

# 동북진흥전략 배경하에서 흑룡강성 관광산업의 효율성 변화

왕뢰\*, 정기영\*\*

중국 통화사범대학교 강사\*, 세한대학교 경영학과 교수\*\*

## The Change of Tourism Industry Efficiency in Heilongjiang Province under the Background of Northeast Revitalization Strategy

Lei Wang\*, Gi young Chung\*\*

Lecturer, Dept. of Economics and Management, Tonghua Normal University, China\*

Professor, Dept. Of Management, Sehan University, Korea\*\*

**요약** 중국 동북진흥전략의 시행과 함께 흑룡강성 관광산업은 지역 경제발전에 점점 더 큰 영향을 미치고 있다. 본 논문은 2005-2021년 흑룡강성 관광 패널데이터를 기반으로 DEA-BCC와 Malmquist Index를 사용하여 관광 산업의 정적 및 동적 변화를 분석하였다. 연구의 결과는 다음과 같다. (1) 정적: OE 값은 2010년, 2013년 및 2019년에 DEA의 강력한 효과에 도달하여 관광 자원이 충분히 활용된 것으로 나타났다. SE 값은 0.354-1 사이에서 급격히 변하고, PTE 값은 1에 가까우며 OE는 주로 SE 변화의 영향을 받은 것으로 나타났다. (2) 동적: 총 요소 생산성(TFP)은 전체적으로 1보다 크고, 연평균 13.8%의 성장률을 보였다. TFP의 변동은 주로 기술진보지수에 의해 영향을 받았으며, 흑룡강성의 관광산업이 상대적으로 높은 수준의 개발 효율성을 보였으며, 자원개발에 기술을 충분히 활용하고 있음을 알 수 있었다. 따라서 흑룡강성 관광산업은 향후 산업규모, 기술혁신 및 정책최적화에 중점을 두는 것이 적절할 것으로 보인다.

**주제어** : 동북진흥전략, 흑룡강성, 관광산업 효율성, DEA-BCC 모델, 맘퀴스트 지수

**Abstract** With the implementation of the Northeast Revitalization Strategy, the tourism industry in Heilongjiang Province had an increasingly greater impact on regional economic development. Based on the tourism panel data of Heilongjiang Province from 2005 to 2021, this paper used DEA-BCC and Malmquist Index to analyze the static and dynamic changes of the tourism industry. The results of the study were as follows: (1) Static: The OE value reached strong DEA effectiveness in 2010, 2013, and 2019, indicated that tourism resources had been fully utilized. The SE value changed dramatically between 0.354 and 1, and the PTE value approached 1. OE was mainly affected by SE changes. (2) Dynamic: The total factor productivity (TFP) was overall greater than 1 and grew at an average annual rate of 13.8%. The variation in TFP was primarily influenced by the index of technological progress, indicated that the tourism industry in Heilongjiang Province made full use of technology for resource development, with a relatively high level of development efficiency. Therefore, the future focus of Heilongjiang Province's tourism industry will be on adjustments in industrial scale, technological innovation, and policy optimization.

**Key Words** : Northeast Revitalization Strategy, Heilongjiang Province, Tourism Industry Efficiency, DEA-BCC Model, Malmquist Index

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Corresponding Author: Giyoung Chung  
(Sehan University)

Email: crose@sehan.ac.kr

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## 1. Introduction

The strategy of revitalizing the Northeast was one of the important development strategies proposed by the 16th National Congress of the Communist Party of China. The goal was to balance the economic development of the eastern, central, western and northeastern regions. This was an important layout for the modernization of the old industrial base in the Northeast and also the development problem of the region after energy shortage was solved. After more than 20 years of efforts to revitalize Northeast China, the country had provided strong policy support from the national level in terms of the introduction of foreign capital, the reform of state-owned enterprises and heavy industry enterprises, comprehensively deepening reforms, and intellectual property strategies. The Chinese government encouraged the Northeast region to adjust its industrial structure and actively developed the tertiary industry, that was to solve the problem of the continuous decline in economic and social benefits of the primary and secondary industries. The tourism industry had given full play to its characteristics of low pollution, high output, and strong economic driving force, became a key industry for the revitalization of the economy and industrial structure adjustment in the Northeast region, and had received great attention from the government and enterprises.

Heilongjiang Province is an important province in the implementation of the strategy to revitalize the Northeast. From the implementation of the strategy in 2003 to 2022, its economic development had achieved outstanding results, with per capita GDP

increasing 4.4 times from 11,615 yuan/person to 51,096 yuan/person. In the process of strategy implementation, tourism had achieved an average annual growth rate of 12.56% in total revenue, and was a key development industry in Heilongjiang Province to adjust the structure of the three major industries and carried out the transformation of heavy industry. China's 14th Five-Year Plan and the Northeast Region Tourism Development Plan issued by the Ministry of Culture and Tourism in 2023 pointed out that the development of tourism focused on high-quality development, that is, the impact of technology on industrial development. The development of tourism industry had shifted from scale development to technological development, and more attention had been paid to the comprehensive efficiency of tourism industry development. This paper takes the tourism development data of Heilongjiang Province from 2005 to 2021 as the research object and scope, and uses DEA-BCC and DEA-Malmquist index methods to analyze the change of tourism efficiency in Heilongjiang Province, hoping that the research results can help provide data reference for the high-quality development of tourism in Heilongjiang Province.

## 2. Literature Review

Tourism industry efficiency focuses on the proportional relationship between the input factors and output results of tourism destinations. Finding the optimal solution for resource allocation and maximizing the output per unit input factor are the main indicators for high-quality tourism development. At present, Chinese scholars' research tends to be macro-field, mainly focusing on the

production efficiency, spatiotemporal changes, and influencing factors of the national and regional tourism industries.

Static and dynamic analysis of tourism industry efficiency. When analyzed the efficiency of the tourism industry, Chinese scholars often used DEA-Malmquist analysis methods for time series data. They conducted static and dynamic analysis of the efficiency of a certain region's tourism industry, deeply analyzed the characteristics of efficiency changes, the actual development of resource allocation and management level, and help to point out the direction for regional tourism development policy formulation. For example, Wang [1] used the DEA-Malmquist model to calculate the efficiency of the tourism industry in six major urban agglomerations in central China, including Jinzhong, Jianghuai, and Poyang Lake, using tourism panel data from 2005 to 2015. The calculation results showed that the annual average TE was 0.712, with a large room for future development. The TFP values were all greater than 1. Technological progress had the greatest impact on the change in TFP value, but technological progress had failed to drive the improvement of technical efficiency. Therefore, the tourism industry in this region urgently needed to transform. Zheng [2] used the DEA-Malmquist model to calculate the three-year cultural tourism efficiency value based on the tourism panel data of 14 cities in Hunan Province from 2016 to 2018. The results showed that the overall efficiency value of the cultural tourism industry in Hunan Province was relatively high, and only a few cities had a certain gap between cultural tourism input and output. The TFP value was mainly affected by the technological progress index and scale

efficiency. The future development of the cultural tourism industry in Hunan Province should pay attention to both scale and technological investment.

Analysis of spatiotemporal changes in tourism industry efficiency. In the study of tourism industry efficiency analysis, some scholars focused on the time and space characteristics of efficiency, analyzed the spatial allocation and management level of tourism resources, explored the development difficulties of the tourism industry, and adjusted the spatial layout of regional tourism. For example, Wang [3] used the gravitational model and social network analysis method, based on the data of China's provincial tourism economic development from 2000 to 2015, and found that China's provincial tourism economic correlation network level was high and the network optimization space was large; Song et al. [4] used the three-stage DEA model and Moran's I index to study the tourism industry efficiency and spatial differences in various provinces in western China from 2014 to 2018, and found that the overall efficiency level of the western region was low and the spatial differences were large, showed obvious spatial agglomeration characteristics. Through the spatiotemporal analysis of the tourism industry, it could be clearly understand the spatial allocation level and layout of tourism resources in the region, which could help the government to make spatial adjustments to industrial investment and improved industrial technical efficiency.

Analysis of factors affecting changes in tourism industry efficiency. Since the tourism industry efficiency value belonged to the interval value, that was truncated data, the TOBIT model was often choosed to analyze

this type of data. For example, Wang et al. [5] took 9 land border provinces and Hainan Island as the research objects, used the DEA-Malmquist index method to measure tourism efficiency, they used the TOBIT model to analyze the influencing factors. The analysis pointed out that transportation level, tourism management level and cultural construction level, which had a significant positive impact on the tourism efficiency of border provinces, while the industrial environment had a certain negative impact on it. In the future, in addition to improving transportation networks and cultural construction, a good industrial environment must be created. Through regression analysis of influencing factors, it can help research subjects clarify the focus of future tourism development and thus improve industrial efficiency.

The research of Western scholars tends to be in the micro field, specific to certain types of enterprises in the tourism industry, such as specific hotels, airline companies, travel agency companies, etc. Barros et al.[6] analyzed hotel efficiency and production growth; Assaf and Barros[7] used A bootstrapped metafrontier approach to analyze hotel efficiency; Zou et al.[8] used the stochastic frontier method to analyze the fuel efficiency of 15 large jet operators in the United States in 2010, the analysis found that tourist mileage and flight departure altitude were highly correlated with fuel consumption; Ram rez-Hurtado and Contreras[9] analyzed the efficiency and influencing factors of Spanish franchise travel agencies. Western scholars mainly choosed efficiency evaluation methods such as DEA, Malmquist Index, and SFA when conducting research on tourism industry efficiency.

To sum up, tourism efficiency measurement in China and the West mainly served the formulation and implementation of national tourism policies, tourism industry development prediction and adjustment, and tourism enterprise development strategies. The use of data analysis methods could improve the accuracy and timeliness of management decisions. However, in the research process, the different setting of input and output indicators, the different internal and external influencing factors in the region, and the availability of data were taken into account, resulted in different results of tourism industry efficiency measurement, which might have a certain impact on the accuracy of the final research conclusions. Therefore, in the setting of input and output indicators, this study took tourism industry data as the standard to reduce the measurement error caused by excessive data range, hoped to more accurately reflect the change of tourism industry efficiency in Heilongjiang Province.

### 3. Research Methods and Data Sources

#### 3.1 Research methods

In this paper's efficiency measurement research, researcher mainly used the DEA-BCC and DEA-Malmquist Index methods to analyze the efficiency of the tourism industry in Heilongjiang Province.

##### 3.1.1 DEA-BCC model

Data Envelopment Analysis was a method for measuring the relative efficiency values of multiple similar decision-making units. It used multiple input and multiple output indicators and used mathematical linear programming methods to analyze data. DEA included two types: CCR and BCC, which were

distinguished based on whether returns to scale were variable. The DEA-BCC model was based on the situation of variable returns to scale and decomposed technical efficiency (TE or OE) into scale efficiency (SE) and pure technical efficiency (PTE), which could more clearly see the efficiency changes brought about by technological progress. Therefore, the DEA-BCC model was more suitable for discovering changes in industrial efficiency. The specific calculation formula of the BCC model was as follows:

$$\theta^* \begin{cases} \sum_{j=1}^{m+n} x_j \lambda_j + s^- = \theta x_0 \\ \sum_{j=1}^n y_j \lambda_j - s^+ = y_0 \\ \sum_{j=1}^n \lambda_j = 1 \\ \lambda_j \geq 0, j = 1, 2, \dots, n; s^+ \geq 0; s^- \geq 0 \end{cases}$$

In the formula,  $\theta$  was the efficiency value of DMU<sub>j0</sub>,  $x_j$  was the input variable,  $y_j$  was the output variable,  $s^-$  and  $s^+$  were the input and output relaxation variables respectively, and  $\lambda_j$  was the weight coefficient of the input and output indicator values.

The comprehensive efficiency  $\theta$  value satisfied  $\theta=1$ , and  $s^-=0$ ,  $s^+=0$ , DEA was strong and effective, reached the optimal value of efficiency; satisfied  $\theta=1$ ,  $s^+=0$  or  $s^-=0$ , DEA was weakly effective, and there was excess input or insufficient output; If  $\theta < 1$ , DEA was ineffective.

### 3.1.2 DEA-Malmquist Index analysis method

DEA-Malmquist Index was an analysis and evaluation method for dynamic changes of technical efficiency based on the measurement of technical efficiency of DEA model. It represented the final result of technological

change according to the total factor productivity (TFP) of different time points or decision units. The data measurement results showed changes in technical efficiency (TE) and technical progress (TC), and technical efficiency (TE) could be divided into the product of pure technical efficiency (PTE) and scale efficiency (SE)[10]. The calculation formula of DEA-Malmquist Index was as follows:

$$MI = TFP(X_{t+1}, Y_{t+1}, X_t, Y_t) = TE(X_{t+1}, Y_{t+1}, X_t, Y_t) \times TC(X_{t+1}, Y_{t+1}, X_t, Y_t)$$

in:

$$MI = TFP(X_{t+1}, Y_{t+1}, X_t, Y_t) = \left[ \frac{D^i(X_{t+1}, Y_{t+1})}{D^i(X_t, Y_t)} \times \frac{D^{oi}(X_{t+1}, Y_{t+1})}{D^{oi}(X_t, Y_t)} \right]^{1/2}$$

$$TE(X_{t+1}, Y_{t+1}, X_t, Y_t) = \left[ \frac{D^i(X_{t+1}, Y_{t+1})}{D^{oi}(X_{t+1}, Y_{t+1})} \times \frac{D^i(X_t, Y_t)}{D^{oi}(X_t, Y_t)} \right]^{1/2}$$

$$TC(X_{t+1}, Y_{t+1}, X_t, Y_t) = \frac{D^{oi}(X_{t+1}, Y_{t+1})}{D^i(X_t, Y_t)}$$

$$MI = TFP = TE \times TC = PTE \times SE \times TC$$

The MI index was used to measure the change in technical efficiency between two time points, two regions or two organizational units. Technological progress (TC) reflected the degree of adoption of new technologies or new production methods, and technical efficiency (TE) reflected the efficiency of resource used in the production process. The MI index results showed that when  $MI > 1$ , the efficiency was improved; When  $MI < 1$ , the efficiency was reduced. When  $MI = 1$ , there was no change in efficiency.

## 3.2 Model indicator selection and data sources

### 3.2.1 Construction of model indicator system

As a comprehensive industry, tourism was affected by various internal and external factors. Its industrial efficiency had the typical characteristics of multiple inputs and

multiple outputs. Therefore, when constructed the tourism efficiency measurement index system, researcher might adhere to scientific principles, the principle of accuracy, through reading and analysis of relevant literature, the input indicators selected in this article are: capital investment mainly considered the number of travel agencies, the number of A-level tourist attractions, the number of star-rated hotels, the number of museums and the mileage of highways in the investment results; The labor input was selected by the sum of employees working in travel agencies, tourist attractions and star-rated hotels [11]. The output indicators included total tourism revenue and the number of tourists. The specific interpretation of input-output indicators was shown in Table 1.

A travel agency was an enterprise legal person that specialized in attracting and organizing tourists to carry out tourism service business(The concept of travel agency originated from the "Regulations on Travel Agencies" promulgated by China's National Tourism Administration in 2009). It satisfied the needs of tourists in tourism activities by providing tourism products and services for tourists. The number of travel agencies directly reflected the scale of tourism development, and could form a tourism industry chain in tourist destinations, thereby increased the attractiveness and competitiveness of destinations and improved the efficiency of the overall tourism industry.

Star-rated hotels usually had higher service standards and richer facilities and equipment to provide a better accommodation experience. Having higher star-rated hotels could improve the accommodation level of the destination, metted the accommodation needs of different

consumers, and then increased the satisfaction of tourists, improved the buyback rate of tourists, and affected the efficiency of the tourism industry.

As the core attraction of tourism destinations, A-level tourist attractions could not only attract a large number of tourists to visit, but also drive the development of other surrounding industries such as hotels, catering, entertainment and retail, and improved tourism development income and tourism efficiency.

Museums usually displayed the cultural and historical heritage of the tourist destination. In the context of the integrated development of culture and tourism, they were more attractive to tourists, and the number of tourists would increase, which would also affect the efficiency of the tourism industry.

Tourism transportation was the lifeblood of tourism development, which was determined by the off-site characteristics of tourism activities. Highways could solve the accessibility problem of tourist destinations and could reflect the current status of tourism development to a certain extent.

The number of tourism employees could reflect the scale and current situation of tourism development, and was one of the important indicators to measure the development of tourism and its impacted on economy and society. At the same time, the change of the number of employees might reflect the influence of the government's support policy or control policy on tourism. In this paper, the sum of the number of employees in travel agencies, tourist attractions and star-rated hotels, which constituted the "three pillars" of tourism, was used as an indicator of labor input.

As an output indicator, total tourism

revenue could reflect the efficiency level of the tourism industry in terms of economy, employment, resource utilization, and service quality. It was one of the important indicators for evaluating the development status and benefits of the tourism industry.

As an output indicator, the number of tourists (10,000 persons) could well measure the efficiency of the tourism industry in terms of market competitiveness, resource utilization efficiency, economic contribution, and marketing and service levels.

[Table 1] Indicator system of tourism industry efficiency measurement in Heilongjiang Province

Indicator type	First level indicator	Secondary indicators	Previous research
Input indicators	Tourism industry input	Number of travel agencies	SHEN Peng-peng.et(2018)[12] Wang Ning, Chen Lan, Luo Zhihui (2019)[13]
		Number of star-rated hotels	SHEN Peng-peng.et(2018)[12] Wang Ning, Chen Lan, Luo Zhihui (2019)[13]
		Number of A-level tourist attractions	WANG Zhao-feng , ZHAO Song-song(2019)[14] Wang Ning, Chen Lan, Luo Zhihui (2019)[13]
	Tourism resource input	Number of museums	WEI Ming,NIAN Sifeng(2023)[15] Yan Pei(2022)[16]
		Traffic input	TAO Chunmei,YANG Xiaoxia,WANG Wenjing(2021)[17] ZOU Quan(2018)[18]
	Labor input	Number of tourism employees	Wang Ning, Chen Lan, Luo Zhihui (2019)[13] Dai Siwei, Dai Zhimin(2023)[19] Dai Siwei, Dai Zhimin(2023)[19]
Output indicators	Tourism income	Total tourism revenue	LIU Shuguang,SHANG Yingshi(2018)[20] SHEN Peng-peng.et(2018)[12]
	Tourism scale	Number of tourists	LIU Shuguang,SHANG Yingshi(2018)[20]

### 3.2.2 Data sources

According to the model index system, this paper mainly selected tourism data from 2005 to 2021. Dued to the impact of the Asian SARS epidemic in 2003, the tourism data in 2003 experienced great fluctuations and began to recover in 2004. Some data in the tourism statistics in 2004 were missing. Therefore, 2005 was chosen as the starting year for the efficiency change of Heilongjiang’s tourism industry after the implementation of the strategy of revitalizing Northeast China. The outbreak of COVID-19 in December 2019 had caused great obstacles to tourists’ travel, led to a downturn in the global tourism industry and great changes in tourism data. This special situation couldn’t fully reflect the law of tourism development. Considered the scientific, accurate and available data as well as the actual situation of China’s tourism data statistics, 2021 was chosen as the end

year of the data study.

The data of this article mainly came from the “China Tourism Statistical Yearbook”, “China Cultural Relics and Tourism Statistical Yearbook”, “China Statistical Yearbook” and Heilongjiang Province’s “National Economic and Social Development Statistical Bulletin”, government work report and other official website related information.

## 4. Analysis of efficiency change of tourism industry in Heilongjiang Province

Before the efficiency analysis, in order to meet the data requirement that the number of decision-making units is 2-3 times the sum of the number of efficiency indicators, this paper adopted the entropy method to set the weights of the number of A-level tourist attractions and museums in the tourism resource input, calculated the tourism resource input index value, and used the same method

to calculate the tourism industry input value to ensure the effectiveness and objectivity of the data.

According to the information analysis in Table 2, the number of input-output indicators were 6 and the sample size was 17, which met the requirements for data

indicators and sample size used the DEA-BCC model. At the same time, Table 2 performs descriptive statistical analysis on specific indicator data. There were no invalid data and missed data, which could meet the efficiency measurement requirements.

[Table 2] Descriptive statistics of tourism efficiency index data in Heilongjiang Province from 2005 to 2021

Indicator items	Sample size	Mean value	Standard deviation
Number of tourism employees	17	38783.882	9901.126
Highway mileage	17	153231.118	24010.373
Tourism resource input	17	255.376	128.921
Tourism industry input	17	346.126	25.555
Total tourism revenue	17	1223.041	672.498
Number of tourists	17	14800.753	6845.37

#### 4.1 Comprehensive efficiency analysis of tourism industry in Heilongjiang Province

As the northernmost province of China, Heilongjiang Province was rich in natural resources such as forests, ice and snow, lakes, volcanic land forms, colorful folk customs resources of the Daur, Xibe, Hezhen, Oroqen, Wenke, Kirgiz and other ethnic minorities, as well as cultural tourism resources with regional characteristics in northeast China. With the implementation of the revitalization strategy of Northeast China, the three major industries in Heilongjiang Province had developed rapidly. In particular,

in order to make up for the impact of the continuous depletion of non-renewable resources on the economy, tourism had attracted more and more attention from the government based on its economic contribution and low-carbon output. This paper measured the efficiency of the tourism industry in Heilongjiang Province from 2005 to 2021, and obtained the efficiency and effectiveness of the tourism industry in Heilongjiang Province from 2005 to 2021 (Table 3) and the change trend of the efficiency and decomposition items of the tourism industry in Heilongjiang Province from 2005 to 2021 (Figure 1).

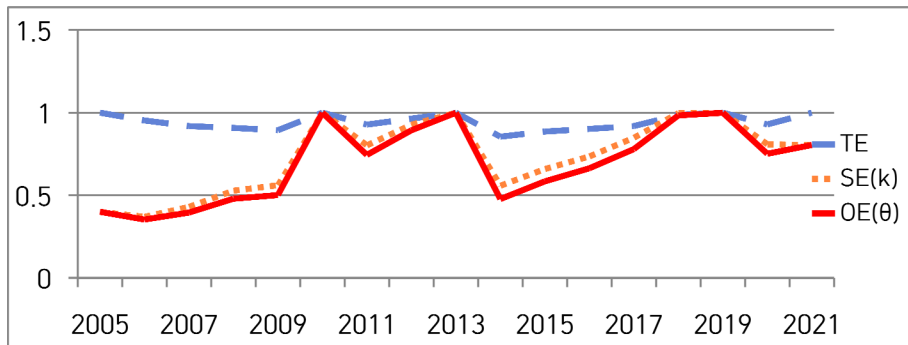
[Table 3] Analysis of efficiency and effectiveness of tourism industry in Heilongjiang Province from 2005 to 2021

years	Pure technical efficiency PTE	Scale efficiency SE(k)	Overall efficiency OE(θ)	Effectiveness	Coefficient of returns to scale	Types
2005	1	0.401	0.401	Non-dea effective	0.166	irs
2006	0.953	0.371	0.354	Non-dea effective	0.253	irs
2007	0.919	0.431	0.396	Non-dea effective	0.31	irs



The Change of Tourism Industry Efficiency in Heilongjiang Province under the Background of Northeast Revitalization Strategy

2008	0.908	0.529	0.48	Non-dea effective	0.406	irs
2009	0.894	0.562	0.502	Non-dea effective	0.469	irs
2010	1	1	1	DEA strong and efficient	1	---
2011	0.928	0.803	0.745	Non-dea effective	0.72	irs
2012	0.964	0.928	0.894	Non-dea effective	0.885	irs
2013	1	1	1	DEA strong and efficient	1	---
2014	0.855	0.559	0.478	Non-dea effective	0.453	irs
2015	0.886	0.66	0.585	Non-dea effective	0.562	irs
2016	0.902	0.736	0.664	Non-dea effective	0.639	irs
2017	0.919	0.849	0.78	Non-dea effective	0.774	irs
2018	0.986	0.998	0.984	Non-dea effective	0.991	irs
2019	1	1	1	DEA strong and efficient	1	---
2020	0.929	0.809	0.752	Non-dea effective	0.74	irs
2021	1	0.805	0.805	Non-dea effective	0.64	irs
mean	0.944	0.732	0.695			



[Figure 1] Change trend of tourism industry efficiency and decomposition items in Heilongjiang Province from 2005 to 2021

From the perspective of comprehensive efficiency, the comprehensive efficiency in 2010, 2013 and 2019 reached the optimum, and the data analysis results showed that DEA was strong and effective. It showed that tourism resources had been fully utilized in these three years, both technical efficiency and scale efficiency had reached the optimum, without excessive input or insufficient output. After the implementation of the Northeast Revitalization Strategy, this

study had divided it into stages every five years starting from 2005, which could be

divided into Stage I (2005–2009), Stage II (2010–2014), Stage III

(2015–2019), and Stage IV (2020 –2021), conducted comprehensive efficiency analysis respectively, it could be seen that the comprehensive efficiency of Stage I was increasing year by year;The efficiency of stage II showed a "U"-shaped change, with large changes, with a maximum value of 1

and a minimum value of 0.478; stage III efficiency showed an upward trend again, developed from 0.585 in 2015 to 1 in 2019, and the development situation was excellent; stage IV the efficiency dropped from the highest value of 1 to 0.752 in 2020, and began to increase again in 2022. The main reason for the drastic changes in comprehensive efficiency was the change in scale efficiency.

From Table 2 and Figure 1, the study found that the technical efficiency value varies between 0.855–1, and the average technical efficiency from 2005 to 2021 was 0.944, the values were all close to 1, indicated that the technical level had developed and remained at a certain level, there was not much room for improvement. The scale efficiency value changed drastically between 0.354–1, according to the formula of comprehensive efficiency = technical efficiency  $\times$  scale efficiency, it could be seen that the comprehensive efficiency of the tourism industry in Heilongjiang Province from 2005 to 2021 was mainly affected by scale efficiency. The scale of the provincial tourism industry continued to expand, and the comprehensive efficiency of tourism was also constantly improving. This conclusion was in line with the provincial conditions of Heilongjiang Province.

The primary and secondary industries in the original industry composition of Heilongjiang Province accounted for a large proportion. They were derived from Heilongjiang's typical "black soil" resources, the "forest" resources of the Greater and Lesser Xingan Mountains and rich minerals. It was an important grain producing area, timber producing area and heavy industry base after the founding of New China.

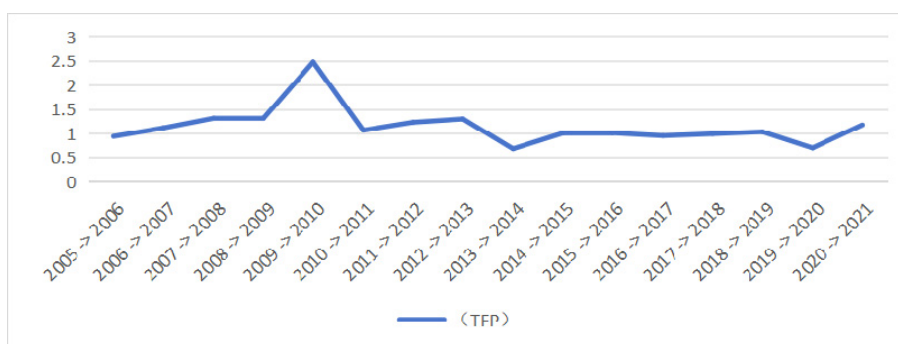
However, with the impact of overuse of land, continued depletion of resources, and the global greenhouse effect, Heilongjiang was in urgent need of industrial structure adjustment. In 2002, the central government began to implement the strategic plan for the revitalization of the Northeast, guided the Northeast region to carry out industrial structural reform. The tourism industry had made great progress with the help of national policies and its own industrial advantage, so the overall efficiency was also constantly improving. Regarding the decline in comprehensive efficiency and returns to scale in stage IV, it was mainly due to the fact that the new coronavirus infection requires people to stay home for protection and was not allowed to go out, which had caused some tourism companies to withdraw from industry in 2020 and 2021, resulting in the reduction of tourism scale, comprehensive efficiency and returns to scale.

#### 4.2 Analysis of total factor productivity of tourism industry in Heilongjiang Province

According to the characteristics of the Malmquist Index, it could dynamically reflect the changes in the efficiency of the tourism industry in Heilongjiang Province from 2005 to 2021. Therefore, the total factor productivity changed in Heilongjiang Province from 2005 to 2021 were obtained in the table (Table 4) and figure (Figure 2).

[Table 4] Changes of total factor productivity of tourism industry in Heilongjiang Province from 2005 to 2021

Years	MI(TFP)	Years	MI(TFP)
2005 -> 2006	0.9339	2013 -> 2014	0.6801
2006 -> 2007	1.1072	2014 -> 2015	1.0001
2007 -> 2008	1.3066	2015 -> 2016	1.0044
2008 -> 2009	1.3063	2016 -> 2017	0.9472
2009 -> 2010	2.4673	2017 -> 2018	0.9863
2010 -> 2011	1.0602	2018 -> 2019	1.0273
2011 -> 2012	1.225	2019 -> 2020	0.698
2012 -> 2013	1.2916	2020 -> 2021	1.1694



[Figure 2] Change trend of total factor productivity of tourism industry in Heilongjiang Province from 2005 to 2021

According to the change law of total factor productivity, 11 of the 16 results of total factor productivity in Heilongjiang Province had MI values greater than 1, indicated that total factor productivity had improved, with the largest increase rate of 88.88% from 2009 to 2010, and the smallest increase rate of 0.43% from 2015 to 2016. In the remaining 5 years, the MI value was less than 1, and the smallest MI value reached 0.68 in 2013–2014, followed by 0.698 in 2019–2020. The two MI values vary greatly. The changes in the MI value from 2013 to 2014 might be related to the Tourism Law of the People's Republic of China, which was promulgated and implemented on October 1, 2013. The Tourism Law regulated tourism operators'

professional behavior, professional qualification requirements, staff professional qualifications and enterprise operations, etc. Standardization began at the legal level, so that the tourism market could be rectified. Enterprises and staff that did not comply with legal regulations would either withdraw from the tourism industry or undergo rectification, resulted in a decline in tourism reception capacity and a regression in total factor productivity. The decrease of MI value in 2019–2020 had a lot to do with the COVID-19 epidemic. The Chinese government required people to work at home as much as possible and could not move across regions, this had led to a significant decrease in the number of tourists, a large number of companies have

withdrawn from the tourism industry, and similarly, a significant decrease in international tourists. In addition, the total factor productivity of 2005–2006, 2016–2017 and 2017–2018 was 0.9339, 0.9472 and 0.9863 respectively, which were all lower than the average MI of 1.138 from 2005–2021, reflected that the efficiency level of tourism resources development and utilization in Heilongjiang Province had a certain decline or stagnation. The contradiction between supply and demand in the tourism industry had become prominent, and then it had entered the stage of promotion.

Similarly, the MI value from 2005 to 2021 was divided into four stages for trend analysis. The MI value of stage I (2005–2009) was the upward climbing stage, which was mainly influenced by the technological progress index. In stage II (2010–2014), MI value showed an "M"-shaped change, mainly due to the influence of technological progress index on MI value. In stage III (2015–2019), the MI value varied from 0.9472–1.0273, and the change trend was slight and linear. In stage IV (2020–2021), the MI value showed an increasing trend under the influence of the technological progress index, while the other indexes change slightly. Therefore, the MI value of Heilongjiang Province from 2005 to 2013 was mainly affected by technological progress, in which the technical efficiency index, pure technical efficiency index and scale efficiency index were all 1, indicated that these three indexes had not changed in 8 years. From 2014 to 2021, the MI index mainly showed slight fluctuations, indicating that both technical efficiency and technological progress had slight changes. However, from the average point of view,

technological progress had the greatest impact on MI value, indicated that Heilongjiang tourism industry made full use of technology to develop resources and had a high level of development efficiency.

## 5. Conclusion and Suggestion

By applying DEA–BCC model and DEA–Malmquist index model to analyze the efficiency of tourism industry in Heilongjiang Province during 2005–2021, it could be seen that:

### 5.1 Research Conclusion

First, the comprehensive efficiency of tourism industry in Heilongjiang Province during 2005–2021 was mainly affected by scale efficiency. As the scale of the tourism industry in Heilongjiang Province continued to expand, the comprehensive efficiency of tourism was also constantly improving, which was closely related to the increase of the proportion of tertiary industry in Heilongjiang Province and the importance of tourism development. By improving the investment of tourism industry and tourism resources, that was, expanding the scale, it could meet the tourism needs of tourists and improved the comprehensive efficiency of tourism industry. This investment benefited from the policy guidance of the implementation of the national Northeast revitalization strategy and the tourism development plan of Heilongjiang Province, which helped enterprises solve the problems of financing channels of shortage of funds, the reserve of human resources and the improvement of quality, and promotes the expansion of the scale of the tourism industry.

Second, the regularity of MI value of

tourism industry efficiency in Heilongjiang Province was not strong, and MI value is mainly influenced by technological progress index. The MI value of Heilongjiang Province from 2005 to 2013 was mainly affected by technological progress, in which the technical efficiency index, pure technical efficiency index and scale efficiency index were all 1, indicated that the three indexes had not changed in 8 years. From 2014 to 2021, the MI index mainly showed slight fluctuations, indicated that both technical efficiency and technological progress had slight changes. However, from the average point of view, technological progress had the greatest impact on MI value, indicated that Heilongjiang tourism industry made full use of technology to develop resources and had a high level of development efficiency.

Third, the static changes of tourism industry efficiency in Heilongjiang Province were affected by scale efficiency, and the dynamic change was affected by technological progress index. This change might be driven by the demand of the rapidly developing tourism market, and tourists' requirements for tourism products or travel experiences should be both deep and broad. Therefore, while expanding the scale of the industry, it was necessary to improve the quality of products, and the technical requirements of tourism products were getting higher and higher, which had spawned many new forms of tourism, such as "health + tourism", "ecological + tourism", "culture + tourism" and so on.

## 5.2 Countermeasures and Suggestions

First, scientific planning of industrial scale and in-depth exploitation of industrial potential. The static tourism industry

efficiency of Heilongjiang Province mainly changes with the change of scale efficiency, indicating that industry scale drives the development of tourism in Heilongjiang Province. However, in the process of scale expansion, to avoid excess investment of capital and human resources, it is necessary to make scientific planning for scale expansion, scientifically investigate the tourism market demand, and adjust and optimize the industrial scale according to the resource characteristics of each region in Heilongjiang Province, so as to improve the positive impact of scale effected on the tourism industry in Heilongjiang Province.

Second, increase investment in science and technology and manpower to promote industrial innovation. The change of dynamic tourism industry efficiency in Heilongjiang Province is mainly affected by the technological progress index, that is, the high technical content of tourism products and the high level of resource development. Therefore, it should continue to carry forward the integration and development of science and technology and tourism resources, and apply digital technologies such as AI and VR to smart scenic spots, smart cities and tourism operations to improve the attractiveness of tourist destinations and enrich the types of tourism products.

Third, optimize tourism policies and promote the efficiency of tourism industry. China's tourism development is dominated by the government, so the tourism policy has a great impact on the development of the tourism industry. In order to continuously improve the efficiency of the tourism industry, the government needs to demonstrate repeatedly when designing policies and formulate them based on the

actual development of local tourism. At the same time, local governments should be given a certain degree of autonomy when implementing policies, simplify administrative procedures, and improve the efficiency of government work.

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### 왕 리 (Wang Lei)



- 2021년 12월~현재, 세한대학교 대학원 경영학과 박사과정
- 2006년 7월~현재, 중국 길림성 통화사범학원 경제관리학원 교사
- 2011년 9월~2013년 6월, 중국 광서대학교 경영대학원 졸업(석사)
- 2002년 9월~2006년 6월, 중국 길림성 통화사범학원 졸업(학사)
- 관심분야: 기업관리, 관광관리
- E-Mail: 173384473@qq.com

### 정 기 영 (Chung Giyoung)



- 1997년 3월~현재: 세한대학교 경영학과 교수
- 1990년 9월~1993년 9월: 금문대학교 대학원 경영학과(경영학박사)
- 1988년 1월~1990년 9월: 코네티컷 브리지포트 대학교 대학원(경영학석사)
- 1984년 9월~1987년 2월: 명지대학교 대학원(경영학석사)
- 1978년 3월~1984년 2월: 조선대학교 공학(공학학사)
- 관심분야: 글로벌 경영 관리, 관리 정보 시스템
- E-Mail: crose@sehan.ac.kr