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Does green finance enable firms to promote environmental performance: Evidence from random forest methods?

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ABSTRACT

There is a limited body of research that specifically examines the influence of green finance on the environmental performance of enterprises. Employing the panel data of Chinese A-share listed firms from 2012 to 2017 and random forest methods, we intend to examine whether green finance contributes to promoting firms' environmental performance. If yes, how does green finance promote firms' environmental performance? Using various empirical tests, we obtain the main results as follows: First, the baseline results show that green finance is conducive to improving firms' environmental performance. The baseline results are supported in various model settings, including Difference-In-Difference (DID), Bayesian Additive Regression Trees (BART), and matching approaches. Secondly, the internal mechanism tests show that a rise in green innovation and an improvement in green investment efficiency are the main channels through which green finance helps to improve firms' environmental performance. In addition, considering firm-scale heterogeneity and ownership heterogeneity, we conduct heterogeneity checks. The results of heterogeneity checks show that the positive effect of green finance on the environmental performance of firms is only pronounced for small- and medium-scale firms and for non-state-owned enterprises. Our study expands the framework of green finance research on firms' environmental performance and provides practical implications for the development of strategies for emerging economies.

Contribution/Originality: This paper introduces green finance into the framework of the drivers of firms 'environmental performance and proposes a new method for estimating the impact of green finance on environmental performance.

1. INTRODUCTION

The environmental performance of firms significantly contributes to the enhancement of a nation's environmental quality. Nevertheless, the external attributes of corporate green innovation may lead managers to prioritise company economic performance over environmental performance, thereby creating a disparity between economic advancement and ecological preservation. In addition, the environmental performance upgrading behaviour of enterprises also faces problems such as high financing and adjustment costs and requires stable and lasting financial resources. Green finance, supported by green credit policies, has the dual attributes of environmental regulation and allocation of financial resources, which can supplement the deficiencies of traditional financial policies in environmental regulation and play a critical role in promoting firms' environmental performance through financial means. Therefore, analysing

the relationship and internal mechanisms between green finance and corporate environmental performance is an important issue for strengthening environmental governance.

A growing body of studies has focused on investigating the determinants of firms' environmental performance, including market-level factors, *i.e.*, environmental management, Fintech finance, policy uncertainty, and so on (e.g., (Jin, Dai, Jiang, & Cao, 2023; Ngo, 2023; Song, Dai, & Bian, 2023) and firm-level factors, including board gender diversity, ownership, ESG performance, and so on (e.g., Naeem, Cankaya, and Bildik (2022)). According to the findings of existing research, we deduce that the improvement in green innovation and then enhancement in green innovation efficiency drive firms to upgrade their environmental performance (He, Liu, Zhong, Wang, & Xia, 2019). Limited financial resources inhibit the improvement in green innovation and the enhancement in green innovation efficiency (Du, Wang, Peng, Jiang, & Deng, 2022). Hence, adequate financial resources play a primary role in improving firms' environmental performance (Salama, 2005). In the context of China, firms generally face financing constraints that inhibit their willingness to improve environmental performance (Chen, Zhu, Luo, & Zhang, 2022). To improve environmental quality, the Chinese government has issued a strand of green finance policies (Xue & Feng, 2023).

Especially in 2012, the China Banking Regulatory Commission first issued a project named "Green Credit Guidelines" to improve finance allocation efficiency and provide more finance resources to firms that are willing to improve environmental performance. Though a series of studies have examined the impact of green financial policies on firms' green innovation and environmental performance, the results are inconsistent. Some studies support that green credit contributes to improving firms' environmental performance (Shen, Wu, Long, & Luo, 2021; Sun, Wang, Yin, & Zhang, 2019), while others suggest that green credit adversely influences firms' environmental performance (Hu, Jiang, & Zhong, 2020; Liu, Xia, Fan, Lin, & Wu, 2017). In terms of methods, the majority of existing studies employ traditional estimation procedures like the fixed effect panel model. To the best of our knowledge, the empirical model setting will have an impact on the results. Considering the limitations of traditional methods, *i.e.*, endogeneity issues in the panel fixed model, this paper intends to examine the impact of green finance on firms' environmental performance by taking the "Green Credit Guidelines" project in 2012 as a natural quasi-experiment and using a random forest approach. The random forest method is preferred because it can make estimations less dependent on the choice of subjective criteria by giving observations that are closest to the decision a fair amount of weight through a machine learning process.

The main contributions of this paper are as follows: First, this study introduces green finance into the framework of the drivers of firms 'environmental performance, thereby enriching the prevailing research. Second, our results expand the evidence disentangling the relationship between the environmental performance of enterprises and green finance in emerging economies like China. Third, we propose a new method for estimating the impact of green finance on environmental performance.

In comparison to traditional methodology, random forest methods are able to reduce the dependence of estimation results on the choice of subjective criteria (Couronné, Probst, & Boulesteix, 2018). Fourth, our results shed light on important policy implications for policymakers in emerging countries.

The subsequent sections of the paper are structured in the following manner: Section 2 of the research paper comprises a comprehensive literature assessment and presents a set of hypotheses. Section 3 provides an overview of the research design. Section 4 provides a detailed analysis of the empirical findings. The concluding portion serves as the culmination of this work.

2. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Based on existing studies, green credit policies affect corporate investment and financing behavior (Liu et al., 2017) and encourage companies to pay attention to environmental information disclosure (Su, Pan, Zhou, & Zhong, 2022), which helps to improve investment efficiency (Lee & Lee, 2022; Zhang, Luo, & Ding, 2022), promote corporate

green innovation performance, and upgrade corporate environmental performance (Zheng, Deng, Zhuo, & Sun, 2022). Firstly, the specialized products and services of green finance can provide enterprises with financial resources and alleviate their financial difficulties (Yin, Wang, Lu, & Liu, 2023), which motivates them to innovate. Secondly, green finance also plays a supervision role, *i.e.*, "Green Credit Guidelines", which can help curb managers' inefficient investments.

Firms that obtain bank green credit immediately fall under supervision from both banks and shareholders (Ioannidou, 2005). Faced with strengthened supervision, shareholders have a strong incentive to urge companies to carry out green research and development to reduce the potential risks of environmental violations (Carretta, Farina, Fiordelisi, Schwizer, & Lopes, 2015). Thirdly, strengthened supervision reduces both information asymmetry and the agency cost of managers and further consolidates investment efficiency (Li, Qiu, Xu, & Zheng, 2023). Zheng et al. (2022) supported the idea that green credit can enhance investment efficiency by strengthening the monitoring effect and helping firms avoid inefficient investments.

Therefore, green finance will help firms increase green innovation, improve green investment efficiency, and upgrade their environmental performance. Based on the above discussion, we propose the first hypothesis as follows:

H_1: Green finance contributes to improving the environmental performance of enterprises.

Since small and medium-sized enterprises usually have difficulty supplying comparable financial indicators and credit records as large enterprises, they usually face more serious financing difficulties (Hope, Thomas, & Vyas, 2011). This makes it more difficult for them to raise funds to support green innovations and environmental improvements. Thus, traditional financial institutions may be more inclined to lend to enterprises with stable profitability and low risks (Chen et al., 2022). Green finance, on the other hand, focuses more on the environmental impact and sustainability of an enterprise (Mejia-Escobar, González-Ruiz, & Duque-Grisales, 2020). Thus, the specialized products and services of green finance can provide small and medium-sized enterprises with targeted financing solutions and alleviate their financial difficulties. Secondly, in modern society, sustainable development and environmental protection have become crucial issues of concern, and the government and society generally support companies that care about the environment and take positive steps to protect it (Jeucken, 2001). As a result, small and medium-sized businesses are more motivated to pursue green innovation because it can have a positive impact on businesses and receive support from the government and society at large (Bocken, Farracho, Bosworth, & Kemp, 2014). Therefore, according to the above discussion, we propose the second hypothesis as follows:

H_2: In comparison with large-scale firms, the improvement effect of green finance on firms' environmental performance is pronounced for small- and median-scale firms.

Non-state-owned enterprises (non-SOEs) usually face more severe financing constraints since they don't have a government background (Luo, Ni, & Tian, 2020). Therefore, in comparison with state-owned enterprises, it is harder for non-SOEs to get funding for green innovations (Wang & Jiang, 2021). Green finance provides specialized financial products, like green bonds, green loans, *etc.* These financial products provided for environmental protection and sustainable development can help non-SOEs get financing (Xiang, Liu, & Yang, 2022). Therefore, green finance can provide the necessary financial support and encourage them to invest more actively in green technology. Furthermore, state-owned enterprises are often subject to more government regulation, which means they make more conservative decisions and are slower to innovate (Tan, 2005). Conversely, due to less government intervention, non-SOEs can adjust their strategies and innovation directions more flexibly (Guan, Richard, Tang, & Lau, 2009). Non-SOEs can use green finance to raise funds to innovate in the field of environmental protection, so they'll be able to improve environmental performance faster. Due to their focus on efficiency and flexibility in terms of governance, non-SOEs are more likely to adopt green technology (Alshuwaikhat & Abubakar, 2008). Based on these two points, green finance has a stronger effect on improving non-SOEs' environmental performance.

H_3: In comparison with SOEs, the improvement effect of green finance on firms' environmental performance is pronounced for non-SOEs.

3. RESEARCH DESIGN

3.1. Data

Our empirical data are from the following databases: the Chinese Securities Markets and Accounting Research (CSMAR) database, the China Research Data Service Platform (CNRDS), and the Rankins CSR Ratings (RKS) database. The CSMAR database includes firm-level information. CNRDS provides patent classification numbers. The RKS database provides information on all environmental management.

Due to the following reasons, we determined the sample period from 2012 to 2017: Firstly, owing to employing the random forest method to test the causal relation between green finance and firms 'environmental performance, there should be treated groups and control groups. The China Banking Regulatory Commission first formulated a green credit system and issued a series of green finance projects in 2012. The firms supported by this project are able to obtain green finance, which can be the treated groups, while other firms can be the control groups. Secondly, the accessibility of firms' environmental performance data is only up to 2017.

After merging the three data sources based on their uniform stock code, we exclude observations satisfying one of the following criteria: (i) financial and insurance companies; (ii) Special Treatment (ST), ST*, and Perseroan Terbatas (PT) firms; (iii) companies with asset-liability ratios between 0 and 1; (iv) missing value of main variables or abnormal value of main variables. We winsorize all continuous variables at the 1 % and 99 % levels.

3.2. Random Forest Method

Suppose there are n sets of independently distributed observations $(X_i, Y_i, W_i), i = 1, 2, \cdots, n$,where X_i is a vector of covariates, $Y_i \in R$ represents the response values, and $W_i \in \{0,1\}$ is the treatment variable. There are two potential outcomes, $Y_i^{(1)}, Y_i^{(0)}$ corresponding to the response value of the individual in the two states of green credit-restricted and unrestricted industries.The treatment effect at feature space x is:

$$\tau(x) = \mathrm{E}[Y_i^{(1)} - Y_i^{(0)} \mid X_i = x] \tag{1}$$

The goal of causal inference is to estimate $\tau(x)$, but we can observe only one of two potential outcomes, so we cannot directly impose an effect on $\tau(x)$. In this regard, it is standard practice to impose the assumption of confoundedness on the dataset, *i.e.*, that the potential outcome Y_i conditional on X_i is uncorrelated with the treatment variable W_i.

$$\left\{Y_i^{(1)}, Y_i^{(0)}\right\} \perp W_i \mid X_i \tag{2}$$

Under this assumption, we can consider the observations in the nearest neighbor in x-space as randomly distributed. By the non-confusion assumption, we have

$$\tau(x) = E\left[Y_i\left(\frac{W_i}{e(x)} - \frac{1-W_i}{1-e(x)}\right) \mid X_i = x \right] \tag{3}$$

Where $e(x) = E[W_i \mid X_i = x]$ denotes the propensity (probability) of receiving treatment at x. In the case of sufficiently small partitions, the observations can be obtained by estimating the mean on each partition and then differencing the two types of means:

$$\hat{\tau}(x) = \frac{1}{\{i : W_i = 1, X_i \in L(x)\}} \sum_{\{i:W_i=1, X_i \in L(x)\}} Y_i - \frac{1}{\{i : W_i = 0, X_i \in L(x)\}} \sum_{\{i:W_i=0, X_i \in L(x)\}} Y_i \tag{4}$$

In this paper, the outcome variables (Y_i) are firms' environmental performance in year t. First, we employ Corporate Social Responsibility (CSR) performance to represent the environmental performance of firms. Second, we

adopt Es indicators to estimate firms' environmental performance where Es index refers to the environmental protection rewards. Based on Klassen and McLaughlin (1996), the value of Es is determined by whether the firm has received environmental recognition, *i.e.*, it equals to 1 if the firm has received environmental recognition or other positive evaluations, and 0 otherwise. $W_i = 1$ indicates that A-share listed companies are green credit restricted; $W_i = 0$ indicates that A-share listed companies are not green credit restricted.

Based on previous studies, we also control for the following firm-level characteristics: firm size (*Size*), which is estimated by using the natural logarithm of number of employees; firm growth (ROA), which is estimated by using the ratio of net profit to total assets; firm leverage, which is estimated by using the ratio of total debt to total assets; and total factor productivity (TFP), which is computed using ACF-OP method. The ACF-OP methodology is proposed by Ackerberg, Caves, and Frazer (2006) to correct the OP method proposed by Olley and Pakes (1996); managerial myopia (*Myopia*), which is calculated by using the text analysis approach. Moreover, to alleviate the endogeneity issues caused by omitted variables, we further control firm fixed terms, province fixed terms, and year fixed terms.

Table 1 reports the descriptive results for the main variables.

Table 1. Descriptive results.

Variables	Mean	Max.	Min.	Std. dev.	Obs.
CSR	3.612	4.344	2.921	0.309	4422
Es	0.456	1	0	0.269	4422
Myopia	0.112	0.762	0	0.095	4422
ROA	0.247	0.955	0	0.197	4422
Size	23.122	29.333	18.275	1.496	4422
Leverage	0.506	1.668	-0.510	0.205	4422
TFP	4.102	6.990	2.688	0.761	4422

4. EMPIRICAL RESULTS

4.1. Baseline Results

Table 2 reports the baseline results. In Panel A of Table 2, firms' environmental performance is estimated as CSR performance. In column 1, control variables are added to reduce the interference of omitted variables. Fixed terms are excluded in column 2, but control variables are retained. Based on the preceding columns, we gradually introduce firm fixed, year fixed, and province fixed effects in columns 3 to 5. In Panel B of Table 2, the dependent variables are Es. All the coefficients of the treatment effect are significantly positive at the 1% significance level. The results indicate that firms obtaining green finance have a higher environmental performance than other firms. That is, green finance is beneficial to improving firms' environmental performance, which supports the first hypothesis.

4.2. Robustness Results

To test the robustness of the results, we will employ different methods to rerun the regressions. First, we use the one-to-one nearest neighbor Propensity Score Matching (PSM) method to get new samples and the random forest method to re-estimate the treatment effect. This lowers the estimation bias caused by sample sub-selection. The results in column 1 of Table 3 support that the baseline results are robust. In columns 2, 3, and 4, we use Difference-in-Difference (DID), Bayesian Additive Regression Trees (BART), and matching approaches, respectively. The results in the three models are in line with the baseline results. In panel A, environmental performance is calculated as CSR performance, while environmental performance is calculated as Es in panel B. Therefore, we can confirm that green finance helps to upgrade firms' environmental performance.

Table 2. Baseline results.

Panel A (CSR)	M1	M2	M3	M4	M5
Treatment effect	0.302*** (0.000)	0.312*** (0.000)	0.518*** (0.000)	0.607*** (0.000)	0.522*** (0.000)
Control variables	Yes	No	Yes	Yes	Yes
Firm fixed effect	No	Yes	Yes	Yes	Yes
Year fixed effect	No	Yes	No	Yes	Yes
Province fixed effect	No	Yes	No	No	Yes
Observations	4422	4422	4422	4422	4422
Panel B (Es)	M1	M2	M3	M4	M5
Treatment effect	0.215*** (0.000)	0.225*** (0.000)	0.286*** (0.000)	0.023*** (0.000)	0.224*** (0.000)
Control variables	Yes	No	Yes	Yes	Yes
Firm fixed effect	No	Yes	Yes	Yes	Yes
Year fixed effect	No	Yes	No	Yes	Yes
Province fixed effect	No	Yes	No	No	Yes
Observations	4422	4422	4422	4422	4422

Note: *** indicate statistical significance at the 10% levels, respectively.

Table 3. Robust results.

Panel A (CSR)	M1	M2	M3	M4
Treatment effect	0.219*** (0.000)	0.218*** (0.000)	0.213*** (0.000)	0.222*** (0.000)
Control variables	Yes	Yes	Yes	Yes
Firm fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Province fixed effect	Yes	Yes	Yes	Yes
Observations	1622	4422	4422	4422
Panel B (Es)	M1	M2	M3	M4
Treatment effect	0.219*** (0.000)	0.225*** (0.000)	0.286*** (0.000)	0.023*** (0.000)
Control variables	Yes	Yes	Yes	Yes
Firm fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Province fixed effect	Yes	Yes	Yes	Yes
Observations	1622	4422	4422	4422

Note: *** indicate statistical significance at the 10% levels, respectively.

4.3. Internal Mechanisms

Based on Section 2, we document that the main channels through which green finance improves firms' environmental performance are green innovation improvement and green investment efficiency enhancement. In this section, we will test the two channels empirically.

4.3.1. Green Innovation Improvement Effect

In this subsection, we examine the effect of green finance on firms' green innovation. Green innovation is estimated as the natural logarithm of one plus the number of green-granted patents. The coefficients of the treatment effect in Table 4 are all significantly positive at the 1% significance level, which indicates that green finance upgrades green innovation significantly.

4.3.2. Green Investment Efficiency Enhancement Effect

Next, we test the impact of green finance on the efficiency of firms' green investments. Drawing inspiration from Richardson (2006), we employ the following steps to assess green investment efficiency: Firstly, we calculate the anticipated investment expenditure of companies using formula 5.

Table 4. Possible channels: green innovation improvement.

Green innovation	M1	M2	M3	M4
Treatment effect	0.481*** (0.000)	0.496*** (0.000)	0.495*** (0.000)	0.488*** (0.000)
Control variables	Yes	No	Yes	Yes
Firm fixed effect	No	Yes	Yes	Yes
Year fixed effect	No	Yes	No	Yes
Province fixed effect	No	Yes	No	No
Observations	4422	4422	4422	4422

Note: *** indicate statistical significance at the 10% levels, respectively.

$$Inveff_{it} = \alpha_t + \alpha_i + \lambda_1 Inv_{it-1} + \lambda_2 Growth_{it-1} + \lambda_3 Debt_{it-1} + \lambda_4 LnAge_{it-1} + \lambda_5 Cash_{it-1} + \sum Ind + \sum Year + \varepsilon_{it} \quad (5)$$

Where $Inveff$ indicates the quantity of capital investment estimated as the ratio of capital investment to total assets[1]; $Growth$ equals to the growth rate of operating income; $Debt$ indicates the asset-liability ratio, which is estimated by using the ratio of liability to assets; $LnAge$ represents firms' age, which is estimated by using the natural logarithm of a company's listing period; $Cash$ represents firms' cash flow, which is estimated by using the ratio of cash to total assets. Furthermore, Ind and Year, respectively, represent the industry and year-fixed effects. Secondly, by running Equation 5, we obtain the residual error, which represents the disparity between actual investment expenditure and expected investment expenditure.

Table 5 shows that the treatment effect is significantly positive at the 1% significance level, which confirms that green finance contributes to improving green innovation investment efficiency. Efficient green innovation is the main way to improve firms' environmental performance.

Based on the above tests, we propose that a rise in green innovation and green innovation efficiency promotes firms' environmental performance.

Table 5. Internal mechanisms: green investment efficiency improvement.

Green investment efficiency	M1	M2	M3	M4
Treatment effect	0.381*** (0.000)	0.385*** (0.000)	0.371*** (0.000)	0.395*** (0.000)
Control variables	Yes	Yes	Yes	Yes
Firm fixed effect	No	Yes	No	Yes
Year fixed effect	No	Yes	No	Yes
Province fixed effect	No	Yes	No	Yes
Observations	4422	4422	4422	4422

Note: *** indicate statistical significance at the 10% levels, respectively.

4.4. Heterogeneity Checks

4.4.1. Firm Scale Heterogeneity

In this subsection, we further investigate the heterogeneous effect of green finance on the environmental performance of firms between large-scale firms and small- and medium-scale firms. We split the samples into two subgroups based on whether the value of firms' size is greater than the median value of firms' size in the same industry: large-scale firms (the value of firm's scale is greater than the median value) and small- and medium-scale firms (the value of firm's scale is less than the median value). The results in Table 6 show that the treatment effect of green finance on large-scale firms' environmental performance is insignificant, while the coefficients of treatment effect of green finance on small- and medium-scale firms' environmental performance are significantly positive at the 1% significance level, which supports the fact that the positive effect of green finance on environmental performance is only significant for small- and medium-scale firms, which is consistent with H2.

[1] Capital investment is equal to (capital expenditure + Merger & Acquisition (M&A)) expenditure-income from selling long.

Table 6. Heterogeneity checks: large scale firms vs small- and medium-scale firms.

Panel A (CSR)	Large-scale		Small-and medium-scale	
	M1	M2	M3	M4
Treatment effect	0.021	0.021	0.302***	0.302***
	(0.017)	(0.017)	(0.000)	(0.000)
Control variables	Yes	Yes	Yes	Yes
Firm fixed effect	No	Yes	No	Yes
Year fixed effect	No	Yes	No	Yes
Province fixed effect	No	Yes	No	Yes
Observations	1231	1231	3191	3191
Panel B (Es)	Large-scale		Small-and median-scale	
	M1	M2	M3	M4
Treatment effect	0.015	0.016	0.017***	0.016***
	(0.017)	(0.015)	(0.000)	(0.000)
Control variables	Yes	Yes	Yes	Yes
Firm fixed effect	No	Yes	No	Yes
Year fixed effect	No	Yes	No	Yes
Province fixed effect	No	Yes	No	Yes
Observations	1231	1231	3191	3191

Note: *** indicate statistical significance at the 10% levels, respectively.

4.4.2. Firm Ownership Heterogeneity

Next, we further examine the heterogeneous effect between SOEs and non-SOEs. We divide the samples into two sub-groups based on the ownership information recorded in the CSMAR database: non-SOEs and SOEs. The results are reported in Table 7. The coefficients of treatment effect for SOEs are insignificant, while the treatment effects for non-SOEs are all significantly positive at the 1% significance level. This indicates that the effect of "Green Credit Guidelines" on the environmental performance of firms is only pronounced for non-SOEs. The results are in line with H3.

Table 7. Heterogeneity checks: SOEs vs non-SOEs.

Panel A (CSR)	SOEs		Non-SOEs	
	M1	M2	M3	M4
Treatment effect	0.081	0.081	0.261***	0.265***
	(0.176)	(0.176)	(0.000)	(0.000)
Control variables	Yes	Yes	Yes	Yes
Firm fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Province fixed effect	Yes	Yes	Yes	Yes
Observations	1231	1075	3191	3347
Panel B (Es)	SOEs		Non-SOEs	
	M1	M2	M3	M4
Treatment effect	0.012	0.012	0.013***	0.013***
	(0.010)	(0.010)	(0.000)	(0.000)
Control variables	Yes	Yes	Yes	Yes
Firm fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Province fixed effect	Yes	Yes	Yes	Yes
Observations	1075	1075	3347	3347

Note: *** indicate statistical significance at the 10% levels, respectively.

5. CONCLUSION

In order to promote firms' environmental performance, the Chinese government has issued a strand of green finance policies. In this paper, we examine the impact of green finance on the environmental performance of enterprises by employing advanced random forest methods. Employing panel data from A-share listed Chinese firm-level samples from 2012 to 2017, we obtain the core results as follows: The baseline results show that digital finance

is beneficial for boosting the environmental performance of firms. These results are supported in various model settings. Secondly, the internal mechanism checks show that the main channels through which green finance improves firms' environmental performance are an increase in green innovation and green innovation investment efficiency upgrading. Moreover, the heterogeneity checks show that the positive effect of green finance on firms' environmental performance is only pronounced for small- and medium-scale firms and non-SOEs.

The main conclusions clarified a number of policy consequences. First, from the viewpoint of those in charge of policy. By increasing the effectiveness of the allocation of financial resources, they should encourage businesses to finish the green transformation, especially non-SOEs and small- and medium-sized businesses. Local governments ought to be more attentive to green credit policies, clear any obstacles to the financial system's policy transmission, and pique businesses' interest in being green. Second, from the standpoint of businesses, particularly private and small- and medium-sized businesses, they ought to use green finance in order to boost expenditures in green R&D and enhance the efficiency of green innovation.

Though this paper achieves several findings, there are several limitations. First, we only focus on the direct effect of green finance on environmental performance, and future research can try to explore its spillover effect on environmental performance. Second, we chose Chinese A-share-listed firms as samples. The results cannot be used to explain other firms' environmental performance. It would be interesting to expand the samples to other firms in future studies.

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