

Evaluation and Research on Urban Carbon Peak Development in China from the Perspective of Green Finance

-- Empirical Study based on Sample Data from Pilot Cities

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Abstract

In September 2020, China first proposed carbon peak, and China's green finance development ushered in new development opportunities. Based on the important influence and role of cities in the national carbon emission reduction work, and under the background of green finance, this paper evaluates and studies the carbon peak development of pilot cities of low-carbon economy in China. This paper first takes low carbon pilot cities as samples, incorporates green finance into the influencing factors of carbon peaking, and constructs indicators of urban green finance development degree through entropy method. Secondly, factor analysis is used to summarize the relevant factors that affect the carbon peak development process of pilot cities, and a comprehensive ranking and evaluation of factor scores are given for the selected sample cities. Once again, by using cluster analysis to understand the types, characteristics, and differences of carbon peak trends in sample cities, local governments can design and carry out differentiated carbon peak actions to promote energy conservation and emission reduction in pilot cities. Finally, suggestions and suggestions are proposed to accelerate China's efforts to achieve carbon peak targets.

Keywords

Carbon Peaking; Factor Analysis; Cluster Analysis; Entropy Method.

1. Introduction

In recent years, the severe changes in global climate have led to a series of natural disasters, causing a sharp deterioration of the future living environment for humanity. In the face of the common challenges of human survival, all countries should adopt positive policies, vigorously develop green finance, actively promote carbon peaking, carbon neutrality, and build a dual cycle development pattern at home and abroad. However, due to the different basic situations in different countries, scholars from each country have different perspectives on the development of carbon peaking in each country, and different countries have also introduced corresponding policy measures. For example, the EU has a sound carbon neutrality policy system for carbon peaking, Germany is the country most actively implementing the energy transition, the UK is the first country in the world to legislate on emission reduction targets, the United States returns to climate diplomacy in uncertainty, etc., and China has also clearly proposed the goal of "carbon peaking" by 2030 as early as September 2020.

At present, China's carbon emissions have not yet reached the peak. In terms of research on carbon peaking in the context of green finance, there are few existing relevant literature in China on the analysis and evaluation of the development of carbon peaking in low-carbon pilot cities. Therefore, in order to accelerate the goal of achieving urban carbon peaking in China as soon as possible, this article will select 15 low-carbon economy pilot cities in China as research samples, conduct factor analysis and cluster analysis on the corresponding indicators, combine with the domestic development status, conduct a comprehensive evaluation of China's carbon peaking development, and propose corresponding opinions and suggestions on China's existing system policies to promote the development of China's carbon peaking process.

2. Research Methods

2.1. Entropy Method

The main principle of entropy method is to determine the weight of each index by using the variation degree of the selected index. Its information utility can be observed according to the information entropy of the selected evaluation index. Generally, the larger the information entropy is, the greater the index weight is, and the greater the information utility it carries; At the same time, entropy method can also be used to determine the degree of dispersion of indicators in the indicator system. Generally, the greater the degree of dispersion is, the greater the impact on the evaluation system.

2.2. Factor Analysis Method

Factor analysis mainly extracts common factors (relatively independent new variables) from the original variable group by linearly recombining the original variables. These recombined common factors have the meaning of comprehensive indicators and can replace the original variables, making it easier for researchers to grasp the key points of complex problems when studying multivariate complex problems, which is conducive to problem analysis and processing.

2.3. Cluster Analysis Method

The main purpose of cluster analysis is to identify the relationships between data objects, group the original data, and classify them based on the properties and characteristics of the original data. Those with similar original data are classified into one category, while those with significant differences in properties are classified into different categories. It can intuitively display the similarities and differences between various objects, and has less limitations and strong operability when applied.

3. Empirical Analysis

3.1. Construction of Indicator System

On the basis of reading a large amount of relevant literature, the author draws on the existing indicator system for predicting and estimating urban carbon peak, and constructs an evaluation indicator system based on relevant literature. Ten indicators are selected from four aspects of urban green finance development level, economic development level, urban population size, industrial structure and energy environment to evaluate the carbon peak development of low-carbon pilot cities. See Data Table 1.

Table 1. Indicator Evaluation System

Primary indicators	Secondary indicator code	Secondary indicators
Development level of green finance	X1	Green finance Index
Level of economic development	X2	Energy conservation and environmental protection expenses/100 million yuan
	X3	Energy conservation and environmental protection growth rate/%
	X4	Year-end total GDP/100 million yuan
	X5	GDP year-on-year growth rate
Urban population size	X6	Year-end resident population in the region/10000 people
	X7	Average annual growth rate of population/%
Industrial Structure and Energy Environment	X8	Total social electricity consumption/10000 kW • h
	X9	Industrial added value/100 million yuan
	X10	Increase rate of added value in industries above designated size/%

3.2. Data Source

Due to the fact that some provinces and cities have not yet released data for 2022, this article is mainly based on relevant data from 2021. It is mainly sourced from authoritative institutions such as national and provincial statistical bureaus, Ministry of Science and Technology, Ministry of Finance, People's Bank of China, and various authoritative statistical yearbooks, For example, the China Science and Technology Statistical Yearbook, the China Energy Statistical Yearbook, the China Financial Yearbook, the China Industrial Statistical Yearbook, and the China Tertiary Industry Statistical Yearbook.

3.3. Research Process

First, the entropy method is used to measure the development level of green finance in 15 selected pilot cities, so as to quantify the development level of green finance in each pilot city; Secondly, after quantifying the level of green development, factor analysis is used to evaluate and analyze the scores of various factors in the carbon peak development level of pilot cities; Then, cluster analysis is used to classify and discuss the similarities and differences of different categories; Finally, corresponding opinions and suggestions are given through comprehensive evaluation.

3.3.1. Use Entropy Method to Evaluate the Development Level of Green Finance

(1) Construct the evaluation index system of green finance development level

Since it is difficult to measure the development level of green finance, this paper builds a comprehensive evaluation system by referring to relevant literature, as shown in Data Table 2:

Table 2. Evaluation Index System of green finance Development Level

Primary indicators	Secondary indicators	Third level indicators	Definition of tertiary indicators
Development level of green finance	Green credit	Proportion of environmental protection project credit	Total credit for environmental protection projects in the province/total credit for the province
	Green investment	Proportion of investment in environmental pollution control to GDP	Environmental pollution control investment/GDP
	Green insurance	Extent of promotion of environmental pollution liability insurance	Environmental pollution liability insurance income/total premium income
	Green bonds	Development level of green bonds	Total issuance of green bonds/total issuance of all bonds
	Green support	Proportion of fiscal environmental protection expenditure	Financial environmental protection expenditure/general budget expenditure
	Green Fund	Proportion of green funds	Total market value of green funds/total market value of all funds
	Green rights	Depth of green rights development	Total amount of carbon trading, energy trading, emission trading/equity market transactions

(2) Green finance index estimated by entropy weight method

① Data standardization processing. Due to the differences in the units of different indicators, in order to enable the synthesis of indicators from different units, it is first necessary to standardize the calculation formula as follows.

$$R_{ij} = \frac{X_{ij} - \min(X_{ij})}{\max(X_{ij}) - \min(X_{ij})} \tag{1}$$

Among them: i represents a low-carbon pilot city; j represents various indicators; X_{ij} is the jth indicator of the i-th pilot city; R_{ij} represents the standardized value of the jth indicator for the i-th low-carbon pilot city.

② Calculate the relevant proportion of the jth project indicator in the i-th city.

$$P_{ij} = \frac{R_{ij}}{\sum_{i=1}^n Y_{ij}} \tag{2}$$

Where, $i=1, \dots, n$; $j=1, \dots, m$.

③ Calculate the information entropy of each index.

$$U_{ij} = -\ln(n)^{-1} \sum_{i=1}^n P_{ij} \ln P_{ij} \tag{3}$$

Among them, $U_j \geq 0$. If $P_{ij}=0$, define $U_j=0$.

④ Calculate the coefficient of difference for each indicator.

$$d_j = 1 - U_j \tag{4}$$

⑤ Determine the weight of each indicator.

$$W_j = \frac{d_j}{K - \sum U_j} \quad (j = 1, 2, \dots, m) \tag{5}$$

⑥ According to the linear weighting method, the development level of green finance in each pilot city is measured, and the quantitative green finance index is obtained.

$$S_i = \sum_{j=1}^m W_j P_{ij} \tag{6}$$

Among them, S_i refers to the relevant development level of green finance industry in city i . The larger S_i is, the higher the development level of green finance.

(3) Entropy weight method evaluation

By using EXCEL and repeating the steps of determining weights using the entropy method mentioned above for sorting, Table 3 can be obtained.

Table 3. Ranking of green finance Index

City	Green finance Index	Ranking
Shenzhen	0.611474	1
Beijing	0.609506	2
Shanghai	0.60393	3
Guangzhou	0.58876	4
Ningbo	0.477158	5
Nanjing	0.476584	6
Wuxi	0.473714	7
Qingdao	0.472484	8
Wenzhou	0.470926	9
Wuhan	0.435174	10
Hangzhou	0.435092	11
Jinan	0.434272	12
Suzhou	0.43132	13
Xiamen	0.415494	14
Tianjin	0.289788	15

3.3.2. Evaluation of "Carbon Peak" in Low-carbon Pilot Cities Using Factor Analysis

(1) Adaptability testing

Firstly, use statistical software SPSS23 for standardization processing to eliminate the influence of different dimensions of the selected indicators, enabling them to undergo unified data processing; Secondly, KMO and Bartlett tests were conducted on the partial correlation matrix of indicator variables through software to determine whether the conditions for factor analysis were met. The specific data are shown in Table 4.

Table 4. KMO and Bartlett's tests

KMO sampling suitability quantity		0.603
Bartlett sphericity test	Approximate chi square	131.840
	Freedom	45
	Significance	0.000

According to Table 4, the KMO value is 0.603, which is greater than the critical value of 0.5; And the Bartlett sphericity test results show that the significance of its evaluation index is 0.000, less than 0.05, indicating that the original hypothesis is not valid; Therefore, it indicates that the selected indicators are suitable for factor analysis.

(2) Extract factor variables

By using SPSS software to extract four factors, a table explaining the total variance was obtained. From the table below, it can be seen that although the eigenvalues of the fourth factor extracted are less than 1, the overall contribution rate of its factors to the variance is close to 1. In addition, from the output gravel map, the trend changes of the first four extracted factors are relatively obvious, indicating that there is also a lot of information that can carry the response. Secondly, the cumulative contribution rate of the first four extracted factors also reached 88.437%, including 88.437% of the 10 indicator information, which can play a role in dimensionality reduction and can be well evaluated. Therefore, overall, it can be used to extract factor variables.

Table 5. Explanation of total variance

Principal component	Initial eigenvalue			Extract the sum of squares of the load		
	Total	Variance (%)	Cumulative (%)	Total	Variance (%)	Cumulative (%)
1	5.350	53.497	53.497	5.350	53.497	53.497
2	1.666	16.655	70.152	1.666	16.655	70.152
3	1.109	11.090	81.242	1.109	11.090	81.242
4	0.720	7.195	88.437	0.720	7.195	88.437
5	0.659	6.587	95.025			
6	0.237	2.369	97.394			
7	0.183	1.828	99.222			
8	0.047	0.469	99.691			
9	0.024	0.245	99.935			
10	0.006	0.065	100.000			

(3) Factor rotation

In order to reduce the number of variables in the extracted factors and make the explanatory power of the extracted factors more prominent, show significant differences. Using the maximum variance orthogonal rotation method for factor rotation, the rotated component matrix obtained is shown in Table 6, which can be further analyzed.

From the factor component matrix obtained after rotation, it can be seen that factor 1 affects energy conservation and environmental protection expenditure in Zscore (X2).

Zscore (X4) year-end total GDP, Zscore (X6) year-end resident population, Zscore (X8) total social electricity consumption, and Zscore (X9) industrial added value have the maximum load, which can be named as economic factors. Factor 2 has the maximum load on the energy-saving and environmental protection increase of Zscore (X3), and can be named as the green factor. Factor 3 has the largest load on the Zscore (X1) green finance index and the growth rate of

industrial added value above Zscore (X10) scale, which can reflect the relationship between industry and the development level of green finance, and can be named as the financial industry factor. Factor 4 can be named as the population and GDP growth rate factor in terms of the year-on-year growth rate of GDP in Zscore (X5) and the average annual growth rate of population in Zscore (X7).

Table 6. Component matrix after rotation

Indicator	Principal component			
	1	2	3	4
Zscore(X1)	0.545	-0.114	0.564	-0.188
Zscore(X2)	0.671	0.072	0.552	-0.321
Zscore(X3)	-0.024	0.968	0.011	-0.087
Zscore(X4)	0.801	0.196	0.51	-0.166
Zscore(X5)	-0.537	-0.813	-0.014	0.109
Zscore(X6)	0.723	0.314	0.438	-0.184
Zscore(X7)	-0.191	-0.139	0.078	0.943
Zscore(X8)	0.838	0.397	0.142	-0.111
Zscore(X9)	0.971	-0.024	-0.066	-0.08
Zscore(X10)	0.039	0.023	0.867	0.206

(4) Factor Score

The SPSS software is used to calculate the scores of the four extracted factors using the regression method of factor scores. According to the contribution rate of the sum of squares of the extracted loads after the rotation of the extracted factors, as shown in Table 7, the F comprehensive factor scores are calculated. The linear expression is:

$$F = 0.38848 F1 + 0.19306 F2 + 0.18581 F3 + 0.11702 F4.$$

The comprehensive factor scores obtained after calculation are sorted in descending order as shown in Table 8.

Table 7. Explanation of total variance after rotation

Principal component	Initial eigenvalue			Extract the sum of squares of the load		
	Total	Variance (%)	Cumulative (%)	Total	Variance (%)	Cumulative (%)
1	5.350	53.497	53.497	3.885	38.848	38.848
2	1.666	16.655	70.152	1.931	19.306	58.154
3	1.109	11.090	81.242	1.858	18.581	76.735
4	0.720	7.195	88.437	1.170	11.702	88.437
5	0.659	6.587	95.025			
6	0.237	2.369	97.394			
7	0.183	1.828	99.222			
8	0.047	0.469	99.691			
9	0.024	0.245	99.935			
10	0.006	0.065	100.000			

Table 8. Factor Score and Comprehensive Score

City	F1	F2	F3	F4	F	Ranking
Shanghai	1.921	1.315	0.283	-0.754	0.965	1
Beijing	0.101	0.168	3.343	-0.286	0.659	2
Guangzhou	0.297	1.415	0.142	1.042	0.537	3
Suzhou	1.211	0.404	-0.815	0.337	0.437	4
Wuxi	0.107	-0.038	-0.179	1.905	0.224	5
Wuhan	0.403	-1.223	-0.117	2.074	0.141	6
Shenzhen	1.633	-1.536	-0.477	-1.407	0.084	7
Tianjin	-0.503	1.849	-1.146	-0.383	-0.096	8
Hangzhou	-0.048	-0.766	-0.228	0.142	-0.192	9
Nanjing	-0.385	-0.565	-0.086	-0.252	-0.304	10
Ningbo	-0.215	-0.428	-0.346	-0.778	-0.322	11
Xiamen	-1.429	-0.145	0.269	0.329	-0.495	12
Jinan	-1.022	0.294	-0.431	-0.671	-0.499	13
Wenzhou	-1.369	0.443	-0.018	-0.662	-0.527	14
Qingdao	-0.702	-1.188	-0.194	-0.636	-0.612	15

From the single factor score of factor analysis, the economic factor F1 indicates the correlation between economic development level, population base, and energy conservation and environmental protection expenditure during the process of urban carbon peaking. The higher the correlation is, the higher the score. Among them, Shanghai is far ahead of other cities, indicating that Shanghai has grasped the fundamental principles of green development in the development of green economy, can reasonably grasp economic expenditure and income, and do a good job in green economy, In the future, it can make good use of its own advantages and accelerate the process of urban carbon peaking. Secondly, regarding the green factor F2, it mainly represents the increase rate of energy conservation and environmental protection expenditure in promoting the process of carbon peaking. Among them, the increase rate of energy conservation and environmental protection expenditure in Tianjin is higher than that in other cities, indicating that the focus of Tianjin's development of urban economy and finance is biased towards the growth rate of energy conservation and environmental protection expenditure. With regard to the financial industry factor F3, it can be observed that the development level of regional green finance has a high correlation with the growth rate of industries above designated size. Beijing has the highest score in the factor score, indicating that the growth rate of industrial economies above designated size and the development of green finance are both prominent and have the greatest correlation in the process of urban carbon peak development. For the factor F4 of population and GDP growth rate, it mainly represents the connection between urban population and GDP growth rate. In the process of promoting economic development, a reasonable population structure can bring good labor force to accelerate economic and financial development. However, in the single factor score table, Wuxi has the highest score. Therefore, other cities can learn from it and inject vitality into economic development when promoting green economy development.

From the comprehensive score ranking of factor analysis, on the premise of considering the development level of green finance, Shanghai, Beijing and Guangzhou are expected to reach the carbon peak in advance, while Ningbo, Xiamen, Jinan, Wenzhou and Qingdao are relatively slow, and the results are in line with the reality. According to the data analysis results of factor analysis, it is not difficult to find that the main reasons for accelerating the process of carbon peaking are as follows: firstly, the scores of a single factor are all positive, indicating that the scores of each factor are high; Secondly, the development level of green finance in Shanghai,

Beijing, Guangzhou and other cities is above that of other cities, and their energy conservation and environmental protection expenditure and increment are also ahead of other cities. Therefore, the process of urban carbon peak can be seen from the data. It is of great significance to consider the development level of green finance in the city from the perspective of green finance and incorporate green finance into the process of carbon peak.

To sum up, the promotion of urban carbon peak process is closely related to green finance. Each low-carbon pilot city can reasonably allocate resources and build a green economy according to the urban development status; In the development process of industrial economy, increasing investment in energy conservation and environmental protection expenses, carrying out energy conservation and emission reduction, is of great significance for achieving carbon peak as soon as possible.

3.3.3. Evaluation of "Carbon Peak" in Low-carbon Pilot Cities Using Cluster Analysis

To further assist investors in making more accurate decisions, four single factor scores of F1, F2, F3, and F4 obtained from the above factor score analysis and the F comprehensive factor score variable were selected as indicators for K-means clustering analysis of these 15 low-carbon pilot cities using SPSS software, and the average scores of various factors after clustering were calculated, as shown in Tables 9 and 10.

Table 9. Cluster Analysis of 15 Cities

City	F1	F2	F3	F4	F	Category
Shanghai	1.92088	1.31539	0.28335	-0.75417	0.96457	1
Guangzhou	0.29727	1.41453	0.14204	1.04212	0.53692	
Suzhou	1.21139	0.40395	-0.8147	0.33716	0.43666	
Tianjin	-0.50277	1.84887	-1.14612	-0.38283	-0.09613	
Beijing	0.10062	0.16842	3.34265	-0.28614	0.65922	2
Wuxi	0.10737	-0.03785	-0.17932	1.90542	0.22405	3
Wuhan	0.40265	-1.22274	-0.11746	2.07393	0.14122	
Hangzhou	-0.04792	-0.76622	-0.22789	0.14179	-0.19229	
Nanjing	-0.385	-0.56505	-0.08641	-0.25151	-0.30414	
Ningbo	-0.21514	-0.42809	-0.34592	-0.77819	-0.32156	
Xiamen	-1.42948	-0.14488	0.26943	0.32904	-0.49473	
Jinan	-1.02204	0.29432	-0.43075	-0.67113	-0.49879	
Wenzhou	-1.36883	0.44279	-0.01778	-0.66167	-0.52701	
Qingdao	-0.70195	-1.1877	-0.1937	-0.63637	-0.61245	
Shenzhen	1.63296	-1.53574	-0.47742	-1.40745	0.08447	

Table 10. Mean Scores of Various Factors

Category	F1	F2	F3	F4	F
Category 1	0.7317	1.2457	-0.3839	0.0606	0.4605
Category 2	0.1006	0.1684	3.3427	-0.2861	0.6592
Category 3	-0.5178	-0.4017	-0.1478	0.1613	-0.2873
Category 4	1.6330	-1.5357	-0.4774	-1.4075	0.0845

According to the clustering analysis results in Tables 9 and 10, it can be seen that the first category mainly includes four cities, which have higher F1 and F2 factor scores on average. Its characteristic is that its year-end GDP, year-end permanent population, and energy conservation and environmental protection expenses are relatively high. Although Tianjin's development level is relatively low, it is relatively balanced. Therefore, the overall development

prospects of Tianjin are still good, and Tianjin, as one of the municipalities directly under the central government, Having excellent resources to utilize, there is great potential for future development. The second type is mainly the only one in Beijing, whose average score of F3 factor is high, so its green finance and industries above designated size have outstanding development performance. The third category mainly includes 9 cities. Although the average factor scores of these cities are relatively low, their average factor scores of F3 are positive, indicating that their industrial and financial development level is above the average level of the selected cities. These cities can learn from the policies of relatively developed cities, adjust the economic development structure, and strive to promote the development of green finance, energy conservation and emission reduction according to their own development. The fourth category mainly includes Shenzhen, which has a higher average F1 factor score compared to other cities, indicating that Shenzhen's economic development status is good, but its relative level in other aspects is relatively low compared to the cited cities. Therefore, Shenzhen can maintain the development of its existing advantageous economy, adjust other shortcomings, promote the process of urban carbon peaking, and strive to achieve carbon peaking as soon as possible according to future development needs.

4. Conclusions and Suggestions

4.1. Conclusions

Through comprehensive evaluation and analysis of these 15 cities, it was found that: ① There are significant differences in the performance of the four factor indicators in the carbon peak development evaluation system among different cities, and the main influencing factors on the progress of carbon peak development are different. ② The economic development level and green finance development level of the 15 selected pilot cities are significant factors that affect their carbon peak promotion, among which the pilot cities ranking top have obvious advantages in green finance index, energy conservation and environmental protection expenditure and expenditure growth rate. ③ Among the four factors, economic factor and green factor are the important factors that affect the progress of carbon peak. Through SPSS analysis, it can be found that the GDP growth rate is fast, the green finance index is high, and cities above the designated size with fast industrial development growth rate often have better development space potential, and their ability to promote the progress of carbon peak is more prominent. ④ The promotion of carbon peaking in low-carbon pilot cities is closely related to the local industrial resource structure, especially the corresponding policies and regulations on energy conservation, environmental protection, resource allocation, etc. introduced by cities that value industry in the process of promoting carbon peaking are conducive to the early realization of urban carbon peaking.

4.2. Suggestions

Based on the above conclusions, the following suggestions are put forward: ① In terms of urban finance and economy, cities can play a key role of green finance in relevant economic fields, develop green finance, promote green finance products and derivatives, and accelerate the pilot cities to achieve carbon peak. ② Local governments can adopt corresponding policies and guidelines based on the development situation of local cities, allocate and utilize resources reasonably, increase expenditure on energy conservation and environmental protection policies, and vigorously develop the green economy. Cities in various regions can optimize the energy supply and consumption of industries above designated size in terms of urban industrial structure, promote the use of clean energy, and reduce carbon emissions. Cities in various regions can promote measures such as afforestation and returning farmland to forests and grasslands in cultural dissemination; Individual urban residents can actively promote green travel methods, establish a concept of green development among residents, and reduce

personal carbon emissions With the gradual advancement of the new development pattern of carbon neutrality and carbon peaking in China, cities around the country should seize the relevant national policies and skillfully apply them to help achieve the goal of urban carbon peaking as soon as possible.

Acknowledgments

This research is funded by 2023 Anhui University of Finance and Economics Undergraduate Research Innovation Fund Project (No.: XSKY23098).

References

- [1] Su Yali, Zeng Xiaohan, Mao Ying. Analysis of China's urban carbon peak potential and path in the context of green finance - based on cross-sectional data of 17 low-carbon pilot cities [J]. Green Science and Technology, 2022,24 (17): 274-280.
- [2] Zhang Youguo, Dou Ruoyu, Bai Yujie. Measurement of China's green and low-carbon carbon cycle development economic system construction level [J]. Research on Quantitative Economy and Technology Economy, 2020,37 (08): 83-102.
- [3] Wang Yanhong. Research on Investment Value of Listed Companies Based on Principal Component and Cluster Analysis [J]. Inner Mongolia Science and Technology and Economy, 2022 (12): 50-51+54.
- [4] Li Jie Research on the Motivation Mechanism of Manufacturing Industry Transformation and Upgrading Based on the Diffusion of Information Network Technology [D]. Shandong University, 2019.
- [5] Qiu Yue. Analysis of the Consumption Expenditure Structure of Chinese Residents Based on Factor Analysis [J]. Journal of Ningxia Normal University, 2018,39 (04): 73-78.
- [6] Lai Shengyu Zhi Evaluation of Green Development Competitiveness of Provincial Capital Cities and Municipalities in the Yangtze River Economic Belt [D]. Chongqing University of Technology and Industry, 2019.
- [7] Yuan Qian, Wu Lihua, Zhang Ping. Research on the Measurement and Convergence of Green Total Factor Productivity in Patent Intensive Industries in China [J]. Science and Technology Progress and Countermeasures, 2020,37 (14): 76-85.