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Dynamic evaluation research on competition and cooperation indicators of urban agglomeration in Western Guangdong based on niche theory

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Abstract

With the deepening of regional integration, urban competition and cooperation have evolved into a complex symbiotic system centered on urban agglomerations. This study measures and diagnoses the competition–cooperation relationship within the western Guangdong urban agglomeration (Zhanjiang, Maoming, and Yangjiang), and proposes feasible pathways for coordinated regional development. Based on niche theory, a four-dimensional indicator system covering environment, resources, economy, and society was constructed. The CRITIC weighting method, together with niche breadth, overlap, and expansion models, was applied to quantitatively measure the degree of inter-city competition and cooperation. The results show that: (1) niche breadth differs markedly among the three cities; (2) niche expansion remains weak overall (mean < 0.5), reflecting insufficient endogenous growth and constrained regional competitiveness; (3) niche overlap stays persistently high (mean > 0.85), carrying risks of industrial isomorphism and vicious competition. Taken together, the agglomeration faces a structural dilemma of "low expansion and high overlap." Escaping homogeneous competition requires shifting from confrontational rivalry toward complementary collaboration. Three strategies are proposed: building a differentiated industrial division system, deepening the "dual-zone linkage" open pattern, and jointly developing a regional science and technology innovation corridor. These findings offer decision-making references for resolving homogenized competition and achieving the collaborative evolution of the urban agglomeration.

Keywords: Co-opetition index, Ecological niche, Niche breadth, Niche expansion, Niche overlap; Urban agglomeration.
JEL Classification: C55; O44; R11.

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Contents

Contribution of this paper to the literature

This study applies niche theory to explore the competitive-cooperative dynamics among Zhanjiang, Maoming, and Yangjiang. Amid regional isomorphism risks and the Greater Bay Area strategy, it analyzes environmental, resource, economic, and social niches to reveal the agglomeration's evolution mechanisms and collaborative optimization paths.

1. Introduction

Cities are the core spatial carriers of the national economy, and the problem of uneven development has become increasingly prominent with the rapid advancement of urbanization. The western Guangdong urban agglomeration (including Zhanjiang, Maoming, Yangjiang, etc.) serves as a strategic hinterland for the coordinated development of the Guangdong-Hong Kong-Macao Greater Bay Area and the Beibu Gulf Economic Zone. It is not only a key pivot for Guangdong Province to promote the progress of both the eastern and western wings, but also an important growth pole for the Beibu Gulf Economic Circle. At present, the region is in a stage of accelerated industrialization and urbanization, facing a severe situation of "two-way squeezing": on the one hand, the polarization effect of core cities is significant, and high-quality factors continue to overflow to the Pearl River Delta, leading to obvious disadvantages in high-end talent, technological innovation, financial capital, and other aspects in western Guangdong. On the other hand, the industrial structure of cities within the region has a high degree of convergence, and areas such as port industry and coastal tourism have fallen into a low-level homogenization competition and resource competition dilemma, failing to fully leverage their respective comparative advantages to form a complementary and interconnected development pattern (Wang, Zhang, & Li, 2021). In this context, clarifying the competition and cooperation within urban agglomerations and formulating differentiated collaborative development strategies are of great strategic significance for promoting the deep integration of western Guangdong into the "dual zone" construction and achieving high-quality development.

2. Literature Review

2.1. Research on the Application of Ecological Niche Theory

The ecological niche theory was initially applied to land use, industrial development, culture, and population. Ma and Wang (1984) introduced the ecological niche theory into the field of urban research, promoting its continuous expansion in urban ecology, human ecology, land use optimization, industrial competitiveness evaluation, and other fields. At the practical level, different scholars have conducted extensive explorations. Sengers and Raven (2015) analyzed the internal driving mechanism of the new mode of urban transportation transformation from the perspective of ecological niche development logic. Pallante, Drucker, and Sthapit (2016) focused on the empowering effects of ecological niche evolution on farmers' livelihoods and agricultural biodiversity. Li and Chen (2014) explored the influencing factors of changes in urban tourism niche dynamics based on niche theory. Qin and Fu (2013) employed niche theory to analyze the development of the Changsha-Zhuzhou-Xiangtan urban agglomeration, providing a theoretical reference for the coordinated development of urban agglomerations. Wang, Sheng, and Gong (2023) evaluated the level characteristics and spatial correlation laws of rural industrial integration development in the three regions of southern Xinjiang based on ecological niche theory. Hu and Xia (2024) established a theoretical analysis framework for the competitiveness of innovative industrial clusters based on ecological niche cities.

2.2. Niche-Based Urban Competition and Cooperation Indicators

Tang (2017) applied the niche position theory to construct an urban niche assessment system for Fujian Province. Nie et al. (2018) constructed an expansion separation analysis framework based on the theory of urban ecological niche to measure the ecological niche of county-level cities in the Hexi Corridor. Hu, Zhang, Liang, and Peng (2016) employed spatial autocorrelation methods to measure the ecological niche of the urban agglomeration on the northern slope of the Tianshan Mountains and analyzed its spatiotemporal variations. Shen, Shi, Li, and Cao (2020)introduced a coupling coordination degree model to evaluate the spatial function and comprehensive competitiveness of the Beijing-Tianjin-Hebei urban agglomeration. They found that the overall economic, social, and environmental niche width of the region showed differentiated evolution, and the uneven development of the region was significant. Liu, Huang, Yang, Lin, and Cui (2022) established a multi-scale urban ecological niche model using Zhejiang Province as the empirical object, achieving for the first time a horizontal comparison at the three levels of city, district, and township. Li and Luo (2025) conducted comprehensive ecological niche measurement and cluster analysis on 14 cities in Guangxi, revealing the uneven distribution pattern of ecological niche width in each city. Yang et al. (2023) used multivariate effective flow matrix and social network analysis methods to analyze the spatial heterogeneity and hierarchical scale differentiation of the overall potential energy structure of cities in the Guangdong Hong Kong Macao Greater Bay Area. Sun, Fan, and Zhao (2020) used the ecological niche expansion compression model to quantify the competition and competition relationships among core cities in Xinjiang, and confirmed that there are significant differences in the ecological niche expansion compression effect caused by different city competitiveness. Wang, Zhang, and Li (2020) conducted a systematic evaluation of seven coastal cities in the Beibu Gulf using an ecological niche width spatial pattern map and overlap network, demonstrating the positive promotion effect of overall ecological niche optimization on regional industrial sustainable development. Fan, Yang, and Liu (2024) measured the competitive level of 41 cities in the Yangtze River Delta and analyzed the overall trend and evolution characteristics of the competitive situation in the region.

In summary, the application research of urban niche theory has achieved significant progress, and the research scope has expanded from a pure ecological perspective to multiple dimensions such as industrial transformation, land use, and competitiveness evaluation. The research scale has also achieved a transition from a single city to multi-scale coupling. However, there are still two limitations to existing research: firstly, in terms of research perspective, existing studies mostly focus on mature urban clusters or independent administrative regions such as the Yangtze River Delta and the Pearl River Delta, and lack in-depth exploration of emerging regions such as western Guangdong that possess both "strategic hinterland" and "inter-provincial edge" attributes. With the deepening of

regional integration, urban competition has evolved into a complex symbiotic system formed by urban agglomerations, and there are still blind spots in existing research on such special areas. Secondly, in the design of the evaluation system, most current research focuses on dimensions such as population, economy, and society, depicting the competitive relationship between cities, while the dynamic evaluation of ecological niche competition indicators in urban agglomerations lacks systematic consideration. In view of this, this article selects the western Guangdong urban agglomeration as the research sample, uses the ecological niche theory to measure its degree of competition from the perspectives of environment, resources, economy, and society, analyzes the structural contradictions faced by urban competition, and proposes a coordinated development strategy for urban agglomerations, in order to solve the dilemma of regional homogenization competition and resource mismatch, and provide theoretical support and practical guidance for the coordinated evolution of urban agglomerations.

3. Methodology

3.1. Index System and Data Sources

Based on the resources, environment, and economic and social development of the three cities of Zhanjiang, Maoming and Yangjiang in accordance with the principles of scientific rigor, systematicity, and operability, a competitive index system for the ecological niche of the western Guangdong urban agglomeration is constructed. Specifically, it includes 4 primary indicators, 10 secondary indicators, and 27 tertiary indicators. The data in this article are sourced from China National Knowledge Infrastructure's China Economic and Social Big Data Research Platform, including the China Urban Statistical Database (CUSD), Guangdong Social Statistical Yearbook (GSSY), and Guangdong Provincial Statistical Yearbook (GSY). The research period is from 2018 to 2023. See Table 1.

Table 1. Niche competition index system in western Guangdong.

First-grade index	Second-grade index	Third-grade index	Data source
Environmental niche	Ecological environment	X1 Per capita park green area in urban areas (square meters)	CUSD
		X2 Urban sewage treatment rate (%)	CUSD
		X3 Harmless treatment rate of household waste (%)	GSY
	Cultural environment	X4 Expenditure on culture, tourism, sports, and media (in billions of yuan)	GSY
		X5 Public Library Collection (10000 Books)	GSSY
	Financial environment	X6 Balance of various RMB deposits in financial institutions (in 10000 yuan)	CUSD
		X7 Balance of RMB loans from financial institutions (in billions of yuan)	CUSD
Resource niche	Social resources	X8 Urbanization level (%)	GSY
		X9 Number of newly added urban employment (persons)	GSSY
	Economic resources	X10 Per capita disposable income of urban residents (yuan)	GSY
		X11 International tourism foreign exchange income (USD 10000)	CUSD
		X12 Total export value (in billions of US dollars)	GSY
		X13 Total import amount (in billions of US dollars)	GSY
	Talent resources	X14 Number of students enrolled in regular higher education institutions (persons)	GSSY
	Knowledge resources	X15 Per capita ownership of books in public libraries (volumes)	GSSY
Economic niche	Economic strength	X16Gross Domestic Product(yuan)	GSY
		X17 Per capita gross domestic product （yuan)	GSY
		X18 Growth rate of energy consumption per unit of GDP (%)	GSY
		X19 Growth rate of electricity consumption per unit of GDP (%)	GSY
		X20 Per capita consumption expenditure of urban residents (yuan)	GSY
Social niche	Technology guarantee	X21 Science and technology expenditure in local general public budget expenditure (10000 yuan)	CUSD
		X22 Science and technology expenditure of research and development institutions under the jurisdiction of government departments at or above the county level in each city (10000 yuan)	GSY
		X23 Number of R&D personnel in industrial enterprises above designated size (piece)	GSY
		X24 Internal expenditure of R&D funds for industrial enterprises above designated size (in billions of yuan)	GSY
	Educational security	X25 Number of regular higher education institutions (piece)	GSSY
		X26 Number of full-time teachers in regular higher education institutions (person)	GSSY
		X27 Education expenditure in local general public budget expenditure (10000 yuan)	CUSD

The environmental niche assessment system covers three core dimensions: ecological environment, cultural environment, and financial environment. Among them, ecological environment is the foundation of urban development, focusing on the level of urban greening and livability. Cultural environment reflects social behavior norms and value orientations. The financial environment provides capital support for the operation of cities. The resource niche (Li & Li, 2023) is developed from four dimensions: social resources, economic resources, talent resources, and knowledge resources. Social resources reflect the carrying capacity and development vitality of the

social system. Economic resources reflect the thickness of the economic foundation and the efficiency of resource conversion. Talent resources measure the stock of potential high-quality human resources. Knowledge resources are a quantitative measure of the ability to produce and store knowledge. The evaluation of economic niche anchors the economic strength of cities. The social ecological niche is evaluated based on two major areas: technological support and educational support. Technological support reflects the comprehensive strength of a city in terms of technological innovation, research and development investment, and talent reserves, while educational support reflects the degree of aggregation of urban educational resources and their potential effectiveness in cultivating high-quality talents.

3.2. Ecological Niche Assessment Model

(1) Urban ecological niche width model

$$N_i = (S_i + A_i P_i) / \sum_{j=1}^{n} (S_j + A_j p_j) \qquad (1)$$

In the formula, Ni is the ecological niche width of city i, Si and Sj are the states of city i and j, Pi and Pj are the potentials of city i and j, and Ai and Aj are the dimensionless conversion coefficients. Regarding the value and calculation of the dimensional conversion coefficient: To eliminate the difference in absolute orders of magnitude and dimension between "state" and "potential", make them comparable, and achieve weighted summation, Ai is usually set as the product of the reciprocal of each indicator "state" in city i and the time scale. In practical calculations, the specific calculation formulas for Ai and Aj are Ai=1/(t, Si) and Aj=1 (t, Sj), where t is the time span of the study (in this article t=5, which is the number of years from 2018 to 2023). Therefore, AiPi represents the transformation of the annual growth trend of city i into an equivalent stock of the same magnitude as the "state". The ecological niche width Ni ranges from 0 to 1. The larger its value, the stronger the city's ability to utilize resources and the greater its development potential. Conversely, it indicates that the poorer the city's ability to utilize resources, the weaker its development potential (Yang, Zhou, & Yang, 2021).

(2) Urban ecological niche overlap index model

$$s(x, y) = \sum_{i=1}^{n} X_i Y_i \Big/ \sqrt{\sum_{i=1}^{n} x_i^2 \sum_{i=1}^{n} y_i^2} \qquad (2)$$

In the formula, S (x, y) is the urban ecological niche overlap index, X and Y represent two cities respectively, n represents the number of industries, i is the i-th industry sector, Xi and Yi are the proportion of the output value of the i-th industry sector to the GDP of X and Y cities, respectively. The overlap index of urban ecological niche is usually between 0 and 1. If the overlap index is 1, it indicates that the industrial structure between cities is consistent. If the overlap index is 0, it indicates that the industrial structure between cities is not consistent (Cui, Hou, & He, 2022).

(3) Urban ecological niche expansion model

$$T = \frac{\sum_{j=1}^{n} P_{ij}}{\sum_{j=1}^{n} S_{ij}} \qquad (3)$$

In the formula, T represents the expansion rate of urban ecological niche, P represents the "potential" of urban ecological niche, and S represents the "state" of urban ecological niche. T>0, the urban ecological niche is in a favorable state, and the competitiveness and influence are gradually increasing. T<0, the situation of urban ecological niche is poor, and its competitiveness and influence are gradually weakening; T=0, the situation of urban ecological niche has not changed, and competitiveness and influence are developing steadily (Li & Luo, 2025).

3.3. Evaluation Process

Firstly, use SPSS software to normalize the original indicator data. Then, the CRITIC method was used to determine the weights of each three-level indicator, as shown in Table 2. The advantage of the CRITIC method is that it can simultaneously consider the variability and conflict of indicators, making the weighting more scientific. It can avoid subjective interference from human factors in weight assignment, effectively identify redundant indicators, make the results have strong stability, and truly reflect the actual discriminatory power of each indicator. This method is suitable for comprehensive evaluation of multiple indicators. According to formulas (1) and (3), calculate the ecological niche width and ecological niche expansion of the three competing indicators of environment, resources, economy, and society in the three cities of western Guangdong from 2018 to 2023. Use the weight values in Table 2 to weight the data and calculate the ecological niche width and ecological niche expansion of environment, resources, economy, and society in Yangjiang, Zhanjiang, and Maoming from 2018 to 2023. Finally, according to formula (2), calculate the ecological niche overlap between Yangjiang and Zhanjiang, Zhanjiang and Maoming, and Maoming and Yangjiang.

Table 2. Weight table of urban ecological niche competition indicators.

Environmental		Resource		Economic		Social	
Third-grade index	Weight	Third-grade index	Weight	Third-grade index	Weight	Third-grade index	Weight
X1	22.17%	X8	8.01%	X16	50.90%	X21	8.66%
X2	6.36%	X9	23.96%	X17	12.57%	X22	18.73%
X3	0.00%	X10	0.87%	X18	15.09%	X23	25.25%
X4	13.27%	X11	9.31%	X19	14.11%	X24	11.26%

Environmental		Resource		Economic		Social	
Third-grade index	Weight	Third-grade index	Weight	Third-grade index	Weight	Third-grade index	Weight
X5	15.67%	X12	4.41%	X20	7.33%	X25	10.66%
X6	20.05%	X13	27.46%			X26	14.46%
X7	22.48%	X14	16.31%			X27	10.97%
		X15	9.68%				

4. Result and Discussion

4.1. Urban Niche Differentiation and Zhanjiang's Multidimensional Prominence

The comprehensive evaluation results of the environment, resources, economy, and social-ecological niche of the western Guangdong urban agglomeration are shown in Table 3. From the perspective of the average ecological niche width, there are significant differences in the environmental dimension. Among them, Zhanjiang has the largest ecological niche width, with an average of 0.387 from 2018 to 2023, indicating a strong capacity to utilize the environment and great potential for development in ecological, cultural, and financial environments. The average of Maoming is 0.341, ranking second. However, Yangjiang is the smallest with an average of only 0.272, reflecting its relatively weak ability to utilize the environment. The development potential of the above dimension needs further exploration and improvement.

In terms of resource dimensions, the average ecological niche width of Zhanjiang is as high as 0.54, followed by Maoming (0.236), and Yangjiang is the smallest (0.211). This indicates that Zhanjiang has significant advantages in the reserve and transformation of social, economic, talent, and knowledge resources, and has great development potential. Maoming and Yangjiang are relatively weak, and their resource aggregation capabilities need to be improved. In terms of the economic dimension, the average of Zhanjiang is 0.381, followed closely by Maoming at 0.367 and Yangjiang at only 0.251, reflecting that Zhanjiang's economic development momentum is good and its industrial support is strong, while Yangjiang's economic ecological foundation is relatively weak and its development momentum is insufficient. In terms of the social dimension, Maoming has a slightly higher average of 0.227 than Zhanjiang (0.224), while Yangjiang only has 0.086, indicating that Maoming and Zhanjiang have a good development trend in science and technology investment, education security, and other aspects, and their public service systems are relatively complete. However, Yangjiang still has obvious shortcomings in education and technology development, and urgently needs to strengthen policy support and resource allocation.

4.2. Weak Overall Niche Expansion, Strong Economic Expansion in Yangjiang

From the perspective of the average ecological niche expansion, the average values of the four dimensions in the three cities of Zhanjiang, Maoming and Yangjiang are all below 0.5, indicating that the overall degree of regional ecological niche expansion is relatively weak. The highest environmental dimension in Yangjiang is 0.090. The average values of the three cities in the resource dimension are all below 0, and the ecological niche expansion degree of Yangjiang in the economic dimension is 1.845, indicating strong competitiveness and influence. The average values of Zhanjiang and Maoming are both below 0, and the ecological niche expansion of the three cities in the social dimension is negative, indicating that the competitiveness and influence of the three cities in science and technology and education are relatively weak.

Table 3. Niche width and expansion in western Guangdong (2018-2023).

City	Evaluation dimension	Indicator type	2018	2020	2022	2023	Mean
Yangjiang	Environmental	Width	0.231	0.292	0.276	0.292	0.272
		Expansion degree	0.110	0.089	0.104	0.092	0.090
	Resource	Width	0.259	0.195	0.193	0.222	0.211
		Expansion degree	0.049	-0.421	0.037	-0.124	-0.051
	Economic	Width	0.299	0.206	0.342	0.177	0.251
		Expansion degree	0.033	4.345	5.025	1.185	1.845
	Social	Width	0.051	0.123	0.085	0.129	0.086
		Expansion degree	0.016	0.176	0.216	0.078	-0.059
Zhanjiang	Environmental	Width	0.492	0.357	0.403	0.328	0.387
		Expansion degree	0.122	0.055	0.002	0.051	0.061
	Resource	Width	0.496	0.558	0.546	0.589	0.540
		Expansion degree	-2.199	-0.780	0.118	0.031	-0.406
	Economic	Width	0.282	0.498	0.360	0.299	0.381
		Expansion degree	-0.839	0.749	-0.804	-1.465	-0.433
	Social	Width	0.198	0.230	0.279	0.215	0.224
		Expansion degree	-3.527	0.078	0.128	-0.069	-0.525
Maoming	Environmental	Width	0.277	0.351	0.321	0.381	0.341
		Expansion degree	0.085	0.082	0.037	0.053	0.070
	Resource	Width	0.230	0.233	0.247	0.186	0.236
		Expansion degree	-0.752	-0.47	0.080	-0.098	-0.128
	Economic	Width	0.419	0.296	0.298	0.525	0.367
		Expansion degree	-4.422	0.420	-0.804	1.771	-0.255
	Social	Width	0.289	0.183	0.170	0.193	0.227
		Expansion degree	-0.994	0.000	0.014	0.088	-0.089

4.3. High Niche Overlap and Intensifying Homogeneous Competition

The evaluation results of social-ecological niche overlap are shown in Table 4. From the mean values, the ecological niche overlap of the four dimensions of environment, resources, economy, and society all exceed 0.85. The environmental dimension has the highest overlap between Zhanjiang and Maoming (mean 0.932), followed by Maoming and Yangjiang (mean 0.923), and Yangjiang and Zhanjiang have the lowest (0.878), indicating that there

is universal overlap in the environmental industry structure among the three cities. The resource dimension of Zhanjiang and Maoming has the highest overlap (0.928), and the two cities have a high degree of homogenization in the resource-based industrial structure. In terms of the economic dimension, Maoming and Yangjiang have the highest degree of overlap (0.855), indicating that Maoming and Yangjiang compete fiercely in the economic and industrial ecology. The highest degree of overlap between Yangjiang and Zhanjiang in the social dimension (0.871) highlights the significant competitive pressure between Yangjiang and Zhanjiang in social industry ecology such as science and education.

Table 4. Niche overlap in western Guangdong (2018-2023).

Indicator type	City pair	2018	2020	2022	2023	Mean
Environmental niche	Yangjiang—Zhanjiang	0.876	0.755	0.914	0.840	0.878
	Zhanjiang—Maoming	0.943	0.805	0.944	0.993	0.932
	Maoming—Yangjiang	0.963	0.930	0.907	0.863	0.923
Resource niche	Yangjiang—Zhanjiang	0.767	0.858	0.942	0.840	0.873
	Zhanjiang—Maoming	0.994	0.745	0.965	0.923	0.928
	Maoming—Yangjiang	0.769	0.893	0.962	0.947	0.894
Economic niche	Yangjiang—Zhanjiang	0.295	0.420	0.950	0.913	0.769
	Zhanjiang—Maoming	0.659	0.486	0.859	0.873	0.780
	Maoming—Yangjiang	0.911	0.688	0.758	0.986	0.855
Social niche	Yangjiang—Zhanjiang	0.726	0.887	0.927	0.912	0.871
	Zhanjiang—Maoming	0.579	0.875	0.856	0.906	0.846
	Maoming—Yangjiang	0.370	0.705	0.777	0.869	0.717

From the perspective of evolutionary trends, the competitive landscape in the economic dimension is showing significant convergence characteristics. As shown in Figure 1, the overlap of economic ecological niches among the three cities has remained high for a long time, and the growth rate of the "Yangjiang-Zhanjiang" curve is particularly rapid, showing a sharp upward trend. Specifically, the overlap value has surged from 0.295 in 2018 to 0.950 in 2022. This data change clearly confirms that the homogenization competition among cities in key areas such as the port industry and clean energy is rapidly deteriorating, and resource competition has become increasingly fierce. It is urgent to be vigilant about the risk of internal friction caused by excessive overlap.

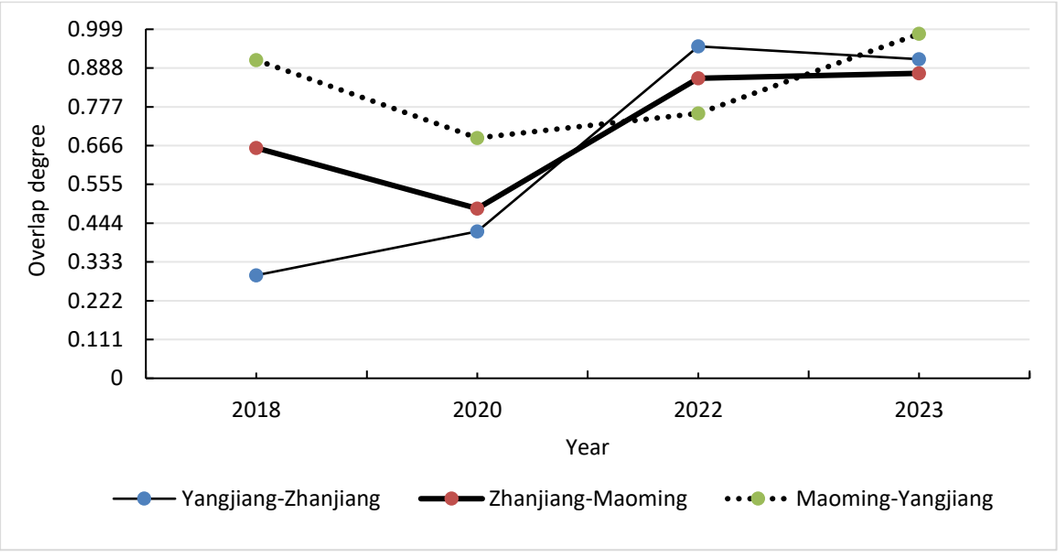

Figure 1. Economic niche overlap in western Guangdong (2018-2023).

5. Conclusion and Recommendations

5.1. Conclusion

(1) The ecological niche breadth exhibits significant differentiation, with Zhanjiang having prominent resource advantages but also evident shortcomings in the social dimension.

Between 2018 and 2023, the ecological niche breadth of the western Guangdong urban agglomeration exhibited distinct urban differentiation characteristics. In terms of environmental ecological niche breadth, Zhanjiang ranked first with an average value of 0.387, followed by Maoming (0.341) and Yangjiang (0.272), indicating that Zhanjiang possesses significant advantages in the comprehensive utilization of ecological, cultural, and financial environments. Similarly, in terms of resource ecological niche breadth, Zhanjiang led the way (0.54), followed by Maoming (0.236) and Yangjiang (0.211), reflecting that Zhanjiang's development potential in social, economic, talent, and knowledge resource ecology is significantly superior to the other two cities. This result is closely related to Zhanjiang's vigorous promotion of policies such as synergistic reduction of pollution and carbon emissions, construction of a waste recycling system, and implementation of ecological environment zoning control in recent years. In terms of economic ecological niche breadth, Zhanjiang ranked first with an average value of 0.381, followed by Maoming (0.367) and Yangjiang (0.251), indicating that Zhanjiang has strong momentum in economic ecological development. Social ecological niche breadth was also highest in Maoming (0.227), followed by Zhanjiang (0.224), and lowest in Yangjiang (0.086). Overall, Zhanjiang has absolute advantages in environmental, resource, and economic dimensions, with slight shortcomings in the social dimension. Maoming has slight advantages in the social dimension. Yangjiang exhibits non-balanced characteristics with weaknesses in all dimensions.

(2) The overall degree of ecological niche expansion is relatively weak, and there are structural challenges in enhancing regional competitiveness and influence.

The average ecological niche expansion is below 0.5, and the competitiveness and influence of the three cities in western Guangdong are at a weak level in all four dimensions. In terms of environmental niche expansion, Yangjiang ranks first with an average of 0.090, followed closely by Maoming (0.070) and Zhanjiang (0.061). Although all three cities have positive values, the values are relatively low, indicating that the overall environmental situation is improving but the increase is limited. The expansion degree of resource ecological niche is not optimistic, with the average values of the three cities being negative. Zhanjiang has the lowest value (-0.406), Maoming is -0.128, and Yangjiang is -0.051, indicating that the overall competitiveness and influence of the three cities in the resource industry ecology are relatively weak. However, Zhanjiang has rebounded to 0.031 in 2023, showing a trend of improvement. The expansion degree of economic ecological niche is only positive in Yangjiang (1.845), showing a strong trend of competitiveness and influence expansion, while Maoming (-0.255) and Zhanjiang (-0.433) are both negative, but Maoming will significantly increase to 1.771 in 2023, indicating a clear improvement in the situation. The "abnormal" high-value expansion of Yangjiang's economy has profound practical industrial logic: in recent years, Yangjiang has firmly grasped the strategic positioning of "wind power capital", and the offshore wind power industry has shown explosive growth, forming a cluster effect of billions of industrial clusters from wind turbine equipment manufacturing to wind power operation and maintenance. At the same time, its traditional advantage industry of alloy materials is also accelerating its transformation towards high-end. The "dual wheel drive" of emerging green energy and advanced materials industries, coupled with the rapid transformation of project investment, has injected far stronger momentum into the ecological niche of Yangjiang's economy, enabling it to achieve a strong breakthrough in economic competitiveness under the pressure of limited resources and social expansion.

(3) The degree of ecological niche overlap remains high, and the risks of industrial isomorphism and cut-throat competition are intensifying.

The average ecological niche index among the three cities in western Guangdong exceeds 0.85, indicating a significant phenomenon of industrial isomorphism. In terms of environmental niche overlap, Zhanjiang and Maoming have the highest (0.932), followed by Maoming and Yangjiang (0.923), and Yangjiang and Zhanjiang have the lowest (0.878), indicating a high degree of overlap in the environmental industry structure among the three cities. The overlap of resource ecological niches also presents similar characteristics, with Zhanjiang and Maoming reaching 0.928, Maoming and Yangjiang at 0.894, and Yangjiang and Zhanjiang at 0.873. The overlap degree of economic ecological niche is highest between Maoming and Yangjiang (0.855), 0.780 between Zhanjiang and Maoming, and 0.769 between Yangjiang and Zhanjiang. The degree of social-ecological niche overlap is highest in Yangjiang and Zhanjiang (0.871), 0.846 in Zhanjiang and Maoming, and lowest in Maoming and Yangjiang (0.717). From the trend, the overlap of economic and social ecological niches in the three cities is gradually increasing, with Zhanjiang and Yangjiang in the economic dimension and Maoming and Yangjiang in the social dimension showing the fastest growth rate. The highly overlapping ecological niches imply strong resource and market competition among the three cities in terms of industrial development. This is highly related to the industrial policies of all three cities vigorously developing the marine economy, port industry, and clean energy. There is a clear industrial intersection among the three cities in the fields of green chemicals, new energy, and marine equipment. If there is a lack of effective regional coordination mechanisms, it is easy to fall into vicious competition and restrict the overall high-quality development of urban agglomerations.

5.2. Recommendations

(1) Build a differentiated industrial division system to break the dilemma of homogenization competition.

In response to the prominent issue of homogenization competition in the leading industries of the western Guangdong urban agglomeration (with an average overlap degree exceeding 0.85), it is necessary to reshape the regional division of labor with the core of industrial dislocation development. Establish a "Zhanjiang-Maoming-Yangjiang Industrial Coordinated Development Coordination Mechanism" to coordinate and optimize the layout of port-proximate industries, and promote precise docking between upstream and downstream industrial chains based on the resource endowments of each city. For example, Zhanjiang should focus on the development of high-end marine engineering equipment and deep processing of steel, Maoming should anchor on the extension of green fine chemicals to the middle and downstream of petrochemicals, and Yangjiang should focus on the manufacturing of advanced alloy materials and offshore wind power equipment. Simultaneously, establish a regional industrial access negative list and a capacity warning mechanism, dynamically track the investment enthusiasm of the three cities, avoid low-end redundant construction, and transform homogenization competition into a cross-regional chain collaboration model of "raw material sharing - component matching - complete machine integration".

(2) Deepen the "dual-zone linkage" open pattern and activate the growth momentum of economic expansion.

Anchor the policy window period for the transfer of industrial gradients in the Greater Bay Area and the operation of the Hainan Free Trade Port, and create a two-way opening and empowerment pivot. To the south, leveraging the advantages of the Qiongzhou Strait Interconnection Channel, we will jointly build the "Zhanqiong Offshore Wind Power Operation and Maintenance Base" and the "Guangdong Hainan Agricultural Cold Chain Logistics Hub" with Hainan. With the solid energy and raw material industry foundation in the region, we will provide customized energy supply guarantee and chemical new material cooperation for Hainan. From the perspective of development timeliness, the economic expansion degree of Maoming in 2023 (1.771) releases a signal of recovery. By promoting the coordinated operation of port clusters and the interconnection of infrastructure, the logistics resources of node cities such as Zhanjiang and Maoming will be effectively integrated, significantly reducing the comprehensive logistics costs of regional bulk cargo and cold chain agricultural products. Ultimately, a cross-regional collaborative development paradigm of "bay area research and development design+intelligent manufacturing in western Guangdong+Hainan opening up to the sea" will be formed.

(3) Co-build a regional science and technology innovation corridor, and strengthen the shortcomings in social ecological roles.

In response to the low efficiency of scientific and educational investment in the three cities of Zhanjiang, Maoming, and Yangjiang (Zhanjiang expansion degree -0.525, Maoming -0.089, Yangjiang -0.059) and the

fragmented allocation of innovative elements, we will work together to promote the "Regional Science and Education Resource Sharing Plan". Strengthen Zhanjiang's leading role in scientific and technological innovation as a provincial sub-center city, and build a three-city industry-university-research cooperation alliance based on existing universities and research institutes. Support Zhanjiang in deepening marine technology research, linking Yangjiang clean energy equipment manufacturing enterprises with Maoming Petrochemical's deep processing industry, building a cross-regional technology transfer service platform, realizing instrument and equipment sharing, scientific research data exchange, and dynamic docking of research and development achievements. Establish a mechanism for mutual recognition of professional qualifications and scientific research achievements among high-level talents in the three cities, pilot cross regional entrepreneurship support policies in fields such as ocean engineering and clean energy, guide Yangjiang to leverage its active advantages in the private economy, pilot the "unveiling and leading" research and development model of "enterprise problem-solving, university problem-solving, and government assistance", gather regional innovation forces, jointly overcome key core technology bottlenecks, and comprehensively enhance the overall scientific and technological innovation level of the region.

References

Cui, M., Hou, L., & He, X. (2022). Study on the multi-dimensional niche characteristics of the urban system of the Chengdu Chongqing economic circle from the perspective of niche. *Journal of Southwest University of Science and Technology*, *39*(6), 60–70.

Fan, Q.-Y., Yang, S., & Liu, S.-B. (2024). Spatial evolution of urban co-opetition in Yangtze River Delta region based on regional integration. *Journal of Natural Resources*, *39*(4), 929–941. https://doi.org/10.31497/zrzyxb.20240411

Hu, M.-M., Zhang, J.-M., Liang, E.-M., & Peng, L.-Y. (2016). Measurement and spatial-temporal differences of niche of urban agglomerations on northern slope of Tianshan Mountains. *Chinese Journal of Ecology*, *35*(9), 2463–2470.

Hu, Y., & Xia, Y. (2024). Competitiveness evaluation of innovative industrial clusters from the perspective of niche. *Journal of Statistics and Information*, *39*(1), 30-43.

Li, S., & Chen, J. (2014). A study on the competitive-cooperative dynamics in regional tourism development in Shandong Province based on niche theory. *Economic Geography*, *34*(9), 179–185.

Li, Y., & Li, J. (2023). Suitability evaluation of urban innovation space and its improvement strategies from the niche perspective: A case study of Nanjing. *Science and Technology Management Research*, *43*(7), 62-69.

Li, Y., & Luo, L. (2025). Dynamic evaluation of tourism niche and study on competition-cooperation patterns in Guangxi. *Journal of Guangxi University of Finance and Economics*, *38*(3), 120–136.

Liu, D., Huang, A., Yang, D., Lin, J., & Cui, Y. (2022). Scale effect of urban niche in Zhejiang Province. *Acta Ecologica Sinica*, *42*(2), 528-538. https://doi.org/10.5846/stxb202012093136

Ma, S., & Wang, R. (1984). The social-economic-natural complex ecosystem. *Acta Ecologica Sinica*, *4*(1), 1–9.

Nie, X., Shi, P., Lü, R., Zhang, X., Liang, B., & Wei, W. (2018). Ecological niche-based competition and cooperation relationships among county-level cities in Hexi Corridor. *Acta Ecologica Sinica*, *38*(3), 841-851. https://doi.org/10.5846/stxb201612272680

Pallante, G., Drucker, A. G., & Sthapit, S. (2016). Assessing the potential for niche market development to contribute to farmers' livelihoods and agrobiodiversity conservation: Insights from the finger millet case study in Nepal. *Ecological Economics*, *130*, 92-105. https://doi.org/10.1016/j.ecolecon.2016.06.017

Qin, L., & Fu, X. (2013). Co-opetition and harmonious development of Changsha-Zhuzhou-Xiangtan urban agglomeration based on niche theory. *Economic Geography*, *33*(11), 58–62.

Sengers, F., & Raven, R. (2015). Toward a spatial perspective on niche development: The case of bus rapid transit. *Environmental Innovation and Societal Transitions*, *17*, 166-182. https://doi.org/10.1016/j.eist.2014.12.003

Shen, Y., Shi, S., Li, X., & Cao, Y. (2020). Analysis of spatial coupling between urban expansion and niche change in the Beijing-Tianjin-Hebei Joint Region. *Geography and Geo-Information Science*, *36*(2), 100-107.

Sun, Y.-F., Fan, J.-Y., & Zhao, J. (2020). The cooperative relationship of core cities in Xinjiang silk road economic belt based on niche theory. *Mathematics in Practice and Theory*, *50*(7), 252-262.

Tang, L. (2017). The cooperation-competition model of regional tourism cities of Fujian province based on niche theory. *Journal of Central South University of Forestry & Technology*, *37*(12), 189–194.

Wang, Q., Zhang, Y., & Li, Z. (2020). Study on the comprehensive measurement and dynamic changes of the tourism niche of coastal cities in Beibu Gulf urban agglomeration. *Ecological Economy*, *36*(8), 120–127.

Wang, Q., Zhang, Y., & Li, Z. (2021). Research on the multidimensional ecological niche and competitive-cooperative development strategies for coastal tourism in the "Zhanmaoyang" region. *Resources Development and Market*, *37*(1), 101–106.

Wang, Y., Sheng, X., & Gong, X. (2023). Evaluation and spatial correlation analysis of rural industrial integration development from the perspective of niche—Taking the three prefectures in southern Xinjiang as an example. *Chinese Journal of Agricultural Resources and Regional Planning*, *44*(10), 242–252.

Yang, H., Zeng, D., Li, M., Wu, Y., Fan, X., & Tong, D. (2023). Urban niche in the Guangdong-Hong Kong-Macao Greater Bay Area from the perspective of multiple space of flows. *Acta Geographica Sinica*, *78*(8), 1983–2000. https://doi.org/10.11821/dlxb202308009

Yang, Y.-J., Zhou, X.-T., & Yang, Q. (2021). Research on the coordinative development of three cities in southern Shaanxi based on niche theory. *Hubei Agricultural Sciences*, *60*(3), 167–170.