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ORIGINAL PAPER

Building Eco-friendly Corporations: The Role of Minority Shareholders

Shouyu Yao[1] · Yuying Pan[2] · Lu Wang[3,4] · Ahmet Sensoy[5,6] · Feiyang Cheng[1,7]

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Abstract
Based on China's mandatory requirement for listed firms to implement online voting in their annual general shareholder meetings, we investigate whether and how minority shareholders influence corporate environmental performance (CEP). We use the difference-in-difference approach and find that the implementation of online voting promotes minority shareholders' participation in shareholder meetings, which, in turn, leads to improved CEP of listed firms. We discover that "local pollution" exposure and "the increasing awareness of listed firms' environmental risks" are the main motives of minority shareholders concerning listed firms' environmental performance. Furthermore, we find that the minority shareholders improve CEP of listed firms through influencing groups with greater bargaining power.

Keywords Minority shareholders' activism · Online voting · Corporate environmental performance · Bargaining power

JEL Classification M14 · G34 · G32 · G38

Introduction

Pollution has impacted and deteriorated the global environment. Based on the statistics from World Health Organization (WHO, 2021), anthropogenic air pollution accounts for approximately 8 million deaths annually on a global scale, and 91% of the population of the world residents in regions in which air quality is below WHO standard. Thus, environmental protection is significant and urgent and has garnered the attention of academics and the public. Aiming to reduce industrial environmental pollution, the literature concerning corporate environmental performance (CEP) has explored the roles played by various firm insiders and external stakeholders.[1] Besides, prior studies also indicate that firm investors can exert influence on environmental protection through sustainable investments. Sustainable, or impact

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✉ Feiyang Cheng
fycheng@tju.edu.cn

Shouyu Yao
yaosy@tju.edu.cn

Yuying Pan
panyuying125@163.com

Lu Wang
wanglu726@zufe.edu.cn

Ahmet Sensoy
ahmet.sensoy@bilkent.edu.tr

1 College of Management and Economics, Tianjin University, Tianjin, China

[1] These include board directors (Dixon-Fowler et al., 2017), government agents (Chang et al., 2015; Wang et al., 2018), foreign investors (Lan et al., 2012), institutional investors (Fernando et al., 2009; Kordsachia et al., 2021), environmental interest groups (Delmas and Toffel, 2004), and local communities (Lee et al., 2018).

2 School of Finance, Shandong University of Finance and Economics, Jinan, China

3 School of Accountancy, Zhejiang University of Finance and Economics, Hangzhou, China

4 School of Economics and Finance, Massey University, Palmerston North, New Zealand

5 Faculty of Business Administration, Bilkent University, Ankara, Turkey

6 Adnan Kassar School of Business, Lebanese American University, Beirut, Lebanon

7 Macquarie Business School, Macquarie University, Sydney, Australia

investments are investments that incorporate environmental, social, and governance (ESG) considerations to facilitate the achievement of social objectives (Busch et al., 2021; Kölbel et al., 2020). Recently, a growing number of investors are motivated by their altruistic incentives to engage in impact investments and expect to exert a positive influence on social challenges, such as environment protection (Hartzmark & Sussman, 2019; Riedl & Smeets, 2017).

However, the influence of minority shareholders has been largely overlooked by the literature. As environmental protection receives more and more public attention, minority shareholders' awareness of corporate environmental risks has also significantly increased (de Villiers & van Staden, 2010). For instance, minority shareholders in China raised more than 8000 questions regarding listed firms' environmental issues to China's stock exchanges in 2018, 20 times higher than the number in 2010. Hence, it is both crucial and meaningful to explore the role of minority shareholders in the building of eco-friendly corporations. To fill the gap of minority shareholders' role in the literature, this paper investigates whether and how minority shareholders' activism influences CEP of listed firms by exploiting China's mandatory requirements for listed firms to implement online voting in annual general shareholder meetings (AGMs).[2]

In China, the Shenzhen Stock Exchange (SZSE) and the Shanghai Stock Exchange (SHSE) issued the implementation rules of online voting (*Rules*) in late 2014 and early 2015 to mandatorily require listed firms to fully implement online voting in shareholder meetings. *Rules* were issued to improve participation of shareholders, especially minority shareholders in AGMs. Owing to the increasing attention paid to corporate social responsibility (CSR) and environmental pollution issues, listed firms' CEP has become a hot topic of discussion in AGMs. Accordingly, minority shareholders may exert influence on CEP of listed firms through online AGM channels. More importantly, the mandatory nature of *Rules* creates a clear quasi-natural experiment to identify potential causal effects. On the one hand, listed firms that had not yet implemented online voting in AGMs are required to do after the issuance of *Rules*. On the other hand, listed firms that had already adopted online voting are not influenced by *Rules* and thus are used as the benchmark for evaluating CEP of influenced listed firms.

Typically, minority shareholders are considered vulnerable and powerless (Johnson et al., 2000; La Porta et al., 2002) due to their small stake in firms and barriers to acquire information (Bharath et al., 2013; Chen et al., 2013a, 2013b). Different from existing studies, we posit that minority shareholders may be motivated to impact listed firms' environment-related decisions through online voting due to "local pollution" exposure and their improved awareness of environmental risks. First, owing to the convenience of acquiring information and local preferences, investors prefer to hold stocks in local firms (Graham et al., 2009; Huang et al., 2016; Lewis, 1999; Nieuwerburgh & Veldkamp, 2009; Strong & Xu, 2003). However, local listed firms' environmental pollution may directly damage the living environment and the health conditions of minority shareholders, among other local residents (Chen et al.,). Hence, they may utilize online voting to speak out on corporate environmental issues. Second, due to the Chinese governments' concern over listed firms' pollutant emissions, several regulatory and punishment measures have been formulated to restrain environmental pollution at corporate level (Fang et al., 2021). As the equity value of listed firms is closely related with their CEP (Chan & Milne, 1999; Endrikat, 2016), minority shareholders may be motivated to care about and monitor CEP of listed firms to protect their investments.

Notwithstanding the motivations of minority shareholders' concern over CEP, a more important issue is how minority shareholders can influence firm decisions given their limited shareholding. We argue that under the rapid development of internet technology and the prosperity of social media, minority shareholders can exert pressure on firm management through their influence on groups with greater bargaining and monitoring power. Although their online votes are unlikely to directly influence firm decisions (Bharath et al., 2013; Chen et al., 2013a, 2013b), their voices may draw the attention of the media and analysts, who possess significant influential power over firm decisions (Dyck et al., 2008; Enikolopov et al., 2018; Wang & Ye, 2015; Ye et al., 2015) and tend to respond favorably to the demands of minority investors (Boubaker & Labégorre, 2008).

Exploiting *Rules* in 2014[3] as an exogenous incident, we employ a difference-in-difference (DID) approach and find that listed firms that are influenced by *Rules* experience a significant improvement in both the AGM participation rate of minority shareholders and CEP. Our triple difference analysis further indicates that the CEP improvement

[2] In AGMs, investors will discuss and vote on matters on the firm's annual report, investments, financing, etc. As an important part of firm social responsibility, CEP is mentioned by most of the firms in their annual reports. Additionally, various measures have been formulated by the regulators to mitigate environmental pollution of listed firms and have led to a large number of firms being punished for environmental damages (Fang et al., 2021). Hence, CEP of listed firms may become the issue of focus and attract attention of minority shareholders in AGMs. Accordingly, minority shareholders may exert influence on CEP through online AGM channels.

[3] As AGMs of a listed firm in China is held within 6 months after the end of the fiscal year, all 2014 AGMs of Shanghai listed firms adopted online voting as a result of regulation. Therefore, in the interest of brevity, the rules issued by the SZSE and the SHSE in late 2014 and early 2015, respectively, are collectively referred to as *Rules* in 2014 since they apply to the 2014 AGMs of all listed firm. Data of AGMs are also collected based on the fiscal year of AMGs rather than the actual meeting year.

of listed firms with a higher minority ownership participation in AGMs is more prominent once online voting is mandatorily adopted. We adopt various robustness tests, including parallel trend analysis, placebo test, multiple fixed effect models, propensity score matching (PSM) analysis, etc., to ascertain that these findings are not driven by endogeneity. We then explore the motives that minority shareholders encourage CEP. Our results reveal that the improvement in CEP is more prominent in listed firms that are located in places where environmental pollution is more severe and raises more public concerns, and in listed firms that are in heavy-polluting industries and have been punished more by the regulators due to environmental issues. Lastly, our channel analysis results suggest that minority shareholders improve CEP by influencing groups with greater bargaining power, such as the media and analysts.

Our paper makes the following key contributions. First, this paper contributes to the literature of shareholder activism. Different from existing studies that heavily concentrate on the activism of large shareholders (Dimson et al., 2015, 2020) and the notion that shareholder activism requiring CSR transparency does not necessarily lead to other improved corporate CSR behaviors (Michelon et al., 2020), we focus on minority shareholders and find that their increased online voting not only promotes listed firms to improve their disclosure and awareness of environmental protection but also results in substantial improvements in their pollutant emission reduction and environmental protection investments. Second, we contribute to the literature concerning the influence of ideology on corporate ethical behaviors (Bento et al., 2017; Idowu, 2012). Existing studies heavily concentrate on firm insiders' ideology, such as managers and board directors (Gupta et al., 2021; Hafenbrädl & Waeger, 2017). Expanding on de Villiers and van Staden (2010), who argue that the awareness of environmental protection and corporate environmental risks of minority shareholders significantly improved, we provide evidence that such improvement further leads to improved CEP, including improved awareness of environment protection at the company level. Third, our results provide evidence to impact investments. and the mechanisms. According to Kölbel et al. (2020), there are mainly three mechanisms through which investors exert real-world impact, namely shareholder engagement, asset allocation and indirect impacts. Our results provide evidence that minority shareholders utilize shareholder engagement (increased online voting) and indirect impact (increased attention from the media and analysts), to exert their positive influence on corporate environment protection. Finally, this paper contributes to the role of minority shareholders in corporate governance. The literature generally assumes that minority shareholders play a passive role in corporate governance due to their limited shareholding and difficulty to obtain information (Bharath et al., 2013; Chen et al., 2013a, 2013b). We find that minority shareholders, motivated by their concern of local pollution and improved awareness of environmental protection (de Villiers & van Staden, 2010), are more likely to participate in AGMs online.

The rest of the paper is structured as follows. "Institutional Background and Hypothesis Development" section presents the institutional background, literature review, and research hypotheses. "Research Design" section describes the data and methodologies. "Empirical Results" section reports the empirical results. Finally, "Discussion and Conclusion" section concludes the study.

Institutional Background and Hypothesis Development

Institutional Background of Online Voting

Traditionally, shareholders either attend on-site AGMs and vote in person or entrust agents to attend AGMs and vote on their behalf. However, with the fast diversification of the stock market and the increasing dispersion of shareholding, not all shareholders can attend AGMs due to distance and time constraints. To mitigate such issues, various communication technologies, ranging from mailing written votes to telephone or telegraph voting, are implemented by firms to facilitate shareholder voting. As the pioneer of informatization and communication technology development, the US was the first to initiate electronic reforms of shareholder meetings, and the state of Delaware was the first to legally stipulate online shareholder meetings. According to the statistics of Automatic Data Processing Inc., in 2003, among all votes sent through communication technologies, 83% of them were made through online voting. Following the US, other countries, such as Britain, Germany, and Denmark, actively made attempts to reform shareholder meetings and adopted online voting.

Before 2004, China's capital market had just taken shape, and the shareholder meeting system was far from perfect. During this period, shareholders, especially minority shareholders, were reluctant to exercise their voting rights in AGMs of listed firms due to the cost of attending. Drawing experience from the US and western countries, Chinese regulatory authorities implemented a series of reforms regarding the shareholder meeting system of listed firms. In 2004, China Securities Regulatory Commission (CSRC) successively issued *The Guidelines of Online Voting at Listed Firms' Shareholders Meeting* and *The Provisions of Strengthening the Protection of Public Shareholders' Rights and Interests* to encourage the adoption of online voting in listed firms' shareholder meetings. Celebrity Real Estate

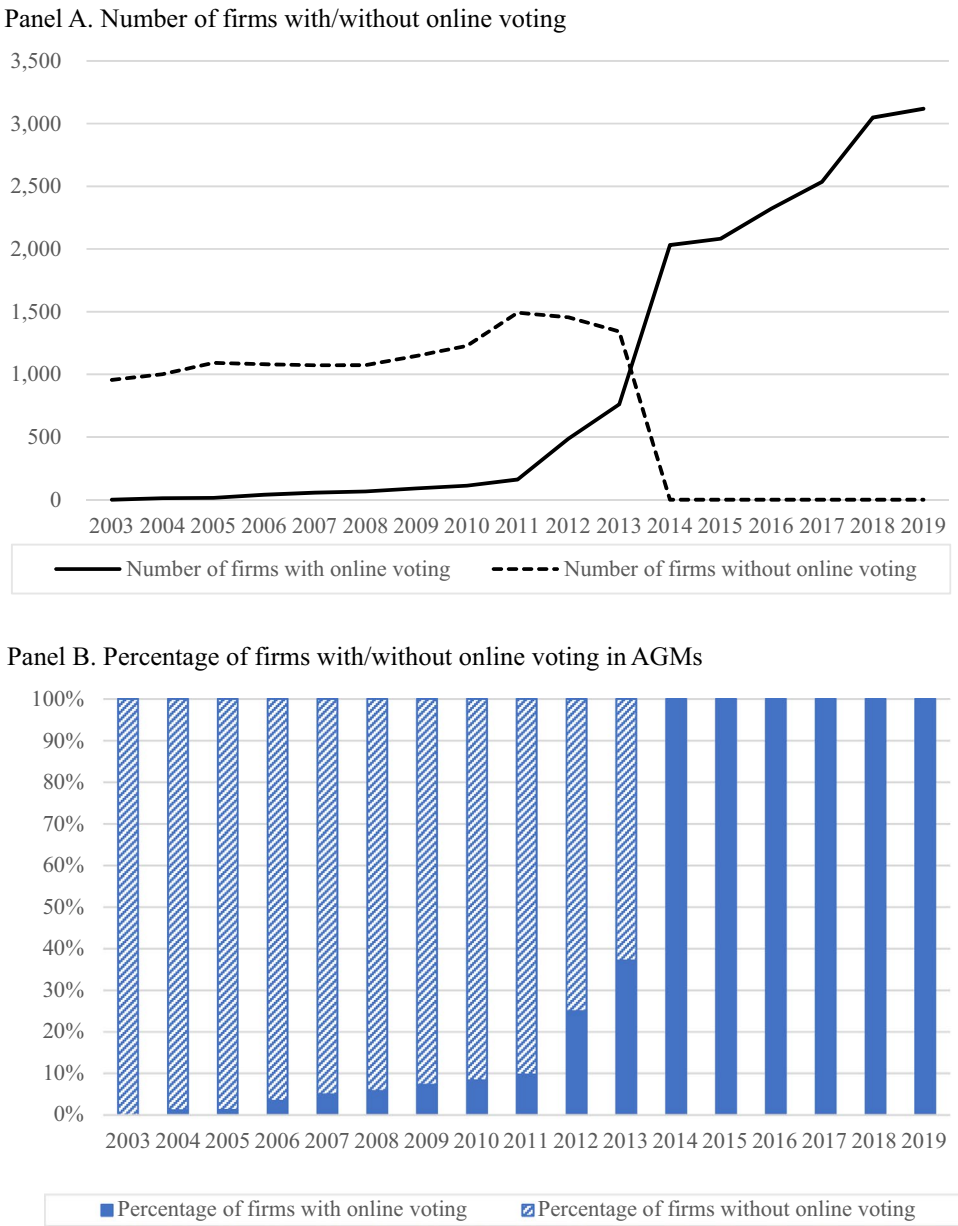

Fig. 1 Number/percentage of firms with/without online voting in AGMs. The figures show that number/percentage of firms with/without online voting in AGMs during 2003–2019. The sample contains firms listed on SHSE and SZSE. **A** Number of firms with/without online voting. **B** Percentage of firms with/without online voting in AGMs

Development Group Ltd. held the 2004 AGM with the adoption of online voting and became the first company in China that adopted an online voting system for AGMs. The meeting report showed that 225 shareholders voted online, and the proportion of shareholders that attended the AGM reached 76.88%.

Encouraged by the above policies and the prosperity of internet technology, listed firms gradually started to implement online voting in AGMs voluntarily. Figure 1 shows the implementation of online voting in China's listed firms from 2003 to 2019. Notably, only 12 firms adopted online voting in their AGMs in 2004. This number increased to 761 in 2013, which comprised for more than a third of all China's listed firms. More importantly, to further strengthen the protecting of the legal rights of minority investors in the capital market, the SZSE and the SHSE issued the *Rules* in late 2014 and early 2015, respectively, mandatorily requiring listed firms to fully implement online voting in shareholder meetings. Since AGMs of a listed firm in China is held within 6 months after the end of the fiscal year, all 2014 AGMs of Shanghai listed firms adopted online voting as a result of regulation. Therefore, for the brevity of reporting, *Rules* issued by the SZSE and the SHSE in late 2014 and early 2015, respectively, are collectively referred to as *Rules* in 2014 since they are effective to the 2014 AGMs of all listed firm. Data of AGMs is also collected based on the fiscal year of AMGs, rather than the actual meeting year. As shown in Fig. 1, the proportion of listed firms

that established network-based voting systems in AGMs has reached 100% after 2014.

Literature Review and Hypothesis Development

Literature Review

There is a serious agency conflict between controlling and minority shareholders (Jensen & Meckling, 1976; Shleifer & Vishny, 1997; De Cesari, 2012; Chen et al., 2013a, 2013b; Chen et al., 2015). Owing to information asymmetry, controlling shareholders may exploit their control power to extract firms' property through channels of related transactions, loans, etc. and thus infringe upon the rights and interests of minority investors (Johnson et al., 2000; La Porta et al., 2002; Peng et al., 2011; Wang & Xiao, 2011; Zhang et al., 2014). To tackle this issue, external mechanisms such as the independent director system, the board of supervisor system, and the independent audit system have been gradually established and improved (Imhoff et al., 2003; Nguyen & Nielsen, 2010; Wang et al., 2015; Jiang & Kim, 2020). However, evidence shows that these mechanisms do not always result in desired effects (Yuan et al., 2016). As opposed to external regulatory mechanisms, minority shareholders require an internal incentivizing force to realize the protection of their own rights and interests (Ang et al., 2021).

Voting is a key approach for minority shareholders to partake in corporate decision-making and defend their rights and interests (Berkman et al., 2010; Bhagat & Brickley, 1984). However, due to limited shareholding and barriers to acquire information, minority shareholders often vote by free riding on the opinions of other shareholders (Bharath et al., 2013; Chen et al., 2013a, 2013b). Although this is believed to be cost-efficient by minority shareholders, potential opportunities are created for large shareholders' tunneling activities. Therefore, by improving the shareholder meeting mechanism and facilitating the participation of minority shareholders in AGMs, minority shareholders are allowed to fight for their rights and defend their personal interests.

With the development of the Internet, the emergence of online voting platforms enables virtual participation of shareholders in AGMs, which significantly reduces the cost of attending and stimulates the enthusiasm of minority shareholders to participate in shareholder meetings (Kong, 2019). Such increased participation of minority shareholders may further lead to a stricter supervision of firm management and thus guide decision-making toward the firms' long-term interests. More importantly, by expressing their opinions via online voting, minority shareholders may assist in alleviating the information weakness of external stakeholders and raise the attention of external supervision forces (Ang et al., 2021; Bebchuk, 2006; Berkman et al., 2010; Bhagat & Brickley, 1984), thus inhibiting controlling shareholders' expropriation of minority shareholder interests.

Hypothesis Development

Recently, as CSR has gained increasing attention, topics related to ESG have been widely discussed (Clementino & Perkins, 2020; Drempetic et al., 2019; Gillan et al., 2021; Khan, 2019). Among them, CEP and environmental protection are at the center of attention. Air pollution, water pollution, and other environmental problems that are induced by industrialization have posed a significant challenge to the living environment and health conditions of human beings (Ebenstein, 2012; Khajavi et al., 2019; Min et al., 2018). Firms' generation and emission of pollutants may directly cause irreversible damage to the local environment and the health conditions of local residents (Chen et al.,). For instance, waste gas emitted from steel factories may increase air pollution in surrounding areas, which may eventually lead to various respiratory diseases of local residents.

Previous studies have highlighted that due to the convenience of acquiring information and local preferences, investors prefer to hold stocks of local firms (Graham et al., 2009; Huang et al., 2016; Lewis, 1999; Nieuwerburgh & Veldkamp, 2009; Strong & Xu, 2003). However, corporate environmental pollution may directly expose local residents, including minority shareholders, to potential damages of their living environment and health (Chen et al.,). Such exposure may prompt local investors' concern regarding CEP of local listed firms (Tan et al., 2021). Therefore, given that online voting significantly reduces the cost of attending shareholder meetings and stimulates the enthusiasm of minority investors' engaging in corporate governance (Kong, 2019), we argue that minority investors, who are concerned about local listed firms' environmental pollution, may utilize online voting to speak out on corporate environmental issues, and thus, exert positive influence CEP.

In addition, with the increasing severity of environmental pollution and public concern, minority shareholders' awareness of environmental protection and perception of listed firms' environmental risks are increasing as well. To mitigate the environmental pollution by listed firms, various regulatory measures have been formulated by the Chinese government and regulatory agencies (Fang et al., 2021), which have resulted in numerous firms being punished for corporate environmental pollution. Consequently, the social image and the stock prices of punished firms are negatively influenced (Gong et al., 2020). To protect their investment, minority shareholders need to prevent listed firms from being publicly warned or punished due to environmental pollution. Accordingly, minority shareholders tend to request listed firms to improve the disclosure of environment-related

information to mitigate their information disadvantages and reduce the uncertainty of their investments (de Villiers & van Staden, 2010). More importantly, given the convenience of online voting, minority shareholders that are concerned about listed firms' environmental risks, may actively participate in the making of environment-related decisions and thus positively influence CEP. Based on the above discussion, we formulated our first hypothesis as follows:

H1 The participation of minority shareholders in online voting will improve CEP.

Further, we posit that minority shareholders are concerned about CEP of listed firms due to the "local pollution" exposure and their "increasing awareness of corporate environmental risks." Accordingly, we formulated the following two sub-hypotheses:

H1a "Local pollution" exposure is a potential motive that encourages minority shareholders' online voting participation to improve CEP.

H1b Minority shareholders' increasing awareness of environmental risks of listed firms is a potential motive to their online voting participation for improving CEP.

Although the adoption of online voting in shareholder meetings provides convenience to minority shareholders, studies suggest that minority shareholders' limited shareholding prohibits them from making any real impact on corporate decisions (Bharath et al., 2013; Chen et al., 2013a, 2013b). However, with the rapid development of internet technologies and the prosperity of social media, information can be quickly disseminated through various channels to different groups of people (Dickson and Ekman, 2008; Dyck et al., 2008; Cahan et al., 2015). In particular, although votes of minority shareholders may be overthrown by interest-seeking controlling shareholders regarding corporate environmental decisions, the online voting system provides a platform for the voices of minority shareholders to be heard by other groups that have greater bargaining power. These groups, such as the media and analysts, may respond to the voices of minority shareholders and exert pressure on listed firms (Chen et al., 2010; Chung & Zhang, 2011; Luo et al., 2015; Jia et al., 2016; Kolbel et al., 2017).

Evidence shows that the media and analysts have a substantial influence on corporate decisions, especially decisions concerning CSR (Chen et al., 2010; Chung & Zhang, 2011; Luo et al., 2015; Jia et al., 2016; Kolbel et al., 2017). When voting online on corporate environmental issues, minority shareholders' opinions may be captured and amplified by these groups, who may, in turn, exert pressure on the management and eventually cause firms to change their decisions. Therefore, based on the above discussions, we formulated our second hypothesis below:

H2 The positive impact of minority shareholders on CEP after the adoption of online voting may be exerted via influencing groups with greater bargaining power.

Research Design

Data and Sample

Our initial sample includes all firms listed on the SHSE and the SZSE from 2008 to 2019. As the majority of the listed firms in China completed the non-tradable share reform before the end of 2007, we select our sample from 2008. Following Chen et al. (2018a, 2018b), we exclude (1) financial service firms, (2) special treatment firms[4] during the sample period, and (3) firm-year observations with missing data for control variables. Finally, our full sample comprised 24,494 firm-year observations.[5]

In 2014, the SHSE and the SZSE mandatorily required all listed firms to construct and apply network-based voting platforms in which shareholders are allowed to vote in AGMs without presence. We employ the DID approach to explore the impact of minority investors on CEP. In the DID analysis, we select 2011–2016 as our sample period (3 years prior and 3 years after the mandatory requirement of online voting) and thus obtain 11,697 firm-year observations from 2031 firms.[6]

Most of our financial data are obtained from four sources, including Wind, Chinese Research Data Services Platform (CNRDS) databases, the Chinese Stock Market and Accounting Research (CSMAR), and the *China's Environment Yearbook*. Specifically, we obtain AGM information of listed firms from Wind and CSMAR databases. The data used to construct CEP measurements are retrieved from Wind, CSMAR, and CNRDS databases. Additionally, we

[4] In China, listed firms that face financial distress are labeled "ST." The ST label is used to signal investors for firms with high delisting risk.

[5] We pre-processed the data and excluded observations with missing data for control variables to avoid the influence of sample size volatility. Such approach is adopted by many studies in the literature, such as Abdelfattah et al. (2020) and Dong et al. (2021).

[6] We choose 2011–2016 as the sample period of our DID analysis. We divide the treatment and control groups based on whether listed firms voluntarily adopted online voting in AGMs before 2014 (2011–2013). To ensure that a listed firm can make its own comparison before and after the policy and the preciseness of identification, we also construct the DID samples by only including firms that were listed before 2014 or 2011. The untabulated results are similar with those that are reported.

supplement the information of the participating shareholders and their respective shareholdings from listed firms' AGM reports. The data used in the robustness checks and "Discussion and Conclusion" section of the study include the following: the pollutant emission data such as the concentration of PM2.5 in each city, the total number of letters, phones, and emails regarding environmental pollution that are received by provincial governments of provinces in which the headquarters of the firms are based, and the number of polluting enterprises in the province in which the headquarters of the firms are located based on *the List of Key Enterprises under State Supervision*. All these data are obtained from the *China's Environment Yearbook*.

Shareholder Participation in AGMs

We measure the participation of different shareholders in listed firms' AGMs by using the following three proxies, based on the data collected from the CSMAR database and AGM reports:

Ownership representation is a proxy to the participation of all shareholders in AGMs. This proxy is measured as the number of shares that voted in AGMs over total number of shares.

Block ownership representation is a proxy to the block shareholders' participation in AGMs, which is measured as the number of shares owned by block shareholders that voted in AGMs over total number of shares. Block shareholders are those who possess no less than 5% of the firm.[7]

Minority ownership representation represents the participation of minority shareholders in AGMs, which is calculated as the number of shares owned by minority shareholders that voted in AGMs over total number of shares. Minority shareholders are those who possess less than 5% of the firm.

Corporate Environmental Performance

Regarding measuring CEP, various attempts have been made by researchers to measure CEP both conceptually and practically (Escrig-Olmedo et al., 2017; Xie & Hayase, 2007). Following prior studies, we construct a more comprehensive CEP index. Specifically, the CEP index is measured based on four aspects—their environmental information disclosure, environmental awareness, green emission, and environmental investment. The four sub-measurements of CEP are constructed as follows:

Environmental disclosure index (Disclosure) is measured based on three indicators that take the value of either one or zero, including whether (i) the corporate environment-related information is disclosed in the annual report; (ii) the corporate environment-related information is disclosed in the CSR report; and (iii) the firm disclose environment-related information separately. We aggregate the above indicators for a listed firm as its environmental disclosure score and calculate *Disclosure* as (the listed firm's disclosure score-minimum disclosure score of the year)/(maximum disclosure score of the year-minimum disclosure score of the year). Accordingly, the values of *Disclosure* range from zero to one.

Environmental awareness index (Awareness) is measured based on eight indicators that take the value of either one or zero, including whether (i) the firm mentions environmental protection concept, environmental guidelines, environmental management organizational structure, recycling economy development model, and green development in the annual report; (ii) the firm mentions the achievement of environmental targets in the past year and the future environmental targets; (iii) the firm formulates relevant environmental management system, regulations, and obligations; (iv) the firm implements environmental education and training; (v) the firm participates in environmental protection public welfare activities; (vi) the firm constructs emergency response mechanisms for major environment-related emergencies; (vii) the firm receives honors or awards for environmental protection; and (viii) the firm executes the "Three Simultaneity" system.[8] We aggregate the value of the above eight indicators as the environmental awareness score and calculate *Awareness* as (awareness score of the listed firm-minimum awareness score of the year)/(maximum awareness score of the year-minimum awareness score of the year). Accordingly, the values of *Awareness* range from zero to one.

[7] Most of the capital markets (such as the US market and the China's stock market) require public firms to disclose the shareholding information when the shareholding ratio exceeds or changes to 5%. Therefore, most previous studies have regarded 5% as the standard to recognize block shareholders (Edmans, 2014; Jiang and Kim, 2015; Jiang et al., 2020). Therefore, we take 5% as the standard to distinguish block shareholder ownership and minority ownership in AGMs. In our robustness checks, we also recognize block shareholders as shareholders who own more than 10% or 20% of the total shares and yielded similar results.

[8] The "Three Simultaneity" system refers to the designing, building, and operating of facilities for prevention and containment of pollution and other environmental protection facilities in the productive process. This system was proposed and encouraged by the Chinese government in *the Provisions Concerning the Protection and Improvement of the Environment* in 1973.

Green emission index (Green Emission) is measured by a dummy variable that takes the value of one if the firm adopts policies, measures, or techniques that result in a reduction of either wastewater,[9] gas, sludge or greenhouse gas discharge, and zero otherwise.[10] It evaluates environmental performance of a firm from an output perspective. *Environmental investment index (Investment)* is measured based on three indicators that take the value of either one or zero, including whether (i) the firm exploits or adopts innovation products, equipment, or techniques that are beneficial to the environment; (ii) the firm adopts renewable energy policies and measures of circular economy; (iii) the firm adopts policies, measures, or techniques to save energy and resources. Similarly, the environmental investment score is the aggregation of above indicators, and *Investment* is defined as (investment score of the listed firms-minimum investment score of the year)/(maximum investment score of the year-minimum investment score of the year). Accordingly, the values of *Investment* range from zero to one. *Investments* evaluates a firm's environmental performance from an input perspective. It focuses on whether the firm has made investments and efforts to promote energy conservation and sustainable energy utilization.

Finally, our CEP index, which measures the overall CEP of listed firms, is calculated as the equal-weighted average of the above four sub-measurements.

Model Specification

First, we test whether the adoption of online voting in AGMs can improve the shareholder participation in AGMs and CEP based on the following regression model:

$$Ownership\ participation_{i,t} = \beta_0 + \beta_1 Online\ voting_{i,t} + \sum_k \gamma_k Control_{k,i,t} + \varepsilon_{i,t} \quad (1)$$

$$CEP_{i,t+1} = \beta_0 + \beta_1 Online\ voting_{i,t} + \sum_k \gamma_k Control_{k,i,t} + \varepsilon_{i,t+1} \quad (2)$$

where $Ownership\ participation_{i,t}$ denotes the measures of ownership participation in AGMs, including *ownership representation*, *Block ownership*, and *Minority ownership*, for firm i in year t. $CEP_{i,t+1}$ represents the CEP measures of listed firm i, including *CEP index*, *Disclosure*, *Awareness*, *Emission*, and *Investment*, in year $t+1$. The independent variable of interest is $Online\ voting_{i,t}$, which is a dummy variable that is coded one if shareholders of firm i can vote online in AGMs in year t and zero if they cannot. Following Earnhart and Lizal (2006), Flammer (2015), and Dixon-Fowler et al. (2017), we include a set of control variables denoted as $Control_{k,i,t}$, including financial information such as firm size (*Size*), book-to-market ratio (*BM*), leverage ratio (*Leverage*), return on assets (*ROA*), firm age (*Age*), the core business income growth rate (*Growth*), and the proportion of tangible assets (*Tangible*). We also include corporate governance variables such as institutional shareholding (*Inst*), whether the CEO and chairman is the same person (*Duality*), board independence (*Indp*), auditing quality (*Big4*), and firm state-ownership (*SOE*). Detailed definitions of these variables are shown in the "Appendix" section. Industry and year fixed effects are included in all regressions unless otherwise specified. Following Petersen (2009), we cluster the standard errors by firm. All continuous variables are winsorized at the 1% level in each tail to mitigate the impact of outliers. Furthermore, we perform a variance inflation factor (VIF) test to avoid the issue of multi-collinearity. The results (not tabulated in the interest of conciseness) suggest that there is no multi-collinearity among variables.

Our results based on Eqs. (1) and (2) may be subject to an endogeneity bias due to omitted variables. For instance, firms that have a democratic culture may prefer applying online voting in their AGMs and thus have higher shareholder participation rate (Gao et al., 2020). The unobservable corporate culture may lead to a positive correlation between online voting and shareholder participation in AGMs. To address this concern, we consider the introduction of *Rules* in 2014 as a natural shock and adopt a DID approach to investigate the impact of online voting on ownership participation in AGMs and CEP of listed firms. The purpose of *Rules* is to promote minority shareholders' enthusiasm of participating in listed firms' AGMs via online voting and thus result in improved activism of minority shareholder. Specifically, we track ownership participation in listed firms' AGMs in a six-year window surrounding 2014 (2011–2016).[11] The regression models are as follows:

[9] Industrial wastewater is one of the most important and high-impact pollutants and thus is included in the Green Emission Index. The statistics from World Health Organization (WHO) show that water pollution is responsible for 1.6 million deaths per year globally (WHO, 2009). More importantly, He et al. (2020) point out that in China, wastewater emission is an important indicator applied by the government to evaluate local government officials. They find that local governments' monitoring on wastewater emission significantly influences firms' production behavior. Hence, in China's environmental pollution emission assessment system, wastewater is considered as important as other pollutant emissions, such as waste gas.

[10] Since different types of firms produce different pollutant emissions, it is difficult for the CSMAR database to construct dummy variables for each pollutant. As firms' emission reduction actions have similar economic significance, the CSMAR database unifies them into green emission reduction.

[11] [12] As discussed in Footnote 2 in the Institutional Background section, data of AGMs is also collected based on the fiscal year of AMGs, rather than the actual meeting year. Specifically, since AGMs of a listed firm in China is held within 6 months after the end of the

$$Ownership\ participation_{i,t} = \beta_0 + \beta_1 Treat_i * Post_t + \beta_2 Treat_i + \beta_3 Post_t + \sum_k \gamma_k Control_{k,i,t} + \varepsilon_{i,t} \quad (3)$$

$$CEP_{i,t+1} = \beta_0 + \beta_1 Treat_i * Post_t + \beta_2 Treat_i + \beta_3 Post_t + \sum_k \gamma_k Control_{k,i,t} + \varepsilon_{i,t+1} \quad (4)$$

where $Treat_i$ is a dummy variable that is coded one for firms that had not established network-based voting mechanisms in AGMs before 2014 (during 2011–2013) and zero otherwise. In other words, we classify treatment firms as those that are mandatorily required to establish network-based voting mechanisms in AGMs after 2014 (2014–2016), and identify the control firms as those that had voluntarily established such mechanisms in AGMs before 2014 (during 2011–2013).[12] In the above setting, the control group, which had voluntarily adopted online voting in AGMs, is not affected by the mandatory shock. $Post_t$ is a dummy variable that is coded one for the period from 2014 to 2016 and zero for the period from 2011 to 2013. We include control variables that are consistent with Eqs. (1) and (2). The interaction term $Treat_i$*$Post_t$ is our key independent variable, which proxies the impact of *Rules* in 2014 on CEP of firms in the treatment group as compared to the control group.

Empirical Results

Descriptive Statistics

Panel A of Table 1 presents the descriptive statistics of our key variables. Notably, the mean of *Ownership representation* is 0.50 during our sample period, ranging between 0.15 and 0.85. Meanwhile, the mean values of *Block ownership* and *Minority ownership* are 0.42 and 0.07, respectively. The statistics indicate that about 50% of total ownership representation voted in listed firms' AGMs, and block shareholders and minority shareholders account for approximately 42% and 7%, respectively. The mean of the *CEP index* is 0.25, and its maximum and minimum values are 0.00 and 1.00, respectively, indicating that the CEP varies widely across firms. *Online voting* has a mean of 0.68, which suggests that 68% of firm-year observations adopted online voting during our full sample period (2008–2019). Moreover, the statistics of control variables are in reasonable ranges according to Du et al. (2018). We report the distribution of listed firms that adopted online voting by year in Panel B of Table 1. The distribution shows that the percentage of firms that established and applied network-based voting systems increased from no more than 6% in 2008 to 100% in 2014 and remain unchanged since then.[13]

In addition, before empirical analysis, we have tried to provide more direct evidence that minority shareholders are concerned about the CEP of listed firms. In China, the SZSE and the SHSE have established online platforms for minority shareholders to raise questions to listed firms regarding issues of their interests. Timely responses to these questions are urged by regulators (Liu et al., 2017). Using data collected from these platforms, we count the questions of minority shareholders on 10 categories of listed firms' environmental issues. We identify environment-related questions by searching for 10 key words in all questions, namely environmental protection, pollution, haze, waste gas, wastewater, water pollution, emission, emission reduction, sewage and waste disposal. The number of questions raised by minority shareholders regarding listed firms' environmental issues in each year is summarized in the Fig. 2. We observe that the number of minority shareholders' questions regarding listed firms' environmental issues shows a clear upward trend, indicating that minority shareholders are indeed concerned about CEP of listed firms and their concern is gradually increasing.

Preliminary Verification of the Impact of Online Voting

Table 2 reports the regression results of Eq. (1). We see that in Columns (1) and (2) in Table 2, the coefficients of *Online voting* are all significantly positive, indicating that shareholder participation in AGMs significantly increases in listed firms that adopted online voting in AGMs. When examining different types of ownership representation, as observed from Columns (3) to (6), we find that the coefficients of *Online voting* in Columns (5) and (6) are significantly positive, while they are insignificant in Columns (3) and (4). The results suggest that the improved

Footnote 11 (continued)

fiscal year, all 2014 AGMs of Shanghai listed firms adopted online voting as a result of regulation. Therefore, for the brevity of reporting, *Rules* issued by the SZSE and the SHSE in late 2014 and early 2015 respectively, are collectively referred to as *Rules* in 2014 since they are effective to the 2014 AGMs of all listed firm.

[12] We also conduct robustness analysis by excluding the year of policy intervention. Specifically, we adopt 2011–2013 as the pre-policy period and 2015–2017 as the post-policy period to conduct the DID analysis. The untabulated results are similar to those reported in Tables 5 and 6.

[13] As online voting is fully adopted in listed firms' AGMs since 2014, we also use 2008–2013 as an alternative sample period to ensure that CEP of firms with online voting in AGMs is better than those without. The results (not tabulated in the interest of conciseness) are similar to the results in Tables 2 and 3.

Table 1 Summary statistics

Variable	*N*	Mean	SD	Min	25th	Median	75th	Max
Panel A: Summary statistics of variables								
Ownership representation	24,494	0.50	0.16	0.15	0.37	0.49	0.61	0.85
Block ownership	24,494	0.42	0.16	0.13	0.35	0.41	0.59	0.85
Minority ownership	24,494	0.07	0.08	0.00	0.00	0.05	0.16	0.25
CEP index	24,494	0.25	0.31	0.00	0.13	0.27	0.35	1.00
Disclosure	24,494	0.52	0.25	0.00	0.33	0.50	0.66	1.00
Awareness	24,494	0.24	0.30	0.00	0.13	0.25	0.63	1.00
Green Emission	24,494	0.18	0.38	0.00	0.00	0.00	0.00	1.00
Investment	24,494	0.12	0.26	0.00	0.00	0.33	0.50	1.00
Online voting	24,494	0.68	0.47	0.00	0.00	1.00	1.00	1.00
Size	24,494	8.66	0.97	6.74	7.97	8.56	9.23	11.56
BM	24,494	0.62	0.25	0.12	0.43	0.62	0.81	1.14
Leverage	24,494	0.44	0.21	0.05	0.27	0.43	0.60	0.95
ROA	24,494	0.06	0.07	−0.20	0.03	0.05	0.09	0.27
Age	24,494	2.17	0.75	0.69	1.61	2.30	2.83	3.26
Growth	24,494	0.15	0.34	−0.57	−0.02	0.11	0.26	1.81
Tangible	24,494	0.23	0.17	0.00	0.09	0.19	0.32	0.72
Inst	24,494	0.39	0.23	0.00	0.20	0.40	0.57	0.88
Duality	24,494	0.25	0.43	0.00	0.00	0.00	1.00	1.00
Indp	24,494	0.34	0.10	0.00	0.33	0.33	0.40	0.57
Big4	24,494	0.06	0.23	0.00	0.00	0.00	0.00	1.00
SOE	24,494	0.42	0.49	0.00	0.00	0.00	1.00	1.00

Year	No. of firms	No. of firms with online voting	Percentage of firms with online voting (%)
Panel B: Distribution of firms with online voting in AGMs by year			
2008	1139	66	5.79
2009	1237	90	7.28
2010	1339	112	8.36
2011	1653	161	9.74
2012	1941	486	25.04
2013	2046	761	37.19
2014	2031	2031	100.00
2015	2082	2082	100.00
2016	2322	2322	100.00
2017	2536	2536	100.00
2018	3049	3049	100.00
2019	3119	3119	100.00
Total	24,494	16,758	68.42

Panel A reports the descriptive statistics of variables. The sample consists of firms listed on SHSE and SZSE from 2008 to 2019. Panel B reports the distributions of the number/percentage of firms with online voting during our sample period. Detailed definitions of variables are shown in "Appendix" section

shareholder participation in AGMs is mainly driven by the improved participation of minority shareholders as compared to block shareholders. As they have greater interests in the firm, block shareholders are expected to attend AGMs even if online voting is not adopted by the listed firm. However, minority shareholders that are reluctant to attend on-site AGMs due to high costs are encouraged by the establishment of online voting systems to participate in AGMs.

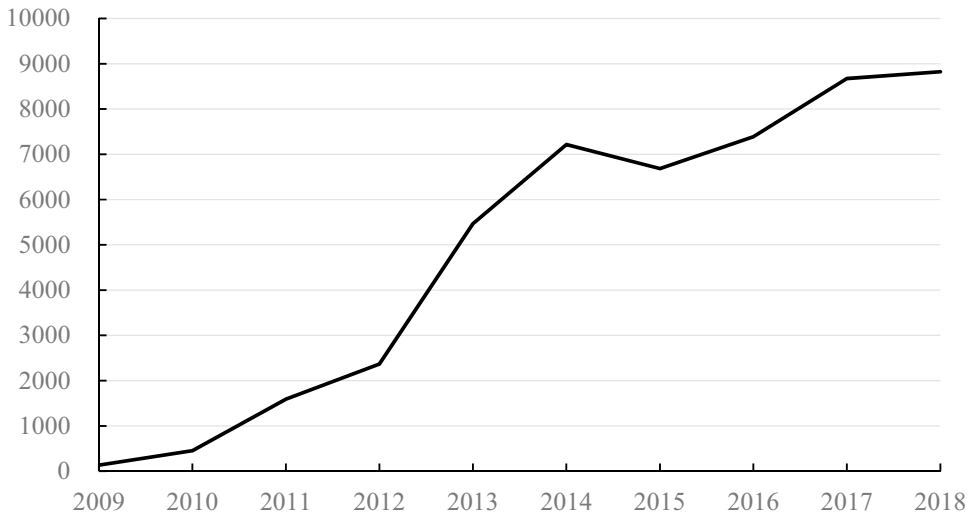

Fig. 2 The number of questions raised by minority shareholders regarding listed firms' environmental issues. In China, the Shanghai and Shenzhen Stock Exchanges have established online platforms for minority shareholders to raise questions to listed firms regarding issues of their interests. Using data collected from these platforms, we count the questions of minority shareholders on 10 categories of listed firms' environmental issues. We identify environment-related questions by searching for 10 key words in all questions, namely environmental protection, pollution, haze, waste gas, wastewater, water pollution, emission, emission reduction, sewage and waste disposal. The number of questions raised by minority shareholders regarding listed firms' environmental issues in each year is summarized in the figure

The coefficients of the control variables are generally similar with those of previous studies (Gao et al., 2020). For instance, the coefficients of firm size, BM ratio, and state-owned enterprises are significantly positive, suggesting that larger firms, firms with higher BM ratio, and SOEs tend to have higher ownership participation in AGMs, and firms with higher leverage ratio tend to have lower ownership participation.

Table 3 reports the regression results of Eq. (2). As shown in Column (1), the coefficient of *Online voting* is significantly positive at the 5% significance level, suggesting that the adoption of online voting in AGMs improves listed firms' overall CEP. We further examine the impact of establishing and implementing online voting in AGMs based on the four sub-measurements of listed firms' CEP—environmental disclosure, environmental awareness, green emission, and environmental investment. Results are in Columns (2) to (5) in Table 3. We show that the coefficients of *Online voting* are all positive and significant, at least at the 10% significance level. Notably, the significance of the coefficients in Columns (2) and (3) (at the 1% significance level) are more prominent than those in Columns (4) and (5) (at the 10% significance level). This indicates that the promoting effect of online voting on CEP is more prominent for environmental disclosure and awareness as compared to green emission and environmental investment. We posit that compared with improving green emission and environmental investment, which require heavy capital investments, listed firms prefer to improve their environmental information disclosure and environmental awareness to satisfy minority shareholders' growing demand of building eco-friendly corporations once online voting is adopted.

Similarly, the results of the other variables are similar with those of previous studies (Dixon-Fowler et al., 2017; Du et al., 2018). That is, firms with larger size, higher BM ratio, higher institutional shareholding, and higher board independence are more likely to have better CEP. In addition, driven by the government's endeavor to mitigate corporate environmental pollution, SOEs tend to have better CEP than non-SOEs.

DID Analysis

As discussed in "Model Specification" section, our results may be subject to an endogeneity bias. To address this concern, we identify the introduction of *Rules* in 2014 as a natural shock and adopt a DID approach to investigate the association of the mandatory implementation of online voting and CEP. We classify the treatment firms as those that are mandatorily required to implement online voting in AGMs after 2014 (2014–2016) and the control firms as those that had voluntarily established network-based voting mechanisms in AGMs before 2014 (during 2011–2013).

Table 2 The impact of online voting on ownership representation in AGMs

Dependent variable	Ownership representation		Block ownership		Minority ownership	
	(1)	(2)	(3)	(4)	(5)	(6)
Online voting	0.037***	0.028***	0.007	0.006	0.023***	0.021***
	(10.45)	(9.45)	(1.48)	(1.25)	(10.54)	(9.98)
Size		0.039***		0.035***		0.005***
		(4.24)		(3.43)		(3.90)
BM		0.150***		0.152***		0.001***
		(9.46)		(9.17)		(7.10)
Leverage		−0.028***		−0.027***		0.001
		(−2.88)		(−2.68)		(0.19)
ROA		0.153***		0.109***		0.049***
		(8.66)		(6.69)		(4.37)
Age		−0.133*		−0.121		−0.014
		(−1.78)		(−1.45)		(−1.46)
Growth		−0.005**		−0.003		−0.002
		(−2.23)		(−1.55)		(−1.45)
Tangible		0.016		0.028**		−0.008
		(1.29)		(2.05)		(−1.14)
Inst		−0.115***		0.123**		−0.014***
		(−9.43)		(2.27)		(−3.72)
Duality		0.001		0.003		0.001
		(0.52)		(1.07)		(0.82)
Indp		0.002		0.006		0.003
		(0.32)		(0.88)		(0.52)
Big4		0.017**		0.023***		0.007
		(1.97)		(2.77)		(1.63)
SOE		0.037***		0.031***		0.008***
		(7.05)		(5.38)		(3.03)
Constant	0.496***	0.263***	0.492***	0.258***	0.011*	−0.007
	(2.71)	(8.49)	(7.37)	(8.08)	(1.76)	(−0.52)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,494	24,494	24,494	24,494	24,494	24,494
Adjusted R^2	0.061	0.307	0.047	0.306	0.058	0.403

This table reports the regression results of Eq. (1). *Ownership participation*$_{i,t}$ denotes the measures of shareholder participation in AGMs, including *Ownership representation*, *Block ownership representation*, and *Minority ownership representation*. *Online voting*$_{i,t}$ is an indicator variable takes the value of one if shareholders of firm *i* can vote online in AGMs in year *t*, and zero if they cannot. Other variables are defined in "Appendix" section. The sample period covers 2008–2019. The *t*-statistics are given in parentheses with robust standard errors clustered by firm

*, **, and *** denote 10%, 5%, and 1% statistical significance levels

Table 4 shows the summary statistics of the DID sample. In Panel A, we see that the means of $Treat_i$ and $Post_t$ are 0.59 and 0.52, suggesting that 59% of the observations are included in the treatment group[14] and 52% of the observations are after the implementation of *Rules*.

Subsequently, we perform *t*-tests to compare the differences between treatment and control groups and report the results in Panel B of Table 4. First, we note that the control group had a significantly high rate of ownership participation than the treatment group during the sample period; this difference is mainly driven by the higher participation rate of minority shareholders in AGMs in the control group. Second, CEP of the control group is better than that of the treatment group. Concerning control variables, in comparison to treated firms, control firms tend to have a large size,

[14] Notably, to ensure the sample size of the control group, we select firms that had at least one online voting during 2011–2013 as the control group. Therefore, the proportion of the control group is a little higher than the sample proportion of the online voting adoption in 2013 (37.19%). In addition, among the results that are not tabulated, we also select listed firms that continuously adopted online voting during 2011–2013 as the control group, and our results are not affected.

Table 3 The impact of online AGM voting on CEP

Dependent variable	CEP index (1)	Disclosure (2)	Awareness (3)	Green emission (4)	Investment (5)
Online voting	0.121**	0.232***	0.215***	0.157*	0.132*
	(2.24)	(3.47)	(2.75)	(1.87)	(1.83)
Size	0.711***	0.195***	0.893***	0.874***	0.990***
	(4.26)	(8.08)	(3.28)	(3.12)	(4.12)
BM	1.319***	0.627***	1.227***	1.489***	1.698***
	(3.53)	(6.82)	(3.06)	(4.10)	(8.20)
Leverage	0.424***	0.103	0.177	−0.082	0.296***
	(5.89)	(1.03)	(1.62)	(−0.67)	(2.75)
ROA	0.606***	0.237	0.604*	0.073	0.257
	(2.79)	(0.79)	(1.75)	(0.19)	(0.77)
Age	0.137	0.076	−0.448	0.433	0.404
	(1.09)	(1.11)	(−1.32)	(0.65)	(0.87)
Growth	−0.334***	−0.076	−0.385***	−0.273***	−0.396***
	(−8.65)	(−1.45)	(−6.32)	(−3.92)	(−6.62)
Tangible	1.007***	1.216***	−0.158	0.219	−0.055
	(10.99)	(9.44)	(−1.13)	(1.55)	(−0.44)
Inst	0.511***	0.037	0.541***	0.909***	0.962***
	(8.17)	(0.43)	(5.86)	(9.01)	(10.47)
Duality	−0.124***	−0.038	−0.104**	−0.136**	−0.168***
	(−4.35)	(−0.93)	(−2.13)	(−2.55)	(−3.46)
Indp	0.497***	0.243	0.352**	0.803***	0.683***
	(4.37)	(1.44)	(2.08)	(4.42)	(4.23)
Big4	0.608***	−0.035	0.447***	0.654***	0.470***
	(10.58)	(−0.40)	(7.25)	(9.40)	(8.09)
SOE	0.231***	0.077*	0.201***	0.326***	0.267***
	(7.59)	(1.91)	(4.59)	(7.08)	(6.42)
Constant	0.950***	0.953***	1.225***	−1.150***	1.261***
	(5.77)	(6.50)	(4.57)	(−3.97)	(4.79)
Industry FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	24,494	24,494	24,494	24,494	24,494
Adjusted R^2	0.117	0.172	0.141	0.131	0.115

This table reports the regression results of Eq. (2). *CEP index*, *Disclosure*, *Awareness*, *Emission*, and *Investment* measure the overall CEP, environmental disclosure, environmental awareness, green emission, and environmental investment of listed firms. *Online voting*$_{i,t}$ is an indicator variable equals one if shareholders of firm *i* can vote online in AGMs in year *t*, and zero otherwise. Other variables are defined in "Appendix" section. The sample period covers 2008–2019. The *t*-statistics are given in parentheses with robust standard errors clustered by firm

*, **, and *** denote 10%, 5%, and 1% statistical significance levels

higher BM ratio, lower firm leverage level, higher profitability capacity, higher institutional ownership, higher board independence, and are more likely to be SOEs.

To further examine the differences between the treatment group and the control group prior and after the issuance of *Rules* in 2014, we perform *t*-tests in each period. As shown in Panel C, the control group had significantly higher ownership participation rate (49.5%) than the treatment group (48.2%) before 2014. This difference is primarily driven by minority shareholders' participation rate in AGMs. As expected, after the mandatory adoption of online voting in 2014, the differences of ownership and minority shareholder participation between treated and control firms become insignificant due to the improved AGM engagement of minority shareholders in treated firms. Further, we observe that, before 2014, the overall CEP of the control group is significantly higher than that of the treatment group, and this difference turns negative post 2014, which indicates a significant increase of CEP in the treated firms. In addition, before the implementation of online voting, the four

Table 4 Summary statistics of the DID sample

Variable	*N*	Mean	SD	Min	25th	Median	75th	Max
Panel A: Summary statistics of Treat and Post								
Treat	11,697	0.59	0.53	0.00	0.00	1.00	1.00	1.00
Post	11,697	0.52	0.50	0.00	0.00	1.00	1.00	1.00

Variables	Control	Mean	Treatment	Mean	Mean diff
Panel B: t-tests that compare the differences between the treatment and control group					
Ownership representation	4796	0.494	6901	0.488	0.006***
Block ownership	4796	0.422	6901	0.421	0.001
Minority ownership	4796	0.071	6901	0.064	0.008**
CEP index	4796	0.256	6901	0.243	0.013***
Disclosure	4796	0.540	6901	0.501	0.038**
Awareness	4796	0.278	6901	0.240	0.037**
Emission	4796	0.217	6901	0.165	0.052***
Investment	4796	0.138	6901	0.125	0.012***
Size	4796	8.781	6901	8.598	0.183***
BM	4796	0.644	6901	0.601	0.042***
Leverage	4796	0.437	6901	0.466	−0.029***
ROA	4796	0.058	6901	0.056	0.002***
Age	4796	2.312	6901	2.311	0.001
Growth	4796	0.152	6901	0.154	−0.002
Tangible	4796	0.236	6901	0.237	−0.001
Inst	4796	0.420	6901	0.392	0.029***
Duality	4796	0.223	6901	0.225	−0.002
Indp	4796	0.344	6901	0.341	0.002*
Big4	4796	0.064	6901	0.059	0.005
SOE	4796	0.466	6901	0.436	0.031***

Period	2011–2013					2014–2016				
	Control	Mean	Treatment	Mean	Mean diff	Control	Mean	Treatment	Mean	Mean diff
Panel C: t-tests that compare the differences between the treatment and control group before and after the implementation of Rules in 2014										
Ownership representation	2302	0.495	3313	0.482	0.012***	2494	0.493	3588	0.494	−0.001
Block ownership	2302	0.421	3313	0.419	0.003	2494	0.422	3588	0.421	0.001
Minority ownership	2302	0.071	3313	0.050	0.022***	2494	0.073	3588	0.075	−0.002*
CEP index	2302	0.254	3313	0.230	0.024***	2494	0.255	3588	0.261	−0.006**
Disclosure	2302	0.541	3313	0.457	0.084**	2494	0.543	3588	0.545	−0.002**
Awareness	2302	0.277	3313	0.198	0.079***	2494	0.280	3588	0.282	−0.002*
Emission	2302	0.235	3313	0.168	0.067***	2494	0.225	3588	0.213	0.012*
Investment	2302	0.137	3313	0.115	0.023**	2494	0.138	3588	0.134	0.004
Size	2302	8.407	3313	8.179	0.228***	2494	9.165	3588	9.014	0.151***
BM	2302	0.693	3313	0.658	0.035***	2494	0.539	3588	0.485	0.054***
Leverage	2302	0.421	3313	0.457	−0.036**	2494	0.419	3588	0.439	−0.020*
ROA	2302	0.064	3313	0.061	0.003*	2494	0.054	3588	0.054	0.000
Age	2302	2.046	3313	2.044	0.002	2494	2.321	3588	2.320	0.001
Growth	2302	0.143	3313	0.153	−0.010	2494	0.128	3588	0.134	−0.005
Tangible	2302	0.235	3313	0.228	0.007	2494	0.236	3588	0.221	0.016***
Inst	2302	0.420	3313	0.376	0.044***	2494	0.431	3588	0.411	0.020***
Duality	2302	0.224	3313	0.240	−0.015	2494	0.244	3588	0.248	−0.004
Indp	2302	0.343	3313	0.342	0.002	2494	0.345	3588	0.347	−0.002
Big4	2302	0.059	3313	0.055	0.004	2494	0.062	3588	0.053	0.009
SOE	2302	0.464	3313	0.429	0.035***	2494	0.436	3588	0.401	0.035***

This table reports the summary statistics of the DID analysis sample. *t*-tests to examine the differences between treatment and control groups and report the results in Panel B of Table 4. Panel A presents the statistics (mean, standard error, minimum, Q1, median, Q3, and maximum) of *Treat* and *Post*. $Treat_i$ is a dummy variable that takes the value of one for firms that had not established network-based voting mechanisms during 2011–2013, and zero if they had. $Post_t$ is indicator variable that takes the value of one for the period from 2014 to 2016 and zero for the period

Table 4 (continued)

from 2011 to 2013. Panel B presents *t*-tests results that compare the differences between the treatment and control group. Panel C reports the *t*-tests results that compare the differences between the treatment control group before and after the implementation of *Rules* in 2014

*, **, and *** denote 10%, 5%, and 1% statistical significance levels

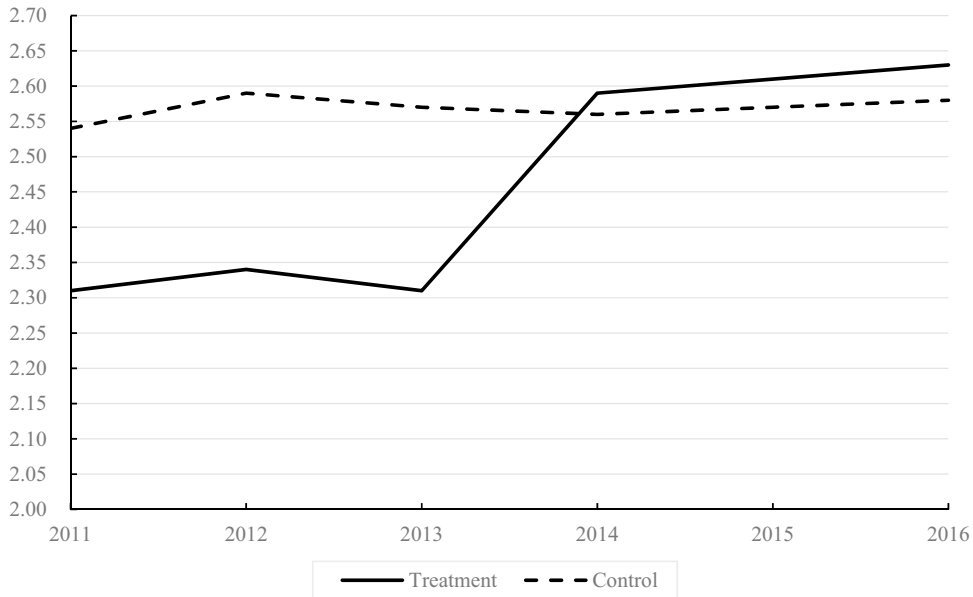

Fig. 3 CEP index trend of treated firms and control firms. This figure presents the time-varying trend of CEP index of treated firms and control firms. CEP index is composed by four subitems, including environmental disclosure, environmental awareness, green emission, and environmental investment. Specific definition of CEP index is shown in "Appendix" section. The treated firms are those that are influenced by the mandatory requirements of online voting, and the control firms are those that are not influenced

sub-measurements of CEP are higher for the control group as compared to the treatment group. These differences significantly narrow or even reverse post 2014.

Figure 3 illustrates the time-varying trend of CEP of the treated and control firms. To observe the differences more clearly, we magnify the mean of CEP by a factor of 100. Consistent with the results of Table 4, we observe that, before *Rules* was implemented in 2014, the CEP of treated firms is significantly worse than that of control firms. However, CEP difference between treatment and control firms significantly narrows from 2014 onward, and the CEP index of treated firms is even higher than that of control firms afterward.

Subsequently, we conduct the multi-variate DID analysis to explore the impact of mandatory adoption of online voting on the ownership participation in AGMs and CEP. Table 5 reports the regression results of Eq. (3), in which the coefficients of the interaction term $Treat_i*Post_t$ are significantly positive in Columns (1) and (3), while they are insignificant in Column (2). In other words, the mandatory requirement of online voting significantly improves the participation of shareholders in AGMs, especially the participation of minority shareholders.

Table 6 presents the results of Eq. (4). As Column (1) shows, the coefficient of $Treat_i*Post_t$ is 0.022 and is statistically significant, indicating that, after the mandatory adoption of online voting in 2014, CEP of treated firms significantly increases as compared to control firms. Similar with the results of Table 3, the coefficients of the interaction term in Columns (2) and (3) are more prominent than those in Columns (4) and (5) in Table 6. The significance differences of coefficients indicate that, after the adoption of online voting, the positive impact of minority investors' increased participation in AGMs on treated firms' environmental disclosure and awareness is more pronounced as compared to green emission and environmental investment.

Furthermore, a triple difference analysis is performed to ensure that improved CEP of listed firms is a result of the increased minority shareholder participation in AGMs. Table 7 reports the results, wherein the coefficients of *Treat*Post*Minority ownership* are positive and significant. This suggests that, after the implementation of *Rules* in 2014, the increased minority shareholders' participation in AGMs is positively associated with improved CEP of treated firms when comparing with the control firms. Additionally, the coefficients of *Minority ownership* are all significantly positive, indicating that minority shareholders' participation in AGMs has a positive influence on CEP.

Table 5 DID analysis: the impact of online voting on ownership representation in AGMs

Dependent variable	Ownership representation	Block ownership	Minority ownership
	(1)	(2)	(3)
Treat*Post	0.011***	0.003	0.008***
	(2.97)	(0.85)	(3.00)
Treat	−0.009*	0.018	−0.007**
	(−1.76)	(0.12)	(−2.36)
Post	0.006*	0.006	0.002**
	(1.87)	(1.34)	(2.03)
Size	0.039***	0.040***	0.002
	(12.22)	(11.97)	(1.31)
BM	0.169***	0.176***	−0.003
	(7.56)	(7.51)	(−0.51)
Leverage	−0.022*	−0.034***	0.010
	(−1.95)	(−2.78)	(1.41)
ROA	0.168***	0.125***	0.052***
	(6.55)	(5.35)	(2.99)
Age	−0.128***	−0.115***	−0.010***
	(−3.47)	(−2.81)	(−4.42)
Growth	−0.010***	−0.007**	−0.004*
	(−3.41)	(−2.40)	(−1.73)
Tangible	0.026	0.046	0.013
	(1.32)	(1.05)	(1.60)
Inst	−0.117***	0.119***	−0.017***
	(−5.29)	(6.61)	(−3.47)
Duality	−0.001	0.003	−0.003
	(−0.18)	(0.78)	(−1.13)
Indp	0.004	0.007	−0.002
	(0.42)	(0.80)	(−0.30)
Big4	0.010	0.017*	0.017***
	(1.04)	(1.76)	(2.62)
SOE	0.027***	0.020***	0.007**
	(4.40)	(3.02)	(2.39)
Constant	0.247***	0.194***	0.028
	(6.63)	(4.97)	(1.61)
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	11,697	11,697	11,697
Adjusted R^2	0.285	0.212	0.307

This table reports the regression results of Eq. (3).*Ownership participation*$_{i,t}$ denotes the measures of shareholder participation in AGMs, including *Ownership representation*, *Block ownership representation*, and *Minority ownership representation*. *Treat*$_i$ is a dummy variable that takes the value of one for firms that had not adopted online voting during 2011–2013, and zero if they had. *Post*$_t$ is a dummy variable that takes the value of one for the period from 2014 to 2016 and zero for the period from 2011 to 2013. Other variables are defined in "Appendix" section. The *t*-statistics are given in parentheses with robust standard errors clustered by firm

*, **, and *** denote 10%, 5%, and 1% statistical significance levels

Overall, the above results support H1 as minority shareholders' participation in AGMs through online voting improves CEP of listed firms.

Motives of Minority Shareholders

In this sub-section, we examine whether "local pollution" exposure and the increasing awareness of listed firms' environmental risks are the two potential motives that encourage minority shareholders to participate in online voting to improve CEP.

Local Pollution Exposure

We now examine the local pollution exposure as a potential motivation for minority shareholders to concern the environmental performance of listed firms. Local bias theory indicates that investors prefer to hold stocks in local firms (Graham et al., 2009; Huang et al., 2016; Lewis, 1999; Nieuwerburgh & Veldkamp, 2009; Strong & Xu, 2003).[15] Accordingly, we posit that if the local pollution level is more serious, the minority investors who prefer to invest in local firms are exposed to more severe corporate environmental pollution. Thus, they may utilize online voting to speak out on corporate environmental issues, and consequently, encourage listed firms to improve CEP.

To test the above hypothesis, we mainly use three proxies to measure local pollution—*PM2.5*, *Letters*, and *Monitornum*. *PM2.5* is applied to measure the local environmental pollution and is defined as the average annual concentration (micrograms per cubic meter) of PM2.5 in the city in which the sample firms' headquarters are located. PM2.5 is one of the most prominent pollutants monitored by the Chinese government, and its concentration is a frequently used indicator to measure city level air pollution in China (Greenstone et al., 2021; He et al., 2016). *Letters* is used as a proxy for local residents' enthusiasm toward local environmental issues and is measured as the log of the total number of letters, phone calls, and emails received by provincial governments regarding environmental issues in the province in which the sample firms' headquarters are located plus one. *Monitornum* measures the severity of regional corporate environmental pollution. It is the number of polluting firms in the province in which the sample firms' headquarters are located based on the *List of Key Enterprises under State Supervision*.

[15] Among our results that are not tabulated, we find that online search volume from the firm location is significantly higher than that outside the location. This result further indicates that local investors prefer local firms.

Table 6 DID analysis: the impact of online voting on CEP

Dependent variable	CEP index (1)	Disclosure (2)	Awareness (3)	Green emission (4)	Investment (5)
Treat*Post	0.022**	0.024***	0.018***	0.002**	0.003**
	(2.25)	(3.91)	(3.00)	(2.06)	(2.11)
Treat	−0.020	−0.002	−0.007**	−0.019**	−0.012
	(−0.58)	(−0.15)	(−2.36)	(−2.09)	(−0.74)
Post	0.178*	0.287**	0.002*	0.143*	0.268*
	(1.85)	(2.08)	(1.84)	(1.85)	(1.83)
Size	0.699***	0.018***	0.002	0.141***	0.333***
	(3.60)	(2.87)	(1.31)	(2.87)	(2.76)
BM	1.126***	0.092***	0.003	0.216***	0.525***
	(5.35)	(4.00)	(0.51)	(2.85)	(4.90)
Leverage	0.047	0.032	0.010	−0.039**	0.006
	(0.61)	(1.21)	(1.41)	(−2.07)	(0.18)
ROA	0.542**	0.113	0.052***	0.124**	0.502***
	(2.15)	(1.37)	(2.99)	(1.96)	(4.20)
Age	−0.161***	−0.026***	−0.010***	−0.050***	−0.077***
	(−6.63)	(−3.29)	(−4.42)	(−8.52)	(−6.67)
Growth	−0.281***	−0.043***	−0.004*	−0.043***	−0.119***
	(−7.61)	(−3.01)	(−1.73)	(−4.59)	(−7.03)
Tangible	0.364	0.268	−0.013	0.042	0.087*
	(0.68)	(0.66)	(−1.60)	(0.67)	(1.83)
Inst	0.464***	0.013	0.017***	0.126***	0.240***
	(6.78)	(0.60)	(3.47)	(7.69)	(7.53)
Duality	−0.055*	0.015	−0.003	−0.007	−0.043***
	(−1.80)	(1.42)	(−1.13)	(−0.90)	(−3.09)
Indp	0.342**	0.001	−0.002	0.101***	0.222***
	(2.43)	(0.02)	(−0.30)	(2.88)	(3.27)
Big4	0.860***	−0.014	0.017***	0.194***	0.432***
	(10.72)	(−0.69)	(2.62)	(10.57)	(10.68)
SOE	0.117***	0.026**	0.007**	0.044***	0.071***
	(3.53)	(2.52)	(2.39)	(5.35)	(4.53)
Constant	−4.693**	1.323**	0.028	−1.258**	−2.909
	(−2.17)	(2.07)	(1.61)	(−2.16)	(−1.39)
Industry FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	11,697	11,697	11,697	11,697	11,697
Adjusted R^2	0.290	0.271	0.231	0.243	0.207

This table presents the regression results of Eq. (4). *CEP index*, *Disclosure*, *Awareness*, *Emission*, and *Investment* measure the composite environmental performance, environmental disclosure, environmental awareness, green emission, and environmental investment of listed firms. $Treat_i$ is a dummy variable that takes the value of one for firms that had not adopted online voting during 2011–2013, and zero if they had. $Post_t$ is a dummy variable that takes the value of one for the period from 2014 to 2016 and zero for the period from 2011 to 2013. Other variables are defined in "Appendix" section. The *t*-statistics are given in parentheses with robust standard errors clustered by firm

*, **, and *** denote 10%, 5%, and 1% statistical significance levels

To examine whether "local pollution" is a motive that minority shareholders improve CEP of listed firms, the following regression model is formulated:

$$CEP_{i,t+1} = \beta_0 + \beta_1 Treat_i * Post_t * Local_pollution_{i,(j),t} + \beta_2 Local_pollution_{i,(j),t} + \beta_3 Treat_i + \beta_4 Post_t + \sum_k \gamma_k Control_{k,i,t} + \varepsilon_{i,t+1} \quad (5)$$

Table 7 The triple difference analysis on minority ownership representation in AGMs

Dependent variable	CEP index (1)	Disclosure (2)	Awareness (3)	Green emission (4)	Investment (5)
Treat*Post*Minority ownership	0.146**	0.172***	0.149**	0.085**	0.194**
	(2.21)	(2.67)	(2.13)	(2.15)	(2.18)
Minority ownership	0.211*	0.117*	0.240**	0.039***	0.202**
	(1.87)	(1.83)	(2.24)	(2.81)	(2.12)
Treat*Post	0.029***	0.026**	0.015***	0.001***	0.001***
	(2.67)	(2.17)	(3.09)	(3.10)	(2.83)
Treat	−0.023	−0.002	0.038	−0.019**	−0.014
	(−0.65)	(−0.20)	(1.19)	(−2.15)	(−0.85)
Post	0.182*	0.284*	0.198*	0.144	0.270*
	(1.92)	(1.89)	(1.87)	(1.46)	(1.83)
Size	0.700***	0.018***	0.258	0.141***	0.334***
	(3.58)	(2.93)	(1.32)	(2.88)	(2.81)
BM	1.122***	0.090***	1.000***	0.215*	0.523*
	(5.29)	(3.91)	(4.38)	(1.80)	(1.85)
Leverage	0.046	0.033	0.073	−0.041**	0.005
	(0.60)	(1.24)	(0.99)	(−2.13)	(0.13)
ROA	0.555**	0.117	0.455*	0.128**	0.494***
	(2.19)	(1.41)	(1.82)	(2.01)	(4.12)
Age	0.160	0.025	0.159	0.050	0.076
	(0.58)	(1.17)	(1.44)	(1.45)	(1.37)
Growth	−0.280***	−0.042***	−0.238***	−0.043***	−0.119***
	(−7.56)	(−2.95)	(−6.75)	(−4.58)	(−7.05)
Tangible	0.358	0.267	0.568	0.041	0.082*
	(0.60)	(1.40)	(1.16)	(1.32)	(1.72)
Inst	0.461***	0.009	0.370***	0.124***	0.236***
	(6.69)	(0.44)	(5.76)	(7.57)	(7.36)
Duality	−0.055*	0.017	−0.076***	−0.007	−0.045***
	(−1.78)	(1.60)	(−2.61)	(−0.97)	(−3.18)
Indp	0.348**	0.005	0.221	0.103***	0.227***
	(2.47)	(0.12)	(1.63)	(2.92)	(3.35)
Big4	0.846***	0.014	0.396***	0.190***	0.421***
	(10.51)	(0.69)	(4.96)	(10.33)	(10.39)
SOE	0.117***	0.026**	0.141***	0.044***	0.072***
	(3.52)	(2.54)	(4.66)	(5.31)	(4.56)
Constant	−4.687**	1.322	−3.771	−1.257***	−2.904***
	(−2.10)	(0.32)	(−0.57)	(−5.09)	(−8.31)
Industry FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	11,697	11,697	11,697	11,697	11,697
Adjusted R^2	0.290	0.311	0.258	0.242	0.286

This table presents the results of triple difference analysis. *Minority ownership* representation measures the participation of minority shareholders in AGMs, which is calculated as the number of shares owned by minority shareholders that voted in AGMs scaled by the total number of shares. Minority shareholders are those who own less than 5% of the firm. Other variables are defined in "Appendix" section. The *t*-statistics are given in parentheses with robust standard errors clustered by firm

*, **, and *** denote 10%, 5%, and 1% statistical significance levels

Table 8 The motive of "local pollution" exposure

Dependent variable	CEP index		
	(1)	(2)	(3)
Treat*Post*PM2.5	0.004**		
	(2.15)		
PM2.5	−0.002*		
	(−1.73)		
Treat*Post*Letters		0.003***	
		(3.41)	
Letters		0.011	
		(0.55)	
Treat*Post*Monitornum			0.003**
			(2.20)
Monitornum			0.007
			(0.61)
Treat*Post	0.037**	0.035**	0.039***
	(2.05)	(2.10)	(2.77)
Treat	−0.020	−0.020	−0.021
	(−0.57)	(−0.56)	(−0.59)
Post	0.177*	0.165	0.173**
	(1.87)	(1.61)	(2.04)
Size	0.699***	0.699***	0.698***
	(3.61)	(3.58)	(3.49)
BM	1.126***	1.127***	1.126***
	(5.36)	(5.36)	(5.37)
Leverage	0.045	0.047	0.049
	(0.58)	(0.62)	(0.64)
ROA	0.540**	0.550**	0.532**
	(2.14)	(2.18)	(2.11)
Age	0.158	0.162	0.160
	(1.50)	(0.66)	(1.49)
Growth	−0.282***	−0.282***	−0.281***
	(−7.63)	(−7.62)	(−7.61)
Tangible	0.362	0.365	0.367
	(0.66)	(0.69)	(0.70)
Inst	0.469***	0.465***	0.464***
	(6.86)	(6.78)	(6.78)
Duality	−0.055*	−0.056*	−0.055*
	(−1.79)	(−1.82)	(−1.80)
Indp	0.342**	0.342**	0.341**
	(2.43)	(2.43)	(2.42)
Big4	0.866***	0.859***	0.858***
	(10.76)	(10.71)	(10.68)
SOE	0.119***	0.119***	0.115***
	(3.59)	(3.59)	(3.44)
Constant	−4.638***	−4.704**	−4.675
	(−2.68)	(−2.06)	(−1.03)
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	11,697	11,697	11,697
Adjusted R^2	0.291	0.290	0.290

Table 8 (continued)

This table reports the regression results of Eq. (5). *PM2.5* is the average annual concentration (micrograms per cubic meter) of PM2.5 in the city where the sample firm's headquarter is located; *Letters* is the natural logarithm of the total number of letters, phone calls, emails received by provincial governments regarding environmental issues in the province where the sample firm's headquarter is located plus one. *Monitornum* is the number of polluting firms in the province where the sample firm's headquarter is located based on the *List of Key Enterprises under State Supervision*. Other variables are defined in "Appendix" section. The *t*-statistics are given in parentheses with robust standard errors clustered by firm

*, **, and *** denote 10%, 5%, and 1% statistical significance levels

where $Local_pollution_{i,(j),t}$ denotes the three "local pollution" measures of firm *i* (province or city *j*) in year *t*. Other variables are consistent with those used in Eq. (4) and are defined in the "Appendix" section. The triple interaction term $Treat_i * Post_t * Local_pollution_{i,(j),t}$ is our independent variable of interest.

Table 8 reports the regression results of Eq. (5). We see that the triple interaction terms are positively and significantly related to the dependent variable in all columns of Table 8, suggesting that the improvement in CEP is more prominent when minority investors are exposed to "local pollution."[16] Thus, the results support H1a as "local pollution" is a motive that encourage minority shareholders improve the CEP of listed firms.

Awareness of Listed Firms' Environmental Risk

We argue that if the listed firms' environmental risk is higher, minority shareholders' financial interests will be at stake if listed firms' pollution activities are exposed and punished. Therefore, minority shareholders, who are in a disadvantaged information position, may be also motivated to care about and monitor the CEP of listed firms to protect their investment interests. We apply two measures to proxy for the environmental risk of listed firms. The first measure is an indicator variable that is coded 1 if the listed firm belongs to heavy-polluting industries, denoted as *Heavy*. According to the *List of Classified Management of Environmental Protection Verification Industry of Listed Firms (2008)* and the *Guidelines for Listed Firms on Environment-related Information Disclosure (2010)* published by the Ministry of Ecology and Environment of China, 16 industries are identified as heavy-polluting industries. These include

[16] In addition, we use local investor attention (the number of searches by local investors) for grouping regression. The results (not tabulated in the interest of conciseness) show that the above interaction coefficient is more significant in the sub-sample with high local investor attention.

mining, electrolytic aluminum, fermentation, textiles, steel, chemical engineering, thermal power, building materials, coal, brewing, petrification, cement, metallurgy, paper-making, tanning, and pharmaceuticals. Firms in heavy-polluting industries tend to cover up their pollutant emissions and thus have greater environmental uncertainty and risks (Lin et al., 2021). The second measure is the number of punishments that a listed firm received for environmental pollution incidents in a year, denoted as *Punishment times*. Greater number of punishments implies greater environmental risks of listed firms. Minority shareholders are thus expected to pay more attention to CEP due to higher environmental risks as their financial interests will be jeopardized if the listed firms are publicly warned or punished due to environmental pollution.

Subsequently, we establish the regression model below to examine if the increased awareness of listed firms' environmental risks is a motive that encourages minority shareholders to improve CEP through online voting:

$$\begin{aligned} CEP_{i,t+1} = {} & \beta_0 + \beta_1 Treat_i * Post_t * Heavy_i\left(Punishment\ times_{i,t}\right) \\ & + \beta_2 Heavy_i\left(Punishment\ times_{i,t}\right) + \beta_3 Treat_i \\ & + \beta_4 Post_t + \sum_k \gamma_k Control_{k,i,t} + \varepsilon_{i,t+1} \end{aligned} \tag{6}$$

As shown in Table 9, the coefficients of both *Treat*Post*Heavy* and *Treat*Post*Punishment times* are significantly positive, suggesting that the CEP improvement is more pronounced in firms with higher environmental risks once voting via internet is allowed. The above results are consistent with H1b as minority shareholders' increasing awareness of firms' environmental risks is a motive that encourages them to improve CEP through online voting.

Channel Analysis

In this sub-section, we analyze the mechanism through which online voting of minority shareholders improves CEP of listed firms. Due to limited shareholding, prior studies show that it is particularly difficult for retail and minority shareholders to influence firm decisions (Bharath et al., 2013; Chen et al., 2013a, 2013b). However, with the rapid development of the Internet and social media, the role of minority shareholders will also change. We argue that in the era of the Internet, minority shareholders can exert pressure on firm management by influencing groups that have greater bargaining power regarding changing firm decisions, such as the media and analysts (Ang et al., 2021; Chen et al., 2010; Chung & Zhang, 2011; Dong et al., 2021; Jia et al., 2016; Kölbel et al., 2017; Luo et al., 2015). Following Kim et al. (2016), we construct the following two-stage regression model to conduct the channel analysis:

Table 9 The motive of minority shareholders' increasing awareness of environmental risks

Dependent variable	CEP index	
	(1)	(2)
Treat*Post*Heavy	0.127**	
	(2.23)	
Heavy	0.188	
	(1.59)	
Treat*Post*Punishment times		0.062**
		(2.31)
Punishment times		0.097
		(0.34)
Treat*Post	0.028***	0.134***
	(3.31)	(2.61)
Treat	0.017	−0.607***
	(0.26)	(−3.60)
Post	0.188*	0.200
	(1.74)	(0.77)
Size	0.679***	0.346***
	(7.88)	(3.43)
BM	1.171***	1.540***
	(8.69)	(3.89)
Leverage	−0.242	−1.241***
	(−1.59)	(−2.91)
ROA	0.914*	2.409*
	(1.93)	(1.88)
Age	0.153***	0.357**
	(3.20)	(2.20)
Growth	−0.173*	−0.170
	(−1.72)	(−0.62)
Tangible	0.553	0.024
	(0.96)	(0.05)
Inst	0.745***	0.138
	(5.83)	(0.39)
Duality	−0.083	−0.137
	(−1.26)	(−0.62)
Indp	0.144	0.014
	(0.59)	(0.02)
Big4	0.948***	0.070
	(8.67)	(0.31)
SOE	0.223***	0.210**
	(3.55)	(2.15)
Constant	−4.494***	0.573
	(−2.75)	(0.60)
Industry FE	Yes	Yes
Year FE	Yes	Yes
Observations	11,697	11,697
Adjusted R^2	0.286	0.272

This table reports the regression results of Eq. (6). *Heavy* is an indicator variable that takes the value of one if the listed firm belongs to the heavy-polluting industries. *Punishment times* number of punishments that a listed firm received for environmental pollution incidents in a year. Other variables are defined in "Appendix" section. The *t*-statistics are given in parentheses with robust standard errors clustered by firm

*, **, and *** denote 10%, 5%, and 1% statistical significance levels

Table 10 Channel test analysis

Dependent variable	Media (1)	Analyst (2)		CEP (3)	CEP (4)
Treat*Post	0.023**	0.013**	Media	0.491***	
	(2.16)	(2.19)		(2.89)	
Treat	−0.020	−0.012	Analyst		0.208***
	(−0.57)	(−0.90)			(2.84)
Post	0.177*	0.054*	Size	0.119***	0.626***
	(1.81)	(1.79)		(5.13)	(3.74)
Size	0.698***	0.207***	BM	0.142***	0.866***
	(3.60)	(2.71)		(5.89)	(4.28)
BM	1.127***	0.294	Leverage	−0.004**	−0.020***
	(5.38)	(1.30)		(−2.19)	(−2.68)
Leverage	0.044	0.047*	ROA	0.006	0.299***
	(0.58)	(1.66)		(2.11)	(2.68)
ROA	0.544**	0.029	Age	−0.055	−0.196
	(2.18)	(0.30)		(−1.37)	(−1.16)
Age	0.162***	0.060***	Growth	−0.001	−0.003
	(6.69)	(6.37)		(−0.98)	(−1.48)
Growth	−0.267***	−0.074***	Tangible	0.138	0.051
	(−7.74)	(−5.78)		(0.96)	(0.78)
Tangible	0.358***	−0.035	Inst	0.022**	0.362**
	(3.63)	(−0.92)		(2.13)	(2.10)
Inst	0.464	0.085**	Duality	−0.014	−0.050**
	(0.78)	(2.18)		(−1.29)	(−2.51)
Duality	−0.056*	−0.020*	Indp	0.068	0.294***
	(−1.81)	(−1.67)		(1.43)	(3.43)
Indp	−0.344**	−0.020	Big4	0.111***	0.796***
	(−2.44)	(−0.38)		(3.66)	(4.08)
Big4	0.865***	0.250***	SOE	0.014**	0.149***
	(10.78)	(7.01)		(2.16)	(6.70)
SOE	0.117***	0.028**			
	(3.54)	(2.17)			
Constant	4.690**	1.848**	Constant	0.278***	0.497***
	(2.16)	(2.05)		(3.70)	(3.38)
Industry FE	Yes	Yes	Industry FE	Yes	Yes
Year FE	Yes	Yes	Year FE	Yes	Yes
Observations	11,697	11,215	Observations	11,697	11,215
Adjusted R^2	0.290	0.241	Adjusted R^2	0.310	0.354

This table reports the regression results of Eqs. (7) and (8). *Media* is the amount of news that relate the listed firm to environmental issues divided by the amount of news of the listed firm on *Sina* Finance; *Analyst* is the number of analysts that follow the firm. Other variables are defined in "Appendix" section. The *t*-statistics are given in parentheses with robust standard errors clustered by firm

*, **, and *** denote 10%, 5%, and 1% statistical significance levels

$$Media_{i,t+1}\left(Analyst_{i,t+1}\right) = \beta_0 + \beta_1 Treat_i * Post_t + \beta_2 Treat_i + \beta_3 Post_t + \sum_k \gamma_k Control_{k,i,t} + \varepsilon_{i,t+1} \quad (7)$$

$$CEP_{i,t+1} = \beta_0 + \beta_1 Media_{i,t+1}\left(Analyst_{i,t+1}\right) + \sum_k \gamma_k Control_{k,i,t} + \varepsilon_{i,t+1} \quad (8)$$

where $Media_{i,t+1}$ represents the amount of news that associates the listed firm to environmental issues, over the amount of news of the listed firm on *Sina Finance* in year $t+1$.[17] $Analyst_{i,t+1}$ represents the number of analysts that follow firm

[17] Sina Finance is one of the top three financial media in China, which provides comprehensive news reports on listed firms (Cheng et al., 2021).

i in year $t+1$. Other variables are consistent with those in Eq. (4) and are defined in the "Appendix" section.

In the first stage, we examine if the mandatory adoption of online voting in 2014 attracts more media (analyst) coverage. In the second-stage estimation, we examine the relation between media (analyst) coverage and firms' CEP. If influencing the media and analysts is the channel through which minority investors' online voting improves CEP, we expect β_1 in both Eqs. (7) and (8) to be positive and statistically significant.

Table 10 reports the regression results of the channel analysis. We observe that, in Columns (1) and (2), the coefficients of *Treat*Post* are all positive and statistically significant, indicating that after adopting online voting in AGMs, more attention of the media and analysts is drawn by the voice of minority shareholders. Meanwhile, results of the second-stage analysis are shown in Columns (3) and (4) in Table 10, which show that *Media* (*Analyst*) is positively related to CEP. Overall, the findings support H2 that minority shareholders can exert pressure on firm management by influencing groups that have the greater bargaining power to shift firm decisions and cause firms to increasingly engage in environmental protection activities (Table 11).

Robustness Checks

Parallel Trend Analysis and Placebo Test

Following Chen et al. (2018a, 2018b) and Cheng et al. (2021), we conduct tests to verify if our DID analysis meets the parallel trend assumption. Specifically, we run a model that regresses the *CEP index* on the treatment variable interacted with five-year dummies, *Year* − 3 to *Year* + 2, which represent three years before the implementation of *Rules* and two years after the implementation. The results in Table 11 show the interaction terms are not associated with the dependent variable before 2014. On the other hand, they are positively and significantly associated with the dependent variable afterward. Hence, the results support the parallel trend assumption of DID analysis.

To further verify that our results are not caused by chance, we follow Pan and Tian (2020) to perform Placebo tests. First, we conduct simulations that randomly assign listed firms into the treatment control groups. Subsequently, based on Eq. (4) and using *CEP index* as the dependent variable, we perform the DID analysis using the artificially created sample and repeat the process 1000 times. We plot the cumulative distribution function and density of the coefficients of *Treat*Post*. As shown in Fig. 4, the distribution of

Table 11 Robustness check: Parallel trend analysis

Dependent variable	CEP index	
	(1)	(2)
Treat*Year-3	−0.206	−0.075
	(−0.70)	(−0.85)
Treat*Year-2	−0.231	−0.034
	(−0.34)	(−0.53)
Treat*Year-1	0.014	0.016
	(0.13)	(0.20)
Treat*Year+1	0.015**	0.018**
	(2.12)	(2.14)
Treat*Year+2	0.009**	0.014***
	(2.11)	(3.24)
Size		0.666***
		(5.27)
BM		0.962***
		(5.14)
Leverage		0.009
		(1.24)
ROA		0.357***
		(3.31)
Age		0.194
		(1.12)
Growth		−0.005**
		(−1.96)
Tangible		0.243
		(0.51)
Inst		0.358***
		(7.38)
Duality		−0.061***
		(−2.87)
Indp		0.346***
		(3.83)
Big4		0.802***
		(3.75)
SOE		0.139***
		(5.90)
Constant	1.833***	−4.337***
	(2.71)	(−3.66)
Industry FE	Yes	Yes
Year FE	Yes	Yes
Observations	11,697	11,697
Adjusted R^2	0.069	0.284

This table reports the results parallel trend test. The five-year dummies, *Year-3* to *Year+2*, represent three years before the implementation of Rules and two years afterward. Other variables are defined in "Appendix" section. The *t*-statistics are given in parentheses with robust standard errors clustered by firm

*, **, and *** denote 10%, 5%, and 1% statistical significance levels

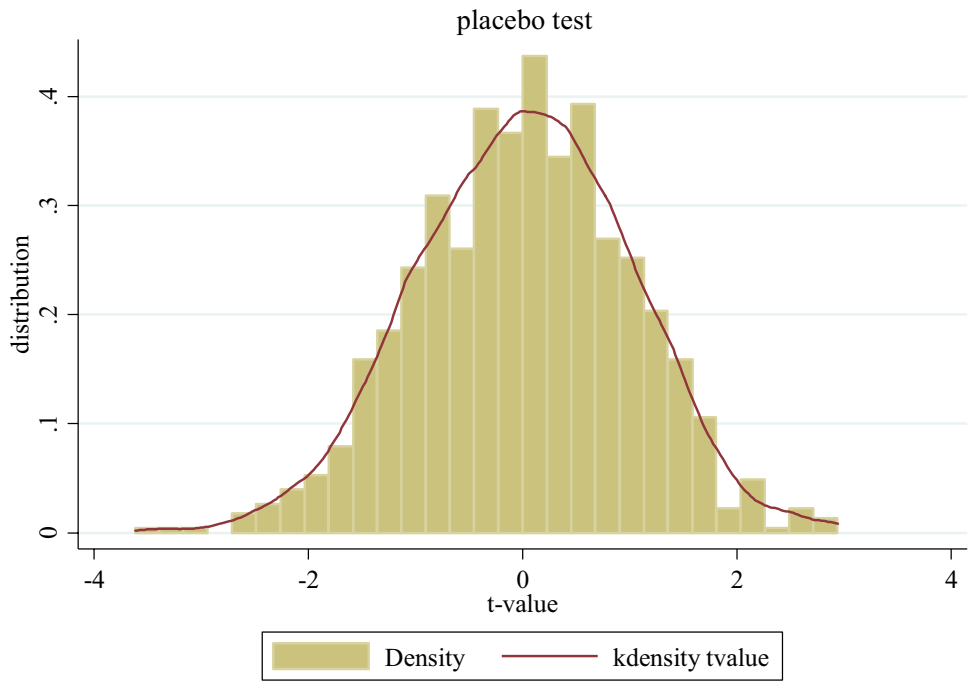

Fig. 4 Placebo test. The distribution of *t*-values of the regression coefficients in the Placebo tests. Specifically, we first randomly assign listed firms into the treatment group and the control group. Then, based on Eq. (4) and using CEP index as the dependent variable, we perform DID analysis using the artificially created sample and repeat the process for 1000 times. We plot the cumulative distribution function and density of the estimated coefficients of *Treat*Post*

the *t*-values of the estimate coefficients is centered around zero, which supports the validity of our findings.

Multiple Fixed Effect Models

To mitigate potential issues of omitting firm-specific characteristics and time-invariant factors, we focus on *CEP index* as the dependent variable and re-estimate the regressions based on Eq. (4) by including various fixed effects. Table 12 presents the results of the firm fixed effects models with the inclusion of industry-year interactions, province-year interactions, and both interactions in Columns (1), (2), and (3), respectively. Notably, all three coefficients of *Treat*Post* remain positive and significant, suggesting that the results of Table 6 still hold after controlling for multiple fixed effects.

PSM-DID Analysis

There may be some differences between firms that are included in the treatment and control groups. We apply propensity score matching (PSM) to mitigate such concern. Specifically, in each industry and year, we first obtain propensity scores by performing a logit model that regresses $Treat_i$ on various control variable specified in Eq. (1). Then, using the one-to-one Kernel matching, we obtain a matched sample that consists of 12,184 observations (6092 pairs of treated observations and control observations).[18] Last, we re-estimate the DID analysis regression based on Eq. (4) in the matched sample. The results reported in Table 13 show that the coefficients of the interaction term remain significantly positive at least at the 5% significance level, which are consistent with the results in Table 6.

Mitigating the Influence of Other Contemporary Policies

The impacts of other contemporary policies may mingle with the influence of *Rules*. In this section, we consider four policies implemented by regulators that are potentially impactful to minority shareholders and CEP and examine whether our previous results are driven by these contemporary policies.

First, the *Guidelines on Cash Dividends* (hereafter, *Guidelines2013*) was issued in November 2013 to encourage minority shareholders' engagement in listed firms' cash dividend decision-making process. Therefore, increased activism of minority shareholders in AGMs may be driven by *Guidelines2013* instead of the implementation of *Rules* in 2014.

Second, *Guidance on Strengthening the Follow-up Administration of Enterprise Income Tax* (hereafter, *Guidance*) was issued in August 2013 to improve the quality and efficiency of enterprise income tax administration through enhanced tax-related data collection and give preferential treatments to the follow-up tax administration regarding environmental protection matters. According to Col and Patel (2019), listed firms' environmental performance may be influenced by this as firms tend to participate in

[18] We conduct *t*-tests to ensure the matching accuracy. The untabulated results show no significant difference between the treatment and the control group in the propensity score matched sample.

Table 12 Robustness check: Multiple fixed effects model

Dependent variable	CEP index		
	(1)	(2)	(3)
Treat*Post	0.020***	0.023***	0.016**
	(2.75)	(2.79)	(2.34)
Size	0.037	0.327**	0.280***
	(1.17)	(2.05)	(7.22)
BM	0.263***	0.716***	1.483***
	(2.74)	(4.98)	(5.79)
Leverage	−0.056	0.074	0.127
	(−1.14)	(1.45)	(1.49)
ROA	0.362***	0.384***	0.577***
	(3.91)	(5.15)	(3.91)
Age	0.198	0.193	0.175
	(0.89)	(1.43)	(1.32)
Growth	−0.001	−0.001	−0.002
	(−0.74)	(−0.30)	(−0.63)
Tangible	−0.015	0.528*	1.229
	(−0.12)	(1.72)	(0.78)
Inst	0.049	0.188**	0.429***
	(0.64)	(2.55)	(3.46)
Duality	−0.016	−0.046	−0.053
	(−0.47)	(−1.43)	(−0.99)
Indp	0.029**	0.032	0.075
	(2.26)	(1.28)	(1.39)
Big4	0.258**	0.827***	1.156***
	(2.04)	(6.90)	(6.30)
Constant	1.543***	−1.602***	−2.415***
	(4.85)	(−5.50)	(−5.49)
Firm FE	Yes	Yes	Yes
Industry*Year FE	Yes	No	Yes
Province*Year FE	No	Yes	Yes
Observations	11,697	11,697	11,697
Adjusted R^2	0.156	0.172	0.181

This table reports the results of multiple fixed effects model based on Eq. (4). Other variables are defined in "Appendix" section. The *t*-statistics are given in parentheses

*, **, and *** denote 10%, 5%, and 1% statistical significance levels

eco-friendly activities as cover-ups for their tax avoidance behavior.

Third, *Measures for Evaluation of Enterprise Environmental Credit* (hereafter, *Measures*) was issued in December 2013 and implemented in 2014 by the Ministry of Ecology and Environment of China. *Measures* provided a detailed interpretation of the evaluation of corporate environmental credit and the punishments for corporate environmental pollution incidents. Listed firms, especially those with poor CEP, may have been motivated to reduce corporate environmental pollution to avoid punishments.

Finally, *Guidelines on Giving Full Play to the Leading Role of New Consumption and Accelerating the Cultivation of New Supply and New Driving Forces* (hereafter, *Guidelines2015*) was announced by the State Council in 2015 to promote the vigorous development of circular, ecological, and low-carbon economy. It also suggested that government subsidies and financial supports should be provided to corporate activities that involve environmental protection, pollution control, and ecological protection and restoration. Such suggestions were subsequently implemented by *Guidelines on Increasing Financial Support for New Consumer Sectors*. According to Lee et al. (2017), governance subsidies are positively associated with CEP.

To verify that our results in Table 6 are not influenced by the above contemporary government policies, we follow Liu et al. (2021) and add *Dividend*, *ETR*, *Punishment*, and *Subsidy* and their interactions with *Post* (post-periods of these contemporary policies) separately in Eq. (4). Subsequently, we re-estimate the regression using *CEP Index* as the dependent variable. *Dividend* is calculated as the average after-tax cash dividends per share of a listed firm three years prior to *Guidelines2013*, and *ETR* is measured as the average effective tax rate of a listed firm three years prior to *Guidance*. Further, *Punishment* is the average number of punishments a listed firm received due to environment-related incidents three years prior to *Measures*, and *Subsidy* is defined as the average value of green subsidies received by a listed firm from the government three years prior to *Guidelines2015*. Table 14 reports the relevant results that show that the coefficients of *Treat*Post* remain positive and significant, indicating that our results in Table 6 are independent from the influence of the above four contemporary policies.[19]

Alternative Measure of Minority Ownership

As discussed in "Shareholder Participation in AGMs" section, we distinguish minority shareholders from block shareholders based on the threshold of 5% ownership. Previous studies suggest that due to the heterogeneity of capital

[19] Links of contemporary policies in "DID Analysis" section are provided as follows: (1) *the Guidelines on Cash Dividends:* http://www.csrc.gov.cn/pub/newsite/zjhxwfb/xwdd/201311/t20131130_239076.html; (2) *the Guidance on Strengthening the Follow-up Administration of Enterprise Income Tax:* http://www.chinatax.gov.cn/chinatax/n810341/n810765/n812146/201305/c1081470/content.html; (3) *Measures for Evaluation of Enterprises' Environmental Credit:* http://www.mee.gov.cn/gkml/hbb/bwj/201401/t20140102_265940.htm; (4) *the Guidelines on Giving Full Play to the Leading Role of New Consumption and Accelerating the Cultivation of New Supply and New Driving Forces*: http://law.esnai.com/view/168013/; http://law.esnai.com/do.aspx?controller=home&action=show&lawid=164421.

Table 13 PSM-DID analysis

Dependent variable	CEP index (1)	Disclosure (2)	Awareness (3)	Green emission (4)	Investment (5)
Treat*Post	0.038**	0.041***	0.031***	0.004**	0.010**
	(2.14)	(3.93)	(2.95)	(2.14)	(2.19)
Treat	−0.047*	−0.014	−0.032	−0.026	−0.024
	(−1.85)	(−0.53)	(−0.38)	(−1.21)	(−0.59)
Post	0.324*	0.236*	0.051*	0.189*	0.303
	(1.71)	(1.84)	(1.83)	(1.80)	(1.48)
Size	0.741***	0.036**	0.326***	0.136***	0.347***
	(4.29)	(2.21)	(6.42)	(4.71)	(4.48)
BM	0.868***	0.019	0.875***	0.203***	0.493***
	(4.65)	(0.32)	(4.78)	(4.46)	(5.72)
Leverage	−0.069	−0.016	0.091	0.001	−0.076
	(−0.33)	(−0.25)	(0.44)	(0.02)	(−0.77)
ROA	0.323***	0.019	1.117	0.114	0.518
	(3.46)	(0.09)	(1.62)	(0.67)	(1.60)
Age	−0.247	−0.053	0.199	0.074	0.133
	(−0.97)	(−0.71)	(1.27)	(0.85)	(0.64)
Growth	−0.252**	−0.061*	−0.205*	−0.003	−0.113**
	(−2.35)	(−1.81)	(−1.95)	(−0.10)	(−2.28)
Tangible	0.464*	0.279***	0.661***	0.097	0.097
	(1.86)	(3.56)	(2.70)	(1.58)	(0.84)
Inst	0.565***	0.037	0.381**	0.099**	0.295***
	(3.32)	(0.69)	(2.29)	(2.39)	(3.75)
Duality	0.053	0.025	−0.094	0.019	0.010
	(0.64)	(0.97)	(−1.15)	(0.92)	(0.25)
Indp	−0.016	0.053	0.074	−0.017	−0.093
	(−0.05)	(0.49)	(0.22)	(−0.21)	(−0.59)
Big4	0.198***	0.028	0.640***	0.228***	0.556***
	(7.91)	(0.59)	(4.31)	(6.17)	(7.95)
SOE	0.051	0.032	0.031	0.027	0.013
	(0.64)	(1.27)	(0.40)	(1.35)	(0.34)
Constant	−5.002***	1.304***	−4.150***	−1.257***	−3.065***
	(−9.36)	(7.79)	(−7.92)	(−9.62)	(−12.41)
Industry FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	12,184	12,184	12,184	12,184	12,184
Adjusted/Pseudo R^2	0.309	0.272	0.278	0.252	0.316

This table reports the result of DID analysis based on Eq. (4) in the PSM matched sample. *CEP index*, *Disclosure*, *Awareness, Emission*, and *Investment* measure the overall CEP, environmental disclosure, environmental awareness, green emission, and environmental investment of listed firms. $Treat_i$ is a dummy variable that takes the value of one for firms that had not adopted online voting during 2011–2013, and zero if they had. $Post_t$ is a dummy variable that takes the value of one for the period from 2014 to 2016 and zero for the period from 2011 to 2013. Other variables are defined in "Appendix" section. The *t*-statistics are given in parentheses with robust standard errors clustered by firm

*, **, and *** denote 10%, 5%, and 1% statistical significance levels

markets and firm equity structures, recognizing minority shareholders and block shareholders at the 10% or 20% ownership is also acceptable (Jiang & Kim, 2015; Jiang et al., 2020). Therefore, to mitigate the possibility that our triple difference results are driven by our definition of minority shareholding, we apply 10% and 20% shareholding as alternative thresholds for minority shareholder identification and re-conduct the triple difference analysis. As shown in Table 15, the coefficients of the triple difference indicator and *Minority ownership* remain positive and significant,

Table 14 Excluding the influence of contemporary policies

Dependent variable	CEP index			
	(1)	(2)	(3)	(4)
Treat*Post	0.031***	0.021**	0.022**	0.177**
	(2.70)	(2.22)	(2.14)	(2.35)
Treat	−0.018	−0.016	−0.023	−0.008
	(−0.52)	(−0.45)	(−0.65)	(−0.15)
Post	0.170*	0.178*	0.182*	0.127
	(1.84)	(1.87)	(1.68)	(1.54)
Dividend*Post	0.007			
	(1.29)			
Dividend	−0.014			
	(−1.07)			
ETR*Post		−0.004**		
		(−2.16)		
ETR		−0.005**		
		(−2.24)		
Punishment*Post			0.008**	
			(2.31)	
Punishment			−0.014	
			(−1.38)	
Subsidy*Post2015				0.016**
				(2.25)
Subsidy				0.028***
				(3.18)
Size	0.710***	0.697***	0.701***	0.811***
	(3.61)	(3.78)	(3.57)	(2.66)
BM	1.011***	1.109***	1.156***	1.678***
	(4.62)	(5.41)	(5.53)	(6.64)
Leverage	0.007	0.058	0.002	0.013
	(0.09)	(0.76)	(0.02)	(0.12)
ROA	0.589**	0.590**	0.500	0.275
	(2.35)	(2.35)	(1.37)	(0.74)
Age	0.100	0.153	0.170	0.184
	(1.39)	(1.43)	(0.90)	(0.90)
Growth	−0.317***	−0.270***	−0.289***	−0.528***
	(−8.59)	(−7.26)	(−7.80)	(−9.49)
Tangible	0.856	0.508	0.503	0.994
	(0.87)	(1.23)	(0.86)	(1.01)
Inst	0.406***	0.454***	0.476***	0.646***
	(5.90)	(6.60)	(6.92)	(6.60)
Duality	−0.053*	−0.055*	−0.053*	−0.049***
	(−1.70)	(−1.78)	(−1.71)	(−2.68)
Indp	0.347**	0.339**	0.330**	0.593***
	(2.44)	(2.38)	(2.34)	(2.79)
Big4	0.835***	0.834***	0.872***	0.921***
	(10.25)	(10.32)	(10.94)	(7.83)
SOE	0.096***	0.122***	0.123***	0.180***
	(2.91)	(3.70)	(3.63)	(3.88)
Constant	−4.549***	−4.699**	−4.988***	−6.535***
	(−3.62)	(−2.35)	(−9.51)	(−3.83)
Industry FE	Yes	Yes	Yes	Yes

Table 14 (continued)

Dependent variable	CEP index			
	(1)	(2)	(3)	(4)
Year FE	Yes	Yes	Yes	Yes
Observations	11,697	11,697	11,635	11,153
Adjusted R^2	0.268	0.281	0.296	0.274

This table presents the analysis results when controlling for the impact of other contemporary policies. *Dividend* is calculated as the average after-tax cash dividends per share of a listed firm 3 years prior Guidelines2013; *ETR* is measured as the average effective tax rate of a listed firm 3 years prior Guidance; *Punishment* is defined as the average number of punishments a listed firm received for environment-related incidents 3 years prior Measures; *Subsidy* is the average value of government green subsidies received by a listed firm 3 years prior Guidelines2015. Other variables are defined in "Appendix" section. The *t*-statistics are given in parentheses with robust standard errors clustered by firm

*, **, and *** denote 10%, 5%, and 1% statistical significance levels

suggesting that the triple difference analysis results in Table 7 are not driven by the 5% ownership threshold of minority shareholder identification.

Discussion and Conclusion

This study analyzes the impact of minority investors on the environmental performance of China's listed firms. We account for the mandatory online voting requirements in the Chinese stock market to identify causality.

We first reveal that the adoption of online voting mechanisms encourages the activism of shareholders in AGMs, especially it of minority shareholders, and CEP. Then, we employ the mandatory online voting requirements issued in 2014 as an exogenous shock and perform DID analysis. The DID analysis results demonstrate that compared with listed firms that had applied online voting before, listed firms that are new to online voting experience significant improvement in AGM participation rate of shareholders, especially minority shareholders, and CEP. Our triple difference analysis results show that the improved CEP is more pronounced in listed firms with a larger minority shareholding. These results collectively indicate that induced by listed firms' adoption of online voting, minority shareholders' activism significantly improves CEP of listed firms. The validity of our results is supported by various robustness checks. Subsequently, we explore the motives and potential channels through which minority shareholders improve the CEP of listed firms. We find that "local pollution" exposure of minority shareholders and their improved awareness of listed firms' environmental risks motivates them to influence firms' environment-related decisions. Lastly, we identify that minority shareholders improve CEP of listed firms via influencing groups (media coverage and analyst coverage) with greater bargaining power.

This paper contributes to the literature and practice in the following ways. First, the evidence contributes to the literature of shareholder activism. Shareholder activism can exert pressure on listed firms to meet basic ethical and social criteria and has become an important feature of capital markets around the world (Kurtz, 2008). However, it is still under debate whether shareholder activism considering environmental and social issues can modify firm financial decisions and behaviors. On one hand, some studies find evidence that shareholders' activism promotes firm ethical behaviors. For instance, Chen et al. (2020a, 2020b) find that through CSR-related proposals, institutional investors are able to improve firms' CSR performance and reduce the likelihood of lawsuits or regulatory penalties regarding environmental and social issues. Barko et al. (2021) also provide evidence that the engagement of investment management firms concerning firms' ESG issues enhances firms' both ESG and financial performance. On the other hand, it is argued that the activism of shareholders only has cosmetic, but not tangible impact on firm ethical behaviors. For example, Michelon et al. (2020) find that shareholders' requests on CSR transparency is associated with more disclosure of firm CSR-related information, but heavier concern over firms' CSR practices. They suggest that firms' improved CSR information disclosure is merely a trade-off approach to balance firms' profit maximization objective and social idealism. In addition, profit-oriented investors, such as mutual funds, may not be motivated to enhance CSR behaviors, and may only engage in pretend activism to satisfy fund investors (Eurosif, 2016). Different from the majority of existing studies, that focus on a broader range of CSR issues, we provide an interesting case of minority shareholders' activism and examine its influence on firms' environmental performance. Our evidence suggests that minority shareholders' activism toward environmental issues can not only promote listed firms to improve their environmental disclosure and environment protection awareness, but also result in substantial improvements in listed firms' environmental protection activities, such as pollutant emission reduction and increased environmental

Table 15 Alternative measure of minority ownership

Dependent variable	CEP index			
	(1) 10%	(2) 10%	(3) 20%	(4) 20%
Treat*Post*Minority ownership	0.125***	0.127***	0.103**	0.104**
	(2.79)	(3.05)	(2.16)	(2.08)
Minority ownership	0.210**	0.204**	0.179*	0.174*
	(2.16)	(2.22)	(1.85)	(1.86)
Treat*Post	0.028***	0.026**	0.023***	0.024**
	(3.56)	(2.29)	(3.13)	(2.29)
Treat	−0.163	0.002	−0.157***	−0.001
	(−0.83)	(0.05)	(−2.89)	(−0.02)
Post	0.100**	0.107*	0.171**	0.107*
	(2.32)	(1.85)	(2.09)	(1.74)
Size		0.750***		0.751***
		(6.13)		(5.88)
BM		1.831***		1.902***
		(7.42)		(7.94)
Leverage		0.068		−0.021
		(0.58)		(−0.17)
ROA		0.054		0.042
		(0.14)		(0.11)
Age		0.259		0.277
		(1.43)		(1.38)
Growth		−0.443***		−0.463***
		(−7.12)		(−7.44)
Tangible		0.954		1.171
		(0.73)		(0.92)
Inst		0.742***		0.772***
		(7.61)		(7.90)
Duality		−0.114**		−0.110**
		(−2.35)		(−2.28)
Indp		0.542***		0.507***
		(2.85)		(2.67)
Big4		0.996***		1.013***
		(11.32)		(11.50)
SOE		0.231***		0.256***
		(5.00)		(5.48)
Constant	2.798***	−6.608***	1.245***	−7.082**
	(4.33)	(−2.71)	(4.52)	(−2.23)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	11,697	11,697	11,697	11,697
Adjusted R^2	0.136	0.323	0.165	0.330

This table reports analysis results of applying alternative measures of minority ownership. *Minority ownership* measures the participation of minority shareholders in AGMs, which is calculated as the number of shares owned by minority shareholders that voted in over total number of shares. Minority shareholders are shareholders who possess less than 10% (20%) of the firm. Other variables are defined in "Appendix" section. The *t*-statistics are given in parentheses with robust standard errors clustered by firm

*, **, and *** denote 10%, 5%, and 1% statistical significance levels

protection investments. This evidence contributes to a tangible and positive impact of shareholder activism on corporate environment protection.

Second, we contribute to the positive influence of ethical ideology on corporate environment protection. Expanding on de Villiers and van Staden (2010), who argue that

minority shareholders are becoming more concerned about CEP due to their improved awareness of environmental protection and corporate environmental risks, we discover that such improved ethical standards of minority shareholders can shift corporate decisions, guide firms toward their long-term interests and improve firms' awareness of environment protection. Existing literature recognizes ideology as one of the most prominent determinants of corporate ethical behaviors (Bento et al., 2017; Idowu, 2012). However, it heavily focuses on the influence of firm insiders' ideology, such as managers and board directors (Gupta et al., 2021; Hafenbrädl & Waeger, 2017) on CSR behavior. Our finding adds to the literature by providing evidence that the improved ethical standards of non-managerial and disadvantaged groups, such as minority investors, can prompt firms to perform social and environmental responsibilities. Augmenting the discussion of ESG topics, our result provides empirical evidence and deepens the understanding of the real-world impact of environment-orientated ideology on social and environmental welfare.

Third, our results provide evidence to impact investments and the mechanisms through which investors exert real-world impact. Sustainable, or impact investments are investments that incorporate ESG considerations to facilitate the achievement of social objectives (Busch et al., 2021; Kölbel et al., 2020). According to Kölbel et al. (2020), there are mainly three mechanisms of investor impact through impact investment. (i) Active engagement of shareholders can promote firms to enhance their environmental and social behaviors. For instance, Dyck et al. (2019) and Barko et al. (2021) provide evidence that shareholder proposals can improve firms' environmental and social performance. (ii) Shareholders can influence corporate decisions through their capital allocation. For instance, Hong and Kacperczyk (2009) find that shareholders' divestment can result in a lower stock price, thereby punish firms that conduct unethical businesses. (iii) Shareholders may rely on indirect impact mechanisms, such as endorsement and benchmarking, to modify firm behaviors. However, little empirical evidence has been found to directly support this mechanism (Kölbel et al., 2020). In addition, Dimson et al. (2015) and Chen et al. (2020a, 2020b) also find that investors can impact social and environmental issues through joining coalitions and cooperating with other investors. More integrated efforts can prompt firms to improve the management and investment behaviors regarding environmental and social issues. Our results show that with the adoption of online voting systems, minority shareholders' activism can improve firms' environment-related activities. Our study differs from the majority of impact investment literature, which suggests that large shareholders may have a stronger influence (Dimson et al., 2015, 2020), and provides a more interesting case of minority shareholder activism. The above findings make an important supplement to shareholders' engagement channel of impact investment. In addition, our study is closely associated with ethical consideration, which shows that the improvement of minority shareholders' moral standards that relate to environmental awareness will promote the role of minority shareholders' activism. Such improvement can promote listed firms to implement environmental protection activities and achieve positive and tangible changes in society through impact investment. Furthermore, our results show that minority shareholders' activism on environmental issues can trigger the attention of influential third-party groups, such as the media and analysts, thus amplify the impact of minority shareholders. The results also provide evidence to the indirect impact mechanism of investor impact and further indicate. We suggest that for certain investors, the mechanisms of their impact do not function independently. In this case, minority shareholders' impact is exerted through the collective functioning of their engagement (online voting) and indirect impact (increased attention from the media and analysts).

Fourth, this paper contributes to the further understanding of the role of minority shareholders in corporate governance. Minority investors are typically considered to have limited influence on firms' decision-making due to limited shareholding and barriers to acquiring information (Bharath et al., 2013; Chen et al., 2013a, 2013b). When voting, minority shareholders often free ride on others' opinions (Bharath et al., 2013; Claessens et al., 2002). We find that if motives and means are provided, minority shareholders are more likely to participate in AMGs and corporate governance. The results are consistent with the notion that virtual AGMs attract more shareholder participation due to reduced cost of attending (Kong, 2019) and provide evidence to the effectiveness of the online voting policy. Additionally, the positive influence of minority shareholders on listed firms' CEP through increased attention from the media and analysts sheds light on the indirect monitoring function of minority investors and adds to a more thorough understanding of the role played by minority shareholders in corporate governance.

Finally, our paper sheds light on the protection of minority shareholders' rights. Previous studies find that external attention and pressure influence firm behavior. For instance, Ang et al. (2021) find that minority shareholders' social media postings can predict firm acquisition decisions. Further, Borghesi et al. (2014) suggest that media attention induces firms to make socially responsible decisions. Moreover, Ye et al. (2015) show that negative media coverage can mitigate controlling shareholders' expropriation activities. Groups with limited bargaining power can utilize such external attention and pressure to influence management decisions. With the development of the Internet and the entering into national scrutiny era, the influence of previously

underrated groups may be amplified through rapid information dissemination (Ang et al., 2021). In this paper, we discover that by voting online, minority shareholders can influence firm decisions by attracting the attention of the media and analysts. These results not only provide evidence regarding the strategic function of external attention and its capability of influencing firm decisions, but also have valuable implications for the protection of minority investors by pointing out the collective influence of external attention and minority shareholder incentives on corporate governance. In other words, self-protection may be realized by minority shareholders in the face of expropriation by actively expressing their opinions and borrowing force from other connected social groups.

We acknowledge that there are limitations in our research. First, limited by our focus on minority shareholders and the availability of data on unlisted firms, our research is somewhat biased toward public stock markets and listed firms. As discussed in Kölbel et al. (2020), there may exist further relevant impact mechanisms in other types of financial markets, such as corporate bond, private equity, venture capital investment, bank lending, and real estate, which are not examined in this research. Therefore, it is also of great significance to explore whether investor impact can play a role in above markets. Recently, a growing number of studies have dedicated their attention toward this issue. For instance, Huynh and Xia (2021) explore whether investors that are concerned about climate risk are willing to pay higher prices for bonds issued by firms with better environmental performance. Flammer (2021) shows that investors respond positively to the issuance announcements of green bonds.

Second, limited by the availability of data, we do not explore indirect impacts through which minority shareholders influence listed firms' environment-related behaviors beyond increased attention of the media and analysts. It is possible that other influential groups may respond to minority shareholders' activism the exert pressure on firms to promote environment protection. For example, Cialdini and Trost (1998) point out that sustainable investors may help establish sustainable investments as a social norm by encouraging other investors to do the same. Future studies are encouraged to further explore the indirect impact channel of minority shareholders through which they exert impact.

Third, focusing on environmental issues does not imply that other ethical and social issues such as human rights and ethics (gender equality, anti-corruption, etc.), labor standards and employee protection, and corporate governance are not important. Given that minority shareholders can shape firm decisions through attracting attention from other influential groups, it is of great interest to examine whether minority shareholders' activism can further affect firm behaviors regarding other ethical and social related issues.

Appendix: Variable Definitions

Variables	Definitions
Ownership representation	Number of shares that voted in AGMs over the total number of shares
Block ownership	Number of shares owned by block shareholders that voted in AGMs over the total number of shares. Block shareholders are those who possess no less than 5% of the firm
Minority ownership	Number of shares owned by minority shareholders that voted in AGMs over the total number of shares. Minority shareholders are those who possess less than 5% of the firm
CEP index	Corporate environmental performance index, which is average value of its four sub-measurements, including environmental disclosure, environmental awareness, green emission, and environmental investment
Disclosure	Environmental disclosure index. We calculate *Disclosure* as (disclosure score of the listed firm -minimum disclosure score of the year)/(maximum disclosure score of the year—minimum disclosure score of the year). The environmental disclosure score is the sum of three dummy variables, including (i) whether the environmental information is included in the annual report; (ii) whether the environmental information is included in the corporate social responsibility report; and (iii) whether the firm discloses environmental information separately
Awareness	Environmental awareness index. We calculate *Awareness* as (awareness score of a listed firm -minimum awareness score of the year)/(maximum awareness score of the year—minimum awareness score of the year). The awareness score is the aggregation of eight dummy variables, including (i) whether the firm mentions environmental protection concept, environmental guideline, environmental management organizational structure, recycling economy development model, green development in the annual report; (ii) whether the firm mentions the achievement of environmental targets in the past year and the future environmental targets; (iii) whether the firm formulates relevant environmental management system, regulations, obligations; (iv) whether the firm takes part in environmental education and training; (v) whether the firm takes part in environmental protection public welfare activities; (vi) whether the firm constructs emergency response mechanism for major environment-related emergencies; (vii) whether the firm receives honors or awards in environmental protection; and (viii) whether the firm executes "Three Simultaneity" system

Variables	Definitions
Emission	Green emission index, an indicator variable that takes the value of one if the firm adopts policies, measures, or techniques to reduce wastewater, gas, sludge and greenhouse gas discharge, and zero otherwise
Investment	Environmental investment index. We calculate *Investment* as (investment score of the listed firm—minimum investment score of the year)/(maximum investment score of the year—minimum investment score of the year). The investment score is the aggregation of three dummy variables, including (i) whether the firm exploits or adopt innovation products, equipment, or techniques which are beneficial to environment; (ii) whether the firm adopts renewable energy or policies and measures of circular economy; (iii) whether the firm adopts policies, measures, or techniques to save energy and resources
Online voting	An indicator variable that takes the value of one if shareholders of the firm are able to vote in AGMs online
Size	The natural logarithm of the firms' equity market value (Million RMB)
BM	The ratio of the firm's equity book value to its market value
Leverage	Total debt over total assets
ROA	Net income over total assets
Age	Log of firm age since listing
Growth	Income growth rate of the firms' core business segment, calculated as (income in year t-income in year $t-1$)/income in year $t-1$ multiplied by 100%
Tangible	Tangible assets over total assets
Duality	An indicator variable that takes the value of one if the chief executive officer (CEO) and chairmen of the board is the same person
Indp	Number of independent directors over total number of directors
Big4	An indicator variable that takes the value of one if the firm hires Big4 auditor
SOE	An indicator variable that takes the value of one if the firm is a State-owned-enterprise (SOE), and zero otherwise
Treat	A dummy variable that takes the value of one for firms that had not established network-based voting mechanisms in AGMs during 2011–2013, and zero if they had
Post	A dummy variable that takes the value of one for the period from 2014 to 2016 and zero for the period from 2011 to 2013
PM2.5	The average annual concentration of PM2.5 in the headquarter city of the firm, which is obtained from *the China's Environment Yearbook*
Letters	The logarithm value of the total number of letters, phones, emails related environmental pollution received by provincial governments in the headquarter of the firm plus one, which can reflect the overall situation of the local environmental pollution problem. These data are obtained from *the China's Environment Yearbook*
Monitornum	The number of polluting enterprises in the headquarter of the firm in *the List of Key Enterprises under State Supervision*, which is obtained from *the China's Environment Yearbook*
Heavy	An indicator variable that takes the value of one if the firm is included in the heavy-polluting industries. According to the "*List of Classified Management of Environmental Protection Verification Industry of Listed Firms (2008)*" and "*Guidelines for Listed Firms on Environmental Information Disclosure (2010)*" published by *the Ministry of Ecology and Environment of People's Republic of China*, 16 industries are classified as heavy-pollution industries, including mining, electrolytic aluminum, fermentation, textiles, steel, chemical engineering, thermal power, building materials, coal, brewing, petrification, cement, metallurgy, paper-making, tanning, and pharmaceuticals
Punishment times	The number of times that the firm is penalized for environmental pollution incidents in the given year
Media	The media coverage, which is measured as the ratio of the number of times for which a firm is mentioned in news related to environmental issues on *Sina Finance* in all news related to this firm on this website. As the largest Internet financial media in China, *Sina Finance* accounts for more than 80% of financial and economic news coverage (http://finance.sina.com.cn). We clawed all news on *Sina Finance* and filter out news including "environment," "environmental protection," "pollution," "green emission," "green investment," "clean production," and so on
Analyst	Analysts following, measured as the number of analysts following the firm
Dividend	The average value of the cash dividend per share for a firm from 2011 to 2013
ETR	The average value of the effective tax rates for a firm from 2011 to 2013. The effective tax rate is calculated as (tax expenses − deferred tax expenses + deferred tax income)/(pre-tax profit − (deferred tax expenses − deferred tax income)/statutory tax rate)
Punishment	The average number of times a firm is penalized for environmental pollution incidents from 2011 to 2013
Subsidy	The average value of the firm's environmental subsidies obtained from government before the *Guidelines2015*

Variables	Definitions
Post2015	An indicator variable that takes the value of one for the period from 2015 to 2016 and zero for the period from 2011 to 2014

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Declarations

Conflict of interest All authors declare that they have no conflict of interest.

Ethical Standards All authors contributed to the study conception and design. Data collection and analysis were performed by Shouyu Yao, Feiyang Cheng, and Yuying Pan. The first draft of the manuscript was written by Yuying Pan and Lu Wang and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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