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Performance Evaluation and Influencing Factors of China's Low-Carbon Economic Development

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ABSTRACT

The global climate change scenario is dire, making low-carbon development crucial for all nations. China, the largest developing country, has notably promoted low-carbon economy. This study evaluates China's low-carbon development (2011-2022) using entropy method data from economic & social big data platforms. Findings show an overall rise but significant regional disparities, with eastern regions ahead and central-west lagging. Key to this is technological innovation, especially patent counts in large industrial enterprises. Ecological governance, economic growth, energy consumption, and investments also impact low-carbon development, highlighting the balance between economy, environment, and energy. Recommendations: Strengthen technological innovation, elevate low-carbon industries, optimize energy structures, protect the environment, and foster regional low-carbon coordination for green, sustainable development. Governments should invest in low-carbon tech, refine policies, create a supportive environment, and contribute to climate change mitigation.

KEYWORDS: *entropy right method; low carbon economy; scientific and technological innovation; energy consumption; ecological environment*

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Research Background:

In the academic discourse surrounding the global climate governance system and climate change, the concept of "low-carbon emissions" is multifaceted and subject to diverse interpretations. Firstly, grounded in the principle of international equity, it underscores the collective responsibility of nations towards emission reduction, thus conceiving low-carbon emissions as an absolute decline in a country's total carbon emissions. Secondly, adopting an interpersonal equity perspective, carbon emissions are regarded as an integral right in the pursuit of human development at both national and individual levels. Here, the emphasis is on mitigating wasteful carbon emissions in developed nations to ensure that developing countries can fulfill their basic developmental aspirations. Lastly, in line with the economic efficiency principle of resource input-output, low-carbon emissions are viewed as a metric for assessing the efficiency of carbon resource utilization within an economy, measuring the corresponding output generated per unit of carbon consumed. Specifically, an economy achieving a growth in economic output that exceeds the increase in greenhouse gas emissions is deemed to practice low-carbon emissions. In practical terms, if an economy manages to contain the growth rate of greenhouse gas emissions below its economic growth rate while expanding its output, it is considered to have attained low-carbon emissions.

The concept of low-carbon development holds diverse significance and imposes varying requirements on different countries. As its core element, low-carbon emissions can be construed as both a relative and an absolute concept, with its delineation hinged on a country's stage of development and the corresponding emission reduction responsibilities it bears. For developing nations, which are still striving to meet fundamental human development needs, achieving a relative reduction in carbon emissions amidst economic growth can be considered emblematic of low-carbon development. In contrast, faced with the increasing scarcity of global emission space, developed countries must actively fulfill their emission reduction commitments while maintaining high levels of human development, striving for an absolute decrease in their total carbon emissions to propel the global transition towards a low-carbon future.

Face The Challenge:

China's ecological and environmental protection still faces structural, fundamental, and trend-based pressures that have not been fundamentally alleviated. Our country's economic and social development has entered a stage of high-quality development characterized by accelerated greenification and low-carbonization. However, the construction of an ecological civilization is still in a critical period of overlapping pressures and challenging progress.

To plan and advance the work of ecological and environmental protection in the new journey, we must do so from a higher perspective, with a broader vision, and greater efforts. This will allow us to write a new chapter in the construction of ecological civilization in the new era. By summarizing the practical experience of the past decade and analyzing the new situations and challenges we face, we must continue to advance the construction of an ecological civilization under the guidance of the socialist ecological civilization thought with Chinese characteristics for a new era. We need to correctly handle several major relationships:

First, the relationship between high-quality development and high-level protection: We must plan for development from the perspective of harmonious coexistence between humanity and nature. Through high-level environmental protection, we can continuously shape new drivers and advantages for development, focusing on building a green, low-carbon, and circular economy system. This will effectively reduce the resource and environmental costs of development and continuously enhance the potential and resilience of development.

Second, the relationship between key challenges and collaborative governance: We must adhere to a systematic approach, grasp the principal contradictions and the main aspects of the contradictions, and take strong measures to address prominent ecological and environmental issues. At the same time, we need to strengthen target coordination, control of multiple pollutants, departmental coordination, regional coordination, and policy coordination to continuously enhance the Systematic policy, integrity, and synergy of all work.

Third, the relationship between natural restoration and artificial remediation: We must adhere to the integrated protection and systematic governance of mountains, waters, forests, fields, lakes, grasslands, and deserts. By building a grand pattern of protection and governance from the mountaintop to the ocean, we can comprehensively use both natural restoration and artificial remediation methods. We should adapt to local conditions and implement policies by category and region to find the best solutions for ecological protection and restoration.

Fourth, the relationship between external constraints and internal dynamics: We must always protect the ecological environment with the strictest systems and most rigorous rule of law, maintaining constant external pressure. Simultaneously, we need to stimulate the endogenous motivation of the whole society to jointly care for the ecological environment.

Fifth, the relationship between the "dual carbon" commitment and independent action: Our commitment to the "dual carbon" goals is unwavering. However, the path, methods, pace, and intensity to achieve these goals should and must be determined by ourselves. We will not be influenced by others.

China's Pivotal Role in Ecological and Environmental Protection:

The text highlights China's efforts in promoting ecological and environmental protection, particularly in the context of its major rivers and lakes, and emphasizes the importance of maintaining a harmonious relationship between mankind and the natural environment. Here are some key points extracted and elaborated:

1. **Efforts in Water Protection and Management:**
   - The Ministry of Ecology and Environment has intensified its efforts to protect and manage the Yangtze, Yellow, and other major rivers and lakes.
   - The quality of water ecological environments across the country has been improving, with a decline in major water pollutant discharges and an increase in the proportion of excellent surface water quality.
   - The Ministry plans to further coordinate water resources, water environment, and water ecological governance, promoting the construction of an ecological environment governance system that integrates upstream and downstream areas of important river basins.
2. **Beautiful Rivers and Lakes Initiative:**
   - The Ministry has issued a list for the protection and construction of beautiful rivers and lakes, covering main and tributaries of major rivers and important lakes and reservoirs.
   - The initiative aims to guide local governments in formulating implementation plans and include

small and micro water bodies in the scope of control.

- Excellent cases of beautiful rivers and lakes have been collected to provide a reference for other regions.

3. **Combating Fraud in Environmental Protection Services:**

- With increasing intensity in ecological and environmental protection work, some third-party environmental protection service agencies have been cheating for economic interests.
- The Ministry has carried out special rectification actions to maintain a high-pressure situation against fraud and plans to continue these efforts.
- The use of big data and artificial intelligence will be strengthened to prevent fraud.

4. **Global Environmental Governance and China's Role:**

- The disharmonious relationship between mankind and the natural environment has become increasingly apparent, leading to challenges such as climate change and biodiversity loss.
- President Xi Jinping has put forward the concept of "jointly building a community of life between man and nature" as a Chinese solution for global environmental governance.
- China holds high the banner of multilateralism and advocates fair and just global environmental governance, leading to responses and recognition from other countries.
- China has demonstrated its commitment to green development through various initiatives, such as climate remote sensing satellites in Africa, low-carbon demonstration zones in Southeast Asia, and energy-saving lamps in small island countries.

In summary, China is playing a pivotal role in promoting ecological and environmental protection both domestically and internationally. Its efforts in managing major rivers and lakes, combating fraud in environmental protection services, and advocating for global environmental governance reflect its commitment to building a cleaner and more sustainable world. By demonstrating the value of green development, China is not only improving its own ecological environment but also providing useful help and inspiration to other countries.

Data Collection:

This paper uses the China Economic and Social Big Data research platform and statistical yearbook to collect the data. Browse the literature related to the theme of low carbon economy or green protection in the past decade and summarize four first-level indicators of low carbon economic development:

A. **Technological innovation.**

- In the practice of low-carbon economy, the level of science and technology will also have an impact on the process of economic transformation. For example, low-carbon technology and new energy technology, the development of these technologies will directly enhance the carbon production capacity, improve the carbon conversion rate, reduce the carbon consumption, and then promote the low-carbon development of social economy to complete the transformation to a low-carbon economy.

B. **Ecological environment and governance.**

- As the scale of industry continues to expand, the impact of industry on the environment also continues to increase. Ecological environment is the foundation of low-carbon economy, and ecological environment governance is the guarantee of low-carbon economy. In the process of promoting the development of low-carbon economy, we attach importance to ecological environmental protection, increase the strength and effect of ecological environmental governance, so as to lay a solid foundation and provide a strong guarantee for the sustainable development of low-carbon economy.

C. **Economy and urban development.**

- In the process of promoting economic and urban development, we should attach great importance to the development of low-carbon economy and the protection of ecological environment, so as to realize the sustainable development of economy, society and environment. The combination of economy and urban development reflects the measures and results taken by various provinces and cities in promoting low-carbon economy

D. **Energy consumption and investment.**

- Energy consumption is one of the main sources of carbon emissions, and the structure of energy consumption directly affects carbon emissions. By optimizing the energy consumption structure, carbon emissions can be reduced and the development of low-carbon economy can be promoted. Energy investment is a key force driving low-carbon energy development. The layout and trend of energy investment can map and influence the development direction of low-carbon economy.

According to the above four first-level indicators, some of the second and third-level indicators were selected and the index system was constructed. For the specific index system is shown in Table 1.

Table 1. Evaluation index system of low-carbon economic development level

Level 1 indicators	Level 2 indicators	Level 3 indicators	unit
technological innovation	R & D input and output	Full-time equivalent of R & D personnel in industrial enterprises above designated size	Person-years
		R & D funds for industrial enterprises above designated size	Ten thousand yuan
		The number of valid invention patents of industrial enterprises above designated size	Count
Ecological environment and governance	Ecological environment	Area of land used for forestry	Ten thousand hectares
		Forest coverage rate	%
		Total area of afforestation	Thousand hectares
	Environment governance	Local fiscal expenditure for environmental protection	Hundred million yuan
		Completed investment in industrial pollution control	Hundred million yuan
Economy and urban development	Urban traffic	Public tram ridership	Ten thousand person-time
		Civilian automobile ownership	Ten thousand cars
	Urban gas	Investment in urban gas construction	Hundred million yuan
	Economic development	Regional GDP	Hundred million yuan
		Per capita GDP	yuan
Energy consumption and investment	Energy consumption	Coal consumption	Ten thousand tons
		Crude oil consumption	Ten thousand tons
		Coke consumption	Ten thousand tons
		Diesel consumption	Ten thousand tons
		Gasoline consumption	Ten thousand tons
		Electricity consumption	Hundred million kilowatt-hours
		Total amount of urban natural gas supply	Hundred million cubic meters
		Total amount of urban liquefied petroleum gas supply	Ten thousand tons
	Energy investment	Energy industry investment	Hundred million yuan
		State-owned economy and energy industry fixed assets investment	Hundred million yuan

Entropy Weight Method:

Entropy weight method(EWM) is a weight calculation method based on information entropy. It uses the basic principle of information theory to determine the weight by calculating the entropy value of each factor, and then used for the comprehensive evaluation of multiple indicators.

Entropy weight method is an objective empowerment method, by calculating the entropy value of each factor to judge its degree of dispersion, and then determine the weight. In information theory, entropy represents a measure of uncertainty. The smaller the entropy, the lower the uncertainty of information, the greater the influence on the comprehensive evaluation (i. e., the weight).

Entropy is a measure of the degree of disorder of a system. For a certain index, the entropy value can be used to judge the degree of dispersion. In information theory, the smaller the entropy value, the greater the degree of dispersion of the index, which indicates that the greater the information provided by the index, the greater the impact on the comprehensive evaluation, so the higher the weight will be.

Entropy Weight Method Steps:

The entropy weight method is mainly divided into the following six steps.

- Step 1: the normalization of indicators (homogenization of heterogeneous indicators): because the measurement units of each indicator are not unified, so before using them to calculate the comprehensive indicators, standardized treatment should be carried out first, that is, the absolute value of the indicators into the relative value, so as to solve the problem of homogenization of the value of different quality indicators.

In addition, the values of positive and negative indicators represent different meanings (the higher the positive indicator, the better, the lower the negative indicator, the better). Therefore, we need to use different algorithms for standardizing the positive and negative indicators. In this article, Indicators "R & D personnel equivalent", "R & D industrial enterprises above designated size R & D funds", "industrial enterprises effective invention patent number", "energy industry investment", "state-owned economy energy industry investment in fixed assets", "forestry land area", "the" forest coverage "," total area "afforestation", "urban gas construction investment", "GDP", "per capita GDP", "local fiscal environmental protection spending", "industrial pollution control complete investment", "public trolley passenger traffic" as the positive index; The indicators of "electricity consumption", "total amount of urban natural gas supply", "total amount of urban liquefied petroleum gas supply", "civil automobile ownership", "consumption of coal", "crude oil consumption", "coke consumption", "diesel consumption" and "gasoline consumption" are negative indicators.

forward pointer:, $x_{ij} = \frac{x_{ij}-min\{x_{1j},\dots,x_{nj}\}}{max\{x_{1j},\dots,x_{rj}\}-min\{x_{1j},\dots,x_{rj}\}}$

Negative indicators:. $x_{ij} = \frac{max\{x_{1j},\dots,x_{nj}\}-x_{ij}}{max\{x_{j},\dots,x_{rj}\}-min\{x_{1j},\dots,x_{nj}\}}$

- Step 2: Calculate the proportion of the i sample value under the j index;

$P_{ij} = \frac{x_{ij}}{\Sigma_{i=1}^{n} x_{ij}}, i = 1, \cdots, n, j = 1, \dots, m.$

- Step 3: Calculate the entropy value of item j index;

$e_j - k\Sigma_{i=1}^{n} P_{ij} \ln(P_{ij}), j = 1, \dots, m,$

Among them, $k = 1 / \ln(n) > 0, e_j > 0$

- Step 4: Calculate the information entropy redundancy (difference);

$d_j = 1 - e_j, j = 1, \dots, n.$

> Step 5: Calculate the weight of each indicator:

, $w_j = \frac{dj}{\Sigma_{j=1}^{m} d_j}, j = 1, \dots, m.$

- Step 6: Calculate the comprehensive score of each sample;

$s_i = \Sigma_{j=1}^{m} w_j x_{ij}, j = 1, \dots, n.$

This is the standardized data x_{ij}.

The final calculation of the weight of each indicator is shown in Table 2.

Table 2 Weight allocation table of each indicator of the level of low-carbon economic development

index	weight (%)
Full-time equivalent of R & D personnel in industrial enterprises above designated size	11.783
R & D funds for industrial enterprises above designated size	11.082
The number of valid invention patents of industrial enterprises above designated size	17.517
Energy industry investment	4.296
State-owned economy and energy industry fixed assets investment	3.886
Area of land used for forestry	5.881
Forest coverage rate	3.776

Total area of afforestation	5.398
Investment in urban gas construction	6.415
Regional GDP	5.511
Per capita GDP	3.520
Local fiscal expenditure for environmental protection	4.067
Completed investment in industrial pollution control	7.137
Public tram ridership	4.082
Electricity consumption	0.801
Total amount of urban natural gas supply	0.712
Total amount of urban liquefied petroleum gas supply	0.349
Civilian automobile ownership	0.649
Coal consumption	0.686
Crude oil consumption	0.394
Coke consumption	0.479
Diesel consumption	0.826
Gasoline consumption	0.797

Based on the calculation results, the weight of the index "Full-time Equivalent of R & D Personnel in Industrial Enterprises Above Designated Size" was 11.783%; the weight of the index "R & D Funds of Industrial Enterprises Above Designated Size" is 11.082%; the weight of the index "The Number of Effective Invention Patents of Industrial Enterprises Above Designated Size" is 17.517%; the weight of the index "Energy Industry Investment" was 4.296%; the weight of the index "State-owned Economy and Energy Industry Fixed Asset Investment" was 3.886%; the weight of the index "Forestry Land Area" is 5.881%; the weight of the index "Forest Coverage Rate" was 3.776%; the weight of the index "Total Afforestation Area" was 5.398%; the weight of the index "Urban Gas Construction Investment" is 6.415%; the weight of the index "Regional GDP" was 5.511%; the weight of the index "Per Capita GDP" was 3.520%; the weight of the index "Local Fiscal Expenditure on Environmental Protection" was 4.067%; the weight of the index "Completed Investment in Industrial Pollution Control" was 7.137%; the weight of the index "Public Bus and Tram Passenger Volume" was 4.082%; the weight of the index "Electricity Consumption" is 0.801%; the weight of the index "Total Urban Natural Gas Supply" is 0.712%; the weight of the index "Total Amount of Urban LPG Gas Supply" was 0.349%; the weight of the index "Civil Automobile Ownership" was 0.649%; the weight of the index "Coal Consumption" was 0.686%; the weight of the index "Crude Oil Consumption" was 0.394%; the index of "Coke Consumption" weight is 0.479%; the weight of the index "Diesel Consumption" was 0.826%; the index of "Gasoline Consumption" weight is 0.797%. According to the established index system, the weight of the first-level index "Scientific and Technological Innovation" is 40.382%; the weight of "Ecological Environment and Governance" is 26.259%; the weight of "Economic and Urban Development" is 20.177%; and the weight of the first-level index "Energy Consumption and Investment" is 13.226%.Scientific and technological innovation: the weight of 40.382%, is the most weighted index, indicating the importance of scientific and technological innovation in the evaluation system. Scientific and technological innovation can drive industrial upgrading, improve production efficiency, promote the development of new products and new services, so as to promote the development of the whole social economy.

Ecological environment and governance: the weight is 26.259%, which is the second highest weighted index, reflecting the importance of environmental protection and governance in the evaluation. It also explains that the evaluation system emphasizes the concept of environmental protection and sustainable development. A good ecological environment is the foundation of economic development, and effective governance can ensure the rational use of resources and the long-term health of the environment.

Economy and urban development: the weight is 20.177%, which is the third highest weight index, indicating that the economic scale and urban development level are also the key factors in the evaluation. The evaluation system also attaches great importance to the construction and development of economic scale and urban infrastructure. The level of economic and urban development directly affects the quality of life of residents, the ability to attract foreign investment and the overall competitiveness of the region.

Energy consumption and investment: 13.226%, the lowest weight, but is still an important part of the evaluation system. Energy is the foundation of economic development, and energy consumption efficiency and investment structure have an important impact on sustainable economic development and environmental protection.

Using the weight and the standardized data, the comprehensive score of each sample is calculated, and then the comprehensive score of each year is obtained. Comprehensive score in 2011 was 5.107; 5.395 in 2012; 5.949 in 2013; 6.163; 6.279 in 2015; 2019 in 2016,6.318; 6.439 in 2017,6.476 in 2018; 6.707 in 2020,6.589; 6.653 in 2021; 7.022,7.025.

Table 3 Measurement results of the level of low-carbon economic development

a particular year	score	ranking	speed increase
2011	5.108	12	
2012	5.395	11	5.625%
2013	5.949	10	9.316%
2014	6.164	9	3.601%
2015	6.279	8	1.875%
2016	6.319	7	0.632%
2017	6.439	6	1.904%
2018	6.477	5	0.588%
2019	6.708	2	3.572%
2020	6.589	4	-1.771%
2021	6.654	3	0.978%
2022	7.026	1	5.559%

From 2011 to 2013, the comprehensive score rate increased rapidly, indicating rapid development during this period. From 2014 to 2016, the growth rate slowed somewhat, but it continued to grow. From 2017 to 2019, the growth rate accelerated again. In 2020, the composite score declined, possibly due to external factors (such as global economic fluctuations, epidemics, etc.). The score decline in 2020 could be a short-term volatility, followed by a return to growth in 2021 and 2022, indicating that the long-term trend remains positive. The composite score for 2022 reached 7.025, the highest of all years, indicating that during this year, the subjects evaluated reached a new developmental height. It shows that this evaluation system is basically in line with the reality and has a high credibility.

The final calculation is that the annual development level of low-carbon economy in each province and city is shown in Table 4.

Table 4 Calculation results of the low-carbon economic development level in various provinces and cities

province	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	mean	rank
Beijing	0.147	0.161	0.194	0.181	0.182	0.185	0.231	0.197	0.194	0.183	0.196	0.198	0.187	16
Tianjin	0.121	0.126	0.149	0.168	0.165	0.137	0.134	0.134	0.135	0.122	0.123	0.128	0.137	27
Hebei	0.164	0.177	0.193	0.217	0.205	0.212	0.222	0.279	0.247	0.217	0.190	0.199	0.210	13
Shanxi	0.190	0.207	0.219	0.206	0.202	0.183	0.184	0.180	0.201	0.180	0.173	0.185	0.192	15
Inner Mongolia	0.210	0.206	0.248	0.260	0.236	0.231	0.216	0.201	0.213	0.195	0.193	0.201	0.217	10
Liaoning	0.166	0.175	0.191	0.190	0.169	0.147	0.154	0.160	0.162	0.153	0.157	0.162	0.166	20
Jilin	0.127	0.133	0.142	0.151	0.155	0.149	0.147	0.135	0.133	0.133	0.139	0.141	0.140	26
Heilongjiang	0.157	0.166	0.171	0.167	0.165	0.151	0.152	0.146	0.149	0.141	0.146	0.149	0.155	24
Shanghai	0.180	0.185	0.192	0.200	0.207	0.231	0.236	0.232	0.248	0.230	0.241	0.256	0.220	9
Jiangsu	0.231	0.267	0.308	0.322	0.353	0.395	0.371	0.409	0.414	0.439	0.438	0.478	0.369	2
Zhejiang	0.215	0.232	0.264	0.286	0.295	0.300	0.301	0.316	0.336	0.353	0.353	0.384	0.303	4
Anhui	0.136	0.152	0.189	0.179	0.188	0.204	0.207	0.200	0.212	0.219	0.227	0.238	0.196	14
Fujian	0.179	0.188	0.206	0.216	0.232	0.226	0.229	0.236	0.253	0.258	0.261	0.266	0.229	8
Jiangxi	0.166	0.185	0.171	0.160	0.170	0.177	0.184	0.193	0.196	0.203	0.208	0.213	0.186	17
Shandong	0.242	0.262	0.295	0.346	0.325	0.351	0.362	0.329	0.328	0.297	0.311	0.341	0.316	3
Henan	0.166	0.168	0.192	0.197	0.195	0.217	0.228	0.231	0.252	0.237	0.234	0.230	0.212	12

Hubei	0.163	0.169	0.190	0.195	0.201	0.264	0.219	0.222	0.241	0.227	0.232	0.264	0.216	11
Hunan	0.186	0.194	0.203	0.212	0.231	0.223	0.232	0.242	0.250	0.276	0.263	0.277	0.232	7
Guangdong	0.300	0.338	0.363	0.397	0.421	0.429	0.472	0.527	0.567	0.592	0.657	0.686	0.479	1
Guangxi	0.133	0.134	0.148	0.150	0.158	0.152	0.146	0.149	0.153	0.158	0.158	0.156	0.150	25
Hainan	0.113	0.116	0.117	0.120	0.119	0.119	0.121	0.126	0.129	0.127	0.128	0.132	0.122	28
Chongqing	0.140	0.143	0.158	0.169	0.178	0.166	0.176	0.182	0.185	0.190	0.186	0.195	0.172	18
Sichuan	0.208	0.208	0.222	0.235	0.253	0.262	0.276	0.275	0.277	0.266	0.268	0.279	0.252	6
Guizhou	0.138	0.134	0.159	0.161	0.169	0.162	0.175	0.157	0.171	0.174	0.164	0.178	0.162	21
Yunnan	0.153	0.157	0.168	0.161	0.182	0.161	0.147	0.154	0.165	0.154	0.145	0.164	0.159	22
Xizang	0.070	0.074	0.080	0.085	0.083	0.082	0.089	0.087	0.090	0.090	0.088	0.089	0.084	31
Shaanxi	0.225	0.235	0.260	0.258	0.262	0.245	0.265	0.254	0.266	0.251	0.257	0.273	0.254	5
Gansu	0.152	0.159	0.177	0.172	0.168	0.167	0.158	0.166	0.172	0.161	0.159	0.180	0.166	19
Qinghai	0.108	0.109	0.116	0.115	0.121	0.122	0.115	0.119	0.129	0.131	0.120	0.121	0.119	29
Ningxia	0.086	0.088	0.096	0.106	0.103	0.106	0.097	0.096	0.096	0.098	0.101	0.106	0.098	30
Xinjiang	0.132	0.146	0.168	0.180	0.185	0.160	0.198	0.143	0.145	0.137	0.138	0.156	0.157	23

Descriptive Analysis:

The example data is put into the entropy weight model to calculate the score of all indicators, and then the comprehensive score of each year is calculated according to the score of each indicator. Finally, the comprehensive score of each year is presented in the form of visual image (as shown in Figure 1).

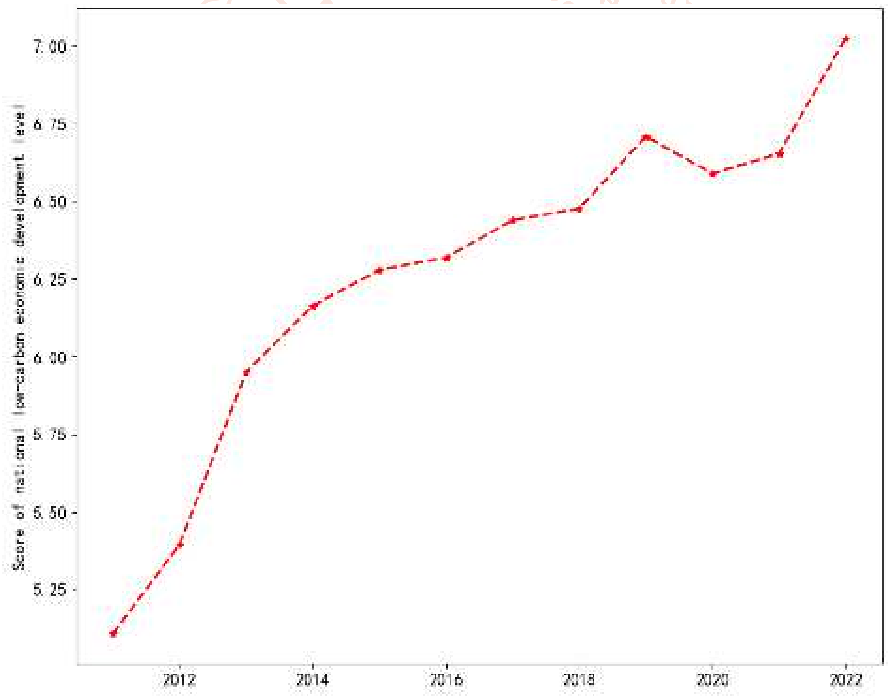

Figure 1 The trend of national low carbon economic development level with time in the past decade

Figure 1 shows the annual score calculated from 2011 to 2022, with an overall upward trend (slightly decreased in 2020), and the score in 2022 has far exceeded that in 2011. This continuous upward trend shows that China has made great achievements in low carbon economy, and in the future, we should further develop low carbon economy while stabilizing the current situation. Figure 1 intuitively shows the change trend of the comprehensive score of each year in the past ten years through the form of the line chart, which provides an important reference for further analysis and decision-making.

In recent years, the top five provinces drew images and analyzed them (Figure 2)

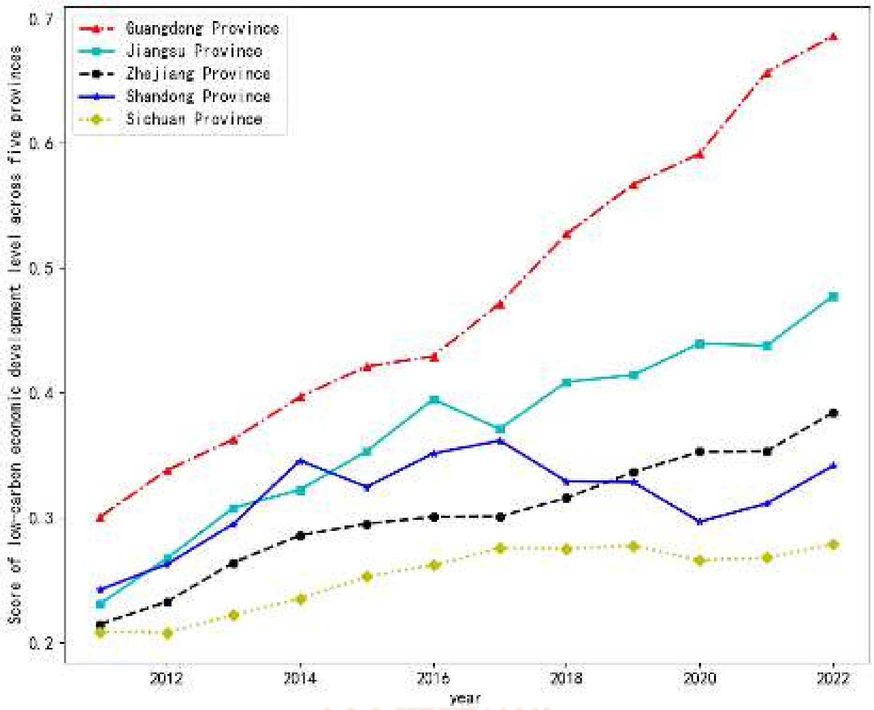

Figure 2 The evolution trend of low-carbon economic development level scores in the five provinces in the past ten years

Figure 2 shows the annual comprehensive scores of Guangdong, Jiangsu, Zhejiang, Shandong and Sichuan provinces. These five provinces are the five provinces with the highest scores in the country. In Guangdong province, the gap between the scores and the other four provinces has widened since 2017.

Next, the three indicators of industrial pollution control investment with a high impact level of low carbon and the number of effective invention patents of industrial enterprises above the designated size are drawn and compared (see Figure 3-5)

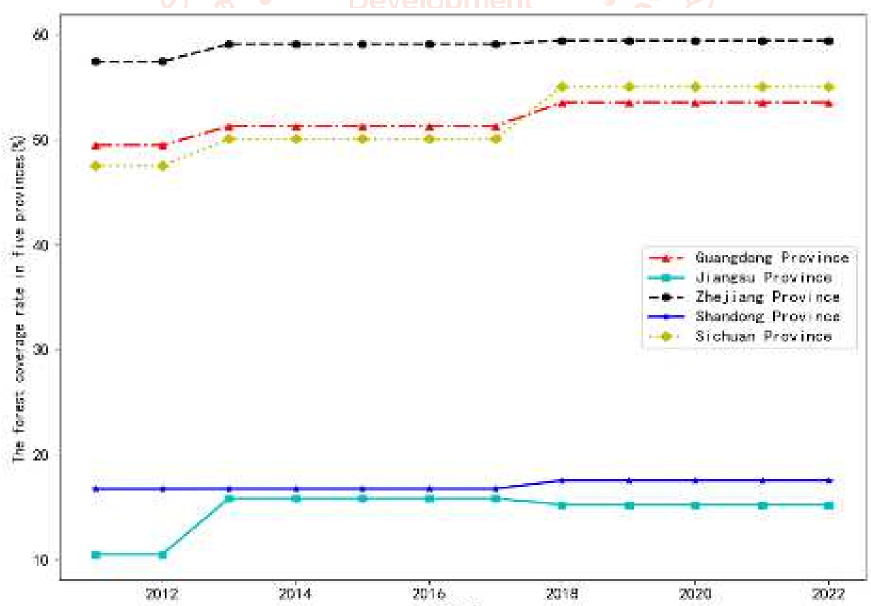

Figure 3 Time evolution trend chart of forest coverage rate in the five provinces in recent ten years

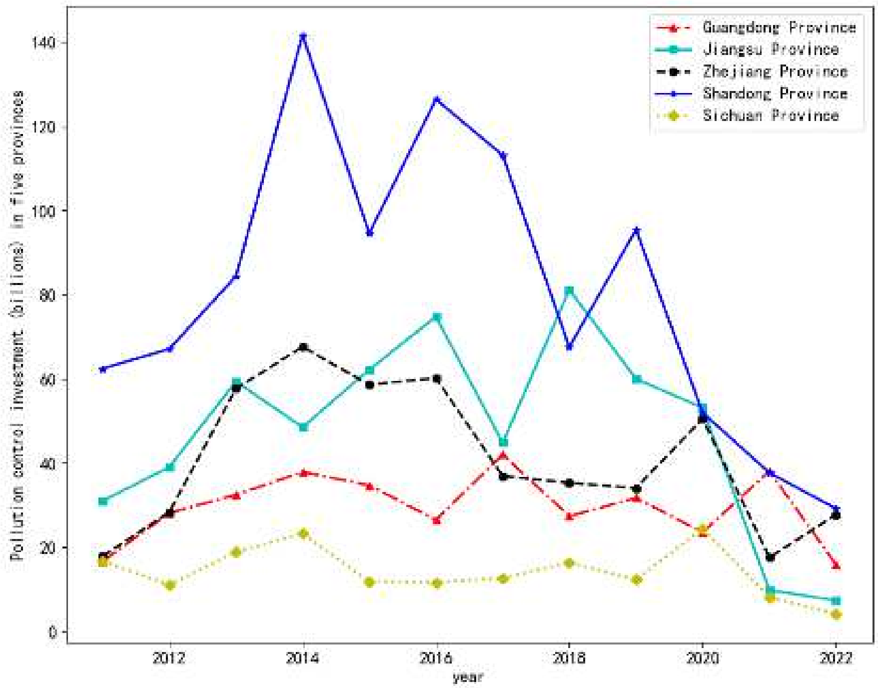

Figure 4 The evolution trend of pollution control investment in the five provinces in the past ten years

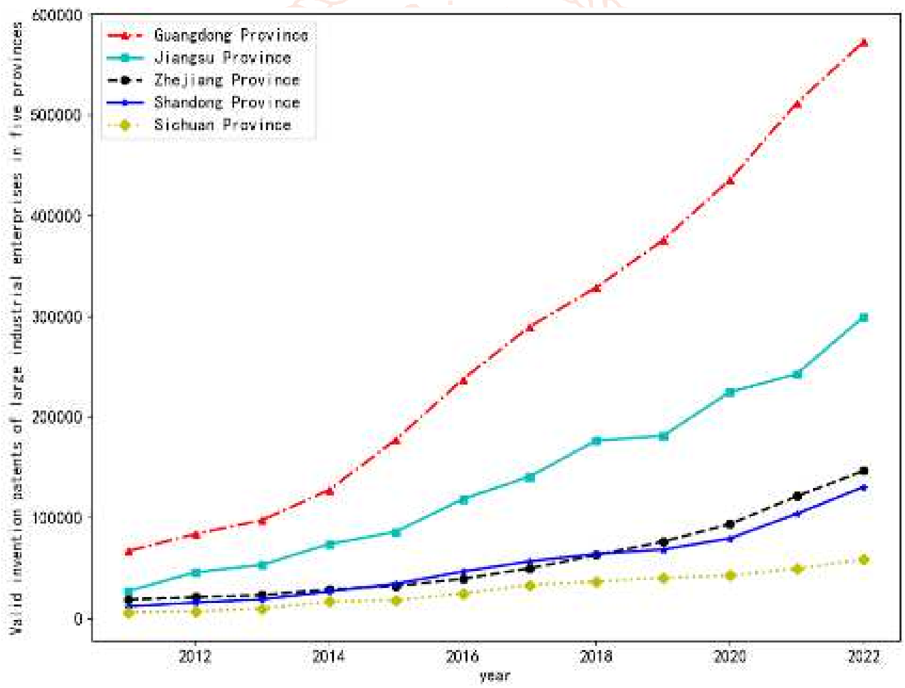

Figure 5 The evolution trend of effective invention patents of industrial enterprises above designated size in the five provinces in the past ten years

Figure 3-5 shows that the forest coverage rate of Guangdong, Sichuan and Zhejiang is much higher than that of Shandong and Jiangsu provinces, but Shandong and Jiangsu provinces have a high degree of investment in industrial pollution control, and the investment is higher than that of other three provinces. The forest coverage rate of the five provinces has basically increased year by year, indicating that most provinces and cities in China have paid attention to the planting of forests, and the effective planting of forests can greatly improve the low-carbon economic benefits of China. The investment in industrial pollution control in the five provinces was on the rise before 2016, which shows that the country attaches great importance to pollution control in the industrial industry and reduces pollution reduction from the source. Since 2016, the domestic pollution control effect has been remarkable, so the investment in industrial pollution control has still been reduced. Based on the number of effective invention patents of industrial enterprises above the scale, which is the most important influencing factor in Figure 5. According to Figure 5, it can be seen that Guangdong Province has an absolute advantage in invention patents, so that its score is higher than that of other provinces.

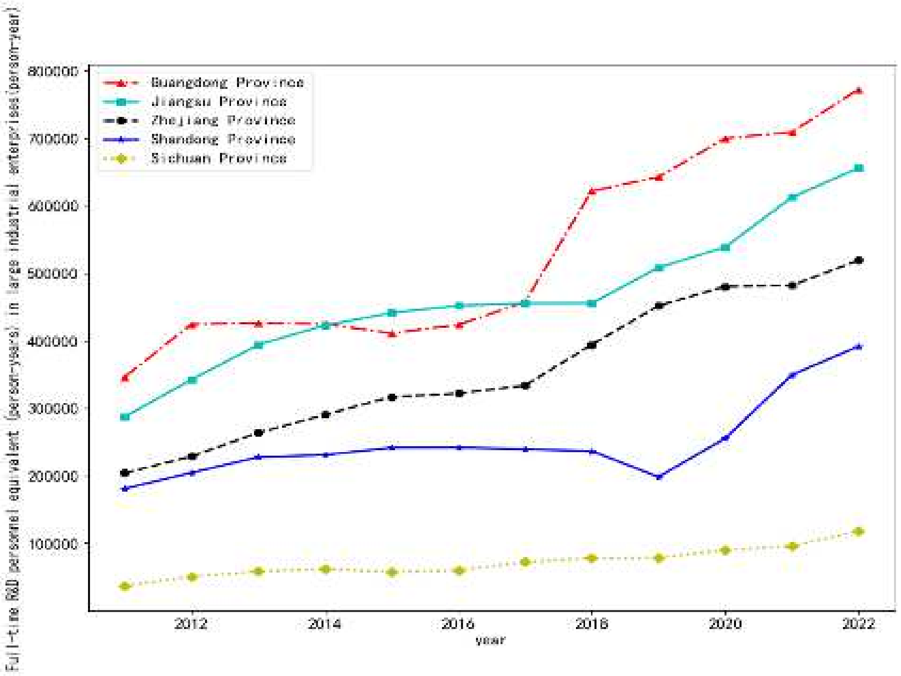

Figure 6 Trend of R & D personnel in industrial enterprises above designated size in five provinces

Figure 6 shows that the full-time equivalent of R & D personnel in industrial enterprises above designated size in 5 provinces increased year by year, but the growth rate was low or even decreased from 2013 to 2017. Taking 2011 and 2022 as the benchmark, Guangdong province has the highest growth rate and the highest, and Sichuan Province has the lowest growth rate. Enterprises and governments in Sichuan province still need to pay more attention to this.

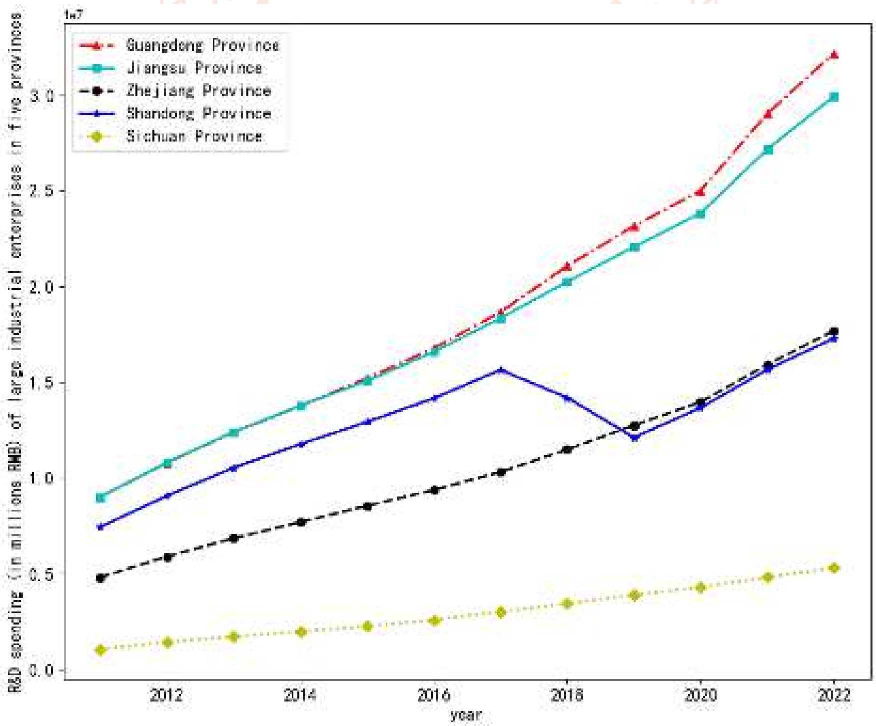

Figure 7 The evolution trend chart of R & D funds of industrial enterprises above designated size in five provinces over time

Figure 7 shows that the R & D expenditure of industrial enterprises above designated size in 5 provinces has increased year by year. Among them, Shandong Province may decrease its funds from 2017 to 2019 due to local policy reasons. In 2011 and 2022, the highest and the lowest growth rate is the lowest.

After drawing the map of the top five provinces, the provinces with higher per capita GDP, such as Beijing, Guangdong and Shanghai, were compared with important influencing factors (see Figure 6-7).

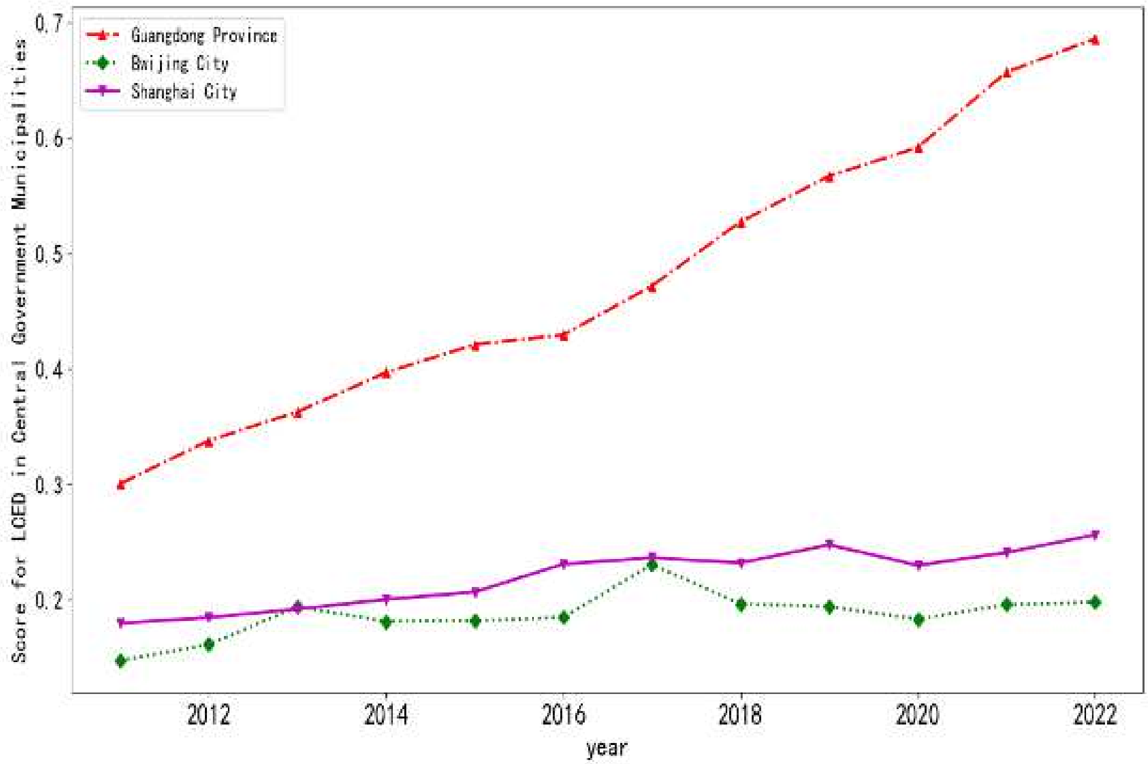

Figure 8 The evolution trend of low carbon economy development level in the past ten years

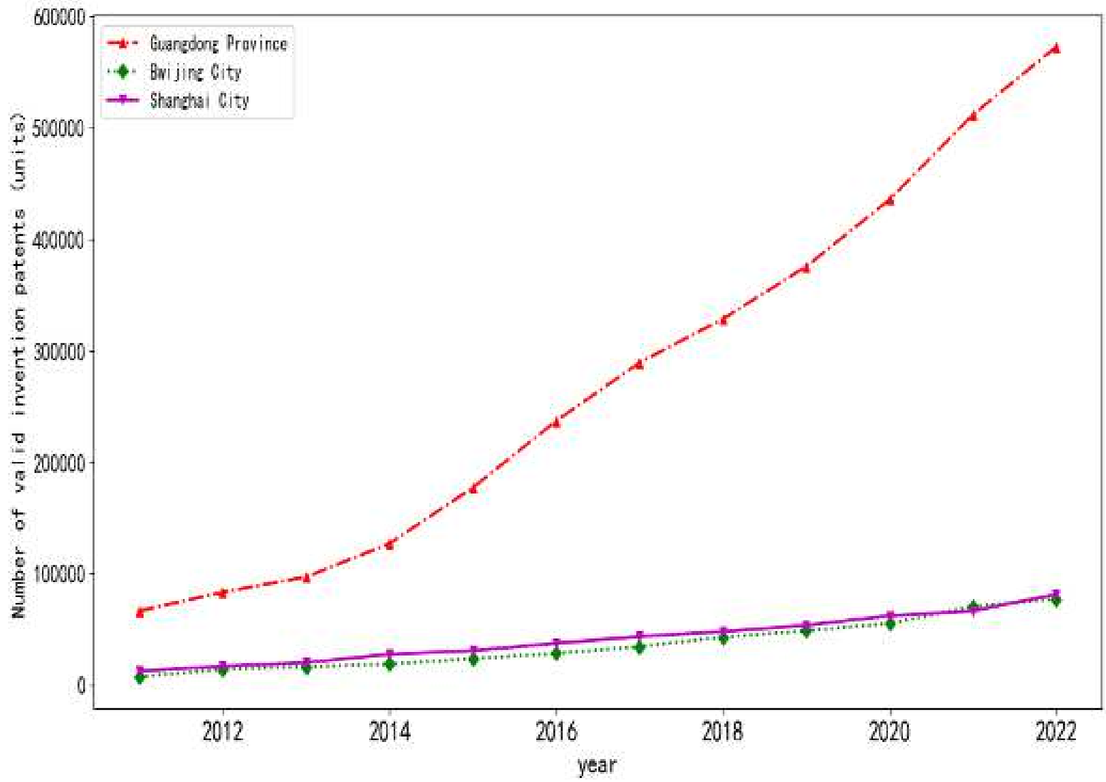

Figure 9 The evolution trend of the number of effective invention patents of industrial enterprises above designated size in provinces and municipalities directly under the Central Government in the past ten years

Figure 8 and Figure 9 show that Beijing and Shanghai are not outstanding in low-carbon economy, and do not highlight their political and economic advantages, but show a sustained growth trend on the whole. This reflects the differences in the measures taken by different cities to improve the environment and improve the quality of services and the final results. Figure 7 shows the main reason why Guangdong province far exceeds that of Beijing and Shanghai scores.

Conclusion:

According to the entropy right method, the final conclusion is drawn that since 2011, China's low-carbon economic performance evaluation has been increasing year by year, indicating that China pays more attention to the green development of low-carbon economy, which coincides with General Secretary is view that clear water and green mountains are gold and silver mountains, and will further increase in the future. For the main factors affecting the low carbon economy research found that science and technology innovation direction dominated, it also shows the science and technology change society, innovation can let society further, at the same time science and technology innovation can drive industrial upgrading, improve production efficiency, promote the development of new products and new services, so as to promote the development of the whole social economy. The most important three-level index influencing factor reflecting the low carbon economy is the number of effective invention patents of industrial enterprises above the scale, which also shows that innovation can vigorously promote process development and create low carbon operation.

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