

Article

Coupling Coordination and Spatial Patterns of Tourism Development Foundation, Platform Visibility, and Tourism Market Performance: Evidence from Urban Agglomeration in the Middle Reaches of the Yangtze River

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Abstract

With the continuous improvement of tourism infrastructure and the rapid development of digital platforms, tourism development is increasingly shaped by both traditional and digital factors. As one of China's major urban agglomerations, the Urban Agglomeration in the Middle Reaches of the Yangtze River provides an important case for examining regional tourism development in the digital era. This study investigates 31 prefecture-level cities and develops a comprehensive evaluation framework covering tourism development foundation, platform visibility, and tourism market performance. The entropy weight-TOPSIS method, coupling coordination model, GIS spatial analysis, and optimal-parameter geographical detectors are employed to examine spatial patterns and driving mechanisms. The results show that Wuhan, Changsha, and Nanchang constitute three major tourism growth poles. Tourism development foundation exhibits a clear core-periphery pattern, while the overall coupling coordination degree remains moderate to low, with some cities characterized by high coupling but low coordination. Platform visibility is identified as a key factor contributing to spatial disparities and demonstrates a significant nonlinear enhancement effect when interacting with transportation factors. These findings highlight the importance of digital platforms in regional tourism development and provide implications for promoting coordinated tourism development within urban agglomerations.

Keywords: urban agglomeration in the middle reaches of the Yangtze river; coupling coordination degree model; accessibility; coordinated tourism development; digital platform



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1. Introduction

Tourism has become an important force in promoting global economic growth, playing a key role in promoting regional economic development, creating employment opportunities and promoting cultural exchanges. It is also regarded as a key area for achieving the United Nations Sustainable Development Goals (SDGs). With the rapid expansion of the digital economy, the tourism industry is gradually shifting from traditional factor-driven development to digital and platform-driven development. Digital technology and mobile Internet have fundamentally changed the dissemination of tourism information, the decision-making of tourists and the governance of tourist destinations. Digital platforms, including search engines, online travel agencies (OTAs) and short video social media, have

become the main channels for tourists to obtain travel information, share travel experiences and make consumption decisions, thus having a profound impact on the tourism market performance and the regional competitiveness of tourist destinations [1–4]. At the same time, the continuous improvement of transportation infrastructure, especially the expansion of railway and highway networks, has greatly shortened the space–time distance between cities and promoted more efficient cross-regional tourist flow [5–7]. Against this background, the development of tourist destinations no longer relies only on traditional factors such as transportation convenience and the endowment of tourism resources, but is increasingly affected by the dissemination of information on digital platforms. As the main spatial unit with a high concentration of population and economic activities, urban clusters are not only important carriers for the gathering and diffusion of tourism resources, but also a key stage for promoting regional coordinated development and sustainable tourism governance. However, there are still significant differences between cities in terms of transportation infrastructure, tourism resource endowment and digital platform development. These differences not only shape the level and spatial pattern of tourism market development, but also may affect the efficiency of tourism resource allocation, the fairness of regional development and the environmental carrying capacity of tourist destinations [8]. Although digital platforms improve the efficiency of tourism information dissemination and the visibility of tourist destinations, algorithm-driven recommendations and passenger flow concentration may also exacerbate the crowding of tourists in popular tourist destinations, thus increasing environmental pressure and public service burden, while further enlarging the digital gap between core cities and peripheral cities. Therefore, coordinating the relationship between the basis of tourism development, platform visibility and tourism market performance to achieve a dynamic balance between economic growth, social equity and environmental sustainability has become a key issue for the sustainable development of tourism in urban settlements under the background of digital economy.

A large number of studies have explored the important factors of tourism development from multiple angles. In the field of tourism geography and regional research, the spatial distribution and traffic accessibility of tourism resources are widely regarded as the basic factors affecting the spatial organization of tourism activities. Existing studies usually use indicators such as transportation network structure, travel time and spatial distance to evaluate the accessibility of destinations, and further examine the impact of these factors on tourist flow and regional tourism development [9–13]. The wide application of Internet technology has also promoted the integration of digital platform data into tourism research. By using search indexes, online comments and other social media data, previous studies have quantified the online attention and information dissemination of destinations, thus revealing the role of online platforms in shaping tourism demand [1,3,14,15]. In addition, some studies use a systematic perspective to explore the interaction between tourism and regional economic development, ecological environment or transportation system, which provides new insights for the coordinated development of multiple tourism-related factors [16–22]. Traditional tourism development research only focuses on economic benefits, while sustainable tourism development emphasizes the coordination and balance of economic vitality, social inclusiveness and long-term environmental sustainability. Although the digital platform can improve the efficiency of tourism operation, it may also reshape the clustering pattern of tourism space, resource utilization mode and the carrying capacity of tourist destinations. Therefore, clarifying the synergistic relationship between the basis of tourism development foundation, platform visibility, and tourism market performance is conducive to the sustainable governance of tourist destinations.

2. Construction of Research Model

2.1. Tourism Development Foundation and Platform Visibility

On the one hand, the tourism development foundation—including tourism resources, transportation conditions and accommodation facilities—constitutes the fundamental basis for information dissemination and the visibility of destinations on digital platforms. Previous studies unanimously pointed out that tourism resource endowment, transportation accessibility and destination reception capacity are the fundamental determinants of destination development and the main source of destination competitiveness [23,24]. Tourism assets, such as scenic spots, hotels, travel agencies, travel routes and transportation infrastructure, not only support the on-site travel experience, but also continue to generate digital content for online travel platforms, search engines and social media. With the rapid progress of digital technology, the scope of research is increasingly expanding to digital platforms. Research shows that the dissemination of tourism information in the online environment is not independent of physical space, but the digital embodiment of tourism resources and destination service systems [25,26]. The study of platform visibility further shows that digital platforms mainly play the role of information amplification and dissemination. Its content mainly comes from accumulated tourism resources, destination services and tourist experiences, rather than creating the attractiveness of destinations independently [27,28]. Existing evidence also shows that more online attention for tourist destinations can stimulate digital economic development and promote tourism growth, and developed transportation infrastructure further strengthens this positive relationship [29]. Therefore, a solid foundation for tourism development not only determines the actual supply capacity of the destination, but is also an important support for the visibility of the platform.

On the contrary, the improvement of platform visibility can also further consolidate the tourism development foundation. In recent years, the feedback effect of digital platforms on the development of destinations has attracted more and more attention. Online travel platforms, search engines and social media have fundamentally changed the way tourism information is disseminated. Online search, user-generated comments, short video content and social media interactions are increasingly influential in the decision-making process of tourists [30]. The improvement of platform visibility not only expands the market influence of tourist destinations and attracts more tourists and investment, but also prompts the government and tourism enterprises to improve transportation infrastructure, accommodation facilities, public services and tourism products in response to the growing tourism demand [31]. In addition, the digital platform has also established a continuous feedback mechanism. Positive electronic word of mouth can improve the competitiveness of tourist destinations, while negative evaluation and online public opinion will expose the shortcomings in tourism infrastructure and service management, thus promoting the improvement of transportation organization, public service supply and tourist destination governance [32]. As emphasized by recent research institutes, digital platforms have evolved from traditional communication channels to an important governance mechanism for shaping the development of tourist destinations. Therefore, the visibility of the platform continues to promote the dynamic optimization of the tourism development foundation [33].

2.2. Platform Visibility and Tourism Market Performance

There is a mutual influence between the platform visibility and the tourism market performance. The existing research mainly focuses on the positive impact of platform visibility on the tourism market performance. With the rapid development of the digital economy and platform economy, digital platforms have become an important channel for tourism

information dissemination, tourist decision-making and destination marketing, making platform visibility (online attention) an increasingly important determining factor affecting the tourism market performance. Previous studies have shown that search engines, online travel platforms, social media and short video platforms enable tourists to obtain richer and more authentic travel information through user-generated content, online comments and social media interactions, thus fundamentally changing the traditional tourism information dissemination mode. This process reduces information asymmetry, improves decision-making efficiency, and ultimately stimulates tourism consumption [34,35]. At the same time, the online exposure and electronic word of mouth generated by digital platforms have further strengthened the image of the destination, improved the willingness of tourists to visit, and promoted hotel reservations, tourist visits and tourism income, thus improving the tourism market performance [36,37]. In addition, with the continuous evolution of platform recommendation algorithms and content dissemination mechanisms, platform-based exposure has become an increasingly valuable strategic resource to attract the attention of tourists and enhance the competitiveness of destinations. Therefore, digital platforms have evolved from traditional information dissemination channels to a key driving force for the development of the tourism market [38].

On the contrary, more and more studies emphasize the feedback effect of tourism market performance on platform visibility. With the increase in the number of tourists and the continuous expansion of the tourism market, destinations have accumulated more online comments, travel blogs, short video content and social media discussions, thus constantly enriching the digital content on the online platform [39]. At the same time, the improvement of tourism market performance has provided stronger financial resources for the government and tourism enterprises, so that they can invest in digital marketing, destination brand building and platform operation, thereby further improving the exposure of destinations on search engines, online travel platforms and social media [40]. In addition, the expansion of the tourism market encourages tourists to participate more widely in online comments and experience sharing, which not only enriches platform information, but also improves the recommendation effect and information dissemination efficiency [41]. Therefore, tourism market performance should not only be regarded as the result of platform visibility, but also an important driving force—it continuously strengthens platform communication through the accumulation of digital content and marketing investment, thus forming a self-reinforcing cycle between platform communication, market growth and platform enhancement.

2.3. Tourism Market Performance and Tourism Development Foundation

In recent years, the tourism market performance has increasingly been regarded as an important indicator to measure the overall development capacity of tourist destinations, and the tourism development foundation is widely regarded as its key determining factor. Previous studies have shown that although the tourism market performance will be affected by changes in tourist demand, infrastructure, transportation connectivity and tourism resource supply are still the main drivers of tourist visits and tourism economic performance. The regional differences in the tourism market performance largely reflect the differences in the overall level of tourism development [42]. Gómez-Vega et al. (2022) further pointed out that input factors, including accommodation capacity, tourism employment, tourism resource supply and destination infrastructure, directly affect the performance of the destination and constitute a necessary condition for improving tourism competitiveness and economic returns [43]. Similarly, Purwono et al. (2024) used the Travel and Tourism Development Index (TTDI) to prove that transportation connectivity, infrastructure, sustainability and market-supported environment can significantly improve the performance of destina-

tions, thus promoting tourism revenue growth and job creation [44]. Therefore, the tourism development foundation not only provides the necessary supply conditions for the tourism market, but also continuously shapes the tourism market performance by enhancing the overall competitiveness of the destination.

On the contrary, the enhancement of tourism market performance can also further consolidate the tourism development foundation. The growing demand for tourism has enhanced the investment capacity of the tourism industry and promoted the continuous improvement of transportation infrastructure, public services and tourism supporting facilities. The improvement of tourism market performance is conducive to employment growth and regional economic development, thereby encouraging further investment in transportation infrastructure, tourism public services and supporting industries, so as to promote the positive interaction between tourism development and regional development. Streimikiene et al. (2021) pointed out in the study that the sustainable growth of the tourism market can enhance investment capacity, promote the development of tourism resources, the construction of accommodation facilities and the upgrading of the tourism industry, and finally consolidate the tourism development foundation [45]. These research results show that the tourism market performance not only reflects the level of the tourism development foundation, but also continuously strengthens the foundation through market demand, industrial investment and resource allocation, thus forming a dynamic mutual evolution process.

In summary, the basis of tourism development, the platform visibility and the tourism market performance have strong interdependence and two-way interaction, which together form a coupled and coordinated system (hereinafter referred to as the FVP system) (Figure 1). Specifically, the tourism development foundation affects the platform visibility through transportation accessibility, tourism resources and destination reception capacity, and directly supports the tourism market performance. Platform-based visibility further improves the tourism market performance by promoting information dissemination, influencing tourist decision-making and strengthening destination marketing, while promoting the continuous optimization of the tourism development foundation through feedback effects. On the other hand, tourism market performance strengthens the tourism development foundation through capital accumulation, infrastructure improvement and industrial upgrading, while generating additional digital content and market influence, thus further improving platform-based visibility. Through the continuous interaction between resources, information and the market, these three dimensions establish a dynamic feedback mechanism to jointly promote the high quality and sustainable development of regional tourism.

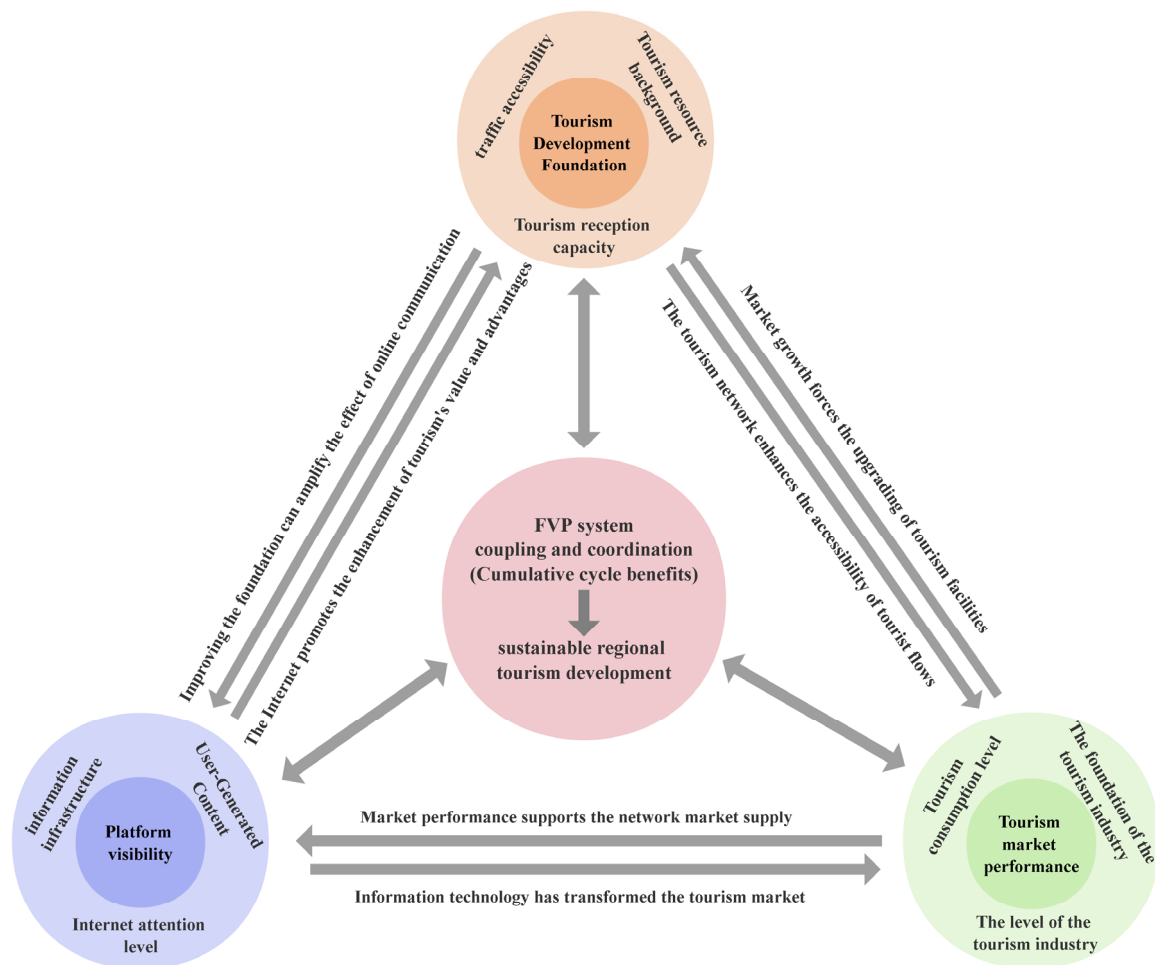


Figure 1. Coupling coordination model of FVP system.

3. Indicator System and Research Design

3.1. Overview of the Study Area

The study area is located in central China (Figure 2). It is one of the five major urban clusters in China and an important part of the Yangtze River Economic Belt. The region is a key urban cluster for the rise of the central region and the coordinated development of the region. It covers a number of subregional clusters in Hubei, Hunan, and Jiangxi provinces, such as the Wuhan metropolitan area, the Changsha–Zhuzhou–Xiangtan urban cluster, and the Poyang Lake urban cluster. In recent years, with the growth of the urban economy and the improvement of the comprehensive transportation system, the accessibility of transportation in the region has been significantly improved; the connection between cities has become closer, and the advantages of population concentration, industrial development, and regional coordination are increasingly prominent. The shortening of the space–time distance within the region and with the surrounding areas is conducive to the flow of tourism elements. The region has rich tourism resources, including many national scenic spots and historical and cultural heritage sites, which plays an important role in the tourism pattern of the central region. Against this background, this area shows certain spatial differences in terms of tourism development basis, platform visibility, and tourism market performance, which provides a suitable case for examining the synergistic relationship between tourism development factors on the scale of urban clusters. Therefore, choosing this area as a research object is of representative significance to reveal the interaction between the basis of tourism development, platform visibility, and tourism market performance.

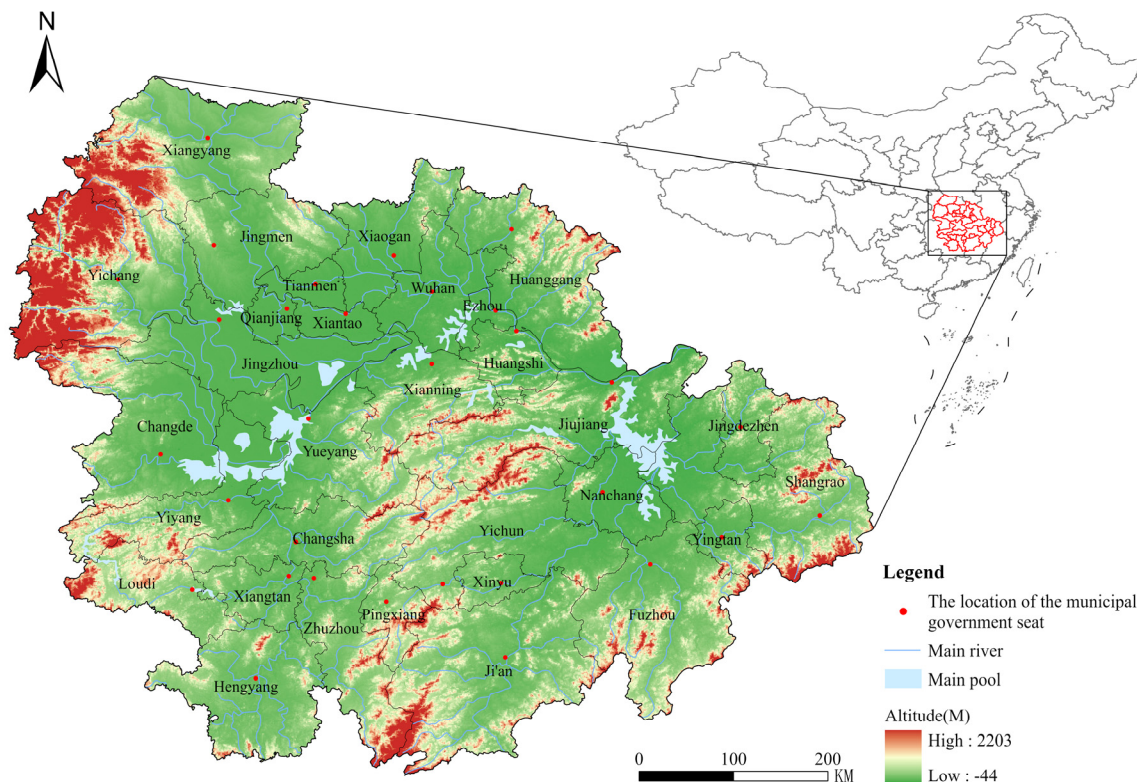


Figure 2. Location Map of the Urban Agglomeration in the Middle Reaches of the Yangtze River.

3.2. Data Sources and Preprocessing

This study takes 31 prefecture-level cities in this area as research samples and constructs an evaluation index system including tourism development foundation, platform visibility, and tourism market performance. The research data comes from multiple channels, mainly including the statistical yearbook of each city in 2023, the official data of government channels, and the data of the network platform. The relevant data on the basis of tourism development and tourism market performance mainly come from provincial and municipal statistical yearbooks and government public statistics to reflect the development level of tourism infrastructure in sample cities.

The data of the platform visibility comes from multiple Internet platforms. From 1 January 2023 to 31 December 2023, the search range is measured by the data of Baidu index (<https://index.baidu.com>) and Douyin index (<https://creator.douyin.com/creator-micro/creator-count/arithmetic-index>, (accessed on 1 July 2026)). For the index value, we use the method of adding sum to judge the popularity of platform search behavior related to tourism topics in each city this year. When setting Baidu index keywords, this study follows the principle of directly reflecting tourism behavior and information search, and selects “city name + tourism” and “city name + travel strategy” as the core search terms. The corresponding indicators include the search index and the information index, which are used to comprehensively portray the public’s online attention to the destination. At the same time, in view of the increasing role of short video platforms in the dissemination of tourism information, this article further obtains Douyin platform data through the Douyin index. In terms of keyword setting, “city name + tourism” and “city name + travel strategy” are also selected as topic search terms to ensure the comparability between data on different platforms. Based on this, the relevant topic index, the number of works, the number of likes and the number of plays and other indicators are obtained to reflect the dissemination effect of the tourist destination on the short video platform from the two dimensions of communication scale and user interaction. In addition, in order to further portray the

experience, expression and sharing behavior of tourists on the network platform, this article also collects the data on the number of travel notes in online travel platforms such as Ctrip and Mafengwo, and excludes advertising notes through manual screening to supplement the information dissemination characteristics at the content level generated by tourists.

The platform visibility data comes from multiple Internet platforms, and the network attention of tourist destinations is measured by the Baidu Index (<https://index.baidu.com>) and Douyin Index (<https://creator.douyin.com/creator-micro/creator-count/arithmetic-index>, (accessed on 1 July 2026)). When setting Baidu index keywords, this study follows the principle of directly reflecting tourism behavior and information search and selects “city name + tourism” and “city name + travel guide” as the core search terms; the data of the Douyin index adopt the same keyword settings, that is, “city name + tourism” and “city name + travel guide,” which ensures the comparability of cross-platform data. It is also convenient to reflect the communication effect of tourist destinations on short video platforms from the perspective of communication scale and user interaction. Based on this, indicators such as topic index, number of posts, number of likes, and number of views are collected to reflect the communication effects of tourism destinations on short video platforms from the perspectives of dissemination scale and user interaction. In addition, to further capture tourists’ experiential expression and sharing behavior on online platforms, this study also collects data on the number of travel notes from online travel platforms such as Ctrip and Mafengwo, thereby supplementing the analysis of user-generated content (UGC) in tourism information dissemination.

Meanwhile, in terms of data preprocessing and parameter setting, elevation data, river network data, road network data, and railway network data for this area are obtained from the Geospatial Data Cloud (<https://www.gscloud.cn/home>), the Amap Open Platform (<https://lbs.amap.com>), and the OpenStreetMap platform (<https://www.openstreetmap.org>). Based on these data, the road network is first classified according to road hierarchy. Drawing on existing studies, different travel speed parameters are assigned to different types of roads to support the requirements of accessibility analysis. Specifically, according to road function and traffic conditions, roads in the study area are categorized into five levels: high-speed rails, expressways/railways, trunk roads, primary roads, and secondary roads, with corresponding travel speeds set at 240 km/h for high-speed rails, 100 km/h for expressways/railways, 80 km/h for trunk roads and railways, 60 km/h for primary roads, and 35 km/h for secondary roads. By assigning driving speeds to different levels of roads, this method can more accurately reflect the time cost of tourism. This study also obtains the data of 3A-level and above tourist attractions from the POI data set and further improves it through manual screening and collation to improve the accuracy of the data. By integrating multi-source data, this study comprehensively shows the overall performance of the city in terms of tourism development foundation, digital communication capacity, and tourism market achievements.

3.3. Construction of the Indicator System

This research follows the principles of scientific validity, representativeness, and data availability and draws on the existing literature [1,17,39,46–55]. A three-dimensional evaluation index system has been built from a systematic perspective, including three subsystems: tourism development basis, platform visibility, and tourism market performance.

Specifically, the basic subsystem of the tourism development foundation reflects the spatial conditions and service capabilities that support tourism activities. The indicator includes travel convenience (measured by transportation accessibility) and resource attractiveness (measured by resource background), covering relevant indicators such as transportation infrastructure, tourism resource endowment, and reception capacity. Representative indicators

include railway mileage, highway mileage, urban passenger traffic, the number of A-level tourist attractions, and the number of star hotels, which together reflect the basic conditions for the development of tourism in each city. Platform visibility reflects the ability of tourist destinations to disseminate information and attract attention on the network platform. Relevant indicators include search engine attention, online travel platform content, and short video platform data. Representative indicators include the Baidu search index, Baidu information index, short video platform topic index, number of posts, number of likes, and number of views, which together reflect the information exposure and user participation of tourist destinations in the digital platform environment. The tourism market performance subsystem reflects the economic development status and market size of the tourism industry, including indicators such as total tourism revenue, the number of tourists, and the proportion of tourism revenue to GDP and related industry expenditure, thus reflecting the development level of tourism and its contribution to the regional economy.

The entropy weight method is used to calculate the Index weight within each subsystem separately, and the three subsystems are set with equal weights in the subsequent coupling coordination analysis, so as to ensure the equal status of the three dimensions in the system interaction. By building the above index system, the tourism development of this area can be comprehensively evaluated from the three aspects of tourism foundation, information dissemination, and market performance so as to provide a basis for subsequent measurement and analysis of the coupling and coordination relationship between these three subsystems. The specific indicators and their definitions are shown in Table 1.

Table 1. Coupling and Coordination Index System for FVP in the Urban Agglomeration in the Middle Reaches of the Yangtze River.

System	Dimension	Indicator	Description	Weight	Property
	traffic accessibility	Rail mileage X_1	Length of railway lines (km)	10.83%	(+)
		Highway mileage X_2	Length of the expressway route (km)	10.31%	(+)
		The convenience of transportation within the city X_3	Intra-urban travel time (minutes)	8.98%	(−)
		Average accessibility of the scenic area X_4	Average travel time to attractions (minutes)	8.85%	(−)
Tourism development foundation	Tourism resource background	The number of Grade 3A or higher scenic spots X_5	Number of 3A-level or higher tourist attractions (numbers)	10.81%	(+)
		Tourism resource abundance X_6	Tourism resource abundance	11.32%	(+)
	Tourism reception capacity	Total urban passenger traffic X_7	Passenger transport volume (10,000 persons)	12.60%	(+)
		Number of travel agencies X_8	Number of travel agencies (number)	15.62%	(+)
		Number of star-rated hotels X_9	Number of star-rated hotels (number)	10.68%	(+)
Platform-based visibility	Information infrastructure	Fixed broadband access number X_{10}	Number of fixed broadband internet users (10,000 households)	6.41%	(+)
		The number of mobile phone users at the end of the year X_{11}	Number of mobile communication users at the end of the year	6.73%	(+)
		Baidu Search Index X_{12}	Keyword search frequency index (times)	7.13%	(+)
	Internet attention level	Baidu Information Index X_{13}	Number of information dissemination (units)	18.36%	(+)
		The number of trips booked through Ctrip and Mafengwo Travel Notes X_{14}	Number of city travel diaries (pieces)	8.02%	(+)
		Douyin Topic Index X_{15}	Tourism topic index	17.41%	(+)
		Number of Douyin works X_{16}	Number of posts related to tourist destinations (pieces)	18.36%	(+)
		The number of plays and views on Douyin X_{17}	Short-video views (time)	17.59%	(+)

Table 1. Cont.

System	Dimension	Indicator	Description	Weight	Property
Tourism market performance	Tourism consumption and industry foundation	Total tourism revenue X_{18}	Economic income from tourism activities (billion yuan)	14.48%	(+)
		Total number of tourists X_{19}	Number of tourists (10,000 persons)	13.42%	(+)
		Value added of the tertiary industry X_{20}	Newly created value in the service industry (billion yuan)	17.63%	(+)
		Cultural tourism and sports media expenditure X_{21}	Public expenditure on culture, tourism, sports, and media (billion yuan)	14.20%	(+)
	The level of the tourism industry	Regional per capita tourism revenue X_{22}	The ratio of total tourism revenue to the permanent resident population (yuan)	13.14%	(+)
		Tourism economy supports regional economy by factor X_{23}	The proportion of tourism revenue in the GDP (%)	13.88%	(+)
		Tourism labor productivity X_{24}	The ratio of total tourism revenue to the number of employees in the tertiary industry	13.24%	(+)

4. Research Method

4.1. Tourism Abundance Index

The tourism abundance index is used to measure the richness of high-quality tourism resources within a region. This study selects tourist attractions rated 3A and above and assigns differentiated weights according to their respective grades to construct a weighted index:

$$R_i = \sum_{j=1}^n w_j \cdot n_{ij}$$

where R_i denotes the tourism resource abundance index of region i ; n_{ij} represents the number of tourist attractions of category j (i.e., different grades) in region i ; w_j is the weight assigned to attractions of grade j (typically set such that 5A > 4A > 3A); and n is the total number of attraction grade categories.

The formula used in this study is as follows:

$$R_i = 1.75n_{i3} + 2.5n_{i4} + 5n_{i5}$$

$$n_{ij} = \frac{D_{ij} - D_{jmin}}{D_{jmax} - D_{jmin}} \times 100$$

Through weighted adjustment, the method emphasizes the leading role of high-grade scenic spots in shaping the attractiveness of tourism, thus more accurately reflecting the endowment of high-quality tourism resources in a region.

4.2. Entropy Weight–TOPSIS Composite Index Measurement

In the comprehensive evaluation of the tourism development of Urban Agglomeration in the Middle Reaches of the Yangtze River, the determination of the index weight is a key step. There are three main methods for determining weights in existing research: objective weighting method, subjective weighting method and combination weighting method. In order to maintain the objectivity of the results and avoid the deviation brought about by subjective methods, this study adopts a hierarchical weighting strategy. First, the entropy weight method is applied within each of the three subsystems to obtain the weight of each indicator and calculate the comprehensive development index of each subsystem. Then, the three subsystem indexes are substituted into the coupling coordination model with equal weights. This method can handle the overlap between multiple indicators well

and is suitable for such complex evaluation tasks [56]. The TOPSIS method evaluates the observation unit based on the original data. It does not have strict requirements for the distribution of indicators or the nature of the object of evaluation, which helps to reduce information loss. The entropy weight–TOPSIS method avoids the deviation caused by subjective weighting and allows the comparison of the relative performance of different evaluation units, thus obtaining more reliable comprehensive evaluation results [57].

4.3. Coupling Coordination Degree (CCD) Model

To capture both the interaction and coordination among subsystems, the three-system coupling coordination model is introduced based on the entropy weight–TOPSIS results. The comprehensive development levels of the three subsystems are represented by tourism development foundation (Q), platform visibility (F), and tourism market performance (L). The functional forms are as follows:

$$C = 3 \times \frac{\sqrt[3]{Q \cdot F \cdot L}}{Q + F + L}$$

where C denotes the coupling degree of the three systems, with a value range of $0 \leq C \leq 1$. A higher value indicates stronger interactions among systems, but it does not directly reflect the level of coordinated development. Since the development levels of each subsystem have already been comprehensively measured using the entropy weight–TOPSIS method, no additional weighting is introduced. The composite development index is defined as the average of the three subsystems:

$$T = \frac{Q + F + L}{3}$$

This treatment avoids the problem of repeated weighting and ensures a more consistent and parsimonious model structure.

$$D = \sqrt{C \cdot T}$$

where D represents the CCD, ranging from 0 to 1. A higher value of D indicates a higher level of coordinated development among the systems. Referring to previous studies [54,58–60], the coordination degree is classified into five categories using unequal intervals (Table 2): $D \in (0.00, 0.15]$ indicates severe imbalance, $D \in (0.15, 0.25]$ indicates moderate imbalance, $D \in (0.25, 0.40]$ indicates basic coordination, $D \in (0.40, 0.60]$ indicates moderate coordination, and $D \in (0.60, 1.00]$ indicates high coordination.

Table 2. Classification of Coupling Coordination Degree Levels.

Coordinated Development Level D Value	Coordination Level
[0.00, 0.15]	Serious imbalance
(0.15, 0.25]	Moderate imbalance
(0.25, 0.40]	Basic coordination
(0.40, 0.60]	Moderate coordination
(0.60, 1.00]	High coordination

4.4. GIS-Based Spatial Analysis Methods

This study uses ArcGIS Pro 3.5.0 software to conduct spatial analysis through nuclear density estimation and OD cost matrix to reveal the spatial differences on the basis of tourism development and provide support for the interpretation of the coupling coordination model. Nuclear density estimation is used to describe the spatial clustering of tourism resources and directly present its distribution structure; the OD cost matrix is used to

calculate the minimum travel cost or shortest path distance between the starting point and the end point pair, so as to quantitatively evaluate the accessibility level and its spatial differences in the regional transportation network.

4.5. Optimal Parameter-Based Geographical Detector (OPGD)

The optimal parameter-based geographical detector (OPGD) extends the traditional geographical detector by introducing a parameter optimization mechanism. This mechanism tests different discretization schemes for explanatory variables in a systematic way and improves the stability and explanatory power of the model. The method compares the goodness of variance fit under different stratification schemes, measured by the Geographical Variance Factor (GVF), and selects the discretization result that yields the highest q value as the optimal parameter combination. The OPGD formula is as follows:

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

where q represents the explanatory power of the driving factor; N is the total number of samples; L denotes the number of strata; N_h is the number of samples in stratum h ; σ^2 is the overall variance of the dependent variable y ; and σ_h^2 is the variance within stratum h . Here, σ_{SSW} denotes the sum of within-group variances, while σ_{SST} represents the total variance. In practical application, multiple discretization schemes are tested for each driving factor by setting different numbers of strata (e.g., 4, 6, 8, and 10 classes), and the corresponding q -values are calculated. The optimal scheme is determined based on both the significance and explanatory power of the q -value. In this study, a four-class stratification is ultimately selected as the optimal discretization scheme, and subsequent geographical detector analysis is conducted accordingly.

5. Research Results

5.1. Spatial Pattern of Tourism Development Foundation

5.1.1. Spatial Distribution of Tourism Resources

As shown in Figure 3, based on the spatial distribution and kernel density analysis of A-level tourist attractions in this area, tourism resources in the study area display an uneven pattern of spatial clustering, with a multi-core structure overall. This pattern is consistent with the relevant research results on the spatial distribution of tourism resources [61].

From a spatial perspective, high-density clusters are mainly concentrated in Wuhan, Changsha, Nanchang, and surrounding areas, forming the three major growth poles of tourism resources in the region. Among them, the nuclear density value in the surrounding areas of Changsha and Nanchang is the highest, which is higher than the regional average, indicating that it has a strong foundation of tourism resources; the surrounding areas of Wuhan constitute a secondary high-density cluster, showing the model of spreading the influence of provincial capital cities to the surrounding areas. This multi-core cluster model is closely related to the high level of economic development of core cities and also provides financial support for the development of tourism resources; the transportation advantages of these cities also promote the integration and concentration of tourism resources and strengthen the spatial cluster effect [62]. In contrast, Xiantao, Tianmen, and Qianjiang around Wuhan; Loudi and Yiyang around Changsha; and Shangrao, Yichun, and other peripheral areas of urban clusters around Nanchang are relatively scattered, and the nuclear density value is also relatively low. This pattern reflects the spatial differences in the supply of tourism resources. In terms of resource levels, high-level scenic spots, including 4A and 5A scenic spots, also show an obvious trend of gathering around core cities. More than half of the 5A-level scenic spots in the region are located in the core area, indicating that

high-quality tourism resources present a concentrated distribution pattern. This result is consistent with the research results of Zhu et al. (2025) [62].

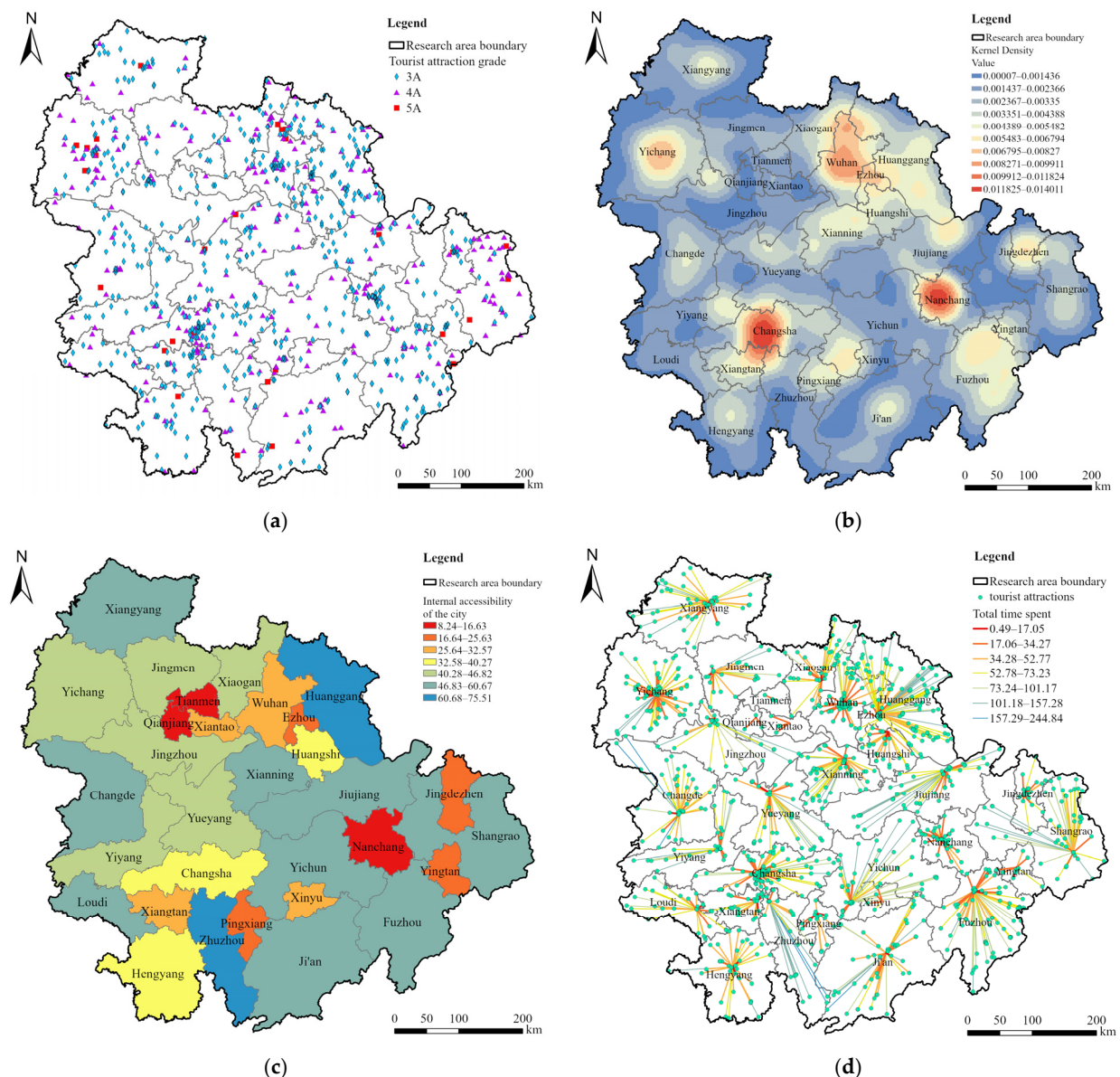


Figure 3. Distribution map and kernel density analysis chart of 3A (a) and Above Grade Scenic Areas (b) in the Urban Agglomeration in the Middle Reaches of the Yangtze River. Urban Internal Vehicle Accessibility (c) and Tourist Attractions OD Matrix Map (d) of the Urban Agglomeration in the Middle Reaches of the Yangtze River.

5.1.2. Spatial Distribution of Transport Accessibility

Tourism accessibility is a key condition for turning tourism resources into market attraction. This study examines the accessibility of tourist attractions from the internal and regional levels of the city. Based on the analysis of the accessibility of internal urban transportation (Figure 4), there are obvious spatial differences between cities in terms of internal transportation convenience. The accessibility of core cities is better than that of most other cities in the region. In Wuhan, Changsha, and Nanchang, the average travel time to tourist attractions is less than 40 min. It is worth noting that although Nanchang has a relatively large administrative area, its travel time is also one of the shortest cities. Its level is similar to that of Qianjiang and Tianmen, which are smaller in the region, and lower than the regional average. This result is closely related to its perfect urban transportation

network. Shortening the travel time within the city can improve the accessibility of tourist experiences and tourism resources [63,64].

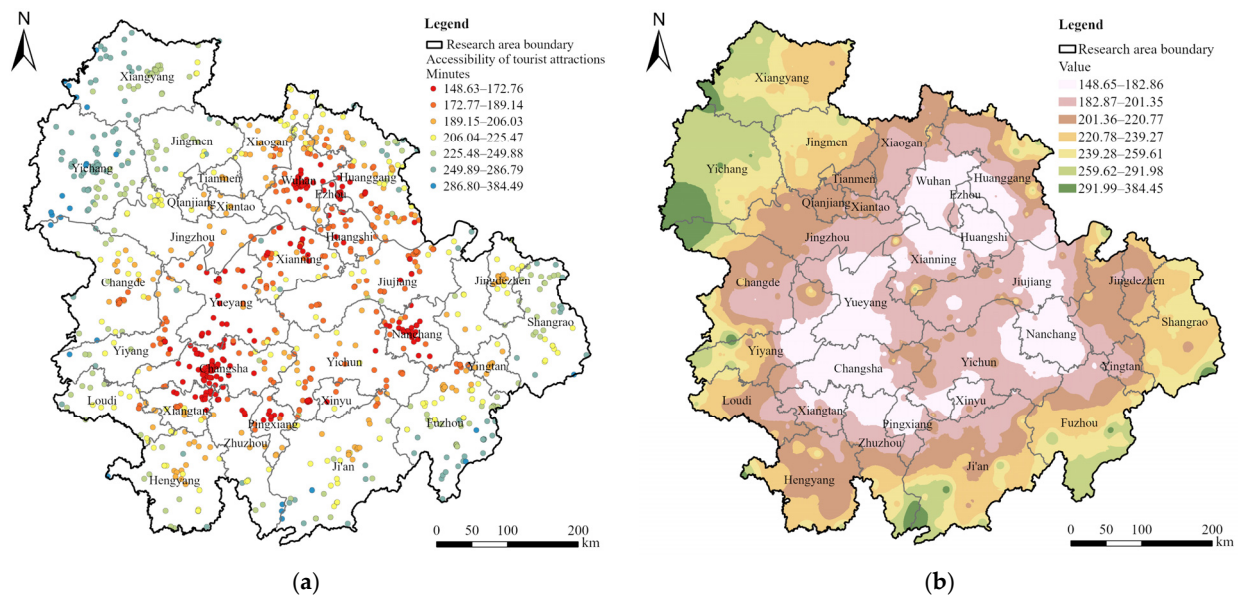


Figure 4. Distribution Map (a) and Interpolation Map of Tourist Accessibility (b) in the Urban Agglomeration in the Middle Reaches of the Yangtze River.

In contrast, the average travel time in most cities is more than 40 min. These cities lack a dense high-grade road network, the development of the comprehensive transportation system is weak, and the travel time between scenic spots or between scenic spots and the city center is long, even more than 60 min in some surrounding cities. This constraint limits the effective use of tourism resources. This shows that even if a city has a certain level of tourism resources, inconvenient internal transportation will hinder the formation of a comprehensive tourism product system and weaken the transformation of resources into actual tourist attractions [65].

From the perspective of regional accessibility, Figure 5 clearly shows the hollow circular pattern of the urban cluster in this area. The high accessibility area forms a ring area around Wuhan, Changsha, Nanchang, and their surrounding cities. In the region, the drive to tourist attractions is usually less than 3 h, so that intercity travel can be completed in a short time. The medium and low accessibility areas are located on the edge of the core area, including Xiangtan, Yichun, and Jiujiang, with an average drive of 3 to 5 h. In contrast, low-accessible areas are mainly located on the edge of urban clusters, with a drive of more than 5 h, indicating that the spatial accessibility of tourism resources in these areas is poor. This spatial pattern is closely related to the structure of the regional transportation network. In general, the development of tourism in the region reflects the dual mechanism of resource concentration and transportation support. Core cities benefit from resource endowment and transportation advantages and become the main driving force for tourism development. The surrounding area is limited by the relative lack of resources and infrastructure, resulting in low accessibility [66].

5.2. Spatial Pattern and Influencing Mechanism of Coupling Coordination Development

5.2.1. Spatial Distribution of Coupling Coordination

The spatial differences in the basis of tourism development provide an important basis for understanding the differences in the degree of coupling and coordination between cities. As shown in Table 3 and Figure 5, the 31 cities in the middle reaches of the Yangtze River show an obvious hierarchical structure, among which the core cities have significant

advantages in coupling and coordination. The spatial distribution of coupled coordination (CCD) presents a distinct multi-core pattern, which closely corresponds to the spatial configuration of the basis of tourism development. The first echelon is composed of Wuhan and Changsha, and its CCD values are 0.682 and 0.639 respectively, both of which have reached the stage of high coordination. This shows that the three subsystems of tourism development foundation, platform visibility and tourism market performance have established a highly coordinated interaction mechanism to strengthen each other through the positive feedback process [67]. The second echelon is represented by Nanchang, and its CCD value is 0.476, which is in the middle coordination stage. As one of the core cities in the region, Nanchang has come out of the imbalance stage, although there is still a large gap compared with Wuhan and Changsha. The third echelon is composed of cities around these three core cities, including Yichang, Shangrao, Xiangyang, Zhuzhou and Jiujiang. Its CCD value is between 0.25 and 0.40, and it is in the basic coordination stage. These cities have established a preliminary synergy between the three subsystems. The fourth level includes Huanggang, Xiangtan and Changde, and its CCD value is between 0.15 and 0.25, indicating that it is in the middle disorder stage. These cities form an obvious low-value cluster, which is characterized by relatively weak coordination between subsystems [67]. The last level includes Xiantao, Qianjiang and Tianmen. The CCD values of these cities are all below 0.15, indicating that they are in a state of serious imbalance.

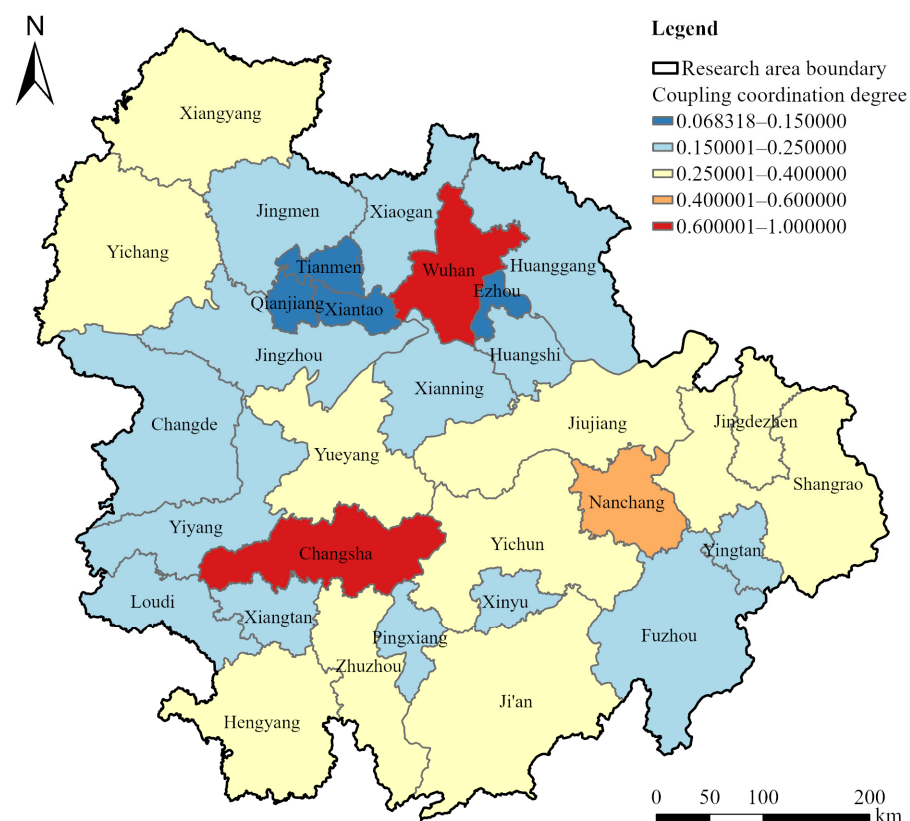


Figure 5. Distribution Map of Coupling and Coordination Degree of the Yangtze River Middle-Route Urban Agglomeration.

A comprehensive comparison of Figures 2, 4 and 5 and Table 4 shows that the spatial pattern of tourism resource aggregation, tourism accessibility and coupling coordination is not completely consistent. Wuhan and Changsha have shown obvious advantages in these three dimensions, while cities such as Yichang and Jiujiang, although they have a relatively strong tourism development foundation and a high level of tourism resource aggregation, have failed to achieve a corresponding higher level of coupling and coordination due to

their relatively low visibility based on the platform. In contrast, although Nanchang has not shown an absolute advantage in tourism resource density or accessibility, its strong platform visibility and tourism market performance have made it achieve a relatively high level of system coordination. In addition, cities such as Xianning and Changde, although the overall development level is relatively low, have a more balanced development in the three subsystems, so they perform better than some resource-rich cities in terms of coupling and coordination.

Table 3. Coupling Coordination Degree of the Urban Agglomeration in the Middle Reaches of the Yangtze River.

City	Coupling Degree	Coordination Index	Coupling Coordination Degree	City	Coupling Degree	Coordination Index	Coupling Coordination Degree
Wuhan	0.696	0.669	0.682	Yueyang	0.282	0.226	0.252
Huangshi	0.185	0.131	0.156	Yiyang	0.330	0.154	0.226
Ezhou	0.091	0.112	0.101	Changde	0.320	0.186	0.244
Huanggang	0.231	0.230	0.231	Hengyang	0.365	0.216	0.280
Xiaogan	0.196	0.146	0.169	Loudi	0.300	0.152	0.213
Xianning	0.236	0.193	0.214	Nanchang	0.523	0.433	0.476
Xiantao	0.070	0.082	0.076	Jiujiang	0.368	0.309	0.338
Qianjiang	0.054	0.087	0.068	Jingdezhen	0.320	0.271	0.294
Tianmen	0.072	0.096	0.083	Yingtian	0.141	0.242	0.185
Xiangyang	0.336	0.227	0.276	Xinyu	0.138	0.210	0.171
Yichang	0.323	0.311	0.317	Yichun	0.328	0.255	0.289
Jingzhou	0.307	0.196	0.245	Pingxiang	0.179	0.235	0.205
Jingmen	0.320	0.119	0.195	Shangrao	0.386	0.354	0.369
Changsha	0.612	0.667	0.639	Fuzhou	0.233	0.211	0.221
Zhuzhou	0.339	0.237	0.284	Ji'an	0.353	0.289	0.319
Xiangtan	0.277	0.175	0.220				

Table 4. C Values of Relative Proximity of FVP System in Urban Agglomeration in the Middle Reaches of the Yangtze River.

City	C Value of Tourism Development Foundation	C Value of Platform Visibility	C Value of Tourism Market Performance	City	C Value of Tourism Development Foundation	C Value of Platform Visibility	C Value of Tourism Market Performance
Wuhan	0.798	0.639	0.570	Yueyang	0.398	0.079	0.201
Huangshi	0.279	0.045	0.069	Yiyang	0.251	0.049	0.163
Ezhou	0.276	0.020	0.039	Changde	0.320	0.078	0.161
Huanggang	0.444	0.085	0.162	Hengyang	0.349	0.097	0.201
Xiaogan	0.302	0.047	0.090	Loudi	0.262	0.050	0.144
Xianning	0.338	0.039	0.202	Nanchang	0.578	0.247	0.473
Xiantao	0.214	0.014	0.018	Jiujiang	0.475	0.121	0.331
Qianjiang	0.232	0.012	0.016	Jingdezhen	0.261	0.103	0.450
Tianmen	0.249	0.017	0.022	Yingtian	0.261	0.021	0.444
Xiangyang	0.387	0.115	0.179	Xinyu	0.247	0.014	0.369
Yichang	0.490	0.099	0.344	Yichun	0.393	0.070	0.303
Jingzhou	0.330	0.064	0.195	Pingxiang	0.264	0.028	0.413
Jingmen	0.203	0.043	0.110	Shangrao	0.440	0.116	0.505
Changsha	0.664	0.834	0.504	Fuzhou	0.377	0.048	0.207
Zhuzhou	0.263	0.076	0.373	Ji'an	0.395	0.067	0.406
Xiangtan	0.306	0.051	0.167				

The above research results show that although tourism resource endowment and transportation conditions are still the fundamental foundation for the development of regional tourism, platform-based visibility and the vitality of the tourism market have become increasingly important determinants for the development of the coordinated system. Their

compensatory effects can offset the constraints of traditional resource endowment to a certain extent, thus promoting a more balanced and coordinated development of tourism throughout the region.

5.2.2. Influencing Mechanisms of Coupling Coordination Development

In order to further reveal the deep mechanism that promotes the coordinated development of these three subsystems, this study adopts a geographical detector (OPGD) based on optimal parameters to identify the independent interpretation ability of each factor and the interaction between them. The selected explanatory variables cover the three subsystems of tourism development basis, platform visibility and tourism market performance. The results show that there are significant differences in the explanatory power of each factor in terms of coupling coordination (CCD).

Among the indicators representing the tourism development foundation (Table 5), the abundance of tourism resources (X_6) shows the strongest explanatory power ($q = 0.752$, $p < 0.001$), while the three traffic-related indicators—transportation infrastructure (X_1), traffic accessibility (X_2) and internal tourism accessibility (X_3)—have relatively low q values and are not statistically significant. These findings show that under the background of digital transformation, the continuous improvement of transportation infrastructure within urban clusters has reduced the ability of accessibility differences to explain the heterogeneity of coordinated tourism development space. On the contrary, transportation infrastructure is increasingly functioning as a supporting condition to promote the efficient allocation of tourism resources and market elements, rather than as the main driving force for coordinating tourism development [68].

Table 5. Results of single-factor detection.

	X_1	X_2	X_3	X_6	X_{12}	X_{15}	X_{17}	X_{18}	X_{20}	X_{22}	X_{23}
q statistic	0.601492	0.404432	0.031694	0.751656	0.88194	0.718847	0.718847	0.872969	0.827601	0.451897	0.279659
p value	0.175199	0.093712	0.948783	0.000	0.000	0.252045	0.252045	0.000	0.008149	0.035516	0.269837

Note: The q statistic represents the explanatory power of each factor for the spatial differentiation of coupling coordination. Larger q values indicate stronger explanatory ability. The p value is obtained through a permutation significance test; $p < 0.05$ indicates that the observed explanatory effect is statistically significant rather than resulting from random spatial variation.

Among the platform visibility indicators, the Baidu search index (X_{12}) shows the highest explanatory power and extremely high statistical significance ($p < 0.001$), indicating that the attention of online search has become a key driving force for coordinating the development of tourism [69]. As an important indicator of tourists' willingness to travel and destination recognition, Baidu Search Index effectively links tourism supply with market demand. In contrast, the independent explanatory power of the Douyin topic index (X_{15}) is relatively weak and does not reach statistical significance, although its q value is still relatively high ($q = 0.7188$). This result shows that short video platforms continue to make significant contributions to destination exposure; however, there are significant differences in their influence between cities. Therefore, the platform exposure generated by Douyin is unlikely to promote the coordinated development of tourism independently, but exerts a stronger impact through interaction with other development conditions.

In the tourism market performance indicators, the total revenue of tourism (X_{18}) and the added value of the tertiary industry (X_{20}) show high explanatory power, indicating that the prosperity and industrial development of the tourism market are important foundations for improving the degree of coupling and coordination. Per capita tourism income (X_{22}) shows moderate but statistically significant explanatory power ($q = 0.4519$, $p < 0.05$), which indicates that the growth of per capita tourism income has a positive effect on the

coordinated development of tourism. In contrast, the contribution of tourism to regional GDP (X_{23}) shows relatively weak explanatory power ($q = 0.2797$) and is statistically not significant, which shows that the dependence of the regional economy on tourism alone is not enough to explain the spatial heterogeneity of the coordinated development of tourism.

The results of the interaction test (Table 6) further show that the coordinated development of the tourism system is driven by the combined effect of multiple factors, rather than by the independent influence of any single variable. Most factor combinations show a two-factor enhancement effect, while several interactions involving domestic tourism accessibility (X_3) show a significant nonlinear enhancement effect. Among all the interactions, the combination of internal tourism accessibility (X_3) and total tourism income (X_{18}) has the highest explanatory power ($q = 0.9724$), followed by the interaction between X_3 and tourism resource richness (X_6) ($q = 0.9539$), the interaction between X_3 and the Douyin topic index (X_{15}) ($q = 0.8766$), the interaction between X_3 and per capita tourism income (X_{22}) ($q = 0.7759$), and the interaction between X_3 and the contribution rate of tourism to regional GDP (X_{23}) ($q = 0.5948$). It is worth noting that although internal tourism accessibility (X_3) has almost no independent explanatory power, its interaction with tourism resource abundance (X_6), Douyin topic index (X_{15}), total tourism income (X_{18}), per capita tourism income (X_{22}) and tourism's contribution to regional GDP (X_{23}) has produced a significant nonlinear enhancement effect. This finding shows that in the digital age, transportation infrastructure is no longer a direct determinant of the coordinated development of tourism. On the contrary, as a basic empowerment condition, it can amplify the positive impact of tourism resources, digital platform visibility and tourism market performance on system coordination [56].

Table 6. Results of Factor Interaction Detection.

	X_1	X_2	X_3	X_6	X_{12}	X_{15}	X_{17}	X_{18}	X_{20}	X_{22}	X_{23}
X_1	0.6015	+	*	+	+	+	+	+	+	+	+
X_2	0.7217	0.4044	*	+	+	+	+	+	+	+	+
X_3	0.7350	0.7238	0.0317	*	+	+	+	+	+	+	+
X_6	0.8744	0.8195	0.9539	0.7517	+	*	*	*	+	*	*
X_{12}	0.9420	0.9397	0.9328	0.9518	0.8819	+	+	+	+	+	+
X_{15}	0.8707	0.9014	0.8766	0.9326	0.8874	0.7188	+	+	+	+	+
X_{17}	0.8427	0.8935	0.8693	0.9056	0.8604	0.7079	0.7213	+	+	+	+
X_{18}	0.9144	0.9107	0.9724	0.8908	0.9701	0.9038	0.9458	0.8730	+	+	+
X_{20}	0.8663	0.8998	0.8884	0.9346	0.9045	0.8312	0.8529	0.9522	0.8276	+	+
X_{22}	0.7733	0.6630	0.7759	0.8455	0.9429	0.9034	0.8812	0.9375	0.9124	0.4519	+
X_{23}	0.7539	0.5618	0.5948	0.8804	0.9587	0.8271	0.8380	0.9327	0.9460	0.5863	0.2797

Note: “*” denotes nonlinear enhancement, i.e., $q(X_i \cap X_j) > q(X_i) + q(X_j)$; “+” denotes bi-factor enhancement, i.e., $q(X_i \cap X_j) > \max\{q(X_i), q(X_j)\}$.

6. Conclusions and Discussion

6.1. Conclusions

This study takes 31 prefecture-level cities in the Urban Agglomeration in the Middle Reaches of the Yangtze River as the research sample and uses GIS tools to build a comprehensive evaluation index system to analyze the spatial distribution of tourism resources, the coupling and coordination characteristics of tourism development, and their main driving factors. The main research results are as follows:

There is an obvious coupling relationship between the development base of tourism in the middle reaches of the Yangtze River, the visibility of the platform and the performance of the tourism market, but there is still a lot of room for improvement in the overall coordination level, and the regional differences are significant. During the research period,

from a spatial point of view, the research area showed an obvious “core-periphery” pattern, with Wuhan and Changsha as the center, with a high level of coupling and coordination, and gradually decreasing to the surrounding cities. Wuhan and Changsha have reached the stage of high coordination, while most peripheral cities are still in the stage of imbalance or primary coordination, which shows that the overall quality of coordinated development of regional tourism is still limited and there is still great potential for improvement.

Secondly, platform visibility has become a key driving factor affecting the coupled and coordinated development of urban tourism, and has replaced traditional transportation advantages as an important source of regional tourism competitiveness. The richness of tourism resources is still an important driving force for the development of tourism. The single-factor detection results show that digital attention indicators such as Baidu search index and short video platform dissemination have the highest explanatory power for the spatial difference in coupling and coordination. In the results of the interactive factor detection, the interaction between the urban internal transportation and the abundance of tourism resources, the number of Douyin plays and readings and the total tourism income is particularly significant.

In terms of logical correlation between FVP systems, there is not a simple linear relationship between traffic accessibility, platform visibility and tourism market performance, but forms a development mechanism that promotes and evolves together. With the continuous improvement of the regional comprehensive transportation network, transportation accessibility has more basic supporting functions for the development of tourism. Its independent explanation is weak, but it has shown a significant synergy enhancement effect with the visibility of the platform and the performance of the tourism market. This shows that the digital platform is reshaping the driving force mechanism for regional tourism development, and the competitive advantage of tourism is gradually changing from traditional resources and transportation advantages to digital communication ability, market response ability and comprehensive coordination ability.

6.2. Discussion

Existing studies generally believe that traffic accessibility is a spatial constraint for the sustainable development of tourism, which has the dual attributes of growth support and carrying boundaries [69,70], but in this study, the independent explanation of traffic accessibility is relatively limited. With the gradual improvement of the comprehensive transportation network of the middle reaches of the Yangtze River city cluster, accessibility has gradually changed from a direct driving factor in the traditional sense to the basic supporting conditions for the development of tourism in the digital age. This result is consistent with the research conclusion of Xiang and Gretzel (2010) on the digital information environment to reshape the decision-making process of tourists, that is, tourists are increasingly relying on digital platforms to obtain tourism information, while physical transportation is more responsible for the basic guarantee of tourism activities [25], which also echoes the research findings on the interaction between digital economy and transportation infrastructure in recent years [29]. And from the perspective of sustainable tourism development, high accessibility does not necessarily mean that tourism development is highly sustainable. The perfect transportation network has indeed improved the efficiency of regional tourism links and enhanced the gathering capacity of core cities for tourism flow. However, when the scale of tourists continues to grow and exceeds the ecological environment, public service facilities and community carrying capacity of the destination, it is easy to induce a series of negative effects such as traffic congestion, excessive consumption of resources, ecological environment degradation and decline in the quality of life of residents. Tourism growth should be based on the constraints of

resource and environmental carrying capacity, rather than unlimited pursuit of tourist scale expansion [71,72]. In this study, Wuhan and Changsha not only have a good foundation for tourism development, but also have advantages in tourism market performance and platform visibility. This means that while continuing to improve tourism competitiveness in the future, these core cities need to pay more attention to tourist capacity control, ecological protection and tourism space optimization to achieve a dynamic balance between economic growth and environmental protection. In comparison, although the size of the tourism market is relatively limited, some marginal cities still retain a good ecological environment and cultural resources. In the future, they can rely on the advantages of differentiated resources to develop ecological tourism, rural tourism and cultural experience tourism, and explore a sustainable development path that is more in line with resource endowment [8].

This study further confirms that platform visibility has become the primary driving factor affecting the spatial division of coupling and coordination in the tourism system, and its explanatory power is obviously higher than that of traditional tourism resource elements. This shows that in the context of the digital economy, the competitive advantage of tourism is gradually shifting from traditional resource competition to competition for digital communication ability, and platform visibility has become an important medium to connect tourism supply and tourism demand. This discovery further confirms that digital platforms are profoundly changing the marketing model of tourist destinations and the decision-making mechanism of tourists. It also coincides with the empirical conclusions in China [3,73,74]. However, the rapid improvement of platform visibility does not mean that tourism development is absolutely sustainable. The digital platform relies on the algorithm recommendation mechanism to continuously strengthen the exposure of popular destinations, so that tourists continue to gather in a few core cities. It is easy to form a circular accumulation mechanism of “platform exposure increase-tourists’ attention increase-tourism consumption growth-platform further recommendation”, which is extremely detrimental to the overall development of regional tourism. Although the digital amplification effect can significantly improve the performance of the tourism market, it may also further induce problems such as overtourism, increased ecological pressure and imbalance in the spatial distribution of tourism income [2]. Milano et al. (2019) pointed out that the platform algorithm continues to strengthen the dissemination of popular tourist destinations, which will further improve the spatial gathering of tourists and increase the environmental pressure and the difficulty of community governance [74]. In this study, the visibility of Wuhan and Changsha platforms leads synchronously with the performance of the tourism market, while some marginal cities have been in low platform attention and low coordination for a long time, which also shows from the empirical level that the digital divide may further evolve into a tourism development gap [74]. Therefore, the construction of digital platforms in the future should not only pay attention to the growth of tourism traffic, but also strengthen regional balanced diversion, optimized allocation of tourism space and monitoring of destination carrying capacity, so as to realize the coordination and unity of digital governance and fair and sustainable tourism development [17,69].

6.2.1. Theoretical Implications

First, this study expands the analytical dimension of traditional tourism system research. Most of the existing coupled collaborative studies explore the relationship between tourism development, economic growth and ecological environment, and most of the digital factors are only included in the analysis as background variables. This study integrates platform visibility into the coupled analysis framework, and regards platform visibility as an endogenic subsystem, rather than just treating digital technology as external support conditions or destination marketing tools, confirming that digital information flow

has become a structural component that drives the evolution of tourism systems. This conceptual innovation expands the collaborative research of traditional tourism from the perspective of physical resources to the perspective of entity–digital interactive system, and builds a more adaptable theoretical framework for analyzing the development of tourism under the platform economy.

Second, this study reveals that there is a nonlinear interaction mechanism between the digital platform and the basic elements of tourism development, which enriches the explanation of the digital tourism driving mechanism. In the past, relevant studies have mostly focused on collaborative horizontal measurement or single driver factor identification, and the analytical framework constructed in this paper can clarify how to form a mutual promotion relationship between transportation infrastructure, platform visibility and tourism market performance through the nonlinear gain effect. This method provides a new analysis path for analyzing the complex linkage relationship between multi-tourism subsystems.

Third, the empirical research conclusions add a new basis for the research in the field of regional digital transformation and sustainable development. Based on the empirical data of urban clusters in the middle reaches of the Yangtze River, this article finds that compared with traditional tourism development factors, the spatial cluster characteristics of platform visibility are more prominent, and have become the core driving factor of coupling and coordinated development. The conclusion shows that while improving the competitiveness of regional tourism, digital platforms will also strengthen the “core-edge” spatial pattern, providing new empirical support for understanding the dual role of digital platforms in the sustainable development of tourism.

6.2.2. Practical Implications

Based on the conclusions of the previous research, the following policy suggestions are put forward to promote the systematic coordinated development of urban cluster tourism in the middle reaches of the Yangtze River and narrow the regional development gap:

First, implement the coordinated development strategy of differentiated cities to improve the coordination and sustainability of regional tourism development. For Wuhan, Changsha, Nanchang and other core cities, we should strengthen the driving role of radiation and promote the orderly flow of tourism elements to the surrounding areas. At the same time, we should rely on the smart tourism platform to strengthen the management of tourist capacity and environmental carrying capacity monitoring, so as to realize the coordinated development of tourism growth and ecological protection. For sub-core cities such as Yichang and Xiangtan, we should make up for the shortcomings of digital communication and public services, and improve the regional hub function. Marginal cities should rely on ecological, cultural and other characteristic resources to develop eco-tourism and characteristic tourism, avoid homogeneous competition, and enhance the resilience and sustainability of regional development.

Second, strengthen the empowerment of digital technology, promote the transformation of platform traffic into high-quality tourism development, and achieve inclusive and sustainable growth. All localities should attach great importance to the construction of network platform visibility, especially in marginal cities. They should increase digital marketing investment in short videos, social media and online travel platforms, explore the characteristics of local tourism resources, improve the network exposure of destinations and the level of user interaction, and solve the communication dilemma of valuable but not exposed. At the same time, we should give full play to the synergy enhancement effect between transportation and digital platforms, and effectively transform digital attention into tourism market performance. In addition, it is necessary to strengthen platform gov-

ernance, guide the platform algorithm to pay more attention to the display opportunities of small and medium-sized destinations and special tourism products, avoid the excessive concentration of digital traffic to a few hot cities, promote the fairer distribution of regional tourism opportunities and development benefits, and improve the ability of local residents and small and medium-sized tourism enterprises to share the dividends of the digital economy.

Third, deepen cross-regional collaborative governance and promote the green integrated development of urban cluster tourism. Establish a cross-regional tourism cooperation mechanism, coordinate tourism resources, brand building and transportation networks, create cross-city boutique tourism routes, and enhance the radiation-driving role of core cities in surrounding areas. At the same time, we should strengthen regional ecological environment protection and tourist flow monitoring, give full play to the role of digital platforms in appointment management, passenger flow regulation and green travel guidance, guide the transformation of tourism consumption to green, low-carbon and high-quality development, improve the efficiency of resource utilization, and realize the coordination and unity of economic, social and ecological benefits.

6.3. Research Limitations and Future Directions

This study still has several limitations that warrant further improvement in future research. First, tourism accessibility is examined primarily from a theoretical perspective, which may deviate from actual accessibility conditions, as factors such as traffic congestion and multimodal transport combinations are not incorporated. Second, due to data availability constraints, this study relies on cross-sectional data. Moreover, as tourism development in some cities was severely disrupted during the pandemic, temporal analysis and evolutionary dynamics could not be conducted, limiting the ability to capture long-term development trends. Finally, the measurement of platform-based visibility does not sufficiently distinguish the heterogeneous effects of different digital platforms, and the varying roles of different platform types have not been fully explored.

Future research could extend the temporal scope by incorporating multi-period panel data to systematically examine the spatiotemporal evolution of coupling coordination and reveal its long-term dynamic patterns. In addition, further differentiation of the roles of various types of digital platforms would be valuable, with more in-depth analysis of the heterogeneous effects of search engines, short video platforms, and online travel platforms, thereby providing a more comprehensive understanding of coordinated tourism system development in the digital era. Furthermore, future studies could introduce infrastructure investment data and tourism demand simulation methods to conduct cost–benefit analysis of transportation upgrading, so as to provide more practical decision support for regional tourism investment planning.

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