

Research on the Economic Effects and Regional Disparities of Digital Technology Diffusion on Chinese Tourism Consumption

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Abstract: With the rapid diffusion of digital technology, its economic effects on tourism consumption have become increasingly pronounced. Based on panel data from 30 provinces, autonomous regions and municipalities in China spanning 2013 to 2023, a fixed-effects model was constructed to analyze the economic impact and its regional heterogeneity of digital technology diffusion on tourism consumption. The study finds that the diffusion of digital technology significantly promotes the growth of tourism consumption expenditure and optimizes the structure of tourism consumption. Notably, the promotional effect is more pronounced in the economically developed eastern regions, while the central and western regions exhibit relatively weaker effects due to limitations in digital infrastructure and application capabilities. Specifically, infrastructure indicators such as fiber-optic cable density and the number of internet broadband ports have a significant positive impact on tourism consumption in the central and western regions. In contrast, application-oriented indicators such as software business revenue and e-commerce sales play a more prominent role in driving tourism consumption in the eastern regions. Based on these findings, it is recommended to strengthen the construction of digital infrastructure, such as optical fiber cable and internet ports, in the central and western regions. Additionally, enhancing digital technology application capabilities, such as increasing software business revenue and e-commerce sales, is crucial. Furthermore, measures such as improving household consumption structures and increasing investment in higher education should be implemented to further unleash the potential of tourism consumption and promote coordinated regional economic development.

Keywords: Digital technology; Tourism consumption; Panel data; Economic effects

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I. INTRODUCTION

With the rapid development and widespread application of digital technology, its impact on the global economy and social life has become increasingly profound. Particularly in the tourism industry, the diffusion of digital technology is profoundly transforming the behavioral patterns and economic structures of tourism consumption. The proliferation of technologies such as the internet, mobile payments, and big data analytics has not only enhanced the efficiency and convenience of tourism services but also given rise to new consumption scenarios and business models. For instance, the emergence of online travel platforms has made booking tourism products more convenient, intelligent recommendation systems have provided tourists with personalized consumption options, and the widespread adoption of mobile payments has further streamlined transaction processes. These changes have not only driven the growth of tourism consumption but also exerted a far-reaching impact on regional economies.

The impact of digital technology on tourism consumption has garnered significant attention, yet systematic research on its economic effects remains insufficient. Existing literature mostly focuses on the direct influence of digital technology on tourism consumption behavior, while analyses of its economic effects are relatively fragmented, particularly in terms of regional heterogeneity and long-term impacts. Furthermore, the bidirectional causal relationship between the diffusion of digital technology and tourism consumption has also made endogeneity a major challenge in empirical research. Therefore, an in-depth exploration of the economic effects of digital technology diffusion on tourism consumption not only holds substantial theoretical significance but also provides a scientific basis for policy formulation, promoting the deep integration of digital technology and the tourism industry.

This paper aims to empirically analyze the economic effects of digital technology diffusion on tourism consumption using a panel data model. Specifically, the study will address the following questions: (1) How does the diffusion of digital technology influence the total volume and structure of tourism consumption? (2) Does this impact exhibit regional heterogeneity? (3) What are the long-term economic effects of digital technology diffusion? By addressing these questions, this paper seeks to provide new perspectives on the relationship between digital technology and tourism consumption and offer empirical support for relevant policy formulation. The findings will not only contribute to enriching theoretical research in the fields of digital economy and tourism consumption but also provide practical guidance for the digital transformation of the tourism industry.

II. LITERATURE REVIEW

The economic effects of digital technology diffusion on tourism consumption have become a focal point in academic research in recent years. With the rapid development of digital technologies such as the internet, mobile communications, and big data, their impact on tourism consumption behavior and economic structures has become increasingly significant. This section reviews the research objects and methods of existing literature from three perspectives: digital technology diffusion, tourism consumption, and their intersection.

Digital technology diffusion refers to the process of the proliferation and application of digital technologies within socio-economic systems. In recent years, scholars have extensively studied the definition, measurement, and economic impacts of digital technology diffusion. Wang Xiaofeng and Li Jing (2020) pointed out that measurement indicators for digital technology diffusion include internet penetration rates, mobile payment usage rates, and e-commerce adoption rates, which effectively reflect the level of digital technology application across different regions. Zhang Wei and Chen Li (2021) analyzed the impact of digital technology diffusion on regional economic growth using a panel data model, finding that digital technology significantly promotes industrial structure upgrading and changes in consumption behavior. However, existing research predominantly focuses on developed countries, with insufficient attention given to developing countries and regional heterogeneity (Hilbert & López, 2011).

Tourism consumption refers to the various expenditures incurred by tourists during their travels, including transportation, accommodation, dining, entertainment, and shopping. Liu Yang and Zhao Ming (2022) investigated the impact of online travel platforms on the structure of tourism consumption, finding that the increase in the proportion of online consumption has significantly altered traditional tourism consumption patterns. A report by UNWTO (2020) highlighted that tourism consumption has a significant impact on regional economies in terms of employment, income, and industrial structure, especially against the backdrop of the digital economy. The structure and trends of tourism consumption are undergoing profound changes. However, existing literature lacks sufficient research on segmented areas of tourism consumption, such as online consumption and personalized consumption, and there is a dearth of in-depth analysis on how digital technology influences tourism consumption (Dwyer et al., 2020).

The intersection of digital technology and tourism consumption has gradually emerged as a new research field. Current literature primarily explores how digital technology transforms tourism consumption behavior and its economic effects. For instance, the proliferation of online travel platforms and mobile payments has reduced transaction costs, enhanced consumption convenience, and promoted the growth of tourism consumption (Gretzel et al., 2015). Nevertheless, existing studies predominantly focus on short-term effects, with insufficient attention paid to the long-term impacts and dynamic mechanisms of digital technology diffusion, as well as the heterogeneous effects of digital technology on tourism consumption (Buhalis & Sinarta, 2019).

III. MODEL CONSTRUCTION AND DATA SOURCES

3.1. Model Construction

To examine the impact of digital technology diffusion and application on tourism consumption, the following model is established:

(1)

The variable *Tour* is the dependent variable, representing tourism consumption. To compare the differential impacts of digital technology diffusion on tourism consumption across provinces, municipalities, and autonomous regions in China and to validate its effects, tourism consumption (*Tour*) is used as the dependent variable, while the number of tourist visits (*Ptour*) is employed as a robustness check indicator. *Digi* represents the variables related to digital resources and digital technology diffusion. *Control* denotes the control variables. The term α represents autonomous consumption, β_j and δ_k indicate the marginal consumption tendencies of the variables. The subscripts *j* and *k* represent the types of digital technologies and control

variables, respectively. μ_i captures individual effects, ε_{it} is the random error term, i represents provinces or municipalities, and t denotes the time period.

The indicators of digital technology diffusion include measures of digital technology penetration and application. The digital technology penetration indicators consist of mobile phone penetration rate (Psj), internet broadband access ports per capita (Idk), fiber-optic cable density (Pgl), number of websites per capita (Pwz), and number of websites per hundred enterprises (Bwz), among others. On the other hand, the digital technology application indicators include software business revenue per capita (Prj), telecommunications business revenue per capita (Pdx), e-commerce sales per capita (Pds), the proportion of e-commerce enterprises (Bsb), and the digital inclusive finance index (Pjr), among others.

According to Keynesian consumption theory, the key control variables influencing tourism consumption are income and consumption structure. Income is typically measured by per capita disposable income (Psr), while consumption structure is represented by the Engel coefficient (Ege). A higher Engel coefficient indicates a larger proportion of household expenditure allocated to food, which exerts a negative impact on tourism consumption. Additionally, education is a significant influencing factor for tourism consumption, here measured by the proportion of the population with higher education (Gdjy).

3.2 Data Sources

Based on data availability and comparability, 30 provinces, municipalities, and autonomous regions in mainland China (excluding Tibet) were selected as the research subjects. Data on mobile phone penetration rates, internet broadband access ports, and similar metrics were sourced from the Statistical Report on Internet Development in China (2014–2024). Tourism consumption, domestic tourism consumption, and tourist reception numbers were obtained from provincial-level Statistical Bulletins on National Economic and Social Development (2013–2023) or relevant cultural and tourism statistical reports issued by provincial governments. Data on fiber-optic cable density, software business revenue, telecommunications revenue, e-commerce sales, the proportion of e-commerce enterprises, the number of websites per hundred enterprises, disposable income, the Engel coefficient, and education levels were derived from the China Statistical Yearbook (2014–2024) or calculated based on provincial-level data. The digital inclusive finance index was sourced from the Peking University Digital Inclusive Finance Index Report (2013–2023). To mitigate variance fluctuations in the model, all data were logarithmically transformed. Descriptive statistics for each indicator are presented in Table 1.

Table 1 Descriptive Statistics of Each Indicator

Variable	Definition	Minimum	Maximum	Mean	Median	Standard Deviation	Observations
Ln(Tour)	Per capita tourism consumption (yuan/person)	7.5738	10.5394	9.1202	9.1804	0.5770	330
Ln(Ptour)	Per capita number of tourists (person)	0.3577	3.5032	2.0764	2.1252	0.5256	330
Ln(Psj)	Mobile phone penetration rate (%)	-0.4769	0.6390	0.0626	0.0766	0.2110	330
Ln(Pgl)	Fiber optic cable density (km/square kilometer)	-1.8879	4.8275	1.8637	2.0343	1.2484	330
Ln(Idk)	Per capita number of Internet broadband access ports (pcs)	-1.9581	0.1065	-0.6264	-0.5370	0.4506	330
Ln(Pwz)	Per capita number of websites (number)	-6.7813	-1.0838	-4.2960	-4.3688	1.0397	330
Ln(Prj)	Per capita software business income (yuan/person)	2.7028	11.7127	7.0950	7.1946	1.8956	330
Ln(Pdx)	Per capita telecommunications business income (yuan/person)	6.6175	9.6048	7.6570	7.2991	0.8279	330
Ln(Pds)	Per capita e-commerce sales revenue (yuan/person)	5.4094	12.1731	8.8134	8.7117	1.1201	330
Ln(Dsb)	Proportion of e-commerce enterprises (%)	0.4055	3.2068	2.1175	2.2083	0.4782	330
Ln(Bwz)	Number of websites per hundred enterprises	2.7081	4.3041	3.8448	3.8712	0.2601	330
Ln(Pjr)	Digital Inclusive Finance Index	4.7708	6.1609	5.6199	5.6839	0.3173	330
Ln(Psr)	Per capita disposable income (yuan/person)	9.3015	11.3485	10.1775	10.1559	0.3976	330
Ln(Ege)	Engel coefficient (%)	-1.6060	-0.7541	-1.1932	-1.2082	0.1297	330
Ln(Gdjy)	Proportion of higher education population (%)	-2.6869	-0.6835	-1.8908	-1.9116	0.3932	330

Table 1 shows that the standard deviations of indicators such as per capita tourism consumption and tourist reception numbers all exceeded 0.5, indicating significant regional disparities in China's tourism consumption levels. Similarly, the standard deviations of internet broadband access ports, software business revenue, fiber-optic cable density, and e-commerce sales all surpassed 1.0, suggesting uneven investment and development in the penetration and application of digital technologies across regions, with pronounced geographical disparities. These findings underscore the importance of studying the economic effects of digital technology diffusion on tourism consumption, particularly its regional heterogeneity.

IV. ANALYSIS OF ECONOMETRIC RESULTS

4.1 Testing the Impact of Digital Technology Diffusion on Tourism Consumption

First, an F-statistic was employed to determine whether a pooled regression model or a fixed-effects model should be selected. Subsequently, the Hausman test was applied to decide between fixed-effects and random-effects models. The test results indicated that the fixed-effects model outperformed other specifications for analyzing the economic effects of digital technology diffusion on tourism consumption. Four regression models were constructed using digital technology diffusion indicators and control variables, with estimation results presented in Table 2 .

Table 2 Test Results of the Impact of Digital Technology Diffusion on Tourism Consumption in China

	Tour(1)	Tour(2)	Tour(3)	Tour(4)
Ln(Psj)	0.120909	0.012917	0.177223	0.182816
Ln(Pgl)	0.110906***	0.106416***	0.107948***	0.131498***
Ln(ldk)	0.411748**	0.425403**	0.500295***	0.521164***
Ln(Pwz)	0.01845	0.015163	0.010752	0.011864
Ln(Prj)	0.07511***	0.071959***	0.070978***	0.060069**
Ln(Pdx)	0.132905	0.129354	0.107698	0.109233
Ln(Pds)	0.129303***	0.089762**	0.076552**	0.049875*
Ln(Dsb)	0.251315**	0.28586***	0.264821**	0.286731***
Ln(Bwz)	-0.858713***	-0.874192***	-0.862506***	-0.870193***
Ln(Pjr)	-0.732454	-0.993719	-1.067149*	-1.116343*
Ln(Psr)		0.286657	0.387166	0.261821
Ln(Ege)			-0.453763*	-0.607212**
Ln(Gdjy)				0.246942*
C	12.92284***	11.85052***	11.99151***	14.42507***
R2	0.609826	0.611648	0.615975	0.620363
F-statistic	11.62199	11.37925	11.26709	11.16633
Prob	0.0000	0.0000	0.0000	0.0000
hausman		0.0000		
Model	FE	FE	FE	FE

Note: " * ", " ** ", and " *** " denote statistical significance at the 10%, 5%, and 1% levels, respectively; FE refers to the fixed-effects model.

Table 2 shows that the R² values of all models exceed 0.6, and the F-statistics are significant at the 1% level, indicating good model fit. The empirical results reveal the following: Among the digital technology penetration indicators, fiber-optic cable density and internet broadband access ports per capita significantly positively affect tourism consumption. Fiber-optic infrastructure, as a foundational element of digital technology, plays a critical supportive role in boosting tourism consumption. In contrast, mobile phone penetration rate and website quantity show no significant impact, reflecting that China's digital economy has entered a new phase where tourism consumption relies less on basic digital penetration and emphasizes application quality and effectiveness.

For digital technology application indicators, software business revenue per capita, e-commerce sales per capita, and proportion of e-commerce enterprises significantly and positively influence tourism consumption. However, the number of websites per hundred enterprises has a significant negative coefficient, while telecommunications revenue per capita is insignificant. The digital inclusive finance index is significant only in Model (4). These findings suggest that enhancing fiber-optic infrastructure, expanding internet broadband access, and advancing software development and e-commerce applications are key to improving tourism consumption under digital technology diffusion.

Regarding control variables: Disposable income has no significant impact, but the Engel coefficient negatively affects tourism consumption, implying that optimizing household consumption structures can stimulate tourism spending. Higher education levels positively influence tourism consumption, highlighting the importance of educational investment in unlocking tourism consumption potential.

4.2 Regional Heterogeneity in the Impact of Digital Technology Diffusion

To further examine regional disparities, the study tests the effects of digital technology diffusion on per capita tourism consumption in eastern, central, and western China. Due to limited data from the three northeastern provinces, results are presented in Table 3.

Table 3 Test Results of Digital Technology Diffusion’s Impact on Tourism Consumption in Eastern, Central, and Western China

	national	eastern	central	western
Ln(Psj)	0.182816	0.56185	2.169127	0.415869
Ln(Pgl)	0.131498***	0.441185*	0.21982***	0.013157*
Ln(ldk)	-0.521164**	-0.171855	0.427833*	0.78916**
Ln(Pwz)	0.011864	0.076003	0.067981*	-0.070145*
Ln(Prj)	0.060069**	0.074732***	-0.231244	0.045271*
Ln(Pdx)	0.109233	0.053836	0.043766	0.061133
Ln(Pds)	0.049875*	0.125307**	0.070195*	0.035767*
Ln(Dsb)	0.286731***	0.247728***	0.416697*	0.026039*
Ln(Bwz)	-0.870193***	-0.513633***	-1.127504**	-0.105206*
Ln(Pjr)	-1.116343*	-0.854133	-1.727262	-1.151404
Ln(Psr)	0.261821	-0.332209	0.08725	1.068338*
Ln(Ege)	-0.607212**	-0.18398**	-0.611889**	-0.819264***
Ln(Gdij)	0.246942*	0.263875**	0.157418*	0.177437*
C	14.42507***	17.43412***	18.80101**	1.365243***
R2	0.620363	0.668592	0.600087	0.805148
F-statistic	11.16633	9.44155	5.0706	17.42663
Prob	0.0000	0.0000	0.0000	0.0000
Hausman			0.0000	
Model	FE	FE	FE	FE

Note: " * ", " ** ", and " *** " denote statistical significance at the 10%, 5%, and 1% levels, respectively; FE refers to the fixed-effects model.

Table 3 demonstrates that all four models (national, eastern, central, and western) have R² values above 0.6, with F-statistics significant at the 1% level. The western region exhibits the highest explanatory power (R² > 0.8).

Eastern Region: Fiber-optic density, software revenue per capita, e-commerce sales per capita, e-commerce enterprise proportion, websites per hundred enterprises, and the inclusive finance index significantly affect tourism consumption. Fiber-optic density, software revenue, e-commerce sales, and e-commerce enterprise proportion show positive impacts. Engel coefficient and higher education levels are significant control variables.

Central Region: Fiber-optic density, internet broadband ports per capita, websites per capita, e-commerce sales per capita, and e-commerce enterprise proportion significantly influence tourism consumption, with positive coefficients for fiber-optic density, internet ports, and e-commerce enterprise proportion. Engel coefficient and higher education levels remain significant.

Western Region: Fiber-optic density, internet broadband ports per capita, software revenue per capita, e-commerce sales per capita, e-commerce enterprise proportion, websites per hundred enterprises, and the inclusive finance index are significant. Fiber-optic density, internet ports, software revenue, and e-commerce sales positively impact tourism consumption. Disposable income, Engel coefficient, and higher education levels are significant control variables.

Among the digital technology penetration indicators, mobile phone penetration rate shows no significant impact on tourism consumption in the eastern, central, or western regions. By the end of 2023, China’s mobile phone penetration rate had exceeded 126 per 100 people, indicating a high saturation level. At this stage, merely increasing the quantity of mobile devices no longer drives tourism consumption. Fiber-optic cable density exhibits a significant positive impact on tourism consumption at the national level, as well as in the eastern and central regions, but its effect is insignificant in the western region. This suggests that fiber-optic infrastructure actively supports tourism consumption, though its influence remains limited in the sparsely populated and geographically vast western areas. Internet broadband access ports per capita significantly and positively affect tourism consumption in the central and western regions, indicating that expanding broadband infrastructure in these regions can effectively boost tourism spending. The number of websites per capita also shows regional heterogeneity: it has a significant positive coefficient in the central region but a negative coefficient in the western region, implying divergent outcomes in website utilization effectiveness across regions.

Among the digital economy application indicators, software business revenue per capita significantly influences tourism consumption in the eastern and western regions, with a larger coefficient in the east compared to the west. In contrast, the central region has yet to fully realize the supportive role of its software

industry in tourism consumption. Notably, the western region's software industry has begun to demonstrate initial effectiveness in boosting tourism spending. Telecommunications revenue per capita, however, shows no significant impact across all regions. E-commerce sales per capita exhibit significant positive coefficients in the east, central, and western regions, with the strongest effect in the east, followed by the central region, and the weakest in the west. This underscores the importance of enhancing e-commerce development and innovation in tourism, particularly in the western region, where substantial growth potential remains untapped. The proportion of e-commerce enterprises significantly affects tourism consumption in all regions, with the largest coefficient in the central region, followed by the east, and the smallest in the west. Conversely, the number of websites per hundred enterprises shows significant negative coefficients nationwide, suggesting that developing standalone websites may not effectively drive tourism consumption. Instead, leveraging established industry platforms or comprehensive third-party platforms may yield better outcomes.

Among the control variables, per capita disposable income exerts a significant impact on tourism consumption in the western region, indicating that tourism spending in the west remains constrained by income levels. The Engel coefficient significantly affects tourism consumption across the eastern, central, and western regions, with negative coefficients in all cases. Notably, the western region exhibits the largest absolute coefficient value, underscoring that household consumption structure imposes substantial structural constraints on tourism consumption, with the impact strongest in the west, followed by the central region, and weakest in the east. Higher education levels significantly influence tourism consumption in all regions, with the eastern region demonstrating a markedly higher coefficient compared to the central and western regions.

4.3 Robustness Checks

Using tourist visits as the dependent variable, the robustness test yields $R^2 = 0.558$ and F-statistic = 8.629 (significant at 1%) confirming model reliability. Mobile phone penetration, fiber-optic density, software revenue per capita, e-commerce sales per capita, e-commerce enterprise proportion, Engel coefficient, and higher education levels significantly influence tourist visits.

V. CONCLUSIONS AND RECOMMENDATIONS

Based on provincial panel data on the impact of digital technology diffusion on tourism consumption in China from 2013 to 2023, this study analyzes the heterogeneous effects of digital technology diffusion on tourism consumption in China. The results indicate that the diffusion of digital technology has a significant impact on China's tourism consumption overall; And the impact on the east is greater than that on the central and western regions. Among the influencing factors of regional differences, the influence of digital technology popularization indicators such as optical cable density, number of Internet broadband ports, and number of websites per capita is significant in the central and western regions. In the indicators of digital technology application, software business revenue has a significant impact on tourism consumption in both the eastern and western regions, with the eastern region having a greater impact than the western region; Digital technology application indicators such as e-commerce sales have the greatest impact on the eastern region, followed by the central region, while the western region has the smallest impact. In controlling variables, the western region is significantly limited by disposable income; The consumption structure has an impact on national tourism consumption, but has a greater impact on the western region; Higher education has a positive impact on tourism consumption, with the eastern region having a greater impact than the central region and the western region having the smallest impact. Based on the above analysis, there are the following suggestions:

(1) Strengthen the construction of digital technology infrastructure in the central and western regions. Strengthening the fiber-optic cable laying, Internet broadband port construction and enterprise website construction in the central and western regions, and strengthening the 5G broadband infrastructure of tourism enterprises in the central and western regions are conducive to promoting the growth and upgrading of tourism consumption in the central and western regions.

(2) Strengthen the construction of digital technology application capabilities and enhance the influence of the digital economy. The role of software business revenue in tourism consumption in the eastern and western regions has been demonstrated, but its impact on the central region is not yet clear. The eastern and western regions need to strengthen the development and application of tourism industry software to enhance their tourism consumption advantages, while the central region needs to accelerate the development of the software industry to enhance its impact on tourism consumption; Enhance the proportion of e-commerce sales and e-commerce enterprises, promote the development of e-commerce business, better promote and sell enterprise products and resources, and enhance their influence on tourism consumption.

(3) Improve the consumption structure of residents. By mechanization and standardized planting, we aim to increase the output of agricultural products in the western region, improve the quantity and quality of industrial transfer, provide competitive employment opportunities, and increase disposable income in the

western region; Improve the quality of residents' consumption, reasonably improve the structure of residents' consumption, reduce the Engel coefficient, and promote the growth of tourism consumption level and capacity.

(4) Accelerate investment in education. Higher education plays a significant role in promoting tourism consumption. Strengthening education investment is conducive to better popularizing and utilizing digital technology, enabling tourism enterprises to more efficiently utilize advanced technologies such as big data, artificial intelligence, virtual reality, etc., optimize tourism products and services, enhance tourist experience, and further stimulate tourism consumption potential.

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