



Study on the Coupling and Coordination Relationship between Green Finance and Greening

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Abstract. Based on the coupling coordination model, this paper analyzes the coupling coordination relationship between green finance and green finance. The study found that the average development of green finance and greenization shows a steady growth trend, and the coupling coordination between the two is also constantly improving. It generally shows the spatial distribution characteristics of "high coastal, low inland; high in the north; low in the south". The ranking of the impact intensity of the first-level indicators of green and green finance has basically not changed, from large to small are green credit, green insurance, green securities; green governance, green life, and green production. Based on this, the government can improve the green living standards of all provinces by improving them with green governance, vigorously develop green credit and green insurance, and promote. The coupled and coordinated development of green finance and greenization.

Keywords: Green finance; greening; coupling coordination; obstacles.

1 Introduction

Green finance and greenization complement each other and jointly promote the sustainable development of the economy and society. From the perspective of the relationship between green finance and greenization, the two have a high degree of coupling and coordination, which can promote and complement each other. On the one hand, green finance provides financial support for greening. The implementation of green projects often requires a lot of capital investment, and green finance provides the necessary financial support for these projects by providing special financing channels and financial products, which promotes the process of greening. On the other hand, greening is the basis for the development of green finance. The development of green finance is inseparable from the support of green projects, and the implementation of green projects is a concrete embodiment of greening. Based on this, this paper explores the coupling mechanism of green finance and greenization, and empirically analyzes the coupling coordination level, the differences in space-time evolution and obstacle factors between the two. Infer a more scientific win-win approach from the

relevance of the interactive development of the two, laying the foundation for green finance to better promote green development.

2 The Coupling Mechanism of Green Finance and Greening

The coupling relationship between green finance and greenization is mainly manifested in the following two aspects: one is the role of green finance in promoting greening, and the other is the role of green finance in promoting green finance.

2.1 Green Finance is the Driving Force of Greening

Green finance can Drive the financial system "Greening" and enterprise emission reduction[1], Provide financial support for green projects, including the issuance of green bonds, providing green loans, etc., help enterprises and projects obtain funds, so as to promote the development of green technology and green industry. Green finance plays a key role in the process of green transformation of manufacturing enterprises, and it is also found that activating the inherent advantages of green finance is more conducive to enterprises to promote green transformation from internal multiple sources[2]. In a word, green finance has become an important driving force for greening through the provision of financial support and financial product innovation, and has promoted the realization of environmental protection and sustainable development goals.

2.2 Greening is the Driving Force of Green Finance

As people protect the environment the improvement of awareness and the popularization of the concept of sustainable development have continuously increased the demand for green technology and green industries, which has prompted financial institutions to develop and provide more green financial products to meet market demand. Pass Research Discover, The improvement of macro-ESG, environmental regulation and financial digitalization is conducive to promoting the coordinated development of the green financial system, and its positive role is more obvious in vulnerable areas[3]. Promotion of greening. It enables financial institutions to actively develop green financial products to meet market needs, support technological innovation, manage risks, meet corporate responsibilities and respond to policies, so as to achieve the goal of environmental protection and sustainable development[4].

3 Research Methods

3.1 Selection of Indicators

1. Construction of Green Financial Indicator System.

Green financial development level index system. This article draws on Zhu Guangyin and Wang Simin[5] Ji Ning Yixuan and Zhong Xiyu(2023)[6] In the study,

the method of measuring the development of green finance will be measured from five levels. The construction of the specific indicator system is shown in the table.1.

Table 1. Green Finance Indicator system.

Comprehensive indicators	First-level indicators	TargetTier	TargetImplication	Nature
Green Finance	Green credit	Borrowing scale of environmentally friendly listed companies	Total loans of A-share listed environmental protection companies in various provinces and cities/Total loans of A-share listed companies	Positive
		The proportion of interest expenditure in the regional high-energy-consuming industry	Interest expenditure for regional high-energy industries/interest expenses for regional industrial industries	Negative
	GreenSecurities	The proportion of market value of regional environmental protection enterprises	Regional environmental protection enterprise A stock market value/regional listed enterprise A total market value	Positive
		High energy consumption in the regionListed companyThe proportion of industrial market value	Regional high energy-consuming industry A stock market value/Total market value of A-shares of regional listed enterprises	Negative
	Green insurance	Regional agricultural insuranceDepth	Regional agricultureInsurance income/agricultural output value	Positive
		Regional agricultural insurance compensation rate	Regional agricultural insurance compensationForehead/Regional agricultural insurance income	Positive
	Green investment	The proportion of public expenditure on energy conservation and environmental protection in the region	Regional Energy Conservation and Environmental Protection Industry Financial Expenditure/Regional Financial Expenditure	Positive
		Pertainment of investment in environmental pollution control	Investment in environmental pollution control/GDP	Positive
	Carbon finance	Financial carbon strength	Regional carbon dioxide emissions/GDP	Negative

2. Construction of Green Indicator System.

This article draws on the construction of the green system of predecessors [7], a more comprehensive analysis from three aspects our country2013-2021year 30 provinces Greening level.The construction of the specific indicator system is shown in the table.2.

Table 2. Green Indicator System.

Comprehensive indicators	First-level indicators	Secondary indicators	Nature
Greening level	Green governance	General industrial solid waste disposal	Positive
	Green life	Green coverage	Positive

		Park green space per capita	Positive
		Daily water per capita	Go in the opposite direction
		Number of public steam (electric) vehicles operated	Positive
	Green production	GDP per capita	Positive
		The proportion of tertiary industry	Positive
		Wastewater discharge per unit GDP	Go in the opposite direction
		Sulfur dioxide per unit of GDP	Go in the opposite direction

3.2 Coupling Coordination Model Construction

The known comprehensive evaluation model above can find the comprehensive development level of the system S_{ki} . Since this article has two systems of green finance and green, $k=1,2$, S_{ki} for the comprehensive level of system k in the i year.

On this basis, the total efficiency function C is established to reflect the overall effect of the coupling system, that is, the degree of coupling:

$$C_i = 2 \sqrt{\frac{S_{1i} \times S_{2i}}{(S_{1i} + S_{2i})^2}}$$

C_i represents the degree of coupling between systems in the i year. The larger C , the stronger the degree of interaction between systems. According to the nature of inequality $2\sqrt{ab} \leq a + b$ It can be seen that the coupling value C is in the range of $[0, 1]$.

However, for the same degree of coupling, it is difficult to reflect whether the systems are coordinated at a high level or restricting each other at a lower level. Therefore, it is necessary to establish a coupling coordination model for further judgment and analysis.

Sequence I Year's coupling coordination degree D_i , As shown in the formula:

$$D_i = \sqrt{C_i \times T_i}$$

Among them:

$$T_i = \alpha S_{1i} + \beta S_{2i}$$

T_i represents the contribution of the two systems to the entire coupling system, and α and β represent the weight of the impact of the two systems on the development of the entire coupling system. Considering that green finance and greening have the

same importance, This text take $\alpha=\beta=0.5$.

This article refers to Song Weixuan, the coupling degree stage division standard and coupling coordination type proposed by He Yiqing and others classify the calculated results, as shown in Tables 3 and 4.

Table 3. Coupling degree classification standard.

Coupling degree C interval	Coupling level
(0,0.3]	Low-level coupling
(0.3, 0.5]	Fly up and down
(0.5, 0.8]	Break in
(0.8, 1]	High-level resonance

Table 4. Coupling Coordination Grading Criteria.

Coordination interval	Coordination level	Coupling coordination level
(0,0.1]	Extreme imbalance	Low level
(0.1, 0.2]	Serious imbalance	
(0.2, 0.3]	Medium-disadjustment	
(0.3, 0.4]	Mild imbalance	
(0.4, 0.5]	On the verge of disorder	Medium level
(0.5, 0.6]	Reluctant coordination	
(0.6, 0.7]	Primary coordination	
(0.7, 0.8]	Intermediate coordination	High level
(0.8, 0.9]	Good coordination	
(0.9, 1]	High-quality coordination	

Calculation method based on coupling coordination, provincesGreen Finance The formula for measuring the barrier factor coordinated with green coupling is:

$$O_{ij} = \frac{F_j I_{ij}}{\sum_{j=1}^n F_i I_{ij}}$$

4 Empirical Analysis

4.1 Evaluation of the Development Level of Green Finance and Greening

30 provinces in China (except Tibet, Hong Kong, Macao and Taiwan) were selected through the entropy right method from 2013 to 2021The data is measured separately. Province the development level of green finance and greening, The results are shown in Figure 1. It can be seen from Figure 1 that when the country focuses on green finance and green development, the development level of green finance and greenization in China is basically on the rise.

30In each provinceGreen Finance The province at the top of the development level

is Beijing, which shows the province's achievements in reform and opening up in the field of green finance. Notable; The last-ranked province is Liaoning Province. It may be by At The development of local green finance lacks systematic planning and substantive incentive policies. The result is. 30 Green in all provinces Change The top development level is Shanxi Province. It has a good effect in terms of greening coverage in built-up areas and the disposal of general industrial solid waste; Qinghai Province. At the bottom, we need to further strengthen the green. Level of transformation.

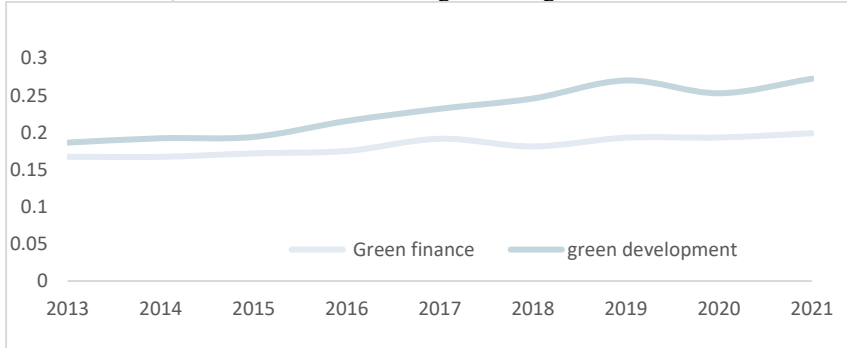


Fig. 1. Green finance and green development level.

4.2 Analysis of the Coordination of Green Finance and Green Coupling

Based on the above green gold the calculation results of the integration and green development level are calculated by using the coupling coordination model to measure the coupling coordination between the two (see Table 5) to judge the stage of the coupling coordination relationship between green finance and greening in various provinces from 2013 to 2021. According to the previous coupling coordination division standard, the degree of coupling between China's green finance and greening is basically in the stage of high-level resonance, the degree of coupling coordination is basically in the stage of near imbalance, and a small number of them is in the stage of mild imbalance, barely coordination and primary coordination. During the research period, the coupling coordination between green finance and greening reached the highest in 2021. But from the whole Let's see, the coupling coordination of the two is in On the verge of imbalance, to be further promoted to Primary coordination Stage. From the perspective of the province, Green finance and greening the province with the highest average coupling coordination is Inner Mongolia. During the research period, Green Finance and Greening in Inner Mongolia the mean of the coupling coordination is in Primary coordination stage; green finance and greening in Hainan and Guizhou the mean of the coupling coordination is in Mild imbalance Stage. The mean of coupling coordination is in reluctant coordination stage the provinces are in order. Beijing, Shanxi, Hebei, Shandong, Liaoning, Ningxia, Jiangsu and Yunnan. The mean coupling coordination of the rest of the provinces is in on the verge of disorder Stage.

Table 5. The coupling coordination of green finance and greenization in various provinces.

Province	2013	2015	2017	2019	2021	Mean value
Beijing	0.5288	0.5470	0.5924	0.6061	0.6363	0.5826
Tianjin	0.4068	0.4151	0.4374	0.4829	0.4479	0.4326
Shanghai	0.4440	0.4810	0.4950	0.5189	0.5526	0.4954
Chongqing	0.4855	0.4766	0.4742	0.4700	0.4755	0.4720
Hebei Province	0.6062	0.5782	0.5209	0.6364	0.5395	0.5640
Shanxi Province	0.4912	0.5295	0.6021	0.6515	0.5907	0.5737
Liaoning Province	0.5309	0.5260	0.5179	0.5366	0.5438	0.5238
Jilin Province	0.3916	0.4250	0.4441	0.4455	0.4457	0.4326
Heilongjiang Province	0.4535	0.4372	0.4644	0.4701	0.4553	0.4553
Jiangsu Province	0.4992	0.4992	0.5071	0.5102	0.5371	0.5086
Zhejiang Province	0.4334	0.4497	0.4643	0.4665	0.4790	0.4579
Anhui Province	0.4490	0.4318	0.4556	0.4743	0.4774	0.4580
Fujian Province	0.4039	0.4155	0.4369	0.4791	0.4401	0.4325
Jiangxi Province	0.4379	0.4203	0.4781	0.4750	0.5223	0.4663
Shandong Province	0.5173	0.4929	0.5573	0.5817	0.6027	0.5448
Henan Province	0.4359	0.4671	0.5097	0.5080	0.4923	0.4824
Hubei Province	0.4548	0.4457	0.4595	0.4844	0.4536	0.4608
Hunan Province	0.4645	0.4752	0.4630	0.4654	0.4784	0.4650
Guangdong Province	0.4615	0.4514	0.4657	0.4914	0.4842	0.4649
Hainan Province	0.3416	0.3558	0.3843	0.4028	0.3936	0.3774
Sichuan Province	0.4839	0.4821	0.4667	0.4793	0.4756	0.4773
Guizhou Province	0.3658	0.3910	0.4125	0.4094	0.4232	0.3979
Yunnan Province	0.4844	0.4762	0.5401	0.5053	0.5080	0.5039
Shaanxi Province	0.4398	0.4521	0.4953	0.5153	0.5248	0.4815
Gansu Province	0.4431	0.4460	0.4567	0.4723	0.4841	0.4577
Qinghai Province	0.4061	0.4277	0.4523	0.4891	0.4941	0.4530
Inner Mongolia	0.6036	0.6140	0.6693	0.6485	0.6528	0.6327
Guangxi	0.3679	0.3920	0.4104	0.4178	0.4656	0.4084
Ningxia	0.4424	0.4828	0.5334	0.5307	0.5826	0.5115
Xinjiang	0.4456	0.4395	0.4828	0.4966	0.5025	0.4758
Mean value	0.4573	0.4641	0.4883	0.5040	0.5054	0.4817

4.3 Analysis of Spatial and Temporal Evolution Characteristics of Coupling Coordination

For more intuitive analysis 30 Provinces Green finance and greening the time evolution trend and spatial distribution characteristics of coupling coordination, Use the above coupling coordination measurement results to judge the spatial and temporal evolution characteristics of the coupling coordination of the two (see table 6). From the perspective of time evolution trend, during the research period Green finance and greening the coupling coordination relationship is in Mild imbalance the number of

provinces is gradually decreasing, in on the verge of disorder the number of provinces in the stage is gradually increasing. Generally speaking, although all provinces Green finance and greening the coupling coordination continues to rise, but step into Primary coordination there are fewer provinces in the stage, and there is still a lot of room for improvement. Judging from the spatial distribution characteristics, 30 The coupling and coordination relationship between the digitalization of the circulation industry and green technology innovation in each province is basically manifested as Northern region high coupling coordination, Southern region Spatial distribution pattern with low coupling coordination.

Table 6. Coupling coordination spatial and temporal evolution characteristics.

A particular year	Mild imbalance	On the verge of disorder	Reluctant coordination	Primary coordination
2013	Jilin, Hainan, Sichuan, Guangxi	Tianjin, Shanghai, Chongqing, Shanxi, Heilongjiang, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Henan, Hubei, Hunan, Guangdong, Sichuan, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang	Beijing, Liaoning, Shandong	Hebei, Inner Mongolia
2017	Hainan Province	Tianjin, Shanghai, Chongqing, Jilin, Heilongjiang, Zhejiang, Anhui, Fujian, Jiangxi, Hubei, Hunan, Guangdong, Sichuan, Guizhou, Shaanxi, Gansu, Qinghai, Xinjiang	Beijing, Hebei, Liaoning, Jiangsu, Shandong, Henan, Yunnan, Ningxia	Shanxi, Inner Mongolia
2021	Hainan Province	Tianjin, Chongqing, Jilin, Heilongjiang, Zhejiang, Anhui, Fujian, Henan, Hubei, Hunan, Guangdong, Sichuan, Guizhou, Gansu, Qinghai, Guangxi	Shanghai, Hebei, Shanxi, Liaoning, Jiangsu, Jiangxi, Henan, Yunnan, Shaanxi, Ningxia, Xinjiang	Beijing, Shandong, Inner Mongolia

4.4 Diagnosis of Coupling Coordination Disorder Factors

Combined with the above analysis results, the obstacle model is used to calculate Green finance and greening the obstacle degree of the first-level index and the second-level index in the index system, analyze the coupling and coordinate obstacle factors of the two and sort the impact intensity. In terms of time evolution, there is basically no change in the ranking of the impact intensity of the primary indicators of green and green finance in 2013-2021, specifically green credit > green insurance > green securities; green governance > green life > green production. During the research period, the impact factors of the secondary indicators of the top three indicators are relatively stable, specifically the disposal of general industrial solid waste, the number of public vehicle (electric) vehicles, the per capita GDP, the loan scale of environmental protection listed companies, the proportion of the market value of environmental protection enterprises and the depth of agricultural insurance.

5 Conclusions and Recommendations

5.1 Research Conclusion

Entropy weight method and coupling coordination model based on considering time variables and the obstacle model, build a green finance and green coupling coordination evaluation index system, and briefly analyze the coupling coordination relationship, space-time evolution characteristics and obstacle factors of green finance and greenization in 30 provinces selected from 2013 to 2021. The specific conclusion is that the average water of green finance and green development is rising steadily, and the coupling coordination between the two continues to improve, generally showing the spatial distribution characteristics of "high coastal, low inland; high in the north; low in the south".

5.2 Policy Recommendations

1. Improve the Green Financial Policy System.

Continue to improve the top-level design of green finance and clarify the development goals and paths of green finance. Promote the establishment and improvement of the green financial standard system, including the standard formulation and unification of green credit, green bonds, green funds and other financial products. Strengthen international cooperation, actively participate in the formulation of international green financial standards and rules, and promote the integration of China's green financial standards with international standards. Strengthen cooperation with international financial institutions and organizations to jointly promote the development of global green finance.

2. Promote the Innovation of Green Financial Products.

Enrich the range of green financial products: encourage financial institutions to innovate green financial products, such as green bonds, green insurance, green funds, etc., to meet the financing needs of different enterprises and projects. Promote the combination of green financial products and digital technology to improve the convenience and transparency of green financial products.

3. Promote Greening and Industrial Transformation and Upgrading.

Promote the optimization of industrial structure: guiding funds through green financial policies. It will flow to the industrial fields with low energy consumption, low pollution and high added value, and promote the transformation of the industrial structure to a green and low-carbon direction. Support the development of new industrial models such as green manufacturing and green supply chain, and promote the green transformation and upgrading of traditional industries.

4. Improve Public Awareness and Participation.

Strengthen the publicity and education of green finance: strengthen the publicity and education of green finance through various channels and forms, and improve the public's awareness and participation in green finance. Popularize the knowledge and concepts of green finance and guide the public to form a green and low-carbon lifestyle and consumption habits.

In summary, to promote the coordinated development of green finance and greenization, it is necessary to start from the policy system, product innovation, industrial transformation, project docking and public participation and other aspects to form a collaborative promotion mechanism of government guidance, market leadership and social participation.

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