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Research Article

Analysis on the Adjustment of Marine Economic Industrial Structure Based on the Least Square Regression Model

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In order to intuitively analyze and clearly understand the effect of industrial structure adjustment of the marine economy in recent years in China, modeling and empirical research on industrial structure adjustment of the marine economy are carried out. Three comparisons of marine economic industrial structure and per capita output value coefficient of the marine industry are selected as scientific measurement indexes, the ratio of regional entropy to the output value of marine scientific research management service industry is selected as the height analysis index, and the econometric model is constructed according to the influence of the scientificity and advancement of marine economic industrial structure on marine economic GDP. Based on the empirical analysis of the relevant economic data of China's marine industry from 2008 to 2018, the model variable stationarity test and least squares regression analysis showed that the fitting degree of the model was good and significant; with every 1% increase in the scientificity and height of marine economic industrial structure adjustment, the marine economy increased by 1.88% and 2.80%, respectively. The development of marine science and technology can promote the rise of the marine economy. According to the model, the adjustment strategy of the marine economy industrial structure is made to further promote the development of the marine economy.

1. Introduction

In recent years, the adjustment of marine economic industrial structure has led to the rapid growth of marine economic industrial output value [1]. Taking the marine economic industry along the Yellow Sea as an example, in the 1980s, the total output value of the marine economic industry along the Yellow Sea coast was about 6.5 billion, which rose rapidly to about 89 billion in the mid-1990s and reached more than 117 billion by the end of the 1990s, accounting for 32% of the total output value of China's marine economic industry [2]. At the beginning of the 21st century, the output value of the marine economic industry along the Yellow Sea rose to nearly 130 billion, accounting for 31% of the total output value of the national marine economy industry [3]. During the same period, the output value of the fishery, salt, marine transportation, and oil and gas in the region accounted for 39.6%, 74.0%, 23.3%, and 18.9% of the national total output value, respectively. In order to intuitively analyze and clearly understand the effect of China's marine economic industrial structure adjustment in recent years, the modeling and empirical research of marine economic industrial structure adjustment are carried out.

Scholars Wang and Zhai analyzed the adjustment of marine industrial structure, spatial spillover, and coastal economic growth [4] and obtained that coastal economic growth and marine industrial structure adjustment have obvious spatial dependence and marine industrial adjustment can promote the development of the marine economy; scholars Ning and Song have studied marine scientific and technological innovation and the dynamic relationship between marine total factor productivity and marine economic development [5] and obtained that marine economic development has an important impact on marine total factor productivity, so as to promote marine economic development. Strengthening the self enhancement mechanism can promote the promotion effect between marine total factor

productivity and scientific and technological innovation and enhance the development of the marine economy. Scholars Di and others studied the spatiotemporal coordination mode of marine economic development under the background of high-quality growth through the average model of spatiotemporal coordination degree based on the empirical results of prefecture level cities around the Bohai Sea [6]. They found that the economic system, ecosystem, and comprehensive system of the marine economy showed an alternating upward trend of small-scale concentration and dispersion, and the spatiotemporal clustering area of coordination degree had both spatial differentiation and overlap. However, the above-given three methods only analyze the influencing factors of the development of marine economic industry and do not consider the impact of the upgrading of marine economic industrial structure, so the analysis results have certain limitations.

Based on the above-described research, this paper constructs the regression model of industrial structure adjustment of the marine economy based on the least square method from the two aspects of scientific measurement indicators and high analysis indicators and makes an empirical study. The stationarity test of the model is carried out to verify the effectiveness of the model. Through the research of this paper, it is helpful to intuitively analyze and clearly understand the effect of industrial structure adjustment of the marine economy. At the same time, it can provide a basis for the industrial structure adjustment scheme of the marine economy.

2. Literature Review

China's economy is in a critical period of transformation from a traditional land economy to a marine economy. China is rich in marine resources and faces important development opportunities and challenges. The adjustment of marine economic industrial structure is of great significance to promote the development of China's marine economy. Li expounds the relevant theories of the linkage mechanism of marine and land industries, then analyzes the evolution and characteristics of Liaoning marine industry and land industry, measures the correlation between Liaoning marine and land industries through the grey correlation index, explores the corresponding relationship and correlation degree between marine and land industries, and finally puts forward countermeasures and suggestions from the aspects of extending the marine and land industrial chain, developing and utilizing the coastal zone, and enhancing the ability of scientific and technological innovation [7]. Xiaodan and Wu put forward the concept of an ecological industry network, analyzed four ecological industry levels of Poyang Lake Ecological Economic Zone: point, slice, line, and surface, analyzed the three-dimensional ecological industry network structure according to the characteristics of each network level, expounded the applicability of three different evolution paths of point slice surface, point line surface, and point surface, introduced the ecological industry network model into the path of ecological industry development of Poyang Lake Ecological Economic Zone, and identified four modes of eco-industrial network in the region to improve the ability of enterprises in the region to coordinate economic and environmental management; at the same time, based on the network structure and mode of ecological industry, this paper puts forward corresponding countermeasures and suggestions to enrich the construction content of ecological industry development in the region [8]. Jiaxin et al. measured the adjustment of China's marine industrial structure from the perspective of "two modernizations" and used Eviews 8.0 software to test the stability, cointegration, and least square regression between the "two modernizations" of China's marine industrial structure and marine economic growth from 2005 to 2015. According to the cointegration equation, every 1% increase in the rationalization and upgrading of marine industrial structure will drive the marine economy to rise by 1.87% and 2.96%, respectively; from the directionality of the regression coefficient of the least square method, it can be seen that the rationalization and upgrading of the marine industrial structure will promote the growth of the marine economy [9]. From the above-mentioned analysis, it can be seen that reasonable adjustment of marine economic industrial institutions is conducive to the further development of the marine economy. In addition to the above-given research, scholars Du et al. analyzed the relationship between marine industrial structure upgrading, marine scientific and technological innovation, and marine economic growth based on the provincial data panel vector autoregressive (pvar) model [10]. Scholars Ning et al. analyzed the marine industrial structure and employment effect based on the dynamic panel GMM estimation model [11].

3. Methods

The least squares regression model has the advantage of a simple solution, so this paper puts forward the analysis of industrial structure adjustment of the marine economy based on the least squares regression model. It is expected to provide data reference for making adjustment strategy of marine economy industry structure.

3.1. Modeling of Industrial Structure Adjustment of Marine Economy

3.1.1. Main Industrial Structure and Industrial Structure Adjustment of Marine Economy. The industrial structure of the marine economy mainly includes marine fishery, marine transportation, marine salt, marine oil and gas industry, and marine tourism. At present, the growth rate of the marine economic industry output value is higher than the overall development speed of the national economy, the development mode has changed from single project plane development to overall industry three-dimensional development, and the development scope gradually moves from coastal to shallow water.

(1) Marine Fisheries. As the first mock exam of marine economy, the development of marine fishery has changed from single mode to multimode and common development.

The backbone and main body of China's marine fishery development are state-owned fishery and mass fishery. Taking the Bohai Sea economic industry as an example, there are nearly 100000 fishing motor boats in this region and the labor force of mass fishery covers 170 towns and nearly 1500 fishing villages along the coast of the Bohai Sea. In the field of marine fishery in China, the Bohai Sea, the Yellow Sea, the East China Sea, and the ocean and other sea areas account for 30%, 50%, 10%, and 10%, respectively.

(2) Marine Transportation. China's coastline is the fourth largest in the world, reaching more than 32000 square kilometers. The rich marine resources provide the basic conditions for the development of the marine transportation industry. The development of China's marine transportation industry has a long history. Since Zheng He's voyages to the West in the Ming Dynasty, China's marine transportation industry has radiated to the south of Asia and involved some regions such as Africa and Europe. After that, due to the relevant policies of the government, the development of China's marine transportation industry once declined. After the founding of new China, affected by the reform and opening up policy, China's marine transportation industry has developed rapidly. In 2014, the overall throughput of China's ports increased by more than 5% compared with the previous year and the total trade volume of the marine transportation industry reached 4159 billion US dollars.

(3) Marine Salt Industry. The marine salt industry is also a traditional marine industry in China and plays an important role in the industrial structure of the marine economy, mainly including the production activities of sea salt drying, underground brine salt drying, and salt product processing [12]. The marine salt industry is the main source of salt production in China. Liaoning, Shandong, Jiangsu, Changlu, and other coastal areas are the main production areas of sea salt in China, and the annual output accounts for more than three-quarters of the total output.

(4) Offshore Oil and Gas Industry. Bohai oilfield is the earliest offshore oil field in China. Shengli, North China, and Liaoning oil and gas fields in the Bohai Sea area are connected with Bohai offshore oil fields and develop a lot of oil and gas resources. At present, the geological reserves of Jinzhou 9–3 oil and gas field, 20–2 oil and gas field, and Penglai 19–3 oil and gas field in Laizhou Bay in the Liaodong Peninsula are as high as 200 million tons, and the reserves of Bozhong 28–1 and 34–2 oil and gas fields in Central Bohai Sea are also high. At the end of the 20th century, the output of crude oil in the Bohai Sea was nearly 60 million tons, and it reached more than 6.5 million tons in the early 21st century, accounting for 30.5% and 31% of the national crude oil production, respectively. This shows that the offshore oil and gas industry in the Bohai sea has stepped from exploration to development.

(5) Marine Tourism. Marine tourism is one of the main modes of tourism development in China. For example, the Bohai Sea has famous coastal tourism cities such as Dalian, Qingdao, and Weihai, the Yellow Sea has coastal tourism cities such as Nantong, Lianyungang, and Rizhao, and the East China Sea includes famous tourist cities such as Shanghai, Xiamen, and Quanzhou. The development of the national economy drives the rapid development of tourism. At present, the infrastructure of coastal tourism cities is gradually improved, and the comprehensive tourism reception capacity is gradually improved.

3.1.2. Evaluation Index of Marine Economic Industrial Structure Analysis. In the analysis of marine industrial structure, this paper considers the availability of relevant data of the marine economic industry [13] and analyzes the scientificity and advancement of China's marine economic industrial structure adjustment from the aspects of three marine economic industrial structure comparisons. The main data sources used in the analysis are "China Marine Statistical Yearbook" and "China Marine Economic Statistics Bulletin."

3.1.3. Scientific Industrial Structure of Marine Economy. The scientificity of marine economic industrial structure is used to describe the enhancement of coordination ability and the improvement of correlation level among marine economic industries. When measuring the scientificity of marine economic industrial structure, three comparisons of marine economic industrial structure and per capita output value coefficient of the marine industry can be selected as measurement indexes.

(1) Comparison of Three Marine Economic Industrial Structures. The relative coordination of three marine economic industrial status is the basic requirement for the scientificity of marine industrial economic structure. The international comparison method is selected to measure the scientificity of marine economic industrial institutions, and the standard of Chenery is to standardize the industrial structure. Under the condition of the same GNP, the value of marine economic industrial structure and standard industrial structure of a country or region is compared. When the comparison results show that there is no deviation or the deviation is small, it is scientific to define the marine economic industrial structure of the country or region. On the contrary, it is not scientific to define the marine economic industrial structure of the country or region when the comparison results show that the deviation is large. As a part of the economic industrial structure, the marine economic industry has the characteristics of strong dependence on capital and technology [14]. Therefore, the development and adjustment of marine economic industrial structure is obviously different from that of ordinary economic industrial structure.

(2) Coefficient of Per Capita Output Value of Marine Economy Industry. The scientificity of marine economic industrial structure of a country or region requires that the technical level of marine economic industry in different regions should be kept in a coordinated state for a long time, that is to say, the numerical distribution of comparative

labor productivity of marine economic industries in different regions has the characteristics of concentration and hierarchy. The coefficient of per capita output value C is used to reflect the labor productivity of an industry in a region compared with the same industry in China. The calculation formula is as follows:

$$C = \frac{C_q}{C_g}. \tag{1}$$

Here, C_q and C_g, respectively, describe the per capita output value of an industry in a certain region and the per capita output value of similar industries in China.

Formula (1) is used to calculate the coefficient of per capita output value of the marine economy industry. When the calculation result is greater than 1, it means that the labor productivity of the research industry in the research area is higher than the national average level and it belongs to the specialized department of the research area. When the calculation result is less than 1, it means that the labor productivity of the research industry in the research area is lower than the national average level.

For a certain sea area, the per capita output value coefficients of marine economic industries in different provinces and cities in the sea area are compared, so as to measure the coordination of the technical level of marine economic industries among different provinces and cities in the sea area, and whether it meets the scientific requirements of the economic and industrial structure in the sea area.

3.1.4. Upgrading of Industrial Structure of Marine Economy

(1) Location Entropy. The industrial structure of the marine economy evolves in accordance with the dominant position of the three marine industries, which is the basic requirement for the upgrading of the industrial structure of the marine economy [15]. The development status of three marine industries can be judged by location entropy. The regional concentration index, i.e., location entropy, is used to describe the production. It can judge the relative specialization degree of different industrial sectors in different regions. Output value is a commonly used measurement index in location entropy. Therefore, location entropy, which uses output value as an indicator, can also be defined as output value concentration. The following formula shows the calculation formula of location entropy output value:

$$\begin{aligned} S &= \frac{f/F}{w/W} \\ &= \frac{f/w}{F/W}. \end{aligned} \tag{2}$$

Here, f and F describe the output value and GDP of an industry in the region and w and W, respectively, describe the output value and national GDP of the industry in China. In the process of determining the location entropy of marine economic industrial institutions, due to the fact that there are marine economic structure industries in 11 provinces and cities in China without considering Hong Kong, Macao, and Taiwan, the W value in formula (2) can be converted into China's coastal regional GDP. The result of the location entropy calculation is greater than 1, which means that the industrial development intensity of this region is higher than the average level of similar industries in China; on the contrary, it shows that the industrial development intensity in this region is low.

(2) Proportion of Output Value of Marine Scientific Research, Education, and Management Service Industry. In different periods, the ratio of high-tech industry in all industries of a country or a region can describe the level of the industrial structure of the marine economy. The higher the ratio is, the higher the industrial structure of the marine economy is. The development of the high-tech industry can be reflected by the level of marine scientific research and education management service industry. Comparing the proportion of marine scientific research and management service output value in the marine GDP of the region with the economic development level can describe the high level of the regional marine economic industrial structure.

4. Construction of the Industrial Structure Adjustment Model of Marine Economy

4.1. Model Construction. According to the view of structuralism, the transfer of production factor resources from departments with low utilization rate to departments with high utilization rate can promote economic upgrading [16]. At the same time, according to Solow's surplus theory, the improvement of the scientific and technological level also has a positive impact on economic promotion. Therefore, the scientific and technological project factors of marine scientific research institutions reflecting the level of marine science and technology can be used as auxiliary explanatory variables of the econometric model to improve the rationality of the measurement model. Thus, the econometric model of the impact of marine economic industrial structure adjustment on marine economic growth is obtained as follows:

$$\ln P_t = c_t + \alpha \ln R_t + \beta \ln H_t + \delta \ln T_t + y_t. \tag{3}$$

Here, P and t describe the growth and time of marine economy, R and H describe the scientificity and advancement of marine economic industrial structure, T and y describe scientific and technological projects and random interference items of marine scientific research institutions, ln describes logarithmic sequence, and c is constant.

4.2. Description of Variables and Data. In the econometric model shown in formula (3), there are four main variables: P (gross marine product), R (scientific nature of marine economic industrial institutions), H (upgrading of marine economic industrial structure), and T (scientific and technological projects of marine scientific research institutions). In the research process, the relevant data from 2008 to 2018 are selected as samples.

5. Results

5.1. Stability Test of Variables. In the process of empirical analysis, some economic variables are unstable, which easily leads to pseudo-regression. In order to avoid the phenomenon of pseudo-regression, the ADF unit root test method can be selected to test the stationarity of the model variables before using the model for regression analysis. Before testing the stationarity of variables, logarithm processing can be applied to the initial economic data to prevent heteroscedasticity in the initial economic data. The unit root test results of model variable ADF are shown in Table 1.

From the analysis of Table 1, the initial sequence of the four main variables in the model is shown as an unstable state. Therefore, the initial economic data are treated by differential processing. Thus, the four main variables are shown to be second-order stationary at the 5% significance level.

5.2. The Impact of Marine Economic Industrial Structure Adjustment on Marine Economic Growth. The least square regression analysis is used to analyze the influence of industrial structure adjustment of the marine economy on marine economic growth in China. The results are shown in Table 2.

From the analysis of Table 2, the fitting degree of the model in this paper is good, which shows that the model is significant. Therefore, the regression model of the least square method is determined as follows:

$$\ln P_t = 2.9763 + 1.8810 \ln R_t + 2.7979 \ln H_t + 0.7690 \ln T_t + u_t. \quad (4)$$

It can be seen from Table 2 that the coefficients of constants and auxiliary variables in the model passed the significance test, while the scientific and advanced coefficients did not pass the significance test. Every 1% increase of independent variables ln R, ln H, and ln T will lead to the increase of dependent variable ln P by 1.88%, 2.80%, and 0.77%, respectively. Based on the regression coefficient, the scientific and advanced marine economic industrial structure can enhance the marine economic growth more than its own proportion and the development of marine science and technology can also promote the rise of the marine economy.

Table 1: ADF unit root test results of model variables.

Variable	lnP	ddlnP	lnR	ddlnR
ADF value	7.718	−4.271	−0.766	−3.391
1% threshold	−2.927	−4.693	−2.927	−4.693
5% threshold	−2.093	−3.431	−20.93	−3.431
10% threshold	−1.712	−2.912	−1.712	−2.912
Is it stable	NO	YES	NO	YES
Variable	lnH	ddlnH	lnT	ddlnT
ADF value	1.771	−4.393	2.947	−5.366
1% threshold	−2.927	−4.693	−2.927	−6.403
5% threshold	−2.093	−3.431	−20.93	−3.431
Variable	−1.712	−2.912	−1.712	−3.812
ADF value	NO	YES	NO	YES

Data source: 2008–2018 China Ocean Statistical Yearbook.

Table 2: Analysis results.

Variable	C	lnR	lnH	lnT
Coefficient	2.9763	1.8810	2.7979	0.7690
Standard error	0.6523	2.6395	2.1448	0.0783
T value	4.6349	0.7225	1.4322	9.9192
P value	0.0024*	0.4999	0.2391	0.0000*

Note. *Rejection of the original hypothesis at the 5% significance level.

6. Discussion

The traditional economic growth theory holds that when the economy is in equilibrium, economic growth is subject to capital, labor, and technology and the industrial structure has no impact on the efficiency of economic growth. Due to the interference of government intervention, market obstacles, and institutional factors, the market is difficult to achieve equilibrium. Therefore, this paper puts forward the analysis of industrial structure adjustment of the marine economy based on the least square regression model, in order to provide some help for the development of the marine industry in the future.

Firstly, this paper summarizes the main structure of the marine economic industry and the industries of industrial structure adjustment, including marine fishery, marine transportation, marine salt industry, marine oil and gas industry, and marine tourism. Analyzing the marine economic industry from many aspects will help to solve the singleness of the analysis results of industrial structure adjustment with a single industry as the starting point in the existing research.

Secondly, it analyzes the scientificity and height of China's marine economic industrial structure adjustment from the three comparisons of marine economic industrial structure. Among them, the scientific aspect is compared from the industrial structure of three marine economies and the per capita output value coefficient of the marine economy industry and the high degree is analyzed from the two aspects of location entropy and the output value proportion of marine scientific research, education, and management service industry.

Finally, based on the least square method, this paper constructs the regression analysis model of industrial structure adjustment of the marine economy and makes an empirical analysis by using the time series data from 2008 to 2018. According to the results of empirical analysis, the following conclusions are drawn: the scientificity and upgrading of China's marine industrial structure has a positive effect on China's marine economy. According to the empirical analysis results, the scientific and advanced marine industrial structure is conducive to the improvement of marine economic growth efficiency; that is, the scientific and advanced marine industrial structure has a positive effect on China's marine economy.

7. Conclusion

This paper constructs an econometric model from the scientific and advanced aspects of the industrial structure of the

marine economy, analyzes the impact of the industrial structure adjustment of the marine economy on the increase of the marine economy, and makes an empirical analysis based on the time series data from 2008 to 2018. The results show that the scientific and advanced industrial structure of the marine economy has a positive effect on marine economic growth.

However, this study failed to pass the significance test. The reason is that the relevant data volume does not meet the sample size required for multiple regression analysis, resulting in insignificant regression results. It may also be that the scientific and highly oriented adjustment of marine economic industrial structure in the time series data used in the process of model analysis is not obvious, resulting in insignificant regression results.

Therefore, the next research will focus on the significance test to further improve the scientificity of the model.

Data Availability

The data used to support the study are included in the paper.

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Conflicts of Interest

The author declares that there are no conflicts of interest.

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