



Study on the Evolution Characteristics of Coupling Coordination Between Tourism Industry and New-type Urbanization in Sichuan Province

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Abstract: This study investigates the evolutionary characteristics of the coupling coordination relationship between new-type urbanization and the tourism industry in Sichuan Province. Based on panel data from 2014 to 2024, an evaluation framework incorporating multiple dimensions of urbanization and tourism development is established. The entropy weight method and coupling coordination degree model are employed to examine the temporal changes and interaction patterns between the two systems. The results indicate that new-type urbanization experienced continuous improvement during the study period, with social and ecological dimensions serving as major contributors to its development; (2) The tourism industry presents a development pattern of "slow growth - sharp decline during the COVID-19 pandemic - strong rebound", and its infrastructure shows significant counter-cyclical resilience; (3) The coupling coordination level improved from mild imbalance to high-quality coordination, accompanied by a transition in the dominant relationship between the two systems from urbanization-led lag, to tourism development lag, and eventually toward synchronized growth; (4) The COVID-19 pandemic exerted an asymmetric shock effect, while the two systems demonstrated strong self-repair capabilities.

Key words: Tourism Industry; Temporal Evolution; New-type Urbanization; Sichuan Province; Coupling Coordination Degree

Introduction

In recent years, China's urbanization process has entered a new stage that emphasizes quality-oriented development rather than merely pursuing spatial expansion. This transformation reflects a broader shift from rapid urban growth toward a more human-centered approach involving social welfare, ecological sustainability, and coordinated development^{[1][2]}. As a strategic pillar industry, tourism plays an important role in optimizing industrial structure and promoting employment^{[3][4]}. In 2024, Sichuan Province received 1.119 billion tourist visits with total tourism revenue of 1.76 trillion yuan, and its permanent resident urbanization rate reached 60.10%^[5]. Tourism and urbanization are naturally linked: tourism requires urban infrastructure^[6] while promoting urbanization through employment and consumption^[7]; new-type urbanization facilitates sustainable tourism development through ecological and public service improvements^[8]. Mullins (1991) proposed "tourism urbanization"^[9], and domestic scholars have studied tourism-urbanization coupling coordination using quantitative models^{[10][11]}. Yet, the chronological dynamics of the synergistic relationship between the tourism sector and new-type urbanization in Sichuan post-2014, the asymmetric shock of COVID-19, and the structural transformation of the two systems remain underexplored. This paper addresses these gaps using entropy method and coupling coordination degree model based on 2014–2024 data.

1 Research Area Overview

Situated in the southwestern interior of China, Sichuan Province, with an area of 486,000 square kilometers, administering 21 prefecture-level divisions. At the end of 2024, it had a permanent resident population of about 83.64 million and a GDP of 6,469.70 billion yuan. With 979 national A-level scenic spots, 5 World Heritage Sites, 153 national intangible cultural heritage items, and total tourism revenue of 1,760 billion yuan in 2024, it is one of the provinces with the richest tourism resources in western China^{[12][13][14]}.

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2 Research Methods

2.1 Formulation of the Assessment Framework

Urbanization covers multiple dimensions such as population, economy, society, and environment^[15]. Drawing on existing studies^{[16][17][18][19][20]}, To establish a robust assessment framework for new-type urbanization, this study incorporates 14 specific metrics distributed across four core domains: demographic, economic, societal, and ecological development. Tourism is a systematic structure^[21]; based on existing research^{[22][23][24][25]}. To formulate the assessment framework for the tourism sector, this research integrates 8 distinct metrics spanning three structural domains: industry magnitude, supporting infrastructure, and resource endowment. (Table 1).

Table 1 Assessment Metrics for the Synergy Between Tourism and New-type Urbanization in Sichuan

Target Layer	First-level Index	Second-level Index	Direction
New-type Urbanization Subsystem (U ₁)	Population Urbanization	Population Urbanization Rate	+
		Urban Employed Population (10,000)	+
	Economic Urbanization	Per Capita GDP (yuan)	+
		Per Capita Disposable Income-Urban (yuan)	+
		Per Capita Disposable Income-Rural (yuan)	+
		GDP (100 million yuan)	+
	Social Urbanization	Share of Secondary & Tertiary Industries	+
		Per Capita Urban Road Area (m ² /person)	+
		Medical & Health Institutions (units)	+
		Medical Insurance Participants (10,000)	+
	Ecological Urbanization	Urban Greening Coverage Area (hectares)	+
		Waste Treatment Capacity (tons/day)	+
		Per Capita Park Green Space (m ²)	+
		Sewage Treatment Capacity (10,000 m ³ /day)	+
Tourism Industry Subsystem (U ₂)	Tourism Scale	Total Tourism Revenue (100 million yuan)	+
		Tourism Revenue Share	+
		Tourist Visits (100 million)	+
	Infrastructure	Star-rated Hotels (units)	+
		Travel Agencies	+
	Resource Endowment	National A-level Scenic Spots	+
		Museums	+
		National Intangible Cultural Heritage	+

2.2 Data Acquisition and Preprocessing

Spanning an 11-year period from 2014 to 2024, the dataset relies primarily on official statistical publications. Key references encompass the Sichuan Statistical Yearbook, China Tourism Statistical Yearbook, and the China Statistical Yearbook. These are further supplemented by tourism-specific data from the Department of Culture and Tourism of Sichuan Province, as well as the Annual Statistical Communique. Any minor data gaps encountered during collection were addressed utilizing the linear interpolation method.

2.2.1 Data Processing

(1) Standardized processing: Positive indicators: $x_{ij} = \frac{x_j - x_{min}}{x_{max} - x_{min}}$

Negative indicators: $x_{ij} = \frac{x_{max} - x_j}{x_{max} - x_{min}}$

For the value equal to 0 after standardization, this paper reassigns a positive tiny quantity to the 0 value, and selects 0.001 as the translation amount to include it in the calculation process.

(2) Calculation of indicator weight and information entropy (m represents the total number of observations):

$$w_{ij} = \frac{x_{ij}}{\sum_{i=1}^m x_{ij}} (0 \leq w_{ij} \leq 1)$$

$$e_j = -\frac{1}{\ln m} \sum_{i=1}^m w_{ij} \ln w_{ij}$$

(3) Derivation of the information utility score (d_j) for the j-th parameter.:

$$d_j = 1 - e_j$$

(4) Calculation of evaluation indicator weight:

$$c_j = \frac{d_j}{\sum_{j=1}^n d_j}$$

(5) Calculation of comprehensive evaluation value, the formula is as follows:

$$U_i = \sum_{j=1}^n c_j x_{ij}$$

(6) Overall Synergy Index (T): To quantify the joint development status of both the urbanization (U_1) and tourism (U_2) systems, a composite index T is constructed. Assuming both sectors contribute equally to regional progress, the weighting parameters are defined as $\alpha = \beta = 0.5$, restricting T within the [0,1] interval:

$$T = \alpha U_1 + \beta U_2$$

(7) Modified coupling degree model:

$$C = 2\sqrt{U_1 \times U_2} / (U_1 + U_2)$$

(8) Coupling coordination degree:

$$D = \sqrt{C \times (\alpha U_1 + \beta U_2)}$$

Integrating the coupling metric with the synergy index yields the final coordination degree D. Bounded between 0 and 1, an elevated D value signifies a superior level of harmonized development achieved by the dual systems

To quantitatively gauge the interaction status, this research utilizes a ten-tier benchmark formulated by Liao (1999)^[26]. Within the lower spectrum, a D score constrained to 0.000–0.099 corresponds to Extreme Imbalance, while the adjacent bands of 0.100–0.199 and 0.200–0.299 are categorized as Severe and Moderate Imbalance, respectively. The threshold of 0.300–0.399 manifests as Mild Imbalance, escalating to an On the Verge of Imbalance state when D reaches 0.400–0.499. Breaking the 0.500 milestone initiates the coordination phase, starting with Barely Coordination (0.500–0.599) and advancing to Primary Coordination (0.600–0.699). Subsequent improvements yield Intermediate Coordination at 0.700–0.799 and Good Coordination at 0.800–0.899. Culminating at the peak, a D value spanning 0.900 to 1.000 embodies High-quality Coordination..

3 Empirical Results and Analysis

3.1 Analysis of Comprehensive Development Index

From 2014 to 2024, U_1 escalated from an initial 0.0454 to 0.9321, demonstrating a mean annual expansion rate of 15.9 % (Table 2). Its evolution falls into two stages: stable growth (2014–2018) and accelerated growth (2018–2024), with social and ecological urbanization as the main driving forces^[28].

U_2 presented three distinct phases: slow growth (2014–2019, from 0.1827 to 0.2821), pandemic-induced slump (plummeting to 0.1729 in 2020), and rebound growth (2023–2024, from 0.6751 to 0.8646). Notably, tourism infrastructure maintained contrarian growth during the pandemic, reflecting rigid input characteristics of the tourism supply side.

The coupling relationship underwent a three-stage transformation: urbanization lag type (2014–2016, $U_2>U_1$, supported by outstanding tourism resource endowment^[29]), tourism industry lag type (2017–2023, U_1 surpassed U_2 driven by urbanization policies), and synchronous development type (2024, index gap of only 0.0675).

3.2 Analysis of Coupling Coordination Degree

The coupling degree (C) remained at a high level of 0.7988–0.9993 with a “first rising, then falling, then rising” trend, indicating sustained close correlation between the two systems (Table 2). High coupling does not mean high coordination: in 2016, C reached 0.9985 while D was only 0.4608, presenting a typical “high coupling, low coordination” state.

D increased from 0.3019 (mild imbalance) in 2014 to 0.9475 (high-quality coordination) in 2024, spanning five coordination grades. Its evolution: imbalance stage (2014–2016), barely coordination (2017–2020, D fell to 0.5796 in 2020), intermediate coordination (2021–2022), good coordination (2023), and high-quality coordination (2024).

Table 2 Temporal Evolution of Holistic Scores and Synergy Levels for Urbanization and Tourism in Sichuan(2014-2024)

Year	U_1	U_2	T	C	D	Grade	Type
2014	0.0454	0.1827	0.1141	0.7988	0.3019	Mild	Urbanization
						Imbalance	Lag
2015	0.1011	0.2028	0.1520	0.9424	0.3785	Mild	Urbanization
						Imbalance	Lag
2016	0.2011	0.2243	0.2127	0.9985	0.4608	On the Verge	Urbanization
							Lag
2017	0.3129	0.2331	0.2730	0.9892	0.5197	Barely Coord.	Tourism Lag
2018	0.4306	0.2363	0.3334	0.9566	0.5648	Barely Coord.	Tourism Lag
2019	0.5739	0.2821	0.4280	0.9401	0.6343	Primary Coord.	Tourism Lag
2020	0.6527	0.1729	0.4128	0.8138	0.5796	Barely Coord.	Tourism Lag
2021	0.7418	0.4770	0.6094	0.9761	0.7713	Intermediate	Tourism Lag
2022	0.7507	0.5163	0.6335	0.9827	0.7890	Intermediate	Tourism Lag
2023	0.8625	0.6751	0.7688	0.9925	0.8736	Good Coord.	Tourism Lag
2024	0.9321	0.8646	0.8983	0.9993	0.9475	High-quality	Synchronous
							Dev.

3.3 Shock Response and Driving Mechanism

The COVID-19 pandemic provided a basis for analyzing the asymmetric shock. In 2020, D fell from 0.6343 to 0.5796 (down 8.6%), far smaller than U_2 's 38.7% decline, indicating the urbanization system buffered the tourism industry. After the pandemic, D rebounded with “overshoot” to 0.9475, leaping from barely coordination to high-quality coordination.

This leap is driven by rigid tourism supply-side input, consumption preference shifts, and emerging formats such as culture-tourism integration and suburban tourism. Dimensional analysis shows: population urbanization is the basic factor, economic urbanization the core driver, social urbanization the key to the late-stage leap, and ecological urbanization reflects high-quality development direction. Notably, the weight of national intangible cultural heritage items is abnormally high due to a single numerical jump, so the comprehensive tourism index should be interpreted with caution.

4 Conclusions and Policy Suggestions

4.1 Main Conclusions

First, new-type urbanization maintained steady growth, with social and ecological urbanization as core drivers, shifting from scale expansion to quality improvement. Second, the tourism industry showed a “slow growth – sharp decline – strong rebound” pattern, with infrastructure presenting counter-cyclical resilience. Third, the degree of systemic synergy experienced a progressive leap, evolving from an initial state of mild disequilibrium to ultimate high-quality coordination, with the two systems realizing a structural transformation of “urbanization lag – tourism industry lag – synchronous development”. Fourth, the COVID-19 pandemic imposed an asymmetric shock, while both systems showed strong self-repair capabilities.

4.2 Policy Suggestions

(1) Deepen quality improvement of new-type urbanization, improve traffic accessibility in tourism-rich areas, and upgrade public services and ecological civilization. (2) Enhance tourism industry's anti-risk capability, develop new formats such as culture-tourism integration and health tourism, and advance digital transformation^[30]. (3) Build a long-term coordinated development mechanism, promote the Bashu Cultural Tourism Corridor^[31], and establish a statistical monitoring and early warning system. (4) Guide protective development of intangible cultural heritage resources and promote diversified transformation of the accommodation industry.

4.3 Limitations and Prospects

Limitations: provincial-scale analysis cannot capture internal spatial differences; some quality indicators are excluded due to data availability; the coupling coordination model focuses on state description with causal mechanism to be further analyzed; conclusions based on Sichuan's case need multi-case verification for universality.

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