

# Research on Coordinated Development of Jiaodong Urban Agglomeration

Bo Song<sup>1</sup>, Yusen Bai<sup>2</sup>, Tingting Wang<sup>3</sup>, Yunlong Pang<sup>3,\*</sup>

<sup>1</sup>Weihai Oceanic Development Bureau, Weihai, China

<sup>2</sup>Weihai financial operation testing center, Weihai, China

<sup>3</sup>Weihai Vocational College, Weihai, China

\*Corresponding Author.

**Abstract:** Regional coordinated development has always been an essential strategic deployment in China. Since the 18th National Congress of the Communist Party of China, the Party Central Committee has placed regional coordinated development in a more crucial position and included it in the national five-year development plans multiple times. The Jiaodong Economic Circle is the most dynamic region for economic development and opening-up in Shandong, representing the province's strategic planning for deepening the transformation of old and new driving forces and promoting high-quality development in the Yellow River Basin in the new era. This paper employs various methodologies, such as the Gini coefficient, market integration index, gravity model, and the degree of specialization in marine industries, to examine the level of coordinated development among the five cities in the Jiaodong region, and offers corresponding suggestions.

**Keywords:** Jiaodong Economic Circle; Regional Coordinated Development; Urban Agglomeration

## 1. Introduction

Since the reform and opening-up, China's economic development has largely been propelled by urbanization. Through the process of regional integration evolving from large cities to metropolitan areas and ultimately urban agglomerations [1], China has gradually formed urban agglomerations centered around Beijing in the Beijing-Tianjin-Hebei region [2], Shanghai in the Yangtze River Delta [3], and Guangzhou, Hong Kong, Macao, and Shenzhen in the Guangdong-Hong Kong-Macao Greater Bay Area [4]. Internationally, there are also urban agglomerations such as the Tokyo Metropolitan

Area in Japan and the San Francisco Bay Area urban agglomeration in the United States. Urban agglomerations have become a new territorial unit for countries to participate in global competition and international division of labor, representing the most dynamic and promising economic growth point in China's context of dual domestic and international economic cycles in the new era [5]. In 2022, the work report of the 20th National Congress of the Communist Party of China reaffirmed regional coordinated development as an essential measure to promote high-quality development [6]. In 2020, Shandong Province implemented the "Opinions on Establishing a More Effective New Mechanism for Regional Coordinated Development" issued by the Central Committee of the Communist Party of China and the State Council, considering regional coordinated development as one of the eight major development strategies of the provincial government. It proposed to construct a regional development pattern of "one group, two centers, and three circles" and issued a series of important documents, including the "Guiding Opinions on Accelerating the Integrated Development of the Jiaodong Economic Circle" and the "Integrated Development Plan for the Jiaodong Economic Circle," aiming to promote coordinated development in the Jiaodong region. The term "Jiaodong" generally refers to the coastal region in the eastern part of Shandong Province. Drawing on the planning scope of the Jiaodong Economic Circle outlined in the "14th Five-Year Plan for the Integrated Development of the Jiaodong Economic Circle" [7], this study covers five coastal cities in Shandong Province, namely Qingdao, Yantai, Weifang, Weihai, and Rizhao. Occupying approximately one-third of the province's land area, the Jiaodong region boasts a solid economic foundation, with a gross domestic product (GDP) of 3.1113 trillion yuan

in 2020, accounting for 42.5% of the province's total. Additionally, the region's marine GDP stands at 915 billion yuan, representing 70% of the province's total and 11% of the national total. The region is home to three major ports in Qingdao, Rizhao, and Yantai, each handling over 400 million tons of cargo annually. In 2020, the combined cargo throughput of these ports reached 1.59 billion tons, accounting for 16.8% of the national total.

The level of coordinated development in the Jiaodong region is crucial in determining whether Shandong can achieve breakthrough results in its pursuit of pioneering progress and new development paradigms, play a leading role in promoting high-quality development along the Yellow River Basin, and rejuvenate itself in the process of deepening the transformation of old and new driving forces to achieve green development. This study first analyzes the basic conditions of the Jiaodong region, including its population, resources, and economy. Based on

this analysis, it employs various methodologies, such as the Gini coefficient, market integration index, gravity model, and the degree of specialization in marine industries, to examine the level of coordinated development among the five cities in the Jiaodong region, and offers corresponding suggestions.

## 2. Basic Situation of Jiaodong Region

### 2.1 Situation of Population

According to statistical data, the proportion of the permanent resident population in Jiaodong in Shandong Province has gradually increased from 31.6% to 31.9% between 2016 and 2020. Specifically, the population in Jiaodong has grown from 31,499,400 to 32,400,800, with an average annual growth rate of 0.57%, which is approximately 0.2 percentage points higher than that of Shandong Province. This trend is illustrated in Figure 1.

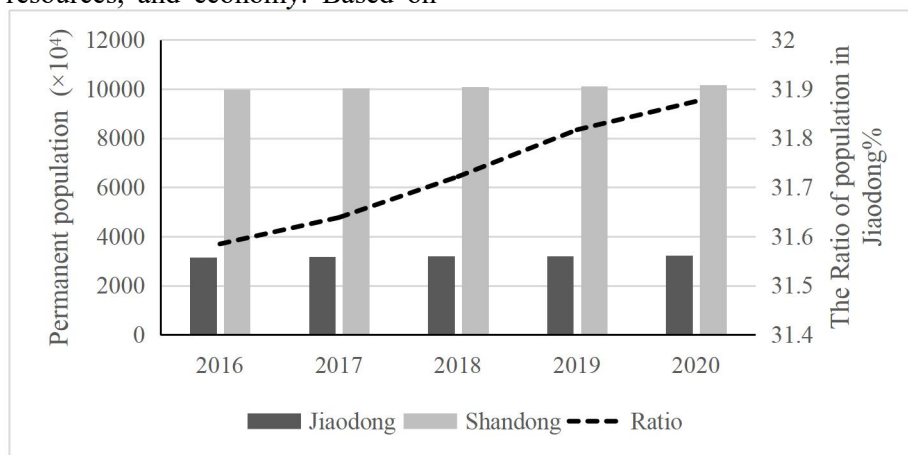


Figure 1. Permanent Population Map of Jiaodong

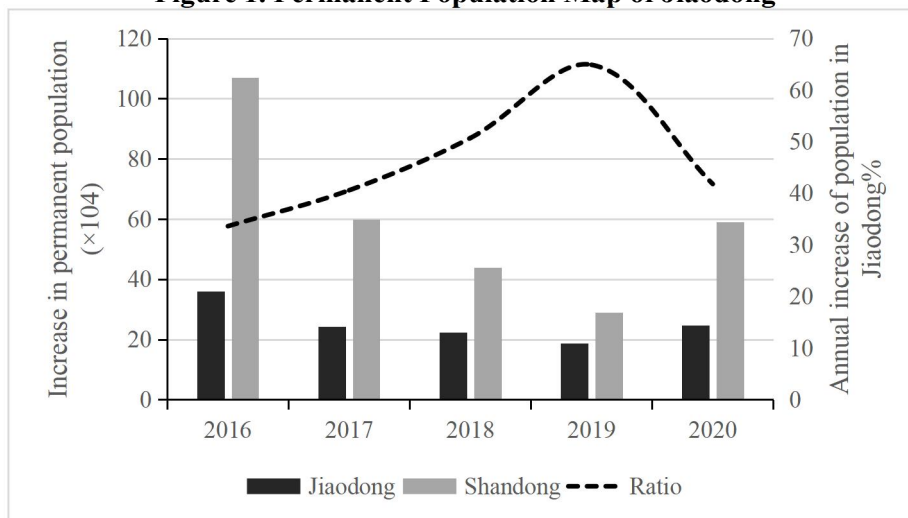


Figure 2. Annual Increase of Permanent Resident Population in Jiaodong and its Proportion in Shandong

Between 2016 and 2020, the permanent resident population in Jiaodong increased by 900,000, accounting for 47% of the total population growth in Shandong Province. The average annual increase in the permanent resident population accounted for 46%, peaking at 65% in 2019, as shown in Figure 2. The analysis indicates that the Jiaodong region is not only a concentration center of Shandong Peninsula but also a major area for the sustained and stable growth of Shandong's population.

In 2020, Shandong's urban population reached 64,088,400, an increase of 8,383,300 from 2016, with 47% of the new additions originating from the Jiaodong region, as depicted in Figure 3.

During the "13th Five-Year Plan" period, the proportion of urban population in Jiaodong to the provincial total increased by 1.1 percentage points, reaching 35%. This indicates that the urbanization process in the Jiaodong region is faster than the provincial average. As shown in Figure 4, except for Rizhao City, the urbanization rates of the other four cities are higher than the provincial level. In 2020, the overall urbanization rate in the Jiaodong region was 69%, surpassing the provincial and national averages by 5.9 and 5.1 percentage points, respectively. This translates to approximately 30% of the population residing in rural areas.

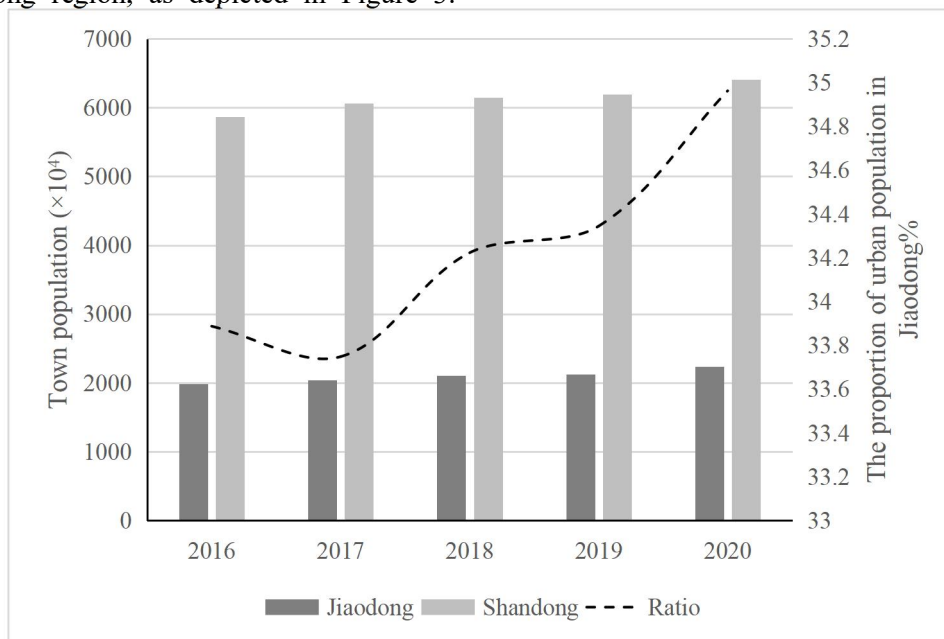


Figure 3. Urban Population of Jiaodong and its Proportion in Shandong Province

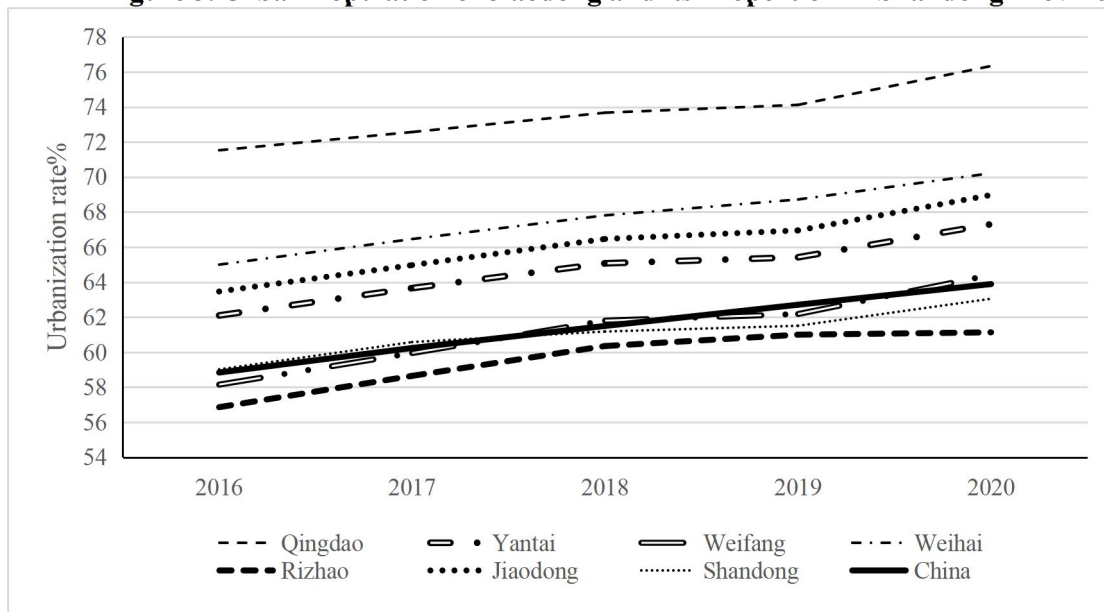
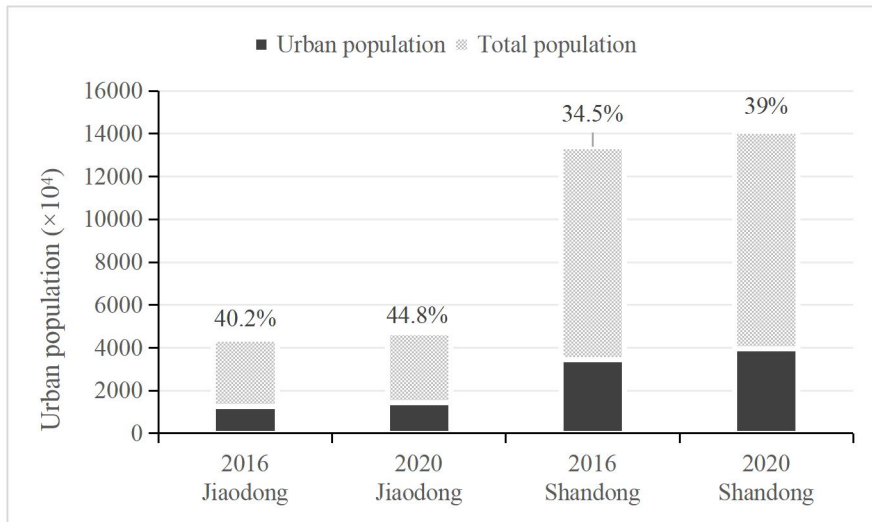


Figure 4. Urbanization Rate of Jiaodong



**Figure 5. Number and Proportion of Population in Jiaodong Urban Area**

The phenomenon of urban-rural migration has been particularly salient in tandem with accelerated urbanization. From 2016 to 2020, the urban population in the Jiaodong region grew from 12.652 million to 14.483 million. In 2020, the urban population's proportion surpassed the provincial average by 5.8 percentage points, as illustrated in Figure 5.

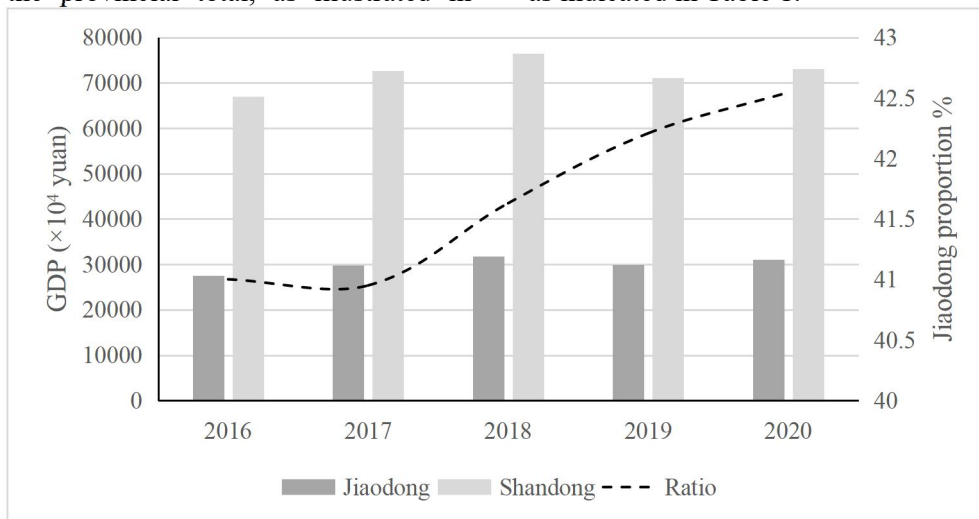
**2.2 Economy**

In 2020, the gross domestic product (GDP) of the Jiaodong region reached 3,111,337 million yuan, accounting for 42.5% of the provincial total. During the "13th Five-Year Plan" period, the Jiaodong economy entered a rapid development phase, with an average annual growth rate of 2.6%, exceeding the provincial average of 1.8%, as depicted in Figure 6. In 2020, the gross oceanic product (GOP) of the Jiaodong region accounted for approximately 66% of the provincial total, as illustrated in

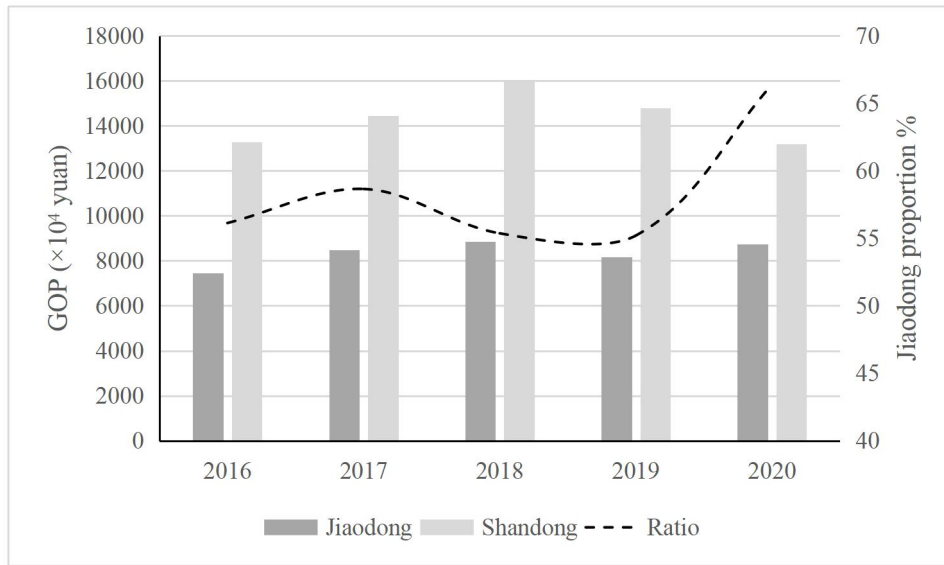
Figure 7. Between 2016 and 2020, the marine economy in the Jiaodong region performed better than its GDP, with an average annual growth rate exceeding the GDP growth rate by 0.9 percentage points.

**2.3 Resources**

The Jiaodong region boasts a coastline (including islands) of 3,104.3 kilometers, accounting for 93% of the provincial coastal resources. More than one-fifth of the country's mariculture waters are located in the Jiaodong region, covering an area of over 4,000 square kilometers, representing 70% of the provincial total. In 2020, the Jiaodong region produced over 4.5 million tons of marine aquaculture products, accounting for 88% of the provincial total and 21% of the national total. Additionally, the marine fishing catch in the Jiaodong region accounted for over 95% of the provincial total, as indicated in Table 1.



**Figure 6. GDP of Jiaodong**



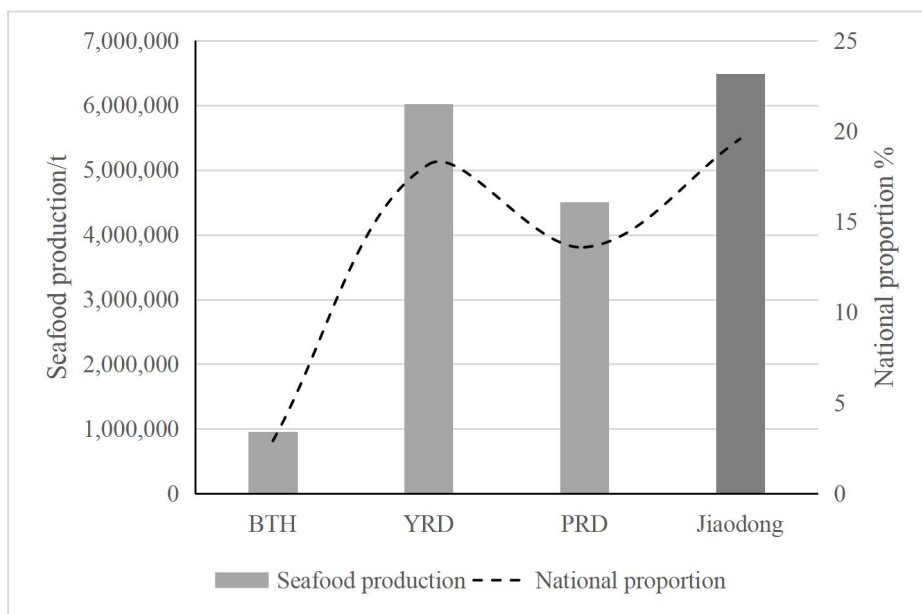
**Figure 7. Situation of GOP in Jiaodong**

Based on the analysis of the 2020 China Statistical Yearbook and various local statistical yearbooks, the Jiaodong region ranks first in both marine aquaculture and marine fishing product output when compared to the urban agglomerations of Beijing-Tianjin-Hebei (BTH), the Yangtze River Delta (YRD), and the Pearl

River Delta (PRD), as shown in Figures 8 and 9. With a national share of 16.48%, the region's marine fishing catch ranks third among the 11 coastal provinces and cities in China, trailing behind Zhejiang (26.61%) and Fujian (18.12%), as depicted in Figure 10.

**Table 1. Summary of Marine Aquatic Resources in Jiaodong in 2020**

	Jiaodong	The proportion of the whole province %	National proportion %
Area for seafood cultivation /km <sup>2</sup>	4,078.03	70.27	20.44
Seafood production /t	6,486,858	90.33	19.57
Total aquaculture production of seafood /t	4,539,179	88.29	21.26
Amount of seafood caught /t	1,942,697	95.25	16.48



**Figure 8. Output of Seafood in Jiaodong in 2020**

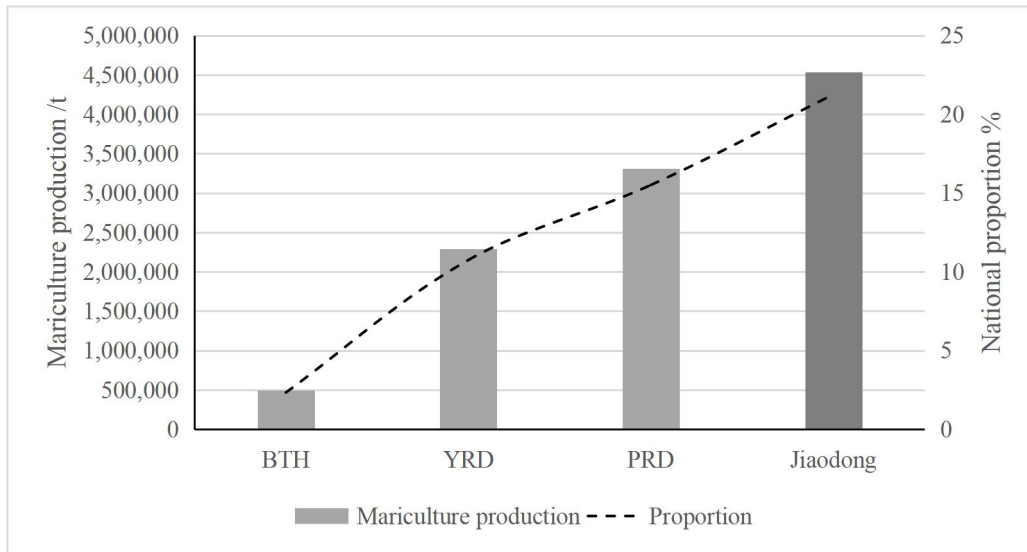


Figure 9. Output of Mariculture in Jiaodong in 2020

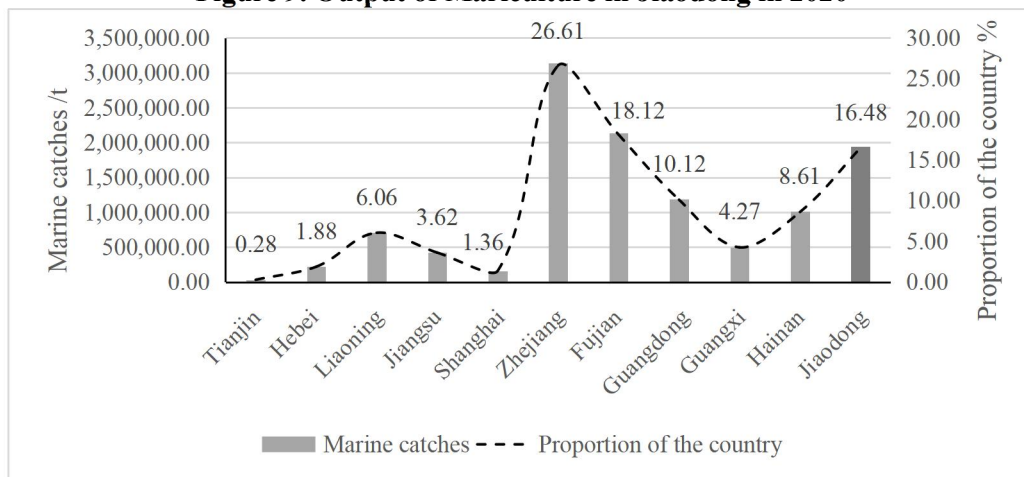


Figure 10. Fishing Catch in Jiaodong in 2020

**2.4 Openness and cooperation**

The advantages of open cooperation in Jiaodong are evident, as both the total import and export value and the total amount of actual foreign capital utilized (TAFUCU) account for more than half of the provincial total. According to the analysis of the 2020 Shandong Statistical

Yearbook and various local statistical yearbooks, Jiaodong actually utilized foreign direct investment of \$11,043.72 million, accounting for 62.58% of Shandong Province, and the total import and export value reached 1,413.7 billion yuan, representing 64.34% of Shandong Province. This is illustrated in Figure 11.

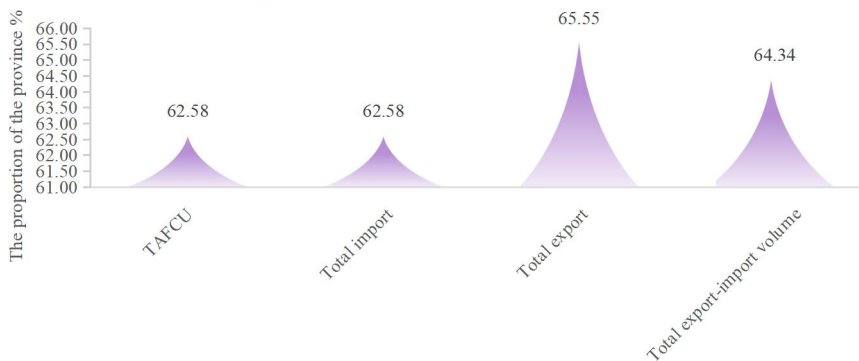


Figure 11. Import and Export and TAFUCU in Jiaodong in 2020

### 3. Analysis of regional Coordinated Development in Jiaodong

#### 3.1 Analysis of Differences in Economic Development

In this study, the standard deviation is selected to measure the absolute differences in economic development among the five cities in Jiaodong, while the Gini coefficient is employed to assess the relative differences. The calculation formulas for the standard deviation and Gini coefficient are provided below. To highlight the marine economic development status of each city, the author also analyzes the development disparities using data on per capita GDP (Gross Domestic Product) and per capita GOP (Gross Oceanic Product) from 2016 to 2020. This analysis is presented in Figures 12 and 13.

$$S = \sqrt{\frac{\sum_{i=1}^n (Y_i - \bar{Y})^2}{N}}$$

The standard deviation (S) represents the degree of deviation between the indicator values of each region and their arithmetic mean. Here,  $Y_i$

denotes the per capita GDP (or per capita GOP) of the  $i$ -th region,  $\bar{Y}$  signifies the mean per capita GDP (or per capita GOP) across all regions, and  $N$  stands for the total number of regions. A higher value of the standard deviation indicates a greater disparity among regions.

$$G = \frac{\sum_{i=1}^n \sum_{j=1}^n |Y_i - Y_j|}{2N(N-1)\bar{Y}}$$

The Gini coefficient (G) is a measure of income or wealth disparity among regions. Here,  $|Y_i - Y_j|$  represents the absolute difference in per capita GDP (or per capita GOP) between regions  $i$  and  $j$ ,  $N$  denotes the total number of regions, and  $\bar{Y}$  stands for the mean per capita GDP (or per capita GOP) across all regions. The Gini coefficient ranges from 0 to 1, with higher values indicating greater disparities. Conventionally, a Gini coefficient less than 0.2 is deemed highly equalized, between 0.2 and 0.3 is considered relatively equalized, between 0.3 and 0.4 is regarded as comparatively reasonable, between 0.4 and 0.5 suggests significant disparities, and a value of 0.5 or higher indicates extreme disparities.

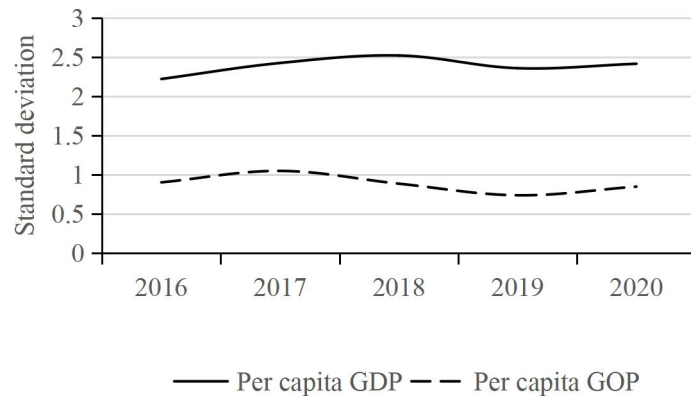


Figure 12. Absolute Differences in Jiaodong

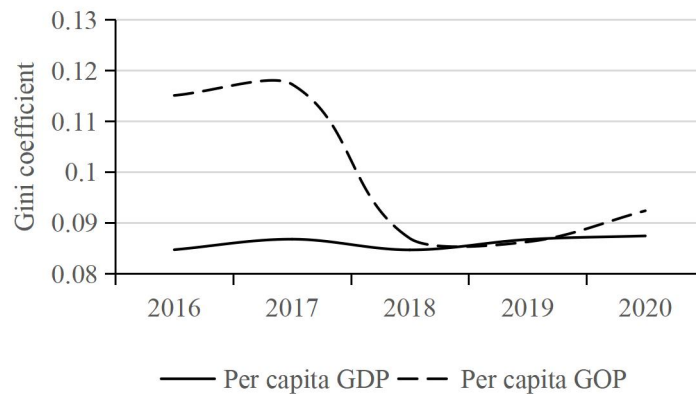


Figure 13. Relative Difference Map of Jiaodong

From the perspective of absolute differences, the absolute difference in GDP in the Jiaodong region increased from 22,233 yuan to 24,172 yuan from 2016 to 2020, representing an 8.7% growth. Conversely, the GOP difference decreased from 9,047 yuan to 8,503 yuan, a decline of 6.4%. This indicates that since the 13th Five-Year Plan, while the absolute difference in GDP in the Jiaodong region has gradually widened, the GOP difference in marine economic development has narrowed.

From the perspective of relative differences, both the GDP and GOP Gini coefficients are below 0.2, indicating that the economic development in the Jiaodong region is highly equalized. The GDP Gini coefficient has undergone small fluctuations with a slight increasing trend, achieving an average annual growth of 0.6%. In contrast, the GOP Gini coefficient has experienced more significant fluctuations, with a turning point in 2018, where the coefficient decreased by 26%. This decline can be attributed to the implementation of policy documents such as the "Shandong Provincial Marine Main Functional Area" and the "Action Plan for the Construction of a Marine Powerhouse in Shandong" in 2017-2018, which accelerated the transformation of marine economic development and placed greater emphasis on coordinated development among regions. These policies promote open cooperation in areas such as technological innovation, economic development, and resource environment, thus contributing to narrowing the regional disparities. This demonstrates that the integration of the marine sector in the Jiaodong region has achieved significant results, which is crucial for reducing disparities and serves as an important force for promoting integration in the Jiaodong region.

### 3.2 Analysis of Regional Economic Integration

The unification of product and factor markets is a crucial aspect in analyzing regional economic integration, and this gradual unification is primarily manifested in the convergence of product and factor prices among regions. Divergences in product and factor prices across regions suggest impediments in the circulation of product and factor markets, resulting in a sluggish process of regional integration. This paper measures the degree of market integration in the Jiaodong region using the relative price

method referenced from Sheng Bin [8]. Specifically, we select the consumer price indices (CPI) for residents from the statistical yearbooks of the five cities in Jiaodong from 2016 to 2020, covering eight categories: food, aquatic products, clothing, housing, daily necessities and services, transportation and communication, education, culture, and entertainment, as well as healthcare. By calculating the market integration index (MI), we can gauge the level of market integration. A higher MI value indicates a higher degree of market integration, and vice versa. The specific calculation process is as follows:

① The logarithm of the consumer price index  $\ln(P_{at}^k)$  for all types of commodities is calculated annually, where  $k=1, \dots, K$  represents the commodity categories,  $a=1, \dots, N$  represents the regions, and  $t=1, \dots, T$  represents the time periods.

② For all  $T$  years and  $K$  categories of commodities, the difference in the logarithmic price index ( $\Delta Q_{ab,t}^k$ ) between each city and all other cities, forming  $N(N-1)/2$  "city pairs," is calculated as  $\Delta Q_{ab,t}^k = \ln(P_{at}^k) - \ln(P_{bt}^k)$ , where  $a \neq b$ .

③ The absolute value  $|\Delta Q_{ab,t}^k|$  of all "city pairs"  $\Delta Q_{ab,t}^k$  is calculated.

④ For a given  $t$  and  $k$ , the mean value of all "city pairs" ( $\bar{q}_{ab,t}^k$ ) is computed.

⑤ Given  $t$  and  $k$ , the mean value is subtracted from all  $|\Delta Q_{ab,t}^k|$  values to obtain  $q_{ab,t}^k = |\Delta Q_{ab,t}^k| - |\bar{q}_{ab,t}^k|$ .

⑥ For a given  $t$ , the variance  $\text{Var}(q_{ab,t}^k)$  of all "city pairs" in commodity category  $k$  is calculated annually, where  $a \neq b$ .

⑦ Given a specific region  $a$ , the arithmetic mean of the variances of all "city pairs" that include region  $a$  is calculated annually, denoted as  $\text{Var}(\bar{q}_{a,t}) = \frac{1}{N-1} \sum \text{Var}(q_{ab,t}^k)$ .

⑧ The commodity market integration index for city  $a$  in year  $t$  is denoted as

$$MI_{at} = \sqrt{\frac{1}{\text{Var}(\bar{q}_{a,t})}}$$



Step ⑧ is a positive transformation of Step ⑦, where a higher value of  $MI_{at}$  indicates a higher level of market integration in the region, and vice versa. The author calculates the mean of the market integration indices for all cities to obtain the overall market integration index for the Jiaodong region. The calculation formula is

as follows:

$$MI = \frac{1}{N} \sum MI_{at}$$

Based on the aforementioned calculation methodology, the market integration levels of individual cities and the Jiaodong region from 2016 to 2020 were determined, as presented in Table 2.

**Table 2. Analysis Table of market Integration Level in Jiaotong Region**

Year Region	Qingdao	Yantai	Weifang	Weihai	Rizhao	Jiaodong
2016	84.70	89.57	63.75	72.36	65.99	75.28
2020	88.65	85.18	92.73	75.59	74.11	83.25

As evident from the table, the market integration level in the Jiaodong region has been continuously deepening from 2016 to 2020, with an increase of 10.6%, indicating that during the 13th Five-Year Plan period, the cities in Jiaodong have achieved success in promoting market integration. Specifically, the consumer prices in areas such as food, aquatic products, clothing, housing, daily necessities and services, transportation and communication, education, culture, entertainment, and healthcare are converging among cities in the Jiaodong region. Among the five cities, except for Yantai, which experienced a slight decline in market integration with surrounding cities, the other four cities showed an upward trend. The integration enhancement rates of Weifang and Rizhao exceeded the average level in Jiaodong, with Weifang achieving the most significant increase of 45% and Rizhao increasing by 12.3%. This suggests that Weifang has become a driving force in promoting regional integration in Jiaodong. Located at the core of Jiaodong, Weifang borders Yantai and Qingdao to the east and Rizhao to the south. In recent years, Weifang has seized the historical opportunity of coordinated regional development, comprehensively enhancing the connectivity of infrastructure, accelerating the construction of high-speed rail and expressway projects, and improving the service capabilities of seaports and airports. Closely following Qingdao, the "leading city," Weifang has continuously deepened economic, talent, and cultural exchanges and integration. In 2021, Weifang's economic growth rate ranked first in the province, with GDP exceeding 700 billion yuan. However, the market integration level of Yantai has not improved but decreased, which should be a matter of concern for the local government. Although Yantai's economic strength remains

among the top three in Shandong, its GDP ranking within the province fell from second to third during the 13th Five-Year Plan period. Finding a breakthrough in regional integration may be a crucial way for Yantai to revitalize its economy during the 14th Five-Year Plan period.

**3.3 Analysis of Economic Relations**

Regional economic linkage serves as a significant indicator to measure the degree of regional economic integration, encapsulating both the radiative capacity of a central city towards its surrounding areas and the acceptance level of these peripheral regions towards the radiation from the central city. Drawing inspiration from the research methodology of Wen Kui [9], this study employs the gravity model to quantify the economic linkage between cities in the Jiaodong region. Specifically, data from 2016 and 2020 are selected for model calculations, and the methodology is outlined as follows:

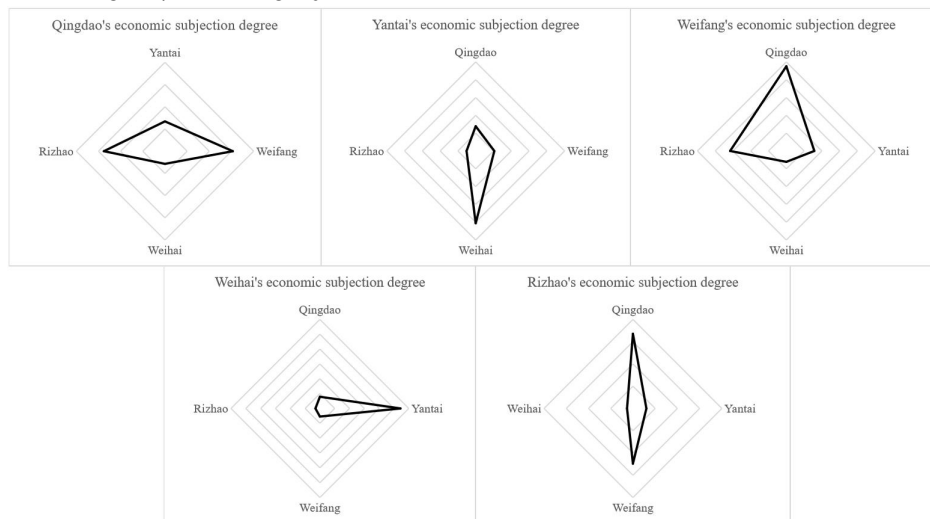
$$R_{ij} = \sqrt{P_i \times V_i} \times \sqrt{P_j \times V_j} / D_{ij}^2, \quad F_{ij} = \frac{R_{ij}}{\sum_{i=1}^n R_{ij}}$$

In this model,  $R_{ij}$  represents the economic linkage between city i and city j.  $P_i$  signifies the number of non-agricultural inhabitants in city i,  $V_i$  denotes the GDP of city i,  $D_{ij}$  stands for the distance between city i and city j, which is measured by the shortest highway mileage on Baidu Maps, and  $F_{ij}$  represents the economic dependency of city j on city i. As shown in Figures 14 and 15, based on the economic linkage in the Jiaodong region from 2016 to 2020, the Jiaodong region can be divided into two economic centers: the "Qingdao-Weifang-Rizhao" economic circle

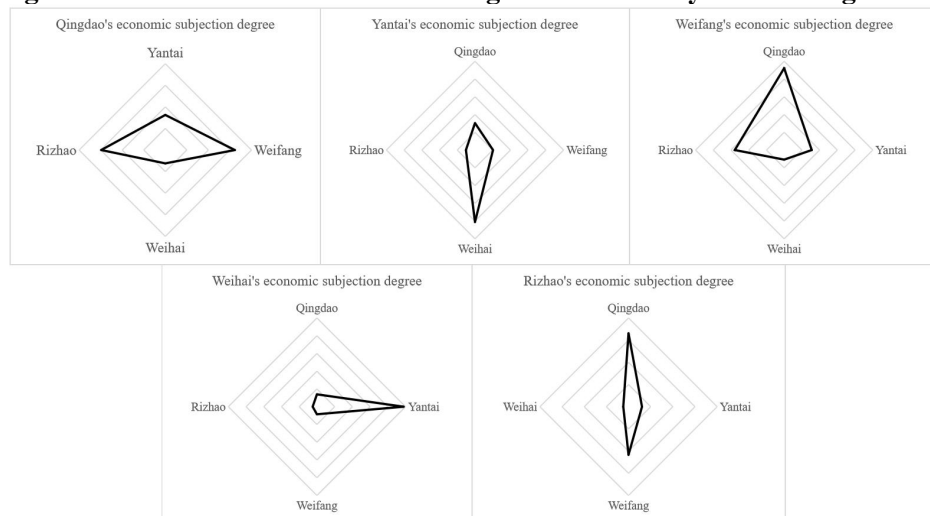
centered around Qingdao and the "Yantai-Weihai" economic circle centered around Yantai. Economic exchanges between Qingdao, Weifang, and Rizhao are more closely intertwined, while economic interactions within the Yantai-Weihai region are even more intense. During the 13th Five-Year Plan period, there was no significant change in this level of economic linkage, and the economic linkage between Qingdao and Weifang, as well as Rizhao, accounted for more than 60% of Qingdao's total economic linkage with other cities. Over the five-year period, Qingdao's status as a core city in the Jiaodong region has been further strengthened, with an increase in its economic dependency on other cities. However, Yantai's economic linkage and economic dependency on Weihai have declined, with the proportion of economic linkage decreasing from 54.37% to 48%, and the economic dependency decreasing from 81.17% to 81.04%. This

suggests that although Yantai maintains the closest economic linkage with Weihai in the Jiaodong region, its economic influence on Weihai has waned.

In 2020, the total economic linkage of the "Qingdao-Weifang-Rizhao" economic circle increased by 16.8% compared to 2016, while the total economic linkage of the "Yantai-Weihai" economic circle only grew by 5.8%. Notably, Weihai was the only city in the Jiaodong region with negative growth in economic linkage. It is worth mentioning that in 2016, Yantai's economic linkage with other cities led the Jiaodong region, slightly surpassing Qingdao. However, after five years of development, Yantai has fallen significantly behind Qingdao, with a difference of 4.797 billion yuan per 10,000 people per square kilometer, equivalent to 2.3 times the economic linkage between Yantai and Rizhao. As shown in Tables 3 and 4



**Figure 14. Economic Subordination Degree of Each City in Jiaodong in 2016**



**Figure 15. Economic Subordinate Degree of Each City in Jiaodong in 2020**

**3.4 Analysis of Division of Labor in Major Marine Industries**

The degree of industrial specialization serves as a crucial indicator for evaluating the level of regional economic integration. This paper analyzes the specialization degree of marine industries in the Jiaodong region, focusing on major marine industry development data, to explore the integration level of marine industrial development in the Jiaodong region. It is noted that since 2019, Shandong Province has initiated the construction of a marine economic accounting system to further standardize the statistical survey of marine economies in coastal cities. Currently, the available data on marine industry development is not comprehensive. Based on the data released by various municipal

governments' platforms, the author has ultimately selected the output values of marine fisheries (OVMF), marine shipbuilding industry (MSI), marine renewable energy utilization (MREU), seawater utilization (SU), marine pharmaceuticals and biological products industry (MPBPI), marine transportation industry (MTI), and marine tourism (MT) in Qingdao, Yantai, and Weihai in 2019 as the data sources for analyzing the degree of industrial specialization. This analysis represents the overall level of marine economic integration in the Jiaodong region. The specific methodology is outlined as follows:

$$S_{jk} = \sum_{i=1}^n \left| \frac{q_{ij}}{q_j} - \frac{q_{ik}}{q_k} \right|$$

**Table 3. Economic Connection Strength of Cities in Jiaodong in 2016**

	Qingdao		Yantai		Weifang		Weihai		Rizhao	
	Economic Contact (100 million yuan·Ten thousand people /km <sup>2</sup> )	Degree of economic subordination %	Economic Contact (100 million yuan·Ten thousand people /km <sup>2</sup> )	Degree of economic subordination %	Economic Contact (100 million yuan·Ten thousand people /km <sup>2</sup> )	Degree of economic subordination %	Economic Contact (100 million yuan·Ten thousand people /km <sup>2</sup> )	Degree of economic subordination %	Economic Contact (100 million yuan·Ten thousand people /km <sup>2</sup> )	Degree of economic subordination %
Qingdao	-	-	166.38	27.77%	284.82	47.54%	47.33	7.90%	100.54	16.78%
Yantai	166.38	26.85%	-	-	97.54	15.74%	336.93	54.38%	18.77	3.03%
Weifang	284.82	61.20%	97.54	20.96%	-	-	25.36	5.45%	57.69	12.40%
Weihai	47.33	11.40%	336.93	81.17%	25.36	6.11%	-	-	5.49	1.32%
Rizhao	100.54	55.09%	18.77	10.29%	57.69	31.61%	5.49	3.01%	-	-
Total	599.07	-	619.62	-	465.42	-	415.12	-	182.50	-

**Table 4. Economic Connection Strength of Cities in Jiaodong in 2020**

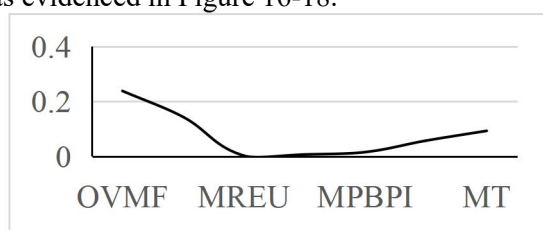
	Qingdao		Yantai		Weifang		Weihai		Rizhao	
	Economic Contact (100 million yuan·Ten thousand people /km <sup>2</sup> )	Degree of economic subordination %	Economic Contact (100 million yuan·Ten thousand people /km <sup>2</sup> )	Degree of economic subordination %	Economic Contact (100 million yuan·Ten thousand people /km <sup>2</sup> )	Degree of economic subordination %	Economic Contact (100 million yuan·Ten thousand people /km <sup>2</sup> )	Degree of economic subordination %	Economic Contact (100 million yuan·Ten thousand people /km <sup>2</sup> )	Degree of economic subordination %
Qingdao	-	-	222.29	30.40%	337.18	46.11%	50.96	6.97%	120.86	16.53%
Yantai	222.29	32.53%	-	-	106.29	15.56%	333.95	48.87%	20.77	3.04%
Weifang	337.18	64.56%	106.29	20.35%	-	-	22.27	4.26%	56.56	10.83%

ang				%						%
Weihai	50.96	12.37%	333.95	81.04%	22.27	5.40%	-	-	4.90	1.19%
Rizhao	120.86	59.51%	20.77	10.23%	56.56	27.85%	4.90	2.41%	-	-
Total	731.28	-	683.31	-	522.30	-	412.08	-	203.09	-

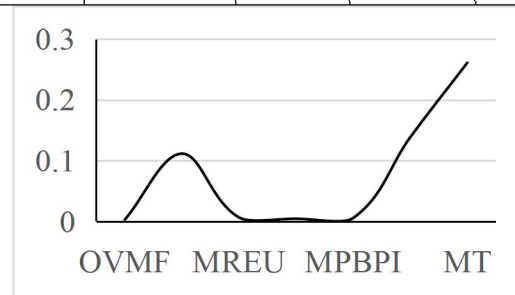
In this context, A and B represent the output values of industry *i* in region *j* and region *k*, respectively, while C and D represent the total output values of the marine industries in region *j* and region *k*. E denotes the degree of specialization of the marine industries in both regions, ranging from 0 to 2, where a higher value indicates a higher degree of difference in marine industries between the two regions.

The analysis reveals that Qingdao and Yantai exhibit the highest degree of specialization, reaching 0.56, with distinct development orientations in marine fisheries and marine shipbuilding industries. However, there is a lack of specialization and differentiation in industries such as marine renewable energy utilization, seawater utilization, marine pharmaceuticals and biological products, and marine transportation. On the other hand, Yantai and Weihai exhibit the most severe homogeneity in their overall marine industries, with a low degree of specialization of 0.53, though they demonstrate a higher degree of specialization in marine tourism and marine transportation. Qingdao and Weihai occupy an intermediate position with a specialization degree of 0.54, exhibiting a higher degree of specialization in marine fisheries and marine tourism.

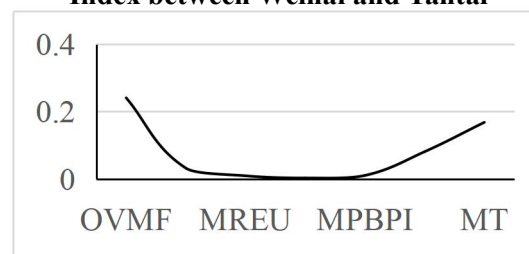
Overall, the lack of clear specialization and insufficient differentiation in marine renewable energy utilization, seawater utilization, marine pharmaceuticals and biological products industries in the Qingdao-Yantai-Weihai region reflects a deficiency in unified planning for the development of emerging marine industries in the Jiaodong region. Coastal cities tend to converge on similar projects and strategies for the development of strategic emerging industries, as evidenced in Figure 16-18.



**Figure 16. Main Marine Industry Division Index between Qingdao and Yantai**



**Figure 17. Main Marine Industry Division Index between Weihai and Yantai**



**Figure 18. Main Marine Industry Division Index between Weihai and Qingdao**

#### 4. Conclusion

The aforementioned analysis indicates that during the 13th Five-Year Plan period, the market integration in the Jiaodong region has continuously deepened, with Qingdao occupying a pivotal position in promoting the integrated development of the region. The economic connectivity analysis reveals the presence of two economic centers in Jiaodong: the "Qingdao-Weifang-Rizhao" economic circle centered on Qingdao and the "Yantai-Weihai" economic circle centered on Yantai. Economic exchanges between Qingdao, Weifang, and Rizhao are more intimate, while the economic interactions within the Yantai-Weihai region are even closer. The economic development of the five cities in Jiaodong is relatively balanced, and the development of the marine economy serves as a significant force driving the integration of the region, laying a solid economic foundation for coordinated regional development.

However, there is insufficient differentiation in the development of marine industries in the Jiaodong region, and there is a lack of unified deployment in the development plans for emerging marine industries, leading to

convergence and clustering of projects. In response to these issues, the following suggestions are proposed:

#### 4.1 Unified Planning and Overall Layout

To avoid unilateral and fragmented efforts, Jiaodong should prioritize the implementation of a unified planning and joint compilation of specialized plans encompassing green industrial development, efficient resource utilization, environmental protection, and infrastructure construction. The key considerations should be: first, a comprehensive evaluation of Jiaodong's resources, its position, and role within Shandong, followed by a scientifically planned development direction and strategic positioning; second, a rational planning of the industrial structure, particularly the strategic layout of emerging marine industries, to foster advantageous industrial clusters through industrial upgrading and relocation; third, a unified approach to regional public services and an overall planning of regional infrastructure construction; fourth, multi-stakeholder participation to ensure the scientific and rational nature of the planning.

A comprehensive mechanism for coordinating land and sea use scales and indicators should be established to prioritize projects included in the overall strategic plan for Jiaodong. This should include improving the mechanism for guaranteeing the supply and demand of industrial land and sea use, as well as establishing a platform for supply and demand. Additionally, policies for the protection of ecological land and sea use should be formulated, including separation of land acquisition and conversion, planning adjustments, and accounting of scale indicators, with a focus on conservation. Cities should strengthen cooperation based on the overall planning for Jiaodong, reasonably determine their urban positioning and development direction according to their unique characteristics and development realities, adjust their industrial structure and spatial layout, avoid redundant construction, and prevent resource wastage.

#### 4.2 Coordinating the Development of Marine Industries

A major issue hindering the development of marine industries in Jiaodong lies in the high degree of industrial duplication, which is prevalent not only in traditional industries but

also in emerging marine industries. This is a common challenge faced by coastal urban agglomerations in China. For instance, all five cities in Jiaodong have identified marine equipment manufacturing, marine pharmaceuticals and bioproducts, and seawater desalination as key emerging marine industries to be fostered in their "14th Five-Year Plan" for marine economic development. This underscores the significant potential for cooperation in Jiaodong's marine industries, yet it also poses a risk of vicious competition. Therefore, cities in Jiaodong should collaborate and implement the "14th Five-Year Plan for the Integrated Development of Jiaodong Economic Circle." Leveraging the development strategy of the Jiaodong Economic Circle, cities should prioritize enterprises, utilize marine industrial parks and projects as primary carriers, cultivate industrial clusters with distinct positioning and functions, emphasize optimal allocation of marine resources and targeted investment attraction for marine industrial chains. Additionally, cities should focus on cultivating upstream and downstream enterprises and innovative projects that complement the leading and advantageous marine industries, improve park infrastructure, and enhance the attractiveness of the parks.

#### Acknowledgement

This work was financially supported by the Shandong Provincial Social Popularization and Application Research Project(2021-SKZZ-60) fund.

#### References

- [1] W. Wang, X.C Zhu, Y. Wang (2020). Evolution and knowledge map analysis of urban agglomeration research in China. *Beijing Planning Review*, vol.3, no.6, p.74-79.
- [2] H.C Wang, J. Miao (2022). Suggestions on promoting the coordinated development of Beijing-Tianjin-Hebei to further expand. *CHINA STATE FINANCE*, vol.16, p.74-79..
- [3] W.D Cao, G. Zeng, S.J Zhu (2022). High-quality integrated development in the Yangtze River Delta region: Problems and solutions. *Journal of Natural Resources*, vol.37, no.6, p.1385-1402.
- [4] Y.W Feng, X.C Zhang, Y.S Xu (2022). Evolution and coupling relationship between

- regional cooperation and industrial integration in the Guangdong-Hong Kong-Macao Greater Bay Area. *Progress in Geography*, Vol.41, No.9, p.1647-1661.
- [5] L. Yuan (2014). Research on Mechanism, Ways and Recommendations of Synergistic Development of Urban Agglomeration - A Case Study of "Changsha-Zhuzhou-Xiangtan". Central South University.
- [6] Central People's Government of the People's Republic of China (2022). Report to the 20th National Congress of the Communist Party of China.
- [7] Development and Reform Commission of Shandong Province (2021).. Jiaodong Economic circle "14th Five-Year" integration development plan.
- [8] B. Sheng, Q.L. Mao (2011). Trade opening, domestic market integration and inter-provincial economic growth in China :1985-2008. *the Journal of World Economy*, Vol.11, p.44-66.
- [9] K. Wen, E.J. Zhu (2012). Beijing-tianjin-hebei regional integration development report. Social Sciences Literature Press.