Spatiotemporal Evolution Characteristics and Driving Factors of the Development of New-Quality Productive Forces in Xinjiang' s Culture and Tourism Sector (Postprint)

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Abstract

From the three dimensions of laborers, means of labor, and objects of labor, this study constructs a comprehensive evaluation index system for the development of new quality productive forces in Xinjiang' s culture and tourism sector. Using the entropy weight method, spatial autocorrelation analysis, and the geographic detector, it explores the spatiotemporal evolution characteristics and driving factors of the development level of new quality productive forces in the culture and tourism industry across the 14 prefectures of Xinjiang from 2013 to 2023. The results show that: (1) From 2013 to 2023, the overall level of new quality productive forces in Xinjiang' s culture and tourism industry has shown a continuous upward trend, with improvements observed across all dimensions, among which the means-of-labor dimension in culture and tourism has increased the most. (2) The development level of new quality productive forces in Xinjiang' s culture and tourism industry exhibits a spatial pattern of "Northern Xinjiang > Southern Xinjiang > Eastern Xinjiang" ; the degree of spatial agglomeration has gradually weakened, but the overall spatial clustering characteristics remain evident. (3) The level of economic development, level of industrial development, market demand, intensity of scientific and technological investment, educational level, and transportation conditions are important driving factors for the development of new quality productive forces in Xinjiang' s culture and tourism sector, among which transportation conditions and market demand exert the most significant driving effects. The findings can provide data support for fostering new quality productive forces in Xinjiang' s culture and tourism industry and contribute to the realization of high-quality development of the culture and tourism sector.

Full Text

Preamble

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Spatiotemporal Evolution Characteristics and Driving Factors of New Quality Productive Forces Development of Cultural Tourism in Xinjiang

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Abstract: This study constructs a comprehensive evaluation index system for new quality productive forces development in Xinjiang' s cultural tourism sector from three dimensions—laborers, labor materials, and labor objects. Using the entropy method, spatial autocorrelation analysis, and geographic detector methods, we investigate the spatiotemporal evolution characteristics and driving factors of cultural tourism new quality productive forces development across 14 prefectures and regions in Xinjiang from 2013 to 2023. The results indicate that: (1) From 2013 to 2023, the overall level of Xinjiang' s cultural tourism new quality productive forces demonstrated a continuous growth trend, with all dimensional development levels improving, among which the cultural tourism labor materials dimension showed the most significant increase. (2) The development level presents a spatial pattern of "northern Xinjiang > southern Xinjiang > eastern Xinjiang," with spatial agglomeration gradually weakening but remaining notably significant overall. (3) Economic development level, industrial development level, market demand, scientific and technological investment intensity, education level, and transportation conditions constitute important driving factors, with transportation conditions and market demand exhibiting the most pronounced driving effects. These findings provide data support for cultivating new quality productive forces in Xinjiang's cultural tourism industry and facilitate its high-quality development.

Keywords: cultural tourism new quality productive forces; spatiotemporal evolution; driving factors; Xinjiang

Introduction

The evolution of productive forces fundamentally drives human civilization and high-quality economic and social development. In September 2023, General Secretary Xi Jinping first introduced the concept of "new quality productive

forces," injecting powerful momentum into high-quality social development and coordinated regional economic growth. Regions must leverage their resource advantages and develop new quality productive forces according to local conditions. Xinjiang possesses abundant natural resources and unique cultural assets, with significant advantages in its cultural tourism industry. The combined forces of policy support, market vitality, digital technology application, and industrial integration deepening have collectively propelled the vigorous development of Xinjiang' s cultural tourism sector. Currently, Xinjiang' s cultural tourism industry has entered a critical development period, yet still faces challenges such as insufficient scientific and technological innovation capacity and obstructed factor resource circulation. These issues necessitate the promotion of high-quality development through cultivating new quality productive forces in cultural tourism. Against this backdrop, investigating the development level of Xinjiang' s cultural tourism new quality productive forces and analyzing its spatiotemporal evolution characteristics and driving factors holds important theoretical and practical significance.

Existing research on new quality productive forces primarily focuses on three aspects. First, theoretical connotations: from the perspective of productive force elements, new quality productive forces constitute an organic whole formed by new-type laborers, new-type labor materials, and new-type labor objects connected through certain structural forms. From a complex systems perspective, new quality productive forces emphasize the collaborative integration of data elements with technology, capital, and talent, transcending geographical resource constraints and demonstrating multi-spatiotemporal interactions between virtual and real spaces. Second, research methodology: most studies employ qualitative approaches, with relatively few quantitative investigations, primarily at inter-provincial and cross-regional scales. Quantitative indicator construction mainly builds upon the three elements of laborers, labor objects, and labor materials, employing systems methodology to construct comprehensive evaluation index systems from physical, logical, and human reasoning dimensions, or focusing on the "three highs, three transformations, and three characteristics"features. Third, research fields: new quality productive forces research concentrates on agriculture, digital technology industries, services, sports industries, and other sectors. Studies specific to cultural tourism emphasize theoretical analysis. As an advanced productive force aligned with new development concepts, the cultivation and strengthening of cultural tourism new quality productive forces represents a long-term social construction process centered on innovation, driving supply and model innovation in tourism. Currently, through the application of high and new technologies, profound transformations are occurring in the cultural tourism industry, manifested through expanding industrial scale and sustained consumption growth. However, challenges remain, including the need to optimize production relations and resource allocation, mismatches between professional talent cultivation and industry demands, and insufficient laborer participation in digital and green transformations. Existing research provides valuable references, yet the comprehensive evaluation index system for cultural

tourism new quality productive forces development requires improvement, and few studies systematically examine development levels from a regional scale spatiotemporal perspective.

Accordingly, this study takes Xinjiang' s 14 prefectures and regions as research objects, constructs a comprehensive evaluation index system based on the three elements of new quality productive forces, employs entropy method and spatial autocorrelation analysis to dynamically examine spatiotemporal characteristics from 2013 to 2023, and utilizes geographic detector to explore driving factors. The aim is to provide reference for guiding the formation and development of Xinjiang' s cultural tourism new quality productive forces according to local conditions.

1.1 Study Area

Xinjiang is located in northwestern inland China and can be geographically divided into three major regions: northern Xinjiang, eastern Xinjiang, and southern Xinjiang. Northern Xinjiang includes Urumqi City, Karamay City, Changji Hui Autonomous Prefecture (Changji Prefecture), Ili Kazakh Autonomous Prefecture directly-administered counties and cities (Ili Prefecture Direct), Tacheng Prefecture, Altay Prefecture, and Bortala Mongol Autonomous Prefecture (Bortala Prefecture). Eastern Xinjiang includes Turpan City and Hami City. Southern Xinjiang includes Bayingolin Mongol Autonomous Prefecture (Bayingolin Prefecture), Aksu Prefecture, Kizilsu Kirghiz Autonomous Prefecture (Kizilsu Prefecture), Kashgar Prefecture, and Hotan Prefecture (Fig. 1). In 2023, Xinjiang received 265 million tourist visits, generating tourism revenue of 296.7 billion RMB. The cultural tourism industry was incorporated as Xinjiang' s ninth major industrial cluster in 2021. Cultivating and enhancing cultural tourism new quality productive forces according to local conditions represents a crucial stage for Xinjiang' s cultural tourism industry transformation and upgrading.

1.2 Data Sources

This study selected Xinjiang' s 14 prefectures and regions as research objects, with data spanning 2013–2023 sourced from the *Xinjiang Statistical Yearbook*, *China Statistical Yearbook on Science and Technology*, prefecture-level yearbooks, China E-Commerce Reports, Xinjiang E-Commerce Development Research Reports, national economic and social development statistical bulletins, and relevant functional department statistics. Missing data were supplemented through interpolation and averaging of adjacent years.

1.3 Methodology

1.3.1 Evaluation Index System for Cultural Tourism New Quality Productive Forces Development With the optimization and upgrading of factor combinations as its core connotation, new quality productive forces development in cultural tourism requires a robust evaluation framework. Building

upon existing research and considering data availability, this study constructs a comprehensive evaluation index system from three dimensions: cultural tourism laborers, cultural tourism labor materials, and cultural tourism labor objects (Table 1).

Cultural tourism laborers encompass the expansion of talent scale, structural optimization, and efficiency improvement, which are crucial for cultivating the workforce and driving industrial innovation. The scale of cultural tourism majors in secondary and higher education institutions reflects talent pool size, while the proportion of cultural tourism employees indicates workforce structure. Laborer efficiency represents scientific and technological output and economic value generated, measured by cultural tourism patents granted per 10,000 people, cultural tourism revenue share, and openness level.

Cultural tourism labor materials involve new production tools such as digitalization and technological innovation that expand connotations and provide new momentum. Based on equipment used in cultural tourism development, we incorporate digitalization and technological innovation indicators. According to the *Implementation Plan for Equipment Renewal in Culture and Tourism* issued by the National Development and Reform Commission and other departments, increased investment in sightseeing facilities, amusement equipment, performance equipment, and museum facilities reflects equipment development. Drawing on existing research, we use informatization infrastructure, internet infrastructure, e-commerce transaction levels, and digital inclusive finance indices to reflect digitalization development, while employing cultural tourism R&D personnel and technological innovation environment to measure technological innovation development.

Cultural tourism labor objects comprise resources and green development, which propel the leap-forward development of new quality productive forces. Cultural tourism resources involve scenic areas and cultural heritage, reflected through the proportion of A-level scenic spots, intangible cultural heritage ratios, and investment intensity. Green development is measured through cultural tourism wastewater discharge, water consumption, and electricity consumption.

1.3.2 Entropy Method Following established research, we employ the entropy method to calculate development levels of cultural tourism new quality productive forces and each dimension. The entropy method measures system disorder through information entropy to determine relative variation magnitude. Its objective weighting approach effectively avoids subjective bias, ensuring scientific rigor in weight calculation.

1.3.3 Spatial Autocorrelation Spatial autocorrelation analyzes the degree of mutual dependence among geographically located events, comprising global and local spatial autocorrelation. Global spatial autocorrelation assesses overall spatial dependency and significance, while local spatial autocorrelation describes

spatial association patterns between individual units and their neighborhoods. Computational procedures follow established literature.

1.3.4 Geographic Detector Geographic detector examines spatial stratified heterogeneity of dependent variables and quantifies explanatory power of independent variables, including interaction detection, factor detection, risk zone detection, and ecological detection. Interaction detection identifies interactions among different influencing factors, while factor detection uses q values to characterize explanatory degrees. The factor detection formula is:

$$q = 1 - \frac{SSW}{SST} = 1 - \frac{\sum_{h=1}^{L} N_h \sigma_h^2}{N\sigma^2}$$

where h represents strata of cultural tourism new quality productive forces development level Y or influencing factor X; N and N_h denote the number of units in Xinjiang prefectures and stratum h, respectively; σ^2 and $*\sigma^2\_h*$ represent variances of Xinjiang prefectures and stratum h; SSW is the sum of within-stratum variances; and SST is the total variance. The q value ranges [0, 1], where larger values indicate stronger explanatory power for spatial differentiation.

Results

2.1 Spatiotemporal Evolution Characteristics

2.1.1 Temporal Evolution Overall, Xinjiang' s cultural tourism new quality productive forces development level increased from 0.12 in 2013 to 0.28 in 2023, showing continuous growth (Fig. 2). Before 2018, development exhibited low-level growth with an average rate of 2.87%, primarily due to relatively small industry scale and talent shortages. From 2018 onward, under the "Cultural Enrichment of Xinjiang" project and "Tourism-Driven Xinjiang" strategy, the sector entered rapid growth with the average rate increasing to 3.04%.

All dimensions showed upward trends, with differentiated development emerging after 2018 (Fig. 2). Cultural tourism labor materials demonstrated the most significant increase, while labor objects remained relatively stable with less pronounced growth. Notably, the development gap between labor objects and labor materials continuously widened after 2018, forming "scissor-shaped" curves. This divergence stems from constraints in resource development and future green development capabilities limiting labor object growth, while robust digitalization development drove sustained leaps in labor materials.

2.1.2 Spatial Evolution Using quantile classification, we divided 2013–2023 development levels into five grades for spatial visualization (Fig. 3). Xinjiang' s cultural tourism new quality productive forces gradually formed a "northern Xinjiang > southern Xinjiang > eastern Xinjiang" pattern. Northern Xinjiang

developed a "high-level" agglomeration centered on Urumqi City and Ili Prefecture Direct, benefiting from Urumqi' s infrastructure and cultural creative industries and Ili Prefecture Direct' s emphasis on the tertiary sector. The number of high-level prefectures gradually increased, generating spatial spillover effects. Conversely, Kizilsu Prefecture and Bortala Prefecture remained "low-level" areas due to underdeveloped distinctive tourism and slow industry growth, evolving into "value depressions" in northern Xinjiang.

Dimensionally, cultural tourism laborers showed north-south and east-west strength patterns before 2018, with east-west development further improving by 2023, forming a leadership cluster of Ili Prefecture Direct, Urumqi City, and Changji Prefecture. Southern Xinjiang' s advantages became prominent after 2018, particularly in Aksu and Kashgar prefectures, which improved conditions through tourism brand festivals and comprehensive upgrading projects. Cultural tourism labor materials showed steady growth before 2018, with Urumqi City most prominent; Tacheng Prefecture, Turpan City, and Aksu Prefecture were weaker but improved by 2023, except for Hami City and Turpan City which focused more on regional characteristics than large-scale upgrades. Cultural tourism labor objects centered on Ili Prefecture Direct and Bayingolin Prefecture in a northeast-southwest distribution in 2013, shifting to a north-south pattern centered on Urumqi City by 2023.

2.1.3 Spatial Agglomeration Global Moran' s I values for prefectural development levels were all positive (Table 2) and significant at $P < 0.01$ with Z-values ≥ 1.96, indicating significant positive spatial correlation and pronounced spatial agglomeration. The declining trend in Global Moran' s I suggests gradually weakening spatial agglomeration, though overall characteristics remain significant.

Local spatial autocorrelation analysis (Fig. 4) reveals that high-high clusters gradually increased in northern Xinjiang, indicating spatial spillover effects and radiation impacts on surrounding prefectures, while weakening the development effects of Urumqi City. Low-low clusters initially decreased then increased, concentrated in Hotan Prefecture and surrounding areas in southern Xinjiang. By 2023, high-high clusters shifted northward, concentrating in Urumqi City, Ili Prefecture Direct, and Tacheng Prefecture, while low-low clusters appeared in Tacheng Prefecture, Aksu Prefecture, and Turpan City. Eastern and southern Xinjiang prefectures have not fully leveraged advantages in transportation, resources, and facilities, showing weak industry development correlations and representing important future development zones.

2.2 Driving Factors

2.2.1 Selection of Driving Factors Cultural tourism new quality productive forces development is influenced by multiple factors. Based on existing research, we selected six factors: economic development level, industrial development level, market demand, scientific and technological investment intensity,

education level, and transportation conditions. Economic development affects R&D funding support and stimulates consumption growth and market expansion. Industrial development level, measured by the proportion of tertiary industry value-added, generates new quality productive forces. Market demand, reflected by total retail sales of consumer goods, is crucial for sustainable development. Scientific and technological investment intensity, measured by the ratio of technology investment, reflects government emphasis on innovation. Education level, measured by per capita education fiscal expenditure, is key to talent quality. Transportation infrastructure is fundamental support, with road network density reflecting transportation conditions.

2.2.2 Analysis of Driving Factors We applied geographic detector to analyze driving factors. Using natural breaks classification with consistent grading standards across time periods and conducting VIF multicollinearity tests, all factors passed significance tests at $P < 0.01$, confirming their significant influence on spatial distribution (Table 3). All factors showed q values > 0.1, indicating they are major driving factors.

Examining factor explanatory power across different periods (Table 4) reveals variations: market demand and education level showed gradually decreasing influence, with education level becoming the weakest factor by 2023 due to more balanced resource distribution. Economic development level and scientific and technological investment intensity showed minimal change. Transportation conditions demonstrated rising influence, becoming the strongest factor by 2023. Increased transportation infrastructure investment and smart transportation system applications enhanced accessibility, linkage, service quality, and market competitiveness. Industrial development level' s influence continuously strengthened, particularly after 2018, as supply-side structural reforms, emerging industry clusters, and digital transformation effectively promoted new quality productive forces development.

Interaction detection results (Fig. 5) show all factor pairs produce enhancement effects, meaning interactive effects exceed individual or summed effects. In 2013, the most significant synergies were between scientific and technological investment intensity and economic development level ($q = 0.69$), transportation conditions and industrial development level ($q = 0.68$), and transportation conditions and education level ($q = 0.67$). Transportation conditions showed the most prominent synergy, producing dual-factor enhancement effects when interacting with other drivers, indicating that higher transportation development levels yield higher new quality productive forces when combined with other factors.

Discussion

This study's analysis of Xinjiang's cultural tourism new quality productive forces spatiotemporal characteristics reveals rising development levels, consistent with existing research and demonstrating the effectiveness of Xinjiang' s innovation

strategies. However, inter-prefectural differences reveal complexity and diversity in development, likely related to resource endowments and varying emphasis on the cultural tourism industry. Xinjiang' s cultural tourism industry has entered a critical period, making the investigation of spatiotemporal characteristics and driving factors essential for high-quality development.

Compared with previous studies, this research constructs an evaluation index system from the three elements of new quality productive forces, quantifies development levels, and empirically analyzes dynamic evolution characteristics and influencing factors, providing data support for regional development strategies. Data availability limitations constrain the time span, potentially obscuring long-term trends. Future research should extend the temporal scope and reduce spatial scale for more comprehensive and in-depth results.

Cultural tourism new quality productive forces present unique opportunities, heavily dependent on cultural and natural resource exploitation and transformation. Product supply upgrading and value-added enhancement require industrialization and market demand realization for economic growth, facilitated by transportation improvements. Industrial development, transportation conditions, and market demand all play important roles, with transportation conditions and market demand having the most significant driving effects. This suggests that infrastructure construction, transportation environment improvement, and meeting new market demands should be prioritized.

Conclusions

This study yields three main conclusions:

1. **Temporal Growth:** Xinjiang' s cultural tourism new quality productive forces development level showed continuous growth from 2013 to 2023, transitioning from low-level growth to rapid growth after 2018. All dimensional development levels increased overall, with differentiated development emerging after 2018, particularly in labor materials.
2. **Spatial Pattern:** The development level presents a "northern Xinjiang > southern Xinjiang > eastern Xinjiang" spatial pattern that gradually strengthened. Northern Xinjiang formed a "high-level"agglomeration area, with the number of high-level prefectures gradually increasing. Spatial correlation results show significant spatial agglomeration characteristics, with northern Xinjiang demonstrating spatial spillover effects over time, while eastern and southern Xinjiang show weak industry development correlations.
3. **Driving Factors:** Development is influenced by multiple factors including economic development level, industrial development level, market demand, scientific and technological investment intensity, education level, and transportation conditions. Transportation conditions and market demand have the strongest influence, while economic development level has

the weakest effect, indicating that new quality productive forces development relies less on economic drivers. Infrastructure construction, transportation environment improvement, and meeting new market demands should be prioritized. Across different periods, market demand and education level influences gradually declined, while transportation conditions' influence rose. Factor interactions produce stronger enhancement effects than single factors.

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Note: Figure translations are in progress. See original paper for figures.