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RESEARCH ARTICLE

Analysis of Tourism Economic Efficiency and Its Influencing Factors in the CCEC: An Empirical Study Based on SBM-DEA and Tobit Models

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ABSTRACT

This paper utilizes the Super-Efficiency SBM-DEA model to measure the tourism economic efficiency of various cities in the CCEC and employs the Tobit model to analyze the key factors influencing this efficiency. The findings reveal that the region's tourism economic efficiency has remained relatively stable, with notable exceptions in 2020 and 2021. Factors such as industrial structure and the degree of openness to external markets significantly influence the enhancement of tourism economic efficiency. Accordingly, this paper proposes policy recommendations to optimize tourism economic efficiency in the Chengdu-Chongqing region, with the goal of promoting sustainable regional tourism development.

1. INTRODUCTION

1.1 Research background and significance

The Chengdu-Chongqing Economic Circle (CCEC), located in south western China, encompasses 42 cities and regions across Chongqing Municipality and Sichuan Province, with a total permanent resident population of 112,493,000. Chengdu and Chongqing, as the region's core cities, have populations of 21,268,000 and 28,753,000, respectively. With the release of the "Outline of the Construction Plan for the CCEC," this region has become a key component of China's national strategy, aimed at driving greater economic and social development in the western part of the country. In 2023, the region's Gross Domestic Product (GDP) reached 9,027.869 billion yuan, with the tertiary industry contributing 4,914.147 billion yuan, representing an increase of 7.1%. The tourism industry alone employed 4,193,600 people, attracted 527 million overnight visitors, and generated an added value of 255.112 billion yuan from tourism and related industries.

As the regional tourism industry experiences rapid growth, several critical issues have emerged, including enhancing tourism economic efficiency, reducing resource wastage, improving input-output ratios, and achieving high-quality tourism development. Addressing these issues is essential for fostering sustainable tourism in the region.

Thus, the study of tourism economic efficiency and its influencing factors in the CCEC holds significant theoretical value and offers a scientific basis for policy formulation. This paper constructs an evaluation system for tourism economic efficiency based on the Super-Efficiency SBM-DEA model, providing a comprehensive assessment of the tourism economic efficiency of major cities within the region. Additionally, the Tobit model is applied to conduct regression analysis on the efficiency measurements, identifying key factors influencing tourism economic efficiency and elucidating the causes of efficiency disparities among cities. Finally, tailored policy recommendations for optimizing tourism economic efficiency are proposed, considering the specific conditions of the CCEC.

2. LITERATURE REVIEW

2.1 Overview of theories related to tourism economic efficiency

The core concept of tourism economic efficiency is cantered on maximizing economic output from the tourism industry with limited resource inputs. (Barros, 2005) pioneered the application of Data Envelopment Analysis (DEA) in the study of tourism efficiency, establishing a theoretical foundation for subsequent research. (Hsu et al., 2008) discovered that developed countries tend to exhibit higher tourism economic efficiency, while developing countries often lag due to inefficient resource utilization and insufficient infrastructure development. Scholars have since expanded their research focus to more micro-levels, such as cities and tourist destinations, to explore specific efficiency measurements. (Crouch, Ritchie, 1999) comprehensive evaluation framework for tourism destination competitiveness has provided significant theoretical support for subsequent studies. (Zhou et al., 2019) employed Stochastic Frontier Analysis (SFA) to measure inter-provincial tourism efficiency in China, revealing that uneven resource allocation is a primary factor contributing to regional efficiency disparities.

2.2 Applications of SBM-DEA and Tobit models

2.2.1 Application of the SBM-DEA model in economic efficiency analysis

The Slack-Based Measure Data Envelopment Analysis (SBM-DEA) model is an enhancement of the traditional DEA model, which evaluates the relative efficiency of Decision Making Units (DMUs). Traditional DEA models establish an efficiency frontier through linear programming, against which all DMUs are evaluated (Charnes et al., 1978). The Super-Efficiency SBM-DEA model, introduced by (Tone, 2001), accounts for slack variables in both inputs and outputs, providing a more accurate assessment of the actual efficiency level of DMUs. (Gao et al., 2022) evaluated the tourism efficiency of 30 provinces in China using the SBM-DEA model, identifying environmental factors, tourism resource inputs, and infrastructure construction as the most critical input factors.

2.2.2 Suitability of the Tobit model in studying factors influencing efficiency

The Tobit model is a widely used econometric method designed to address truncated data, making it particularly suitable for regression analysis in studies of efficiency-influencing factors. Tobin (1958) first introduced this model in his research on household expenditure. The Tobit model has since been extensively applied in the context of tourism economic efficiency. Assaf and Josiassen (2012) used the Tobit model to examine internal and external factors influencing tourism enterprises' efficiency and proposed relevant policy recommendations (Assaf, Josiassen, 2012). (Liu et al., 2017) analyzed the factors influencing tourism efficiency in China's coastal cities using the Tobit model, finding that economic development, policy support, and infrastructure construction have a significant impact on tourism efficiency. (Wu et al., 2024) utilized the Tobit model to explore the role of information and communication technology (ICT) in enhancing the sustainable performance of smart tourism destinations, emphasizing undesirable outputs (such as air pollution) and tourist satisfaction as key indicators for measuring destination sustainability.

The study of tourism economic efficiency has evolved into a well-established theoretical system both domestically and internationally. Research on China's tourism economic efficiency has gradually developed a theoretical framework encompassing resource utilization, policy support, market environment, and other dimensions. In terms of research methods, the combination of the SBM-DEA and Tobit models provides robust tools to support the empirical analysis in this study.

3. EMPIRICAL ANALYSIS OF TOURISM ECONOMIC EFFICIENCY IN THE CCEC

3.1 Data sources

This study aims to comprehensively analyze the tourism economic efficiency of the CCEC using data spanning from 2011 to 2023. The primary sources of data include the National Bureau of Statistics, Chongqing Statistical Yearbook, Sichuan Statistical Yearbook, the Sichuan Statistical Bulletin and the Chongqing Statistical Bulletin.

3.2 Construction and analysis of the SBM-DEA model

3.2.1 Selection of indicators

In constructing the SBM-DEA model, it is crucial to define the DMUs and select appropriate input and output indicators. In this study, the CCEC is defined as the DMU. The input indicators include the number of star-rated hotels and the number of travel agencies, while the output indicators consist of tourism revenue and the total number of tourist arrivals (Li, Liu, 2022; Hadad et al., 2012; Bayrak, Bahar, 2018; Li et al., 2020).

Table 1: Efficiency evaluation indicator system

Inputs	Outputs
Number of Star-rated Hotels	Tourism Revenue
Number of Travel Agencies	Total Tourist Arrivals

After compiling the data, the following table presents the original input-output data for the tourism industry in the region over a 13-year period:

Table 2: Original Input-Output Data for the Tourism Industry in the CCEC (2011-2023)

Year	Number of Star-rated Hotels	Number of Travel Agencies	Tourism Revenue (in Billions of RMB Yuan)	Total Tourist Arrivals (in Millions)
2011	679	1004	371.78	5.74
2012	656	969	497.12	7.32
2013	715	1090	567.10	8.12
2014	631	961	689.44	8.86
2015	627	1024	835.23	9.55
2016	515	1031	1035.07	10.84
2017	533	1332	1223.11	12.12
2018	526	1674	1445.69	12.97
2019	543	1915	1733.34	14.08
2020	529	2046	747.92	4.94
2021	482	2169	714.49	5.72

2022	468	2452	818.98	6.23
2023	450	2971	865.03	7.42

The data indicates that, in terms of tourism inputs, the number of star-rated hotels in the CCEC decreased from 679 in 2011 to 450 in 2023 (as shown in Figure 1), while the number of travel agencies increased from 1,004 in 2011 to 2,971 in 2023 (as shown in Figure 2). Regarding tourism outputs, the total tourism revenue in the region rose from 371.782 billion yuan in 2011 to 865.029 billion yuan in 2023 (as shown in Figure 3), and the total number of tourist arrivals grew from 573.6397 million in 2011 to 741.9324 million in 2023 (as shown in Figure 4). Due to the impact of the COVID-19 pandemic, tourism revenue declined by 98.5419 billion yuan and 3.3429 billion yuan in 2020 and 2021, respectively. However, from 2021 onward, the total number of tourist arrivals began to recover, showing year-on-year growth rates of 15.75%, 8.83%, and 19.12% up to 2023, demonstrating the strong resilience of the regional tourism industry.

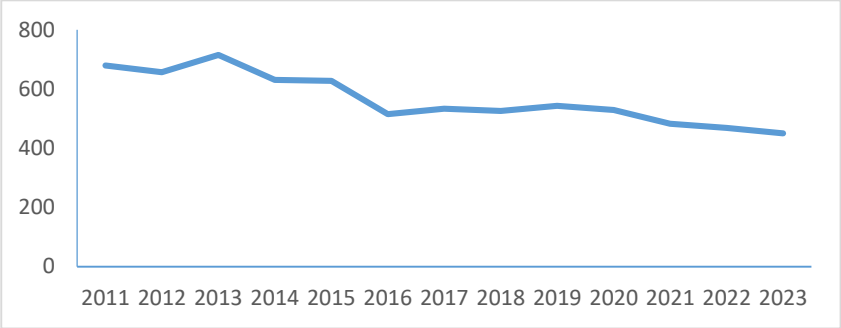

Figure 1: Changes in the number of star-rated hotels in the CCEC (2011-2023)

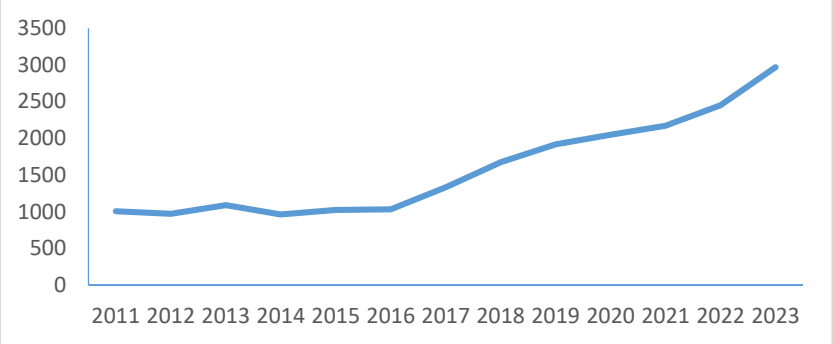

Figure 2: Changes in the number of travel agencies in the CCEC (2011-2023)

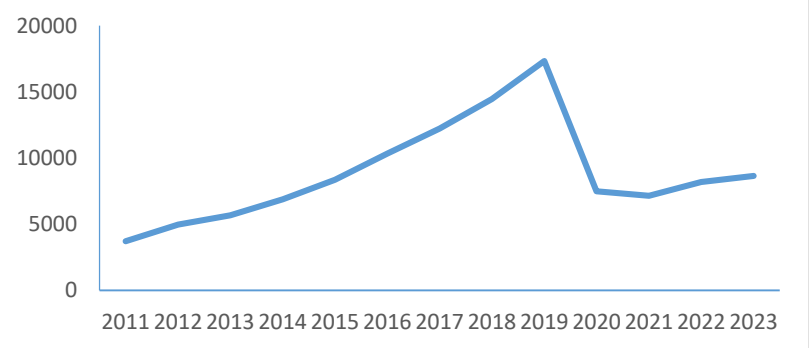

Figure 3: Changes in tourism revenue in the CCEC (2011-2023)

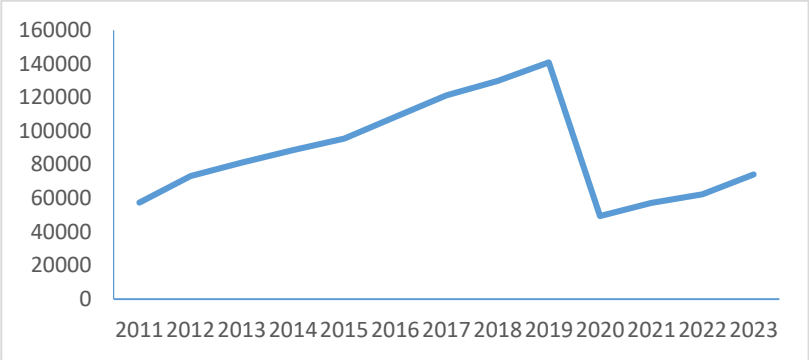

Figure 4: Changes in the total number of tourist arrivals in the CCEC (2011-2023)

3.2.2 Model setup

Assuming there are n DMUs, each with m inputs and s outputs, the input and output data can be defined as follows:

$$x_i = (x_{i1}, x_{i2}, \ldots, x_{im})^T$$
$$y_i = (y_{i1}, y_{i2}, \ldots, y_{is})^T$$
$$X = \{x_1, x_2, \ldots, x_n\}$$
$$Y = \{y_1, y_2, \ldots, y_n\}$$

The SBM-DEA model is designed to evaluate the efficiency of DMUs by considering slacks in both inputs and outputs. The model is formulated as follows:

$$\rho^* = \min \frac{1 - \frac{1}{m}\sum_{i=1}^{m} s_i^- / x_{i0}}{1 - \frac{1}{s}\sum_{r=1}^{s} s_i^+ / y_{r0}}$$

s.t.

$$X\lambda + s^- = x_0$$
$$Y\lambda - s^+ = y_0$$
$$\lambda \geq 0$$
$$s^- \geq 0$$
$$s^+ \geq 0$$

Where:

- ρ represents the efficiency score.
- x_0 and y_0 are the input and output vectors for the DMU under evaluation.
- s_i^+ and s_i^- are the slack variables for inputs and outputs, respectively.
- λ is the intensity variable.
- s^+ and s^- represent input and output slack variables, respectively.

The SBM-DEA model aims to minimize inefficiencies by simultaneously reducing inputs and increasing outputs, incorporating slacks in both directions. If $\rho = 1$, the DMU is considered efficient. A value of $\rho < 1$ indicates inefficiency.

Using the SBM-DEA model, a 13-year evaluation of tourism economic efficiency for the Chengdu-Chongqing Dual-City Economic Circle was conducted. The results are summarized in Table 3.

Table 3: Tourism economic efficiency of the Chengdu-Chongqing dual-city economic circle (2011-2023)

YEAR	TECH	PECH	SECH
2011	0.543444	0.917861	0.59207658

2012	0.718785	0.983623	0.73075253
2013	0.708212	0.797133	0.88844898
2014	0.877318	1	0.877318
2015	0.88733	0.945423	0.93855343
2016	1	1	1
2017	1	1	1
2018	0.99178	1	0.99178
2019	1	1	1
2020	0.44291	0.851226	0.5203201
2021	0.464371	0.981608	0.47307174
2022	0.548204	0.998057	0.54927123
2023	0.63579	1	0.63579

Note: Compiled based on the processing results of MAXDEA.

Comparing the maximum and minimum values from 2011 to 2023, it is evident that tourism economic efficiency within the Chengdu-Chongqing Dual-City Economic Circle has remained relatively stable over the years. Specifically, in 2016, 2017, and 2019, comprehensive technical efficiency, pure technical efficiency, and scale efficiency all reached a value of 1. This indicates constant returns to scale, an optimal state for the tourism industry, and peak scale efficiency. In contrast, comprehensive technical efficiency in 2020 was at its lowest, recorded at 0.44, suggesting that the outbreak of the COVID-19 pandemic severely impacted the regional tourism industry, leading to a significant decline in tourism economic efficiency. However, as the pandemic was gradually contained, the tourism industry within the region rebounded rapidly in 2021 and 2022, with efficiency levels progressively recovering. Overall, the Chengdu-Chongqing Dual-City Economic Circle demonstrates relatively high comprehensive technical efficiency and pure technical efficiency in tourism economics.

Based on the efficiency frontier standards set by the model, the input-output slack variables in the non-oriented mode are presented in Table 4.

Table 4: Slack Variables of Input-Output Indicators in the Chengdu-Chongqing Dual-City Economic Circle (2011-2023)

YEAR	Input Slack Movement (Number of Star-rated Hotels)	Input Slack Movement (Number of Travel Agencies)	Output Slack Movement (Tourism Revenue)	Output Slack Movement (Total Tourist Arrivals
2011	-124.98575	0	2280.49258	0
2012	-143.83346	0	2352.1008	0
2013	-141.39976	0	2434.08789	0
2014	-141.10048	0	1672.542	0
2015	-108.60169	0	815.775444	0
2016	0	0	0	0
2017	0	0	0	0
2018	0	0	630.38927	0
2019	0	0	0	0
2020	0	-110.73364	0	15686.781
2021	0	-297.53382	0	1109.91598

2022	0	-565.4841	0	5483.3621
2023	0	-1075.0608	590.077026	0

If the slack variable for input factors is negative, it indicates input redundancy; conversely, a positive slack variable signifies insufficient input. For output indicators, a negative slack variable indicates output surplus, while a positive one reflects insufficient output. Table 4 demonstrates that, except for the years 2016, 2017, and 2019, the Chengdu-Chongqing Dual-City Economic Circle experienced input redundancy and insufficient output in all other years. Specifically, from 2011 to 2015, there was input redundancy in the number of star-rated hotels, accompanied by insufficient output in tourism revenue indicators. From 2020 to 2022, input redundancy was noted in the number of travel agencies, alongside insufficient output in the total number of tourist arrivals.

4. ANALYSIS OF TOBIT MODEL INFLUENCING TOURISM ECONOMIC EFFICIENCY

To explore the key factors influencing tourism economic efficiency, this paper employs the Tobit model for analysis. The Tobit model is a regression model designed to address the issue of truncated dependent variables. In efficiency analysis, because efficiency scores range from 0 to 1, both lower and upper truncation are present. The specific form of the Tobit model is expressed as follows:

$$y_i^* = \beta x_i + \varepsilon_i$$

$$y_i = \begin{cases} 0 & \text{if } y_i^* \le 0 \\ y_i^* & \text{if } 0 < y_i^* < 1 \\ 1 & \text{if } y_i^* \ge 1 \end{cases}$$

Where y_i^* represents the latent dependent variable, x_i is the vector of explanatory variables, β is the vector of parameters to be estimated, and ε_i is the error term, which is assumed to follow a normal distribution: $\varepsilon_i \sim N(0, \sigma^2)$.

Taking the efficiency values obtained from the SBM-DEA model as the dependent variable, four independent variables were selected to examine their primary influences on tourism economic efficiency in the Chengdu-Chongqing Dual-City Economic Circle. These variables include tourism industrial structure (T), represented by the proportion of tourism's gross domestic product in the regional gross domestic product; economic development level (G), represented by per capita regional gross domestic product; tourism resource endowment (R), represented by the completed mileage of expressways; and the degree of openness to the outside world (E), represented by the proportion of total import and export trade in regional gross domestic product (Haibo et al., 2020; Brida et al., 2014; Cao et al., 2016; Liu et al., 2021). The final form of the regression analysis model is expressed as follows:

$$y_i^* = \beta_1 \ln T_t + \beta_2 \ln G_t + \beta_3 \ln R_t + \beta_4 \ln E_t + \varepsilon_i$$

The Tobit regression results obtained using Stata 17 software are presented in Table 5.

Table 5: Tobit regression results for factors influencing tourism economic efficiency

EFF	Coefficient	Std. Err.	t	P> |t|	95%conf.	interval
T	3.147*** (9.60)	0.328	9.60	0.000	2.391	3.903
G	-0.566 (-2.24)	0.253	-2.24	0.055	-1.149	0.016
R	0.628* (2.34)	0.269	2.34	0.048	0.008	1.248
E	-0.756 (-1.52)	0.499	-1.52	0.168	-1.906	0.396
_cons	1.219 (1.60)	0.761	1.60	0.148	-0.536	2.974

Note: t statistics in parentheses : * p < 0.05, ** p < 0.01, *** p < 0.001

The model results reveal that among the various factors influencing tourism economic efficiency, both the tourism industrial structure and the degree of openness to the outside world pass the significance test, confirming the validity of the selected indicators. Specifically, the tourism industrial structure exhibits a significant positive correlation with economic efficiency at the 0.1% level, suggesting that a larger proportion of tourism within the national economy enhances the comprehensiveness and driving force of the tourism industry, thereby promoting improvements in tourism efficiency. Consequently, regions should continue to deepen economic transformation models and promote the optimization and upgrading of the tourism industrial structure in the future.

Moreover, the degree of openness to the outside world is significantly positively correlated with tourism economic efficiency at the 5% level, indicating that increased openness can facilitate the enhancement of tourism economic efficiency. Therefore, efforts should be made to strengthen international tourism cooperation, optimize inbound tourism policies, and enhance the quality and internationalization of tourism services.

5. CONCLUSIONS AND POLICY RECOMMENDATIONS

This paper employs the SBM-DEA model to measure the tourism economic efficiency of the Chengdu-Chongqing Dual-City Economic Circle from 2011 to 2023 and utilizes the Tobit regression model to investigate the factors influencing tourism efficiency. The results indicate that:

1) The tourism economic efficiency within the Chengdu-Chongqing Dual-City Economic Circle has remained relatively stable over the years. In 2016, 2017, and 2019, comprehensive technical efficiency, pure technical efficiency, and scale efficiency were all equal to 1, indicating that the tourism industry reached an optimal scale. However, the outbreak of COVID-19 in 2020 severely impacted the region's tourism industry, leading to a significant decline in tourism economic efficiency. Nonetheless, the tourism industry quickly recovered in 2021 and 2022, with efficiency levels gradually rising.

2) Tourism economic efficiency is primarily influenced by the industrial structure and the degree of openness to the outside world, with the industrial structure being the most significant factor. This suggests that, in the process of enhancing tourism economic efficiency, priority should be given to industrial structure adjustment while simultaneously expanding openness.

Based on the above empirical analysis, the following policy recommendations are proposed:

a. **Optimize industrial structure and promote integrated development of the tourism industry**
   Increase support for tourism-related industries, particularly the development of special tourism products such as cultural tourism, ecotourism, and red tourism, to enhance the added value of the tourism industry. Promote deep integration between agriculture, industry, and tourism through initiatives such as rural tourism and industrial tourism to enrich the tourism product system and enhance tourist attraction. Encourage and support technological innovation and brand building among tourism enterprises to improve tourism service quality and market competitiveness.

b. **Expand openness and enhance international tourism influence**
   Strengthen exchanges and cooperation with the international tourism market, actively attract foreign investment, and improve tourism infrastructure and service levels. Simplify visa processes and optimize the international tourism service environment to attract more foreign tourists. Organize international tourism cultural festivals, exhibitions, and other events to enhance the visibility and influence of the Chengdu-Chongqing Dual-City Economic Circle in the international tourism market.

c. **Strengthen regional collaboration and promote the integrated development of the tourism economy**
   Establish and improve regional tourism cooperation mechanisms to enhance the sharing of tourism resources and mutual tourist flow between Chengdu and Chongqing, as well as surrounding cities. Promote the integrated development of tourism transportation and

improve the regional tourism transportation network to enhance accessibility. Jointly develop cross-regional tourism routes and products to achieve mutually beneficial outcomes in tourism economic development.

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