



# Assessing Urban Tourism Development Efficiency: Based on a DEA Approach

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## Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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## Abstract

Based on the data of 16 prefecture level cities in Anhui Province, eight indicators in the three directions of environmental pollution, resource input and labor input are selected as input variables. The output indicators include economic and social benefits. Combining the traditional DEA and SBM super efficiency data envelopment analysis model, the super efficiency value and ranking of tourism development of each prefecture level city under the non-oriented and variable return to scale model are obtained. This paper analyzes the development efficiency of tourism in this period from the prefecture level city and regional level, and puts forward reasonable suggestions. Increase the development of tourism resources; Improve the urban tourism system with weak potential; Promote regional cooperation and linkage development; Promote the common growth of tourism industry and regional economy.

*Keywords:* Regional development; urban tourism; DEA model; super efficiency value.

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## **1 Introduction**

Since the reform and opening up and under the background of the "One Belt One Road", the development of China's tourism has realized the transformation from a shortage type to a large tourism country, which has promoted tourism to become a leading industry in China's economic development. Anhui Province is located in the hinterland of East China, adjacent to the Yangtze River Delta urban agglomeration, and has abundant tourism resources. In the report of the 19th National Congress of the CPC, it was pointed out that we should combine learning and implementing the spirit of the 19th National Congress with promoting the reform and development of the tourism industry, and strive to cultivate the tourism industry into an important force for economic transition. However, due to the uneven distribution of tourism resources and different traffic locations in different cities, there are significant differences in regional tourism economy. Therefore, studying the regional differences in Anhui's tourism economy is of great practical significance for understanding the differences in regional tourism economic development in Anhui Province and promoting the coordinated development of regional tourism economy in Anhui Province.

Anhui Province is located in the inland of East China, close to the Yangtze River Delta urban agglomeration. During the 12th Five Year Plan period, the development of the tourism industry in the province was steadily promoted in accordance with the overall deployment of the Provincial Party Committee and Provincial Government. This study explores the development of regional tourism in Anhui Province through super efficiency analysis, and provides a deeper understanding of the differences in tourism development levels among the three major urban clusters in Anhui Province. This is beneficial for timely adjustment of urban development positioning and industrial development structure, providing theoretical basis and decision-making reference for coordinated regional tourism development and the comprehensive realization of the tourism industry's "14th Five Year Plan" goals.

## **2 Literature Review**

At present, research on the development efficiency of the tourism industry both domestically and internationally is constantly being refined and deepened. Among them, foreign scholars started researching the development efficiency of the tourism industry relatively early, and with the passage of time and the updating of research methods, they have a deeper understanding of development efficiency. In terms of studying traditional industry factors such as hotel operating efficiency and travel agency development, they have formed relatively fixed research ideas and methods. Different from the focus of foreign scholars, domestic scholars pay more attention to the macro level when studying the development efficiency of the tourism industry. However, due to the different research perspectives of researchers, the emphasis also is different. While analyzing the coupling mechanism between tourism public services and tourism efficiency, many scholars construct a comprehensive evaluation system to evaluate the coordination level and coupling degree of each province.

The tourism industry, as a livelihood industry, is receiving increasing attention by domestic and foreign researchers. Foreign scholars have conducted extensive research on tourism development and found that tourism differences are influenced by factors such as climate, environmental factors, and economic development [1,2]. In China, as the tourism industry has gradually become an important industry of economic development, more and more domestic scholars are analyzing the influencing factors of urban tourism development differences from different perspectives while considering the national conditions. They have concluded that these differences are mainly influenced by factors such as economic level, tourism foundation, and industrial structure [3,4,5]. Based on this research, considering spatial effects has become a trend for contemporary scholars to analyze urban tourism development differences. Du Jieli established a regression model between tourism economy and influencing factors to statistically verify the spatial impact mechanism of regional tourism economy [6]. Zhang Xianxian et al. focused on cities in the Yangtze River Delta region and used spatial analysis methods to study the differences in urban tourism development. The results showed that the overall tourism development trend in the Yangtze River Delta was good, but regional differences were significant [7,8,9,10]. In the study of combining tourism development efficiency with spatial analysis, Yu Tingting and Zuo Bing [11] used the DEA model to evaluate the comprehensive efficiency, pure technical efficiency, and scale efficiency of various prefecture level cities. Based on this, they analyzed the impact of tourism development on economic comprehensive efficiency through spatial econometric models. Ji Xiaomeng, Qin Weishan [12], and others evaluated the efficiency of tourism development in coastal cities and cities in Hebei Province through Data Envelope under spatial effects.

When studying the efficiency of urban tourism development in Anhui Province, some researchers used DEA to measure the comprehensive efficiency of each city and found that there were significant differences in the tourism industry between cities in Anhui Province.

Using traditional DEA models to measure the efficiency of tourism development in cities and provinces often results in multiple decision-making units being effective at the same time, making it difficult to evaluate the DEA effective decision-making units in the next step. Therefore, more and more scholars are introducing super efficient DEA to measure the efficiency of urban tourism development, which can solve the above problems and achieve better results. Wei Jun and Gong Yan used the super efficiency model and Malmquist index to measure the tourism efficiency index of the province, and based on this, provided policy recommendations for the development of regional tourism industry.

### 3 Model and Indicator Selection

#### 3.1 Measurement method for tourism development efficiency ——super efficiency SBM model

In 1978, operations researcher Charnes proposed a relatively effective measurement method for evaluating decision units, namely Data Envelopment Analysis (DEA). It is a very important non parametric statistical method in production inputs and has become one of the most common methods for studying efficiency. However, traditional DEA models ignore the impact of input-output relaxation variables on model reliability, which leads to decision-making units located on the efficiency frontier hyperplane having efficiency values of 1, making it impossible to compare. To solve this problem, Tone proposed a super efficiency SBM model based on slack variables to evaluate the relative efficiency of decision units. The principle is to directly add slack variables to the objective function and exclude the evaluated decision units, which effectively solves the problems brought by the radial model. At the same time, the super efficiency model combines super efficiency DEA and SBM models, solving the problem of incomparable decision units at the forefront of efficiency. Assuming there are  $n$  decision-making units, each with  $m$  inputs and  $s$  outputs, the expression for the super-efficient SBM model based on non-radial variable returns to scale is:

$$\left\{ \begin{array}{l} \delta^* = \min \delta = \frac{1}{m} \sum_{i=1}^m \frac{x_i}{x_{i0}} \\ \frac{1}{s} \sum_{r=1}^s \frac{y_r}{y_{r0}} \\ s.t. \quad \tilde{x} \geq \sum_{j=1, \neq 0}^n \lambda_j x_j \\ \tilde{y} \leq \sum_{j=1, \neq 0}^n \lambda_j y_j \\ \tilde{x} \geq x_0, \quad \tilde{y} \leq y_0, \quad y \geq 0, \quad \lambda \geq 0 \end{array} \right. \quad (1)$$

In the above formula, the efficiency value of equation  $\delta$  super efficiency SBM is the  $\lambda$  weight vector, and the optimal solution  $(\delta^*, \tilde{x}^*, \tilde{y}^*, \lambda^*)$  can be obtained by solving the fractional programming of equation (1).

#### 3.2 Indicator selection

When calculating the efficiency of tourism development in various prefecture level cities in Anhui Province, taking into account the relationship between tourism economic development and resource environment, combined with the availability of data, 16 prefecture level cities in Anhui Province were selected as decision-making units. Considering that Chaohu City was revoked in 2011, a panel dataset was established using 7-year data (2012-2018). In terms of environmental pollution factors, resource input and environmental pollution were

used as input indicators, and tourism benefits (total tourism revenue and total tourism population) were used as output indicators to establish an evaluation system (see Table 1). Due to the fact that the Anhui Provincial Statistical Yearbook does not separately list the "three wastes" of the tourism industry, referring to the research results of scholar Lin Wenkai, the proportion of total tourism revenue in various cities to Anhui Province's GDP is used for conversion. All the data in this article are from the Anhui Provincial Statistical Yearbook and the Statistical Bulletin on National Economic and Social Development in various regions.

**Table 1. Evaluation system for tourism development efficiency of various cities in anhui province**

Input indicators	Environmental pollution factors	Industrial wastewater discharge (10000 tons)
		Industrial exhaust gas emissions (billion standard m <sup>3</sup> )
		Industrial solid waste generation (10000 tons)
	Resource investment factors	Number of star rated hotels (number)
		Highway mileage (kilometers)
		Fixed investment in accommodation and catering (100 million yuan)
		Fixed assets investment in leasing and service industry (100 million yuan)
Labor input factor	number of employees in the tertiary industry (10000 people)	
Output indicators	Economic benefits	total domestic tourism revenue (100 million yuan)
	Social benefits	Number of domestic tourists (10000 people)

## 4 Results of the Evaluation

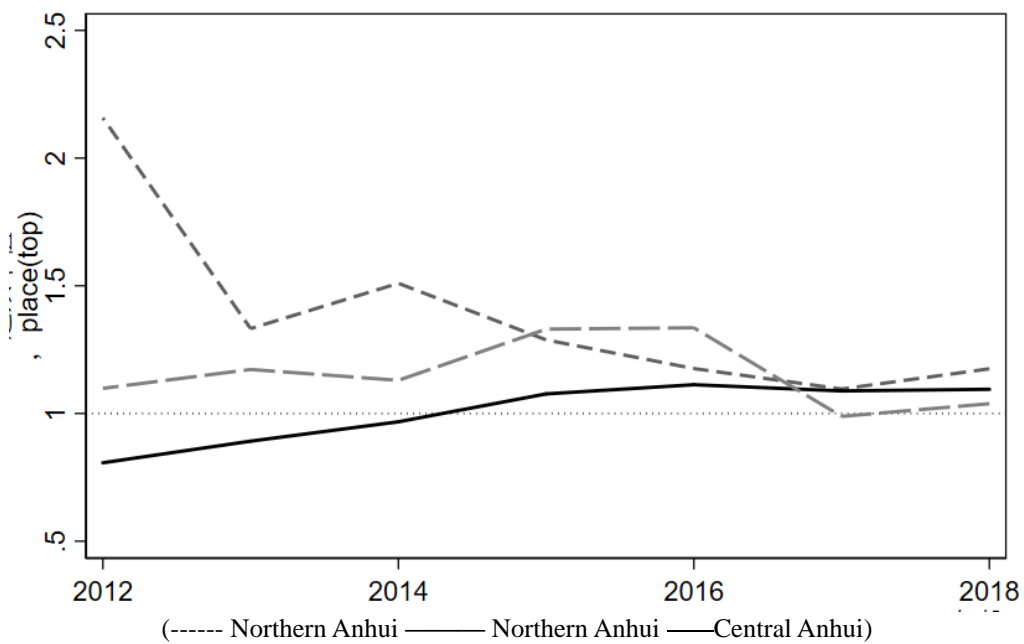
Based on input-output data from 16 prefecture level cities in Anhui Province from 2012 to 2018, DEA-SOLVER software was used to calculate the super efficiency value of tourism development efficiency in Anhui Province by setting non-directional and variable returns to scale. The calculation results are shown in Table 2.

**Table 2. The super efficiency value of tourism development in various prefecture level cities in anhui province**

Zone	Cities	2018	2017	2016	2015	2014	2013	2012	AVG	Ranking
Northern Anhui	HuaiBei	1.991	1.448	0.785	1.439	1.431	1.653	1.471	1.460	3
	Bozhou	1.132	1.145	3.088	2.373	3.482	2.093	7.515	2.976	2
	Suzhou	1.014	1.142	0.508	1.124	1.156	1.193	1.131	1.038	8
	Bengbu	1.287	1.352	1.324	1.205	1.207	1.711	1.094	1.311	6
	Fuyang	1.204	1.125	1.070	1.062	1.110	1.024	1.194	1.113	7
	Huainan	0.422	0.363	0.281	0.526	0.673	0.321	0.540	0.447	16
	AVG								1.391	
Central Anhui	Hefei	1.705	1.689	1.638	1.437	1.261	1.207	1.119	1.437	4
	Anqing	0.554	0.932	1.008	1.281	1.164	1.190	1.026	1.022	9
	Chuchou	1.015	0.625	1.077	1.059	1.028	0.710	0.733	0.892	10
	Luan	1.105	1.107	0.728	0.530	0.417	0.460	0.350	0.671	13
	AVG								1.006	
Southern Anhui	Ma'anshan	0.444	0.442	0.334	0.513	0.511	0.509	0.439	0.456	15
	Wuhu	0.578	0.678	0.510	1.019	1.016	1.006	1.020	0.832	11
	Xuancheng	0.480	0.471	0.450	0.491	0.378	0.566	0.379	0.459	14
	Tongling	1.118	0.600	0.483	1.134	0.760	0.744	0.719	0.794	12
	Chizhou	1.345	1.296	1.268	1.646	1.213	1.356	1.295	1.345	5
	Huangshan	2.265	2.445	4.969	3.178	2.901	2.853	2.738	3.050	1
	AVG								1.156	

From the perspective of each prefecture level city, Huangshan City, as a strong city in tourism development in Anhui Province, has the advantages of Mountain Huangshan, Jiuhua Mountain and other scenic spots to promote the overall development of Huangshan City's tourism industry. Its average efficiency is the first in the

province, reaching 3.05. At the same time, in the tourism development in recent years, its efficiency value is also the first, which has been in the DEA effect for seven years, indicating that Huangshan City's tourism industry input and output structure and resource element allocation are reasonable, and the city has well realized the transition to an ecological civilization green city. As one of the first excellent tourist cities in Anhui Province, Bozhou is a national level historical and cultural ancient city. The average tourism efficiency of Bozhou City ranks second in the province, reaching 2.976, which has greatly developed the city's tourism and cultural industry. However, in recent years, the super efficiency value of tourism development has been continuously decreasing, indicating that the input and output structure of its tourism industry has undergone unreasonable changes. As the capital city of Hefei, its economic development strength ranks first in the province, and the number of tourists and tourism income are also at the highest level in the province. However, its tourism development efficiency ranks third in the province, at 1.437, which is DEA effective. This indicates that Hefei can improve tourism development efficiency by adjusting tourism industry factors and input-output structure. The tourism development efficiency values of Ma'anshan and Huainan are at the bottom of the province, and in the next seven years, their tourism efficiency values are generally less than 0.5, which belongs to DEA inefficiency. Ma'anshan and Huainan are heavy industrial bases in Anhui Province, and have always followed the development strategy led by industry. At the same time, industrial development has a serious impact on environmental pollution, making the tourism industry in a low position in the city, resulting in low tourism development efficiency.



**Chart 1. Regional super efficiency diagram**

From the regional level, Anhui Province is divided into southern Anhui (Huangshan, Wuhu, Ma'anshan, Tongling, Chizhou, Xuancheng), central Anhui (Hefei, Lu'an, Anqing, Chuzhou) and northern Anhui (Bengbu, Fuyang, Huainan, Huaibei, Bozhou, Suzhou) city groups by taking the Yangtze River and Huaihe River as the boundary. From the results in the chart, it can be seen that the tourism development efficiency of other cities in the northern Anhui city group is in the front position, especially Bozhou, Huaibei, and Bengbu. Although the economic development of cities in northern Anhui is not as good as that of southern Anhui and central Anhui, the tourism development in recent years is in the leading position. The efficiency of tourism development in southern Anhui is in the middle, and there is a significant gap in this region, which is specifically reflected in the two cities of Huangshan City, which is dominated by tourism, and Ma'anshan City, which is dominated by heavy industry. Except for Hefei, the tourism development efficiency of the other three cities in central Anhui is relatively low.

Anhui Province is located in the lower reaches of the Yangtze River, in the hinterland of East China, adjacent to the Yangtze River Delta Economic Circle. The province has abundant natural and cultural resources, which

promote economic growth and also drive the development of tourism industry in Anhui Province. According to the analysis of the collected data on the total domestic tourism revenue and the total number of domestic tourists in Anhui Province, it can be seen that the overall development of the tourism industry in Anhui Province is showing a growth trend, and the development trend of the tourism industry in various cities is good.

## **5 Discussion**

Increase the development of tourism resources in strong cities. Hefei, Huangshan, Anqing and Wuhu are strong tourism cities in Anhui Province. Each city should make full use of its own advantages to increase the development of tourism resources. As the capital of Anhui Province, Hefei is the economic center of Anhui Province and has been promoted to a new first tier city. Its unique geographical advantages, resource advantages, and unique transportation conditions make its tourism industry the first in the province. Hefei should make full use of existing resources, further increase the development of the tourism industry, and strengthen connections between various tourism departments.

Improving the tourism system in cities with weak potential, such as Tongling, Ma'anshan, and the northern Anhui urban agglomeration, has relatively small tourism development potential. The development of tourism in these cities and the improvement of their tourism systems should first start from the current situation. Xuancheng, Tongling, and Ma'anshan are located in the southern part of Anhui Province, close to Huangshan and Wuhu, which are strong tourism cities. They have superior geographical conditions. Ma'anshan has the Yangtze River Bridge, which can make full use of its geographical advantages through the Yangtze River Delta, conform to the development trend of the tourism industry, create a tourism system that conforms to its own development, and constantly improve it, give play to its unique industrial advantages, and enhance the popularity of tourism brands.

To promote regional cooperation and development, on the one hand, it is necessary to quickly build transportation routes covering key tourist attractions in our province, achieve interconnection between cities, shorten the travel time between scenic spots, and strengthen the connection between cities, saving tourists as much time as possible for play and rest. On the other hand, it is necessary to connect the tourism products of the cities along the route, reasonably integrate the resources and cultural characteristics of each other, achieve resource sharing, and thus narrow the gap between the north and south.

To promote the joint growth of tourism industry and regional economy, on the one hand, there are many 2A level and above scenic spots in southern Anhui. We should fully utilize this advantage, build tourism brands, continuously promote the internationalization of tourism products, and open up the domestic market to drive the growth of the entire regional economy; The central Anhui region utilizes its geographical advantages to attract more tourists to Anhui for tourism, combining tourism products with industrial characteristics; The northern Anhui region strengthens the improvement of tourism services and customizes a tourism route that suits its own tourism needs, attracting tourists through strengthened services. On the other hand, due to the proximity of Anhui Province to the Yangtze River Delta Economic Zone, it is necessary to fully utilize this geographical advantage, strengthen the connection and interaction with the Yangtze River Delta Economic Circle, continuously expand market demand, create a service system suitable for the development of tourism groups, and achieve good development of tourism groups. At the same time, tourism groups should make full use of existing advantageous resources to provide tourists with comprehensive tourism services, improve their experience, and promote the linkage development of the tourism industry and regional economy through the role of tourists.

## **6 Conclusion**

By using empirical analysis, we compare the inter-city tourism level and find that Huangshan City has the highest average tourism development efficiency in the past seven years, followed by Bozhou. Hefei, the provincial capital, ranked fourth. From the regional point of view, there are 6 cities in northern Anhui, and 5 of them are in the top 50% of the province. It can be seen that the tourism development efficiency of northern Anhui is relatively high, while other cities in southern Anhui, except the famous tourist city Huangshan, are ranked low.

Therefore, to promote the joint growth of tourism industry and regional economy, on the one hand, there are many 2A level and above scenic spots in southern Anhui. We should fully utilize this advantage, build tourism brands, continuously promote the internationalization of tourism products, and open up the domestic market to drive the growth of the entire regional economy; The central Anhui region utilizes its geographical advantages to attract more tourists to Anhui for tourism, combining tourism products with industrial characteristics; The northern Anhui region strengthens the improvement of tourism services and customizes a tourism route that suits its own tourism needs, attracting tourists through strengthened services. On the other hand, due to the proximity of Anhui Province to the Yangtze River Delta Economic Zone, it is necessary to fully utilize this geographical advantage, strengthen the connection and interaction with the Yangtze River Delta Economic Circle, continuously expand market demand, create a service system suitable for the development of tourism groups, and achieve good development of tourism groups. At the same time, tourism groups should make full use of existing advantageous resources to provide tourists with comprehensive tourism services, improve their experience, and promote the linkage development of the tourism industry and regional economy through the role of tourists.

## Competing Interests

Authors have declared that no competing interests exist.

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