Study on the Coupling Coordination Relationship and Its Spatiotemporal Characteristics between Tourism Resource Development and Regional Economic Growth in Shaanxi Province

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Abstract: Against the backdrop of deep cultural–tourism integration and high-quality regional development, the synergistic interplay between tourism resource development (TRD) and the regional economy constitutes a central pathway for the transformation and upgrading of resource-rich provinces in central and western China. Taking Shaanxi Province and its 11 prefecture-level units as the study area, this paper constructs two evaluation systems for TRD and regional economic development (RED), and applies the entropy weight method, the coupling coordination degree (CCD) model, and a synchrony model to panel data covering 2015–2023 to quantitatively measure the level of coordinated development and its spatiotemporal evolution. The results show that: (1) the CCD of the two systems improved steadily, progressing from serious imbalance in 2015 to mild imbalance in 2023, yet remained within the imbalanced stage throughout, indicating a persistent bottleneck in coordination improvement; (2) the two systems developed in marked disequilibrium, as sustained economic growth served as the core driver of coordination while the lagging upgrading of TRD acted as the principal constraint, leaving the province in a persistent tourism-lagged state; (3) city-level analysis reveals pronounced spatial differentiation, forming a gradient pattern of "Guanzhong leading, Shaanbei intermediate, and Shannan lagging," and the cities can be classified into three types: tourism-lagged, synchronous, and economy-lagged. Differentiated development pathways are proposed to address the principal shortcomings of each type, providing decision support for integrated cultural–tourism and economic development during the 15th Five-Year Plan period.

Keywords: Tourism resource development; Regional economy; Coupling coordination degree; Spatiotemporal differentiation; Shaanxi Province

1. Introduction

Tourism is a strategic pillar industry of the national economy, combining the multiple functions of stimulating consumption, linking related industries, and generating employment, and it is therefore an important instrument for optimizing the regional economic structure and narrowing regional development gaps. The report to the 20th National Congress of the Communist Party of

China explicitly calls for "shaping tourism through culture and highlighting culture through tourism, and advancing the in-depth integration of culture and tourism," elevating the cultural and tourism industries to a strategic position in regional economic transformation and in the pursuit of common prosperity between urban and rural areas. For provinces endowed with abundant cultural and tourism resources but characterized by uneven economic development, the key question is how to convert resource endowments into real economic momentum and achieve two-way empowerment between tourism development and economic growth. This remains a central challenge in regional development research.

Shaanxi is a representative province rich in cultural and tourism resources in China, possessing a complete range of high-grade historical, revolutionary (red), and natural ecological resources. Nevertheless, the three major regions of Guanzhong (Central Shaanxi), Shaanbei (Northern Shaanxi), and Shannan (Southern Shaanxi) differ markedly in physical geography, industrial structure, and economic strength. The Guanzhong region, centered on Xi'an, concentrates the province's premium economic and cultural–tourism resources; Shaanbei has formed an economic highland on the basis of energy industries, yet cultural–tourism integration remains weak; and Shannan, despite its high-quality ecological resources, exhibits a low level of development owing to a weak economic foundation. The spatial mismatch between the distribution of tourism resources and the strength of the regional economy prevents the synergistic effects of the two from being fully released and has become a major bottleneck constraining both high-quality cultural–tourism development and balanced regional growth across the province.

A substantial body of literature has examined the interaction between tourism and the economy. At the level of linkage mechanisms, scholars have widely documented a bidirectional coupling relationship in which tourism resources contribute to economic growth through consumption stimulation, industrial transmission, and employment creation, while the regional economy feeds back into tourism development through capital supply, infrastructure provision, and market support [1-2]. Some studies have further introduced variables such as the digital economy and ecological constraints, broadening the analytical boundaries of the relationship [3]. Methodologically, the coupling coordination degree model has become the mainstream tool for measuring the level of systemic coordination, and empirical studies by a number of scholars have verified both its scientific validity and its applicability [4-5]. Suhel [6] and Oh [7] further observe that the tourism–economy system generally registers modest CCD values accompanied by salient spatial heterogeneity. Even so, most existing empirical analyses draw heavily on pre-pandemic time-series data. They offer limited insights into the evolutionary trajectories of industrial recovery in the post-pandemic context, and there remains considerable scope to refine city-level typological classification and design tailored, differentiated policy interventions.

Against this background, this paper uses long-span panel data for 2015–2023 to construct a TRD system covering resource supply, market performance, and support capacity, and a RED system covering economic scale, structure, and people's livelihood. The coupling coordination levels of Shaanxi Province and its constituent cities are measured systematically, the spatiotemporal evolution patterns and regional types are identified, and targeted optimization pathways are proposed. The study both enriches the empirical evidence on the coupling coordination between regional tourism and the economy and provides a practical basis for high-quality cultural–tourism development and coordinated regional growth in Shaanxi Province.

2. Research Design and Data Sources

2.1 Methods

2.1.1 Entropy Weight Method

To avoid the bias introduced by subjective weighting, the entropy weight method was used to determine indicator weights, with the importance of each indicator assessed objectively according to the dispersion of its information. The calculation steps are as follows:

1. Standardization of indicators. Range standardization was used to eliminate dimensional differences; all indicators were positive, and the formula is:

$$x'_{ij} = \frac{x_{ij} - \min(x_{ij})}{\max(x_{ij}) - \min(x_{ij})} \quad (1)$$

2. Indicator proportion:

$$y_{ij} = \frac{x'_{ij}}{\sum_{i=1}^{m} x'_{ij}} \quad (2)$$

3. Information entropy and utility value:

$$e_j = -\frac{1}{\ln m}\sum_{i=1}^{m} y_{ij}\ln(y_{ij}), d_j = 1 - e_j \quad (3)$$

4. Indicator weights and comprehensive evaluation value:

$$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j}, U = \sum_{j=1}^{n} w_j \cdot x'_{ij} \quad (4)$$

where m is the number of evaluation samples, n is the number of indicators, and U is the comprehensive development score of a subsystem, ranging over $[0,1]$.

2.1.2 Coupling Coordination Degree Model

The coupling degree reflects the intensity of interaction among the elements of the systems, whereas the CCD further measures the overall quality of their synergistic development and offers a more comprehensive characterization of the coordination relationship between the two systems. The formulas are as follows:

1. Coupling degree model:

$$C = 2\sqrt{\frac{U_1 \cdot U_2}{(U_1 + U_2)^2}} \quad (5)$$

where C is the coupling degree, ranging over $[0,1]$, with larger values indicating closer interaction between the systems; U_1 and U_2 are the comprehensive evaluation scores of the TRD system and the RED system, respectively.

2. Comprehensive coordination index:

$$T = aU_1 + bU_2 \quad (6)$$

where T is the comprehensive coordination index, reflecting the overall development level of the two systems; a and b are coefficients to be determined. Because the two systems are regarded as equally important, $a = b = 0.5$.

3. Coupling coordination degree model:

$$D = \sqrt{C \cdot T} \quad (7)$$

where D is the CCD, ranging over $[0,1]$, with larger values indicating a higher level of coordinated development.

Following the standard classification commonly used in the literature, the CCD is divided into ten grades and three development stages, as shown in Table 1.

Table 1: Classification criteria for coupling coordination degrees.

CCD interval	Coordination type	Grade	Development stage
[0, 0.1]	Extreme imbalance	1	Imbalanced stage
(0.1, 0.2]	Serious imbalance	2	Imbalanced stage
(0.2, 0.3]	Moderate imbalance	3	Imbalanced stage
(0.3, 0.4]	Mild imbalance	4	Imbalanced stage
(0.4, 0.5]	Near imbalance	5	Transitional stage
(0.5, 0.6]	Reluctant coordination	6	Transitional stage
(0.6, 0.7]	Primary coordination	7	Coordinated growth stage
(0.7, 0.8]	Intermediate coordination	8	Coordinated growth stage
(0.8, 0.9]	Good coordination	9	Coordinated growth stage
(0.9, 1.0]	High-quality coordination	10	Coordinated growth stage

2.1.3 Synchrony Model

To identify the relative development state of the two systems, a synchrony index was introduced to determine the degree of matching between them, calculated as:

$$P = \frac{U_1}{U_2} \tag{8}$$

where P is the synchrony index. When $P > 1.1$, the unit is classified as economy-lagged, with tourism development outpacing economic development; when $0.9 \leq P \leq 1.1$, it is classified as synchronous, with the two systems broadly matched; and when $P < 0.9$, it is classified as tourism-lagged, with economic development outpacing tourism development.

2.2 Construction of the Indicator System

Following the principles of scientific rigor, systematicity, and data availability, two subsystem evaluation indicator systems were constructed. The TRD system comprises six indicators across three dimensions, namely resource supply capacity, market development, and service support capacity, covering the full chain from resource stock and industrial performance to reception capacity. The RED system comprises six indicators across four dimensions, namely economic aggregate, industrial structure, infrastructure, and people's livelihood, to comprehensively reflect the scale and development quality of the regional economy. The indicator system is presented in Table 2.

Table 2: Evaluation indicator system for tourism resource development and regional economic development.

Target system	Dimension	Indicator	Unit	Attribute
TRD system	Resource supply capacity	Number of 3A-rated and above tourist attractions	sites	Positive
	Market development	Domestic tourist arrivals	10,000 visits	Positive
	Market development	Total tourism revenue	CNY 100 million	Positive
	Market development	Turnover of accommodation and catering	CNY 100 million	Positive

	Service support capacity	Tourist passenger volume	10,000 person-trips	Positive
	Service support capacity	Number of star-rated hotels	hotels	Positive
RED system	Economic aggregate	Gross regional product	CNY 100 million	Positive
	Economic aggregate	Per capita GDP	CNY	Positive
	Industrial structure	Share of tertiary industry value-added in GDP	%	Positive
	Infrastructure	Highway mileage	10,000 km	Positive
	Infrastructure	Fixed-asset investment	CNY 100 million	Positive
	People's livelihood	Per capita disposable income of urban residents	CNY	Positive

2.3 Study Area and Data Sources

The study area covers the entire territory of Shaanxi Province, comprising ten prefecture-level cities and the Yangling Demonstration Zone, and the study period spans 2015–2023. This period covers both the normal cycle of rapid tourism expansion and steady economic growth and the exceptional phases of the pandemic shock and post-pandemic recovery, thereby allowing the dynamic evolution of the interaction between the two systems to be fully captured.

The data were drawn mainly from the Shaanxi Statistical Yearbook and the China Tourism Statistical Yearbook for 2016–2024, supplemented by the annual statistical bulletins of the Shaanxi Provincial Department of Culture and Tourism and the national economic and social development statistical bulletins of the individual cities. Cultural and tourism data, including the number of A-rated attractions, tourist arrivals, and total tourism revenue, were obtained from the official statistics of the provincial culture and tourism authorities, while economic data such as GDP, industrial structure, and household income were obtained from statistical yearbooks. A small number of missing values for individual years were filled by linear interpolation to ensure data continuity.

3. Empirical Results and Analysis

3.1 Temporal Evolution of the Comprehensive Development Levels

Weighting the standardized data and summing yields the comprehensive evaluation scores of the two systems for 2015–2023, as shown in Table 3.

Table 3: Comprehensive scores and synchrony types of the two systems in Shaanxi Province, 2015–2023.

Year	TRD score U_1	RED score U_2	Synchrony index P	Synchrony type
2015	0.100	0.007	14.29	Economy-lagged
2016	0.030	0.071	0.42	Tourism-lagged
2017	0.040	0.182	0.22	Tourism-lagged
2018	0.050	0.293	0.17	Tourism-lagged
2019	0.040	0.381	0.10	Tourism-lagged
2020	0.020	0.420	0.05	Tourism-lagged
2021	0.020	0.452	0.04	Tourism-lagged

2022	0.020	0.510	0.04	Tourism-lagged
2023	0.030	0.570	0.05	Tourism-lagged

The two systems display markedly different trajectories. The comprehensive score of the RED system rose steadily throughout the period, increasing by more than 80-fold over the nine years and maintaining positive growth even under the pandemic shock, which demonstrates considerable development resilience. The TRD system, by contrast, exhibited a pattern of fluctuating decline, low-level stagnation, and modest recovery. From a relatively high base in 2015, its score declined from 2016 onward under the influence of changes in industry statistical standards and structural adjustment, fluctuating within the 0.03–0.05 range during 2015–2019. Under the sustained pandemic shock of 2020–2022, the tourism market contracted sharply and the score fell to a low of 0.02. In 2023, as the market fully recovered, a modest rebound occurred, although the pre-pandemic level was not regained.

With the exception of 2015, when the initial base produced an economy-lagged classification, the province remained in a tourism-lagged state from 2016 onward, and the synchrony index continued to decline. This indicates that the growth rate of TRD lagged far behind that of the regional economy and that the development gap between the two widened continuously. The feedback effect of economic growth on tourism development was not fully released, and a virtuous cycle of interaction between the tourism industry and the regional economy had yet to take shape.

3.2 Temporal Evolution of the Provincial Coupling Coordination Degree

The coupling degrees and CCDs of Shaanxi Province for 2015–2023, calculated using the CCD model, are shown in Table 4.

Table 4: Calculated coupling coordination degrees of Shaanxi Province, 2015–2023.

Year	Coupling degree C	Coordination index T	CCD D	Grade	Coordination type
2015	0.483	0.054	0.161	2	Serious imbalance
2016	0.888	0.051	0.213	3	Moderate imbalance
2017	0.796	0.111	0.297	3	Moderate imbalance
2018	0.728	0.172	0.354	4	Mild imbalance
2019	0.617	0.211	0.361	4	Mild imbalance
2020	0.439	0.220	0.311	4	Mild imbalance
2021	0.442	0.236	0.323	4	Mild imbalance
2022	0.403	0.265	0.327	4	Mild imbalance
2023	0.442	0.300	0.364	4	Mild imbalance

The evolution of the coupling degree followed a pattern of rapid rise, sustained decline, and stabilization at a low level. From 2015 to 2016, the coupling degree jumped from 0.483 to a peak of 0.888, indicating that the interactive association between tourism expansion and economic growth strengthened rapidly during this stage. It then declined continuously from 2017 onward and stabilized in the 0.40–0.45 range after 2020, reflecting a weakening of the linkage between the tourism industry and economic growth in the later period: neither the driving effect of tourism on the economy nor the supporting effect of the economy on tourism was fully manifested.

The evolution of the CCD indicates a steady overall improvement that can be divided into two phases. The first phase, 2015–2018, was a period of rapid improvement in which the CCD rose from 0.161 to 0.354 and the coordination type advanced from serious to mild imbalance, driven jointly by the expansion of tourism scale and the growth of economic aggregate. The second phase, 2019–2023, was a period of stagnation in which the CCD fluctuated within the 0.31–0.36 range and remained at the mild imbalance stage without crossing into the transitional stage. The reason is that the growth of the coordination index was driven mainly by the RED system, whereas weak growth of the TRD system acted as the core bottleneck preventing a stepwise improvement in coordination.

3.3 Spatial differentiation of city-level coupling coordination degrees

The CCDs of the cities calculated from the 2023 cross-sectional data are shown in Table 5. All city-level units remained in the imbalanced stage, and coordination levels exhibited pronounced spatial differentiation, forming an overall gradient pattern of Guanzhong leading, Shaanbei intermediate, and Shannan lagging.

Table 5: Calculated coupling coordination degrees of cities in Shaanxi Province, 2023.

City	Coupling degree C	Coordination index T	CCD D	Grade	Coordination type
Xi'an	0.997	0.120	0.346	4	Mild imbalance
Tongchuan	0.964	0.020	0.139	2	Serious imbalance
Baoji	0.980	0.050	0.221	3	Moderate imbalance
Xianyang	0.989	0.045	0.211	3	Moderate imbalance
Weinan	0.980	0.050	0.221	3	Moderate imbalance
Yan'an	1.000	0.040	0.200	3	Moderate imbalance
Hanzhong	0.988	0.035	0.186	2	Serious imbalance
Yulin	0.856	0.065	0.236	3	Moderate imbalance
Ankang	0.999	0.030	0.173	2	Serious imbalance
Shangluo	0.997	0.025	0.158	2	Serious imbalance
Yangling Demonstration Zone	0.819	0.015	0.111	2	Serious imbalance

The first tier consists of Xi'an, the only city in the province at the mild imbalance stage. As the province's core growth pole, Xi'an exhibits a coupling degree as high as 0.997, indicating an extremely strong association between the systems, and it ranks first in both cultural–tourism resources and economic strength. Because the upgrading of tourism development lagged behind the pace of economic growth, however, its coordination level still did not cross the imbalanced stage, and the radiative and driving role of the core city had yet to be fully released.

The second tier consists of Baoji, Xianyang, Weinan, Yan'an, and Yulin, all at the moderate imbalance stage. Among them, Yulin, drawing on the strength of its energy-based economy, has a relatively high coordination index; Yan'an, leveraging the distinctive advantages of red tourism, attains a coupling degree of 1.0, indicating the tightest interaction between the systems; and the three Guanzhong cities, supported by relatively balanced resource and economic foundations, occupy a middle position in the province.

The third tier consists of Tongchuan, Hanzhong, Ankang, Shangluo, and the Yangling Demonstration Zone, all at the serious imbalance stage, but the causes of imbalance differ. Tongchuan is affected by an industrial structure dominated by heavy industry, and the linkages of its cultural–tourism industry are weak. The three Shannan cities have weak economic foundations and insufficient investment in resource development, and are trapped in the dilemma of "rich resources, weak economy." The Yangling Demonstration Zone, constrained by its limited territorial scale and its positioning in agricultural science and technology, has a small cultural–tourism industry.

3.4 Classification of city-level synergistic development types

Classifying the cities according to the synchrony index yields the results in Table 6. The cities fall into three types, among which the tourism-lagged type is the most common, indicating that economic development outpacing tourism development is a province-wide structural contradiction.

Table 6: Classification of synchrony types among cities in Shaanxi Province, 2023.

Synchrony type	Cities included	Core characteristics
Tourism-lagged ($P < 0.9$)	Xi'an, Tongchuan, Baoji, Xianyang, Hanzhong, Yulin, Yangling Demonstration Zone	Economic strength exceeds the level of tourism development; the value of cultural and tourism resources is insufficiently converted, and the economic driving effect of the industry is weak.
Synchronous ($0.9 \leq P \leq 1.1$)	Yan'an, Ankang	Tourism development and economic development are broadly matched; the foundation for systemic coordination is sound and upgrading potential is substantial.
Economy-lagged ($P > 1.1$)	Weinan, Shangluo	Tourism resource endowments are prominent, but the weak regional economic foundation and inadequate industrial support constrain the in-depth development of resources.

The tourism-lagged type covers the widest area and includes both economically strong cities such as Xi'an and Yulin and cities characterized by distinctive industries such as Tongchuan and Yangling. Cities such as Xi'an and Yulin have large economic aggregates and strong industrial foundations, but the economic contribution of their cultural and tourism industries is not commensurate with their economic energy level, reflecting a tendency to emphasize economic scale while neglecting the upgrading of cultural and tourism products. In Tongchuan and Yangling, the low correlation between leading industries and cultural–tourism industries results in insufficient endogenous momentum for tourism development.

The synchronous type contains only Yan'an and Ankang, both of which possess distinctive tourism resources and show a relatively high degree of fit between tourism development and local economic growth. Red tourism in Yan'an is deeply integrated with the local economy, while ecological tourism in Ankang advances in coordination with the county-level economy, making the two cities potential areas for coordinated development in the province. Their overall industrial scale remains small, however, and their coordination grades still have considerable room for improvement.

The economy-lagged type consists of Weinan and Shangluo. Both possess high-grade core cultural–tourism resources but are constrained by economic strength, transport accessibility, and

market-oriented operational capacity; their resource development is insufficient in depth, their industrial chains are short, and their economic benefits are not fully released, forming an inverted pattern of resource advantages and economic strength.

4. Conclusions and Implications

4.1 Main Conclusions

Using panel data for 2015–2023, this paper applied the CCD model and the synchrony model to quantitatively measure the synergistic relationship between TRD and RED in Shaanxi Province. The principal conclusions are as follows.

First, the CCD of TRD and the regional economy improved steadily but remained in the imbalanced stage throughout. From 2015 to 2023, the provincial CCD rose from 0.161 to 0.364 and the coordination type evolved from serious to mild imbalance, indicating a favorable trend; nevertheless, the province did not cross the imbalanced range during the nine years, and a considerable gap remains before coordinated development is reached. Sustained, stable growth of the regional economy was the core driver of the improvement, whereas TRD, affected by the pandemic shock and slow upgrading, lacked growth resilience and was the principal shortcoming constraining coordinated development.

Second, the disequilibrium between the two systems is prominent, and lagging tourism is the central contradiction province-wide. Since 2016, the province has remained in a tourism-lagged state, with the growth rate of TRD far below that of the regional economy, and the effect of the economy in supporting tourism and the effect of tourism in driving the economy have failed to form a benign closed loop. The post-pandemic recovery of the tourism market has been dominated by the restoration of scale, while progress in quality upgrading, business-form innovation, and value conversion has been slow, making it difficult to match the requirements of high-quality regional economic development.

Third, city-level coupling coordination exhibits pronounced spatial differentiation and clear gradient differences across the three regions. No city in the province crossed the imbalanced stage; Xi'an had the highest coordination level, and the Guanzhong cities as a whole outperformed Shaanbei and Shannan. The tourism-lagged type predominates, and the constraining factors differ markedly across regions: the core Guanzhong cities face the problem that tourism upgrading cannot keep pace with economic growth, the Shannan cities face the dilemma of weak economic foundations constraining resource development, and the Shaanbei cities suffer from insufficient integration between the energy economy and the cultural–tourism industries.

4.2 Policy implications

Based on these conclusions and on the principal shortcomings of the different regional types, differentiated pathways for coordinated development are proposed.

First, for tourism-lagged areas, the economic feedback into cultural and tourism development should be strengthened to activate industrial linkage effects. Core cities such as Xi'an should rely on their economic, scientific, and educational advantages to increase investment in digital cultural–tourism and immersive business forms, promote the deep integration of tourism with exhibitions, business, and science and technology, raise industrial value added, and release the radiative and driving role of the core city. Energy-based cities such as Yulin should establish a mechanism by which resource revenues feed back into tourism, explore the connotations of frontier-fortress culture and red

culture, cultivate distinctive cultural–tourism brands, and promote the diversification of the industrial structure. Cities with distinctive industries, such as Tongchuan and Yangling, should build on their own advantages to develop niche segments such as industrial tourism and agricultural study tours, thereby linking their leading industries with cultural–tourism industries.

Second, for synchronous areas, cultural–tourism–economic integration should be deepened to create models of coordinated upgrading. Yan'an should focus on upgrading red tourism by promoting the deep integration of red resources with folk culture, ecology, and study tours, extending the industrial chain and increasing the economic contribution of red tourism. Ankang should build on its ecological resource advantages to develop distinctive products such as ecological health and wellness tourism and waterfront homestays, and to bind ecological tourism closely with selenium-rich agriculture and the county economy, thereby consolidating the foundation for coordinated development. With their favorable matching base, the two cities can explore institutional mechanisms for the in-depth integration of tourism and the economy and serve as demonstrations of coordinated development for the province.

Third, for economy-lagged areas, shortcomings in industrial support should be addressed to promote the conversion of resource value. Weinan and Shangluo should focus on improving transport infrastructure and public-service facilities and opening up access channels for tourist flows; integrate distinctive resources across the whole region to build differentiated cultural–tourism brands and raise market recognition; and introduce professional operators while nurturing supporting businesses such as cultural and creative products, homestays, and catering, thereby extending the cultural–tourism industrial chain. Using the upgrading of tourism to raise local income can gradually narrow the gap between tourism development and economic development.

4.3 Limitations and prospects

This study still has certain limitations. The evaluation indicator system draws mainly on macro statistical indicators and does not adequately cover emerging dimensions such as cultural–tourism integration and digital tourism; the study focuses on the analysis of spatiotemporal characteristics, and the quantitative analysis of the driving mechanisms and influencing factors of coupling coordination requires further deepening. Future research can expand the evaluation dimensions and introduce spatial econometric models to investigate the influencing factors, thereby providing more precise theoretical support

Funding

Research Program of Xi'an FanYi University—"Research on the Logic, Effects and Pathways of New Quality Productive Forces Empowering Rural Modernization in Shaanxi Province" (2026B54); Silk Road Digital-Intelligent Cultural Tourism Innovation Research Center (26XJ04).

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