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Research Article

Regional Agglomeration Characteristics and Spatiotemporal Evolution of Snow and Ice Sports Industry in Heilongjiang Province from the Perspective of Time and Space

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There are great differences in the regional development of the ice and snow sports industry in China. Most scholars only pay attention to the labor-related data while ignoring the regional spatial differences when calculating the industrial agglomeration level. This study takes the development of the ice and snow sports industry in Heilongjiang Province as the research object, studies and analyzes the agglomeration characteristics and spatiotemporal evolution characteristics of the ice and snow sports industry in Heilongjiang Province, and takes the location quotient as the response index to optimize the agglomeration and spatial layout of the ice and snow sports industry in order to obtain the optimal scheme for ice and snow sports industrial agglomeration and spatial layout. The results show that the spatial Gini coefficient (SGC) has increased from 0.043 in 2005 to 0.062 in 2019, but the overall trend shows periodic agglomeration and relative dispersion. More than 90% of the ice and snow sports output is concentrated in Harbin, Qiqihar, and other four cities, and the industrial geographical concentration (IGC_4) is as high as 94.90%; the location quotient (*LQ*) gradually increased with time. After 2010, the industrial agglomeration level of Harbin surpassed Qiqihar and always ranked first ($LQ_{max} = 3.412$). From 2012 to 2019, the spatial correlation of industrial agglomeration continuously increased ($P < 0.01$), and Moran's I index showed a trend of first decreasing and then increasing with time. The response surface model for optimizing the agglomeration and spatial layout of the ice and snow sports industry is $R = 2.58 + 0.42A + 0.06B - 0.17C + 0.17AB - 0.03AC + 0.035BD + 0.28A^2 - 0.2B^2 - 0.28C^2 - 0.26D^2$, and the optimal scheme is as follows: when the industrial ecological efficiency (IEE) is 0.9, the ratio of tertiary industry to primary industry (PI/TI) is 2.37, industrial pollution index (IPI) is 14.68, energy consumption index (ECI) is 0.57, and LQ can reach the maximum value of 3.386.

1. Introduction

As a new development model of the ecological-oriented industrial structure, industrial ecologicalization improves the utilization efficiency of natural resources from the source of the industry, optimizes industrial production technology in the intermediate process, and then improves environmental pollution control and energy-saving and emission reduction at the end. By adjusting and optimizing the industrial structural function, it can reduce the negative disturbance of industrial manufacturing activities to the ecological environment and finally realize the green, ecological, harmonious, and unified development of the regional economy [1–3].

At this stage, the industrial agglomeration has become an essential feature of the sports industry in China. Under the two-wheel drive of government guidance and market demand, regional industrial agglomeration is an important channel to promote the rapid development of the ice and snow sports industry and enhance regional economic linkage [4]. In this context, the agglomeration of the ice and snow sports industry in China, especially in the northeastern region, has become a concern of the sports industry. Based on the data integrity, qualitative/quantitative analysis of the industrial agglomeration characteristics, and spatiotemporal evolution law, it is of great significance to optimize the overall layout of the ice and snow sports industry, and promote the coordinated development of the regional ice and snow sports and the development of green ecology [5–7]. Since there are great differences in the regional development of the ice and snow sports industry in China, most scholars only pay attention to labor-related data when calculating the industrial agglomeration level but ignore the regional spatial differences [8–11].

Based on this, this study takes the development of the ice and snow sports industry in 13 cities of Heilongjiang Province as the research object. First, the spatial Gini coefficient, industrial geographic concentration, location quotient, and Moran's I index are used as research indexes to study and analyze the agglomeration characteristics and spatiotemporal evolution characteristics of the ice and snow sports industry in Heilongjiang Province [12–14]. Then, taking the location quotient as the response index, the response surface analysis method is used to optimize the agglomeration and spatial layout of the ice and snow sports industry, to obtain the optimal scheme for ice and snow sports industrial agglomeration and spatial layout.

2. Materials and Methods

2.1. Agglomeration Characteristics and Spatiotemporal Evolution Characteristics of the Ice and Snow Sports Industry

2.1.1. Research Objects and Data Sources. In this study, the development of the ice and snow sports industry in 13 cities (46 counties) of Heilongjiang Province is taken as the research object, and the output value of the ice and snow sports goods manufacturing industry is selected as the main analysis index [15, 16]. The data come from the *Heilongjiang Statistical Yearbook*. In order to eliminate the influence of price fluctuation, according to the ex-factory price index of manufacturing industrial products of the ice and snow sports industry in various cities, the corresponding data are offset. Then, taking spatial Gini coefficient, industrial geographical concentration, location quotient, and Moran's I index as research indexes, the agglomeration characteristics and spatiotemporal evolution characteristics of the ice and snow sports industry in Heilongjiang Province are studied and analyzed [17].

2.1.2. Spatial Gini Coefficient. In this study, the spatial Gini coefficient (SGC) is selected to calculate the ratio of the total output value of the ice and snow sports industry in Heilongjiang Province to the total output value of the sports industry [18]. This parameter can reflect the distribution uniformity and spatial agglomeration characteristics of the ice and snow sports industry in Heilongjiang Province from a macroperspective. The calculation formula is as follows:

$$SGC = \sum_{i} \left(c_i - k_i\right)^2. \quad (1)$$

Among them, SGC is the spatial Gini coefficient, C_i is the ratio of the output value of the ice and snow sports goods manufacturing industry in i cities to the total output value of the ice and snow sports product manufacturing industry in Heilongjiang Province, k_i is the ratio of the output value of manufacturing enterprises in i cities t to the total output value of the ice and snow sports manufacturing enterprises in Heilongjiang Province, and the value of SGC is between 0 and 1.

2.1.3. Industrial Geographical Concentration. Industrial geographical concentration (IGC) is an index used to measure the spatiotemporal evolution of industry. This study uses IGC to reflect the proportion of several cities with a large scale of ice and snow sports industry in Heilongjiang Province, which is the application of market concentration in regional economic analysis. The calculation formula is as follows:

$$IGC_n = \frac{\sum_{i=1}^{n} Y_i}{\sum_{i=1}^{N} Y_i}. \quad (2)$$

Among them, N is the total number of all research cities, Y_i is the ice and snow sports output value of i region, IGC_n represents the sum of the proportion of ice and snow sports industry in the top n cities to the total output of the ice and snow sports industry, and the value is between 0 and 1. The value of n in this study is 1, 2, and 4.

2.1.4. Location Quotient. Location quotient (LQ) is mainly used to measure the spatial agglomeration and distribution of elements in the ice and snow sports industry, and the main index parameters to judge whether there is an agglomeration of the ice and snow sports industry [19]. By measuring the total output value of the ice and snow sports industry, added value of the ice and snow sports industry, employment, sales revenue, and other parameters, the calculation formula is obtained as follows:

$$LQ_{ij} = \frac{\left(Qi_j/Q_j\right)}{\left(Q_i/Q\right)}. \quad (3)$$

Among them, Q_{ij} is the output of industry i in J area, Q_j is the total output of the ice and snow sports manufacturing industry in J area, Q_i is the output of the national ice and snow sports goods industry, and Q is the total output of national sports goods industry.

2.1.5. Analysis of Global/Local Spatial Autocorrelation Data. The analysis of global/local spatial autocorrelation data takes spatial correlation measure as the core. Through the data analysis of spatial distribution pattern of phenomena, spatial agglomeration and spatial anomaly are found, and then, the spatial interaction mechanism between research objects can be explained [20]. Among them, global spatial autocorrelation analysis is used to analyze the average correlation degree of research objects in the overall space, which is expressed by Moran's I index (the calculation formula is shown in equation (4)), while the local spatial autocorrelation analysis analyzes the degree of association and the spatial distribution pattern of local spatial regions, which is used to analyze the degree of spatial difference between each region and surrounding regions, and to test whether the high or low values of local regions are clustered in spatial regions, which is expressed by L_i (the calculation is shown in equation (4)).

$$\text{Moran's}I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} C_{ij}\left(Y_i - \overline{Y}\right)\left(Y_j - \overline{Y}\right)}{R^2 \sum_{i=1}^{n}\sum_{j=1}^{n} C_{ij}}, \tag{4}$$

where $R^2 = 1/n\sum_{i=1}^{n}(Y_i - \overline{Y})^2$, $\overline{Y} = 1/n\sum_{i=1}^{n} Y_i$, and Y_i are the observed values of region i, n is the number of regions, and C_{ij} is the spatial weight matrix. Moran's I index ranges from −1 to 1. When Moran's I > 0, it indicates that there is a spatial positive correlation. The larger Moran's I is, the stronger the spatial positive autocorrelation is. When Moran's I < 0, it indicates that there is spatial negative correlation, and the smaller Moran's I indicates that spatial negative autocorrelation is stronger. When Moran's I is close to 0, it shows that the observed value obeys random distribution in space.

$$L_i = \sum_{j=1}^{n} P_{ij}\left(Y_i - \overline{Y}\right)\left(Y_j - \overline{Y}\right), \tag{5}$$

where L_i is the local Moran's I index, Y_i is the observed value of region i, and P_{ij} is the spatial weight matrix.

2.2. Agglomeration and Spatial Layout Optimization of Ice and Snow Sports Industry. This study uses the response surface analysis method to optimize the agglomeration and spatial layout of the ice and snow sports industry. The ice and snow sports industrial agglomeration index is selected as the response value, and the industrial ecological efficiency (A), the ratio of the output value of the tertiary industry to the primary industry (B), the environmental pollution index (C), and the energy consumption intensity (D) are selected as the corresponding variables, in which the environmental pollution index refers to the ratio of the total wastewater, waste gas, and solid waste produced in the production process of ice and snow sports manufacturing industry to the number of manufacturing enterprises, and the energy consumption intensity refers to the standard coal consumed per 10,000 yuan of regional GDP. At last, using Design Expert 10.0 software, the Box-Behnken response surface experimental design was carried out and the experimental results were analyzed. The experimental design scheme is shown in Table 1.

Table 1: Factor-level design scheme of Box-Behnken response surface method.

Experiment factor	Coded value	Factor level and coding design		
		−1	0	1
Industrial ecological efficiency (IEE)	A	0.5	0.7	0.9
Primary industry/tertiary industry (PI/TI)	B	1.9	2.2	2.5
Industrial pollution index (IPI)	C	12.4	15.8	19.2
Energy consumption index (ECI)	D	0.4	0.6	0.8

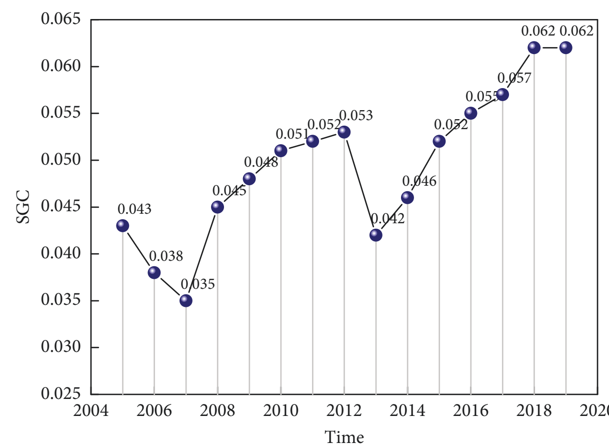

Figure 1: Development trend of spatial Gini coefficient of ice and snow sports industry in Heilongjiang province from 2005 to 2019.

3. Results

3.1. Agglomeration Characteristics and Spatiotemporal Evolution Characteristics of the Ice and Snow Sports Industry

3.1.1. Spatial Gini Coefficient. The larger the spatial Gini coefficient, the higher the industrial agglomeration level, that is, the more uneven the spatial distribution. Figure 1 shows the development of the spatial Gini coefficient in Heilongjiang Province from 2005 to 2019. It can be seen from the figure that during the research period, the agglomeration development of the ice and snow sports industry in Heilongjiang Province presents periodic fluctuations, which can be divided into four stages as a whole. The first stage was from 2005 to 2007, and the SGC dropped from 0.043 to 0.035 in 2007. The second stage was from 2008 to 2012, and SGC increased from 0.035 to 0.053 in 2012. In the third stage, from 2012 to 2013, SGC sharply dropped from 0.053 to 0.042. The fourth stage was from 2013 to 2019, and the SGC increased from 0.042 to 0.062 in 2019. Generally speaking, during the study period, the regional distribution of the ice and snow sports industry showed a fluctuating trend of phased agglomeration and relative dispersion.

3.1.2. Industrial Geographical Concentration. The greater the industrial geographical concentration means the higher the regional concentration of the industry. Table 2 is the calculation of the geographical concentration of the ice and snow sports industry in Heilongjiang Province from 2005 to 2019. It can be found that the geographical concentration of the ice and snow sports industry in Heilongjiang Province is higher during the research period, and IGC_1 and IGC_2 are 25.15% and 71.66% respectively, while IGC_4 is as high as 94.90%, which shows that more than 90% of the ice and snow sports output is concentrated in the top four cities. It

Table 2: Calculation of geographical concentration of the ice and snow sports industry in Heilongjiang Province from 2005 to 2019.

/	2005	2010	2015	2016	2017	2018	2019
IGC_1	22.45	25.22	23.46	25.98	26.12	26.23	26.57
IGC_2	68.85	69.76	70.45	72.11	73.18	73.27	74.02
IGC_4	95.58	94.58	95.09	95.62	95.11	94.89	93.45
Top four cities	Qiqihar, Harbin, Yichun, and Suihua	Qiqihar, Harbin, Yichun, and Suihua	Qiqihar, Harbin, Yichun, and Suihua	Harbin, Qiqihar, Yichun, and Suihua	Harbin, Qiqihar, Suihua, and Yichun	Harbin, Qiqihar, Suihua, and Yichun	Harbin, Qiqihar, Yichun, and Suihua

can also be seen that after 2015, Harbin has always been in the first place, showing a high degree of industrial geographical concentration.

3.1.3. Location Quotient. The location quotient is a relative measure of industrial agglomeration, and it is also a key index to measure the degree of industrial specialization. The larger its value, the higher the degree of specialization and industrial agglomeration in the region where the industry is located. Table 3 shows the calculation of the industrial agglomeration index (IAI) of ice and snow sports in Heilongjiang Province from 2005 to 2019. From the calculation results, it can be seen that the industrial agglomeration index of Heilongjiang Province gradually increases with time, and the development trend is consistent with the development trend of the spatial Gini coefficient mentioned above. Comparing the industrial agglomeration of different cities, it can be found that before 2010, Qiqihar's industrial agglomeration index was always in the first place (maximum $LQ = 2.889$), while after 2010, Harbin's industrial agglomeration level surpassed Qiqihar and was always in the first place (maximum $LQ = 3.412$). The calculation results are also consistent with the calculation results of industrial geographical concentration. At the same time, it can also be found that the agglomeration of the ice and snow sports industry in Heilongjiang Province showed the characteristics of the local transfer before and after 2010.

Table 3: Calculation of ice and snow sports industrial agglomeration index in Heilongjiang province from 2005 to 2019.

2005		2010		2015		2019	
Top 4	*LQ*	Top 4	*LQ*	Top 4	*LQ*	Top 4	*LQ*
Qiqihar	2.859	Qiqihar	2.889	Harbin	2.924	Harbin	3.412
Harbin	2.605	Harbin	2.662	Qiqihar	2.711	Qiqihar	3.025
Suihua	1.885	Suihua	2.551	Yichun	2.107	Yichun	2.314
Yichun	1.258	Yichun	1.248	Suihua	1.435	Suihua	1.522

Table 4: Calculation of Moran's I index among ice and snow sports industrial agglomeration index in Heilongjiang Province from 2005 to 2019.

/	C_1		C_2		C_3	
	Moran's I	*P*	Moran's I	*P*	Moran's I	*P*
2005	0.3876*	0.015	0.1136	2005	0.3876*	0.015
2010	0.3988**	0.008	0.1564	2010	0.3988**	0.008
2011	0.3791*	0.018	0.1098	2011	0.3791*	0.018
2012	0.3213**	0.006	0.0982	2012	0.3213**	0.006
2013	0.3532**	0.005	0.1554	2013	0.3532**	0.005
2014	0.3772**	0.001	0.0321	2014	0.3772**	0.001
2015	0.3913**	0.019	0.0432	2015	0.3913**	0.019
2016	0.4005**	0.025	0.0543	2016	0.4005**	0.025
2017	0.4225**	0.005	0.0176	2017	0.4225**	0.005
2018	0.4434**	0.031	0.0248	2018	0.4434**	0.031
2019	0.4763**	0.007	0.0793	2019	0.4763**	0.007

Note. C_1, C_2, and C_3 are first-order, second-order, and third-order standardized queen adjacency matrices, respectively; *and **mean that it is significant at the level of 5% and 1%, respectively.

3.1.4. Global/Local Spatial Autocorrelation Data Analysis. In this study, Moran's I index was used to further analyze the global/local spatial correlation of ice and snow sports industrial agglomeration level in Heilongjiang Province. Table 4 is the calculation results of Moran's I index among ice and snow sports industrial agglomeration index in Heilongjiang Province from 2005 to 2019. It can be seen from the table that Moran's I index values of industrial agglomeration based on the first-order queen adjacency matrix are all greater than 0, showing a significant difference level, and the spatial correlation of industrial agglomeration has been continuously enhanced since 2012 ($P < 0.01$). Further comparison of Moran's I index in different periods shows that Moran's I index first decreases and then increases with time, which indicates that the difference in ice and snow sports industrial agglomeration in Heilongjiang Province is not randomly generated but caused by the positive spatial correlation between regions. In addition, combined with the calculation results of location quotient, it can be found that the industrial agglomeration indexes of Harbin, Suihua, and Qiqihar are more concentrated and similar, which shows that under the influence of spatial spillover effect, spatial proximity effect can promote the formation of industrial agglomeration to a certain extent. In contrast, Moran's I index value based on the second-order and third-order queen adjacency matrices is obviously decreased, and all the results are insignificant, which indicates that the ice and snow sports industry in Heilongjiang Province presents a development trend that the spatial spillover effect gradually decreases with the increase in spatial geographical distance to a certain extent.

3.2. Analysis of the Agglomeration and Spatial Layout Optimization of Ice and Snow Sports Industry

3.2.1. Results of Variance Analysis. The results of variance analysis of the response surface model for optimizing the agglomeration and spatial layout of the ice and snow sports

Table 5: The results of variance analysis of the response surface model for optimizing the agglomeration and spatial layout of the ice and snow sports industry.

Source	Sum of squares	Df	Mean Square	F Value	P value Prob > F	—
Model	4.59	14	0.33	15.27	<0.0001	Significant
A-IEE	2.15	1	2.15	100.18	<0.0001	
B-PI/TI	0.044	1	0.044	2.04	0.0175	
C-IPI	0.35	1	0.35	16.08	0.0013	
D-ECI	5.76E-03	1	5.76E-03	0.27	0.6126	
AB	0.12	1	0.12	5.67	0.032	
AC	3.60E-03	1	3.60E-03	0.17	0.0385	
AD	0.018	1	0.018	0.82	0.3759	
BC	1.56E-03	1	1.56E-03	0.073	0.6451	
BD	4.76E-03	1	4.76E-03	0.22	0.0415	
CD	1.64E-03	1	1.64E-03	0.076	0.7863	
A^2	0.5	1	0.5	23.28	0.0003	
B^2	0.25	1	0.25	11.77	0.0041	
C^2	0.52	1	0.52	24.32	0.0002	
D^2	0.43	1	0.43	19.89	0.0005	
Residual	0.3	14	0.021			
Lack of fit	0.3	10	0.03	1557.92	<0.0001	Significant
Pure error	7.72E-05	4	1.93E-05			
Cor total	4.89	28				

industry are shown in Table 5. The F value of the model is 15.27, $P < 0.0001$, indicating that the model has very significant differences and high reliability. Therefore, it can be used to optimize the influencing parameters of the industrial agglomeration index. It can be seen from the table that the interaction between IEE, PI/TI and IPI, IEE and PI/TI, IEE and IPI, and PI/TI and ECI in the model is significant. Through regression analysis of the above data, the optimization model for ice and snow sports industrial agglomeration and spatial layout is obtained. The R^2 of the secondary multiple regression equation (equation (6)) is 0.94, indicating a good degree of fitting.

$$R = 2.58 + 0.42A + 0.06B - 0.17C + 0.17AB - 0.03AC + 0.035B\ D + 0.28A^2 - 0.2B^2 - 0.28C^2 - 0.26D^2. \tag{6}$$

In the equation, A, B, C, D, and R represent IEE, PI/TI, IPI, ECI, and IAI, respectively, and their values are all coded values.

3.2.2. Analysis of the Interaction of Influencing Factors. Figure 2 shows the contour map and the 3D model of the response surface under the interaction of two factors. It is found that IEE and PI/TI, IEE and IPI, and PI/TI and ECI have significant interaction effects. The interaction between IEE and PI/TI, and IEE and IPI has a positive promotion effect on IAI, while the interaction between PI/TI and ECI has a negative effect on IPI, that is, the ecological efficiency of industry and the vigorous development of the tertiary industry can promote the agglomeration of the ice and snow sports industry, while the growth of industrial pollution index will have a negative effect on the environment, which is not conducive to the agglomeration and development of the ice and snow sports industry. Further comparison shows that the development of ecological agglomeration and industrial pollution and energy consumption of the ice and snow sports industry are mutually restricted. This also suggests that in the future industrial developments, we should not only consider the development of industrial green ecology but also promote the technological development of the green industry with high-tech content. Furthermore, it is necessary to further optimize the existing industrial structure, reduce the proportion of the first industry with high energy consumption, high pollution, and lower added value, increase the development of the tertiary industry of ice and snow sports industry, actively guide the industry to gather into green ecological industrial parks, and enhance the industrial aggregation capacity of key cities.

3.2.3. Solution for the Optimization Scheme of Ice and Snow Sports Industrial Agglomeration. According to the fitting results of the regression equation and the interactive analysis results of influencing factors, taking the maximum value of location quotient as a setting, the optimization scheme of ice and snow sports industrial agglomeration and spatial layout is solved (as shown in Table 6 and Figure 3). It can be seen from Table 6 that by comparing the location quotient, schemes 1–4 have realized the optimization of ice and snow sports industrial agglomeration and spatial layout in different degrees, among which scheme 1 has realized the optimization of industrial agglomeration and spatial layout to the greatest extent, with the maximum location quotient of 3.386, and the simulation values of the corresponding influencing parameters are IEE = 0.9, PI/TI = 2.37,

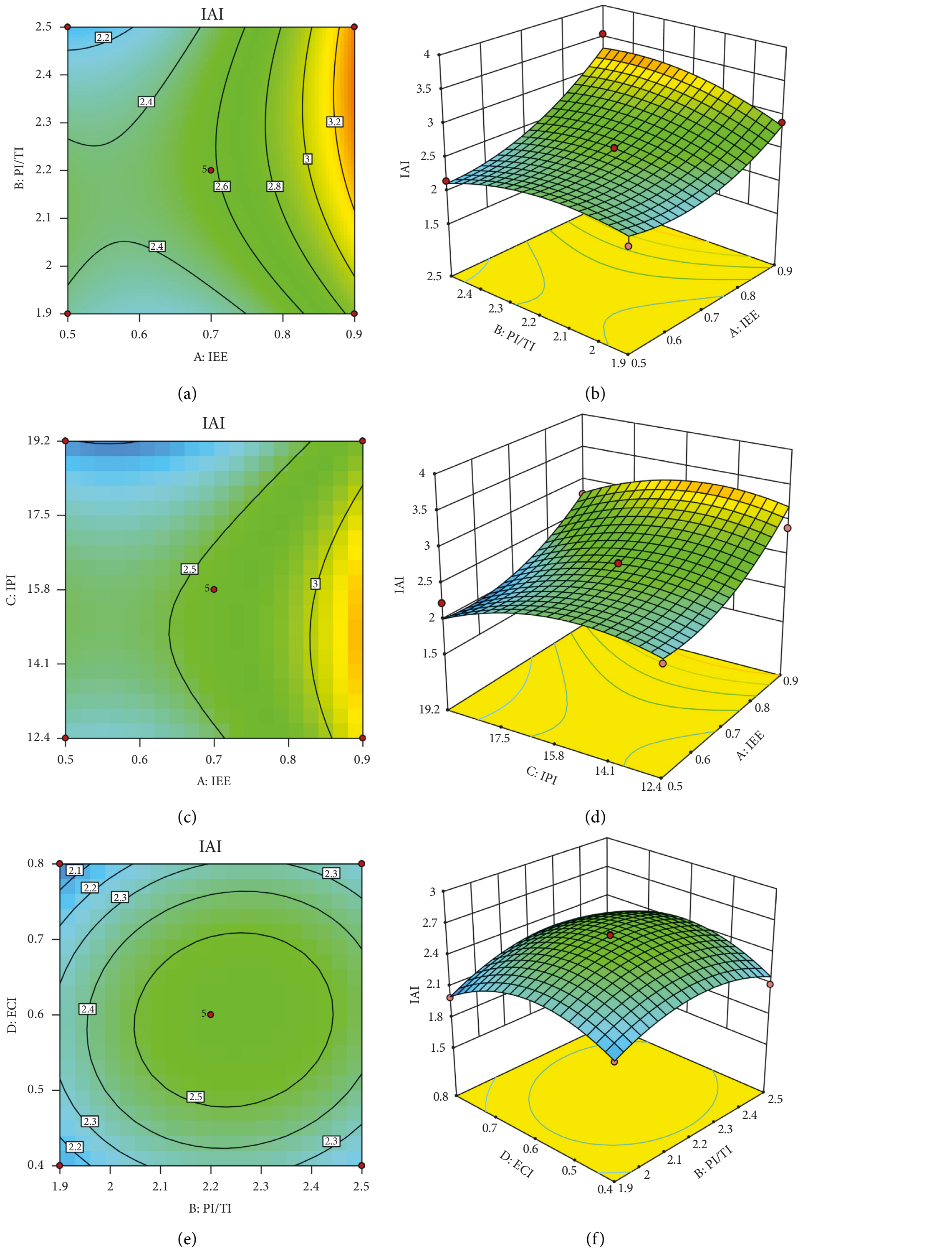

Figure 2: Response surface contour map and the 3D model under the interaction of two factors. (a) The 3D model of interaction between AB factors. (b) Contour map of interaction between AB factors. (c) The 3D model of interaction between AC factors. (d) Contour map of interaction between AC factors. (e) The 3D model of interaction between BD factors. (f) Contour map of interaction between BD factors.

IPI = 14.68, and ECI = 0.57, respectively. In comparison, the industrial ecological efficiency of schemes 2, 3, and 4 gradually declines, and the corresponding location quotient also gradually decreases, which indicates that while the industrial agglomeration and spatial layout optimization of the ice and snow sports industry are rapidly promoted, and the industrial ecological efficiency, as the core concern index, plays a key role. In addition, from the simulation results of interaction optimization, it can be seen that the optimization of location quotient needs to balance the relationship

Table 6: Results of optimization scheme for the agglomeration and spatial layout of the ice and snow sports industry.

Schemes	IEE (A)	PI/TI (B)	IPI (C)	ECI (D)	IAI (E)
Scheme 1	0.90	2.37	14.68	0.57	3.386
Scheme 2	0.78	2.36	14.68	0.58	3.134
Scheme 3	0.74	2.37	14.68	0.58	3.098
Scheme 4	0.69	2.37	14.67	0.58	2.996

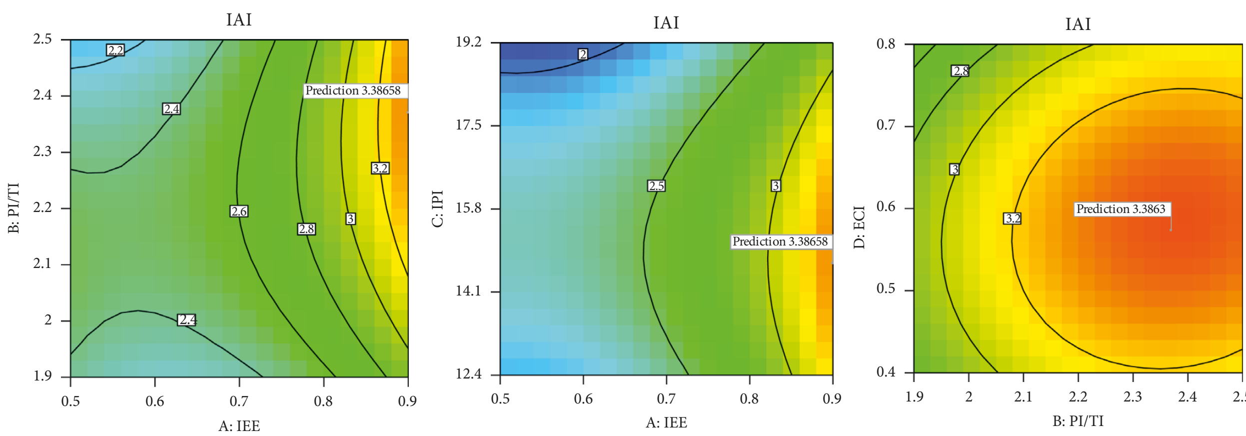

Figure 3: Simulation results of agglomeration and spatial layout optimization of ice and snow sports industry.

between negative effects such as industrial pollution index and energy consumption index, and further optimize the existing ice and snow sports industrial pattern, so as to promote the ice and snow sports industry to gather and develop into high-tech and green ecological industrial parks.

4. Conclusions

(1) The results of the agglomeration characteristics and spatiotemporal evolution characteristics of the ice and snow sports industry show that SGC has increased from 0.043 to 0.062, but the whole shows the fluctuation trend of periodic agglomeration and relative dispersion. More than 90% of the ice and snow sports output is concentrated in Harbin, Qiqihar, and other four cities, and IGC_4 is as high as 94.90%.

(2) The calculation results of the location quotient of the ice and snow sports industry in Heilongjiang Province show that the location quotient gradually increases with time. After 2010, the industrial agglomeration level of Harbin surpassed Qiqihar and always ranked first (maximum LQ = 3.412), and the ice and snow sports industrial agglomeration in Heilongjiang Province showed the characteristics of local regional transfer around 2010.

(3) The analysis results of global/local spatial autocorrelation data show that Moran's I index values of industrial agglomeration based on the first-order queen adjacency matrix are all greater than 0, showing significant differences. During the period of 2012-2019, the spatial correlation of industrial agglomeration continuously increased ($P < 0.01$), and Moran's I index showed a trend of first decreasing and then increasing with time.

(4) The response surface model for optimizing the agglomeration and spatial layout of the ice and snow sports industry is $R = 2.58 + 0.42A + 0.06B - 0.17C + 0.17AB - 0.03AC + 0.035BD + 0.28A^2 - 0.2B^2 - 0.28C^2 - 0.26D^2$, and the optimal scheme is as follows: when IEE = 0.9, PI/TI = 2.37, IPI = 14.68 and ECI = 0.57, the location quotient reaches the maximum, which is 3.386.

Data Availability

The labeled datasets used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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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 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).

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