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Efficiency Evaluation of Eco-tourism in China's Coastal Cities Based on DEA Method

Yu-qin SUN[1,a] and Yi-ming GUO[2,b*]

[1,2]School of Economics and Management, Shanghai Maritime University, Shanghai, China.

[a]yuqinsun@126.com, [b]ymguo@shmtu.edu.cn

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Abstract. This paper studies the efficiency of eco-tourism in China's coastal cities by using the method of Data Envelope Analysis (DEA). Five inputs including the length of coastline, number of employees in the tertiary industry, urban fixed asset investment, tourism resources attractiveness, eco-environmental attractiveness and two out puts including the total tourism revenue and total tourist amount were adopted to analyze the eco-tourism efficiency of 12 China's coastal cities. The result shows that 25% of the evaluated cities were ineffective by using DEA model. To promote sustainable eco-tourism development in China's coastal cities, some suggestions are proposed for the cities either effective or ineffective for DEA model.

Introduction

Eco-tourism efficiency evaluation and analysis play an important role in tourism planning and management. Various econometric evaluation and analysis techniques have been developed and applied to the tourism research, amongst which Data Envelopment Analysis (DEA) has been paid more and more attention [1]. As an excellent tool for assessing the efficiencies of economic communities characterized by multi-input, multi-output operation model, ever since its inception by [2], DEA has won increasing popularity in the research area [3]. The DEA has been involved in a number of efficiency concepts, including cost efficiency or revenue efficiency and assessing the relative efficiencies of decision-making units (DMUs) [4]. However, there is seldom research about the coastal zone eco-tourism efficiency evaluation by using DEA method [5].

The objectives of the present work are 1) to evaluate the eco-tourism efficiency of the typical Chinese coastal cities and 2) to give reasonable guidance for allocating coastal eco-tourism resources through the application of DEA. To ensure authenticity and validity, the selection of evaluating indexes and grade appraisal on China's coastal city ecological environment for DEA evaluation was tried in the light of the approach introduced by Tan etc. [6].

Methodology

Research Procedure

Recently, DEA has matured as an indispensable tool in the areas of operations research and management science [7]. To evaluate the efficiency of eco-tourism in China's coastal cities, the approach of applying DEA model will provide an effective method of

the outcome of the analysis.

Defining Input-output Factors

The basic advantage of DEA is that it can incorporate any number of inputs and outputs into the analysis. There were 5 inputs and 2 outputs have been selected in this study. Therefore, in accordance with the principles of systematic, scientific, comparable, measurable and general explanation of economics on inputs production process, in this research, land, labor, capital as well as ecological environmental resources was considered as the investment factors. The five specific input indicators are the length of coastline (LC), number of employees in the tertiary industry (NETI), urban fixed asset investment (UFI), tourism resources tourism resources attractiveness (TRA) and eco-environmental attractiveness (EA).

The total tourism revenue (TTR) and total tourist amount (TTA) were determined as two output indicators, because on the one hand, it would be difficult to calculate the regional tourism benefits directly in the way (social, economic and environmental benefits) traditional tourism economic research adopted, on the other hand, the regional eco-tourism benefits can also be revealed by the TTR and TTA as the common-sense tourism revenues [8].

Research Objects

The organization and coordination of community tourism in China are usually under the supervision of governments at all levels. In this study, 12 prefecture-level representative quality seashore eco-tourism cities as the objects or DMUs of this paper were selected: Dalian, Qinghuangdao, Weihai, Yantai, Qingdao, Shanghai, Ningbo, Wenzhou, Xiamen, Shenzhen, Guangzhou, Sanya. All the 12 DMUs share two characteristics, firstly, they have very attractive tourism resources, and secondly, they have the basic conditions for and high value of seashore eco-tourism.

Data Collection

In principle, the DEA is not financially-oriented. Instead the objectives are to perform an analysis of the process of transformation of inputs into outputs that generate a measurement or set of measurements, which reflect the efficiency of DMUs with regard to this transformation process. Therefore, in this study, besides 3 dimensional and weighable input indexes (LC, NETI, UFI), 2 dimensionless inputs (TRA, EA) were adopted in the DEA operation. The TRA and EA calculation mirrors the method Tan and Wu *et al.* [6, 9].

To some extent, the regional TTR and TTA can reflect its comprehensive development of tourism and the favor and recognition of consumers. Although this study focus on seashore eco-tourism efficiency, there is no clear-cut distinction can be drawn between TTR and the common sense tourism revenue.

This study first applied the method of Tan and Wu *et al* to empirical research, and the concrete values of TRA and EA are described in Table 1. The statistical table of the outputs is shown in Table 2.

Results and Discussion

The Efficiency and Super Efficiency of the DMUs

The efficiency and super-efficiency of all the 12 DMUs are illustrated in Figure 1.

Table 1 Input indexes in the evaluation[a]

DMU S.no.	Cities	Input indexes				
		LC (km)	NETI (Thousand)	UFI (Billion Yuan)	TRA	EA
1	Dalian	1906	1939	3114	59	153
2	Qinhuangdao	162	529	257	40	160
3	Weihai	986	523	1166	24	171
4	Yantai	909	1204	2222	60	155
5	Qingdao	731	1787	2459	57	163
6	Shanghai	450	5342	7998	98	154
7	Ningbo	1594	1354	2048	56	158
8	Wenzhou	339	1984	805	43	155
9	Xiamen	234	1134	882	25	168
10	Shenzhen	230	3184	1709	22	155
11	Guangzhou	550	3616	2660	62	152
12	Sanya	259	143	211	30	186

[a]The LC, NETI, UFI data are from the China national tourism administration's official website, 2008. The calculation of TRA, EA see supplementary data.

Table 2 Output indexes in the evaluation[a]

DMU S.no.	Cities	Output indexes	
		TTR(Billion Yuan)	TTA(Thousand)
1	Dalian	476.98	3506.77
2	Qinhuangdao	129.61	1660.82
3	Weihai	187.88	1870.87
4	Yantai	271.96	2802.79
5	Qingdao	486.65	4003.47
6	Shanghai	2220.22	12894.39
7	Ningbo	528.38	4042.05
8	Wenzhou	265.07	2963.67
9	Xiamen	298.72	1916.39
10	Shenzhen	532.25	2840.27
11	Guangzhou	978.03	3975.5
12	Sanya	102.96	669.08

[a]The TTR and TTA data come from the China Statistical Yearbook for Regional Economy, 2010.

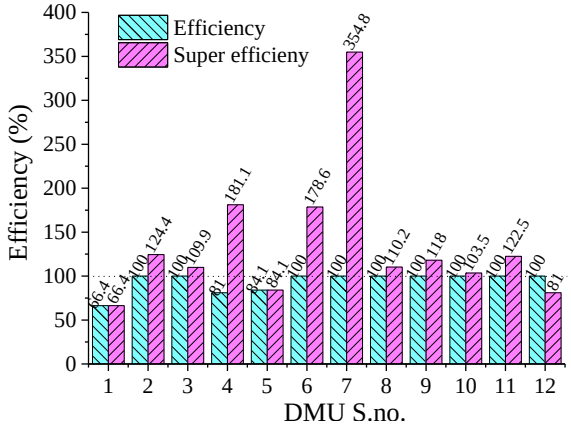

Figure 1. The efficiency and super efficiency of the DMUs

Detailed order of super efficiency according to FAS results (Fig. 3) is as follows: DEA-effective cities order, Shanghai > Qinhuangdao > Sanya > Guangzhou >

Wenzhou > Weihai > Shenzhen > Ningbo > Xiamen, and DEA-ineffective cities order, Qingdao > Yantai > Dalian.

Potential Improvements for the DEA Ineffective DMUs

The potential improvements of 3 DEA-ineffective DMUs are shown in Figure 2.

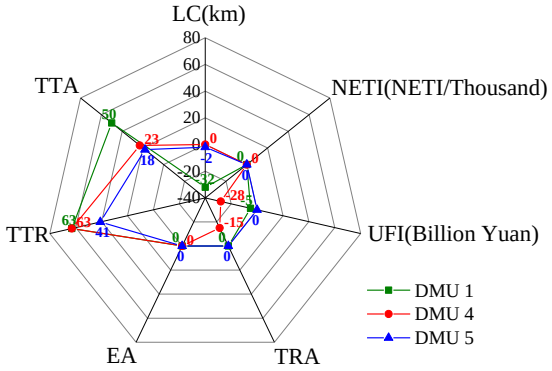

Figure 2. Optimization scheme of the DEA-ineffective DMUs based on the FAS

All the 3 DEA-ineffective DMUs exhibit varying degrees of efficiency losses. To get Dalian (DMU 1) up to the ideal develop situation, the city should consider the following two approaches: first, to increase the TTR by 63% and TTA by 50% under the current investment unchanged; second, to reduce the current LC investment by 32%, UFI by 5% and TRA by 14% so as to get adapt to the present TTR and TTA.

The efficiency of DMU 4 which denote the city Yantai is 81%. The first way to get Yantai up to the ideal situation is to remain the current investments stable, and promoting the growth of TTR by 63%, TTA by 23%. And the second approach is cutting down the UFI investment by 28%, TRA by 15% to fit the present TTR and TTA.

DMU efficiency of Qingdao (DMU 5) is 84.1%. The first optimization for Qingdao to shift towards the idealized development is to remain all the current investments unchanged and make TTR grow by 41%, TTA by 18%. The second approach aims to reduce the current LC investment by 2% to meet the present TTR and TTA.

Obviously, the optimization provided by the FAS which requires Dalian and Yantai to decline their TRAs is inappropriate for their durable development. For Qingdao, 1) it can decide to make an effort to promote the growth of its TTR and TTA; 2) it also can choose to reduce the LC investment slightly to ensure a sound eco-efficiency. These results suggest that all the 3 DEA-ineffective DMUs should be alongside a connotative development road and enhance their quality of eco-tourism development efficiency.

Contribution Analysis of DEA Effective DMUs

The distribution of DEA effective DMUs is shown in Fig. 3.

As shown in Figure 3, the inputs and outputs contributions of all the DEA effective DMUs are quite different, which reveals the significantly different development status of each coastal city in China. It is intuitively to find out which DMU hold the first place or the last by counting the contribution of each inputs or outputs. Take the NETI contribution axis for example, the order is DMU 3 > DMU 7 > DMU 12 > DMU 2 > DMU 9 > DMU 8 = DMU 10 = DMU 11 = 0. It helps top management to choose a model city, and to exchange information about past development success. Detailed data of inputs and outputs contribution of DEA effective DMUs are listed in Table 3.

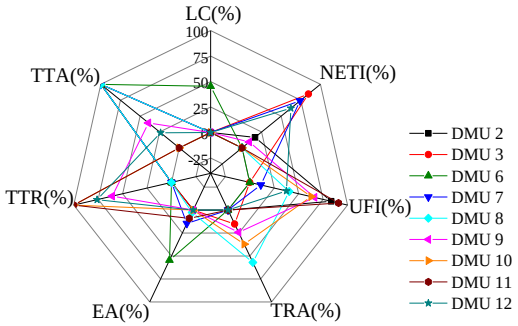

Figure 3. Spider chart for contribution analysis of DEA effective DMUs

Table 3. Detailed data of inputs and outputs contribution of DEA effective DMUs

DMU S.no.	LC (%)	NETI (%)	UFI (%)	TRA (%)	EA (%)	TTR (%)	TTA (%)
2	0	16.6	83.3	0	0	0	99.9*
3	0	84.7	0	15.2	0	0	99.9*
6	45.4	0	0	0	54.5	0	99.9*
7	0	74	11.3	0	14.6	0	99.9*
8	0	0	40.3	57	2.6	0	99.9*
9	0	9.3	66.3	24.2	0	60.6	39.3
10	0	0	62.8	37.1	0	99.9*	0
11	0	0	90.8	0	9.1	99.9*	0
12	0	62.4	37.5	0	0	76.1	23.8

According to Figure 2 & 3 and Table 3, two prominent phenomena can be yielded. First, though most cities have an adequate LC, only Shanghai achieved a LC efficiency contribution by 45.4%, which may due to its major port and trade center role in China. Another input contribution of Shanghai is derived from EA by 54.5%. Second, between the outputs contribution TTR and TTA, there are 55.6% cities (Qinhuangdao, Weihai, Shanghai, Ningbo, Wenzhou) entirely from TTA, 22.2% cities (Shenzhen, Guangzhou) entirely from TTR, Xiamen (TTR 60.6%, TTA 39.3%) and Sanya (TTR 76.1%, TTA 23.8%) from both the two inputs. Table3 also illustrate the right direction and specific way for the efficient eco-tourism development of each DMUs. Take the city Sanya (DMU 12) for example, the two main eco-tourism efficiency inputs contribution is NETI (62.4%) and UFI (37.5%), and the output contributions of TTR and TTA are 76.1% and 23.8%, respectively. Based on the outcome of the DEA efficiency evaluation, there are 75% of China's coastal cities attained DEA effective. Such results conform to the development of eco-tourism industry in Chinese coastal cities. The result would also certify the capacity of part of coastal cities in China, and proved the importance of using eco-tourism resources effectively.

Conclusion

DEA, as an efficient modeling tool for measuring the efficiencies of DMUs, was first applied to evaluate the eco-tourism development efficiency of Chinese coastal cities in this study. The present research also first tried to apply the classification and grading indicator system as well as of coastal eco-tourism zones that were proposed by [6, 9]. The study shows that the minority of cities (25%) were operated inefficiently by DEA model in the year 2010. The DEA analysis provided general guidance for the ineffective cities to achieve potential improvements and new methods for the effective cities to

upgrade their highly efficient development.

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