Research on the Coordinated Development of Real Estate Economy and Hinterland Economy in the Chengdu Chongqing Economic Circle

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Abstract. The real estate industry is a pillar industry in the regional economic development of the Chengdu Chongqing Economic Circle, closely related to the economic growth of the hinterland. With the acceleration of the urbanization process of Chengdu Chongqing Economic Circle, the development of the real estate industry has also exposed obvious problems. The real estate economy does not match the economic rhythm of the hinterland, leading to a series of problems such as the foam of real estate, confusion of industrial layout, resource mismatch and social contradictions. It is of great practical significance to explore the coordinated development of the two, which is not only conducive to solving the current downturn of the real estate economy, but also to improving regional competitiveness, promoting industrial integration and innovation, promoting urbanization and other advantages. This article selects four cities in the Chengdu Chongqing Economic Circle, namely Yibin, Luzhou, Fuling, and Wanzhou, and measures the current situation and problems of coordinated development between their real estate economy and hinterland economy through grey correlation model and coupling coordination degree model. Improvement measures are proposed to help promote high-quality and sustainable development of the real estate economy and hinterland economy in the Chengdu Chongqing Economic Circle.

Keywords: Chengdu Chongqing Economic Circle; Real Estate Economy; Hinterland Economy; Grey Relation Analysis; Coupled Coordination Model.

1 Introduction

Chengdu Chongqing Economic Circle, located at the intersection of the "the Belt and Road" and the "Yangtze River Economic Belt", is not only a strong strategic support for the Western Development, but also a strategic hinterland of the new pattern of comprehensive opening up of China's inland. Since the release of the Chengdu Chongqing Economic Zone Regional Plan in 2011, the regional economic development of the Chengdu Chongqing Economic Circle has been very rapid, and it has become an important economic center in the western region[1]. In 2020, at the 6th

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meeting of the Central Committee of Finance and Economics, promoting the construction of the Chengdu Chongqing dual city economic circle was officially elevated to a national strategy, and it was clearly stated that the Chengdu Chongqing region will become an important economic center with national influence, creating an important growth pole for high-quality development in the western region[2]. The Chengdu Chongqing Economic Circle has always maintained a high-speed development trend, and its regional economy has been continuously rising year by year. In this development process, the real estate industry, due to its strong correlation, has driven the rapid progress of related industries, becoming a true pillar industry and playing a crucial role in promoting economic progress that cannot be ignored.

However, for a long time, China's economic growth has overly relied on the development of the real estate market, which has also brought huge hidden dangers[3]. Over time, the Chinese real estate market has shown significant development bottlenecks. A series of serious problems have emerged, such as excessive investment in real estate, serious speculation in real estate, obvious regional differentiation of real estate, high ratio of house price to income, unreasonable housing structure, and large foam in real estate[4,5], This has seriously affected social stability and the sustainable development of the national economy. Faced with many problems exposed in the real estate industry, the government has taken active action and continuously introduced various policies to effectively regulate the real estate market[6]. In this context, in-depth research on the coordinated development of the real estate economy and the hinterland economy in the Chengdu Chongqing economic circle highlights a strong urgency and necessity. By comprehensively analyzing the relationship and mutual influence between the two, exploring the path and strategy of coordinated development, it has profound significance for promoting the sustainable development of the Chengdu Chongqing economic circle, enhancing economic vitality, and ensuring social stability.

2 Research Method and Model

2.1 Grey Relation Analysis Model

Grey correlation analysis, as a multifactor statistical analysis method, is represented by the difference in size between curves at the geometric level[7].Firstly, there is a correlation between the reference sequence X_0 and the comparison sequences X_1, X_2... Xn. Therefore, there are corresponding correlation coefficients on the comparison sequence X_i, indicating its degree of association with the specified reference sequence X_0. The formula is as follows[8]:

$$\gamma(x_0(k), x_i(k)) = \frac{\Delta min + \rho \Delta max}{\Delta_{ik} + \rho \Delta max} \tag{1}$$

Secondly, calculate the correlation coefficient between the corresponding elements of each comparison sequence and the reference sequence, expressed as:

$$\Delta_{ik} = |x_0(k) - x_i(k)| \tag{2}$$

Finally, calculate the weighted average of the correlation coefficients between the corresponding elements of the comparison sequence and the reference sequence, i.e. the correlation degree:

$$r_{0i} = \frac{1}{m}\sum_{k=1}^{m} W_k \, \zeta_i(k) \tag{3}$$

Establish a correlation sequence for each evaluation object based on the grey weighted correlation degree. The greater the correlation, the higher the relevance of the evaluation object to the evaluation criteria.

2.2 Coupling Coordination Model

Weick first applied the concept of coupling to the field of social sciences, and subsequently, the coupling coordination model has been widely used in various fields such as architecture and finance[9]. Due to the difficulty of reflecting the "coordination" effect of subsystems under certain conditions, the upper and lower limits of each subsystem indicator in coupling degree are taken as the extreme values of each indicator. However, the extreme values have dynamic and unbalanced characteristics, and relying solely on coupling degree judgment may result in errors. Therefore, a coupling coordination degree model is proposed[10]:

$$C = 2\{\frac{(u_1 \cdot u_2)}{(u_1+u_2)^2}\}^{1/2} \tag{4}$$

$$\begin{aligned} D &= (C \cdot T)^{1/2} \\ T &= au_1 + bu_2 \end{aligned} \tag{5}$$

In the formula, C represents the coupling degree; D is coupling co scheduling; T is the comprehensive evaluation index; U1 and U2 are system evaluation indices; A and b are undetermined weights. Due to the equal importance of the real estate economy and the hinterland economy, a=b=0.5 is taken, and the coupling co scheduling types are divided according to the midpoint scoring method, as shown in Table 1.

Table 1. Coupling Coordination Level Classification.

D-value	Coupling coordination level	D-value	Coupling coordination level
D∈(0.0, 0.1]	Extreme imbalance	D∈(0.5, 0.6]	Barely coordinate
D∈(0.1, 0.2]	Severe imbalance	D∈(0.6, 0.7]	Primary coordination
D∈(0.2, 0.3]	Moderate imbalance	D∈(0.7, 0.8]	Intermediate coordination
D∈(0.3, 0.4]	Mild imbalance	D∈(0.8, 0.9]	Good coordination
D∈(0.4, 0.5]	Near imbalance	D∈(0.9, 1]	High quality coordination

3 Determination of Evaluation Indicators and Data Sources

3.1 Selection of Evaluation Indicators

In the Chengdu Chongqing Economic Circle, Wanzhou and Fuling both belong to Chongqing, which is an important region for economic development. Luzhou and Yibin both belong to Sichuan, which is a node city for economic development. The four cities are similar in scale and economy, and real estate is their pillar industry, which has certain representativeness. Taking the four cities in the Chengdu Chongqing Economic Circle as the research objects and referring to relevant literature, eight indicators including GDP of hinterland cities were accurately selected as the evaluation basis from four dimensions: economic benefits, industrial structure, hinterland trade, and real estate economy, as shown in Table 2.

Table 2. Evaluation Indicators for Real Estate Economy and Hinterland Economy

Category	Indicator selection	Literature sources
Economic benefits	GDP of hinterland cities (100 million yuan) Per capita GDP in the hinterland (yuan)	Li Dongrui et al. [11];Xia Siyou et al.[12];Zhan Bin et al.[13];
Industrial structure	Total value of primary industry (100 million yuan) Total value of the secondary industry (100 million yuan) Total value of the tertiary industry (100 million yuan)	Wang Zhaofeng et al. [14];Sun Yanli[15]; Li Yong et al. [16]
Hinterland trade	Total import and export volume of hinterland cities (100 million yuan) Total retail sales of consumer goods in society (100 million yuan)	Zu Peifu et al.[17];Hua Min [18];Dong Beibei [19]
Real estate economy	Gross Domestic Product of Real Estate Industry (100 million yuan)	Qi Xijing et al.[20];Yuan Yuan et al.[21]; Liu Shui [22]

3.2 Source of Indicator Data

To ensure data integrity, accuracy, and timeliness, the evaluation indicators for the real estate economy and hinterland economy in the Chengdu Chongqing Economic Circle are sourced from the latest official "City Statistical Yearbook (2019-2023)" for the four cities of Wanzhou, Fuling, Luzhou, and Yibin. It is worth mentioning that this article also conducted repeated comparisons of multiple data sources to confirm

the authenticity of the data before entering it for use, in order to reveal the current situation of coordinated development to the greatest extent possible. Descriptive statistical analysis was conducted using SPSS software, and the results are shown in Table 3.

Table 3. Descriptive Statistics of Indicator Data

Economic indicators	Sample size	Minimum value	Maximum value	Average value	Standard deviation	Deviation median
GDP of hinterland cities (100 million yuan)	20.00	860.67	3427.84	1843.38	816.78	1699.96
Per capita GDP in the hinterland (yuan)	20.00	44918.00	134655.00	73384.70	27053.19	61585.50
Total value of primary industry (100 million yuan)	20.00	65.30	395.96	186.19	109.99	156.13
Total value of the secondary industry (100 million yuan)	20.00	263.92	1723.21	889.63	462.35	903.98
Total value of the tertiary industry (100 million yuan)	20.00	407.49	1308.67	770.88	271.03	719.21
Total import and export volume of hinterland cities (100 million yuan)	20.00	8.54	316.85	123.85	82.91	106.49
Total retail sales of consumer goods in society (100 million yuan)	20.00	338.20	1244.40	763.17	346.27	753.13
Gross Domestic Product of Real Estate Industry (100 million yuan)	20.00	46.77	202.77	123.36	54.76	132.92

4 Empirical Analysis

4.1 Analysis based on Grey Relational Degree Model

Before analyzing the coupling coordination between the real estate economy and the hinterland economy, the grey correlation model is used to determine the degree of correlation between the hinterland economic indicators and the real estate economic indicators. Based on the principles of selectivity, operability, and comprehensiveness, the selected hinterland economic indicators include the GDP of hinterland cities (x_1), per capita GDP of hinterland cities (x_2), total output value of the primary industry (x_3), total output value of the secondary industry (x_4), total output value of the tertiary industry (x_5), total import and export value of hinterland cities (x_6), and total retail sales of consumer goods (x_7) as comparative sequence indicators. The GDP of the real estate industry is used as a reference sequence, and the data is normalized using the mean method. Then, it is substituted into the grey correlation model and calculated through Matlab programming. The results are shown in Table 4.

Table 4. Grey Correlation Degree Between Real Estate Economy and Hinterland Economy

Reference/Indicator	X1	X2	X3	X4	X5	X6	X7	Average value
Grey correlation degree with the gross domestic product of the real estate industry	0.800	0.531	0.798	0.752	0.809	0.625	0.785	0.73
Correlation Ranking	2	7	3	5	1	6	4	/

As shown in Table 4, the correlation between the real estate economy and the hinterland economy ranges from 0.531 to 0.809, with an overall average of 0.73, both of which are in the upper middle level. This indicates a high correlation between the real estate economy and the hinterland economy. Among them, the highest correlation with the total output value of the tertiary industry is 0.809, indicating that the real estate economy is closely related to the tertiary industry. This is because the investment and development activities of the real estate industry mainly involve the integration, organization, and management of resources, as well as the circulation and service activities that mainly create economic benefits for the tertiary industry. In addition, the correlation between the real estate economy and the GDP of hinterland cities is second, at 0.800, indicating a close relationship between the real estate economy and the GDP of hinterland cities. This is because real estate is a capital intensive industry, and a large amount of development investment and sales transactions directly contribute to GDP, driving the development of many related industries and indirectly increasing GDP. Overall, in the past five years, the real estate economy and the hinterland economy have mutually influenced and promoted each other.

4.2 Analysis based on Coupling Coordination Model

The grey correlation degree shows a high correlation between the real estate economy and the hinterland economy in the Chengdu Chongqing economic circle. In order to better reflect the development relationship between the two, a coupled coordination degree model is further used for analysis. Determine the order parameters of the coupling coordination degree model based on principles such as systematicity and representativeness. This article establishes order parameters based on the real estate economic indicators and hinterland economic indicators in Chapter 2. The entropy weight method is used to assign weights to each economic indicator, and the weights are multiplied by the standardized values of the indicators to calculate their comprehensive scores. The evaluation index for coupling coordination is calculated using Matlab, and the results are shown in Table 5.

Table 5. Real Estate Economy and Hinterland Economic System Order Parameters

Term	Information entropy value e	Information utility value d	Weight coefficient w
GDP of hinterland cities (100 million yuan)	0.9692	0.0308	9.85%
Per capita GDP in the hinterland	0.9804	0.0196	6.26%

Term	Information entropy value e	Information utility value d	Weight coefficient w
(yuan)			
Total value of primary industry (100 million yuan)	0.9447	0.0553	17.67%
Total value of the secondary industry (100 million yuan)	0.9536	0.0464	14.82%
Total value of the tertiary industry (100 million yuan)	0.9807	0.0193	6.17%
Total import and export volume of hinterland cities (100 million yuan)	0.9248	0.0752	24.03%
Total retail sales of consumer goods in society (100 million yuan)	0.9663	0.0337	10.78%
Real estate gross domestic product (100 million yuan)	0.9674	0.0326	10.43%

The entropy weight method calculates the weights by multiplying them with the dimensionless standard values of each indicator in the previous text and summing them up to calculate the comprehensive score of each economic system. This is used as the comprehensive evaluation index for coupling coordination analysis. The results are calculated using Matlab and are shown in Table 6.

Table 6. The Coupling and Coordinated Scheduling of Real Estate Economy and Hinterland Economy

Hinterland city	2018		2019		2020		2021		2022	
	C	D	C	D	C	D	C	D	C	D
Wanzhou	0.275	0.267	0.458	0.352	0.904	0.356	0.970	0.375	0.499	0.193
Fuling	0.930	0.297	0.951	0.371	0.949	0.425	0.886	0.498	0.851	0.501
Luzhou	0.995	0.736	0.969	0.717	0.980	0.734	0.997	0.777	0.999	0.803
Yibin	0.958	0.795	0.972	0.865	0.984	0.915	0.997	0.955	1.000	0.990
Average value	0.790	0.524	0.838	0.576	0.954	0.608	0.963	0.651	0.837	0.622

Note: The C value represents coupling degree, and the D value represents coupling co scheduling.

As shown in Table 6, with the annual growth of port logistics evaluation index and regional economic evaluation index, the coupling degree and coordination degree between the real estate economy and the hinterland economy in the Chengdu Chongqing Economic Circle have shown an overall trend of first increasing and then decreasing. This may be related to factors such as earlier policy implementation and accelerated urbanization process, as well as significant fluctuations in the real estate market in recent years. The average coupling degree of each year ranges from 0.790 to 0.963, indicating a very high overall coupling degree. The coupling coordination degree of each year ranges from 0.524 to 0.651, and the overall coupling coordination degree is relatively low. In these five years, the coupling coordination degree between Wanzhou and Fuling has been relatively low, especially Wanzhou, which had a coupling coordination degree as low as 0.193 in 2022. This may be related to factors such

as the economic development level and industrial structure of these cities. The coupling coordination degree between Luzhou and Yibin is relatively high, especially Yibin, with a coupling coordination degree of 0.990 in 2022, which is in a high-quality coordination state. This indicates that the coordination between the real estate economy and the hinterland economy in these two cities is good, which may be attributed to their good economic foundation, industrial development, and policy support. Further dividing the coupling co scheduling types based on the D value, the results are shown in Table 7.

Table 7. Classification of Coupling Coordination Types

Hinterland city	2018	2019	2020	2021	2022
Wanzhou	Moderate imbalance	Mild imbalance	Mild imbalance	Mild imbalance	Severe imbalance
Fuling	Moderate imbalance	Mild imbalance	Near imbalance	Near imbalance	Barely coordinate
Luzhou	Intermediate coordination	Intermediate coordination	Intermediate coordination	Intermediate coordination	Good coordination
Yibin	Intermediate coordination	Good coordination	High quality coordination	High quality coordination	High quality coordination

As shown in Table 7, after being divided by coupling coordination types, Wanzhou has been in a state of imbalance from 2018 to 2022, and has shown a trend of gradually deteriorating from moderate imbalance to severe imbalance. This indicates that Wanzhou's degree of coupling coordination in relevant aspects is continuously decreasing, and there may be some issues that need to be paid attention to and solved that affect its coordinated development. The overall situation in Fuling has improved, gradually transitioning from moderate imbalance to mild imbalance, and then to near imbalance, finally reaching a barely coordinated state in 2022. This shows that Fuling is showing a positive development trend in related areas, but there is still room for further improvement and optimization. Luzhou has almost maintained an intermediate level of coordination, indicating that its development in related areas is relatively stable and has a certain degree of coordination, but has not achieved further breakthroughs and improvements. Yibin has shown outstanding performance, continuously improving from intermediate coordination in 2018 to achieving good coordination and high-quality coordination in the following years, and maintaining a high level. This means that Yibin's development in related fields has strong coordination and sustainability, and is in a leading position. Overall, there are significant differences in the coupling and coordination types among different hinterland cities in different years, reflecting the imbalance in the process of regional economic development. Wanzhou and Fuling need to focus on improving the imbalance situation and further enhancing coordination; Luzhou can seek breakthroughs to improve coordination levels, while Yibin should continue to maintain a good development trend and continuously consolidate and enhance its advantages.

5 Conclusion

Overall, the coordination performance between the real estate economy and the hinterland economy in the Chengdu Chongqing economic circle is poor. Firstly, the grey correlation degree indicates that the real estate economy has a closer relationship with the tertiary industry and the GDP of the hinterland. Secondly, the high coupling degree reveals a strong correlation between the two, mainly driven by the real estate economy driving the growth of the hinterland economy. Finally, the coupling coordination degree is in a primary coordination state, which means that there are differences between the two and they have not developed synchronously. Based on this, specific suggestions will be made from the following three aspects.

5.1 Specific Recommendations for Different Cities

For Yibin, its coordination performance is the best, but there are still issues of intensified market differentiation and inventory backlog. On the one hand, the housing subsidy policy should be refined, providing precise subsidies for different regions and types of properties, especially increasing subsidies for properties in emerging regions and middle and low-income groups to stimulate market demand and alleviate inventory pressure. On the other hand, promoting real estate enterprises to combine Yibin regional cultural development projects, creating residential or commercial blocks with characteristics such as wine culture, enhancing the cultural connotation and attractiveness of projects, avoiding homogeneous competition, and promoting regional balanced development.

For Luzhou, its coordination performance is good, but there are problems of homogeneous competition and oversupply in some areas. Firstly, in the planning and approval process, policy preferences should be given to real estate projects that focus on ecological livability, such as prioritizing land supply and reducing related taxes and fees, to guide enterprises in creating distinctive living environments. Secondly, strengthen cooperation with surrounding cities, jointly create advantageous industrial clusters, attract talent and capital inflows, provide a solid economic foundation and industrial support for the real estate market, and promote differentiated development and transformation and upgrading of the real estate industry.

For Fuling, its coordination performance is poor, and although the real estate economy has shown some growth, there are still many problems. Firstly, scientifically plan land supply, determine the scale and pace of supply based on market demand and population growth trends, strengthen land transfer supervision, ensure that land is used for reasonable real estate project development, and optimize the market supply structure. Secondly, formulate preferential policies to encourage enterprises to build affordable housing, provide financial subsidies and tax reductions, increase the proportion of affordable housing supply, meet the housing needs of low - and middle-income groups, stabilize housing prices, and promote the healthy development of the real estate market.

For Wanzhou, its coordination performance is the worst, with significant regional development imbalances and market fluctuations. On the one hand, increasing in-

vestment in public service facilities such as transportation, education, and healthcare, improving regional development conditions, enhancing urban attractiveness, and creating a favorable environment for the stable development of the real estate market. On the other hand, actively attracting diversified industries to settle in, formulating industrial development policies, reducing excessive dependence on the real estate economy, enhancing regional economic resilience, and achieving diversified development and sustainable growth of the regional economy.

5.2 Policy Recommendations for Promoting Real Estate Development

In terms of financial policies, relevant departments can optimize credit policies, increase financial support for real estate enterprises, and strengthen risk prevention and control to ensure financial security. This helps real estate companies obtain stable sources of funding, promote project development and transformation, and promote the healthy development of the real estate market. Establish a real estate development fund to provide financial support for potential projects, strengthen supervision to ensure the safe and effective use of funds, and provide guarantees for the stable development of the real estate market.

In terms of land policy, relevant departments need to arrange land supply reasonably, determine the supply scale and pace based on market demand and urban development planning, and avoid waste of land resources and supply-demand imbalance in the real estate market. Promote land system reform, explore diversified land supply methods, increase land supply channels, reduce real estate development costs, and provide a foundation for the stable development of the real estate market.

In terms of industrial policies, relevant departments need to strengthen the integration and development of industries, promote the integration of real estate with tourism, culture, elderly care and other industries, expand the development space of real estate, increase the added value of real estate, and achieve diversified industrial development. Intensify support for emerging industries, cultivate new economic growth points, attract diversified industries to settle in, reduce excessive dependence on the real estate economy, and enhance the vitality and competitiveness of regional economy.

In terms of regulatory policies, relevant departments need to strengthen market supervision, formulate strict regulatory policies to regulate corporate behavior, increase efforts to investigate and punish illegal and irregular behaviors, maintain market order, and safeguard the legitimate rights and interests of consumers. Establish a real estate market information platform, improve market transparency, guide rational market development, and provide accurate information references for government decision-making, corporate investment, and consumer home purchases.

5.3 Comparative Analysis with other Economic Circles

Compared with the Yangtze River Delta economic circle, the industrial structure of the Yangtze River Delta region is diversified, with developed high-tech industries and modern service industries, and the real estate economy is well coordinated with other

industries. The Chengdu Chongqing Economic Circle should increase efforts to adjust its industrial structure, support emerging industries, increase industrial added value, and reduce excessive dependence on real estate. Drawing on the policy support of the Yangtze River Delta in regional integration development, we will strengthen the coordinated development of public service facilities such as transportation, education, and healthcare. Learn from their experience in regulating the real estate market and develop scientifically reasonable regulatory policies based on local conditions.

Compared with the Guangdong Hong Kong Macao Greater Bay Area, the Pearl River Delta region has strong economic vitality, outstanding innovation capabilities, and attracts a large number of talents and capital inflows. The Chengdu Chongqing Economic Circle should strengthen technological innovation, enhance economic vitality and competitiveness, and provide support for the stable development of the real estate market. Learn from its diversified real estate market development model, develop the rental market, increase the construction of affordable housing, and meet the housing needs of different levels of people. Strengthen cooperation and communication between cities, clarify the functional positioning of each city, achieve complementary advantages, and jointly promote regional economic development.

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