International Journal of Economics and Finance; Vol. 17, No. 1; 2025
ISSN 1916-971X E-ISSN 1916-9728
Published by Canadian Center of Science and Education

The Spatiotemporal Evolution Characteristics and Improvement Paths of China's Green Finance Level——Empirical Study on Panel Data Based on Dynamic QCA and NCA Methods

Xin Tong[1], Ke Li[1] & Xuesen Li[2]

[1] Northeastern University School of Business Administration, Shenyang, China

[2] College of Science and Technology, Shenyang Polytechnic College, Shenyang, China

Correspondence: Xin Tong, Northeastern University School of Business Administration, Shenyang, China. Tel: 86-186-0066-2323. E-mail: tongxin@qhd.neu.edu.cn

Received: October 31, 2024 Accepted: November 25, 2024 Online Published: November 30, 2024

doi:10.5539/ijef.v17n1p48 URL: https://doi.org/10.5539/ijef.v17n1p48

Abstract

Green finance (GF) is the core driving force in solving environmental problems. Under the digital background, how to improve the GF with the help of digital technology is a topic worthy of further study. Based on data from 29 provinces from 2014 to 2021, this study uses the entropy weight method to estimate the level of GF in China,and uses Dagum Gini coefficient and Kernel density estimation method to explore the spatio-temporal evolution characteristics of green finance level. Finally, based on the theory of the digital innovation ecosystem (DIE), we use NCA and dynamic QCA methods to explore the configuration effects of various elements within the DIE over time. The results show that the overall level of GF in China has a steady upward trend, achieving nearly double growth, yet there are significant regional differences, and the level of GF in Northeast China fluctuates unsteadily; From the perspective of regional differences, the level of GF in different regions of China is quite different, among which the western region has the largest regional difference, and super-variable density is the main source of regional differences. From the perspective of dynamic evolution, the overall level of GF in China is on the rise, among which, there is a "catch-up effect" among provinces. A single factor does not constitute the necessary conditions to improve the level of GF, and then through linkage matching, three promotion paths are obtained, and further divided into two models: environmental support model and multi-agent comprehensive development model. Deepening the rational understanding of the complex interaction of multiple factors behind the improvement of the level of GF has important implications for sustainable economic development (SED).

Keywords: green finance, digital innovation ecosystem, Dagum Gini Coefficient, Dynamic QCA and NCA

1. Introduction

In the face of increasingly serious environmental problems such as global warming, it has become particularly urgent to find ways for SED (Zhang et al., 2023). However, in order to achieve SED, it is not enough to rely on government support alone, and the role of market mechanisms needs to be fully brought into play. Therefore, GF is crucial in promoting China's economy towards sustainable development and low-carbon transformation. In 2016, the People's Bank of China, together with seven other ministries and commissions, issued the 'Guiding Opinions on Building a Green Financial System', which emphasized the key role of GF in supporting the green development of industries and sustainable economic growth, aiming to address ecological and environmental issues by providing services to the real economy. According to data, as of June 2023, the global balance of green credits and green bonds ranks first, while the balance of green loans tops 27 trillion. In addition, with the rapid development of digital technology, the application of emerging digital technologies such as ICT in the financial field has not only injected new impetus into the development of GF, but also injected sufficient elements into the construction of ecological civilization (Zhao & Li, 2022). However, it is worth noting that at present, there is a lack of theoretical and empirical research on whether the level of GF is significantly different in different regions, and how to find the path to improve the GF in the context of digitalization. Based on this, this article endeavors to examine the dynamic evolution trend and improvement path of China's GF development level at the provincial level, with the aim of furnishing relevant departments with a point of reference for future effective efforts.

At present, the research on GF mainly involves three aspects. First, the construction and evaluation of GF indicators. Some scholars use green bonds, green investment, green credit and other single indicators to measure GF (Alharbi et al., 2023; Starr, 2008; Pang, 2022; Liu & Tang, 2011), and analyze its impact on high-quality economic development, ecological environment and enterprise innovation. Other scholars build core evaluation indicators from aspects such as green credit, green investment, and carbon emissions to calculate GF (Wang, 2022; Chin et al., 2022; Gao & Zhang, 2021; He et al., 2019). Second, the temporal and spatial evolution characteristics of GF (Zhao et al., 2023; Yin & Xu, 2022; Lv et al., 2021). Studies on the dynamic evolution of GF are currently few, but both static and dynamic researches indicate a long-term upward tendency in the amount of GF in China. At the regional level, China's GF scene clearly exhibits the polarized and uncoordinated features of regional development. Third, explore the influencing factors of GF. Through reading the existing literature, it is found that GF is not only affected by the internal level, but also by the external level. The anti-risk ability of financial institutions and the repayment ability of green enterprises audited by financial institutions are the main factors affecting their internal level. Meanwhile, other academics suggested that green credit, which serves as the primary means of funding for GF, has a significant impact on the field's growth (Yan & Gong, 2024). On the external level, growth of GF is facilitated by improvements in economic conditions, government backing, and scientific and technical advancements (Wu et al., 2023; Jiang et al., 2023; Madalena et al., 2022). In addition, in this process, some scholars also explored the spatial correlation and spillover effects of GF by constructing spatial econometric models. For instance, Huang et al. (2022) found that the local GF would be affected by the positive spillover of neighboring areas by constructing a spatial econometric model.

This research discovers that there is variation in the choice of GF indicators after a thorough review of the literature. In particular, the features of GF's temporal and spatial progression are not paid enough attention, and the regional heterogeneity of GF development is not fully considered. Furthermore, the promotion path of GF has not gotten much attention in the context of digitalization. Thus, possible contributions of this work include the following: First, the index system of GF is enriched. Green energy is included in the GF index system, and by creating green energy industry, changing the energy consumption structure and realizing energy cleanliness. It helps to advance the industrial integration of GF and green energy (Cui et al., 2023; Ainou et al., 2023; Yu et al., 2021). Second, it enriches the research perspective. Under the background of digitalization, this study builds the core elements of DIE based on the theory of DIE, and explores the promotion path of multi-factor combination to GF. Thirdly, it enriches the research methods. At present, the research methods of path Analysis are mainly Qualitative Comparative Analysis (QCA) based on cross-sectional data, which ignores the time effect of cases. Therefore, this research adopts dynamic QCA method and NCA (Necessary Condition Analysis) method to discuss the necessity of antecedent variables from both quantitative and qualitative perspectives, and takes provincial panel data as research samples to explore the promotion route with the time impact.

2. Theoretical Analysis

2.1 Green Finance and Digital Innovation Ecosystem

GF, as a new economic activity, is essential to China's efforts to save the environment, combat climate change, and use resources more wisely. Currently, the continuous and accelerated construction of GF is not only consistent with the long-term development strategic goals of China's small and medium-sized enterprises, but also consistent with the strategic goals of pursuing sustainable development. At present, there are two primary ways that GF is guiding the economy toward sustainable development.

First, encourage the industrial structure's optimization by providing financial support. Both new green sectors and industries with high emission levels exist in China today. The growth of traditional industries will unavoidably result in resource waste and pollution of the environment. However, the development time of green enterprises in China's economic market is short, most of them are based on new energy, green environmental protection and other industries, and the development scale is small, and there are financing difficulties, so it is difficult to achieve the expansion of production scale. The creation of GF will allow the financial sector to leverage commercial banks and other financial institutions to develop innovative green financial solutions, encourage the modernization and transformation of established sectors, strictly control the flow of funds, reduce the financing of high-polluting industries, increase the financing amount of clean industries such as new energy, so as to achieve SED (Wang, X. & Wang, Q., 2021; Chien, 2023; Nian & Dong, 2022).

The second is encouraging green development to strengthen the double cycle on the domestic and international fronts. GF not only provides a new development opportunity for green consumption, but also drives the international economy and cooperation. From the perspective of consumption, actively advocating GF is conducive to popularizing and propagating the concept of green consumption to the public, changing the demand

structure from the consumption side, enhancing the public's preference for green products, and thus encouraging the creation of green products and green production. On this basis, it not only assists the public to form a healthy and scientific concept of green consumption, businesses in incorporating green production concepts into their operations, encouraging green enterprise innovation, reviving the social economy, and achieving two-way driving development from quantitative change to qualitative change (Geetha & Biju, 2023; Chae, 2019; Cai X, Chen et al., 2023). Innovative green financial products are helpful in fostering low-carbon and environmentally friendly development from an investment standpoint (Chae, 2023; Helfat & Raubitschek, 2018). Green financial goods, heavily rely on green credit, and multi-level green financial products and market systems, including carbon financing, insurance, and green bonds, are becoming more and more widespread. The use of green financial instruments by financial institutions to measure corporate risks is conducive to guiding the transformation of resource allocation structure to the direction of green and low-carbon. Furthermore, with the continuous advancement of a new round of industrial reform, it is necessary to use financial technology as a means to achieve breakthroughs in green financial innovation (Song, 2019; Zhang & Umair, 2023; Zhang et al., 2024). However, with the continuous improvement of the green financial system, its development still faces issues such as information asymmetry, industrial innovation and risk, non-market risk. To address the aforementioned issues, the collection and screening of corporate data information and risk monitoring can be realized through the use of digital technology. In contrast to the industrial era, innovation in the digital age has undergone fundamental changes, and has taken on ecological structural and operational characteristics. As a DIE with the common attributes of digital innovation and innovation ecosystem (Shan et al., 2023), it can not only encourage the production and application of digital innovation through digital entities, but also deeply integrate the digital process and the innovation behavior of innovation entities to encourage the GF. Consequently, this research explores the impact path of GF based on the theory of DIE. The primary components and environmental elements make up the majority of the composition of the DIE at the moment. It covers digital government (DG), digital enterprises (DE), digital talent (DT), and financial institutions (FI) as its primary aspects. Its environmental elements cover digital innovation infrastructure (DII) and digital financial services (DFS). This allows us to completely study how digital technologies affect GF. Fig. 1 displays the unique research framework.

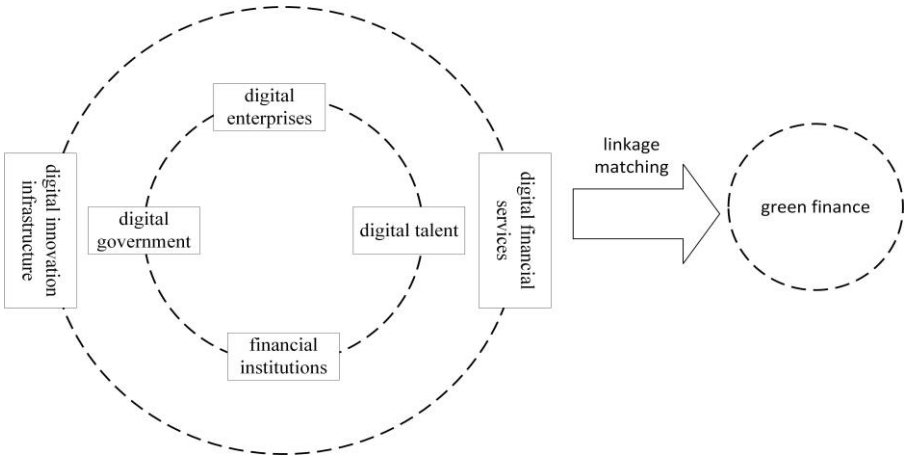

Figure 1. Research framework

2.2 Green Finance and Core Elements of the System

2.2.1 Green Finance and Main Elements

The government plays a guiding and supporting role in promoting the development of GF, and the construction of DG has a decisive impact on the growth of GF. Creating a DG can enhance government operations, streamline business procedures, promote government integration, and leverage information technology to develop cutting-edge instruments for fiscal policy and fund the construction of green financial infrastructure. For instance, the government of Quzhou in China is utilizing digital technology to create a credit information system for green financial services. The main engine propelling the growth of GF is DE. By encouraging the efficient flow of both digital and non-digital resources and the sensible use of financial products, DE may significantly raise the level of GF. For example, DE can use digital technologies to build green information detection models, build risk knowledge maps, and monitor corporate risks (Brika, 2022; Yue et al., 2022; Dagum, 1997), thus quantifying

environmental benefits, reducing environmental pollution, and realizing the development of GF. DT forms the foundation of the DIE. A healthy talent development environment is a key prerequisite for digital innovation and driving the economy in a green direction. Currently, banks and other financial institutions have continued to increase the demand for DT who understands big data and financial technology. DT can empower GF through innovative fintech products. Digital empowerment contributes to a decrease in the losses incurred by financial organizations. Digital technology itself has green properties, and FI innovate financial products through digital technology, which supports the growth of GF (Du & Kim, 2021; Garcia-Castro & Ariño, 2016; Fiss, 2011; Guedes et al., 2016; Schneider & Wagemann, 2012). At present, FI in developed countries have identified green development and digitalization as the main strategic direction of enterprises. In addition, the application of "meta-universe" technology can help FI improve decision-making levels and minimize innovative errors in green financial products (Chang & Zhao, 2024; Dwivedi et al., 2018; Zhang, 2023).

2.2.2 Green Finance and Environmental Elements

DII mainly involves technology centers, data centers, 5G base stations, which is the foundation for the creation of DIE and digital technology enabling GF. Enhancing the infrastructure for digital innovation can help elevate the financial sector's digital standing and foster the growth of GF. A new class of financial services known as "digital finance" makes use of digital technology to develop new financial service offerings, boost their effectiveness, and stimulate the growth of GF.

3. Model Setting and Data Source

3.1 Research Method

3.1.1 Dagum Gini Coefficient

This research uses the Dagum-Gini coefficient method to examine the relative differences in GF. The following is the precise calculating formula.

$$\begin{aligned} G &= \frac{\sum_{j=1}^{k}\sum_{h=1}^{k}\sum_{i=1}^{n_j}\sum_{r=1}^{n_h}|y_{ji}-y_{hr}|}{2n^2u} \\ &= G_w + G_{nb} + G_t \\ &= \sum_{j=1}^{k} G_{jj}p_j s_j + \sum_{j=2}^{k}\sum_{h=1}^{j-1} G_{jh}(p_j s_h + p_h s_j)D_{jh} + \sum_{j=2}^{k}\sum_{h=1}^{j-1} G_{jh}(p_j s_h + p_h s_j)(1-D_{jh}) \end{aligned} \quad (1)$$

Where, G is the overall Gini coefficient, k is the number of regions divided, n is the number of provinces, and u is the average of regional GF level. G_w, G_{nb} and G_t represent intra-regional difference contribution, inter-regional net difference contribution and super-variable density contribution, respectively. G_{jj} and G_{jh} represent intra-regional Gini coefficient and inter-regional Gini coefficient, respectively, and D_{jh} represents the relative influence with inter-regional green finance level. p_j and p_h are respectively represented as j, and the provinces contained in region h account for the share of all provinces; s_j, s_h are respectively represented as the sum of the green finance level of region j, h and the ratio of the total GF level.

3.1.2 Kernel Density Estimation

In order to better investigate the absolute difference and dynamic evolution of the whole and each region, the kernel density estimation method is further used for analysis. This is the precise calculation technique. Suppose f(x) is a function of the level of green finance:

$$f(x) = \frac{1}{nh}\sum_{i=1}^{n} K\left(\frac{X_i - x}{h}\right),\ K(x) \geq 0,\ \int_{-\infty}^{+\infty} K(x)\,dx = 1 \quad (2)$$

Where, $K(\bullet)$ is the kernel function, h is the bandwidth, the smaller the bandwidth, the more accurate the result; n is the number of observations, X_i, x represents the independent and equally distributed observations and the mean of the observations respectively.

3.1.3 Dynamic QCA and NCA

Due to the characteristics of "synergistic relationship" and "complex interaction" among various elements of the DIE, the path analysis to investigate the DIE to improve the level of GF is a typical problem of complex causality. Therefore, it is difficult to obtain effective analysis results from previous basic quantitative research. As a configuration effect research method, QCA can effectively explain the causal complexity problems such as

"multiple effects, one cause", and is an effective analysis technique to investigate how different DIE components affect GF. In addition, compared with QCA method, which can only study the necessity of antecedent variables from a qualitative perspective, NCA method can not only identify whether antecedent variables are necessary conditions, but also identify the degree to which antecedent variables can achieve the requirements for the required outcomes from a quantitative perspective .

It is worth noting that most of the traditional QCA methods focus on the research of cross-section data, and their ability to explore the longitudinal configuration effect is limited, while the impact of various elements of the DIE on the level of GF is a continuous process that evolves over time. Traditional QCA analysis based on cross-sectional data cannot fully demonstrate the complex causal relationship from the time dimension. Based on this, this study uses the relevant methods of Garcia-Castro and Arino (2016) for reference, and uses the dynamic QCA method to discuss the configuration relationship under the time effect. In addition, dynamic QCA can be measured from the three dimensions of between, within and pooled, and the change characteristics of time dimension and individual dimension can be explored using the consistency adjustment distance. Therefore, this study combined the dynamic QCA method and NCA to investigate the impact of DIE on GF, so as to obtain more convincing analysis results.

3.2 Variable Setting

3.2.1 Result Variables

This research constructs green finance index from six aspects, and uses entropy weight method to get GF level of each province. The analytic sample for the data used is from 2014 to 2021 since this time frame can offer a comprehensive and continuous data collection, guarantee the consistency of data sources, and have high timeliness, all of which are beneficial for examining the intricate causality of temporal effects. Then the missing data is completed by linear interpolation method through stata software. The data are normalized because the indicators are susceptible to minor modifications with societal evolution. The specific indicator system is shown in Table 1.

Table 1. Index construction of result variables

variables	Primary index	Secondary index
GF	Green credit	The proportion of interest expenses of high energy-consuming industries
		Redit for environmental protection projects
	Green securities	The proportion of green bonds and green funds
	Green insurance	agricultural insurance payout rate
		Development degree of environmental pollution liability insurance
	Green investment	Proportion of investment in environmental pollution control
		Proportion of fiscal expenditure on environmental protection
	Green energy	Clean energy development
	Environmental rights and interests	Development degree of green rights and interests

3.2.2 Condition Variables

Because of the delay in the effects of different DIE components on GF, the time lag period is set to 1 year, that is, the condition variable from 2013 to 2020 and the result variable from 2014 to 2021 are selected for analysis. It is important to note that DIE theory is still in its early stages of development, and there is still a lack of standard theoretical basis for the construction and measurement of various elements of DIE. Therefore, this investigation takes the indicators in the Evaluation Report of China's Regional Innovation Capacity as the reference standard, combines with existing literature, and sets up a secondary index for antecedents based on the availability and scientificity of data. Since the indicators will change slightly with social development, the data will be standardized with reference to the outcome variables. The weight of the secondary index is determined by entropy weight method. The specific indicators are seen in Table 2.

Table 2. Index construction of condition variables

Primary index	Secondary index
DG	Government digital attention word frequency statistics
	Science and technology expenditure /GDP
	Intellectual property Protection Index
DE	Number of websites per 100 businesses
	Number of enterprises with e-commerce activities
	E-commerce sales volume
DT	The proportion of information transmission and software practitioners
	The proportion of graduate students enrolled in computer science and other majors in each university
FI	Number of outlets of financial institutions
	Non-performing loan ratio of commercial banks
DII	Length of long distance optical cable line
	Internet penetration
	Internet broadband access port
	Mobile phone penetration
	Number of IPV4 addresses
DFS	Mobile payment level
	The extent to which digital financial services are promoted

3.2.3 Data Sources

This paper takes the data of 29 provinces from 2014 to 2021 as the research object. The data of GF are mainly from China Energy Statistical Yearbook, China Industrial Statistics Yearbook, China Insurance Yearbook and China Science and Technology Statistical Yearbook. The data of conditional variables are mainly from the National Bureau of Statistics and provincial statistical yearbooks, in which the government's digital attention comes from the provincial statistical yearbooks, the intellectual property protection index comes from the national intellectual property development status, and the number of graduate students enrolled in computer and other majors in universities comes from the National Research network and the Wind database. The data of financial institutions came from the provincial banking Regulatory Commission and the provincial financial operation report.

4. Regional Differences and Dynamic Evolution of Green Finance Level

4.1 The Result Analysis of Green Finance Level

Figure 2 in this research depicts the overall and regional changing trends of China's GF level. In general, it has doubled from 0.36 in 2014 to 0.70 in 2021, exhibiting a consistent growing trend year over year. Among these, the growth rate of GF in 2015-2016 and 2020-2021 is higher than other years, which could be because of the following factors: Relevant policies such as the Green Credit Guidelines in 2012 and the Outline of Ecological Civilization Construction in 2013 were promulgated, but there is a certain time lag in the implementation of policy effectiveness. Therefore, after giving full play to the effectiveness of relevant policies in 2015-2016, China's GF level has also been greatly improved. 2020 is the end of the "13th Five-Year Plan", during the "13th Five-Year Plan" period, China has basically established the relevant policy system of GF, which has laid a good foundation for the "qualitative leap" of GF in the "14th Five-Year Plan" period. As the first year of the 14th Five-Year Plan period, 2021 has made innovative breakthroughs in the development of GF in China in terms of green products and ESG results disclosure. Therefore, China's GF will achieve a higher level of growth in 2020-2021.

At the regional level, the eastern, central and western regions of China all exhibit a steady growth trend, among which the overall level of GF in the eastern region is higher than that in other regions, which may be because the eastern region has a relatively high-quality talent reserve and a developed economic foundation. These conditions make the eastern region more comfortable in using various financing instruments for sustainable development, and its ability to effectively deal with ecological and environmental challenges is significantly better than that of other places. Furthermore, the central region has a higher degree of GF than the western region, which could be explained by the central region's active introduction of a variety of financial services. After the National Development and Reform Commission issued the "13th Five-Year Plan for Promoting the Rise of the Central Region" in 2016, the central region began to vigorously promote the construction of financial back-end service bases in Hefei, Changsha and other regions, and further promote the construction of Henan Lankao

inclusive financial reform pilot zone and other related measures, which greatly promoted the GF in the central region. It is worth noting that by observing Figure 1, although the overall GF level in the western region is lower than that in the eastern and central regions, the gap between the two regions is small and shows a generally consistent evolution trend. This is inseparable from the state's ecological environmental protection policy for the western region, through the implementation of a series of protection policies such as returning farmland to forest, the Three North shelterbelt project will help the western region to get more financial support. In comparison to other regions, northeast China has a shifting tendency, first declining and then rising. The fluctuation trend is closely related to its extensive economic growth mode. Northeast China's natural environment has improved recently, and there is a great deal of room for the growth of the green economy. However, GF in northeast China has shown an unstable growth tendency due to the pressure of industrial transformation and upgrading, the absence of new stimulus for economic growth, and financial innovation.

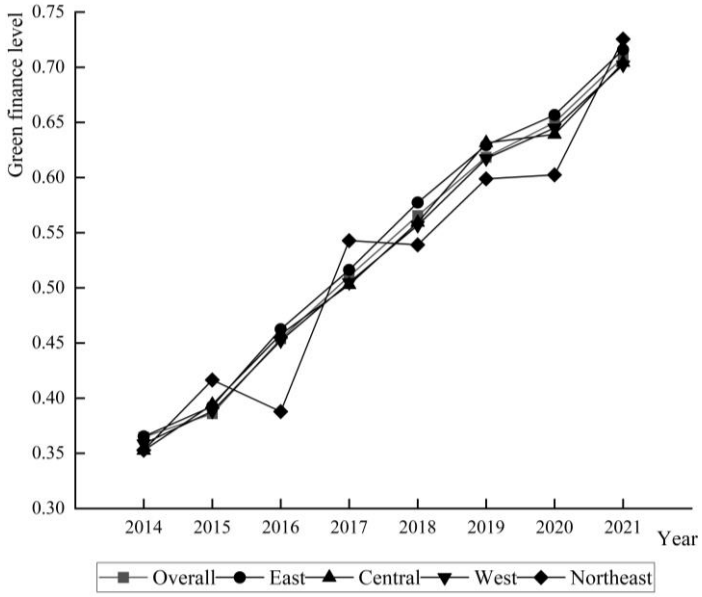

Figure 2. National and regional trends of green finance

4.2 The Regional Differences of Green Finance Level

The regional and overall trends of GF levels are depicted in Figure 3. Overall, there are significant regional variations in GF levels. The Gini coefficient started at 0.086 in 2014, reached its highest point of 0.091 in 2016, dropped sharply to 0.072 in 2017, and then kept going down until it reached 0.082 in 2020.

1) Intra-regional differences. In terms of numerical value, the western region has the largest regional difference, with an average of 0.074. In terms of the degree of reduction, the Northeast region has the largest decline, from 0.80 in 2014 to 0.026 in 2021, a decrease of 67%.The fluctuation trend of the eastern and western regions during 2014-2021 is obvious, and the fluctuation changes are irregular.

2) Inter-regional differences. The regional differences and contribution sources can be seen in Table 3. When looking at the numbers, the east-west and east-northeast regions' values are comparable and clearly higher than the east-central regions. It demonstrates that there are more regional variations in GF between the east-west and east-northeast than other groups. With the exception of the west-northeast, the fluctuation patterns of the other five groups exhibit a general trend of dropping, rising, declining, increasing, and declining from the perspective of changing trend.

3) Sources and contributions of regional differences. According to Table 3, supervariable density is the main source of regional differences in GF, with a fluctuation range of 27.09%~46.23%, followed by inter-regional differences, with a contribution rate range of 25.54%~47.27%, and the difference within the region with the least contribution degree, with a fluctuation range of 25.63%~28.23%. From the perspective of evolution, the contribution rate of intra-regional differences shows a gentle growth trend. The contribution rate of inter-regional difference and supervariable density is increasing and decreasing.

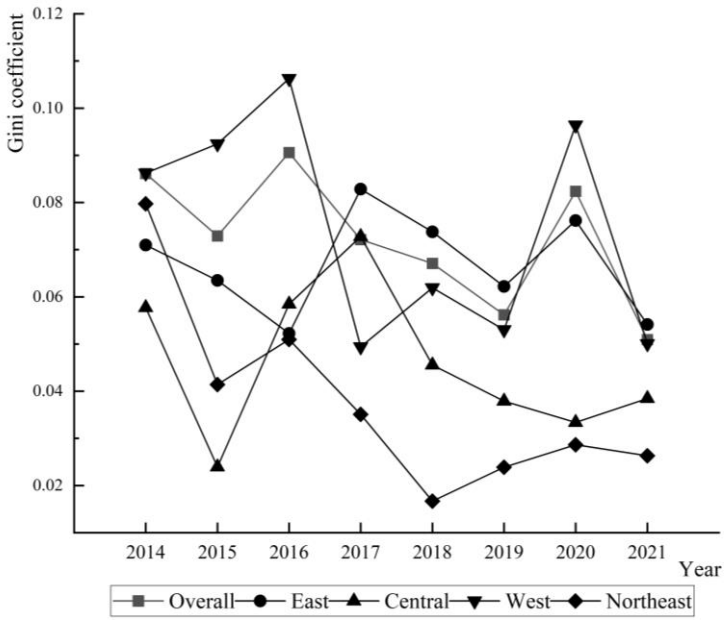

Figure 3. National and regional Gini coefficient trends

Table 3. Inter-regional differences and sources of green finance

Year	Between-group differences						Rate of contribution		
	East-Central	East-West	East-Northeast	Central-West	Central-Northeast	West-Northeast	Intra-regional	Inter-regional	Super variable density
2014	0.094	0.095	0.100	0.078	0.078	0.091	26.33%	38.40%	35.27%
2015	0.061	0.089	0.059	0.069	0.052	0.086	28.23%	25.54%	46.23%
2016	0.083	0.096	0.133	0.088	0.078	0.111	25.63%	47.27%	27.09%
2017	0.089	0.078	0.073	0.070	0.084	0.056	25.81%	32.17%	42.02%
2018	0.080	0.080	0.072	0.058	0.039	0.050	27.38%	40.02%	32.61%
2019	0.056	0.069	0.064	0.051	0.040	0.042	27.57%	30.14%	42.29%
2020	0.074	0.102	0.095	0.076	0.045	0.075	27.78%	38.67%	33.55%
2021	0.051	0.060	0.046	0.047	0.039	0.048	28.08%	31.41%	40.51%
average	0.073	0.084	0.080	0.067	0.057	0.070	27.10%	35.45%	37.44%

4.3 Analysis on the Dynamic Evolution of Green Finance Level

This study examines the GF level's dynamic progression from four aspects: distribution location, distribution form, distribution ductility and polarization trend. The particular outcomes are displayed in Fig.4. Regarding distribution position, both the national and local nuclear density curves exhibit a rightward tendency, suggesting that GF in China is generally increasing, with a "catch-up effect" shown in the amount of GF across provinces. In terms of distribution form and distribution ductility, the peak height did not change significantly on the whole, and the distribution width of nuclear density narrowed, indicating that the total GF differential between the provinces was becoming less of an absolute difference. Among them, the right tailing phenomenon occurred during 2014-2018, suggesting that at this point, the degree of divergence between the provinces grew.

The nuclear density distribution width is wide and the peak height is first modest and then high in the eastern section. Furthermore, the lack of a trailing phenomenon in the nuclear density curve in the eastern area of China suggests that the growth of GF in this region is much different. The peak height of the nuclear density curve in the central region decreased during 2016-2017, and the width increased significantly, suggesting that, between 2016 and 2017, there were significant differences amongst the provinces in the central area. The peak height increased during 2018-2021, and there was no trailing phenomenon, indicating that the absolute difference between provinces was weakening during this stage. On the whole, the width of nuclear density distribution in the western region is large, indicating a large degree of difference in the western region. However, the western area's peak height is increasing and there is no tailing phenomenon when seen from the perspective of temporal

evolution, suggesting that the absolute differences between the provinces in the western region are getting smaller over time. In northeast region, the peak height of the wave increases continuously, and the width of the distribution of nuclear density decreases, and there is no trailing phenomenon, indicating that the absolute difference between provinces in northeast is small. From the perspective of polarization trend, multi-level differentiation exists both in the whole and in each region.

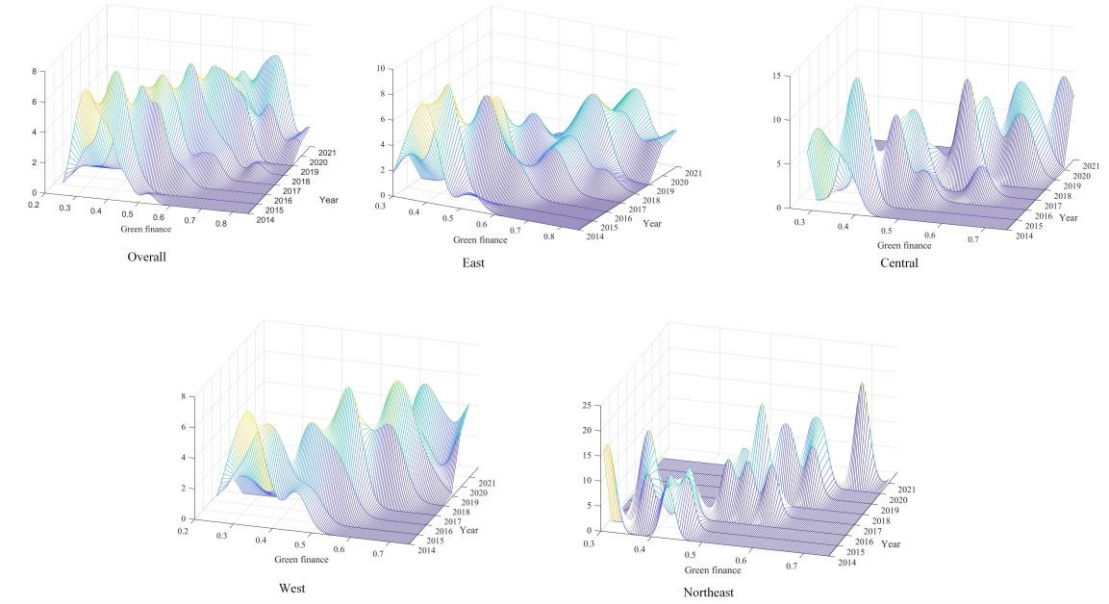

Figure 4. Distribution and evolution of green finance nationwide and in various regions

5. Analysis of the Path to Improve the Level of Green Finance

5.1 Data Calibration

The present study employed the direct calibration approach to perform a uniform calibration of data (Fiss, 2011; Guedes et al., 2016), with the aim of enabling the following investigation of inter-group, intra-group, and adjustment consistency and coverage. The calibration anchor point for full membership, crossing point, and complete unmembership are placed at the data's quartile (95%, 50%, and 5%), respectively. Table 4 displays the specific outcomes.

Table 4. Calibration results

Variables		Calibration		
		Full membership	Crossing point	Complete unmembership
Result variables	Y:GF	0.751	0.528	0.316
Condition variables	A:DG	0.713	0.338	0.194
	B:DE	0.610	0.225	0.142
	C:DT	0.503	0.321	0.108
	D:FI	0.883	0.477	0.229
	E:DII	0.093	0.054	0.033
	F:DFS	0.053	0.028	0.013

5.2 Necessary Condition Analysis

5.2.1 NCA Method

Cross-section data research is the primary use of NCA in the literature currently under publication. Since 2018 is the year that China vigorously promotes the application of big data, The General Office of the State Council issued the Scientific Data Management Measures in 2018. In light of this, this article considers 2018 to be the beginning of the time period, with periods 1 and 2 being 2014–2017 and 2018–2021, respectively. The following two requirements must be satisfied in order to apply the NCA method: d must be more than 0.1 and the p value

must be significant (p<0.01). Table 5 presents the particular outcomes, encompassing the impact sizes derived from the CR and CE estimate techniques. In period 1, the effect size (d) of DG, DE, FI and DFS are all greater than 0.1, but their P-values are all greater than 0.01, so there is no necessary condition in period 1. In period 2, the effect size (d) of DT and DII are both greater than 0.1, but their P-values are both greater than 0.01, so there is no necessary condition in period 2. In summary, individual elements of the DIE are not necessary to improve the level of GF. Bottleneck level analysis can calculate the bottleneck value of the condition variable corresponding to a certain level value of the result variable, as seen in Table 6. Taking period 2 as an example, to reach the GF level of 90%, DI, DE, DT, FI, DII and DFS need to reach 34.8%, 16.2%, 48.0%, 5.3%, 37.2% and 31.1% respectively.

Table 5. Analysis results of NCA necessary conditions

Condition variables	Method	Periods 1		Periods 2	
		ffect size	p value	ffect size	p value
DG	CR	0.20	0.165	0.07	0.581
	CE	0.24	0.104	0.09	0.429
DE	CR	0.20	0.124	0.04	0.598
	CE	0.21	0.115	0.04	0.556
DT	CR	0.00	0.895	0.11	0.247
	CE	0.00	0.933	0.05	0.515
FI	CR	0.20	0.251	0.02	0.861
	CE	0.29	0.092	0.04	0.791
DII	CR	0.02	0.688	0.17	0.185
	CE	0.04	0.574	0.19	0.154
DFS	CR	0.10	0.254	0.09	0.495
	CE	0.06	0.628	0.06	0.666

Table 6. NCA bottleneck analysis results

GF	DG	DE	DT	FI	FII	DFS
0	NN/NN	NN/NN	NN/NN	NN/NN	NN/NN	NN/NN
10	NN/NN	NN/NN	NN/NN	NN/NN	NN/NN	NN/NN
20	NN/NN	NN/NN	NN/NN	NN/NN	NN/NN	NN/NN
30	NN/NN	NN/NN	NN/NN	NN/NN	NN/4.1	NN/NN
40	NN/NN	NN/NN	NN/NN	NN/NN	NN/9.6	NN/NN
50	NN/NN	NN/NN	NN/NN	NN/NN	NN/15.1	4.8/NN
60	10.7/NN	12.5/1.1	NN/NN	10.8/NN	NN/20.6	10.9/3.3
70	30.5/NN	30.7/6.1	0.4/7.2	30.2/NN	NN/26.1	17.0/12.6
80	50.3/0.0	48.9/11.2	0.9/27.6	49.6/NN	NN/31.6	23.1/21.8
90	70.1/34.8	67.1/16.2	1.3/48.0	69.1/5.3	NN/37.2	29.3/31.1
100	89.9/69.5	85.2/21.3	1.8/68.4	88.5/30.6	44.9/42.7	35.4/40.3

Note. The left side is the result of period 1 and the right side is the result of period 2.

5.2.2 Dynamic QCA Method

The above necessity analysis is mainly carried out from a quantitative point of view. This study further analyzes the necessity from a qualitative point of view using the dynamic QCA approach in order to strengthen the analytical results. In the traditional QCA method, it may be concluded that this condition is required for the result variable if the consistency is higher than 0.9, but in the dynamic QCA, the size of the adjustment distance needs to be further studied. A judgment can be made when the consistency accuracy is higher and the adjustment distance is less than 0.2 [42]. When the adjustment distance is greater than 0.2, the necessity of the condition variable needs to be further investigated. In Table 7, the summary consistency of the six condition variables is all less than 0.9, suggesting that the condition variable is not a necessary condition for the result variable, but the consistency distance is more than 0.2. This paper gives the following explanations: First, when the consistency distance between groups is greater than 0.2, by observing the consistency and coverage of the corresponding variables in each year, this study finds that each variable cannot meet the requirements of consistency greater than 0.9 and coverage greater than 0.5 at the same time (Schneider & Wagemann, 2012). Therefore, no condition

variable passes the necessity test (see annexed table). Second, the intra-group consistency adjustment distance is greater than 0.2, which is related to the differences between samples. This paper selects 29 provinces in China as samples, which have obvious differences in scientific and technological level, industrial structure, resource endowment and so on. In the process of promoting the level of GF, the elements of the DIE are easily affected by internal and external conditions, resulting in excessive adjustment distance of consistency within the group. Through further analysis, it is found that there are no necessary conditions for generating outcome variables, which is consistent with the analysis results of NCA.

Table 7. Dynamic QCA necessity analysis results

Condition variables	High-level GF				Low-level GF			
	Aggregate consistency	Aggregate coverage	Adjustment distance between groups	Adjustment distance within groups	Aggregate consistency	Aggregate coverage	Adjustment distance between groups	Adjustment distance within groups
A	0.687	0.718	0.164	0.464	0.557	0.579	0.285	0.549
~A	0.598	0.576	0.252	0.510	0.729	0.698	0.121	0.447
B	0.659	0.739	0.188	0.538	0.52	0.579	0.309	0.595
~B	0.624	0.567	0.248	0.498	0.765	0.691	0.127	0.396
C	0.61	0.608	0.238	0.498	0.688	0.682	0.154	0.481
~C	0.681	0.687	0.201	0.430	0.605	0.606	0.258	0.498
D	0.684	0.665	0.205	0.436	0.643	0.621	0.201	0.442
~D	0.61	0.632	0.248	0.527	0.653	0.672	0.221	0.487
E	0.738	0.792	0.057	0.306	0.509	0.542	0.503	0.521
~E	0.573	0.54	0.359	0.402	0.804	0.753	0.067	0.368
F	0.757	0.812	0.144	0.232	0.538	0.573	0.533	0.294
~F	0.603	0.567	0.332	0.368	0.824	0.771	0.144	0.255

5.3 Adequacy Analysis of Conditional Configuration

5.3.1 Pooled Results

Configuration analysis in the QCA method is mainly to explore the combination of multiple condition variables that produce the result variable. As the criterion for judging adequacy, Schneider and Wagemann (2012) proposed that the consistency level should not be less than 0.75. Based on this, this study set the consistency threshold as 0.8, frequency threshold as 2, and PRI domain value as 0.7 (Dwivedi & Joshi, 2018), finally covering 29 cases. Construct a truth table and conduct further reinforcement criteria analysis (Zhang, 2023). At the same time, due to the large differences in resource endowments among provinces in China, it is difficult to make a unified judgment on the generation of results by anthems. Therefore, this study does not preset the direction, but uniformly selects “presence” or “absence” in order to better analyze the synergistic effects of various elements of the DIE in improving the level of GF. Through the above analysis, the enhanced simple solution, intermediate solution and complex solution are obtained, and the core and edge conditions are determined mainly by the enhanced intermediate solution and simple solution. In Table 8, there are three configurations in total, with the overall consistency, overall coverage and overall PRI being 0.834, 0.755 and 0.703 respectively, among which the consistency of a single configuration is greater than 0.85. Moreover, the consistency adjustment distance of configuration 2 and configuration 3 is less than 0.2, indicating that configuration 2 and configuration 3 are the key strategies to improve the level of GF at present. The inter-group consistency adjustment distance of configuration 1 is greater than 0.2, which is explained as follows: Configuration 1 mainly contains two elements: DII and DFS, both of which are environmental elements and lack the core leadership role of the main body. At the same time, the coverage of configuration 1 is 0.674, covering most samples, indicating that this configuration is a common condition for improving the level of GF, and is not unique. Therefore, the explanatory power of configuration 2 to improve the level of GF is weaker than that of configuration 2 and Configuration 3. Based on the analysis of configuration results, this paper further refines the three configurations into two paths, namely, the environment support type (Configuration 1) and the multi-agent comprehensive development type (configuration 2 and 3). These two paths can effectively stimulate the synergistic advantages of multiple elements in the DIE, thereby improving the level of GF.

Table 8. Configuration analysis results

Condition variables	Environmental Support	Multi-agent comprehensive development	
	Configuration 1	Configuration 2	Configuration 3
A:DG			●
B:DE		●	●
C:DT			
D:FI		●	●
E:FII	●		●
F:DFS	●	●	
Consistency	0.862	0.911	0.934
PRI	0.747	0.786	0.847
Coverage	0.674	0.460	0.397
Unique coverage	0.273	0.058	0.023
Adjustment distance between groups	0.231	0.144	0.171
Adjustment distance within groups	0.130	0.084	0.067
Aggregate consistency		0.834	
Aggregate PRI		0.703	
Aggregate coverage		0.755	

Note. ● is the core condition, ● is the auxiliary condition, the space indicates that the condition can be present or missing.

1) Environmental Support (Configuration 1)

Configuration 1 is deemed environmentally favorable since it explains 67.4% of the sample with consistency of 0.862 and coverage of 0.674. DII and DFS are major contributors to this configuration. Using Beijing as an example, Configuration 1 may be applied to Beijing as a typical case because it encompasses all the years Beijing is studied in this study, which are 2014–2021. Since the "Digital Beijing" growth plan was presented in 1999, Beijing has concentrated on creating a digital economic innovation ecology, using its advantages in geography and policy, in terms of DII. Beijing has achieved significant advancements in artificial intelligence during this phase, giving special focus to this field's growth and development. For instance, Baidu's AI algorithm foundation and the hardware and software solutions that go along with it have demonstrated significant global competitiveness. Beijing also has clear fundamental competitive advantages, ranking first in the nation in terms of key industries like industrial Internet, innovation, and artificial intelligence. Beijing is one of the few Chinese cities that spearhead blockchain research. Therefore, Beijing's digital technology capabilities keep getting better thanks to the robust support of the DII. Regarding DFS, they are a new breed of financial services that primarily rely on mobile payments, network banking, and online payments to serve the public. Beijing is home to 11 of the top 30 Internet companies by market value, including leading companies such as JD.com and Meituan. Taking Jingdong Finance as an example, it has realized the transformation of its business model by using digital technology to serve finance. In this context, Beijing can make full use of strong environmental factors to help raise the level of GF.

2) Multi-agent comprehensive development (Configuration 2 and 3)

Configurations 2 and 3 have coverage of 0.460 and 0.397 and consistency of 0.911 and 0.934, respectively, which account for 46% and 39.7% of the samples.FI have a supporting role in Configuration 2, while DE and DFS take center stage. DII and DE are key components of Configuration 3. This research designated these two setups as the multi-agent comprehensive development type based on observations of their shared features. This paper follows this route, using Zhejiang as an example of a typical case study. Zhejiang is mostly affected by configuration 2 from 2016 to 2019, whereas configuration 3 affects not only 2016 to 2019 but also the amount of green funding in 2020–2021. Since 2003, the "Digital Zhejiang" project was launched and in 2014, a provincial-level to village-level government network system was successfully built. At the same time, the "one run at most" policy, which began in 2016, is driving the government's transformation to digital. In addition, in order to break the "gap" between enterprises and banks, the Zhejiang Banking and Insurance Regulatory Bureau, together with the provincial Development Planning Commission and the provincial big data management agency, jointly created the "Zhejiang Comprehensive Financial Platform" to deal with the problems caused by insufficient information or imbalances.DE will continue to play a central role in 2020-2021, likely due to the impact of the COVID-19 pandemic. During this period, digital applications, represented by health codes, demonstrated the power of DG. Meanwhile, e-commerce in Zhejiang Province has also been booming, highlighting the power of DFS. In general, Zhejiang can jointly match the role of various entities to promote the

promotion of GF.

5.3.2 Between Results

Out of the three configurations, configuration 1 has a clear temporal effect compared to 2 and 3, as evidenced by the fact that configuration 1's inter-group consistency adjustment distance is larger than 0.2 while those of 2 and 3 are less than 0.2. By further investigating the change of their consistency level over time and drawing the graph (Figure 5), it is found that the three configurations are less than 0.75 in 2015, which is not a random distribution, so it is not a benign deviation (Helfat & Raubitschek, 2018). Furthermore, the three configurations' consistency level demonstrated a clear rising tendency after 2015. Regarding this general upward trend, the explanation that follows is provided: 2015 is a year for provinces to vigorously develop the digital economy, and relevant policies have been introduced. Simultaneously, the consistency of the three configurations has altered dramatically after 2015 as a result of the policy's delayed implementation. For example, Zhejiang Province formulated the "Made in China 2025 Zhejiang Action Program" in the same year, and began to implement the Wuzhen Internet Innovation and Development Experimental Zone project to help the development of its big data and artificial intelligence industry, so as to build a solid data infrastructure for the development of GF and further optimize the allocation of financial assets. In this context, the joint matching of multiple elements of the DIE will help further promote the level of GF. Through the analysis of the inter-group results, the shortcomings of traditional QCA on the cross-section platform are made up, and the time effect of the configuration is demonstrated.

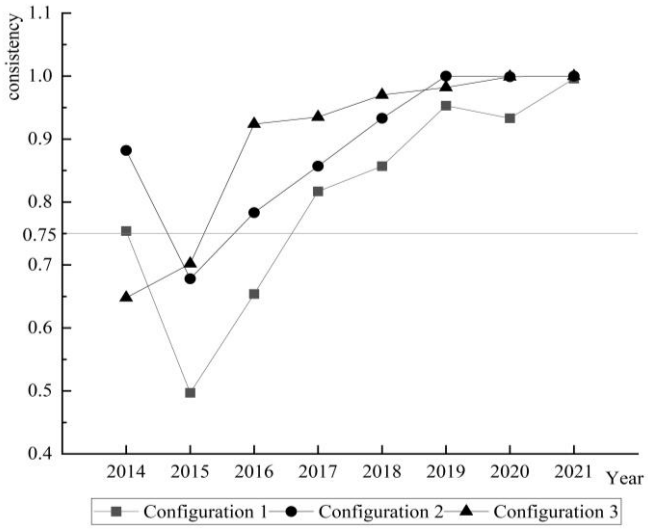

Figure 5. Consistency change between group

5.3.3 Within Results

It is found that the consistency adjustment distance of the three configurations is less than 0.2 by analyzing the results within the group. Nevertheless, a closer look at each province's consistency level reveals that several provinces—mostly impoverished areas like Ningxia and Qinghai—have consistency levels lower than 0.75 in configuration 1. The only province in configuration 2 is Hubei Province, which is not unique. In configuration 3, no province has a population smaller than 0.75 (Figure 6). Comparing configuration 1 to 2 and 3, it is evident that 1 has less ability to explain changes in the amount of GF in less developed locations. The following are the causes: First, undeveloped places have a poor information infrastructure. The level of informatization in underdeveloped areas is stagnant due to a variety of factors, including location, science and education levels, and other factors. This prevents financial development from realizing the integration of finance and digital with the aid of information technology, thereby limiting the development of GF. Second, there is a lack of policy support. In recent years, the state has attached great importance to environmental protection in the less developed areas of northwest China and promulgated a series of policies to achieve ecological construction, such as setting up nature reserves and property transfer payments. However, in this process, less developed regions still receive insufficient financial support, resulting in a lack of financial support for the various elements of the DIE to facilitate GF. Therefore, it is necessary to take targeted measures for these special areas to help GF.

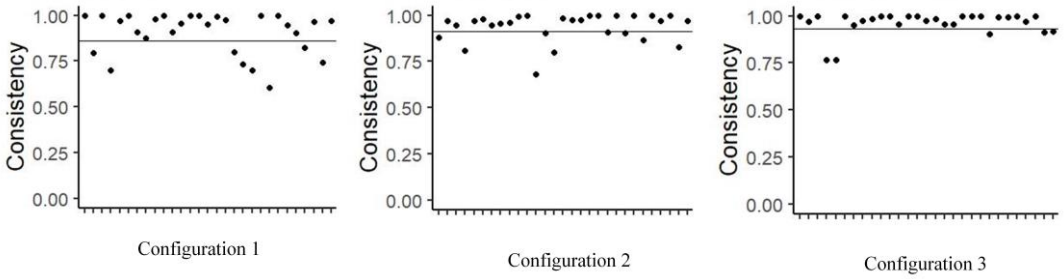

Figure 6. Consistency results within groups

5.3.4 Robustness Test

In this paper, by changing the robustness of the consistency threshold test results, the consistency threshold is adjusted to 0.85, and the analysis results are obtained by using R4.3.1 software. The observation results show that the configuration obtained after adjusting the consistency threshold is consistent with the above, which proves the robustness of the research results.

6. Conclusions and Suggestions

6.1 Conclusions

In the face of increasingly severe environmental problems, low-carbon transformation and green transformation have become an important trend in today's world development, and the development of GF has also become a hot research topic. Based on the theory of sustainable development, this paper constructs a green finance evaluation system from six aspects, and uses Dagum Gini coefficient and kernel density estimation methods to explore the temporal and spatial evolution characteristics of GF. Finally, based on the theory of DIE, and the promotion path of GF is studied with the aid of dynamic QCA and NCA methodologies. The empirical study found that: on the whole, the level of GF in China has shown a steady upward trend and achieved double growth. From the regional level, China's eastern, central, and western regions all exhibit a pattern of stable expansion, but the northeastern area, which is inextricably linked to the wide local economic growth mode, exhibits a fluctuating trend of first fall and then rise. In addition, the Gini coefficient of China's GF exhibits a fluctuating trend, indicating that the gap between the GF in different regions of China varies greatly. From the perspective of regional differences, the western region has the largest regional differences, and the middle - northeast region has the smallest regional differences. Among them, supervariable density is the main source of regional differences. From the perspective of dynamic evolution, both the overall and regional nuclear density curves show a rightwing trend, indicating that the GF in China is generally on the rise, among which there is a "catch-up effect" among provinces. Meanwhile, this study uses NCA to explore the necessity of individual elements in the DIE, and uses dynamic QCA to further verify, and the results show that individual elements do not constitute the necessary conditions to improve the level of GF. Dynamic QCA is used to identify three paths to improve GF, and according to the characteristics of the three paths, they are further divided into two models, which are environmental support type (configuration 1) and multi-agent comprehensive development type (configuration 2 and 3). Among them, the explanation of environmental support for the less developed areas is weak, which is mainly due to the weak information infrastructure in the less developed areas and the weak government policy support.

6.2 Suggestions

Green finance can help enterprises obtain low capital costs, enhance their social image, and strengthen their brand competitiveness. To promote green finance, enterprises need to improve their management. Integrating green concepts into strategic planning, clarifying green development goals and paths, and guiding business operations. Establish a comprehensive environmental risk management system, identify risks caused by environmental factors in advance, strengthen green performance evaluation, set corresponding indicators to assess the implementation of green measures in various departments, and motivate all employees to participate in green actions. At the same time, we focus on cultivating and introducing green talents, forming professional teams, better connecting with green finance projects, and enabling enterprises to achieve sustainable development with the help of green finance.

Increase investment in grassroots GF to alleviate the imbalance in the spatial structure of GF. Due to the unbalanced economic development of different regions in China, factors such as resource endowment and

location conditions also have great differences. Developed regions have more financial support and can provide more financial support for regional green development. Less developed areas should learn from the advantages of GF in the management capacity and investment experience of developed areas, define the green development orientation suitable for their own development, guide GF to play a greater role in pollution prevention and control, and raise the development of GF into a regional economic development strategy. For example, through the establishment of GF reform and innovation pilot zone, regional resource advantages; Establish a review mechanism to eliminate potentially risky green projects.

Give play to the guiding role of the government to increase the construction of environmental elements of the DIE. Local governments should give full play to their leading role, improve the construction of DII, create a good DFS environment and policy environment, and create new financial products that integrate digital technology and finance, so as to provide positive forces for the GF. In addition, local governments should pay full attention to the importance of grassroots exploration in promoting the GF, and find a green finance innovation path that matches the actual local situation, so as to provide replicable and generable experience for the further development of regional GF in China. Such as improving the construction of institutional mechanisms and policy systems, developing green leasing business, innovating green financial derivatives, setting up local green banks, and innovating effective mechanisms for government capital and financial capital cooperation.

Strengthen the coordination and cooperation of various elements in the DIE, form the linkage and matching of the government, society and market, and then promote the enabling role of multi-element combination in GF. In the process of digital technology promoting the GF, there is still a problem that the integration of new generation information technology and GF is not perfect. Therefore, while providing policy support, the government should speed up the training of digital talents such as green financial technology, promote the integrated development of industry, university and research, and reserve scientific and technological talents for the large-scale application of information technology in the field of GF in the future. Financial institutions provide personalized services to green enterprises through digital technologies such as big data and expand the coverage of green products and services.

Establish and improve regulatory measures and incentive mechanisms for GF. At present, the phenomenon of local protectionism still exists widely, which makes the functions of many local governments have not been fully developed and implemented. Due to the insufficient supervision and punishment of polluters by relevant government departments with regulatory capabilities, and the failure of FI to provide adequate incentives for employees, the further development of GF is severely restricted. In the current context, giving full play to the advantages of information technology and constructing and improving the regulatory framework of GF will help fill the shortcomings of GF supervision in the past. For example, in the process of promoting the construction of green credit, in order to ensure the effective implementation of green credit policies, it is necessary for enterprises to establish green evaluation and reward and punishment systems, and FI should optimize their internal rules and regulations and establish clear performance evaluation criteria. In addition, in view of the externalities of some green projects, it is necessary to establish a comprehensive incentive mechanism, for example, the finance can provide discounts and guarantees to ensure the efficient implementation of green projects.

Explore financial technology to enable GF. At present, the rapid development of fintech has had a profound impact on China’s financial industry and has made positive contributions to the GF. In order to more effectively promote the role of fintech in promoting GF, first of all, governments at all levels should strengthen the top-level design of green fintech, unify and improve GF standards, establish unified green information disclosure standards, and promote the development of fintech and GF. Secondly, based on the cluster construction of data centers, the real-time collection of GF business data is realized through the construction of a green information platform, and the financing efficiency of GF is improved through the establishment of a GF and green project information docking platform. Finally, sandbox regulation is introduced to innovate green financial products under controllable risks and reduce regulatory costs after the products are put on the market.

Funding

This work was supported by The National Social Science Fund of China “Research on the measurement, spatiotemporal evolution characteristics and improvement path of China’s green development level”(21BTJ054)

Conflicts of Interest

There are no conflicts of interest to declare.

Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Ainou, F. Z., Ali, M., & Sadiq, M. (2023). Green energy security assessment in Morocco: Green finance as a step toward sustainable energy transition. *Environmental Science and Pollution Research International, 30*(22), 61411-61429. https://doi.org/10.1007/s11356-022-19153-7

Alharbi, S. S., Al Mamun, M., Boubaker, S., & Kumail, A. R. S. (2023). Green finance and renewable energy: A worldwide evidence. *Energy Economics, 118*, 106499. https://doi.org/10.1016/j.eneco.2023.106499

Brika, S. K. M. (2022). A bibliometric analysis of fintech trends and digital finance. *Frontiers in Environmental Science, 9*, 796495. https://doi.org/10.3389/fenvs.2022.796495

Cai, X., Chen, G. R., & Wang, F. (2023). How Does Green Finance Policy Affect the Capacity Utilization Rate of Polluting Enterprises? *Sustainability, 15*(24), 16927. https://doi.org/10.3390/su15246927

Chae, B. (2019). A General framework for studying the evolution of the digital innovation ecosystem: The case of big data. *International Journal of Information Management, 45*, 83-94. https://doi.org/10.1016/j.ijinfomgt.2018.12.003

Chang, H. D., & Zhao, Y. P. (2024). The impact of carbon trading on the "quantity" and "quality" of green technology innovation: A dynamic QCA analysis based on carbon trading pilot areas. *Heliyon, 10*, e25668. https://doi.org/10.1016/j.heliyon.2024.e25668

Chien, F. S. (2023). The role of technological innovation, carbon finance, green energy, environmental awareness and urbanization towards carbon neutrality: Evidence from novel CUP-FM CUP-BC estimations. *Geoscience Frontiers*, 101696. https://doi.org/10.1016/j.gsf.2023.101696

Chin, M. Y., Ong, S. L., Ooi, D. B. Y., & Puah, C. H. (2022). The impact of green finance on environmental degradation in BRI region. *Environment, Development and Sustainability, 26*, 303-318. https://doi.org/10.1007/s10668-022-02709-5

Cui, G. H., Mao, H. Z., Dong, X., Liang, Q. X., Shao, L., & Wang, M. (2023). Will green financial policy influence energy consumption structure? Evidence from pilot zones for green finance reform and innovation in China. *Frontiers in Environmental Science, 1*, 2955517. https://doi.org/10.3389/fenvs.2023.1216110

Dagum, C. (1997). A new approach to the decomposition of the Gini income inequality ratio. *Empirical Economics, 22*(4), 515-531. https://doi.org/10.1007/BF01205777

Dikau, S., & Volz, U. (2021). Central bank mandates, sustainability objectives and the promotion of green finance. *Ecological Economics, 184*, 107022. https://doi.org/10.1016/j.ecolecon.2021.107022

Du, Y., & Kim, P. H. (2021). One size does not fit all: Strategy configurations, complex environments, and new venture performance in emerging economies. *Journal of Business Research, 124*, 272-285. https://doi.org/10.1016/j.jbusres.2021.01.017

Dwivedi, P., Joshi, A., & Misangyi, V. F. (2018). Gender-inclusive gatekeeping: How (mostly male) predecessors influence the success of female CEOs. *Academy of Management Journal, 61*(2), 379-404. https://doi.org/10.5465/amj.2015.1238

Fiss, P. C. (2011). Building better causal theories: A fuzzy set approach to typologies in organization research. *Academy of Management Journal, 54*(2), 393-420. https://doi.org/10.5465/amj.2011.60263120

Gao, J. J., & Zhang, W. W. (2021). Research on the Impact of Green Finance on the Ecologicalization of China's Industrial Structure-Empirical Test Based on System GMM Model. *Economic Review Journal*, (02), 105-115.

Garcia-Castro, R., & Ariño, M. A. (2016). A General Approach to Panel Data Set-Theoretic Research. *Journal of Advances in Management Sciences & Information System, 2*, 63-76. https://doi.org/10.6000/2371-1647.2016.02.06

Geetha, S., & Biju, A. V. N. (2023). Is green FinTech reshaping the finance sphere? Unravelling through a systematic literature review. *Environmental Science and Pollution Research, 31*, 1790-1810. https://doi.org/10.1007/s11356-023-31382-y

Guedes, M. J., da Conceição, G. V., Soares, N., & Valente, M. (2016). UK evidence for the determinants of R&D

intensity from a panel fsQCA. *Journal of Business Research, 69*(11), 5431-5436. https://doi.org/10.1016/j.jbusres.2016.06.001

He, L. Y., Liu, R. Y., Zhong, Z. Q., Wang, D. Q., & Xia, Y. F. (2019). Can green financial development promote renewable energy investment efficiency? A consideration of bank credit. *Renewable Energy, 143*, 974-984. https://doi.org/10.1016/j.renene.2019.05.059

Helfat, C. E., & Raubitschek, R. S. (2018). Dynamic and integrative capabilities for profiting from innovation in digital platform-based ecosystems. *Research Policy, 47*(8), 1391-1399. https://doi.org/10.1016/j.respol.2018.07.002

Huang, Y. M., Chen, C., Lei, L. J., & Zhang, Y. P. (2022). Impacts of green finance on green innovation: A Spatial and nonlinear perspective. *Journal of Cleaner Production, 365*, 132548. https://doi.org/10.1016/j.jclepro.2022.132548

Jiang, J., Li, J., & Wang, W. (2023). How does blockchain technology affect the development of green finance? Theoretical analysis and empirical verification. *Environmental Science and Pollution Research, 30*(58), 122774-122790. https://doi.org/10.1007/s11356-023-31035-0

Liu, Q., & Tang, L. (2022). Research on the accelerating effect of green finance on the transformation of energy consumption in China. *Research in International Business and Finance, 63*, 101771. https://doi.org/10.1016/j.ribaf.2022.101771

Lv, C., Bian, B., Lee, C. C., & He, Z. (2021). Regional gap and the trend of green finance development in China. *Energy Economics, 102*, 105476. https://doi.org/10.1016/j.eneco.2021.105476

Madalena, M., Dogan, E., & Taskin, D. (2022). A step forward on sustainability: The nexus of environmental responsibility, green technology, clean energy, and green finance. *Energy Economics, 109*, 105945. https://doi.org/10.1016/j.eneco.2021.105945

Nian, W., & Dong, X. H. (2022). Spatial correlation study on the impact of green financial development on industrial structure upgrading. *Frontiers in Environmental Science, 10*, 1017159. https://doi.org/10.3389/fenvs.2022.1017159

Pang, L., Zhu, M. N., & Yu, H. (2022). Is green finance really a blessing for green technology and carbon efficiency? *Energy Economics, 114*, 106272. https://doi.org/10.1016/j.eneco.2022.106272

Ringel, M., & Mjekic, S. (2023). Analyzing the Role of Banks in Providing Green Finance for Retail Customers: The Case of Germany. *Sustainability, 15*(11), 8745. https://doi.org/10.3390/su15118845

Schneider, C. Q., & Wagemann, C. (2012). *Set-theoretic methods for the social sciences: A guide to qualitative comparative analysis*. Cambridge University Press. https://doi.org/10.1017/CBO9781139004244

Shan, S., Mirza, N., Umar, M., & Hasnaoui, A. (2023). The nexus of sustainable development, blue financing, digitalization, and financial intermediation. *Technological Forecasting and Social Change, 195*, 122772. https://doi.org/10.1016/j.techfore.2023.122772

Song, A. K. (2019). The Digital Entrepreneurial Ecosystem—a critique and reconfiguration. *Small Business Economics, 53*(3), 569-590. https://doi.org/10.1007/s11187-019-00232-y

Starr, M. A. (2008). Socially responsible investment and pro-social change. *Journal of Economic Issues, 42*(1), 51-73. https://doi.org/10.1080/00213624.2008.11507114

Wang, R., & Wang, F. Y. (2022). Exploring the role of green finance and energy development towards high-quality economic development: Application of spatial Durbin model and intermediary effect model. *International Journal of Environmental Research and Public Health, 19*(14), 8875. https://doi.org/10.3390/ijerph19148875

Wang, X. Y., & Wang, Q. (2021). Research on the impact of green finance on the upgrading of China's regional industrial structure from the perspective of sustainable development. *Resources Policy, 74*, 102436. https://doi.org/10.1016/j.resourpol.2021.102436

Wu, J., & Shang, J. (2021). Green credit financing equilibrium under government subsidy and supply uncertainty. *Sustainability, 13*(22), 12917. https://doi.org/10.3390/su132212917

Yan, M., & Gong, X. S. (2024). Impact of green credit on green finance and corporate emissions reduction. *Finance Research Letters, 60*, 104900. https://doi.org/10.1016/j.frl.2023.104900

Yin, X. L., & Xu, Z. R. (2022). An empirical analysis of the coupling and coordinative development of China's

green finance and economic growth. *Resources Policy, 75*, 102476. https://doi.org/10.1016/j.resourpol.2022.102476

Yu, C. H., Wu, X., Zhang, D., Chen, S., & Zhao, J. (2021). Demand for green finance: Resolving financing constraints on green innovation in China. *Energy Policy, 153*, 112255. https://doi.org/10.1016/j.enpol.2021.112255

Yue, P., Korkmaz, A. G., Yin, Z., & Zhou, H. (2022). The rise of digital finance: Financial inclusion or debt trap? *Finance Research Letters, 47*, 102604. https://doi.org/10.1016/j.frl.2022.102604

Zhang, F. (2023). Determinants of local governments' information disclosure: a dynamic QCA analysis based on provincial panel data. *Journal of Intelligence, 42*(01), 133–141+207.

Zhang, G., Guo, B., & Lin, J. (2023). The impact of green finance on enterprise investment and financing. *Finance Research Letters, 58*, 104578. https://doi.org/10.1016/j.frl.2023.104578

Zhang, W., Ke, J., Ding, Y., & Chen, S. (2024). Greening through finance: Green finance policies and firms' green investment. *Energy Economics, 131*, 107401. https://doi.org/10.1016/j.eneco.2023.107401

Zhang, Y. F., & Umair, M. (2023). Examining the interconnectedness of green finance: An analysis of dynamic spillover effects among green bonds, renewable energy, and carbon markets. *Environmental Science and Pollution Research, 30*, 77605-77621. https://doi.org/10.1007/s11356-023-27870-w

Zhao, Y. T., & Li, X. (2022). Research on green innovation countermeasures of supporting the circular economy to green finance under big data. *Journal of Enterprise Information Management, 35*(4/5), 1305-1322. https://doi.org/10.1108/JEIM-01-2021-0039

Zhao, Y., Zhao, N., & Lyu, R. (2023). The dynamic coupling and spatio-temporal differentiation of green finance and industrial green transformation: Evidence from China regions. *Heliyon, 9*(12), e22726. https://doi.org/10.1016/j.heliyon.2023.e22726