Do government policies drive institutional preferences on green investment? Evidence from China

Wu-E Yang1 · Pei-Wen Lai1 · Zhi-Qiu Han1 · Zhen-Peng Tang2

Abstract
Through the introduction of green finance policies, governments hope to improve the guiding role of institutional investors in green investment and provide financial support for green enterprises. Using the data in China, the difference-in-difference (DID) analysis explores whether the implementation of policies could change institutional investors’ attitude to environmental factors when making investment decisions. Considering the effect of investment horizons, we find that long-term institutional investors have shown symmetric preferences on green investment, while short-term institutions are more affected by green finance policies. Additionally, the mechanism analysis shows that green finance policies can influence the green investment of institutional investors not only by affecting stock price returns but also by increasing the innovation capabilities of green companies and thus improving corporate performance. Besides, heterogeneity and moderating effect analyses find that green finance policies can achieve better policy effects when financial institutions invest in non-state-owned enterprises, enterprises with higher quality of information disclosure and poor external supervision. The finding would extend the studies of green investment in emerging markets and present new evidence about the policy effect on institutions’ preferences for green investment.

Keywords Green investment · Institutional preferences · Environmental information disclosure · Government policies · Green finance · External audits

Introduction
The conflict between economic growth and environmental protection makes sustainable development and green recovery become a common topic all around the world (Sun et al. 2019; Zhang 2022). Major economies have issued corresponding policies to improve environmental quality and support sustainable development (Tao et al. 2022). One of the common strategies is to encourage financial sectors to participate in green projects (Cui et al. 2022). Thus, developing green finance and green investment has become an irreversible trend in the global world.

Then, a series of studies about green finance have been conducted. Many of them focus on the macroeconomy, such as exploring whether green finance policies are conducive to sustainable development (Hussain and Lee 2022; Zhang et al. 2022c) and reducing carbon emissions (Han 2020; Lee et al. 2022a; Tong et al. 2022). At the micro-level, the impacts of green finance policies on green innovation (Yang et al. 2022; Yu et al. 2021; Zhao and Wang 2022) and promoting the transformation of heavily polluting enterprises (Shi et al. 2022; Tian et al. 2022; Xu and Li 2020; Zhang and Lu 2022) are mainly discussed. However, research on green investment needs to be deepened.

We focus on the policy impact on green investment of financial institutions. On the one hand, institutional investors appear to be more rational (Daniel et al. 1997) and possess
more information advantages, professional skills, processing capabilities, and stronger financial strength (Stolin and David 2008). They could be more sensitive to policy changes, and then release signals to the market, thus attracting more social capital like individual investors to enter the field of green investment through direct or indirect financing (Khursheed et al. 2014). On the other hand, as major promotors of green finance, studying whether financial institutions are willing to carry out green finance business and engage in green investment is directly related to whether the implementation of green finance policies is sustainable.

Although prior studies have proved that institutional investors in developed markets are willing to actively participate in corporate governance and promote the improvement of environmental performance (Dyck et al. 2019; Fu et al. 2019; Kordsachia et al. 2021), institutional investors’ preferences on green investment remain uncertain in emerging markets. For example, in China, they rely more on government pressure to provide financial loans, bonds, stocks, insurance, and other financial services for green industries (Lee 2020). This means that its development pattern of green finance may be quite different with developed countries (DRC 2016). We believe that understanding the stories in these developing regions can better help us understand the role of green finance policies in guiding global sustainable development and then accelerate this great transformation. It encourages us to examine the evidence in China, the biggest manufacturing country and the second largest economy in the world.

In recent years, environmental issues have been one of the important factors restricting China’s sustainable economic growth. China has determined to shift its economy from high-speed growth to high-quality development. The transformation of its overall development strategy requires financial institutions to play a guiding role in resource allocation to promote the improvement of green investment and the development of the low-carbon business.

Chinese governments, as a key driver, have promulgated a series of measures in establishing the green finance system (Xu and Liu 2020). Since the People’s Bank of China and other Chinese ministries and commissions have promulgated the guidelines for green finance in 2016, the green finance system began taking shape (Feng et al. 2021). In June 2017, the central bank and other four regulators issued a plan of financial standardization system from 2016 to 2020. This action makes the green financial standardization project one of the main projects of financial standardization during the 13th Five-Year Plan. Besides, the State Council approved the construction of pilot zones for green finance reform and innovation in five provinces, namely Zhejiang, Jiangxi, Guangdong, Guizhou, and Xinjiang. One of the top priorities in pilot zones is to support financial institutions to set up green finance business units and encourage venture capital, private equity funds, and QFII to participate in green investment.

Such top-down establishment of the green finance system thus provides a perfect quasi-natural experiment to mitigate potential endogenous problems (Cui et al. 2022) and test more pure policy effects on institutional awareness of green investment.

Besides, as the first country in the world that the central government promotes the establishment of a green finance system and a country whose economy is in transition to high-quality development, China’s experience can provide important prior experience for manufacturing countries and emerging markets that are in a period of economic transition and green investment is still in its infancy.

In this paper, we use Chinese local ESG rating database to explore the policy effect on the relationship between green investment and institutional ownership. Based on the sample period from 2016Q1 to 2019Q3, we find that green finance policies do change institutional preferences on green investment. After conducting a series of robustness tests, this result remains robust. The mechanism analysis shows that green innovation, improved corporate values, and changes in stock prices are potential channels for green finance policies to influence institutional preferences. Additionally, comparing with long-term investors, short-term institutions react more positively to green finance policies and the changes of their holdings are positive associated with abnormal returns aroused by green finance policies. Finally, the further study proves that green finance policies can achieve better policy effects when institutional investors invest in non-state-owned enterprises, enterprises with higher quality of information disclosure and poor external supervision.

This paper would make the following contributions. Firstly, it discusses the effect of green finance policies on green investment preferences of institutional investors rather than on enterprises (Liu et al. 2019; Zhou et al. 2021). It could provide a new perspective for the policy effect of green finance, supplement the literature related to green investment, and further provide a reference for the green finance policies of other emerging markets.

Secondly, by exploring the mechanisms of policies affecting green investment and the responses of different types of institutional investors to policies, we can further understand how green finance policies can better encourage more institutional investors and social capital into green enterprises to promote the green transformation of enterprises.

Thirdly, by exploring the preferences of financial institution investors for green investment, it could help us further understand the possibility of financial institutions participating in corporate governance to promote the green transformation of enterprises in emerging markets.

The remainder content is organized as follows. “Theoretical background and hypothesis development” section
describes the related literature and hypothesis. Then we introduce the data and model used in the “Data and method” section and describes the main empirical results in the “Baseline empirical results” section. “Further studies” section empirically examines mechanism analysis, heterogeneity analysis, and moderating effect analysis. Finally, we present the conclusion in the final section.

**Theoretical background and hypothesis development**

Green investment originated from social responsibility investment and has gradually grown with the environmental issues being gradually valued. By using systematic green investment strategies to invest in enterprises or projects that can produce environmental benefits, it can promote corporate environmental performance, develop green industries, and reduce environmental risks (Cui et al. 2020). Cai and Guo (2021) collected relevant literature and found that research on corporate social responsibility has become popular from 2015 to 2018, while until 2019, green investment became an independent topic for researchers.

Green finance policies and green investment of financial institutions

Doval and Negulescu (2014) have pointed out that green finance is one of the key drivers to green investment. In this paper, we focus on the policy impact on green investment of institutional investors who play a significant role in supporting the green projects (Taghizadeh-Hesary and Yoshino 2019). Besides, Colenbrander et al. (2017) also emphasized the importance of institutional investors in establishing a green finance system.

Previous studies have proved that the promulgation of government policies could affect the investment decision of institutional investors (You and Zhang 2008). After investigating political intervention at the national and regional level, Lin et al. (2013) found that both nationwide and regional political shocks have a significant impact on the investment behavior of mutual funds. Additionally, Doval and Negulescu (2014) studied the effect of green finance on financial institutions and found that the regulatory pressure will impact financial sectors’ behaviors.

Considering the implementation of green finance policies could bring external pressure on financial institutions and encourage them to focus more on firms’ environmental practices, hypothesis 1 is proposed as follows:

**H1:** The implementation of green finance policies would affect financial institutional preferences on green investment.

### The mediating effect of green innovation and firm values

Green finance policies can indirectly influence investment preferences of institutional investors by affecting corporate performance. Prior studies have different opinions in the impact of green finance policies. Some believe that the implementation of policies will pose great pressure on enterprises, increase pollution control costs, and reduce corporate performance (Li et al. 2022; Shi et al. 2022; Zhang et al. 2022a), thus resulting the reduction of institutional holdings. For example, a firm who commits to mitigate environmental problems by conducting waste management or hiring environmental auditors (Blomgren 2011), may increase more potential costs and then cause damages to their productivity and profitability (Lee et al. 2015; Palmer et al. 1995). He et al. (2019) investigated 141 listed renewable energy enterprises in China and found that green finance policies inhibit the improvement of renewable energy investment efficiency. Fang and Shao (2022) also proved that green finance will weaken the positive effect of “market-incentive” environmental regulations on green innovation.

However, others support the Porter hypothesis (Porter and Van der Linde 1995) and indicate that the green finance policy can effectively alleviate financing restrictions on green innovation (Jin et al. 2021; Yu et al. 2021), and spur firms to innovate (Zhang et al. 2022b; Zhang and Li 2022), thereby significantly improving the level of green productivity (Lee and Lee 2022; Lee et al. 2022b). Thus, institutional investors who focus on corporate profitability and growth prospects would be attracted and increase their investment (Ng and Rezaee 2020). Wang et al. (2022) used the data of 57 developing countries and found green finance policies positively affect green innovation in emerging markets, proving the Porter hypothesis. But some scholars have different views on the incentive mechanism of green finance. After investigating the influence of green finance pilot zones on heavy-polluting enterprises, Shi et al. (2022) found that the improvement of productivity is a result of “stimulating reputation insurance effect,” rather than the “innovation compensation effect” proposed by Porter hypothesis.

In this paper, we follow the Porter hypothesis to investigate the policy impact on green innovation and firm values, and examine whether the changes of green innovation and firm values would affect investment preferences of institutional investors. Thus, we propose the hypothesis 2:

**H2:** Green finance policies could promote institutional investor preferences for green investment by green innovation and improved firm values.

However, in the Chinese financial system, SOEs always have preferential credit channels, lower loan terms, and
lower interest rates (Feng et al. 2019; Yu et al. 2021), while non-SOEs may face more financing constraints, making them face stronger survival pressure (Cui et al. 2022). Thus, in order to obtain more financial support from green finance, non-SOEs have stronger incentives to improve their green innovation efficiency. Prior research also shows that the impact of green finance policies on innovation capacity and financial performance of non-SOEs is more pronounced (Cui et al. 2022; Wu et al. 2022). Therefore, we propose the hypothesis 3:

H3: The implementation of green finance policies can achieve more significant policy effects when financial institutions invest in non-SOEs.

The mediating effect of abnormal returns

As a government policy, the implementation of the green finance policy will also cause market reactions in the stock market. Existing research has revealed that firms with poor environmental performance in heavily-polluting industries have experienced a significant decrease in cumulative abnormal returns after the government announcing policies about carbon emission (Chen et al. 2020; Guo et al. 2020; Ramiah et al. 2013). Besides, the stock market tends to encourage those firms with higher environmental performance by providing higher returns (Wang et al. 2019; Xu et al. 2011). Therefore, as rational investors, institutional investors may increase investment after the introduction of favorable policies to obtain higher returns and quickly leave the market after the introduction of bearish policies to reduce potential losses.

Additionally, considering the heterogeneity of financial institutional investors, prior studies have found that long-term institutions focus more on firms’ fundamentals and long-term values (Shirasu and Kawakita 2021), while short-term institutions have more short-sightedness and prefer short-term returns (Bushee 2001; Lowenstein 1989). Therefore, long-term institutional investors who focus more on fundamental analysis, appear to have stable stock holdings, and the impact of abnormal returns on them will not be particularly significant. However, short-term institutions who prefer to participate in aggressive investments strategies due to short-term performance pressure, may be more responsive to the change of abnormal returns affected by policies. Hence, we formulate the following hypothesis:

H4: Green finance policies could affect institutional investor preferences for green investment by changing abnormal returns, and short-term institutional investors would be affected more significantly.

The moderating effect of internal disclosure

We compose the signaling theory to discuss the moderating effect of internal disclosure on environmental performance. When a company discloses environmental-related reports, it is equivalent to sending a signal to the outside world that the company attaches greater importance to environmental changes and has achieved better environmental performance (Shi et al. 2022). As signal receivers, investors will interpret the signal as the potential for companies to increase revenues, leading to a positive reaction in the stock market (Chen et al. 2020). Stuart et al. (2020) also indicated that independent announcement on environmental issues can be viewed as a positive ethical signal.

Therefore, environmental disclosure as a signal does not always bring positive effects. When a company has poor environmental performance but still chooses to disclose environmental indicators, it may ultimately bring about a negative reaction in the stock market and exacerbate the reduction of investors’ shareholdings. Hypothesis 5 for internal disclosure of environment information is thus presented:

H5: The higher level of environmental disclosure would expand the policy effect on institutional preferences.

The moderating effect of external audits

External auditors may provide assurance of the quality of publicly reported accounting information, and stricter oversight by higher quality auditors will reduce the discretion of inside managers to distort financial reporting, thereby limiting managers’ ability to extract wealth from outside shareholders (Fan and Wong 2005; Guedhami et al. 2014). This evidence implies that high quality auditors are more likely to protect outside investors from varnishing of company’s financial reports by insiders.

Additionally, prior research has found that Big 5 auditors generally have higher international reputations and appear to be more independent than local auditors (Fan and Wong 2005). Comparing with non-Big 4 auditors, Big 4 auditors tend to show lower earnings management costs, greater accounting transparency, higher valuations, and lower equity financing costs (Guedhami et al. 2014). They may also supply better external supervision, thus enhancing investor confidence in the company’s financial integrity (Goldie et al. 2018; Kim and Zhang 2014).
Chen (2014) also found that the existence of Big 4 auditors may mitigate the possibility of involving in corporate scandals of a company. Investors would automatically reduce their expectations for the severity of undiscovered misconduct when evaluating stocks of listed companies. Besides, considering institutional investors may originally hold more shares in companies with high external audit quality, the increase of shareholdings in firms with high external audit quality and better environmental performance would be smaller than that hiring non-Big 4 auditors. Hence, the sixth hypothesis is proposed as follows:

H6: The stronger external audits would narrow down the policy effect on institutional preferences.

Data and method

Sample selection and data sources

We examine the environmental scores and institutional ownership of all listed A-share firms in the China stock market. The data cover the period from the first quarter of 2016 to the third quarter of 2019. We obtain environmental ratings from Huazheng ESG database and A-share firms’ information from the Chinese Securities Market and Accounting Research (CSMAR) database. To control for bias, we remove financial companies and specially treated (ST) firms on the verge of delisting. Besides, firms with missing data are excluded. All continuous variables are winsorized at the 1st and 99th percentiles to reduce the influence of outliers. The final sample consists of 43,953 firm-quarter observations.

Huazheng environmental ratings

The Huazheng ESG database is produced by Sino-Securities Index Information Service (Shanghai) Co.ltd in China. We construct our environmental measures using this database for two reasons. First, it has a larger database of China environmental ratings covering all-listed A-share firms in China across time with the earliest data reporting backtrack to 1990, while the widely used datasets around the world like MSCI ESG Ratings only measure hundreds of firms in the China stock market. Second, it will be better suited to properly measure firms’ performance, since the green investment still be a new topic in China. For instance, indicators like fossil energy utilization, green finance will have a huge difference compared to foreign countries. Thus, it would be better to use China local database to capture the environmental performance of firms in China. These ESG rating data are divided into nine levels from AAA to C respectively. Figure 1 shows the tendency of the average scores of firms in sample from 2016Q1 to 2019Q3. And we define AAA to C as 9 to 1 point. Comparing with the average ESG scores which is from 6 to 7 point, the average environmental scores are lower, from 4 to 5 point. There is huge room for financial institutions and companies to drive corporate environmental performance in China.

Institutional ownership (IO)

Institutional investors in China can be classified as financial institutions (like QFII, mutual funds, securities et al.) and general legal person institutional investors (like non-financial publicly listed firms). Based on the purpose of the research, we only analyze financial institutional investors consisting of QFII, mutual funds, securities, social security funds, insurance companies, trusts, banks, and finance companies (accounting for almost 99% among all financial institutional investors).

Institutional investors are able to get more information about the company through various channels and professional analysis capabilities. And the changes in institutional investors’ shareholdings can convey the information they get. So, we calculate the institutional ownership using the number of institutional holdings divided by the company’s outstanding shares.

To figure out the heterogeneity of institutional investors, we further compute the portfolio turnover over the past 2 years as an investment horizon proxy in our research. Following the prior research, this variable is constructed in three steps (Zhang and Yan 2009). Firstly, we calculate each institutional investor’s churn rate semiannually by applying the following equation:

\[
CR_{buy,i} = \sum_{t=1}^{N_i} \left| S_{k,i,t} \cdot P_{i,t} - S_{k,i,t-1} \cdot P_{i,t-1} - S_{k,i,t-1} \cdot \Delta P_{i,t} \right| \quad \text{if } S_{k,i,t} > S_{k,i,t-1}
\]

\[
CR_{sell,i} = \sum_{t=1}^{N_i} \left| S_{k,i,t} \cdot P_{i,t} - S_{k,i,t-1} \cdot P_{i,t-1} - S_{k,i,t-1} \cdot \Delta P_{i,t} \right| \quad \text{if } S_{k,i,t} < S_{k,i,t-1}
\]

where \(P_{i,t-1}\) and \(P_{i,t}\) are the share prices for stock \(i\) at the end of period \(t-1\) and \(t\), and \(S_{k,i,t-1}\) and \(S_{k,i,t}\) are the number of shares of stock \(i\) held by investor \(k\) at the end of period \(t-1\).
and $t$ respectively. $CR_{buy_k_t}$ and $CR_{sell_k_t}$ are institution $k$’s aggregate purchase and sale for period $t$, respectively. Institution $k$’s churn rate for period $t$ is then defined as follows:

$$CR_{k,t} = \min \left( CR_{buy_k,t}, CR_{sell_k,t} \right) \frac{\sum_{i=1}^{N_5} S_i \cdot p_{i,t} + \sum_{j=1}^{N_5} p_{j,t-1}}{2}$$

we finally calculate the investor turnover of firm $i$ as the weighted average of the total portfolio churn rates of its investors over our sample period, as follows:

$$\text{Investor Turnover}_i = \sum W_{i,t} \left( \frac{1}{4} \sum_{r=1}^{3} CR_{k,t-r+1} \right)$$

where $W_{i,t}$ is the proportion of investor $i$’s ownership in the total ownership held by institutional investors at period $t$. Given the average churn rate measure, we sort all institutional investors into three tertile portfolios based on the firms’ turnover rate. Those ranked in the top tertile are classified as short-term institutional investors and the bottom tertile are classified as long-term institutional investors.

**Control variables**

To mitigate the heterogeneity of different firms and improve the robustness of analysis, seven control variables, namely $PB$, $ROE$, $IPOA$, $LEV$, $HHI5$, $SIZED$, and $BIG4$ are included following the previous studies.

Following Graves and Waddock (1994), we use the debt-to-asset ratio ($LEV$) as the measurement of firm leverage and $ROE$ as the measurement of firm performance. Besides, price-to-book ratio ($PB$) measures the value of investing in a company. $IPOA$ refers to the number of years that a company exists after IPO, measuring the cognition degree of investors, since stock with longer IPO ages could have more open data. Unlike the common practice measured by the natural logarithm of the firm’s market capitalization (Bushee 2001), we set a dummy variable ($SIZED$) that equals to one if the firm is a big company and zero if it is not according to the standard of China’s National Bureau of Statistics (2017) to measure this variable.

According to Fan and Wong (2005), high-quality auditors could provide better supervision and reliable reports for investors. We add $BIG4$ as the measure of a dummy variable that equals to one if the firm is audited by Big 4 global accounting firms and equals to zero if it is not. We also set $HHI5$, the total squares of the ratio of the top 5 large shareholder’s ownership to measure the ownership concentration (Jiang et al. 2018). Table 1 shows the explanation of all variables.

**Model specification**

Considering almost 9% of publicly trading firms do not receive financial institutional investors’ investment, it could be hard to get the unbiased result by OLS regression. After conducting the maximum likelihood test, we choose the random-effects Tobit regression model instead of the pooled panel Tobit regression to test the policy effect on institutional preferences. To avoid the endogeneity, we use one-period lag variables and add industry and time dummy variables in the model.

To measure the effect of green finance policies, we treat the plan of implementing “the guidelines for green finance” (the plan) at 2017Q2 as an exogenous regulatory shock and consider a time period from 2016Q1 to 2019Q3 to conduct a DID analysis. As the promulgation of policies are exogenous relative to the microeconomic subjects, the excellent feature of the DID model help us avoid a large part of the endogeneity (J. He and Huang 2017; Zeng et al. 2022). We thus estimate DID models using the following equations:

$$IO_{i,t} = \alpha + \beta_1 E_{weakness_{i,t-1}} + \beta_2 E_{weakness_{i,t-2}} \cdot \text{Post} + \Sigma \beta_j \text{Control}_{i,t-1} + \epsilon_{i,t} \tag{1}$$

$$IO_{i,t} = \alpha + \beta_1 E_{strength_{i,t-1}} + \beta_2 E_{strength_{i,t-2}} \cdot \text{Post} + \Sigma \beta_j \text{Control}_{i,t-1} + \epsilon_{i,t} \tag{2}$$

where $IO_{i,t}$ is the institutional ownership for firm $i$ in at the end of each quarter $t$. We divide environmental scores into three groups: weakness, average, and strength. Then we set two dummy variables: $weakness$ and $strength$. The $E_{weakness}$ ($strength$) variable is a dummy variable, which equals to 1 when the environmental scores of firm $i$ in quarter $t-1$ belong to the lowest (highest) group and equals to 0 when they are in the average group. Standards that divide environmental scores into $weakness$ and $strength$ are shown in Table 1. Control refers to various firm specific control variables. All of the firm-specific control variables are from quarter $t-1$ to minimize endogeneity concerns.

The dummy variable Post is defined in the following way: the first quarter of 2016 (t-5) to the first quarter of 2017 (t-1) are defined as “pre” period, and the third quarter of 2017 (t+1) to the third quarter of 2019 (t+9) are defined as “post” period. By defining pre- and post-periods in this way, there is a clear prediction on the sign of the coefficient $\beta_2$ from the above equation. After the policy, financial institutions are expected to improve their investment in firms with environmental strength and reduce their investment in environmental weakness. Hence, $\beta_2$ is predicted to be negative in the Eq. (1) and positive in the Eq. (2).

**Summary statistics**

The summary statistics of variables are reported in Table 2. Panel A shows that the average value for financial institutional investors
is 4.94%, only accounting for relatively small proportions. However, the maximum value is 26.55%, suggesting the institutional ownership varies greatly among different enterprises.

Panel B presents the descriptive statistics of two groups: environmental weakness and strength respectively. The average value of \( IO \) in environmental strength group (6.43%) is much higher than that in environmental weakness group (4.40%). Besides, long-term institutional investors also have higher ownership for firms with environmental strength, while there is no obvious difference for short-term institutions. The above results support our assumption that financial institutions with longer investment horizons would show more interest in green investment. The distribution of other variables is within a reasonable range.

Table 3 reports the correlation matrix of the variables used in the empirical analysis. The correlation results show that correlations among all variables are pretty low with a 1% significance level.

### Baseline empirical results

#### Difference-in-difference (DID)

We first estimate the DID model of environmental weakness and strength by controlling the time and industry fixed effects. Columns (1) and (2) in Table 4 display the regression results respectively. In column (1), the coefficient of \( \text{Environmental weakness} \times \text{Post} \) is statistically insignificant, suggesting that there are no different changes in institutional holdings for stocks with poor and average environmental performance after the plan. In contrast, the coefficient of \( \text{Environmental strength} \times \text{Post} \) in column (2) is significantly positive (0.814%), meaning that financial institutions would increase their investment for firms with high environmental performance after the plan.

However, the bidirectional causality problem could exist in the regression, since the increase in the positive relationship between institutional ownership and environmental scores could be the result of institutions promoting the environmental scores after the plan (Dyck et al. 2019; Kim et al. 2019a; Kordsachia et al. 2021). We thus remove firms that produce changes in environmental scores to mitigate the endogenous problem. Therefore, we get the pure impact of policies on institutional preferences. Columns (3) and (4) show the results after considering the endogenous problem. For environmental weakness, the interaction \( \text{Environmental weakness} \times \text{Post} \) is insignificant, consistent with the result in column (1). For environmental strength, the proportion of institutional holdings increases significantly (0.744%) after the plan, while the degree of increase is less than the result in column (2).

### Table 1 Variable definitions

| Variable name                     | Variable symbol | Description                                                                 |
|-----------------------------------|-----------------|-----------------------------------------------------------------------------|
| Dependent variable                |                 |                                                                             |
| Institutional ownership           | \( IO \)        | The number of financial institutional holdings divided by the company’s outstanding shares |
| Short-term institutional ownership| \( SHORT\_IO \) | The number of short-term financial institutional holdings divided by the company’s outstanding shares |
| Long-term institutional ownership | \( LONG\_IO \)  | The number of long-term financial institutional holdings divided by the company’s outstanding shares |
| Independent variables             |                 |                                                                             |
| Environmental scores              | \( E \)         | Firms’ environmental ratings, setting AAA to A as environmental strength and CCC to C as environmental weakness |
| Control variables                 |                 |                                                                             |
| Price-to-book ratio               | \( PB \)        | Price-to-book ratio to measure the value of investing in a company          |
| Profitability                     | \( ROE \)       | Rate of return on common stockholders’ equity to measure the companies’ profitability |
| IPO age                           | \( IPOA \)      | The year a company exists after IPO                                         |
| Firm leverage                     | \( LEV \)       | Liabilities divided by net assets to measure a companies’ debt paying capacity |
| Ownership concentration           | \( HHI5 \)      | The total squares of the ratio of the top5 large shareholder’s ownership to measure the ownership concentration |
| Firm size dummies                 | \( SIZED \)     | A dummy variable that equals to one if the firm is a big companies according to the standard of China’s National Bureau of Statistics and equals to zero if it is not |
| Auditors                          | \( BIG4 \)      | A dummy variable that equals to one if the firm is audited by Big Four global accounting firms and equals to zero if it is not |
Robustness test

Placebo test

To further prove the accuracy of the baseline regression, we also conduct a placebo test. Because the DID test for environmental weakness is insignificant, we only test the regression of environmental strength. We first assume that the green finance policy was implemented in 2015Q2, 2 years before the plan. And then we test the policy effect from 2014Q1 to 2017Q1. The result in Table 5 shows that the hypothetical policy does not impact the green investment preferences of financial institutions, enhancing the robustness of the baseline results.

Then we randomly select the firms with environmental strength. Regressions are repeated at 500 times according to Eq. (2). The kernel density distribution of the estimated coefficients is shown in Fig. 2. The result shows that the distribution of coefficients follows a normal distribution and the mean of coefficients is 0.0018. Besides, the coefficient of the baseline regression is a significant outlier, indicating that the baseline results are unlikely to be obtained randomly, which further proves the credibility of our research.

Table 2 Summary statistics.
This table provides summary statistics of financial institutions and firms' characteristics. The sample consists of 43,953 firm-quarter observations across A-share firms over the 2016–2019 period. All continuous variables are winsorized at the 1st and 99th percentiles.

| Panel A: full sample | Variables   | Observation | Mean   | SD     | Min    | Median   | Max     |
|----------------------|-------------|-------------|--------|--------|--------|----------|---------|
| IO (%)               | 43953       | 4.94        | 5.605  | 0.000  | 3.020  | 26.546   |
| SHORT_IO (%)         | 43949       | 2.04        | 3.713  | 0.000  | 0.3171 | 19.094   |
| LONG_IO (%)          | 43949       | 1.47        | 3.267  | 0.000  | 0.001  | 18.714   |
| PB                   | 42408       | 3.70        | 2.968  | 0.588  | 2.847  | 19.731   |
| LEV                  | 43858       | 0.37        | 0.206  | 0.012  | 0.346  | 0.887    |
| IPOA                 | 43865       | 10.16       | 7.661  | 0.000  | 8.000  | 27.000   |
| ROE                  | 42207       | 0.03        | 0.041  | −0.079 | 0.023  | 0.195    |
| HH15                 | 43953       | 0.16        | 0.110  | 0.014  | 0.132  | 0.540    |
| SIZED                | 43953       | 0.69        | 0.462  | 0.000  | 1.000  | 1.000    |
| BIG4                 | 43953       | 0.06        | 0.243  | 0.000  | 1.000  | 1.000    |

| Panel B: sub-samples with environmental strength and weakness |
|-------------------------------------------------------------|
| Variables               | Weakness Mean | SD   | Strength Mean | SD   |
|-------------------------|---------------|------|---------------|------|
| IO (%)                  | 4.40          | 5.507| 6.43          | 5.898|
| SHORT_IO (%)            | 1.96          | 3.762| 2.03          | 3.242|
| LONG_IO (%)             | 1.32          | 3.267| 1.83          | 3.468|
| PB                      | 3.85          | 2.987| 2.82          | 2.314|
| LEV                     | 0.36          | 0.203| 0.42          | 0.208|
| IPOA                    | 8.92          | 7.533| 14.29         | 6.812|
| ROE                     | 0.03          | 0.040| 0.04          | 0.041|
| HH15                    | 0.15          | 0.107| 0.17          | 0.114|
| SIZED                   | 0.65          | 0.476| 0.81          | 0.389|
| BIG4                    | 0.03          | 0.181| 0.15          | 0.353|

Table 3 Correlation matrix

| Variables | IO   | SHORT_IO | LONG_IO | E    | PB   | LEV   | IPOA   | ROE   | HH15 | SIZED | BIG4 |
|-----------|------|----------|----------|------|------|-------|--------|-------|------|-------|------|
| IO        | 1.000|          |          |      |      |       |        |       |      |       |      |
| SHORT_IO  | 0.461| 1.000    |          |      |      |       |        |       |      |       |      |
| LONG_IO   | 0.512| 0.004    | 1.000    |      |      |       |        |       |      |       |      |
| E         | 0.113| 0.019    | 0.046    | 1.000|      |       |        |       |      |       |      |
| PB        | 0.021| 0.188    | −0.062   | −0.052| 1.000|       |        |       |      |       |      |
| LEV       | 0.069| −0.038   | 0.055    | 0.030| −0.066| 1.000 |       |       |      |       |      |
| IPOA      | 0.129| −0.134   | 0.070    | 0.173| −0.204| 0.243 | 1.000  |       |      |       |      |
| ROE       | 0.120| 0.220    | −0.022   | 0.026| 0.073 | −0.167| −0.128 | 1.000 |      |       |      |
| HH15      | −0.110| −0.029   | −0.029   | 0.022| −0.034| 0.031 | −0.068| 0.123 | 1.000|      |      |
| SIZED     | 0.126| 0.094    | 0.050    | 0.109| −0.165| 0.164 | 0.081 | 0.190 | 0.084| 1.000|      |
| BIG4      | 0.064| 0.021    | 0.034    | 0.123| −0.064| 0.098 | 0.086 | 0.042 | 0.182| 0.094| 1.000|
Parallel trend test

An important assumption of DID model is that the trend of treatment and control groups should be consistent before the shock of policies. To check it, we execute a parallel trend test that not only can show the tendency of two groups before policies conducted, but also can check the duration of the impact after enacting policies.

The result for the dynamic effect test is reported in Fig. 3 along with a simultaneous 90% confidence band. Because the policy effect on environmental weakness is insignificant, we only test the dynamic effect on environmental strength. The result shows that all coefficients are insignificantly indifferent from zero before the plan issued (2017Q2), meeting the assumption of the parallel trend test. But after the shock of the green finance policy, institutional ownership for environmental strength grows rapidly comparing the control group, and all coefficients are significantly positive during the sample period. This trend indicates that the issue of the plan obviously promotes institutional holdings for firms with environmental strength.

Table 4 This table shows the result for the effect of the plan issued in 2017Q2. The scores are calculated using data from the CSMAR database. The sample period is from the first quarter of 2016 to the third quarter of 2019. Variables are winsorized at the 1st and 99th percentiles. The independent variables are lagged by one quarter. The result of t-statistics is reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively.

| Dependent variables: | IO |
|----------------------|----|
|                      | (1) | (2) | (3) | (4) |
| Environmental scores:|     |     |     |     |
| Weakness_t-1         | −0.098 | −0.109 |     |     |
|                      | (0.150) | (0.156) |     |     |
| Strength_t-1         | 0.306** | 0.450*** |     |     |
|                      | (0.153) | (0.159) |     |     |
| Environmental scores*post | 0.030 | 0.814*** | 0.021 | 0.744*** |
|                      | (0.087) | (0.097) | (0.088) | (0.095) |
| PB_t-1               | 0.073*** | 0.181*** | 0.075*** | 0.176*** |
|                      | (0.012) | (0.014) | (0.012) | (0.014) |
| LEV_t-1              | −0.878*** | −0.350* | −0.872*** | −0.303 |
|                      | (0.180) | (0.198) | (0.182) | (0.192) |
| ROE_t-1              | 1.671** | 0.065 | 1.685** | 0.142 |
|                      | (0.651) | (0.710) | (0.658) | (0.691) |
| HHI5_t-1             | −9.435*** | −10.792*** | −9.696*** | −10.281*** |
|                      | (0.613) | (0.711) | (0.626) | (0.685) |
| IPOA_t-1             | 0.077*** | 0.110*** | 0.077*** | 0.097*** |
|                      | (0.014) | (0.017) | (0.014) | (0.016) |
| SIZED_t-1            | 0.223*** | 0.094 | 0.222*** | 0.112* |
|                      | (0.058) | (0.066) | (0.058) | (0.064) |
| BIG4_t-1             | 1.934*** | 2.262*** | 1.916*** | 2.018*** |
|                      | (0.469) | (0.425) | (0.480) | (0.408) |
| Constant             | 5.206*** | 4.578*** | 5.215*** | 4.654*** |
|                      | (0.241) | (0.287) | (0.245) | (0.277) |
| Industry and time dummies | Yes | Yes | Yes | Yes |
| Log likelihood       | −75888.647 | −60023.847 | −73790.137 | −59640.682 |
| sigma_u              | 4.569*** | 4.953*** | 4.586*** | 4.749*** |
| sigma_e              | 3.136*** | 3.075*** | 3.135*** | 2.991*** |
| N                    | 30119 | 24416 | 29631 | 24046 |

Table 5 This table shows the result for the placebo test of environmental strength. We assume the plan was issued in 2015Q2, two years before 2017Q2 and choose the sample period from the first quarter of 2014 to the first quarter of 2017. Variables are winsorized at the 1st and 99th percentiles. The independent variables are lagged by one quarter. The result of t-statistics is reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively.

| Dependent variables: | IO |
|----------------------|----|
|                      | (1) | (2) | (3) | (4) |
| Environmental strength_t-1 | 0.119 |     |     |     |
|                      | (0.247) |     |     |     |
| Environmental strength*post | 0.217 |     |     |     |
|                      | (0.152) |     |     |     |
| Constant             | 6.558*** |     |     |     |
|                      | (0.333) |     |     |     |
| Industry and time dummies | Yes |     |     |     |
| Log likelihood       | −37970.628 |     |     |     |
| sigma_u              | 4.475*** |     |     |     |
| sigma_e              | 3.939*** |     |     |     |
| N                    | 13377 |     |     |     |
To eliminate the sample selectivity bias and further mitigate the endogenous problem of the estimation results, the propensity scores matching method (PSM-DID) is used for robustness test. We match treatment groups (environmental weakness and strength, respectively) with the control group (average environmental scores group) by using the one-to-one caliper nearest neighbor match. Columns (1) and (2) in Table 6 represent the results of the PSM-DID model. The coefficient of Environmental weakness×Post is statistically insignificant, and the coefficient of Environmental strength×Post is significantly positive, further proving the validity of the main regressions.

Adding the industry×time fixed effect

Considering adding the industry fixed effect can only control the time-invariant factors, we add a set of time variant controls on industry of firms (industry×time fixed effect) to reduce the omitted variable bias. The coefficients of interaction terms are statistically insignificant for environmental weakness in column (3) and significantly positive for environmental strength in column (4), indicating that the baseline regressions remain robust and reliable.

Changing variables

We use the logarithm of the number of financial institutional holdings to replace $IO$, the proportion of the top1 shareholder to replace $HHI5$, and the ratio of return on assets to replace $ROE$. Results are shown in columns (5) and (6) of Table 6. Consisting with the result in Table 4, the coefficients of interaction terms are statistically significant.
positive for environmental strength, but insignificant for the weakness group.

The dynamic institutional preferences

To further prove the changes of institutional preferences on environmental criteria, the rolling window estimation is conducted. The window for rolling estimation is set to a year (four quarters). By choosing a shorter window, we can effectively control the impact of other events (such as the stock market crashes of 2015 and 2018, the COVID-19 global pandemic and etc.) and capture the gradual effect of green finance policies issued. We choose the sample period from the first quarter of 2015 to the second quarter of 2021. Specifically, the first regression is from 2015Q1 to 2015Q4, and the second regression is from 2015Q2 to 2016Q1, and so on. Then we can have insight into the changes of institutions’ preferences on green investment in difference period by observing the change of coefficients in different windows. Those coefficients mean that institutions’ interest in strength (weakness) scores would be how much higher (lower) comparing with average scores. The proposed hypothesis is tested with the model:

\[ IO_{it} = \alpha + \beta_i E_{weakness.t-1} \left( E_{strength.t-1} \right) + \Sigma \beta_j Control_{j.t-1} + \epsilon_{it} \]

Figure 4 demonstrates the dynamic relationship between institutional investors and environmental scores. After the implementation of the plan at 2017, institutional preferences on environmental strength become much clearer, which supports the research conclusion of the article to a certain extent.

Do short-term and long-term investors show different responses on the policy?

Based on the previous analysis, we find that the construction of a green finance system could promote the whole financial institutions’ preferences on green investment. However, different kinds of institutional investors may show different behaviors when they making investment decisions. Whether the policy effect on institutions with different investment horizons could be various is still uncertain. To tackle this end, the examinations of short-term and long-term institutional preferences are made in this section.

Results are listed in the Table 7 for short-term institutions in columns (1) and (2), and long-term institutions in columns (3) and (4). For short-term institutions, the interaction Environmental weakness×Post is significantly negative, and the coefficient of Environmental strength×Post is significantly positive, suggesting that the plan did drive short-term institutional investors to reduce the investment in environmental weakness firms and increase holdings on firms with environmental strength. However, it still be no difference for short-term institutions to invest in firms with different environmental scores, since the coefficients of environmental weakness and strength are insignificant. These results indicate that although the green finance policy failed to transform the preferences of short-term institutional investors thoroughly, it did improve their preferences for green investment to a certain extent.

For long-term institutional investors, all coefficients of interaction terms are insignificant, meaning the policy effect on the long-term institutions is ineffective. However,
Table 7 This table shows the heterogeneity analysis considering the investment horizon. Following the prior research, we calculate turnover rate and rank the top tertile as short-term institutional investors, the bottom tertile as long-term institutional investors. The scores are calculated using data from the CSMAR database. The sample period is from the first quarter of 2016 to the third quarter of 2019. Variables are winsorized at the 1st and 99th percentiles. The independent variables are lagged by one quarter. The result of t-statistics is reported in parentheses. *, **, *** denote statistical significance at the 1%, 5%, and 10% level, respectively.

| Dependent variables: | SHORT_IO (1) | SHORT_IO (2) | LONG_IO (3) | LONG_IO (4) |
|----------------------|--------------|--------------|-------------|-------------|
| Environmental scores: |              |              |             |             |
| Weakness_{t-1}       | 0.153        | -0.353**     |             |             |
| Strength_{t-1}       |              | -0.043       |             |             |
| Environmental scores*post | -0.187*** | 0.560***     | 0.042       | -0.157      |
| Constant             | 3.008***     | 3.279***     | 1.643***    | 1.368***    |
| Control variables    | Yes          | Yes          | Yes         | Yes         |
| Industry and time dummies | Yes       | Yes          | Yes         | Yes         |
| Log likelihood       | -64615.518   | -50654.305   | -45770.724  | -38698.162  |
| sigma_u              | 3.279***     | 3.020***     | 4.098***    | 3.708***    |
| sigma_e              | 2.379***     | 2.260***     | 3.107***    | 2.763***    |
| N                    | 29631        | 24046        | 29631       | 24046       |

To sum up, the policy of establishing a green finance system has promoted short-term institutional preferences on green investment, while do not affect long-term institutions’ investment behaviors.

Further studies

Mechanism analysis

Our research reveals that green finance policies are able to improve financial institutions’ preferences on green investment. However, only short-term institutions show more aversion to environmental weakness after the plan. Why would different types of financial institutions show different reactions to the green finance policies? To answer this question, we estimate the transmission mechanisms of green finance policies on green investment preferences of financial institutions. The following models are set up according the method of Baron and Kenny (1986):

\[
\text{Mediator}_{ij} = \alpha + \beta_1 \text{Strength}_{ij-1} \left( E_{\text{strength},ij} \right) + \beta_2 \text{Strength}_{ij-1} \left( E_{\text{strength},ij} \right) \ast \text{Post} + \Sigma \beta_i \text{Control}_{ij-1} + \epsilon_{ij} \tag{4}
\]

\[
\text{IO}_{ij,t} = +\beta_1 \text{Weakness}_{ij-1} \left( E_{\text{strength},ij-1} \right) + \beta_2 \text{Weakness}_{ij-1} \left( E_{\text{strength},ij-1} \right) \ast \text{Post} + \beta_3 \text{Mediator} + \Sigma \beta_i \text{Control}_{ij-1} + \epsilon_{ij,t} \tag{5}
\]

where, Mediator in Eqs. (4) and (5) refers to the mediator variables, including green innovation (GI), firm values (Tobin Q), and abnormal returns (Alpha). Variable GI is measured by the number of green patent grants (S. Liu et al. 2021). According to prior study (Hu et al. 2021), we use Tobin Q to illustrate firm values. And variable Alpha is measured by average abnormal returns at every quarter calculated by CAPM.

We use the following method to examine the mediating effect. If \( \beta_2 \) in Eq. (4) is statistically significant, mediator factors will be added to Eqs. (1) and (2) to construct Eq. (5). Then if \( \beta_2 \) in Eq. (5) is significant and \( \beta_2 \) is insignificant, it means that the mediator factor has the complete mediating effect; if \( \beta_2 \) in Eq. (5) is significant and \( \beta_2 \) is significant but smaller than that in Eqs. (1) and (2), it indicates that the partial mediating effect exists. Considering the investment behaviors of long-term institutions are not affected by the
plan, we only test the mediating effect for financial institutions and short-term institutions.

The mediating effect of green innovation and firm values

The purpose of green finance policies is to enable enterprises to carry out green transformation through green innovation. The promotion of corporate innovation abilities could also increase the value of enterprises and attract more investors. To explore whether green finance policies can affect the green investment preferences of institutional investors through green innovation and firm values, we conduct the following mediating test.

Panel A in Table 8 reports the results for the policy effect of green innovation and firm values on environmental weakness and strength respectively based on the Eq. (4). For environmental weakness, the coefficients of Environmental Weakness×Post in columns (1) and (3) are statistically insignificant, implying GI and Tobin Q do not pass the mediating effect test. For environmental strength, the coefficients of Environmental strength×Post are significantly positive in columns (2) and (4), meaning the conduct of green finance policies increase green innovation and firm values of publicly traded companies in Chinese stock market, consistent with prior research (Yang et al. 2022). Thus, firms with environmental strength tend to promoting their innovation capacity after the plan, which is common with the aim of green finance that helping green enterprises to achieve the green transformation and transition.

In panel B, we test whether the improvement of green innovation and firm values could promote the investment preferences for firms with environmental strength based on the Eq. (5). The results in the second step show that both GI and Tobin Q indicators are still significantly positive in both two regressions, and the interaction terms are significant and smaller than the result in the baseline regressions of Tables 4 and 7, indicating that the promotion of green innovation and firm values plays a partial intermediary role in the process of policy effect on institutional preferences for green investment.

This result proves H2 that the implementation of green finance could encourage green innovation and then increase firm value in firms with better environmental performance, finally attracting more financial institutions.

The mediating effect of abnormal return

As a policy shock, green finance will cause market reactions, and institutional investors, as market participants, will also respond to abnormal returns generated by the market reactions. Therefore, we explore the changes in stock returns before and after the policy and test whether it can serve as an intermediary variable for policy effects on institutional preferences.

In panel A of Table 9, the coefficient of Environmental weakness×Post is negative, and the coefficient of Environmental strength×Post is positive, both significant at the 1% level, passing the first stage of the mediating effect test.

Panel B shows the result of the second step. After adding the Alpha indicator, the coefficients of abnormal return in all column are significantly positive. Besides, for the whole institutional investors, the coefficient of interaction term in column (1) is significantly positive and smaller than that in baseline regression of Table 4. The result indicates that green finance policies would trigger more abnormal returns for firms with environmental strength, thus attracting financial institutions to increase their investment.

For short-term institutional investors, the coefficients of Environmental weakness (strength)×Post in columns (2) and (3) are significant and much smaller than that in regression of Table 7. Thus, abnormal returns can be viewed as a partial mediator in the environmental weakness and strength group. Both short-term shareholdings of environmental weakness and strength change due to the changes of abnormal return, confirming the hypothesis 4 that short-term institutions are more likely to be affected by abnormal returns.

Heterogeneity analysis

According to the above analysis, the policy effect could be different for firms with different ownership patterns. Therefore, it is necessary to discuss whether the impact of the plan would be various when institutions invest in state-owned or non-state-owned enterprises and explore the reason behind it.

Results are listed in Table 10 for institutional ownership, short-term institutional ownership and long-term institutional ownership respectively. In panel A, only the coefficients of interaction terms for short-term institutions in the non-SOE group and long-term institutions in the SOE group are significant negative. For short-term institutions, it is the result of more decreasing in abnormal return of non-SOEs than SOEs, since SOEs with environmental weakness still can gain more government support than non-SOEs with environmental weakness (Yu et al. 2021). For long-term institutions, the decline of investment in SOE group seems to be more obvious because they have invested more in state-owned enterprises before the plan (Wenjing Li and Lu 2015).

Panel B shows that all the coefficients of Environment strength×Post in the non-SOE group are significantly positive and the results of chow test further prove that these coefficients are higher than that in the SOE group. This implies that financial institutions with different investment horizons all increase their investment preferences for non-SOEs with higher environmental performance after the plan. Results above are consistent with our assumption.
that after the implementation of green finance, non-SOEs have more incentive to increase their green innovation, which helps improve their firm values and stock returns, and finally attract more institutional investors.

**Moderating effect tests**

To test the moderating effect of internal disclosure and outside audits, we examine the triple-difference (DDD) model using the following equations:

\[
IO_{it} = \alpha + \beta_1 E_{\text{weakness}_{i,t-1}} (E_{\text{strength}_{i,t-1}}) + \beta_2 E_{\text{weakness}_{i,t-1}} (E_{\text{strength}_{i,t-1}})^{\text{Post}} + \beta_3 E_{\text{weakness}_{i,t-1}} (E_{\text{strength}_{i,t-1}})^{\text{Post} \times \text{Moderator}_{i,t-1}} + \beta_4 E_{\text{weakness}_{i,t-1}} (E_{\text{strength}_{i,t-1}})^{\text{Moderator}_{i,t-1}} + \beta_5 E_{\text{weakness}_{i,t-1}} (E_{\text{strength}_{i,t-1}})^{\text{Control}_{i,t-1}} + \epsilon_{ij}
\]

where Moderator refers to the moderator variables including internal disclosure (Disclosure) and outside audits (BIG4). Variable Disclosure is a dummy variable that equals to 1 if the listed company discloses its own environmental report at the 1st and 99th percentiles. The result of \(t\)-statistics is reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively.

Table 8 This table shows the result for the mediating effect of financing constraints and green innovation. The scores are calculated using data from the CSMAR database. The sample period is from the first quarter of 2016 to the third quarter of 2019. Variables are winsorized at the 1st and 99th percentiles. The result of \(t\)-statistics is reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively.

Panel A: mixed effect model

| Dependent variables | GI | Tobin Q |
|---------------------|----|---------|
| Environmental scores: |
| Weakness_{i,t-1} | -1.147 | -0.073 |
| (0.836) | (0.047) |
| Strength_{i,t-1} | 2.122 |
| (1.323) |
| Environmental scores*post | -0.563 |
| (0.400) |
| Constant | 0.545 |
| (1.540) |
| Control variables | Yes |
| Industry and time dummies | Yes |
| \(R^2\) | 0.083 |
| N | 29631 |

Panel B: panel Tobit model

| Dependent variables | IO | SHORT_IO |
|---------------------|----|----------|
| Environmental strength*post | 0.731*** | 0.555*** |
| (0.095) | (0.073) |
| GI | 0.004*** |
| (0.001) |
| Tobin Q | 0.301*** |
| (0.027) |
| Constant | 4.652*** |
| (0.277) |
| Control variables | Yes |
| Industry and time dummies | Yes |
| Log likelihood | -59626.122 |
| sigma_u | 4.727*** |
| 2.990*** |
| N | 24046 | 24046 | 23574 | 23574 |
separately and equals to zero if it is not. And BIG4 is a dummy variable that equals to 1 if the firm is audited by Big Four global accounting firms and equals to zero if it is not. We focus on the coefficients of Environmental scores*Post*Moderator ($\beta_3$) in Eq. (6).

The role of internal disclosure

In columns (2) and (3) of Table 11, given the positive coefficients of DID in environmental strength, the positive and significant coefficients of Environmental strength*Post*Disclosure in columns (2) and (4) show that comparing with companies that do not self-disclose environmental reports, the policy effect is stronger when institutional investors invest in companies that have better environmental disclosure. This result confirms hypothesis 5 that the impact of green finance policies could be more pronounced when institutions invest in green enterprises with the higher level of self-environmental disclosure.

The role of external audits

As is shown in Table 12, given the positive coefficients of DID in environmental strength, the negative coefficients of Environmental strength*Post*BIG4 in columns (2) and (4) show that comparing with firms without Big 4 auditor, the effect of policies on institutional preferences for green investment is weaker for firms that appoint a Big 4 auditor. Additionally, the coefficient of Environmental weakness*Post*BIG4 in column (3) is positive under the negative coefficients of DID in environmental weakness, implying that the stronger external supervision of a firm, the weaker policy effect on institutional aversion to its low environmental performance. It is worth noting that stronger
external audits will narrow down the effect results of green finance policies, which is consistent with the hypothesis 6.

### Conclusion

This paper provides a perspective on the evolution of institutional preferences on green investment in the China’s stock market and the role of green finance exerting in the

### Table 10

This table shows the heterogeneity analysis for state-owned enterprises and non-state-owned enterprises. The scores are calculated using data from the CSMAR database. The sample period is from the first quarter of 2016 to the third quarter of 2019. Variables are winsorized at the 1st and 99th percentiles. The independent variables are lagged by one quarter. The result of $t$-statistics is reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively.

#### Panel A: heterogeneity analysis for environmental weakness

| Dependent variables: | IO | SHORT_IO | LONG_IO |
|----------------------|----|----------|---------|
| (1) SOE              | 0.047 | 0.040 | -0.304*** |
| (2) NON-SOE          | -0.007 | -0.089 | -0.326** |
| Environmental weakness*post | (0.144) | (0.095) | (0.126) |
| Log likelihood       | -21995.36 | -17819.646 | -14326.708 |
| sigma_u              | 4.572*** | 2.581*** | 3.821*** |
| sigma_e              | 2.955*** | 1.930*** | 2.913*** |
| Chow-test            | 0.183 | 0.372* | -0.319* |
| (1) SOE              | 0.637*** | 0.367*** | -0.400*** |
| (2) NON-SOE          | 0.968*** | 0.663*** | 0.286*** |
| Environmental strength*post | (0.129) | (0.082) | (0.128) |
| Log likelihood       | -34718.405 | -27880.547 | -32133.839 |
| sigma_u              | 4.760*** | 2.332*** | 3.545*** |
| sigma_e              | 2.728*** | 1.736*** | 2.473*** |
| Chow-test            | 0.967 | 0.576** | -0.731*** |

### Table 11

This table shows the result of the moderating effect of environmental information disclosure in the plan issued in 2017Q2. The scores are calculated using data from the CSMAR database. The sample period is from the first quarter of 2016 to the third quarter of 2019. Variables are winsorized at the 1st and 99th percentiles. The independent variables are lagged by one quarter. The result of $t$-statistics is reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively.

| Dependent variables: | IO | SHORT_IO | LONG_IO |
|----------------------|----|----------|---------|
| (1) Environmental weakness | 0.154 | 0.207 | 0.264 |
| (2) Environmental strength | 1.005*** | 0.756*** | -0.299 |
| Environmental weakness*post*disclosure | (0.301) | (0.231) | (0.323) |
| Constant             | 5.062*** | 2.868*** | 1.553*** |
| (3) Environmental weakness | (0.312) | (0.233) | (0.319) |
| Control variables    | Yes | Yes | Yes |
| Industry and time dummies | Yes | Yes | Yes |
| Log likelihood       | -72190.22 | -62906.863 | -63664.553 |
| sigma_u              | 4.555*** | 3.245*** | 4.089*** |
| sigma_e              | 3.131*** | 2.377*** | 3.107*** |
| N                    | 29631 | 29631 | 29631 |

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evolution. The baseline regression shows that after the implementation of the plan, financial institutions significantly increase their investment in companies with better environmental performance. Additionally, results of the mechanism analysis show that the green finance policies mainly affect institutional preferences on green investment by promoting corporates’ green innovation, increasing firm values and affecting stock returns.

Considering the heterogeneity of institutional investors, we divide institutional investors into short-term and long-term institutions according to the investment horizons. The study finds that although the policy effect on long-term institutions is insignificant, they have shown a symmetrical preference for environmental performance due to their greater focus on fundamentals, which is consistent with the previous research (Cremers et al. 2020). In terms of short-term institutional investors, we find that although they are affected by the policy and improve their investment behavior to a certain extent, the changes in their behaviors are more driven by abnormal returns.

Further analysis indicates that the effect of the green finance policies is prominent when institutions invest in non-SOEs with higher environmental performance. Besides, the higher level of environmental information disclosure could expand the policy effect, and the better outside audits could narrow the policy effect by providing investors with more accurate reporting information and improving investor confidence.

Therefore, our findings could have important implications. First, this paper affirms the role of green finance policies in attracting more green investment in green enterprises, especially for non-SOEs. The green industry could be hard to gain financing support, since it has a long investment period with a large degree of uncertainty and risk. Obtaining financing for green enterprises can promote corporate performance and further attract more institutional investors. And then the investment of institutional investors can in turn solve financing problems of green enterprises and further promote the transformation and upgrading of enterprises, which can ultimately turn into a virtuous cycle. Thus, the development of green finance is inseparable from green investment.

Second, more medium- and long-term investors need to enter the market, since green transformation takes a long time. As stated in the paper, institutional investors with the longer investment horizons appear to have more pronounced preferences for green investment. Those sustainable investors would provide more fundings for green enterprises than short-term institutions. Besides, longer funds into the market can make the investment and financing period match, solving the mismatching of debt maturity structure.

Finally, this paper confirms the importance of improving environmental information disclosure. In order to develop green investment, it is necessary to continuously promote the standardization of green finance, further improve the disclosure of environmental information, and ultimately break the bottleneck of green investment caused by information asymmetry.

Acknowledgements We would like to thank the editor and the anonymous referee for their highly constructive suggestions.

| Dependent variables: | IO | SHORT_IO | LONG_IO |
|----------------------|------------------|------------------|------------------|
|                      | (1) | (2) | (3) | (4) | (5) | (6) |
| Environmental weakness | 0.115 | −1.007*** | 0.963*** | −0.579** | 0.096 | 0.331 |
| Environmental strength | Environmental weakness | Environmental strength | Environmental weakness | Environmental weakness | Environmental weakness |
| Environmental scores*post*BIG4 | 5.214*** | 5.126*** | 2.884*** | 3.128*** | 1.752*** | 1.368*** |
| Constant | 5.214*** | 5.126*** | 2.884*** | 3.128*** | 1.752*** | 1.368*** |
| Control variables | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry and time dummies | Yes | Yes | Yes | Yes | Yes | Yes |
| Log likelihood | −73745.034 | −59613.886 | −64565.695 | −52253.764 | −45770.374 | −39955.528 |
| sigma_u | 4.578*** | 4.744*** | 3.270*** | 3.028*** | 4.099*** | 3.682*** |
| sigma_e | 3.130*** | 2.988*** | 2.375*** | 2.277*** | 3.106*** | 2.779*** |
| N | 29303 | 23601 | 29303 | 23601 | 29303 | 23601 |

Table 12 This table shows the result of the moderating effect of external audits in the plan issued in 2017Q2. The scores are calculated using data from the CSMAR database. The sample period is from the first quarter of 2016 to the third quarter of 2019. Variables are winsorized at the 1st and 99th percentiles. The independent variables are lagged by one quarter. The result of t-statistics is reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively.
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Data availability The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

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