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Tourism Digitalization and Urban–Rural Income Inequality in China: Evidence from Provincial Panel Data

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Article

Keywords: tourism digitalization, urban–rural income inequality, Theil index, industrial structure upgrading, regional innovation, China

Posted Date: March 10th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-8795898/v1

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Additional Declarations: No competing interests reported.

Type of the Paper (Article, Review, Communication, etc.)

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Abstract

Urban–rural income inequality remains a major impediment to inclusive and sustainable development in China. Meanwhile, digital transformation in the tourism industry has accelerated, yet quantitative evidence on its distributional effects is still limited. Using balanced panel data for 30 Chinese provinces from 2013 to 2022, this study constructs a multidimensional tourism digitalization index based on six dimensions and 35 indicators, with weights determined by the entropy method. Urban–rural income inequality is measured by the Theil index. Employing a two-way fixed-effects model, we find that tourism digitalization significantly reduces the urban–rural income gap. Mediation analyses further indicate that tourism digitalization narrows inequality by promoting industrial structure upgrading and enhancing regional innovation capacity. Heterogeneity tests reveal pronounced regional differences: the inequality-reducing effect is strongest in central China, followed by western China, and is weakest in eastern China. A series of robustness checks—using alternative sample periods and replacing the dependent variable with the urban–rural disposable income ratio—support the baseline findings. These results suggest that advancing tourism digitalization can serve as an effective pathway toward more inclusive growth, especially in less-developed regions, and highlight the importance of complementary policies that strengthen digital infrastructure, innovation capability, and structural upgrading.

Keywords: tourism digitalization; urban–rural income inequality; Theil index; industrial structure upgrading; regional innovation; China

1. Introduction

The Urban–rural income inequality remains a persistent challenge for achieving inclusive and sustainable development in many developing economies, particularly in China. Despite sustained economic growth over recent decades, disparities between urban and rural residents in income, employment opportunities, and access to public services continue to constrain social equity and long-term development. According to official statistics, China's Gini coefficient has remained at a relatively high level in recent years, indicating that income inequality—especially the urban–rural divide—remains a structural issue[1-3]. Narrowing this gap is therefore a central objective of China's sustainable development agenda and is closely aligned with the United Nations Sustainable Development Goals (SDGs), particularly SDG 8 (decent work and economic growth) and SDG 10 (reduced inequalities).

As one of China's strategic pillar industries, tourism plays a critical role in regional development and income redistribution. Owing to its strong industrial linkages, high labor absorption capacity, and spatial flexibility, tourism has long been regarded as an effective channel for promoting rural development and increasing household incomes in less-developed areas. In recent years, rapid advances in digital technologies—such as big data, mobile internet, artificial intelligence, and online platforms—have fundamentally

reshaped the tourism industry[4]. Tourism digitalization, characterized by the integration of digital infrastructure, digital platforms, and data-driven services into tourism production and consumption processes, has become a key driver of tourism upgrading and sustainable growth[5-7]. Through digital tools, tourism destinations can improve resource allocation efficiency, expand market access, and enhance service quality, potentially generating new income opportunities for rural residents and reducing urban–rural disparities.

However, the impact of tourism digitalization on urban–rural income inequality is theoretically ambiguous and empirically underexplored. On the one hand, digital transformation may promote inclusive growth by lowering information barriers, enabling rural tourism resources to reach broader markets, and creating diversified employment opportunities[4,8]. Digital platforms and online marketing can help rural areas overcome geographical constraints, attract tourists, and stimulate local entrepreneurship, thereby increasing rural incomes[6,9]. On the other hand, uneven digital infrastructure development and disparities in digital skills may exacerbate the digital divide between urban and rural areas, limiting rural residents' ability to fully benefit from tourism digitalization[10]. In this context, tourism digitalization could potentially reinforce existing inequalities rather than alleviate them[11]. Existing studies have largely focused on the relationship between tourism development or the digital economy and economic growth, while systematic quantitative evidence on how tourism digitalization affects urban–rural income inequality—and through what mechanisms—remains scarce[12-15].

To address this gap, this study empirically examines the impact of tourism digitalization on urban–rural income inequality in China using provincial panel data from 2013 to 2022[16]. Specifically, a comprehensive tourism digitalization index is constructed based on six dimensions—digital infrastructure, digital innovation, digital tourism resources, overall tourism development, digital economic foundation, and digital human capital—using the entropy-weighting method[11,17]. Urban–rural income inequality is measured by the Theil index, which captures both income distribution and population structure. A two-way fixed-effects model is employed to estimate the baseline effects, while mediation analyses are conducted to explore the roles of industrial structure upgrading and regional innovation capacity[8,12,16-18]. In addition, regional heterogeneity and robustness tests are performed to ensure the reliability of the results[4,6,13,18]. By providing systematic evidence on the inequality-reducing effects of tourism digitalization, this study contributes to the literature on sustainable tourism and inclusive development and offers policy insights for leveraging digital transformation to narrow urban–rural income gaps, particularly in less-developed regions.

2. Materials and Methods

2.1. Analytical Framework

This study aims to examine whether and how tourism digitalization affects urban–rural income inequality in China. Building on the literature on digital economy, tourism development, and income distribution, we propose that tourism digitalization may influence the urban–rural income gap both directly and indirectly. On the one hand, tourism digitalization can improve resource allocation efficiency, expand market access for rural tourism, and generate employment opportunities, thereby increasing rural incomes and narrowing income disparities. On the other hand, tourism digitalization may exert its effects through structural channels, such as industrial structure upgrading and regional innovation enhancement.

Accordingly, this study develops an analytical framework in which tourism digitalization is the core explanatory variable and urban–rural income inequality is the outcome variable. Industrial structure upgrading and regional innovation capacity are introduced

as potential mediating variables to explore the underlying mechanisms. In addition, regional heterogeneity is considered to assess whether the effects differ across eastern, central, and western regions of China.

2.2. Measurement of Key Variables

2.2.1. Urban–Rural Income Inequality

Urban–rural income inequality is measured using the Theil index, which is widely applied in inequality studies due to its sensitivity to income distribution changes and its ability to incorporate population structure. Compared with simple income ratios, the Theil index provides a more comprehensive representation of inequality dynamics.

The Theil index is calculated as follows equation (1):

$$Theil_t = \sum_{i=1}^{2} \left(\frac{x_{it}}{x_t} ln \frac{x_{it}/x_t}{y_{it}/y_t}\right) \quad (1)$$

where $i = 1$ denotes urban areas and $i = 2$ denotes rural areas; x_{it} and x_t represent the population of group i and the total population, respectively; and y_{it} and y_t denote total disposable income and total income in year t.

2.2.2. Tourism Digitalization Index

Tourism digitalization is the core explanatory variable of this study. Following existing research, a multidimensional tourism digitalization index is constructed based on six dimensions: digital infrastructure, digital innovation development, digital tourism resources, overall tourism development, digital economic foundation, and digital human capital. These dimensions collectively capture the level of digital transformation within the tourism industry.

A total of 35 indicators are selected to measure tourism digitalization. To ensure objectivity and reduce subjective bias in weighting, the entropy-weighting method is employed. The procedure includes data standardization, entropy value calculation, and weight determination. The composite tourism digitalization score for each province and year is calculated as the weighted sum of standardized indicators.

Following the principles of scientific relevance, systematic structure, and data availability, this study constructs a comprehensive tourism digitalization index from six dimensions: digital infrastructure, digital innovation development, digital tourism resources, overall tourism development, digital economic foundation, and digital human resources. In total, 35 indicators are selected to capture the multidimensional characteristics of tourism digitalization. The detailed indicator system and corresponding weights determined by the entropy method are presented in Table 1.

Table 1. Indicator System for Measuring Tourism Digitalization

Dimension	Indicator	Code	Unit	Direction	Weight
Digital Infrastructure (A1)	Telephone penetration rate	A11	Units per 100 persons	Positive	0.0111
	Length of optical fiber cables	A12	km	Positive	0.0226
	Broadband internet access ports	A13	10,000 units	Positive	0.0219
	Number of broadband users	A14	10,000 households	Positive	0.0243
	Number of internet webpages	A15	10,000 pages	Positive	0.0888
	Computers per 100 persons	A16	Units	Positive	0.0165
	Value added of transportation, warehousing, and postal services	A17	RMB 100 million	Positive	0.0223
Digital Innovation Development (A2)	Internal expenditure on R&D	A21	RMB 100 million	Positive	0.0440

	Full-time equivalent of R&D personnel	A22	Person-years	Positive	0.0420
	E-commerce sales of enterprises	A23	RMB 100 million	Positive	0.0537
	Software business revenue	A24	RMB 10,000	Positive	0.0737
	Number of enterprises with e-commerce activities	A25	Units	Positive	0.0398
	Share of enterprises with e-commerce transactions	A26	%	Positive	0.0105
	Number of valid domestic invention patents	A27	Items	Positive	0.0605
Digital Tourism Resources (A3)	Number of A-level tourist attractions	A31	Units	Positive	0.0177
	Number of travel agencies	A32	Units	Positive	0.0182
	Number of star-rated hotels	A33	Units	Positive	0.0162
	Number of above-scale accommodation enterprises	A34	Units	Positive	0.0235
	Number of performing arts groups	A35	Units	Positive	0.0436
	Value added of accommodation and catering industries	A36	RMB 100 million	Positive	0.0255
	Forest coverage rate	A37	%	Positive	0.0158
	Share of nature reserves in total area	A38	%	Positive	0.0221
Overall Tourism Development (A4)	Domestic tourism revenue	A41	RMB 100 million	Positive	0.0198
	Number of tourists received	A42	100 million person-times	Positive	0.0278
	Ticket revenue of tourist attractions	A43	RMB 100 million	Positive	0.0271
	Operating revenue of star-rated hotels	A44	RMB 1,000	Positive	0.0317
Digital Economic Foundation (A5)	GDP per capita	A51	RMB/person	Positive	0.0194
	Value added of the tertiary industry	A52	RMB 100 million	Positive	0.0276
	Per capita consumption expenditure	A53	RMB/person	Positive	0.0163
	Per capita transportation and communication expenditure	A54	RMB/person	Positive	0.0138
	Tourism consumer price index	A55	Previous year = 100	Positive	0.0028
Digital Human Resources (A6)	Share of tertiary industry employment	A61	%	Positive	0.0084
	Number of tourism employees (hotels, agencies, attractions)	A62	Persons	Positive	0.0207
	Number of employees in above-scale accommodation enterprises	A63	Persons	Positive	0.0260
	Number of ICT service enterprises	A64	Units	Positive	0.0442

[1] Notes: All indicators are standardized using the min–max normalization method. Indicator weights are determined by the entropy-weighting method.

2.2.3. Mediating Variables

Two mediating variables are introduced to explore the mechanisms through which tourism digitalization affects urban–rural income inequality.

First, industrial structure upgrading is measured using a weighted index that reflects the relative importance of primary, secondary, and tertiary industries. Specifically, the index is calculated as equation (2):

$$Strul = 1 \times S_1 + 2 \times S_2 + 3 \times S_3 \quad (2)$$

where S_1, S_2, and S_3 represent the output shares of the primary, secondary, and tertiary sectors, respectively. A higher value indicates a more advanced industrial structure.

Second, regional innovation capacity is measured using a composite index that captures innovation inputs and outputs, such as R&D investment, innovation environment, and innovation performance. This indicator reflects the overall innovative capability of a region.

2.2.4. Control Variables

To mitigate omitted variable bias, several control variables commonly used in inequality studies are included. These include the degree of openness (measured by the ratio of total imports and exports to GDP), postal and telecommunications development (measured by the ratio of postal and telecommunications business volume to GDP), infrastructure level (measured by per capita road mileage), financial development (measured by the ratio of financial sector value added to GDP), and fiscal capacity (measured by the ratio of tax revenue to GDP). For clarity and ease of reference, Table 2 summarizes the definitions, symbols, and measurements of all variables used in the empirical analysis.

Table 2. Definitions and Measurements of Variables

Variable Type	Variable Name	Symbol	Definition
Dependent variable	Urban–rural income inequality	Theil	The Theil index calculated based on urban and rural population shares and total disposable income
Independent variable	Tourism digitalization	Dig	Composite index measuring the level of tourism digitalization, constructed using 35 indicators and entropy weighting
Mediating variable	Industrial structure upgrading	Strul	Weighted index of sectoral output shares: primary (1), secondary (2), and tertiary (3) industries
	Regional innovation capacity	Innov	Composite index reflecting innovation inputs, environment, and performance
Control variables	Degree of openness	Open	Ratio of total imports and exports to regional GDP
	Postal and telecommunications development	Niq	Ratio of postal and telecommunications business volume to GDP
	Infrastructure level	Road	Per capita road mileage
	Financial development	Fin	Ratio of financial sector value added to GDP
	Fiscal capacity	Tax	Ratio of tax revenue to GDP

2.3. Model Specification

To estimate the impact of tourism digitalization on urban–rural income inequality, a two-way fixed-effects panel model is employed, controlling for both province-specific and time-specific effects as equation (3):

$$Theil_{it} = \alpha + \beta Dig_{it} + \gamma Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (3)$$

where i and t denote province and year, respectively; Dig_{it} represents the tourism digitalization index; $Controls_{it}$ is a vector of control variables; μ_i and λ_t capture province and year fixed effects; and ε_{it} is the error term.

To examine the mediating effects of industrial structure upgrading and regional innovation capacity, the following equations are estimated like equation (4) and (5):

$$Mediator_{it} = \alpha + \delta Dig_{it} + \gamma Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4)$$

$$Theil_{it} = \alpha + \beta Dig_{it} + \theta Mediator_{it} + \gamma Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (5)$$

2.4. Data Sources

This study uses balanced panel data for 30 Chinese provinces from 2013 to 2022. Due to data limitations, Tibet, Hong Kong, Macao, and Taiwan are excluded. Data are obtained

from the China Statistical Yearbook, China City Statistical Yearbook, China Regional Innovation Capability Evaluation Report, and provincial tourism statistical yearbooks. Missing values are supplemented using linear interpolation. All monetary variables are adjusted to real terms where appropriate.

3. Results

3.1. Baseline Effects of Tourism Digitalization on Urban–Rural Income Inequality

This subsection examines the baseline relationship between tourism digitalization and urban–rural income inequality. Based on the Hausman test results, a two-way fixed-effects model controlling for both province-specific and year-specific effects is employed. The baseline regression results are reported in Table 3.

Table 3. Baseline Regression Results

Variables	(1)	(2)
Tourism digitalization (Dig)	−0.1725***	−0.1245***
	(−13.64)	(−11.63)
Openness (Open)		−0.0253***
		(−3.32)
Postal & telecom (Niq)		−0.0027
		(−1.09)
Infrastructure (Road)		−0.0017***
		(−12.54)
Financial development (Fin)		0.1908***
		(3.36)
Fiscal capacity (Tax)		0.2439***
		(4.87)
Constant	0.1127***	0.1441***
	(46.22)	(15.13)
Province FE	Yes	Yes
Year FE	Yes	Yes
Observations	300	300
R-squared	0.409	0.771

[1] Notes: t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

As shown in Column (1) of Table 3, tourism digitalization exhibits a significantly negative effect on the Theil index (coefficient = −0.1725, $p < 0.01$), indicating that higher levels of tourism digitalization are associated with a narrower urban–rural income gap. After incorporating a full set of control variables, the estimated coefficient remains negative and statistically significant at the 1% level (Column (2)), although its magnitude decreases to −0.1245. This suggests that the inequality-reducing effect of tourism digitalization is robust and not driven by omitted variable bias.

Regarding the control variables, openness, infrastructure development, financial development, and fiscal capacity display statistically significant effects on income inequality, implying that multiple structural factors jointly shape urban–rural disparities. Overall, the baseline results provide strong empirical support for Hypothesis 1, confirming that tourism digitalization contributes to reducing urban–rural income inequality in China.

3.2. Mediation Effects: Industrial Structure Upgrading and Innovation Capacity

To further explore the mechanisms underlying the baseline relationship, this study investigates whether industrial structure upgrading and regional innovation capacity mediate the effect of tourism digitalization on urban–rural income inequality. The mediation analysis results are summarized in Table 4.

Table 4. Mediation Effects of Industrial Structure Upgrading and Innovation Capacity

Variables	Strul	Innov	Theil
Tourism digitalization (Dig)	0.3139***	15.5542***	−0.1147***
	(8.04)	(4.31)	(−9.65)
Industrial structure upgrading (Strul)			−0.0311*
			(−1.85)
Innovation capacity (Innov)			−0.0003*
			(−1.80)
Controls	Yes	Yes	Yes
Province FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	300	300	300
R-squared	0.683	0.107	0.774

[1] Notes: Each column reports a separate regression. Controls include openness, infrastructure, financial development, and fiscal capacity.

Columns (1) and (2) of Table 4 show that tourism digitalization has a positive and statistically significant impact on both industrial structure upgrading and regional innovation capacity. This indicates that digital transformation in the tourism industry promotes structural upgrading and enhances regional innovation performance. When the mediating variables are included in the inequality equation (Column (3)), both industrial structure upgrading and innovation capacity are negatively associated with the Theil index, while the coefficient of tourism digitalization remains significant but decreases in magnitude.

These results suggest that tourism digitalization reduces urban–rural income inequality not only directly but also indirectly through improving industrial structure and strengthening regional innovation capacity. The mediation effects are partial rather than full, implying that additional channels may also exist. Therefore, Hypotheses 2 and 3 are supported.

3.3. Regional Heterogeneity Analysis

Given China's substantial regional disparities in economic development, digital infrastructure, and tourism resources, this study further examines whether the impact of tourism digitalization varies across regions. Provinces are grouped into eastern, central, and western regions, and separate regressions are estimated for each group. The results are presented in Table 5.

Table 5. Regional Heterogeneity Analysis

Variables	Eastern	Central	Western
Tourism digitalization (Dig)	−0.0956***	−0.2034***	−0.1951***
	(−10.89)	(−6.99)	(−5.73)
Controls	Yes	Yes	Yes
Province FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	110	80	110
R-squared	0.780	0.781	0.845

Tourism digitalization has a statistically significant negative effect on urban–rural income inequality in all three regions, indicating a consistent inequality-reducing role nationwide. However, the magnitude of the effect differs markedly across regions. Specifically, the effect is strongest in central China, followed by western China, and weakest in eastern China.

These findings suggest that the marginal benefits of tourism digitalization in narrowing the urban–rural income gap are greater in regions with relatively lower levels of economic development and digital maturity. In more developed eastern regions, the redistributive effect of further digitalization may be constrained by diminishing marginal returns.

3.4. Robustness Checks

To verify the robustness of the baseline findings, two additional tests are conducted. First, the sample period is restricted to 2016–2022 to mitigate potential biases arising from early-stage structural changes. Second, the dependent variable is replaced with the urban–rural disposable income ratio as an alternative measure of inequality. The results of these robustness checks are reported in Table 6.

Table 6. Robustness Checks

Variables	Reduced sample	Alternative dependent variable
Tourism digitalization (Dig)	−0.1219***	−1.1333***
	(−8.35)	(−9.81)
Controls	Yes	Yes
Province FE	Yes	Yes
Year FE	Yes	Yes
Observations	210	300
R-squared	0.768	0.698

[1] Notes: Column (1) uses data from 2016–2022. Column (2) replaces the Theil index with the urban–rural disposable income ratio.

Across both alternative specifications, the estimated coefficient of tourism digitalization remains negative and statistically significant at the 1% level. These consistent results confirm that the main conclusions are not sensitive to sample selection or the measurement of income inequality, thereby reinforcing the reliability of the empirical findings.

4. Discussion

4.1. Principal Findings and Interpretation

This study provides empirical evidence that tourism digitalization contributes to narrowing the urban–rural income gap in China. Using provincial panel data from 2013 to 2022 and a two-way fixed-effects specification, the baseline results consistently indicate a statistically significant negative association between tourism digitalization and the Theil index of urban–rural income inequality[13,19]. The effect remains robust after controlling for openness, infrastructure, financial development, and fiscal capacity, as well as when the sample period and inequality measure are altered[15,19-21].

These findings suggest that the digital transformation of tourism is not only an efficiency-enhancing process but also an inclusion-relevant development pathway. From a sustainable development perspective, tourism digitalization can be understood as an enabling infrastructure and service ecosystem that improves market connectivity, reduces transaction costs, and expands the reach of tourism products and services[15,21-23]. In rural settings, such improvements may translate into broader access to tourism markets, new income-generating activities, and enhanced opportunities for micro-entrepreneurship and employment, thereby increasing rural incomes relative to urban incomes.

4.2. Mechanisms: Why Tourism Digitalization Reduces Inequality

A key contribution of this study lies in uncovering two structural mechanisms through which tourism digitalization reduces urban–rural income inequality: industrial

structure upgrading and regional innovation capacity[15,17,24]. The mediation results indicate that tourism digitalization significantly promotes industrial structure upgrading and regional innovation, and both mediators are associated with a lower level of inequality[17,19,25]. Importantly, tourism digitalization remains significant after mediators are introduced, implying partial mediation and suggesting the presence of additional channels.

Industrial structure upgrading can reduce inequality through multiple pathways. Digitalization may facilitate the transition from low-productivity activities toward more service-oriented and higher value-added tourism-related sectors, including digital marketing, smart destination management, online travel services, and experience-based products. This upgrading can generate more diversified job opportunities and enhance the absorptive capacity of the local service economy, which is particularly relevant for rural labor transfer and employment creation[16,19,26]. Furthermore, as tourism is highly linked with local agriculture, handicrafts, and small-scale services, digitalization may also stimulate cross-sector spillovers that raise rural household incomes through integrated "tourism + local industries" models.

Regional innovation capacity represents another key pathway. Tourism digitalization often requires and simultaneously stimulates innovation in business models, service design, platform governance, and data-driven marketing. Regions with enhanced innovation capacity can better adopt and diffuse digital tourism applications, which may strengthen productivity and competitiveness. In rural areas and less-developed provinces, innovation-enabled digital tools may reduce information asymmetry, improve market matching between rural tourism supply and tourist demand, and lower entry barriers for local households and small firms[4,8,20,27]. In this sense, innovation acts as an amplifier of digitalization's inclusive effects by improving the functioning of tourism markets and expanding opportunities for rural participants.

4.3. Regional Heterogeneity: Central and Western Regions Benefit More

This study further identifies strong regional heterogeneity in the inequality-reducing effect of tourism digitalization. The estimated coefficient is most pronounced in central China, followed by western China, and is weakest in eastern China. This heterogeneity is consistent with the notion of diminishing marginal returns: eastern provinces typically exhibit higher baseline levels of economic development, tourism maturity, and digital infrastructure, meaning that additional improvements in tourism digitalization may yield smaller incremental redistributive gains. In contrast, central and western regions often face larger initial digital and development gaps; therefore, tourism digitalization can generate stronger marginal benefits by expanding market access, improving tourism services, and stimulating new employment and entrepreneurial activities.

Another plausible explanation concerns tourism endowments and constraints. Central and western regions may possess rich natural and cultural resources but have historically been constrained by accessibility, information barriers, and marketing limitations. Digital tools can partially relax these constraints by enabling online promotion, smart travel planning, and targeted marketing, thereby translating resource advantages into income opportunities. Additionally, the structure of rural livelihoods differs across regions; in less-developed areas, tourism-related income can represent a more substantial share of total rural household income, meaning that improvements in tourism performance may have larger effects on the urban–rural income gap.

4.4. Policy Implications for Sustainable and Inclusive Tourism Development

The results yield several policy implications for leveraging tourism digitalization to advance inclusive and sustainable development.

First, strengthen digital infrastructure and connectivity in rural tourism areas. The inequality-reducing effect of tourism digitalization depends on the accessibility and reliability of digital infrastructure. Policymakers should prioritize broadband and mobile network coverage in rural destinations and key tourism corridors, while also supporting data platforms and smart tourism facilities. Such investments can improve the feasibility of online booking, digital payment, smart navigation, and content marketing for rural tourism suppliers.

Second, invest in digital skills and inclusive human capital development. Digitalization generates inclusive benefits only when local residents and small firms can effectively participate. Targeted programs that improve digital literacy, platform operation skills, online marketing capabilities, and service standards are crucial for enabling rural households to capture tourism value. In particular, training initiatives can be designed for farmers, rural entrepreneurs, and returning migrants to foster inclusive participation in digital tourism ecosystems.

Third, promote tourism-driven structural upgrading through integrated industrial policies. Given the mediating role of industrial structure upgrading, local governments can encourage the integration of tourism with agriculture, cultural industries, and modern services. Policies may include supporting digital platforms that connect local products with tourist demand, promoting destination branding, and fostering tourism clusters that facilitate knowledge spillovers and economies of scale.

Fourth, strengthen regional innovation systems that support digital tourism transformation. Since innovation capacity mediates the digitalization–inequality relationship, public support for R&D, innovation incubation, and entrepreneurship ecosystems can enhance the diffusion and effectiveness of digital tourism solutions. This is particularly important in central and western regions, where stronger innovation capabilities can help overcome structural disadvantages and convert digitalization into inclusive outcomes.

Collectively, these measures align with sustainability-oriented goals by facilitating decent work and inclusive growth (SDG 8), reducing inequalities (SDG 10), and promoting resilient infrastructure and innovation (SDG 9).

4.5. Limitations and Future Research Directions

This study has several limitations that offer avenues for future research. First, the analysis is conducted at the provincial level, which may mask within-province disparities and micro-level behavioral mechanisms. Future studies could employ prefecture-level or county-level data, or household survey data, to examine how tourism digitalization affects income distribution within regions. Second, although the mediation framework identifies industrial upgrading and innovation as two important channels, additional mechanisms—such as labor mobility, entrepreneurship dynamics, and the digital divide—deserve further investigation. Third, potential endogeneity issues (e.g., reverse causality between inequality reduction and digitalization investment) could be addressed in future work using instrumental variables, spatial econometric approaches, or quasi-experimental designs. Finally, the tourism digitalization index could be refined by incorporating platform-based real-time data (e.g., online travel agency usage, digital payment penetration, or digital content metrics) to better capture the evolving nature of digital transformation.

5. Conclusions

This study investigates the impact of tourism digitalization on urban–rural income inequality in China using panel data for 30 provinces from 2013 to 2022. A multidimensional tourism digitalization index is constructed based on six dimensions and 35 indicators, with entropy-based weights, while urban–rural income inequality is measured using

the Theil index. Employing a two-way fixed-effects model, the study finds that tourism digitalization significantly reduces the urban–rural income gap. The main results remain robust when restricting the sample period and when replacing the dependent variable with the urban–rural disposable income ratio.

Beyond the baseline relationship, this study identifies two key mechanisms. Tourism digitalization narrows inequality partly by promoting industrial structure upgrading and enhancing regional innovation capacity, indicating that digital transformation in tourism contributes to more inclusive development through structural and innovation-driven pathways. Moreover, the inequality-reducing effect exhibits pronounced regional heterogeneity: the effect is strongest in central China, followed by western China, and weakest in eastern China, suggesting larger marginal benefits of tourism digitalization in less-developed regions.

These findings offer important implications for sustainability-oriented policymaking. To maximize the inclusive benefits of tourism digitalization, policymakers should (i) accelerate digital infrastructure deployment in rural destinations, (ii) enhance digital skills and inclusive human capital to enable rural participation, (iii) foster tourism-led structural upgrading through cross-sector integration, and (iv) strengthen innovation ecosystems to support digital tourism transformation—especially in central and western regions. By aligning tourism digitalization strategies with inclusive growth objectives, China can better leverage digital transformation to promote sustainable tourism development and reduce urban–rural inequality.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data used in this study are derived from publicly available sources, including the China Statistical Yearbook, China City Statistical Yearbook, China Regional Innovation Capability Evaluation Report, and provincial tourism statistical yearbooks. The datasets analyzed during the current study are available from the corresponding author upon reasonable request. No new datasets were generated during the study.

Acknowledgments: The authors would like to thank the anonymous reviewers and the academic editor for their constructive comments and suggestions, which helped to improve the quality of this manuscript. During the preparation of this manuscript, the authors used ChatGPT for the purposes of language polishing and academic writing support. The authors reviewed and edited the content generated by the tool and take full responsibility for the integrity and accuracy of the final manuscript.

Conflicts of Interest: The authors declare no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

Abbreviations

The following abbreviations are used in this manuscript:

Dig	Tourism Digitalization
Theil	Theil Index
Strul	Industrial Structure Upgrading
Innov	Regional Innovation Capacity
FE	Fixed Effects
FTE	Full-Time Equivalent
ICT	Information and Communication Technology

R&D	Research and Development
SDGs	Sustainable Development Goals
GDP	Gross Domestic Product

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