

Coordination Appraisal Research of Industrialization and Greenization Based on China's Provincial Data

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Abstract. This paper constructed and coordination appraisal method of industrialization and greenization based on the coupling theory in physics; and gave an empirical test and analysis on the support of Chinese provincial regional data for the year 2014. Research results indicates: the coordination appraisal method of industrialization and greenization of this paper constructed is a scientific and comprehensive appraisal method of coincidence the idea of sustainable development. The method has considerable significance theoretical innovation and practical application value, can appraise and analyze availably the interaction and coordination between industrialization and greenization, provide decision references and theory supports for a nation or a region to develop new type industrialization, realize sustainable development.

Keywords: industrialization; greenization; coupling coordination degree; sustainable development; green growth.

1. Introduction

Greenization is the significant practical way to bring about the drawbacks of the road of industrialization. Greenization is the major support for the sustainable development of human society. But the greenization research has just begun, at home and abroad, and the research of industrialization and greenization interaction and coordination development is very little, so it is difficult to guide the practice. Therefore, it has a significant theoretical and practical significance to research theory and practice of the interaction and coordination of industrialization and greenization, to take on a new road of industrialization and to realize sustainable development for the human society. Based on the above considerations, this paper constructed an interaction and coordination appraisal method of industrialization and greenization based on the coupling theory in physics; and gave an empirical test and analysis on the support of Chinese provincial regional data for the year 2014.

2. The related research review

2.1 The literatures review of related problems

The related literatures review of Industrialization and Greenization are as follows. Xu etc. [1] studied the synchronous development of industrialization, informatization, urbanization, agricultural modernization. At present, the concept of green growth with the highest citation rate is given by OECD [2]. Campiglio [3] explored green growth in the service industry. Baharat [4] considered the sustainable development of human society depends on the ecological and green transformation of the industry. Dercon [5] researched the role of green growth on climate change and aiding poor countries. McKendry and Janos [6] discussed green growth and sustainable development of industrial cities in developed countries. Feng etc. [7] explored the concept of greenization in china. Liu etc. [8] studied the evolution characteristics of greenization in China. Ding etc. [9] give a general introduction on progress of coordinated development of industrialization, urbanization, agricultural modernization, informationization, and greenization in China, and other literatures, etc.

2.2 Limitations of existing research

(1)The research on the industrialization needs to be further deepened at home and abroad.

(2) The research on the greenization is at the initial stage, and the research is not deep enough, and the research has not formed theoretical system.

(3)The interaction and coordination research of industrialization and greenization is less, and it is difficult to guide the practice.

This paper made up for these shortcomings.

3. Coordination appraisalment method of industrialization and greenization

3.1 coordination appraisalment indicators system of industrialization and greenization

This paper constructed a coordination appraisalment of industrialization and greenization, Table 1 is the appraisalment indicators system. In this paper, we use AHP (Analytic Hierarchy Process) Method to synthesize 4 indicators (Degree of industrialization etc.) into industrialization comprehensive index. Similarly, we use AHP Method to synthesize 4 indicators (Renewable energy power generation ratio etc.) into greenization comprehensive index.

Table 1. Coordination appraisalment indicators system of industrialization and greenization

	Industrialization and greenization	Evaluation indicator	Concrete representation
Coordination degree of industrialization and greenization	Industrialization comprehensive index	Degree of industrialization	Second industry added value/GDP(proportion)
		Industrial employment proportion	Second industry employment number/total number of social workers(proportion)
		Industrial per capita productivity	Second industry value added/second industry employment number(proportion)
		Industrial science and technology level	R&D funding/second industry added value(proportion)
	Greenization comprehensive index	Renewable energy power generation ratio	Renewable energy power generation accounts for the proportion of total energy power generation (percentage)
		Per capita sulfur dioxide emissions	Annual average sulfur dioxide emissions per capita(ton/person)
		Investment proportion of environmental pollution government	Environmental pollution government investment accounted for GDP (percentage)
		GDP energy intensity	Ten thousand yuan GDP energy consumption(tons of standard coal)

3.2 Coupling degree model and coupling coordination degree model

In this paper, the coupling theory of physics subject is introduced, which is used to explore the coordination degree appraisalment of industrialization and greenization. The model of coupling theory used in this paper is as follows.

(1) Coupling degree model

Coupling degree model of physics subject is as follows:

$$C_n = \left\{ \frac{(U_1 \times U_2 \times \dots \times U_n)}{\prod (U_i + U_j)} \right\}^{\frac{1}{n}} \quad (1)$$

In the above formula, U_1, U_2, \dots, U_n represent n systems, C_n represent Coupling degrees of the n systems.

There are two systems(industrialization and greenization) in this paper, So, the coupling degree of the two systems is as follows:

$$C = C_2 = \left\{ \frac{(U_1 \times U_2)}{(U_1 + U_2)^2} \right\}^{\frac{1}{2}} \quad (2)$$

In the above formula, U represents industrialization comprehensive index, and U_2 represents greenization comprehensive index, C_2 represents coupling degree index C of the two systems, $0 \leq C < 1$.

(2) Coupling coordination degree model

Coupling degree index C express two system coupling degree, but it can't reflect the actual interaction and coordination degree of the two systems, such as: the industrialization and greenization

level of a region is low, but we can draw high coupling degree evaluation results, and this is not meaningful. Therefore, we need to introduce coupling coordination index D to measure the degree of interaction and coordination between the two systems.

$$D = \sqrt{C \times T} \quad (3)$$

$$T = \alpha u_1 + \beta u_2 \quad (4)$$

Among them, D represents coupling coordination index, expresses the degree of interaction and coordination of the systems. T represents comprehensive evaluation index of two systems, reflect the overall efficiency of the two systems. α and β represent undetermined coefficients. Generally speaking, we think that industrialization and greenization are equally important. So, α and β values are the same, both are 0.5.

3.3 Coordination degree appraisalment standard of industrialization and greenization

Coupling coordination index D is the indicator which measures the degree of interaction and coordination between industrialization and greenization, the measuring standard is in Table 2.

Table 2. Coordination degree appraisalment standard of industrialization and greenization

Coordination development phase	Coupling coordination degree of D value	Coordination type	Coordination development phase	Coupling coordination degree of D value	Coordination type
Low level coordination: Very little contact	0.0000-0.0999	Extreme lack of coordination	Strengthen coordination: Running in contact	0.5000-0.5999	reluctant coordination
	0.1000-0.1999	Serious lack of coordination		0.6000-0.6999	Primary coordination
	0.2000-0.2999	Moderate lack of coordination		0.7000-0.7999	Intermediate coordination
Start coordination: Contend with each other	0.3000-0.3999	Slight lack of coordination	High level coordination: Fusion and symbiosis	0.8000-0.8999	Good coordination
	0.4000-0.4999	On the verge of lack of coordination		0.9000-1.0000	High quality coordination

4. Appraisalment and analysis of the coordination degree of China's industrialization and greenization

Specific data of each indicator which is showed in table 1, of coordination appraisalment between China's industrialization and greenization in 2014, is derived from China Statistical Yearbook (2015), Statistical Yearbook of Chinese various provincial regions in the year 2015, China population and employment statistics yearbook, China industrial economy statistical yearbook, China economic information network statistics database, CNKI "Statistical database of China's economic and social development", People's Republic of China "national statistical database" and other relevant statistical data. According to the coordination appraisalment method of industrialization and greenization presented above, we got coordination degree appraisalment results of China's industrialization and greenization in 2014, the results are shown in table 3.

The data in table 3 are analyzed as follows. In the coordination degree of China's provincial regional industrialization and greenization in 2014, Shanghai, Tianjin, Beijing belong to the primary coordination. Guangdong, Jiangsu, Zhejiang, Fujian, Shandong, Chongqing belong to reluctant coordination. Liaoning, Shaanxi, Jilin, Hainan, Heilongjiang, Hubei, Henan, Hunan, Hebei, Sichuan, Jiangxi are on the verge of lack of coordination. Anhui, Guangxi, Inner Mongolia, Yunnan, Shanxi, Xinjiang, Guizhou, Qinghai, Gansu belong to the Slight lack of coordination. Ningxia, Tibet belong to Moderate lack of coordination. Overall, there are some certain extent coordinations in China's provincial regional industrialization and greenization in 2014, but the degree and level of coordination is not high. At present, the industrial green development plan (2016-2020) which is implemented in China's national level, is an opportunity for the China's provincial region. Every province should hold this opportunity, vigorously promote the local area of industrialization and

greenization, and promote the coordination between industrialization and greenization; to make industrialization and greenization become the transformative power which promote the development level of the local economy, society, science and technology, and other aspects. This is a necessary way which is used to narrow the regional gap, to make China as a whole realize modernization.

Table 3. Coordination degree appraisal results of industrialization and greenization of Chinese provincial regions in 2014

Geographical district	Provincial region	Coupling degree index C	Comprehensive evaluation index T	Coupling coordination index D	Coordination degree appraisal
North China	Beijing	0.4931	0.7426	0.6051	Primary coordination
	Tianjin	0.4958	0.7534	0.6112	Primary coordination
	Hebei	0.3526	0.5463	0.4389	On the verge of lack of coordination
	Shanxi	0.3390	0.3475	0.3432	Slight lack of coordination
	Inner Mongolia	0.3459	0.3962	0.3702	Slight lack of coordination
Northeast China	Heilongjiang	0.3867	0.5721	0.4704	On the verge of lack of coordination
	Jilin	0.3824	0.5846	0.4728	On the verge of lack of coordination
	Liaoning	0.3971	0.6183	0.4955	On the verge of lack of coordination
East China	Shanghai	0.4973	0.7692	0.6185	Primary coordination
	Jiangsu	0.4579	0.6917	0.5628	reluctant coordination
	Zhejiang	0.4625	0.6844	0.5626	reluctant coordination
	Anhui	0.3682	0.4038	0.3856	Slight lack of coordination
	Fujian	0.4317	0.6530	0.5309	reluctant coordination
	Shandong	0.4264	0.6381	0.5216	reluctant coordination
Jiangxi	0.3791	0.4357	0.4064	On the verge of lack of coordination	
Central China	Henan	0.4029	0.4972	0.4476	On the verge of lack of coordination
	Hubei	0.3755	0.5795	0.4665	On the verge of lack of coordination
	Hunan	0.3678	0.5328	0.4427	On the verge of lack of coordination
South China	Guangdong	0.4716	0.7213	0.5832	reluctant coordination
	Guangxi	0.3597	0.4126	0.3852	Slight lack of coordination
	Hainan	0.4280	0.5177	0.4707	On the verge of lack of coordination
Southwest China	Chongqing	0.4173	0.6052	0.5025	reluctant coordination
	Sichuan	0.3694	0.4539	0.4095	On the verge of lack of coordination
	Guizhou	0.3268	0.3184	0.3226	Slight lack of coordination
	Yunnan	0.3487	0.3590	0.3538	Slight lack of coordination
	Tibet	0.3126	0.2618	0.2861	Moderate lack of coordination
Northwest China	Shaanxi	0.3928	0.5971	0.4843	On the verge of lack of coordination
	Gansu	0.3357	0.2849	0.3093	Slight lack of coordination
	Qinghai	0.3292	0.2953	0.3118	Slight lack of coordination
	Ningxia	0.3193	0.2597	0.2880	Moderate lack of coordination
	Xinjiang	0.3425	0.3365	0.3395	Slight lack of coordination

5. Conclusion

This paper constructed a coordination appraisal method of industrialization and greenization based on the coupling theory in physics; and gave an empirical test and analysis on the support of Chinese provincial regional data for the year 2014. Research results indicates: the coordination appraisal method of industrialization and greenization of this paper constructed is a scientific and comprehensive appraisal method of coinciding the idea of sustainable development. The method has considerable significance theoretical innovation and practical application value, can appraise and analyze available the coordination between industrialization and greenization, provide decision references and theory supports for a nation or a region to develop new type industrialization, realize sustainable development.

Acknowledgments

This study is supported by The National Natural Science Foundation Major International (Regional) Joint Program of China (No.71320107006); The National Social Science Foundation Key Projects of China (No.14AZD090).

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