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The influencing factors and pathways of China's green finance development towards the Carbon Peaking and Carbon Neutrality —evidence from fuzzy-set qualitative comparative analysis based on 30 provinces of China

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In the context of the Carbon Peaking and Carbon Neutrality, the significance of green development, including the development of green finance, has gained increasing attention. It is important to explore the factors and pathways that have impacts on the progress of green finance; however, these are not clearly defined. In this paper, using data from 30 provinces (autonomous regions and municipalities directly under the central government) in China, we investigate the factors that drives the advancement of green finance in China. We utilize the fuzzy set qualitative comparative analysis (fsQCA) technique to scrutinize the effects of economic development, industrial structure, government investment in environmental protection and green innovation capability on the progress of green finance development. The results show that the development of green finance is not solely dependent on the four aforementioned conditions alone. However, according to the group analysis, we find three pathways towards achieving the development of green finance, among which the conditions show relationships of complementarity and substitutability. In order to promote the growth of green finance in China, the local government should leverage the distinctive characteristics of the regions by the method of encouraging green patents, developing clean and green projects and strengthening the regional innovation capacity. Furthermore, the government should play a leading role in enhancing the promotion of green patent applications. Finally, it is essential for each region to conduct a comprehensive analysis of their local resources and devise differentiated strategies for the development of green finance.

KEYWORDS

carbon peaking, carbon neutrality, green finance, fuzzy-set qualitative comparative analysis, sustainable development

1 Introduction

Green finance aims to promote environmental protection and governance, and guide resources from industries with high pollution and energy consumption to sectors with advanced concepts and technologies. The economic development has exacerbated CO₂ emissions to some extent (Ali and Oliveira, 2022b). The discharge of various pollutants in the process of social production is constantly increasing, causing damage to the natural environment including water and air, and provoking drastic climate changes (Gao et al., 2020). In recent years, issues about reducing environmental pollution and promoting the sustainable development of human society have become the key concerns of the international community (Ali and Oliveira, 2022a). In order to mitigate global climate change and achieve Sustainable Development Goals (SDGs), many countries are actively taking measures to reduce carbon emissions and developing green economy (Lee & Lee, 2022). At the 75th session of the UN General Assembly, China promised that carbon emissions would peak around 2030–2040 and achieve carbon-neutral before 2060, which is not only the embodiment of great nation responsibility, but also the requirement of promoting sustainable development through green and low-carbon transformation.

The carbon peaking and carbon neutrality goals mean that China will go through economic growth decoupled with emissions. However, compared with other developed countries, China's carbon peaking and carbon neutrality goals are tight in time and heavy in task. Green finance is an important source of funds to support the energy structure optimization and the acceleration of the construction of carbon emission trading system. To promote economic sustainable development with the growth of green industries and green projects, it is necessary to rationally allocate financial resources and guide social capital flow to green industries. Existing studies have shown that green finance which can reduce carbon emissions and provide for environmental sustainability is crucial in financing renewable energy and green energy projects. Thus, green finance plays a critical role in facilitating the achievement of the carbon peaking and carbon neutrality targets. It is thus of great pragmatic importance of determining the factors that influence the development of green finance and investigating the trajectory of its development.

In this paper, We use case-oriented qualitative comparative analysis (QCA), which was put forward by Charles Larkin in 1980s, to explore the driving factors and design pathways of the high-quality development of green finance. This QCA technique can collect available information from intensive case studies and is suitable for solving the common "multiple coincidence points" causality problem in comparative theory.

Compared with the existing literature, this paper reflects its marginal contribution from the following aspects. First, it focuses on the development level of green finance, explores the development mode and path of green finance, and enriches the existing literature on the qualitative and quantitative research of green finance development. Second, regarding the measure of the level of green finance development, compared with the methods of single evaluation index. The multidimensional evaluation system can cover green finance more comprehensively. Finally, a creative use of fuzzy set qualitative comparative analysis is

employed to explore the path to improve the level of green finance development.

This paper is structured as follows: Section 2 presents literature review. Section 3 describes methodology and research design, the results of which are presented in Section 4. Section 5 discusses the main findings, followed by the conclusion in Section 6.

2 Literature review

2.1 Green financial development

The goal of transition to green economy greatly contribute to the development of green finance. Existing literature suggests that green finance is the best financial strategy to reduce CO₂ emissions (Meo & Abd Karim, 2022), while the development level of green finance directly affects the allocation efficiency of funds in the field of green economy. Many studies have focused on investigating the driving factors of the development of green finance. (Coulson, 2003). found that the development of green finance is influenced by multidimensional factors. According to the OECD report in 2007, financial support and foreign environmental factors are important for the development of green finance ("Trends in Environmental Finance in Eastern Europe, Caucasus, and Central Asia (EECCA)", OECD, 2007). By combining the development features of China's green finance, (Zeng et al., 2014), as well as (Fu & Peng, 2020), studied the influencing factors of green finance's development from the perspective of index system construction. They showed that the development of green finance was directly affected by five factors: green credit, green insurance, green investment, green securities and carbon finance (Zhang et al., 2018) used DEA and entropy method to measure the development level of green finance of enterprises in China. It is worth noting that although the existing literature on evaluating the development level of green finance is abundant, most of them use entropy method to calculate the content of green credit, green fund, *etc.* However, the development of green finance is also influenced by market popularization and policy promotion. Evaluating these factors can gain deep insight into the correlation between local green finance and local financial capacity, macro-economic development level and ecological environment quality, and may make the development blueprint of green finance more reasonable.

2.2 Influencing factors of the green finance development

2.2.1 The level of economic development and green finance

There is positive relationship between the level of economic development and green finance development, i.e., the higher the level of economic development, the stronger the awareness and ability of propelling green finance development. An important indicator to measure the development level of green finance is to test the change of social expenditure (Lyeonov et al., 2019). (Yin & Xu, 2022) found that the development of green finance had obvious synergy with economic growth through the coupling coordination scheduling model (Ren, 2020) suggested that the level of economic

development will have an impact on the efficiency of green finance, that is, the higher the level of economic development, the higher the level of green finance in the region. Similarly, based on 30 Chinese provinces, (Zhang, et al., 2022), showed that industrial structure and level of economic development positively affect the coordination of green finance and environmental performance.

2.2.2 Industrial structure and green finance

Industrial upgrading and optimization can effectively promote green development (Zhu et al., 2019) found that upgrading industrial structure in China had a positive impact on the efficiency of green development by using the measurement of industrial structure adjustment, the measurement of super-efficient bad output and the panel regression model. By employing system GMM model, (Wang & Wang, 2021), found that the tertiary industry had the strongest correlation with the development of green finance, followed by the primary industry and the secondary industry. (Zhao, 2022). used DEA method to measure regional green innovation efficiency from input and output aspects. Their results provided evidence that industrial structure had a significant impact on green innovation efficiency in three regions of China.

2.2.3 Government support and green finance

After the government contributes to guide the market capital, it can leverage social capital to participate in the development of green finance. Renewable energy spending can have a clear policy-driven impact on the development of green finance (Mngumi et al., 2022). (Ikram et al., 2019) did literature review and showed that few scholars studied the relationship between government expenditure and green development. In this part of the research, (Feng et al., 2022), found that government support had a positive and significant impact on the performance of green economy from the perspective of the state. Environmental investments by local governments not only mitigate the negative effects of green credit policies on radical innovation, but also promote the positive effects of green development (Zhang et al., 2022a).

2.2.4 Green innovation and green finance

Green technology innovation is the preferred instrument to achieve green economic growth, and green financial development can positively regulate the sensitivity between the two (Dong et al., 2022). Through the analysis of Asian countries, (Tolliver et al., 2021), found that the adaptability of each country in green patent registration, green bond issuance and green investment will affect the process of the country's transition to sustainable development mode (Du et al., 2021) stated that the financing constraints faced by enterprises in green innovation are an important driving force to improve the green financial policy when taking the listed companies in China as the research object. Later, (Ali et al., 2022a) deepen their research on Chinese companies and conclude that green innovation has a positive mediating effect on the relationship between TI environmental performance and clarify the transmission mechanism between green innovation and green development. It is thus clear that green finance has become the main propellant of green development, and scholars such as (Yang et al., 2022) considered that green innovation has become the key method.

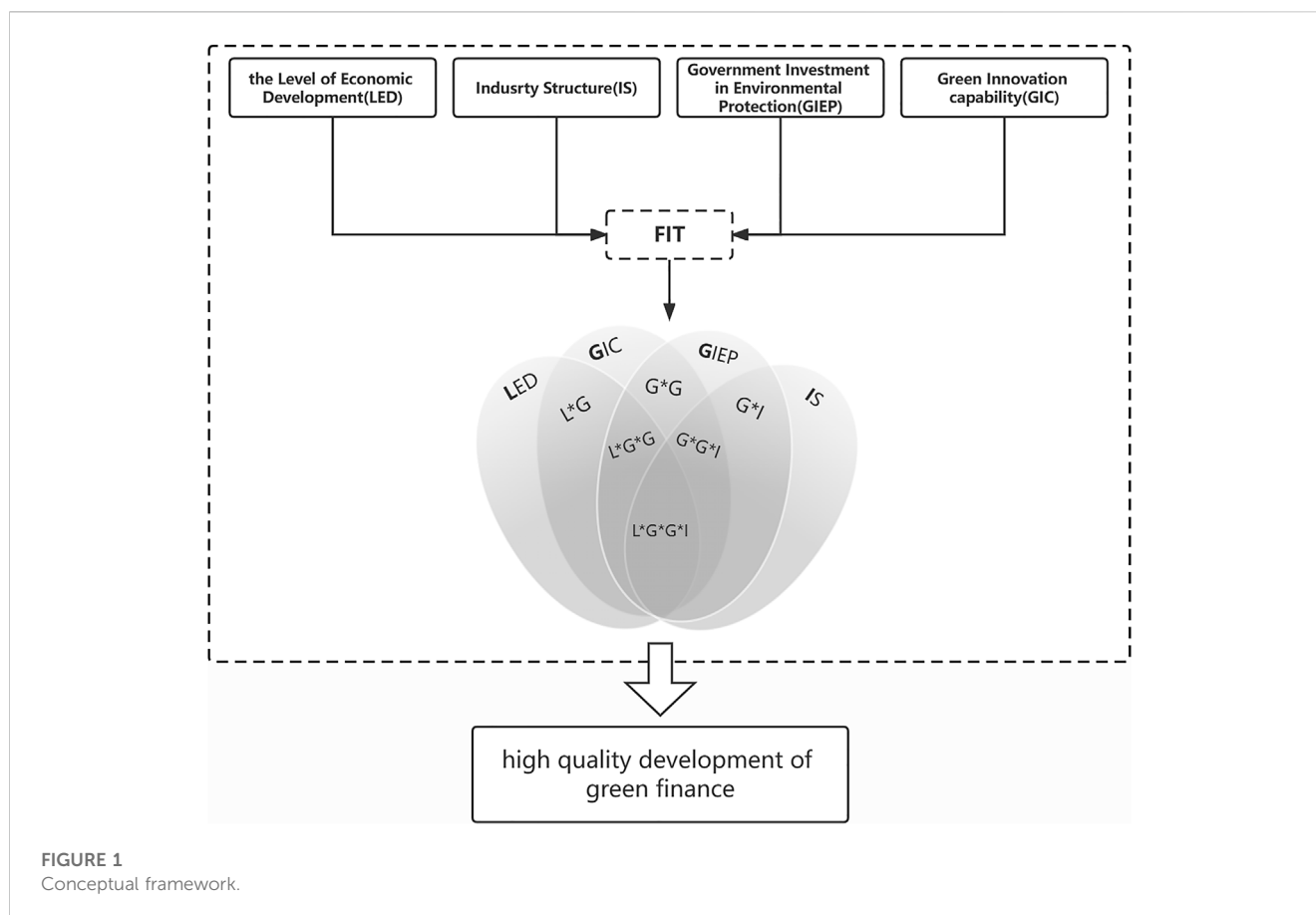
Green finance is of irreplaceable importance to the country. According to existant literature, we can form a clear understanding of the research framework of green finance. However, most studies focusing on the influencing factors and development paths of green finance are mainly based on quantitative research, and use the degree of influence as a proxy for the development level of green finance. Few scholars combine qualitative and quantitative research on how various factors work jointly to promote green finance. Although there are some studies on the development of green finance in North America and East Asia, research on the development model of green finance in China remains limited. Therefore, this paper employs fuzzy-set qualitative comparative analysis method and use development level of green finance as the outcome variable, and taking the level of economic development, industrial structure, government investment in environmental protection, and green innovation capability as the explanatory variables for configuration analysis, with the aim of exploring how each of these factors affects the development level of green finance (Zhou, 2022). Figure 1 illustrates the framework of this research.

3 Methodology

3.1 Fuzzy-set qualitative comparative analysis

We used a combination of qualitative and quantitative methods, focusing on the analysis of the degree of correlation among various factors. Namely, which factors will significantly improve the level of green finance and which factors will adversely affect the level of green finance in the process of regional economic development. The development of green finance is often the result of multiple factors, not caused by a single factor, therefore, it is reasonable to adopt the fuzzy set qualitative comparative analysis method when studying the drivers of green finance development. This method integrates the advantages of traditional qualitative analysis and quantitative analysis, and is a research method beyond qualitative analysis and quantitative analysis (Ragin & Ragin, 2014).

The qualitative comparative analysis method imposes some constraints on the sample size. The sample size is preferably in the range of 10–60 (X.-m. Zeng & Dai, 2020). In addition, there are three variants of QCA method, separately for csQCA (crisp set QCA), mvQCA (multi-value QCA) and fsQCA (fuzzy-set QCA) (Pappas & Woodside, 2021). The fsQCA method jumps out of the limitation of mvQCA and csQCA, the variable is no longer binary, but an arbitrary value in the range of 0–1. fsQCA has attracted more and more attention because of this feature (Xiong & Sun, 2022) used the panel data of 34 provinces in China to explore the mixed effects of green finance on carbon dioxide emissions through fuzzy-set qualitative comparative analysis (Peng & Hou, 2020) take the panel data of 29 provinces, regions and municipalities as the research samples, and use the fuzzy-set qualitative comparative analysis method to investigate the condition configuration and path that affect the improvement of regional innovation capability. These studies all make good use of fuzzy-set qualitative comparative analysis method to study the mechanism and path of the interaction of multiple factors on the results.



The reasons for adopting fuzzy-set qualitative comparative analysis method in this paper are as follows: Firstly, this method is suitable for small samples' data analysis. We use the data of development level of green finance from 30 provinces in China in 2020, the number of samples thus meets the requirements of fuzzy-set qualitative comparative analysis method. Secondly, the improvement of the development level of green finance is the consequence of the multifaceted interaction enhancement, and the influencing mechanism is complicated. Using fuzzy-set qualitative comparative analysis, we can determine the configuration by comparing different cases, sort out the configuration and core conditions for realizing the high-level development of green finance, and provide reference for the development of green finance in each area.

3.2 Data and descriptive analysis

3.2.1 Data

Green financial development level: The International Research Institute of Green Finance in Central University of Finance and Economics released the Local Green Financial Development Index and Evaluation Report (2020) in 2021, in which the Green Financial Development Index objectively evaluated the developing status of green finance in provincial administrative regions, and it has strong authority and representation in China. Therefore, this paper takes the 2020 China Local Green Finance Index published by this institution as the outcome variable.

Based on the existing research, this paper uses economic development level, industrial structure, financial support and regional innovation capability as explanatory variables. On the level of economic development, most of existing studies use *per capita* GDP to measure economic growth. As the studies of (Surugiu & Surugiu, 2012; Lyeonov et al., 2019), this paper uses the *per capita* GDP of each region to represent the local economic development level; In terms of industrial structure, this paper drawing on the research of (Ren & Zhu, 2017), and constructs $industry = O + 2T + 3R$ as the industrial upgrading index system to measure it, where O is the proportion of the added value of the primary industry to the regional GDP, T is the proportion of the added value of the secondary industry to the regional GDP, and R is the proportion of the added value of the tertiary industry to the regional GDP; In the aspect of government investment in environmental protection, we borrowed from (Zhou, 2022), and measures government investment in environmental protection by the provincial fiscal expenditure on energy conservation and environmental protection.; In terms of green innovation capability, we take a cue from (Scarpellini et al., 2019) and (Yu et al., 2021), and take the number of green patents in each province as the green innovation index. Table 1 explains the variable names as well as the definitions.

This paper takes 30 provinces, autonomous regions and municipalities as the research objects (Tibet was excluded due to serious data deficiency). The data of the green financial development level score of the outcome variable comes from the Evaluation Report of China Local Green Financial Development Level

TABLE 1 Description of variables.

Variable	Index description
Level of economic development	Per capita gross domestic product (GDP/population)
Industrial structure	$industry = O + 2T + 3R$
Government investment in environmental protection	Fiscal expenditure on energy conservation and environmental protection
Green innovation capability	Number of green patents each province

TABLE 2 Descriptive statistics.

	Number of observations	Mean	Standard deviation	Min	Max
Green finance level	30	32.804	11.661	17.38	57.1
Level of economic development	30	65982.04	29330.68	31336.1	140211
Government investment in environmental protection	30	230.968	140.345	54.32	746.19
Industrial structure	30	2.429	0.108	2.307	2.806
Green innovation capability	30	28.086	10.838	18.14	59.49

(2020), considering the time lag of the impact of each explanatory variable on the development of green finance, we use the data of the *per capita* GDP data, industrial structure data, financial expenditure on energy conservation and environmental protection, and green patent data in 2018 for observation, and the above information is obtained from the statistical yearbook of each province, autonomous region and municipality directly under the central government.

3.2.2 Descriptive analysis

Next, the specific situation of each region in green financial development will be analyzed, and the descriptive statistics of each variable data are shown in Table 2.

From the table, we can see that the green financial development scores of each province are comparatively low, and the values of green innovation capability and government investment in environmental protection are low, but level of economic development and the industrial structure are high, which indicates that the green financial development in China is still in the initial stage, and at this stage, although the economic development level is high in all parts of China, the economy is mainly dominated by the secondary industry, and the development of the secondary industry has not stimulated the vitality of green innovation. Government investment in environmental protection has not played a good role in escorting the green development process.

3.2.3 Calibration

This paper use the direct calibration method to calibrate the data, and set the fully subordinate degree, intersection point and fully non-subordinate point respectively to 0.75, 0.5 and 0.25 (Garcia-Castro & Francoeur, 2016). All data are calibrated to fuzzy subordinate values between 0 and 1. After calibration, a sample data occurs 0.5. If the retained value is 0.5, the data may be ignored in the subsequent operation. Therefore, this paper adopts the correction measure of adding 0.001 to the data (Fiss, 2011). Subordinate degree of each variable is shown in Table 3.

4 Results

In the process of configuration analysis, firstly, it is necessary to explore the relationship between the necessity and sufficiency of explanatory variable to the outcome variable. The judgment of necessity relationship is measured by consistency, if the consistency is greater than 0.9, it is considered that this variable is a necessary condition for the occurrence of the outcome variable (Morgan, 2010). If the variables pass the consistency test, the coverage test is conducted to measure the degree of explanation of a single variable to the outcome variable. The higher the interpretation degree, the higher the coverage.

The explanatory variables of this paper are analyzed by necessity conditions, and the results are shown in Table 4. It can be found from the figure that the consistency of the four antecedents is less than 0.9. It can be seen that the four antecedents of economic development, industrial structure upgrading, government financial support for energy conservation and environmental protection and regional innovation capability are not necessary conditions for the development of green finance, so the development of green finance is the result of the interaction of many variables. Therefore, the explanatory variables of this paper are not absolutely necessary for the outcome variable, so further configuration analysis is needed to explore the influence degree of explanatory variables on the outcome variable.

In the configuration analysis, the truth table should be constructed first, and the fuzzy subordinate value between 0 and 1 should be converted into a clear value of 0 or 1. This paper uses fsQCA software to analyze the data. Since the number of cases in this paper is 30, the frequency is set to 1, and the consistency threshold is set to 0.7. The PRI consistency threshold is set to 0 by referring to (Patala et al., 2021). Three solutions can be obtained through conditional configuration analysis, namely, complex solution, median solution and simple solution. The median solution lies between the simple solution and the complex solution, and contains the logical remainder which accords with the theoretical direction and empirical evidence. Therefore, this paper adopts the median solution as the first choice for configuration

TABLE 3 Fuzzy-set membership calibrations.

	Fully subordinate degree	Intersection point	Fully non-subordinate point
Green finance level	35.928	31.265	28.848
Level of economic development	74275.975	53521.4	125586
Industrial structure	2.453	2.404	2.634
Government investment in environmental protection	278.985	208.11	258.92
Green innovation capability	29.115	24.335	20.98

TABLE 4 Set-theoretical necessity analysis.

Explanatory variable	Consistency	Coverage
Level of economic development	0.582311	0.625520
~ Level of economic development	0.510007	0.507060
Industrial structure	0.591349	0.619337
~ Industrial structure	0.477728	0.486522
Government investment in environmental protection	0.636540	0.649539
~ Government investment in environmental protection	0.446094	0.46262
Green innovation capability	0.679794	0.691853
~ Green innovation capability	0.382828	0.401218

Note: ~ sign refers to the absence of the condition.

TABLE 5 Configurations for achieving quality development of green finance.

	High performance path		
	H1	H2	H3
Level of economic development	⊗		●
Industrial structure		●	⊗
Government investment in environmental protection	●	●	⊗
Green innovation capability	●	●	●
Consistency	0.877	0.843	0.797
Original coverage	0.245	0.434	0.088
Unique coverage	0.125	0.312	0.041
Typical case of coverage	Anhui, Sichuan	Beijing, Guangdong	Fujian
Consistency degree of overall solution	0.820		
Coverage of overall solution	0.609		

Note: ● = core condition (present); ⊗ = core condition (absent); ● = peripheral condition (present); ⊗ = peripheral condition (absent); blank space = the conditions may be present or absent. The size of the expression symbol for the presence and absence of the core condition should be twice the size of the expression symbol for the presence and absence of the peripheral condition

analysis, and the simple solution is used as an auxiliary explanation. If a variable appears in the median solution and the simple solution at the same time, it is considered as the core condition. The configuration analysis results are shown in Table 5.

As can be seen from the table, under the interaction of economic development, industrial structure, government

investment in environmental protection and green innovation capability, three pathways of high green financial development level are generated, with the consistency of 0.877, 0.843 and 0.797 respectively, and the consistency of the overall solution reaches 0.820. The consistency of two of three pathways is greater than 0.8, which satisfies the sufficiency analysis conditions,

indicating that most pathways are sufficient conditions for the formation of high green finance development level.

Specifically, configuration 1 (~ economic development level * government investment in environmental protection * green innovation capability) means that with a large number of regional green patents and favorable technical support, the province may have a high level of green finance development, regardless of whether the local industrial structure is upgraded or not, even if the regional economic development level is not in the forefront of the national ranking. It is a “capital investment-innovation-driven” high green financial development path. This path covers 11.5% of the provinces, and the representative provinces are Anhui and Sichuan. Configuration 2 (industrial institution * government investment in environmental protection * green innovation capability) means that when government provides sufficient financial support for the region, well-matched industrial structure upgrading and regional innovation capability can lead to a high development level of green finance. Industrial structure transformation and upgrading play an important role in reducing greenhouse gas emissions, and is one of the key methods to achieve the carbon peaking and carbon neutrality goal. This pathway indicates that the development of green finance depends on the interaction of three factors: industrial structure upgrading, government financial support and regional innovation capability. This path covers 31.2% of the provinces, which is the main path to realize the development of green finance in all provinces of China. The representative provinces are Beijing and Guangdong. Configuration 3 (economic development level * ~ industrial structure upgrading * ~ government investment in environmental protection * green innovation capability) means that when a region forms a high level of regional innovation capability with the assistance of economic development, a high level of green financial development can be generated even if the industrial structure is not upgraded and the government’s financial expenditure on energy conservation and environmental protection is lacking. It is an “economic development-innovation-driven” high green finance development path. The coverage rate of this path is 4.1%, and the typical province is Fujian.

In a word, through the research results, it can be found that no explanatory condition is sufficient in itself to achieve high performance in the process of green finance development. There are three different pathways in the analysis of green finance development in 30 provinces and cities of China. In order to better understand these pathways, the next part tries to give a deeper understanding through the combination of theory and practice.

5 Discussion

5.1 Empirical applications

Green finance development displays significant heterogeneity among the provinces and regions in China. While some provinces and cities, such as Jilin and Tibet, have struggled to keep up, others have made notable progress in policy promotion and market effectiveness evaluation. Although all regions are moving towards green finance development, they have achieved varying levels, of

development, which reflect their distinct regional characteristics. Moreover, the analysis indicates that there are no certain conditions for improving the green finance development level. Based on the above findings, the following propositions are proposed.

Proposition 1: The deep integration of economic development and green innovation capability is conducive to promoting the development process of green finance and providing preferable technical support for the high-performance development of local green finance.

A comparative analysis of the three high development pathways of green finance shows that green innovation capability appears in all configurations and is the core condition which indicates that green patent application has a great influence on the development level of green finance. Under the condition that multidimensional factors work together to promote the development of green finance, increasing the number of green patent applications plays a more important role. In the past ten years, Fujian is the fastest economic growing province in China. In 2010, Fujian’s economic development level ranked 12th among all provinces in China. After ten years of development, Fujian’s economic development level has reached 7th place, providing a stable economic foundation for the development of green finance. During the “Thirteenth Five-Year Plan” period, Fujian gradually transformed into a supporting intellectual property province, and took the lead in exploring the related work of green patent development in the whole country. It was recognized by the State Intellectual Property Office as one of the ten provinces in the country to carry out green patent pilot work. Under the background of “carbon peaking and carbon neutrality goals”, the application of green patent can promote the improvement and replacement of traditional technologies, promote the research and development of cleaner production processes, and create favorable conditions for the development of green finance as well as energy conservation and emission reduction.

Proposition 2: The deep integration of industrial structure upgrading and government investment in environmental protection will improve the environment of local green finance development and provide the capital elements needed for the high-performance development of local green finance.

It can be found that government investment in environmental protection exists in two configurations, which indicates that government financial support for energy conservation and environmental protection has a significant effect in promoting the high development of green finance, and the government plays a leading role in the process of achieving the “carbon peaking and carbon neutrality goals”. Financial expenditure for energy conservation and environmental protection can reduce the production and operation costs of local enterprises, increase the enterprises’ operating profits, and help improve the development level of green finance. It is “industrial upgrading-innovation-driven” path of high development of green finance. Take Guangdong province as an example. In 2019, Guangdong gave full play to the leading role of the government and issued the Decision on Promoting Industrial Structure and Labor Transfer, which reflected the importance attached to the upgrading of industrial structure. Guangdong Department of Finance helps

the development of green finance through financial measures such as increasing clean energy credit support and reducing the cost of green bonds issuing. The overall layout of green patent technology in Guangdong is elaborate. The “green and low-carbon” industry includes three major fields: new energy automobile industry, new energy industry as well as energy conservation and environmental protection industry. Among the three major fields, Guangdong’s patents account for more than 50% of the national patents, forming a dense green patent application atmosphere and promoting the development of green finance in Guangdong in many aspects.

Proposition 3: The explanatory configuration to realize the high-performance development of green finance is not unique, and there is a certain degree of substitutability among similar conditions.

The empirical results show that there are three pathways of high-performance development of regional green finance, hence, it shows that the path of high-performance development of green finance is not single. Each region should deeply analyze the local basic resources, choose different pathways of green finance development according to reality, and implement the differentiation strategy of green finance development.

We use fuzzy set qualitative comparative analysis to examine the drivers of green finance development in 30 provinces (autonomous regions and municipalities directly under the central government) in China, and we find that none of the four variables is necessary to constitute high-quality development of green finance, but in the group analysis, we obtain three paths of green finance development, and different regions can choose the green finance development path with the highest matching degree according to the actual local situation. Comparing and analyzing the three paths, we can know that the deep integration of economic development and green innovation capacity will provide good technical support for local green finance high performance development, and the deep integration of industrial structure upgrading and government investment in environmental protection will provide the capital elements needed for local green finance high performance development. This paper presents an in-depth analysis of the driving factors and development paths of green finance, and the results of the study will help all parties in society understand the current situation of green finance development and grasp the improvement direction of green finance development.

6 Conclusion

This study uses fsQCA to evaluate the influence of four variables. They are the level of economic development, industrial structure, government investment in environmental protection and green innovation capability. Using data from 30 provinces, autonomous regions and municipalities directly under the central government in China, we draw the following conclusions: (1) No variable alone in the four dimensions is a necessary condition to the development level of green finance, which is still valid after the robustness test. (2) Through configuration analysis of four variables, the three paths are the sufficient conditions for improving the development level of

green finance. At the same time, various configurations also show that the factors driving the development of green finance have diversity and synergy.

Having concluded that, the government needs to emphasize the following points in the process of promoting the quality development of green finance. First, enhance regional innovation capability. The government should fully explore local characteristics and apply for green patents to develop clean and green projects. Second, give play to the leading role of the government. Provinces should strengthen the leading role of the government in promoting the development of green finance, and formulate reasonable fiscal expenditure plans according to local actual conditions. Third, implement a differentiated development strategy. All regions should deeply analyze the local basic resources, combine different realistic conditions to choose different green financial development paths and implement differentiated strategies for green financial development.

The main contribution of paper is that, different from the single qualitative and quantitative analysis in the existing literature, we apply a fuzzy-set qualitative comparative analysis method to explore the extent to which the level of economic development, industrial structure, government investment in environmental protection and green innovation capability on the development level of green finance, and design the development pathways of green finance according to different development levels.

Like many studies, this study inevitably has some shortcomings which need to be solved in future studies. On the one hand, this study can only discuss the limited antecedents so as to seek the balance between the number of conditions and cases due to the limitation of the number of cases. Future research can combine more theoretical perspectives to explore other antecedents, and further enrich the existing research framework with a large number of cases. On the other hand, although QCA method is used to study how to improve the development quality of green finance in various regions, the research angle is relatively macro, and it still remains unknown how micro-subjects such as enterprises and financial institutions help green finance development. In the future, we can combine other research methods to explore how each micro-subject participates in the development of green finance and further improve the research perspective.

Data availability statement

The original contributions presented in the study are included in the article/[Supplementary Materials](#), further inquiries can be directed to the corresponding author.

Author contributions

HW: validation, writing—review and editing, supervision, project administration, funding acquisition JL: Formal analysis, investigation, data curation, writing—original draft ZH: Conceptualization, methodology.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fenvs.2023.1145671/full#supplementary-material>

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