Postprint: Comprehensive Measurement of New-Type Urbanization Levels in Western Provincial Capital Cities

Authors: Zou Yafeng, Yajing Li

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Abstract

New-type urbanization constitutes the fundamental pathway for the healthy, stable, and sustainable development of China's economy and society, and represents the essential solution to eradicating the urban-rural socioeconomic "dual structure" in China. Based on the connotation of new-type urbanization, this study constructs a comprehensive measurement indicator system for new-type urbanization level, encompassing 24 indicators across six dimensions: population, economic development, quality of life, infrastructure, resources and environment, and urban-rural coordination. Employing the entropy method, we conduct a comprehensive measurement of the urbanization development levels of 11 provincial capital cities in western China from 2005 to 2015. The research demonstrates that significant disparities exist in the development level of new-type urbanization among these western provincial capital cities, which can be broadly categorized into three tiers: "high level", "medium level", and "low level". Infrastructure construction serves as the primary driving force behind these differences. The influencing factors of individual urbanization dimensions exhibit diversification across different years and cities; thus, future development should prioritize specific aspects according to local conditions while simultaneously emphasizing urbanization quality to promote coordinated urban-rural development.

Full Text

Comprehensive Research on New Urbanization Level of Provincial Capital Cities in Western China

ZOU Yafeng[1],[2], LI Yajing[1], YUAN Zhihong[1] [1]School of Public Administration, Inner Mongolia University, Hohhot 010021, Inner Mongolia, China

[2]Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China

Abstract

New urbanization represents the fundamental pathway for healthy, stable, and sustainable development of China's economy and society, as well as the essential solution to eliminating the urban-rural dual economic structure. Based on the connotation of new urbanization, this study constructs a comprehensive evaluation index system comprising 24 indicators across six dimensions: population, economic development, quality of life, infrastructure, resources and environment, and urban-rural coordination. Using the entropy method, we measured the comprehensive development level of new urbanization in 11 provincial capital cities in western China from 2005 to 2015. The results reveal significant disparities in new urbanization development levels among these cities, which can be classified into three distinct tiers: high-level, medium-level, and low-level. Infrastructure construction emerges as the primary driver of these differences. The factors influencing individual urbanization dimensions vary across cities and years, indicating that future development should prioritize specific weak areas while simultaneously emphasizing urbanization quality and promoting coordinated urban-rural development.

Keywords: new urbanization; comprehensive evaluation; entropy method; provincial capital cities in western China

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1. Basic Ideas and Research Methods

1.1 Basic Ideas

According to the connotation of new urbanization, we establish a multi-system, multi-level comprehensive evaluation index system for new urbanization levels. The entropy method is employed to determine indicator weights, and the comprehensive index method is used to calculate composite scores for new urbanization levels in western provincial capital cities. Using the standard deviation classification method, cities are categorized into high, medium, and low levels to analyze spatiotemporal differences in urbanization development. Focusing on disparities in individual dimensions of new urbanization in western provincial capital cities, we conduct dynamic comparisons across six aspects—population development, economic development, resident quality of life, infrastructure, resources and environment, and urban-rural coordination—and analyze the main driving factors behind these differences. The research framework is illustrated in [Figure 1: see original paper].

1.2 Comprehensive Evaluation Model—Entropy Method

The entropy method is an objective weighting approach that determines indicator weights based on the amount of information provided by observed values. If an indicator's entropy value is smaller, its variation degree is greater, it provides more information, and thus plays a more significant role in comprehensive evaluation, warranting a larger weight, and vice versa. Therefore, weights can be calculated according to entropy values, which reflect the variation degree of indicator values. The main steps are as follows:

First, standardize the initial data to eliminate interference from differences in indicator dimensions, magnitude, and orientation:

For positive indicators: $X'_{ij} = \frac{X_{ij} - \min\{X_j\}}{\max\{X_j\} - \min\{X_j\}}$

For negative indicators: $X'_{ij} = \frac{\max\{X_j\} - X_{ij}}{\max\{X_j\} - \min\{X_j\}}$

Next, calculate the information entropy of indicator j: $e_j = -\frac{1}{\ln n} \sum_{i=1}^{n} Y_{ij} \times \ln Y_{ij}$, where $Y_{ij} = \frac{X'_{ij}}{\sum_{i=1}^{n} X'_{ij}}$.

Then, compute the weight of indicator i: $w_i = \frac{1 - e_j}{\sum_{j=1}^{m} (1 - e_j)}$.

Finally, using the weighted summation method, construct the new urbanization comprehensive level measurement model: $S_i = \sum_{j=1}^{m} w_j X'_{ij}$, where S_i represents the comprehensive score of new urbanization level for city i, and w_i is the weight of indicator i.

1.3 Comprehensive Level Classification—Standard Deviation Grading Method

Standard deviation grading is an unequal-interval classification method where the number of classes is determined by the data's dispersion degree and the multiples of standard deviation used, commonly employed to represent deviations from the mean. This study classifies the new urbanization levels of western provincial capital cities in 2005, 2010, and 2015 into three tiers to analyze spatial distribution changes. The classification formula is: $\bar{S} + 0.5\delta$, $\bar{S} - 0.5\delta$, where $\bar{S}$ is the average comprehensive score and δ is the standard deviation.

1.4 Data Sources

This study takes 11 provincial capital cities in western China as the basic evaluation units, with 2005, 2010, and 2015 as evaluation time points. To ensure data accuracy and comparability, all data are sourced from statistical yearbooks and bulletins of corresponding years from national and provincial statistical bureaus, primarily including the *China Statistical Yearbook*, *China City Statistical Yearbook*, *China Environmental Status Bulletin*, and statistical yearbooks of individual cities. Due to missing data for Lhasa, adjacent year data were processed

to fill gaps.

2. Case Analysis

2.1 Index System Construction

New urbanization is characterized by urban-rural integration, industrial interaction, intensive and economical development, ecological livability, and harmonious development, with human-centered development at its core and continuous improvement of urbanization quality and connotation as its essence. Based on the National New Urbanization Plan and existing research, and adhering to the "people-oriented" concept while fully considering actual development conditions in western China, we define new urbanization comprehensive level measurement across six dimensions: (1) **Population development**, manifested as rural-to-urban population agglomeration, agricultural population transitioning to non-agricultural status, and continuous improvement of population quality; (2) **Economic development**, reflected in efficient economic agglomeration and industrial structure optimization; (3) **Resident quality of life**, which prioritizes people's livelihood improvement and quality of life enhancement; (4) **Infrastructure**, providing essential support for urban development and requiring strengthened construction and improved functions; (5) **Resources and environment**, representing rigid constraints on urban development that advocate for resource conservation and environmental friendliness to promote sustainable urbanization; and (6) **Urban-rural coordination**, embodying narrowed urban-rural wealth gaps and equal exchange of factors to promote coordinated development.

Following principles of representativeness, comprehensiveness, scientific rigor, systematicity, and operability, we selected 24 indicators from these six dimensions to construct the comprehensive evaluation index system (Table 1). Due to inconsistent dimensions and magnitudes across indicators, the range method was used for standardization, and the entropy method was applied to determine weights for each indicator in corresponding years.

2.2 Comprehensive Level Calculation of New Urbanization in Western Provincial Capital Cities

Using the comprehensive measurement formula, we calculated composite scores for urbanization development levels in 11 provincial capital cities (Table 2) and applied the standard deviation classification method to categorize cities into high, medium, and low levels (Table 3). The results show:

1) **Significant regional disparities in urbanization development**: Overall, substantial differences exist across cities and periods. Chengdu consistently ranked highest (0.479 in 2005, 0.492 in 2010, and 0.497 in 2015), while Lhasa ranked lowest (0.177, 0.203, and 0.220 respectively).

The large gap between Chengdu and other cities aligns with its status as a science and technology, commerce, finance center, and comprehensive transportation hub in southwestern China. Dynamically, Xining showed the largest increase (0.020), while Urumqi, Yinchuan, Hohhot, and Lanzhou showed the smallest increases (0.005, 0.005, 0.006, and 0.006 respectively), indicating widening development gaps over time. Analysis reveals that since the 12th Five-Year Plan, Xining's government introduced financial policies supporting economic restructuring and prioritized producer services, seizing Silk Road Economic Belt opportunities to optimize investment structure and develop tertiary industries and cultural services, leading to rapid economic growth, improved infrastructure, and significantly enhanced resident quality of life. In contrast, cities with smaller growth rates faced constraints from location conditions, economic foundations, and openness.

2) **Continuous improvement in urbanization quality**: Indicator weights show that infrastructure consistently had the highest weight across the three evaluation periods, followed by economic development and resident quality of life, reflecting that infrastructure remains the primary driver of new urbanization in western provincial capitals.

3) **Poor internal coordination in urban development**: Cities showed varied and unbalanced development patterns across dimensions. For example, in 2015, Lhasa scored highest in infrastructure but lowest in population development and urban-rural coordination, while Lanzhou ranked first in population development but last in infrastructure and resources-environment. This reveals significant internal development imbalances.

2.2.1 Population Development Status The population development status in western provincial capitals shows relatively uniform urbanization rates across cities, but slow growth in non-agricultural employment ratios. The large gap in university student enrollment per 10,000 people is the main factor affecting population development differences. Xi'an scored highest in 2005 (0.083), while Lanzhou ranked highest in both 2010 and 2015 (0.089 and 0.091). This reflects limited job creation in secondary and tertiary industries and severe employment challenges, as well as uneven educational resource allocation among cities. Future urbanization efforts should pay greater attention to employment and education.

2.2.2 Economic Development Status Economic development status varied significantly across cities and years. Hohhot (0.081), Chengdu (0.083), and Urumqi (0.084) scored highest in 2005, 2010, and 2015 respectively, closely related to each city's economic structure and development model. Hohhot's GDP exceeded 700 billion yuan, forming a characteristic dairy industry that drove rapid economic growth. After adjusting its import-export structure and improving export quality, Chengdu's economic development accelerated. Urumqi's

"five major industrial bases" and high-tech enterprises contributed over half of the city's total economic output and fiscal revenue, demonstrating strong economic driving effects. The largest gaps were observed in tertiary industry output ratio and per capita import-export volume, indicating that industrial and trade structures significantly impact economic growth. Cities should accelerate economic transformation, optimize industrial structures, and unleash growth potential.

2.2.3 Resident Quality of Life Status Resident quality of life status was relatively balanced but showed large overall differences. Chengdu consistently ranked highest (0.074 in 2005, 0.077 in 2010, and 0.079 in 2015), holding absolute advantages related to its status as a national commercial logistics center and comprehensive transportation hub. However, Lhasa ranked last across all periods (0.014, 0.017, and 0.019), reflecting how its unique natural geographical environment constrains economic development and living standards, leaving considerable room for improvement as urbanization progresses. Analysis of specific indicators shows that registered urban unemployment rate, per capita disposable income, and broadband internet access users fluctuated significantly, becoming the main factors affecting quality of life changes across years. Generally, as unemployment decreases, per capita disposable income increases. During 2005-2015, economic development absorbed large numbers of workers while driving substantial income growth. Informatization transformed residents' production and lifestyles, further promoting new urbanization.

2.2.4 Infrastructure Status Infrastructure status showed Lhasa ranking first in all three years (0.092, 0.095, and 0.098), while Nanning, Guiyang, and Lanzhou ranked last (0.038, 0.039, and 0.034 respectively). The gap between Lhasa and other cities gradually narrowed. Lanzhou's score decreased notably (from 0.041 to 0.034), indicating that while advancing urbanization, the city failed to coordinate urbanization quality development, with inadequate infrastructure supporting facilities and prominent "semi-urbanization" issues among transferred agricultural populations. The large differences in buses per 10,000 people and per capita urban road area are the main factors causing infrastructure disparities. This stems from Lhasa's small population base and recent massive infrastructure investments that transformed the cityscape, though infrastructure lag remains a bottleneck for Lhasa and Tibet's economic and social development. In 2015, Urumqi invested 8 billion yuan in urban infrastructure maintenance and construction, significantly improving the urban landscape.

2.2.5 Resources and Environment Status Resources and environment status showed Kunming ranking highest in all years (0.069, 0.071, and 0.073), while Chengdu ranked highest in 2015 (0.073). Other cities also showed upward trends with relatively balanced development, reflecting current emphasis on resources and environment in China's urban construction. The largest gaps were in built-up area green coverage, domestic sewage treatment rate, and urban air

quality excellence rate, which are the main factors causing differences. Kunming's "Spring City" reputation reflects its unique environmental advantages, and its "Green Kunming" initiative has yielded significant results. Since 2010, Kunming has established a comprehensive air quality automatic monitoring system, maintaining over 98% air quality excellence rate with overall improvement trends, providing momentum for economic growth. In 2015, Chengdu's green coverage reached 17,964.71 hectares, with all indicators exceeding national averages, further achieving national ecological garden city goals. Cities should prioritize green urban construction as an entry point to resolve contradictions between urbanization and ecological environment, continuously promoting new urbanization development.

2.2.6 Urban-Rural Coordination Status Urban-rural coordination status showed Urumqi ranking first in all years (0.067, 0.069, and 0.071), while Lhasa ranked last (0.012, 0.014, and 0.016), with different economic foundations, natural geographical conditions, and consumption structures being objective factors causing these differences. In 2005 and 2010, Chengdu and Nanjing had the highest and lowest scores (0.059 and 0.032), respectively. Analysis shows that Nanjing, as the China-ASEAN exchange center and core city of the Beibu Gulf Economic Zone, has unique geographical advantages driving rapid economic growth and rising urban-rural incomes. However, in 2015, climate change and rising agricultural materials and land rents reduced rural households' operational income, widening the urban-rural income gap. Chengzhou's significant reduction in urban-rural income disparity benefited from its pioneering rural property rights system reform and the creation of a farmland protection fund, which promoted orderly rural capital circulation and increased farmers' property income. The ratios of rural to urban per capita disposable income and consumption levels show relatively large differences between and within cities, reflecting significant urban-rural wealth gaps. To narrow these gaps and promote rural economic development, cities should increase support for rural economies, expand farmer employment, guide consumption rationally, accelerate transformation of the urban-rural dual structure, and reform the household registration, land, and social security systems to achieve integrated urban-rural development.

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3. Conclusions

Based on the connotation of China's new urbanization path, this study constructs a comprehensive evaluation index system and employs the entropy method for weighting, yielding objective and scientific results that comprehensively and authentically reflect new urbanization levels in western provincial capitals. Combining temporal and spatial analysis reveals the dynamic spatiotemporal characteristics of new urbanization levels. The main findings are:

1) Overall, new urbanization development levels in the 11 western provincial

capitals exhibit significant regional disparities, continuous quality improvement, and poor internal coordination. Using the standard deviation classification method, cities are divided into three tiers: "high level," "medium level," and "low level." Infrastructure construction is the dominant factor causing differences in new urbanization levels among western provincial capitals.

2) Factors influencing individual urbanization dimensions are diversified. The driving factors in six aspects—population development, economic development, resident quality of life, infrastructure, resources and environment, and urban-rural coordination—show different evolutionary characteristics across stages. Future new urbanization construction should prioritize specific weak areas, emphasize "people-oriented" development, consider urban development quality, narrow urban-rural gaps, and foster coordinated development among urbanization, economy, society, and environment.

3) This study establishes a comprehensive evaluation index system and applies the entropy method for weighting, producing objective and scientific results that reflect new urbanization development levels in western provincial capitals. The temporal-spatial analysis reveals dynamic characteristics. However, the dynamic analysis of urbanization levels remains superficial, without comparing western regions with national or other regional patterns to highlight western region particularities. Therefore, more accurate and in-depth reflection of comprehensive new urbanization development levels in western China requires further research.

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