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A Study on the Economic Interdependence Between Jiangmen and Other Cities in the Pearl River Delta Urban Agglomeration

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Abstract

This study takes the Pearl River Delta Urban Agglomeration in 2023 as its research sample, employing principal component analysis to measure economic quality. The indicators used to assess economic quality include economic development level, economic structure, population and logistics, and degree of openness. By constructing a modified gravity model, the study analyzes the economic interdependence between Jiangmen and other cities in the Pearl River Delta Urban Agglomeration. Jiangmen ranks highest in terms of economic ties with Shenzhen, followed by Guangzhou, while their economic connections with other cities are relatively weak. Based on an analysis of the current state of economic interdependence between Jiangmen and other cities in the Pearl River Delta Urban Agglomeration, together with its existing issues, several policy recommendations are proposed.

Keywords: Pearl River Delta Urban Agglomeration, economic connectivity, gravity model, principal component analysis

1. Introduction

Classified among China's three major urban agglomerations, the Pearl River Delta Urban Agglomeration is further identified as a region that exhibits high economic vibrancy and an extraordinarily high level of openness to external entities. In 2008, the "Guangdong-Hong Kong-Macao Greater Bay Area Development Plan Outline" issued explicitly stated that the Pearl River Delta is a pioneer region in China's reform and opening-up, an important economic hub, and serves as a core driver for national socio-economic development as well as reform and opening-up, holding a strategically significant position. The focus on developing the Guangdong-Hong Kong-Macao Greater Bay Area persisted until 2019, when the *Guangdong-Hong Kong-Macao Greater Bay Area Development Plan Outline* was issued. The repeated emphasis on the construction of the Guangdong-Hong Kong-Macao Greater Bay Area further underscores its status as a strategically pivotal point in the overall national development framework. What makes the Guangdong-Hong Kong-Macau Greater Bay Area an upgraded version of the Pearl River Delta urban agglomeration is, in truth, merely the inclusion of Hong Kong and Macao—two special administrative regions—on top of the Pearl River Delta. The advancement of the Guangdong-Hong Kong-Macao Greater Bay Area's development will drive the further deepening of economic exchanges and cooperation across its cities. As economic links between node cities and core cities are reinforced in this context, the need to advance the coordinated economic development of the Greater Bay Area has emerged as a critical issue that must be addressed.

Jiangmen, as an indispensable key component of the Pearl River Delta city cluster, occupies a strategic pivotal position linking east and west. It also serves as a vital transportation hub connecting Pearl River Delta with Guangxi region as well as broader southwest region. Jiangmen boasts a vast hinterland with significant land carrying capacity advantages and enjoys unique natural conditions. Its industrial foundation is robust, and its overseas Chinese resources are prominent, laying a solid foundation for it to emerge as the western hub belonging to the Pearl River Delta urban agglomeration. However, despite Jiangmen's long-standing commitment to industrial development, it still lags significantly behind more developed cities like Guangzhou and Shenzhen in the Pearl River Delta regarding economic development. The year 2023 saw Jiangmen rank seventh in GDP among the nine Pearl River Delta cities, while its GDP was roughly equivalent to one-ninth of Shenzhen's total economic output.

The Pearl River Delta urban cluster, a key part of the Greater Bay Area, creates an opportunity for Jiangmen to lead the way in the next stage of development. To do so, it must actively integrate into the Greater Bay Area and leverage an open framework to fortify its connectivity and interactions with other cities through an open approach.

Consequently, there is a necessity to perform a detailed examination of the economic ties between Jiangmen and other cities in the Pearl River Delta urban cluster, and on this basis, propose strategies as well as recommendations to promote positive interactions between Jiangmen and other cities within the Pearl River Delta.

Economic ties within urban agglomerations serve as the core linkages for regional development, the key support for high-quality regional development, and the core driving force for sustained and healthy regional development [1]. Therefore, the academic community places great emphasis on the regional economic interconnections within urban agglomerations. Currently, the majorities of research on urban agglomerations revolve around the Beijing-Tianjin-Hebei region [2] as well as Chengdu-Chongqing urban agglomeration [3]. Research on Pearl River Delta urban agglomeration chiefly entail comparisons with other urban agglomerations, with limited specialized studies on the Pearl River Delta urban agglomeration itself [4-6]. Additionally, in terms of research methods, existing studies primarily employ gravity models [7-9], urban flow intensity models [10], and DEA models [11].

Through a review of the literature, it is evident that most academic research has focused on the overall economic evolution of urban agglomerations, while studies into the economic connections between node cities and core cities within the Pearl River Delta remain limited, and further research is needed in this area. Based on this, this paper aims to conduct an empirical analysis to rank the comprehensive strength of cities within the Pearl River Delta urban agglomeration as well as to explore the economic interdependence between Jiangmen and other cities in the Pearl River Delta urban agglomeration. The research seeks to offer reliable and reasonable policy recommendations to help Jiangmen better integrate into the economic growth process of Pearl River Delta urban agglomeration as well as enhance its economic development level.

2. Research Methods

2.1 Gravity Model

In the theoretical development of economics, the gravity model finds its origin in Newton's law of universal gravitation, which holds that any two objects have a mutual gravitational force acting between them. Tinbergen (1962) derived a basic trade gravity model based on this law, expressed as follows:

$$T_{ij} = K\frac{Y_i * Y_j}{D_{ij}} \tag{1}$$

whereT_{ij} represents the trade flow between two countries, K represents the trade constant, Y_i and Y_j represent the economic scales of countries i and j, respectively, and D_{ij} represents the economic distance between the two countries.

2.2 Modifications to the Gravity Model

Primarily, the gravity model serves to characterize inter-urban links, but when applied to economic connections, adjustments must be made to the research objects and distances. After years of modifications to the gravity model by economists, combined with abundant research findings and case studies from both domestic and international academic circles, this paper distinguishes and reconstructs the existing gravity model. It uses the transportation time between two cities to represent “distance” and measures the “size” of a city using its economic scale, thereby comprehensively demonstrating the interconnectivity of various cities [12]. Based on the characteristics of economic connections in various regions, this paper has made the following adjustments to the above model:

(1) Optimization of gravity constantly K. This coefficient is typically treated as a constant, meaning it does not affect the final calculation results in the model. However, considering the actual economic growth process of cities in the Guangdong-Hong Kong-Macao Greater Bay Area, between cities, the economic interactions and influences vary. Therefore, drawing on existing research findings, this study replaces the constant K with the urbanization rates of the two cities [13].

(2) Correction of city distance D. Due to the close economic ties within the Greater Bay Area, high transportation accessibility, and differing modes of transportation between cities, it is not feasible to directly use city distance to measure the degree of economic ties between cities. Following Yang Weizhong's approach, we use the road density and straight-line distance (i.e., economic distance) among cities in the Greater Bay Area as a replacement for inter-city distance in the traditional gravity model [14]. The calculation of road density involves taking the proportion of total road length to 100 square kilometers.

$$D_{ij} = L_{ij}(1 + e^{\sqrt{p_i p_j}}) \tag{2}$$

where D_{ij} represents the economic distance between two locations, L_{ij} represents the straight-line distance between two locations, and p_i and p_j represent the highway densities of cities i and j, respectively.

(3) Optimization of economic scale Y. The concept and indicators of urban agglomeration economic quality are introduced to adjust the numerator part of the model, and a multi-dimensional indicator system is constructed for specific research objects (see Table 1). Based on this, the weights of the selected key indicators are calculated via principal component analysis, and through dimensionality reduction, the principal component factors are extracted and the component scores for each sample are calculated. Finally, the total factor score is used as the quantitative basis for the economic scale index, and the economic scale index values for each urban agglomeration are determined through comprehensive weighting, forming a scientifically reasonable evaluation system [15].

In light of the above content, the corrected model's final expression is as follows:

$$F_{ij} = \frac{UR_i}{UR_j} \cdot \frac{EM_i^2 \times EM_j^2}{\sqrt{D_{ij}}} \quad (3)$$

where F_{ij} represents the economic connectivity between two regions, UR_i and UR_j represent the urbanization rates of cities i and j, respectively, EM_i and EM_j represent the economic quality of cities i and j, respectively, and D_{ij} represents the economic distance between the two regions.

3. Empirical Analysis

3.1 Study Area and Data Sources

This study uses the years spanning 2014 to 2023 as the sample period, with nine cities in the Pearl River Delta urban agglomeration as the research subjects to empirically examine the economic interdependence between Jiangmen and other cities within the Pearl River Delta urban agglomeration.

This paper primarily classifies its research data into two broad categories: urban socio-economic development data and inter-city distance data. To ensure data comparability, population and economic figures for each city are primarily obtained from Guangdong Provincial Statistical Yearbook as well as Urban Statistical Yearbook. For cities with missing data in the target year, the closest and most appropriate substitute data were used to fill the gaps. Regarding inter-city spatial distances, the straight-line distance data between Jiangmen and other cities in the Pearl River Delta Urban Agglomeration were obtained using Baidu Maps' distance measurement tool.

3.2 Principal Component Analysis

Considering that the selection of economic quality indicators should adhere to principles of comprehensiveness and quantifiability, data from the ten-year period between 2014 and 2023 were selected for principal component analysis. This study selected four first-level indicators—economic development level, economic structure, extent of opening up to the outside world, and population and logistics—and 12 second-level indicators to construct an economic quality indicator system for cities in the Guangdong-Hong Kong-Macao Greater Bay Area, and the economic quality of Jiangmen and other cities in the Pearl River Delta urban agglomeration was calculated using the system. As shown in Table 1.

Table 1. Economic Quality Indicator System for Cities in the Pearl River Delta Urban Agglomeration

First-level indicator	Second-level indicator	Symbol
Economic development level	Per capita GDP (yuan)	X1
	GDP Growth Rate (%)	X2
	Local General Public Budget Revenue (billion yuan)	X3
	Fixed Asset Investment (billion yuan)	X4
Economic Structure	The ratio of the secondary industry's added value to GDP (%)	X5
	The ratio of the tertiary industry's added value to GDP (%)	X6
Degree of Openness to the Outside World	Total Imports and Exports (billion yuan)	X7
	Foreign Direct Investment Utilization (ten thousand yuan)	X8
Population and logistics	Passenger transport volume (thousand people)	X9
	Freight transport volume (million tons)	X10
	Year-end permanent resident population (thousand people)	X11
	Year-end total registered population (thousand people)	X12

First, the raw data set to be calculated was organized. Using SPSS 27 software, the raw data was standardized, and then principal component analysis was performed on the above data, as shown in Table 2:

Table 2. Total variance explained

	Initial Eigenvalues			Extracted Loadings Sum of Squares			Rotated Loadings Sum of Squares		
Component	Total	Variance %	Cumulative %	Total	Variance %	Cumulative %	Total	Variance %	Cumulative %
1	7.409	61.744	61.744	7.409	61.744	61.744	4.194	34.950	34.950
2	1.624	13.536	75.280	1.624	13.536	75.280	3.326	27.719	62.670
3	1.093	9.110	84.390	1.093	9.110	84.390	2.242	18.683	81.353
4	0.729	6.075	90.465	0.729	6.075	90.465	1.093	9.111	90.465

As illustrated in Table 2, three components exhibit eigenvalues in excess of 1. However, the first three components account for a cumulative variance contribution rate of 81.353%, which does not meet the Kaiser criteria. Therefore, the first four factors are selected as common factors, and their cumulative variance contribution rate reaches 90.465%. By calculating the variable functions, the coefficients corresponding to each principal component are derived, which are then multiplied by the normalized data to calculate the corresponding scores for the principal component scores. Subsequently, X1–X12 are converted into four indicators—F1, F2, F3, and F4—to reflect the economic quality development levels of cities in the Pearl River Delta urban agglomeration. F1, F2, F3, and F4 in linear combination were:

$$F1 = 0.26X1 + 0.32X3 + 0.34X4 - 0.27X5 + 0.33X6 + 0.27X7 + 0.34X8 + 0.26X9 + 0.31X10 + 0.34X11 + 0.29X12 \quad (4)$$

$$F2 = 0.29X1 + 0.01X2 + 0.36X3 + 0.06X4 + 0.28X5 - 0.12X6 + 0.5X7 + 0.17X8 - 0.39X9 - 0.35X10 + 0.06X11 - 0.36X12 \quad (5)$$

$$F3 = -0.02X1 + 0.94X2 + 0.02X3 - 0.14X4 + 0.1X5 - 0.02X6 + 0.07X7 + 0.06X8 + 0.25X9 + 0.05X10 - 0.01X11 - 0.11X12 \quad (6)$$

$$F4 = -0.38X1 + 0.04X2 + 0.07X3 + 0.28X4 + 0.48X5 - 0.45X6 + 0.09X7 - 0.09X8 - 0.07X9 + 0.15X10 + 0.37X11 + 0.4X12 \quad (7)$$

Subsequently, the comprehensive score for urban economic quality in the Pearl River Delta (designated as F) is computed. It is derived from the proportion of each principal component's corresponding eigenvalue to the sum of eigenvalues of the four extracted principal components, with the calculation formula provided below:

$$F = \frac{\lambda_1}{\lambda_1+\lambda_2+\lambda_3+\lambda_4} * F_1 + \frac{\lambda_2}{\lambda_1+\lambda_2+\lambda_3+\lambda_4} * F_2 + \frac{\lambda_3}{\lambda_1+\lambda_2+\lambda_3+\lambda_4} * F_3 + \frac{\lambda_4}{\lambda_1+\lambda_2+\lambda_3+\lambda_4} * F_4 \quad (8)$$

3.2.1 Principal Component Analysis of the Comprehensive Scores for Each City in the Pearl River Delta Urban Agglomeration in 2023

By applying the formula, one can calculate the comprehensive economic quality scores of all cities in the Pearl River Delta in 2023 can be calculated using the formula, Table 3 presents the relevant data as follows:

Table 3. Comprehensive Economic Quality Scores for Cities in the Pearl River Delta Urban Agglomeration in 2023

City	F1	F2	F3	F4	F	Comprehensive Ranking
Guangzhou	6.077782	-1.73559	-0.98069	0.023002	3.791488	2
Shenzhen	6.259525	2.802851	-0.20405	0.457023	4.70187	1
Zhuhai	-0.92294	0.433152	-0.84319	-2.06865	-0.78898	5
Foshan	-0.32371	0.481668	-0.59603	1.052658	-0.1382	3
Jiangmen	-1.47686	-0.49765	-0.41139	-0.06659	-1.12837	7
Zhaoqing	-1.81523	-0.81986	-1.11606	-0.05877	-1.47796	9
Huizhou	-1.28105	0.037474	-0.32404	0.81946	-0.84636	6
Dongguan	-0.87142	1.100554	-1.1917	0.707864	-0.50258	4
Zhongshan	-1.98439	0.116892	-0.20343	-0.35787	-1.38146	8

As shown in Table 3, Shenzhen and Guangzhou remain the top-ranked cities in terms of economic dominance. Additionally, Foshan, Dongguan, and Zhuhai have achieved leading positions in economic development quality due to their central geographical locations within the region, with overall economic trends showing positive momentum. In contrast, Huizhou, Jiangmen, Zhongshan, and Zhaoqing lag behind in rankings and require opportunities for breakthroughs in future economic development.

3.2.2 Changes in the Comprehensive Score Levels of Cities in the Pearl River Delta Urban Agglomeration from 2014 to 2023

Employing the identical method to handle data from 2014 to 2022 yielded comprehensive scores and rankings for cities in the Pearl River Delta Urban Agglomeration covering 2014–2023. Through data processing via Excel, line charts were generated to display both the changes in their comprehensive scores (Figure 1) and the variations in their ranking orders (Figure 2) during 2014–2023.

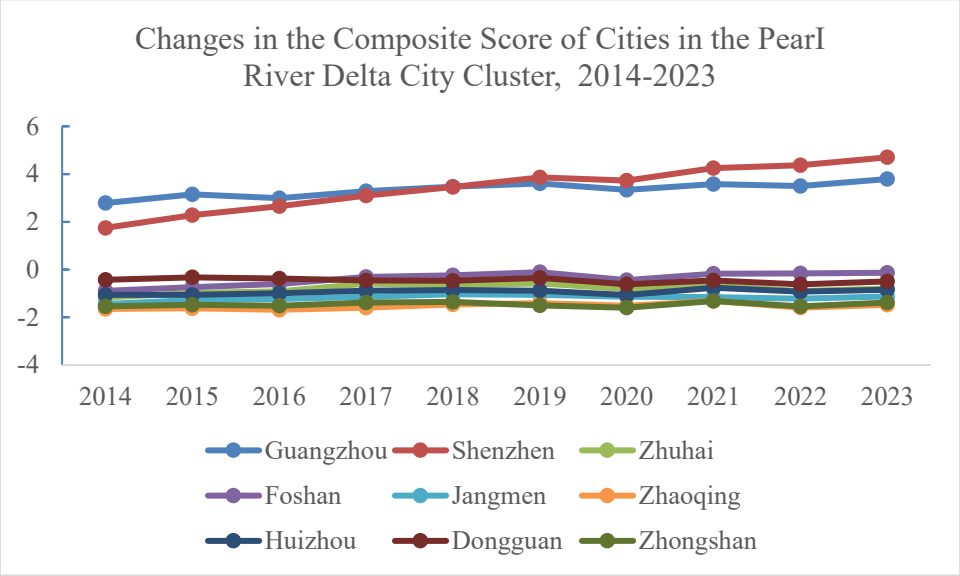

Figure 1. Line chart showing changes in the comprehensive scores of cities in the Pearl River Delta urban agglomeration from 2014 to 2023

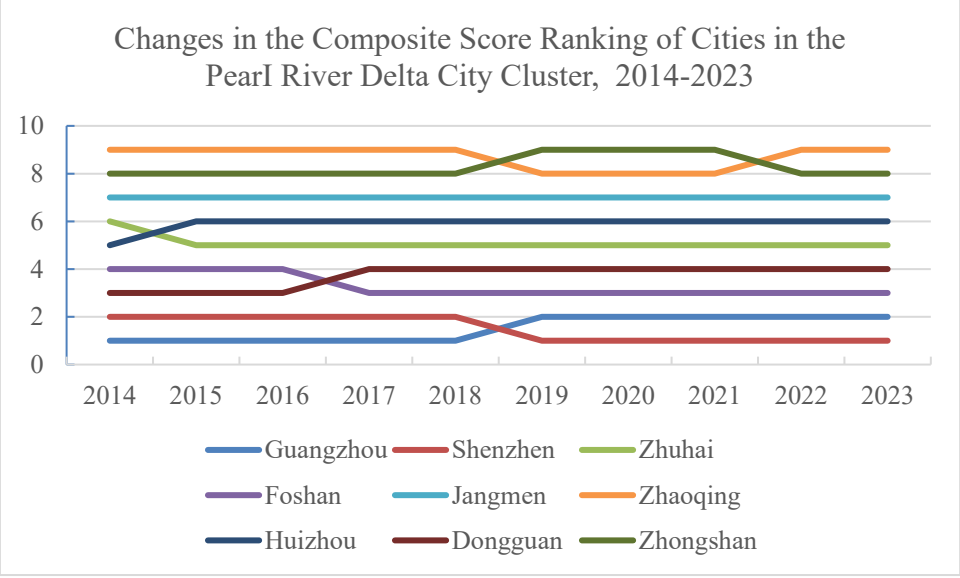

Figure 2. Line chart showing changes in the comprehensive score rankings of cities in the Pearl River Delta urban agglomeration from 2014 to 2023

As shown in Figures 1 and 2, Guangzhou and Shenzhen have experienced significant fluctuations in their composite scores, yet their rankings have remained relatively stable, consistently ranking among the top two cities from 2014 to 2023. In contrast, Foshan, Dongguan, Zhuhai, Huizhou, Zhaoqing, and Zhongshan have seen minimal changes in their rankings over the past decade, with each city fluctuating by only one position. Jiangmen City is the only city whose ranking remains unchanged, consistently maintaining the seventh position. Guangzhou City and Shenzhen City have consistently maintained positive composite scores from 2014 to 2023; Foshan City, Dongguan City, Zhuhai City, Huizhou City, Jiangmen City, Zhaoqing City, and Zhongshan City all had negative composite scores during this period. Compared to 2014, except for Dongguan City, the composite scores of the remaining eight cities all increased, with Shenzhen City seeing the largest increase, approximately 3 points. In summary, it can be observed that Shenzhen City and Guangzhou City have significantly higher overall composite scores and rankings than other cities. In contrast, cities with lower comprehensive levels, such as Jiangmen City, Zhongshan City, and Zhaoqing City, have weak industrial development foundations and relatively low levels of economic development. A city's comprehensive level is largely determined by its economic level. As a key node city in the Pearl River Delta urban agglomeration, Jiangmen City ranks very low in all indicators, indicating that it has not fully leveraged its geographical advantages, resulting in a lower comprehensive level and a significant gap compared to other cities.

3.3 Results Analysis

Based on the revised model (3), this paper calculates the economic connectivity (i.e., F_ij) between Jiangmen and other cities in the Pearl River Delta urban agglomeration in 2023, Table 4 presents these results:

Table 4. Economic Connectivity Between Jiangmen and Other Cities in the Pearl River Delta Urban Agglomeration in 2023

Economic Connectivity	Guangzhou	Shenzhen	Zhuhai	Foshan	Zhaoqing	Huizhou	Dongguan	Zhongshan
Jiangmen	1.453	2.423	0.070	0.002	0.123	0.039	0.022	0.249

Based on the calculation results, it can be seen that, in terms of economic connectivity from highest to lowest, Jiangmen has the closest economic ties with the first-tier cities of Shenzhen and Guangzhou, with values of 2.423 and 1.453, respectively. The next closest ties are with Zhongshan and Zhaoqing, with values of 0.249 and 0.123, respectively. followed by Zhuhai and Huizhou, with values of 0.070 and 0.039, respectively. The weakest economic ties are with Dongguan and Foshan, with values of 0.022 and 0.002, respectively. This is closely related to the geographical distance between Jiangmen and other Greater Bay Area cities, industrial succession as well as division of labor, economic as well as population exchanges, and economic and trade interactions.

Taking Guangzhou and Shenzhen, which have the closest economic ties with Jiangmen, as examples, the high economic connectivity is due to Jiangmen primarily receiving industrial transfers from Guangzhou and Shenzhen. Additionally, industrial work division between Jiangmen and these two cities is relatively clear, with Shenzhen serving as a research and development base, Guangzhou as a marketing base, and Jiangmen as a manufacturing base. Driven by cost gradient factors, Shenzhen has gradually shifted land-intensive manufacturing industries to Jiangmen, while Jiangmen has achieved its own industrial upgrading by progressively taking over industrial transfers from other regions. For example, Jiangmen has made significant breakthroughs in the new energy battery industry, with 70% of its orders coming from leading companies such as Shenzhen BYD and Guangzhou Automobile Group Aion. This is also the case in terms of policy support and development planning. For instance, the “Guangdong-Hong Kong-Macao Greater Bay Area Development Plan Outline” clearly outlines the direction as well as core of coordinated evolution between Jiangmen, Guangzhou, and Shenzhen, coordinating planning in areas such as industrial layout, policy implementation, infrastructure construction, and public services, providing a policy basis and guarantee for strengthening economic ties among the three regions. Additionally, the breakthrough progress in transportation infrastructure has been a key factor and important driving force in strengthening economic ties between regions. For example, the inauguration of the Zhongshan-Jiangmen Expressway and the Shenzhen-Zhongshan Channel has significantly reduced travel time between Jiangmen and Guangzhou and Shenzhen. This not only facilitates personnel movement but also lowers logistics costs, promoting trade and industrial synergy among the three regions.

Zhongshan ranks among the top three in terms of economic ties with Jiangmen. The most critical reason lies in the fact that Jiangmen and Zhongshan are both positioned on the west bank of the Pearl River Estuary y, with a land

distance of only 40 kilometers, and the Xi River waterway runs through both regions, forming a natural geographical link. The industrial ties between Jiangmen and Zhongshan exhibit a composite characteristic of "vertical division of labor and horizontal collaboration." In the manufacturing sector, Zhongshan has leveraged the renovation of low-efficiency industrial parks to free up over 2,000 hectares of industrial space, focusing on the development of high-end manufacturing. Meanwhile, Jiangmen, leveraging its land cost advantages and unique large-scale industrial clusters that Zhongshan lacks, has actively partnered with Zhongshan and absorbed its industrial transfers, forming a distinctive complementary industrial landscape between the two regions. Additionally, in terms of cultural identity, Jiangmen and Zhongshan both belong to the Lingnan cultural sphere. The historical ties between Sun Yat-sen's hometown and Kaiping overseas Chinese community (such as the revolutionary friendship between Sun Yat-sen and Szeto Mei-tong) have strengthened the cultural cohesion between the two areas.

4. Conclusions and Implications

4.1 Conclusions

A gravity model is utilized in this paper to examine the economic links between Jiangmen and other cities within the Pearl River Delta urban agglomeration in 2023, thereby uncovering the mutual interactions among them. By establishing an economic quality indicator system, the model was optimized to more accurately reflect the factors influencing economic activities. Additionally, by integrating economic distance indicators, the paper delves deeper into the economic interconnections between Jiangmen and other cities in the Pearl River Delta urban agglomeration. We arrived at following conclusions:

(1) "Hard connectivity" of locational advantages and transportation interconnectivity serves as the foundational support for interconnections and interactions. As an important transportation hub in the Pearl River Delta region, Jiangmen has considerably reduced the temporal as well as spatial distances between itself and core cities such as Shenzhen and Zhuhai through the successive completion of the Shenzhen-Zhongshan Channel and the Huangmao Sea Cross-Sea Channel over the past years. Thanks to the upgrading of this transportation network, Jiangmen has succeeded in establishing a "one-hour economic circle" with neighboring cities. While significantly enhancing transportation convenience, it has also optimized the logistics cost structure. Enterprises can now allocate resources more efficiently during goods transportation, reduce logistics costs, and thereby enhance overall economic efficiency. Additionally, the convenient transportation conditions have facilitated the efficient flow of factors of production, attracting more investment and talent, and injecting new vitality into Jiangmen's economic development. However, in the process of transportation integration within the Pearl River Delta region, Jiangmen faces structural shortcomings. Compared to core growth poles across the eastern Pearl River Delta (including Dongguan and Huizhou), Jiangmen's inter-city rail network coverage density is significantly insufficient, making it difficult for Jiangmen to integrate into the Guangzhou-Shenzhen-Dongguan-Huizhou "30-minute economic circle," thereby hindering its rapid economic development. Meanwhile, the highway network within Jiangmen's counties and between Jiangmen and surrounding cities also has "discontinuous" defects, leading to poor transportation connectivity and affecting the efficient flow of resources and coordinated development between regions. To enhance Jiangmen's locational comparative advantages, it is imperative to speed up the building of rail transit and highway networks, strengthen connectivity with surrounding cities, promote economic integration, and better integrate into the economic growth process of the Pearl River Delta.

(2) Industrial gradation and functional complementarity are the core driving forces of interconnected interaction. As an important city in the Pearl River Delta, Jiangmen has actively promoted vertical division of labor and horizontal collaboration through industrial cooperation with Shenzhen, Dongguan, and other regions, forming a unique cross-regional value chain division model. Leveraging its land cost advantages, Jiangmen has successfully attracted industrial transfers from surrounding cities, fostering coordinated regional economic development. In this process, Jiangmen has not only attracted a large amount of investment but also driven local industrial upgrading and transformation, infusing new vitality into the Greater Bay Area. By integrating resources and leveraging complementary advantages, Jiangmen has increasingly demonstrated its significant value in industrial cooperation within the Pearl River Delta. During the previous three years, we have seen that the total investment of Shenzhen-based industrial projects with investments exceeding 100 million yuan introduced to Jiangmen has approached 78 billion yuan. Among these projects, 85% adopted a collaborative development model combining Shenzhen's innovative resources with Jiangmen's manufacturing base. The application of this model has effectively promoted the vertical expansion of the regional industrial chain. However, Jiangmen also faces issues of homogenized competition with neighboring regions in industrial collaboration. For example, there is low-level duplication construction in industrial division of labor between Jiangmen and Zhuhai in the integrated development of port

clusters, and between Jiangmen and Zhongshan in the field of low-temperature storage and transportation equipment manufacturing.

(3) Policy coordination and institutional innovation are key safeguards for interrelated interaction. Guangdong Province has designated Jiangmen as the primary platform for the orderly transfer of industries from the Pearl River Delta, providing specialized support in areas such as land and finance. In terms of cross-regional cooperation mechanism innovation, Jiangmen and Shenzhen have pioneered the exploration of the 2.0 version of "flying land economy" through the joint construction of the Shenzhen-Jiangmen Economic Cooperation Zone, establishing a cross-regional governance model characterized by "R&D in Shenzhen, production in Jiangmen, and shared benefits." However, the cross-city interest-sharing mechanism remains incomplete. For example, in the cooperation between Jiangmen and Zhongshan in the field of low-temperature storage and transportation equipment manufacturing, institutional obstacles such as the absence of a tax-sharing mechanism, inconsistent GDP calculation standards, and difficulties in cross-regional allocation of environmental capacity led to a six-month delay in the expansion of the second phase of the project due to delayed interest coordination, resulting in direct economic losses exceeding 120 million yuan. The more fundamental issue lies in the lack of top-level design support for cross-regional policy coordination.

4.2 Implications

(1) Strengthen the "systematic" and "precise" nature of transportation connectivity. Jiangmen should adopt a "transportation-led strategy" to systematically advance the interconnectivity of transportation infrastructure and establish itself as a hub node in the western wing of the "rail-based Pearl River Delta." Priority should be given to ensuring the construction sequence of strategic corridors such as the Guangzhou-Foshan-Jiangmen-Zhuhai Intercity Railway and the Shenzhen-Jiangmen High-Speed Railway, achieving one-hour direct commuting to the Guangzhou-Foshan core area and the Shenzhen-Dongguan urban agglomeration through "four-network integration," at the trunk transportation level. In terms of road network optimization, "bottleneck breakthrough projects" should be implemented for inter-city connecting channels such as Provincial Highway S385, using technical measures such as widening exits and three-dimensional remodeling of ramps to increase peak-hour traffic capacity to over 85% of design capacity. Additionally, the intelligent toll collection robot system based on ETC+AI should be fully promoted to achieve full coverage of electronic toll collection for inter-city channels, thereby reducing inter-city commuting costs.

(2) Promote "differentiation" and "high-end development" in industrial collaboration. Jiangmen should leverage its regional comparative advantages to implement an industrial upgrading strategy of "differentiated competition and specialized clustering." By establishing an industrial ecosystem based on "vertical specialized division of labor combined with horizontal innovative collaboration," it can avoid low-level repetitive construction in traditional low-end manufacturing sectors with neighboring cities. For example, Jiangmen can leverage its geographical advantage adjacent to Shenzhen to deeply integrate into Shenzhen's global innovation network, focusing on cutting-edge technology fields such as solid-state battery electrolyte materials to address issues in the new energy battery industry. In the marine economy sector, Jiangmen should collaborate with Zhuhai and Zhongshan to establish a "Delta Marine Economy Corridor," establishing a marine equipment manufacturing base and implementing a "three-city, six-party" collaborative innovation mechanism to create a full-chain innovation ecosystem encompassing "R&D-manufacturing-services."

(3) Deepen the "institutional" and "practical" aspects of policy coordination. Jiangmen should take institutional openness as a breakthrough point and systematically promote rule alignment and mechanism innovation with other cities in the Pearl River Delta. In respect of interest-sharing mechanism innovation, establish a cross-city tax-sharing database to dynamically collect indicators such as enterprise output value, employment, and R&D investment to achieve precise tax allocation; At the regional collaborative governance level, institutionalize the "Hundred-Thousand-Million Project" joint conference system to regularly negotiate matters such as industrial cooperation and mutual recognition of public welfare. Additionally, conduct third-party assessments of reform outcomes to ensure policies transition from 'documents' to "effectiveness," focusing on monitoring core indicators such as land use efficiency and energy consumption output benefits, and driving reform measures from "paper implementation" to "value creation."

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