

EvIEWS-Based Causality Analysis of Nanjing's Tourism Growth

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Abstract. Leveraging 2006–2022 time-series data, this research constructs an EvIEWS-based multiple regression model to examine determinants of tourism economic development in Nanjing, China. Methodologically rigorous model specification tests and econometric refinements confirm domestic tourist arrivals ($\beta=0.82$, $p<0.01$) and urban disposable income ($\beta=0.67$, $p<0.05$) as significant drivers of tourism revenue growth. These findings suggest policymakers should prioritize domestic market expansion and income enhancement initiatives to maximize Nanjing's tourism potential.

Keywords: Nanjing, Tourism Economics, Influencing Factors, EvIEWS Software, Multiple Regression Analysis.

1. Introduction

With the continuous economic development and transformation in China, along with improvements in people's material and spiritual living standards, the tourism industry has progressed alongside economic growth. Tourism development generates not only economic benefits but also significant social and environmental benefits, playing a crucial role in building harmonious societies and stimulating related industries.

Contemporary tourism is no longer influenced solely by traditional singular factors. Evolving lifestyles, economic conditions, and social dynamics have made tourism susceptible to multidimensional determinants. Empirical studies of Nanjing's tourism data reveal that tourism economies fluctuate consistently with local economic growth. Tourism has assumed a pivotal role in Nanjing's economy, with tourism-derived revenues increasing annually. As a pillar industry within China's service sector, identifying factors influencing tourism development has become imperative.

Therefore, while quantitative methodologies for tourism research are well-established, few quantitative studies specifically examine Nanjing's tourism influencing factors. This study employs EvIEWS software to conduct empirical analysis using Nanjing's 2006-2022 data, exploring determinants of tourism development in Nanjing.

2. Overview of Tourism Development in Nanjing

Nanjing, an ancient capital of six dynasties, is located in the densely populated central area of East China, straddling both sides of the Yangtze River. With a population exceeding 20 million, it ranks among China's top eight transportation hubs, offering comprehensive and convenient access in all directions. The city boasts a pleasant environment, a developed economy, and stands as a vibrant modern metropolis. Nanjing's tourism resources are exceptionally rich and distinctive, reflecting the profound historical heritage of this ancient capital. Among the six major categories and 74 types of national tourism resources, Nanjing possesses all six categories and 61 specific types, accounting for 83% of national resource varieties. This makes Nanjing an exceptionally resource-rich tourist destination. To date, Nanjing has over 500 tourist attractions spanning imperial legacy cultures (Six Dynasties stone carvings), ancient human civilization (Tangshan Man caves), Ming-Qing culture (Ming City Wall, Ming Xiaoling Mausoleum, Qinhuai Scenic Belt), Republican-era history (Sun Yat-sen Mausoleum, Presidential Palace), folk traditions (Confucius Temple, Gongyuan Street), patriotic education sites (Jinghai Temple, Yuhuatai Memorial), and natural landscapes (Golden Bull Lake, Yuejiang Tower, Yanzi Ji). Beyond traditional attractions, Nanjing actively develops unique folk

culture products and specialties. As one of China's early-opening industries, Nanjing's tourism sector has progressively become market-oriented and scaled. Tourism revenue has maintained over 20% annual growth for years. Designated among China's first 24 Historical-Cultural Cities and first 54 "China Excellent Tourist Cities," Nanjing ranks fourth in comprehensive strength among sub-provincial cities. This prominence stems from its cultural depth and resource richness. With rapid socioeconomic development and rising living standards, changed consumption patterns combined with holiday policies (Spring Festival, Labor Day, National Day, paid leave) have spurred travel demand. These holiday peaks generate massive market opportunities, driving integrated development across catering, accommodation, and transportation sectors while creating substantial employment. Tourism has become a pillar industry energizing Nanjing's tertiary sector and overall economy. With continued resource development and service enhancements, Nanjing's tourism industry is positioned to sustain robust growth and further contribute to regional socioeconomic advancement.

3. Variable Selection and Data Sources

3.1. Variable Selection

Nanjing's total tourism revenue represents the aggregate consumption generated by tourists during their travels in Nanjing. Therefore, we use Nanjing's total tourism revenue to reflect the development level of Nanjing's tourism industry, designating it as the dependent variable Y . Existing research indicates that factors influencing tourism economic development include social factors, economic factors, and transportation factors. The direct factor affecting total tourism revenue is tourist arrivals, which reflects the attraction influence of Nanjing's various scenic spots suitable for visitation. Thus, we select domestic tourist arrivals and overseas tourist arrivals as explanatory variables X_1 and X_2 . The disposable income of both urban and rural residents determines their consumption capacity for tourism activities, thereby impacting tourism revenue. Consequently, we designate urban disposable income per capita as explanatory variable X_3 and resident population as explanatory variable X_4 . Since the reform and opening-up, China's social environment has continuously evolved. With increasing fiscal revenue, Nanjing's municipal government has gradually intensified investments in infrastructure development. The continuous improvement of transportation infrastructure has created convenient travel conditions for tourists visiting Nanjing, thereby promoting the development of the provincial tourism economy. Thus, road mileage is designated as explanatory variable X_5 . Based on the above analysis, we preliminarily conclude that Nanjing's tourism economic development is associated with these five variables (see Table 1). All data in this study are sourced from the *Nanjing Statistical Yearbook*.

Table 1. Explanatory Variables Affecting Nanjing's Tourism Economic Development

Variable Name	Unit of Measurement	Variable Symbol	Expected Impact
Domestic Tourist Arrivals	10k person-times	X_1	+
Overseas Tourist Arrivals	10k person-times	X_2	+
Urban Disposable Income per Capita	RMB	X_3	+
Permanent Resident Population	10k persons	X_4	+
Permanent Resident Population	km	X_5	+

3.2. Data Sources

This study utilizes statistical data spanning 17 years from the Nanjing Statistical Yearbook (2006–2022) as sample observations to investigate factors influencing Nanjing's tourism economic development. The specific dataset is presented in Table 2, while descriptive statistics of all variables are summarized in Table 3.

Table 2. 2006–2022 Total Tourism Revenue and Related Data of Nanjing

Year	X ₁	X ₂	X ₃	X ₄	X ₅
2006	491.20	3800.00	100.92	17537.72	719.06
2007	614.90	4489.00	116.12	20317.17	741.30
2008	714.30	4970.00	119.52	23122.69	758.89
2009	822.16	5519.91	113.45	25504.12	771.31
2010	951.61	6366.00	130.88	28312.00	800.76
2011	1106.23	7181.02	150.64	32200.00	810.91
2012	1272.50	7950.45	55.50	36322.00	816.10
2013	1360.67	8674.01	51.90	39881.00	818.78
2014	1520.83	9419.31	56.62	42568.00	821.61
2015	1688.12	10175.19	58.81	46104.00	823.59
2016	1909.26	11142.00	63.78	49997.00	827.00
2017	2168.90	12221.00	71.80	54538.00	833.50
2018	2460.20	13327.99	81.01	59308.00	843.62
2019	2784.95	14597.00	85.31	64372.00	928.16
2020	1822.64	9687.54	16.46	67553.00	931.97
2021	2130.45	10830.60	13.40	73593.00	942.34
2022	1946.18	10329.02	11.62	76643.00	949.11

Table 3. Statistical Description of Factors Affecting Tourism Economic Development

Variable Name	Mean	Std. Dev.	Min	Max
Domestic Tourist Arrivals	1515.594	676.6257	491.2	2784.95
Overseas Tourist Arrivals	8863.532	3152.844	3800	14597
Urban Disposable Income per Capita	76.33765	41.58392	11.62	150.64
Permanent Resident Population	44580.75	19028.8	17537.72	76643
Permanent Resident Population	831.6476	69.51971	719.06	949.11

4. Model Specification

To analyze factors influencing Nanjing's tourism economic development using time-series data, an Ordinary Least Squares (OLS) estimation method is employed for the constructed time-series model. After taking natural logarithms of X_i and Y , they are incorporated into the model. The model is specified as:

$$\ln Y = \alpha + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \mu \quad (1)$$

4.1. Section Headings

The preliminary regression results of the model are shown in the figure below, according to the data in Figure 1, the model estimation results are as follows:

$$\ln Y = -3.328038 + 0.993469 \ln X_1 + 0.029436 \ln X_2 + 0.295599 \ln X_3 + 0.73617 \ln X_4 - 0.234745 \ln X_5$$

(1.895515) (0.099854) (0.021033) (0.124179) (0.239457) (0.130775)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3.328038	1.895515	-1.755744	0.1069
LNx1	0.993469	0.099854	9.949187	0.0000
LNx2	0.029436	0.021033	1.399563	0.1892
LNx3	0.295599	0.124179	2.380428	0.0365
LNx4	0.073617	0.239457	0.307433	0.7643
LNx5	-0.234745	0.130775	-1.795023	0.1001
R-squared	0.999152	Mean dependent var	7.212556	
Adjusted R-squared	0.998767	S.D. dependent var	0.511278	
S.E. of regression	0.017954	Akaike info criterion	-4.931485	
Sum squared resid	0.003546	Schwarz criterion	-4.637409	
Log likelihood	47.91762	Hannan-Quinn criter.	-4.902253	
F-statistic	2592.933	Durbin-Watson stat	2.224964	
Prob(F-statistic)	0.000000			

Figure 1. Output of OLS

From Figure 1, it can be observed that the model's coefficient of determination (R^2) is 0.999152, and the adjusted R^2 is 0.998767, which is very close to 1, indicating an excellent model fit. However, some of the explanatory variables show statistically insignificant coefficients, suggesting the likely presence of multicollinearity in the model.

Using EViews software, we analyzed the high correlation coefficients among the explanatory variables (see Table 4). The results reveal that the explanatory variables are highly correlated, confirming the existence of multicollinearity. Therefore, we need to correct and adjust for multicollinearity in the model using a stepwise regression approach.

Table 4. Correlation Coefficient Matrix

	$\ln X_1$	$\ln X_2$	$\ln X_3$	$\ln X_4$	$\ln X_5$
$\ln X_1$	1.0000	-0.4641	0.9282	0.8038	0.3201
$\ln X_2$	-0.4641	1.0000	-0.7392	-0.7845	0.3371
$\ln X_3$	0.9282	-0.7392	1.0000	0.9457	0.0425
$\ln X_4$	0.8038	-0.7845	0.9457	1.0000	-0.1718
$\ln X_5$	0.3201	0.3371	0.0425	-0.1718	1.0000

$$\ln Y = 1.289527 \ln X_1 - 4.421379$$

$$(0.289848) (0.032098)$$

$$R^2 = 0.990792 \quad \bar{R}^2 = 0.990178$$

$$\ln Y = -0.342018 \ln X_2 + 8.620632$$

$$(0.142404) (0.596125)$$

$$R^2 = 0.277749 \quad \bar{R}^2 = 0.229599$$

$$\ln Y = 1.055243 \ln X_3 - 3.983679$$

$$(0.083301) (0.884623)$$

$$R^2 = 0.914518 \quad \bar{R}^2 = 0.908819$$

$$\ln Y = 5.257496 \ln X_4 - 28.1187$$

$$(0.838719) (5.636723)$$

$$R^2 = 0.723726 \quad \bar{R}^2 = 0.705308$$

$$\ln Y = 2.108681 \ln X_5 - 12.3212$$

$$(2.173232) (20.1321)$$

$$R^2 = 0.059058 \quad \bar{R}^2 = -0.003671$$

Based on the coefficient of determination R^2 and the adjusted coefficient of determination $\bar{R}^2$ from the above regression equations, it is determined that $\ln X_1$ has the most significant effect on $\ln Y$. Consequently, using the regression equation corresponding to $\ln X_1$ from Eq. (1) as the base, $\ln X_2$, $\ln X_3$, $\ln X_4$, and $\ln X_5$ are sequentially introduced to determine the modified multiple regression equation.

Table 5. Stepwise Regression Results

	$\ln X_1$	$\ln X_2$	$\ln X_3$	$\ln X_4$	$\ln X_5$	R^2	$\bar{R}^2$
$\ln Y = f(\ln X_1)$	4.421379	1.289527					0.990792
$\ln Y = f(\ln X_1, \ln X_2)$	3.750068	1.239669	0.053816				0.996187
$\ln Y = f(\ln X_1, \ln X_3)$	4.622084	1.0084214		0.25794			0.998352
$\ln Y = f(\ln X_1, \ln X_4)$	9.018781	1.140555			0.884116		0.998035
$\ln Y = f(\ln X_1, \ln X_5)$	2.031852	1.324442				0.730635	0.997156
$\ln Y = f(\ln X_1, \ln X_2, \ln X_3)$	5.345207	0.858213	0.046886	0.435632			0.99886
$\ln Y = f(\ln X_1, \ln X_2, \ln X_4)$	8.098323	1.152895	-0.01314		0.738627		0.99816
$\ln Y = f(\ln X_1, \ln X_2, \ln X_5)$	0.486042	1.286201	-0.03006			0.513164	0.998275

Based on the regression equation of $\ln X_1$, $\ln X_2$, $\ln X_3$, $\ln X_4$, and $\ln X_5$ were sequentially introduced for bivariate regression. Subsequently, using $\ln X_1$ and $\ln X_3$ as the base, trivariate regression was performed. After including new variables, coefficients either turned negative or failed t-tests. Thus, stepwise regression was applied to other explanatory variables to obtain the optimal regression equation:

The stepwise regression results are presented in Table 5, and the optimal equation derived is:

$$\ln Y = 1.008424 \ln X_1 + 0.257940 \ln X_3 - 4.622084$$

$$(0.037787) \quad (0.032186) \quad (0.129370)$$

$$R^2 = 0.998352 \quad \bar{R}^2 = 0.998117 \quad (7)$$

5. Model Validation

5.1. Economic Significance Test

Eviews analysis confirms that tourism revenue in Nanjing is positively influenced by domestic tourist arrivals and urban residents' disposable income (Table 7), which aligns with economic theory.

Dependent Variable: LNY Method: Least Squares Date: 04/12/24 Time: 20:01 Sample: 2006 2022 Included observations: 17				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.622084	0.129370	-35.72770	0.0000
LNX1	1.008424	0.037787	26.68692	0.0000
LNX3	0.257940	0.032186	8.014150	0.0000
R-squared	0.998352	Mean dependent var	7.212556	
Adjusted R-squared	0.998117	S.D. dependent var	0.511278	
S.E. of regression	0.022189	Akaike info criterion	-4.619691	
Sum squared resid	0.006893	Schwarz criterion	-4.472654	
Log likelihood	42.26738	Hannan-Quinn criter.	-4.605075	
F-statistic	4240.609	Durbin-Watson stat	1.153187	
Prob(F-statistic)	0.000000			

Figure 2. Two or more references

5.2. Goodness-of-Fit Test

Based on the modified model's regression results, the coefficient of determination R^2 is 0.998352, and the adjusted $\bar{R}^2$ is 0.998711. Both values approach 1, indicating that 99.8532% of variations in $\ln Y$ can be explained by changes in the explanatory variables ($\ln X_1$, $\ln X_3$). This demonstrates exceptional model fit.

The $\text{Prob}(F\text{-statistic}) = 0.0000$. At $\alpha = 0.05$, the null hypothesis H_0 : "The linear relationship of the model is statistically insignificant" is tested. Since $\alpha > \text{Prob}(F\text{-statistic})$ ($0.05 > 0.0000$), H_0 is rejected. Thus, the model's linear relationship is statistically significant, confirming that the F-test is passed.

All explanatory variables in the modified model pass the t-test ($\alpha = 0.05$). The null hypothesis H_0 : " $\ln X_i$ has no significant effect on $\ln Y$ " is evaluated using the p-values corresponding to each t-statistic (Table 2). All p-values are < 0.05 , rejecting H_0 . This verifies that the statistical significance test of the modified model is passed.

5.3. Heteroscedasticity test

Based on White's heteroscedasticity test, with $\alpha = 0.05$, the null hypothesis H_0 : "No heteroscedasticity exists" is tested. As $P(\text{Obs} \cdot R\text{-squared}) = 0.9833 > 0.05$ (see Figure 3), H_0 is accepted, indicating absence of heteroscedasticity in the modified model.

Heteroskedasticity Test: White			
F-statistic	0.281354	Prob. F(5,11)	0.9138
Obs*R-squared	1.927586	Prob. Chi-Square(5)	0.8591
Scaled explained SS	0.694428	Prob. Chi-Square(5)	0.9833

Figure 3. White Test Results

5.4. Autocorrelation Test

First-order autocorrelation is examined using residual plot analysis, while higher-order autocorrelation is assessed through both partial autocorrelation coefficient (PACF) tests and the Breusch-Godfrey (B-G) test method. Specific procedures are as follows.

5.4.1. Residual Plot Analysis

Based on residual plot analysis, it is evident that the residuals exhibit no systematic alternating pattern (Figure 4), demonstrating absence of autocorrelation in the model.

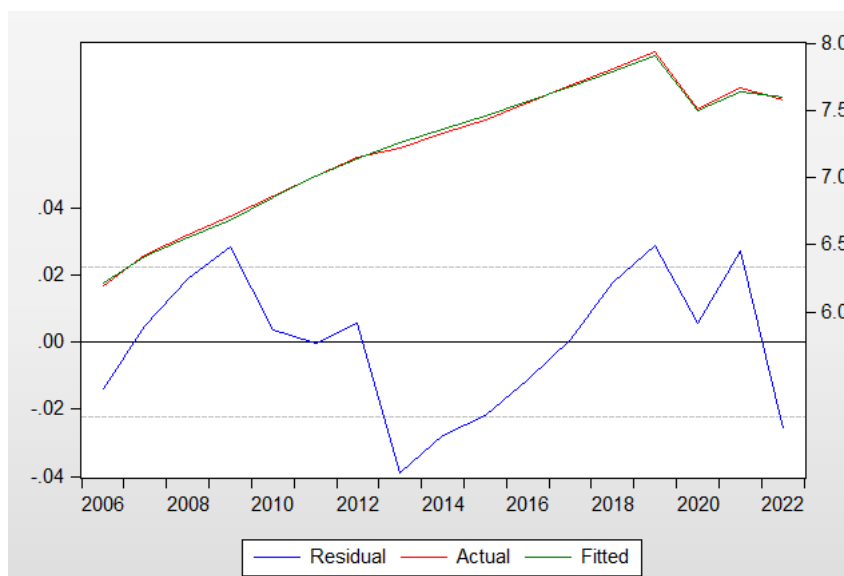


Figure 4. Residual Plots of the Modified Model

5.4.2 Partial Autocorrelation Function (PACF) Test

As shown in the figure below, the results clearly show that the modified regression model does not exhibit high-order autocorrelation.

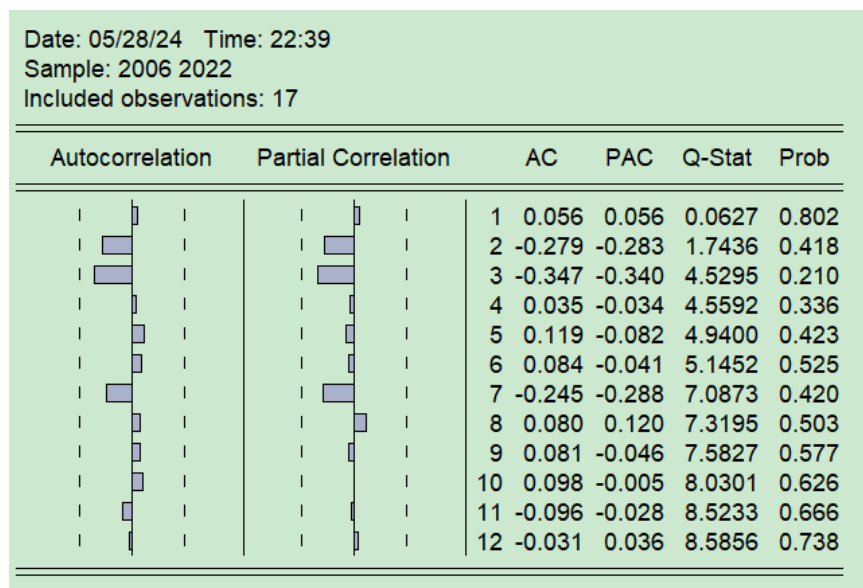


Figure 5. PACF Test Results

5.4.3 Breusch-Godfrey (B-G) Test

The null hypothesis H_0 : No autocorrelation exists. At a significance level of $\alpha = 0.05$, the accompanying probability from Figure 6 is $0.1713 > 0.05$. Thus, H_0 is accepted, indicating absence of higher-order autocorrelation in the modified model.

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	1.571801	Prob. F(2,12)	0.2476
Obs*R-squared	3.528964	Prob. Chi-Square(2)	0.1713

Figure 6. Breusch-Godfrey Test Results

6. Countermeasures and Suggestions

Based on multivariate regression analysis, domestic tourist arrivals have the most significant impact on Nanjing's tourism revenue. 1% increase in domestic tourists raises tourism revenue by approximately 1.108424%; urban residents' disposable income has a smaller effect, with 1% increase raising tourism revenue by about 0.25794%. Based on these regression results, the following recommendations are proposed for Nanjing's tourism development:

6.1. Optimize Tourism Infrastructure to Consolidate the Domestic Tourism Market

Improve tourism infrastructure to consolidate the domestic tourism market. Consolidate domestic tourism market best way is improve Nanjing characteristic scenic areas visibility and attractiveness. At various tourist attractions need fully display Nanjing historical cultural heritage, allowing visitors unconsciously immerse themselves into local characteristic culture. Meanwhile, this requires high-level scenic area service quality. Only when all aspects tourist experience is perfected, Nanjing scenic areas reputation can be improved, achieving zero-cost publicity effect to attract more domestic tourists. To provide high-quality services, focus on two dimensions:

First, "hard services": Improve tourist attractions basic supporting facilities; Expand visitor service facility construction; Increase online-offline interpretation service points.

Second, "soft services": Establish humanized service concept; Strengthen tourist safety awareness; Create official website visitor feedback system, prioritize domestic tourists needs, make tourism industry closer to people.

6.2. Stimulate tourism enthusiasm and strengthen tourism brand

Research results show urban residents' disposable income has positive correlation with tourism revenue. With Nanjing economic development, recently under big data, high-speed rail, tourism driving force, Nanjing economy grows steadily, urban residents' disposable income continues increasing. However, due historical, economic, environmental factors, Nanjing residents' consumption concept relatively backward, mainly focusing daily necessities, shopping, catering. Past transportation inconvenience caused weak tourism awareness. Therefore, propose countermeasures from three levels:

First, conceptual level: Promote tourism consumption awareness through economic development. Second, social level: Improve household disposable income through social security system enhancement. Third, policy level: Optimize tourism preferential policies, improve service facilities and quality.

6.3. Consolidate domestic market while fully developing international market

Currently Nanjing tourism revenue and tourist numbers mainly rely on domestic tourists as support, and international tourists show declining trend, especially after 2012, Nanjing international tourist arrivals decreased from 1, 506, 400 person-times to 555, 000 person-times. Thereafter, international tourist arrivals continuously declined, reaching only 116, 200 person-times in 2022, less than 12% of 2006 international tourist arrivals level. This indicates that as important tourism city in China, Nanjing's attractiveness to international tourism is sharply declining. This may be due to Nanjing airport construction being relatively poor, and neighboring city Shanghai having multiple international airports whose strong international passenger throughput absorbed many international tourists, causing Nanjing international tourist arrivals gradually reducing. As China's historical and cultural famous city, Nanjing's unique charm should attract numerous domestic and international tourists. However, current sharp decline in international tourist numbers is not just loss for Nanjing tourism industry, but also regret for city's profound historical culture. Facing this situation, besides increasing airport investment construction, Nanjing can start from multiple aspects: For example, can deeply explore Nanjing historical cultural resources through hold various international cultural exchange activities let world better understand Nanjing's profound heritage; simultaneously utilize Nanjing's special status as important anti-fascist battlefield develop related thematic cultural tourism activities let tourists feel Nanjing's heroism and resilience during visits; additionally Nanjing can collaborate with surrounding provinces jointly create tourism routes with Jiangnan characteristics. Jiangnan region renowned for unique water town scenery, exquisite gardens and profound humanistic heritage. These elements all important factors attracting international tourists. Through joint publicity and promotion let more international tourists understand this route's charm thus attract them come experience.

Overall, Nanjing is tourism city full historical deposits and unique charm. Whether explore ancient capital culture, experience natural scenery, or taste delicious foods, experience folk customs, Nanjing all can bring tourists unforgettable travel experience. With tourism industry continuous development and improvement, believe Nanjing will attract more tourists visit, become more prosperous and full vitality tourism sacred place.

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