Volume 18 Issue 6
Originally issued as E2



Global Journal of HUMAN-SOCIAL SCIENCE: E
Economics
Volume 18 Issue 2 Version 1.0 Year 2018
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-460x & Print ISSN: 0975-587X

Research on Coordination Degree between Regional Marine Scientific and Technological Innovation and Blue Economic Development

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GJHSS-E Classification: FOR Code: 140202



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Research on Coordination Degree between Regional Marine Scientific and Technological Innovation and Blue Economic Development

Wang Dongmei [α], Shi Hongbo [σ] & Wang Miyao [ρ]

Abstract- There is a strong interactive coordination relationship between scientific and technological innovation and economic development and the coordinated development between the two has become a key factor in the healthy and sustainable development of regional economy. This paper constructs the index system of regional marine scientific and technological innovation capability and blue economic development level, and takes the data of blue economic zone of Shandong peninsula for 2005-2014 years as the sample to establish the coordination degree model. The results show that the overall trend of coordination degree between marine scientific and technological innovation and blue economic development in Shandong blue economic zone is increasing year by year. The coordination degree between regional marine scientific and technological innovation and blue economic development depends on the joint efforts of marine scientific and technological innovation and blue economic development, and the lagging development of either side will hinder the promotion of coordination degree.

Keywords: coordination degree; marine scientific and technological innovation; blue economic development; blue economic zone of shandong peninsula.

I. Introduction

Practices of the domestic and international economic and social development show that, there is a strong coordination relationship between scientific and technological innovation and economic development, scientific and technological innovation has become the leading force in the economic development of a country or region, economic development brings capital nurture scientific and technological innovation. As the blue economy based on the concept of sustainable development is increasing in the national strategic system, the coordinated development between marine scientific and technological innovation and the blue economy has also attracted widespread attention.

With the rapid development of marine economy in the world, the status of marine development and utilization in the world's development strategy has gradually improved. Since 1960s, the tide of marine development has risen in the world, and the marine economy has become an important component of the global coastal countries or regional economic system. The rapid development of marine economy and the constant rising of marine development and utilization level cannot do without progress and innovation in the field of marine science and technology, the level of marine economic development in a country or region basically depends on the level of marine scientific and technological innovation capability. Marine scientific and technological innovation supports and guides the transformation and upgrading of traditional marine industries, and promotes the optimization and development of the emerging strategic marine industry. It plays a powerful dynamic role in the development of regional marine economy.

However, in the joy of the achievements in the rapid development of marine economy, the great damage of the global marine ecological environment cannot be ignore dof the same. In order to protect marine ecology and realize rational utilization of resources, people advocate the development of blue economy. Different from the pure economic growth, the blue economy needs more scientific and technological innovation to achieve the coordination and sustainability of resources and environment development and utilization in economic development, the status of scientific and technological innovation in the blue economic development are more prominent. Blue economic development needs to rely on marine scientific and technological innovation, and establish a close and harmonious development relationship with marine scientific and technological innovation, and achieve a positive interaction with marine science and technology.

Shandong province is a big marine economic province in China. It also has great advantages in marine scientific and technological innovation, becoming a strong marine province. Shandong Peninsula marine economic development has a long history. Many ports, perfect infrastructure, with strong marine scientific research strength and professional marine talents; it plays a very important role in the overall pattern of the development of China's marine economy. Although the Shandong Peninsula has a dominant position in the development of the blue economy and marine scientific and technological innovation, this does not mean that the two have formed a good coordinated development relationship. In the

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process of speeding up the construction of Blue Economic Zone of Shandong Peninsula and realizing the transformation of Shandong province into a strong marine province, measuring the coordination degree between the marine scientific and technological innovation and development of blue economy has great significance for rationally evaluating the construction of Blue Economic Zone of Shandong Peninsula and promoting the healthy and sustainable development of the blue economy.

II. Literature Review

The related literatures at home and abroad mainly focus on the interactive coordination relationship between scientific and technological progress and economic development, as well as the blue economy. Now briefly summarized as follows:

a) Research on the relationship between scientific and technological innovation and economic development

Foreign scholars' research on the relationship between technological innovation and economic development is mainly embodied in the study of the relationship between technological progress, technological innovation and economic growth. Many scholars have discussed the key role of technological progress in promoting sustained economic growth. Adam Smith (Smith, 1776) pointed out that the accumulation of a nation's wealth depended mainly on technological progress. He pointed out that scientific and technological progress was one of the main reasons for economic growth [1]. The growth model put forward by Thoreau (Solow, 1956) reflects the role of technological progress, the estimation of the rate that technological progress contributed on economic growth was as high as 90%, and put forward the main factor to promote economic growth is technological progress, the second is the capital accumulation [2]. This is the first time that technological progress has been introduced into the economic system independently. Since then, scholars have begun to add variables to the equation to better distinguish the role of science and technology [3]. Although the traditional theory that Solow represented admitted the important role of technological progress, he placed the elements of technological progress into the external variables, and thought that technological progress was outside the economic system. In addition, many scholars have demonstrated the important assertion that technological progress plays a decisive role in promoting economic growth from a variety of perspectives (A. Antoci, 2013; T. Nicholas, 2014; M. Adak, 2015) [4-7].

With the increasingly close relationship between scientific and technological innovation and economic development, more and more scholars in China have studied the coordinated development relationship between the two. Yang Wu (2016) established a coupling model of the coordinated development of 1991-2012 Chinese technological innovation and economic development system, and found that achieving good coordination between technological innovation and economic development is an important condition for the successful implementation of China's innovation driven strategy [8]. Based on system collaboration theory, Zhao Min (2017) constructed the composite system of R & D investment, scientific and technological innovation and economic factors in China, and found under the condition of higher in the overall system coordination degree; R&D investment can promote the development of scientific and technological innovation and economic [9].

In recent years, with the development of marine economy, many domestic scholars begin to shift their research attention to the relationship between scientific and technological innovation and marine economic development, focusing on the role of scientific and technological innovation in marine economy. By establishing the coordination degree model, Ma Renfeng (2017) evaluated the coordinated development in the Yangtze River Delta region in 2006-2013 of China, put forward the development path of optimizing marine science and technology policy, integrating technology resources to speed up marine regional construction [10].

b) Blue Economy Research

Blue economy, as a new economic development theory, has been the focus of discussion in the industry and academic circles since it was first introduced in twentieth Century. The concept of "blue economy" was first proposed at the forum on the theme of the blue economy held in Canada in 1999 [11]. At this forum, the participants focused on the important role played by the blue economy in the sustainable development and utilization of the St. Lawrence estuary. Since then, in the "blue economy" hearing that held in 2009 in America and the introduction to the American marine and coastal economic situation (2009), the United States explained the specific meaning of the blue economy, and emphasized the important position that marine economic in the national development strategy system [12-14]. This was the first time that the concept of the blue economy appeared in government documents.

Since the blue economy was put forward, its connotation has not been clearly defined. Early scholars thought that the concept of "blue economy" and "marine economy" could be replaced by each other, and their connotations were not different. They believed that the blue economy included the related production activities of marine exploitation and utilization. Later, different opinions came into being, which thought that the scope and connotation of the blue economy should be different from the marine economy and larger than

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that of the marine economy. Sun Jiting (2011) thought that China's current blue economy formed in the practice mainly refers to the economy with land and sea coordinated, common coupling development. And he put forward the concept of the blue economy should include marine water economy, coastal area and sea related economy [15]. The third view was that the blue economy was sustainable marine economy, and it was an economic development model combining marine economy and marine ecological protection. This is also the blue economic connotation that majority of scholars agree with. The International Ocean Institute president Bergnan (Behnam, 2012) thought that in the background of blue economy, human beings coexisted with the ocean, the development of human society cannot do without the sea, and the core of blue economy was harmonious coexistence of man and ocean [16-17]. Through systematically expounding the research of the blue economy by scholars from all over the world, Guangshun (2013) proposed that blue economy is on the premise of strengthening the ecological environment construction, a comprehensive of all marine economic activities to achieve rapid development and utilization of natural resources. [18].

In general, all over the world, scholars' research on the relationship between technological innovation and economic development mainly focus on the study of the promotion that scientific and technological innovation to economic development unilaterally, and less involved in science and technology support and nurtures the economy. The foreign study on scientific and technological innovation and economic development coordination relationship is less, domestic researches in this area are more abundant, but the study on the mechanism of coordinating role in scientific and technological innovation and economic development is still in a relatively weak state. The domestic empirical research in this field mainly uses the mathematical tool model to calculate the quantitative relationship between science and technology and economy coordination, but less deeply discusses the uncoordinated reasons and the factors that affect the coordination degree. In recent years, some domestic literatures have begun to discuss the coordination relationship between scientific and technological innovation and economic development in the marine field, but still focus on the one-way role of scientific and technological innovation in the development of marine economy. The research status at home and abroad shows that the coordination problem between scientific and technological innovation and economic development has not attracted enough attention from scholars.

At present, the domestic and foreign literature about the blue economy problem is still more stay in the theoretical research stage, the analysis is relatively simple. The conception of blue economy has not formed a conclusion yet, and the evaluation index system and evaluation method of the blue economic development level need to be further expanded and improved.

To sum up, in the field of marine scientific and technological innovation and the coordinated development of the blue economy, scholars at home and abroad have done little research on this aspect, and lack of specialized research. Therefore, in the current age, blue economy leads the rapid development of regional economy, marine scientific and technological innovation leads blue economic development, the study of the coordination degree between the two is particularly important. In this case, this paper uses the Blue Economic Zone of Shandong Peninsula as an example, study the coordination degree problems of marine scientific and technological innovation and development of the blue economy, explore Peninsula coordination degree development and changes from the empirical view, in order to enrich the theoretical results of this filed and thus better guide practice activities.

III. Evaluation Index System and Model Construction

a) Establishment of evaluation index system

This paper constructs the index system of regional marine scientific and technological innovation capability and blue economic development level, and establishes the coordination degree model of the two, which lays the foundation for the after empirical research. This paper divides the index system of scientific and technological innovation capability into 3 first level indexes: marine science and technology foundation, science and technology input and output. Under is divided into 14 second level indexes, as shown in Table 1, and interpretations for each index.

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Table 1: Evaluation index system of regional marine scientific and technological innovation capability

Total index	First level index	Second level index
Regional marine scientific and technological innovation capability	Marine Science and Technology Foundation	Number of marine scientific research institutions (units)X_1
		Marine scientific research employees (person)X_2
		Marine Scientific and technological personnel (person)X_3
		Proportion of senior titles（%）X_4
	Marine Science and technology input	Marine scientific research regular expenses and income (10000 yuan)X_5
		Number of subjects of marine scientific research institutions (item)X_6
	Marine Science and technology output	Number of published papers about marine science and Technology (chapters)X_7
		Number of papers published in foreign countries（%）X_8
		Scientific and technical books (species)X_9
		Number of patent applications for marine scientific and technological inventions (pieces)X_{10}
		Number of authorized patents for marine scientific and technological inventions (pieces)X_{11}
		Number of invention patents per person (person)X_{12}
		Total number of invention patents (pieces)X_{13}
		Proportion of results to applications（%）X_{14}

(1) Basic index of marine science and technology the basic level of marine scientific and technological innovation is the prerequisite for marine research and development, reflecting the capability of a country or region to support marine science and technology research. The number of regional marine scientific research institutions reflects marine research and development infrastructure construction and other hardware conditions, the number of marine scientific research employees and marine scientific and technological personnel reflect the status of marine science and technology talents and other soft conditions for marine scientific and technological innovation. In addition, proportion of senior titles reflects the proportion of high-level and highly educated scientific and technical personnel.

(2) Marine Science and technology input index the input factors of marine science and technology mainly include the various funds involved in marine scientific and technological innovation activities. Marine scientific research regular expenses and income reflect the capital input of R&D of marine science and technology. In addition, the number of subjects of marine scientific research institutions can reflect the knowledge investment in marine science and technology, and it is also an important index of marine science and technology input.

(3) Marine Science and technology output index Marine science and technology output is the most direct embodiment of regional marine scientific and technological innovation capability. The output of marine scientific and technological achievements is reflected by the output of papers, the number of books, the total amount of patent inventions in marine science and technology, the amount of applications, the amount of authorization and the number of inventions patents per person. The proportion of papers published abroad reflects the impact of our papers on the international community. The proportion of results to applications reflects the technical achievements transformation capability.

From the five aspects of economic scale, economic structure, ecological environment, marine resources and regional economy, this paper constructs the index system of regional blue economic development level, shown in Table 2, and explains the indexes.

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Table 2: Evaluation index system of regional blue economic development level

Total index	First level index	Second level index
Regional blue economic development level	Economic scale	Regional marine GDP (billion yuan) Y_1
		Per capita regional marine GDP(10000 yuan / person) Y_2
		Sea area utilization efficiency (100 million yuan / square kilometer) Y_3
		Port international standard container throughput (10000 TEU) Y_4
		Passenger throughput of coastal ports (10000 passengers) Y_5
		Cargo throughput of coastal ports (10000 tons) Y_6
	Economic structure	Blue economy third industry proportion (%) Y_7
		Blue economy second industry proportion (%) Y_8
		Percentage of marine GDP in coastal areas (%) Y_9
		Marine industry location quotient Y_{10}
	Ecological environment	Total area of marine type reserve (sq km) Y_{11}
		The proportion of the sea area of the two types of standards over the whole sea area (%) Y_{12}
		Total discharge of industrial wastewater (10000 tons) Y_{13}
		Year completion of wastewater treatment projects (unit) Y_{14}
		Year completion of the control of solid wastes projects(unit) Y_{15}
		Occurrence frequency of red tide (times) Y_{16}
	Marine resources	Per capita water resources (cubic meter / person) Y_{17}
		Per capita output of marine mineral industry (ton / person) Y_{18}
		Per capita sea salt resource(ton / person) Y_{19}
		Output area of aquatic product per unit sea area (ton / HA) Y_{20}
	Regional economy	Number of persons engaged in sea employment (10000 persons) Y_{21}
		Gross Regional Product (100 million yuan) Y_{22}
		Regional Engel coefficient (%) Y_{23}
		Per capita regional income level (yuan) Y_{24}

(1) Economic scale index Regional marine GDP and per capita regional marine GDP reflects the scale of regional blue economic development. The Sea area utilization efficiency is used to reflect the economic output efficiency of the sea area, which is indicated by the ratio of regional marine GDP to that of the right area of unit sea area (that is, the sea area of the project approved by the government). Port international standard container throughput is the sum of the total number of containers imported and exported within a year in the main coastal ports of the region. The passenger throughput of coastal ports is the number of tourists entering and leaving ports through waterways in the region. The cargo throughput of the coastal ports is the weight of the goods loaded, unloaded and transported through waterways into and out of the port.

(2) Economic structure index the proportion of blue economy second industry and third industry can reflect the rationalized and advanced degree of the blue economy industrial structure. The Percentage of marine GDP in coastal areas reflects the contribution of marine economic development in regional economic development and the driving force of economic development. The marine industry location quotient reflects the degree of specialization of the blue economic industry in the region, which is showed by the Shandong's coastal region's marine output accounts for the proportion of the total marine output value of China's coastal areas, divided by the value of GDP in Shandong's coastal areas as the proportion of GDP.

(3) Ecological environment index the total area of marine type reserve and the proportion of sea areas of the two types of standards over the whole sea area reflect the efforts of local governments to protect marine ecological environment and governing effects. Year completion of wastewater treatment projects and year completion of the control of solid wastes projects reflect the governing situation of wastewater pollution and solid waste by local governments. The total discharge of industrial wastewater is a negative index, which is one of the main indexes of environmental statistics. The occurrence frequency of red tide belongs to negative index, which reflects the frequency of occurrence of marine disasters in the near coastal area.

(4) Marine resources index Per capita water resources is the ratio of total water resources to the number of population at the end of the year, reflecting the basic situation of water resources. Per capita output of marine mineral industry is the ratio of regional seabed mineral production to the total population at the end of the year, which reflects the basic situation of marine energy resources. Per capita sea salt resource is the

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ratio of sea salt production to the total population at the end of the year, reflecting the situation of sea salt resources. Output area of aquatic product per unit sea area reflects the output of aquatic products in the sea, which is showed by the ratio of the output of water products to the mariculture area.

(5) Regional economy index the number of persons engaged in sea employment refers to the amount of labor engaged in sea related activities and reflects the capability of the sea industry to absorb the labor force. Gross Regional Product is the most important index of the level of economic development in an area. The regional Engel coefficient reflects the affluence of living in a region, that is, the ratio of food expenditure in coastal areas to personal consumption expenditure. The per capita income level is expressed by the sum of the average annual household income of the urban residents in the region and that of the rural households.

Before measuring the coordination degree between marine scientific and technological innovation and the blue economic development, it is necessary to choose the appropriate evaluation method to obtain the standardized data and weights of indexes, and then establish the coordination degree model between the two.

b) Construction of coordination model

(1) Data standardization the raw data is processed by the deviation normalization (Min-max normalization) method. The positive correlation index can improve the development level or capability score, the greater the better; negative correlation index will reduce the score; the larger the value is, the greater the obstacle to the improvement of the score will be. Aimed at the positive correlation index and the negative correlation index, we use the formula (3-1) and the formula (3-2) to carry on the standardized processing:

$$Z_{ij} = \frac{X_{ij} - X_{\min}}{X_{\max} - X_{\min}} \tag{3-1}$$

$$Z_{ij} = \frac{X_{\max} - X_{ij}}{X_{\max} - X_{\min}} \tag{3-2}$$

In the formula, Z_{ij} is the value after normalization treatment to the range of [0, 1] value, X_{ij} is the value of the statistical indexes, X_{max} and X_{min} represent the maximum value and the minimum value of the same index. i for the number of the selected samples, the j for the number of indexes.

(2) Index weighting in this paper, the objective weight method is used to determine the weight of the index. The concrete calculation process is as the follow: First, calculate the mean variable mean p_j, see formula (3-3). See each evaluation index as a random variable, Z_{ij} is the standardized value, and the average value of each index is obtained.

$$p_j = \frac{1}{n}\sum_{i=1}^{n} z_{ij} \tag{3-3}$$

Second, calculate the mean square deviation of σ_j, see formula (3-4).

$$\sigma_j = \sqrt{\sum_{i=1}^{n}\left(z_{ij} - p_j\right)^2} \tag{3-4}$$

Third, get the index weight w_j, see formula (3-5).

$$w_j = \frac{\sigma_j}{\sum_{j=1}^{m}\sigma_j} \tag{3-5}$$

(3) Construction of coordination degree model Set the marine scientific and technological innovation capability index system indexes for $x_1, x_2, x_3, \ldots, x_m$, the various indexes under the blue economic development level index system for $y_1, y_2, y_3, \ldots, y_n$, then the two composite score:

$$u(x) = \sum_{i=1}^{m} a_i x_i \tag{3-6}$$

$$e(y) = \sum_{i=1}^{n} b_i y_i \tag{3-7}$$

In the formula, u(x) and e(y) respectively indicate the comprehensive scores of regional marine scientific and technological innovation capability and regional blue economic development level; a_i and b_i respectively indicate the weight of each index.

Then, the coordination coefficient between regional marine scientific and technological innovation capability and blue economic development level is calculated as follows:

$$C = \left\{ \frac{u(x)e(y)}{\left[\frac{u(x)+e(y)}{2}\right]^2} \right\}^k \tag{3-8}$$

In the formula, C is the coordination coefficient, and the value of C is in the [0, 1] range. K is the adjustment coefficient, k≥2.

The coordinated development degree (D), while measuring the coordination degree between regional marine scientific and technological innovation and regional blue economic development, embodies the overall synergy or contribution of the two. The calculation formula is as follows:

$$T = \alpha u(x) + \beta e(y) \tag{3-9}$$

$$D = \sqrt{CT} \tag{3-10}$$

In formula (3-9) and (3-10), D score for the coordinated development degree, T score for the regional marine scientific and technological innovation

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and blue economic development composite score index, to measure the whole benefit of the marine scientific and technological innovation and development of blue economy. α and β are undetermined weight coefficient, the contribution degree of marine scientific and technological innovation and blue economic development on the coordination degree are the same, so take α=0.5, β=0.5.

(4) Sample selection and data sources this paper chooses Blue Economic Zone of Shandong Peninsula as the research object, established data sample on the Peninsula Blue Economic Zone marine scientific and technological innovation capability and the blue economic development level index system of indexes from 2005 to 2014 a total of ten years of data sample. According to the administrative division of the statistical yearbook, the Peninsula Blue Economic Zone contains Qingdao, Yantai, Weihai, Weifang, Rizhao, Dongying and Wudi county and Zhanhua County of Binzhou. The related data of marine scientific and technological innovation mainly comes from the "Chinese Marine Statistical Yearbook", most data of the blue economic development comes from the "China Marine Statistical Yearbook", "Shandong Statistical Yearbook" and "Shandong Province Environment Bulletin", other data comes from Shandong statistical information network and other government statistics department websites. The entire index data collected in this paper is authoritative statistical data, and some data which cannot be directly obtained are obtained by processing and calculating. After obtaining the data, use Excel to sort, calculate with Excel and SPSS 20.

(5) Grade Classification of coordination degree in this paper, the coordinated development of regional marine scientific and technological innovation and blue economic development is divided into 5 major categories and 15 small categories, which are shown in table 3.

Table 3: Grade classification of regional marine scientific and technological innovation and blue economic development

D	Type	First level	Second level
0.8~1.0	Good coordinated development	u(x)>e(y)	Good coordinated development, blue economy lags behind
		u(x)=e(y)	Good coordinated development, marine scientific and technological innovation and blue economy synchronization
		u(x)<e(y)	Good coordinated development, marine scientific and technological innovation lags behind
0.6~0.8	Moderate coordinated development	u(x)>e(y)	Moderate coordinated development, blue economy lags behind
		u(x)=e(y)	Moderate coordinated development, marine scientific and technological innovation and blue economy synchronization
		u(x)<e(y)	Moderate coordinated development, marine scientific and technological innovation lags behind
0.4~0.6	Barely coordinated development	u(x)>e(y)	Reluctantly coordinated development, blue economy lags behind
		u(x)=e(y)	Reluctantly coordinated development, marine scientific and technological innovation and blue economy synchronization
		u(x)<e(y)	Reluctantly coordinated development, marine scientific and technological innovation lags behind
0.2~0.4	Moderately maladjusted	u(x)>e(y)	Moderate maladjusted, blue economy lags behind
		u(x)=e(y)	Moderate maladjusted, marine scientific and technological innovation and blue economy synchronization
		u(x)<e(y)	Moderately maladjusted, marine scientific and technological innovation lags behind
0~0.2	Severe dysregulation	u(x)>e(y)	Severe dysregulation, blue economy lags behind
		u(x)=e(y)	Severe dysregulation, marine scientific and technological innovation and blue economy synchronization
		u(x)<e(y)	Severe dysregulation, marine scientific and technological innovation lag

IV. An Empirical Study on the Coordination Degree between Regional Marine Scientific and Technological Innovation and Blue Economic Development

a) Coordination degree calculation between regional marine scientific and technological innovation and blue economic development

Firstly, the extreme value and mean value of each index are calculated by using SPSS 20 software. Standardization of data was carried out by using deviation normalization method. After calculating the weight of each index of regional marine scientific and technological innovation capability, according to formula (3-6), the score of marine scientific and technological innovation capability of Blue Economic Zone of Shandong Peninsula is calculated by u(x), and the calculation results are shown in table 4.

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Table 4: Marine scientific and technological innovation capability score of Blue Economic Zone of Shandong Peninsula

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
u(x)	0.1192	0.2367	0.2305	0.2859	0.4298	0.5116	0.5978	0.7185	0.8845	0.9317

Similarly, the economic development level of the Blue Economic Zone of Shandong Peninsula is calculated by e(y), and the results are shown in table 5.

Table 5: Economic development level of Blue Economic Zone of Shandong Peninsula

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
e(y)	0.1855	0.3736	0.4264	0.4801	0.4701	0.5156	0.6217	0.5873	0.5695	0.6670

The coordination degree is calculated according to formula (3-10). This paper holds the viewpoint that regional marine scientific and technological innovation capability is as important as the level of blue economic development. Therefore, we should take $\alpha = 0.5$, $\beta = 0.5$, and $k=2$. Then use formula (3-8) and (3-9) to calculate the coordination coefficient and the comprehensive evaluation index of regional marine scientific and technological innovation capability and blue economic development level, and according to the formula (3-10) to calculate the coordination degree, according to the table 3 to classify, the specific results are shown in table 6.

Table 6: 2005-2014 coordination degree of marine scientific and technological innovation and blue economy development in Shandong Blue Economic Zone

Year	u(x)	e(y)	C	T	D	Coordination type
2005	0.1192	0.1855	0.9076	0.1524	0.3719	Moderately maladjusted, marine scientific and technological innovation lags behind
2006	0.2367	0.3736	0.9020	0.3052	0.5246	Reluctantly coordinated development, marine scientific and technological innovation lags behind
2007	0.2305	0.4264	0.8300	0.3285	0.5221	Reluctantly coordinated development, marine scientific and technological innovation lags behind
2008	0.2859	0.4801	0.8756	0.3830	0.5791	Reluctantly coordinated development, marine scientific and technological innovation lags behind
2009	0.4298	0.4701	0.9960	0.4500	0.6694	Moderate coordinated development, marine scientific and technological innovation lags behind
2010	0.5116	0.5156	1.0000	0.5136	0.7167	Moderate coordinated development, marine scientific and technological innovation lags behind
2011	0.5978	0.6217	0.9992	0.6097	0.7806	Moderate coordinated development, marine scientific and technological innovation lags behind
2012	0.7185	0.5873	0.9799	0.6529	0.7998	Moderate coordinated development, blue economy lags behind
2013	0.8845	0.5695	0.9084	0.7270	0.8126	Good coordinated development, blue economy lags behind
2014	0.9317	0.6670	0.9459	0.7993	0.8695	Good coordinated development, blue economy lags behind

b) Result Analysis

According to the calculation results of table 6 and the coordination degree grade classification of table 3-3, this paper analyzes the coordination degree of marine scientific and technological innovation capability and the blue economic development in the Blue Economic Zone of Shandong Peninsula respectively according to the year. From Figure 1, first, on the whole, the scores of marine scientific and technological innovation capability and the coordination degree of marine scientific and technological innovation and blue economic development in Peninsula Blue Economic Zone always showed an increasing trend, the growth of marine scientific and technological innovation capability was rapid, and the scores of blue economic development level showed a zigzag growth, experienced three small amplitude decline. Regional marine scientific and technological innovation capability score increased from 0.1192 to 0.9317, an increase of 0.8125. Blue economic development level increased from 0.1855 to 0.667, an increase of 0.4815. Coordinated development degree increased from the initial 0.3719 to 0.8695, an increase of 0.4976.

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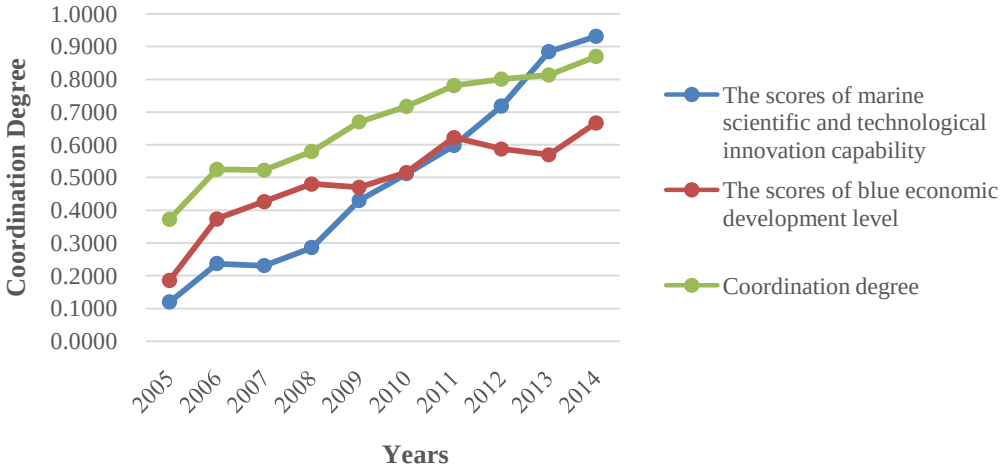

Figure 1: Coordination index chart of Blue Economic Zone of Shandong Peninsula in 2005-2014

Take 2011 as the boundary, it can be seen from Figure 1 that from 2005 to 2011, the development of marine scientific and technological innovation has always lagged behind the blue economic development level, the score of regional marine scientific and technological innovation capability in 2012 was 0.7185, which exceeded the score of blue economic development level, 0.5873,for the first time, and the coordination type transformed from marine scientific and technological innovation lags behind into blue economy lags behind. This is mainly because the establishment of the Blue Economic Zone of Shandong Peninsula in 2011 was formally proposed, marine scientific and technological innovation input increased significantly. During the period from 2005 to 2011, the income of research funding increased from 450 million yuan to 25 billion 460 million yuan, the number of subjects of marine scientific research institutions increased from 836 up to 1477. In addition, marine scientific research and innovation output increased significantly, the number of marine science and technology invention patent increased from 36 to 142, the proportion of the number of papers published in foreign countries increased from 13.9% to 30.2%.Thetransformation rate of results to applications of was increased by 2.17%. After the establishment of the Blue Economic Zone from 2011 to 2014, marine scientific and technological innovation continues to maintain rapid growth, while the blue economic development level declined for two consecutive years in 2012 and 2013.The main reason is the first economic growth still relies on consumption of marine natural resources to drive too much, while ignoring the protection of the marine ecological environment. In recent years, with the rise of the conception of sustainable development, economic development pays more and more attention to the ecological harmony and sustainable development, the blue economic development level gradually rises.

Overall, the marine scientific and technological innovation capability and the blue economic development level of the peninsula Blue Economic Zone continue to increase, the coordination degree of the two are increasing year by year. The coordination type transformed from the initial moderately maladjusted, marine scientific and technological innovation lags behind into good coordinated development, blue economy lags behind.

To sum up, the coordination degree of regional marine scientific and technological innovation and blue economic development depends on the common development of both, and the lagging development of either side will hinder the improvement of coordination. According to the changes of coordination type from 2005 to 2014 of, the peninsula Blue Economic Zone marine scientific and technological innovation capability and blue economic development coordination degree change is divided into three stages, and analyzed respectively.

(1) The first stage (2005 - 2008)

It can be seen from Figure 2, from 2005 to 2008, the score of the blue economic development level of the peninsula Blue Economic Zone has always been on the rise, from 0.1855 in 2005 to 0.4801 in 2008, an increase of 0.2946. The score of marine scientific and technological innovation increased from 0.1192 in 2005 to0.2859in 2008, an increase of 0.1667. The coordinated development degree of the two has increased from 0.3719 to 0.5791, with an increase of 0.2072. Marine scientific and technological innovation capability and blue economic development level increased significantly from 2005 to 2006, the main reason is the number of marine scientific research institutions and employees increased, and the funds income of scientific research institutions and the output of scientific research achievements have significant growth. The score of marine scientific and technological innovation capability

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declined slightly in 2007, the main reason was on the scientific output, due to the decrease in the amount of scientific and technological publications and the total number of patented inventions. Since then, from 2007 to 2008, marine scientific and technological innovation and blue economic development continued to achieve small growth.

In 2005, the coordination type of the marine scientific and technological innovation and the blue economic development in the peninsula Blue Economic Zone was moderately maladjusted, marine scientific and technological innovation lags behind. The coordination degree increased from 0.3719 to 0.5246 in 2006, the coordination type of it was reluctantly coordinated development, and marine scientific and technological innovation lags behind. From then on to 2008, it has kept this type. The development of marine scientific and technological innovation capability has lagged behind, and the output rate of marine science and technology investment and scientific research innovation achievements was low, which has not played a significant role in promoting the blue economic development.

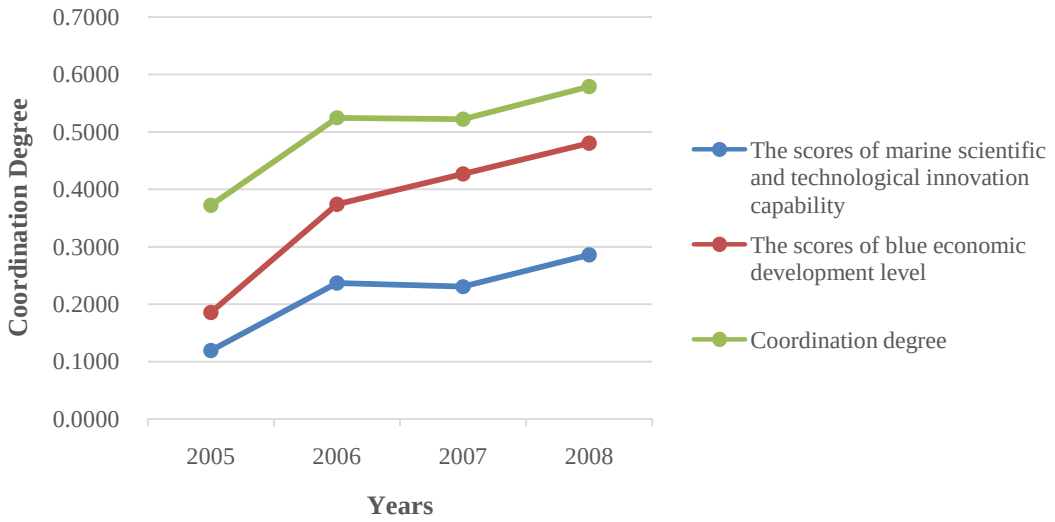

Figure 2: Coordination index chart of Blue Economic Zone of Shandong Peninsula in 2005-2008

(2) The second stage (2008 to 2012)

From 2008 to 2012, see Figure 3, marine scientific and technological innovation capability of the Peninsula Blue Economic Zone showed a substantial growth, an increase from 0.2859 to 0.7185, an increase of 0.4326, and the score of blue economic development level from 0.4801 in 2008 to0.5873 in 2012, the growth rate was 0.1072, and in 2009 and 2012 went through two smaller decline, a decline of 0.01 and 0.0344. Marine scientific and technological innovation capability was growing rapidly, mainly because of the number of technical staff, the input of marine science and technology and the output of scientific achievement were significantly increased, and there was a fast growth in the funds income of scientific research institutions and the total number of paper output and invention patents. The score of blue economic development level decreased in 2009, the main reason is the index data in the ecological environment, the number of year completion of wastewater treatment projects and the control of solid wastes projects has decreased, and then the number of red tide increased that year. Then in 2012the blue economic development level slightly reduced once again, the main reason is that the sea use efficiency decreased significantly in 2012, and in the index of marine resources, per capita water resources and per capita sea salt resources were lower than that in 2011.

In 2008, the coordination type of marine scientific and technological innovation and blue economic development in Peninsula Blue Economic Zone is reluctantly coordinated development; marine scientific and technological innovation lags behind.

Since the beginning of 2009, the coordination type transformed to moderate coordinated development, marine scientific and technological innovation lags behind. Then to 2012,the coordination type has been maintained in the moderate coordinated development, coordination degree increased from 0.5791 in 2008 to 0.7998, the growth rate was 0.2207. It is worth noting that, in 2012, the score of marine scientific and technological innovation capability, which was 0.7185, exceeded the score of blue economic development level, which was 0.5873, for the first time, and the coordination type also transformed from the marine scientific and technological innovation lag into blue economic lag. This is because the marine scientific and technological innovation capability has been

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increased greatly all the way, while the blue economic development speed was relatively slow, and has been influenced by the index data of ecological environment and marine resources, has experienced two down in the comprehensive score.

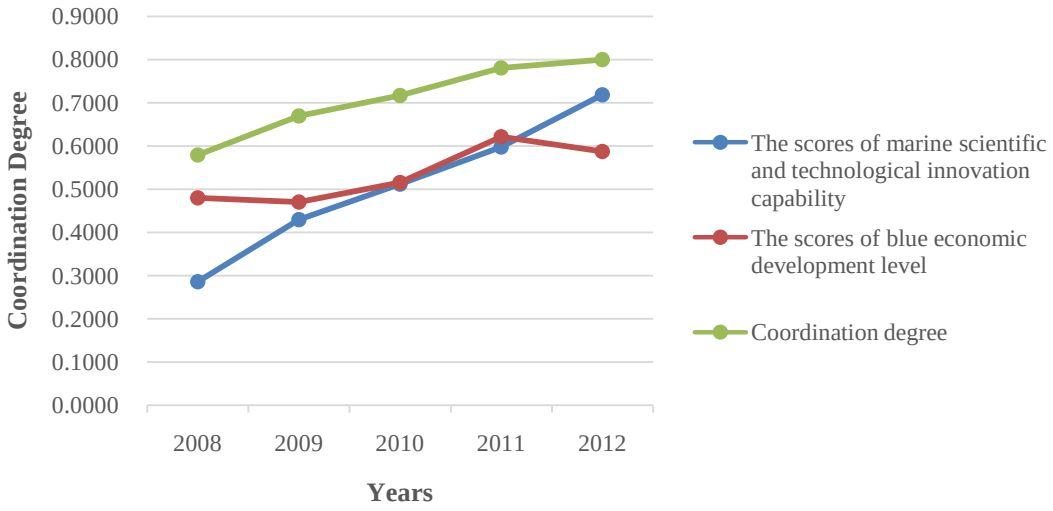

Figure 3: Coordination index chart of Blue Economic Zone of Shandong Peninsula in 2008-2012

(3) The third stage (2012 to 2014)

From 2012 to 2014, from Figure 4 we can see that marine scientific and technological innovation capability of Peninsula Blue Economic Zone continued to show rapid growth speed, an increase from 0.7185 in 2012 to 0.9317 in 2014, the growth rate was 0.2132, while the blue economic development level decreased by 0.0178in 2013, which is the second consecutive decline of blue economy since 2011. Marine scientific and technological innovation capability sustained and rapidly growed, and the main reason is that with the formally approval about the establishment of the Blue Economic Zone in 2011, marine scientific and technological innovation investment continued to increase, the marine research institutions funds income increased from 25 billion 460 million yuan in 2011 to 38 billion 180 million yuan, and the output rate of technological innovation achievement is greatly improved, the number of papers published at home and abroad, the per capita patents and other aspects all have significantly growth. But the score of the blue economic development level since the establishment of Peninsula Blue Economic Zone has declined for two years. The main reason is that although the blue economic output and the regional productivity level increased, the ecological environment and marine resources index data partly reduced, such as the year completion of wastewater treatment projects, the per capita water resources and the per capita marine resources, has declined. Obviously, in the pursuit of the rapid development of regional economy, we should also pay attention to the sustainable development of marine economy. On the basic of the development and utilization of marine resources we should also pay attention to the protection of the ecological environment, sacrificing the environment for economic growth is not a healthy growth.

In 2012, the coordination degree of marine scientific and technological innovation and blue economic development in the Peninsula Blue Economic Zone was 0.7998. The coordination type was moderate coordinated development, blue economy lags behind. Since 2013 it changed to good coordinated development, blue economy lags behind, and then kept this type until 2014. The coordination degree increased from 0.7998 to 0.8695, the growth rate was 0.0697. The coordination degree raised less from 2012 to 2013, which was mainly affected by the fall of blue economic development level, then with the rising of marine scientific and technological innovation capability and the blue economic development level, coordination degree increased steadily in 2014.

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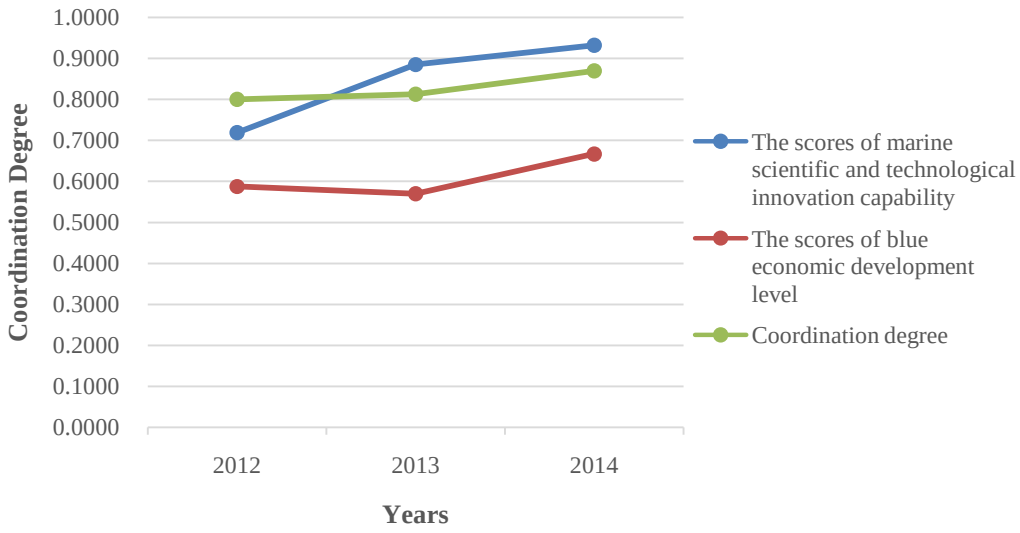

Figure 4: Coordination index chart of Blue Economic Zone of Shandong Peninsula in 2012-2014

V. Conclusion

This paper discussed around the problem about the coordination degree of regional marine scientific and technological innovation and the blue economic development, and based on the basic theory analysis, using the Blue Economic Zone of Shandong Peninsula as the object, constructed the index system of regional marine scientific and technological innovation and blue economic development, according to the coordination degree model, estimated the coordination degree of the Blue Economic Zone of Shandong Peninsula from 2005 to 2014. Through the empirical study, we found that the coordination degree of marine scientific and technological innovation and the blue economic development in peninsula increased from 0.3719 to 0.8695 in ten years. The coordination type changed from moderately maladjusted, marine scientific and technological innovation lags behind into good coordinated development, blue economy lags behind. The results show that the coordination degree of regional marine scientific and technological innovation and blue economic development level depends on the common development of the both, and the lagging development of either side will hinder the improvement of the coordination degree.

In the process of speeding up the construction of the Peninsula Blue Economic Zone, realizing the transformation of Shandong province to a strong marine province, this paper measures the coordination degree of the marine scientific and technological innovation and blue economic development in Blue Economic Zone of Shandong Peninsula, gives a reasonable evaluation on the construction of the Peninsula Blue Economic Zone, and put forward suggestions for its development, which has important significance to promoting the healthy and sustainable development of blue economy.

Acknowledgement

Sponsored by the Weihai Torch High-tech Science Park science and technology development plan project: Research on the joint army-civilian industrial innovation system based on the industrial clusters (Grant No. 201714).

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