ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202204_5(4).0041

Research on Evaluation of Green Finance Level in Yangtze River Economic Belt Based on Entropy Weight Method

Fengjun Cui, Bo Cai and Jiajun Xu

School of Business, Yangzhou University, Yangzhou, 225100, China

Abstract

In the new era of socialism with Chinese characteristics, green finance has become the top priority of sustainable development. China has a vast territory, and the level of green finance varies greatly from region to region. In order to reduce regional differences and promote the coordinated development of green finance, the evaluation and comparison of green finance level between regions should be solved first. This paper takes the Yangtze River Economic Belt region, which is mature in green finance development, as the sample, constructs an appropriate index system, uses entropy weight method to assign weight to each index and evaluates the green finance level of each province and city, conducts cluster analysis according to the evaluation results, and puts forward policy suggestions for the problems reflected in the evaluation. The empirical results show that Shanghai, Chongqing and Yunnan have a high level of green finance, which is worthy of learning and refering to other provinces and cities.

Keywords

Yangtze River Economic Belt; Green finance level; Entropy weight method; Cluster analysis.

1. Introduction and Literature Review

Since the reform and opening up, China's economy has developed rapidly. However, with the economic development, the corresponding environmental protection measures failed to follow up in time, causing a huge impact on the sustainable development of the economy. In this context, the concept of green finance is gradually rising, Salazar (1998) [1] pointed out that green finance is a bridge connecting the two industries of environment and finance, and aims to realize the purpose of environmental protection by relying on financial innovation. Scholtens (2006) [2] focuses on the transmission mechanism between finance and sustainable development and points out that green finance can solve resource and environmental problems through the optimal combination of financial instruments. At present, the country is paying more and more attention to the development of green finance. In August 2016, the People's Bank of China, together with seven ministries and commissions, issued a guideline on building a green finance System, laying out a top-level design for the development of green finance in China.

Since 2004, the research on green finance has generally entered the concept introduction stage. The research entered the expansion stage around 2010, and entered the application stage around 2015. For a long time, China's domestic research on green finance remained at the conceptual stage, and the time for in-depth theoretical expansion was short in the expansion stage. In the case of insufficient theoretical expansion, China has directly entered the stage of applied research, accompanied by partial theoretical deepening.

At the current stage of applied research, research on financial instruments, evaluation system, policy system and so on shows explosive growth in China. Su Dongwei and Lian Lili (2018) [3] used the differences-in-differences method for the first time to show that green credit in China

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202204_5(4).0041

has significant financing penalty effect and investment inhibition effect. Zhu Xiangdong et al. (2021) [4] concluded regional differences in the development of green finance in China by using panel data model and spatial Dubin model. Specifically, the eastern region makes a favorable transition driven by policy incentives and financial basis, while the central and western regions need to deal with the resistance caused by environmental pollution.

In China, the Yangtze River Economic Belt is a key area to develop green finance. Feng Yue and Cheng Chunlin (2017) [5] believe that the industrial structure of the Yangtze River Economic Belt is unreasonable and the environmental load is serious. Green finance is an important engine for the transformation and upgrading of the industrial structure of the Yangtze River Economic Belt. Zhou Wuqi and Zhu Yanan (2018) [6] found that the growth of green total factor productivity in the Yangtze River Economic Belt has big fluctuations and regional differences, and suggested further improving the green financial system, expanding the scale of green financing, and establishing the financial cooperation framework of the Yangtze River Economic Belt.

The evaluation index of green finance efficiency level in China has not yet formed a systematic system in line with international standards. Most scholars measure the development level of green finance from the perspective of green credit, green bonds and other financial instruments, while some scholars try to establish a more complete evaluation system of green finance efficiency from the medium or macro perspective, combining industrial structure, regional economic development and financial industry development level. Ning Wei (2014) [7] studied the long-term stable and balanced relationship between green finance development and macroeconomic development in China through cointegration test and vector error correction model. Qiao Qin (2021) [8] believes that the level of economic development, technological innovation and regional financial development have significant positive effects on the development of green finance. Yang Linjing and Liao Zhigao (2021) [9] studied the moderated mediating effect model and panel quantile model and concluded that the change of industrial structure significantly affected the adjustment of green finance to energy structure.

From the current research results, the construction of green finance evaluation system in China is still redundant and complex. As for the Yangtze River Economic Belt, which is very suitable for the development of green finance, most studies focus on the environmental effect of green finance and the effect of policy practice, and there is a lack of literature to evaluate the level of green finance through empirical analysis. Based on the research of domestic and foreign scholars, this paper takes 11 provinces and cities along the Yangtze River Economic Belt, which are relatively mature in the development of green finance, as the research object, analyzes the specific influencing factors and indicators of green finance in the Yangtze River Economic Belt, so as to build a rigorous, reasonable and innovative green finance index system. According to the index system, this paper firstly analyzes the relevant data, uses the entropy weight method to assign weights to each index, and then calculates the score of the green finance development in the provinces and cities, so as to achieve objective and accurate evaluation results. Secondly, based on the data analysis results, regional comparison is conducted to explore the common and individual problems existing in the development of green finance in provinces and cities of the Yangtze River Economic Belt. Feasible suggestions are put forward based on the national policy background and social background, which can provide reference for other regions of the country.

2. Empirical Analysis

2.1. The Construction of the Index System

By analyzing the concept of green finance and reading relevant literature [10, 11], it can be seen that green finance covers green credit, green investment, green bond, green fund and other

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202204_5(4).0041

aspects, among which green credit and green investment are the most representative. The level of green finance is directly related to the level of macroeconomic development and financial industry development. Therefore, the index system for evaluating green finance level is divided into three levels: overall level, first-level index and second-level index. The comprehensive index of green finance, macroeconomic development level and financial industry development level are taken as first-level indexes. In the selection of secondary indicators, it is necessary to ensure the representativeness and scientificity of indicators and the availability of data. The construction of the index system is shown in Table 1.

Table 1. Index system

Overall layer	Level indicators	Secondary indicators	Index attribute
Green finance level evaluation index system	Comprehensive indicators for green finance	Unit green credit	+
		Unit green investment	+
	Macroeconomic development level	GDP per capita	+
		Industrial structure	-
		Non-performing loan ratio	-
	Financial industry development level	Unit added value of financial industry	+
		Insurance penetration	+

In the index system, the measurement of green credit is complicated. With reference to Zhang Lili (2018) [12], from the angle of green enterprise, this paper selects 35 green concept plate including environmental protection engineering, carbon neutral and new energy. The financial statements of the listed companies were queried in order to extract the short-term loans and long-term loans. The total amount of short-term loans and long-term loans are used as green credit. The data comes from Ruisi Database, the Shanghai Stock Exchange, the Shenzhen Stock Exchange and the National Equities Exchange and Quotations.

In this paper, the proportion of environmental pollution control investment in GDP represents unit green investment. The proportion of primary industry GDP and secondary and tertiary industry GDP represents industrial structure. The data of unit green investment, macro-economic development level index and financial industry development level index are all from EPS database.

In order to ensure the evaluation results are reasonable, the time period of data is appropriately extended. In addition, due to incomplete information disclosure of green investment and added value of financial industry in recent years, the data period is determined to be 2008-2017.

2.2. The Evaluation of the Green Finance Level

2.2.1. Method for Evaluation

In order to ensure evaluation results fair and objective, the Entropy Weight Method (EWM) is used to determine the green credit level along the Yangtze River Economic Belt in various provinces and cities. This method determines the weight by the amount of information conveyed by each index. It can comprehensively consider the amount of information provided by each index, and then calculate the evaluation result. The specific steps are as follows:

(1) Data standardization. Since the dimension and unit of each index are not consistent, the indexes need to be standardized. For positive indicators, use the formula $x_{ij\mu}^{*} = x_{ij\mu} - x_{min}/x_{max} - x_{min}$ to standardize. For negative indicators, use the formula $x_{ij\mu}^{*} = x_{max} - x_{ij\mu}/x_{max} - x_{min}$ to standardize.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202204_5(4).0041

(2) Calculate the index weight of each year: $y_{ij\mu} = x^*_{ij\mu} / \sum_\mu \sum_i x^*_{ij\mu}$.

(3) Calculate the information entropy: $e_j = -\ln(rn) \sum_\mu \sum_i y_{ij} \ln y_{ij\mu}$.

(4) Calculate the information utility value: $g_j = 1 - e_j$.

(5) Calculate the index weight: $\omega_j = g_j / \sum_j g_j$.

(6) Calculate the score: $S_{i\mu} = \sum_j (\omega_j \, x^*_{ij\mu})$.

(7) Visualize the score: $S^*_{i\mu} = 100 S_{i\mu} + 50$.

In the formula above, i represents provinces and cities in the Yangtze River Economic Belt, j represents indicators, and μ represents the year. In addition, r represents the total number of years and n represents the total number of provinces and cities, that is, in this case, r=10 and n=11.

2.2.2. Method for Evaluation

Table 2. Evaluation results of green finance level

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Shanghai	82.37	86.86	81.96	81.54	82.92	86.78	92.73	95.95	90.40	94.16
Jiangsu	71.94	71.29	72.58	74.40	76.60	80.77	81.22	82.83	81.56	81.98
Zhejiang	82.65	70.46	74.81	71.98	75.41	75.52	76.93	76.37	80.77	77.60
Anhui	74.50	74.45	74.12	76.92	78.78	86.33	81.73	81.86	83.08	82.11
Jiangxi	67.88	70.20	77.30	81.79	86.17	80.15	80.11	79.43	82.74	82.17
Hubei	71.88	74.52	72.31	76.54	77.27	76.19	78.12	77.98	84.19	83.83
Hunan	70.67	73.06	68.21	68.27	69.93	71.55	71.11	81.58	71.24	70.87
Chongqing	88.78	92.41	96.91	99.22	92.29	87.86	87.21	84.71	84.20	90.28
Sichuan	75.79	72.82	70.25	73.93	76.32	78.91	81.13	81.75	85.96	87.05
Guizhou	73.46	72.27	74.33	77.72	76.38	79.84	85.58	83.09	81.72	88.57
Yunnan	95.47	84.45	81.52	81.46	80.87	85.11	81.92	81.66	81.83	84.10
Mean	77.76	76.62	76.75	78.52	79.36	80.82	81.62	82.47	82.52	83.88

Through entropy weight method, the evaluation results of green finance level of provinces and cities in the Yangtze River Economic Belt are shown in Table 2.

The table shows that the overall level of green finance in the Yangtze River Economic Belt has been steadily improving year by year, with the mean score rising from 77.76 in 2008 to 83.88 in 2017.The growth trend of Jiangsu, Hubei, Sichuan and Guizhou is relatively stable, as other provinces and cities have fluctuations. Among the provinces and cities, Jiangxi province saw the largest increase, while Zhejiang and Yunnan provinces saw a decline instead of a rise.

In order to detail the scoring differences between regions, K-means clustering method is used to conduct cluster analysis on the evaluation results. In this paper, provinces and cities in the Yangtze River Economic Belt are divided into three levels: high-level region, middle-level region and low-level region. Therefore, the number of designated clusters is 3. The cluster analysis results are shown in Table 3.

The final cluster centers in the above table represent the average of the final cluster centers each year. The larger the final cluster center is, the higher the level of green finance is. Therefore, cluster center 1 has the highest score, followed by cluster center 3, and cluster center 2 has the lowest score. According to the results of cluster analysis, the classification of green finance level in all provinces and cities is summarized in Table 4.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202204_5(4).0041

Table 3. Cluster analysis result

Cluster	Region	Distance	Final Cluster Center
1	Shanghai	15.97	87.26
	Chongqing	17.93	
	Yunnan	15.68	
2	Jiangsu	4.90	78.45
	Anhui	6.97	
	Jiangxi	11.54	
	Hubei	6.81	
	Sichuan	7.24	
	Guizhou	7.07	
3	Zhejiang	10.61	73.95
	Hunan	10.61	

Table 4. Classification

Levels	Provinces and Cities
High Level	Shanghai, Chongqing, Yunnan
Medium Level	Jiangsu, Anhui, Jiangxi, Hubei, Sichuan, Guizhou
Low Level	Zhejiang, Hunan

High-level areas include Shanghai, Chongqing and Yunnan. Relevant data shows that Chongqing and Yunnan achieve high scores mainly because of their emphasis on green credit and green investment. The high score of Shanghai is mainly due to the high level of macroeconomic development and financial industry development.

Low-level areas include Zhejiang and Hunan. The development level of macro-economy and financial industry in Zhejiang province is considerable, but the score of unit green credit is extremely low, with an average of less than 1% each year. As for Hunan province, the rankings of each index are relatively low.

3. Conclusion and Suggestions

The empirical analysis results show that Shanghai, Chongqing and Yunnan have high green finance level in the Yangtze River Economic Belt. Therefore, the experience of the three regions in developing green finance has a certain demonstration role, which is good demonstration for other provinces or cities to learn from. This paper analyzes the shining points of green finance development in the above regions, and puts forward the following suggestions based on the characteristics of the Yangtze River Economic Belt:

3.1. Combine with Regional Characteristics and Develop Green Business

According to their own reserves of resources and demand of the enterprises, the provinces and cities in the Yangtze River Economic Belt can introduce the third party certification body to evaluate the main business of the enterprise and evaluate the corresponding grade. Banks may issue green ultra-short-term financing bonds with different interest rates for different levels of enterprises to reduce financial costs of green enterprises, increase the proportion of direct financing, help enterprises develop green businesses, and promote the development of green finance in the region.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202204_5(4).0041

3.2. Innovate Green Financial Products and Build a Multi-tiered Green Market System

In order to improve market vitality, the provinces and cities can take a page from Chongqing's measure， which is credit product innovation of ecological protection theme. They can introduce multiple transaction elements. For example, environmental elements equity pledge such as emission rights and carbon emission rights, the financing of ecological revenue rights such as the profit right of waste from livestock and poultry industry and the profit right of contracted water-saving management will both improve market vitality. Secondly, traditional financing methods also need to be managed well. Relevant departments need to specify green enterprise evaluation standards to provide the final guarantee of green risks for capital providers and guide capital to flow to green enterprises. Finally, it is necessary to contact all market players, improve the construction of green infrastructure, digitize green credit through the comprehensive service system of big data, and build a shared environmental protection information system and green project library.

3.3. Optimize Industrial Structure and Support Travel Industry

The Yangtze river economic belt provinces and cities should make full use of the Yangtze river and increase green credit support for green cultural tourism projects. With the Yangtze River as the main line and scenic spots along the river as the subordinate line, green, healthy and ecological tourism should be developed in many areas. With the development direction of internationalization, high-end, characteristic and intelligence, the integrated development of health industry and tourism, sports, culture, education and other industries ought to be promoted. Internationally renowned tourism demonstration areas are supposed to be created.

3.4. Guide the Green Upgrading of Industries Based on the Conservation of Water Resources

All provinces and cities in the Yangtze River Economic Belt can carry out green reform based on water resource protection, and advocate innovation of green financial products and financing methods with water resource protection as the starting point. Additionally, the establishment of green finance demonstration zones can provide reference samples for the development of green finance in other regions. Experimental reform can be carried out in the demonstration area first to eliminate polluting and backward production capacity and ensure that green production capacity occupies more market share.

References

[1] J. Salazar: Environmental Finance: Linking Two World, Presented at a Workshop on Financial Innovations for Biodiversity Bratislava, (1998) No. 1.

[2] B. Scholtens: Finance as a driver of corporate social responsibility[J]. Journal of Business Ethics, Vol. 68 (2006) No. 1, p. 19-33.

[3] D.W. Su, L.L. Lian: Does green credit policy affect corporate financing and investment? Evidence from publicly listed firms in pollution - Intensive Industries, Financial Research, (2018) No.12, p. 123-137.

[4] X.D. Zhu, X.Y. Zhou, S.J. Hu, et al: The development of Chinese urban green finance and its influencing factors: An empirical analysis based on green bond, Journal of Natural Resources, Vol. 36 (2021) No. 12, p. 3247-3260.

[5] Y. Feng, C.L. Cheng. Research on Green Financial Support for Industrial Transformation and Upgrading of Yangtze River Economic Zone, Financial Development Review, (2017) No. 6, p. 107-117.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202204_5(4).0041

[6] W.Q. Zhou, Y.N. Zhu: The Effect of Financial Development on Green Total Factor Productivity Growth in the Yangtze River Economic Belt, Journal of Macro-quality Research. Vol. 6 (2018) No. 3, p. 74-89.

[7] W. Ning, J.H. She: Empirical Study on the Dynamic Relationship between Green Finance and Macroeconomic Growth, Seeker, (2014) No.8, p. 62-66. (In Chinese)

[8] Q. Qiao, J. Fan, Y. Sun and Q.H. Song: Research on the Measurement and Influencing Factors of Green Finance in the Provinces Along "the Belt and Road" in China, Journal of Industrial Technological Economics, Vol. 40 (2021) No.7, p. 120-126.

[9] L.J. Yang, Z.G. Liao: Green Finance, Structural Adjustment and Carbon Emissions——A Test Based on the Regulated Mediation Effect, Finance and Economics, (2021) No.12, p. 31-39.

[10] J. Ma: On the construction of China's green finance system, Financial Forum, Vol. 20 (2015) No. 5, p. 18-27.

[11] N. Zhu, X.X. Lai: Research on efficiency evaluation and improvement path of green credit in China, Research on Financial Regulation, (2020) No. 6, p. 41-58. (In Chinese)

[12] L.L. Zhang, L.M. Xiao and J.F. Gao: Measurement and comparison of green financial development level and efficiency in China: Based on data of 1040 public companies, China Science and Technology Forum, (2018) No. 9, p. 100-112 + 120.