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Effects of Green Finance Pilot Policies on Regional Green Development: An Experiment Based on Data from Four Provinces

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Abstract. Against the backdrop of the in-depth implementation of China's sustainable development strategy, green finance plays an essential role in advancing regional ecological governance. Based on the panel data of Zhejiang, Guangdong, Anhui and Henan provinces from 2015 to 2023, this paper conducts an empirical analysis with the rollout of green finance pilot zones in 2017 as the standard natural experiment and completes the robustness test by eliminating control variables and samples from the initial stage of the policy. Research shows that the pilot policies of green finance have significant positive governance effects, can optimize the regional green fund allocation structure, and help the pilot areas build a new green development model. In non-pilot areas, due to the absence of policies, weak economic and industrial foundations, there are problems such as single funding channels, rigid development models, and low levels of marketization. The imbalance in regional green finance development is significant. This study clarifies the practical value of the pilot policies and regional development differences, providing empirical support and decision-making references for improving the local green financial system and promoting regional green and high-quality coordinated development.

Keywords: Pilot policies for green finance, regional green development, fund disposition, regional difference, difference-in-differences model

1. Introduction

Under the dual carbon goals, low-carbon transformation has emerged as the core threat of China's economic development. The coordinated advancement of ecological governance and industrial upgrading cannot do without the precise empowerment and financial support of the financial system. Green finance, as an important tool to guide social capital towards sustainable development and correct the high energy use and heavy pollution development model, is a core approach to resolving the contradiction between regional ecological protection and economic development and promoting the green transformation of industries. To systematically promote the standardized and market-oriented development and make up for the shortage of regional green development funds, China has implemented green finance pilot policies in batches since 2017. Through institutional innovation, it has optimized the allocation mechanism of green funds and gradually changed the traditional green

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development model that relies on fiscal input, injecting new impetus into the green and low-carbon construction of various regions. At present, green finance pilot policies have been implemented in many places, but there are obvious differences in their regional implementation effects. The green development paths, the efficiency of fund allocation, and the level of market-oriented development between pilot and non-pilot regions differ markedly. The imbalance in regional green finance development is becoming increasingly prominent. Existing scholarship primarily explores the comprehensive influences of green finance. The detailed research on quasi-natural experiments of the pilot policies in 2017 and the analysis of regional differentiation shortcomings still need to be supplemented, making it difficult to precisely meet the actual needs of regional coordinated green development. Therefore, this paper takes panel data of Zhejiang, Guangdong, Anhui and Henan provinces (2015-2023) as sample, and regards the pilot initiative in 2017 as an external institutional shock. The difference-in-differences method is employed to test policy outcomes, alongside a systematic comparison of green development performance between polit and non-polit regions. By clarifying the mechanism by which policies empower regional green development and analyzing the core causes of the imbalance in regional green finance development, it is expected to enrich the empirical research results of green finance policies, and provide practical theoretical references and practical basis for optimizing the allocation of regional green finance resources, narrowing the gap in regional green development, and promoting the green and high-quality coordinated development of all regions.

2. Literature review

Under the backdrop of the "dual carbon" goals and high-quality economic development, green finance has become a core tool for promoting green innovation, optimizing resource allocation, and achieving coordinated development of ecology and the economy. A large number of researchers across the globe have explored relevant topics thoroughly, like transmission paths, regional differences and micro-impacts of green finance, and have formed relatively rich theoretical and empirical achievements.

In terms of policy effects, multiple studies have taken the pilot projects of green finance in China as quasi-natural experiments and used DID approach to confirm that the policies have a significant positive effect. It was found green finance pilot programs have a stronger incentive impact on regional green innovation [1]. It is pointed out that the pilot policies expand the financing volume of green firms and exert a reverse pressure effect on the green innovation of heavily polluting enterprises [2]. Meanwhile, it was found that green finance policies can reduce the debt financing costs of enterprises with high ESG ratings, highlighting the financing adjustment function of policies on micro-entities [3].

In terms of the mechanism of action and mediation pathways, existing research has revealed multi-level transmission channels. Studies have reached a consensus that green innovation can be effectively stimulated by green finance through improving industrial layout, driving economic development and expanding R&D input [1]. Multiple studies have shown that green finance facilitates high-quality economic development by stimulating technological innovation and industrial structure upgrading and propose that financial technology innovation promotes green growth through green credit and green investment as intermediaries [4, 5]. Another study has found that green finance can enhance the investment level of renewable energy enterprises, but excessive financing constraints will weaken this effect [6]. In addition, green finance is capable of promoting green total factor productivity in an indirect manner through financing structure optimization and capital flow guidance [7].

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In terms of regional and subject heterogeneity, the research shows obvious differentiation characteristics. Fintech and green finance exert a stronger driving effect on green growth in eastern areas relative to China's inland underdeveloped regions [5]. For central and western regions, green finance delivers a stronger driving force for high-quality economic development compared with other areas [8]. Green credit yields a stronger facilitating effect on green innovation for large enterprises, but it imposes constraints on private firms and SMEs [9]. Overall, the effect of green finance is influenced by economic levels, policy coverage, property rights nature and scale differences, showing significant regional and enterprise heterogeneity.

In terms of expanding the research perspective, some literature has extended to fields such as renewable energy and sustainable development, confirming that the advancement of green finance effectively boosts renewable energy expansion [10]. Incorporating eco-friendly finance and financial development into a unified framework has enriched the research system of green productivity [7].

Based on this, this paper selects panel data from Zhejiang, Guangdong, Anhui and Henan provinces, and takes the 2017 green finance pilot as the standard natural experiment to systematically test the net effect of policies, regional differences and restrictive factors, analyzes the differences in green fund allocation between pilot and non-pilot regions, further enriches the empirical research on green finance policies, and provides empirical support for regional green coordinated development.

3. Research design

3.1. Sample selection and data sources

This study empirically examines the policy effects utilizing provincial-level panel data covering the period 2015–2023. Combined with the launch of the 2017 green finance pilots, Zhejiang and Guangdong, the two pilot provinces, are selected as the treatment group, while Anhui and Henan, which have similar development conditions but did not participate in the pilot, are selected as the control group. This article defines the period from 2015 to 2016 as the pre-implementation period and the period from 2017 to 2023 as the later stage. All research data was sourced from the official database of the National Bureau of Statistics. After data cleaning, verification and organization, 36 complete and valid observation samples were finally obtained, with no missing data, which can effectively support this empirical research.

3.2. Variable definition

This paper classifies its empirical variables into three main types, and the specific setting methods are as follows.

The explained variable is the level of green fiscal input (GF), which is measured by the proportion of local environmental protection fiscal expenditure to regional GDP. It is used to reflect the fiscal input intensity of local governments in ecological and green construction and embody the characteristics of regional green development.

The core explanatory variable is the difference-in-differences interaction term (Treat×Post). Among them, the grouping dummy variable (Treat) is used to distinguish sample groups. Regions implementing the green finance pilot policy are defined as 1, and other provinces are set to 0. Post is used to identify the policy implementation stages. This dummy variable equals 1 for observations in 2017 and beyond, and 0 for 2015-2016. The interaction term obtained by multiplying the two is used to measure the net effect of the policy.

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To control the interference of regional individual differences on the empirical results and ensure the fitting accuracy of the model, this paper introduces three control variables: Per capita gross domestic product (Pgdp) measures the region's overall economic development level; The degree of government intervention is characterized by the share of local fiscal general public spending in regional economic output. Industrial structure is quantified using the proportion of value added by the tertiary industry in regional GDP.

3.3. Specification of model

To accurately calculate the net effect of the implementation of policies and eliminate the interference of individual differences and time trends, this paper constructs a DI model suitable for this study. The specific formula is as follows:

$$GF_{it} = \beta_0 + \beta_1 Treat_i \times Post_t + \beta_2 Pgdp_{it} + \beta_3 Gov_{it} + \beta_4 Indus_{it} + \mu_i + \varepsilon_{it} \quad (1)$$

In the formula, GF it represents the green fiscal input level of each province in each year, Treat i×Post t is the core interaction term of the policy, μ i represents the fixed effect of the province, ε it is the random disturbance term of the model, and the core coefficient β 1 is used to determine the actual net effect of the policy.

4. Empirical analysis

The analysis in this chapter relies on panel data from four provinces for the years 2015-2023, taking the 2017 green finance pilot reform as the benchmark natural experiment, and completing the empirical analysis by combining independent sample t-tests and difference-in-differences models. Through inter-group horizontal difference comparison, benchmark regression analysis, exploration of restrictive factors and multiple robustness tests, the effectiveness of the pilot is empirically and systematically confirmed, the causes of the differences between pilot and non-pilot provinces were analyzed, and the two core research questions of this paper were answered.

4.1. Empirical testing and result analysis

4.1.1. Inter-group difference t-test

To visually compare the basic differences in green construction between pilot and non-pilot provinces, this paper divides the samples into two stages: the policy early stage (2015-2016) and the policy late stage (2017-2023) and conducts independent sample t-tests respectively.

From the test results, before the policy was implemented, the average green fiscal input of the pilot provinces was 0.00374, that of the non-pilot provinces was 0.00497, and the two-tailed P-value was 0.0010. There were significant differences between the two groups of samples, which could reflect the inherent differences in the green development models between the coastal pilot provinces and the inland non-pilot provinces. After the policy was implemented, the average value of the pilot group was 0.00386, that of the control group was 0.00520, and the two-tailed p value was 0.0184. The differences between the groups remained significant.

As reflected in the data, the share of green fiscal input remains lower in pilot provinces compared with non-pilot provinces. However, this difference does not mean that the green development level

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of the pilot regions is lower but rather stems from the substitution of fiscal input by market-oriented funds of green finance. Based on the actual development situation, the GF indicator only counts the green investment from the government's fiscal end. In non-pilot areas, there is a lack of a mature market-oriented green investment and financing system. Ecological governance and environmental protection construction basically rely on the government's fiscal guarantee, so the proportion of fiscal green investment is relatively high. In contrast, the pilot provinces have leveraged market-oriented funds such as social capital and green credit to participate in green construction. By using market-oriented tools like green credit and green bonds to replace fiscal funds, they have reduced the government's burden and achieved sustainable investment, thus forming a more mature and sustainable market-oriented green development model.

4.1.2. Benchmark regression analysis

To isolate confounding factors and accurately estimate the net policy effect, the benchmark difference-in differences regression is adopted. According to the regression results, the coefficient of the core interaction term is 0.00140, and the P-value is 0.046, which is significantly positive at the 5% significance level. This indicates that the green finance pilot has significantly improved the regional green development level. The goodness-of-fit R^2 of the model reaches 0.503, revealing a favorable overall fitting effect of the model. The empirical results have reference value.

Table 1. DID difference-in-differences

	Coefficients	standard error	t Stat	P-value
Intercept	-0.00445	0.004842	-0.91867	0.365359
Treat*Post	0.001401	0.000673	2.082558	0.045634
Pgdp	-0.00053	0.000214	-2.45488	0.019905
Gov	0.030311	0.015568	1.947079	0.060634
Indus	0.013726,	0.009447	1.452924	0.156293

As shown in Table 1, the green finance pilot policies implemented in 2017 have achieved good positive implementation effects. After the policy was implemented, the pilot provinces effectively optimized the local green construction fund allocation structure, broke away from the previous single governance model that relied entirely on fiscal appropriations, and supported ecological construction and green industry development with the help of a market-oriented green financial system, truly exerting the policy's enabling value.

As revealed by the estimated results of control variables, the coefficient corresponding to per capita GDP is negative at a statistically significant level, suggesting that regions with higher economic development possess larger market-oriented capital reserves, and the government's reliance is less dependent on green fiscal input. The coefficient of government intervention is positive and statistically significant at the 10% level, which means fiscal expenditure serves as the main pillar of green governance in non-pilot areas. The industrial structure coefficient is not significant, indicating that the tertiary industry has not yet provided significant support for the allocation of green funds. This suggests that within this sample period, the development of the tertiary industry has not yet had a clear empowering effect on the allocation of regional green funds.

Based on the results, the first research question can be answered: Green finance pilot policies have proven to be highly effective in implementation, which can effectively optimize the regional green fund allocation structure and upgrade the green development model. However, the problem of

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unbalanced regional green development in China is prominent, and non-pilot areas without policy support have obvious development shortcomings.

4.1.3. Restrict factor analysis

Combining the benchmark regression data and the characteristics of inter-group differences, this paper further sorts out the core constraints of the rigidification of green construction models in non-pilot provinces and completes the empirical analysis of the second research question.

First, the weak regional economic foundation is a fundamental constraint. The per capita GDP has a significant negative impact on green fiscal input. The economic development levels of inland non-pilot provinces such as Anhui and Henan are relatively limited, and their market capital reserves are insufficient. The scale of local green industries is small, and they cannot spontaneously form a mature market-oriented green investment and financing atmosphere. It is difficult for them to independently complete green transformation and upgrading without government fiscal support.

Second, the core shortcoming lies in the rigid governance model and high reliance on fiscal revenue. Due to the lack of special pilot policies for green finance, non-pilot provinces have no complete market-based channels for supplementing green funds. All work such as ecological protection, environmental governance, and the cultivation of green industries is supported by local fiscal input. This has long led to a fixed development model of "fiscal guarantee and market absence", which not only increases the burden on local finances It also leads to a lack of sustainable impetus for regional green development.

Third, insufficient industrial support capacity is an important restrictive condition. The industrial structure variable is not significant, which can reflect that the development of the tertiary industry in non-pilot provinces lags behind relatively, and the volume of green service industries and low-carbon industries is insufficient. It is impossible to drive the development of the green financial market through industrial upgrading, and it is difficult to build a market-oriented green investment and financing system. Ultimately, this has restricted the process of regional green development.

Based on the above analysis, non-pilot provinces are constrained by multiple factors such as policy absence, weak economic foundation, and lagging industrial structure, resulting in slow development of green finance, single funding channels, and rigid governance models. This precisely responds to the second research question in this paper.

4.2. Robustness test

To verify that the results of this benchmark regression are not obtained by chance, to eliminate the interference of factors such as variable Settings and sample fluctuations on the empirical conclusions, and to ensure he accuracy and trustworthiness of the empirical findings, this paper, in combination with the characteristics of short-panel data, adopts two mainstream methods to conduct robustness tests: eliminating invalid control variables and reducing samples during the policy transition period, to provide dual guarantees for the stability of the empirical conclusions.

The specific results of the two groups of robustness tests are analyzed as follows.

As shown in Table 2, after eliminating the control variable of industrial structure, the model only retains two control variables, Pgdp and Gov, and the sample size remains at 36 groups. Estimation results reveal that the core interaction term Treat×Post is 0.00149, and the p value is 0.036, which is significantly positive at the 5% level. The significance of the remaining control variables was slightly optimized compared with the benchmark regression. The goodness of fit of the model was 0.469, and the fitting state was good. Overall, the symbols and significance of the core variables

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have not changed, with only the coefficient values fluctuating slightly. This proves that the model is not disturbed by redundant variables and the results are relatively stable.

Table 2. Excluding industrial structure control variables

	Coefficients	standard error	t Stat	P-value
Intercept	0.000506	0.003497	0.144828	0.885755
Treat*Post	0.001492	0.000681	2.190237	0.035909
Pgdp	-0.00032	0.000162	-1.96125	0.058601
Gov	0.034162	0.015604	2.18926	0.035986

As shown in Table 3, after excluding the samples from the early stage of the policy in 2017-2018, the sample size was reduced to 28 groups. It can be observed from regression results that the key interaction variable takes a coefficient value of 0.00152 and a p-value of 0.088. It presents a significantly positive effect at the 10% significance level, and its coefficient sign matches the benchmark regression perfectly. Due to the reduction in sample size, the significance slightly declined, but it still met the statistical significance criteria. All variables present coefficient signs and significance comparable to the baseline regression outcomes.

Table 3. Excluding the samples from the initial policy period of 2017-2018

	Coefficients	standard error	t Stat	P-value
Intercept	-0.00387	0.00563	-0.68738	0.498715
Treat*Post	0.001522	0.000853	1.784073	0.087612
Pgdp	-0.00051	0.000256	-1.98688	0.058974
Gov	0.026643	0.017484	0.141182	-0.00953
Indus	0.013284	0.010514	0.219074	-0.00847

Based on the results of the two sets of robustness tests, whether it is to eliminate the inefficient control variables or to delete the samples of policy transition period fluctuations, the core explanatory variables remain positively significant all the time, and no problems such as sign reversal or significance failure occur. This fully proves that the benchmark regression results of this paper are stable and effective.

Meanwhile, the slight decline in the significance of the initial sample test of the policy can also reflect that there is a certain lag in the green finance pilot policy. In the early stage of policy implementation, the market, enterprises and financial institutions were not well adapted to the new policy, and the effect of policy empowerment was limited. As the policies continue to be implemented and promoted, the market system is constantly improving, and the green empowerment effect of the pilot policies is gradually becoming prominent, further enriching the conclusions of this research.

By combining benchmark regression with two sets of robustness tests, it can be determined that the empirical results of the DID model in this paper are highly reliable. The policy can effectively optimize the green fund allocation model in the pilot areas and promote the market-oriented transformation of regional green governance. The lack of policy empowerment in non-pilot areas, coupled with the shortcomings in economic and industrial foundations, has led to the solidification of the green development model, further verifying the empirical conclusions of the two major research questions mentioned earlier.

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5. Conclusion

Based on the 2015–2023 panel data of Zhejiang, Guangdong, Anhui and Henan provinces, this paper regards the 2017 green finance pilot policy as a quasi-natural experiment and adopts the DID model and independent sample t-test to assess its policy effects. The results indicate that the green finance pilot policy significantly boosts regional green development, optimizes green fund allocation in pilot areas, and drives the transformation of regional green development from a single fiscal-dependent model to a diversified market-oriented model. In contrast, non-pilot regions suffer from policy gaps, weak economic foundations and backward industrial structures. Their green development relies heavily on fiscal investment, with drawbacks including single funding channels, rigid development modes and low marketization, leading to prominent regional green development imbalances. Robustness tests by removing control variables and initial policy-year samples verify the reliability of baseline regression results. Additionally, the policy presents a lagging effect with more prominent long-term benefits.

This study has three main limitations. First, sample selection bias exists: the treatment group covers developed coastal provinces while the control group consists of inland provinces, and large disparities in regional endowments and economic bases may interfere with the identification of policy net effects. Second, the limited sample size of 36 observational data sets weakens the model's statistical power and the universality of research conclusions. Third, the single indicator of environmental protection fiscal expenditure used to measure green development only reflects government investment intensity, failing to capture actual green development achievements with poor representativeness.

Future research can expand the provincial sample scope and match pilot and non-pilot regions with similar economic levels to mitigate selection bias. It can also construct a comprehensive evaluation system by incorporating multi-dimensional indicators such as green total factor productivity, carbon emission intensity and pollution control efficiency to improve measurement accuracy. Furthermore, adopting multi-period DID and synthetic control methods can precisely analyze policy heterogeneous effects, transmission mechanisms and regional difference causes, so as to provide solid empirical evidence for optimizing the green finance system and advancing coordinated, high-quality regional green development.

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