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# Spatiotemporal Dynamics of Domestic Tourist Flows and Tourism Industry Agglomeration in the Yangtze River Delta, China

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**Abstract**

The Yangtze River Delta (YRD) region has experienced rapid development in its tourism industry, establishing itself as a leading force within China's tourism sector. However, significant regional disparities continue to hinder its sustainable development. This study adopts a mixed-methods approach to analyze the spatiotemporal evolution of domestic tourist flows and tourism industry agglomeration patterns in the region. Using city-level data from 2016 to 2022, the analysis employs a comprehensive methodology including standard deviation, coefficient of variation, standard deviation ellipse, and locational entropy. The main findings are as follows: (1) In the pre-pandemic period (2016–2019), absolute disparities in tourist flows widened, whereas relative disparities narrowed. During the pandemic (2020–2022), absolute disparities decreased, while relative disparities initially increased before contracting. (2) Tourist flows displayed a southeast–northwest gradient, with high-value areas clustered along the southeastern coast. Standard deviation ellipse analysis reveals that tourist flows were primarily distributed along the eastern coastal corridor, parallel to the coastline. Prior to the pandemic, tourism growth showed a tendency toward spatial equilibrium; however, this trend was disrupted during the pandemic, resulting in a more decentralized spatial pattern. (3) Throughout the pandemic, tourism industry concentration increased significantly in most cities. Cities with renowned scenic attractions and diversified economic structures demonstrated stronger resilience, while those heavily reliant on tourism were more vulnerable to the pandemic's effects.

**Keywords:** domestic tourist flows; tourism industry agglomeration; regional tourism disparities; spatiotemporal dynamics; the COVID-19 pandemic; the Yangtze River Delta

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## 1. Introduction

Established in 2016, the Yangtze River Delta (YRD) has rapidly become a dynamic and innovation-driven hub of China's economy (Wu et al., 2025), serving as a key driver of domestic tourism development nationwide (M. Chen et al., 2024). In 2019, the YRD accounted for 63.5% of China's gross domestic tourism revenue. By 2022, in the post-pandemic era, this share had risen to 70.2%, highlighting the region's increasingly dominant role within the national tourism landscape (Shanghai Municipal Bureau of Statistics, 2024). The YRD's remarkable strength is evidenced by the significant increase in its share of domestic tourism revenue, which occurred amidst a nationwide economic slowdown. Key drivers of YRD's

robust growth include robust regional tourism policies, convenient and efficient transportation networks, city cluster advantages, a strong economic foundation, rapid growth in short-haul and local travel markets, widespread adoption of digital cultural tourism formats, post-pandemic recovery in consumer confidence, strong purchasing power in source markets, and a robust supply of high-quality tourism products. As a result, tourism has become a pillar industry in the YRD (Lu, 2024), contributing significantly to regional economic growth, employment generation, poverty alleviation, and foreign exchange earnings, collectively advancing the region's path toward sustainable development (Seraj et al., 2025). Despite this overall success, significant inequalities remain among the region's cities. This severe imbalance between core and peripheral cities poses a challenge to regional integration and threatens the long-term sustainability of the YRD's domestic tourism economy.

Since the establishment of the YRD City Cluster in 2016 (Ye et al., 2024), which aimed to create a unified large-scale market and stimulate domestic tourism, the region has experienced a notable increase in domestic tourist numbers and a narrowing of relative disparities in tourist volumes across cities (Pan et al., 2024). However, the outbreak of the COVID-19 pandemic severely disrupted this progression (N. Wang & Weng, 2025). China's tourism industry experienced a significant downturn following the implementation of strict nationwide mobility restrictions (Bai et al., 2025). The YRD, one of the nation's core tourism hubs, was particularly hard hit, with significant negative impacts on the regional economy (Pan et al., 2024). For example, the number of domestic tourists in Shanghai dropped sharply from 361.41 million in 2019 to 188.16 million in 2022. The spread of COVID-19 had a significant impact on local tourism development. At the same time changing tourists' travel behaviors and diversifying the factors in tourism can also affect the disparities in regional tourism economic development. The COVID-19 pandemic has fundamentally altered the spatiotemporal dynamics of domestic tourism disparities in the YRD.

The negative impact of regional tourism disparities on sustainable development has become a significant challenge, driving a growing body of research in this field. Most of the studies on regional tourism disparities explained the disparities in the level and scale of tourism development between regions in terms of the spatial structure of tourism (Ma et al., 2022; Ran et al., 2023). Tourism spatial structure refers to the spatial collection of all elements related to tourism in a region, which are essentially the spatial reflection of tourism activities, including the subjects, objects, and media participating in tourism activities, which interact with each other and jointly form the tourism spatial structure (Li et al., 2023). The theory of tourism spatial structure and tourism economic disparities are closely related, as the spatial structure of tourism destinations could significantly impact tourism economic disparities within and between regions. Spatial analysis methods have recently been applied to explore various aspects of tourism, including efficiency (Tan et al., 2024), tourism demand (Iamtrakul et al., 2025), competitiveness (Yang et al., 2025), and the tourism economic disparities (Ling & Qiu, 2024).

The YRD region represents a flagship demonstration zone for China's regional integration strategy. Key policy milestones include the approval of the YRD Urban Agglomeration Development Plan by the State Council Executive Meeting in 2016, followed by the official release of the Outline of the YRD Regional Integration Development Plan in 2019. The latter encompasses the entirety of 41 cities across Jiangsu, Zhejiang, Anhui, and Shanghai provinces. As one of China's most economically advanced and interconnected tourism regions, the YRD exhibits a distinctive combination of developmental disparities and collaborative synergy. This makes it an exceptionally representative and compelling case for investigating the spatiotemporal evolution of tourism flows and regional resilience.

While existing literature extensively examines regional disparities in tourism development, few studies analyze the spatiotemporal shifts in these disparities or the formation mechanisms of urban tourism resilience under major external shocks (such as global pandemics) from a dual perspective of tourist flows and industrial agglomeration (Wickramasinghe & Naranpanawa, 2023). Additionally, previous studies have primarily focused on provincial-level analyses, with relatively few addressing disparities at the inter-city level (Iamtrakul et al., 2025; Ling & Qiu, 2024; Tan et al., 2024). To address this gap, this study conducted a spatiotemporal analysis of domestic tourist flows and tourism industry agglomeration across 41 cities in the YRD, encompassing both the pre-pandemic years of 2016–2019 and the pandemic years of 2020–2022. Utilizing an integrated methodology that combines econometric techniques with spatial analysis, this study aims to investigate the temporal and spatial disparity in tourism development across the YRD region, with a particular focus on how the COVID-19 pandemic has altered the spatiotemporal evolution patterns of this disparity. Unlike previous studies that typically focus solely on economic or geographic dimensions, this research employs a comprehensive approach combining quantitative spatial analysis methods, including standard deviation ellipses, natural break classification, and locational entropy, with policy recommendations grounded in a regional governance framework. Furthermore, this study adopts a comparative perspective, not only contrasting pre- and post-pandemic tourism patterns within the YRD but also linking them to international cases. This broadens the application of core–periphery theory, growth pole theory, and tourism network theory in crisis scenarios. Methodologically, the simultaneous application of multiple complementary indicators enables the study to reveal the evolving characteristics of both absolute and relative disparities with greater precision. Together, these perspectives provide new insights on how resource allocation, industry diversification, and cross-regional cooperation help regional tourism systems improve resilience

This study aims to address the following research questions:

1. How did inter-city disparities in tourist volumes and spatial distribution patterns in the YRD evolve before and after the emergence of COVID-19?
2. How has the agglomeration of the tourism industry in cities within the YRD developed in the pre- and post-pandemic periods, and what variations in tourism resilience emerged across different city types in response to pandemic-induced disruptions?
3. Drawing on the analysis of spatiotemporal variations and agglomeration characteristics, what differentiated policy measures should be implemented in the YRD to address regional development imbalances?

By addressing these research questions, this study offers significant theoretical and practical contributions to the field of tourism studies. Theoretically, it advances the understanding of the dynamic mechanisms driving regional tourism resilience and spatial development disparities, while also extending established theoretical frameworks such as core–periphery theory, growth pole theory and tourism network structures. From a practical perspective, the findings provide empirically grounded insights and strategic guidance for fostering high-quality, balanced, and sustainable tourism development in the YRD and other comparable regions.

## 2. Literature Review and Hypothesis

### *2.1. Tourism Development*

Tourism development level referred to the stage of development a particular destination or region had achieved in terms of its tourism industry, which was the scale and level of the entire tourism system in different periods formed by the interaction of regional tourism and regional economic, policy, environment, science and technology, and was the

organic unity of the quantity and quality of tourism phenomenon (He et al., 2024). The tourism development level encompassed various factors including infrastructure, attractions, number of tourists, services, marketing, and overall visitor experience (Baloch et al., 2023). Among these, visitor numbers are central to informing strategies and evaluating tourism development. Visitor numbers could be used to analyze destination attractions, as well as future visitor flows and trends (Q. Chen et al., 2021; Ji & Wang, 2022). Tourism competitiveness is a pivotal metric for assessing a region's level of tourism development (Song, 2025). Unlike visitor volume, which reflects mere scale, competitiveness captures efficiency and overall appeal. A highly competitive destination excels not only in attracting larger numbers of visitors but also in drawing high-spending tourists, prolonging their stays, and encouraging repeat visits—all of which contribute to more sustainable and high-quality tourism growth (Tleuberdinova et al., 2024). Therefore, this study adopts a dual analytical framework, examining regional tourism development through the lenses of both visitor numbers and tourism industry competitiveness.

### *2.2. Spatial and Temporal Disparities in Tourism Development*

The spatial tourism development concerns the geographical distribution of tourism-related activities. It included how tourism resources, services, infrastructure, and visitor flows were spread across regions. The temporal tourism development referred to the dynamic changes in tourism-related activities over time. The temporal tourism development referred to how tourism-related indicators (e.g., number of tourists, tourism revenue) change over time (Jiang et al., 2025). Temporal disparities may emerge from seasonal fluctuations, economic cycles, policy shifts, or external shocks like the COVID-19 pandemic (Kronfeld-Schor et al., 2021). For instance, during the COVID-19 pandemic, many tourism destinations experienced a sharp decline in visitor numbers followed by uneven recovery phases, illustrating the temporal volatility of tourism economies. For example, a metropolis like Shanghai recovers faster than a backward area like Huaibei. Similarly, long-term trends toward digital transformation and eco-tourism were reshaping tourism demand patterns over time.

Spatial and temporal disparities in the tourism development referred to the uneven distribution and development of tourism activities across different regions and over different time periods (Liu et al., 2021). These disparities were shaped by a combination of geographic, economic, social, and policy-related factors (Ma et al., 2022). This paper focuses on shifts in the spatiotemporal variations in tourism development before and during the pandemic.

### *2.3. The Tourism Development Disparities and the Impact of the COVID-19 Pandemic*

Most of the studies on regional tourism development disparities explained the disparities in the level and scale of tourism economic development between regions in terms of the spatial structure of tourism (Ma et al., 2022; Ran et al., 2023). Tourism spatial structure referred to the spatial collection of all elements related to tourism in a region, which was essentially the spatial reflection of tourism activities, including the subjects, objects, and media participating in tourism activities, which interact with each other and jointly form the tourism spatial structure (Li et al., 2023). The theory of tourism spatial structure and tourism economic disparities were closely related, as the spatial structure of tourism destinations could significantly impact tourism economic disparities within and between regions.

Tourism economic disparities were constantly and dynamically changing over time, driven by a variety of factors, and there were certain regularities. Ji and Wang (2022) discovered that there was a pattern of a decrease followed by an increase in the level of

tourism development in China's coastal cities. There were notable regional variations in the growth of seaside tourism, primarily due to intra-group and inter-group disparities, and there was an obvious gradient impact and divergence in the development of tourism in coastal cities over time.

The COVID-19 pandemic had a profound impact on the global tourism industry, exacerbating economic disparities within and between countries, particularly in regions heavily dependent on tourism. The COVID-19 pandemic had seriously affected the tourism development (Ahmed, 2025), so many economists had specialized in studying the impact of COVID-19 on the tourism economy to explore the future development of tourism. Sigala (2020) examined the reasons and issues raised by the pandemic, as well as the main effects, behaviors, and experiences that three major tourism stakeholders—namely, tourism demand, supply, and destination management organizations and policymakers—was going through during the three COVID-19 stages (response, recovery, and reset). He concluded by outlining why and how the pandemic could be a transformative opportunity. Sun et al. (2022) assessed how the decline in international tourism consumption affected tourism employment and its potential for income loss in 132 countries. COVID-19 had led to a collapse in international travel, increased tourism unemployment, and exacerbated short-term income inequality within and between countries. COVID-19 had a significant impact on tourism development, which had also become the focus of scholars' attention (Tan et al., 2022), but there were fewer comparative studies on regional tourism disparities before and after the outbreak of COVID-19.

### *2.4. The Sustainable Development of Tourism*

The sustainable development of tourism referred to the sustainable development of tourism economy based on the integration of the environment, society, and economy without damaging the local natural environment, existing and potential tourism resources, making rational use of tourism resources, and protecting the existing resources that had been developed (Stojanović et al., 2024). Sustainable tourism provided long-term economic benefited to all stakeholders through their participation, consensus-building, and impact monitoring, while respecting and maintaining socio-cultural authenticity, essential ecological processes, biodiversity, and the integrity of life support systems, and minimizing impacts on environmental resources (Jones, 2012). Sustainable tourism development required tourism to be integrated with the natural, cultural, and human living environment, which focused on the protection or preservation of all resources and the enhancement of human well-being for future generations (Hall, 2011). It could be concluded that sustainable tourism was described as tourism development in an area that remained sustainable for an indefinite period, did not lead to a decline in the functioning of the surrounding environment, and brought prosperity from tourism activities (Prayitno et al., 2024).

The sustainable growth of tourism may be aided by an understanding of the economic disparities in the YRD. First, knowing the economic differences in the YRD's tourism industry made it easier to allocate resources efficiently (Q. Chen et al., 2021). Second, more inclusive tourism growth may result from examining economic disparities in the industry. Many people in the area relied on tourism for their jobs and means of subsistence (Parvaneh Safa et al., 2021). Understanding the disparities of the tourism economy could help in the creation of focused training and employment initiatives for the underprivileged, which could lower unemployment and poverty rates, and, consequently, income inequality. Thirdly, wealthier regions might have more resources to spend on environmental initiatives, while poorer regions might have difficulty implementing sustainable development practices (Y. Feng et al., 2023). Identifying these differences could help ensure that environmental protection efforts were evenly distributed. Therefore, analyzing disparities in

tourism development in the YRD was critical to achieving sustainable tourism development that benefited all communities in the region. It allowed for a more comprehensive understanding of the unique challenges and opportunities in different sectors, enabling policymakers and stakeholders to make informed decisions for sustainable tourism growth.

### *2.5. Theoretical Foundations*

Theoretical foundations and empirical studies on economy disparities provided a solid basis for this research. Williamson (1965) argued that the spatial polarization of economic activities is an inevitable stage in early national development, but such regional disparities tend to diminish as economic maturity is achieved (Lessmann, 2014). Building on this, Friedmann (1966) proposed the core–periphery model, highlighting the importance of spatial distance from the economic core. This model describes two distinct phases: the polarization effect, where resources such as capital and labor concentrate in the core, exacerbating peripheral underdevelopment; and the diffusion effect, where growth in the core gradually spills over to the periphery, narrowing regional gaps (Klimczuk & Klimczuk-Kochańska, 2023). The theory was used to explain the spatial correlation of regional tourism economic disparities. McKercher (2021) found that 30% of the population in the periphery of Australia's urban centers and residents of these regional and rural communities were just as interested in travel as urban dwellers, had similar attitudes and motivations for travel, and had the same level of propensity and intensity to travel, and were capable of serving as a potential source market for the periphery.

Drawing on the concept of growth poles proposed by Perroux (1955), the clustering of dominant industries or competitive enterprises within specific regions or metropolitan areas generates significant economies of scale through the concentration of capital, technology, and talent, thereby stimulating the development of surrounding areas. In this context, the growth of regional tourism economies is not limited to local impacts but can exert a spillover effect on adjacent regions. As Daniels (2007) further noted, the stronger the agglomeration of tourism hubs, the greater their capacity to attract visitors and promote tourism expansion in neighboring zones.

Finally, the study of regional economic disparities has advanced due to the advent of new economic geography and other research findings. P. Krugman (1991) represented the new economic geography. He gave particular attention to market externalities and spatial variables. In order to better explain the dynamics of spatial agglomeration and dispersion of economic activities, he introduced the law of increasing rewards into the economic system. He also promoted the use of spatial analytical methods in regional studies and underlined the importance of geography in influencing economic processes. A more intuitive understanding of regional economic differences can be obtained by using economic geography tools for spatial comparison and characteristic description. Studies investigating regional economic disparities provide a critical theoretical and empirical foundation for subsequent research on geographical variations in tourist development.

Network Structure Theory represents a pivotal and modern framework within tourism geography, integrating multidisciplinary insights such as Castells (2020)' "Space of Flows" and Jacob Moreno's foundational work on network sociology (Gießmann, 2017). Since the 2000s, prominent tourism researchers, including Buhalis et al. (2023), Scott et al. (2008), as well as Hall (2013), have systematically incorporated these ideas into tourism studies, progressively shaping a coherent theoretical approach to network structures in the field. This evolution marks a paradigm shift from a traditional focus on "place and space" toward a dynamic "relationship and flow" orientation. Rather than treating tourism space as a mere geometric system of isolated attractions or zones, the theory reconceptualizes it as a dynamic network defined by complex interactions among diverse actors. It offers practical

value for regional tourism integration by helping planners identify critical hubs, vulnerable links, and "structural holes," thereby enabling targeted strategies to enhance infrastructure connectivity, facilitate information exchange, foster collaborative partnerships, and ultimately strengthen overall tourism efficiency and regional resilience.

### 2.6. Hypothesis

This study systematically examines the spatiotemporal patterns and underlying mechanisms of tourism development in the YRD. The core objectives are to analyze the spatiotemporal differentiation of tourism flows and industrial agglomeration from 2016 to 2022, and to elucidate how the COVID-19 pandemic reshaped the regional tourism structure.

The following hypotheses are proposed:

**H1.** *Before the pandemic, tourism flows in the YRD were characterized by expanding absolute disparities but converging relative disparities—a trend that was significantly altered or reversed during the pandemic.*

**H2.** *A distinct southeast–northwest spatial gradient existed in tourism distribution, which was disrupted by the pandemic, resulting in a more decentralized spatial pattern.*

**H3.** *While tourism agglomeration increased across most cities during the pandemic, regions with resilient tourism assets—such as iconic attractions or economically diversified urban centers—exhibited stronger recovery capacity and adaptive resilience, whereas tourism-specialized cities suffered more severe disruptions.*

## 3. Data Collection and Methodology

### 3.1. Research Region

The YRD region encompasses 41 cities across Jiangsu, Zhejiang, Anhui Provinces, and Shanghai Municipality (see Figure 1 and Table 1). Recognized for its high level of economic integration and competitiveness, the YRD region is a region in China with a high degree of economic integration, strong competitiveness, and huge development potential (X. Wang et al., 2024).

**Table 1.** Overview of Provinces and Cities in the YRD.

| Region | City Count | Constituent Cities |
|---|---|---|
| Shanghai City | 1 | Shanghai |
| Jiangsu Province | 13 | Nanjing, Wuxi, Xuzhou, Changzhou, Suzhou (J), Nantong, Lianyungang, Huai'an, Yancheng, Yangzhou, Zhenjiang, Taizhou (J), Suqian |
| Zhejiang Province | 11 | Hangzhou, Ningbo, Wenzhou, Jiaxing, Huzhou, Shaoxing, Jinhua, Quzhou, Zhoushan, Taizhou (Z), Lishui |
| Anhui Province | 16 | Hefei, Wuhu, Bengbu, Huainan, Ma'anshan, Huaibei, Tongling, Anqing, Huangshan, Lu'an, Bozhou, Chuzhou, Fuyang, Suzhou (A), Chizhou, Xuancheng |

Source: (China-Government, 2019); Note: The abbreviations J, Z, and A correspond to Jiangsu Province, Zhejiang Province, and Anhui Province, respectively.

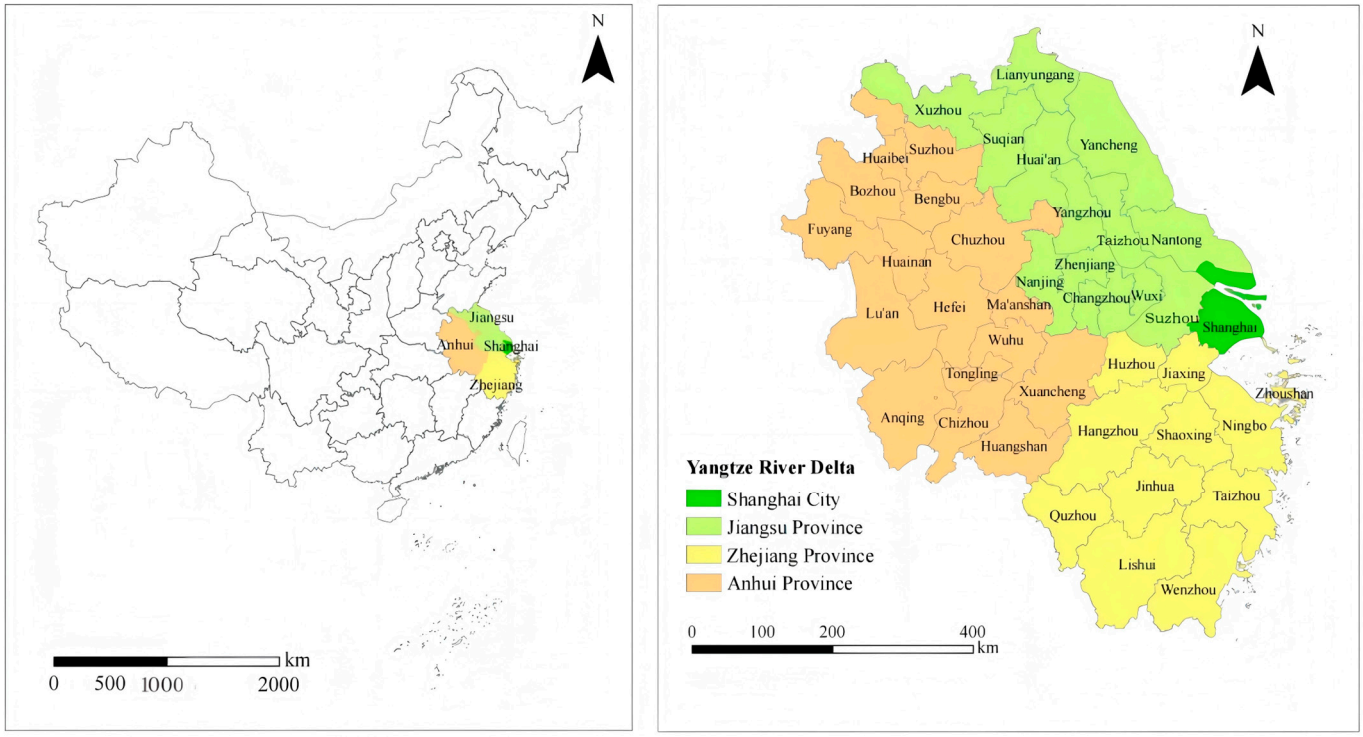


**Figure 1.** The YRD Urban Agglomeration, China (Map found Xu (2023), free of copyright restrictions).

### *3.2. Sources of Data*

This study selected 41 cities in the YRD region as the primary unit. Temporal analysis used data from 2016 to 2022, while comparative spatial analysis selected three equally spaced years: 2016, 2019, and 2022. These three time points were chosen based on their significance in the trajectory of the YRD's tourism economy. The YRD regional integration strategy was officially launched in 2016. This initiative was further strengthened in 2019 with the release of the Outline of the YRD Regional Integration Development Plan, which expanded the scope to include 41 cities across Jiangsu, Zhejiang, Anhui, and Shanghai. The year 2019 also represented the peak of China's pre-pandemic tourism industry. In contrast, 2022 saw the most severe pandemic-induced contraction in the tourism sector, while simultaneously marking the conclusion of the pandemic's acute disruptive phase. To systematically analyze the spatial evolution of domestic tourism development in the YRD, this study adopts a time-interval-equal division approach for temporal segmentation. This phased methodology enables a structured comparison of tourism disparities among cities before and after the pandemic, offering clearer insights into the spatial dynamics and resilience of the region's tourism landscape.

This study's time series analysis utilizes annual data from 2016 to 2022. The dataset comprehensively covers domestic tourist arrivals, domestic tourism revenue, city GDP, as well as China's total domestic tourism revenue and GDP across 41 cities. Data were sourced from the National Statistical Yearbook and the statistical yearbooks of each province, ensuring consistency and reliability for longitudinal comparisons.

### *3.3. Research Methods*

This study uses the number of domestic tourists to characterize tourism growth and tourism industry agglomeration to quantitatively characterize tourism competitiveness. These two indicators provide a comprehensive assessment of tourism development from both quantitative and qualitative perspectives: the number of domestic tourists directly reflects the scale and vitality of domestic tourism activities in the YRD region and is a

core indicator for measuring overall tourism growth; tourism industry agglomeration highlights the concentration and specialization of the tourism industry, directly reflecting the competitiveness and resource allocation efficiency of tourism in different regions.

This study enhances its validity and reliability by employing a combination of methods that mutually corroborate each other. First, the standard deviation method (Milon, 2024) and the coefficient of variation (Zhang et al., 2025) were used to assess the absolute and relative differences in the number of domestic tourists among 41 cities from 2016 to 2022. Standard deviation quantifies absolute variation, capturing the actual scale of disparities in tourist volumes. In contrast, the coefficient of variation measures relative variation by adjusting for differences in scale and central tendency, allowing for a more objective comparison of dispersion across time periods. The complementary use of both metrics ensures a comprehensive analysis. Second, the "natural breakpoints" (Jenks) classification method (Gui et al., 2025) in ArcGIS 10.8 was used to categorize the spatial distribution of domestic tourist numbers into five levels. In contrast to more arbitrary approaches such as equal interval or quantile classification—which can impose artificial boundaries or distort underlying data structures—the Jenks method is designed to minimize variance within each category and maximize differences between categories. This allows it to detect inherent clustering patterns within the dataset and identify meaningful thresholds that may reflect genuine socioeconomic variations or regional typologies. By ensuring that spatial categories align closely with the intrinsic structure of the data, the Jenks method significantly improves the accuracy of regional differentiation and cartographic representation. Furthermore, the standard deviation ellipse method was used to visualize the spatial clustering patterns of domestic tourists (Zheng et al., 2023). The standard deviation ellipse method identifies directional bias and central tendency of tourist flows, adding a geometric representation of spatial change over time. Third, position entropy (Gullu & Yilmaz, 2020) analysis is used to reveal regional differences in the competitiveness of the tourism industry in the YRD region. Location entropy measures regional specialization in tourism relative to the broader economy, highlighting competitiveness independent of city size or economic volume. By integrating spatial, temporal, and structural methods with validated statistical techniques, the study mitigates the limitations of any single method and provides a robust, multi-dimensional understanding of tourism disparities and their evolution.

#### 3.3.1. Standard Deviation (SD)

SD reflects the amount of variation or dispersion within a dataset (Rakrak, 2025). In the context of regional tourism, it is used to assess the absolute level of balance in tourism development across different regions. A higher standard deviation indicates greater differences and more unbalanced development between regions, while a lower value indicates a more balanced and uniform tourism economy. Therefore, standard deviation effectively reflects the absolute differences in tourism development between regions (Boto-García & Pérez, 2023).

Its functional expressions are as follows:

$$S = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \overline{x})^2}{n}} \quad (1)$$

where in Equation (1) S is the standard deviation, $x_i$ is the domestic tourist number of ith city in the YRD, $\overline{x}$ is the average domestic tourist number of 41 cities in the YRD, and n refers to the number of cities, which is 41 (Boto-García & Pérez, 2023).

3.3.2. Coefficient of Variation (CV)

CV, obtained by dividing the standard deviation by the mean, serves to standardize variability by removing the effects of measurement scale and data magnitude (Alabi & Bukola, 2023). Its value is influenced not only by the degree of dispersion but also by the average level of the variable. Therefore, it can serve as an effective indicator for measuring relative differences in regional tourism development (Boto-García & Pérez, 2023).

Its functional expressions are as follows:

$$CV = \frac{S}{\bar{x}} \tag{2}$$

In Equation (2), S is the standard deviation and $\bar{x}$ is the average domestic tourist number of 41 cities in the YRD (Boto-García & Pérez, 2023).

3.3.3. Standard Deviation Ellipse (SDE)

The functional expression is presented as follows (Zeng et al., 2024):

$$C = \begin{pmatrix} var(x) & cov(x,y) \\ cov(y,x) & var(y) \end{pmatrix} \tag{3}$$

where $var(x) = \frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2$, $cov(x,y) = \frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})$, $var(y) = \frac{1}{n}\sum_{i=1}^{n}(y_i - \bar{y})^2$.

In Equation (3), x and y correspond to the spatial positions of characteristic i and n denotes the total number of characteristics. These coordinates are used to calculate the mean center of all spatial features. If the spatial distribution of features follows a normal distribution, approximately 63% of the datapoints fall within the one-standard-deviation ellipse boundary, 98% within the ellipse defined by two standard deviations, and 99% within the confidence ellipse at three standard deviations. The standard deviation ellipse thus provides a visual summary of the spatial dispersion and directional trends of geographic phenomena (Zheng et al., 2023).

3.3.4. Location Entropy (LE)

LE is a commonly used indicator for measuring the degree of regional industrial agglomeration. Higher values indicate a higher degree of industrial concentration, indicating a region's greater national competitiveness. Therefore, LE can be used as an effective tool for measuring regional disparities in tourism industry competitiveness (Gullu & Yilmaz, 2020).

The function expression of LE is as follows:

$$Q_{ij} = \frac{e_{ij}}{e_i} / \frac{E_{gj}}{E_g} \tag{4}$$

In Equation (4), $Q_{ij}$ is the entropy value of the tourism area of each city in the YRD cities. $e_{ij}$ is the total domestic tourism revenue of each city in the YRD. $e_i$ is the gross domestic product of the YRD's cities. $E_{gj}$ denotes the total output value generated by the national domestic tourism industry, calculated by the total domestic tourism income of the whole country. $E_g$ is the gross domestic product of the country. If $Q_{ij} > 1$, it shows that the level of domestic tourism industry agglomeration in the city is higher than the national average level. If $Q_{ij} = 1$, it indicates that it is equal to the national average. If $Q_{ij} < 1$, it shows that the level of domestic tourism industry agglomeration in the city is lower than the national average level (Ding et al., 2021; Goodbody et al., 2021).

## 4. Spatiotemporal Analysis of Domestic Tourist Flows

### *4.1. The Disparities of the Domestic Tourist Numbers Between the Provinces*

Figure 2 demonstrates notable differences in domestic tourist flows among cities in the YRD, but their development trends are relatively similar. The YRD experienced a marked expansion in domestic tourist flows from 2016 to 2019. The top-ranked city, Shanghai, grew from 296.21 million to 361.41 million, an increase of 22% over three years, while the worst-ranked city, Huaibei, grew from 8.24 million to 18.52 million, an increase of 124.78% over three years. In comparison, the emergence of the COVID-19 pandemic precipitated a sharp contraction in domestic tourist flows across cities, resulting in a pronounced downturn in the regional tourism economy during 2020–2022. Shanghai, the top-ranked city, saw domestic tourist numbers fall from 361.41 million during 2019 to 188.16 million during 2022, amounting to a 47.94% decrease, and the worst-ranked Huaibei decreased from 18.52 million to 10.5 million, a decrease of 43.31%. Therefore, the study period was segmented into two distinct phases: the intervals spanning 2016–2019 (pre-pandemic) and 2020–2022 (pandemic).

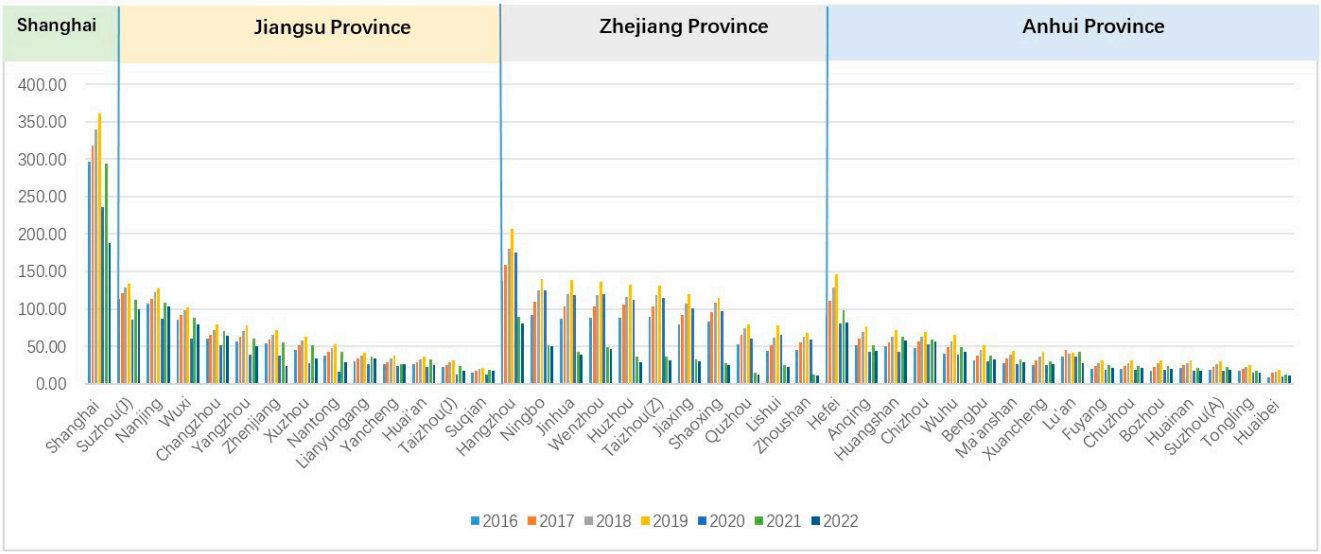


**Figure 2.** Annual Domestic Tourist Numbers in Cities of the YRD (Unit of measure: million).

#### 4.1.1. The 2016–2019 Pre-Pandemic Period

Before COVID-19, the YRD's domestic tourist flows in most cities showed a stable growth trend. Shanghai consistently maintained the highest arrival numbers, exceeding 361.41 million by 2019, clearly demonstrating its prominence as the leading tourism destination in the YRD, attracting far more tourists than other cities. Major cities, such as Hangzhou, Suzhou, and Nanjing, also maintained high growth rates in the number of visitors, thanks to their strong economic and political foundations, well-developed tourism infrastructure, and abundant cultural and tourism resources. In contrast, medium-sized cities in Zhejiang and Jiangsu Provinces, such as Wenzhou, Nantong, and Changzhou, although achieving moderate growth, still lagged far behind the leading cities in the region. Anhui Province still had the lowest number of tourists among the provinces in the YRD. Although the number of tourists in the provincial capital Hefei and the tourist city Huangshan improved, there was still a significant disparity compared to the major tourist destinations in Jiangsu and Zhejiang Provinces.

#### 4.1.2. The 2020–2022 Pandemic Period

The COVID-19 epidemic has caused a significant drop in the domestic tourist flows in provinces of the YRD region. However, there were substantial disparities in terms of the extent and pace of recovery among provinces. As a pre-pandemic leader, Shanghai suffered a sharp drop in domestic tourist numbers to 236.06 million in 2020 and as of 2022 (188.16 million), has yet to recover to pre-pandemic levels. Likewise, other major cities such as Hangzhou, Suzhou, and Nanjing also showed similar declines, mirroring the combined effects of lockdown policies, interprovincial travel restrictions, and changes in consumer travel behavior.

Between 2021 and 2022, some major tourist destinations began to show evidence of partial recovery: Hangzhou and Suzhou saw moderate year-on-year growth in tourist numbers, while smaller cities within Anhui Province made limited improvement. For example, Xuancheng and Huai'an saw visitor numbers remain largely stagnant, highlighting the spatial dynamics of uneven recovery.

In general, the pandemic did not fundamentally change the spatial hierarchy of tourism in the YRD. During the pandemic, the differences in tourist concentration among major metropolitan areas such as Shanghai, Hangzhou, and Suzhou remained largely unchanged. Large cities normally displayed stronger resilience and faster recovery trajectories, thanks to their strong economic foundations, abundant tourism resources, and more advanced infrastructure. In contrast, smaller cities, especially those in Anhui Province, continue to report the lowest visitor numbers. Medium-sized cities in Jiangsu and Zhejiang, with their mature tourism markets and enhanced connectivity, have recovered more quickly, further widening the performance gap compared to tourism destinations in Anhui Province.

### *4.2. The Temporal Evolution of Domestic Tourism Disparities*

Table 2 provides descriptive statistics for domestic tourist arrivals within the YRD urban agglomeration spanning the years 2016 to 2022. The statistics include Range, minimum (MIN), maximum (MAX), Mean (M), SD, and CV. It is clearly seen that there are also great differences in the YRD cities' quantity of domestic tourists. The data demonstrate a distinct pattern characterized by growth prior to the pandemic, succeeded by a pronounced decline in 2020 attributable to the COVID-19 pandemic, a partial rebound in 2021, and a subsequent contraction in 2022. Notably, the coefficient of variation (CV) values, which assess relative disparities, reveal a consistent reduction in regional inequality before the onset of the pandemic. However, these values exhibited considerable fluctuations during the health crisis, indicating a disruption in the region's trajectory toward convergent development.

**Table 2.** Statistics of Number of Domestic Tourism Tourists.

| Year | Range (mn) | MIN (mn) | MAX (mn) | M (mn) | SD | CV |
|---|---|---|---|---|---|---|
| 2016 | 287.97 | 8.24 | 296.21 | 58.13 | 49.56 | 0.85 |
| 2017 | 303.68 | 14.77 | 318.45 | 66.69 | 53.87 | 0.81 |
| 2018 | 323.10 | 16.66 | 339.77 | 74.66 | 58.39 | 0.78 |
| 2019 | 342.88 | 18.52 | 361.41 | 82.71 | 63.19 | 0.76 |
| 2020 | 225.90 | 10.16 | 236.06 | 57.97 | 49.09 | 0.85 |
| 2021 | 281.49 | 12.33 | 293.82 | 49.95 | 46.69 | 0.93 |
| 2022 | 177.66 | 10.50 | 188.16 | 41.16 | 33.24 | 0.81 |

Note: "mn" was short for million.

#### 4.2.1. Trends Before COVID-19 Pandemic (2016–2019)

From 2016 to 2019, the domestic tourism industry in the YRD continued to grow. The average domestic tourists' quantity per city increased from 58.13 million to 82.71 million, demonstrating a strong growth momentum. At the same time, the total range of tourist arrivals widened from 287.97 million to 342.88 million, indicating a growing absolute gap between the most and least visited cities continued to widen. This growth was largely propelled by the development of high-end city, with Shanghai's tourist numbers increasing from 296.21 million to 361.41 million.

The SD, which measures absolute disparities, also grew steadily from 49.56 to 63.19, confirming increased dispersion in tourist volumes across cities. Conversely, the CV, which reflects relative disparities, declined from 0.85 to 0.76. This contrasting pattern suggested that although absolute disparities in visitor numbers expanded, relative disparities narrowed, indicating that the growth in the region was more balanced.

#### 4.2.2. Trends During COVID-19 Period (2020–2022)

Domestic tourism in the YRD experienced a sharp downturn as a result of the COVID-19 pandemic. Between 2019 and 2020, the average domestic tourist number per city plummeted from 82.71 million to 57.97 million, further decreasing to 41.16 million in 2022, indicating a significant contraction and weak recovery momentum. The range of tourist numbers shrank from 342.88 million in 2019 to 225.9 million in 2020, and further to 177.66 million in 2022, reflecting a narrowing gap between the cities with the highest and lowest tourist numbers.

Similarly, the SD decreased from 63.19 in 2019 to 33.24 in 2022, indicating a narrowing of the absolute difference in tourist numbers. In contrast, the CV increased during the early stages of the pandemic, peaking at 0.93 in 2021 before declining to 0.81 in 2022. This suggested that as a result of the uneven effects of the pandemic on different cities, the relative difference initially widened, but then narrowed as tourism activities generally declined.

In summary, prior to the pandemic, the number of tourists continued to grow, with the absolute difference expanding and the relative difference narrowing. During the pandemic, total visitor numbers plummeted, and the relative difference initially widened, reflecting the uneven impact. However, by 2022, these disparities had stabilized, while the overall tourism industry remained far below the baseline level of 2016.

### *4.3. Comparative Analysis of Domestic Tourist Flows Spatial Distribution*

#### 4.3.1. Spatial Characteristics of Domestic Tourist Flows

Between 2016 and 2022, the spatial pattern of domestic tourist flows evolved from a southeast-high, northwest-low distribution to a center-high, northwest-low distribution, and the quantity of domestic tourists changed from a balanced growth to an unbalanced development, with significant spatial heterogeneity (as shown in Figure 3).

- Spatial Distribution in 2016

In 2016, domestic tourist flows in the YRD exhibited a clear southeast-to-northwest gradient, with higher numbers of tourists in the southeast and fewer in the northwest. Shanghai dominates the region with the highest value, with 12 surrounding medium-high-value cities primarily located in the southeast, including provincial capitals Hefei and Nanjing. Ten medium-value cities were concentrated in the southwest and central areas, while nine medium-low and nine low-value cities were primarily distributed across the northwest and northern parts of the YRD.

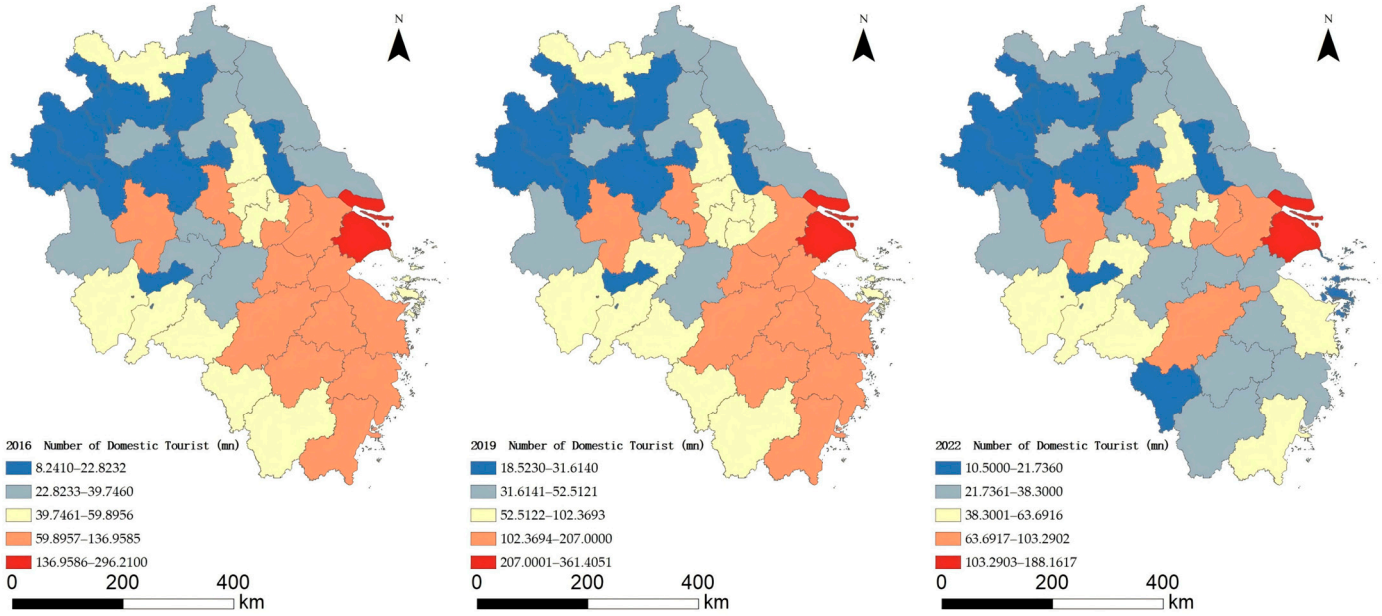


**Figure 3.** Comparison of Spatial Patterns of Domestic Tourist Numbers in the YRD.

Shanghai tops the list in terms of visitor numbers, thanks to its international influence, advanced infrastructure, convenient transportation, and diverse attractions. Other key cities such as Suzhou (Jiangsu Province), Hefei, Nanjing, Hangzhou, and several Zhejiang cities benefited from their status as provincial capitals or proximity to major hubs. In contrast, surrounding cities, particularly those in Anhui (e.g., Huai'an, Chuzhou, Bozhou) and northern Jiangsu (e.g., Taizhou, Suqian), attracted significantly fewer visitors owing to weaker economies, limited infrastructure, and reliance on niche tourism offerings. This spatial distribution highlights a distinct "core–periphery" pattern, with tourism development primarily concentrated in the southeastern YRD region.

- Spatial Distribution in 2019

In 2019, domestic tourism reached its pre-pandemic peak, with its overall spatial distribution largely consistent with 2016, indicating a stabilization of the tourism industry's hierarchical structure. Notable changes include Wuxi's rise from a medium-high value to a medium value, and Wuhu's rise from a medium-low value to a medium value, indicating more balanced tourism development across much of the YRD region.

- Spatial Distribution in 2022

The COVID-19 pandemic triggered the most severe tourism contraction during the study period, with tourist numbers hitting a record low in 2022. Tourism flows became more dispersed, with peaks in central cities, with subsequent levels in the southern region, and the northwestern region showing the lowest values. Shanghai remained the only high-value city, while five cities, such as Suzhou, Wuxi, Hangzhou, Nanjing, and Hefei, were in the upper-middle range. Eight cities fell into the medium range, while 16 medium-low-value cities formed the largest category, with 11 low-value cities concentrated in the northwest.

Despite the impact of the pandemic, major provincial capitals maintained relatively high visitor volumes, supported by stronger human, financial, and policy resources. Cities in Jiangsu and Anhui exhibited minimal ranking changes, reflecting uniform contraction and relative resilience. Conversely, most Zhejiang cities (excluding Hangzhou) dropped at least one classification level, with Zhoushan and Quzhou falling two levels, primarily due

to the province's reliance on services and foreign trade, coupled with recurring pandemic situations and stringent controls.

Over the past three years, the YRD's tourism geography retained a core–periphery structure. High visitor flows remained concentrated in southeastern core cities, while the northwest lagged behind. Pre-pandemic growth solidified the dominance of core cities, fueled by advanced infrastructure, diverse attractions, and effective marketing. The pandemic led to a sharp decline in overall visitor numbers, initially dispersing tourism flows and weakening spillover effects from core cities, particularly in Zhejiang. By 2022, while the gap had stabilized, a spatial hierarchy persisted, highlighting the structural advantages of core cities in the southeast and the continued lag of peripheral cities in the northwest.

#### 4.3.2. Standard Deviation Ellipse of Domestic Tourist Flows

The ellipses were consistently located in the eastern YRD (as shown in Figure 4), oriented parallel to the coastline, indicating tourism activities were concentrated along the southeast-northwest axis. The mean centers for 2016, 2019, and 2022 showed slight but significant shifts along the Huzhou–Xuancheng–Changzhou axis, indicating the geographical focus of tourism activities was gradually changing.

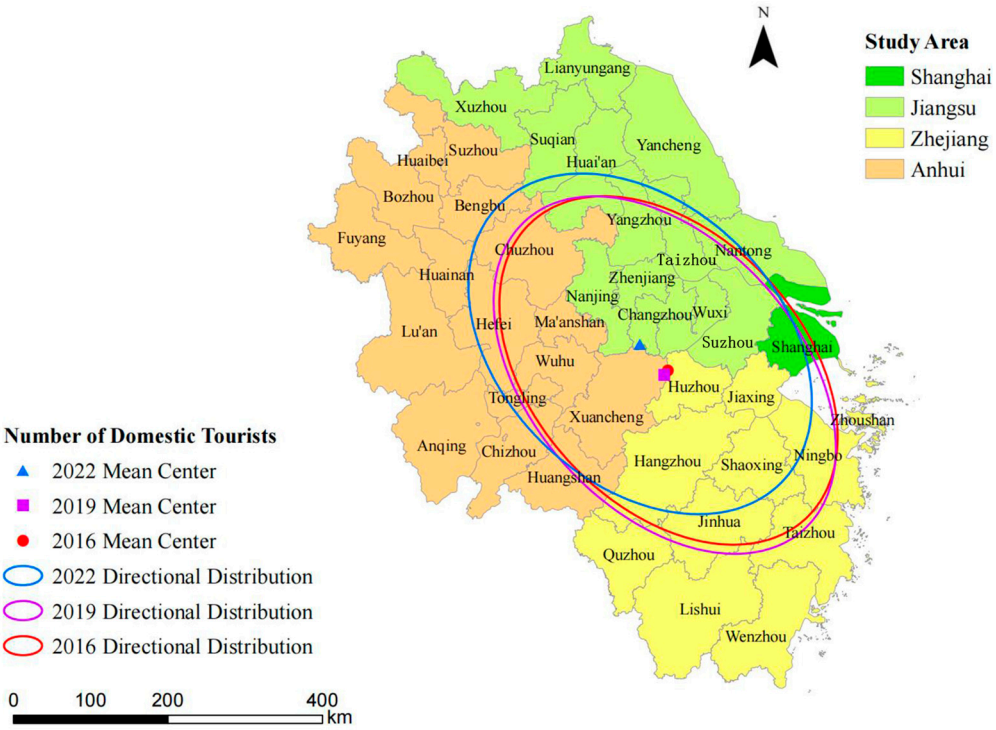


**Figure 4.** The SDE of the Domestic Tourist Flows in the YRD.

In 2016, the mean center was located northwest Huzhou, highlighting the dominance of southeastern coastal cities like Shanghai, Hangzhou, Suzhou, and Nanjing in attracting domestic tourists. The narrow oval indicates that tourists were primarily concentrated in these core cities, while also including inland hubs such as Nanjing and Hefei.

In 2019, the mean center shifted slightly southwestward, reflecting the growing share of tourists from inland areas such as Huangshan and Chizhou, driven by ecotourism and convenient transportation. The oval widened and shifted southwest, highlighting the wider range of tourist destinations in inland Zhejiang cities and surrounding Anhui Province, consistent with growing demand for nature-based and rural tourism.

In 2022, the mean center shifted further northwestward, primarily due to a sharp decline in tourist arrivals in most cities of Zhejiang Province (except Hangzhou) due to recurring COVID-19 outbreaks and strict control measures. This reduced the regional share of the southeastern region, causing the oval to shift northwestward. The results suggest that export- and service-oriented tourism economies are more vulnerable to shocks, while some inland regions experienced smaller declines.

SDE analysis shows that domestic tourist flows in the YRD region exhibits a persistent core–periphery pattern, with visitors concentrated primarily in the southeastern region (centered around Shanghai, Hangzhou, Suzhou, and Nanjing), while peripheral cities such as Anhui and northern Jiangsu have seen smaller numbers of visitors. Before the COVID-19 outbreak, growth in the region was balanced with gradual inland diffusion. However, the pandemic triggered a shift in tourism activity to the northwestern periphery, weakening the influence of core cities and exposing the vulnerability of the tourism industry, which relies on services and exports. Despite the impact of the pandemic, core cities have maintained their dominance, while peripheral cities have remained stable, albeit with a decline in visitor numbers.

### *4.4. Spatiotemporal Analysis of Tourism Industry Concentration*

#### 4.4.1. Temporal Characterization of Tourism Industry Concentration

The location entropy of the domestic tourism industry can effectively measure the relative concentration of the domestic tourism industry in a region (Ding et al., 2021; Goodbody et al., 2021). Figure 5 shows that the spatial concentration index of domestic tourism in all 41 YRD cities was greater than 1 (as shown in Figure 5), demonstrating that the domestic tourism industry in the YRD exhibited a concentration level surpassing the national average. Domestic tourism economic concentration in the majority of the YRD was increasing, especially after the outbreak of COVID-19, the increase in the concentration of the domestic tourism in most of the cities has increased, indicating the higher resilience of the YRD cities' the domestic tourism in China.

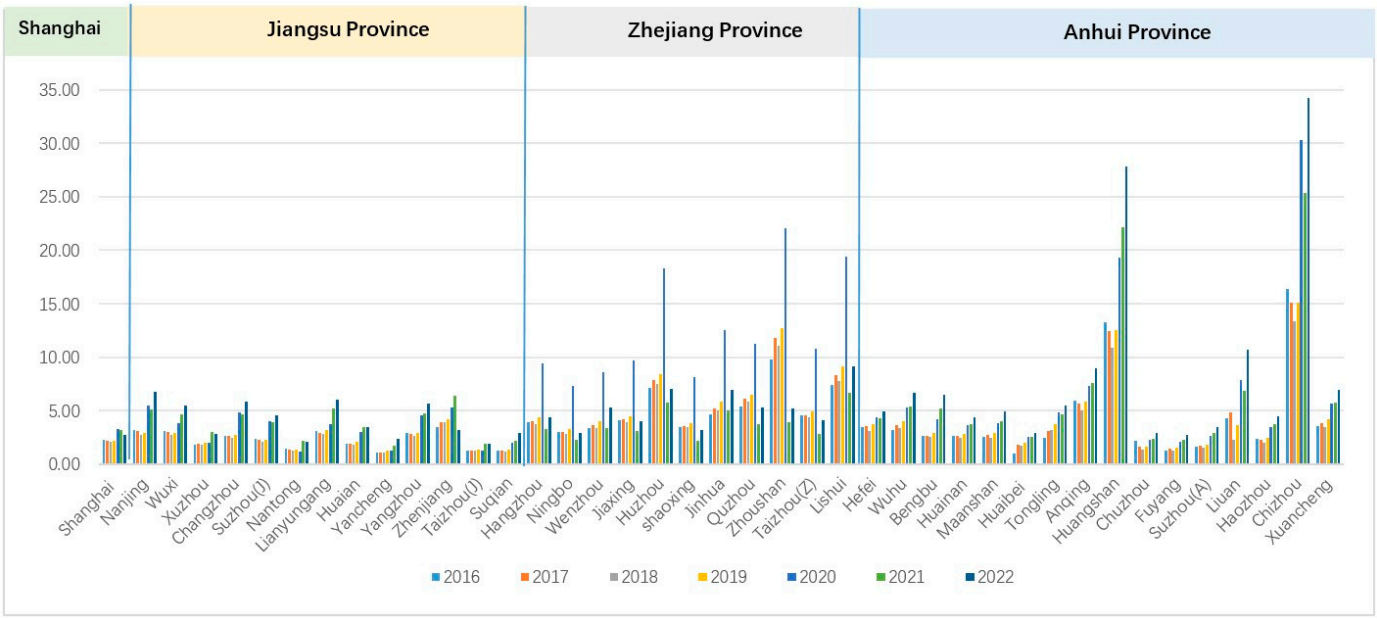


**Figure 5.** The LE of Municipal Domestic Tourism Revenue in the YRD.

- Pre-COVID Stability (2016–2019)

Between 2016 and 2019, LE values in major metropolitan areas fluctuated minimally, indicating relatively stable tourism concentration patterns within diversified urban

economies. Shanghai's LE declined slightly, from 2.31 in 2016 to 2.16 in 2019; Suzhou (Jiangsu Province)'s LE value fell from 2.36 to 2.29; while Hangzhou's LE value increased from 3.94 to 4.43; and Hefei's LE value rose from 3.48 to 3.73. These relatively low LE levels reflected the broader economic diversity of these cities, with tourism playing a supplementary rather than dominant role in GDP composition, thereby reducing the overall economy's vulnerability to sector-specific shocks.

In contrast, cities with developed tourism industries have significantly higher LE values, indicating greater industrial concentration and a larger contribution of tourism to local GDP. In Anhui Province, Huangshan City's LE value declined slightly from 13.27 to 12.54, and Chizhou City's LE value decreased from 16.37 to 15.13 over the same period, but both remained well above the regional average. Similarly, in Zhejiang Province, Zhoushan City's LE value rose from 9.82 to a peak of 12.71, and Huzhou City's LE value increased from 7.11 to 8.38. These persistently high LE values highlight the strong dependence of local economies on tourism, making fluctuations in the tourism industry potentially more impactful than in more diversified cities.

In Anhui Province, smaller cities such as Wuhu (LE: rising from 3.21 to 4.05) and Xuancheng (LE: rising from 3.59 to 4.19) maintained high LE values between 2016 and 2019, indicating a continued concentration of tourism activity and a significant contribution to local GDP. The LE values of the YRD's smaller cities experienced a gradual rise, indicating that the tourism industry's competitiveness was constantly improving and its position in the local economic structure was becoming increasingly important.

- Impact of COVID-19 (2020)

The COVID-19 pandemic triggered significant spatial shifts in the YRD's tourism concentration. In 2020, the LE values of most cities increased significantly, indicating that tourism revenue was increasingly concentrated in a few locations. This trend reflects both the severe contraction in tourist flows and the relative competitive advantages maintained by some destinations during the national economic downturn.

Tourism-dependent cities saw the most significant increases in LE values. Hangzhou's LE value soared to 9.43, Zhoushan's to 26.25, and Huzhou's to 18.29, driven by the continued strong appeal of renowned attractions despite a decline in overall tourism demand. Smaller cities primarily focused on tourism, such as Huangshan (LE: 19.30) and Chizhou (LE: 30.32), saw even more significant increases in LE values, highlighting their vulnerability to shocks due to their reliance on tourism.

In contrast, diversified urban economies mitigate the effects of overconcentration. Shanghai's LE value rose slightly from 2.16 in 2019 to 3.31 in 2020, while Nanjing's LE value rose from 2.96 to 5.53, suggesting that despite a slight increase in the tourism sector's share of GDP during the pandemic, the overall economic structure provided relative stability. However, these modest increases also indicate that even large cities are increasingly relying on regional tourism markets during a period of plummeting national demand.

- Post-Pandemic Recovery Dynamics (2021–2022)

During the recovery phase of from 2021 to 2022, 13 cities saw declining LE values, indicating a greater dispersion of tourism revenue across destinations and a corresponding decline in industry concentration. This trend suggested that reducing reliance on highly concentrated tourism markets may help local economic activity recover more quickly. Notably, Shanghai's LE value declined from 3.31 in 2020 to 2.76 in 2022, while Hangzhou experienced an even larger decline, from 9.43 to 4.38.

However, this pattern was not universal. Small cities heavily reliant on tourism, particularly in Anhui Province, continued to maintain elevated LE values in 2022. Chizhou City's LE value reached 34.25, and Huangshan City's LE value reached 27.79, indicating a

high concentration of revenue and continued reliance on a limited number of well-known attractions. Jinhua (LE: 6.96) and Lishui (LE: 9.14) in Zhejiang Province also exhibited similarly persistently high values, indicating that their tourism economies remain highly concentrated and more vulnerable to a slow recovery.

The evolution of LE values from 2020 to 2022 highlighted two distinct recovery dynamics. Cities with diversified economies showed a normalization trend in LE values, indicating a rebalancing of income sources and a stronger recovery trajectory. In contrast, tourism-dependent cities, despite their strong national brand recognition, maintained higher LE values, reflecting a slower recovery and continued income concentration. This divergence highlighted the resilience of diversified economies and the increased vulnerability of single-sector economies to systemic shocks.

#### 4.4.2. Spatial Distribution of Tourism Industry Concentration

Domestic tourism industry agglomeration in the YRD was not only different in spatial distribution but also characterized by a clear phased development over time. The agglomeration of the YRD's domestic tourism industry exhibits a spatial gradient, with higher levels in the southwest and lower levels in the northeast. (as shown in Figure 6). To further analyze the spatial disparities in domestic tourism industry agglomeration across YRD cities, the cross-section data of three nodal years, 2016, 2019, and 2022, were selected and grouped into five agglomeration levels (high, medium-high, medium, medium-low, and low) based on the Natural Breaks (Jenks) classification in ArcGIS 10.8 (Gui et al., 2025).

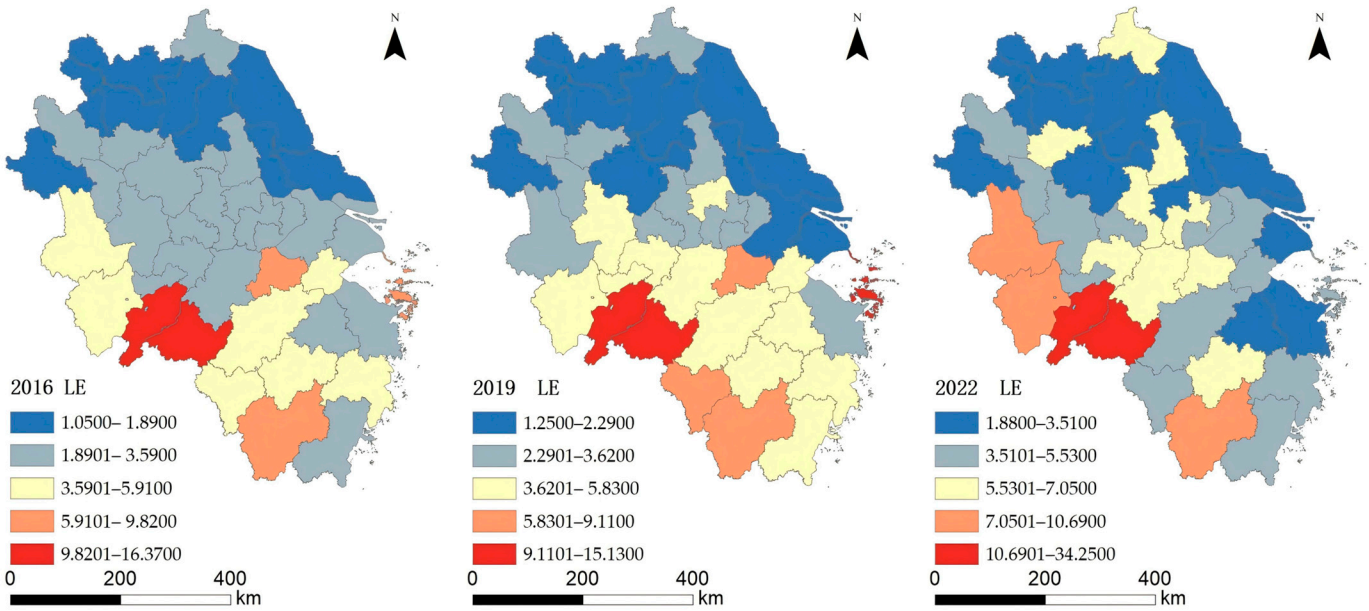


**Figure 6.** Comparison of Spatial Patterns of Location Entropy in the YRD in 2016, 2019, and 2022.

- YRD Establishment Period (2016)

In 2016, LE values in the YRD exhibited a clear spatial gradient, with high and medium-high agglomeration concentrated in the west and southwest, and low values prevailing in the north and northeast. Two cities were in the high agglomeration zone, three in the medium-high agglomeration zone, seven in the medium agglomeration zone, 20 in the medium-low agglomeration zone, and nine in the low agglomeration zone.

Notably, major cities with strong tourism revenues, such as Shanghai, Nanjing, and Hefei, had lower LE values, reflecting their diversified economic structures and the low contribution of tourism to GDP. For instance, Shanghai achieved the highest domestic tourism revenue in 2016, yet tourism accounted for only 12.22% of its GDP, placing it in the

low agglomeration category. In contrast, cities with marginal tourism characteristics, such as Huangshan, Chizhou (Anhui Province), and Zhoushan (Zhejiang Province), recorded the highest LE values, primarily due to their reliance on single, well-known attractions such as Huangshan and the Zhoushan Islands. A UNESCO World Cultural and Natural Heritage site, Huangshan derives 70.79% of its GDP from domestic tourism, making it a major growth driver of the local economy. Overall, the map reveals structural differences between core, multi-sector cities with decentralized tourism activity and smaller, niche destination cities with highly concentrated tourism.

- Peak Tourism Economy (2019)

In 2019, as the YRD's tourism economy reached its peak. Domestic tourism industry agglomeration showed a spatial pattern of high concentration in the west and southwest and low concentration in the north and northeast. In terms of agglomeration levels, there were three high, three medium-high, 12 medium, 11 medium-low, and 12 low cities. Compared with 2016, the overall agglomeration level increased, as the number of cities with medium-high concentration rose from 5 to 6, while those with medium-low concentration declined from 29 to 23. The concentration of the domestic tourism industry is generally on the rise.

Driven by the accelerated development of the tourism sector, the concentration levels of many cities in provinces such as Anhui and Zhejiang have increased significantly. Zhoushan showed the most significant change, jumping from medium-high concentration in 2016 to high concentration in 2019. This shift is primarily attributed to the significant increase in the contribution of tourism to local GDP, with domestic tourism revenue accounting for 73.8% of GDP in 2019, up from 52.0% in 2016.

In contrast, most developed coastal cities saw a decline in tourism's economic contribution due to the rapid growth of non-tourism sectors, resulting in relatively low agglomeration levels. For example, the agglomeration levels of Shanghai and Suzhou (Jiangsu Province) fell from medium-low to low, indicating that despite strong tourism markets in these two cities, the concentration of the tourism industry declined.

- Final Year of the Epidemic (2022)

The 2022 map indicates that the COVID-19 pandemic markedly altered tourism concentration patterns in the YRD, with elevated levels in the west and southwest and reduced levels in the north and east. Specifically, there were two high agglomeration cities, three medium-high agglomeration cities, nine medium agglomeration cities, 13 medium-low agglomeration cities, and 14 low agglomeration cities. Compared with 2019, the number of cities above the medium agglomeration level declined from six to five, accompanied by a rise in below-medium agglomeration cities, from 23 to 27, indicating an overall decline in tourism concentration across the region.

Notably, tourism-focused cities such as Chizhou and Huangshan maintain high concentration levels, reflecting their reliance on world-renowned attractions such as Jiuhua Mountain Scenic Area and Huangshan Mountain. In 2022, domestic tourism revenue in Chizhou and Huangshan accounted for 57.9% and 50.0% of GDP, respectively, underscoring the key contribution of tourism to the regional economies of these two areas.

In contrast, economically diversified coastal cities like Shanghai and Suzhou, due to their broader economic base, still have relatively low tourism agglomeration levels. Meanwhile, some smaller cities suffered severe declines; for example, the proportion of Zhoushan's domestic tourism revenue to GDP dropped sharply from 73.8% in 2019 to 8.8% in 2022, highlighting the devastating blow of the epidemic on Zhoushan's tourism industry.

In summary, the YRD's tourism agglomeration levels remained consistently above the national average, but with significant temporal and spatial variations. Prior to the

COVID-19 outbreak (2016–2019), domestic tourism agglomeration in the region remained relatively stable, with marked differences between economically diversified metropolitan areas and smaller cities with distinctive tourism characteristics. During this period, tourism experienced rapid growth, particularly driven by cities in the resource-rich southwest, boosting overall agglomeration and enhancing local competitiveness. In contrast, the eastern coastal core and other diversified cities exhibited lower locational entropy, while the economically weaker northwest region continued to exhibit lower agglomeration levels. The pandemic exacerbated these disparities from 2019 to 2022. Well-known tourist cities demonstrated greater resilience, while smaller, less diversified cities experienced significant disruptions. Overall agglomeration levels declined due to pandemic-related restrictions and reduced tourism demand. Western tourist cities such as Huangshan have maintained a high degree of tourism industry concentration, reflecting their dependence on the tourism industry and high resilience, but their growth is constrained by a single tourism economic structure and a weak economic foundation.

## 5. Discussion and Conclusions

### *5.1. Discussions*

#### 5.1.1. New Empirical Insights into Dynamics of Domestic Tourist Flows Under Crisis Conditions

Prior to the pandemic, domestic tourism in the YRD urban cluster was expanding rapidly. While absolute disparities in visitor numbers widened due to divergent growth rates across cities, relative disparities narrowed, indicating enhanced regional integration. This trend indicates that relatively underdeveloped cities are gradually converging with mature tourism hubs, consistent with the synergistic development effects observed in economically integrated regions of the European Union (Agiropoulos et al., 2024). These findings highlight the efficacy of integrated regional policies in fostering more balanced tourism development.

The outbreak of COVID-19, however, interrupted this convergence (Ahmed, 2025). Although the overall scale of tourism activities contracted—reducing absolute disparities in domestic tourist numbers—relative disparities fluctuated, initially widening before eventually narrowing. This pattern reflects varying capacities among cities to cope with external shocks.

Those highly reliant on tourism were disproportionately affected, underscoring the structural vulnerability associated with a mono-industrial economy. In contrast, economically diversified and more developed cities exhibited greater risk resistance and recovery resilience. This divergent recovery trajectory illustrates how economic foundations and industrial dependencies influence regional resilience during crises, revealing the asymmetric nature of systemic shocks.

When compared with other key tourism regions, such as Beijing–Tianjin–Hebei (BTH), it demonstrates stronger resilience in major crises. In the BTH region, however, Beijing's pronounced core effect initially intensified tourism leakage from peripheral areas, contrasting with the polycentric structure observed in the YRD (Ma et al., 2024). Such comparisons not only enrich the understanding of regional tourism resilience but also emphasize the distinctiveness and theoretical relevance of the YRD as an empirical case.

#### 5.1.2. Transformation of the Core–Periphery Structure and Tourism Recovery Mechanisms

The spatial gradient anticipated by Krugman's economic geography framework (P. R. Krugman, 1997) is empirically substantiated by the sustained predominance of core urban centers—namely Shanghai, Suzhou, Hangzhou, and Nanjing—which consistently register the largest tourist inflows and function as principal distribution nodes. Similar

"core–periphery" contradictions have also been observed in other regions dominated by leading cities, such as the development of core–periphery relationships in Mediterranean island tourism (Agius & Chaperon, 2023).

The pre-pandemic trend of tourist dispersion toward the northwestern peripheral regions corresponds with the theoretical prediction of progressive spatial diffusion emanating from central economic hubs. This pattern is further supported by the advancement of infrastructure integration and the implementation of market expansion strategies throughout the YRD region. However, this process remained uneven due to structural constraints—including a weaker economic base, insufficient tourism infrastructure, and limited resource endowments in northwestern areas—highlighting persistent challenges in achieving balanced tourism development.

Driven by municipal-level pandemic controls, COVID-19 precipitated a shift from concentrated urban tourism to more decentralized, localized, rural, and short-distance travel patterns. This transition revealed vulnerabilities in traditional tourism cores and emphasized the need for diversified and adaptive tourism strategies. By focusing on 2022—the year of most severe contraction—this study offers deeper insights into changes within the tourism system than previous studies that focused primarily on the recovery period.

At the theoretical level, these findings refine and extend the application of classical core–periphery theory in tourism geography. While Krugman's framework effectively explains the spatial concentration and gradual diffusion of tourism under normal conditions, this study reveals that major external shocks—such as a pandemic—can temporarily weaken the dominance of core areas. In contrast, peripheral regions (e.g., rural and small-scale destinations) gained prominence due to the rise in short-haul and localized travel. This indicates that tourism restructuring during crises is not solely shaped by traditional factors like economic scale and infrastructure, but is profoundly influenced by risk perception, policy intervention, and adaptive tourist behavior. By integrating perspectives of crisis and resilience, this study contributes to spatial economic theory, underscoring the need to incorporate behavioral adaptability and institutional responsiveness into core–periphery models to improve their explanatory relevance and practical utility.

#### 5.1.3. Insights from Changes in Domestic Tourism Agglomeration

Between 2016 and 2019, tourism agglomeration in the YRD region increased markedly, especially in its western and southern parts. This suggests that rising tourism-related economic activity significantly contributed to local and regional economic growth in these areas—a pattern consistent with Perroux (1970)'s "growth pole theory," wherein industrial clustering stimulates development in surrounding regions. By contrast, tourism agglomeration relatively decreased in eastern coastal and northern zones, reflecting both the economic diversification of the former and the constrained tourism competitiveness of the latter. Agiropoulos et al. (2024) emphasized the notable disparities in tourism performance across the Eurozone, underscoring the growing role of economic resilience as a critical determinant. Economic vitality significantly shapes a region's tourism attractiveness and operational capacity. This observation strongly supports the view that economic diversification is key to strengthening a city's resilience in the tourism sector.

Despite the disruptions caused by the COVID-19 pandemic, the tourism sector in the YRD demonstrated resilience above the national average, reinforcing its competitive standing in China's tourism landscape. Western YRD cities with internationally recognized attractions—such as Huangshan and Chizhou—continued to draw considerable tourist numbers. This underscores that developing high-quality, high-profile attractions is more conducive to tourism growth than simply expanding the quantity of tourism sites, corroborating M. Chen et al. (2024)'s emphasis on the pull of elite, Grade A scenic spots.

These outcomes offer actionable insights for local governments, especially in less-developed, resource-limited regions, to focus strategically on flagship attraction development. It is noteworthy, however, that during the pandemic, tourism-centric cities like Huangshan saw a sharp increase in tourism concentration. While this reaffirms the sector's critical role in local economies, it also reveals the structural vulnerability associated with mono-industrial dependence. Such reliance heightens exposure to external shocks—including public health crises, natural disasters, or volatility in tourism demand. These results extend growth pole theory by highlighting the risks of overdependence on a single industry and emphasizing the need for economic diversification. The economic impact of the pandemic has disproportionately affected cities that rely significantly on tourism, including Thailand's coastal districts. This emphasizes the structural weaknesses inherent in a single-industry tourism economy (Janjua et al., 2021).

The primary theoretical contribution of this study lies in its extension and contextual refinement of Perroux (1970)'s "growth pole theory." While the classical framework emphasizes how spatial agglomeration of key industries, such as tourism, drives regional development through polarization-diffusion effects, our findings both affirm and complicate this mechanism. On one hand, the study observed that tourism clustering in the western and southern YRD between 2016 and 2019 effectively stimulated local economic growth, consistent with the theory's central proposition. On the other hand, the study revealed that overreliance on a single tourism-led growth pole significantly amplifies regional vulnerability in the face of systemic external shocks, such as pandemics. These insights introduce "resilience" and "risk" as critical dimensions to the growth pole framework. A growth pole should be conceptualized not only as a spatial-economic organizing node but also as a system highly sensitive to external disruptions, the stability of which depends fundamentally on economic diversity and adaptive capacity. In contrast to the traditionally linear polarization-diffusion trajectory, this study shows that in the absence of industrial diversification or risk mitigation mechanisms, growth poles can themselves become sources of systemic fragility.

Consequently, explanations of spatial inequality must account not only for disparities in development levels but also for differences in resilience. That is, the capacity to withstand and recover from shocks. This redefined perspective offers a more nuanced theoretical lens for examining regional development under conditions of crisis and uncertainty.

From a policy standpoint, this expanded theoretical understanding argues for moving beyond the maximization of singular growth poles toward fostering multipolar, multilayered, and economically diversified regional structures. Such an approach can enhance systemic stability and long-term resilience in the face of evolving risks.

#### 5.1.4. Insights from the Application of an Integrated Analytical Framework

This study adopts a comprehensive methodological framework—integrating SD (Rakrak, 2025), CV (Boto-García & Pérez, 2023), natural breakpoint (Jenks) classification, SDE (Zeng et al., 2024), and location entropy (Gullu & Yilmaz, 2020)—to systematically examine the spatiotemporal evolution of tourism development in the YRD. These methods collectively capture multiple facets of tourism dynamics, including absolute and relative disparities, spatial clustering and directional trends, and sectoral specialization. The hybrid analytical strategy mitigates the constraints inherent in single-method studies and strengthens the robustness and dimensionality of the findings. The following discussion interprets key results within this integrated methodological context:

First, the selection of methods allowed for precise delineation of developmental disparities. The pre-pandemic divergence in absolute tourist volumes alongside convergent relative disparities was effectively identified through the complementary use

of SD and CV. The former reflects actual scale-based differences, while the latter controls for scale effects to reveal underlying coordination tendencies. This dual-metric approach offers a nuanced perspective: although absolute gaps in tourism activity widened, the region exhibited trends toward relative equilibrium, a conclusion reinforced through methodological triangulation.

Second, spatial analytics unveiled structural patterns and evolutionary trajectories. The natural breaks method (Jenks) provided an objective basis for classifying tourist distributions into five tiers by minimizing within-group variance, thereby avoiding arbitrary thresholding and capturing intrinsic clustering patterns. Concurrently, standard deviation ellipse analysis quantified directional bias and centroid movement, clearly illustrating a persistent southeast–northwest gradient consistent with core–periphery theory. The post-pandemic spatial reorganization—notably the dispersal of tourism activity from core to peripheral areas—contrasts with findings by X. Feng et al. (2024), who reported strengthened spillover effects in early recovery phases based on simplified modeling. This discrepancy underscores how methodological choices and temporal scope influence interpretations of tourism resilience and reconfiguration.

Lastly, LE analysis elucidated mechanisms of industrial resilience. The observed rise in tourism agglomeration during the pandemic in most cities was discerned by isolating tourism-specific specialization from general economic size. This indicates that cities endowed with high-quality resources or economic diversification were better able to sustain or enhance tourism competitiveness amid external shocks. The method thus highlights the distinct roles of resource endowment and structural diversity in fostering regional resilience.

In conclusion, the multi-method framework employed in this study does not facilitate cross-validated, multidimensional insight into tourism evolution but also provides a rigorous foundation for examining underlying mechanisms of spatial, temporal, and structural change in complex tourism systems.

### *5.2. Conclusions*

Based on a systematic analysis of the spatiotemporal evolution of tourist flows, tourism industry agglomeration, and differential urban resilience in the YRD before and after the pandemic, this study arrives at the following key conclusions:

First, in the pre-pandemic period, the YRD exhibited widening absolute disparities but narrowing relative disparities in tourist volumes, signaling a trend toward coordinated and convergent regional tourism development. The pandemic disrupted this trajectory, exposing the heightened vulnerability of tourism-dependent cities and highlighting divergent regional recovery pathways in response to external shocks.

Second, tourism spatial patterns in the YRD have consistently followed a southeast–northwest gradient, aligning with core–periphery theory. The pandemic, however, precipitated a dispersal of tourism activities from traditional core areas to peripheral destinations, illustrating the capacity of tourism networks to undergo temporary restructuring and adaptive reorganization under extreme conditions.

Third, contrary to expectations, most cities in the YRD experienced an increase in tourism industry agglomeration during the pandemic. Those endowed with high-quality attractions or economically diversified structures demonstrated stronger resilience, underscoring the role of resource caliber and industrial diversity in enhancing regional capacity to withstand risks.

These conclusions deepen the understanding of how regional tourism systems respond to major crises and extend the applicative scope of tourism network structure, growth pole, and core–periphery theories in crisis contexts. They also provide an empirical founda-

tion and strategic insights for fostering high-quality, balanced, and sustainable tourism development in the YRD and other comparable regions.

### *5.3. Recommendations and Theoretical Contributions*

Based on the findings of this study, the following recommendations are proposed to mitigate regional development disparities and foster sustainable growth of domestic tourism in the YRD region:

#### 5.3.1. Develop High-Quality Distinctive Tourist Attractions

Local governments should prioritize the formulation of policies that foster differentiated tourism products and enhance destination branding. In accordance with the Tourism Law of the People's Republic of China and relevant local tourism regulations, investment should target culturally distinctive scenic areas—such as those exemplifying Wu-Yue culture, Huizhou culture, and Jiangnan water towns—with strong potential for international recognition. Such focused development will strengthen their attractiveness in both domestic and overseas markets. Furthermore, scenic areas should be encouraged to pursue international designations, including UNESCO World Heritage status or Global Geoparks, guided by China's "Regulations on the Protection of World Cultural Heritage" and aligned with pertinent international standards, so as to elevate their global profile. Tourism development must emphasize quality over quantity, eschew redundant construction and inefficient investment, and actively implement clauses within regional tourism development plans that mandate resource conservation and sustainable utilization.

Theoretical Contribution: This recommendation aligns with and extends resource-based theory and differentiation strategy, highlighting how cultural resources underpin sustainable tourism competitiveness. The study provides empirical evidence on how high-quality, iconic attractions contribute to regional resilience and reduce homogeneous competition, thereby enriching the discourse on place-making in tourism geography under crisis conditions.

#### 5.3.2. Promote Economic Diversification in Tourism-Reliant Cities

To increase resilience and achieve sustainable development, cities with high tourism dependence should actively pursue integration between tourism and other sectors—such as agriculture, cultural heritage, sports, and industry—to develop composite tourism products. A cross-departmental collaboration mechanism may be designed in accordance with regional industrial policies and the specific requirements outlined in the "14th Five-Year Plan for Tourism Development" regarding the promotion of integrated "tourism plus" development. Cross-sector synergy will diversify economic structures, buffer systemic risks from external shocks, and contribute to a more robust and sustainable local economy.

Theoretical Contribution: This approach advances the application of economic resilience theory and industrial diversification within tourism studies. By demonstrating how industrial hybridization and functional complementarity can alleviate structural vulnerabilities, the study offers new insights into institutional and organizational dimensions of regional resilience.

#### 5.3.3. Enhance Infrastructure and Support in Less-Developed Areas

Policy and financial support for peripheral regions should be strengthened. Key measures include improving transportation connectivity in remote inland areas in accordance with the National Plan for Higher-Quality Integrated Development of Transportation in the YRD Region—such as launching tourist trains and optimizing visitor shuttle systems. Additionally, accommodation and service facilities should be upgraded as required by the Domestic Tourism Enhancement Plan (2023–2025), while enhancing the efficiency of

public services. These efforts will strengthen the market's systemic competitiveness in the tourism sector.

Theoretical Contribution: Reflecting the policy-oriented logic of core–periphery theory, this recommendation underscores how infrastructure investment can rebalance regional development. The study argues that targeted investment in peripheral areas is not only vital for short-term recovery but also foundational to long-term spatial equity and regional cohesion.

#### 5.3.4. Strengthen Regional Coordination Mechanisms

Cities across the YRD should deepen policy coordination and resource sharing. Initiatives may include establishing a regional tourism big data platform, co-developing intercity tourism circuits, and implementing joint branding and marketing campaigns. Such coordination will amplify positive spillovers from core regions and help narrow interregional economic disparities.

Theoretical Contribution: Integrating tourism network theory with multi-level governance, this study shows that institutional collaboration and information interoperability are crucial for post-crisis recovery. It further posits that regional coordination evolves from incremental cooperation into a necessary strategy for systemic resilience, expanding the theoretical implications of regional integration under crises.

## 6. Limitation and Further Research

This study primarily utilizes secondary statistical data from official sources, which may provide only a partial representation of the complex and multidimensional nature of tourism dynamics., including visitor satisfaction, informal economic activities, and emerging digital trends. While it analyzes the spatiotemporal evolution of domestic visitor numbers and tourism concentration across YRD cities, it does not address the underlying drivers of these disparities. Moreover, the data are limited to 2022 and earlier, constraining assessment of post-COVID-19 recovery.

Future research will incorporate primary data, such as surveys and interviews with tourists and tourism professionals, to more comprehensive insights into stakeholder views. A more comprehensive and in-depth exploration of the factors influencing tourism disparities across the region is necessary. Furthermore, extending the research period to three years after the pandemic would facilitate a more accurate assessment of tourism recovery trends.

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