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Research on Evaluation of Comprehensive Competitiveness of Marine Economy in Coastal Provinces of China

Huijian Zhang[1,2], Junfeng Wang[1] and Jun Jiang[1,2,*]

[1]Institute of Scientific and Technical Information, Chinese Academy of Tropical Agricultural Sciences (CATAS), Haikou 571101, Hainan, P. R. China
[2]School of Tourism, Hainan Tropical Ocean University (HNTOU), Sanya 572022, Hainan, P. R. China

*Corresponding author. Email: danielchyang@126.com

Abstract. On the basis of statistics and analysis of the overall development of China's marine economy, this study analyzes the main factors affecting the comprehensive competitiveness of marine economy from four aspects, marine resource endowment, marine economy development level, local macro-environment of marine economic development, and marine environmental protection capability. Constructing the comprehensive competitiveness index system of China's coastal provinces, which includes 4 second-level indicators, 12 third-level indicators and 50 fourth-level indicators. Meanwhile, using hierarchical analysis, equal weighting method, entropy method to measure the weight of indicators at all levels. Conclusions of this study show that the rank of comprehensive competitiveness of coastal provinces is stable, the level of marine economy development is the most important factor to improve the comprehensive competitiveness of marine economy, the strength of marine science and technology and the level of marine industry production are the main factors to enhance the comprehensive competitiveness of marine economy by analyse the data from 2002-2017.

Keywords: Coastal provinces, Marine economy, Comprehensive competitiveness, Evaluation.

1. Introduction

The ocean is increasingly becoming the most important place for human to live and the greatest development intensity region for economic resources. Therefore, it is of great significance to pay attention to the reasonable development of the ocean and to plan to strengthen the scientific development of the marine economy to realize the sustainable utilization of the ocean. The 19th Congress of the Chinese Communist Party explicitly requested “adhering to coordinate the development of land and ocean, accelerating to construct a powerful marine country", which stressed the importance of constructing a powerful marine country once again.

In 2011, Shandong, Guangdong, Zhejiang, Fujian and Tianjin were approved as the national pilot provinces for marine economy development by government, the average annual growth rate of marine GDP in Guangdong, Zhejiang, Fujian and Tianjin has been 11.4%, 7.4%, 13.1% and 12.7% respectively. There are two features of construction in these provinces which are large investments and large projects. Using the huge capital flow to drive the development of marine economy. This

development pattern has become a new engine for transformation and upgrade of economy in these provinces.

The ocean contains precious wealth for sustainable development of mankind and is a strategic area for country's development. At present, China's marine resources utilization and development system is still not complete. We should consider urgently that how to utilize the ocean more efficiently. Under this situation, this study takes 11 coastal provinces of China as research objects, constructing an evaluation index system of marine economy competitiveness. The purpose of this study is to understand the contribution of marine science and technology and other factors to marine economy competitiveness in coastal regions. Meanwhile, compare the competitiveness of 11 coastal provinces, cities autonomous district and municipality to provide intellectual support for Chinese marine economy development planning.

2. Overview of China's marine economic development

Statistics data from China's Marine Economic Statistics Bulletin 2018 shows that the country's gross marine product output reached 8341.5 billion yuan, increase 6.7% over the previous year, accounting for 9.3% of the GDP, with an increase of 6.9% of previous proportion. The added value of marine primary, secondary and tertiary industries accounted for 4.4%, 37.0% and 58.6%. Among them, the total marine output of the northern marine economy circle was 2621.9 billion yuan, increase 7.0% over the previous year, accounting for 31.4% of the national marine output. The total ocean output of the eastern ocean economy circle was 2426.1 billion yuan, increase 8.0% over the previous year, accounting for 29.1% of the nation's total ocean output. The total marine output of the southern ocean economy circle was 3293.4 billion yuan, increase 10.6% over the previous year, accounting for 39.5% of the nation's total marine output. The marine economy in these three major economic zones continues to maintain a steady growth trend. Although the growth rate has been slowing down, the marine economy is still an important mainstay of the national economy in these three zones.

The prevention and control of marine pollution in coastal provinces has achieved initial achievement, such as shutting down polluting enterprises, eliminating backward production capacity, popularizing healthy breeding method, and implementing "zero emission" of ship oil have been fully carried out. Marine industrial pollution and agricultural non-point source pollution have been controlled preliminarily. Ecological restoration of crucial sea areas, beaches, islands and coastal zones continued to implement, and damaged marine resources and marine ecological functions were initially restored. The provincial, city and county constitute the three-level marine environmental monitoring system which has been continuously improved. A remote online monitoring system for marine disasters at the provincial level has been initially established. The capability of marine disaster emergency warning and reporting has been further improved at the same time.

The system of marine laws and regulations is improving day by day, the mechanism of marine comprehensive management are continuously improving, the marine affairs are developing prosperously, the capabilities of marine administration agencies are significantly enhanced, the abilities of coordination, rapidly response and public service in marine affairs are significantly enhanced. It has strengthened its ability to participate in maritime rights protection objectively.

The advancing of the strategy of strengthening the country through the sea has promoted the nurturing of highly educated talents, bringing a large number of experts to the development of the marine economy. According to the China Ocean Statistics Yearbook (2008-2017), the number of graduate students majoring in ocean-related disciplines in China increased from 2253 to 5680 in 2007-2016. The increasing number indicates that there are sufficient reserve talents for the development of marine economy in China.

In summary, the marine economy in China's coastal areas has made great progress in recent years. However, due to historical development, resource endowment, policy imbalance and other reasons, there are great differences in the current development situation and industrial structure of marine economy in different regions. At the same time, the economic growth rate and level of economy development between different regions are also quite different. In order to promote the sustainable

development of China's marine economy and regional cooperation, it is necessary to study the real situation of the development of different regions of China's marine economy which can help to obtain its successful experience and the weakness which needs improvement. However, the comprehensive competitiveness of China's marine economy in different regions is the main factor leading to the shift of the center of economic gravity. Identifying the differences between the influence factors on the marine economy in different regions is helpful for a deeper understanding of the unbalanced regional development of China's marine economy and finally promoting the sustainable and healthy development of China's marine economy.

3. Evaluation of the comprehensive competitiveness of marine economy in coastal provinces

3.1. Data sources

This study covered 11 provinces (or municipality) and the number of data is more than 12,000. The data sources mainly include China Ocean Statistics Yearbook, China Statistics Yearbook, China Ocean Fisheries Statistics Yearbook and China Environment Statistics Yearbook from 2002 to 2017. According to the evaluation method of the comprehensive competitiveness of marine economy, this paper makes statistical analysis on the relevant indicator datum of China's coastal areas from 2002 to 2017 and obtains the scores of each indicators. According to the scores, ranking the comprehensive competitiveness of the marine economy in the coastal areas.

3.2. Evaluation index system

In order to scientifically judge the contribution rate of various influencing factors to the comprehensive competitiveness of marine economy in various regions, it is necessary to construct the comprehensive competitiveness level of marine economy in 11 coastal provinces and cities in China. This study uses hierarchical analysis method to analyze the comprehensive strength of every region. Comprehensive strength reflect the influence of the marine economy in a coastal region.

According to the principles of scientificity, practicality and universality, the author referred relevant materials to find the key indicators which were influencing factors of marine economic competitiveness from three mainstream Chinese databases. This study analyzes the main factors influencing the comprehensive competitiveness of marine economy from four aspects: marine resource endowment, level of marine economy development, local macro-environment development of marine economy, and marine environment protection capacity. Constructing an index system of comprehensive competitiveness of marine economy for China's coastal provinces. Under the evaluation system, there are 4 second-level indicators, 12 third-level indexes, and 50 fourth-level indicators. At the same time, using hierarchical analysis method, equal weighting method, entropy method to determine the weights of indicators at all levels (Standardized processing of original data and correlation analysis charts among variables are omitted).

Table 1. Evaluation index system of comprehensive competitiveness of marine economy in China's coastal provinces.

First-level indicator	Second-level indicator	Third-level indicator	Fourth-level indicator
Comprehensive competitiveness of marine economy	Marine resources endowment	Marine natural resources	Maritime area (km^2)
			Island area (km^2)
			Length of continental coastline (km)
			Length of island shoreline (km)
			Mudflat area (km^2)
			Shallow sea area (km^2)
		Marine renewable	Offshore tidal energy reserve (MW)
			Offshore wave energy reserve (MW)

First-level indicator	Second-level indicator	Third-level indicator	Fourth-level indicator
		energy	Offshore tideway energy reserve (MW)
			Offshore salinity energy reserve (10^4KW)
		Port resources	Length of deepwater shoreline (km)
			Number of bays (> 10 KM^2)
		Coastal tourism resources	Number of 5A-Class tourist attractions in coastal areas
			Number of 4A-class tourist attractions in coastal areas
			Number of potential coastal tourist Attractions
	Development level of marine economy	Scale of marine economy	Gross marine product (in 100 million Yuan)
			Gross marine product/Regional product (%)
			Marine tertiary industry output value/Gross marine product (%)
			Number of marine-related employment (in ten thousands)
			Number of marine-related employment/Number of employment at the end of the year (%)
			Foreign exchange income from international tourism (in million Dollors)
		Production capacity of marine industry	Domestic marine fishing output (t)
			Pelagic fishing output (t)
			Mariculture output (t)
			Cargo throughput (in ten thousands tons)
			International standard Container Throughput of port (in 10 thousands tons)
			Number of inbound overnight tourists (in 10 thousands)
		Management Capability of marine area	Number of the issued certificates of the right to use marine areas
			Using confirmed area (hm^2)
			Marine area using fee (in 10 thousands Yuan)
	Local macro-environment for marine economic development	Economic strength and supporting policies of coastal provinces	Gross regional product (in 100 million Yuan)
			Per capita Gross regional product (Yuan/person)
			Provincial area (km^2)
			Regional fixed assets Investment (in 100 million Yuan)
			Marine Economic Demonstration Zone (yes/no)
			Urbanization rate (%)
		Strength of marine science and technology	Number of scientific research institutions
			Number of researchers
			Number of science-related employment
			Total research funds (in thousands Yuan)
			Government Investment in Infrastructure

First-level indicator	Second-level indicator	Third-level indicator	Fourth-level indicator
			Construction (in thousands Dollar)
			Number of project
			Number of published scientific papers
			Number of patents
			Number of R&D employment
	Capability of marine environmental protection	Capability of waste management	Proportion of industrial waste water directly pouring into the ocean (%)
		Condition of marine nature reserve construction	Number of marine nature reserves in coastal areas
			Number of national marine nature reserves in coastal areas
			Area of marine nature reserve in coastal regions (km^2)
		Distribution of coastal observation stations	Number of observation stations

3.3. Empirical analysis

According to the evaluation method of the comprehensive competitiveness of marine economy, this study makes statistical analysis on the relevant indicators' data of China's coastal areas from 2002 to 2017, and getting the scores of each indicator. According to the scores, obtaining the rank of the comprehensive competitiveness of the marine economy in the coastal areas, and the results will be emphatically analyzed below. (Standardized processing of original data and correlation analysis charts among variables are omitted).

3.3.1. Comprehensive competitiveness evaluation of marine economy. The comprehensive competitiveness evaluation results of the coastal marine economy are shown in Table 2. According to this table, the cluster analysis method is used to divide the comprehensive competitiveness scores of the 11 coastal areas into 3 categories: the stronger ones, the middle ones and the weaker ones. Finally, the conclusion of competitiveness in this study is that Guangdong, Shandong and Zhejiang are stronger, Fujian, Liaoning, Shanghai and Jiangsu are in the middle. Tianjin, Hainan, Hebei and Guangxi are weaker.

Table 2. Ranking of comprehensive competitiveness evaluation of marine economy.

	Guangdong	Shandong	Fujian	Shanghai	Jiangsu	Zhejiang	Tianjin	Liaoning	Hebei	Guangxi	Hainan
2001	1	2	4	7	6	3	8	5	11	10	9
2002	1	2	4	7	6	3	8	5	11	10	9
2003	1	2	4	7	6	3	8	5	11	9	10
2004	1	2	4	6	6	3	8	5	11	10	9
2005	1	2	5	6	7	3	8	4	9	11	10
2006	1	2	5	7	7	3	8	4	9	11	10
2007	1	2	4	6	6	3	8	5	9	11	10
2008	1	2	4	6	7	3	8	5	10	11	9
2009	1	2	5	6	7	3	8	4	10	11	9
2010	1	2	5	6	7	3	8	4	10	11	9
2011	1	2	5	6	7	3	8	4	9	11	10
2012	1	2	5	6	7	3	8	4	10	11	9
2013	1	2	5	6	7	3	8	4	10	11	9
2014	1	2	5	6	7	3	8	4	10	11	9

	Guangdong	Shandong	Fujian	Shanghai	Jiangsu	Zhejiang	Tianjin	Liaoning	Hebei	Guangxi	Hainan
2015	1	2	4	6	7	3	8	5	10	11	9
2016	1	2	4	6	7	3	8	5	11	10	9

From Table 2, we can know that the overall competitiveness of the marine economy in the 11 coastal areas of China is relatively stable from 2001 to 2016. Among them, Guangdong, Shandong, Zhejiang and Tianjin's rank of the comprehensive competitiveness of the marine economy has remained unchanged, ranking 1st, 2nd, 3rd and 8th respectively. Liaoning and Fujian alternate at 4th and 5th place. In the most of the time, Fujian is at the 4th place and Liaoning is at the 5th place. Shanghai and Jiangsu alternate at 6th and 7th place, Shanghai is at the 6th place and Jiangsu is at 7th place overall, Hainan is at 9th place, Guangxi and Hebei are at 10th and 11th respectively. .

3.3.2. Evaluation on competitiveness of marine resources endowment. The marine resources endowment indicators in the first-level includes marine natural resources, marine renewable energy, port resources and coastal tourism resources. Table 3 shows the evaluation and ranking results of marine resource endowment competitiveness of 11 coastal regions and result of its 4 second-level branch of indicators.

Table 3. Marine resources endowment competitiveness and subordinate indicators evaluation ranking.

	Marine resources endowment	Marine area resources	Marine renewable energy	Port resources	Coastal tourism resources
Guangdong	3	2	3	5	2
Shandong	4	5	5	2	6
Fujian	2	4	2	4	3
Shanghai	7	8	4	8	7
Jiangsu	9	6	8	9	9
Zhejiang	1	1	1	1	1
Tianjin	11	11	11	11	8
Liaoning	6	7	6	3	4
Hebei	10	10	10	10	11
Guangxi	8	9	9	7	10
Hainan	5	3	7	6	5

From Table 3, we can see that the competitiveness of marine resources endowment in coastal areas is Zhejiang, Fujian, Guangdong, Shandong, Hainan, Liaoning, Shanghai, Guangxi, Jiangsu, Hebei and Tianjin from strong to weak.

Zhejiang's four second-level indicators of marine resources endowment are at the first place. Compared with other provinces Zhejiang, Guangdong and Hainan are with advantages on marine area resources. Zhejiang, Fujian and Guangdong are with advantages on marine renewable energy. Zhejiang, Shandong and Liaoning are with advantages on the port resources. Meanwhile, Zhejiang, Guangdong and Fujian are with advantages on the coastal tourism resources.

3.3.3. Evaluation on the development level of marine economy. The marine economic development indicators in the second-level indicators include the scale of marine economy, the production capacity of marine industry and the management capability of marine area. The evaluation results of marine economic development level indicators are shown in Table 4.

From Table 4, Guangdong, Shandong and Zhejiang has the best development environment among the 11 coastal areas in the evaluation of marine economic development level. Liaoning and Fujian are in the middle. Tianjin, Shanghai, Jiangsu, Hebei, Hainan and Guangxi has a lower marine economic development level.

The evaluation result of scale competitiveness of marine economy shows that Guangdong, Shandong and Zhejiang are stronger. Fujian, Shanghai, Liaoning and Tianjin are in the middle. Jiangsu, Hainan, Hebei and Guangxi are weaker.

The evaluation result of marine industry productivity competitiveness shows that Guangdong, Shandong and Zhejiang are the strongest. Liaoning, Tianjin, Fujian and Hebei are in the middle. Jiangsu, Shanghai, Guangxi and Hainan are weaker.

The evaluation result of sea area management level shows that Liaoning and Shandong are the strongest. Fujian, Jiangsu, Zhejiang and Guangdong are in the middle. Hebei, Guangxi, Tianjin, Hainan and Shanghai are weaker.

Table 4. Evaluation on the development level of marine economy.

	Guangdong	Shandong	Fujian	Shanghai	Jiangsu	Zhejiang	Tianjin	Liaoning	Hebei	Guangxi	Hainan
2001	1	2	4	7	8	3	6	5	9	10	11
2002	1	2	5	8	7	3	6	4	9	11	10
2003	1	2	4	7	8	3	6	5	9	11	10
2004	1	3	5	7	8	3	6	4	9	10	11
2005	1	2	5	7	8	3	6	4	9	10	11
2006	2	1	5	7	9	3	8	4	6	11	10
2007	1	2	5	9	7	3	6	4	8	11	10
2008	1	2	5	7	8	3	6	4	9	11	10
2009	1	2	4	7	8	3	6	5	9	11	10
2010	1	2	5	7	8	3	6	4	9	11	10
2011	2	1	5	9	8	3	6	4	7	10	11
2012	2	1	5	8	7	3	6	4	9	10	11
2013	2	1	5	8	7	3	6	4	9	11	10
2014	2	1	5	8	7	3	6	4	9	11	10
2015	2	1	4	8	7	3	6	5	9	11	10
2016	2	1	4	8	7	3	6	5	9	11	10

3.3.4. Macro-environmental assessment of local marine economy development. The local macro-environmental of marine economic development in the second-level indicators include the economic strength and supporting policies of coastal provinces and the strength of marine science and technology.

From Table 5, Shandong, Guangdong, Shanghai and Jiangsu has the best local marine economy environment among the 11 coastal areas in terms of local macro-environmental assessment results for each year. Zhejiang, Fujian, Tianjin and Liaoning are in the middle. Hebei, Hainan and Guangxi are weaker.

The evaluation result of marine scientific and technological strength shows that Shandong, Guangdong, Shanghai and Jiangsu have the best strength in science and technology. Tianjin, Zhejiang, Fujian and Liaoning are in the middle. Hebei, Guangxi and Hainan are the weakest.

The evaluation result of local economic strength and preferential policies shows that Guangdong has the strongest strength in local economy. Zhejiang, Shanghai, Shandong, Jiangsu and Fujian are in the middle. Liaoning, Guangxi, Hebei, Tianjin and Hainan are weaker.

Table 5. Macro-environmental assessment of local marine economy development.

	Guangdong	Shandong	Fujian	Shanghai	Jiangsu	Zhejiang	Tianjin	Liaoning	Hebei	Guangxi	Hainan
2001	2	1	6	4	3	5	7	8	10	9	11
2002	3	1	6	2	4	5	7	8	10	9	11
2003	3	1	7	5	4	2	6	9	11	8	10
2004	2	1	6	4	3	5	7	8	9	11	10
2005	2	1	7	4	3	5	6	8	10	11	9
2006	2	1	7	3	4	5	6	8	9	10	11
2007	1	2	7	3	4	5	6	8	9	10	11
2008	1	2	7	3	4	5	6	8	9	10	11
2009	2	1	7	3	4	5	8	6	9	10	11
2010	1	2	5	3	4	7	8	6	11	10	9
2011	1	2	7	3	4	5	8	6	9	11	10

	Guangdong	Shandong	Fujian	Shanghai	Jiangsu	Zhejiang	Tianjin	Liaoning	Hebei	Guangxi	Hainan
2012	1	2	6	3	4	5	8	7	9	10	11
2013	2	1	8	3	4	5	6	7	9	10	11
2014	1	2	8	3	4	5	7	6	9	10	11
2015	1	2	8	3	4	5	7	6	9	10	11
2016	1	2	8	3	4	5	7	6	9	11	10

3.3.5. Assessment of marine environmental protection capacity. The marine environmental protection capability includes three second-level indicators: waste management capability, condition of marine nature reserve construction, and distribution of coastal observation station. The evaluation results of marine environmental protection capability are shown in Table 6.

Table 6. Assessment of marine environmental protection capacity.

	Guangdong	Shandong	Fujian	Shanghai	Jiangsu	Zhejiang	Tianjin	Liaoning	Hebei	Guangxi	Hainan
2001	1	6	11	8	3	7	10	2	9	5	4
2002	1	2	7	9	3	6	11	10	5	4	8
2003	1	2	6	10	3	5	11	8	9	4	7
2004	1	3	7	10	2	5	9	11	8	4	6
2005	1	2	9	10	6	4	8	5	7	3	11
2006	1	4	11	9	5	7	10	3	8	6	2
2007	1	4	6	9	3	8	11	2	10	7	5
2008	1	2	6	8	4	5	11	7	9	10	3
2009	1	4	9	8	3	6	11	2	10	7	5
2010	1	3	11	8	5	4	10	6	9	7	2
2011	1	2	8	11	5	3	10	4	9	6	7
2012	1	3	6	9	5	8	11	4	10	7	2
2013	2	3	6	8	5	7	11	4	9	10	1
2014	2	3	6	8	5	7	11	4	9	10	1
2015	2	3	6	8	5	7	11	4	9	10	1
2016	2	3	6	8	5	7	11	4	9	10	1

From Table 6, Guangdong has the strongest marine environment protection capability among the 11 coastal areas in terms of the evaluation results in every year. Shandong, Jiangsu, Hainan, Liaoning, Guangxi and Zhejiang are in the middle. Fujian, Hebei and Tianjin are weaker.

The evaluation result of waste management capability (chart was omitted) shows that Jiangsu, Guangdong, Hebei, Zhejiang and Tianjin are the stronges. Shandong, Hainan, Guangxi and Shanghai are in the middle. Liaoning and Fujian are weaker.

The evaluation result of the construction of marine nature reserves (chart was omitted) shows that Guangdong is the strongest. Liaoning, Hainan and Shandong are in the middle. Fujian, Jiangsu, Guangxi, Zhejiang, Shanghai, Hebei and Tianjin are weaker.

Evaluation result of coastal observation stations shows that Guangdong has the largest number of observation stations. Fujian, Zhejiang, Shanghai, Shandong, Jiangsu and Liaoning are in the middle. Hainan, Hebei, Guangxi and Tianjin are relatively few.

The comprehensive competitiveness evaluation system of marine economy reflects a coastal area's development competitiveness in marine resources, marine industry, marine science and technology, marine environment, marine management and other aspects. It reflects the competitive position in the whole country. The development of various aspects promote and restrict each other, and jointly affect the ranking and changing trend of the comprehensive competitiveness of marine economy in coastal areas. It also shows certain laws and characteristics.

4. Conclusion

4.1. The rank remained stable

The overall competitiveness of the coastal provinces (municipalities) has remained stable. From 2001 to 2016, only minority provinces change the rank position. In terms of comprehensive competitiveness of marine economy, Guangdong, Shandong and Zhejiang are the strongest, while Hainan, Hebei and Guangxi are weaker.

4.2. The development level of marine economy is the most important factor to enhance the comprehensive competitiveness of marine economy

In the second-level evaluation index of the comprehensive competitiveness of marine economy, the development level of marine economy is a significant factor affecting the promotion of comprehensive competitiveness, of which Guangdong, Shandong and Zhejiang have the strongest comprehensive competitiveness, while Hebei, Hainan and Guangxi are weaker.

4.3. The strength of marine science and technology and the production level of marine industry are the main factors to enhance the comprehensive competitiveness of marine economy

In the third-level evaluation indicators of the comprehensive competitiveness of the marine economy, the strength of marine science and technology and the production capacity of marine industry in the 11 coastal regions greatly affect the strength of the comprehensive strength of the marine economy in the region. These two evaluation indicators have their respective functions and they are interrelated and need to be developed together. At the same time, the marine protection ability is gradually showing its influence on the comprehensive competitiveness of marine economy.

Study shows that promote the rank of competitiveness of the coastal marine economy requires long-term efforts and requires comprehensive development in all aspects. At present, under the situation of resource constraints, enhancing the strength of marine science and technology is one of the core elements for a powerful marine country. Environmental protection capability is the guarantee of a country's sustainable development. The tertiary industry of marine economy has gradually revealed its importance in the process of optimizing and adjusting the industrial structure. The related government departments of the 11 coastal provinces, cities and autonomous regions should strengthen their investment in marine science and technology. Meanwhile, pay more attention to improving the marine environmental protection capability, emphatically develop the tertiary industry, and actively adjust and optimize the structure of the marine primary industry.

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