

# The Study of DEA Application in Tourism City: A Case for Members of the World Tourism City Federation in China

Dantong Man and Hui Zhang

**Abstract** With the method of Data Envelopment Analysis (hereinafter referred to as DEA) was carried out to analysis the factors that influence efficiency of urban tourism industry which is useful for the resource input and output of tourism optimization. The results show that: Eastern region is of better overall in comprehensive technical efficiency; Central region has been paid attention to the development of tourism industry; urban tourism development in western China still need to put in more management and technical factors. Just rely on the growth of tourists, Blind tourism infrastructure investment does not bring comprehensive technical efficiency.

**Keywords** DEA · Tourism city · Comprehensive technical efficiency · Pure technical efficiency · Scale efficiency

## 1 Introduction

The satisfaction of tourists and development of the regional tourism economy will be as the output elements of urban development. It is used “efficiency” to characterize the urban development in the relationship between the input and output elements, then based on the calculation and analysis of “efficiency” level, evaluating the development potential of tourism cities objectively. DEA will verify the technology efficiency which influences the development of city. Based on this level, it is very necessary to introduce the efficiency study of city.

In foreign tourism study, DEA method is mainly used in tourism enterprise management efficiency evaluation, such as Cracolici uses the competitive model and DEA method analyzing the efficiency of Italian tourist destination (Cracolici et al. 2008). Bernini used DEA method to study the efficiency and competitiveness of

---

D. Man (✉) · H. Zhang

School of Economics and Management, Beijing Jiaotong University, 100044 Beijing, China  
e-mail: mandantong@126.com

H. Zhang

e-mail: peihui1@sina.com

© Springer-Verlag Berlin Heidelberg 2015

Z. Zhang et al. (eds.), *LISS 2014*, DOI 10.1007/978-3-662-43871-8\_119

831

hotel industry in Italy (Bernini and Guizzardi 2010). Since Wei Quanling published works in 1998 (Wei 1998), the domestic scholars began to apply DEA. ZuoBing and Bao Jigang estimates tourism total factor productivity (TTFP) growth rates and identifies sources of tourism economic growth for the period from 1992 to 2005 in China and its 30 provinces (Zuo and Bao 2008). So many scholars analyze and evaluate the efficiency of macro development of tourism, tourist areas, tourist industries and so on, this essay evaluates and compare the efficiency of tourism cities in China and discussed the characteristics of tourism city.

## 2 Research Design

### 2.1 Research Methods

The earliest DEA method is addressed by Charnes, Cooper and Rhodes (Charnes et al. 1981). The DEA method is especially suitable for urban research in complex factors of input and output. This essay uses the BBC model of DEAP2.1 (VRS) to calculate the efficiency of tourism city. Set to evaluate K production unit efficiency, assuming that for L kinds of input index, M kinds of output indicators, set  $x_{jl}$  represents the L kind of resource inputs in j unit,  $y_{jm}$  represents the M kind of output in j unit, for the first n ( $n=1, 2, \dots, K$ ) units, the DEA application model for (Wei 1998):

$$\min \left( \theta - \varepsilon \left( e_1^T s^- + e_2^T s^+ \right) \right); s.t. \sum_{j=1}^k x_{jl} \lambda_j + s^- = \theta x_1^n; \sum_{j=1}^k y_{jm} \lambda_j - s^+ = y_m^n; \lambda \geq 0.$$

Type: In the above type will be on type into the size of the Variable remuneration (Variable Returns to Scale, VRS) product of DEA, VRS model for short.  $\theta_b$  as pure technical efficiency index,  $0 < \theta_b \leq 1, \theta \geq 0$ ,  $SE = \theta / \theta_b$  as the scale efficiency,  $0 < SE \leq 1$ , when the  $\theta_b = 1$  or  $SE = 1$ , pure technical efficiency optimal or scale efficiency optimal.

### 2.2 Research Objects

WTCF as the representative of tourism city, it is a typical representative for city study. Therefore, this study selects the members of WTCF in China, (as of February 2014, a total of 21 cities), analyzing the efficiency of tourism city, hoping it is useful for the development of other regions.

### 2.3 Indicators and Data Selection

It is more difficult to directly measure tourism city input, based on the analysis of the literature, the authors from tourism resources and tourism facilities to measure investment level. Numbers of a-level scenic area as a tourism resources evaluation

index; numbers of Hotel and travel agency as tourism facilities evaluation index. The tourist trips as one of the important output indicators; tourism revenue as another important indicator of output. And choose 2012 data as efficiency evaluation period. The output indexes are derived from the statistical bulletin released by the national economic and social development, input indicators from tourism official website.

### 3 Research Results

#### 3.1 City Tourism Efficiency Results

Use DEAP2.1 software to analyze the tourism industry efficiency level and scale reward of member cities. In Table 1, It is unchanged for scale reward of Guangzhou, Luoyang, Shanghai, Tianjin and Wuhan; It is increasing for scale reward of Altay,

**Table 1** Comprehensive technical efficiency, pure technical efficiency and scale efficiency in tourism cities

Order number	City	crste	vrste	Scale	Scale reward
1	Altay	0.230	1.000	0.223	irs
2	Beijing	0.528	1.000	0.528	drs
3	Chongqing	0.561	0.703	0.798	drs
4	Chengdu	0.765	0.890	0.860	drs
5	Dalian	0.409	0.411	0.995	irs
6	Guangzhou	1.000	1.000	1.000	–
7	Hangzhou	0.796	0.823	0.968	irs
8	Harbin	0.429	0.449	0.955	irs
9	Jiaozuo	0.641	1.000	0.641	irs
10	Kunming	0.654	0.854	0.765	irs
11	Luoyang	1.000	1.000	1.000	–
12	Nanjing	0.708	0.714	0.991	drs
13	Qingdao	0.416	0.457	0.911	drs
14	Shanghai	1.000	1.000	1.000	–
15	Taiyuan	0.705	1.000	0.705	irs
16	Tianjin	1.000	1.000	1.000	–
17	Wuhan	1.000	1.000	1.000	–
18	Xi'an	0.678	0.685	0.990	drs
19	Xiamen	0.844	1.000	0.844	irs
20	Yangzhou	0.588	0.744	0.790	irs
21	Zhangjiajie	0.682	0.872	0.782	irs
	Mean	0.697	0.838	0.845	

Crste = vrste \* scale

crste comprehensive technical efficiency, vrste pure technical efficiency, scale represents scale efficiency, irs increase scale reward, drs decrease scale reward, –represents unchanged

Dalian and other eight cities; It is diminishing returns for scale reward of Beijing, Chongqing and other six cities. It is worth thinking about that Beijing tourism industry development is diminishing returns stage.

The average comprehensive efficiency in Table 1 is on general level. The results of DEA calculation show that the comprehensive efficiency of the 21 cities tourism industry average is 0.697, that only 69.7% of the optimal. Comprehensive efficiency of Guangzhou, Luoyang, Shanghai, Tianjin and Wuhan reached an optimal; Altay, Beijing and other seven cities are below average, achieving the optimal only 23%–58.8%. Average pure technical efficiency value in Table 1 is higher, reaching the 83.8% optimum, there are more cities reached the pure technical efficiency optimal level. Among them, Altay, Beijing and other ten cities achieve optimal for one. Average scale efficiency is high, the mean reaching 84.5% of the optimal, there are still five cities reaches the optimal scale efficiency. Chongqing, Chengdu and other 11 cities is slightly higher than or close to the average, achieving the optimal 79%–99.1%.

### 3.2 City Tourism Efficiency Analysis

The authors divided the 21 cities into eastern, central and western regions Geographically. In order to study differentiation of city tourism industry development in space, calculating the three regional average comprehensive efficiency, average pure technical efficiency and scale efficiency.

From Table 2 shows that the average pure technical efficiency of eastern region reached 80%, lower than all the cities mean 3.8% (Table 1), It shows that these cities have too little management and technical input, lower its tourism production efficiency. The average scale efficiency of central and western region is 78.2%72.7%, lower than all the cities mean scale efficiency (Table 1) (84.5%), It shows that the gap between central & western cities and the optimal production scale is bigger.

**Table 2** The comparative efficiencies of eastern, central and western regions

Region	City	Mean of comprehensive technical efficiency	Mean of pure technical efficiency	Mean of scale efficiency
Eastern region	Beijing\Dalian\Hangzhou\Harbin\ Nanjing\Qingdao\Shanghai\Tianjin\ Wuhan\Xiamen\Yangzhou\ Guangzhou\	0.763	0.800	0.915
Central region	Jiaozuo\Luoyang\Taiyuan\ Zhangjiajie\	0.757	0.968	0.782
Western region	Altay\Chongqing\Chengdu\ Kunming\Xi'an	0.578	0.826	0.727

## 4 Conclusion and Discussion

From the analysis above, we can see that firstly condition of city is a key factor in the efficiency of the tourism industry, it determines the ability of enterprise to get resources, technology and information. Tourist cities like Beijing, Shanghai, Tianjin, its superior location means to attract external resources advantages, combined with management and technology factors, promoting the tourism industrial upgrading and optimization, improving the pure technical efficiency; And the western city of does not occupy good geographic location; The central city promotes resource utilization, also will have great development potential.

The cities which are diminishing returns in the scale should adjust the investment structure, They should not blindly invest without considering the economic benefits, receiving numerous tourist trips but can't bring tourism income; Western cities should expand tourism facilities, attracting more tourists, bringing more tourism income and promoting the comprehensive technical efficiency. The tourism management of central cities shall be deepened and more elements shall be input, these all acquire attention.

## References

- Bernini C, Guizzardi A (2010) Internal and locational factors affecting hotel industry efficiency: evidence from Italian business corporations. *Tourism Econ* 16(4):883–913
- Charnes A, Cooper WW, Rhodes E (1981) Evaluating program and managerial efficiency: an application of data envelopment analysis to program follow through. *Manage Sci* 27(6):668–697
- Cracolici MF, Nijkamp P, Rietveld P (2008) Assessment of tourism competitiveness by analysing destination efficiency. *Tourism Econ* 14(2):325–342
- Wei QL (1998) Institute of operation research mathematics of economics. Renmin University of China, Beijing
- Zuo B, Bao JG (2008) Tourism total factor productivity and its regional variation in China from 1992 to 2005. *J Geographical Sci.* 63(4):417–427