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Research on the Measurement of Green Development Level in Western China

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ABSTRACT
Green development in western China is a strategic requirement to meet the general trend of China's economic development. From the perspective of green development level, this paper takes 12 provinces and cities in western China as the research object, and uses the improved entropy method to calculate the green development level of the three subsystems of economy, ecological environment and government policy support in western China from 2010 to 2017, and finds that the level of green development in the western region is still in a lower level. Finally, some Suggestions are put forward to improve the level of green development in western China.
Keywords: *Green development, entropy method, spatio-temporal evolution, western region*

1. INTRODUCTION

Global climate change is an indisputable fact, and green development has become an irresistible trend. Only by vigorously developing the green economy can we effectively break through the bottleneck of resources and environment, realize the high-quality development of China's economy.The western region has a great resource advantage. However, the ecological environment of western China is relatively fragile and its economic development lags behind that of eastern and central China.Green development is the latest concept of modern development to foster economic sustainability[1].Coordinated development was first proposed by Norgaad [2], and Grossman et al. [3] proposed the famous environmental Kuznets curve (EKC), discussing the constraint effect of environment on economic development.Ke Wang et al. [4]believed that the realization of green development path in the western region was an organic unity. Xiaoxi Li et al. [5]assessed the green development index in Chinese provinces.

This paper analyzes the existing literature and finds that most of them take the green development level as a subsystem to evaluate.This paper chooses the improved entropy method and takes 12 provinces and cities in the western region as the research object to measure the green development level from 2010 to 2017, analyzes the temporal and spatial evolution, and put forward suggestions for the development of the western region.

2. BACKGROUND

2.1. The Index System Construction

From the perspective of the development level of green, with reference to the 2012 China green development index roundup, an evaluation index system is constructed, consisting of 3 criteria levels, 6 factor levels and 20 indicators， are shown in Table 1 below:

2.2. Data

The specific data are from China Statistical Yearbook (2011-2018), China Environmental Statistical Yearbook (2011-2018) and statistical bulletins and yearbooks of national Economic and social Development of all provinces. For the missing of some original index data, the mean value method is adopted in this paper.

3. METHOD

3.1. Standardization of Indicator Data

Indicator type can be positive(+) or negative(-),and the statistical units and dimensions of indicator values may differ.Accordingly,we applied the maximum difference normalization method to create dimensionless indicators.

Table 1 Ecological - economic complex system of government support index evaluation system

Target layer	Criterion layer	Element layer	Index layer	Indicator Type	Unit
Green Development level	Green economic growth	Green growth efficiency indicator	GDP per capita	+	yuan/person
			Per capita disposable income of urban residents	+	yuan
			Investment in fixed assets throughout society	+	One hundred million yuan
			Industrial water consumption	-	Billion cubic meters
		Industry index	Gross output value of agriculture, forestry, animal husbandry and fishery	+	One hundred million yuan
			Industrial added value	+	One hundred million yuan
			The proportion of added value of tertiary industry in GDP	+	%
	The ecological environment	Indicators of resource and ecological protection	Water resources per capita	+	m^3/person
			Forest coverage rate	+	%
			Park green area per capita	+	m^2/person
		Environmental and climate change indicators	Sulfur dioxide emissions	-	t
			Cod emissions	-	t
			Effluent discharge	-	t
			Urban population density	-	person/km^2
	Government policy support	Green Investment Indicators	Urban infrastructure investment completed	+	Ten thousand yuan
			Investment in industrial pollution control was completed	+	Ten thousand yuan
			Total investment in environmental pollution control	+	One hundred million yuan
		Environmental governance indicators	Investment in wastewater treatment project completed	+	Ten thousand yuan
			Investment in the waste gas treatment project completed	+	Ten thousand yuan
			Solid waste treatment project completed investment	+	Ten thousand yuan

Assuming that there were n samples and m indicators,we created the original indicator data matrix$X=(X_{\theta ij})_{m\times n}$,($1\leqslant i\leqslant n$, $1\leqslant j\leqslant m$),where i is the number of samples and j is the number of indicators.(1) and (2),to obtain standardized indicator data.The variable $X_{\theta ij}$ is the original value of the jth indicator of the ith sample in the θth year,and X_{max} and X_{min} are the minimum and maximum values,respectively, of the jth indicator indicator of the ith sample.The variable $X'_{\theta ij}$ denotes the standarized value.

In order to eliminate the influence of the extreme value "0", the original data are processed as follows:

For positive indicators:

$$X'_{\theta ij}=\frac{X_{\theta ij}-X_{min}}{X_{max}-X_{min}}*0.9+0.1(i=1,2...n;j=1,2...m) \quad (1)$$

For positive indicators:

$X'_{\theta ij}=\frac{X_{max}-X_{\theta ij}}{X_{max}-X_{min}}*0.9+0.1(i=1,2...n;j=1,2...m)$ (2)

3.2. The Entropy Method

The proportion $P_{\theta ij}$ of indicator sample i was calculated as follows: $P_{\theta ij}=\frac{X_{\theta ij}}{\sum_{\theta}^{\rho}\sum_{i=1}^{n}X'_{\theta ij}}$ (3)

The value of e_j was calculated using the following formulas: $e_j = -k\sum_{i=1}^{n}P_{\theta ij}\ln(P_{\theta ij})$, k=1/ln(n)>0 (4)

The otherness coefficient g_j, of indicator j was calculated as follows: $g_j = 1 - e_j$ (5)

Last, we calculated the entrogy weight w_j of indicator j using the following formula: $w_j = g_j / \sum_{j=1}^{m} g_j$ (6)

Calculate the comprehensive score of green development level of each province(Table 2): $H_{\theta i} = \sum_{j}^{m}(w_j X'_{\theta ij})$ (7)

3.3. Results

(1) Comprehensive analysis of measurement results. Since 2010, the overall green development level of the 12 provinces and cities in the western region has shown a slow rising trend, with the average annual growth rate rising from 0.349 in 2010 to 0.4499 in 2017, reaching an average annual growth rate of about 5.21%. Among them, the growth rate of four provinces exceeded the average growth rate of the western region. However, there are regional differences among provinces and cities with different development rates. The fastest is Xinjiang (12.8%) and Sichuan (9.11%), and the slowest is Xizang (0.8%), with a difference of 12%.

(2)Regional analysis of measurement results.From all the regions of space scale, the green level of economic development level gradually increased to 0.400 to 0.499 within the scope of the area increases gradually, there are three provinces and cities in 2010, gansu, qinghai, xinjiang) green development level between 0.200 to 0.299, the low level of development, all 12 western provinces and cities in 2013 reached more than 0.300, and level of development of Inner Mongolia reaches 0.5888, between 0.4000 0.4999 provinces increased to 6.By 2017, except for Gansu and Qinghai, which were still at the level of 0.300-0.399, all other provinces and cities had increased to more than 0.4000, and Inner Mongolia, Guangxi and Sichuan reached more than 0.5000.Generally speaking, the green development level of southern provinces and cities is more in high-value regions, while the green development level of Northern Gansu and Qinghai provinces is always at a low level.

Table 2 Evaluation results of green development level in western China

Year / Region	2010	2011	2012	2013	2014	2015	2016	2017
Inner Mongolia	0.4287	0.5017	0.5091	0.5888	0.5997	0.5552	0.5862	0.5498
Guangxi	0.4193	0.4244	0.4529	0.4790	0.4935	0.5269	0.5326	0.5047
Chongqing	0.3820	0.4250	0.4132	0.4352	0.4396	0.4490	0.4597	0.4816
Sichuang	0.3537	0.3845	0.4111	0.4320	0.5008	0.4893	0.5284	0.5469
Guizhou	0.3269	0.3883	0.3497	0.3800	0.3882	0.4192	0.4292	0.4322
Yunnan	0.3576	0.3693	0.3851	0.4446	0.4655	0.4488	0.4666	0.4554
Tibet	0.4155	0.4266	0.3945	0.4011	0.4046	0.4064	0.4000	0.4324
Shanxi	0.3285	0.3401	0.3656	0.3855	0.3948	0.4275	0.4340	0.4626
Gansu	0.2807	0.2767	0.3420	0.3227	0.3319	0.3146	0.3730	0.3335
Qinghai	0.2979	0.3009	0.2989	0.3050	0.3287	0.3341	0.3507	0.3425
Ningxia	0.3539	0.3562	0.3653	0.3923	0.4201	0.3956	0.4269	0.4119
Xinjiang	0.2436	0.2789	0.3121	0.3524	0.3655	0.3993	0.4163	0.4449

4. CONCLUSION

On the coupling of regional economy, ecological environment and government support is a necessary condition to realize the development of regional green economy and an important measure to realize high-quality economic development. From the perspective of green development level measurement, there are great spatial differences among western regions, but the overall green development level is still at a low level. By 2017 provincial green development level index of Inner Mongolia>Sichuang>Guangxi>Chongqing>Shanxi>Yunnan>Xinjiang>Tibet>Guizhou>Ningxia>Qinghai>Gansuj.Inner Mongolia, Sichuan and Guangxi in the top three of the western region development, mainly the production of the ecological environment resources of Inner Mongolia high utilization efficiency and energy conservation and emissions reduction, Gansu and Qinghai is located in the western region of the last two, mainly because the arrangement of industrial structure is unreasonable, the second industry than major, resource consumption, waste water, waste gas and other emissions is still high, the dependence on ecological resources to illustrate these provinces is still strong, need to further optimize the industrial structure,We will strengthen environmental governance, develop new energy industries, and improve the development of the green economy.

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