КИТАЙСКАЯ МОДЕЛЬ СОЦИАЛЬНО-ЭКОНОМИЧЕСКОГО РАЗВИТИЯ В СВЕТЕ СОВРЕМЕННЫХ ГЛОБАЛЬНЫХ ВЫЗОВОВ

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THE LOW CARBON DEVELOPMENT BY REGION IN CHINA

As low carbon development has become the dominant development trend in the world, China has started its own exploration in the field of low carbon development. In order to qualitatively and quantitatively examine the low carbon development of China's regions, this paper designs a regional low carbon development evaluation index system. And the entropy weight method is introduced to calculate the low carbon development index of China's regions from 2015 to 2019. In addition, this paper studies the trends of regions low carbon development in China and the problems faced from the perspective of low carbon development status, low carbon development background and low carbon development potential.

Keywords: *low carbon development index, entropy weight method, indicator system.*

Поскольку низкоуглеродное развитие стало доминирующей тенденцией развития в мире, Китай начал свои собственные исследования в области низкоуглеродного развития. Для качественного и количественного анализа низкоуглеродного развития регионов Китая в данной статье разработана система индексов оценки низкоуглеродного

развития регионов. Для расчета индекса низкоуглеродного развития регионов Китая с 2015 по 2019 год используется метод энтропийного взвешивания. Кроме того, в работе исследуются тенденции низкоуглеродного развития регионов Китая и проблемы, с которыми они сталкиваются, с точки зрения состояния низкоуглеродного развития, предпосылок низкоуглеродного развития и потенциала низкоуглеродного развития.

Ключевые слова: *индекс низкоуглеродного развития, метод энтропийного взвешивания, система индикаторов.*

1. Introduction

Nowadays economic tools have become one of the main ways in which countries play competitively. Under the economic framework, low carbon development is a rare economic development strategy with global realisation as the main objective, involving most of the countries in the world, in order to combat common climate change. Low carbon development is the current international consensus and the dominant development trend. China is a major player and promoter of global low carbon development. In terms of policy, the Chinese government has set national targets for carbon peaking by 2030 and carbon neutral by 2050. In terms of finance, China has been increasing its investment in new energy and clean energy in recent years, with a view to improving the current coal-based energy structure of the country. In terms of the economy, the tertiary sector in China continues to develop and some regions have progressed in their industrial structure. However, the background, potential and status of low carbon development is bound to differ between regions, where there are huge differences in endowments and development. In this context, this paper will select appropriate indicators to construct a regional low carbon development evaluation system and analyse the status and trends of low carbon development in various regions of China from 2015 to 2019, with a view to reaching a good start for subsequent research on low carbon development.

2. Methodology

In order to clarify the low carbon development level and development trend of each region in China, this paper will apply the entropy weight method to calculate the low carbon development index of each region in China. The selected indicators and their explanations are shown in Table 1. [1, p. 5463] [2, p. 76]

Table 1. Indicators for low carbon development index

Factor	Indicator	Explanation
Background of low carbon development	Regional economic	Gross regional product
	Industrial structure	Share of tertiary sector
	Energy structure	Proportion of coal consumption to total energy consumption
Status of low carbon development	Carbon emissions per unit of output	CO_2 emissions/Gross regional product
	Carbon emissions per capita	CO_2 emissions/Regional population
	Carbon emissions per unit of energy consumption	CO_2 emissions/Total energy consumption
Potential for low carbon development	Proportion of urban residents	Proportion of urban residents to total regional population
	Proportion of investment in scientific research	Proportion of investment in scientific research to total investment
	Forest coverage	Forest coverage rates

Based on the indicators, we applied the entropy weight method to calculate the low carbon development index in each region of China. As the units of measurement for each indicator are not uniform, the raw data needs to be pre-processed.

For positive indicators:

$$x_{ij} = \frac{x_{ij} - \min(x_{1j}, \ldots, x_{nj})}{\max\left(x_{1j}, \ldots, x_{nj}\right) - \min\left(x_{1j}, \ldots, x_{nj}\right)}.$$

For negative indicators:

$$x_{ij} = \frac{\max\left(x_{1j},\ldots,x_{nj}\right) - x_{ij}}{\max\left(x_{1j},\ldots,x_{nj}\right) - \min\left(x_{1j},\ldots,x_{nj}\right)},$$

where x_{ij} – the value of indicator j in region i, $i \in [1, n]$, $j \in [1, n]$.

The entropy value would be calculated with the formula

$$e_j = -\left(\frac{1}{\ln n}\right)\sum_{i=1}^{n} p_{ij}\ln\left(p_{ij}\right), \;\; 0 \le e_j \le 1,$$

where e_j – the entropy value for indicator j, p_{ij} – the proportion of indicator j in region i.

The coefficient of variation could be calculated with the formula

$$\lambda_j = 1 - e_j,$$

where λ_j – the coefficient of variation of indicator j, e_j – the entropy value for indicator j.

The weight for each indicator could be calculated with the formula

$$w_j = \frac{\lambda_j}{\sum_{j=1}^{m}\lambda_j} = \frac{1 - e_j}{\sum_{j=1}^{m}(1 - e_j)},$$

where w_j – the weight for each indicator, λ_j – the coefficient of variation of indicator j, e_j – the entropy value for indicator j.

The low carbon development index would be calculated with the formula

$$u_i = \sum_{j=1}^{m} w_j * X_{ij},$$

where u_i – the low carbon development index for region i, w_j – the weight for each indicator.

3. Low carbon development of regions in China

We select raw data from 2015 to 2019 and calculate the low carbon development index of each region in China with the entropy weight method. A line graph of low carbon development index is drawn, as shown in Figure 1.
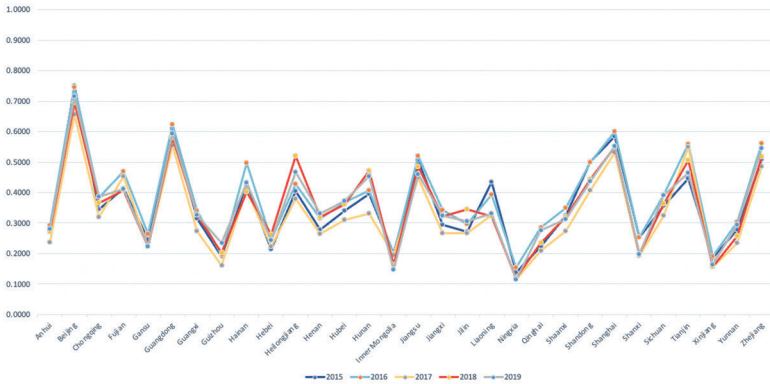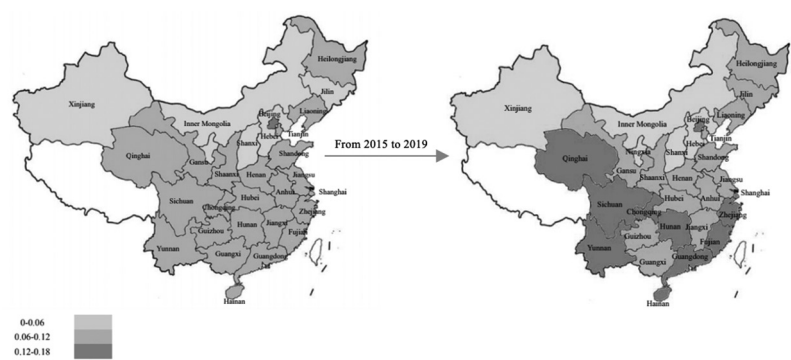

Fig. 1. Low carbon development index by region

As we can see from the figure, the level of low carbon development across regions in China is generally low, with significant differences between regions. Only a few regions have achieved a relatively satisfactory score for the low carbon development index, and their scores have remained largely stable from year to year. These regions are Beijing, Guangdong, Jiangsu, Shanghai, Tianjin and Zhejiang, all of which are located along the Bohai Sea Rim, the Yangtze River Delta or the Pearl River Delta. They are the regions that fall under the three major economic zones of China and are the most developed regions of the country. The majority of regions in China are still at a low level of low carbon development and have not seen any improvement over the years. These regions are mainly represented by Guizhou, Inner Mongolia, Ningxia and Xinjiang, which are relatively underdeveloped. Some of them belong to

autonomous regions of ethnic minorities and are located at the periphery of the Chinese territory. The disadvantage of geographical location limits the exchange and cooperation between these regions and other regions and discourages shared development. In addition, Inner Mongolia and Xinjiang are resource-based regions in China, with a considerable energy production capacity. But such resource endowments have been gradually leading these regions to rely on the energy industry for their regional development, which eventually results in an industrial lock-in effect. Among regions in China, those with an average level of low carbon development show the greatest fluctuations in this index over five years, and the trend tends to rise and then fall. Over the long term, the improvement in the level of low carbon development in these regions is slight and the trends indicate the unpredictability to their future development.

To further explore the differences in various aspects of low carbon development across regions in China, we have plotted the indices of low carbon development by factor for each region in 2015 and 2019 in the map, as shown in Figure 2, 3, 4. [3, p. 666]

Fig. 2. Comprehensive index
of low carbon development statue by region

From the figure we can notice that in 2015 all regions in China generally scored very low on the factor of low carbon development status. After five years, all regions have improved their scores to varying degrees in 2019, but the progress has been modest. The geographical distribution of the index for factors of low carbon development status by region is characterised by high scores in the south of China and low scores in the north. In 2015, except for Beijing, the capital of China, whose score was relatively high, there was a clear upward trend from north to south across all regions of the country. And in that year, all the regions in the south graduated from the lowest index range of 0–0.06 on the low carbon development status. The index for 2019 also reflects a better low carbon development status in the south and a poorer one in the north. As leaders and drivers of low carbon development, most of the regions that experienced a significant advancement in low carbon development status over five years were in the south. Most of the regions in the north of China have not seen significant progress in low carbon development status over five years. Most of them are still lagging behind based on the comprehensive index on the factor of low carbon development status. In addition, a large part of the regions in the north of China that are lagging behind in low carbon development status are traditional resource-based regions of China. Due to a variety of factors, it is difficult to improve the low carbon development status in these regions in the short term. As a result, it can be seen that the low carbon development status in China shows a great start and faster development in the south and a poor start and slow development in the north.

From the figure we can see that the regions of China score poorly on the factor of low carbon development background, with significant differences between regions. From 2015 to 2019, some regions show a trend of regression in this index to some extent. Firstly, over five years, the number of regions in the leading position according to the index of low carbon development background has decreased from four to two. There is also a small reduction in the number of regions falling into ranges with great index This has led to an enlarged proportion of regions falling into the lower index range of 0.18–0.24. The comprehensive

index of low carbon development background still showed certain geographic characteristics. The index of low carbon development background is significantly higher in the eastern coastal regions than in other regions, and their index has remained stable over five years. This is closely related to the distribution of regions with a rapid economic development. The economic zones within China include the Yangtze River Delta Economic Zone, the Pearl River Delta Economic Zone and the Bohai Economic Circle. The rapid economic development and great social potential of these regions has contributed significantly to the excellent background of low carbon development. In addition, although there is a small decrease in this index over five years and a declining trend in index of low carbon development background, the decline is more noticeable in the northern regions, such as Inner Mongolia, Shanxi, Heilongjiang and Liaoning. Therefore, the unbalanced low carbon development background in China is inevitably correlated with unbalanced economic development. This has led to a situation in which the economic zones are better developed and the other regions are lagging behind in terms of low carbon development background.
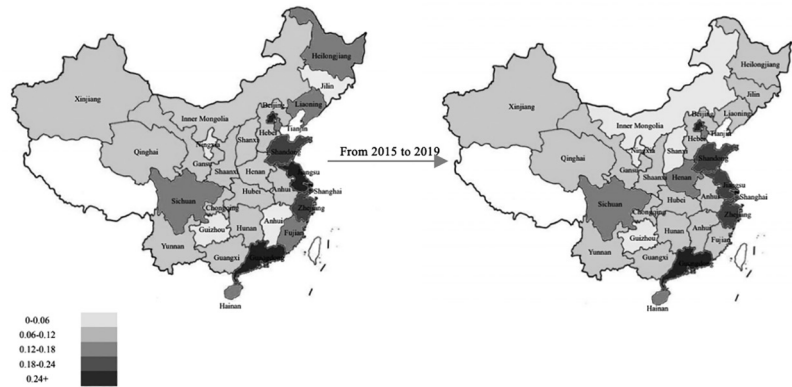

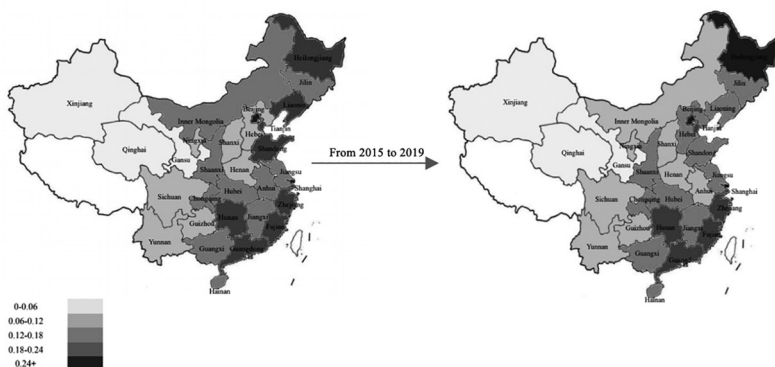*Fig. 3. Comprehensive index of low carbon development background by region*

*Fig. 4. Comprehensive index of low carbon development
potential by region*

The figure reveals that all regions in China score poorly on factors of low carbon development potential, with significant differences between regions. In 2015, the only region that falls into the highest index range of low carbon development potential is Beijing at 0.24+. The rest of the regions fall into different index ranges of low carbon development potential, and there exists some variation across the regions. By 2019, there is some variation in the component regions of each range, but the variation is less pronounced and generally reflects a slight progress. Over five years, there has been an expansion in the number of regions that fall into the higher index range of low carbon development potential. Generally, the regions with a higher low carbon development potential index in 2015 show a strong aggregation. Most of them belong to the Bohai Economic Circle, the Yangtze River Delta Economic Zone and the Pearl River Delta Economic Zone. In 2019, however, the advantage of the Bohai Economic Zone in terms of low carbon development potential has dropped. While the regions within the Yangtze River Delta Economic Zone and the Pearl River Delta Economic Zone still hold a strong advantage in terms of low carbon development potential. As a result, the low carbon development potential of regions in China also reflects, to some extent, the fact that regions with better economic

development have high scores and other regions have low scores. However, the phenomenon tends to weaken over time.

4. Conclusion

As low carbon development has become the dominant development trend in the world, China has also started its own exploration in the field of low carbon development. In order to qualitatively and quantitatively examine the low carbon development of China's regions in different periods, this paper designs a regional low carbon development evaluation index system. And the entropy weight method is introduced to study the low carbon development of China's regions from 2015 to 2019. From our study we can learn that the low carbon development of China's regions is generally lagging behind and there are significant differences across regions. Most of the regions with a good low carbon development index and a relatively stable performance from year to year belong to the Bohai Economic Rim, the Yangtze River Delta or the Pearl River Delta. Other regions suffer from lagging and fluctuating low carbon economies. Some remote and traditional resource-based regions are lagging behind in their low carbon development due to a variety of factors and there is no clear trend towards improvement. When the low carbon development of each region is examined under different factors, we learn that the regions of China score very low on the factor of low carbon development status. And the low carbon development status in China shows a great start and faster development in the south and a poor start and slow development in the north. For the factor of low carbon development background, the overall score of China's regions is not great, and there are significant differences across regions. The index of low carbon development background also shows certain geographic characteristics. A situation arose in which the economic zones are better developed and the other regions are lagging behind in terms of low carbon development background. For the factor of low carbon development potential, scores across China's regions are generally low, also with significant differences across regions. There is a trend of higher scores in the more economically developed

regions and lower scores in other regions in terms of low carbon development potential across regions of China.

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УЧАСТИЕ КИТАЯ В РЕГИОНАЛЬНОЙ ЭКОНОМИЧЕСКОЙ ИНТЕГРАЦИИ

В статье проанализировано участие Китая в договорах о создании зон свободной торговли, установлено существенное отличие целей соглашений об экономической интеграции Китая с зарубежными странами, дана характеристика межконтинентального интеграционного объединения с участием Китая – Всеобъемлющего регионального экономического партнерства, подчеркнута перспективность сотрудничества стран Северо-Восточной Азии, обозначены пять целей концепции Сообщества единой судьбы, взятых Китаем за основу развития.