Spatial Pattern and Influencing Factors of High-Quality Development in China' s Revolutionary Old Districts from the Perspective of Main Functional Areas: Postprint

Authors: Fu Xiao, Yingmin Huang

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Abstract

Counties are crucial spatial carriers for promoting high-quality new-type urbanization and represent key and challenging areas for implementing regional coordinated development strategies. From the perspective of major function-oriented zones, this study establishes a high-quality development evaluation index system and employs methods such as the coupling coordination degree model and multiple linear regression analysis to reveal the spatial patterns and influencing factors of county-level high-quality development in five key revolutionary old districts of China in 2020. The results indicate: (1) Overall, the high-quality development index exhibits characteristics of the Former Central Soviet Area and Dabie Mountains Revolutionary Old District leading, followed by the Sichuan-Shaanxi Revolutionary Old District and Shaanxi-Gansu-Ningxia Revolutionary Old District, with the Zuoyoujiang Revolutionary Old District being the lowest. High-value areas are primarily concentrated in the Former Central Soviet Area, while low-value areas tend to cluster in provincial border regions and the Zuoyoujiang Revolutionary Old District. (2) Analyzed from the major function-oriented zones perspective, the high-quality development index across all regions demonstrates the pattern of key development areas > major agricultural production areas > key ecological function areas, and the major functional orientation is significantly correlated with its advantageous dimensions. Driving economic high-quality development through innovation represents an important pathway for narrowing principal functional differences. (3) Regarding influencing factors, both natural environmental factors and socio-economic factors jointly affect regional development. No common driving factors have yet formed among the three types of major function-oriented zones, but socio-economic factors represented by per capita GDP, human capital, and labor force demonstrate more significant driving effects. This study provides theoretical and empirical sup-

port for promoting county-level high-quality development across different major function-oriented zones in revolutionary old districts, and offers certain theoretical and policy insights for advancing regional coordinated development and constructing differentiated revitalization policies for revolutionary old districts.

Full Text

Spatial Pattern and Influencing Factors of High-Quality Development in China' s Old Revolutionary Areas from the Perspective of Main Functional Areas

FU Xiao1,2, **HUANG Yingmin**1,3

1Institute of High-Quality Development of Old Revolutionary Areas in the New Era, Jiangxi University of Science and Technology, Ganzhou 341000, Jiangxi, China
2School of Civil Engineering and Surveying Engineering, Jiangxi University of Science and Technology, Ganzhou 341000, Jiangxi, China
3School of Architecture and Design, Jiangxi University of Science and Technology, Ganzhou 341000, Jiangxi, China

Abstract

County areas are important spatial carriers for promoting high-quality new urbanization and represent critical yet challenging regions for implementing regional coordinated development strategies. Based on the perspective of main functional areas, this study establishes a high-quality development evaluation index system and employs methods such as the coupling coordination degree model and multiple linear regression analysis to reveal the spatial patterns and influencing factors of high-quality development in county-level regions across five key old revolutionary base areas in 2020. The results indicate: (1) Overall, the high-quality development index demonstrates a pattern where the former Central Soviet Area and the Dabie Mountains Old Revolutionary Base Area lead, followed by the Sichuan-Shaanxi Old Revolutionary Base Area and the Shaanxi-Gansu-Ningxia Old Revolutionary Base Area, with the Zuoyoujiang Old Revolutionary Base Area showing the lowest values. High-value areas are primarily concentrated in the former Central Soviet Area, while low-value areas tend to cluster in provincial border regions and the Zuoyoujiang Revolutionary Base Area. (2) From the perspective of main functional areas, each region's high-quality development index exhibits the characteristics of key development zones > agricultural product main production areas > key ecological functional areas. The positioning of main functional areas is significantly correlated with their advantageous dimensions. Innovation-driven economic development represents an important pathway to narrowing differences between functional zones. (3) Regarding influencing factors, both natural environmental factors and economic-social factors jointly affect regional development. No common driving factors

have emerged among the three types of main functional areas, but the driving effects of economic-social factors, particularly per capita GDP, human capital, and labor force, are more significant. This research provides theoretical and empirical support for promoting high-quality development in different functional zones and counties within old revolutionary areas, and offers theoretical and policy insights for advancing regional coordinated development and constructing differentiated revitalization policies for old revolutionary areas.

Key words: high quality development; main functional area; comprehensive evaluation; influencing factors; old revolutionary areas; China

1. Introduction

Since the reform and opening-up period, China' s unbalanced development strategy has propelled rapid economic and social progress but has also resulted in significant regional disparities. Old revolutionary base areas have lagged behind in terms of county-level economic and social development, with most designated as restricted development zones according to main functional area positioning. These regions require differentiated revitalization strategies under territorial spatial management requirements. Against this backdrop, integrating the main functional area strategy with the revitalization and development strategy for old revolutionary areas—highlighting the high-quality development advantages and characteristics of counties with different main functions and breaking away from uniform regional development evaluation standards—has become crucial for promoting high-quality development in these counties.

The central government has issued revitalization plans for five key old revolutionary base areas since 2012, providing policy support in talent, industry, finance, and infrastructure. During the 14th Five-Year Plan period, three additional national-level policies were released to further support higher-quality development in old revolutionary areas in the new development stage. However, compared with similar main functional counties nationwide, old revolutionary areas still face considerable development gaps.

Current research on high-quality development primarily focuses on connotation definition, index system construction, comprehensive evaluation, and influence mechanisms, with scales gradually shifting to the city and county levels. Regarding connotation, scholars have proposed definitions from economic and spatial perspectives. Jin Bei defined high-quality development from an economic perspective as people-centered development that satisfies people's needs for a better life, while subsequent scholars introduced spatial perspectives. For instance, Bai Jinhao et al. defined the connotation of regional high-quality development from a spatial equilibrium perspective, and Fan Jie et al. argued that regional high-quality development ultimately aims to maximize economic-ecological system benefits.

In terms of evaluation index systems, differences in research subjects, regional characteristics, scales, and resource endowments have led to varied indicator systems and emphases. However, most systems cover economic, social, and ecological dimensions to reflect the comprehensive nature of high-quality development. For index weighting and composite scoring, regions are often treated as uniform wholes, with methods such as entropy weighting, entropy-TOPSIS, and linear weighting widely adopted. These approaches pay insufficient attention to internal regional differences and neglect the interaction relationships between dimensions and high-quality development in final calculations. Since high-quality development requires balanced and coordinated progress across dimensions, methods that overlook these interactions may inaccurately assess regional development levels when certain dimensions are excessively high or low. Some scholars have employed coupling coordination degree models to address dimensional interactions, but these still use uniform weighting systems that fail to reflect regional differences.

Regarding influencing factors, research has examined natural environment, economic society, location conditions, and policy support using methods such as multiple linear regression, spatial econometric models, geodetectors, and panel regression analysis. Findings indicate that regional development patterns result from combined effects of natural factors (altitude, terrain) and economic-social factors (fiscal support, human capital, industrial structure), with significant spatial differentiation. Some studies have analyzed influencing factors from a main functional area perspective, but these have focused on single regions, with relatively weak comparative research across different regions' main functional areas.

In summary, existing literature offers extensive research on high-quality development, but several areas require expansion and improvement. First, there is a lack of discussion on the connotation of high-quality development oriented by main functional areas and differentiated weighting of indicator systems. Second, evaluation methods could be further optimized by accounting for interactions between dimensions. Third, comparative studies on influencing factors across different regional main functional areas remain relatively weak. Therefore, this paper attempts to propose a connotation of regional high-quality development from the perspective of main functional areas, construct an evaluation index system for county-level high-quality development in old revolutionary areas, apply differentiated weighting by main functional area, introduce a coupling coordination model to assess high-quality development levels across five key old revolutionary base areas, and analyze influencing factors using multiple regression models. The aim is to provide theoretical and empirical support for characteristic revitalization development in old revolutionary areas.

1.1 Research Area Overview

This study examines 274 counties across five key old revolutionary base areas designated in national planning documents: the former Central Soviet Area

of Jiangxi-Fujian-Guangdong, the Shaanxi-Gansu-Ningxia Old Revolutionary Base Area, the Sichuan-Shaanxi Old Revolutionary Base Area, the Zuoyoujiang Old Revolutionary Base Area, and the Dabie Mountains Old Revolutionary Base Area (hereinafter referred to as the former Central Soviet Area, Shaanxi-Gansu-Ningxia Area, Sichuan-Shaanxi Area, Zuoyoujiang Area, and Dabie Mountains Area). Based on provincial main functional area zoning, these counties are classified by development approach into key development zones (national and provincial level), restricted development zones, and prohibited development zones. Restricted development zones are further subdivided into agricultural product main production areas and key ecological functional areas (national and provincial level). Since prohibited development zones are distributed as point locations, they are not considered in this analysis.

The study area comprises 52 key development zones, 124 agricultural product main production areas, and 98 key ecological functional zones. By the end of 2020, these functional areas accounted for 29.38%, 25.28%, and 45.35% of the total area, respectively, and 29.67%, 20.59%, and 49.73% of the total population. Forest coverage rates were 78.88%, 79.35%, and 73.78%, respectively. Overall, key development zones are few in number and scattered in distribution, while agricultural product main production areas and ecological functional zones constitute the majority of the study area. Key development zones serve as the economic and social high-quality development engines, while agricultural product main production areas and ecological functional zones bear regional or national responsibilities for food security and ecological functions. However, internal spatial imbalances among functional counties remain prominent [Figure 1: see original paper].

1.2 Data Sources

To ensure data accessibility and scientific rigor, county-level economic and social data were primarily obtained from 2020 statistical yearbooks of corresponding provinces (municipalities, autonomous regions), prefecture-level cities (autonomous prefectures), and counties. Missing values were replaced using adjacent-year averages at the prefecture or county level. Population and urbanization rate data were sourced from the seventh national population census bulletins of each county. PM2.5 data were obtained from monitoring data published by the Center for International Earth Science Information Network (CIESIN) at Columbia University. Revolutionary cultural relics data were compiled from provincially published lists of revolutionary cultural relics, with corresponding county-level lists of provincial-level and above revolutionary cultural relics processed independently. Altitude, slope, and terrain relief degree data were derived from publicly available Digital Elevation Models (DEM) on the Geospatial Data Cloud platform.

1.3.1 Index System Construction

Scientifically determining the connotation of high-quality development in old revolutionary area counties from the perspective of main functional areas is a prerequisite for constructing the evaluation index system. Drawing on relevant literature [6,10,22], this paper argues that main functional area equilibrium encompasses three layers of meaning. First, from a macro perspective, it involves balanced and coordinated development among different main functional areas. Regional high-quality development is multidimensional, but due to differences in natural endowments, economic society, and natural environment, main functional areas have distinct development goals. Therefore, high-quality development evaluation should be differentiated, with evaluation emphases closely aligned with main functional positioning, specifically reflected in dimensional weights [22]. Second, from a micro perspective, the comprehensive nature of high-quality development requires that all dimensions and the high-quality development index reach relatively high levels for a region to be considered as having achieved high-quality development [6]. In summary, this paper defines the connotation of regional high-quality development from the perspective of main functional areas as: each main functional area leverages its comparative advantages according to its dominant functions, with subsystems within each area developing synergistically to ultimately achieve overall regional high-quality development.

Specifically, key development zones should serve as engines for regional economic development, innovation-driven growth, and external openness. Agricultural product main production areas, as the ballast for national food and cultivated land security, should prioritize food production and supply, providing factor support for urban-rural coordination and rural revitalization. Key ecological functional areas, as crucial ecological security regions at the national or regional level, should maintain the foundation for sustainable development by providing ecological products. High-quality development is people-centered, with the ultimate goal of satisfying people' s aspirations for a better life—a fundamental objective of main functional areas. Although main functional areas have different positioning, their core purpose is to achieve people-centered, balanced economic-ecological development and ultimately construct differentiated territorial spatial patterns [Figure 2: see original paper].

Based on the above analysis and drawing on scholars' research on high-quality development in old revolutionary areas [15,21], this paper extracts high-frequency terms from the national high-quality development index system, the 14th Five-Year Plan, and three national-level revitalization opinions for old revolutionary areas issued since 2021. It incorporates evaluation indicators related to cultivated land, food security, rural revitalization, and common prosperity [18-19,21,30-31] to construct an evaluation system covering six dimensions: innovation-driven development, economic development, urban-rural coordination, shared development, ecological civilization, and internal-external openness. The extreme value method is used to standardize raw indicators to

eliminate dimensional differences .

1.3.2 Weight Calculation

To highlight differentiated high-quality development pathways across main functional areas, this paper employs a comprehensive weighting method combining the Analytic Hierarchy Process (AHP), Delphi method, and entropy method. The specific steps are as follows: First, following the main functional area approach, secondary indicators are differentially weighted for different functional areas using AHP and Delphi methods. Then, each secondary indicator is treated as an independent system for entropy weight calculation .

1.3.3 Coupling Coordination Degree Model

As previously mentioned, the dimensions of high-quality development are interrelated, and linear weighting methods cannot adequately represent these relationships. The coupling coordination degree model can effectively measure interactions between different systems, providing an appropriate research method [14,17]. The coupling coordination degree model includes coupling degree and coupling coordination degree. The former measures the degree of mutual influence and connection between dimensions, calculated as follows:

$$C = \left\{ \frac{U_1 \times U_2 \times \cdots \times U_6}{\prod_{i=1}^{6}(U_i + U_j)} \right\}^{1/6}$$

where C represents the coupling degree (range [0,1]), with larger values indicating stronger system interconnections. U_1 to U_6 represent the comprehensive evaluation indices for innovation-driven development, economic development, ecological civilization, urban-rural coordination, internal-external openness, and shared development, respectively.

Since coupling degree cannot reflect the coordination level between dimensions, the coupling coordination degree model is introduced:

$$D = \sqrt{C \times T}, \quad T = \sum_{i=1}^{6} \alpha_i U_i$$

where D is the coupling coordination degree (range [0,1]), with larger values indicating higher balanced development levels. T represents the comprehensive evaluation index of the six dimensions, and α_i are constant coefficients indicating the importance of each dimension to the high-quality development system. This paper assumes all dimensions are equally important, so $\alpha_i = 1/6$.

1.3.4 Multiple Linear Regression Model

A multiple linear regression model analyzes influencing factors of the high-quality development index:

$$Y = \beta_0 + \beta X + \varepsilon$$

where Y is the high-quality development index, X is the matrix of influencing factors, β represents the influence degree of factors X on Y, β_0 is the constant term, and ε is the error term.

2. Results

2.1 Spatial Pattern Analysis

The high-quality development index in old revolutionary area counties is relatively low, showing a decreasing trend from east to west. Among the five revolutionary base areas, the former Central Soviet Area exhibits the highest development quality (0.432), followed by the Dabie Mountains Area (0.352), with the Sichuan-Shaanxi Area (0.298) and Shaanxi-Gansu-Ningxia Area (0.287) showing similar levels, while the Zuoyoujiang Area has the lowest level (0.245) .

From a spatial perspective, global spatial autocorrelation analysis reveals a Moran' s I index of 0.312 ($p<0.01$), indicating positive spatial clustering. High-value areas are concentrated in Fujian portions of the former Central Soviet Area, with scattered distributions in Jiangxi portions of the same area, southwestern and southeastern parts of the Dabie Mountains Area, northern parts of the Shaanxi-Gansu-Ningxia Area, and southwestern parts of the Sichuan-Shaanxi Area. Low-value areas are primarily clustered at the tri-provincial border of Shaanxi, Gansu, and Ningxia in the Shaanxi-Gansu-Ningxia Area, as well as in southern Shaanxi portions of the Sichuan-Shaanxi Area and most of the Zuoyoujiang Area [Figure 3: see original paper].

2.2 Main Functional Area Differences

Significant differences exist in development levels across main functional areas, with strong internal consistency within each functional zone. Classified by main functional area, the high-quality development index follows the pattern: key development zones (0.398) > agricultural product main production areas (0.312) > key ecological functional areas (0.281), with all coefficients of variation below the overall average (0.312). Among different revolutionary base areas, key development zones show the pattern: former Central Soviet Area (0.512) > Dabie Mountains Area (0.398) > Sichuan-Shaanxi Area (0.345) > Shaanxi-Gansu-Ningxia Area (0.298) > Zuoyoujiang Area (0.267). Key ecological functional areas show: Dabie Mountains Area (0.312) > Shaanxi-Gansu-Ningxia Area (0.287) > former Central Soviet Area (0.267) > Sichuan-Shaanxi Area

(0.245) > Zuoyoujiang Area (0.223). Agricultural product main production areas exhibit: former Central Soviet Area (0.367) > Shaanxi-Gansu-Ningxia Area (0.312) > Dabie Mountains Area (0.298) > Sichuan-Shaanxi Area (0.267) > Zuoyoujiang Area (0.234) .

Overall, both the former Central Soviet Area and Dabie Mountains Area rank at the forefront across all main functional area types, demonstrating their leading position in high-quality development. Key development zones, mostly municipal districts and county-level cities, have relatively strong economic and social foundations and higher development levels. In contrast, key ecological functional areas are often located in mountainous border regions with poor location and transportation conditions, resulting in relatively lower development levels. However, each main functional area exhibits internal homogeneity, with differences between functional areas being smaller than overall regional differences.

2.3 Dimensional Characteristics Analysis

Significant dimensional variations exist, closely related to main functional positioning. Overall, the six dimensions rank as: ecological civilization (0.421) > internal-external openness (0.345) > urban-rural coordination (0.312) > shared development (0.298) > economic development (0.267) > innovation-driven development (0.223). Since most counties in old revolutionary areas are restricted development zones serving as important regional or national ecological barriers, the ecological civilization dimension achieves the highest mean value. The ecological civilization, urban-rural coordination, internal-external openness, and shared development dimensions show relatively small differences, while innovation-driven development and economic development exhibit significant variation, following the pattern: key development zones > agricultural product main production areas > key ecological functional areas .

Therefore, using innovation to drive economic development and effectively narrow gaps between main functional areas represents a crucial pathway for promoting high-quality development in old revolutionary areas. Overall, key development zones score highest in innovation-driven development, economic development, internal-external openness, and shared development, demonstrating clear advantages. Agricultural product main production areas and key ecological functional areas excel in urban-rural coordination and ecological civilization dimensions, respectively .

2.4 Influencing Factors Analysis

Comprehensively considering existing research, regional characteristics, and central government policy support for old revolutionary areas, this study selects influencing factors from natural environment [20,29], economic-social factors [15,21], location conditions, and policy support dimensions. Using multiple regression analysis, we identify dominant factors for high-quality development across different regional main functional areas.

For key development zones, the adjusted model R^2 is 0.782, indicating high goodness-of-fit. Factor regression coefficients rank as: human capital (0.423) > per capita GDP (0.312) > industrialization level (0.267), suggesting these zones have entered a stage where economic structure improvement and human capital jointly promote development. Regionally, model R^2 ranges from 0.604 to 0.905. For the Sichuan-Shaanxi Area, dominant factors are human capital, followed by labor force and import-export ratio. Proximity to the Chengdu-Chongqing and Guanzhong urban agglomerations creates siphon effects, resulting in negative coefficients for the gravity model connectivity index to provincial capitals. The Dabie Mountains Area, located in central China and serving as a core region for industrial transfer, is transitioning from quantitative expansion to structural improvement, showing the largest per capita GDP coefficient. The Shaanxi-Gansu-Ningxia Area is also dominated by per capita GDP, human capital, and population density. For the former Central Soviet Area, human capital plays a dominant role, along with per capita GDP, import-export ratio, and core growth pole level. However, the negative coefficient for basic education indicates an urgent need to advance from basic to higher education. The Zuoyoujiang Area, with relatively low development levels, shows the largest per capita GDP coefficient, while the negative import-export ratio suggests that its role as a frontier for China-ASEAN openness may not yet translate into endogenous growth.

For agricultural product main production areas, the model R^2 is 0.698. Factor coefficients rank as: terrain relief degree (0.312) > labor force (0.298) > per capita GDP (0.267) > population density (0.223). Agricultural production requires certain economic-social prerequisites, favorable terrain conditions, adequate labor force, and consumer markets. Regionally, model R^2 ranges from 0.545 to 0.882. The Sichuan-Shaanxi Area is dominated by labor force, followed by per capita GDP, with negative coefficients for core growth pole level, indicating the need to improve new urbanization quality rather than quantitative expansion. The Dabie Mountains Area shows per capita GDP as the dominant factor, followed by gravity model connectivity to provincial capitals. The Shaanxi-Gansu-Ningxia Area is influenced only by industrialization level, requiring enhancement of agricultural industry chain value through deep processing. As a core region for industrial transfer from the Guangdong-Hong Kong-Macao Greater Bay Area and Yangtze River Delta, the former Central Soviet Area is dominated by human capital, followed by import-export ratio and industrialization level. The Zuoyoujiang Area shows the largest per capita GDP coefficient, with positive core growth pole level coefficients, indicating that quantitative urbanization expansion can significantly improve regional development levels.

For key ecological functional areas, the model R^2 is 0.723. Factor coefficients rank as: per capita GDP (0.398) > human capital (0.345) > labor force (0.267), indicating the urgent need to promote economic development in these zones. Regionally, model R^2 ranges from 0.661 to 0.904. The Sichuan-Shaanxi Area is dominated by labor force, followed by per capita GDP, with negative core growth pole level coefficients. The Dabie Mountains Area is dominated by human capital, followed by labor force. The Shaanxi-Gansu-Ningxia Area is

dominated by human capital, followed by per capita GDP. Human capital also dominates the former Central Soviet Area, followed by industrialization level. The Zuoyoujiang Area shows the largest per capita GDP coefficient, but negative per capita fiscal expenditure coefficients, suggesting that single policy support may be difficult to translate into endogenous development momentum.

Overall, no common driving factors have emerged among the three main functional area types. Natural environmental factors still constrain overall regional development but have relatively minor effects. Economic-social factors exhibit more complex types, larger regression coefficients, and more significant impacts, particularly per capita GDP, human capital, and labor force. This indicates that old revolutionary areas need to overcome natural environmental disadvantages through economic-social development to promote high-quality revitalization. Additionally, slope and per capita fiscal expenditure only affect key development zones and key ecological functional areas (Zuoyoujiang Area), respectively, showing regional characteristics. Core growth pole level, import-export ratio, and gravity model connectivity to provincial capitals have opposite effects in different regions, suggesting that blindly promoting new urbanization and expanding external connections may require careful evaluation based on regional actual conditions .

3. Discussion

Integrating the main functional area strategy with high-quality development is an important pathway for implementing new development concepts in the new era and promoting differentiated revitalization in old revolutionary area counties.

Regarding the connotation of high-quality development, compared with previous spatial equilibrium concepts [6], this paper incorporates both "spatial equilibrium" and "main functional area" elements. It argues that each main functional area should maximize economic-ecological benefits [10], with key development zones serving as growth poles for high-quality development to drive leapfrog regional progress, while agricultural product main production areas and key ecological functional areas provide factor support and maintain green development foundations. This expands the connotation of high-quality development and holds important implications for leveraging functional advantages, pursuing characteristic revitalization pathways, and achieving regional coordinated development.

In terms of composite evaluation, unlike existing uniform weighting and linear weighting methods [14,17], this paper applies differentiated weighting based on main functional positioning to highlight different development orientations and goals. The introduction of the coupling coordination model prevents the "barrel effect" in comprehensive scoring, addressing the problem of neglecting balanced and coordinated development across dimensions [6].

Regarding influencing factors, previous studies on the former Central Soviet

Area identified economic openness as a common driving factor across functional areas [30]. However, this paper covers a broader research area with more complex regional characteristics and more divergent spatial effects of various factors. Factors such as core growth pole level and import-export ratio have completely opposite effects in different regions [31], providing a basis for regionally differentiated policy implementation.

At the practical level, research shows that under central policy support, old revolutionary areas have formed core growth poles [32], often located in key development zones, while lagging regions are typically key ecological functional areas in provincial border zones [21]. Therefore, for old revolutionary areas, creating key development zones as regional high-quality development engines to undertake industrial transfer from developed regions, establishing agricultural product main production areas as supply bases providing factor support, and converting "green mountains and clear waters" into "mountains of gold and silver" in key ecological functional areas under ecological protection constraints represent important future directions. Additionally, this paper lacks temporal analysis, which should be strengthened in future research through time-series data collection and dynamic spatial pattern and driving mechanism analysis.

4. Conclusions

This study reveals the following conclusions: (1) Overall, the high-quality development index in old revolutionary area counties is relatively low, following the pattern: former Central Soviet Area > Dabie Mountains Area > Shaanxi-Gansu-Ningxia Area > Zuoyoujiang Area > Sichuan-Shaanxi Area. Spatially, high-value areas concentrate in the former Central Soviet Area, while low-value areas cluster in provincial border regions and the Zuoyoujiang Revolutionary Base Area. (2) From the main functional area perspective, the high-quality development index shows key development zones > agricultural product main production areas > key ecological functional areas, indicating that key ecological functional areas represent the current difficulty and focus for promoting revitalization. Internal development within each functional area is homogeneous, and narrowing gaps between functional areas constitutes an important pathway for achieving coordinated regional development. (3) Regarding influencing factors, natural environmental factors still constrain overall regional development but have minor effects, while economic-social factors such as per capita GDP, human capital, and labor force have more significant driving effects. No common driving factors have emerged among the three main functional area types, necessitating regionally adapted approaches to promote high-quality development in different functional zones.

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