

# Regional Logistics, Carbon Emission Index and Green Financial Performance Enhancement Configuration: A Comparative Study Based on 30 Chinese Provinces

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**Abstract:** In recent years, because of the increasingly severe global environmental protection situation and the superimposed effect of the new crown epidemic, the importance of green finance has been highlighted and gradually elevated to an important future development strategy for the country. However, it is unclear how to improve the effectiveness of green finance in each province. Using 30 Chinese provinces and regions as research samples, this paper summarizes five influencing factors, including regional logistics, carbon emission index, regional finance, economic level, and environmental regulation. Considering the complex causal relationship between factors and green finance performance, fsQCA is used to explore the different configurations formed in the process of developing green finance in each province. The results comprise four different configurations for high performance and four types of configurations for the absence of high performance. Currently, with the regional green finance development model still in its infancy, regional logistics and carbon emission index factors play a key role in stimulating the development of green finance in the provinces and regions. This study has important theoretical and practical significance for the construction of regional green financial system and local government performance appraisal system with local characteristics in each province of China, and provides locally adapted policy suggestions for different provinces to achieve optimal allocation of resources.

**Keywords:** Regional logistics; Carbon emissions index; Green finance; Fuzzy set qualitative comparative analysis (fsQCA); China

## 1. Introduction

With the development of the world economy, the economic constraints brought about by resource and environmental issues are becoming more and more obvious and have attracted the general attention of all countries in the world (Zhang et al., 2021). In this process, global warming caused by carbon emissions has become an important factor threatening the sustainable development of the world. Green finance is a key element in the global response to the extreme climate threat and the goal of carbon neutrality (Lee, 2022). It grafted the concept of "green" and "low-carbon" onto traditional financial instruments, and raised capital to support the response to climate change and efficient use of resources by issuing bonds, institutional financing and credit loans, etc (Larsen et al., 2023). It is a key element that connects the concept of "green" and "low-carbon" to traditional financial instruments, and raises capital to support economic activities in response to climate change and efficient use of resources by issuing bonds, institutional financing and credit loans, and guides the transformation of high-pollution, high-energy-consumption and high-emission industries to green, low-carbon, safe and efficient (Zhou et al., 2020). As the world's largest energy consumer, China is striving to achieve "peak carbon dioxide emissions" by 2030 and "carbon neutrality" by 2060. Since the interval from peak carbon to carbon neutral is only 30 years, which is shorter than the 70-year transition cycle in Europe, China needs to further accelerate the transformation and upgrading of its industrial and energy structures, which will generate huge demand for investment and financing (Zhang et al., 2021). Therefore, China must now promote the development of green finance in order to solve the financing problem (Diaz et al., 2023).

The development of green finance in China relies on the reform and development of the financial industry and capital market, as well as strong policy support (Yu et al., 2021). To further promote the construction of an ecological civilization, China has taken a series of measures in the construction of a green financial system and the development of green finance and has made breakthrough progress (Zhang et al., 2021). From 2012 to 2021, China's green financial system has undergone a process of development from scratch from slow to fast and from surface to surface (Lee, 2022). The scale of green financial products and markets continues to expand, with the total amount of green credit, the number of green bonds, and the scale of the carbon emissions trading market all ranking among the highest in the world (Jinru et al., 2022). In September 2020, General Secretary Xi Jinping made a solemn commitment to the world that China would achieve "peak carbon dioxide emissions" by 2030 and "carbon neutrality" by 2060. With the proposed "peak carbon dioxide emissions" and

57 “carbon neutrality” targets, the task of improving the green financial system to guide the green  
58 transformation of the economy and society has become more urgent (Zhou et al., 2020).

59 In recent years, most scholars have conducted research on the content of green financial  
60 development. From the traditional mainstream academic viewpoint, as green finance needs to fully  
61 rely on the financial sector environment and related resources in the place where it is developed  
62 (Zhou et al., 2020), Chinese provinces and regions with a developed financial sector, such as Beijing  
63 and Shanghai, have achieved more significant results in developing green finance, while Chinese  
64 provinces and regions with a relatively weak financial sector development have achieved relatively  
65 weaker results in implementing local green regional finance (Zhang et al., 2021). In other words,  
66 developed provinces from eastern China have an inherent advantage over central and western  
67 regions in building a green financial system. However, according to the IIGE's 2019 *Local Green*  
68 *Regional Finance Report*, the level of green regional finance in China is uneven across regions, with  
69 significant disparities among provinces (Zhou et al., 2020). In particular, the cluster of Chinese  
70 provinces with high green finance indices includes central and western provinces such as Jiangxi,  
71 Xinjiang, and Sichuan, while the cluster of provinces with low indices includes developed eastern  
72 provinces and regions (Lee, 2022). This suggests that the degree of financialization of each Chinese  
73 province is not the only factor determining the performance of local green finance and that other  
74 factors exist that jointly influence the development of green finance in China (Yu et al., 2021). For  
75 instance, regional logistics can enhance the strength of regional information exchange capacity and  
76 can minimize the negative impact of information asymmetry in the region (Wei et al., 2022). The  
77 carbon emission index can reflect the overall environmental conditions and changes in the industrial  
78 structure of the city, which can effectively assist government decision-making (Bin et al., 2022).  
79 The economic level can represent the comprehensive strength of the province and region and the  
80 potential to support the green finance industry, which can allocate more public resources (Wang et  
81 al., 2021). The stricter the environmental regulation, the more enterprises will reduce pollution  
82 through emission reduction or transformation, which can make provincial and regional industries  
83 develop in the direction of environmental protection and low carbon (Xie et al., 2020). Because of  
84 the differences in local resource endowments and inherent conditions (Afshan et al., 2023), each  
85 Chinese province and region has gradually developed different development configurations in the  
86 process of building a regional green financial system by considering their own characteristics (Zhang  
87 et al., 2021). Therefore, it is important to explore the configuration to improve green financial  
88 performance and identify the causative factors of the differences in green financial performance, so  
89 as to provide theoretical reference for Chinese provinces to build a regional green financial system  
90 with local characteristics and a local government performance appraisal system. Based on the above  
91 analysis, it is obvious that the existing literature still has the following three shortcomings. First,  
92 scholars (e.g., Zhou et al., 2022; Li et al., 2022; Bakry et al., 2023; Zhang et al., 2023) have evaluated  
93 regional green finance as a whole, but the variables used are not simultaneously universal and  
94 targeted, and cannot give full play to the evaluation of green finance. Second, existing studies (e.g.,  
95 Yu et al., 2022; Li et al., 2022; Wang et al., 2021; Ran et al., 2023) focus more on factors or  
96 combinations that can improve green finance performance, but lack analysis on the differential  
97 aspects of green finance performance. However, this has practical implications for how Chinese  
98 provinces allocate factors to achieve high green financial performance or avoid non-high green  
99 financial performance. In addition, most scholars (e.g., Wang et al., 2021; Mao et al., 2021; Wei et  
100 al., 2022; Xu et al., 2023; Li et al., 2023; Ip et al., 2023) focus on green financial performance as an  
101 influencing factor, and explore more how green financial performance contributes to high-quality  
102 economic development or other variable growth, but few studies analyze in depth how to enhance  
103 green finance. However, if a province or a country wants to achieve the ultimate goal, it must first  
104 clarify the configuration of enhancing green financial performance in light of its own actual situation.  
105 Therefore, this paper constructs a data sample based on 30 Chinese provinces from a holistic  
106 perspective and conducts an empirical study through fsQCA to explore the different histories formed  
107 by each province and region in the process of developing green finance. In particular, this study  
108 examines the following three questions:

109 RQ1: How does each conditioning variable affect green finance performance? Are they influenced  
110 by a single variable? Or are they influenced by multiple variables?

111 RQ2: What are the variables or combinations that lead to high green financial performance and  
112 non-high green financial performance?

113 RQ3: What are the relationships between the different configurations? Are there any similarities  
114 or contradictions among them?

115 Compared with previous studies, the innovation of this paper is mainly in the use of fsQCA to  
116 explore the configurations to improve green financial performance from a configuration perspective  
117 and the causal factors of the differences in green financial performance. fsQCA has been recognized  
118 as an effective method for exploring the combined effects (Chen et al., 2021) and has been widely  
119 used in various fields of management disciplines (Zhong et al., 2022). First, it enables us to explore  
120 and compare the key factors affecting the performance of green finance across Chinese provinces  
121 and regions from both a high perspective and the absence of one (Wang et al., 2022). Second, this  
122 paper exceeds previous single-factor studies and conducts a multi-factor combination configuration  
123 analysis with the help of fsQCA, which introduces a new way to study the state of green finance and  
124 expands and enriches previous findings (Liang et al., 2022). In addition, the multi-case analysis  
125 approach is more general than that of single-case analysis (Diao and Liu, 2022).

126 This study contributes in several ways. First, a co-occurring network analysis was conducted to  
127 identify the latest research trends and categorize the literature. Second, a research framework of  
128 green financial performance was constructed. Third, it explored the configurations to improve green  
129 financial performance from a configuration perspective, identified the causal factors for differences  
130 in green financial performance, and enriched the existing literature. Ultimately this study finds four  
131 different types of high-performance configurations and four types of non-high performance  
132 configurations. Further comparing the different types of conditional configurations, it is found that  
133 regional logistics and carbon emission indicator factors play a key role in incentivizing the  
134 development of green finance in each province. This study has important theoretical and practical  
135 significance for the formulation of green finance policies in Chinese provinces, and provides a  
136 reference for different provinces to improve their green finance performance according to local  
137 conditions. Since this study only focuses on China, the largest emerging economy, thus limiting the  
138 generalization of the results to other emerging economies, future studies will compare the results  
139 with those of other countries to further discuss the similarity and heterogeneity of the results obtained.

140 The remainder of this paper will proceed as follows. Section 2 presents the literature review and  
141 the theoretical framework. Sections 3 and 4 present the research methodology and data analysis,  
142 respectively. Section 5 discusses the results of the data analysis. Section 6 reports the conclusions,  
143 implications, and limitations of the study.

## 145 2. Literature review and theoretical framework

### 146 2.1 Literature review

147 This study retrieved data from the WoS database (with SCI-EXPANDED and SSCI only) created  
148 by Clarivate Analytics on 1 January 2023. The study topic was selected as Topic: "Green Finance"  
149 OR "Green Financial Effectiveness" and refined by Language: English AND Document types:  
150 Article OR Review Article OR Meeting Abstract. The time frame chosen for this paper was 2011 to  
151 2022 because the first article was published in 2011. We refined and retrieved 533 records using the  
152 above settings. The literature data download completed the first step in the process of creating the  
153 database. Next, we imported the data into CiteSpace. CiteSpace can identify hot research topics and  
154 cutting-edge research in the field of green finance based on the frequency of popular keywords used  
155 in journal articles (Jia et al., 2019). Bursts of certain keywords can be used to analyze the evolution  
156 of green finance research and identify the latest research trends (Ding and Zhong, 2022). An outburst  
157 is a significant change in the value of a variable over a relatively short period of time (Jia et al.,  
158 2020). The value of a variable can change significantly in a relatively short period of time (Li and  
159 Wang, 2016). CiteSpace considered this type of change to be a way of identifying research frontiers  
160 (Ying et al., 2022).

161 As shown in Fig. 1, co-occurring network analyses were performed using keywords such as "node  
162 type". It indicated that recent popular research topics in green finance included green credit, green  
163 innovation, driving factor, climate change, performance, and economic growth. Topics with high

164 centrality included energy, environmental performance, policy, carbon emission reduction, finance,  
165 economic development, determinant, technology, and management. As can also be seen from the  
166 visualization, green finance was linked to current political hotspots such as carbon finance and  
167 sustainable development and has been used by many scholars for cross-sectional research because  
168 of the policy-oriented nature of the subject itself. Overall, from the results analyzed by CiteSpace,  
169 the research in this field is divided into the following two categories, including the context of the  
170 real-life contextual application of green finance and the factors influencing green finance.



Fig. 1. Popular Research Topics.

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### 2.1.1 Real-life contextual applications of green finance

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175 Green finance is mainly applied in real life around the government's policy strategy, social  
176 development of specific industries and innovation of environmental protection industry. The  
177 implementation of green finance in China is an effective measure to mitigate greenhouse gas  
178 emissions because green finance can influence the greenhouse effect by promoting the rapid growth  
179 of the provincial economy, curbing energy efficiency, and accelerating the optimization of the  
180 current industrial structure (Wang and Ying, 2022). Zhou et al. (2022) found that the levels of  
181 financial development and environmental governance promote the development of green finance,  
182 while the levels of economic growth and energy consumption inhibit the development of green  
183 finance. On this basis, he proposed countermeasures and recommendations in terms of strengthening  
184 government functions and adjusting industrial structures in line with economic growth. Wang et al.  
185 (2021) considered that the development of green finance facilitated the transformation of traditional  
186 energy consumption to renewable energy consumption. The impact of green finance on the structural  
187 transformation of energy consumption is mainly reflected in the direct effect. Therefore, the  
188 government should support green finance to reduce traditional energy consumption and increase  
189 renewable energy consumption. Mao et al. (2021) found that green finance works by improving  
190 economic efficiency, enhancing people's well-being, optimizing economic structure, and promoting  
191 innovation and development. However, the impact of green finance implementation varies from  
192 region to region (Zhang et al., 2023). For example, it is stronger in western China than in the central  
193 and eastern regions. Still, other scholars have found that environmental performance can positively

194 influence green innovation in the long run in non-emerging countries and countries with better green  
195 innovation or environmental performance (Yu et al., 2022). Furthermore, green finance has a  
196 positive impact on green innovation in emerging countries and countries with low levels of green  
197 finance, while green finance has a negative impact on green innovation in countries with better green  
198 innovation or environmental performance (Wang et al., 2022).  
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### 200 **2.1.2 Factors influencing green finance**

201 Academic research on the influence factors of green finance began earlier and is richer in detail,  
202 but the influence factors used by scholars are relatively single, and there is less comparative analysis  
203 between the roles of various factors, as shown in Table 1. Jinru et al. (2022) collected data from 240  
204 respondents in the Chinese manufacturing sector and analyzed them using structural equation  
205 modeling, finding that green financing and green logistics have a significant positive impact on  
206 sustainable production and the circular economy. He also proposed that green financing and green  
207 logistics should be incorporated into companies' sourcing and financing strategies to manufacture  
208 green and sustainable goods and to advance circular economy goals. Wei et al. (2022) claimed that  
209 green finance has clear negative and positive impacts on carbon emissions and green economic  
210 recovery. In his study of the relationship between economic, financial, and environmental  
211 development and green finance, he found that inadequate transport-related infrastructure and  
212 logistics services are the other important contributors to overall carbon dioxide and greenhouse gas  
213 emissions. He also found that sustainable energy development can be facilitated by promoting the  
214 growth of green finance. The logistics sector plays a vital role in the economic development of a  
215 country (Bin et al., 2022). However, logistics development can also affect the quality of the  
216 environment, as the logistics sector is seen as a major energy-consuming sector (Wei et al., 2022).  
217 Therefore, emerging countries need to align their logistics sector policies with sustainable  
218 development goals. At the same time, more resources should be allocated to the green innovation  
219 and renewable energy sectors (Jinru et al., 2022; Taridala et al., 2023), and the globalization of the  
220 economy should be promoted in order to foster sustainable development. Li et al. (2022) constructed  
221 a comprehensive evaluation system for green finance, using the number of patents granted for low-  
222 carbon innovations to measure low-carbon technological innovation. In his study, he found that green  
223 finance can significantly contribute to the transformation of a low-carbon economy, but this  
224 contribution decreases with the intervention of low-carbon technological innovation (Li et al., 2022).  
225 As a result, he recommended helping China improve the development of green finance to facilitate  
226 the transformation and upgrading of a low-carbon economy. Wang et al. (2021) examined the policy  
227 effects, the mechanisms for establishing green financial reforms, and the impact of innovation pilot  
228 zones on green development. The results indicated that the high level of financial input for  
229 environmental protection and marketization helped the pilot zones to further play a positive role in  
230 promoting regional green development (Wang et al., 2022). He also proposed that China make  
231 reasonable arrangements among regions according to local conditions and that the government  
232 should guide market players to establish the concept of green development, gradually build an  
233 environmentally friendly and circular economic model, and enhance the overall green development  
234 capacity of the region. The development of green finance in the Yangtze River Delta region of China  
235 has a clear spatial clustering effect and there are large regional differences (Xie et al., 2020).  
236 Regional GDP, regional innovation level and air quality are the most important factors influencing  
237 green finance, but the degrees of financial development and industrial structure optimization are not  
238 significant (Qian et al., 2022). In fact, financial agglomeration and green economic growth have  
239 become a global trend in financial and economic development, and financial agglomeration has a  
240 significant positive impact on green financial growth (Wang et al., 2021). By comparing different  
241 regions, Zhou et al. (2022) found that the impact of green finance on ecological development has a  
242 U-shaped relationship and that the level of tertiary industry development, economic development,  
243 and foreign direct investment also have a significant positive impact on ecological development, but  
244 the level of urbanization has a negative relationship with regional ecological development.  
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Table 1 Factors influencing green financial performance from prior studies.

Constructs	Context (Study Nature: Region)	Reference
Regional logistics (Logistics performance)	Case study: Manufacturing companies Case study: 25 emerging countries Case study: 22 emerging countries	Jinru (2022) Wei (2022) Bin (2022)
Carbon emission index	Case study: 30 Chinese provinces Case study: 25 emerging countries Case study: 22 emerging countries	Li (2022) Wei (2022) Bin (2022)
Regional finance	Case study: 30 Chinese provinces Case study: Yangtze River Delta region of China Case study: 30 Chinese provinces Case study: 25 emerging countries	Wang (2021) Xie (2020) Qian (2022) Wei (2022)
Economic level (Economic development)	Case study: 25 emerging countries Case study: 22 emerging countries Case study: 30 Chinese provinces Case study: 30 Chinese provinces Case study: Yangtze River Delta region of China	Wei (2022) Bin (2022) Wang (2021) Zhou (2022) Xie (2020)
Environmental regulation (Ecological development)	Case study: 30 Chinese provinces Case study: 30 Chinese provinces Case study: Yangtze River Delta region of China Case study: 25 emerging countries	Wang (2021) Zhou (2022) Xie (2020) Wei (2022)

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## 253 2.2 Research framework

254 Drawing on the context-related literature described above, and through statistical analysis of  
255 scholars' use of each factor, this study have developed a research framework to explain the influence  
256 on the performance of green finance, as shown in Fig. 2. We propose that regional logistics, carbon  
257 emission index, regional finance, economic level, and environmental regulation will have an impact  
258 on green finance. Although scholars have analyzed these five factors individually as having an  
259 influence on green finance, the causal relationship between green financial performance and these  
260 conditional variables is very complex, and it is not inevitable that a single variable plays a role in  
261 causing green finance to have high or non-high performance, so this study needs to further explore  
262 in allocation terms the configurations to improving green financial performance and the differences  
263 in the green financial performance of causal factors.

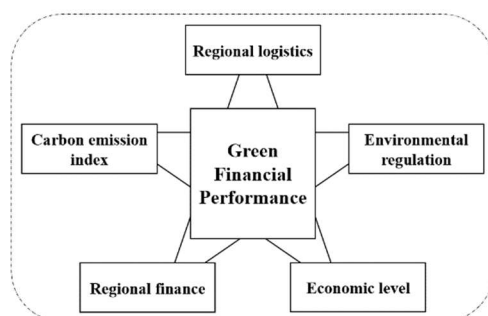


Fig. 2. Research framework.

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### 267 2.2.1 Regional logistics

268 Regional logistics is not only a reflection of regional transport capacity but also represents the  
269 strength of the regional information exchange capacity (Jinru et al., 2022). Regional information  
270 will flow with the transactions between social capital in the supply chain, and in the process of  
271 information exchange and flow, there are often regions that become information nodes because of  
272 their geographical or economic advantages in gathering a large amount of information flow (Wei et  
273 al., 2022). The higher the level of regional logistics, the more it indicates that the region occupies  
274 the core position of information and dominates the process of information flow (Bin et al., 2022). A  
275 high level of regional logistics can minimize the negative impact of information asymmetries, which  
276 is a major risk in the financial sector (Wei et al., 2022).

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### 278 2.2.2 Carbon emissions index

279 A city's carbon emissions index can measure the total carbon emissions of a city over a specific  
280 period, reflecting the changes in the overall environmental conditions and industrial structure of the  
281 city (Li et al., 2022). It also assists the government in decision making, provides a real-time scientific  
282 basis for the development of regional carbon emission reduction plans, and provides a useful  
283 reference for the development of green finance (Wei et al., 2022). When the carbon emission index  
284 of a region remains low, the place can be judged to have entered the post-industrialization stage or  
285 the implementation of environmental protection work is more efficient, which is conducive to  
286 regional green regional finance (Bin et al., 2022).

### 288 **2.2.3 Regional finance**

289 Differentiation in regional financialization is closely related to green regional finance (Wang et  
290 al., 2021). When a locality has a more mature regional financial system, it will be more likely to  
291 develop green financial products and services (Xie et al., 2020). In addition, green finance has been  
292 pushed as a national strategy in recent years. By creating new green finance businesses (Qian et al.,  
293 2022), financial institutions can help to open new markets while strengthening their own sense of  
294 social responsibility and creating a good institutional image (Wei et al., 2022).

### 296 **2.2.4 Economic level**

297 The level of the local economy represents to some extent the comprehensive strength of the region  
298 and the potential to support the green finance industry (Wei et al., 2022; Bin et al., 2022). In an  
299 actual situation, developed regions can allocate more public resources and implement policies more  
300 effectively when developing green finance (Zhou and Xu, 2022; Wang et al., 2021; Xie et al., 2020).

### 302 **2.2.5 Environmental regulation**

303 From the traditional research perspective, the more stringent the environmental regulations, the  
304 more enterprises will reduce their pollution by reducing emissions or transforming themselves in  
305 order to escape the pressure of related policies and systems (Wang et al., 2021), which will lead to  
306 higher costs and lower production capacity during the initial period and indirectly cause the local  
307 economy to regress and the financial sector to develop poorly (Zhou and Xu, 2022). At the same  
308 time, considering severe control measures will bias the regional industry toward environmental  
309 protection and low carbon development, which is conducive to the construction of a more reasonable  
310 industrial structure system in the long run (Xie et al., 2020). In addition, the improvement of the  
311 overall environment will have a positive impact on the innovation of green finance industry (Wei et  
312 al., 2022).

## 314 **3 Research methodology**

### 315 **3.1 Qualitative comparative analysis**

316 Qualitative comparative analysis (QCA) is an empirical research method based on the pooling  
317 theory proposed by Charles C. Ragin, an American sociologist, and is generally applied to small and  
318 medium-sized samples (Du and Kim, 2021). QCA aims to focus on the grouping of configurations  
319 that arise when problematic outcomes occur and to analyze multiple configurations that lead to the  
320 same outcome from a pooling perspective by looking at real-life situational cases behind different  
321 configuration representatives (Chuah et al., 2021). QCA is considered a new type of research method  
322 between qualitative and quantitative (Mei et al., 2022). In addition, QCA is divided into three  
323 specific operations based on the type of variables: crisp set (csQCA), fuzzy set (fsQCA), and multi-  
324 set (mvQCA). Among them, csQCA is only used to deal with dichotomous variables (Chen et al.,  
325 2021), mvQCA is suitable for dealing with multi-category variables (Zhang and Long, 2021), while  
326 fsQCA can solve problems such as partial affiliation or causal changes (Ren et al., 2016).

327 The fsQCA method was chosen for three main reasons. First, the fsQCA method can reorganize  
328 many influencing factors to form a condition configuration and enable a holistic analysis to  
329 investigate how the combination of antecedent conditions leads to continuous changes in the  
330 outcome variables (Chu et al., 2019) and to explore the conditions and combinations of conditions  
331 that have explanatory power on the outcome variables (Zhong et al., 2022). The fsQCA approach

can highlight the combined effect of multiple factors and the effectiveness mechanism driving regional green regional finance. Second, fsQCA is based on the principle of equivalence (Cheng et al., 2019), which summarizes various combinations of conditions that may lead to the same outcome (Xie et al., 2016). The fsQCA method has the advantage of considering multiple condition configurations leading to a specific outcome (Cheng et al., 2022), and it can focus on the diversity of causal relationships (Ren et al., 2016). Although the history of green regional finance varies across Chinese provinces and regions, the impacts of changes in the development of various factors on their ultimate performance may be somewhat consistent (Chuah et al., 2021). fsQCA can be applied to explore which condition configurations can lead to the improvement of regional green finance from a holistic perspective and to uncover the group causes of the relative lag of green regional finance in individual Chinese provinces. The fsQCA method can be applied to explore which condition configurations can be inferred to cause the improvement of regional green finance, as well as the condition configurations that cause the relative lag of green regional finance in individual provinces in China.

Therefore, in order to better elaborate the green regional finance configurations of Chinese provinces and regions and understand the utility mechanisms driving local green regional finance, this paper conducted an exploratory study using fsQCA.

### 3.2 Variable selection and measurement

**Result variable:** In the variable design process, we tried to ensure that the variables were as objective as possible and that the measures were well documented (Du and Kim, 2021). Therefore, we used the data from the green finance index for each region in the *China Local Green Finance Development Report (2021)* published by the International Institute of Green Finance of the Central University of Finance and Economics to measure the outcome variable. This report provides data tracking and an annual evaluation of 31 Chinese provinces in terms of green finance policy system construction, market product and service innovation, and regional exchange and cooperation. The report also analyzes the correlation between local green finance and local government financial capacity, macroeconomic development, financial system development, social and environmental conditions, and ecological environment quality. Its data meet authority, credibility, and objectivity (Cheng et al., 2022).

**Conditional variables:** Consideration of the indicators for the antecedent variables mainly followed the principle of diversification to ensure the reliability of the variables (Zhang and Long, 2021). Based on the literature and the specific conditions of each province and region, the conditional variables affecting the effectiveness of green finance in each province and region were set as five indicators: regional logistics, carbon emission index, regional finance, economic level, and environmental regulation. The data were processed using nine indicators with standardization and the principal component analysis method as a measure of the regional logistics variable, including the regional logistics value added, regional population, regional GDP index, regional total employment, regional logistics employment, per capita cargo turnover, regional total retail sales of consumer goods, regional total investment in fixed assets in logistics, and regional total freight volume. The carbon emission index was applied to calculate the carbon dioxide emissions from energy consumption in each province as a measure of the carbon emission index variables. The regional financial data from the *Report on Local Green Financial Development in China (2021)* published by the International Institute of Green Finance of the Central University of Finance and Economics were used as a measure of the criteria of the regional financial variable. For the economic level variable, the economic level output value of each province was used as a measure. Using industrial SO<sub>2</sub>, industrial wastewater, and industrial soot emissions per unit of output value, a composite index was calculated for measuring the environmental regulation variable.

### 3.3 Data source

In order to explore the principle and inner mechanism of the green regional financial configurations among the regions, this paper considered 34 provincial-level administrative regions in China as the research objects. Because of the wide scope of data collection, there were gaps and deficiencies in the data of some provinces. In order to ensure the relative completeness and relevance



386 of the final empirical findings (Zhong et al., 2022), 30 provinces (except Tibet, Hong Kong, Macao,  
 387 and Taiwan) were finally selected as the research sample. In total, we spent more than three months  
 388 collecting and processing data, and these raw data were obtained from the *China Local Green*  
 389 *Finance Development Report (2021)*, *China Statistical Yearbook (2022)*, *China Urban Statistical*  
 390 *Yearbook (2022)*, *China Energy Statistical Yearbook (2022)*, and the statistical yearbooks of each  
 391 province in 2022.

392

### 393 3.4 Data calibration

394 Before using fsQCA to analyze the data, all variables were calibrated (Mei et al., 2022). The  
 395 calibration was set at three anchor points according to the theoretical knowledge and combined with  
 396 the actual situation: fully in, crossover, and fully out, and the calibrated variables were between 0  
 397 and 1 (Du and Kim, 2021). In this paper, the upper quartile (75% quartile value), the middle value  
 398 (50% quartile value), and the lower quartile (25% quartile value) of the outcome variables and the  
 399 five conditional variables for measuring the high performance of green finance in each province and  
 400 region of China were selected as the three anchor points (Chuah et al., 2021). The three anchor points  
 401 for measuring the absence of green finance high performance in each province and region of China  
 402 were set as the opposite of the above (Chu et al., 2019). The three anchor points for each calibration  
 403 standard are shown in Table 2.

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Table 2 Variable calibration.

Sets		Fuzzy set calibrations		
		Fully in	Crossover	Fully out
Result Variable	Green Financial Performance (GFP)	45.1150	30.4750	20.9875
Conditional variables	Regional logistics (RL)	0.5168	0.1114	0.0058
	Carbon emission index (CEI)	48327.831 2	27412.109 1	17580.7427
	Regional finance (RF)	29.3825	18.5850	11.9125
	Economic level (EL)	4325332.7 50	2483347.5 00	1360878.75 0
	Environmental regulation (ER)	0.8570	0.4969	0.1156

406

## 407 4 Results

408 We performed two types of analysis using fsQCA (Xie et al., 2016). The first was necessary  
 409 conditions analysis (Cheng et al., 2022), which detects whether the presence of a variable will  
 410 directly lead to the generation of the result variable (Ren et al., 2016). The second type of analysis  
 411 was sufficiency analysis for configuration conditions (Chen et al., 2021), which finds the  
 412 configuration conditions that lead to the generation of the result variable (Zhong et al., 2022), where  
 413 the different conditions are analyzed to understand the causal relationship between the conditional  
 414 variables and the result variable (Chu et al., 2019).

415

### 416 4.1 Necessary conditions analysis

417 In this paper, FsQCA 3.0 software was used to test the consistency and coverage of variables to  
 418 measure the sufficiency and necessity of the relationship between variables (the symbol “~”  
 419 indicates the absence of the given variable). Consistency refers to the extent to which all samples  
 420 included in the analysis conform to a given condition or combination of conditions that affect the  
 421 occurrence of the result variable (Mei et al., 2022). Coverage refers to the extent to which a given  
 422 condition or combination of conditions has explanatory power over the result variable (Zhang and  
 423 Long, 2021). For single condition variable necessity analysis, if the necessary consistency of a  
 424 conditional variable is greater than 0.9, the factor is necessary and the resulting necessary condition  
 425 will be excluded in the subsequent sufficient condition analysis, and if it is less than 0.9, it cannot  
 426 be considered necessary (Cheng et al., 2022). For the single condition variable sufficiency analysis,

427 a factor is sufficient if the sufficient consistency of a conditional variable is greater than 0.8,  
 428 indicating that this single factor constitutes a configuration to explain the results (Ren et al., 2016).  
 429 As shown in Table 3, the results of the necessary condition test indicated that the necessary  
 430 consistency of all conditional variables was below 0.9, indicating that the single conditional variable  
 431 lacked sufficient explanatory power for the result variable and that no single variable was necessary  
 432 to influence the result variable. The results of the sufficient condition test indicated that the sufficient  
 433 consistency of all the single conditional variables was also less than 0.8, which was also insufficient  
 434 to constitute a sufficient condition to influence the result variable, indicating that no single  
 435 conditional variable constituted a configuration to explain the result variable.

436  
 437 Table 3 Analysis of necessary conditions for green finance performance in fsQCA.

Sets of conditions	Result variable			
	High green finance performance		Absence of high green finance performance	
	Consistency	Coverage	Consistency	Coverage
Regional logistics (RL)	0.646	0.643	0.425	0.400
~Regional logistics (RL)	0.428	0.447	0.648	0.662
Carbon emission index (CEI)	0.641	0.642	0.463	0.446
~Carbon emission index (CEI)	0.446	0.463	0.629	0.628
Regional finance (RF)	0.509	0.501	0.620	0.587
~Regional finance (RF)	0.580	0.613	0.472	0.481
Economic level (EL)	0.502	0.504	0.598	0.577
~Economic level (EL)	0.579	0.599	0.487	0.485
Environmental regulation (ER)	0.523	0.498	0.654	0.598
~Environmental regulation (ER)	0.578	0.634	0.451	0.477

438

#### 439 4.2 Sufficiency analysis for configuration conditions

440 After analyzing the data, the fsQCA 3.0 software presented three different solutions: complex,  
 441 intermediate, and parsimonious (Wang et al., 2022). The complex solution does not contain logical  
 442 residuals (Liang et al., 2022), the intermediate solution contains only logical residuals that match  
 443 the theoretical basis and the actual situation (Diao and Liu, 2021), and the simple solution contains  
 444 all logical residuals but does not evaluate their reasonableness (Mei et al., 2022). Compared with the  
 445 other two solutions, the intermediate solution was less complex, reasonable, and did not eliminate  
 446 the necessary conditions, so the intermediate solution was chosen for the subsequent study (Chen et  
 447 al., 2021). In addition, the intermediate solution determined the peripheral and core conditions that  
 448 were useful for the outcome variable (Chu et al., 2019). If they do not exist in the simple solution  
 449 but exist in the intermediate solution, they are peripheral conditions (Cheng et al., 2022). If they  
 450 exist in both solutions, they are core conditions (Ren et al., 2016). The core condition has a greater  
 451 effect on the outcome variable, and the peripheral condition plays a secondary role (Xie et al., 2016).

452 We adopted default thresholds to filter the data, with the case frequency benchmark set as 1 and  
 453 the raw consistency benchmark as 0.8 (Du and Kim, 2021). This paper first assumed that the  
 454 presence of all the conditional variables was likely to have a positive impact on green finance  
 455 performance (Chu et al., 2019), which led to four configurations that produced high green finance  
 456 performance (as shown in Table 4). The consistency of the results was 0.706, indicating that 70.6%  
 457 of the provinces and regions that satisfied the four configurations had a high level of green finance  
 458 performance. The coverage of the results was 0.661, indicating that the three types of configurations  
 459 explained 66.1% of the provinces and regions with better green regional finance. Second, if the  
 460 absence of the conditional variables had a negative impact on green finance performance (Mei et al.,  
 461 2022), four types of configurations were derived to represent the absence of high green finance  
 462 performance, and these four types of configurations explained 82.1% of the provinces and regions

463 with a low performance of green regional finance (as shown in Table 5). For all cases that satisfied  
464 these four types of configurations, 79.3% of the provincial and regional cases showed low levels. In  
465 order to better compare the differences between the different configurations at various levels, we  
466 explored the four types of configurations that determined the emergence of high green finance  
467 performance and the four types of configurations that determined the absence of high green finance  
468 performance.

469

#### 470 **4.2.1 Configurations for high green finance performance**

471 H1 (RL-CEI): This configuration is defined as the green regional financial dynamics whereby the  
472 region is expected to be enhanced when the two prerequisites of a high level of transportation and  
473 logistics construction and a high-quality ecological environment are both present. In this  
474 configuration, regional logistics (RL) and carbon emission index (CEI) are the core conditions,  
475 indicating that the importance of RL and CEI is much higher than other elements in this  
476 configuration. In addition, since only two core conditions are identified in this configuration,  
477 superior logistics and transportation conditions and a good ecological environment, as the "hard  
478 conditions" and "soft power" of regional development, are the key factors in the further development  
479 of green finance in these regions. The other factors play a relatively weak role. When RL conditions  
480 are more prominent, the provinces and regions belonging to this configuration have a significant  
481 advantage over other provinces and regions in terms of livelihood infrastructure. However, RL  
482 combined with lower CEI indicates that the relevant regions initially completed the transformation  
483 of industrialization or implemented the green energy-saving and emission reduction policies  
484 effectively. The provincial and regional representative of this configuration was Beijing Province.  
485 In the context of the national construction of a green financial system, Beijing, as the first city, has  
486 explored a new configuration of green regional finance in recent years. By combining the actual  
487 local development and introducing relevant draft practices, a policy framework focusing on building  
488 a global green financial center was initially formed. Specifically, on the one hand, it has actively  
489 gathered a few green financial institutions in the city's sub-center zone to form a large-scale business  
490 platform, laying a realistic foundation for the city's green regional finance strategy while expanding  
491 the market supply capacity. On the other hand, relying on the twin core advantages of being a  
492 national political center and a transportation pivot, Beijing is making efforts to strengthen  
493 international exchange and cooperation in green finance, providing a strong impetus to build a  
494 national carbon financial trading market.

495 H2 (CEI-RF-EL): This construction allows that when the regional economy is developing well,  
496 focusing on consolidating financial development and promoting the transformation of the "three  
497 high" industries will help develop the green finance industry. In this construction, carbon emission  
498 index (CEI) and regional finance (RF) are the core conditions and economic level (EL) is the  
499 peripheral condition. This indicates that CEI and RF are more effective than EL for the green finance  
500 industry in this construction. This again confirms that a good economic foundation will provide  
501 support for the local green finance industry, but the strength of the local economy does not represent  
502 the development height of its green finance industry to some extent. The representative province of  
503 this construction was Hubei Province. In recent years, around its traditional industrial transformation  
504 and development needs, Hubei has formed a preliminary framework of green regional finance,  
505 embedding green elements in the process, such as many banks have jointly launched a number of  
506 green financial products, explored the pilot work of sewage rights mortgage, etc.

507 H3 (~RL~CEI~ER): This construction is peculiar compared to other constructions because it is  
508 composed of missing factors, i.e., it promotes the development and growth of the local green finance  
509 industry when the regional infrastructure is not yet complete, the modern industrial transformation  
510 is not yet completed, and the regional regulation is relatively broad. In this construction, regional  
511 logistics (RL), carbon emission index (CEI), and environmental regulation (ER) are all absent,  
512 indicating that the development of regions belonging to this construction is relatively lagging.  
513 However, the development of its green finance industry is in its prime, implying that factors not  
514 included in the measurement must be at play in influencing the green regional finance of the region.  
515 The representative province and region of this construction was Guizhou Province. Guizhou has a  
516 relatively disadvantaged level of economic development but superior ecological and environmental  
517 conditions. This is one reason why Guizhou was identified as one of the first national experimental

518 zones for green financial reform and innovation, i.e., to explore new ways of development for  
 519 economically disadvantaged regions and to open new horizons for green industrialization. Therefore,  
 520 Guizhou has benefited more from the relevant supporting policies of the central government in  
 521 promoting the development of green finance. In other words, the model of developing green finance  
 522 in Guizhou reflects the criticality of policies from the central government level.

523 H4 (RL-RF-EL-ER): The construction reflects an overall positive tendency. When a region with  
 524 a high level of regional logistics, a good level of economic development, a certain financial industry  
 525 foundation, and more stringent local government regulation of environmental aspects, the level of  
 526 green finance is better. In this configuration, regional logistics (RL), regional finance (RF),  
 527 economic level (EL), and environmental regulation (ER) all exist, reflecting that the provinces and  
 528 regions belonging to this construction have a good development status in all aspects. When EL is  
 529 classified as a peripheral variable and as an antecedent variable, it reflects the strong economic power  
 530 of the provinces belonging to this construction from the side. Market capital transactions are active,  
 531 and the corresponding environmental control initiatives are in line with the local economic  
 532 development rhythm, thus playing a facilitating rather than a moderating role. In this construction,  
 533 the corresponding environmental regulation policies and financial industries are more of a hotbed  
 534 for the development of local green finance. The representative province of this construction was  
 535 Guangdong Province. As China's window to the outside world, Guangdong is regarded as a pilot  
 536 zone for many early policies. In the financial sector, the development scale and standardization of  
 537 financial trading platforms in Guangdong are more comprehensive and complete than those in other  
 538 provinces and regions, and the basic platform for various markets such as banks and securities for  
 539 horizontal linkage and vertical development has been basically established. Objectively, it provides  
 540 the original ecological conditions for the development of green finance; that is, with the support of  
 541 the local financial industry it will be more conducive to the issuance and trading of various green  
 542 credit, bonds, and other products, and revitalize green financial assets. This is also a characteristic  
 543 that distinguishes Guangdong from other provinces and regions with better economic strength. It is  
 544 also a realistic reason why the variable of "economic development" is not a core variable in this  
 545 construction, and the level of provincial and regional economic development is not a key pillar  
 546 supporting the development of green finance in this type of city.

547  
 548

Table 4 Analysis of necessary conditions for high green finance performance in fsQCA.

Configurations	H1	H2	H3	H4
RL	●		○	●
CEI	●	●	○	
RF		●		●
EL		•		•
ER			○	●
Consistency	0.706	0.889	0.844	0.878
Unique Coverage	0.024	0.040	0.010	0.110
Raw Coverage	0.378	0.441	0.300	0.339
Overall Solution Coverage	0.661			
Overall Solution Consistency	0.706			
Note: ● indicates core causal condition present; • indicates peripheral condition present; ○ indicates core causal condition absent.				

549

#### 550 4.2.2 Configurations for absence of high green finance performance

551 AH1 (~RF~EL): This configuration reflects that poor economic development in the region and a  
 552 relatively weak local financial sector will have a negative impact on the local green regional finance.  
 553 In this configuration, both regional finance (RF) and economic level (EL) are indicated as absent,  
 554 and the former is a peripheral variable while the latter is a key variable. It indicates that in this  
 555 configuration the weakening of the local financial industry is only the surface, and the level of

556 regional economic development is the key check on local green regional finance. The representative  
 557 province of this configuration was Qinghai Province. As a large western province, Qinghai has the  
 558 "double contradiction" dilemma of abundant energy resources and fragile ecological environment.  
 559 From the perspective of economic development, Qinghai belongs to the third echelon, its own  
 560 economic development is backward, and the surrounding transportation network is sparse, which  
 561 makes it difficult to link the development of the region to the neighboring provinces and thus difficult  
 562 to create systemic advantages and synergistic effects. In addition, compared with the provinces in  
 563 the Yangtze River Delta region, the development of the financial industry in this area is relatively  
 564 backward, which makes the development of the green financial industry inherently insufficient. In  
 565 addition, considering the severe situation of ecological environmental protection in the region,  
 566 grasping the balance between ecological protection and economic development and then  
 567 strengthening the practical application of green finance will also become key issues for the province.

568 AH2 (~CEI~EL~ER): The configuration proposes that a high carbon emission index (CEI) in  
 569 the region, a declining economic level (EL), and a lack of strong controls on the environmental  
 570 revolution (ER) will have a negative impact on local green finance. The similarity between AH1 and  
 571 AH2 is that the low level of economic strength is the key factor leading to poor local green regional  
 572 finance. The difference is that the marginal factors of AH2 are ~CEI and ~ER, i.e., a too high carbon  
 573 emission index and lax environmental control. The representative province and region of this  
 574 configuration was Liaoning Province. Liaoning's green regional finance journey alongside the other  
 575 two northeastern provinces reflects the transformation configuration of heavily industrial city  
 576 clusters in northern China. From the perspective of policy instruments, Liaoning's government  
 577 signed a cooperation agreement with the European Union to establish China's first green credit  
 578 instrument, and its green finance industry had an early start. However, many factors, such as  
 579 transformation difficulties and weak policy promotion in the later stage indicate that the green  
 580 regional finance is still in its embryonic stage.

581 AH3 (~RL~CEI): The configuration states that when a province or region does not dominate the  
 582 surrounding regional transportation pattern and its own carbon emission index is high, the capacity  
 583 of green finance in that location to generate superior effectiveness will also be relatively insignificant.  
 584 This configuration contains two conditional variables, namely, regional logistics (RL) and carbon  
 585 emission index (CEI), and both are key variables. The representative province of this configuration  
 586 was Henan Province. In the industrial distribution of Henan, secondary industry dominates, the share  
 587 of green and environmental industries is very small, and the overall scale of green economy is small,  
 588 with limited financing channels and lack of landing support, making it difficult to form a synergy to  
 589 stimulate green regional finance.

590 AH4 (RL-CEI-ER): This configuration behaves in the same paradoxical way as H3, which  
 591 proposes that when the region is close to the transportation pivot, with low carbon emission levels  
 592 and strong local government environmental controls, the momentum of local green regional finance  
 593 slows down. The three variables belonging to this configuration are all core variables. The  
 594 representative province of this configuration was Fujian Province. Among the provinces planning  
 595 green development, Fujian was one of the early pathfinders. In 2014, Fujian was awarded the earliest  
 596 ecological civilization demonstration zone in the country. However, in the later development process,  
 597 its policies were not suitable for practical application, and there was a misalignment with local  
 598 market development. In addition, the lack of financial institution participation and the high cost of  
 599 green industry development have also become important problems that hurt local green regional  
 600 finance.

601  
 602

Table 5 Analysis of necessary conditions for absence of high green finance performance in fsQCA.

Configurations	AH1	AH2	AH3	AH4
RL			○	●
CEI		◦	○	●
RF	◦			
EL	○	○		
ER		◦		●

Consistency	0.801	0.952	0.865	0.895
Unique Coverage	0.347	0.011	0.010	0.017
Raw Coverage	0.700	0.231	0.37	0.197
Overall Solution Coverage	0.821			
Overall Solution Consistency	0.793			
Note: ● indicates core causal condition present; ○ indicates core causal condition absent; ◦ indicates peripheral condition absent.				

603

### 604 4.3 Robustness checks

605 Robustness checks are an integral part of the analysis when using the fsQCA method (Mei et al.,  
606 2022). In this paper, we prioritized a specific approach in set theory for robustness checks (Du and  
607 Kim, 2021). First, using the varying consistency benchmark test, the raw consistency benchmark of  
608 0.8 was reduced to 0.77, and the results indicated similarity to the previous condition configurations.  
609 Second, the frequency benchmark was adjusted by increasing the original benchmark from 1 to 2  
610 (Ren et al., 2016), and the same results and consistent conclusions were still obtained. Therefore, it  
611 can be concluded that the findings of this paper were robust.

612

## 613 5 Discussion

614 By distinguishing the different types of condition configurations, it was apparent that the  
615 individualized characteristics among configurations were obvious, but from a systematic perspective,  
616 there was an overall lack of a common basis. According to the distribution of comparison  
617 configurations and conditional variables, the commonality of regional logistics factors was high, and  
618 they were mostly the key factors in various types of condition configurations, indicating that the  
619 level of regional logistics in each Chinese province played a macroscopic role in the enhancement  
620 of local green finance performance. However, it is also important to note that the core variable of  
621 regional logistics was not the only decisive factor in each condition configuration but needed to be  
622 combined with other variables to produce a corresponding high green finance performance. It can  
623 be concluded that this variable's heterogeneity tendency was more prominent in the condition  
624 configurations that led to the absence of high green finance performance. In retrospect, the main  
625 reason for the diversification of green finance was the variability of the development process in  
626 different regions, which made it difficult to generalize the corresponding development model. In  
627 setting up the first batch of green financial reform and innovation pilot zones, the state also set up  
628 different development goals according to the heterogeneity of the logistics development level,  
629 industrial structure, and resource endowment of each region. For example, Guangdong Province has  
630 a high level of logistics development, a strong financial industry, and a more mature policy system,  
631 and it needs to focus on developing a modern green financial market. Guizhou Province, for example,  
632 is rich in natural resources and has little development effort, and it needs to develop a green financial  
633 industry based on its existing advantages and pursue sustainable green development.

634 Looking at the eight types of condition configurations affecting the performance of green finance  
635 and their representative provincial cases, we deduced that the government-led policy variable and  
636 driver played a key role in stimulating the development of green finance in each province. The reason  
637 is that among the eight configurations mentioned above, one conditional variable, the carbon  
638 emission index, played a significant role in promoting the result variable, but the carbon emission  
639 index variable was mainly driven by local government policies to reduce emission levels. For  
640 example, among the condition configurations leading to the high performance of green finance, H3  
641 represents Guizhou Province and H4 represents Guangdong Province, which were included in the  
642 first batch of green finance reform and innovation pilot zones by the state as early as 2016 and  
643 became the first implementers and beneficiaries of relevant policies. In fact, considering both the  
644 positive externalities generated by green finance and its still nascent development status in China,  
645 adopting policy tools to accelerate the pace of green finance development is currently one of the  
646 more effective approaches. Under the policy influence, the government departments in these

647 provinces and regions guided the transitioning enterprises and regulated the enterprises with high  
648 pollution, high energy, and high water consumption, which helped the enterprises to move toward  
649 green development. This also maximized their economic benefits, thus achieving the high-quality  
650 development of the local society and economy, which was also in line with the hypothesis of the  
651 economic man. However, through the condition configuration leading to the absence of high green  
652 finance performance, the limitations of government policy instruments in promoting local green  
653 regional finance can also be glimpsed. The relevant shortcomings were more evident in the  
654 development history of Liaoning Province, a province and region represented by AHb2, and Fujian  
655 Province, a province and region represented by AH4. In both cases, the regions acted early in the  
656 development of green finance and achieved corresponding results in the early stage, but in the middle  
657 and late stages of development, they both showed weaknesses. On the one hand, this proved that  
658 policy instruments can play a more significant incentive role in the initial stage of regional green  
659 regional finance and achieve effective management. On the other hand, because of the uneven  
660 development among Chinese regions and the uneven levels of the overall economy, culture, science,  
661 and technology, there are gaps in the development capacity of each region, making it difficult for  
662 green finance to ensure growth-oriented and sustainable development. In other words, it is difficult  
663 for green policy instruments to fully solve the problems of regional green finance.  
664

## 665 **5.1 Theoretical Implications**

666 By comparing the combined relationship between different configurations, a substitution  
667 relationship between conditional variables can be derived to help provinces and regions improve the  
668 performance of green finance find a more suitable solution for themselves.

669 By comparing the four condition configurations that produce high green finance performance, three  
670 substitution relationships were found. First, comparing H1 with H2, we found that regional logistics  
671 (RL) can be substituted with regional finance (RF) and economic level (EL). This means that if regions  
672 with better control of carbon emissions, regardless of whether the environment is well-regulated or not,  
673 meet the conditions of superior logistics and transportation, or they meet the combination of "high  
674 financial development + high economic level", they can generate a high performance of green finance.  
675 This had similarities and differences with the findings of a previous study (Jinru et al., 2022). The  
676 similarity was that RL did have an impact on green finance in each province and region. The difference  
677 was that, in the previous study, the RL factor influenced the green finance of each province and region  
678 only through its influence on environmental quality, but we found that RL can directly influence the  
679 green finance performance of provinces and regions as a core condition. Second, comparing H1 with  
680 H4 and H2 with H4, we found that the carbon emission index (CEI) could be replaced with RF, EL,  
681 and environmental regulation (ER), or with RL and ER. It suggested that if the region has excellent  
682 logistics and transportation capacity, it can show a high performance of green finance if the carbon  
683 emission is well controlled or the combination of "high financial development + high economic level  
684 + good environmental regulation" is satisfied. It also indicated that if the region has high financial  
685 development and a high economic level, it can maintain high green finance performance by controlling  
686 the carbon emission index or meeting the combination of "high logistics and transportation capacity +  
687 good environmental regulation".

688 A further comparison of the four condition configurations that produced an absence of high green  
689 finance performance revealed a substitution relationship. Comparing AH2 with AH3, we found that an  
690 RL absence can be substituted with an EL absence and an ER absence. In other words, if a region has  
691 a high index of its own carbon emissions, the surrounding regional transportation pattern does not  
692 dominate or is at a low level of economic development, and the government lacks strong controls on  
693 environmental management, it will have a negative impact on the local green finance.  
694

## 695 **5.2 Policy Implications**

696 Three policy implications for policy makers and policy implementers in the provinces are set out  
697 below.

698 First, China's provinces and regions must quickly refine the consensus reached in the development  
699 of green finance in each region, learn from the valuable experience of local governments in developing  
700 green finance, and build a green regional financial system with local characteristics. They must focus

701 on the cities that have made achievements in the field of green finance, guide financial institutions to  
702 invest more in green finance, provide better green financial services, focus on creating generic  
703 demonstration projects, and enhance the guiding role of advanced demonstration cities. It is also  
704 necessary to increase support for universities and research institutes, focusing on cultivating excellent  
705 financial talents to provide professional vitality for the long-term development of the green financial  
706 system in each province.

707 Second, China's provinces and regions need to rely on a solid industrial base and actively develop  
708 local logistics linkages to strengthen urban infrastructure and transportation. At the same time,  
709 governments in each province should also increase local resource environmental protection efforts,  
710 actively promote the development of green branding strategies, highlight the green development  
711 orientation, realize the optimal allocation of resources, prioritize the increase of green financial  
712 resource allocation to environmental protection industries, and standardize the policy and financial  
713 support to enterprises. This conclusion is roughly the same as the improved countermeasures proposed  
714 in previous studies (Zhou et al., 2022; Wang et al., 2021), all aimed at providing a breeding ground for  
715 the development of urban green finance.

716 Third, based on policy orientation, Chinese provinces and regions should integrate green finance as  
717 a measurement indicator into the performance assessment system of local governments to stimulate  
718 them to be more proactive as a driving force to promote green finance development because a single  
719 policy utility is not enough to promote green finance development. We suggest that local governments  
720 introduce more detailed policy guidelines based on the national strategy to further stimulate market  
721 dynamics. For instance, a green information-sharing platform should be created to enhance provincial  
722 interconnections and find emerging development momentum in the society.

## 723 **6 Conclusions**

724 In this paper, based on CiteSpace and the fsQCA method, a qualitative comparative analysis of  
725 fuzzy sets was conducted for 30 provincial and district cases in China. We found four types of  
726 condition configurations that determined the emergence of high green finance performance and four  
727 types that determined the absence of high green finance performance. Among them, regional  
728 logistics factors play a greater role in the regional green finance process in the provinces and regions.  
729 This confirms the view of Wei et al. (2022), who also argues that a high level of regional logistics  
730 can reduce financial risks. However, the regional green finance model is still in the embryonic stage  
731 due to the influence of objective factors such as local characteristic endowment. Existing studies  
732 point out (Zhou et al., 2020) that the level of green finance varies across regions in China, and after  
733 the study in this study, it is indeed found that provinces show diversified development in the process  
734 of growth, which is attributed to the lack of a mature theoretical framework system as a standardized  
735 paradigm to be promoted at the macro level. In addition, the government policy-driven carbon  
736 emission indicator factor plays a key role in stimulating the development of green finance in the  
737 provinces and regions, but it cannot guarantee sustainable growth and plays little role in regulating  
738 the development of regional green finance in the later stage. This supports the findings of Bin et al.  
739 (2022) and broadens his findings.

740 This study has three research contributions. First, co-occurring network analysis was conducted  
741 through CiteSpace to identify the latest research trends and categorize the different literatures.  
742 Second, through reading extensive literature, a scientific and reasonable research framework of  
743 green financial performance is constructed, which lays a theoretical foundation for subsequent  
744 empirical research. Third, this study introduces the fsQCA for the first time, which definitely  
745 enriches the research methodology instrumental tools in this field, explores the configurations to  
746 improve green financial performance from the allocation point of view, identifies the causal factors  
747 of the differences in green financial performance, and enriches the existing literature.

748 Despite our best efforts, there are some limitations in this paper. In the data collection stage,  
749 because of the narrow scope of data collection and some data gaps, Tibet, Hong Kong, Macao, and  
750 Taiwan were not included in the analysis process, and the empirical results were not comprehensive  
751 enough to describe the actual green finance development scenario in China, more effective data  
752 should be obtained for exploratory research in later studies. In addition, This study only collected  
753 and analyzed samples from Chinese provinces, thus limiting the generalization of the findings to



754 other countries or regions, and it is necessary to conduct similar studies in the future to compare the  
755 results of this study with those of other countries to further discuss similarities and heterogeneity.  
756

#### 757 **DATA AVAILABILITY STATEMENT**

758 We would be happy to share the research data in this paper with interested scholars if necessary. If  
759 interested scholars have data requirements, please contact the first author by email  
760 (100604541@unimai.derby.ac.uk).  
761

#### 762 **ETHICS STATEMENT**

763 Written informed consent was obtained from the individual(s) for the publication of any potentially  
764 identifiable images or data included in this article.  
765

#### 766 **AUTHOR CONTRIBUTIONS**

767 Conceptualization, ML and ZL; methodology, ML and LW; software, ML; validation, ML, ZL and  
768 QH; formal analysis, ML; resources, ZL and LW; data curation, ML; writing—original draft  
769 preparation, ML and LW; writing—review and editing, ML, ZL, and QH; visualization, ML;  
770 supervision, ZL and QH; project administration, ZL and LW; funding acquisition, ZL and QH. All  
771 authors have read and agreed to the published version of the manuscript.  
772

#### 773 **FUNDING**

774 This research was supported by a grant from the China Scholarship Council. It was funded by the  
775 National Social Science Foundation Of China, grant number 22BGL049; Project of Humanity and  
776 Social Science Foundation of the Ministry of Education in China, grant number 20YJC630137; the  
777 Key Project of Hunan Provincial Education Department, grant number 22A0403; the Hunan  
778 Provincial Philosophy and Social Science Foundation Project, grant number 18JD25.  
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