Postprint: A Study on the Spatiotemporal Differentiation of Public Cultural Service Resource Allocation in China

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Abstract

[Purpose/Significance] Clarifying the current status and characteristics of spatiotemporal differentiation in public cultural service resource allocation aims to guide allocation efforts and promote the equalization of public cultural services in China. [Method/Process] The global entropy method is employed to measure the allocation level of public cultural service resources across 31 provincial-level administrative regions in China, while the Dagum Gini coefficient and Kernel density estimation are adopted to investigate regional disparities and their dynamic evolution. [Results/Conclusions] Gini coefficient decomposition reveals that the overall disparity in public cultural service resource allocation levels in China is narrowing, with hypervariable density constituting the primary source of regional gaps. Kernel density estimation indicates a slight increase in allocation levels during the observation period, a widening gap between high-level and low-level provincial regions, and notably prominent polarization trends at the national level and in western China.

Full Text

Preamble

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Research on the Spatiotemporal Differentiation of Public Cultural Service Resource Allocation in China

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Abstract:
[Purpose/Significance] Clarifying the spatiotemporal differentiation status and characteristics of public cultural service resource allocation aims to guide resource allocation efforts and promote the equalization of public cultural services in China. [Method/Process] This study employs the global entropy method to measure the resource allocation levels of public cultural services across 31 provincial-level administrative regions in China, and utilizes the Dagum Gini coefficient and Kernel density estimation methods to examine regional disparities and their dynamic evolutionary processes. [Result/Conclusion] The Gini coefficient decomposition results indicate that the overall regional gap in China's public cultural service resource allocation levels is generally narrowing, with transvariation density constituting the primary source of regional disparity. Kernel density estimation reveals that the allocation level has slightly increased during the observation period, yet the gap between provinces with higher and lower allocation levels is gradually widening, with polarization trends being particularly prominent at both the national and western regional levels.

Keywords: public culture; public cultural resources; resource allocation level; spatial inequality; regional disparity
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The 2015 release of the "Opinions on Accelerating the Construction of a Modern Public Cultural Service System" [1] created new opportunities for China's public cultural development, elevating the balanced development of public cultural services and the exploration of effective supply methods to a national strategic priority. As the foundation for basic public cultural services, the balanced allocation of public cultural service resources represents a critical component in achieving equalization. Therefore, scientifically measuring allocation levels and clarifying the characteristics of allocation imbalance are essential for guiding resource allocation and advancing public cultural development. Where do regional gaps in public cultural service resource allocation originate? What are the internal distribution dynamics? Only by answering these questions can we accurately grasp the magnitude and evolution of regional disparities, providing empirical evidence to guide resource allocation and promote balanced development.

2 Literature Review

Understanding the characteristics of unbalanced public cultural resource allocation forms the basis for developing equalization strategies. Existing literature primarily examines regional disparities in public cultural service resource allocation from three perspectives:

First, using single indicators to measure regional differences. This approach has generated substantial research on public library resources [4-5], public cultural fiscal investment [2], and public cultural expenditure [6-7]. Despite varying

research perspectives and indicators, most studies confirm significant regional gaps in China's public cultural service resource allocation.

Second, employing multi-indicator comprehensive measurement. Scholars have used indicators such as public cultural facility quantity, quality, spatial distribution, and satisfaction [8], or per capita cultural expenditure and book holdings [9]. Yang Lin et al. utilized indicators including cultural expenditure, financial subsidies, human resources, and hardware/software facilities, applying the Theil index to measure urban-rural imbalance from 2005-2015, finding decreasing disparity but identifying economic development, fiscal investment, and urbanization as key influencing factors [3]. Others have constructed "input-output-effect" evaluation systems to examine integration performance [10].

Third, examining equalization from a holistic perspective. Since public cultural resources are integral to public cultural services, their balance can be reflected through overall service equalization. Studies have revealed low and imbalanced equalization levels [11], significant inter-city disparities particularly in resource input and service output [12], and notable inter-regional and urban-rural gaps [13]. Inclusive development has been proposed as an effective strategy to address urban-rural inequality [14].

However, existing research exhibits three limitations: (1) Most rely on single indicators that cannot comprehensively describe regional gaps and dynamic patterns. (2) Weight determination methods like Delphi and expert scoring lack consistency and objectivity. (3) Methodological approaches are limited, with most using coefficient of variation, Theil index, or traditional Gini coefficient, which cannot effectively decompose regional gaps to identify sources.

This study addresses these gaps by: (1) Constructing an integrated evaluation index system from three dimensions—human resources, fiscal resources, and material resources—using the global entropy method for objective weighting; (2) Applying Dagum Gini coefficient decomposition to analyze gap composition and sources; and (3) Utilizing Kernel density estimation to reveal internal dynamic evolution patterns.

3 Public Cultural Service Resource Allocation Level Indicator System

Multi-dimensional comprehensive measurement has become consensus in public management and library/information science. However, no unified evaluation system exists. While single-indicator studies are abundant, they cannot reflect overall development levels.

This study defines public cultural resources as factors influencing public cultural activities, categorized by form into hidden/explicit factors and by nature into natural and social resources (e.g., altitude, temperature, human, financial, and material resources) [15]. Due to data limitations, we focus on social resources

from a government supply perspective, including fiscal, human, and material resources [16].

Following scientific, comparable, and operable principles, and considering individual citizens as the service target, we selected per capita rather than aggregate indicators. Drawing on previous research [3, 11, 13], we developed a six-indicator system across three dimensions to reflect resource allocation levels in 31 provincial regions (Table 1):

Table 1. Evaluation Index System for Public Cultural Service Resource Allocation Level

Dimension	Indicator
Public Cultural Human Resources	- Professional technical personnel ratio in major cultural institutions- Employees in major cultural institutions per 10,000 persons
Public Cultural Fiscal Resources	- Per capita cultural expenditure (yuan/person)- Cultural expenditure as percentage of government fiscal expenditure (%)
Public Cultural Material Resources	- Major cultural institutions per 10,000 persons- Per capita area of major cultural institutions (m^2/person)

Note: Major cultural institutions include public libraries, museums, mass art centers (cultural centers, stations, and people's art galleries), art performance troupes, and art performance venues.

4 Research Methods and Data

4.1 Research Methods

4.1.1 Global Entropy Method The global entropy method extends traditional entropy methods, preserving objectivity while enabling longitudinal and 横向 analysis to reflect dynamic trends. It has been widely applied in regional innovation capacity [17], logistics development [18], and public cultural service measurement [13].

The calculation steps are:

Step 1: Establish the global evaluation matrix and standardize it. For s years, k provinces, and m indicators, create matrix $A = \{a\_\{ij\}^{t\}\{ks\times m\}, \textit{where } a\{ij\}t$ represents the value of indicator j for province i in year t. Standardize matrix A using:

$$b_{ij}^t = \frac{a_{ij}^t - a_j^{\min}}{a_j^{\max} - a_j^{\min}} \times 99 + 1 \quad (i = 1, 2, \ldots, k; j = 1, 2, \ldots, m; t = 1, 2, \ldots, s)$$

Step 2: Calculate information entropy for each indicator. The entropy e_j for indicator j is:

$$e_j = -k \sum_{t=1}^{s} \sum_{i=1}^{k} \frac{b_{ij}^t}{\sum_{t=1}^{s} \sum_{i=1}^{k} b_{ij}^t} \ln \frac{b_{ij}^t}{\sum_{t=1}^{s} \sum_{i=1}^{k} b_{ij}^t}$$

where constant $k = 1/\ln(ks)$.

Step 3: Calculate indicator weights:

$$w_j = \frac{1 - e_j}{\sum_{j=1}^{m} (1 - e_j)}$$

where $0 \leq w\_j \leq 1$ and $w\_j = 1$.

Step 4: Compute comprehensive scores:

$$S_i^t = \sum_{j=1}^{m} w_j a_{ij}^{t'}$$

4.1.2 Dagum Gini Coefficient and Subgroup Decomposition The Dagum Gini coefficient effectively addresses gap composition and sources while considering sub-sample distributions and overlap issues, offering more precise results than traditional methods [19-21].

Based on Dagum's method [22], the Gini coefficient is defined as:

$$G = \frac{\sum_{j=1}^{k} \sum_{h=1}^{k} \sum_{i=1}^{n_j} \sum_{r=1}^{n_h} |y_{ji} - y_{hr}|}{2n^2 \bar{y}}$$

where G represents overall inequality, k is the number of regions, $n\_j(n\_h)$ is the number of provinces in region $j(h)$, $y\_\{ji\}(y\_\{hr\})$ is the allocation level, n is total provinces, and $\bar{y}$ is the average level.

Before decomposition, sort regions by average allocation level: $\bar{Y_1} \leq \ldots \leq \bar{Y_h} \leq \ldots \leq \bar{Y_k}$.

The Gini coefficient decomposes into three components: (1) intra-regional gap contribution (G_w), (2) inter-regional gap contribution ($G\_\{nb\}$), and (3)

transvariation density contribution (G_t), satisfying $G = G\_w + G\_\{nb\} + G\_t$.

The intra-regional Gini coefficient for region j and intra-regional contribution are:

$$G_{jj} = \frac{1}{2n_j^2 \bar{Y}_j} \sum_{i=1}^{n_j} \sum_{r=1}^{n_j} |y_{ji} - y_{jr}|$$

$$G_w = \sum_{j=1}^{k} G_{jj} p_j s_j$$

where $p_j = n_j/n$ and $s_j = n_j \bar{Y}_j/(n\bar{Y})$.

The inter-regional Gini coefficient between regions j and h and inter-regional contribution are:

$$G_{jh} = \frac{1}{n_j n_h (\bar{Y}_j + \bar{Y}_h)} \sum_{i=1}^{n_j} \sum_{r=1}^{n_h} |y_{ji} - y_{hr}|$$

$$G_{nb} = \sum_{j=2}^{k} \sum_{h=1}^{j-1} G_{jh}(p_j s_h + p_h s_j) D_{jh}$$

where D_{jh} represents relative influence:

$$D_{jh} = \frac{d_{jh} - p_{jh}}{d_{jh} + p_{jh}}$$

with d_{jh} and p_{jh} defined as:

$$d_{jh} = \int_0^{\infty} dF_j(y) \int_0^{y} (y - x) dF_h(x)$$

$$p_{jh} = \int_0^{\infty} dF_h(y) \int_0^{y} (y - x) dF_j(x)$$

The transvariation density contribution is:

$$G_t = \sum_{j=2}^{k} \sum_{h=1}^{j-1} G_{jh}(p_j s_h + p_h s_j)(1 - D_{jh})$$

4.1.3 Kernel Density Estimation Kernel density estimation is a non-parametric method for examining distribution dynamics by comparing sample distributions across time periods [23-25]. It estimates probability density without requiring a specific model, effectively revealing evolutionary trends.

For random variable x with density function *f(x)*, the density at point x is estimated by:

$$f(x) = \frac{1}{Nh} \sum_{i=1}^{N} k\left(\frac{X_i - x}{h}\right)$$

where N is observations, h is bandwidth, $k(\cdot)$ is the kernel function, and X_i are i.i.d. observations.

We use the common Gaussian kernel:

$$f(x) = \frac{1}{\sqrt{2\pi}h} \exp\left(-\frac{(X_i - x)^2}{2h^2}\right)$$

4.2 Data Sources and Regional Division

Data were obtained from the *China Statistical Yearbook* and *China Cultural and Cultural Relics Statistical Yearbook*. Considering data availability and completeness, the observation period spans 2005-2017 across 31 provincial regions. Following National Bureau of Statistics standards, China is divided into eastern, central, and western regions for comparative analysis.

5 Regional Gap Characteristics of Public Cultural Service Resource Allocation

5.1 Regional Distribution of Allocation Levels

Figure 1 [Figure 1: see original paper] shows the evolution of average allocation levels nationally and by region. Except for 2010, all regions exhibited upward trends. From a recent annual average perspective, the western region developed rapidly with late-mover advantages, gradually surpassing the eastern region, while the eastern region consistently outperformed the central region.

This pattern may be attributed to: (1) government emphasis on public cultural services, evidenced by policies like the "12th Five-Year Plan for National Basic Public Service System" and "Public Cultural Service Guarantee Law," which provided support for equalization strategies; and (2) the Western Development Strategy, which released sustained economic dividends and provided adequate funding for public cultural construction. In 2005, Ningxia had the highest allocation level (26.27), followed by Tibet (22.69), while Henan had the lowest (5.23). By 2017, Tibet ranked highest (80.52), followed by Shanghai (47.57),

with Hebei lowest (16.15). Chongqing experienced the fastest annual growth (12.73%), while Ningxia grew slowest (2.71%).

5.2 Regional Gaps and Evolutionary Trends

Following Dagum Gini coefficient decomposition principles, we calculated overall and regional Gini coefficients for 2005-2017 (Table 2).

Table 2. Regional Gini Coefficients and Decomposition Results for Public Cultural Service Resource Allocation Levels

Year	Overall Gini	Intra-regional Gini	Inter-regional Gini	Contribution Rate (%)
		East	Central	West
2005	0.2273	0.2082	0.1416	0.2294
...	...	...	...	...
2017	0.2046	0.1849	0.1153	0.2190

5.2.1 Overall Regional Gap and Evolution Figure 2 [Figure 2: see original paper] shows a "V-shaped" cyclical pattern in overall regional gaps from 2005-2017, but with a net decline compared to 2005. Specific declining periods were 2005-2006, 2007-2011, 2012-2013, and post-2016, while increasing periods were 2006-2007, 2011-2012, and 2013-2016. Using 2005, 2010, and 2015 as base years, the average annual change by 2017 was -0.87%, +0.22%, and +0.79% respectively.

5.2.2 Intra-regional Gap and Evolution Intra-regional gaps generally declined, with the western region showing the largest gaps, followed by central and eastern regions (Figure 3 [Figure 3: see original paper]). The western region exhibited the greatest fluctuation: rising from 0.2294 in 2005 to 0.1828 in 2006, then continuous increase through 2008, followed by two phases from 2009-2017. Central region gaps remained stable around 0.14 with a narrowing trend. Eastern region gaps showed an inverted "N" pattern, declining from 0.2082 in 2005 to 0.1536 in 2006, rising to 0.2366 in 2007, then generally declining through 2017.

5.2.3 Inter-regional Gap and Evolution Figure 4 [Figure 4: see original paper] shows that east-central gaps were largest in most years, while east-west gaps were smallest. East-central gaps experienced "three rises and three falls," peaking at 0.26 in 2007 but recently narrowing. Central-west gaps showed "V-shaped" cycles with an overall expansion trend, reaching 0.2390 in 2016. East-west gaps declined from 0.2325 in 2005 to 0.1662 in 2006, then experienced two phases: continuous decline through 2011 (reaching 0.1654), followed by sustained increase through 2016 (peaking at 0.2235).

5.2.4 Gap Sources and Contribution Rates Figure 5 [Figure 5: see original paper] reveals that transvariation density is the primary source of regional gaps, exhibiting an "M-shaped" pattern: rising from 47.48% in 2005 to 54.81% in 2006, fluctuating, and reaching 54.08% in 2017. Inter-regional contribution showed opposite trends, declining from 21.28% in 2005 after "W-shaped" fluctuations. Intra-regional contribution remained stable around 31.91% with slight increases.

6 Kernel Density Estimation Analysis of Evolution

6.1 National Level

Figure 6 [Figure 6: see original paper] shows four characteristics: (1) The distribution center shifted rightward, indicating improving allocation levels; (2) Peak height decreased while width increased, suggesting dispersion and divergence from a stable point; (3) The right tail lengthened, showing widening gaps between high-level provinces (e.g., Tibet, Zhejiang) and low-level provinces (e.g., Guangxi, Jiangxi, Henan); (4) Peak numbers increased from one main peak with one side peak in 2005 and 2008 to one main peak with two stable side peaks in 2017, indicating intensifying polarization shifting from bipolar to multipolar.

6.2 Eastern Region

Figure 7 [Figure 7: see original paper] reveals: (1) Rightward shift in distribution center; (2) Consistently decreasing peak height, indicating dispersion; (3) Shortening tail, suggesting narrowing intra-regional gaps; (4) Persistent bimodal patterns indicating polarization, though the 2017 side peak flattened, showing weakening polarization.

6.3 Central Region

Figure 8 [Figure 8: see original paper] shows: (1) Rightward shift in center; (2) Decreasing peak height and increasing width, especially pronounced in 2017, indicating dispersion; (3) Shortening right tail, suggesting narrowing gaps; (4) Transition from bimodal to single peak, indicating effective control of polarization.

6.4 Western Region

Figure 9 [Figure 9: see original paper] demonstrates: (1) Rightward shift in center; (2) Decreasing peak height and increasing width, indicating expanding regional gaps; (3) Lengthening tail, showing widening gaps between high-level provinces (e.g., Tibet, Inner Mongolia) and low-level provinces (e.g., Guizhou, Guangxi); (4) Persistent bimodal patterns with intensifying polarization, particularly evident in 2014 and 2017.

7 Conclusions and Policy Recommendations

Two significant findings emerge:

First, contrary to common perception, eastern regions do not always outperform central and western regions. Recent annual averages show western regions developing rapidly with late-mover advantages, gradually surpassing eastern regions.

Second, intra-regional gaps in western regions rival those between east and central regions, contrasting with previous findings that eastern inequality was most pronounced [26]. This may be attributed to Western Development policies creating favorable conditions while long-standing economic and social differences within the region intensified polarization.

Key findings:
(1) Significant imbalance exists, with western regions recently exceeding eastern levels and eastern regions surpassing central regions, creating a "central depression" pattern.
(2) Gini decomposition shows transvariation density as the primary gap source. Intra-regional gaps are declining overall (west > central > east). Inter-regional gaps between east-west and central-west are expanding, while east-west gaps decline, with east-central gaps being largest in most years.
(3) Kernel density estimation shows improving allocation levels nationally and regionally, but with widening gaps between high and low provinces, and intensifying polarization nationally and in western regions.

Policy recommendations:

First, address overall regional gaps by enhancing government leadership and allocation efficiency: (1) Strengthen government responsibility with regionally differentiated macro-control policies, leveraging high-level regions' radiating effects while providing targeted support to low-level regions; (2) Adjust allocation strategies to balance efficiency and equity; (3) Accelerate digitalization using modern information technology to promote resource sharing and new allocation models.

Second, address inter-regional gaps by facilitating factor mobility: (1) Enhance inter-departmental learning to replicate successful management experiences; (2) Provide preferential fiscal, talent, and technical support to central regions to narrow gaps and overcome "central depression"; (3) Strengthen cross-regional integration and establish balanced allocation systems, particularly between high-level provinces (e.g., Shanghai, Zhejiang) and low-level provinces (e.g., Guangxi, Guizhou).

Third, address intra-regional gaps by establishing coordinated allocation strategies to avoid "Matthew effects": (1) Clarify government responsibilities and allocation standards at all levels; (2) Develop intra-regional coordination strategies for resource sharing and complementary advantages; (3) Encourage social

participation to diversify supply channels and improve allocation levels.

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The Study on the Space-time Differentiation of Resources Allocation of Public Cultural Services in China

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Abstract: [Purpose/significance] To guide the allocation of public cultural services resources and help promote the equalization of public cultural services in China, this paper reveals the spatial and temporal characteristics of the allocation of public cultural services resources. [Method/process] It measured the level of public cultural resources allocation in 31 provinces according to the total entropy method. The Dagum Gini coefficient and Kernel density estimation method were used to examine the regional differences and dynamic evolution. [Result/conclusion] The Dagum Gini coefficient and its subgroups show that the overall inequality level of public cultural resources allocation tends to fall evolution, and the trans-variation is the major source of overall inequality. The estimation of Kernel density shows that the level of public cultural resources is slightly increased. The gap between provinces with higher level of public cultural resources and provinces with lower level of public cultural resources is gradually widening, and the trend of polarization between the whole country and the western region is more prominent.

Keywords: public culture; public cultural resources; resource allocation level; spatial inequality; regional difference

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Editor's Note: This guide outlines key areas of focus for 2020 based on the journal's positioning and disciplinary frontiers, including but not limited to: (1) Construction of disciplinary systems with Chinese characteristics; (2) Integration strategies for library/information/archival science; (3) "14th Five-Year Plan" for libraries; (4) National literature resource security; (5) Open science and information resources; (6) National reading initiatives; (7) Library space services; (8) Embedded subject services; (9) Citizen science and information literacy; (10) Undergraduate education services; (11) Cultural inheritance; (12) Library publishing; (13) Science communication; (14) Marketing strategies;

(15) Pan-cooperation; (16) Regional alliance innovation; (17) Cyberspace governance; (18) Intellectual property services; (19) New technologies in information analysis; (20) Intelligence service standardization; (21) Digital humanities; (22) AI applications; (23) Smart services; (24) Open data metadata; (25) Open science data behavior; (26) Data resources and librarian capacity; (27) Big data organization; (28) Scientific data management; (29) Academic monitoring; (30) Computational intelligence; (31) Service quality evaluation; (32) Intelligence vs. think tank research; (33) Frontier analysis methods; (34) Health informatics; (35) Human-computer interaction; (36) Think tank roles; (37) Intelligent information services; (38) Digital public culture; (39) Government data management; (40) Digital archives governance; (41) Archives data governance; (42) Open government platforms; (43) Social memory preservation; (44) Ethnic literature development; (45) Education and talent cultivation.

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