Hindawi
Mathematical Problems in Engineering
Volume 2023, Article ID 9768629, 1 page
https://doi.org/10.1155/2023/9768629

Retraction

Retracted: Ecological Efficiency Analysis of Ice and Snow Environmental Sports Industry Based on Input-Output Evaluation System

Mathematical Problems in Engineering

Received 1 August 2023; Accepted 1 August 2023; Published 2 August 2023

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] H. Lian and D. Peng, "Ecological Efficiency Analysis of Ice and Snow Environmental Sports Industry Based on Input-Output Evaluation System," *Mathematical Problems in Engineering*, vol. 2022, Article ID 5022761, 9 pages, 2022.

Hindawi
Mathematical Problems in Engineering
Volume 2022, Article ID 5022761, 9 pages
https://doi.org/10.1155/2022/5022761

Research Article

Ecological Efficiency Analysis of Ice and Snow Environmental Sports Industry Based on Input-Output Evaluation System

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Received 21 February 2022; Accepted 6 April 2022; Published 20 June 2022

Academic Editor: Jun Peng

There are still some problems in China's ice and snow environmental sports industry, such as an unbalanced industrial structure and insufficient utilization of ecological resources. In order to achieve leap-forward development, the ice and snow sports industry needs to further optimize the allocation of input-output resources, enhance the overall technical capability, and improve the efficiency level of the industry. This study takes five cities of Heilongjiang, Jilin, Liaoning, Hebei, and Beijing as the research objects, constructs the input-output evaluation system of the ice-snow sports industry, measures the input-output-efficiency level of ice-snow environmental sports industry in China, and studies and analyzes the relationship between efficiency level and industrial input-output. Furthermore, this paper compares and analyzes the traditional total factor productivity and green total factor productivity of the ice and snow environmental sports industry and discusses the influencing mechanism of ecosystem efficiency of the ice-snow sports industry. The results show that the input/output ratio of different regions in 2018 was Heilongjiang (1.12) > Liaoning (1.09) > Beijing (1.08) > Hebei (1.06) > Jilin (0.81). The change in input and output level is the direct influencing factor leading to the change of efficiency, while efficiency is the core to promote the development of the ice and snow environmental sports industry. Comparing traditional and green total factor productivity, it can be found that the GameMaker Language (GML) index of green total factor productivity in Heilongjiang, Jilin, Liaoning, Hebei, and Beijing has increased by 10.50%, 9.59%, 12.22%, 11.34%, and 20.29%, respectively, in 2013. In most cases, the green total factor productivity is higher than the traditional total factor productivity, showing an environment-friendly development. The development of the ice and snow environmental sports industry, talents in the ice and snow tourism industry, urbanization level and promotion of sports cultural products in the ice and snow environment are the main external influencing factors, while the internal influencing factors are mainly reflected in the industrial structure, ownership structure, industrial relevance, industrial agglomeration degree, industrial layout, industrial scale, and differentiation of industrial product.

1. Introduction

In recent years, with the spread of the country to host the Winter Olympic Games, the ice and snow industries, such as sports consumers, venues, and facilities, and transportation services in China have developed rapidly, injecting modern elements of the market economy into ice and snow sports [1]. At present, China's ice and snow environmental sports industry is still in a rising period of development. In order to realize the leap-forward development, it is necessary to further optimize the allocation of input-output resources, improve the overall technical ability, and finally improve the efficiency level of the industry [2].

In the development process of the ice and snow environmental sports industry, ecological environment problems are emerging [3]. For example, the lack of scientific guidance in the development of industrial ecology and the weak awareness of ecological environment protection of industrial subjects have brought damages to the natural ecological environment, such as vegetation destruction, soil erosion, freeze-thaw erosion, waste of water resources, and abnormal regional climate change, which have restricted the

development of ice and snow environmental sports industry to a certain extent [4, 5]. It can be seen that the industrial efficiency is closely related to the ecological environment. Therefore, it is urgent to further improve the efficiency of the industrial ecosystem by optimizing the ecological environment and further promote the harmonious coexistence of the ice and snow environmental sports industry and the natural ecological environment by balancing the relationship between the sports industry and the external ecological environment, so as to promote the healthy development of ecological sports industry in ice and snow environment [6–8].

Based on this, this study takes five cities of Heilongjiang, Jilin, Liaoning, Hebei, and Beijing as the research objects, constructs the input-output evaluation system of the ice and snow environmental sports industry, uses the AHP-CRITIC combination weighting scheme, SBM model, and GML index to measure the input-output efficiency level of China's ice and snow environmental sports industry, and studies and analyzes the influence of technical efficiency, scale efficiency, allocation efficiency, and ecological efficiency on industrial input-output [9–11]. Furthermore, the traditional total factor productivity and green total factor productivity of the ice and snow environmental sports industry are compared and analyzed. Finally, the paper discusses the influencing mechanism of different factors on efficiency, aiming to provide theoretical support for promoting the ecological and healthy development of the ice and snow environmental sports industry.

2. Materials and Methods

2.1. Construction of Index System. This study focuses on the ecosystem efficiency of the ice-snow sports industry in Heilongjiang, Jilin, Liaoning, Hebei, and Beijing from 2015 to 2018 (ecosystem efficiency includes allocation efficiency, technical efficiency, scale efficiency, and ecological efficiency). In order to better measure and analyze the ecosystem efficiency of the ice and snow sports industry, considering the scientificity, availability, and integrity of data selection, this study constructs the input-output evaluation index system of the ice and snow environmental sports industry from the aspects of asset input, scientific research input, environmental protection input, human resource input, and infrastructure input (as shown in Table 1). Among them, input in assets is expressed by fixed assets investment in ice and snow sports, input in scientific research is expressed by capital investment in ice and snow sports, input in environmental protection is expressed by ecological resources, input in human resources is expressed by the number of employees in tourism and manufacturing, and input in infrastructure is expressed by the number of ice and snow gymnasium buildings [3, 12, 13]. There are four output indexes, which are evaluated from the aspects of economic output, scientific and technological innovation, and environmental effect (unexpected output). The economic output includes two output indexes: the added value of ice-snow sports goods manufacturing and the added value of ice-snow sports tourism [14]. The scientific and technological innovation is expressed by the output quantity of scientific and technological innovation achievements, while the environmental effect is expressed by CO^2 emissions, which mainly reflects the impact of energy consumption on the environment. The research data come from the China Statistical Yearbook, the Snow Sports Statistical Yearbook, and the China Energy Statistical Yearbook.

2.2. Weighting of Input-Output Indexes. In this study, the AHP-CRITIC combination weighting scheme is used. Firstly, AHP subjective weighting method is used to calculate and obtain weights ω_i according to the attributes of each input index; secondly, the objective weight τ_i is determined by using the CRITIC subjective weighting method. In the process of data processing, the maximum value and minimum value of each index data from 2015 to 2018 are standardized by the range method (shown in formulas (1) and (2)), and then, the Lagrange multiplier method is used to solve the optimal solution, which is the compound weight ω_{2i} of each index (shown in formula (3)). Finally, the standard data and index weights are processed based on the dimensionless principle, and the input-output evaluation index YIi of ice and snow environmental sports industry is constructed.

$$P_i = k_i \sum_{i=1}^{n} \left(1 - c_{ij}\right), c_{ij} = \frac{\sum_{i=1,j=1}^{i=n,j=m} \left(x_i - \overline{x}\right)\left(x_j - \overline{x}\right)}{\sqrt{\sum_{i=1}^{n} \left(x_i - \overline{x}\right)^2 \times \sum_{j=1}^{n} \left(x_j - \overline{x}\right)^2}}, \quad (1)$$

$$\omega_i = \frac{P_i}{\sum_{i=1}^{m} P_i}, \quad (2)$$

$$\omega_{2i} = \frac{\sqrt{\omega_{1i}\omega_{2i}}}{\sum_{i=1}^{m} \sqrt{\omega_{1i}\omega_{2i}}}, \quad (3)$$

where P_i and k_i are the information amount and variation coefficient of evaluation index i, respectively, c_{ij} is the correlation coefficient of evaluation index i and j, and ω_i and ω_{2i} are the weights and compound weight of each index.

$$YI_i = \sum W_{ij}\omega_{2i}, \quad (4)$$

where YI_i and W_{ij} are the input-output level value and data standardization value of the ice and snow environmental sports industry in different regions.

2.3. Efficiency Measurement Model of Ice and Snow Environmental Sports Industry Ecosystem. In this study, the SBM function model is selected to measure and analyze the efficiency of the ice and snow environmental sports industry ecosystem [15, 16]. This model is a nursing function model based on the mixture of radial and nonradial angles (the model equation is shown in the following (5)). This study constructs a GML index based on the SBM function, aiming at solving the problems of no solution of linear programming and passive improvement of industrial total factor productivity. GML index can be divided into technical progress index (TC) and technical efficiency index (EC). TC is further divided into pure technical efficiency index (PEC)

Table 1: Construction of input-output-efficiency evaluation index system of ice and snow environmental sports industry.

/	Name of the input-output index of ice and snow environmental sports industry	AHP weight	CRITIC weight	Compound weight
Input indexes	X_1 investment in fixed assets of ice and snow sports (10,000 yuan)	0.325	0.228	0.276
	X_2 investment in scientific research of ice and snow sports (10,000 yuan)	0.143	0.196	0.155
	X_3 investment in ecological environment resources of ice and snow sports (10,000 yuan)	0.226	0.187	0.202
	X_4 number of employees in ice and snow sports tourism (person)	0.028	0.057	0.045
	X_5 number of employees in ice and snow sports manufacturing industry (person)	0.174	0.148	0.153
	X_6 number of ice and snow sports gymnasiums (building)	0.104	0.184	0.169
Output indexes	Y_1 added value of ice and snow sporting goods manufacturing industry (10,000 yuan)	0.384	0.324	0.367
	Y_2 added value of ice and snow sports tourism (10,000 yuan)	0.234	0.287	0.251
	Y_3 output of scientific and technological innovation achievements of ice and snow sports (item)	0.249	0.277	0.261
	Y_4 CO_2 emission (10,000 tons)	0.133	0.112	0.121

and scale efficiency index (SEC), and GML = TC×PEC × SEC. When GML index >1, it shows that the green total factor productivity of the ice-snow environmental sports industry increases during the period of $t \sim t+1$; when GML index <1, it shows that the green total factor productivity of ice-snow environmental sports industry decreases; when GML index = 1, it shows that the green total factor productivity remains stable [17, 18]. Finally, the SBM model and GEL index are used to measure the ecological efficiency of the ice-snow environmental sports industry ecosystem in China, and the allocation efficiency, technical efficiency, scale efficiency, and ecological efficiency under different input-output conditions are obtained.

$$\gamma^* = S_V^G\left(x_k^t, y_k^t, a_k^t, g^x, g^y, g^a\right) = \max \frac{1/N\sum_{n=1}^{N} s_n^x/g_n^x + 1/M + I\left(\sum_{m=1}^{M} s_m^y/g_m^y + \sum_{i=1}^{I} s_i^a/g_i^a\right)}{2}, \tag{5}$$

where i γ^* is the efficiency value of ice and snow environmental sports industry ecosystem, g^x, g^y, g^a are the direction variable, which represents the decrease of input, the increase of expected output, and the decrease of unexpected output in ice and snow environmental sports industry, respectively. s_n^x, s_m^y, s_i^a are slack variables, which, respectively, represent input redundancy, insufficient expected output, and overload of unexpected output, and x_k^t, y_k^t, a_k^t represent the input index, expected output, and unexpected output index of k area in t time.

3. Results

3.1. Evaluation and Analysis of Input-Output-Efficiency of Ice and Snow Environmental Sports Industry in Different Regions. By substituting the relevant data of the input level and output level into the SBM function model, the evaluation results of the ecological efficiency of the ice and snow environmental sports industry in different regions are obtained (as shown in Table 2 and Figure 1). It can be seen that Beijing has the highest input and output levels, while Jilin has the lowest one, and the input and output levels of all regions are gradually increasing [19]. The input/output ratio of different regions in 2013 was Liaoning (1.30) > Heilongjiang (1.21) > Hebei (1.06) > Beijing (1.04) > Jilin (0.62). The input/output ratio in 2018 was Heilongjiang (1.12) > Liaoning (1.09) > Beijing (1.08) > Hebei (1.06) > Jilin (0.81). Comparing the efficiency of different regions, it can be seen that in 2013, the technical efficiency (0.8026), scale efficiency (0.8521), allocation efficiency (0.8322), and ecological efficiency (0.8549) in Beijing were the largest, while the efficiency values in Jilin were the smallest. In 2018, the technical efficiency, scale efficiency, allocation efficiency, and ecological efficiency values of various regions have been significantly improved. The efficiency levels of Heilongjiang, Liaoning, Hebei, Beijing, and other regions have shown a competitive upward development trend, which is mainly because these regions take advantage of the policy and accelerate the development of ice and snow sports by hosting international high-level ice and snow sports events. Generally speaking, changes in input and output levels are the direct factors leading to changes in efficiency, while ecological efficiency is the core of promoting the development of the ice and snow environmental sports industry. Technological progress, optimization of ecological resource allocation, and expansion of industrial scale are the main factors to promote the improvement of efficiency level.

3.2. Comparative Analysis of Traditional and Green Total Factor Productivity of Ice and Snow Environmental Sports Industry Ecosystem. Table 3 shows the analysis results of traditional and green total factor productivity of ice and snow environmental sports industry in different regions. It

Table 2: Evaluation results of input-output and efficiency of ice and snow environmental sports industry in different regions.

Time	Area	Input level	Output level	Technical efficiency	Scale efficiency	Allocation efficiency	Ecological efficiency
2013	Heilongjiang	0.212	0.256	0.6156	0.6241	0.6522	0.7421
	Jilin	0.055	0.034	0.5151	0.4652	0.3561	0.3984
	Liaoning	0.235	0.305	0.6249	0.6823	0.7018	0.7253
	Hebei	0.187	0.199	0.7681	0.7781	0.8231	0.7982
	Beijing	0.342	0.356	0.8026	0.8521	0.8322	0.8549
2018	Heilongjiang	0.314	0.352	0.8223	0.9025	0.7786	0.8214
	Jilin	0.155	0.126	0.6051	0.4235	0.5512	0.4925
	Liaoning	0.421	0.458	0.8764	0.8842	0.8221	0.8584
	Hebei	0.322	0.341	0.7681	0.9024	0.8049	0.8165
	Beijing	0.502	0.542	0.9154	0.9257	0.9015	0.9211

can be seen from the table that in 2013, except for Heilongjiang Province, the GML index of traditional and green total factor productivity in all regions was less than 1, among which the GML index of Jilin Province was the smallest. This is mainly due to the uneven economic development of Jilin Province and the insufficient supply of ice and snow sports resources reduced consumers' consumption intention. At the same time, the ice and snow sports industry has failed to integrate with local tourism, culture, and other industries, and making the efficiency of the ice-snow environmental sports industry ecosystem in Jilin Province is low. Comparing traditional and green total factor productivity, it can be found that the GML of green total factor productivity in Heilongjiang, Jilin, Liaoning, Hebei, and Beijing has increased by 10.50%, 9.59%, 12.22%, 11.34%, and 20.29%, respectively, in 2013. Compared with 2013, in 2018, the TC, PEC, SEC, and GML indexes of green total factor productivity in Jilin, Liaoning, and Hebei have been improved to a certain extent, which indicates that the ecosystem efficiency of the ice and snow environmental sports industry in each region is gradually increasing. Beijing's PEC and SEC did not increase, but all other indexes increased. In general, the ice and snow environmental sports industry ecosystem in China is born out of demand, and the green total factor productivity of various regions shows a progressive trend as a whole, but the development trend is unstable due to the influence of various factors. In most cases, green total factor productivity is higher than total factor productivity, showing an environment-friendly development.

3.3. Analysis of the Influencing Mechanism of the Efficiency of Ice and Snow Environmental Sports Industry Ecosystem

3.3.1. External Influencing Factors. Figure 2 shows the analysis of the influencing mechanism of different external factors on the efficiency of ice and snow environmental sports industry ecosystem. Generally speaking, economic development factors, government behavior factors, and ecological environment factors are the external factors affecting the efficiency of the ice and snow environmental sports industry ecosystem. It can be seen from Figure 2(a) that the economic development factors are mainly the external environment that macroscopically affects the ice and snow environmental sports ecosystem, including the development of the ice and snow environmental sports industry (0.523), talents in ice and snow tourism industry (0.212), urbanization level (0.188), and promotion of sports cultural products in ice and snow environment (0.077). The expansion of the development scale, the introduction of industrial talents, and the promotion of related cultural products can improve the scale efficiency and technical efficiency of the ice and snow environmental sports industry. On the other hand, the urbanization level can promote the optimization and upgrading of industrial structure and the technological upgrading of infrastructure, further attract consumers to form clusters, reduce energy consumption, and enhance the allocation efficiency and ecological efficiency of industries. Government behavior plays an essential role in the development of the ice and snow sports environmental industry. From Figure 2(b), it can be found that the factors of government behavior mainly include ice and snow environmental sports industry policy (0.407), financial regulation support (0.203), legal regulation intervention (0.236), and administrative regulation (0.154). By formulating reasonable industrial policies, and through financial, legal, and administrative means, the bad competition of enterprises in subsectors can be effectively avoided while optimizing and adjusting the industrial structure scale and affecting the industrial supply and demand investment structure, thus affecting the ecosystem allocation efficiency, scale efficiency, technical efficiency, and ecological efficiency of ice and snow environmental sports industry. The ecological environment is the basic factor and prerequisite for the healthy development of the ice and snow environmental sports industry (Figure 2(c)). The ecological environment factors mainly include ice and snow resources (0.529), natural ecological environment (0.158), location conditions (0.203), and resource exchange (0.110), which have interactive effects on technology, ecology, scale, and allocation efficiency. Ice and snow resources are an important carrier to carry out sports in ice and snow environment. The natural ecological environment and location conditions will directly affect the mood, behavior, and health of sports consumers. High-quality ecological environment and location conditions are conducive to the agglomeration and development of the ice and snow environmental sports industry and form comparative advantages, so as to attract talents and enterprises to enter and expand the scale and popularity of the industry, thus improving the technology, ecology, and scale efficiency of the industry.

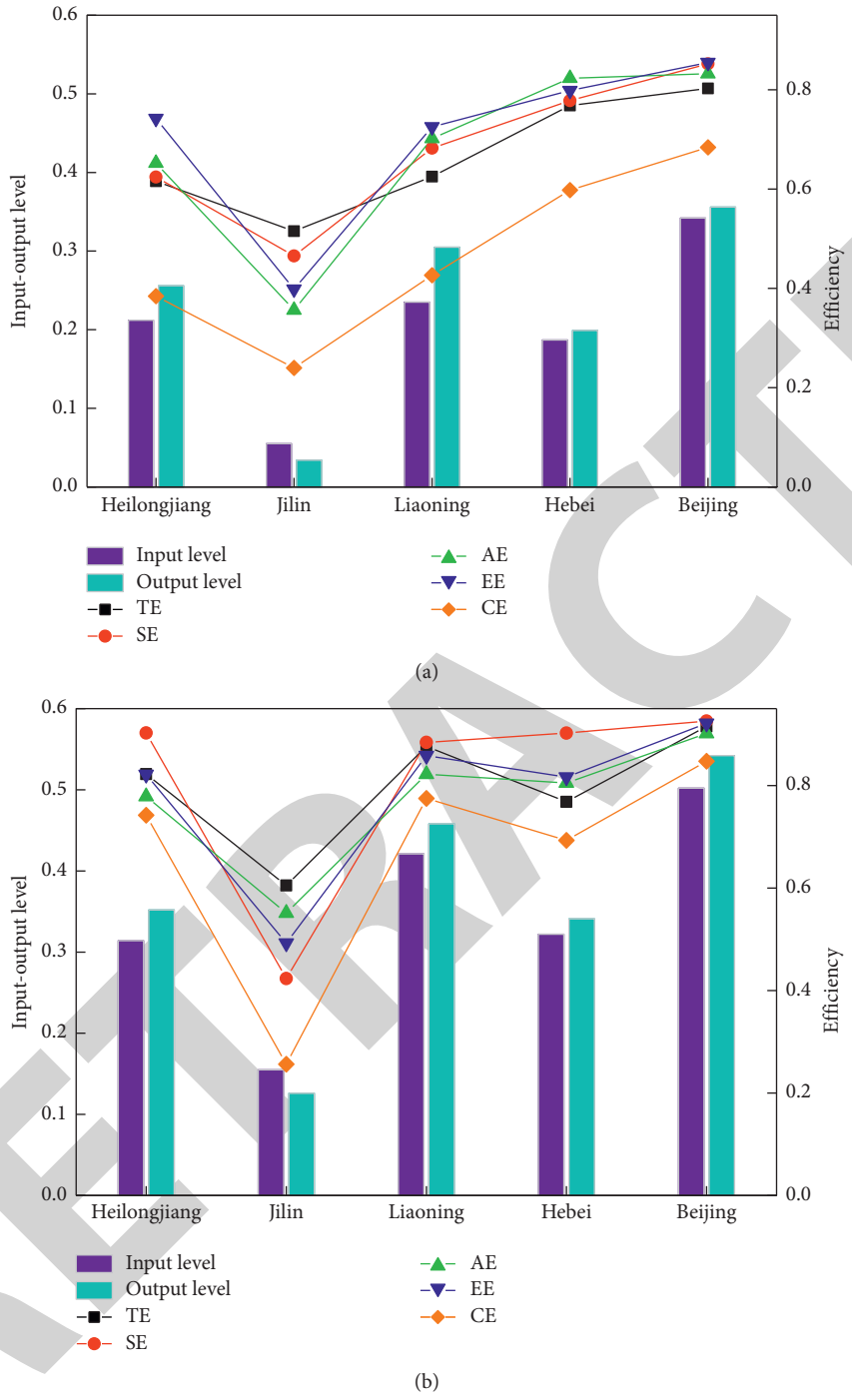
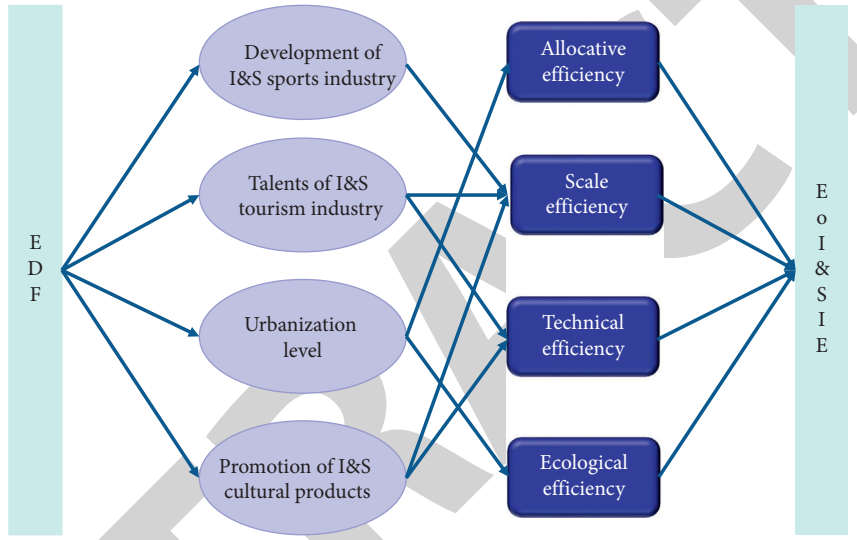


Figure 1: Comparison of input-output and comprehensive efficiency of ice and snow environmental sports industry in different regions. (a) 2013; (b) 2018.

3.3.2. Internal Influencing Factors. Figure 3 shows the influencing mechanism of internal factors on the efficiency of ice and snow environmental sports industry ecosystem. Combined with the above, it can be seen that the input-output of the industry is a vital factor affecting the comprehensive efficiency of the ecosystem. The internal factors of the ice-snow sports industry in this study are mainly reflected in the industrial structure (0.292), ownership structure (0.088), industrial relevance (0.074), industrial agglomeration degree (0.112), industrial layout (0.277), industrial scale (0.101), and differentiation of industrial products (0.056). Industrial structure focuses on the synergy between the sports manufacturing industry and other industries, as well as the synergy between enterprises within the industry. The more reasonable the industrial structure, the more conducive to the promotion of industrial allocation efficiency and technical efficiency. As far as industrial agglomeration, association and layout

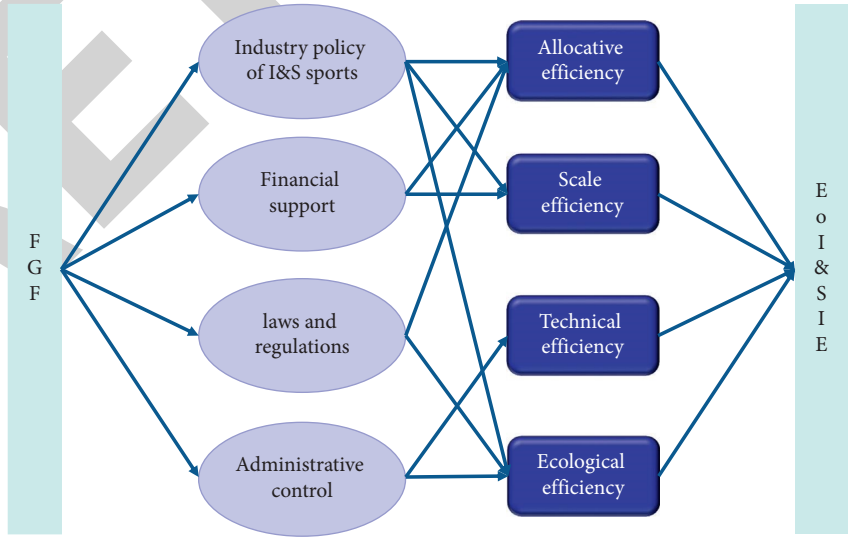
Table 3: Traditional and green total factor productivity of ice and snow environmental sports industry in different regions.

Time	Area	Traditional total factor productivity				Green total factor productivity			
		TC	PEC	SEC	GML	TC	PEC	SEC	GML
2013	Heilongjiang	0.732	1.121	1.324	1.086	0.745	1.232	1.308	1.200
	Jilin	0.694	0.889	0.902	0.557	0.703	0.921	0.942	0.610
	Liaoning	0.783	0.998	1.045	0.817	0.799	1.076	1.066	0.916
	Hebei	0.723	1.021	1.028	0.759	0.757	1.054	1.059	0.845
	Beijing	0.834	1.003	1.006	0.841	0.856	1.023	1.156	1.012
2018	Heilongjiang	0.988	0.962	0.987	0.938	0.991	1.005	1.008	1.003
	Jilin	0.916	0.978	0.947	0.848	0.923	0.983	0.954	0.865
	Liaoning	0.945	0.962	0.987	0.897	0.956	0.978	0.995	0.930
	Hebei	0.918	1.023	0.956	0.898	0.939	1.033	0.971	0.941
	Beijing	0.976	1.000	1.000	0.976	1.023	1.000	1.000	1.023



EDF: Economic development factors
Eo I&S IE: Efficiency of ice and snow sports industry ecosystem

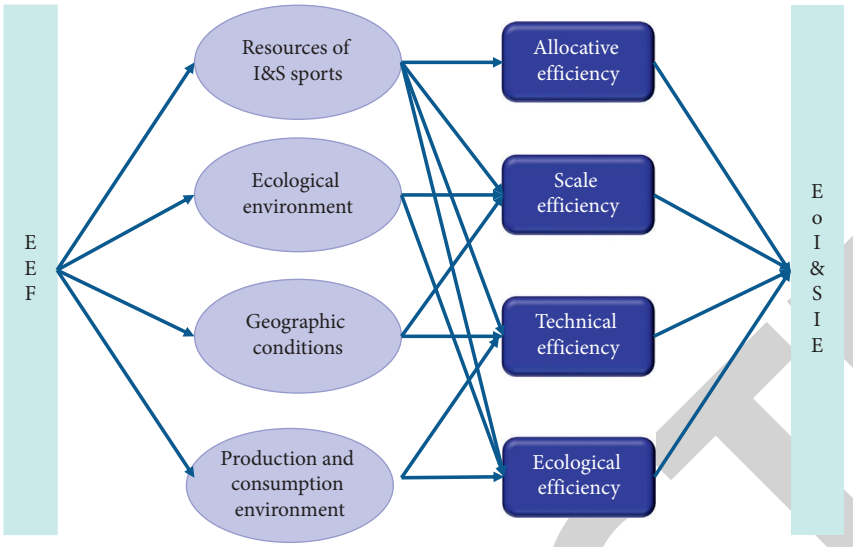
(a)



FGF: Factors of government factors
Eo I&S IE: Efficiency of ice and snow sports industry ecosystem

(b)

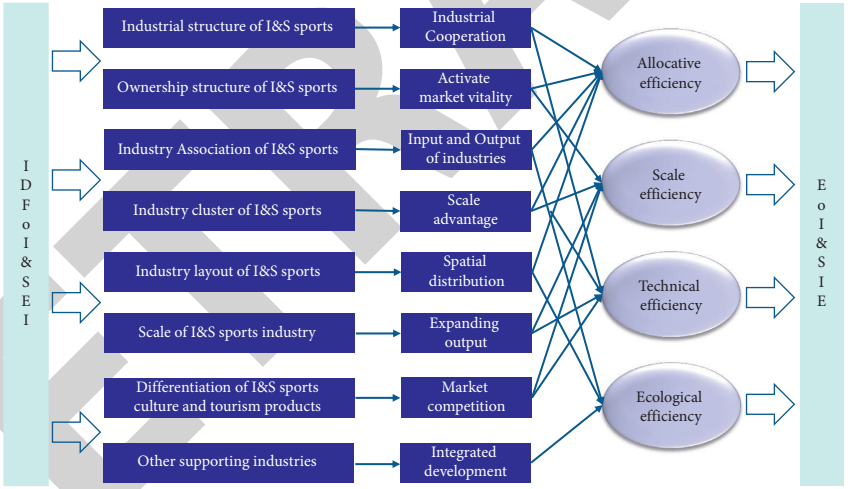
Figure 2: Continued.



EEF: Ecological environment factors
Eo I&S IE: Efficiency of ice and snow sports industry ecosystem

(c)

Figure 2: Influencing mechanism of different external factors on the efficiency of ice and snow environmental sports industry ecosystem. (a) Influence of economic development factors; (b) influence of government behavior factors; (c) influence of ecological environment factors.



IDFo I&S EI : Internal development factors of ice and snow sports industry
Eo I&S IE: Efficiency of ice and snow sports industry ecosystem

Figure 3: Influencing mechanism of internal factors on the efficiency of ice and snow environmental sports industry ecosystem.

are concerned, and the ice-snow environmental sports industry forms a chain of industrial agglomeration covering upstream and downstream based on certain technical and economical associations, and special supply-demand relationship. Among them, ice-snow environmental sports manufacturing and construction belong to upstream enterprises, providing product manufacturing and gymnasium, while tourism and other service industries belong to downstream enterprises, mainly providing different forms of services. In addition, by regulating time, space, and resources among industries, the allocation efficiency, scale efficiency, and ecological efficiency within the system are promoted. However, product differentiation mainly affects the ecosystem efficiency of the industry through the weakening of market competition and the formation of industrial barriers. When the scale economy of the ice and snow environmental sports industry is enhanced, it is easy to form a catalytic effect on the production and trade within the industry and then improve the scale efficiency. On the other hand, the formation of industrial barriers will force small and medium-sized enterprises to enhance technological innovation, improve the technical content and quality of products, and then increase technical efficiency.

4. Conclusion

(1) The efficiency evaluation results of the ice and snow environmental sports industry in different regions show that the input/output ratio of different regions in 2013 was Liaoning (1.30) > Heilongjiang (1.21) > Hebei (1.06) > Beijing (1.04) > Jilin (0.62), while the input/output ratio in 2018 was Heilongjiang (1.12) > Liaoning (1.09) > Beijing (1.08) > Hebei (1.06) > Jilin (0.81). The change in input and output level is the direct factor leading to the change in efficiency, while efficiency is the core of promoting the development of the ice and snow environmental sports industry. Therefore, technological progress, the optimization of ecological resource allocation, and the expansion of industrial scale are the main factors to promote the efficiency level.

(2) Compared with the traditional and green total factor productivity, it can be found that the GML of green total factor productivity in Heilongjiang, Jilin, Liaoning, Hebei, and Beijing has increased by 10.50%, 9.59%, 12.22%, 11.34%, and 20.29%, respectively, in 2013. Compared with 2013, TC, PEC, SEC, and GML index of green total factor productivity in all regions except Beijing have been improved to a certain extent. In most cases, the green total factor productivity is higher than the total factor productivity, showing an environment-friendly development.

(3) The influencing mechanism of ecological efficiency of the ice and snow environmental sports industry reveals that the development of the ice and snow environmental sports industry (0.523), the talents of the ice and snow tourism industry (0.212), the urbanization level (0.188), and the promotion of ice and snow environmental sports cultural products (0.077) are the main external factors affecting the efficiency of ice and snow environmental sports industry ecosystem. Government behavior factors and ecological environment factors are secondary external factors. The internal factors are mainly reflected in the industrial structure (0.292), ownership structure (0.088), industrial relevance (0.074), industrial agglomeration degree (0.112), industrial layout (0.277), industrial scale (0.101), and industrial product differentiation (0.056).

Data Availability

The figures and tables used to support the findings of this study are included in the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

This work was supported by the Heilongjiang Provincial Ordinary Undergraduate Colleges And Universities Young Innovative Talent Training Program Project "Research on the strategy of building a strong ice and snow country in the context of Beijing 2022" (UNPYSCT-2018110), the Heilongjiang Philosophy and Social Science Research Project "Research on the construction path of ice and snow power under the background of 2022 Winter Olympics"(18TYC236), the Heilongjiang Province Higher Education Teaching Reform General Project "Research on collaborative innovation development of Heilongjiang province ice and snow professional talents and universities joint training under the background of 2022 Winter Olympics" (SJGY20190733), the 2018 Heilongjiang Provincial Department of Education basic research business expenses research project (Humanities and social sciences youth innovative talents project) "Promoting China's ice and snow culture industry in the background of the 2022 Beijing Winter Olympics" (135309319), and the Hebei Province "Three Three Three Talent Project" funded project "Research on the path to realize the construction of a powerful ice and snow country under the background of the New Era"(A202101081). The authors would like to show sincere thanks to those techniques who have contributed to this research.

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