



## CRITERIA OF SEA AREA ROYALTY FOR PORT TRANSPORTATION: RESEARCH AND APPLICATION

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# CRITERIA OF SEA AREA ROYALTY FOR PORT TRANSPORTATION: RESEARCH AND APPLICATION

Xiao-Hui Wang<sup>1</sup> and Bo Peng<sup>2</sup>

Key words: charge criteria for sea area usage, evaluation, oceanic economy, Zhejiang oceanic territory.

## ABSTRACT

Criteria of sea area royalty for port transportation are important technical bases to operate marketization of sea. According to factors such as the geographic position of the sea, peripheral social-economic development status and environmental conditions, this paper establishes an evaluation index system of royalty criteria. It builds a calculation model of criteria of sea area royalty for port transportation using an interpolation method, collects relevant index data of 19 coastal areas (cities or districts) in Zhejiang Province and calculates the criteria for sea area use royalty of the Dinghai District. The results indicate that criteria of sea area royalty are closely related to sea level classification and sea area usage charge standards. At the beginning of sea-use rights transactions, criteria of sea area royalty for port transportation can be used as the evaluation base price for sea-use rights in government tender, auctions, and public transfers. Royalty criteria evaluation index weights are based on a synchronous-change rule accounting for social-economic development, ocean resources and the environment, and it is dynamically fluctuant.

## I. INTRODUCTION

Zhejiang Province administers 260,000 km<sup>2</sup> of oceanic territory with a 6,696 km coastline, ranking first in China. Zhejiang is abundant in oceanic resources, including ports, fisheries, tourism, gasoline, petroleum, islands, and ocean, which enhances the province's competitiveness and creates the potential for rapid development of its oceanic economy. The General Office of the State Council of the People's Republic

of China (PRC) approved the "Zhejiang Oceanic Economy Experiment Zone Plan" in 2011, symbolizing that Zhejiang's development of its oceanic economy has been elevated to China's nationwide strategy. Zhejiang Province subsequently initiated the free economy and commercialization for oceanic resource development. To enhance oceanic usage management and promote reasonable oceanic area development, the people's government of Zhejiang Province enacted the "Zhejiang Province Management Guidelines for the Use of Sea Areas" in accordance with the "Law of the People's Republic of China on administration of the use of sea areas" and the "Environmental protection law of the People's Republic of China," as well as other relevant laws. Administrative regulation and the practical needs were addressed, and this administrative act was promulgated on March 1, 2013 after being approved by the 36th conference held by the standing committee of the People's congress that was published in the No. 86 Public Announcement of the committee. The promulgation of the "Zhejiang Province Management Guidelines for the Use of Sea Areas," in conjunction with relevant administrative regulations, incentivizes the development of the oceanic economy.

The charge criteria for the use of sea areas enacted in 2007 by the State Oceanic Administration and Ministry of Finance of the PRC still apply in the 30 coastal counties (or cities and districts) in Zhejiang Province. These 30 coastal counties (or cities and districts) have experienced substantial changes in social and environmental resource development since the promulgation of the administrative act. The current charge criteria for the use of sea areas does not reflect the variation in sea area value among these counties (or cities and districts) or the time value for the use of sea areas, and thus it hinders the royalty system's execution and commercialization of the sea area resources of Zhejiang Province. Although Zhejiang Province is dedicated to developing its oceanic economy, accelerating its free market, and commercializing its sea area resources, a more scientific and comprehensive sea area use royalty system is necessary for the development of Zhejiang's sea area.

Based on the aforesaid considerations, this paper is composed of the following sections, excluding the summary. Section 2 describes relevant research and theoretical discussions concerning Zhejiang's sea area usage price benchmarks.

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Section 3 focuses on the calculation criteria for sea area usage regarding port transportation and indicator system establishment. Section 4 involves collecting indicators and statistics for sea area usage regarding port transportation, handling weight ratios, and evaluating and calculating indicators. Section 5 addresses an empirical analysis of the criteria of sea area royalty for port transportation for the Dinghai district in Zhoushan City. Finally, Section 6 presents the conclusions.

## II. DISCUSSION OF RELEVANT RESEARCH AND THEORIES OF CRITERIA FOR SEA USE ROYALTY

Benchmark prices are typically calculated for energy commodities such as crude oil (Bhar et al., 2008; Kao and Wan, 2012) or assets (Platen, 2006) but are rarely calculated for oceanic ports (Haralambides and Gujar, 2011). However, this evaluation mechanism is a type of price validation applied extensively in many contexts such as oceanic ports (Acciaro, 2013), including the establishment of price benchmarks for airports (Basso and Zhang, 2008), risk hedging (Al-Shboul and Anwar, 2014), transportation mileage (Ashley and Savage, 2010), stock mutual funds, future commodities (Eksi and Filipović, 2014; Nowak and Romaniuk, 2014; Rombouts et al., 2014), consumers (Guler et al., 2014), assets (Hammami and Lindahl, 2014), financial derivatives (Huang and Tu, 2014), e-commerce commodities (Wu et al., 2014), and price criteria strategies (Zhang et al., 2014). Furthermore, the criteria price valuation of sea area use is the basis for computing standardized marine fees (Wang and Xie, 2008); the value of rights to sea use is assessed through FCFF evaluation principles and is applied for such purposes as evaluating a dock basin (Xu et al., 2011).

The aforesaid description indicates that oceanic port pricing (Bandara et al., 2013) is one pricing strategy. Past research has focused mostly on airport pricing (Basso and Zhang, 2008; Daniel and Harback, 2009; Basso and Zhang, 2010; Voltes-Dorta and Lei, 2013; Silva et al., 2014). However, pricing research on oceanic ports is scarce, and research on benchmark prices for oceanic ports is even more scarce (Haralambides and Gujar, 2011).

The oceanic market in Zhejiang Province has just begun to develop, and sea area usage benchmark pricing still cannot be attained entirely through market mechanisms. Thoroughly researching sea area usage benchmark pricing, exploring how the pricing for this market mechanism can be established, and analyzing the structure of sea area usage pricing benchmarks can result in the development of a scientific evaluation methodology and the enactment of reasonable sea area usage pricing benchmarks.

Sea area use occurs when humans exploit sea area resources and to satisfy their demands. Such activity symbolizes that nature, society, and economy correlate with one another. The level of economic development in society, particularly the level of oceanic resource development, affects the compre-

hensive exploitation and development of the oceanic economy, as well as the asset exploitation efficiency level and the ecological diversity. Sea area value depends on sea area exploitation diversity and efficiency (Li and Miao, 2009).

Cases involving sea area value evaluation are scarce worldwide. A paid use system for the sea is implemented by the Chinese government. Users of the sea should pay the using fee according to the charging standard, which is formulated by the government. This enactment is mainly focused on how to adjust the royalty classification for the same usage and category in various sea areas.

The criteria of sea area royalty defined in this research refers to the adoption of standard principles and methods, full consideration of the zoning of each sea area, the economic development level of the surrounding communities, sea usage methods, how human activities influence natural ecology and resources, the expected revenue of the sea area, and the administration of policies and acts. The factors considered in this research include the sea area classification enacted by the Chinese central government, criteria for sea area use royalty, development level of the oceanic economy, status of regional economic development, status of regional social development, and status of environmental resources, uniformity of classification range among various counties (or cities and districts), and exploitation purposes regarding fisheries, transportation, industry, and tourism. All of these factors are applied in classifying the criteria for sea area use royalty.

## III. DECISION STANDARDS OF CRITERIA OF SEA AREA ROYALTY FOR PORT TRANSPORTATION AND INDICATOR SYSTEM CONSTRUCTION

Criteria of sea area royalty for port transportation are decided mainly according to sea area zoning, natural conditions, resource enrichment level, environmental quality status, the economy, and societal conditions of surrounding districts. These factors differ substantially. The sea area royalty evaluation criteria mechanism for port transportation includes the evaluation theory, land valuation methods, and methods commonly adopted by the economics academy. This mechanism targets the structural composition of the criteria for sea area use royalty, comprehensively analyzes the natural, economic, and social factors influencing these criteria, and considers the correlation among the influential factors and indicators, the accessibility of the indicator data, and historical characteristics of the mentioned indicators as well as the scientific and feasible methods. Establishing a standard price accounting system for a sea port for transport requires the determination of selection principles of certain factors, as well as design indexes.

### 1. Selecting Evaluation Principles Applicable to Criteria of Sea Area Royalty for Port Transportation

The selection of relevant factors for the criteria of sea area royalty for port transportation is sophisticated. The precision

**Table 1. Index evaluation system for criteria of sea area royalty for port transportation.**

Factors influencing level classification	Factors	Value Evaluation Index
C1 Development level of the oceanic economy-iceconomy	Total output of oceanic production	C11 Average index for the total output value of oceanic production
	Average coastline economy scale	C12 Average coastline production value
	Port scale	C13 Port transportation capacity
	Oceanic economy stimulus	C14 Oceanic economy value increment in proportion to the domestic GDP
C2 Status of regional economic development	Total domestic production value	C21 Average index for total domestic production value
	Financial status	C22 Average index for local treasury revenue
	Fixed asset investment status	C23 Average index for overall social fixed asset investment
	Commercial activities	C24 Average index for total retailing sale of social consumer goods
C3 Status of regional social development	International trade activities	C25 Average index for international export value
	Basic infrastructure level	C31 Basic infrastructure completeness level
	Traffic location	C32 Traffic condition advancement level
	Industry cluster intensity	C33 Industry cluster intensity
	Population density	C34 Population density
	Outbound radiation capacity	C35 Index for outbound radiation capacity
C4 Status of environmental resources	City government's facilities	C36 Average area infrastructure cost
	Oceanic water quality status	C41 Oceanic water quality index
	Port development status	C42 Number of berths
	Coastline resource status	C43 Coastline length per capita
	Oceanic ecology status	C44 Ocean biological diversity index

of the royalty criteria evaluation depends substantially on the selection of appropriate factors that influence sea area exploitation and development efficiency.

Port transportation among various sea areas is a sophisticated system that includes many factors influencing the royalty criteria evaluation. Several factors greatly influence the sea areas and can reflect differences in economic, social, and natural conditions in various districts and are thus adopted. Some factors with limited influence may be adopted selectively. The royalty criteria evaluation and validation abide by the principles of dominant influential factors, differentiation, comprehensive classification, weight ratios, and timeliness.

## 2. Establishing Evaluation Factors for Criteria of Sea Area Royalty for Port Transportation and the Factor Index Mechanism

Evaluating the port transportation among sea areas involves many fields. Many factors influence sea area use royalties, such as the geographic location of a specific sea area, economic and social development status, natural geographic conditions, sea area resources, and sea area environmental characteristics (Luan and Li, 2008).

In accordance with the correlation between port transportation among sea areas and the level of influence of various factor indices, an expert interview methodology is adopted in this study. The selection principle concerning port transportation among sea areas is adopted. For compiling indicators for the sea area use royalty criteria evaluation, the selection principle focuses on the major factors influencing various sea

areas in Zhejiang Province to demonstrate the characteristics of various sea area resources, environmental conditions, as well as differences among environmental, social, and economic zones.

In addition, the index evaluation system for criteria of sea area royalty for port transportation is provided in Table 1.

## IV. EVALUATION, DATA COLLECTION, PROCESSING AND WEIGHT RATIO MEASUREMENT, AND INDICATORS FOR CRITERIA OF SEA AREA ROYALTY FOR PORT TRANSPORTATION

Information regarding the factors influencing the criteria of sea area royalty in the 19 counties (or cities and districts) along the coastline of Zhejiang Province are obtained from official annual statistics, and the factory index data and extreme value standardization are applied in conducting fuzzy synthetic evaluation concerning the original data of various indicators for our study. To establish a benchmark for scientifically calculating various levels of royalties, the model is also used to inspect the relevant factors and their influence on the criteria of sea area royalty for port transportation.

### 1. Data Collection

Obtaining data about the criteria of sea area royalty for port transportation includes direct accessibility, investigation, and calculation. The various sources of obtained data are described as follows:

- (1) Data obtained directly refer to official statistics that are collected directly.
- (2) Data obtained through inspection refer to information obtained by professional staff through measurement of the target site.
- (3) Data obtained through calculation refer to the mean number that was calculated to reflect the comprehensive index.

## 2. Data Process

### 1) Data Obtained Directly

By applying extreme value standardization to standardize the factors, the factor calculation index can be used to obtain the standardization value of indicators. The extreme value standardization formula is expressed as follows:

$$Y_{ij} = a(i) \times (X_{ij} - X_i) / (X_{\max} - X_{\min}) \quad (1)$$

where  $Y_{ij}$  indicates the standardization value of factor  $i$  for county (or city or district)  $j$ ,  $X_{ij}$  denotes the index value of factor  $i$  in the county (or city or district)  $j$ , and  $a(i) = 1$  and  $X_i = X_{\min}$  if the correlation between factor  $i$  and sea area exploitation benefits are positive; otherwise,  $a(i) = -1$  and  $X_i = X_{\max}$  if the correlation between factor  $i$  and the sea area exploitation benefits is negative.

### 2) Data Obtained by Inspection

Because the denomination units vary with each inspection, differences are found among dimensional analyses, and some indicator data are denominated by different units. The collected data are transformed into dimensionless numbers and standardized values with dimensionless number denominations, and the method is the same as that in Eq. (1).

## 3. Calculation of the Weight Ratio Composition

The weight ratio compositions demonstrate the influence levels of various adopted factors. The evaluation measurement for the weight ratio compositions of the criteria for sea area use royalty is finalized using the following procedures.

### 1) Indicator Standardization

The ratification of weight ratio composition necessitates transforming the various features of dimensional analysis into those of dimensionless analysis. The indifference curve, the standard indices with the same orientation, and the processing of this measure are the same as those of Eq. (1).

### 2) Calculation of Classification Factors Constituting the Weight Ratio Composition

The criteria of sea area royalty are used as the dependent variable, and development level of the oceanic economy, status of regional economic development, status of regional social development, and status of environmental resources are adopted to support the establishment of a multiple regression

model. Statistical software is used for measuring the regression ratio. The normalization computation is as follows:

$$U_t = \frac{R_t}{\sum_{t=1}^n R_t} \quad (2)$$

where  $U_t$  is the weight ratio of classification factor  $t$ ,  $R_t$  denotes the regression ratio of classification factor  $t$ , and  $n$  indicates the number of classification factors.

### 3) Calculation of the Factors Influencing the Weight Composition

The four classification factors (namely, development level of the oceanic economy, status of regional economic development, status of regional social development, and status of environmental resources) are adopted as the dependent variables, and the correlation ratios of these four classification factors are adopted to support the establishment of a multiple regression model. Statistical software is used to predict and measure the regression coefficient. The normalized data-processing interpretation is adopted as the basis for evaluating the weight ratios of the relevant influential factors concerning the four aforementioned factors.

$$V_i = \frac{r_i}{\sum_{i=1}^m r_i} \quad (3)$$

where  $V_i$  is the weight ratio of classification factor  $i$ ,  $r_i$  indicates the regression coefficient of classification factor  $i$ , and  $m$  represents the number of classification factors.

### 4) Calculation of the Comprehensive Weight Ratios

The computation for this calculation is expressed as follows:

$$W_i = U_t \times V_i \quad (4)$$

where  $W_i$  is the comprehensive weight ratio of classification factor  $i$ .

## 4. Validating the Specific Index and Composite Indices

The specific index refers to the influence level of an individual factor concerning the criteria for sea area use royalty. The composition indices refer to the total value of the factors influencing the criteria for sea area use royalty, and this calculation method is similar to the simple additive weighting method (Churchman et al., 1957).

First, multiplying the standardized values of each individual factor in the sample counties (or cities and districts) by the composite weight ratio of that factor reveals the single index for that factor. The evaluation and measurement computations for the individual index are expressed as follows:

$$P_{ij} = W_i \times Y_{ij} \tag{5}$$

where  $P_{ij}$  is the factor index for factor  $i$  of county (or city or district)  $j$ ,  $W_i$  indicates the composite weight ratio of factor  $i$  and  $Y_{ij}$  denotes the standardization value for factor  $i$  of county (or city or district)  $j$ .

Second, adding all individual indices reveals the composite index of a specific area. The composite index calculation is expressed as follows:

$$Q_j = \sum_{i=1}^k P_{ij} \tag{6}$$

where  $Q_j$  indicates the composite index of county (or city or district)  $j$ , and  $k$  is the number of factors.

**5. Establishing the Model for the Criteria of Sea Area Royalty for Port Transportation**

The current criteria for sea area use royalty were enacted in 2007, and the criteria for sea area use royalty for the same classification category among various counties (or cities and districts) are the same. Substantial changes have occurred in the oceanic economy, regional economy, and environmental status in all counties (or cities and districts) in the past six years. A comprehensive classification for the same port transportation among sea areas of various counties (or cities and districts) is thus necessary.

This research yields the fluctuation ranges of extreme values for the criteria for sea area use royalty in Zhejiang Province (the classification mechanism of the sea area royalty levy criteria guidelines of Zhejiang Province is adopted as the minimum value for the same sea royalty criteria, and the sea area royalty levy criteria guidelines of one additional higher level is adopted as the maximum value). Additionally, this research also applies the fluctuation ranges of factors influencing the criteria for sea area use royalty in establishing the theoretical model to calculate the price differences in port transportation among various sea areas.

Criteria of sea area royalty for port transportation is expressed as follows:

$$F_j = F_{\min} + \frac{Q_j - Q_{\min}}{Q_{\max} - Q_{\min}} \times (F_{\max} - F_{\min}) \tag{7}$$

where  $F_j$  is the criteria of sea area royalty for county (or city or district)  $j$ ,  $F_{\min}$  represents the criteria for sea area use royalty for the grade of the sea area in county (or city or district)  $j$ ,  $F_{\max}$  indicates the criteria for sea area use royalty for the upper level of county (or city or district)  $j$ , and  $Q_{\max}$  denotes the maximum value of the composite index for the specific sea area. That is,

$$Q_{\max} = \sum_{i=1}^k \max_j \{P_{ij}\}$$

and  $Q_{\min}$  denotes the minimum value of the composite index of the grade level of a specific sea area. That is,

$$Q_{\min} = \sum_{i=1}^k \min_j \{P_{ij}\}.$$

**V. EMPIRICAL STUDY ABOUT THE SEA SREA ROYALTY FOR PORT TRANSPORTATION OF THE DINGHAI DISTRICT OF ZHOUSHAN CITY**

**1. Defining the Evaluation Items**

The sea area owned by the Dinghai District, which has an area of 875.2 km<sup>2</sup>, is evaluated for this research. In accordance with the sea area classification levels enacted by the Chinese central government and the administrative guidelines for criteria for sea area use royalty of Zhejiang Province, the sea area in the Dinghai District is classified as a Level 3 sea area. Sea area use rights refer to the rights of businesses to operate in the sea area based on approval of an application or on public bidding, auctions, and listings according to the mandatory stipulations of the Chinese government.

**2. Influential Factor Analysis**

- (1) Development level of the oceanic economy: the factors such as oceanic economic scale, industry, structure, and stimulus that can be used to determine the development level of the oceanic economy in the Dinghai District.
- (2) Status of regional economic development: the factors that can be used to determine the economy development status and economy scale in the Dinghai District.
- (3) Status of regional social development: the factors that can be used to determine the population, living standard, public services, and administration concerning the societal development level in the Dinghai District.
- (4) Status of environmental resources: the natural conditions and factors that can be used to determine the zoning and ecology of the oceanic resource environment in the Dinghai District.

The factors for criteria of sea area royalty for port transportation and the ratification factor index are shown in Table 1.

**3. Accessibility of Sample Data and Regression Analysis for Validating the Weight Ratio and Calculating the Composite Indices**

*1) Data Collection and Processing for the Index*

The project team considered the “China Statistics Yearbook,” the oceanic function classification of 19 sample counties (or cities and districts; including Longwang, Dinghai, Putou, Shengsi, Daishan, Linhai, and Pinghu Counties etc.), relevant projects and official reports concerning sea area use analysis, and validation reports. Additionally, the project team collected the four classification factors for port industry of the

**Table 2. Factor index standardization values, composite weight ratios, and index list for the Level 3 port transportation sea areas in the sample counties (or cities and districts).**

Evaluation indicators	Indicator standardization value			Weigh ratio composition	Single indicator			Individual index fluctuation range	
	Dinghai District	Luqiao District	Jiaojiang District		Dinghai District	Luqiao District	Jiaojiang District	Minimum value	Maximum value
C11	0.7409	0.4547	0.1290	0.1515	0.1123	0.0689	0.0196	0.0196	0.1123
C12	0.1230	0.5188	1.0000	0.0109	0.0013	0.0057	0.0109	0.0013	0.0109
C13	1.0000	0.0288	0.1410	0.0192	0.0192	0.0006	0.0027	0.0006	0.0192
C14	0.6247	0.1219	0.1621	0.0532	0.0332	0.0065	0.0086	0.0065	0.0332
C21	0.6084	0.5852	0.4796	0.0403	0.0245	0.0236	0.0193	0.0193	0.0245
C22	0.4871	0.6073	0.4900	0.0519	0.0253	0.0315	0.0254	0.0253	0.0315
C23	0.5790	0.2122	0.3784	0.0135	0.0078	0.0029	0.0051	0.0029	0.0078
C24	0.3373	0.5394	0.3972	0.0429	0.0145	0.0231	0.0170	0.0145	0.0231
C25	0.4447	0.3264	0.5698	0.0067	0.0030	0.0022	0.0038	0.0022	0.0038
C31	0.4900	0.0515	0.0643	0.0212	0.0104	0.0011	0.0014	0.0011	0.0104
C32	0.0056	0.6024	0.1205	0.0407	0.0002	0.0245	0.0049	0.0002	0.0245
C33	0.0941	0.3250	0.2482	0.0166	0.0016	0.0054	0.0041	0.0016	0.0054
C34	0.2804	0.4443	0.9475	0.0057	0.0016	0.0025	0.0054	0.0016	0.0054
C35	0.7712	0.3932	0.5961	0.0190	0.0146	0.0075	0.0113	0.0075	0.0146
C36	0.1944	1.0000	0.7009	0.0760	0.0148	0.0760	0.0533	0.0148	0.0760
C41	0.1028	0.3798	0.3086	-0.0569	-0.0058	-0.022	-0.0176	-0.0216	-0.0058
C42	0.2749	0.0135	0.0162	0.1407	0.0387	0.0019	0.0023	0.0019	0.0387
C43	0.1917	0.0071	0.0049	0.1705	0.0327	0.0012	0.0008	0.0008	0.0327
C44	0.5801	0.7318	0.6172	0.0624	0.0362	0.0456	0.0385	0.0362	0.0456
Composite Index					0.3861	0.3091	0.2170	0.1361	0.5141

coastal counties (or cities and districts) in Zhejiang Province and the 17 factors index value that constitutes the composite index of the oceanic economic production value. Moreover, the project team applied Eq. (1) in conducting the dimensionless analysis to calculate the data standardization value.

### 2) Finalizing the Factors Constituting the Composite Weight Ratio Structure

First, the value of the port transportation royalty among various sea areas in the 19 coastal counties (or cities and districts) of Zhejiang Province (the combined value of the sea area territory and sea port transportation use royalty among various sea areas) is adopted as the dependent variable. Furthermore, regarding the development level of the oceanic economy, status of regional economic development, status of regional social development, and status of environmental resources of these 19 coastal counties (or cities and districts), the four classification factors are used to support the establishment of a multiple regression model. Furthermore, statistical software is applied in predicting the regression coefficient, and Eq. (2) is used according to the regression coefficient to predict the levels of influence of the four classification factors in determining the criteria for sea area use royalty.

Second, the four classification factors, the development level of the oceanic economy of the 19 coastal counties (or cities and districts), status of regional economic development, status of regional social development, and status of environmental resources are adopted as the dependent variables. The correlation factors of each of these four types of classification factors for the 19 counties (or cities and districts) are used to support the establishment of a multiple regression equation model. Statistical software is used to calculate the regression coefficient. Eq. (3) is used for the aforesaid calculation based on the regression coefficient and for the weight ratio measurement of classification factors over evaluation factors.

Third, Eq.(4) is applied to multiply the classification factor weight by the factor weight (i.e., the factor composite weight).

The composite weight ratios of the sea areas designated for the tourism industry in the Dinghai, Luqiao, and Jiaojiang Districts are provided in Table 2.

### 3) Calculating the Composite Index

Eqs. (5) and (6) are applied to standardize the values of all individual factor indexes of the 19 counties (or cities and districts). Multiplying these standardization values by the



**Table 3. Sea area classification levels of Zhejiang Province.**

Levels	Sea area
Level 2 sea area	Haishu, Jiangdong and Jiangbei Districts in Ningpo City; Longwang and Lucheng Districts in Wenzhou City
Level 3 sea area	Zhenhai, Beilun and Yinzhou Districts in Ningpo City; Dinghai District in Zhoushan City; Jiaojiang and Luqiao Districts in Taizhou city
Level 4 sea area	Yuyao City; Cixi City; Pinghu City; Haiyan County; Putou District and Shengsi County in Zhoushan City; Wenling City; Yuhuan County
Level 5 sea area	Fenghua City; Ninghai County; Xiangshan County; Ruiian City; Dongtou County; Linhai City; Sanmen County
Level 6 sea area	Pingyang County; Cangnan County

**Table 4. Criteria of Sea Area Royalty for Port Transportation for Zhejiang Province (Unit: \$10,000 /ha).**

Sea area use category	Sea area classification level						Taxation method
	Level 2	Level 3	Level 4	Level 5	Level 6		
Proprietary navigation route and anchorage	0.18	0.12	0.09	0.06	0.03	Levy annually	

weight ratio of each individual factor index reveals the composite index. The factor composition indexes for the sea areas designated for the tourism industries in the Dinghai, Luqiao, and Jiaojiang Districts are provided in Table 2.

#### 4) Establishing Sea Area Royalty Ranges and Validating Composition Indices

Among the 19 coastal counties (or cities and districts), the Dinghai, Luqiao, and Jiaojiang Districts belong to the Level 3 sea area.

The Level 2 port transportation use sea area, as stipulated in the criteria for sea area use royalty, is used as the maximum value for the Level 3 sea area royalty. The 19 Level 3 factor indices for the same sea area levels in the Dinghai, Luqiao, and Jiaojiang Districts are compared, and the maximum value of each factor index for the areas designated for tourism in the Dingding, Luqiao, and Jiaojiang Districts are applied in determining the maximum value of the composite index of the criteria for sea area use royalty.

As stipulated in the criteria for the Level 3 sea area use royalty, the minimum value for the sea areas belonging to the same levels is adopted. The 19 Level 3 factor indices for the same sea area levels in the Dinghai, Luqiao, and Jiaojiang Districts are compared, and the minimum value of each individual factor index for the areas designated for tourism in the Dingding, Luqiao, and Jiaojiang Districts are used for determining the minimum value of the criteria for sea area use royalty. The maximum and minimum values of the composite index for the criteria for sea area use royalty of the Dinghai, Luqiao, and Jiaojiang Districts are provided in Table 2, the value for the sea area of Zhejiang Province is shown in Table 3, and the criteria for sea area use royalty of Zhejiang Province are listed in Table 4.

#### 5) Linear Interpretation for Ratifying the Criteria for Sea Area Use Royalty for Sample Counties (or Cities and Districts)

The maximum value, minimum value, and corresponding

index of the Level 3 sea area royalty, as well as Eq. (7), can be applied to ratify the criteria of sea area royalty for port transportation (or navigation routes and anchorages).

$$\begin{aligned}
 F_j &= F_{\min} + \frac{Q_j - Q_{\min}}{Q_{\max} - Q_{\min}} \times (F_{\max} - F_{\min}) \\
 &= 0.12 + (0.3861 - 0.1361) / (0.5141 - 0.1361) \times (0.18 - 0.12) \\
 &= 0.168 \text{ (Unit: \$10,000/ha)}
 \end{aligned}$$

## VI. CONCLUSIONS

Regarding practical operation, the establishment of the factor index analysis system should be related to the sea area royalty standard, and the source of the factor should be reliable and acquirable. The indicator statistics are often obtained from official annual data. The determination of calculating weighting is based on the application of the econometric model and the chosen independent variable and dependent variable should be correlated.

The evaluation and ratification methods developed in this study can provide professional support for expediting the establishment of sea area use management guidelines of Zhejiang. Additionally, this study can provide a transfer value reference for sea area use marketability and also a guarantee of sea area resource valuation increments. Moreover, since the sea area market has not been fully developed to date, the transaction volume is marginal or nonexistent, and other ratification methods are difficult to apply to transaction prices. The evaluation and ratification method developed by this study can be used as a pricing benchmark for public bidding, auctions, and publicizing ownership transfers. The conclusion of this research regarding ratification can provide a scientific basis for identifying features of the sea area use valuation based on the economy, society, and natural conditions, as well as a scientific basis for revising the sea area level classification.

The conclusions of this study can thus promote the feasible development and sustainable exploitation of sea areas.

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