Study on The Coupling and Coordinated Development of Urban Resilience and New Urbanization Level in Chengdu-Chongqing Economic Circle

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ABSTRACT

Urban resilience is a powerful guarantee to promote high-quality urban development, and there is a strong relationship between it and the level of new urbanization. Taking a total of 16 cities in the Chengdu-Chongqing economic circle as an example, this paper constructs a comprehensive evaluation index system based on the two systems of urban resilience and new urbanization, comprehensively measures the urban resilience and new urbanization level and change trend of Chengdu-Chongqing economic circle from 2011 to 2019 by using entropy method model, and analyzes the evolution characteristics of coupling coordination degree of different levels of cities with the help of coupling coordination degree model. The results show that: (1) the top two cities in the level of urban resilience from 2011 to 2019 are Chongqing and Chengdu, but compared with the level of urban resilience, the urbanization level of 16 cities in Chengdu-Chongqing economic circle can not be seen from the classification of urban grade and scale; (2) During the study period, the coupling and coordination degree of urban resilience and urbanization in Chengdu-Chongqing economic circle is mostly in the state of near imbalance and slight imbalance; (3) From 2011 to 2019, the coupled coordinated dispatching of urban agglomeration in Chengdu-Chongqing economic circle showed a fluctuating upward trend, but there were great differences among cities at different grades, and the development was unbalanced.

Keywords: Different grades of urban resilience; New urbanization; Entropy method; Coupling coordination

1. INTRODUCTION

The fifth Plenary Session of the 19th CPC Central Committee put forward the proposition of "resilient urban". Therefore, urban resilience has become an important goal of urban development and construction. Urbanization, as an inevitable outcome of urban development, is strongly correlated with urban resilience [9]. At present, China's urbanization process is shifting from the traditional to the new urbanization road with people-oriented, scale, and quality. How to use urban resilience construction to plan regional coordinated development in the process of promoting new-type urbanization has become an urgent problem to be solved. Based on the above background, it is necessary to scientifically measure the level and evolution trend of urban resilience and new urbanization, and analyze the dynamic relationship of coupling and coordination between them.

Urban resilience and new-type urbanization have been studied continuously in recent years.

Urban resilience refers to the ability of the urban system and region to achieve normal operation of public security, social order, and economic construction through reasonable preparation, buffering, and coping with uncertainty disturbance. [19] From the perspective of origin, the concept of resilience started from engineering resilience [4], gradually revised and improved to ecological resilience [5], and then to evolutionary resilience [6]. From the perspective of content composition, different scholars put forward their views from different angles. Jha (2013) et al. [10] believe that

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urban resilience has four parts: infrastructure resilience, institutional resilience, economic resilience, and social resilience. Irene (2013) et al. [8] put forward three aspects of urban resilience, namely, social advocacy, community energy, and social inclusion. From the perspective of coupling relationship with other factors, it mainly involves coupling coordination analysis with economic development level [15], urban land use efficiency [23], urbanization level [22], and technological innovation factors [7].

New-type urbanization refers to the intensive, smart, green, and low-carbon urbanization planned by the Chinese government that is different from the past. From the perspective of source, it is produced in solving problems such as development contradiction in the new period [17]. From the perspective of the core concept, new-type urbanization should be people-oriented [11]. From the perspective of the index system, most scholars use the composite index method to construct an index evaluation system based on different perspectives. Liu et al. (2013) [12] and Niu et al. (2013) [16] added four indicators of residents' life quality, infrastructure construction, ecological environment, and urban-rural integration; Wang (2014) et al. [20] further considered the population quality, urban leisure and the close connection between urban and rural areas from a national perspective. From the perspective of coupling relationship with other factors, the existing literature makes coupling and coordination analysis with new-type urbanization from various aspects such as urban transportation [1], ecological environment [3], medical services [2], Rural Revitalization [24], industrial economy [14], However, there is still a lack of regional resilience urban assessment for the economic circle.

To sum up, in the existing literature, there is a relatively complete conceptual cognition and scientific method evaluation system for urban resilience and new-type urbanization, but there is still a big gap in the research on the coupling and coordinated development of the two. The study of their coupling relationship can provide scientific support for solving the problem of planning regional coordinated development with urban resilience construction on the road of promoting new urbanization. Therefore, this paper selects Chengdu-Chongqing economic circle. including 16 cities. Considering the differences in population size and development level of different cities, to ensure comparability of results and appropriateness of suggestions, 16 cities are divided into three categories: megacities, megalopolis, and metropolis according to The Notice On Adjusting The Classification Standards Of City Size, to build a comprehensive rating index system for urban resilience and new urbanization, and the entropy method model is used to comprehensively measure the urban resilience, new-type urbanization level and change trend of Chengdu-Chongqing economic circle from 2011 to 2019. On this basis, using coupling coordination degree model to analyze the evolution characteristics of the coupling coordination degree of different levels of cities.

2. DATA AND RESEARCH METHODS

2.1 Data sources

This paper takes 16 cities in the Chengdu-Chongqing economic circle as the research objects, and the research time scale is 2011-2019. The data used in this paper are mainly from the 2012-2020 Sichuan Statistical Yearbook, Chongqing Statistical Yearbook, Urban Construction Statistical Yearbook, and the statistical yearbooks of each municipality in the Sichuan-Chongqing region, with some data coming from the statistical bulletins on national economic and social development and the seventh national population census bulletin of each city.

2.2 Overview of the study area

The Chengdu-Chongqing economic circle is an urbanized region with the highest level of development and greater development potential in the western region of China and is an important part of the implementation of the Yangtze River Economic Belt and the Belt and Road Strategy.

In this paper, according to the Notice of the State Council on Adjusting the Standards for Categorizing City Size, taking the resident population in urban areas as the statistical caliber and referring to the data of the seventh census bulletin, the 16 cities in the Chengdu-Chongqing economic circle are classified into megacities: Chongqing and Chengdu; megalopolis: Nanchong and Dazhou; metropolis: Deyang, Mianyang, Meishan, Ziyang, Suining, Ya'an, Leshan, Zigong, Luzhou, Neijiang, Yibin, Guang'an.

2.3 Constructing a system of indicators

The development of a coupled and coordinated degree of urban resilience and new urbanization level requires attention to the interaction between urban resilience and urbanization, and the construction of the indicator system should be able to effectively measure the development level of these two dimensions. Based on the principles of systematicity, scientificity, representativeness, and accessibility, this paper draws on relevant studies by Zhou (2016) [21] and Liu et al. (2014) [13] to construct the first-level evaluation index system of urban resilience in the Chengdu-Chongqing economic circle in four dimensions: social resilience, economic resilience, ecological resilience, and infrastructure resilience, and selects 20 secondary indicators to evaluate urban resilience concretely. At the same time, this paper refers to the study of Ren et al. (2022) [18] and selects 12 secondary indicators in four dimensions, namely economic urbanization, social urbanization, population

urbanization, and spatial urbanization, to build an evaluation system to measure the level of urbanization. The specific evaluation indicators are shown in Table 1.

Table 1 Indicator System and Weights for Evaluating Urban Resilience and Urbanization Levels

Target level	System-level	Indicator layer	Weighting	Properties
Urban resilience	Economic resilience (0.3200)	GDP per capita	0.0200	+
		Regional GDP growth rate	0.0100	+
		The actual amount of foreign capital used	0.1513	+
		General government revenue	0.0658	+
		Number of enterprises above scale	0.074	+
	Social resilience (0.2085)	Population density	0.0232	+
		Number of hospital beds per 10,000 population	0.0639	+
		Percentage of social security expenditure to fiscal expenditure	0.0062	+
		Percentage of employees in public administration and social organizations	0.015	+
		Number of full-time teachers in regular higher education	0.1002	+
	Ecological resilience (0.0958)	Industrial wastewater discharge	0.0042	-
		Carbon emissions per square kilometer	0.0051	-
		Green space coverage in built-up areas	0.0065	+
		Green space per capita	0.064	+
		Harmless disposal rate of domestic waste	0.0136	+
	Infrastructure resilience (0.3566)	Urban road area per capita	0.036	+
		Length of drainage pipe	0.0869	+
		Electricity consumption of the whole society	0.0830	+
		Total fixed assets	0.0764	+
		International Internet users	0.0763	+
Urbanization	Economic urbanization (0.2270)	Share of an output value of secondary and tertiary industries	0.1776	+
		The average wage of urban unit workers on duty municipal districts	0.0164	+
		Disposable income per urban resident	0.0330	+
	Social urbanization (0.3644)	Number of urban workers participating in pension insurance	0.1656	+
		Number of participants in basic urban employees' health insurance at the end of the year	0.1632	+
		Registered urban unemployment rate	0.0356	-
	Population urbanization (0.1021)	Population urbanization rate	0.0312	+
		Percentage of the population employed in secondary and tertiary sectors	0.0397	+

Spatial urbanization (0.3065)	Population urbanization rate	0.0312	+
	Area of built-up area	0.1927	+
	Urban built-up area as a percentage of an urban area	0.0563	+
	Urban living space per capita	0.0575	+

2.4 The coupling coordination degree model of urban resilience and new urbanization

2.4.1 Comprehensive evaluation model

The entropy method is an objective weighting method, which determines the indicator weights according to the degree of variation of each indicator value. The greater the dispersion of the indicators, the greater the influence on the comprehensive evaluation, which can objectively reflect the weight of each indicator and can effectively avoid the bias brought about by the interference of subjective factors. Therefore, this paper adopts the entropy value method model to determine the weights of each indicator and a comprehensive score of urban resilience and urbanization level, and its specific steps are as follows.

Step 1: Collect and sort out the raw data.

If n cities and m indicators are selected, then Xij is the value of the jth indicator for the ith city (i=1, 2,..., n; j=1, 2,..., m).

Step 2: Standardization of data.

Positive indicators.

$$X_{ij} = \frac{X_{ij} - min\{x_{1j}, \dots, X_{nj}\}}{max\{_{1j}, \dots, X_{nj}\} - min\{x_{1j}, \dots, X_{nj}\}} \quad (1)$$

Negative indicators.

$$X'_{ij} = \frac{\max\{x_{1j}, \dots, X_{nj}\} - x_{ij}}{\max\{x_{1j}, \dots, X_{nj}\} - \min\{x_{1j}, \dots, X_{nj}\}} \quad (2)$$

Xij' is the value of the j-th indicator for city i (i=1, 2,.., n; j=1,2,...,m). For convenience, it is still noted that Xij '=Xij.

Step 3: Calculate the weight of the ith sample value under the j index to the index.

$$P_{ij} = \frac{X_{ij}}{\sum_{i=1}^{n} X_{ij}}, i = 1, \dots, n; j = 1, \dots, m \quad (3)$$

Step 4: Calculate the entropy value of the j index.

$$E_j = -k \sum_{i=1}^{n} P_{ij} \ln P_{ij}, j = 1, \dots, m \quad (4)$$

In which Ej ≥ 0.

Step 5: Calculate the redundancy of information entropy.

$$D_j = 1 - E_j \quad (5)$$

Step 6: Ccalculate the weight of the index.

$$W_j = \frac{D_j}{\sum_{j=1}^{m} D_j} \quad (6)$$

Step 7: Calculate the overall score.

$$S_i = \sum_{j=1}^{m} W_j P_{ij}, i = 1, \dots, n \quad (7)$$

2.4.2 Coupling coordination model

The concept of coupling is derived from physics and refers to the behavior of two and more systems that interact with each other under their own and external influences. It is widely used in other research fields because the coupling relationships between systems are relatively similar. The coupling coordination degree model can be used to calculate the coupling coordination degree to reflect the level of coupling coordination between two systems. In this paper, the coupling coordination degree model is used to measure and evaluate the interaction between urban resilience and urbanization level The specific model is as follows.

Coupling model:

$$C = [u_1 u_2 / (u_1 + u_1)^2]^{1/2} \quad (8)$$

Where C is the coupling degree between urban resilience and urbanization level; u_1 is the comprehensive evaluation index of urban resilience; u_2 is the comprehensive evaluation index of urbanization level.

Although the coupling degree can reflect the coupling strength of the two, it is difficult to measure whether their development is consistent. Therefore, this paper introduces the coordination degree model to reflect the coordination degree of the interaction between urban resilience and urbanization level in the Chengdu-Chongqing economic circle.

Coordination model:

$$T = \alpha u_1 + \beta u_2 \quad (9)$$

$$D = \sqrt{CT} \quad (10)$$

Where, D is the coupling coordination between urban resilience and urbanization level, the larger the value of D, the better the coordination relationship between them: T is the comprehensive coordination index between urban resilience and urbanization level; α and β are undetermined coefficients, representing the importance of urbanization level and urban resilience level respectively, where , $\alpha + \beta = 1$. In this paper, the importance of urban resilience level and urbanization level is considered to be equal, so the values of α and β are both 0.5. To directly reflect the coordination relationship between urban resilience and urbanization level, this paper draws on the research of Sun Yu [26] and classifies the coupling coordination degree into 10 levels (Table 2).

Table 2 Classification of coupling coordination levels

Coupling coordination D-value	Coordination level	Degree of coupling coordination
(0.0-0.1)	1	extreme unbalance
[0.1-0.2)	2	severe unbalance
[0.2-0.3)	3	moderate unbalance
[0.3-0.4)	4	slight unbalance
[0.4-0.5)	5	near unbalance
[0.5-0.6)	6	strained balance
[0.6-0.7)	7	primary balance
[0.7-0.8)	8	moderate balance
[0.8-0.9)	9	well balanced
[0.9-1.0)	10	superior balance

3. RESULT ANALYSIS

Table 3 The degree of coupling and coordination of the Chengdu-Chongqing economic circle from 2011 to 2019

	2019	2018	2017	2016	2015	2014	2013	2012	2011
Chongqing	superior balance	superior balance	superior balance	superior balance	well balanced	well balanced	well balance	well balance	well balance
Chengdu	superior balance	well balance	slight unbalance	well balance	moderate balance	moderate balance	moderate balance	moderate balance	moderate balance
Nanchong	near unbalance	near unbalance	near unbalance	near unbalance	slight unbalance	slight unbalance	slight unbalance	moderate unbalance	near unbalance
Dazhou	near unbalance	near unbalance	near unbalance	near unbalance	slight unbalance	near unbalance	slight unbalance	slight unbalance	strained balance
Deyang	near unbalance	near unbalance	near unbalance	slight unbalance	slight unbalance	slight unbalance	slight unbalance	slight unbalance	slight unbalance
Mianyang	near unbalance	near unbalance	near unbalance	near unbalance	slight unbalance	slight unbalance	slight unbalance	moderate unbalance	near unbalance
Suining	slight unbalance	slight unbalance	slight unbalance	slight unbalance	slight unbalance	slight unbalance	moderate unbalance	moderate unbalance	slight unbalance
Neijiang	near unbalance	near unbalance	slight unbalance	slight unbalance	slight unbalance	slight unbalance	moderate unbalance	moderate unbalance	near unbalance
Leshan	near unbalance	near unbalance	near unbalance	near unbalance	near unbalance	near unbalance	slight unbalance	slight unbalance	near unbalance
Zigong	slight unbalance	slight unbalance	moderate unbalance	moderate unbalance	moderate unbalance	moderate unbalance	severe unbalance	severe unbalance	moderate unbalance
Meishan	near unbalance	near unbalance	near unbalance	near unbalance	slight unbalance	near unbalance	slight unbalance	slight unbalance	near unbalance
Yibin	strained balance	near unbalance	near unbalance	near unbalance	near unbalance	near unbalance	near unbalance	slight unbalance	near unbalance
Guangan	near unbalance	near unbalance	near unbalance	near unbalance	slight unbalance	slight unbalance	moderate unbalance	moderate unbalance	near unbalance
Luzhou	near unbalance	slight unbalance	slight unbalance	slight unbalance	slight unbalance	moderate unbalance	moderate unbalance	moderate unbalance	moderate unbalance
Yaan	near unbalance	near unbalance	near unbalance	near unbalance	near unbalance	near unbalance	slight unbalance	slight unbalance	near unbalance
Ziyang	near unbalance	near unbalance	near unbalance	near unbalance	near unbalance	near unbalance	moderate unbalance	moderate unbalance	strained balance

(1) Urban resilience level

During the research period, the top two cities in terms of resilience level are Chongqing and Chengdu, both of which are megacities, and their resilience levels generally show an upward trend in terms of economy, ecology, society, and infrastructure. Part of the reason is that Chongqing, as a municipality, and Chengdu, as a sub-provincial city, has the advantage of resource agglomeration, which has promoted the formation of a growth pole for the development of resilience level of the two cities. From 2011 to 2019, the resilience level of 12 metropolia such as Mianyang, Ziyang, and Zigong fluctuated slightly, but there was a slow upward trend in 2016-2019. Although Ziyang City is in the echelon of Type II metropolis, its urban resilience level is higher than that of the megalopolis. It can be seen that although the urban scale promotes the formation of industrial, human, and other capital agglomeration to a large extent, it cannot be the decisive factor for the level of urban resilience.

(2) Urbanization level

Compared with the level of urban resilience, the urbanization level of the 16 cities in the Chengdu-Chongqing economic circle cannot be differentiated from the division of the urban scale. From 2011 to 2017, the level of urbanization fluctuated greatly, but it was basically in the range of 0.0684-0.3155. From 2018 to 2019, the level of urbanization increased substantially. Among them, the urbanization level of Chongqing was in a low position in the Chengdu-Chongqing economic circle from 2011 to 2013. The urbanization level increased from 2014 to 2017, at a medium level. From 2018 to 2019, the level of urbanization in Chongqing continued. Two years with a larger increase, rising to the third. It can be seen that the urbanization level of the Chengdu-Chongqing economic circle has been continuously improved in terms of population, economy, society, and space, the population has been gathering to cities, and the regional economy has been greatly developed.

(3) Coupling and coordination degree of urban resilience and urbanization

From 2011 to 2019, the coupling and coordination degree of urban resilience and urbanization in the Chengdu-Chongqing economic circle was mostly in a state of near unbalance and slight unbalance. However, with the construction of resilient cities and the promotion of the urbanization process, the coupling and coordination degree of the two cities generally showed an evolution from unbalance to near unbalance and then to superior coordination. The main reason is that the government actively promotes the construction of smart cities and resilient cities, abandons the original fragmented and inefficient management methods, innovates the social governance model, and emphasizes collaborative governance.

From 2011 to 2019, the coupling and coordination of urban agglomeration in the Chengdu-Chongqing economic circle showed a fluctuating upward trend, but the coupling and coordination degree of urban toughness and urbanization level among megacities, megalopolis, and metropolis were quite different, the development was unbalanced, and there were obvious differences in the division of the urban scale. The main reason is that in recent years, the national attention to urban safety construction and the successive introduction of policies for building high-quality cities have improved the level of urban innovation and collaborative governance. However, in previous years, Chongqing and Chengdu, as the core cities of the Chengdu Chongqing region, did not effectively radiate and drive the high-quality coordinated economic development of the region.

4. CONCLUSIONS AND SUGGESTIONS

By constructing a comprehensive evaluation index system of urban resilience and urbanization level in Chengdu-Chongqing economic circle, and comprehensively using entropy method and coupling coordination model to measure its coupling coordination degree and evolution, this paper draws the following conclusions:

(1) In terms of time change from 2011 to 2019, in addition to the significant improvement and ranking first in the urban resilience of megalopolis, the urban resilience development of Chengdu-Chongqing economic circle shows a steady and positive trend;(2)The overall development trend of urbanization level of 16 cities in Chengdu-Chongqing economic circle remains the same, but increased significantly from 2018 to 2019;(3)According to the coupling study of urban resilience and urbanization level, the development trend of the Chengdu-Chongqing economic circle is stable from 2011 to 2019 Generally, and the urban resilience construction and urbanization development are generally coordinated, but the unbalanced development still exists.

According to the research conclusion, the following three suggestions are put forward:

(1) Improve urban resilience policies and accelerate the process of urbanization. On the one hand, generally, the urbanization of the Chengdu-Chongqing economic circle has experienced the process of exploratory development, rapid development, and quality improvement, and caused several problems which restricts which restricts the continuous improvement of the quality of urbanization. Resilient urban is a way to effectively make cities quickly adapt to the dilemma that the process of urbanization caused a contradiction between limited resources and increasing population. Therefore, it is necessary to establish and improve

policies for urban resilience construction, increase resource investment through policy guidance, comprehensively improve urban resilience from the four aspects of society, economy, ecology, and infrastructure; On the other hand, new urbanization is a powerful engine to promote high-quality economic development in the new era, which will strengthen urban development and drive the high-quality development of the region.

(2) Make a development strategy of adjusting measures to local conditions, promote the construction of the Chengdu-Chongqing economic circle.

For megalopolis cities: Chengdu and Chongqing, overall, the coordinated development of urban resilience and urbanization level is generally good, improve the quality of urbanization in the construction of resilient cities, and promote sustainable development with high-quality urbanization construction; For megacities, type I of metropolis cities and type II of metropolis cities, resilience construction, and urbanization cannot achieve long-term coordinated development and even are in a state of imbalance for many years, but they are evolving towards high-quality coordination. In general, we should highlight the leading role of the government in urban development, deeply implement new models of social governance, and give full play to the advantages of collaborative governance.

(3) Carry out intercity cooperation actively and promote the coordinated development of the Chengdu-Chongqing economic circle.

This paper finds that Chengdu and Chongqing develop better than other cities. Therefore, take Chengdu and Chongqing as the leaders, lead and drive the overall and coordinated development of the Chengdu-Chongqing economy circle, while strengthening the benign cooperation between cities in that economy circle, to form a Chengdu-Chongqing economic circle with complementary advantages and high-quality development.

This paper only studies the coupling development state of urban resilience and new urbanization fails to deeply analyze its internal driving mechanism and is limited in the authors' research capacity to not study the temporal and spatial evolution, which is the direction of further research in the future.

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