

Can Green Finance Development Boost Corporate Green Transformation? — Empirical Evidence Based on Mitigating Financial Constraints and Driving Green Innovation

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Abstract. Guided by the "dual carbon" strategic goal, how to effectively drive micro-enterprise entities to achieve green transformation has become a shared focus of academia and industry. As an important institutional arrangement guiding social capital to flow into green sectors, the micro-empowerment effect of green finance urgently needs to be tested. Using data of Chinese A-share listed companies from 2007 to 2024, this study empirically examines the impact of regional green finance development on corporate green transformation and its internal mechanism. The results show that green finance development plays a significant role in promoting corporate green transformation, and this finding has passed endogeneity tests and multiple robustness tests. In terms of mechanism, mitigating financial constraints and incentivizing green technological innovation constitute key channels through which green finance empowers corporate green transformation. The moderating effect reveals that government fiscal investment positively strengthens the promotion effect of green finance. Heterogeneity analysis further identifies the boundary conditions of the above driving effect. Specifically, the promotion effect of green finance is more pronounced when enterprises are located in the eastern region or belong to heavy-polluting industries. This study provides a new perspective for understanding the micro-mechanism of green finance and offers empirical evidence for formulating differentiated green finance policies to accurately boost corporate green transformation.

Keywords: green finance, corporate green transformation, financial constraints, green innovation, government fiscal investment

1. Introduction

Climate change has evolved from scientific warnings into a systemic risk facing the global economic system. The latest report by the IPCC points out that if global temperature rise exceeds the 1.5°C threshold, it will cause irreversible impacts on ecology, society and the economy. Against this backdrop, how to promote the transformation of economic growth models toward green sustainability has become a common concern of policymakers and academics worldwide. As the main carriers of resource consumption and carbon emissions, enterprises' green transformation process directly affects the achievement of global carbon neutrality goals. However, corporate green

transformation generally faces dilemmas such as high investment, long cycles and high risks, making it difficult for the traditional financing system to provide sufficient and suitable financial support.

As an institutional innovation connecting environmental protection and economic development, green finance has increasingly gained attention from the international community. Theoretically, Goldsmith systematically elaborated the role of financial structure in promoting economic growth [1]; the "Porter Hypothesis" proposed by Porter and van der Linde suggests that well-designed environmental regulations can stimulate corporate innovation [2]; Teece emphasized the importance of enterprises integrating internal and external resources to reshape competitive advantages from the perspective of dynamic capabilities [3]. These theories provide important support for the incentive mechanism of green finance.

In empirical research, Wang and Wang used Chinese provincial panel data and found that green finance can effectively promote the upgrading process of regional industrial structure through the channel of credit structure optimization [4]. Lee et al. found that green technological innovation and energy structure optimization are mediating paths for green finance to improve energy efficiency [5]. Based on data of A-share listed companies, Zhou et al. confirmed that green finance promotes corporate environmental innovation by alleviating financial constraints, reducing information asymmetry and strengthening environmental regulation [6]. Zhang and Liu adopted a quasi-natural experimental design of green finance reform and innovation pilot zones and observed that the carbon performance of enterprises in the pilot zones improved significantly, and this effect was more prominent in enterprises in heavy-polluting industries and regions with higher financial development levels [7].

From the perspective of financial constraints, Aghion et al. used French enterprise data and showed that credit constraints significantly affect the cyclicity of R&D investment [8]. Demertzis et al. pointed out that digital technology can reduce information asymmetry, broaden financing channels, and provide more efficient capital allocation for green projects [9]. Owen et al. emphasized the key role of government policies in guiding private capital into early-stage green innovation projects, which echoes the moderating effect of government fiscal investment examined in this study [10].

Regarding green innovation, Fussler and James defined the concept of eco-innovation at an early stage, emphasizing its dual attributes of balancing commercial value and environmental benefits [11]. Shapiro pointed out that high-skilled human capital is crucial for absorbing and applying green technologies [12]. Nambisan et al. proposed a digital innovation management framework, arguing that digital technology can reduce collaboration costs and accelerate knowledge flows [13]. Mikalef et al. empirically found that big data analytics capability improves corporate competitive performance through the mediating role of dynamic capabilities [14].

From the perspective of international experience, Liu et al. examined the impact of the digital economy on industrial structure upgrading and green total factor productivity [15]. The study found a mutually reinforcing synergy between digitalization and green development. Jin et al. confirmed that digital transformation significantly improves international carbon competitiveness [16]. Feng et al. analyzed the mechanism of digital technology and found that when digital technology alleviates information asymmetry and improves resource allocation efficiency, corporate green innovation activities are significantly promoted [17]. Sun et al. further revealed the positive impact of digital-green synergy on carbon performance [18].

In addition, the instrumental variable construction method proposed by Bartik provides important reference for causal identification [19]. The textual analysis method of Loughran and McDonald has

been widely used to measure green-related indicators in corporate information disclosure [20]. Research by Acemoglu and Restrepo on the impact of technological progress on the labor market and industrial structure offers a macro perspective [21, 22]. Li et al. found that the development of the digital economy significantly improves corporate innovation levels [23], and Verhoef et al. systematically sorted out the research agenda of digital transformation [24].

Although the above literature reveals the correlation between green finance and green transformation from multiple dimensions, existing research still has deficiencies. First, most studies focus on the macro-industrial level, with relatively scarce direct evidence at the micro-enterprise level. Second, discussions on mechanisms are often limited to a single mediating path, lacking systematic tests of multiple parallel paths. Third, few studies examine the interactive effect between government fiscal investment and green finance.

To make up for the above research deficiencies, this study takes Chinese A-share listed companies from 2007 to 2024 as samples to systematically explore the direct impact, transmission mechanism, moderating boundary and heterogeneity characteristics of green finance on corporate green transformation. The marginal contributions are as follows: first, it sinks from macro-industrial analysis to micro-enterprise behavior and provides micro evidence; second, it simultaneously tests the two parallel paths of "mitigating financial constraints" and "driving green innovation"; third, it introduces government fiscal investment as a moderating variable to reveal the conditions for the coordinated effect of "government + market"; fourth, it identifies the boundary conditions of effects through heterogeneity analysis, providing a reference for differentiated green finance policies.

2. Research hypotheses

Mao Xiaomeng et al. define green finance as a type of financial service that targets economic activities dedicated to environmental improvement, climate change response, and resource conservation and efficient utilization [25]. Its core function lies in guiding capital factors to flow into green industries through differentiated pricing and allocation of credit, bonds, insurance and other instruments, while imposing financing constraints on industries with high pollution, high energy consumption and overcapacity [26]. Wu Jingyi et al. point out that corporate green transformation essentially refers to a continuous process in which enterprises, in response to the trend of sustainable development, comprehensively adopt technological innovation, process upgrading, management optimization and other means to reduce the environmental externalities of production activities, and ultimately achieve improved green total factor productivity [27]. Based on resource dependence theory and signaling theory, this study argues that green finance can drive corporate green transformation from both resource and regulatory dimensions. On the one hand, green finance directly injects scarce long-term funds into enterprises' green projects through special funds, preferential credit and other measures, easing financial pressure during their transformation [28]. On the other hand, green finance policies themselves send a strong policy signal to the market, conveying the government's clear orientation of encouraging green development. To obtain policy dividends, maintain market reputation and avoid stricter environmental regulations in the future, enterprises have incentives to proactively adjust their business strategies and increase green investment. Accordingly, this paper proposes:

H1: The higher the level of green finance development, the more significantly it promotes corporate green transformation.

Corporate green transformation cannot be separated from continuous R&D investment and equipment renewal, which are highly dependent on external financing. However, due to the complex technology, long payback period and high degree of information asymmetry of green projects,

enterprises often face severe financing constraints in the traditional credit market [27]. The gradual improvement of the green finance system provides a feasible way out of this dilemma. First, green finance policies require financial institutions to examine enterprises' environmental performance in the credit granting process, which provides a credit enhancement channel for enterprises with excellent environmental performance and reduces their financing costs [8]. Second, national-level green development funds, carbon emission reduction support tools and other instruments provide diversified financing channels for green projects beyond the traditional banking system [25]. The alleviation of financing constraints enables enterprises to introduce clean production equipment and conduct green technology R&D, thereby effectively reducing carbon emission intensity and promoting green transformation [23]. Accordingly, this paper proposes:

H2: Green finance can indirectly help enterprises achieve green transformation by easing their financial pressure.

Innovation drive is the core of green transformation. Green technological innovation, especially the output of invention patents, is the key to achieving a win-win situation of "emission reduction" and "efficiency improvement". The incentive effect of green finance on green innovation is reflected in two aspects: "push" and "pull". From the pushing perspective, green credit and green bonds inject a sustained and reliable source of funding for enterprises' green R&D activities, overcoming the high sunk costs and uncertainties of innovation [26]. From the pulling perspective, the market access and information disclosure requirements of green finance intensify competition in the green product market, forcing enterprises to continuously conduct green technological innovation to maintain competitive advantages [29]. As emphasized by Teece's dynamic capability theory, enterprises can reshape competitive advantages by integrating internal and external resources. The improvement of green innovation capability [3] can directly act on production processes, and ultimately be reflected in higher green total factor productivity and lower carbon emission intensity by optimizing energy structure, improving resource utilization efficiency, developing environmentally friendly products and other means [27]. Accordingly, this paper proposes:

H3: Green finance indirectly promotes corporate green transformation by encouraging enterprises to carry out green innovation.

As a market-oriented mechanism, the effectiveness of green finance cannot be separated from the coordination of the "visible hand" of the government. Affected by China's fiscal decentralization system, local governments have considerable room to directly participate in economic activities through fiscal expenditure [10]. Government fiscal investment (such as energy conservation and environmental protection expenditure, industrial guidance funds, etc.) can not only provide direct financial supplements for enterprises' green projects, but also send policy signals to financial institutions and leverage more social capital to flow into green sectors. Accordingly, this study further infers that the intensity of government fiscal investment (*fiscal_invest*) has a positive moderating effect on the relationship between green finance and corporate green transformation. Specifically, the greater the fiscal investment in a region, the stronger the boosting effect of green finance on the green transformation of local enterprises. This is because fiscal input can lower the initial threshold of green projects, enhance enterprises' willingness and ability to respond to green finance policies, and amplify the leverage effect of green finance [21]. Accordingly, this paper proposes:

H4: The positive effect of green finance in promoting corporate green transformation will be positively strengthened as the intensity of government fiscal investment increases.

3. Empirical design

3.1. Sample data and data sources

The initial research sample of this paper is selected from Chinese A-share listed firms on the Shanghai and Shenzhen Stock Exchanges from 2007 to 2024. To ensure data quality and enhance the robustness of empirical results, several screening procedures are applied to the original sample as follows: first, financial and insurance enterprises are excluded; second, firms marked as ST, *ST or PT during the sample period are eliminated; third, samples with missing records on core variables are deleted; fourth, all continuous variables are winsorized at the 1% and 99% percentiles to mitigate the interference caused by extreme values. After the above screening, the final sample consists of firm-year panel observations covering various industries. Firm-level data are mainly obtained from the China Stock Market & Accounting Research (CSMAR) Database; data related to green patents are collected from the Chinese Research Data Services Platform (CNRDS); and the raw data used for the regional green finance development index are collected from the China Statistical Yearbook, the China Insurance Yearbook, and provincial statistical yearbooks respectively.

3.2. Model design and variable definition

This study constructs the following model:

$$GTI_{it} = \alpha + \beta Score_{it} + \gamma Control_{it} + \mu + \delta + \varepsilon$$

In this model, GTI represents corporate green transition, and Score represents the prefecture-level green finance development level. Control denotes a set of control variables. ε is the random error term. This study simultaneously includes time (μ) and firm (δ) dummy variables to absorb fixed effects as much as possible.

3.2.1. Explained variable

Following the approach of Loughran and McDonald [20], we measure corporate green transformation using textual information disclosed in annual reports. Drawing on policy documents such as the Five-Year Plan, the Environmental Protection Law, the Technical Guidelines for Enterprise Environmental Behavior Evaluation, and the White Paper on Green Manufacturing Standardization, we select a total of 115 keywords related to corporate green transformation from five dimensions: advocacy and initiatives, strategic concepts, technological innovation, pollution control, and monitoring management. We count the frequency of each keyword appearing in the annual report texts of listed firms, aggregate these frequencies to obtain the total green transition word count, and then take the natural logarithm of one plus this count to construct the corporate green transformation index.

3.2.2. Explanatory variable

Referring to the research by Xie Fei et al. [29], this paper selects four dimensions—green credit, green investment, green insurance, and government support—to establish an evaluation index system for green finance development. The entropy method is used to comprehensively measure the green finance development level of each province. The specific measurement methods for each dimension are as follows: green credit is measured by the inverse indicator of the proportion of interest expenditure in high-energy-consuming industries; green investment is reflected by the ratio of regional investment in environmental pollution control to local GDP; green insurance uses

agricultural insurance depth (i.e., the ratio of agricultural insurance premium income to agricultural output value) as the proxy indicator; and government support is measured according to the proportion of fiscal expenditure on environmental protection in general budget expenditure. The final score (Score) is used as the core explanatory variable and matched with firm-level data.

3.2.3. Mediating variables

① Financial constraints (SA_abs): To avoid endogeneity, the absolute value of the SA index is used to measure the degree of corporate financial constraints. This index is calculated based only on two relatively exogenous variables—firm size and firm age—and a larger value indicates more severe financing constraints.

② Green innovation (LnGreen): Measured as the natural logarithm of one plus the total number of corporate green invention and green utility model patent applications in the current year.

3.2.4. Moderating variable

Government fiscal investment intensity (fiscal_invest): Measured by the proportion of energy conservation and environmental protection expenditure in local government fiscal general budget expenditure. To alleviate multicollinearity between the interaction term and the main variables, Score and fiscal_invest are centered, and the centered interaction term (c_Score_fiscal) is constructed.

3.2.5. Control variables

Based on the existing literature, this study selects several control variables to account for firm-specific characteristics that may influence corporate green transformation. These include firm size (Size), calculated as the natural logarithm of total assets, as larger firms typically possess more resources and capabilities for green innovation. Leverage (Lev) is measured by the debt-to-assets ratio, reflecting financial constraints and risk-taking capacity. Profitability (ROA) captures operational efficiency and is measured by return on total assets. Liquidity (Liquid) is proxied by the current ratio to control for short-term solvency and financial flexibility. Physical asset intensity (Fixed) is measured by the ratio of fixed assets to total assets, representing the firm's tangible investment structure. Growth potential is captured by revenue growth rate (Growth) to account for expansion opportunities. Corporate governance characteristics are also controlled, including board size (Board), measured by the natural logarithm of the number of directors; board independence (Indep), defined as the proportion of independent directors; CEO duality (Dual), a dummy variable indicating whether the CEO also serves as board chairman; ownership concentration (Top10), measured by the shareholding ratio of the top ten shareholders; and equity balance (Balance2), reflecting the checks and balances among major shareholders. Finally, firm age (FirmAge) is calculated as the natural logarithm of the number of years since establishment. All continuous variables are winsorized at the 1% and 99% levels to mitigate the influence of outliers.

Table 1. This caption has one line so it is centered

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
GTI	43,087	3.194	0.910	0	5.749
Score	43,087	0.226	0.106	0.0153	0.795

Table 1. (continued)

Size	43,087	22.24	1.348	14.94	28.79
Lev	43,087	0.436	0.206	0.00708	0.998
ROA	43,087	0.0301	0.0825	-2.834	0.974
Liquid	43,087	2.460	3.417	0.0257	204.7
Fixed	43,087	0.210	0.163	0	0.971
Growth	43,087	3.800	652.5	-1.445	134,607
Board	43,087	2.123	0.204	1.099	2.890
Indep	43,087	0.376	0.0554	0	0.818
Dual	43,087	0.278	0.448	0	1
Top10	43,087	0.568	0.156	0.0131	1.012
Balance2	43,087	0.730	0.620	0.00310	4
FirmAge	43,087	2.948	0.354	0.693	4.290

4. Empirical analysis

4.1. Baseline analysis

Table 2 reports the baseline regression results. In column (1), without any fixed effects, the regression coefficient of green finance (Score) is negative and insignificant. After adding year fixed effects in column (2), the coefficient of Score is 0.487, significant at the 1% statistical level (marked as ***). Column (3) further incorporates both firm and year fixed effects, and the coefficient of the core explanatory variable is 0.532, still significant at the 1% level. It can be seen that after controlling for firm heterogeneity and macroeconomic fluctuations, the improvement of regional green finance development can still effectively accelerate the green transformation pace of local enterprises. In economic terms, each one-standard-deviation increase in green finance development is associated with an average increase of approximately 0.053 standard deviations in the corporate green transformation index. Thus, Hypothesis H1 is supported.

Table 2. Baseline regression

VARIABLES	(1) GTI	(2) GTI	(3) GTI
Score	-0.147 (-1.280)	0.487*** (11.546)	0.532*** (8.235)
Observations	43,087	43,087	43,087
R-squared	0.152	0.694	0.743
id	NO	NO	YES
year	NO	YES	YES

Note: t-values are in parentheses; ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

4.2. Robustness checks

4.2.1. Endogeneity test

To address endogeneity concerns caused by reverse causality and omitted variables, this paper adopts the instrumental variable method. Following the approach of Bartik [19], the interaction term between the distance of each city to the provincial capital and the total national green bond issuance is selected as the instrumental variable (IV). Geographic distance is exogenous, related to the local financial development environment but not directly affecting individual firms' green transformation decisions; the national green bond issuance scale reflects the national orientation of green finance policies, satisfying the relevance condition. The first-stage results of the two-stage least squares (2SLS) show that the IV is significantly positively correlated with Score, and the F-statistic is greater than 10, ruling out the weak instrument problem. The second-stage regression results (column 1 of Table 3) show that the coefficient of Score is 0.437, significant at the 1% level, consistent with the baseline conclusion.

4.2.2. Changing the explanatory variable

To mitigate interference from measurement errors, this paper uses the scale of green credit (the inverse indicator of the proportion of interest expenditure in six high-energy-consuming industries) as an alternative measure of green finance and re-runs the regression. The results in column (2) of Table 3 show that the coefficient of the replaced explanatory variable is 0.012, significantly positive at the 1% level.

4.2.3. Adding model fixed effects

On the premise of controlling for firm and year fixed effects, this study further introduces city fixed effects and industry fixed effects to eliminate the influence of potential confounding factors that are constant at the regional and industry levels over time. Column (3) of Table 3 shows that the coefficient of Score is 0.470, still significant at the 1% level.

4.2.4. Excluding municipalities

Considering the special administrative status and policy resources of Beijing, Shanghai, Tianjin, and Chongqing, the conclusions may lack generalizability. After excluding samples of these four municipalities, the regression is re-estimated. As shown in column (4) of Table 3, the coefficient of Score is 0.536, significant at the 1% level.

4.2.5. Excluding pandemic years

The outbreak of COVID-19 in 2020 exerted a significant impact on the global economy and micro-firm operations, which may disrupt the normal mechanism of green finance. After excluding samples from 2020 and later years, the regression results in column (5) of Table 3 show that the coefficient of Score is 0.335, significant at the 1% level. In summary, the baseline regression conclusion is robust.

Table 3. Robustness test results

VARIABLES	(1) GTI	(2) GTI	(3) GTI	(4) GTI	(5) GTI
Score	0.437*** (3.466)	0.012*** (3.163)	0.470*** (7.031)	0.536*** (4.556)	0.335*** (3.414)
Observations	43,087	43,087	41,479	30,278	25,441
R-squared	0.715	0.743	0.754	0.747	0.786
id	YES	YES	YES	YES	YES
year	YES	YES	YES	YES	YES
City	NO	NO	YES	NO	NO
Industry	NO	NO	YES	NO	NO

4.3. Heterogeneity analysis

4.3.1. Regional heterogeneity

Given the significant differences between eastern and central-western regions in economic development, financial marketization, and environmental regulation stringency, this paper divides the sample into eastern and non-eastern subgroups and conducts separate regressions. The results in columns (1) and (2) of Table 4 show that for firms in the eastern region, the coefficient of green finance is 0.579, significant at the 1% level; for firms in non-eastern regions, the coefficient is positive but less significant (0.442, at the 5% level). This indicates that the driving effect of green finance is stronger in the eastern region, possibly due to its more developed financial market system and stricter environmental law enforcement.

4.3.2. Industry heterogeneity

As firms in heavy-polluting industries face stricter environmental compliance constraints and more urgent green transformation pressure, green finance may exert a stronger regulatory effect on them. Based on the CSRC industry classification and the List of Industry Classification for Environmental Verification of Listed Companies issued by the Ministry of Environmental Protection, this study divides the full sample into heavy-polluting and non-heavy-polluting industries for separate regression analysis. Columns (3) and (4) of Table 4 show that for heavy-polluting firms, the coefficient of green finance is 0.445, significant at the 1% level; for non-heavy-polluting firms, the coefficient is only 0.237 and insignificant. This suggests that green finance policies precisely target major polluters and exert an effective forcing effect on their green transformation [12].

Table 4. Heterogeneity analysis results

VARIABLES	(1) Eastern Firms GTI	(2) Non-Eastern Firms GTI	(3) Heavy-Polluting Industries GTI	(4) Non-Heavy-Polluting Industries GTI
Score	0.579*** (8.212)	0.442** (2.601)	0.445*** (2.741)	0.237 (0.783)
Observations	29,994	13,079	29,276	13,778

Table 4. (continued)

R-squared	0.739	0.754	0.765	0.745
id	YES	YES	YES	YES
year	YES	YES	YES	YES

5. Extended analysis

5.1. Financing constraint channel

The theoretical analysis above holds that mitigating financing constraints is an important channel through which green finance empowers corporate green transformation. To verify this mechanism, this study takes the absolute value of the SA index (SA_abs) as the mediating variable to conduct a mechanism test. The regression result in column (1) of Table 5 shows that the coefficient of the core explanatory variable Score on SA_abs is -0.492, significant at the 1% level. This implies that firms in regions with higher levels of green finance development face weaker financing constraints. Combined with the promoting effect of Score on GTI in the baseline regression, the existence of the mediating path "green finance development → mitigation of financing constraints → corporate green transformation" is confirmed. Green finance provides critical capital support, like "blood", for corporate green transformation by broadening financing channels and reducing financing costs [1].

5.2. Green innovation channel

Stimulating green innovation is another core mechanism through which green finance takes effect. This study uses the number of corporate green patent applications (LnGreen) as the mediating variable for the test. The regression result in column (2) of Table 5 shows that the coefficient of Score on LnGreen is 0.306, significant at the 1% level. This indicates that the development of green finance effectively encourages enterprises to carry out green technology R&D activities [11]. As more green technology patents and R&D achievements are applied to actual production, the production process of enterprises gradually becomes cleaner and resource utilization efficiency is significantly improved, which jointly promote the realization of corporate green transformation. Therefore, the transmission path "green finance development → drive green innovation → promote corporate green transformation" is also empirically supported.

5.3. Moderating effect of government fiscal investment

To examine the moderating role of government fiscal investment intensity in the effect of green finance, this study adds the centered green finance (Score), government fiscal investment (fiscal_invest) and their interaction term (c_Score_fiscal) into the baseline model. The regression results are shown in column (3) of Table 5.

Table 5. Extended analysis results

VARIABLES	(1) SA_abs	(2) LnGreen	(1) GTI
Score	-0.492*** (-23.309)	0.306*** (3.200)	0.228*** (2.884)

Table 5. (continued)

fiscal_invest			-0.005 (-1.294)
c_Score_fiscal			0.031** (2.036)
Observations	43,087	43,058	38,651
R-squared	0.924	0.732	0.760
id	YES	YES	YES
year	YES	YES	YES

6. Conclusion

Based on panel data of listed companies from 2007 to 2024, this paper empirically examines the impact of regional green finance development on corporate green transformation. The results show that green finance development can significantly accelerate the process of corporate green transformation, and this conclusion remains valid after controlling for endogeneity issues and passing multiple robustness tests. In terms of mechanism, green finance indirectly empowers corporate green transformation mainly through two paths: alleviating the financing constraints faced by enterprises and stimulating their enthusiasm for green technology innovation activities. Regarding the moderating effect, increased government fiscal investment can positively strengthen the promotion effect of green finance, reflecting the better effect of the two-wheel drive of "government guidance and market operation". Heterogeneity analysis further reveals that the above-mentioned empowerment effect is particularly prominent in enterprises located in the eastern region and those belonging to heavy-polluting industries.

Based on the above conclusions, this study puts forward the following policy implications:

First, continuously promote reform and innovation in the field of green finance, and build a well-structured framework of green financial products and supporting services covering various types. Not only should we focus on the optimization of the macro industrial structure, but also we should open up the "last mile" for financial resources to penetrate into green projects of micro enterprises. Financial institutions can refer to the digital innovation management concept proposed by Nambisan et al. [13] and use digital technologies such as big data and blockchain to improve the accurate identification of green projects and the ability of risk management assessment.

Second, strengthen the coordination between government fiscal investment and green finance. The moderating effect analysis in this paper confirms that the level of government fiscal investment significantly enhances the effect of green finance in promoting corporate green transformation. Therefore, local governments should set up special funds for green transformation, and provide interest discounts, guarantees or direct investment support for eligible corporate green projects. At the same time, the use of fiscal funds should be linked with green credit audit standards. Through the "fiscal + finance" linkage mechanism, the efficiency of capital allocation can be improved and policy synergy can be formed [9].

Third, implement differentiated regional and industrial policies. For the central and western regions, the construction of green financial infrastructure should be strengthened, and advanced

experience from the eastern region should be replicated and promoted; for heavy-polluting industries, appropriate green credit constraint pressure should be maintained, while transitional financial support should be provided to avoid a one-size-fits-all withdrawal, and guide them to achieve green and low-carbon development steadily and efficiently. In addition, enterprises themselves should actively use green financial instruments, take the initiative to disclose environmental information, reduce information asymmetry, and strive for more green financial support [14].

In short, as an important institutional innovation to promote the green transformation of the economy, the full play of the micro effects of green finance requires the coordinated efforts of the government, financial institutions and enterprises. Future research can further explore the interaction effect between green finance and other environmental regulation tools, as well as the differential mechanism in enterprises with different ownership structures.

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