Study on the Characteristics and Influencing Factors of Spatial Pattern Evolution of Marine Fisheries in China

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Abstract: This paper takes 11 coastal provinces and cities as the research unit, uses the 2010, 2014 and 2017 data, uses the Theil coefficient and global spatial autocorrelation method and constructs a spatial econometric model to explore the spatial structure characteristics and influencing factors of Marine Fisheries in China. The results show that: the distribution of "one core and two wings" with Shandong as the core has developed to the situation of "dual core leading" of Shandong and Fujian; the economic differences first narrow and then expand, and the spatial agglomeration increases. The level of marine fishery science and technology, marine fishery resources and marine fishery modernization level have a significant impact on marine fishery economy.

Keywords: marine fishery; spatial pattern; spatial econometrics

1. Introduction

Marine economy plays an important role in transforming the mode of economic development, promoting the upgrading of industrial structure and maintaining the stable growth of national economy. In particular, marine fisheries play an irreplaceable role in ensuring national food security and improving people's living standards. How to realize the reasonable spatial distribution of marine fishery area is an important guarantee for the high-quality development of marine fishery economy. On March 3, 2012, the State Council approved the "national marine functional zoning (2011-2020)", through the division of marine functional areas, rational development and utilization of marine resources, effective protection of marine ecological environment, and optimization of marine development layout. On October 25, 2017, the Ministry of Agriculture issued the "national marine ranching demonstration area construction plan (2017-2025)" and proposed that we should focus on promoting the construction of marine ranching in "one belt and multiple areas" (offshore, Yellow Sea and Bohai Sea, East China Sea and South China Sea). By 2025, 178 National Marine ranch demonstration areas will be created and "blue granary" construction will be promoted. However, as a traditional marine industry, the spatial distribution of marine fishery is unreasonable. With the rapid development of regional economic integration, the spatial spillover effect of industrial development is more obvious [1]. Therefore, it is of great significance to study the spatial structure characteristics of marine fishery to give full play to the advantages of marine resources, upgrade the industrial structure of marine fishery, promote the construction of "blue granary" and develop marine economy.

2. Literature Review

The research on the theory of industrial spatial pattern originated from the location theory of Duncan and Weber [2]. With the further development of regional economy, the evolution of industrial spatial pattern and the spatial structure characteristics of regional interaction become the focus of attention [3]. Perroux, a French economist, put forward the theory of industrial growth pole [4]. Friedman put forward the "center periphery" theory, taking the lead in the development of regions. Under the effect of backflow effect, factors continuously gather to form scale economy, that is, the "center" zone, and the surrounding areas become the "periphery" [5]. Krugman proposed the "core periphery" model and introduced the spatial econometric model, which further enriched the theory and method of industrial spatial structure. In the formation mechanism of economic spatial structure system, domestic scholar Lu Da Dao put forward the theory of "point axis system" and "t" spatial structure of "riverside coastal" development [6]. With the state's high attention to the development of marine fishery, the research on marine fishery spatial structure has been widely concerned. Chen Qiu ling and Yu Lili pointed out that China's marine fishery layout has entered the stage of point axis distribution, and the concentration degree of industrial structure is low [7]. For empirical research on spatial pattern evolution, coefficient of variation, Theil index and exploratory spatial analysis are widely used [8]. The index system is constructed from the perspective of marine carrying capacity. Yu Jingkai and Chen Yuci constructed the evaluation index system of marine fishery spatial layout optimization [9], Yu Jingkai and Kong Haizheng established the evaluation model of marine fishery spatial layout rationality [10] to study the optimization of marine fishery spatial layout.

Through combing the theory and empirical methods of industrial spatial structure characteristics, it is found that

there are more researches on the optimization of marine fishery spatial pattern, mainly through the construction of index system and traditional statistical model, this paper uses spatial exploration analysis method and constructs spatial econometric model to explore the spatial structure characteristics and influencing factors of marine fishery in China.

3. Evolution Characteristics of Marine Fishery Spatial Pattern

3.1. Study Area and Data Sources

In this paper, 11 provinces and cities, including Liaoning Province, Tianjin city, Hebei Province, Shandong Province, Jiangsu Province, Zhejiang Province, Fujian Province, Guangxi Province, Guangdong Province, Hainan Province and Hainan Province, are selected as research samples, and three time periods of 2010, 2014 and 2017 are selected. The data mainly comes from the "China fishery Statistical Yearbook". As the marine fishery economic data are mixed into the statistical indicators of fishery economy, this paper draws on the processing methods of marine fishery related data in Wang Bo and Han Limin [11]. Among them, the first industry of marine fishery includes: Mariculture, fishing (offshore fishing, offshore fishing); the second industry includes: marine fishery processing industry; the third industry includes: marine leisure fishery.

Table 1. Marine fishery economic development data and some adjustments.

Industrial output value	Data and partial adjustment method
Mariculture	*China fishery statistical yearbook*
Marine fishing industry	*China fishery statistical yearbook*
Marine fishery processing industry	(total amount of seawater processing products / aquatic products processing products) x aquatic products processing output value
Marine recreational fishery	(marine fishery primary industry output value / fishery primary industry output value) x leisure fishery output value
Total output value of marine fishery economy	Marine aquaculture + marine fishing + marine fishery processing + marine leisure fishery

3.2. Research Methods

3.1.1. Theil Coefficient

The Theil coefficient is suitable for the measurement and analysis of economic development differences in different regions. In this paper, the Theil coefficient is used to reflect the overall difference degree of the economic development level of marine fishery in 11 coastal provinces and cities in China. The larger the value of the Theil coefficient, the greater the difference is. On the contrary, the difference is smaller [12]. The formula is as follows:

$$T = \sum_{i=1}^{n} y_i \log \frac{y_i}{p_i}$$

T is the Theil coefficient; n is China's coastal 11 provinces and cities; y_i is the proportion of the total marine fishery economic value of provinces and cities in the total marine fishery economic value of 11 coastal provinces and cities; p_i is the proportion of the population of each province in the total population of 11 coastal provinces and cities in China.

3.1.2. Spatial Autocorrelation Analysis

Moran's I analyzes the spatial correlation degree of marine fishery economy as a whole [13]. It is expressed by index value. The formula is as follows:

$$I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}\left(x_i - \bar{x}\right)\left(x_y - \bar{x}\right)}{S^2 \sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}}$$

x_i and x_j are the economic gross values of Marine Fisheries of 11 provinces and cities in China, w_{ij} represent the spatial weight matrix, and the first-order adjacency matrix is used in this paper.

3.3. General Evolution Characteristics of Marine Fisheries in China

According to the GDP data of marine fishery of 2010, 2014 and 2017, the spatial pattern evolution of marine fishery economy in China is analyzed. China's marine fishery economy presents the distribution pattern of "one core and two wings" with Shandong as the core, and develops into the situation of "dual core leading" of Shandong and Fujian. Shandong and Fujian have formed two growth poles of marine fishery economy. From 2010 to 2017, the economic level of marine fishery in Liaoning, Hebei, Jiangsu, Guangdong, Guangxi and Hainan provinces decreased significantly, the development level of marine fishery economy in Fujian Province increased, and the development level of marine fishery economy in Zhejiang Province first decreased and then increased.

The development of China's marine fishery initially presents a "point axis" distribution. Taking Shandong and Fujian provinces as the main core points and railway and highway lines as the connecting axis, the preliminary "point axis" spatial layout characteristics are formed along the coastline. The "point axis" mode is still in the primary stage. The economic development level of marine fishery in Zhejiang Province first decreases and then increases from 2010, 2014 and 2017. Zhejiang Province is likely to become the next marine fishery, the core of economic development. With perfect infrastructure, high level of economic development and broad consumption market in the eastern coastal areas, the "point axis" distribution

system of marine fishery will be further mature.

According to the results of Theil coefficient, the value from 2010 to 2014 showed a downward trend, from 0.1412 to 0.1397. From 2014 to 2017, the value increased steadily from 0.1397 to 0.1517. The change trend of Theil coefficient shows that the development difference of marine fishery economy in China first narrows and then expands, and the development state develops in the direction of imbalance balance imbalance. From the global Moran's I value, 2010, 2014 and 2017 were 0.405, 0.4 and 0.607, respectively. The overall situation increased from 0.405 in 2010 to 0.4 in 2014 to 0.607 in 2017, indicating that the marine fishery economy in China showed significant positive spatial correlation and obvious spatial agglomeration characteristics.

4. An Analysis of the Influencing Factors of Marine Fishery Economy

4.1. Selection of Indicators and Sources of Data

According to the development of marine fishery economy and the principle of data availability, this paper selects marine fishery economic gross value, marine fishery machinery power to represent marine fishery science and technology level, and Marine fishery practitioners represent the labor force of marine fishery, the area of mariculture, the output of marine fishing and mariculture, the resources of marine fishery, the proportion of output value of secondary and tertiary industries of marine fishery, and the modernization of marine fishery.

4.2. Construction of Spatial Econometric Model

1. OLS model is mainly used for comparative analysis with spatial econometric model to compare the impact of spatial dependence on economy. The formula is as follows:

$$\ln y = c + \beta_1 \ln x_1 + \beta_2 \ln x_2 + \beta_3 \ln x_3 + \beta_4 \ln x_4 + \beta_5 \ln x_5 + \varepsilon$$

Spatial lag model (SAR). This paper mainly explores the spatial spillover effect of marine fishery economy in neighboring provinces and cities [14], and the formula is as follows:

$$\ln y = c + \rho w y + \rho_1 \ln x_1 + \rho_2 \ln x_2 + \rho_3 \ln x_3 + \rho_4 \ln x_4 + \rho_5 \ln x_5 + \varepsilon$$

Spatial error model (SEM). The influence degree of spatial effect of error term on marine fishery economy is as follows:

$$\ln y = c + \beta_1 \ln x_1 + \beta_2 \ln x_2 + \beta_3 \ln x_3 + \beta_4 \ln x_4 + \beta_5 \ln x_5 + \xi$$

$$\xi = \lambda w \xi + \varepsilon$$

4.3. Result Analysis

Table 2. Analysis of OLS, SAR and SEM results

Statistics	OLS model	SAR model	SEM model
C	0.399	0.501	0.462***
Lnx1	- 0.038	- 0.043***	- 0.060***
Lnx2	0.008	0.011	0.004
Lnx3	0.001	0.001	- 0.001
Lnx4	1.006***	1.003***	1.026***
Lnx5	0.031	0.039 ***	0.034***
Wy		- 0.001	
W§			- 0.853***
AIC	- 47.82	- 46.35	- 58.62
SC	- 45.43	- 43.57	- 56.24

*, * *, and * * are significant at 10%, 5% and 1% levels respectively

Through the Lagrange multiplier test [15]. As shown in Table 2, the significance of lmerr and r-lmerr passed the 10% test, but the significance of lmlag and r-lmlag failed the 10% test. Combined with the result analysis, the spatial error model is selected. Compared with the results of the least square method, it is found that ignoring the spatial factors will have a great impact on the results, and the marine fishery economy in China has significant spatial effects. From the AIC and SC values, the spatial error model fitting is the best. The level of marine fishery science and technology, marine fishery resources and marine fishery modernization are significant.

5. Results and Discussion

The spatial pattern of marine fishery in China has developed from "one core and two wings" distribution with Shandong as the core to the situation of "dual core leading" in Shandong and Fujian. Shandong Peninsula is located in the core position of the fishing ground of the Yellow Sea and Bohai Sea, with rich fishery resources. Under the strategic deployment of "maritime power", Shandong Province vigorously promotes the construction of "maritime granary", and the marine fishery economy of Shandong Province develops rapidly. In the northern part of Shandong Province, the growth rate of marine fishery GDP of Liaoning Province, Tianjin province and Hebei Province is slow, and its proportion in the whole country is decreasing year by year. The development of marine transportation industry accounts for a large proportion in Tianjin, and the marine fishery is not paid much attention to. The marine fishery economy of Liaoning Province is affected by the slow economic development of the three eastern provinces. In the south wing region, the Yangtze River Delta has developed manufacturing industry and financial industry, which has occupied the space for marine fishery economic development. Fujian Province has rich fishery resources, and its close cooperation with ASEAN countries in marine fisheries has gradually become the second core of China's marine fisheries.

The difference between marine fishery economy first narrowed and then expanded, and the development state developed from imbalance to balance imbalance. The economic performance of marine fishery is obviously concentrated. The level of marine fishery science and technology, marine fishery resources and marine fishery modernization level have a significant impact on marine fishery economy. In the 1980s, the rapid development of marine fisheries, marine fisheries mainly offshore aquaculture and primary processing, the total economic volume of marine fisheries has been greatly improved. The sustained low-level development of marine fisheries has resulted in serious homogenization competition, serious structural supply contradiction and slow economic development of marine fisheries. With more and more attention paid to the development of the ocean, the marine industry has developed rapidly, marine energy and marine high-tech industries have developed rapidly, occupying the

development space of marine fisheries.

6. Suggestions and Countermeasures

6.1. We should develop Offshore Fisheries and Control the Fishing Quantity and Aquaculture Area in the Coastal Waters

Due to excessive fishing, the offshore fishery resources are facing serious decline and the ecological structure is destroyed. In order to protect the offshore fishery resources, the State implements a regular fishing ban system. Secondly, the high-density investment of fishery culture results in the serious pollution of the coastal waters. At the same time, coastal engineering construction occupies a large number of marine fishery land. Therefore, the state began to extend from offshore fisheries to offshore fisheries. We should make full use of offshore waters to enrich fishery resources, implement preferential policies for offshore fisheries, give appropriate tax incentives and preferential policies to pelagic fishery enterprises, enhance the manufacturing capacity of pelagic vessels, build large-scale pelagic fishing vessels, and improve the deep-sea aquaculture and fishing capacity. At the same time, we should speed up the construction of offshore fishing bases, strengthen international cooperation and consultation, and protect the offshore fishing companies In order to promote the development of "blue granary", we should vigorously develop deep-sea aquaculture and pelagic fishing, and promote the spatial optimization of offshore marine fisheries, so as to promote the development of "blue granary", guarantee the national food and improve the quality of life of the people.

6.2. Developing Modern Marine Fishery Economy and Constructing Modern Marine Fishery Spatial Pattern

The traditional operation mode of marine fishery results in the unsustainable development of marine fishery, the depletion of offshore fishery resources and the weakness of fishery economic growth. It is necessary to realize the high-quality development of marine fishery, change the mode of development and develop modern marine fishery economy. From offshore fishery to open sea fishery, and then to marine fishery deep processing and leisure fishery, so as to improve the added value of fishery products. We will extend the marine fishery processing chain and develop from primary processing such as freezing and ice fresh to deep and fine processing such as marine biological medicine. Pay attention to scientific and technological innovation and train modern fishery practitioners. The development of leisure fishery, according to the characteristics of resource endowment, reasonable layout of leisure fishery, realize the integration of primary, secondary and tertiary industries of marine fishery. To construct the spatial structure layout of modern marine fishery. The advantages of marine ranching and marine ecological function are the basis of marine ecological planning. Shanghai develops high level marine fishery processing industry. Guangdong Province, Guangxi Province, Hainan Province and Fujian Province have made great efforts to develop offshore fishery and deep-sea aquaculture, strengthen fishery cooperation with ASEAN countries, develop deep processing, and create a growth pole of marine fishery economy in the future. Liaoning Province and Shandong Province in the Bohai Rim region have obvious marine advantages, developing famous, excellent and special products and extending the fishery industry product chain. Hebei Province and Tianjin city are located around Beijing, and the marine environment is relatively fragile, which is mainly protected and supplemented by development.

6.3. We should Promote Marine Fishery Agglomeration and Cultivate Marine Fishery Economic Growth Pole

We should create a blue economic growth engine, generate agglomeration effect through marine fishery agglomeration, promote the professional development of marine fishery, improve the level of scientific and technological innovation, cultivate high-quality and high-level fishery practitioners, develop deep and fine processing, improve the added value of marine fishery products, form a regional marine fishery growth pole, and drive the development of marine fishery in the surrounding areas through spatial spillover effect To realize the high quality development of marine fishery economy

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