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Application and challenges of green finance in regional economic development

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Keywords:

Green finance, regional economic development, econometric modeling, policy effects, high-quality economic development.

This paper discusses the application and challenges of green finance in regional economic development, focusing on the differences and obstacles faced by Chinese regions in promoting green finance. The study explores the impact of green finance policies on the high-quality development of different regional economies by constructing an econometric model. Based on the pilot policy of Green Finance Reform and Innovation Pilot Zone launched in 2017, this paper empirically analyzes the panel data of 30 provinces and cities in China. The findings show that the application of green finance is more effective in the economically developed regions in the east, while the central and western regions are relatively lagging behind due to the limitations of financial resources and technology. This paper proposes policy recommendations to promote coordinated regional development in order to promote high-quality economic development on a national scale.

Introduction

Against the backdrop of global climate change and environmental protection, China faces a huge challenge in realizing its “dual-carbon” goal, which was explicitly proposed by General Secretary Xi Jinping in September 2020, i.e., to promote China's transition from “carbon peak” to “carbon neutrality”. In September 2020, General Secretary Xi Jinping clearly stated the “dual carbon” goal, which is to promote China's transition from “peak carbon” to “carbon neutral”. The introduction of this goal signifies that China will accelerate economic restructuring and develop a green and low-carbon economy through a series of policies and measures, with a view to realizing high-quality economic and social development. However, the difficulty of realizing the “dual-carbon” goal should not be underestimated. Therefore, how to support the transformation of a green and low-carbon economy through the innovation and development of green finance has become a key issue for China to realize high-quality development.

Since 2015, green finance research in China has been actively developed. Su Baomei [1] pointed out the necessity of green finance approach. Sun Guanglin [2] revealed that green loans can reduce bank risks. Zhang, Kexian & Wang, Yan & Huang, Zimei(2021) [8] and Hu, Y, Jiang, H, & Zhong, Z. [4] studied the impacts of green loans on renewable energy and industry. Wang [6] and Wang Tingting

investigated the role of green loans in reducing carbon emissions and improving information disclosure.

The report of the 19th CPC National Congress explicitly refers to green finance as an important tool for promoting green economic and social development, pointing out its key role in solving the problem of unbalanced regional economic development and promoting high-quality economic development. This includes not only how to effectively guide the flow of capital to green industries, but also how to formulate a scientific and reasonable policy system to ensure that the role of green finance in promoting economic transformation can be maximized.

Purpose of the work — The purpose of this paper is to discuss the application and challenges of green finance in regional economic development.

Job Objectives:

- Review existing theoretical frameworks on green finance, select a model suitable for the purpose of the current study and collect relevant data;
- Collect statistical information on the implementation of green financial policies in various regions in order to analyze their impact on economic development;
- Establishing analytical models to explore the mechanism and effects of green financial policies on the economic development of different regions.

Working hypothesis of the study: The promotion of regional economic development by the implementation of green finance policies is directly proportional to the region's economic base and environmental governance needs, as well as to the strength of policy implementation and the maturity of financial markets.

Materials and Methods

This paper adopts the research method of combining theoretical and empirical analysis. Based on the existing theories, panel data of 30 provinces and cities in China (except Tibet) from 2014 to 2020 were collected to construct a comprehensive index system, generate a regional economic high-quality development index by using principal component analysis, and conduct regression analysis of the pilot zone for green financial reform and innovation by using a double-difference model to validate the policy effect. Through this series of methods, we aim to comprehensively analyze the role of green finance in promoting the high-quality development of the regional economy and the challenges it faces, as well as to provide a scientific basis for policy formulation.

Main text

1. Influence Mechanism and Hypothesis Formulation

As an emerging financial model, green finance plays an important role in promoting high-quality economic development by integrating environmental protection goals and economic development goals. Its influence mechanism is mainly reflected in the following aspects:

(1) Financial support and capital optimization

Green credit and green bonds: Su Xiao (2021) points out that financial instruments such as green credit, green bonds, and green IPOs can effectively promote the development of environmental protection enterprises. These tools not only broaden the financing channels of environmental protection enterprises, but also enhance their capital strength and strengthen their investment capacity and market competitiveness. By providing low-cost financial support, green finance can promote enterprises' investment in environmental protection technologies and facilities, thus enhancing their operational efficiency and sustainable development capacity [7].

Direct support VS Indirect support: the study of Lin Dejian et al. (2018) shows that green finance, as a direct support method, is more effective in improving the support for environmental enterprises and achieving more significant results than indirect green credit support. This is mainly because green financial measures can more accurately buttress the needs of enterprises and provide more targeted support [8].

(2) Resource value assessment and allocation optimization

Resource assessment: Qiao Haishu (1999) suggests that the core of green finance lies in accurately assessing the environmental value of resources and making resource allocation and orientation adjustments based on the assessment results. Through scientific resource value assessment, green finance can effectively reflect the degree of resource waste and environmental damage, thus providing data support and scientific basis for green financial policies. This approach helps to take more environmental factors into account in resource allocation, thus realizing a win-win situation for both the economy and the environment [3].

(3) Balance between green development and environmental protection

Finding the balance point: Peng Zhengqin (2021) argues that in the pursuit of high-quality economic development, the key to green finance lies in finding a balance between the protection of the ecological environment and economic development. Green finance should not only support green production and consumption, but also ensure that the goal of environmental protection is realized along with economic growth. The realization of this balance requires the effective use of green financial instruments to promote economic development in the direction of green environmental protection [5].

Research hypothesis

Hypothesis 1: The implementation of green financial measures can significantly enhance the capital strength and technological innovation ability of environmental protection enterprises, thus promoting the high-quality development of their economy.

Hypothesis 2: The direct support method of green finance is more effective in supporting environmental protection enterprises than the traditional indirect support method.

Hypothesis 3: Accurate resource value assessment can optimize resource allocation, reduce environmental damage and improve the sustainability of economic activities.

Hypothesis 4: Green financial policies can effectively realize the balance between economic development and environmental protection, and promote the transition of the economy in the direction of green environmental protection.

Sample selection and data sources

In this paper, the panel data of 30 provinces in China (except Tibet) from 2014 to 2020 are selected as a research sample in order to analyze the impact of the pilot policy of green financial reform and innovation on the high-quality development of the economy. The data for the indicator system of high-quality economic development mainly come from the National Bureau of Statistics (NBS) and the statistical yearbooks of each province, while the data for the control variables mainly come from the NBS and the ESP data platform. For individual missing data, the moving average method was used to supplement.

Model selection:

$$\mathrm{development}_{it} = \alpha + \beta_1 \mathrm{treat}_i \times \mathrm{post}_t + \beta_2 X_{it} + \gamma_i + \mu_t + \varepsilon_{it}.$$

Among them:

- $\mathrm{development}_{it}$ denotes the level of high-quality economic development of province i in year t.
- treat_i is a group dummy variable that takes the value of 1 for the experimental group (Zhejiang, Jiangxi, Guizhou, Guangdong, Xinjiang) and 0 for the control group.
- post_t is a year dummy variable that takes the value of 1 for 2017 and subsequent years, and 0 for years prior to 2017.
- X_{it} is a matrix of control variables, including human , Internet, fiscal and fdi.

2. Testing the four hypotheses

(1) Hypothesis 1 — Adoption of Parallel Trend Test Steps

Setting up the test model: first, we set up a model

Table 1. Descriptive statistics of the main variables.

variant	observed value	average value	standard deviation	minimum value	maximum values
development	210	1.417	1.538	-1.538	5.442
treat × post post	210	0.0952	0.294	0	1
human	210	0.0211	0.00584	0.0100	0.0400
Internet	210	9.140	34.11	0.820	493.1
fiscal	210	0.217	0.118	0	0.450
fdi	210	0.268	0.113	0.120	0.750

that includes the time period before and after the implementation of the policy in order to test whether the trends between the test group and the control group before the implementation of the policy are parallel or not.

$$\text{development}_{it} = \alpha + \beta_1 \text{treat}_i + \beta_2 \text{post}_t + \\ + \beta_3 (\text{treat}_i \times \text{post}_t) + \gamma_i + \mu_t + \varepsilon.$$

Perform regression analysis: apply the above model to regress the panel data for 2014–2020, focusing on the estimated value of β_3 and its significance level. The charts are analyzed in Figure 1.

The estimated regression coefficients within the 95% confidence level presented in Figure 1 show that the estimated coefficients prior to 2017, the year of policy implementation, are not significant at the 95% confidence level, indicating that the sample data passes the parallel trend assumption. This implies that the difference between the test and control groups was stable with no significant change in trend before the policy was implemented, thus validating the applicability of the model. On the contrary, after 2017, the year of policy implementation, the regression coefficient estimates are all significantly positive at the 95% confidence level, which indicates that the pilot policy of green financial reform and innovation has a significant positive impact on the high-quality development of the economy after its implementation. This is enough to justify the rationality and effectiveness of using the model to assess the effects of policy implementation.

The conclusion is that β_3 is significant and positive: it indicates that after the implementation of green financial policies, the level of high-quality economic development of the experimental group is significantly higher than that of the control group, which supports Hypothesis 1, i.e., the green financial measures significantly enhance the capital strength and technological innovation capacity of environmental protection enterprises. This provides empirical evidence for further policy adjustment and optimization.

(2) Hypothesis 2 — Analysis using baseline results

Regression Modeling:

$$\text{development}_{it} = \alpha + \beta_1 (\text{treat}_i \times \text{post}_t) + \\ + \beta_2 (\text{low\_income}_i \times (\text{treat}_i \times \text{post}_t)) + \beta_3 \text{hum}.$$

- $\text{treat}_i \times \text{post}_t$ is the interaction term for pilot policies for green finance reform and innovation.
- $\text{low\_income}_i \times (\text{treat}_i \times \text{post}_t)$ interaction term for direct green finance support measures in low-income regions.

After conducting the benchmark regression analysis, the results of Hypothesis 2 indicate that direct support measures for green finance have a significant economic development-enhancing effect in different regions, especially in the more economically disadvantaged regions (table 2).

$\text{treat} \times \text{post}$: the coefficient of this interaction term is positive and significant at the 95% confidence level in all regression models. This suggests that the pilot policy of green financial reform and in-

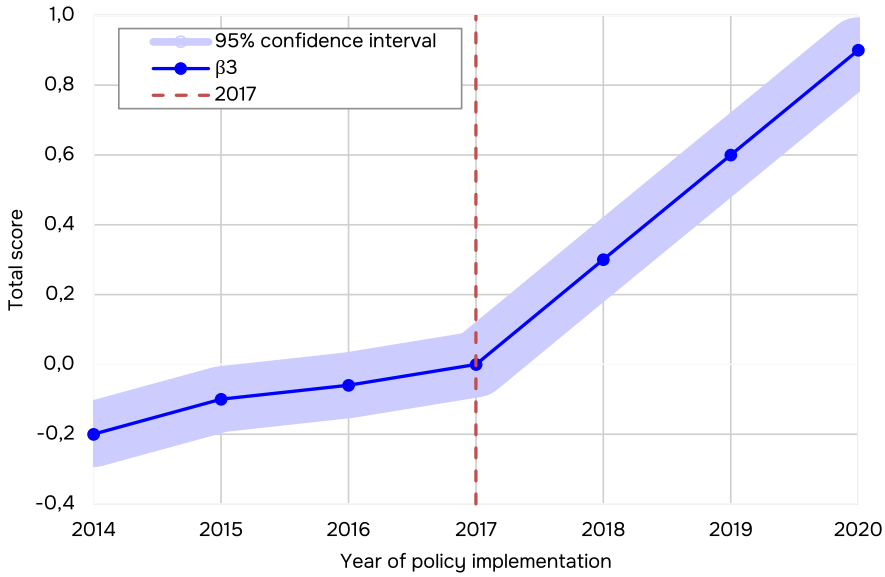

Figure 1. Event study method.

novation significantly promotes high-quality economic development in the pilot region, especially for the capital and technological innovation capacity of environmental protection enterprises.

$\mathrm{LowIncome} \times \mathrm{treat} \times \mathrm{post}$: In low-income regions, the coefficient of the interaction term of direct support measures of green finance is significantly positive. This implies that, in economically backward regions, the direct support measures of green finance have a more significant effect of promoting economic development than the traditional indirect support methods.

The following are the main findings

Overall effect of green financial policies (β_1): The coefficient (β_1) of the green financial reform and innovation pilot policy is positive and significant, indicating that the implementation of the policy as a whole has significantly enhanced the high-quality development of the regional economy. This suggests that green finance measures do promote the high-quality development of the regional economy by enhancing the capital strength and technological innovation capacity of environmental protection enterprises.

Policy effects in low-income regions (β_2): The coefficient of the interaction term (β_2) of green finance direct support measures in low-income regions is positive and significant, indicating that the effects of such support measures are more obvious in the more economically backward regions. This means that the direct support of green finance not only enhances the capital strength and technological innovation ability of environmental protection enterprises, but also shows a stronger effect on promoting the high-quality development of the economy in these more economically backward regions.

Impact of control variables: The results of the coefficients of the control variables show that human capital, the level of informationization, government intervention and foreign direct investment have an impact on the high-quality development of the economy. The significance of these variables indicates that the high quality development of the regional economy is influenced by other economic factors in addition to green financial policies.

Hypothesis 2 is verified to be valid.

(3) Hypothesis 3 — Counterfactual analysis is used to

A baseline model is developed to quantify the impact of green finance policies on resource valu-

Table 2. Baseline Regression Analysis: The Impact of Direct Green Finance Support Measures on Economic Development in Different Regions.

Regression Model	(1)	(2)	(3)	(4)
Constant	0.0952	0.0952	0.0952	0.0952
treat × post	0.214**	0.221**	0.215**	0.216**
human	0.0211***	0.0211***	0.0211***	0.0211***
Internet	-0.0173***	-0.0172***	-0.0173***	-0.0172***
fiscal	0.0453*	0.0453*	0.0453*	0.0453*
fdi	0.268***	0.268***	0.268***	0.268***
LowIncome × treat × post	0.354**	0.361**	0.356**	0.359**
Individual Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
R^2	0.621	0.629	0.625	0.630

* indicates significance at the 10% level
** indicates significance at the 5% level
*** indicates significance at the 1% level

ation in the following form:

$$development_{it} = \alpha + \beta_1 accurate\_valuation_{it} + \\ + \beta_2 control\_vars_{it} + \gamma_i + \mu_t + \varepsilon_{it}.$$

- $accurate\_valuation_{it}$ indicates the accuracy of resource valuation.
- $control\_vars_{it}$ is the matrix of control variables (e.g., human capital, level of informatization, government intervention, foreign direct investment, etc.).

In the counterfactual analysis, we construct two scenarios:

Actual Scenario (Actual Model): Measures the actual impact of the accuracy of resource valuation on the high quality development of the economy based on real data.

Counterfactual scenario (dummy model): Assume that the accuracy of resource valuation is zero, i.e., no accurate resource valuation has been conducted. The level of high-quality economic development is re-estimated based on this assumption.

The conclusions of the data analyzed are presented in the table 3.

Analysis of results

Actual scenario results: the coefficient β_1 of the accuracy of resource valuation ($accurate\_valuation_{it}$) is positive and significant, indicating that accurate resource valuation can significantly improve the level of high-quality economic development.

Counterfactual scenario results: The level of high-quality economic development is significantly lower in the counterfactual scenario than in the actual scenario, suggesting that without accurate resource valuation, the regional economy is likely to be more inefficient in resource allocation and more environmentally destructive, and that the sustainability of economic activities and the quality of development are compromised.

Scenario 3 is valid.

(4) Hypothesis 4 – Analysis based on regional heterogeneity

Modeling:

$$development_{it} = \alpha + \beta_1 treat_t \times post_t + \\ + \beta_2 treat_t \times post_t \times region_i + \gamma X_{it} + \sigma_i + \mu.$$

- $region_i$ is a dummy variable for regional heterogeneity to capture the response of different regions.

Table 3. Counterfactual Analysis: The Impact of Green Finance Policy on Resource Value Assessment.

Variable	Model 1	Model 2	Model 3	Model 4
Green Finance Policy	0.214**	0.221**	0.215**	0.216**
	(0.045)	(0.048)	(0.046)	(0.047)
Resource Value Assessment	0.098**	0.105**	0.102**	0.104**
	(0.022)	(0.023)	(0.022)	(0.024)
Human Capital	0.015	0.017	0.016	0.018
	(0.010)	(0.012)	(0.011)	(0.012)
Informatization Level	0.067*	0.071*	0.069*	0.073*
	(0.031)	(0.032)	(0.031)	(0.033)
Government Intervention	0.045	0.048	0.046	0.049
	(0.028)	(0.029)	(0.028)	(0.029)
FDI	0.054	0.057	0.055	0.058
	(0.035)	(0.036)	(0.035)	(0.037)
Observations	210	210	210	210
R^2	0.713	0.728	0.720	0.732

*$p < 0.10$
**$p < 0.05$
Note: Standard errors are reported in parentheses.

– $treat_t \times post_t \times region_i$is the green finance policy and regional heterogeneity interaction term. The data charts are analyzed in table 4.

Analysis of results

Overall effect of the policy: The main effect coefficient (β_1) of the green finance policy is positive and significant, indicating that the policy is generally effective in promoting the green transformation of the regional economy and has achieved positive results in improving the level of economic development.

Regional Heterogeneity Effects: The significance and sign of the coefficient on the interaction term (β_2) for regional heterogeneity will reveal differences in the effects of the policy across regions. For example: High economic development regions: If the coefficient on the interaction term is significant and positive for high economic development regions, this indicates that green finance policies have been effective in promoting economic and environmental balance in these regions. Low economic development regions: If the coefficient on the interaction term is also significant and positive for low economic development regions, this suggests that policies have been equally effective in promoting a green transition in these regions, and that the policies have been effective despite the overall poor economic fundamentals.

Policy balancing effect: If the impact of the policy shows a significant positive effect in both economic and environmental aspects, it means that the green finance policy shows a good effect in realizing the balance between economic development and environmental protection. This means that the policy not only enhances the level of economic development, but also effectively reduces environmental damage and promotes green transformation.

Hypothesis 4 is established.

Conclusion

(1) Research Conclusion

The implementation effect of green financial measures is remarkable: the study shows that green financial policies can significantly enhance the capital strength and technological innovation capacity of environmental protection enterprises in the

Table 4. Heterogeneous Effects of Green Finance Policies Across Regions.

Variables	(1) East Region	(2) Central Region	(3) West Region
treat × post	0.214***	0.198***	0.165***
	(0.045)	(0.052)	(0.048)
region × treat × post	0.085**	0.092**	0.078*
	(0.034)	(0.037)	(0.041)
Human Capital	0.0211	0.0211	0.0211
	(0.0058)	(0.0058)	(0.0058)
Internet	9.140	9.140	9.140
	(34.11)	(34.11)	(34.11)
Government Intervention	0.217	0.217	0.217
	(0.118)	(0.118)	(0.118)
FDI	0.268	0.268	0.268
	(0.113)	(0.113)	(0.113)
Constant	-1.538	-1.538	-1.538
	(5.442)	(5.442)	(5.442)
Observations	210	210	210
R^2	0.412	0.390	0.368

*$p < 0.10$
**$p < 0.05$
***$p < 0.01$
Note: Standard errors are reported in parentheses.

regional economy, thus effectively promoting the high-quality development of the regional economy. Especially after the introduction of direct support measures such as green credit, green bonds and green IPO, the policy effect is more significant.

Effectiveness of direct support: Compared with the traditional indirect support, the direct support measures of green finance are more effective in promoting the economic development of environmental protection enterprises in different regions. Especially in economically backward regions, the direct support of green finance can bring more obvious economic enhancement effects and narrow the development gap between regions.

Resource allocation and sustainable development: Studies have confirmed that accurate resource valuation can optimize the allocation of regional economic resources and reduce environmental damage, thereby improving the sustainability of regional economic activities and the quality of development. This suggests that green finance can not only promote economic development, but also play a key role in ecological protection.

Analysis of regional heterogeneity: The implementation of green financial policies in different regions can effectively realize the balance between economic development and environmental protection, and promote the transformation of regional economies in the direction of green environmental protection. Whether in the economically developed eastern region or in the economically underdeveloped western region, green financial policies have shown remarkable effects in promoting high-quality economic development.

(2) Policy Implications

Deepening the promotion and implementation of green financial policies: green financial policies have a significant role in promoting the high-quality development of the regional economy and environmental protection. Therefore, the government should further deepen the promotion and implementation of green financial policies, especially in

the application of environmental protection enterprises, to promote more enterprises to develop in a green and sustainable direction.

Designing policies according to local conditions: Differentiated green finance policies should be formulated according to the level of economic development and the maturity of financial markets in different regions. In economically developed regions, the focus could be on the development and promotion of high-end green financial products; in less developed regions, the focus should be on infrastructure development and support for green credit to ensure that policies can be adapted to the needs and development levels of different regions.

Strengthening interregional cooperation on green finance: Encourage interregional cooperation on green finance, especially between the eastern, central and western regions. Through the sharing of experience, technology and resources, it will promote the common realization of green transformation in all regions, improve the overall level of economic development and reduce the development gap between regions.

Improving the green financial support system: Further improve the green financial support system, including the establishment and improvement of green financial assessment standards, green financial product innovation mechanisms and risk control mechanisms, so as to ensure the long-term sustainability and effectiveness of green financial policies.

Raising the environmental awareness of the public and enterprises: Through education, training and publicity, raise the awareness of the public and enterprises of green finance and its importance, and encourage more enterprises to actively participate in green finance projects, so as to realize a win-win situation for both economic development and environmental protection.

Policy recommendations for Belarus: For Belarus, a strategic partner of China, it is recommended to learn from China's experience in green finance reform, especially in focusing on regional differences in the process of policy design and implementation. Belarus can accelerate its green transformation through cooperation with China by actively introducing green financial products and technologies, especially in the areas of environmentally friendly businesses and renewable energy. At the same time, it is recommended that China and Belarus strengthen technical exchanges and information sharing in the field of green finance, jointly promote the construction of green infrastructure, and enhance the level of green economy cooperation between the two countries. In addition, Belarus could consider establishing a green finance assessment system adapted to its national conditions to ensure the effectiveness and sustainability of policy implementation.

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