construction, and calculating the specific values by using the entropy value method. Tst_i is an explanatory variable, representing the degree of stability of the tourism cycle of the i th province at time t. Numerically, it can be expressed as the ratio of the probability of the side with the smaller probability of being in the expansion zone system to the probability of the larger side in two neighboring periods. If P_{it} denotes the probability that province i is in the expansionary zoning system in period t, and $P_i(t+1)$ denotes the probability that province i is in the expansionary zoning system in period $t+1$, then $Tst_i(t+1)$ can be expressed as:

$$Tst_{i(t+1)} = \begin{cases} \dfrac{P_{it}}{P_{i(t+1)}}, P_{it} < P_{i(t+1)} \\ \dfrac{P_{i(t+1)}}{P_{it}}, P_{i(t+1)} \le P_{it} \end{cases} \tag{7}$$

It can be seen that when the probability of two adjacent periods being in the expansion zone system is close, it represents the more stable its local economy is in that time span, and the more stable the tourism cycle is, the larger it is numerically, and the closer it is to 1. And when the probability of two adjacent periods being in the expansion zone system is significantly different, it represents the local economy is fluctuating in that time span, and the more fluctuating the tourism cycle is the smaller it is numerically, and the closer it is to 0.

In expression (5), $Control_{it}$ is the control variable, and with reference to previous studies on the local economy, the level of economic development (Econ), tourism resources (TourR), accessibility (Traf), infrastructure development (Infra), and openness (Open) are included as control variables in the model. Tourism resources are represented by the number of scenic spots of grade 4A and above. Transportation accessibility is expressed as the ratio of highway mileage to urban land area. Infrastructure construction is expressed as investment in fixed assets: the level of economic development is expressed as GDP per capita, and openness is expressed as the ratio of total imports and exports to GDP. μ_i and σ_t denote individual fixed effects and time fixed effects, respectively, and ε_{it} is the random error term.

II. B. 4) Data sources

This paper uses tourism data from 10 major Chinese tourism provinces from 2020-2024 for the experiment. The data were obtained from the China Statistical Yearbook and the statistical yearbooks of each province. In order to ensure the accuracy of the data, the data samples were shrunk by 1% and the missing values were filled in by interpolation.

II. C.Network analysis methods

II. C. 1) Complex network theory

(1) Definition and Characterization of Complex Networks

For complex systems, complex networks regard their elements as nodes and the relationships of nodes as edges, unfolding a series of abstract descriptions, which are considered as complex networks if the network structure is not standardized and has a complex form and large scale [21]. Complex networks have a variety of properties, its three most basic properties, namely: agglomeration, small world and scale-free.

(2) Statistical properties of complex networks

When conducting research, scholars usually adopt some statistical parameters to describe the topology of complex networks and explore the macroscopic properties of complex networks, and there are three most basic parameters, namely: degree and degree distribution, average path length, and clustering coefficient. Among them:

a) Degree and degree distribution

The total number of edges connecting a node with other nodes is called the degree of the node, and the degree can be used to describe the properties of the node, which has a very important role in the analysis of complex networks. The higher the status of a node in a network means that the node has a higher degree value, the average degree of the network is denoted as $\langle k \rangle$, that is:

$$\langle k \rangle = \frac{1}{N} \sum_{i=1}^{N} k_i \tag{8}$$

where N is the total number of nodes in the network.

Not all nodes in the network have the same number of edges. Remember $p(k)$ is the probability of any extracted node in the network with degree k, then the function $p(k)$ is the degree distribution function of the node, which is used to describe the distribution of node degree. In addition, the cumulative degree distribution function can also be used to reflect the dispersion of node degree, the cumulative degree distribution function is:

$$p(k) = \sum_{i=k}^{\infty} p(i) \tag{9}$$

In a fully connected network or in a regular network, the degree distribution function $p(k)$ is a function that obeys a Poisson distribution because the degrees are the same for all nodes in a fully connected network. However, in the real complex network, a large number of real networks obey the power exponential distribution with the distribution function of $p(k) \sim k^{-r}$, and do not present an ideal Poisson distribution, where r is usually between 2 and 3, and the network that satisfies the distribution can be regarded as a "scale-free network", that is, the network has "scale-free".

b) Average path length

Remember that two nodes in the network are n_i and n_j, and d_{ij} is the distance between the two nodes, i.e., the smallest number of edges connecting that node [22]. If there are no paths connecting n_i and n_j, then $d_{ij} = \infty$, the maximum distance between any two nodes in the network, denoted as D, i.e:

$$D = \max_{1 \le i \le j \le N} d_{ij} \tag{10}$$

where N is the total number of nodes in the network.

Averaging the distances between all pairs of nodes yields the average path length of this network graph, which portrays the size of the network and is denoted as L, i.e:

$$L = \frac{1}{N(N-1)/2} \max_{1 \le i \le j \le N} d_{ij} \tag{11}$$

The average path length of the network represents the degree of separation of each node, or reflects the strength of connectivity of the network graph, the smaller L is, the smaller the degree of separation of the nodes, the stronger the connectivity of the network graph, and vice versa, the larger L is, the greater the degree of separation of the nodes, the worse the connectivity of the network graph.

c) Clustering coefficient

The clustering coefficient is an important indicator of the level of node aggregation. If the k nodes adjacent to the node n_i happen to be all neighboring nodes to each other, from the point of view of the undirected network, there are at most $k(k-1)/2$ edges between these k nodes, from the point of view of the directed network, there are at most $k(k-1)$ edges among these k nodes, no matter which kind of network, remember that the network the actual number of edges is E_i, then:

The clustering coefficient of node n_i in a wireless network is:

$$C_i = \frac{2E_i}{k(k-1)} \tag{12}$$

The clustering coefficient of node n_i in a directed network is:

$$C_i = \frac{E_i}{k(k-1)} \tag{13}$$

Then, the average clustering coefficient of the network is:

$$C = \frac{1}{N}\sum_{i=1}^{N} C_i \quad (0 \le C \le 1) \tag{14}$$

where N is the total number of nodes in the network, C takes values in the range [0, 1], and $C = 0$ when only isolated points exist in the network. When all nodes in the network are fully connected, $C = 1$.

II. C. 2) Social network analysis methods

(1) Definition of social network

Social network consists of nodes and their edges, nodes are regarded as actors, and edges are regarded as relationships of actors, which is equivalent to the set containing individual actors and their relationships.

(2) Statistical properties of social networks

The centrality analysis of social network analysis is to analyze whether each individual or the whole organization in the network is in an important and key position in the whole social network, whether it has the power or not, and the size of the power it has, and the object of its study is the nodes in the network or the whole network. Depending on the type of statistics, centrality indicators can be divided into various types, of which the most important types are: degree centrality, intermediate centrality and proximity centrality.

a) Degree Centrality

Degree centrality refers to the total number of connected edges of a node, it is the simplest indicator to evaluate the position of the node in the whole network, which represents its participation in the network, the higher the degree, the more important the position in the network. The centrality of a node is described by counting the number of nodes whose changes in this node have a direct effect on the rest of the network, there are two kinds of metrics usually used to measure the centrality of a point, namely, absolute centrality and relative centrality.

Denote the absolute centrality as C_{AD}, then the absolute centrality for a node i can be expressed as:

$$C_{AD}(i) = d_i = \sum_{j \in G} g_{ij} \tag{15}$$

where d_i denotes the degree of node i. If there exists a connection between i and j, then $g_{ij} = 1$. Conversely, if there is no connection between i and j, then $g_{ij} = 0$.

Remembering the relative centrality as C_{RD}, the relative centrality for a node i can be expressed as:

$$C_{RD}(i) = \frac{C_{AD}(i)}{n-1} \tag{16}$$

where n denotes the number of nodes in the association network.

b) Intermediate Centrality

Intermediate centrality is the proportion of the number of shortest paths through a node in the number of shortest paths in the network, reflecting the degree of dominance over resources [23]. The larger the value, the more it is on the shortest paths of many pairs of nodes, acting as an “intermediary”.

The absolute intermediate centrality of a point is C_{ABi}, and the absolute intermediate centrality of a point i can be expressed as follows:

$$C_{ABi} = \sum_{j}^{n}\sum_{k}^{n} b_{jk}(i), i \ne j \ne k, j < k \tag{17}$$

where $b_{jk}(i)$ denotes the probability that the point i is on the shortcut between the point pair j and k.

Noting that the relative intermediate centrality of a point is C_{RBi}, the relative intermediate centrality of the point i can be expressed as:

$$C_{RBi} = \frac{2C_{ABi}}{n^2 - 3n + 2} \tag{18}$$

where n denotes the total number of nodes in the network.

c) Proximity centrality

Proximity centrality is the reciprocal of the sum of the shortest path lengths from a node to other nodes. The larger the value, the smaller the distance between the node and the other nodes, the closer they are to each other and the more influence they will produce.

Remember that the absolute proximity centrality is C_{APi}, then the absolute proximity centrality of point i can be expressed as:

$$C_{APi} = \frac{1}{\sum_{j \in G} d_{ij}} \tag{19}$$

where G is the set of nodes.

Remembering the relative proximity centrality as c_{RPi}, the relative by proximity centrality of the point i can be expressed as:

$$C_{RPi} = \frac{n-1}{C_{APi}^{-1}} \tag{20}$$

where n denotes the total number of nodes in the network.

II. C. 3) Introduction to the social network analysis software UCINET

UCINET software is full-featured.UCINET has a universal goal, easy to use, with many integrated software, including NetDraw is mainly used to analyze one-dimensional and two-dimensional data, providing a convenient way to draw social network relationship diagrams.Mage focuses on the application of three-dimensional data field.Pajek focuses on the Free application software program M used for the analysis of the structure of a large-scale network. UCINET includes many common multivariate statistical tools, such as correspondence analysis, factor analysis, and multidimensional scale analysis, cluster analysis. In addition, it can read a variety of formats, including not only the common text, excel files, but also Pajek, Negopy, KrackPlot and VNA file ra. The software analyzes the data, which are stored, presented, described and analyzed in the form of matrices, allowing a series of social network analysis to be carried out on more than 30,000 network nodes. UCINET software includes the main menu and sub-menu, sub-menu includes sub-menu, in addition, the software also provides a large number of data conversion programs, can be input data into new data, and then carry out new analysis. UCINET software has become the most commonly used, the most easy to learn and learn and the most conducive to the use of novice social network analysis of a software.

III. Empirical studies

III. A. Data testing based on MS-VAR modeling

III. A. 1) Data Smoothness Test

After second-order differencing, the series shows a stabilizing trend. According to the test results of ADF, it can also be seen that Econ, TourR, TourR, Infra and Open are all second-order single-integrated, and the t-statistic values of -4.360362, -4.501028, -4.215691, -4.51661, and -4.373625 are less than their corresponding critical values at 1% significance level, respectively. So the second order difference series of all three variables are shown to be smooth at 1%, 5% and 10% significance levels.

III. A. 2) Cointegration tests

According to the smoothness test of the variables, they are all second-order difference single-integrated series, so Johansen cointegration test is used to determine whether there is a cointegration relationship. According to the results of the eigenroot test and the maximum eigenvalue test, the P-value of the statistics of each variable is greater than 5% significance level, so there is no cointegration relationship among the five variables. From the perspective of long-term trend, there is no long-term equilibrium relationship among local economic development level (Econ), tourism resources (TourR), transportation accessibility (Traf), infrastructure development (Infra), and openness (Open), which can be examined through the establishment of a VAR model to test their short-term dynamic interaction mechanism.

III. A. 3) Construction of VAR models

(1) Determination of the lag order P. The construction of VAR model needs to determine the ideal lag term of endogenous variables first. In this paper, AIC criterion, SC criterion, HQ criterion, final prediction error criterion, likelihood ratio test and other methods are used to determine the selection of the optimal lag order. According to the selection rule of lag order P, the smaller the test value indicates that this order can better reflect the relationship between the variables. The selection of lag order of VAR model is shown in Table 1. According to the results of the table test, it can be seen that of the five evaluation indicators of the lag order of the VAR model, three indicators show that the optimal lag order is the 1st order, so it is determined that the vector autoregression model in this paper is determined as the 1st order VAR model.

Table 1: The choice of the VAR model

Model	Lag	LogL	LR	FPE	AIC	SC	HQ
VAR	0	22.05672	NA	2.45e-05	-2.125571	-1.968769	-2.121135
	1	96.48621	116.8527*	8.81e-09*	-10.05664	9.479280*	-9.998651
	2	104.3450	6.245233	1.59e-08	-9.622864	-8.5663677	-9.520625
	3	117.5726	12.99936	1.08e-08	-10.43557*	-8.950319	-10.27361*

(2) Estimation of VAR model. And it is estimated and the estimation results are as follows.The estimation of VAR model is shown in Table 2. According to the estimation results of the table, the R^2 of each single equation is high, indicating that the model fits well. From the variable significance test T-test, it can be seen that the partial regression coefficients obtained from the three equations are significant.The VAR model is a model built from data, which can dynamically simulate the process of simultaneous changes in the multivariate time series, and therefore does not need to interpret the partial regression coefficients in the VAR model in an economically meaningful manner, so in the process of the analysis, it is not concerned about the significance or otherwise of the variable significance test T-test.

Table 2: Estimation of the VAR model

LNGDP=	-15.19022	+1.565673 LNGDP(-1)	+0.149786 LNPE(-1)	-1.018634 LNRE(-1)	(2.1)
	(3.04429)	(0.13021)	(0.06261)	(0.22367)	
	R^2=0.9986622	F=48836.877	AIC=-3.934255	SC=-3.61442	
LNPE=	-12.44933	+0.961367 LNGDP(-1)	+0.6788921 LNPE(-1)	-0.7217533 LNRE(-1)	(2.2)
	(15.1633)	(0.656619)	(0.326632)	(1.06445)	
	R^2=0.9867722	F=371.6472	AIC=-0.603885	SC=-0.424936	
LNRE=	-14.082226	+0.623492 LNGDP(-1)	+0.162265 LNPE(-1)	+00.034690 LNRE(-1)	(2.3)
	(1.615536)	(0.06591)	(0.03276)	(0.12617)	
	R^2=0.9986225	F=12625.88	AIC=-5.212298	SC=-5.1124775	
4. Determinant resid covariance (dofadj.)=4.222E-09					
Determinant resid covariance=2.16E-09					
5.AIC=-10.21871			SC=-9.688671336		

III. A. 4) VAR model smoothness test

The smoothness of the model should be tested after constructing the VAR model. According to the principle of VAR model, the model is smooth when the inverse of the mode of all roots is less than 1. If the model is not stable, the corresponding results obtained are invalid. Impulse response function analysis and variance decomposition analysis cannot proceed. The unit root test is shown in Figure 1. As can be seen from the figure, the three roots of the VAR model fall into the circle, which indicates that the VAR model constructed in this paper is smooth.

III. B. Analysis of the spatial correlation between tourism culture and local economy

III. B. 1) Granger causality tests

The VAR model is constructed for tourism culture and local economy data respectively, and the smoothness of the model is tested to be stable. To study the spatial correlation effect between tourism culture and local economy, the core method is to carry out Granger causality test under the framework of VAR model, so as to identify the spatial

correlation effect between tourism culture and local economy, and then carry out the next step of the analysis on the basis of this. The results of Granger causality test of the constructed VAR model are shown in Table 3. The confidence value of Granger causality test of tourism culture on Province B is less than 0.05, and the original hypothesis is rejected that tourism culture is the Granger cause of tourism culture in Province B.

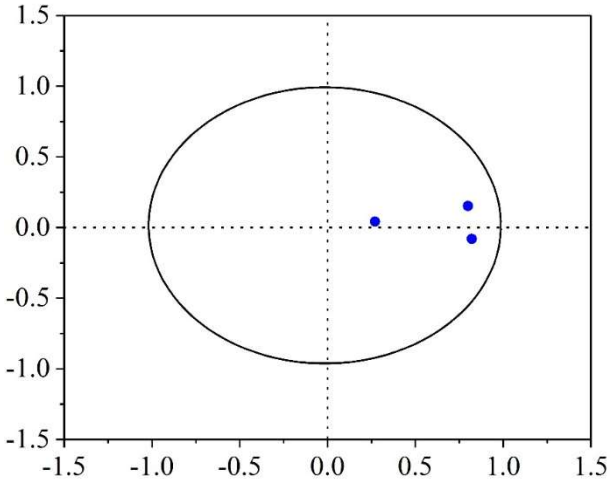

Figure 1: Unit root test

Table 3: The variance of the var model granger results

Original hypothesis	Tourism culture		
	F statistic	P value	Conclusion
Tourism culture is not the granger reason of b province	4.19	0.034	reject
B province is not a granger reason for tourism culture	0.437	0.515	acceptance
Tourism culture is not the granger reason of c province	1.235	0.267	acceptance
C province is not a granger reason for tourism culture	1.813	0.176	acceptance
Tourism culture is not the granger reason of d province	1.17	0.261	acceptance
D province province is not a granger reason for tourism culture	0.828	0.374	acceptance
Tourism culture is not the granger reason of e province	0.198	0.661	acceptance
E province province is not a granger reason for tourism culture	0.00507	0.99	acceptance
Tourism culture is not the granger reason of f province	0.588	0.451	acceptance
F province is not a granger reason for tourism culture	11.409	0.016	reject
Tourism culture is not the granger reason of g province	0.091	0.761	acceptance
G province is not a granger reason for tourism culture	3.172	0.072	acceptance
Tourism culture is not the granger reason of h province	0.622	0.425	acceptance
H province province is not a granger reason for tourism culture	0.004	0.921	acceptance
Tourism culture is not the granger reason of b province	6.646	0.01	reject
B province is not a granger reason for tourism culture	4.213	0.034	reject
Tourism culture is not the granger reason of c province	0.994	0.3	acceptance
C province is not a granger reason for tourism culture	0.058	0.785	acceptance
Tourism culture is not the granger reason of d province	2.335	0.128	acceptance
D province province is not a granger reason for tourism culture	0.135	0.703	acceptance

III. B. 2) Network structure analysis of spatial associations

Tourism culture and local economy of 10 provinces were analyzed through the matching matrix merging function of Ucinet software. The results of the Granger causality test of the VAR model were sorted out, the data were processed according to the social network analysis paradigm, and the network was visualized by using the NetDraw tool of the Ucinet analysis software. The spatial association network of tourism culture and local economy is shown in Figure 2. From the figure, it can be obtained that there is a significant price spatial correlation effect between tourism culture and local economy, and this linkage effect presents an obvious network structure characteristic.

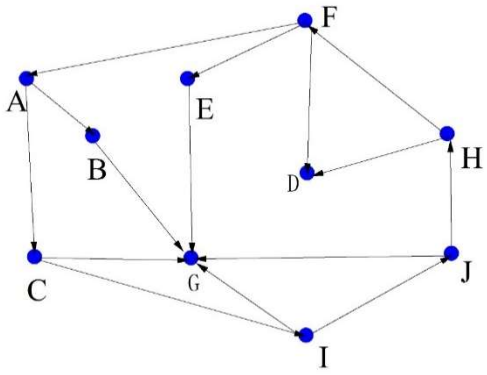

Figure 2: Spatial correlation network

The quantitative study of power in social network analysis usually adopts the relevant index of “centrality” for analysis. We analyze the spatial correlation effect from three dimensions: point centrality, proximity centrality and mediation centrality. According to the operation of Ucinet analysis software, the network centrality of the spatial correlation effect of citrus price in each main production area was calculated, and the centrality of the spatial correlation network point degree is shown in Table 4. From the perspective of point degree centrality, in the spatial correlation network, the point degree centrality ranks in the order of G, I, J, B, F, A, E, C, H and D, among which the first province G has the most correlation with other regions, indicating that G province is in the "core position" of the network and plays an important role in the network and is in the core position in the transmission of tourism and cultural space.

Table 4: Spatial correlation network point center

province	Point center				Proximity center						Intermediate center	
	Point center	ranking	Point of point	Point of entry	approach Center degree	ranking	External proximity	Inner proximity	Point of point	Point of entry	Intermediate center	ranking
A	1	6	1	1	9	1	13	23	40	24	0	5
G	3	1	2	2	5	6	25	3	26	84	3	4
B	2	4	1	0	6	2	3	28	17	29	0	4
C	6	8	2	2	10	3	21	8	25	62	0	4
F	4	5	2	2	7	7	21	25	24	72	3	3
D	5	10	3	3	6	10	14	26	36	21	2	2
I	8	2	4	1	3	5	27	5	27	87	4	2
H	9	9	4	2	4	9	11	32	19	28	0	2
J	10	3	5	3	5	4	23	7	24	62	2	1
E	7	7	6	4	5	8	21	31	24	69	1	2

III. C. Impulse Response Function

In order for the model to better reflect the linear trend with the elimination of the effect of time series heteroskedasticity, the raw data were processed using the natural logarithmic approach to analyze the elasticity change of the variables interacting with each other, i.e., processed and recorded as LNU1 and LNU2. The impulse response function reflects the results of the interactions of the variables between the system, and by shocking them with the standard deviation, it verifies the effects of the variables on each other at the present time as well as at multiple times in the future for the other variables. Therefore, the relationship between tourism culture and local economic development needs to be further analyzed through the impulse response function.

The impulse response function graph of tourism culture on local economic development is shown in Figure 3, the impact of the development of tourism culture on the development of the local economy in general shows a gradual increase in the trend, in the first period to the fifth period there is a slight downward trend, in the sixth period, the degree of response of the information is gradually increased, and eventually leveled off. It shows that the development of tourism culture has an overall positive impact on the local economy, although there is a slight negative impact, the reason may be due to the fact that the initial stage of the development of tourism culture requires a large amount of capital investment, which is used to improve the construction of infrastructure or to

increase the popularity of tourism in the region by adopting the way of Internet publicity and attraction, so it has a negative impact in the first five periods. However, with the increase in the number of tourists, the gradual improvement of the tourism system, the impact of tourism culture development gradually penetrate into all aspects of local economic development, tourism culture and local economic development to enhance the degree of coordination, and ultimately, tourism culture on the local economic development of the positive role in promoting the local economy to be revealed, so the impact of tourism culture on the local economy has gradually changed into a positive direction.

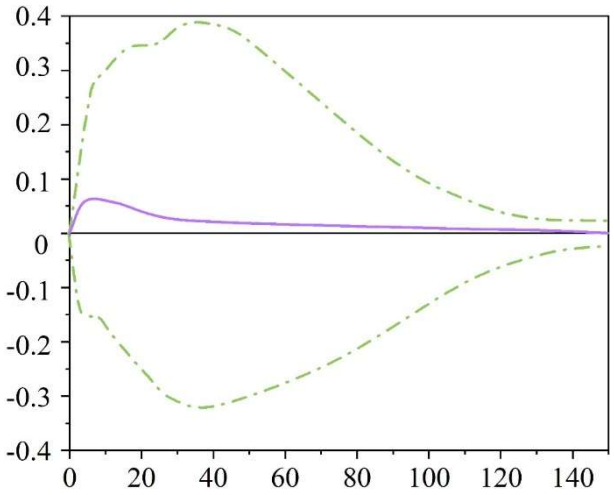

Figure 3: The tourism culture's pulse response function diagram for local economic development

The impulse response function plot of local economic development on tourism culture is shown in Figure 4. From the figure, it can be seen that the local economic development for the development of tourism culture impact shows a trend of increasing first and then decreasing. It rises significantly from the first period to the tenth period, and the information loudness after the tenth period gradually decreases and finally stabilizes. The reason is that in the early stage of local economic development, a large amount of economic input is needed, and economic input will lead to the rapid development of tourism, so in the first ten periods of the local economy for tourism culture impact trend is positively driven, and with the gradual improvement of tourism development, the role of economic promotion is no longer significant. In the long run, the rapid development of local economy provides market, resource and environmental advantages for the expansion of the scale of tourism and culture industry and the upgrading of industrial structure.

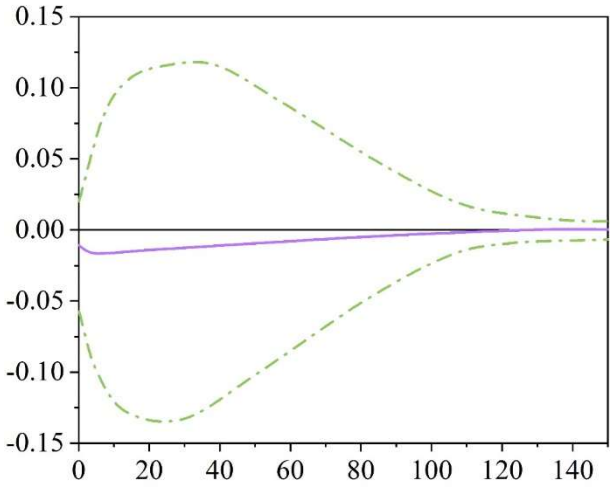

Figure 4: The local economic development is a pulse response function diagram for culture

III. D. Analysis of Variance Decomposition

The variance decomposition can decompose the changes of endogenous variables into the impacts on the components of the VAR model, assess the contribution of the impacts to the changes of endogenous variables, and further reveal the degree of interaction between tourism culture and local economic development. In this section, the variance decomposition of LNU1 and LNU2 within the 20 phases is conducted respectively.

The results of the variance decomposition (LNU1) are shown in Table 5. From the table, it can be seen that the contribution rate of tourism culture to itself reaches the highest from the first period, indicating that tourism culture has a significant positive feedback phenomenon, and the development power of tourism culture mainly comes from the tourism culture itself, and then with the increase of the number of periods shows a gradual decrease in the tendency, and ultimately gradually reaches 60% or so and then tends to stabilize. It shows that in a short period of time, the development of tourism culture is mainly influenced by its own development potential and power, but in the long run, the development of tourism culture mainly comes from external factors. The contribution rate of tourism culture to the local economy shows an overall trend of growth, the contribution rate of the first seven periods shows a faster growth rate, from the eighth period, the growth rate slows down, and the final contribution rate gradually converges to about 40% and then begins to be balanced.

Table 5: Variance decomposition (LNU1)

Period	S.E.	LNU1	LNU2
1	0.30284	100	0
2	0.32177	98.5961	1.38745
3	0.34732	95.7619	4.25049
4	0.36302	92.1586	7.84076
5	0.37011	88.42443	11.56093
6	0.37903	84.90105	15.10104
7	0.38459	81.76954	18.26172
8	0.38964	78.95015	21.03153
9	0.39434	76.48637	23.43881
10	0.39782	74.38742	25.60854
11	0.40831	72.53864	27.48306
12	0.40958	70.90051	29.08683
13	0.41436	69.47448	30.55284
14	0.41492	68.17054	31.82388
15	0.42572	67.05145	32.98024
16	0.4322	65.99935	33.97518
17	0.43977	65.09913	34.86807
18	0.44255	64.31735	35.71793
19	0.4482	63.53188	36.45216
20	0.45797	62.87659	37.14252

The results of variance decomposition (LNU2) are shown in Table 6. From the table, the contribution of the local economy to the comprehensive index of tourism and culture is gradually increasing, but the growth rate is slow, and the overall growth trend tends to be a horizontal straight line, and the final contribution to reach 8.3%. The contribution of the local economy to itself shows a slow decline in the trend, while the trend of change is also very gentle, and finally reached 91.75%. The results of the variance decomposition show that for tourism culture and local economy, the highest contribution rate is the influence factor of itself, the contribution rate reaches 62% and 92% respectively, indicating that the growth of itself is the most powerful pull factor, while the mutual contribution rate between the two is also growing gradually, but the contribution of tourism culture to the comprehensive development index of the local economy is higher, reaching 37.14%, and the contribution of the local economy to the development of tourism culture is lower, reaching 8.3%.

It can be seen that in the process of tourism culture and local economic development, there exists a positive circular feedback effect of mutual advancement between the two, but in terms of the mutual contribution rate between tourism culture and local economic development, the contribution rate of tourism culture to local economic development is greater than the contribution rate of local economic development to the new tourism culture. In other words, the contribution of tourism culture to local economic development is greater than the contribution of local economic development to tourism culture.

Table 6: Variance decomposition (LNU2)

Period	S.E.	LNU1	LNU2
1	0.30284	6.36916	93.61711
2	0.32177	6.89484	93.13271
3	0.34732	7.20358	92.76118
4	0.36302	7.47705	92.55345
5	0.37011	7.60723	92.38707
6	0.37903	7.76936	92.26355
7	0.38459	7.86328	92.11235
8	0.38964	7.9429	92.10094
9	0.39434	8.002	91.99557
10	0.39782	8.11488	91.96068
11	0.40831	8.10734	91.90603
12	0.40958	8.11578	91.8215
13	0.41436	8.15813	91.81963
14	0.41492	8.19687	91.78038
15	0.42572	8.2418	91.77606
16	0.4322	8.24984	91.72082
17	0.43977	8.25799	91.73103
18	0.44255	8.25094	91.7675
19	0.4482	8.27813	91.73493
20	0.45797	8.30407	91.75163

IV. Conclusion

This article adopts the analytical method combining MS-VAR model and network analysis, using the tourism economic data of 10 provinces, to reveal the connection between tourism culture and local economy, and analyze the spatial heterogeneity of the impact of tourism culture on the economic development of different regions, with a view to contributing to the smooth development of the tourism economy. The main conclusions of the article are as follows:

In the analysis of point centrality of the spatial association network, the rankings of point centrality are G, I, J, B, F, A, E, C, H and D in order, and G is ranked first, which means that G is in the “core position” of the network, and it is in the core of the spatial transmission of tourism culture.

The result of variance decomposition shows that the contribution of tourism culture to the comprehensive development index of local economy is high at 37.14%, and the contribution of local economy to the development of tourism culture is low at 8.3%. The contribution of tourism culture to local economic development is greater than the contribution of local economic development to new tourism culture.

References

[1] Richardson, R. B. (2021). The role of tourism in sustainable development. In Oxford research encyclopedia of environmental science.
[2] Liang, J., & Chan, C. S. (2018). Local cultural vicissitudes in regional tourism development: A case of Zhuhai. Tourism management perspectives, 25, 80-92.
[3] Richards, G. (2020). Culture and tourism: natural partners or reluctant bedfellows? A perspective paper. Tourism Review, 75(1), 232-234.
[4] Al-Ababneh, M. (2020). Creative cultural tourism as a new model of the relationship between cultural heritage and tourism. International Journal Of Hospitalit And Tourism Studies, 1(1), 39-44.
[5] Bai, Y. (2021). The impact of the integration of culture and tourism industry on the upgrading of tourism industry performance. Journal of Landscape Research, 13(5), 93-102.
[6] Li, X., Liang, X., Yu, T., Ruan, S., & Fan, R. (2022). Research on the integration of cultural tourism industry driven by digital economy in the context of COVID-19—based on the data of 31 Chinese provinces. Frontiers in Public Health, 10, 780476.
[7] Fang, L., Liu, Z., & Jin, C. (2023). How does the integration of cultural tourism industry affect rural revitalization? The mediating effect of new urbanization. Sustainability, 15(14), 10824.
[8] Pimenta, C. A. M., Ribeiro, J. C., & Remoaldo, P. C. (2021). The relationship between creative tourism and local development: a bibliometric approach for the period 2009-2019. Tourism & Management Studies, 17(1), 5-18.
[9] Tomaz, N., & Caldeira, E. (2021). The Interplay between Culture, Creativity, and Tourism in the Sustainable Development of Smaller Urban Centres. Small Cities: Sustainability Studies in Community & Cultural Engagement.
[10] Noonan, D. S., & Rizzo, I. (2017). Economics of cultural tourism: issues and perspectives. Journal of Cultural Economics, 41, 95-107.
[11] Suhel, S., & Bashir, A. (2018). The role of tourism toward economic growth in the local economy. Economic Journal of Emerging Markets, 32-39.

[12] Pratama, I. G. S., & Mandaasari, I. C. S. (2020). The impact of tourism development on the economic, cultural and environmental aspects of local communities. International Research Journal of Management, IT and Social Sciences, 7(1), 31-36.
[13] Katsoni, V., Upadhya, A., & Stratigea, A. (2017). Tourism, culture and heritage in a smart economy. Springer proceedings in business and economics.
[14] Zunaidi, A., Nofirman, N., Juliana, J., & Wurarah, R. N. (2022). The impact of the development of cultural tourism on the cultural, economic, and social aspects of local communities. Dinar: Jurnal Ekonomi dan Keuangan Islam, 9(2), 88-105.
[15] Gan, C., Voda, M., Wang, K., Chen, L., & Ye, J. (2021). Spatial network structure of the tourism economy in urban agglomeration: A social network analysis. Journal of Hospitality and Tourism Management, 47, 124-133.
[16] Casanueva, C., Gallego, Á., & García-Sánchez, M. R. (2016). Social network analysis in tourism. Current Issues in Tourism, 19(12), 1190-1209.
[17] Xie, W., Li, H., & Yin, Y. (2021). Research on the spatial structure of the European union's tourism economy and its effects. International Journal of Environmental Research and Public Health, 18(4), 1389.
[18] Yang, G., Yang, Y., Gong, G., & Gui, Q. (2022). The spatial network structure of tourism efficiency and its influencing factors in China: A social network analysis. Sustainability, 14(16), 9921.
[19] Chung, M. G., Herzberger, A., Frank, K. A., & Liu, J. (2020). International tourism dynamics in a globalized world: A social network analysis approach. Journal of Travel Research, 59(3), 387-403.
[20] Demetris Koursaros,Nektarios Michail & Christos Savva. (2024). Examining the behaviour of inflation to supply and demand shocks using an MS-VAR model. Economic Modelling,141,106901-106901.
[21] Xiaofei Tang,Yifan Cao,Wenhui Lin,Jinlong Chu & Jiulin Li. (2025). Structural resilience analysis of rural networks based on complex network theory. Frontiers of Earth Science,(prepublish),1-13.
[22] Shurui Zhang,Ziyu Chen,Yingying Chen & Sisongyu Yang. (2025). The Structure and Influencing Mechanisms of the Global Palm Oil Trade: A Complex Network Perspective.Sustainability,17(7),3062-3062.
[23] Vukolic Dragan,Gajić Tamara & Penic Mirjana. (2025). The effect of social networks on the development of gastronomy – the way forward to the development of gastronomy tourism in Serbia. Journal of Tourism Futures,11(1),124-139.