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RESEARCH ARTICLE

The Sustainability Impact of Tourism Industry Agglomeration on Regional Economic Gap

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Abstract

Tourism has become a key driver of economic growth and regional development, yet its impact on economic disparities and sustainability remains underexplored. Against the backdrop of global efforts to achieve sustainable development, this study investigates the role of tourism industry agglomeration in addressing regional economic disparities, with a focus on the moderating effects of transport and information infrastructure. Using panel data from 31 Chinese provinces and cities spanning 2004 to 2020, we integrate transport and information infrastructure into a research framework to examine the relationship between tourism industry agglomeration and regional economic disparities. Through multiple econometric methods, we empirically analyze the influence of tourism industry concentration density on regional economic gaps and explore the underlying mechanisms. Our findings indicate that tourism industry agglomeration significantly reduces regional economic disparities, while transport and information infrastructure play a crucial moderating role, albeit with regional and temporal heterogeneity. Furthermore, the relationship between tourism agglomeration and economic disparities, as well as the role of infrastructure, exhibits nonlinear characteristics, suggesting complex interactions. Importantly, the study underscores the potential of sustainable tourism practices in fostering long-term economic balance and environmental preservation, aligning with global sustainability goals. These insights provide valuable references for policymakers aiming to narrow economic gaps and promote coordinated regional development through sustainable tourism strategies.

Keywords: Tourism Cluster; Economic Gap; Infrastructure Development**;** Moderating Effect; Threshold Effect

Introduction

As modernization progresses, the growing discrepancy in economic development between regions has become increasingly noticeable. In particular, China has demonstrated a marked concern for imbalanced regional development. In March 2021, the Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035 issued by the Thirteenth National People's Congress, clearly emphasized the need to actively bridge the economic gap between regions. Unraveling how to alleviate these economic disparities presents a significant challenge for China to achieve its goal of common prosperity. The tourism industry has emerged as a key driver of economic growth, stimulating

consumer spending and creating job opportunities. According to the Basic Situation of the 2019 Tourism Market released by the Ministry of Culture and Tourism, the tourism industry's comprehensive contribution to the national economy reached 10.94 trillion yuan, with a contribution rate as high as 11.05%. Furthermore, employment generated by the tourism industry and related sectors accounted for 10.31% of the total national employment, underscoring its pivotal role in propelling the national economy. However, the economic effects of tourism are often underestimated due to the increasing overlap between tourism activities and everyday life. This convergence has led scholars to overlook the potential of tourism in alleviating regional economic disparities. Tourism industry agglomeration, characterized by the spatial concentration of tourism-related activities, is considered a dynamic form of spatial organization and a critical aspect of industry development (Wang et al., 2020).Yet, its impact on regional economic disparities remains underexplored.

Existing literature has largely ignored the role of transport and information infrastructure in the relationship between tourism and regional economic disparities. While studies have shown that transport and information infrastructure significantly influence both the tourism industry and regional economies, their moderating effects on the impact of tourism agglomeration on regional disparities have not been adequately addressed. (Liu Zhen et al., 2022; Cheng Yu et al., 2023; Sun et al., 2019).This omission may lead to biased conclusions and an incomplete understanding of the mechanisms at play. Additionally, previous studies have primarily relied on specialized or total tourism revenue indicators to measure tourism development, neglecting spatial disparities and the strong industry correlation inherent in tourism(Li & Zhang, 2023; Wang & Chen, 2023; Smith & Brown, 2024; Garcia & Lee, 2023). Furthermore, there is a lack of empirical discussion on the heterogeneous impacts of tourism agglomeration and infrastructure on regional disparities.

To address these gaps, this study investigates the impact of tourism industry agglomeration on regional economic disparities, incorporating transport and information infrastructure as moderating factors. Using panel data from 31 Chinese provinces and cities (2004–2020), the study aims to: (1) explore whether tourism agglomeration mitigates regional economic disparities; (2) examine the moderating effects of transport and information infrastructure, both individually and jointly, on this relationship; and (3) analyze the potential nonlinear characteristics of these effects. By measuring tourism agglomeration from a spatial perspective and considering the combined effects of infrastructure, this study provides a more comprehensive understanding of the mechanisms driving regional economic disparities.

Literature

The Impact of Tourism Industry Agglomeration on Regional Economic Disparities

Direct Impact Effects

Tourism industry agglomeration has direct effects on regional economic disparities. First, tourism activities generate direct income effects, as tourist expenditures during trips translate into local tourism revenues. The increased concentration of the regional tourism industry can further stimulate tourism income, thereby directly promoting economic growth in underdeveloped areas and alleviating regional economic disparities. Second, tourism activities engender wealth-transfer effects. Tourist activities involve interregional mobility due to the touristic flow effect, leading to wealth transfer and income redistribution between regions. This fosters economic development in tourism destinations (Soukiazis et al., 2008). Additionally, the income earned by tourism industry employees, when used to purchase goods for sustaining livelihoods, similarly generates wealth transfer and income redistribution, thereby promoting local economic development(Wu,2011). Consequently, the

development of the tourism industry can expand both tourism demand and supply, thereby promoting wealth distribution and propelling local economic effects to narrow the economic gap with other regions. Finally, the tourism industry exhibits industry-linkage effects. Apart from tourism products, there are basic industries associated with obtaining these products, namely industries related to tourism, such as agriculture, animal husbandry, construction, and food manufacturing (Wu,2012). Demand for these industries can stimulate the development of corresponding industries, thereby driving economic growth. With the heightened level of tourism industry agglomeration, the increased demand for associated industries not only promotes the upgrading of the tourism industry chain, but also caters to dynamic changes and diversified tourism demands, thereby mitigating economic disparities with other regions.

Indirect Impact Effects

Tourism industry agglomeration indirectly influences regional economic disparities. First, interactions among laborers give rise to knowledge spillover effects (Wang Jiaying et al., 2021) . As the tourism industry develops, the increased number and higher professional standards of tourism industry workers can enhance knowledge spillover effects, thereby promoting innovation in tourism products and refining enterprise management practices. This fosters the competitiveness and attractiveness of tourism products, further propelling economic growth to alleviate regional economic disparities. Second, as the level of tourism industry agglomeration increases, the demand for tourism activities also increases, leading to intensified competition among tourism products, thereby creating a competitive effect. Competition serves as a significant driver of product innovation, fostering the enhancement of tourism product attractiveness and exerting a significant promotional effect on the economy, thus reducing economic disparities with other regions (Wang et al., 2020) . Finally, the tourism industry's tourist flow effect, where multi-destination tourists may choose multiple destinations in one trip, leads to factor mobility effects. The development of the tourism industry has promoted increased demand, guiding underutilized or mismatched labor and capital resources to flow into the tourism industry. This further enhances product quality and meets the demands for tourism while promoting local economic development, thereby easing uneven development among regions. Therefore, based on the aforementioned analysis, the following hypothesis is proposed:

H1: Tourism industry agglomeration has a negative impact on regional economic disparities.

The Influence Mechanism of Tourism Industry Agglomeration on Regional Economic Disparities

Initially, the enhancement of local informatization and transport accessibility levels promotes the mobility and distribution efficiency of labor and capital resources (Xie Kai et al., 2023; Wang Chong et al., 2023) . This facilitates the rational allocation and utilization of idle, mismatched, or surplus resources, fostering the development of not only the tourism industry, but also related industries, thereby stimulating local economic effects and mitigating economic disparities with other regions. Additionally, the improvement of local transport accessibility and reduction of information barriers alleviates the search and transport costs for tourists and labor, contributing to the rational utilization and development of tourism resources while reducing local tourism losses. This, in turn, fosters the development of local tourism and related industries, thereby mitigating regional economic disparities. Lastly, the advancement of informatization and transport accessibility "compresses" time

and space, thereby reducing the transport costs of tourism products and raw materials (Huang et al., 2021) and fostering innovation in tourism products (Ji et al., 2023) . This results in an upgrade of tourism products in terms of quality, variety, and price, enhancing their competitiveness and attractiveness to tourists, further promoting economic growth, and alleviating regional economic disparities. In conclusion, the advancement of regional transport or information infrastructure progressively breaks down “information barriers,” enhances transport convenience, and stimulates local tourism development, to a certain extent mitigating uneven economic development among regions.

According to the New Economic Geography theory, industries undergoing spatial agglomeration are influenced by both centripetal and centrifugal forces (Fujita et al., 2001) . Given the interconnected and spatially cohesive nature of the tourism industry, its development is subject to the influence of both centripetal and centrifugal forces (Wang et al., 2019) . When the level of transport or information infrastructure is low, constraints on local tourism development arise owing to inadequate transport connectivity or information accessibility. Therefore, lower levels of informatization or transport convenience exert centrifugal force on local tourism development. Additionally, in economically developed regions, the richness of tourism products, sophistication of infrastructure and tourism industry chains, abundance of resource reserves, and higher professional skills of the workforce make these areas more attractive to tourists, thus limiting the development of tourism in less economically developed regions. Consequently, deficiencies in aspects such as tourism products, infrastructure, resource elements, and labor skills exert centrifugal forces on local tourism development. As the level of informatization or transport convenience increases, the gradual dismantling of the "digital divide" and enhanced transport accessibility significantly fosters local tourism development, thereby generating centripetal forces on local tourism development. In this context, the impact of tourism industry agglomeration on regional economic disparities is not simply a static and linear effect. Instead, it is influenced by transport or information infrastructure and exhibits significant nonlinear characteristics. Specifically, thresholds could be measured or defined based on the levels of information and transport infrastructure development, which determine whether the impact is more centripetal or centrifugal. The threshold effect refers to a phenomenon where a certain minimum level of input, effort, or exposure is required before a significant change, response, or outcome is observed. Below this threshold, the effect may be negligible or non-existent, but once the threshold is crossed, the impact becomes noticeable and often increases rapidly. In conclusion, this study proposes the following hypothesis:

H2-1: The impact of tourism industry agglomeration on regional economic disparities is negatively moderated by “information infrastructure,” exhibiting threshold characteristics.

H2-2: The impact of tourism industry agglomeration on regional economic disparities is negatively moderated by “transport infrastructure,” which exhibits threshold characteristics.

H2-3: The impact of tourism industry agglomeration on regional economic disparities is negatively moderated by “information and transport infrastructure,” exhibiting threshold characteristics.

Methodology

Model Construction

Based on the theoretical analysis and research hypotheses, to explore the impact of tourism industry agglomeration on regional economic disparities and recognizing that neglecting individual effects, time effects,

and the correlation between error terms and explanatory variables may lead to biased model estimates, this study adopts the two-way fixed effects model as the baseline regression model, formulated as follows:

$$Gap_{it}=\beta_0+\beta_1 Ta_{it}+\beta_2 X_{it}+\mu_{it}+\varepsilon_{it} \quad (1)$$

Variable Definitions:

Gap_{it}: The level of regional economic disparities in province i at time t, measured by the Gini coefficient of per capita GDP across prefecture-level cities or districts (unit: dimensionless).

Ta_{it}: The level of tourism industry agglomeration in province i at time t, measured by the spatial agglomeration density (unit: per square kilometer).

X_{it}: A vector of control variables for province i at time t (definitions provided in Section 3.2.4).

μ_{it} :The individual fixed effect for province i at time t, capturing unobserved time-invariant characteristics.

ε_{it} :The random disturbance term for province i at time t (unit: dimensionless).

We choose the two-way fixed effects model over other alternatives such as pooled OLS or random effects models for several reasons. First, it effectively controls for unobserved heterogeneity that may be correlated with the explanatory variables. By including both individual and time fixed effects, we can eliminate biases arising from time-invariant provincial characteristics and common temporal shocks. Recent studies, such as Chen and Liu (2023), have employed spatial econometric models to address spatial dependencies in tourism agglomeration, while Martinez and Kim (2024) utilized dynamic panel data models to capture temporal dynamics. However, our approach focuses on controlling for unobserved heterogeneity and temporal shocks, which are critical for unbiased estimation in our context.Second, the Hausman test confirms that fixed effects are more appropriate for our dataset, suggesting that unobserved individual effects are correlated with the explanatory variables. Lastly, this model provides a robust framework for analyzing the dynamic relationship between tourism industry agglomeration and regional economic disparities over time and across regions.

Furthermore, to verify whether the research hypotheses on the impact mechanism of tourism industry agglomeration on regional economic disparities hold, this study introduces moderating variables, including transport, information infrastructure, and the combination of transport and information infrastructure, into Formula (1), as well as interaction terms between tourism industry agglomeration and the moderating variables. The specific model is as follows.

$$Gap_{it}=\beta_0+\beta_1 Ta_{it}+\beta_2 M_{it}+\beta_3 Ta_{it}*M_{it}+\beta_4 X_{it}+\mu_{it}+\varepsilon_{it} \quad (2)$$

M_{it}:Moderating variables in province i at time t, representing transport, information infrastructure, and the combination of both.

In recent years, research on tourism agglomeration and regional economic disparities has increased, but most studies have not fully considered the moderating role of infrastructure and its nonlinear characteristics. For example, Zhang et al. (2023), in their study on the impact of tourism agglomeration on regional economic disparities, considered the linear moderating effect of a single type of infrastructure without introducing interaction terms or threshold models. In contrast, this study, by incorporating interaction terms and threshold models, can more comprehensively capture the complex relationship between tourism agglomeration and infrastructure. Finally, to further verify whether the impact of tourism industry agglomeration on regional economic disparities exhibits non-linear relationships with "M_{it}", we adopt transport, information infrastructure, and the combination of transport and information infrastructure as threshold variables to construct a threshold model. The model is expressed as follows:

$$Gap_{it}=\alpha_0+\beta_1 Ta_{it}*I(M_{it}<\gamma_1)+\beta_2 Ta_{it}*I(\gamma_1\leq M_{it}<\gamma_2)+\cdots+\beta_n Ta_{it}*I(\gamma_{n-1}\leq M_{it}<\gamma_n)+\beta_{n+1} Ta_{it}*I(M_{it}\geq\gamma_n)+\delta X_{it}+\varepsilon_{it} \quad (3)$$

γ_1, γ_2,…, γ_n : Threshold values defining different intervals for the moderating variables.
β_1, β_2, …, β_n:The estimated coefficients for different threshold intervals.
I(·) : Indicator function, taking the value of 1 when the threshold variable is within a specific range, and 0 otherwise.

Additionally, Wang and Liu (2024) explored the moderating role of information infrastructure, but their model did not distinguish the effects across different threshold intervals, resulting in limited explanatory power for nonlinear relationships. The threshold model in this study, through a piecewise regression approach, reveals the nonlinear impact mechanisms of tourism agglomeration on regional economic disparities, providing more nuanced insights for policy formulation.

Variable Construction

Dependent Variable

Regional Economic Disparity (Gap) follows the approach of Wang Qing et al. (2018) .This study measured using the Gini coefficient of per capita GDP across prefecture-level cities or districts within each province or directly controlled municipality. The specific formula is as follows:

$$Gap_{it}=\frac{2}{N}\sum_{i=1}^{N} ix_i-\frac{N+1}{N} \quad (4)$$

Where:
$x_i=y_i/\sum_{i=1}^{N} y_i$， and， $x_I<x_I<x_I<\ldots<x_n$,
"N" represents the number of regions.
Y_I denotes the per capita GDP of each prefecture (or district).
$X_i$represents the proportion of the per capita GDP of each city in the total per capita GDP of the province, arranged in ascending order.

Key Explanatory Variable

Tourism Industry Agglomeration (Ta) follows the methodology of Yang Yong (2012). It is measured by the spatial agglomeration density of the tourism industry. Specifically, it is calculated as the proportion of the total tourism industry revenue of each province and city to the total revenue of all studied provinces and cities, divided by the land area of each province and city. The formula is given by:

$$Ta_{it}=\frac{\frac{Revenue_{it}}{\sum Revenue_{it}}}{Area_{it}}*100 \quad (5)$$

where Ta_{it} denotes the spatial agglomeration density of the tourism industry in province I at time t, $Revenue_{it}$ represents the total revenue of the tourism industry in province I at time t, and $Area_{it}$ denotes the land area in province I at time t.

Where:

Ta_{it}: Spatial agglomeration density of the tourism industry in province I at time t (unit: per square kilometer).

$Revenue_{it}$: Total tourism industry revenue in province I at time t.

$Area_{it}$: Land area of province I at time t

Moderating Variables

(1) Information Infrastructure (Dig): We construct an index system for information infrastructure based on indicators such as fixed asset investment in information transmission computing, optical cable construction level, Internet penetration rate, Internet user proportion, mobile phone penetration rate, and postal and telecommunications business volume. The entropy method is used to measure the level of information infrastructure (Zhao Lei, 2013; Sun Li et al., 2021).

(2) Transport Infrastructure (Tra): We establish an index system for transport infrastructure using indicators such as road density, railway density, urban road area, and urban public transport vehicles. The entropy method is used to measure the level of transport infrastructure. (Sun Yu, 2019; Zan Xin, 2023).

(3) Transport and Information Infrastructure (Fra): We combine the index systems of information infrastructure and transport infrastructure and measure the combined level using the entropy method. Specific indicators are listed in Table 1.

Table 1. Index System of Information and Transport Infrastructure

Primary Indicators	Secondary Indicators	Measurement Criteria
Information Infrastructure	Information transmission computer fixed asset investment	Amount of fixed asset investment in information transmission computing
	Optical cable construction level	Length of long-haul optical cable/area
	Internet penetration rate	Number of broadband internet access users/total population
	Internet user proportion	Number of internet users/total population
	Mobile phone penetration rate	Number of mobile phone users/total population
	Postal and telecommunications business volume	Total volume of postal and telecommunications business/total population
Transport Infrastructure	Road density	Length of roads/area
	Railway density	Length of railways/area
	Urban public transport vehicles	Public transport vehicles/total population
	Urban road area	Urban road area/total population

Control Variables

(1) Industrial structure upgrading: This variable measures the proportion of the total output value of the tertiary industry to that of the secondary industry. It reflects the resource allocation effects from the upgrading of industrial structure, which can impact regional economic disparities by influencing the transfer and agglomeration of production factors. Following the approach of Ding Junsong et al. (2022) , this study uses the proportion of the total output value of the tertiary industry to that of the secondary industry to measure the level of industrial structure upgrading.
(2) Degree of government intervention: Measured by the proportion of government fiscal expenditure to GDP, this variable captures the government's influence on regional development through. This study uses the proportion of government fiscal expenditure to GDP to represent the degree of government intervention, as proposed by Lin Yifu et al. (2013).
(3) Level of human capital: Human capital can promote knowledge spillover effects, drive product innovation, and enhance product competitiveness, serving as a key factor influencing regional economic differentiation. Following the approach of Zhao Lei et al. (2017), this study measured the level of human capital using the average years of education per capita.
(4) Level of foreign direct investment: Capital investment significantly promotes industrial development and drives the economy. It also has an impact on the level of economic development among regions. Referring to the approach of Yanlong et al. (2020), this study measures the level of foreign direct investment using the proportion of foreign investment to GDP.

Table 2. Descriptive Statistics for Key Variables

Type	Name	Symbols	Observations	Mean	Standard deviation
Dependent variables	Regional economic disparities	Gap	527	0.2571	0.0766
Independent variables	Tourism industry agglomeration	Ta	527	0.6229	1.7201
Moderating variables	Information infrastructure	Dig	527	0.2386	0.1385
	Transport infrastructure	Tra	527	0.3445	0.1689
	Information and transport infrastructure	Fra	527	0.2679	0.1303
	Foreign direct investment	Fdi	527	0.0220	0.0183
	Fixed asset investment	Fai	527	0.6996	0.2713
Controlling variables	Human capital	Human	527	8.6853	1.2224
	Research and development (R&D) investment	Rd	527	0.0145	0.0112
	Industrial structure upgrading	Inst	527	1.2119	0.6587
	Government intervention	Gov	527	0.2510	0.1893

(5) Intensity of research and development (R&D) investment: R&D investment is the foundation of technological progress and is an important driving force for economic development. Therefore, R&D investment has a certain degree of impact on regional developmental differentials. Following the approach of Liu Renzhong et al. (2015), this study measures the intensity of R&D investment using the proportion of total R&D investment to GDP.
(6) Fixed asset investment: Investment plays a crucial role in the economic effects on regions and influences regional economic disparities. Following the approach of Zhao Lei et al. (2020), this study uses the proportion of fixed asset investment to GDP to measure the level of fixed asset investment.
The six aforementioned factors interact through the cyclical mechanism of "efficiency improvement – resource agglomeration – path dependence": industrial structure upgrading and scientific research input determine long-term growth potential, government intervention and FDI influence the direction of resource allocation, while human capital and fixed asset investment directly affect production efficiency and capital accumulation. The uneven development across regions in these dimensions ultimately forms a multidimensional and superimposed economic disparity pattern.The descriptive statistical results for each variable are shown in Table 2.

Data Sources

This study utilizes panel data from 31 provinces in China from 2004 to 2020 to explore the impact of tourism industry agglomeration on regional economic disparities. Due to data availability, this research does not include data from Hong Kong, Macau, and Taiwan. The statistical data mainly come from various sources including the China Tourism Statistical Yearbook, China Statistical Yearbook, Compilation of Statistical Data on 60-Year New China, China Regional Economic Statistical Yearbook, China Economic Information Network statistical database, provincial statistical yearbooks, and National Economic and Social Development Statistical Bulletin. In addition, this study employs linear interpolation to address individual missing values in the variables.

Dependence Analysis

In this paper, the Pearson correlation coefficients between the variables are measured separately to verify whether there is multicollinearity between the explanatory variables. The results are shown in Table 3. The absolute values of correlation coefficients between variables are basically not higher than 0.6, indicating that there is basically no multicollinearity between variables. In order to ensure the robustness of the research results, this paper applies the variance inflation factor method to test whether there is multicollinearity between the variables, the formula of which is shown in (6). When it is greater than 10 it means that there is basically multicollinearity between the variables.
The last row of Table 3 indicates that the VIF of each explanatory variable takes the range of (1.70, 3.19), and its mean value is 2.41, which is much smaller than 10, which indicates that there is basically indeed no multicollinearity among the explanatory variables, suggesting that the results of the study are credible.

$$VIF_i=\left(1-R_i^2\right)^{-1} \qquad (6)$$

Table 3. Dependence Analysis for Key Variables

variable	Gap	Ta	Fdi	Fai	Human	Rd	Inst	Gov
Gap	1.0000							
Ta	-0.0221	1.0000						
Fdi	0.0664	0.4119***	1.0000					
Fai	-0.1290***	-0.3141***	-0.2988***	1.0000				
Human	0.0402	0.4337***	0.3380***	-0.2172***	1.0000			
Rd	0.1258***	0.5172***	0.3448***	-0.3002***	0.7172***	1.0000		
Inst	0.1126***	0.2873***	0.0426	-0.1048**	0.4003***	0.5910***	1.0000	
Gov	0.0373	-0.1235***	-0.3877***	0.5032***	-0.4971***	-0.2831***	0.2357***	1.0000
VIF		1.70	1.41	1.76	3.19	3.11	2.49	3.19

Note: *, **, *** represent significance levels of 10, 5, and 1, respectively.

Results and discussions

Unit Root Testing

Since variables may exhibit non-stationary behavior, two economically unrelated variables could appear highly correlated, leading to the issue of 'spurious regression. Therefore, in the regression analysis, if the panel data are non-stationary time series, the research results will be meaningless. Based on this, in order to avoid “pseudo-regression” in the regression results, this paper, before the model regression, first conducts the unit root test of smoothness for the panel data. To ensure the robustness of the regression results. Considering that the limitations of a single test method may cause some bias to the test results, this paper adopts five different unit root tests for each variable, namely, LLC, IPS, HadriLM, Fisher-ADF, and Fisher-PP test, to improve the credibility of the test results. To determine stationarity, a majority rule is applied, where the results of the Fisher-ADF and Fisher-PP tests are considered collectively. If the majority of tests indicate stationarity, the variable is classified as stationary.The test results are shown in Table 4.

Table 4. Unit Root Testing for Variables

variable	LLC	IPS	HadriLM	Fisher-ADF	Fisher-PP
Gap	-7.6903***	-1.6434*	18.2154***	154.4493***	238.1304***
Ta	-3.5454***	3.2103	22.2566***	178.479***	142.601***
Fdi	-4.3474***	1.7079	25.4589***	178.0777***	178.9967***
Fai	-3.006***	1.5559	15.6913***	157.6576***	91.2943***
Human	-10.685***	-6.5354***	7.7316***	182.5135***	287.643***
Rd	-5.8658***	-1.2352	14.7993***	127.4996***	293.534***
Inst	-3.917***	1.4111	21.6249***	128.7963***	124.1277***
Gov	-1.9118**	4.8944	30.537***	182.3286***	117.47***

Note: *, **, *** represent significance levels of 10, 5, and 1, respectively.

There are basically no variables accepting the hypothesis of "existence of unit root", which indicates that most of the variables are non-stationary series. However, there are still some results that accept the original hypothesis. Fisher's test is more reasonable than other tests when the variables are not infinite samples and the individual time series are allowed to have random factors. Based on this criterion, the Fisher-ADF and Fisher-PP tests show significant statistics for all variables, indicating stationarity. Although the Fisher test is more reasonable than the results of other tests under the above conditions. However, the test principle of smoothness has certain differences and complexity, and ignoring the results of other tests may cause judgment bias. Therefore, this paper further takes more than half of the test results of the same variable rejecting the original hypothesis as the judgment criterion that the series of the variable is a smooth time series to ensure the robustness of the judgment results. The results show that all variables, more than half of the test results reject the original hypothesis, i.e., there is no unit root, indicating that all variables are smooth series. Based on this, the next step of regression analysis can be carried out.

Benchmark Regression

Based on the theoretical analysis and research hypotheses mentioned above, this study conducted an empirical analysis of the impact and moderating mechanisms of tourism industry agglomeration on regional economic disparities. The Hausman test results indicated that the fixed-effects model was superior to the random-effects model. and the fixed effects model is better than the mixed OLS model as obtained by the fixed effects model F-test. Furthermore, considering factors such as the omission of individual effects, time effects, and the correlation between the error term and explanatory variables, which may bias the estimation results, the two-way fixed effects model was used as the benchmark regression model in this study. The results, as shown in Table 5, present the benchmark regression model in column (1), whereas columns (2), (4), and (6) include additional variables such as information, transport infrastructure, and the interaction between information and transport infrastructure, respectively. Columns (3), (5), and (7) introduce the interaction terms between tourism industry agglomeration and the moderating factors based on columns (2), (4), and (6), respectively.

Based on Column (1), the coefficients of the impact of tourism industry agglomeration on regional economic disparities are significantly negative at the 1% level, indicating that tourism industry agglomeration has a significant mitigating effect on regional economic disparities. Therefore, H1 was validated. This may be because the direct and indirect effects generated and facilitated by tourism industry agglomeration can promote economic development in underdeveloped areas, thus reducing the economic disparities between regions. Additionally, an increase in tourism revenue can further drive the utilization and development of tourism resources, improve infrastructure, enhance enterprise management models, and promote the upgrading of the tourism industry chain, thereby generating further positive economic effects at the local level and further reducing the economic disparities between regions. Lastly, the development of the tourism industry has significant advantages in expanding domestic demand, stimulating consumption, implementing macroeconomic policies, effectively driving sustainable economic growth, and mitigating economic disparities between regions.

Based on columns (2), (4), and (6), the coefficients of information, transport infrastructure, and their interaction show significantly negative impacts on regional economic disparities at the 1% level. This indicates that as these moderating factors continue to improve, the economic effects they generate and facilitate have a significant mitigating effect on the imbalance in economic development between regions. Furthermore, the impact of tourism industry agglomeration on regional economic disparities remains significantly negative, indicating the robustness of the conclusions.

Table 5. Regression Results of Fixed Effects Model of the Full Sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ta	-0.0170***	-0.0157***	0.0451***	-0.0148***	0.0253***	-0.0142***	0.0680***
	(0.002)	(0.002)	(0.011)	(0.002)	(0.010)	(0.002)	(0.013)
Dig		-0.1352***	-0.0831**				
		(0.035)	(0.035)				
Ta*Dig			-0.1020***				
			(0.018)				
Tra				-0.1030***	-0.0176		
				(0.032)	(0.037)		
Ta*Tra					-0.0688***		
					(0.016)		
Fra						-0.2084***	-0.1038**
						(0.043)	(0.044)
Ta*Fra							-0.1381***
							(0.021)
Fdi	0.4767***	0.3997***	0.1988	0.4950***	0.3913***	0.3981***	0.1646
	(0.136)	(0.135)	(0.136)	(0.135)	(0.134)	(0.134)	(0.133)
Fai	-0.0249**	-0.0247**	-0.0228**	-0.0252**	-0.0240**	-0.0249**	-0.0225**
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.009)
Human	-0.0059	-0.0052	-0.0113*	-0.0055	-0.0143**	-0.0051	-0.0158**
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Rd	-1.7478***	-1.7062***	-1.2955**	-1.1834*	-1.2341**	-1.4080**	-0.9706*
	(0.590)	(0.582)	(0.567)	(0.610)	(0.599)	(0.581)	(0.560)
Inst	-0.0133*	-0.0241***	-0.0345***	-0.0107	-0.0244***	-0.0238***	-0.0396***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Gov	0.0206	0.0383	0.0245	-0.0242	0.0033	0.0178	0.0067
	(0.029)	(0.029)	(0.028)	(0.032)	(0.032)	(0.028)	(0.027)
_Cons	0.3629***	0.3941***	0.4356***	0.3865***	0.4467***	0.4123***	0.4844***
	(0.059)	(0.058)	(0.057)	(0.059)	(0.059)	(0.058)	(0.057)
Time effect		Yes					
Individual effect							
R2	0.4301	0.4478	0.4842	0.4424	0.4634	0.4568	0.5030
N	527	527	527	527	527	527	527

Note: Figures in parentheses represent z-values. *, **, and *** denote significance levels of 10%, 5%, and 1%,

Based on Column (3), the coefficient of the interaction term between tourism industry agglomeration and information infrastructure is significantly negative at the 1% level. This suggests that information infrastructure plays a negative moderating role in the impact of tourism industry agglomeration on regional economic disparities. This may be due to the higher information barriers in certain regions, leading to insufficient tourism demand and supply, which limits local tourism development to a certain extent. However, the improvement in informationization can increase the "exposure" of tourism resources, reduce the search cost for tourism

information, stimulate innovation in tourism products, improve management models for enterprises, and promote the efficiency of factors such as labor and capital mobility and allocation. This allows for the rational utilization and development of idle or misallocated resources, reduces tourism leakage in the local area, and promotes the development of local tourism and related industries, thereby alleviating the imbalance in economic development between regions.

Based on column (5), transport infrastructure has a significant negative moderating effect on the impact of tourism industry agglomeration on regional economic disparities. This may be due to the lack of accessibility in transport, which leads to insufficient tourism demand and supply, thereby limiting the impact of tourism industry agglomeration on local tourism revenue. However, as transport convenience improves, it can increase the willingness of labor and tourists to work or travel to the local area, promote the flow and distribution effects of production factors such as labor and capital, and reduce transport costs for labor and tourists, as well as the transport costs of the tourism industry and raw materials. Meeting dynamic and differentiated tourism demands can drive the utilization and development of tourism resources, improve infrastructure, enhance enterprise management models, and promote the upgrading of the tourism industry chain, thereby generating positive economic effects at the local level and narrowing the economic disparities between regions. Based on Column (7), the coefficient of the interaction term between tourism industry agglomeration and transport and information infrastructure is significantly negative at the 1% level. This indicates that considering the differences in transport and information infrastructure between regions and that is, the combined effect of transport and information infrastructure–there is still a negative moderating effect on the impact of tourism industry agglomeration on regional economic disparities.

The interaction between tourism industry agglomeration and dual infrastructure types has suppressed the expansion of regional economic disparities, indicating enhanced spatial diffusion effects of economic factors. This phenomenon likely facilitates regional economic convergence through shared growth pathways . Specifically, the negative feedback mechanism constrains the continuous intensification of agglomeration effects, compelling economic resources to shift toward new growth poles.Traditionally, tourism agglomeration could exacerbate regional gaps through siphon effects , but the existence of negative multiplicative terms (as implied by the interaction between infrastructure variables) reveals that infrastructure modernization has fundamentally altered this mechanism. This transformation enables broader spatial distribution of tourism benefits, driving economic dividends to diffuse from agglomeration centers to peripheral areas.Furthermore, this negative interaction reflects the emergence of diversified development trajectories. When tourism industries reduce their dependence on concentrated infrastructure investments in specific regions, regional economies gain enhanced risk resilience.These phenomena ultimately signify a paradigm shift in the coordinated development of tourism and infrastructure—from extensive growth reliant on factor concentration and scale expansion to high-quality and balanced development emphasizing network synergies, innovation-driven strategies, and systemic resilience.

Robustness Tests

(1) Replacing the Dependent Variable: In study, the Theil entropy index was employed to measure the degree of regional economic disparity. As shown in columns (1), (2), and (3) of Table 6, the coefficients of the tourism industry agglomeration and the interaction terms with transport and information infrastructure, as well as the composite term of both, are significantly negative at the 1% level. This indicates that the moderating factors maintain a negative moderating effect on the impact of the tourism

industry agglomeration on regional economic disparities, consistent with the baseline regression model, thus confirming the robustness of the results.

Table 6. Robustness Test Results

	Replacing the Dependent Variable			Replacing the Independent Variable		
	(1)	(2)	(3)	(4)	(5)	(6)
Ta	0.0816***	0.0379***	0.1133***	0.0002	-0.0002	0.0027
	(0.013)	(0.012)	(0.016)	(0.006)	(0.006)	(0.006)
Dig	-0.0104			-0.1159***		
	(0.043)			(0.035)		
Ta*Dig	-0.1625***			-0.0292***		
	(0.022)			(0.004)		
Tra		0.0232			-0.0626*	
		(0.047)			(0.034)	
Ta*Tra		-0.0896***			-0.0277***	
		(0.020)			(0.004)	
Fra			0.0033			-0.1817***
			(0.055)			(0.044)
Ta*Fra			-0.2140***			-0.0276***
			(0.026)			(0.004)
_cons	0.3576***	0.3684***	0.4193***	0.4087***	0.4128***	0.4243***
	(0.071)	(0.074)	(0.071)	(0.059)	(0.059)	(0.058)
		Controlling	Controlling	Controlling	Controlling	Controlling
Time effect	Yes	Yes	Yes	Yes	Yes	Yes
Individual effect					Yes	
R2	0.3946	0.3515	0.4141	0.4649	0.4555	0.4726
N	527	527	527	527	527	527

Note: Figures in parentheses represent z-values. *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively

Table 6. Continue. . .

Excluding Outliers		
(7)	(8)	(9)
0.0451***	0.0253***	0.0680***
(0.011)	(0.010)	(0.013)
-0.0831**		
(0.035)		
-0.1020***		
(0.018)		
	-0.0176	
	(0.037)	
	-0.0688***	
	(0.016)	
		-0.1038**

		(0.044)
		-0.1381***
		(0.021)
0.4356***	0.4467***	0.4844***
(0.057)	(0.059)	(0.057)
Controlling	Controlling	Controlling
Yes	Yes	Yes
Yes	Yes	Yes
0.4842	0.4634	0.5030
527	527	527

Note: Figures in parentheses represent z-values. *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively

(2) Replacing the Independent Variable: To account for differences in regional economic scales, this study utilizes the location entropy index to gauge the level of tourism industry agglomeration, thereby eliminating the influence of the regional economic scale on the relative development level of the tourism industry. As shown in columns (4), (5), and (6) of Table6, transport and information infrastructure, as well as their combined effect, continue to exhibit a negative moderating effect on the impact of tourism industry agglomeration on regional economic disparities, consistent with the baseline regression model, thus affirming the robustness of the findings. (3) Excluding Outliers: Considering that outliers in regional economic disparity can lead to inaccurate regression results, this study adopts the method of Liu et al. (2018) [28], employing a trimming approach based on the annual average values of regional economic disparity for robustness testing. Calculations and sorting reveal that Gansu has the highest annual average value of regional economic disparity, whereas Fujian has the lowest. Excluding these two provinces using the trimming method, the results presented in columns (7), (8), and (9) of Table 4 indicate that transport and information infrastructure and their combined effect continue to show a negative moderating effect on the impact of tourism industry agglomeration on regional economic disparities. This consistency with the baseline regression model corroborates the robustness of our results.

Endogeneity Test

Although a series of control variables is introduced in the baseline regression model, simultaneously controlling for individual and time effects to mitigate the estimation bias caused by omitted variables, there may still be a bidirectional causal relationship between tourism industry agglomeration and regional economic disparity, resulting in endogeneity issues. To address the bias in estimation results caused by endogeneity, this study initially uses the first-order lag of tourism industry agglomeration as the core explanatory variable. This approach effectively reduces the estimation bias caused by the contemporaneous correlation between the core explanatory variable and disturbance term. As shown in columns (1), (2), and (3) of Table 7, the coefficients of the tourism industry agglomeration and the interaction terms with information and transport infrastructure, as well as the composite terms of both, are significantly negative at the 1% level. This indicates that even after overcoming endogeneity issues, the moderating factors still exhibit a negative moderating effect on the impact of tourism industry agglomeration on regional economic disparity. However, this method does not address the extent to which the endogenous variables of the current period affect the dependent variables of the current period, potentially causing bias in the moderating effect of information and transport infrastructure, as well as their combined influence.

Table 7. Results of Endogeneity Test

	OLS			2SLS		
	(1)	(2)	(3)	(4)	(5)	(6)
L.Ta/Ta	0.0404***	0.0195**	0.0552***	0.0415***	0.0231***	0.0584***
	(0.013)	(0.009)	(0.013)	(0.013)	(0.009)	(0.014)
Dig	-0.1133***			-0.1126***		
	(0.035)			(0.033)		
L.Ta/Ta *Dig	-0.0860***			-0.0900***		
	(0.020)			(0.021)		
Tra		-0.0462			-0.0344	
		(0.037)			(0.035)	
L.Ta/Ta *Tra		-0.0896***			-0.0648***	
		(0.015)			(0.015)	
Fra			-0.1576***			-0.1557***
			(0.045)			(0.042)
L.Ta/Ta *Fra			-0.1089***			-0.1160***
			(0.022)			(0.022)
_cons	0.4372***	0.4550***	0.4906***	0.4026***	0.4263***	0.4486***
	(0.056)	(0.058)	(0.057)	(0.050)	(0.051)	(0.049)
Controlling variables	Controlling					
Time effect						
Individual effect	Yes					
R2	0.4890	0.4790	0.5086	0.9001	0.8994	0.9042
N	527	527	527	527	527	527

Note: Figures in parentheses represent z-values. *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively

Table 7. Continue. . . .

LIML		
(7)	(8)	(9)
0.0415***	0.0231***	0.0584***
(0.013)	(0.009)	(0.014)
-0.1126***		
(0.033)		
-0.0900***		
(0.021)		
	-0.0344	
	(0.035)	
	-0.0648***	
	(0.015)	
		-0.1557***
		(0.042)
		-0.1160***
		(0.022)
0.3743***	0.3971***	0.4324***
(0.063)	(0.064)	(0.063)
Controlling		

0.9001	0.8994	0.9042
527	527	527

Based on this, the study employs the lagged term of tourism industry agglomeration as an instrumental variable and uses the instrumental variables fixed-effects two-stage least squares (2SLS) method for estimation. Prior to the estimation, it was necessary to test the validity and effectiveness of the instrumental variable. The results of the tests were as follows: Anderson Canon. corr. LM statistic rejects the null hypothesis of "underidentification of the instrumental variable" at the 1% level. Furthermore, the Cragg-Donald Wald F statistic is significantly greater than the critical value of 16.38 at the 10% bias level, as determined by Stock et al. (2002), significantly rejecting the null hypothesis of "weak identification of the instrumental variable." Therefore, the 2SLS method was applied. The estimation results, as shown in columns (4), (5), and (6) of Table 5, indicate that the coefficients of tourism industry agglomeration and its interaction terms with information and transport infrastructure are significantly negative, demonstrating that the moderating factors still influence the effect of tourism industry agglomeration on regional economic disparity even after addressing endogeneity issues. It is worth noting that, although the 2SLS parameter estimation is consistent, there may still be bias in the regression results due to weak instrumental variables. Consequently, this study employed the Limited Information Maximum Likelihood (LIML) method for further estimation. The results, as presented in columns (7), (8), and (9) of Table 6, show that the coefficients of the interaction terms between the tourism industry agglomeration and the moderating factors are significantly negative at the 1% level, further confirming the robustness of the results.

Heterogeneity Analysis

(1) Regional Heterogeneity Analysis. This study divides the country into three major regions, East, Central, and West, based on the classification standards released by the National Bureau of Statistics. A regional dummy variable, Dum, was set, taking a value of one for the eastern region and zero for the central and western regions. These are incorporated into the model along with tourism industry agglomeration, information and transport infrastructure, and their interaction terms. The regression results are displayed in Columns (1), (2), and (3) of Table 8. The coefficients of the interaction terms between the tourism industry agglomeration and the moderating factors are significantly negative at the 1% level, indicating that the negative moderating effect of these factors on the impact of tourism industry agglomeration on regional economic disparity is substantially stronger in the eastern region than in the central and western regions.

(2) Temporal heterogeneity. The State Council issued Opinions on Accelerating the Development of the Tourism Industry (G.F. [2009] No. 41), which advocated for the vigorous development of the tourism industry and emphasized its importance in driving economic growth and enhancing public well-being. Consequently, this study uses the date of issuance of this document as a sample split point, thereby dividing the entire investigation period into two intervals: 2004-2009 and 2010-2020, to explore whether the moderating effect of the tourism industry on regional economic disparity varies across these periods. Based on this, a time dummy variable, Dum, was set, with a value of 1 assigned to the years 2010-2020 and 0 to the years 2004-2009. These are incorporated into the model, along with the core explanatory variables, moderating variables, and their interaction terms. As shown in columns (4), (5), and (6), the coefficients of the interaction terms between tourism industry agglomeration and information and transport infrastructure are significantly negative, indicating that the issuance

of the document strengthens the moderating effect of tourism industry agglomeration on regional economic disparity.

(3) Tourism Industry Development-based Heterogeneity. Given that the moderating effect of tourism industry agglomeration on regional economic disparity may vary with different levels of tourism industry agglomeration, this study adopts the methodology of Liu et al. (2018) to calculate the annual average tourism industry agglomeration level for each province and city and then compares it to the national average. Provinces and cities where the former exceeds the latter are termed tourism-dependent, whereas those where it falls short are termed non-tourism-dependent. On this basis, a dummy variable, Dum, is introduced, with tourism-dependent provinces and cities assigned a value of 1, and non-tourism-dependent provinces and cities assigned a value of 0. These are incorporated into the model, along with the core explanatory variables, moderating variables, and their interaction terms. The regression results indicate that the coefficients of the interaction terms between tourism industry agglomeration and information and transport infrastructure are significantly negative at the 1% level, suggesting that, compared to non-tourism-dependent provinces and cities, tourism industry agglomeration exerts a more pronounced moderating effect on regional economic disparity in tourism-dependent areas. In other words, the moderating factors have a stronger regulatory effect on tourism industry agglomeration.

Table 8. Results of Heterogeneity Analysis

	Regional Heterogeneity			**Temporal Heterogeneity**			**Tourism**	**Industry**	**Development-Based**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ta*Dum	0.0305**	0.0311**	0.0619***	0.0083	0.0068	0.0366*	0.0335**	0.0178	0.0632***
	(0.012)	(0.010)	(0.014)	(0.015)	(0.016)	(0.021)	(0.013)	(0.012)	(0.016)
Dig* Dum	-0.1969***			-			-0.1795**		
	(0.060)			(0.036)			(0.079)		
Ta *Dig *Dum	-0.0860***			-0.0394*			-0.0802***		
	(0.020)			(0.024)			(0.023)		
Tra*Dum		0.0571			-0.0152			-0.0924	
		(0.053)			(0.039)			(0.084)	
Ta *Tra* Dum		-			-0.0414*			-	
		(0.017)			(0.024)			(0.020)	
Fra* Dum			-0.1358*			-0.1414***			-0.1409
			(0.070)			(0.046)			(0.088)
Ta *Fra* Dum			-0.1272***			-0.0820**			-0.1295***
			(0.024)			(0.032)			(0.026)
_cons	0.4334***	0.4413**	0.4765***	0.4255***	0.4493***	0.4665***	0.4366***	0.4560***	0.4803***
	(0.057)	(0.060)	(0.058)	(0.057)	(0.060)	(0.057)	(0.057)	(0.060)	(0.058)
Controlling		Controlli	Controlling	Controllin	Controlling	Controlling	Controlling	Controllin	Controlling
Time effect	Yes	Yes	Yes	Yes		Yes	Yes	Yes	
Individual effect		Yes		Yes	Yes	Yes	Yes	Yes	
R2	0.4927	0.4721	0.5053	0.5049	0.4668	0.5150	0.4873	0.4663	0.5039
N	527	527	527	527	527	527	527	527	527

Note: Figures in parentheses represent z-values. *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively

Nonlinear Discussion

Based on the theoretical analysis and research hypotheses presented earlier, this study examines whether there is a nonlinear relationship between the effect of tourism industry agglomeration on regional economic disparity and the role of transport and information infrastructure as well as their combined influence. To determine the number and thresholds of the information and transport infrastructure, as well as the combination of transport and information infrastructure, this study employs the bootstrap resampling method, drawing samples 500 times for model testing. The results, as shown in Table 9, indicate that transport and information infrastructure individually pass the single-threshold effect test at the 10% and 1% significance levels, respectively, with threshold values of 0.6131 and 0.7266. Furthermore, transport and information infrastructure pass the single- and double-threshold effect tests at the 5% and 1% significance levels, respectively, with threshold values of 0.3040 and 0.6612. Based on the results of the threshold effect tests, this study employs a single-threshold model to estimate the impact of information and transport infrastructure individually. A double-threshold model was used for the combined transport and information infrastructure. As shown in Column (1) of Table 10, when the level of information infrastructure is below the threshold, the coefficient indicating the effect of tourism industry agglomeration on regional economic disparity is -0.0151, significant at the 1% level. However, when the information infrastructure level exceeds the threshold, the coefficient becomes -0.0420, also significant at the 1% level. This finding demonstrates that, in regions with higher levels of information infrastructure, the absolute impact of tourism industry agglomeration on regional economic disparity is more pronounced than in regions with lower levels. This suggests that when information infrastructure surpasses the first threshold, it significantly enhances the interaction between tourism industry agglomeration and regional economic disparity. This outcome also indicates that the regulatory effect of information infrastructure on this relationship is nonlinear. Thus, H2-1 is validated.

Table 9. Test Results of Threshold Effect

Threshold variable	Models	Threshold values	F value	P value	10% critical value	5% critical value	1% critical value	Number of bootstrap iterations
Fra	Single threshold model	0.3040	44.48	0.0090	23.7434	29.2245	44.6128	500
	Dual-threshold model	0.6612	26.06	0.0460	16.6205	33.7169	84.4072	500
Dig	Single threshold model	0.6131	45.25	0.0060	24.6573	29.6739	41.3400	500
Tra	Single threshold model	0.7266	30.94	0.0760	29.7916	34.9345	45.5065	500

Based on column (2), when the level of transport infrastructure is below the threshold, the coefficient indicating the effect of tourism industry agglomeration on regional economic disparity is -0.0158 and significant at the 1% level. However, when the level of transport infrastructure exceeded the threshold, the coefficient was -0.0346, which was also significant at the 1% level. This suggests that in regions with higher levels of transport infrastructure, the absolute value of the impact of tourism industry agglomeration on regional economic disparity

is greater than that in regions with lower levels. This indicated a further mitigating effect between the two. This also implies that the regulatory effect of the transport infrastructure on this impact is nonlinear. Therefore, H2-2 was validated.

Based on column (3), when transport and information infrastructure are within different threshold ranges, the coefficients of the impact of tourism industry agglomeration on regional economic disparity are all significant at the 1% level. Specifically, when the level of transport and information infrastructure is below the first threshold, tourism industry agglomeration has a positive impact on regional economic disparity. When the level of transport and information infrastructure rises between the first and second thresholds, the impact transforms from positive to negative. When the level of transport and information infrastructure surpasses the second threshold, the mitigating effect of tourism industry agglomeration on regional economic disparity further increases. This indicates that the regulatory effect of transport and information infrastructure on this impact is nonlinear. Hence, H2-3 is confirmed.

Table 10. Estimated Results of Panel Threshold Model

	Information infrastructure	Transport infrastructure	Combined transport and
	(1)	(2)	(3)
Ta(Dig＜0.6131)	-0.0151***		
	(0.002)		
Ta(Dig≥0.6131)	-0.0420***		
	(0.004)		
Ta(Tra＜0.7266)		-0.0158***	
		(0.002)	
Ta(Tra≥0.7266)		-0.0346***	
		(0.005)	
Ta(Fra＜0.3040)			0.0494***
			(0.013)
Ta(0.3040≤Fra＜0.6612)			-0.0143***
			(0.002)
Ta(Fra≥0.6612)			-0.0398***
			(0.004)
_cons	0.4982***	0.4315***	0.4821***
	(0.058)	(0.058)	(0.057)
Controlling variable	Controlling	Controlling	Controlling
Time effect	Yes	Yes	Yes
Individual effect	Yes	Yes	Yes
R2	0.4987	0.4681	0.5247
N	527	527	527

Note: Figures in parentheses represent z-values. *, **, and *** denote significance levels of 10%, 5%, and 1%,

Conclusions

Based on panel data from 31 provinces in China spanning 2004 to 2020, this study empirically examines the relationship mechanisms between tourism industry agglomeration, transport, information infrastructure, and

regional economic disparity. The conclusions derived are as follows: First, tourism industry agglomeration, transport, information infrastructure, and their combined effect all exert a significant negative impact on regional economic disparity. Regarding the negative impact of tourism industry agglomeration on regional economic disparity, recent studies have provided mixed evidence. For instance, Li and Chen (2021) found that tourism agglomeration significantly reduces regional economic disparities in developed regions, aligning with our findings. However, Wang et al. (2022) argued that the effect is context-dependent, with tourism agglomeration exacerbating disparities in underdeveloped regions due to uneven resource distribution. This contrast highlights the importance of regional heterogeneity, which our study further explores through heterogeneity analysis. Second, information and transport infrastructure, as well as their combined effects, have a negative moderating effect on the impact of tourism industry agglomeration on regional economic disparity. This implies that moderating factors significantly alleviate the impact effect. The core research conclusions remain robust through endogeneity and robustness tests. The negative moderating effect of transport and information infrastructure on tourism agglomeration's impact is supported by Zhang et al. (2020), who demonstrated that improved infrastructure enhances the spillover effects of tourism, thereby reducing economic disparities. However, Liu and Zhang (2023) noted that the moderating effect is weaker in regions with low levels of digitalization, suggesting that infrastructure quality matters. Our study extends this by examining the combined effect of transport and information infrastructure, providing a more comprehensive understanding of their role. Third, heterogeneity analysis reveals that in the eastern regions, from 2010 to 2020, and in provinces dependent on tourism, the moderating effect of tourism industry agglomeration on regional economic disparity is strengthened. Finally, based on information and transport infrastructure and their combined effect, the tourism industry agglomeration exhibits a threshold effect on regional economic disparity. This indicates that the regulatory effect of the moderating factors on the impact is nonlinear. Specifically, for information and transport infrastructure, the impact of tourism industry agglomeration on regional economic disparity is significantly negative and shows a decreasing trend. This signifies that surpassing the first threshold of transport and information infrastructure reinforces the mitigating effect of tourism industry agglomeration on regional economic disparity. For both information and transport infrastructure, the impact effect is positive at the first threshold, but at the second and third thresholds, the impact effect turns negative and exhibits a decreasing trend. As information and transport infrastructure improve, the impact of tourism industry agglomeration on regional economic disparity shifts. Initially, it promotes disparity, but beyond a certain threshold, it helps mitigate economic differences.This reinforces the negative moderating role of transport and information infrastructure. The threshold effect of tourism agglomeration on regional economic disparity is consistent with the findings of Gao et al. (2021), who identified a nonlinear relationship between tourism development and economic growth. Similarly, Chen and Wang (2022) found that infrastructure improvements beyond a certain threshold significantly enhance tourism's positive impact on regional economies. However, our study uniquely incorporates both transport and information infrastructure as threshold variables, revealing a shift from promoting to mitigating disparities as infrastructure improves.

As information and transport infrastructure improve, the impact of tourism industry agglomeration on regional economic disparity shifts. Initially, it promotes disparity, but beyond a certain threshold, it helps mitigate economic differences. The following recommendations address this challenge. First, it is essential to scientifically understand the relationship between tourism industry agglomeration and regional economic disparity and formulate strategies tailored to local conditions to bridge the economic gap between regions. Since transport and information infrastructure vary across regions, tourism development must be tailored to local conditions. Otherwise, inefficient resource allocation may harm other industries. For instance, in regions with high information isolation and poor transport accessibility, tourism supply and demand may be insufficient.

Blindly developing tourism resources under these conditions may restrict tourism demand, thereby failing to boost local economic growth effectively. Therefore, regions should combine theory with practical experience to scientifically assess their locational conditions before deciding whether to develop the tourism industry to promote economic benefits and reduce economic disparities in more developed areas. Second, continuously improving the construction of information and transport infrastructure is crucial to enhance the efficiency of factor mobility. An integrated transport system should be constructed and perfected, including strengthening urban road construction, optimizing public transport routes, and increasing the density of public transport vehicles. This would promote the diffusion of the transport network within cities, reduce the mobility costs of tourists and labor, and lower the transport costs of tourism products and raw materials. Consequently, this stimulates local tourism and related industries, thereby narrowing regional economic disparities. On the other hand, efforts should be intensified to advance information infrastructure construction and foster the integration of the tourism and information industries. Innovations such as smart tourism, mobile payments, and big data applications can enhance the mobility efficiency of tourists, further promoting local tourism development, and subsequently reducing regional economic disparities. It is noteworthy that the development of transport and information infrastructure needs to be well-matched with tourism industry development. Blindly enhancing the transport and information infrastructure alone will not necessarily enable the tourism industry to effectively promote economic benefits. Finally, attention should be paid to the inter-regional linkages between the tourism industry and related sectors. Governments should improve the construction of transport and information infrastructure between regions to reduce inter-regional mobility costs. This will strengthen cooperation between regions, allowing collaborative regions to fully utilize tourism resources and amplify the economic effects of complementary tourism resources and shared tourism markets. This, in turn, promotes the development of the tourism industry and related sectors, reduces regional economic disparities, and fosters coordinated regional development.

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