

Material Capital, Cultural Capital and Inclusive Development: Evidence from Multi-Ethnic Mountainous Regions in China

Wei Wang

wangwei@guet.edu.cn

Guilin University of Electronic Technology

Yanxi Kuang

Guilin University of Electronic Technology

Yonglin Lu

Guilin University of Electronic Technology

Haiyang Wang

Guilin University of Electronic Technology

Research Article

Keywords: inclusive development, common prosperity, SDG 10, regional inequality, multiethnic border region, ecological affluence

Posted Date: October 7th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-11121428/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: No competing interests reported.

Material Capital, Cultural Capital and Inclusive Development: Evidence from Multi-Ethnic Mountainous Regions in China

Author: Wei Wang; Yanxi Kuang; Yonglin Lu; Haiyang Wang

The author's affiliation: Guilin University of Electronic Technology Business School; Guilin, Guangxi, China, 541004

Email: wangwei@guet.edu.cn (W.W.); 1747844008@qq.com (Y.K.); a13380966532@outlook.com (Y.L.); 2125814071@qq.com (H.W.)

ORCID: 0009-0001-3044-8741 (W.W.); 0009-0009-7621-7242 (Y.K.)

Abstract

Current studies mainly focus on material capital, economic resource and sustainable development, while overlooking ethnic, cultural and regional influences. Taking multi-ethnic mountainous regions in China as example, this study extends the existing research and offers references for other countries. This study identifies three core findings that challenge conventional understandings of inclusive development in multi-ethnic mountain regions. First, treating ecological and spiritual affluence as co-equal pillars alongside material wealth reveals that non-material assets—particularly cultural capital—function as critical, non-substitutable resources that mediate well-being in ways income-based metrics cannot capture. Second, intra-provincial inequality, rather than inter-provincial gaps, constitutes the overwhelming source of overall disparity, contributing 92.21% of total inequality—a finding that redirects policy attention from cross-province coordination to within-province spatial justice. Third, provincial heterogeneity is pronounced and structurally distinct: Guangxi's disparities are driven primarily by spiritual-wealth gaps, Yunnan's by material-wealth differentials, and Guizhou's by regional structural gaps, demonstrating that uniform policy packages are inherently ineffective. Using panel data from 39 prefecture-level cities in the Guangxi-Yunnan-Guizhou (GYG) region (2013–2024), we construct a multidimensional inclusive development index and employ dynamic panel evaluation, Dagum Gini decomposition, and Quadratic Assignment Procedure (QAP) regression. Results show overall well-being improved steadily, with Guizhou exhibiting the strongest catch-up effect (cumulative growth: 100.35%), while the regional Gini coefficient narrowed by 42% (0.0924→0.0534). These findings challenge the assumption that aggregate growth automatically reduces spatial inequality, highlighting the need for province-tailored policies balancing material wealth accumulation with cultural resource redistribution and targeted dividend allocation. This framework offers actionable metrics for monitoring SDG 10/11 progress in analogous Global South regions.

Keywords

inclusive development; common prosperity; SDG 10; regional inequality; multiethnic border region; ecological affluence

1. Introduction

Regional inequality remains a core obstacle to achieving Sustainable Development Goal 10 (reduced inequalities) and SDG 11 (sustainable communities) across the Global South [1] (Alkire et al., 2023). In the Guangxi–Yunnan–Guizhou (GYG) multi-ethnic mountainous region of Southwest China, this issue is particularly acute: the area serves both as an ecological security barrier and a repository of ethnic cultural heritage, while simultaneously being a focal point of China's Western Development Strategy and rural revitalisation efforts. Yet a persistent policy paradox endures, despite sustained high-speed economic growth, urban–rural income gaps,

disparities between border and interior areas, and differences in public service accessibility across ethnic groups have not narrowed synchronously, and in some periods have even widened.

Existing literature has approached regional inequality from multiple perspectives, which can be grouped into three main traditions. First, the political economy and spatial development tradition. Williamson's (1965) inverted-U hypothesis predicts that development disparities first widen and then narrow with economic growth[2]; however, Rodríguez (2015) recent evidence shows that in peripheral regions[3], spatial inequality tends to persist due to agglomeration forces and institutional inertia. Atkinson (1970) provided a normative foundation for inequality measurement by introducing an explicit welfare-theoretic basis[4], yet subsequent empirical applications in developing regions have rarely extended this normative logic to assess the distributional equity of non-income dimensions such as cultural access and ecological amenities. This theoretical debate has not been sufficiently tested in a context like the GYG multi-ethnic mountainous area—most empirical studies focus on national-scale or coastal region analyses, lacking dynamic tracking of specific mountainous multi-ethnic regions.

Second, the multidimensional poverty and well-being measurement tradition. Sen's (1985) capability approach provides a theoretical foundation for expanding well-being assessment beyond income[5], and the Multidimensional Poverty Index (MPI) developed by Alkire and colleagues has been widely applied in developing countries[1]. Chinese scholars have also measured multidimensional poverty using CHNS and similar data[6,7]. However, these studies tend to adopt a “deficit” perspective (e.g., lack of education, health, or living standards) rather than a “developmental” one. They can identify who is poor, but they cannot answer questions such as: “To what extent has a region progressed in terms of material affluence, spiritual fulfilment, and ecological well-being?” and “Have these gains been shared across cities, urban–rural divides, and occupational groups?” For a region like the GYG, which possesses both ecological advantages and cultural diversity, neglecting ecological capital and cultural capital as non-substitutable assets[8,9]. This perspective aligns with recent calls to incorporate ecological efficiency into development metric[10], which argue that aggregate human development gains must be assessed against their environmental footprints—a consideration particularly salient for ecologically fragile mountain regions. Although studies on underdeveloped urban clusters in the western region have noted the nonlinear enhancement effect of interaction among dimensions[11], their analytical framework still relies on geographical distance as the basis and fails to answer the question of whether the gap in sub-dimensions between two cities that are not spatially adjacent but have similar structures can also explain the overall gap in inclusive development. This provides a direct empirical gap reference for the introduction of the QAP method in this study.

Third, the regional inequality decomposition and drivers tradition. Recently, several studies have examined common-prosperity levels in western China[12-15] and inclusive development in ethnic minority regions[16-17]. Yet these works suffer from two methodological limitations. One, in spatial analysis, they mostly rely on provincial- or county-level autocorrelation models, implicitly assuming that “closer geographic distance implies stronger association.” However, in multi-ethnic mountainous areas, welfare gaps between cities may be more shaped by non-geographic factors such as administrative hierarchy, resource endowments, and industrial structure—geographically adjacent cities are not necessarily comparable, while structurally similar cities, even if far apart, warrant comparison. Two, temporally, most adopt static or two-period cross-sectional comparisons, failing to capture the dynamic effects of major policies

and external shocks—such as the deepening of the Western Development Strategy, poverty alleviation campaigns, and the COVID-19 pandemic—on inequality trajectories since the 2010s.

In sum, the existing literature exhibits three critical gaps: (1) theoretically, it lacks an integrated analytical framework that addresses the “growth-sharing” tension specific to multi-ethnic mountainous regions; (2) methodologically, existing well-being indicators do not treat ecological and cultural capital as co-equal dimensions with material wealth, and they favour deficit accounting over developmental assessment; and (3) empirically, there is a shortage of integrated tools that simultaneously handle temporal dynamics, multi-dimensional structural decomposition, and non-geographic relational drivers.

To fill these gaps, we construct a seven-dimensional inclusive development indicator system based on panel data from 39 prefecture-level cities in the GYG region for 2013–2024, and we integrate three complementary methods: dynamic evaluation via the vertical-horizontal scatter-degree (VHSD) method, Dagum Gini decomposition, and Quadratic Assignment Procedure (QAP) regression. This methodological combination is deliberately chosen for specific reasons: VHSD maximises the discriminative power of composite scores across years, avoiding temporal incomparability inherent in static weighting; Dagum decomposition precisely partitions overall inequality into intra-regional, inter-regional, and transvariation components; and QAP regression goes beyond geographic-proximity assumptions to directly test whether “the gap between two cities in any sub-dimension significantly explains their overall well-being gap”—a design that directly addresses the methodological gap identified above regarding the role of non-geographic relationships in shaping spatial inequality in multi-ethnic mountainous regions.

This study aims to answer three sequential questions: (1) What are the overall level, growth dynamics, and provincial differentiation of inclusive development in the GYG region? (2) What are the main spatial sources (intra- vs. inter-provincial) and structural sources (across the seven sub-dimensions: material, spiritual, ecological, urban–rural, regional, demographic, and public service) of inequality? (3) Do the key sub-dimensional drivers of inter-city welfare gaps exhibit provincial heterogeneity? Answering these questions will not only deepen theoretical understanding of the growth-inequality nexus but also provide actionable policy-monitoring tools for analogous multi-ethnic mountainous regions in the Global South striving to achieve SDG 10 and SDG 11.

2. Indicator System and Data Sources

2.1 Construction of the Indicator System

Our indicator system is methodologically and theoretically grounded in Amartya Sen's capability approach[5], which posits that human inclusive development depends not only on income (material wealth) but, more fundamentally, on the substantive freedoms (capabilities) that enable people to achieve various functioning. Specifically, a region's "well-being equity" rests on three pillars: (a) material endowments, (b) access to cultural/spiritual fulfilment, and (c) ecological resilience. Moreover, to capture the "shared" dimension, we incorporate the spatial equity principle articulated by the World Bank (2008) regarding geographic concentration[18], ensuring that our assessment reflects not only aggregate wealth levels but also its distributional fairness across urban–rural, regional, and occupational domains(Table 2).

Affluence extends beyond mere material prosperity; following Zhang & Mao (2024) and Zhou & Li (2024)[19,20], we incorporate both ecological and spiritual dimensions. The

establishment of the spiritual wealth dimension is supported by both the theoretical framework of Sen's (1985) capability approach and empirical evidence from ethnic minority areas[5]. Tan Jianmei et al. (2026) found that social and cultural factors are the core driving force of the spatial pattern of traditional villages in Guangxi[21], surpassing natural and economic factors. This indicates that cultural capital is a non-substitutable asset in the GYG mountainous area and has a spatial allocation effect. It should be evaluated independently of material wealth. For the material dimension indicators, we draw on recent methodological discussions regarding the role of income in multidimensional well-being measurement[22]: even if income is not viewed as an ultimate end in itself, it should still be included in a composite index as a means that indirectly facilitates well-being. Accordingly, we retain core indicators such as per capita GDP and per capita disposable income in the material dimension, while integrating ecological and cultural capital as non-substitutable asset categories. In ethnically concentrated areas with significant ecological advantages—such as the GYG region—a high-quality natural environment itself constitutes a form of sustainable natural capital. Therefore, treating ecological affluence alongside material and spiritual affluence as coordinate dimensions is both theoretically justified and practically meaningful.

In contrast, shared prosperity focuses on narrowing multidimensional gaps. To measure inter-occupational inequality, we employ the coefficient of variation of wage levels across industries—an indicator that directly addresses a core concern of shared prosperity, namely that wide inter-industry wage differentials are a salient manifestation of distributional inequity, and the coefficient of variation effectively captures this imbalance. In addition, disparities in the minimum living standard guarantee can serve as a proxy for the social safety net, thereby providing a more comprehensive reflection of shared prosperity across different population groups. The differentiated features of China's urban–rural well-being landscape have been systematically documented in this journal: multiple multidimensional poverty studies have repeatedly confirmed that urban–rural disparities persist even after controlling for income and education levels. This substantiates our rationale for including the urban–rural ratios of income, consumption, and Engel's coefficient as independent sub-indicators within the shared-prosperity dimension—rather than treating them as mere by-products of material affluence. Beyond demographic structural differences, the shared-prosperity dimension also encompasses urban–rural gaps, inter-regional disparities, and public-service access differentials. Together, these elements form a coherent evaluation system that spans affluence across material, spiritual, and ecological domains, alongside disparities in urban–rural, regional, demographic, and public-service dimensions.

Table 1

Indicator System for Inclusive Development in the GYG Region

<i>Primary Indicator</i>	<i>Secondary Indicator</i>	<i>o.</i>	<i>Tertiary Indicator</i>	<i>Direction</i>	<i>Weight</i>
<i>Affluence</i>	<i>Material affluence</i>		<i>GDP per capita (CNY)</i>	+	0.043
			<i>Per capita disposable income of residents (CNY)</i>	+	0.033
			<i>Per capita consumption expenditure of residents (CNY)</i>	+	0.030
			<i>Per capita savings deposits of residents</i>	+	0.

			(CNY)		044
			Private cars per 10,000 persons (units)	+	0.051
	Spiritual affluence		Per capita education expenditure (CNY)	+	0.080
			Number of national-level intangible cultural heritage items	+	0.065
			TV population coverage rate (%)	+	0.078
			Museums per million persons (incl. cultural centers and stations)	+	0.007
	Ecological affluence	0	Per capita park green space area (m ² /person)	+	0.028
		1	Forest coverage rate (%)	+	0.024
		2	Air quality (PM2.5 annual average concentration, µg/m ³)	–	0.016
Shared Prosperity	Urban-rural disparity	3	Urban-rural income gap	–	0.024
		4	Urban-rural consumption gap	–	0.017
		5	Urban-rural Engel coefficient ratio	–	0.028
	Regional disparity	6	Per capita local government general public budget expenditure (CNY)	+	0.077
		7	Urbanization rate of registered population (%)	+	0.053
	Demographic disparity	8	Average wage of employed persons in urban non-private units (CNY)	+	0.053
		9	Inter-industry wage gap (coefficient of variation)	–	0.038
		0	Minimum subsistence allowance standard gap	–	0.034
	Public service disparity	1	Licensed (assistant) physicians per 10,000 persons	+	0.046
		2	Hospital beds per 10,000 persons	+	0.050
		3	Full-time teachers in compulsory education per 10,000 persons	+	0.037
		4	Social security and employment expenditure as share of general public budget	+	0.042

			<i>expenditure (%)</i>		
--	--	--	------------------------	--	--

All seven sub-dimensions were assigned equal weights (with a 50 % allocation to each core dimension: affluence and shared prosperity). Within affluence (comprising material, spiritual, and ecological sub-dimensions) and within shared prosperity (comprising urban–rural, regional, demographic, and public-service sub-dimensions), the sum of the tertiary-level weights equals the corresponding secondary-level weight share.

2.2 Data Sources and Explanation of Some Indicators

The primary data were drawn from the China Statistical Yearbook, provincial and municipal statistical yearbooks of Guangxi, Yunnan, and Guizhou, national and regional economic and social development bulletins, the China Environment Statistical Yearbook, the EPS database, and official statistics from the National Bureau of Statistics and relevant ministries. Intangible cultural heritage data were manually compiled from the China Intangible Cultural Heritage Network. For the occupational wage gap indicator, we collected average annual wages of urban employees across sectors and computed the coefficient of variation: $CV = \sigma/\mu$, where σ denotes the standard deviation and μ denotes the mean. A higher CV indicates greater inter-sectoral wage inequality. Air quality was treated as a negative indicator, proxied by annual average PM2.5 concentration. All indicators were normalized via min-max standardization prior to weighting, and missing values were imputed using interpolation and moving-average methods.

The equal-weight assignment—50% for Affluence and 50% for Shared Prosperity—is a deliberate theoretical choice, rather than an arbitrary convention. Substantively, inclusive development necessitates that aggregate prosperity and distributional equity be pursued in tandem; overweighting either dimension would reduce the index to a mere growth ranking or weaken productivity incentives. Statistically, equal weighting avoids the subjective bias of expert-based methods (e.g., AHP) and the excessive volatility of purely data-driven approaches (e.g., Entropy Weighting), thereby enhancing robustness and inter-temporal comparability. In summary, this design balances value-oriented equilibrium with measurement rigor, offering a regionally adaptive tool for monitoring inclusive development in the GYG area.

3. Methodology

3.1 Vertical-Horizontal Scatter-Degree (VHSD) Method

The construction of multidimensional composite indicators has attracted growing methodological attention in well-being research[23], particularly regarding the trade-offs between weighting schemes and temporal comparability. To adequately capture the temporal dynamics inherent in our panel dataset, we employ the vertical-horizontal scatter-degree (VHSD) method, a dynamic evaluation technique originally proposed by Guo (2002)[24]. Unlike static weighting approaches, such as the entropy method, which determine weights solely based on the information entropy of each indicator within a single cross-section, the VHSD method maximizes the total scatter of the composite scores across both spatial units (cities) and temporal points (years). This dual-objective optimization ensures that the resulting weights not only reflect the relative importance of indicators but also preserve the inter-temporal comparability of the composite indices, a critical feature for analyzing growth trajectories. First, all indicators are normalized using the min-max method to eliminate dimensional effects: for positive indicators, $\phi_{ij}(t_k) = [x_{ij}(t_k) - \min(x_{ij})]/[\max(x_{ij}) - \min(x_{ij})]$; for negative indicators, $\phi_{ij}(t_k) =$

$[\max(x_{ij}) - x_{ij}(t_k)]/[\max(x_{ij}) - \min(x_{ij})]$. Subsequently, the overall composite score for city i at time t_k is calculated as a linear weighted sum: $\rho_i(t_k) = \sum_{j=1}^m \omega_j \cdot \phi_{ij}(t_k)$, where ω_j denotes the weight of the j -th indicator. The optimal weight vector $\omega = (\omega_1, \omega_2, \dots, \omega_m)^T$ is derived by maximizing the sum of squared deviations across all n cities and T years: $\max \sum_{k=1}^T \sum_{i=1}^n [\rho_i(t_k) - \bar{\rho}]^2$, subject to $\sum_{j=1}^m \omega_j^2 = 1$ and $\omega_j \geq 0$. This optimization problem is solved via eigenvalue decomposition of the overall scatter matrix $H = \sum_{k=1}^T Z(t_k)^T Z(t_k)$, where $Z(t_k)$ is the normalized indicator matrix at time. The eigenvector corresponding to the largest eigenvalue of H yields the optimal weight vector, ensuring that the composite scores achieve maximal dispersion, and thus the highest discrimination power among the evaluated units over the entire study period.

3.2 Dagum Gini Coefficient and Its Decomposition

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

In Equation (1), G denotes the overall Gini coefficient for the GYG region; j and h represent the subgroup indices, which in this study refer to the three provinces; i and r index the prefecture-level cities within provinces j and h , respectively; k is the number of subgroups, set to 3; n are the numbers of cities in provinces j and h ; n is the total number of cities, fixed at 39; μ is the mean inclusive development level across the GYG region; and y_{ji} and y_{hr} are the inclusive development scores of city i in province j and city r in province h , respectively. The overall Gini coefficient G is further decomposed into three components: the contribution of intra-regional disparity (G_w), the net contribution of inter-regional disparity (G_{nb}), and the contribution of super-variable density (G_t), satisfying $G = G_w + G_{nb} + G_t$.

3.3 Variance Decomposition of Structural Disparities

We employ variance decomposition to quantify the contribution of each sub-dimension to the overall disparity in the composite inclusive development index, thereby uncovering the structural sources of inequality in inclusive development.

$$I = \frac{\text{cov}(Total, material)}{\text{var}(Total)} + \frac{\text{cov}(Total, spirit)}{\text{var}(Total)} + \frac{\text{cov}(Total, nature)}{\text{var}(Total)} + \frac{\text{cov}(Total, urban)}{\text{var}(Total)} + \frac{\text{cov}(Total, area)}{\text{var}(Total)} + \frac{\text{cov}(Total, people)}{\text{var}(Total)} + \frac{\text{cov}(Total, public)}{\text{var}(Total)}$$

In Equation (2), Total refers to the composite inclusive development index; material denotes the material affluence sub-index; spirit denotes the spiritual affluence sub-index; nature denotes the ecological affluence sub-index; urban denotes the urban-rural disparity sub-index; area denotes the regional disparity sub-index; people denotes the demographic disparity sub-index; and public denotes the public service disparity sub-index.

3.4 QAP

To uncover the relational mechanisms driving inter-city welfare disparities, we move beyond traditional spatial econometrics, which assumes geographic proximity is the primary channel. The Quadratic Assignment Procedure (QAP), originally developed by Krackardt (1987) for dyadic relational data in social network analysis[25], is particularly suited to our research design. Instead, we treat 39 cities as nodes in a network where the link between any two cities is the difference in their inclusive development dimensions. We employ QAP, a method specifically designed for such dyadic relational data, to answer: when the gap in, say, material wealth between two cities widens, does their overall inclusive development gap also widen, regardless of their geographical distance?

Since inclusive development inherently involves the sharing of economic growth, inter-regional economic disparities directly affect collaborative development outcomes. The economic distance matrix provides a direct measure of such disparities and effectively captures the mechanisms through which they influence inclusive development. In Equation (3), D_{ij} represents the degree of disparity between regions i and j , and X_i denotes the vector of sub-indicator variables at the second-level dimension.

$$D_{ij} = |X_i - X_j| \quad (3)$$

Based on the principle of randomization, we constructed a null distribution by destroying the original data structure. Assuming that the composite inclusive development index is unrelated to the second-level indicator variables, we randomly permuted the order of observations to disrupt any inherent structure among the variables. This procedure generates an empirical distribution of the test statistic, against which the significance level of the observed statistic is calculated.

$$Total = f(material, spirit, nature, urban, area, people, public) \quad (4)$$

In Equation (4), the matrices on both sides are the difference matrices. The dependent variable is the inclusive development disparity matrix (total). The independent variables are the sub-dimension disparity matrices from the Affluence pillar—material affluence disparity (material), spiritual affluence disparity (spirit), and ecological affluence disparity (nature)—and those from the Shared Prosperity pillar—urban-rural disparity (urban), regional disparity (area), demographic disparity (people), and public service disparity (public).

4. Results

4.1 Spatio-temporal Evolution of Inclusive Development

To ensure the robustness of our findings, we re-estimated the composite index using entropy and CRITIC weights. The Spearman rank correlation coefficients between the city-level scores under the equal weighting scheme and those under the alternative schemes consistently exceeded 0.95 across all years, confirming that our core conclusions regarding convergence trends and spatial patterns are not materially affected by the choice of weighting method.

Figure 1 displays the composite common prosperity index and its year-on-year growth rates for each province in the GYG region over 2013–2024. A clear secular upward trajectory is evident for all three provinces, yet their growth dynamics differ markedly in magnitude and volatility. Guizhou stands out with the highest cumulative (100.35%) and average annual (7.20%) growth, despite starting from the lowest base. This pronounced catch-up effect suggests that targeted fiscal transfers, infrastructure investment, and industrial policy have effectively unlocked endogenous development potential in less-developed western regions—supporting the view that policy leverage can accelerate convergence when combined with local agency. However, Guizhou's growth path is also the most volatile, with annual rates swinging from 13.8% in 2014 to a trough of 0.9% in 2018. Such instability likely reflects the province's heavy reliance on large-scale investment cycles and external demand shocks, which amplify short-term fluctuations even as long-term trends remain positive.

In contrast, Guangxi and Yunnan exhibited more moderate and stable growth, with average annual rates of 6.74% and 6.45%, respectively. Guangxi, in particular, maintains the narrowest band (4.0%–9.4%) and the lowest cumulative growth among the three, implying a more mature but less dynamic development path, possibly constrained by industrial structure and geographic location. Yunnan's intermediate performance hints at untapped potential, especially in tourism

and cross-border trade; however, it also faces structural bottlenecks that may require tailored policy interventions beyond those already in place.

Notably, inter-provincial growth dispersion widened during 2014–2017 but narrowed considerably after 2022, converging to a common 3%–5% range. This post-2022 convergence signals a transition from divergent catch-up to coordinated stabilization, which may be driven by improved inter-regional policy coordination, the maturing of major infrastructure networks, and shared exposure to macroeconomic headwinds. More importantly, this synchronization does not imply convergence in levels—Guizhou’s higher starting growth has allowed it to maintain a lead in absolute terms—but rather suggests that the region is moving toward a common steady-state phase, where further inclusive development will depend less on aggregate growth acceleration and more on redistributive quality and structural upgrading.

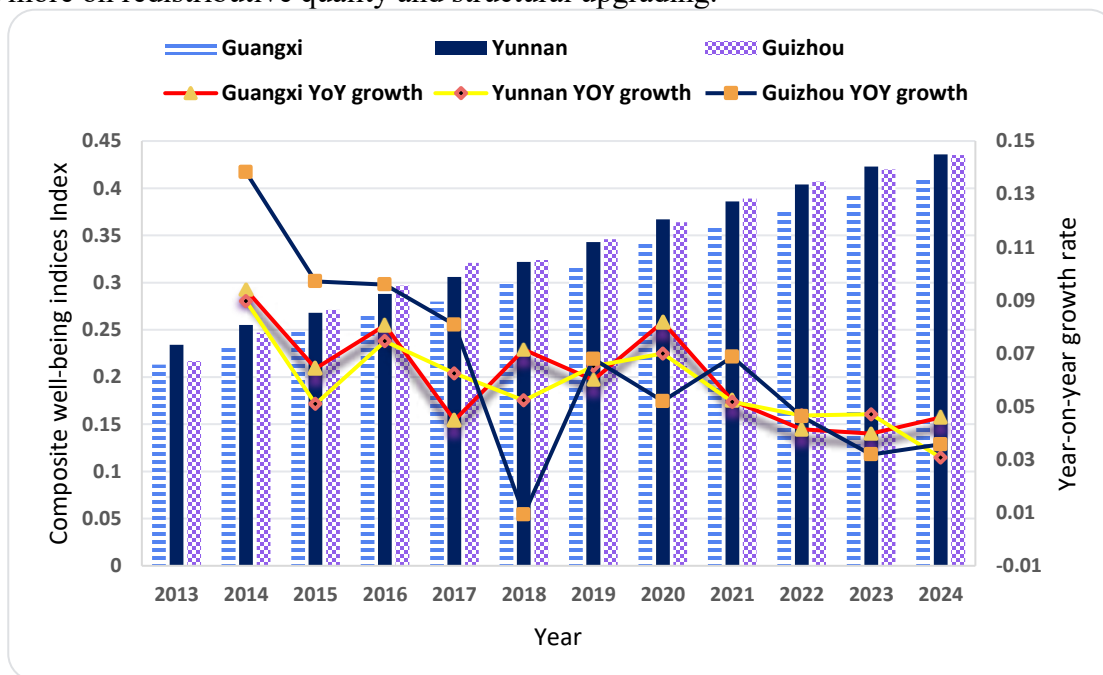


Fig 1. Trends in the inclusive development index and year-on-year growth rates for the Guangxi–Yunnan–Guizhou (GYG) region, 2013–2024

Figure 2 tracks the composite indices of Affluence and Shared Prosperity in the GYG region from 2013 to 2024. Both indicators rose steadily over the period, yet their relative dynamics revealed a distinctive pattern: Affluence consistently outpaced Shared Prosperity, with the gap widening from 0.06 to 0.09, indicating that absolute wealth accumulation grew faster than distributional gains. However, the average annual growth rate of Shared Prosperity exceeded that of Affluence, signalling a robust catch-up effect in foundational dimensions—basic services, accessibility, and social inclusion—that is gradually consolidating the equity base even as the level gap persists. Temporally, the 2013–2019 period saw balanced growth; 2020–2022 demonstrated resilience amid pandemic shocks; and 2023–2024 accelerated recovery, driven by tourism rebound and industrial relocation from coastal provinces. These dynamics collectively suggest a healthy transition from infrastructure-led expansion to a more inclusive phase, where further progress hinges on shifting growth drivers towards innovation-driven productivity gains that can sustain both aggregate wealth and its equitable diffusion.

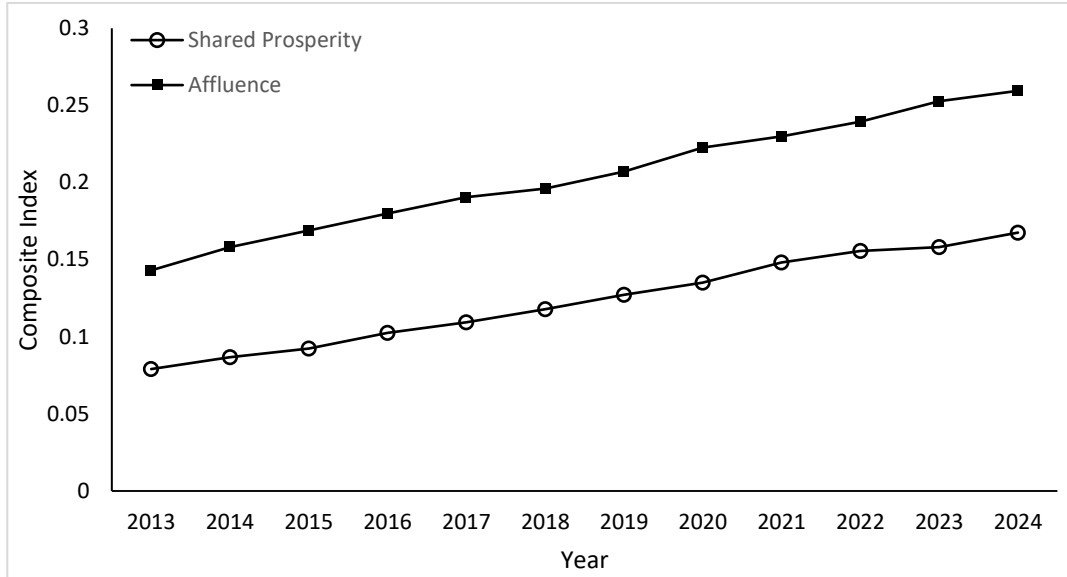


Fig2. Temporal Trends of Affluence and Shared Prosperity Dimensions in the GYG Region

4.2 Spatial Disparities of Inclusive Development in the GYG Region

Figure 3 reports the Gini coefficients for inclusive development at both intra-provincial and inter-provincial levels in the GYG region from 2013 to 2024. Overall disparity narrowed considerably, with the regional Gini coefficient falling from 0.0924 to 0.0534—a 42% reduction—confirming that the western coordinated development strategy has effectively alleviated intra-regional imbalances. At the provincial level, all three provinces recorded declines, with Guizhou recording the sharpest drop (0.0910 → 0.0415), consistent with its stronger catch-up momentum noted earlier. By 2024, the absolute Gini values across provinces had converged substantially, signalling a synchronized trend towards more equitable internal distributions.

Inter-provincially, pairwise Gini coefficients among the three provinces also declined steadily—Yunnan–Guangxi from 0.091 to 0.055, Yunnan–Guizhou from 0.100 to 0.051, and Guangxi–Guizhou from 0.081 to 0.050—demonstrating that development gaps between provinces are narrowing in tandem, reflecting a pronounced regional synergy effect. Collectively, the GYG region has achieved a sustained convergence of development disparities alongside robust aggregate growth—a dual accomplishment emblematic of its inclusive development trajectory. Nonetheless, the average Gini coefficient remains relatively elevated, implying that further policy attention is still needed to address persistent urban–rural, inter-regional, and inter-group divides.

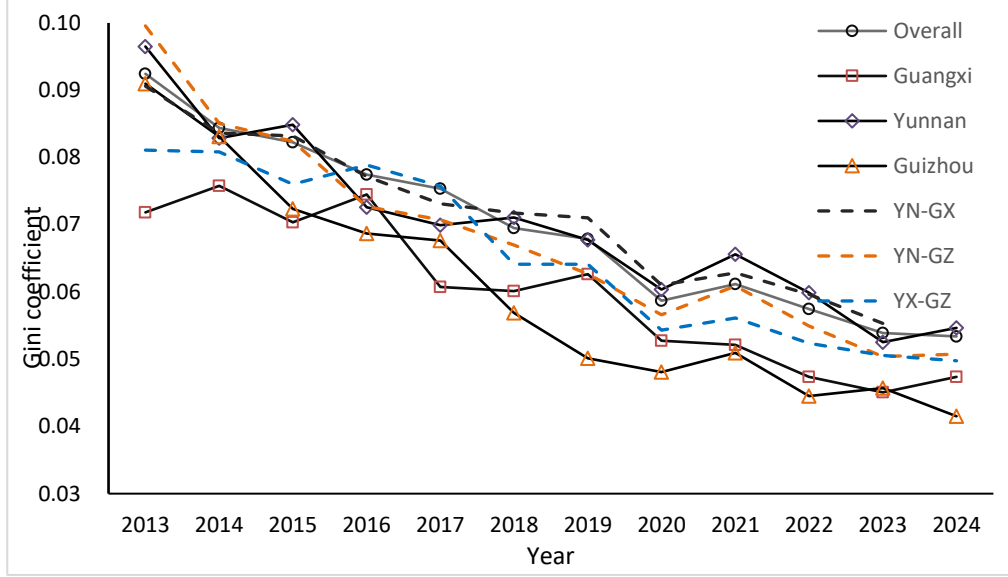


Fig 3. Trends of Intra-regional and Inter-regional Disparities in the GYG Region

4.3 Sources of Spatial Disparities

The decomposition results presented in Table 2 indicate that the spatial disparity in inclusive development across the GYG region is structurally dominated by intra-regional inequality. Throughout the entire sample period, intra-regional inequality consistently constituted the primary source of spatial inequality across the three provinces, with an average contribution share of 92.21 %, whereas inter-regional inequality accounted for only 11.41 %, and the contribution of transvariation density was -3.62% . In terms of temporal dynamics, despite minor fluctuations in certain years, the contribution of intra-regional inequality remained above 86 % throughout the study period, while the contribution of inter-regional inequality edged up slightly from 8.82 % in 2013 to 11.97 % in 2024, albeit remaining at a relatively low level overall. These findings suggest that, within the relatively confined geographical scope of the GYG region, the imbalance in inclusive development manifests primarily as intra-provincial disparities across cities, rather than inter-provincial gaps among the three provinces. Taken together with the declining provincial-level Gini coefficients reported earlier, this implies that, while intra-provincial equity has improved, it remains the primary bottleneck constraining the overall advancement of inclusive development in the region.

Table 2

Sources and Contributions to Spatial Disparities in Inclusive Development in the GYG Region

Year	Intra-regional Disparity (G_w)		Inter-regional Disparity (G_{nb})		Super-variable Density (G_t)	
	Disparity	Contribution(%)	Disparity	Contribution(%)	Disparity	Contribution(%)
2013	0.087	93.86	0.008	8.82	(0.002)	(2.67)
2014	0.081	95.39	0.006	6.59	(0.002)	(1.98)
2015	0.077	93.53	0.008	9.48	(0.002)	(3.01)
2016	0.072	93.35	0.008	10.06	(0.003)	(3.41)
2017	0.066	87.99	0.014	18.02	(0.005)	(6.01)

2018	0.064	92.01	0.008	11.60	(0.003)	(3.60)
2019	0.062	91.02	0.009	13.21	(0.003)	(4.23)
2020	0.055	93.42	0.006	9.47	(0.002)	(2.89)
2021	0.057	93.94	0.005	8.97	(0.002)	(2.91)
2022	0.052	90.39	0.008	14.08	(0.003)	(4.46)
2023	0.048	89.74	0.008	14.71	(0.002)	(4.45)
2024	0.049	91.86	0.006	11.97	(0.002)	(3.82)
Mean	0.064	92.21	0.008	11.41	(0.002)	(3.62)

4.4 Structural Sources of Disparities

The variance decomposition results (Figure 4) reveal both common structural drivers and pronounced provincial heterogeneity in the sources of inclusive development inequality across the GYG region. At the aggregate level, urban–rural gaps, regional disparities, and material affluence emerge as the primary contributors over the sample period; yet, their relative importance differs sharply across provinces, reflecting distinct development stages and structural constraints.

In Guangxi, material and spiritual affluence dominated, whereas the urban–rural gap exerted a negative contribution, suggesting that urban–rural coordination policies have been relatively effective. This pattern implies that further inequality reduction in Guangxi hinges less on bridging the urban–rural divide than on raising overall wealth levels and cultural well-being across the province. In Yunnan, inequality is overwhelmingly concentrated in material affluence and urban–rural gaps, with spiritual and ecological dimensions playing marginal roles. This points to a comparatively narrow development base, where aggregate wealth accumulation remains a binding constraint on inclusive progress. In Guizhou, the structural sources are more evenly distributed across material affluence, demographic composition, and spiritual affluence, while the urban–rural gap has shifted from a negative to a positive contribution over time, reflecting the multidimensional balancing challenge inherent in a province undergoing rapid but uneven transformation.

Dynamically, the contribution share of material affluence surged from 25.0% to 45.1% over 2013–2024, while that of the urban–rural gap turned from negative to positive and steadily expanded. This secular shift indicates that the structural drivers of inequality are consolidating around material accumulation and distributional divides—a transition from a multidimensionally balanced inequality structure to one increasingly dominated by wealth and access disparities. At the provincial level, this trend manifests differently: Guangxi shows rising material contributions alongside fluctuating spiritual components and declining regional gap effects; Yunnan exhibits persistently high material wealth contributions with stable spiritual and ecological shares; and Guizhou experienced a sharp rise in material wealth contribution in 2024, accompanied by a steep decline in spiritual affluence and a widening demographic structure gap.

Taken together, these results underscore a dual imperative for the GYG region’s inclusive development agenda: sustaining rapid material wealth growth to maintain the “enlarging-the-cake” momentum, while simultaneously strengthening redistributive mechanisms and structurally oriented interventions to address the rising salience of urban–rural and demographic divides. The convergence of structural sources towards material dominance does not diminish the importance of non-material dimensions; rather, it signals that their effects are increasingly mediated through and amplified by gaps in material affluence and spatial access.

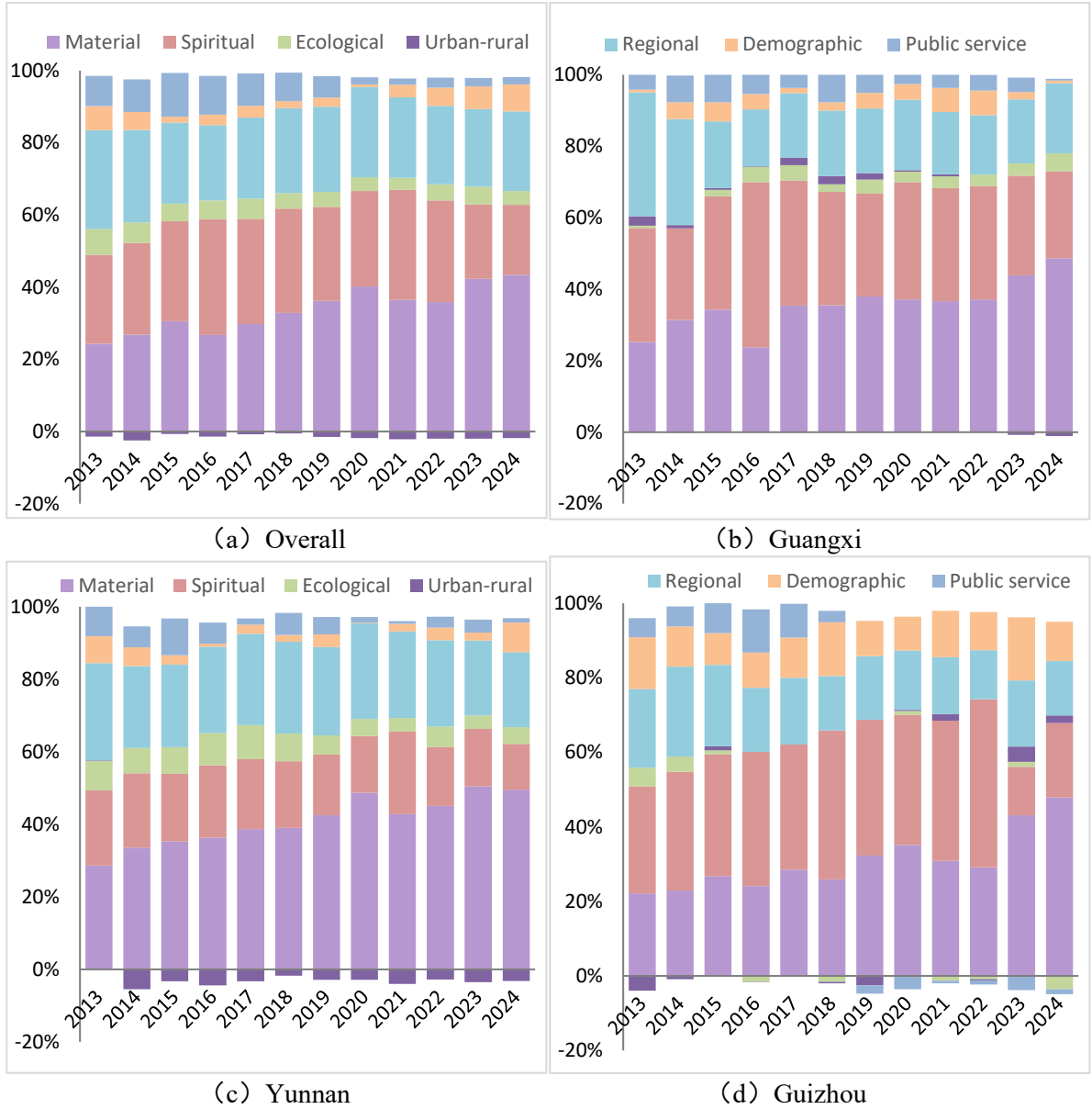


Fig 4. Structural Sources of Inclusive Development Disparities in the GYG Region: Overall and Three Provinces

5 Dyadic-source Identification of Regional Disparities in Inclusive Development in the GYG Region

5.1 Measurement of Inclusive Development Levels in the GYG Region

Table 3 reports city-level inclusive development indices for the GYG region over 2013–2024. While the regional average has risen steadily, substantial heterogeneity persists across cities in both baseline levels and growth momentum. Metropolitan centers —Kunming, Liuzhou, Guiyang—consistently rank at the top throughout the period, whereas peripheral cities such as Zhaotong, Guigang, and Bijie remain at the bottom. In terms of dynamics, Zunyi, Qianxinan, and Zhaotong post the highest average annual growth rates, well above the regional mean, signalling

strong catch-up effects; conversely, Chongzuo, Honghe, Diqing, and Xishuangbanna exhibit sluggish growth, hinting at structural inertia or locational disadvantages.

Crucially, despite the rapid growth in some secondary cities, the absolute level gap between the core and periphery has not narrowed appreciably over the entire sample period. This paradox reflects the operation of agglomeration suction: productive resources, skilled labor, and fiscal capacity continue to concentrate in provincial capitals rather than diffusing outward, offsetting the equalizing influence of faster peripheral growth rates[26]. This interpretation directly corroborates our QAP finding (Section 4.2) that regional disparity is the single most significant contributor to overall inclusive development inequality.

Table 3
Measurement Results of Inclusive Development Levels in the GYG Region, 2013–2024

City	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Mean	AAGR (%)
Nanning	0.217	0.243	0.261	0.292	0.310	0.330	0.357	0.376	0.397	0.402	0.427	0.449	0.338	7.557
Luzhou	0.287	0.303	0.345	0.351	0.372	0.400	0.419	0.432	0.457	0.476	0.484	0.500	0.402	5.709
Guilin	0.218	0.231	0.263	0.273	0.296	0.323	0.343	0.374	0.392	0.399	0.416	0.417	0.329	6.698
Wuzhou	0.201	0.218	0.233	0.257	0.266	0.298	0.299	0.340	0.359	0.371	0.377	0.415	0.303	7.542
Beihai	0.210	0.235	0.242	0.255	0.268	0.289	0.314	0.335	0.362	0.373	0.392	0.403	0.307	6.722
Fangchenggang	0.236	0.275	0.280	0.297	0.301	0.317	0.348	0.355	0.378	0.395	0.418	0.451	0.338	6.676
Qinzhou	0.200	0.247	0.228	0.243	0.264	0.288	0.292	0.321	0.333	0.351	0.375	0.362	0.292	6.098
Guigang	0.177	0.179	0.204	0.218	0.233	0.260	0.279	0.305	0.322	0.331	0.347	0.358	0.268	7.289
Yulin	0.183	0.209	0.217	0.225	0.251	0.267	0.281	0.325	0.348	0.360	0.373	0.394	0.286	7.934
Baise	0.233	0.249	0.263	0.286	0.294	0.310	0.337	0.369	0.381	0.398	0.402	0.411	0.328	5.848
Hezhou	0.194	0.201	0.218	0.243	0.276	0.293	0.308	0.336	0.342	0.362	0.373	0.409	0.296	7.765
Hechi	0.200	0.218	0.237	0.249	0.264	0.282	0.302	0.330	0.350	0.365	0.368	0.394	0.297	7.006
Laibin	0.186	0.201	0.226	0.243	0.252	0.267	0.282	0.303	0.324	0.345	0.372	0.390	0.283	7.698
Chongzuo	0.246	0.259	0.251	0.321	0.268	0.270	0.290	0.310	0.327	0.349	0.363	0.382	0.303	4.500
Kunming	0.299	0.326	0.354	0.355	0.376	0.398	0.425	0.447	0.472	0.489	0.503	0.529	0.414	5.850
Qijiang	0.197	0.221	0.228	0.257	0.253	0.279	0.305	0.342	0.358	0.366	0.391	0.406	0.300	7.483
Yuxi	0.272	0.291	0.311	0.326	0.341	0.354	0.384	0.413	0.435	0.445	0.460	0.477	0.376	5.763
Baoshan	0.220	0.228	0.243	0.264	0.297	0.321	0.347	0.373	0.376	0.411	0.409	0.422	0.326	6.747
Zhaotong	0.156	0.204	0.191	0.220	0.237	0.235	0.264	0.291	0.304	0.315	0.339	0.367	0.260	8.923
Lijiang	0.234	0.265	0.279	0.299	0.317	0.323	0.337	0.357	0.365	0.383	0.414	0.438	0.334	6.462
Pu'er	0.224	0.245	0.262	0.282	0.307	0.323	0.349	0.391	0.417	0.427	0.445	0.432	0.342	6.760
Lincang	0.186	0.214	0.229	0.250	0.262	0.269	0.282	0.324	0.343	0.354	0.381	0.383	0.290	7.494
Chuxiong	0.241	0.256	0.271	0.291	0.318	0.331	0.346	0.360	0.391	0.420	0.437	0.455	0.343	6.587
Honghe	0.262	0.279	0.287	0.311	0.317	0.333	0.353	0.368	0.381	0.406	0.419	0.465	0.348	5.919
Wenshan	0.201	0.207	0.224	0.237	0.257	0.271	0.287	0.313	0.332	0.355	0.376	0.373	0.286	6.358
Xishuangbanna	0.265	0.291	0.292	0.306	0.323	0.350	0.362	0.351	0.376	0.405	0.418	0.420	0.347	4.732
Dali	0.217	0.242	0.257	0.277	0.307	0.323	0.349	0.381	0.394	0.410	0.438	0.441	0.336	7.361
Dehong	0.240	0.264	0.282	0.304	0.320	0.330	0.356	0.382	0.392	0.415	0.435	0.436	0.346	6.171
Nujiang	0.210	0.224	0.252	0.273	0.292	0.313	0.334	0.351	0.358	0.390	0.412	0.429	0.320	7.410
Diqing	0.312	0.317	0.329	0.348	0.373	0.395	0.411	0.427	0.483	0.480	0.488	0.507	0.406	4.969
Guivang	0.297	0.324	0.352	0.366	0.397	0.378	0.399	0.419	0.454	0.456	0.483	0.458	0.399	4.407
Lupanshui	0.205	0.229	0.241	0.275	0.302	0.311	0.327	0.344	0.368	0.393	0.377	0.404	0.315	7.010
Zunyi	0.179	0.201	0.253	0.275	0.303	0.326	0.359	0.371	0.396	0.409	0.441	0.460	0.331	9.884
Anshun	0.207	0.226	0.248	0.277	0.295	0.292	0.318	0.337	0.355	0.370	0.401	0.410	0.311	7.049
Bijie	0.184	0.212	0.234	0.245	0.259	0.269	0.299	0.316	0.336	0.356	0.364	0.390	0.289	7.805
Tongren	0.209	0.243	0.265	0.307	0.324	0.319	0.340	0.357	0.389	0.417	0.436	0.464	0.339	8.307
Qianxinan	0.186	0.233	0.256	0.278	0.306	0.315	0.332	0.354	0.391	0.409	0.418	0.429	0.326	8.715
Qianlongnan	0.275	0.309	0.335	0.363	0.385	0.381	0.395	0.414	0.441	0.460	0.443	0.474	0.390	5.615
Qiannan	0.211	0.242	0.258	0.290	0.321	0.323	0.341	0.365	0.372	0.397	0.414	0.426	0.330	7.265

5.2 QAP Correlation Analysis

Table 4 presents the correlation matrix computed via the QAP procedure, with robust results across both 5,000 and 10,000 random permutations. All sub-dimensional disparities are positively correlated with the overall inclusive development gap, yet the strength of associations varies considerably: the overall gap exhibits the strongest correlation with regional disparities, followed by material-wealth gaps; spiritual-wealth gaps and public-service gaps are both significantly and positively correlated with the overall gap at the 5 % significance level; whereas ecological gaps, urban–rural gaps, and demographic structural gaps do not reach statistical significance. These findings suggest that regional imbalances and material-wealth differentials are the primary structural key correlates of inclusive development disparities in the GYG region.

In terms of inter-dimensional relationships, regional disparities are significantly and positively correlated with both material-wealth gaps and urban–rural gaps, indicating that regional imbalances tend to be intertwined with unequal material-wealth distribution and the urban–rural dual structure. Demographic structural differences exhibit a significant negative correlation with ecological gaps, reflecting a spatial mismatch between ecological resource endowments and population distribution in the western region. Public-service gaps are significantly and positively correlated with both material-wealth gaps and demographic structural

differences, suggesting close linkages among public-service allocation, economic development levels, and demographic composition. Overall, the key correlates of inclusive development disparities in the GYG region exhibit a dual-driven pattern dominated by regional disparities and material-wealth gaps. Narrowing intra-regional development gaps and enhancing material-wealth accumulation should therefore serve as primary policy focal points, while close attention should also be paid to the interactions among regional disparities, urban–rural gaps, and demographic structural differences, so as to prevent cascading multidimensional inequality triggered by any single dimension.

Table 4

QAP Correlation Matrix and Permutation Test Results

Variable	Overall	Material	Spiritual	Ecological	Urban-rural	Regional	Demographic	Public Service
Overall	1.000							
Material	0.580***	1.000						
Spiritual	0.374**	-0.034	1.000					
Ecological	0.058	0.011	-0.032	1.000				
Urban-rural	0.060	0.009	0.066	0.180*	1.000			
Regional	0.638***	0.383**	0.082	0.101	0.389**	1.000		
Demographic	0.103	0.099	0.110	-0.111*	-0.076	0.104	1.000	
Public Service	0.220*	0.220*	0.065	0.000	-0.033	0.115	0.207*	1.000

***Note:** Entries are QAP correlation coefficients based on 5,000 permutations. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

5.3 QAP Regression Results and Provincial Heterogeneity

To identify the key correlates of inclusive development disparities in the GYG region, we estimated the QAP regression specified in Equation (7). Table 5 reports the standardized coefficients for the pooled sample and by province, with significance based on 5,000 permutations.

In the pooled sample, regional and material wealth gaps are the primary key correlates, corroborating our Dagum decomposition. Spiritual wealth gaps also show significant positive coefficients, reflecting the role of cultural and educational resources in a multiethnic context. The urban–rural gap exhibits a significant negative coefficient—not because narrowing it reduces inequality, but because of a structural suppression effect: cities with smaller gaps tend to have uniformly low incomes, while those with larger gaps harbor prosperous metropolitan

centers. Public service gaps are marginally significant; ecological and demographic differences are not.

Provincial regressions reveal marked heterogeneity. In Guangxi, the spiritual wealth gap is most influential, followed by regional and material gaps. We attribute this to cultural capital compensation: intangible cultural heritage enables some communities to convert cultural assets into livelihoods, offsetting material deficits; yet, these resources are unevenly distributed, functioning as differentiated assets rather than public goods, implying that GDP-focused policies may miss cultural redistribution's equilibrating role.

In Yunnan, material wealth and regional gaps dominate, reflecting geographic and industrial lock-in: resource-based sectors concentrate in advantaged areas, while peripheral cities remain constrained. The negative urban–rural coefficient signals low-level convergence—gap narrowing stems from urban income stagnation, not rural catch-up. Yunnan should pursue simultaneous urban and rural income gains in peripheral areas via targeted industrial transfers.

Guizhou is the most distinctive case: regional disparities exert the largest influence; spiritual wealth gaps remain substantial; and material wealth gaps are insignificant. This points to a post-poverty-alleviation lag: central infrastructure investment has raised the minimum floor across cities, yet benefits are uneven—the Guiyang–Zunyi corridor received disproportionate resources, while remoter areas lag. The non-significance of material gaps suggests that accumulation rates matter less than the geography of growth. Rising demographic-structure contributions (Figure 5) signal wage polarization, warranting monitoring.

Notably, GYG disparities narrowed steadily over 2013–2024, contrasting with the U.S. "rise-then-decline" trajectory over the same period[27]. This divergence likely reflects stronger redistributive policy intensity in China—the Western Development Strategy and poverty alleviation may have been more effective than market-driven adjustments in curbing spatial inequality.

Table 5

QAP Regression Results: Full Sample and Sub-provincial Estimates

Variable	Full Sample		Guangxi		Yunnan		Guizhou	
	Std.	p-value	Std.	p-value	Std.	p-value	Std.	p-value
	Coef.		Coef.		Coef.		Coef.	
Intercept	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Material	0.384	0.000	0.310	0.002	0.566	0.000	0.094	0.337
Spiritual	0.359	0.000	0.565	0.004	0.251	0.003	0.441	0.100
Ecological	0.039	0.120	-0.024	0.357	0.144	0.015	-0.059	0.097
Urban-rural	-0.181	0.000	0.026	0.346	-0.225	0.007	-0.031	0.489
Regional	0.526	0.000	0.342	0.001	0.447	0.000	0.758	0.037
Demographic	-0.049	0.046	-0.077	0.106	-0.006	0.469	-0.247	0.209
Public service	0.056	0.052	0.061	0.146	0.005	0.439	0.080	0.297

Figure 5 tracks annual standardised coefficients for each key correlate over 2013–2024. Regional disparities remain the dominant factor throughout. Material-wealth gaps trend steadily upward, peaking around 2020. Spiritual-wealth gaps follow an inverted-U trajectory. Public-service gaps decline markedly, reflecting equalisation progress. The urban–rural gap

maintains a negative coefficient, its absolute value first expanding then shrinking. Demographic structural gaps shift from negative to positive after 2021, emerging as a new dominant contributor. Ecological gaps remain modest and weaken over time.

Collectively, these trends signal a structural transition: inequality dominant contributors are consolidating around regional and material-wealth gaps, with demographic divides gaining traction—while public-service improvements suggest further reduction will increasingly depend on tackling entrenched spatial and wealth-based disparities.

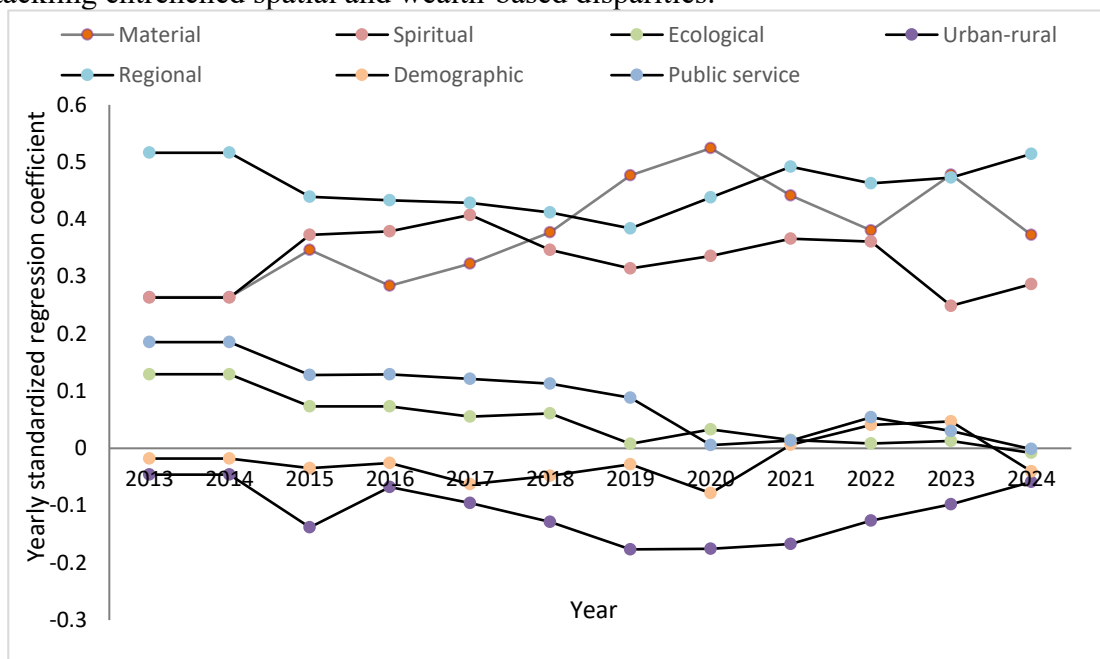


Fig5. Yearly Trajectories of Standardized Regression Coefficients of Driving Factors (2013–2023)

In summary, the provincial-level heterogeneity—with Guangxi driven primarily by spiritual and regional disparities, Yunnan by material and regional disparities, and Guizhou by regional and spiritual disparities—underscores the necessity of province-specific policy tailoring rather than a one-size-fits-all approach, a point we develop further in Section 5.2.

6 Discussion

6.1 Policy Implications

The GYG region exemplifies a common challenge facing underdeveloped multi-ethnic mountainous areas: despite notable overall progress in inclusive development, intra-provincial disparities remain persistently large, with high-value areas heavily concentrated around provincial capitals. Drawing on the empirical findings from Dagum Gini decomposition, variance decomposition, and QAP regression, the seven evaluation dimensions constructed in this study—material affluence, spiritual affluence, ecological affluence, urban–rural gaps, regional gaps, demographic gaps, and public service gaps—serve not only as analytical tools for diagnosing the sources of inequality but also as structural entry points for policy interventions. The three provinces face distinct binding constraints: Guangxi's inequality is primarily driven by spiritual-wealth gaps, Yunnan's by material-wealth differentials, and Guizhou's by regional structural gaps. A uniform policy package applied across the entire region would therefore be ineffective; instead, priorities should be determined across dimensions based on diagnostic evidence.

At the operational level, all three provinces should prioritise narrowing urban–rural income and consumption gaps, whose contribution to overall inequality has shifted from negative to positive over the study period, through county-based urbanisation and rural industrial development. However, the sequencing and weight of secondary interventions should vary: Guangxi should concurrently invest in cultural resource redistribution and digital sharing of intangible heritage to address its spiritual-wealth dominance; Yunnan must prioritise industrial diversification and targeted transfers to peripheral cities to loosen its material-wealth lock-in; and Guizhou should adopt a growth dividend weighting formula that channels fiscal resources disproportionately to counties with lower baseline inclusive development, thereby mitigating its acute regional structural gaps. Foundational enabling measures—strengthening cross-city factor markets, transport network resilience, and emergency coordination mechanisms—should also be reinforced to enhance the effectiveness of all dimension-specific interventions.

For analogous regions in the Global South, particularly those characterised by ethnic diversity, ecological sensitivity, and mountainous topography, the diagnostic-prescriptive logic offered by this study provides valuable reference: identify the dominant contributors of inequality through multidimensional decomposition, then tailor interventions to the specific configuration of binding constraints, while maintaining core investments in infrastructure, connectivity, and institutional coordination. The GYG case demonstrates that such a strategy can simultaneously sustain aggregate growth momentum and gradually narrow spatial disparities—though the persistence of intra-provincial gaps also cautions that this is a long-term process requiring sustained policy commitment rather than short-term fixes.

6.2 Comparison with Existing Studies

Our findings offer a critical refinement and in some respects a direct challenge to both Williamson’s inverted-U hypothesis of 1965 and Rodríguez-Pose’s critique of trickle-down spatial dynamics from 2015[2-3]. At first glance, the GYG region’s 42 percent decline in the overall Gini coefficient over 2013 to 2024 superficially aligns with the predicted descending phase of the inverted-U curve. However, this aggregate convergence masks a structural recomposition of inequality that the original hypothesis was never designed to capture. Williamson’s framework implicitly assumes a unidimensional linear transition from divergence to convergence, where the reduction in overall inequality signals a genuine balancing of development. Our variance decomposition flatly contradicts this assumption. While the overall Gini fell, the contribution of material-wealth gaps surged from approximately 25 percent to 45 percent, and the urban-rural gap shifted from a negative equalising contribution to a positive polarising contribution. In other words, the reduction in overall inequality was achieved largely through the narrowing of inter-provincial gaps, which account for only 11 percent of total inequality, while intra-provincial fractures along wealth and spatial lines deepened. This constitutes a compositional fallacy in the inverted-U framework. A declining aggregate Gini does not imply balanced convergence; rather, it signals a replacement of one form of inequality, inter-regional disparities, by another more pernicious form, intra-regional material and urban-rural divides. The GYG case suggests that the inverted-U curve may be a statistical artefact when applied to multi-dimensional settings, and scholars should disaggregate the quality of convergence rather than merely tracking its quantity.

Our results also sharpen the critique of the trickle-down assumption, moving beyond Rodríguez-Pose’s emphasis on agglomeration forces and institutional inertia. While Rodríguez-Pose rightly argues that growth in peripheral regions often fails to diffuse spatially, the GYG experience reveals an even more uncomfortable truth. Even when trickle-down does occur in aggregate terms, as evidenced by rising per-capita incomes across nearly all cities, it

remains geographically selective and structurally partial. The persistent gap between metropolitan cores such as Kunming, Guiyang, and Liuzhou and peripheral cities like Zhaotong, Bijie, and Guigang confirms that agglomeration suction, the concentration of skilled labour, fiscal capacity, and productive investment in provincial capitals, consistently offsets the equalising effects of faster peripheral growth rates. More critically, the pronounced provincial heterogeneity we uncovered, with Guangxi's spiritual-wealth dominance, Yunnan's material-wealth lock-in, and Guizhou's regional structural gaps, exposes a fundamental blind spot in the trickle-down literature. It treats peripherality as a homogeneous condition, whereas our evidence shows that the binding constraints on diffusion are qualitatively different across provinces. In Yunnan, trickle-down fails because the industrial base is too narrow and resource-extractive. In Guangxi, it fails because cultural capital, which mediates livelihood diversification, is unevenly distributed and cannot be substituted by income transfers. In Guizhou, it fails because infrastructure investments, though massive, are spatially biased toward the Guiyang–Zunyi corridor, creating a growth skeleton without peripheral flesh.

Perhaps the most provocative departure from Rodríguez-Pose lies in the political economy of our findings. Rodríguez-Pose attributes persistent inequality largely to market-driven agglomeration and the retreat of state intervention. In contrast, the GYG region's convergence trajectory is overwhelmingly policy-driven, propelled by Western Development Strategy fiscal transfers, targeted poverty alleviation, and infrastructure mega-projects, rather than by autonomous market correction. This raises a challenging paradox. While policy intervention successfully curbed overall inequality, achieving a 42 percent Gini reduction, it simultaneously engendered new structural imbalances. The negative coefficient of the urban-rural gap in our QAP regression, for instance, does not signal genuine rural catch-up but rather a low-level convergence where urban income growth stagnated relative to rural areas in the poorest cities, an effect of poverty alleviation raising the floor without raising the ceiling. This implies that policy-driven convergence may be inherently brittle. It can compress superficial disparities such as provincial averages while entrenching deeper dimension-specific divides that are harder to detect and reverse. If the intensity of fiscal transfers were to subside, we would expect regional and material divides to rebound sharply, exposing the weakness of relying on administrative redistribution without fostering endogenous market diffusion.

Finally, our findings directly qualify the temporal optimism embedded in both theories. Williamson's hypothesis predicts a natural self-sustaining narrowing of inequality once a country passes a certain development threshold. Yet the GYG's transition from a multidimensionally balanced inequality structure to a material-and-spatial dominated one suggests that convergence is not a monotonic irreversible process. It is a path-dependent trajectory shaped by the sequencing of policy interventions. The 2020 to 2022 pandemic period, during which the region maintained welfare gains without widening disparities, underscores the protective role of redistributive state capacity. But it also signals that without continuous structural recalibration, for instance redirecting fiscal dividends to lagging counties or digitalising cultural resource sharing, the region risks trading old inequalities for new ones. We therefore propose a structural recomposition hypothesis as a necessary supplement to the inverted-U and trickle-down frameworks. Aggregate inequality may decline even as structural inequality, defined as the variance contribution of key well-being dimensions, intensifies. The direction of this recomposition, whether towards or away from genuine inclusive development, depends critically on whether policy targets the dominant binding constraint specific to each sub-region, be it spiritual, material, or regional, rather than applying a uniform convergence prescription. This

proposition, we argue, holds particular relevance for analogous multi-ethnic ecologically fragile borderlands in the Global South, where the trade-offs between aggregate growth, structural equity, and cultural-ecological assets are far more acute than the canonical theories assume.

6.3 Research Limitations and Future Directions

This study takes the GYG region in Southwest China's multi-ethnic mountainous area as a case, constructing an inclusive development evaluation indicator system based on panel data from 39 prefecture-level cities over 2013–2024, and analysing internal development disparities and their structural sources. The evaluation dimensions cover seven aspects—material affluence, spiritual affluence, ecological affluence, urban–rural gaps, regional gaps, demographic gaps, and public service gaps—which are generally comprehensive. However, in terms of indicator selection, on the one hand, due to statistical yearbook constraints and data availability, all selected indicators are at the prefecture-level city scale, which may mask finer spatial heterogeneity at the county and township levels. The GYG multi-ethnic mountainous area often exhibits a nested differentiation pattern of strong cities but weak counties, and future research should attempt to disaggregate the analysis to the county level while introducing nighttime light remote sensing data as a complementary measure of economic activity. On the other hand, the proxy indicators for spiritual and ecological affluence, such as the number of intangible cultural heritage items and PM2.5 concentration, largely reflect inputs or stocks rather than residents' actual cultural engagement and ecological benefits; future studies could incorporate subjective inclusive development survey data to construct an objective-subjective dual-track evaluation framework.

All data used in this study are annual panel data. For rapidly evolving regional development processes, annual data may lag behind actual developmental dynamics, potentially introducing some deviation between analytical results and real-time conditions. Furthermore, the GYG region spans the transition zone from the Yunnan–Guizhou Plateau to the Guangxi hills, characterised by complex and diverse geographical conditions and significant vertical climatic zonation. These factors may exert substantial influence on the spatial development pattern of the region, yet the present study has not fully accounted for the specificities of geographic and climatic factors or their interactions with policy effects. Regional development is deeply shaped by national and local policies and institutional environments, and different policy instruments, such as fiscal transfers, industrial support, and ecological compensation, may produce differentiated effects in promoting inclusive development. Therefore, future research should further employ quasi-experimental methods, such as difference-in-differences or regression discontinuity design, to identify the causal effects of key policies on inclusive development in the GYG.

7 Conclusion

Based on panel data from 39 prefecture-level cities in the GYG region over 2013–2024, this study employs the VHSD dynamic evaluation method to measure inclusive development levels, uses Dagum Gini coefficient decomposition to identify spatial sources of disparities, and applies QAP regression to uncover the contributor of inter-city welfare gaps, systematically analysing the spatiotemporal evolution and structural determinants of inclusive development in multi-ethnic mountainous regions. The main conclusions are as follows:

(1) Inclusive development levels have improved steadily, yet growth paths differ markedly across provinces. During 2013 – 2024, the inclusive development index of the three GYG provinces continued to rise. Guizhou exhibited the strongest catch-up effect, with cumulative

growth of 100.35% and an average annual growth rate of 7.20%, while Guangxi and Yunnan experienced more moderate and stable growth. The absolute level of the affluence dimension consistently exceeded that of the shared prosperity dimension, yet the average annual growth rate of shared prosperity outpaced that of affluence, indicating that distributional equity is accelerating.

(2) Overall disparities have narrowed substantially, but intra-provincial inequality remains the dominant source. The regional Gini coefficient fell from 0.0924 to 0.0534, a reduction of 42%. Intra-provincial disparities contributed an average of 92.21% to total inequality, while inter-provincial gaps accounted for only 11.41%. The structural sources are transitioning from a multidimensionally balanced pattern toward one increasingly dominated by material-wealth and spatial divides: the contribution of material-wealth gaps surged from approximately 25% to 45%, while urban-rural gaps shifted from negative to positive and continued to expand.

(3) Significant provincial heterogeneity exists in the core driving factors. Full-sample QAP regression reveals that regional disparities and material-wealth gaps are the two core drivers of overall inequality. The three provinces face distinct binding constraints: Guangxi is dominated by spiritual-wealth gaps, Yunnan by material-wealth differentials, and Guizhou by regional structural gaps, suggesting that uniform policies cannot effectively address the differentiated challenges across provinces.

References

- [1]Alkire Sabina,Kövesdi Fanni,Scheja Elina & Vollmer Frank.(2023).Moderate Multidimensional Poverty Index: Paving the Way Out of Poverty..Social indicators research,168(1-3),31-37.<https://doi.org/10.1007/S11205-023-03134-5>.
- [2]Jeffrey G. Williamson.(1965).Regional Inequality and the Process of National Development: A Description of the Patterns.Economic Development and Cultural Change,13(4),1-84.
- [3]Andr é s Rodr í guez Pose.(2015).Trade and Regional Inequality.Economic Geography,88(2),109-136.
- [4]Atkinson Anthony B.(1970).On the measurement of inequality.Journal of Economic Theory,2(3),244-263.[https://doi.org/10.1016/0022-0531\(70\)90039-6](https://doi.org/10.1016/0022-0531(70)90039-6).
- [5]Amartya Sen.(1985).Well-being and Freedom.Journal of Philosophy,82(4),185-203.
- [6]Chen KeMei,Leu ChaoHsien & Wang TeMu.(2019).Measurement and Determinants of Multidimensional Poverty.Social Indicators Research,145(2),459-478.
- [7]Jiantuo Yu.(2013).Multidimensional Poverty in China: Findings Based on the CHNS.Social Indicators Research,112(2),315-336.<https://doi.org/10.1007/s11205-013-0250-x>.
- [9]Costanza R ,D'Arge R ,Groot D R , et al.(1997).The value of the world's ecosystem services and natural capital.Nature: International weekly journal of science,387(6630):253-260.<https://doi.org/10.1038/387253a0>.
- [9]DAVID THROSBY.(1999).Cultural Capital.Journal of Cultural Economics,23(1/2),3-12.
- [10]Jason Hickel.(2020).The sustainable development index: Measuring the ecological efficiency of human development in the anthropocene.Ecological Economics,167,106331-106331.<https://doi.org/10.1016/j.ecolecon.2019.05.011>.
- [11]Fang Wang & Xin Li.(2026).Multidimensional evaluation and strategic framework for integrated development of urban agglomerations in underdeveloped regions..PloS one,21(4),e0345887.<https://doi.org/10.1371/JOURNAL.PONE.0345887>.
- [12]Guo Tao & Wang Yu. (2022). Minzu ba sheng diqu gongtong fuyu pingjia yu zhang'ai yinsu fenxi [Evaluation and obstacle factors of common prosperity in the eight ethnic provinces and

- regions]. *Journal of China Executive Leadership Academy* Yan'an, 15(6), 55-62+89.<https://doi.org/10.16223/j.cnki.cn61-1456/c.2022.06.002>. (in Chinese)
- [13]Wu Tong & Zhang Yuepin. (2023). Xibu diqu gongtong fuyu shuiping cedu fenxi [Measurement and analysis of common prosperity level in western China]. *Journal of South-Central Minzu University (Natural Science Edition)*, 42(2), 274 - 282. <https://doi.org/10.20056/j.cnki.ZNMDZK.20230219>.(in Chinese)
- [14]Ma Zhaoming & Liu Ru. (2024). Zhongguo gongtong fuyu shuiping zonghe pingjia ji shikong yanbian fenxi [Comprehensive evaluation and spatiotemporal evolution analysis of China's common prosperity level]. *Statistics & Decision*, 40(19), 44 - 48. <https://doi.org/10.13546/j.cnki.tjyjc.2024.19.007>.(in Chinese)
- [15]Feng Yuan & Nie Changfei. (2024). Gongtong fuyu pingjia zhibiao tixi goujian yu shizheng cedu [Construction of common prosperity evaluation index system and empirical measurement]. *Statistics & Decision*, 40(2), 73 - 77.<https://doi.org/10.13546/j.cnki.tjyjc.2024.02.013>. (in Chinese)
- [16]Ding Hailing & He Quanling. (2024). Guizhou gongtong fuyu yu minzu tuan jie shuang qudong fazhan lujing yanjiu [Research on the dual-driven development path of common prosperity and ethnic unity in Guizhou]. *Guizhou Ethnic Studies*, 45(03), 75-81.<https://doi.org/10.13965/j.cnki.gzmzyj10026959.2024.03.011>. (in Chinese)
- [17]Wang Daoyong & Wang Qing. (2023). Yi cujin gongtong fuyu zhulao zhonghua minzu gongtongti yishi [Consolidating the sense of community for the Chinese nation by promoting common prosperity]. *Guizhou Ethnic Studies*, 44(06), 66-71.<https://doi.org/10.13965/j.cnki.gzmzyj10026959.2023.06.009>. (in Chinese)
- [18]World Bank. (2008). *World development report 2009: Reshaping economic geography*.
- [19]Zhang Xin & Mao Jiaqi. (2024). Gongtong fuyu yu zhulao zhonghua minzu gongtongti yishi guanxi de bianzheng fenxi [A dialectical analysis of the relationship between common prosperity and consolidating the sense of community for the Chinese nation]. *Journal of Xinjiang University-Philosophy and Social Sciences Edition*, 52(04), 15-23.<https://doi.org/10.13568/j.cnki.issn1000-2820.2024.04.003>. (in Chinese)
- [20]Zhou Nannan & Li Ajian. (2024). Gongtong fuyu Beijing xia zhongguo zhongdeng shouru qunti guimo cedu ji zhiliang zhuizong [Scale measurement and quality tracking of China's middle-income group under the background of common prosperity]. *Statistics & Information Forum*, 39(06), 114-128. (in Chinese)
- [21]Jianmei Tan, Jiayan Liu, Yi Zou & Xiaoshu Wei. (2026). Spatial influencing factors and protection strategies of traditional villages in ethnic areas: A case study of Guangxi.. *PloS one*, 21(4), e0336147. <https://doi.org/10.1371/JOURNAL.PONE.0336147>.
- [22]Biggeri Mario, Bortolotti Luca & Mauro Vincenzo. (2020). The Analysis of Well - Being Using the Income - Adjusted Multidimensional Synthesis of Indicators: The Case of China. *Review of Income and Wealth*, 67(3), 684-704. <https://doi.org/10.1111/ROIW.12488>.
- [23]Auke Rijpmma, Robin C. M. Philips & Bas J. P. van Bavel. (2024). Multidimensional composite indicators of well - being: Applications in economic history. *Journal of Economic Surveys*, 39(2), 672-705. <https://doi.org/10.1111/JOES.12622>.
- [24]Guo Yajun. (2002). Yizhong xinde dongtai zonghe pingjia fangfa [A new dynamic comprehensive evaluation method]. *Journal of Management Sciences in China*, (2), 49 - 54. (in Chinese)
- [25]Krackardt David. (1987). QAP partialling as a test of spuriousness. *Social Networks*, 9(2), 171-186. [https://doi.org/10.1016/0378-8733\(87\)90012-8](https://doi.org/10.1016/0378-8733(87)90012-8).

- [26]Krugman Paul. (1991). Increasing Returns and Economic Geography. *Journal of Political Economy*, 99(3), 483-499.
- [27]Shatakshee Dhongde,Prasanta K. Pattanaik & Yongsheng Xu.(2019).Well - Being, Deprivation, and the Great Recession in the U.S.: A Study in A Multidimensional Framework.Review of Income and Wealth,65(s1),S281-S306.<https://doi.org/10.1111/roiw.12411>.

Statements & Declarations

Funding

This work was supported by the author W.W. through the Western Project of the National Social Science Foundation of China, titled "Research on the Coupling Mechanism of High-Quality Tourism Development and Common Prosperity in Ethnic Areas of Guangxi, Yunnan, and Guizhou," with grant number 22XMZ016. The funders played no role in study design, data collection and analysis, the decision to publish, or the preparation of the manuscript.

Competing Interests:

The authors have no relevant financial or non-financial interests to disclose.

Author contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Wei Wang, Yanxi Kuang, Yonglin Lu and Haiyang Wang. The first draft of the manuscript was written by Yanxi Kuang and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Conceptualization: Wei Wang; Data curation:Yanxi Kuang, Yonglin Lu and Haiyang Wang; Formal analysis: Yanxi Kuang, Yonglin Lu and Haiyang Wang; Funding acquisition: Wei Wang; Investigation: Wei Wang; Methodology: Yanxi Kuang, Yonglin Lu; Project administration: Wei Wang; Resources: Wei Wang ;Software: Yanxi Kuang; Supervision: Wei Wang; Validation: Yonglin Lu and Haiyang Wang; Visualization: Yonglin Lu and Haiyang Wang; Writing – original draft: Yanxi Kuang; Writing – review & editing: Wei Wang, Yanxi Kuang.

Ethics approval

This study does not involve human participants, nor does it involve research on data or biological materials from animals.

Data availability statements

The research data used in this study have been uploaded to Figshare; the relevant link is: <https://doi.org/10.6084/m9.figshare.32946791>