Do firms respond to calls for environmental improvements made by retail investors?

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ABSTRACT

Retail investors have become more vocal in pressuring firms to improve their environmental performance, yet little is known about whether and when firms respond to these pressures. We conduct a field experiment on investor online platforms where we inject investor pressure by posting requests for environmental improvement among firms found in violation of pollution standards in China. We find that retail investor pressure can reduce subsequent violations by 4.2%. Amplifying the publicity of the appeal through social media leads to the greatest reduction in subsequent violations, but calling for more disclosure has no incremental effect on violation rates. We find significant within-firm spillover effects to other establishments and to other pollutant sources. The findings suggest that retail investor pressure can lead to improvements in environmental performance by changing firms' perception of investors' demand for such performance.

Keywords: Retail investors, Pollution emissions, Disclosure, ESG, and Investor Online Platforms.

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1. INTRODUCTION

Investors have become more vocal in pressuring firms to improve their environmental performance. Institutional investors in particular are increasingly leveraging their influence to advocate for corporate strategies that improve environmental performance (Dyck, Lina, Roth, and Wagner 2019). Despite the investors' active participation, however, ample evidence suggests that firms' environmental compliance is far from perfect (OECD, 2021).

A new trend in investors' engagement in environmental issues is an increase in retail investors' involvement in pressuring firms (Friedman and Heinle 2016; Hartzmark and Sussman 2019; Brownen-Trinh and Orujov 2023). A key driver behind this phenomenon is the rise of new digital platforms that have empowered retail investors to express their concerns and preferences (Wong et al. 2022; Brochet et al. 2021).[1] Studies show that retail investors have become actively involved in making demands on firms (Brav et al. 2023), challenging the conventional view of them as uninformed and apathetic and signifying their emerging role as a distinct class of investors.

An important assumption underlying retail investors' engagement is that firms will respond to investors' pressure for greater environmental performance. One challenge in testing this assumption is that random variation in investor pressure is difficult to identify. In archival data, the investors' decision to apply pressure to firms is not random, as it is influenced by investors selecting firms where they expect the greatest benefits (Bloomfield et al., 2016). To address this concern, we conduct a field experiment where we randomize investor pressure across a random set of target firms that are found to be in violation of pollution standards. To exert pressure on these firms, we post requests for environmental improvements on the firms' investor platforms. Then, we track how firms respond to our

[1] Historically, there was not a good way to hold the equivalent of institutional meetings with retail shareholders. Today, however, digital communication platforms (e.g., Broadridge) are being broadly adopted for annual shareholder meetings and proxy votes, allowing retail shareholders to access companies more readily.

inquiry and their future violation rate. To investigate the mechanisms through which retail investor pressure can lead to greater environmental performance, we also vary the methods of making these requests.

We focus on China – the world's largest polluter. Despite many top-down attempts to control pollution problems in China, the nation's pollution level remains high. One policy instrument the central government uses to monitor environmental performance is to improve the quality of emission data. As part of this effort, the government has invested heavily in infrastructure, such as the Continuous Emissions Monitoring System (CEMS), that collects and monitors information on the pollution levels of key polluting plants in real time. Starting in 2013, the Ministry of Ecology and Environment (MEE) allowed open access to emission data to the public. By making emission data widely available, the government lets the public take on an active role in monitoring environmental performance (Buntaine et al (2021).[2] We utilize CEMS data to identify polluting firms at a daily level.

We examine whether investors can successfully pressure firms to improve their environmental performance. Unlike government agencies, retail investors do not have the authority to enforce pollution standards. However, if appeals by retail investors change how firms' perceive investors' demand for environmental performance, they could lead firms to change their behavior. If investors' preference for environmental performance poses a valid threat to firms (Hartzmark and Sussman 2019; Li, Watts, and Zhu 2023), firms could respond by rectifying their environmental violations. Another reason why retail investors' appeals may lead to different outcomes is the public nature of the investor platforms, which may be an enforcement mechanism for firms.[3]

[2] Citizens are encouraged to report, to the government, cases involving firms' environmental violations. While such information in theory can improve the effectiveness of government monitoring, transparency alone might fail to change firm behaviour, especially when the incentives of the public and the government are misaligned (Duflo et al. 2018). For example, local governments' incentives to promote economic growth may conflict with the public's incentive to reduce pollution levels in the region.

[3] The government has also introduced ways to increase the general public's participation in environmental protection through national hotlines. However, the appeals on these hotlines are rarely made public. When the local EPA receives an appeal through a hotline, it has ample discretion on whether and how to impose penalties for the violations. The

We conduct a six-month experiment using two major investor interactive online platforms in China: the EasyIR platform for firms listed on the Shenzhen Stock Exchange and the eHudong platform for firms listed on the Shanghai Stock Exchange. These investor platforms offer a few advantages for our experiment. First, all public firms are required to participate on the platform, which eliminates the selection bias found in digital platforms where participation is voluntary. Second, we can observe the firm's responses on the platform, as firms are required, by the exchange, to read and respond to all posts by investors (Wong et al. 2023). Through these responses, we can gauge how serious the firms perceived the allegation to be (e.g., whether they admit a violation exists and what plans they have to rectify it).

Using the CEMS data, we start by identifying firms that are in violation of local emission standards. The Ministry of Ecology and Environment collects the hourly emission data of major polluting plants nationwide, which covers 75% of total emissions in China. In theory, the regulators could use this data to identify violators, but we find that more than 33% of the key polluters in CEMS continue to violate pollution standards. The high violation rates suggests that enforcement may be imperfect. The data is also made available to the public, giving the market the information it needs to identify violators.[4]

Prior to the experiment, we randomly pre-assign all key polluting firms into a control group or treatment groups. During our experiment, when a firm in a treatment group commits a pollution violation, we post, on the firm's investor platform page, a request that the firm rectify its violation. This is our baseline treatment condition (see appendix A). We add two additional treatment groups. In the first additional group, we add more publicity to the appeal by mentioning that we will publicize our concerns on the company's social media page; we then follow through on this by posting on the company's Weibo page. Our

outcome of the investigation is not made public and is rarely shared with the person who made the appeal. Consistent with this, studies find limited effectiveness of these private appeals (Buntaine et al., 2021).

[4] There is still a high cost to identify violators from the CEMS system. We use data provided by an NGO that collects emission records of all key polluters in real time from all provincial or city-level EPA websites.

motivation for the second additional group is literature showing that disclosure can serve as a commitment mechanism for environmental performance. For this treatment condition, we request that firms disclose how they plan to rectify the violation in their subsequent filings.

We start by tracking the firms' responses to our requests on the platform. We find that a substantial proportion (36.4%) respond by providing specific information about the violation and their plans for preventing it in the future, indicating that they take the alleged environmental violations seriously. We also find that the different treatment conditions lead to significant variation in firms' responses. Requests with social media pressure are particularly effective in eliciting responses that provide specific information about the violation in question and comprehensive plans to rectify it. In contrast, when we ask for disclosure about firms environmental plans, the firms offer more general responses – information on company-wide investments in environmental protection and comments about overarching strategies to be environmentally friendly. Additionally, firms in the social media group make timelier responses than the baseline group, implying that social media pressure leads firms to feel a need to respond promptly with targeted answers.

Next, we examine whether our appeals lead to a reduction in future violation rates of environmental standards. We find that treated establishments experience a significant reduction in violations, with average daily violation rates decreasing from 16.2% in the four weeks prior to our inquiry to 12.0% in the subsequent 12 weeks. In contrast, the violation rate in the control group remains virtually unchanged – showing a slight decline of 0.6% – over the same period.

We also examine the impact of the different treatment conditions on subsequent violation rates. The most significant reduction is observed in the social media treatment group, where the probability of daily violations is 3.0% lower than in the control group. This was followed by reductions of 2.6% in the baseline treatment group and 1.9% in the

disclosure treatment group. Our results regarding the different prompts suggest that, on average, the inclusion of social media appeals leads to the most substantial reduction in subsequent violations. We also look at the horizon of the subsequent violation rates and find that in the short run – within four weeks after our intervention – the reduction of violations is significant only among firms receiving the social media appeal. However, firms in all three treatment groups rectify their violations in the long run, with the baseline and social media treatment groups experiencing the greatest reductions.

Next, we document that our appeals lead more firms to include environmental disclosures in their 2022 annual filings – especially when we specifically request more disclosure. Thus, the disclosure condition has the weakest effect on firms' subsequent violations but the strongest effect on firms' subsequent disclosure.

One concern about the treatment-related reduction in subsequent violations is that the drop may come at the expense of increased violation in other establishments run by the same firm. If a firm is allocating limited resources for environmental protection across its establishments, it is possible that the drop in violations in one establishment represents a shift in violations to others.[5] To address this concern, we also test for how our appeals affect subsequent violations in *other* establishments of the same firm. Using a random subsample of firm-establishments in each treatment group as an additional control (see Section 4.5 for more detailed discussion), we find that not only the violating establishments we identified but also other establishments of the same firm reduce their violations. The findings suggest that our treatment has spillover effects within a firm. We also find evidence of spillover effects to pollutants other than those we identify in our appeals. In other words, we find that our intervention reduces not only a firm's future violations involving the same pollutant but also its violations involving other pollutants.

[5] Because we identify subsequent violations at the firm level, it is unlikely that we are picking up mere shifts in violations within a firm.

Finally, we conduct two cross-sectional tests. First, we examine whether our effects differ based on whether a firm is state-owned. We find that that investor appeals are more effective among firms not owned by the state. Among state-owned-enterprises (SOEs), only the appeal through social media leads to reduced violations. This suggests that SOEs are only responsive to investors when they experience sufficient public pressure. Second, we find that investors' appeals are more effective in environmentally clean provinces than in polluted ones, showing that the commitment to environmental issues may an important precondition for firms' response to investor pressure.

Our paper makes several contributions to the literature. Much of the literature focuses on understanding retail investors' preferences (Brav et al, 2023; Li et al., 2023; Serafeim and Yoon 2021). In contrast, we examine whether and how firms respond to retail investors' *demands*, using a field experiment to test the conditions under which firms respond. Similar to Wong et al. (2023), who find that firms respond to retail investors' requests for additional disclosure, we find that firms take real actions to reduce their pollution violations in response to retail investors' demands.

Second, our study adds to the literature on investors' pressure on firms to improve environmental performance. Prior research such as Dyck et al. (2019) and Chen et al. (2020) finds that institutional investors can serve as effective monitors of firms' environmental activities. Because retail investors are not constrained by fiduciary duty, their motive to engage in environmental issues may differ from institutional investors' (Benabou and Tirole 2010). Our study documents that retail investors' pressure on firms can reduce the firms' pollution violations. Our evidence also extends the Buntaine et al. (2022) finding that citizens can support government monitoring by appealing firms' environmental activities to the regulator. In contrast to Buntaine et al. (2022), we show that retail investors can directly pressure firms to reduce their pollution violations.

Third, our paper adds to a growing body of research on disclosure and environmental performance in China. Using a top-down approach, China's air pollution monitoring and disclosure system has significantly impacted individuals' behavior and lowered the environment-related mortality rate (Barwick et al., 2023). Chen et al. (2018) find that China's mandatory CSR disclosure by listed firms has led to reductions in water and air pollution. The public availability of firms' pollution data enables citizens to assume a more active role, such as through citizens' appeals. We extend this bottom-up monitoring channel and find that retail investors can directly pressure firms, via online platforms, to enhance their environmental performance.

2. INSTITUTIONAL BACKGROUND AND LITERATURE REVIEW

2.1 Continuous Emission Monitoring Systems in China

A rigorous system of emission-rate tracking is an important first step to environmental enforcement. China introduced its first set of Continuous Emissions Monitoring Systems (CEMS) in the 1980s. CEMS allowed real-time tracking of the emission rates of pollutants such as sulfur dioxide (SO_2) and nitrogen oxide (NOx). In 1997, China started requiring all thermal power plants to adopt CEMS. However, due to the lack of uniform technical standards, there was wide variation in the quality of the measuring equipment, leading to a lack of authoritative data.

In 2004, the Ministry of Ecology and Environment (formerly known as the Ministry of Environmental Protection) of China launched a nationwide project to automate environmental monitoring systems. The MEE required installation of CEMS in more sectors, including steel, cement, energy, and waste incineration. Enterprises identified as key polluters were required to install monitoring systems that met the specific standard for

the pollutant being emitted and to connect their equipment to MEE's online platform, enabling real-time sharing and monitoring of environmental data.[6]

In 2013, to increase transparency, the Ministry of Ecology and Environment issued the "Measures for the Self-Monitoring and Information Disclosure of National Key Monitoring Enterprises." This regulation required provincial and prefectural EPAs to publicly disclose the hourly emissions data from every monitored facility in real time, covering 337 cities (98% of the country). The publicly disclosed CEMS data also includes the emission concentration standards, allowing the public to cross-check the emissions against the regulatory standards and identify violations. In the early stages, the quality of these websites varied, with many regions showing sparse data. It was not until 2016 that the platforms across the country became a reliable monitoring tool for regulators. By 2021, 46,783 key polluting establishments had been identified and equipped with automatic monitoring systems, with 31,163 wastewater automatic monitoring discharge points and 44,530 exhaust gas automatic monitoring discharge points.[7,8]

While expanded information in theory can improve the effectiveness of government monitoring, transparency alone might fail to change firm behaviour, especially when the

[6] The underlying CEMS data is automatically collected from each installed meter in real time. Each local EPA houses a monitoring center that consists of apparatuses and current meters on the site of key polluters, as well as CCTVs to monitor control facilities, data collection, and transmission apparatuses (Buntaine et al., 2021). The system started collecting data in 2004 in selected locations, then gradually expanded to national coverage. CEMS made the information publicly available starting in 2013.

[7] The EPA also conducts regular on-site inspections to verify whether enterprises are complying with emission standards and permit conditions every month. This includes checking the operational status of the monitoring equipment and the accuracy of the data records. Across the country, a total of 133,000 environmental administrative penalty decisions were issued, with a total penalty amounting to 11.69 billion yuan.

[8] Apart from the CEMS automatic daily monitoring, enterprises are required to report their emission data as stipulated, usually on a monthly, quarterly, and yearly basis. These reports must be provided to the EPA for regulatory purposes and verification of emission compliance. If key polluting enterprises violate emission standards, the environmental protection bureau has the authority to impose penalties, including fines, revocation of emission permits, and the implementation of other legal measures. Usually, the local EPA will maintain some flexibility in daily emission monitoring (especially when violations do not cause significant public discontent), but it carefully monitors the quarterly and yearly levels to control the total pollutant emissions. These records of the quarterly and yearly levels are reported to the central MEE.

involved parties have misaligned incentives (Duflo et al. 2018). Even when the government provides data on firms' violations, the information may be ignored if local governments tolerate pollution to promote economic growth (or for other reasons). In addition, the high number of violations may be too costly for a government with limited resources to fully address. Thus, transparency alone may fail to impact firms.

One way in which transparency can enhance environmental performance is by encouraging other parties to use open source data as a monitoring tool (Duguay et al. 2023). Public scrutiny of environmental performance can be a cost-effective way to monitor firms when the government is resource-constrained. To take advantage of public scrutiny, the Chinese government experimented with policies in which citizens were encouraged to report violations to national hotlines. However, the private nature of these one-on-one hotline interactions may have limited their effectiveness.[9] Consistent with this, Buntaine et al. (2022) find that citizens' appeals to the government on environmental violations are effective only when the appeals are made public.

2.2 China's Environmental Disclosure and Performance

In addition to establishing a more robust system of CEMS, China has pushed to produce other environmental information for the public over the past 20 years. These efforts impacted individual and firm behaviours and led to significant declines in pollution levels. For example, Barwick et al. (2023) find that the 2013 landmark program of monitoring and disclosing real-time air quality ($PM_{2.5}$) data nationwide has triggered individuals' avoidance of outdoor exposure and increased spending on protective products. These changes in behaviour have mitigated the negative impact of pollution on mortality.

[9] When the local EPA receives an appeal through a hotline, it has large discretion on whether and how to impose penalties for the violations. The outcome of the investigation is not made public and is rarely shared with the person making the appeal. Studies find limited effectiveness of these private appeals (Buntaine et al., 2021).

In addition to monitoring and disclosing pollution data to the public, the Chinese government mandated that a subset of listed firms disclose their corporate social responsibility (CSR) activities in their annual filings starting in 2008. Chen et al. (2018) find that the mandatory CSR disclosure has a significantly negative effect on firms' accounting performance. However, the authors also find that, in provinces where more firms are required to disclose their CSR activities, there is a significant reduction in water and air pollutions, suggesting that mandatory disclosure has an externality effect on improving the environment at the expense of the shareholders.

In our study, we conduct a field experiment using the CEMS data to test how investors' appeals to firms – as opposed to citizens' appeals to regulators (as in Buntaine et al. (2022)) – impact emission violations in the firms' establishments. Also, our focus on investors' monitoring differentiates our work from Chen et al. (2018), whose driver of environmental improvement is regulatory forces and disclosure regulation – not investors.

2.3 Investors' Pressure and Firms' Environmental Performance

Investors have been increasingly concerned about environmental issues in recent years. Most empirical evidence of this involves institutional investors. Using a cross-country dataset of 41 countries, Dyck et al. (2019) find that institutional ownership is positively associated with firms' environmental and sustainability performance. Similarly, Chen et al. (2020) find that the increase in institutional holding caused by the Russell Index reconstitution significantly improves the portfolio firms' CSR performance.

Retail investors' interest in environmental performance may also be growing (Bauer et al., 2019). Some studies find that retail investors do not have a keen interest in environmental issues (Moses et al., 2023), but Li et al. (2023) find that U.S. retail investors pay attention to ESG news that has a material impact on firms' financial performance. We extend these studies by considering whether retail investors can pressure firms into improving their ESG performance. The newly developed social media platforms in China

provide a viable channel through which retail investors can increase the power of their voice (Wong et al., 2022). We investigate the extent to which firms respond to retail investors' online requests to improve their environmental performance.

One challenge in testing the firms' response is that pressure from retail investors is hard to observe and can be endogenous to firm characteristics. Studies try to bypass this concern by identifying either shocks in investor participation (through index participation) (Black et al., 2022; Chen et al., 2020; Health et at., 2021) or the returns from environmental performance (Dyck et al., 2019). However, these settings have limitations. In our field experiment setting, we are able to test the causal effects of retail investors' requests to firms by randomizing firms into groups that are – or are not – confronting investor pressure and by varying the form of pressure applied to different groups.

3. SAMPLE AND EXPERIMENT DESIGN

3.1 Sample Selection

Our sample starts with 46,783 key polluting establishments constructed by the MEE using their pollutant emission levels. The list of key polluters is identified on each provincial EPA's website.[10] Key polluters account for nearly 75% of total emissions in China, according to the 2007 CES emission inventory (Buntaine et al. 2021).

The key polluters are identified at the firm-establishment level and can include establishments held by public or private firms. We require all key polluters in our sample to be owned by a publicly listed firm or its subsidiary, as our ability to exert pressure is limited to public firms on investor platforms. We map each establishment to its parent firm using ownership data from the China Stock Market & Accounting Research (CSMAR) database, then further verify this information with records from Industrial & Commercial Registration Information. We drop 42,776 establishments held by private firms. Our final

[10] An example of the list of key polluters in Zhejiang Province: http://sthjt.zj.gov.cn/art/2023/5/5/art_1229589248_58939196.html

sample includes 4,007 key polluting establishments held by 1,304 firms listed on the Shanghai and Shenzhen stock exchanges either directly or through their subsidiaries as of January 1, 2022.

Prior to the experiment, we randomly assign all key polluting establishments into the control group or one of three treatment groups.[11] The randomization is conducted at the firm level as opposed to the establishment level because our intervention (e.g., posting inquiries) is conducted at the firm level. We assign 10% of firms to the control group and the rest to the three treatment groups: baseline (30%), social media (30%), and disclosure (30%).[12] The three treatment conditions are explained in Section 3.2.2.

Table 1, Panel A presents the covariate balance of the treatment and control groups. We present the mean of each group for variables such as log of ending total assets in 2021 (*Size*), whether the firm is listed on the Shenzhen Stock Exchange (*SZSE*), net income divided by total assets (*ROA*), ending tangible assets divided by total assets (*Tangible Assets*), number of violations (*# of Violation Cases*), whether the establishment violates pollution standards during our experiment (*Violation*), and the severity of emission concentrations (SO_2). The statistics indicate that observable covariates are balanced across the treatment and control groups. There is no significant difference in these key characteristics across the treatment and control samples, confirming that our randomization is well executed.[13]

3.2 Experimental Design

[11] Alternatively, one can randomly assign observations at the time the violations occur. We choose to randomly assign all key polluting firms ex ante, because ex post assignment (at the time of violation) will be affected by the sequence in which firms are identified as violators during our experiment. If violations occur nonrandomly over time (perhaps because some firms observe pressure by retail investors from our experiment), the ex post assignment will no longer be random.

[12] Within the treatment groups, we also introduced additional sub-treatment arms (at the establishment level) to investigate spillover effects (explained later, in Section 4.5). For these sub-treatment establishments, we do not post questions even when the establishments violate the standards. We expect that these firm-establishments are likely to reduce their violation rate even if we do not post questions, because their treated parent firms will enhance the pollution violation control for the entire firm and the effect will spill over to them.

[13] Untabulated results show that industry and province distributions are balanced across the treatment and control groups.

We run our experiment between November 1, 2022, and May 17, 2023. The experiment was conducted in three steps, as illustrated in Figure 1. We start by identifying establishments that violated the emission standards based on daily emission data. We preassigned our population of key polluter establishments (at the firm level) into a control or one of three treatment groups. When an establishment from a treatment group violates a pollution standard during our experiment period, we post our question on the investor platform of the establishment's parent company. This is our main intervention and how we inject investor pressure. Finally, we collect the firm's responses on the platform and track the establishment's future violation rate. We provide more details on each of these steps below.

3.2.1 Identifying violating firms

To identify violators, we use emission data collected by the Institute of Public and Environmental Affairs (hereafter, IPE),[14] one of the largest NGOs aimed at improving environmental protection in China. While all emission data is publicly available, it is costly to systematically collect the emission information for all key polluters on the CEMS system, as data sources are widely spread on the websites of EPAs and presented in different formats. To increase public awareness of the pollution levels reported in the CEMS data, IPE compiles a dataset of the emission records of all key polluters in real-time from the websites of different EPAs.

IPE provided us with the daily pollution data for each establishment on a weekly basis. This data allows us to identify the establishments that violate the industry-region pollution standards on any given day. All key polluting establishments emit several pollutants that are monitored.[15] We identify an establishment as having an environmental violation when

[14] The NGO's website: https://www.ipe.org.cn/index.html.
[15] The CEMS monitors the emission concentrations of both water pollutants (COD and NH3-N) and air pollutants (SO2, PM, NOX) for all key polluters in China.

its emission of any monitored pollutant violates the environmental standards on any of the past seven days.

Table 1, Panel B shows the number of violations identified during our experiment. There are 727 violations at the establishment level, indicating that 27.6% (=727/2,634[16]) of establishments report emission levels that exceed the daily pollution standards at least once during our experimental period. The violation rates of the treatment groups range from 24.42% to 31.44%, compared to 26.77% for the control group. There is no significant difference in the violation rate between any treatment group and the control sample.

3.2.2 Posting questions on the online platform

We inject investor pressure by posting questions on the investor platform. For each violating establishment, we post questions on the parent firm's investor platform page. For firms listed on the Shenzhen Stock Exchange, we use the EasyIR platform; for firms on the Shanghai Stock Exchange, we use the eHudong platform. The posts are anonymized, with the firms seeing only the six-digit registration number of the individual making the inquiry. All submitted inquiries become publicly available once approved by the stock exchange. The questions contain the name of the establishment and the details of the violation.

We vary the types of questions we post for each firm based on the group to which the firm was pre-assigned (see Figure 1). The different treatments reflect factors that the literature has found to amplify investors' voices, such as social media and a commitment to disclosure (Li et al. 2021), and allow us to study the underlying mechanism (which cannot be easily observed using archival data). We use the following treatment effects:

- Baseline treatment group (30%): When the IPE data indicates that the firm violated the pollution standards, we post on the investor platform, alleging the violation and asking the firm to provide reasons for and rectify the violation.

[16] The total number of establishments (=2,634) is smaller than the number (=4,007) in the sample we used for random assignment before the start of the experiment, because some of these subsidiaries no longer have emission records in the CEMS. The reasons for this include no longer being key polluters, name changes, bankruptcies, and production cessation.

- Social media treatment (30%): When the IPE data indicates that the firm violated the pollution standards, we post on the investor platform, alleging the violation and asking the firm to provide reasons for and rectify the violation. In addition, we submit a post about the violation on Weibo and cite the Weibo post in our question to the firm on the online platform.
- Disclosure treatment (30%): When the IPE data indicates that the firm violated the pollution standards, we post on the investor platform, alleging the violation and asking the firm to provide reasons for and rectify the violation. In addition, we encourage the firm to disclose, in its annual report, its plans for controlling the pollution.
- Control group (10%): When the IPE data indicates that the firm violated the pollution standards, we do not intervene in any way.

APPENDIX A presents the baseline question and the questions from the additional treatment conditions.

Every month, we generate a list of establishments with one or more environmental violations, summarize each establishment's daily violation cases during the month, and post the questions based on the firm's pre-assigned category.[17] The questions were posted in the second week of each month, after we received the violation records for the last week in the prior month.

During our experiment period, 727 establishments were identified as having violated environmental standards (see Table 1). Eighty-seven of these establishments were from the control group, and 640 were from the treatment group. Our first inquiry on the online platform, posted December 8, 2022, is for Citic Pacific Special Steel (SME code: 00708), whose establishment Qingdao Special Steel violated daily emission standards in November.

[17] Due to the public nature of the online platform, contamination within treatment groups is possible. For example, treatment firms may see similar questions posted on other firms' platforms. To minimize the contamination effects, we posted four different versions of the same question for each treatment group using 40 different ID accounts.

We finished posting questions for all treatment firms by April 11, 2023. We posted 640 questions for the three treatment groups and no questions for the control sample. The number of posts is fewer than the number of violating cases because some firms experienced multiple violations in the same establishment during the month. To ensure a clean pre–post analysis, we only post for the first-time violation for each firm-establishment.[18]

3.2.3 Outcomes

We examine two outcomes. The first is the direct response that firms post on the platform. We follow and collect the timing and content of each response on a weekly basis until 30 days after the question is posted. On average, firms respond to our inquiries within 14.5 days after the post. More than 75% of treatment firms respond within 16 days. The response timeliness is much slower than in Wong et al. (2023), indicating that firms may take longer to investigate and fix the establishments' violation cases. The second outcome we examine is the establishment's propensity to violate in the future. We continually collect emission records for all firm-establishments until May 17, 2023, allowing us to collect up to three months of emission records after each round of posts.

4. EMPIRICAL TESTS AND FINDINGS

4.1 Responses on the Platform

We present the responses of treatment firms that violated emission standards during our experiment. We find a large variation in how firms respond to our questions: some outright deny any violation and provide no further explanation; others mention general plans to enhance their overall environmental performance but do not discuss the violations in question; and still others provide a targeted response outlining the reasons for the

[18] That is, when an establishment reports a repeat violation, we ignore it. Nonetheless, a firm can be treated multiple times if multiple establishments violate pollution standards.

violations and their remedial plans. We therefore categorize the responses into (i) No response, (ii) General response, or (iii) Targeted response.

The *No response* category includes all responses in which firms acknowledge receipt of the question but fail to provide further information or explanation. In some cases, they deny the existence of the violation and offer no additional details. The other two categories involve firms responding more proactively with additional information. We classify these responses into two categories, based on whether the firms directly address the specific violation we raised in our question. If the firm provides only general plans to enhance the firms' overall environmental performance, this is a *General response*. A general response may include details about the firms' financial investments in environmental protection, methods for reducing pollutant emissions (in a broader sense), or an overarching strategy for being environmentally friendly. The third category, *Targeted response*, comprises responses that provide a specific explanation for the identified violation and offer plans to prevent the violation's recurrence. A common example of a *Targeted response* involves a firm investigating the violating establishment, detailing the reasons for the violation, and outlining plans to rectify the issues underlying the violation. APPENDIX B presents examples of the different types of firm responses on the platform.

Table 2, Panel A presents the distribution of the different types of responses for all treatment firms. We find that 41.72% of responses (267 firms) fall under *No response*. Meanwhile, 373 firms (58.28%) respond positively to our questions: 140 (22.88%) provide a *General response* and 233 (36.40%) provide a *Targeted response*. The distribution is quite different from the response pattern in Li et al. (2023), where only 5.10% of firms provide the requested information. The significant number of firms providing targeted responses suggests that firms put significant weight on allegations of environmental violations.

We next examine firms' responses based on the different prompts. We first compare the *Disclosure* group and the *Baseline* group. When we add requests for environmental disclosure, 37.10% of responses fall into *No response*, which is 11.22% lower (z-stat = 2.41) than the rate for the baseline question; and 31.92% of the answers fall into *General response*, which is significantly higher (z-stat= 12.17) than the rate for the baseline question (19.75%). The percentage of responses that fall into *Targeted response* is lower than for the baseline case, but the difference is not statistically significant. Taken together, the distribution of responses across these three categories indicates that requesting disclosure leads firms to shift from giving more negative responses, such as giving no explanation or denying the violation, to more positive ones, such as offering a general environmental plan to control for pollution.

The findings are notably different when we appeal to social media influence. The percentage of *No response* is similar to the rate for the disclosure prompt, but significantly lower, at 38.42%, than the rate for the baseline case. Interestingly, there is a substantial increase in *Targeted response,* which now accounts for 48.42% of the responses – significantly higher (z-stat= 3.47) than the rate in the baseline case. In contrast, *General response* accounts for 13.16% of responses, which is significantly lower (z-stat=-1.81) than in the baseline case. Thus, the social media prompt, relative to baseline, leads to a shift from *No response* to *Targeted response*. This differs from the disclosure prompt, which led firms to shift from *No response* to *General response*.

In Panel C, we find that firms in the *Social media* group respond to our questions more promptly than firms in the *Baseline* group. On average, firms in the *Social media* group respond in just 11.10 days, versus 16.70 days (z-stat = 2.31) in the baseline case. Conversely, in the *Disclosure* group, the average response time is 15.58 days, which is closer to, but still lower than, the baseline response time. This result further confirms that

firms subjected to social media pressure treat our inquires more seriously, offering targeted responses and responding in a timelier fashion.

Overall, we find that adding the two prompts shifts firms' responses from negative to positive. Specifically, requests for environmental disclosure prompt firms to transition from *No response* to *General response*, while requests that appeal to social media lead firms to shift from *No response* to *Targeted response*.

4.2 Subsequent Pollution Violations

To further examine whether our appeals reduce firms' future violations, we estimate the following establishment-day-level regression equation:

$$Violation_{i,t} = \alpha + \sum \beta_n T_i * Post_{i,t} + \beta_m Post_{i,t} + FE + \varepsilon_{i,t} \quad (1)$$

where the outcome variable, $Violation_{i,t}$, is an indicator that equals 1 if establishment i commits any pollution violation on day t and zero otherwise. Future violations include violations due to any pollutant and do not have to involve the same pollutant that triggered the event. T_i represents our treatment group assignment for establishment i, including the overall *Treatment*, *Baseline, Disclosure*, and *Social media*. $Post_{i,}$ is an indicator variable that equals 1 in the period after establishment i is identified as having a pollution violation for the first time in our sample period and zero otherwise. We designate violators on a monthly basis when we receive pollution data on day t, which is typically the second week of each month. We control for establishment fixed effects and day fixed effects. Additionally, since firms face varying EPA monitoring intensities across different provinces, we include province-by-day fixed effects to control for time-varying regional enforcement differences. Standard errors are clustered by day.

For the regression analysis, we include all establishments, even ones that were not identified as having a violation during our sample period. The coefficient on $Post_i$ estimates the changes in the violation rate following a first-time violation for the control sample. The

main variable of interest is T_i * $Post_i$, which estimates the incremental changes in the violation rate following a first-time violation for the treatment sample.

Table 3, Panel A tabulates results of the univariate tests. We find that following our inquiries on the online platform, establishments in the treatment group experience a significant reduction (z-stat = 12.85) in violation rates, from 16.2% daily violations during the four weeks prior to the event to 12.0% in the 12 weeks subsequent to the event. In contrast, establishments in the control group experience an insignificant (z-stat = 0.69) decline (0.6%) over the same period, indicating that the observed reduction cannot be attributed to a mere mean-reversal trend in pollutant emission. We also investigated the impact of the different prompts on subsequent violation reduction. The results indicate that establishments in the *Social media* and *Baseline* groups reduce the probability of daily violations by 5.2%, which is larger than the reduction observed in the *Disclosure* group (2.0%).

The regression results are reported in Table 3, Panel B. As demonstrated in column (1), the coefficient on $Treat_i$ * $Post_{i,t}$ is negative and significant at the 1% level. Our inquiries on the platform on average reduce the probability of a daily violation by 2.5% relative to the control group – a drop of 53.5% from the control group's mean (4.67%).[19] The coefficient on $Post_{i,t}$ is positive yet insignificant, suggesting that, for the control sample, there is no significant change in the violation rate following first-time violations. In column (2), we further examine how the reduction in violations varies with the different question prompts. We find a significant reduction in the probability of violation in all three treatment groups. The most significant is in the *Social media* group, where establishments reduce the probability of a daily violation by 3.0% relative to the control group; this is followed by a 2.6% reduction in the *Baseline* group and a 1.9% reduction in the *Disclosure*

[19] We also examined whether there is substantial reduction in air and water pollutant emission concentrations after the event. In our untabulated results, we do not find any significant reduction in post-event pollutant emission concentrations. This suggests that our appeals can pressure firms to reduce their daily violations but cannot change firms' overall emission concentrations in the post-event period, which would require the firms to substantially change their underlying operations.

group. Interestingly, the reduction in the *Social media* group is larger, although not significantly so (Chi^2-stat=0.61), than the reduction in the *Baseline* group, while the effects in both groups are significantly (Chi^2-stat=3.59) greater than the effect in the *Disclosure* group.

We expect a stronger effect in the *Social media* group because increasing the publicity of the appeal through social media naturally encourages broader societal awareness and garners more attention from the listed firms. We use whether the firms responded to us privately in response to our social media post on Weibo as a proxy for the increase in perceived public pressure. We partition the *Social Media* group based on whether firms initiated private communication with us on Weibo, then examine whether the subgroup that did so – which numbers 13 firms – experiences a more significant decline in the probability of daily emission violation.[20] The results in Table 4 reveal that the firms that communicated with us on Weibo experience a substantial reduction (7.7% relative to the control group) in subsequent violations. The economic significance of this effect appears substantial, with the coefficient on $Social\ Media_i * Post_{i,t}$ being three times (Chi^2-stat=-6.41) that of $Baseline_i * Post_{i,t}$ and four times that of $Disclosure_i * Post_{i,t}$.

The results are similar when we replace day fixed effects with province-by-day fixed effects in Table 3, Panel B, columns (3) and (4), as well as in Table 4, column (2). In summary, these findings imply that publicly posting pollution appeals can increase listed firms' awareness of their pollution issues and motivate them to reduce their likelihood of pollution violations. Additionally, our results regarding the different prompts suggest that the addition of a social media appeal, on average, leads to a more substantial reduction in subsequent violations than direct questioning alone.

[20] These firms privately messaged us regarding their violations. Additionally, two companies complained to Weibo about our posting the pollution violation information on their accounts. Furthermore, on February 16, 2022, at 11:30 p.m., we received a phone call from a person who claimed to be working at a local EPA. This person had noticed our Weibo post and asked for more details about the firm's violation. This incident was surprising, since our identities and phone numbers were not supposed to be accessible to the public.

4.3 Heterogeneity in Treatment Effects: Conditional on Different Time Horizons and Firms' Responses

To provide evidence on how long the impact of our appeals persists, we further partition our sample based on different time horizons.

Before proceeding with the regression results, we present a univariate comparison of the impact of our appeals on future violation during a short window versus a long window. Table 5, Panel A reports the differences in daily pollution violation in the short window, between four weeks (weeks -4 to -1 relative to the event week) before and four weeks (weeks 1 to 4) after the event week. We find that our questions result in a significant 5.7% (1.62% - 1.05%, z-stat=14.50) reduction in the frequency of pollution violations during this window, while the control sample shows a 5.4% (1.57% - 1.03%, z-stat=5.12) reduction. These estimates indicate that, at least in the short run, a mean-reversal trend may explain the reduction in environmental violations in both the control and treatment samples. When we shift the window from weeks 1 to 4 to weeks 5 to 12 after the event, however, the violation rate in the control group reverts to pre-event levels or higher (from 15.7% to 17.6%), while the violation rate in the treatment group remains significantly (z-stat=9.16) lower than the pre-event level (though the effect is weakened). Figure 1 also plots a similar pattern about how the violation rate changes over time.

We also examine the difference based on the types of questions asked. During the first four weeks after the event, the *Social media* group shows a 7.6% reduction in its violation rate, followed by the *Baseline* group at 6.4% and the *Disclosure* group at 3.3%; these reductions move back towards pre-event levels during the following eight weeks. These estimations are consistent with our main finding that when investors publicly question

firms about their environmental violations, the effects continue during the 12 weeks after the questions are posted (although the impact decays over time).[21]

Cross-sectional regression results are presented in Table 5, Panel B. In columns (1) and (2), we partition by different time horizons. In column (1), we find that in the first four weeks after the event, the reduction in violations is only significant among firms facing a social media appeal from retail investors. In the long run (column 2), however, firms in all three treatment groups rectify their violations, though firms in the *Disclosure* group experience the least reduction.

We also partition by different rounds of questions. A listed firm could be questioned several times because multiple establishments from the same firm could violate the emission standards in different months. We define a question as first-round if it was the first question we posed to the firm about any of its establishments. The results in columns (3) and (4) show that all treatment firms commit significantly fewer subsequent violations (relative to the control group) after receiving the first-round question. In contrast, only firms in the *Social media* group significantly reduce the incidence of violations after receiving repeat appeals. This finding again implies that firms are more likely to pay attention to and remedy their environmental violations when they are subjected to the more intense influence of social media.

Table 5, Panel C presents the association between the types of firm responses on the platform and the subsequent environmental performance. The estimated coefficient in column (1) shows that all three types of responses are negatively associated with the future incidence of violations. Specifically, when firms provide no response or deny that there was a pollution violation, the incidence of violations declines by 2.0% – a statistically significant amount (t-stat= 6.23). When firms respond by providing their plans to control

[21] We only execute our experiment during a 6-month period, and we only post a question to each violating establishment once, which explains the limited impact of our appeals. If investors continued to submit appeals to the firms, the improvement of environmental performance may be even larger and more long-lasting.

pollution in general, we find a similar reduction in subsequent violation probability (-1.8%) as in the *No response* group. The F-test suggests that the difference in the two coefficients is not statistically significant (Chi^2- stat = 0.86). We see a stronger effect when firms provide a targeted response: a 3.3% reduction in subsequent violation probability, which is significantly greater than the reduction for the *No response* firms (Chi^2- stat = 32.43). The other three columns present the results partitioned by the different types of appeals, which are similar to the results based on the pooled sample in column (1). In summary, the findings suggest that the response types are associated with different levels of future violation reduction. Although the *General response* group is associated with no more pollution-rectifying action than the *No response* group, the *Specific response* group is associated with substantially more reductions.

4.4 Subsequent Disclosure in Regulatory Filings

In this subsection, we examine whether more firms provide information about environmental performance in their annual reports after our intervention. Table 6 presents the results. For this test, we only keep firms in which at least one establishment committed an environmental violation during the sample period. We collect the environmental disclosure from Section 5 of the 2022 annual reports. We define a firm as having disclosed environmental information if, in its 2022 annual report, it provides (i) numeric data on investment plans for environmental performance, or (ii) a specific description of its environmental investments or pollution-controlling procedures (as opposed to boilerplate text). Manually checking each annual report in the sample, we determine that 18.16% (77 out of 424) of the treatment firms include such information. The rate for the control group is lower, at 2.94% (1 out of 34 firms), which is significantly different from the treatment sample (z-stat=2.27). We also conjecture that if investors appeal for environmental disclosure in annual reports, firms will be under more pressure to provide such information. Consistent with our prediction, firms in the *Disclosure* group are more likely (24.31%) to

include environmental disclosures in their annual report, compared to firms in the other two treatment groups.

When we partition firms by the type of response, we find that the *Targeted response* firms are less likely (diff. = 10.67%, z-stats=3.03) to include environmental disclosure in their annual report. We find no significant difference in subsequent disclosure between the *General response* firms and the *No response* firms. Together, these findings suggest that investors' public appeals for environmental rectification may encourage more firms to make environmental disclosures, complementing a reduction in the incidence of daily violations.

4.5 Spillover Effects

We next test whether our prompts have spillover effects that go beyond the specific pollutants or establishments in question. We conduct two tests involving spillover effects.

First, we repeat the estimation in Equation (1) by restricting the emission violations of the pre- and post-event periods to those involving the same pollutant as in the event period. This allows us to control for any spillover effects on violations involving other pollutants. Empirically, we redefine $Violation_{i,t}$ as a new dummy variable that equals 1 if establishment *i* commits a pollution violation involving the same pollutant as in the event period on day t, and zero otherwise. Table 7, columns (1) and (2) show the estimated results if we only consider subsequent violation cases involving the same pollutant as in the event period: the coefficient on $Treat_i * Post_t$ is still negative and significant at the 1% level (coeff. = -0.017, t-stat = - 2.95). Specifically, our inquiries lead to a reduction in the probability of subsequent violations involving the same pollutant of 1.7%, relative to the control group; this is about 35.1% of the control group mean of 4.84%. Given the decrease of 53.5% in the control group mean in the main results, there is a reduction in economic significance of 18.4% (53.5%-35.1%), which reflects the violations involving other pollutants captured in the regression in Table 3. This finding indicates that the impact of investor appeals for the

reduction of violations involving a given pollutant spills over to other pollutants emitted by the treated establishment.

Second, we test whether the effect will spill over to other establishments controlled by the treated firm. In this estimation, we include a portion of the sample (551 establishments) reserved for testing the spillover effect during the experimental assignment phase. Empirically, we repeat the estimation in Equation (1) with $Spillover_i$, which includes the additional control sample of violating-firm establishments, from each of the three treatment groups, that *do not* receive a question in the online platform. We expect that these establishments will reduce their violation rate – even if we do not post questions about their violations – because their treated parent firms enhance pollution violation controls for the entire organization. The regression results, reported in columns (3) and (4), show that after we add this new group for testing the spillover effect, the coefficient on $Spillover_i * Post_{i,t}$ is negative and significant (coeff. = -0.021, t-stat = - 3.27). This finding indicates that the impact of our questions about violations spills over to other establishments within the treated firm.

Taken together, these results support our conjecture that investors' public appeals to firms' environmental violation control can spill over to other establishments in the organization and other pollutants monitored by CEMS.

4.6 Cross-sectional Tests

To provide further evidence on our appeals' effect on firms' environmental performance, we conduct cross-sectional tests based on whether firms are state-owned enterprises (SOEs) and whether the EPA in the province where the establishment is located cares more about environmental issues.

Table 8, Panel A presents the results of the state-owned enterprise tests. We find that investor pressure significantly reduces subsequent violations for both SOE and non-SOE firms. The impact of investors' appeals is larger in magnitude for state-owned firms than

for privately controlled firms (difference = 0.012), although the difference is not statistically significant by conventional standards. We further examine the difference based on the types of questions asked. Importantly, all three question types reduce non-SOEs' subsequent violations, but only the social media type reduces the SOEs' subsequent violations. These results suggest that SOEs are not responsive to investors' appeals unless they perceive an increase in public pressure through collective action on social media.

Next, we examine how the effect varies with the environmental conditions where the establishment is located. We measure a province's environmental conditions based on its yearly pollution emission level, which is disclosed in the latest MEE-published *Environmental Statistical Yearbook*.[22] We predict that firms located in a relatively more environmentally clean province are more likely to reduce their future violations because the EPA and the public are more likely to care about the environment and take actions against firms' pollution emissions. Also, in provinces with fewer violations, any increase in violations may attract more attention from investors and regulators, heightening the firms' cost of non-response to investors' requests. The results are presented in Table 8, Panel B. We define a province that is in the bottom tercile of pollution level – i.e., one of the 10 provinces (out of 32) with the lowest levels – as an environmental advocate. We find that retail investor pressure significantly reduces the probability of violations by firms located in environmentally cleaner provinces but has no significant effect on firms located in provinces with higher pollution levels. The results in columns (3) and (4) are similar when we further partition on the types of questions. Our findings indicate that investors' appeals are only effective in environmentally cleaner provinces, where the government and the public take environmental issues more seriously.

4.7 Ethical considerations

[22] See https://www.mee.gov.cn/hjzl/sthjzk/sthjtjnb/202301/W020230118392178258531.pdf.

We believe that our research has no ethical related concerns. First, the data used in our paper, including financial data, emission data, and online communication data, are publicly available. We do not have any concern about violating any data privacy and confidentiality. Second, our experiment is using firms on public platforms as its subject, and we do not involve any individual human subjects in the study. All submitted questions are approved by the stock exchange before being made publicly available. Third, our experiment does not induce additional costs to the firms but does increase their awareness of the possible environmental risk. Our appeals were only triggered by strong factual evidence of firms violating the pollution standards set by MEE. By publicly questioning the pollution violation, we hope to raise the firms' awareness of any possible environmental risks and induce them to take necessary actions to protect the environment. Finally, the IRB of University of Michigan, University of Southern California, and The Chinese University of Hong Kong (Shenzhen) all determined that this study was a non-human subject research.

5. CONCLUSION

In this study – a field experiment involving investor online platforms in China – we exert retail-investor pressure on firms with pollution-standard violations by posting requests that they reduce their violations. We find that, in the 12 weeks after our appeals, more than half of the firms respond by disclosing general, overarching environmental plans or providing a specific explanation or plan to reduce the violation. We also find that the retail investor pressure significantly reduces firms' subsequent pollution violations.

When we increase the publicity of the appeal by adding a post on the firms' social media, we observe the greatest reduction in subsequent violations. In contrast, appeals that call for more disclosure have no incremental effect on subsequent violations. We find that our investor questions lead more firms to make environmental disclosures in their

subsequent 2022 annual filing, and that there are significant within-firm spillover effects to other establishments and to other pollutant sources. Our cross-sectional tests also show that non-SOEs significantly reduce their violations in response to all three kinds of appeals, while SOEs only significantly reduce their violations in response to the social media appeal. These findings indicate that retail investor pressure exerted through online platforms can lead to improvements in firms' environmental performance.

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Table 1: Characteristics of Key Polluting Firms and Violation Rates

Panel A compares firm- and establishment-level characteristics of the key polluting firms in the treatment and control groups. The randomization is conducted at the firm level. We assign 10% of the firms to the control group and 30% of firms in each of the three treatment groups: *Baseline*, *Disclosure*, or *Social Media*. The treatment conditions are detailed in Section 3.2.2. Firm-level characteristics include: *Size*, measured as log of ending total assets in 2021; *SZSE*, an indicator that equals 1 if a firm is listed on Shenzhen Stock Exchange and 0 otherwise (Shanghai Stock Exchange); *ROA*, measured as net income divided by total assets; and *Tangible Assets*, measured as tangible assets divided by total assets. Establishment-level characteristics include: *# of Violation Cases*, the number of violations; *Violation*, an indicator that equals 1 if an establishment violates the pollution standard during our experiment and 0 otherwise; and SO_2 concentration, which is the severity of emission concentrations. Panel B presents the number of violations from key polluting establishments. Violations are determined on a daily basis, and are based on the number of times an establishment violates the daily pollution standard during our six-month experiment. We present the average number of each characteristic with T-statistics appearing in parentheses and testing for the difference in means. * p < 0.10, ** p < 0.05, *** p < 0.01.

Panel A: Characteristics of Key Polluting Firms by Treatment and Control

	Control	Treatment		
		Baseline	Disclosure	Social Media
	(1)	(2)	(3)	(4)
# of Establishments	325	757	774	778
# Establishments per firm	3.43	3.20	3.32	3.37
		(0.44)	(0.22)	(0.11)
SZSE	0.54	0.51	0.54	0.58
		(0.40)	(-0.04)	(-0.87)
Size	22.91	23.00	23.13	22.92
		(-0.56)	(-1.25)	(-0.07)
ROA	0.05	0.04	0.05	0.05
		(1.08)	(0.61)	(0.15)
Tangible Assets	0.25	0.25	0.25	0.24
		(-0.11)	(-0.22)	(0.45)
# of Violation Cases	2.87	2.70	2.40	2.32
		(0.31)	(0.88)	(0.97)
Violation	0.27	0.31	0.27	0.24
		(-1.52)	(-0.24)	(0.83)
SO_2 Concentration	21.93	22.19	22.95	23.33
		(-0.11)	(-0.44)	(-0.64)

Panel B: Violation Rates of Key Polluting Firms

Groups	(1) # of establishments	(2) Firms	(3) # of violations	(4) Violation-rate (=(3)/(1))
Total	2,634	1,124	727	27.60 %
Control (10%)	325	108	87	26.77 %
Baseline (30%)	757	334	238	31.44 %
Disclosure (30%)	774	345	212	27.39 %
Social Media (30%)	778	337	190	24.42 %
Spillover sample	551	N/A	148	26.86

Table 2: Treatment Firms' Responses on the Platform

This table presents the distribution of the treatment firms' responses on the platform. Panel A presents the distribution of responses for the entire sample. *No response* refers to firms providing no response or denying that there is a pollution violation. *General response* refers to firms mentioning plans to control pollutions in general. *Targeted response* refers to firms providing a specific explanation for the violation and plans to prevent its reoccurrence in the future. Panel B presents the responses by the type of question we post: (i) baseline (*Baseline*), (ii) asking for input disclosure (*Disclosure*), or (iii) appealing to social media influence (*Social Media*). Panel C presents the response timeliness by the type of question. Timeliness is measured using the duration from when a question is posted to when a firm responds on the platform. *T*-statistics of t-tests and *Z*-scores of proportion tests are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Distribution of Responses for All Treatment Firms

Types of response	No response	General response	Targeted response	Final sample in total
# Response	267	140	233	640
% Response	41.72%	22.88%	36.40%	100%

Panel B: Distribution of Responses by Type of Question

Types of response	# treatment	# & % No response		# & % General response		# & % Targeted response	
Types of question:							
Baseline	238	115	48.32%	47	19.75%	76	31.93%
Disclosure	212	79	37.10%	68	31.92%	65	30.52%
Difference from baseline			-11.22%** (-2.41)		12.17%*** (2.96)		-1.47% (-0.32)
Social Media	190	73	38.42%	25	13.16%	92	48.42%
Difference from baseline			-9.90%** (-2.05)		-6.59%* (-1.81)		16.48%*** (3.47)

Panel C: Type of Question and Response Timeliness

Types of question	Baseline	Disclosure	Social Media
Timeliness	16.70	15.58	11.10
Difference		-1.12 (0.44)	-5.60** (2.31)

Table 3: Online Appeals and Subsequent Pollution Violations

Panel A: Univariate Test

This table presents the changes in the proportion of violation cases before and after our experiment. We only keep violated establishments and define the pre period as the four weeks before the event window and the post period as the 12 weeks after the event window. The three question types are: (i) baseline (*Baseline*), (ii) asking for input disclosure (*Disclosure*), and (iii) appealing to social media influence (*Social Media*). *Z*-statistics of proportion tests are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Groups	Pre-period	Post-period	Difference
Control	0.157	0.151	-0.006
			(0.69)
Treatment	0.162	0.120	-0.042***
			(12.85)
By different questions:			
Baseline	0.167	0.115	-0.052***
			(9.85)
Disclosure	0.143	0.123	-0.020***
			(3.51)
Social Media	0.177	0.125	-0.052***
			(8.72)

Panel B: Regression

This table reports the regression results from estimating the following model using establishment-day-level data:

$$\text{Violation}_{i,t} = \alpha + \sum\beta_n T_i * \text{Post}_t + \beta_m \text{Post}_{i,t} + \text{FE} + \varepsilon_{i,t}$$

In these estimations, the outcome variable $Violation_{i,t}$ is a dummy variable that equals 1 if establishment i commits any pollution violation on day t, and zero otherwise. T_i represents the randomly assigned treatment groups of establishment i, including the overall *Treatment*, *Baseline, Disclosure*, and *Social media*. $Post_{i,t}$ is a dummy variable that equals 1 in the period after establishment i is identified as having a pollution violation for the first time in our sample period. The three question types are: (i) baseline (*Baseline*), (ii) asking for input disclosure (*Disclosure*), and (iii) appealing to social media influence (*Social Media*). Establishment FE and Day FE (Province-day FE) are included in columns 1 and 2 (3 and 4). Standard errors are clustered by day. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable:	Violation			
	(1)	(2)	(3)	(4)
Treat * Post	-0.025***		-0.018***	
	(-4.75)		(-3.33)	

Baseline* Post		-0.026***		-0.019***
		(-4.50)		(-3.09)
Disclosure* Post		-0.019***		-0.010*
		(-3.19)		(-1.70)
Social Media* Post		-0.030***		-0.025***
		(-5.19)		(-4.28)
Post	0.000	0.000	-0.008	-0.008
	(0.08)	(0.08)	(-1.46)	(-1.48)
H0: B-D=0		-0.007**		-0.009**
		(3.59)		(4.72)
H0: B-S=0		0.004		0.006
		(0.61)		(1.65)
# of Observations	348,485	348,485	348,485	348,485
Adjusted R-squared	0.462	0.462	0.470	0.470
Establishment FE	Yes	Yes	Yes	Yes
Day FE	Yes	Yes		
Province-day FE			Yes	Yes

Table 4: Social Media Activities and Firm Violations

This table reports the regression results of the following model using establishment-day-level data:

$$Violation_{i,t} = \alpha + \sum \beta_n T_i * Post_t + \beta_m Post_{i,t} + FE + \varepsilon_{i,t}$$

In these estimations, the outcome variable $Violation_{i,t}$ is a dummy variable that equals 1 if establishment i commits any pollution violation on day t, and zero otherwise. T_i represents our randomly assigned treatment groups of establishment i, including the overall *Treatment*, *Baseline*, *Disclosure*, and *Social media*. $Post_{i,t}$ is a dummy variable that equals 1 in the period after establishment i is identified as having a pollution violation for the first time in our sample period. The three question types are: (i) baseline (*Baseline*), (ii) asking for input disclosure (*Disclosure*), and (iii) appealing to social media influence (*Social Media*). Within *Social Media*, we further partition firms into two subgroups (*No response on Social Media* and *Response on Social Media*) based on whether firms send messages privately to us on Weibo. Establishment FE and Day FE (Province-day FE) are included in Column 1 (2). Standard errors are clustered by day. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable:	Violation	
	(1)	(2)
Baseline* Post	-0.026***	-0.019***
	(-4.50)	(-3.09)
Disclosure* Post	-0.019***	-0.010*
	(-3.19)	(-1.70)
No response on Social Media * Post	-0.027***	-0.022***
	(-4.65)	(-3.75)
Response on Social Media * Post	-0.077***	-0.072***
	(-6.41)	(-6.14)
Post	0.000	-0.008
	(0.08)	(-1.48)
H0: B-D=0	-0.007*	-0.009**
	(3.60)	(4.73
H0: B-NS=0	0.001	0.003
	(0.04)	(0.50
H0: B-RS=0	0.051***	0.053**
	(18.04)	(21.21)
# of Observations	348,485	348,485
Adjusted R-squared	0.462	0.470
Establishment FE	Yes	Yes
Day FE	Yes	

Province-day FE	Yes

Table 5: Different Time Horizons and Different Firms' Response

Panel A: Univariate Test: Conditional on Different Time Horizons

This table presents the changes in the proportion of violation cases before and after our experiment. We only keep violated establishments and define the pre period as the four weeks before the event window and the post period as the 12 weeks after the event window. The three question types are: (i) baseline (*Baseline*), (ii) asking for input disclosure (*Disclosure*), and (iii) appealing to social media influence (*Social Media*). We further partition the post period as short-term (within four weeks after the event window) and long-term (five to twelve weeks after the event window) effect. *Z*-statistics of proportion tests are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Periods:	Pre-period	Post-period	
		In the Short Run	In the Long Run
Control	0.157	0.103***	0.176*
		(5.12)	(1.83)
Treatment	0.162	0.105***	0.129***
		(14.50)	(9.16)
By different questions:			
Baseline	0.167	0.103***	0.121***
		(9.85)	(7.81)
Disclosure	0.143	0.110***	0.130***
		(4.67)	(2.08)
Social Media	0.177	0.101***	0.138***
		(10.43)	(5.81)

Panel B: Regression: Conditional on Different Time Horizons

This table reports the regression results from estimating the following model using establishment-day-level data:

$$Violation_{i,t} = \alpha + \sum \beta_n T_i * Post_t + \beta_m Post_{i,t} + FE + \varepsilon_{i,t}$$

In these estimations, the outcome variable $Violation_{i,t}$ is a dummy variable that equals 1 if establishment i commits any pollution violation on day t, and zero otherwise. T_i represents our randomly assigned treatment groups of Establishment i, including the overall *Treatment*, *Baseline*, *Disclosure*, and *Social media*. $Post_{i,t}$ is a dummy variable that equals 1 in the period after establishment i is identified as having a pollution violation for the first time in our sample period. The three question types are: (i) baseline (*Baseline*), (ii) asking for input disclosure (*Disclosure*), and (iii) appealing to social media influence (*Social Media*). In columns (1), and (2), we partition by different time horizons: the short-term (within one month after posting) and the long-term (more than one month after posting). In columns (3) and (4), we partition by different rounds of questions: the first round and other rounds. Establishment FE and Day FE are included in all columns. Standard errors are clustered by day. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable:	Violation

	(1)	(2)	(3)	(4)
	Short-term	Long-term	First Round	Other Round
Baseline* Post	0.001	-0.034***	-0.038***	-0.002
	(0.12)	(-4.90)	(-5.82)	(-0.34)
Disclosure* Post	0.000	-0.024***	-0.023***	-0.008
	(0.01)	(-3.40)	(-3.65)	(-1.12)
Social Media* Post	-0.021***	-0.033***	-0.033***	-0.024***
	(-2.99)	(-4.95)	(-5.28)	(-3.02)
Post	-0.020***	0.004	0.003	0.001
	(-2.96)	(0.67)	(0.58)	(0.21)
H0: B-D=0	0.001	-0.010**	-0.015***	0.006
	(0.03)	(5.35)	(9.67)	(1.04)
H0: B-P=0	0.022***	-0.001	-0.005	0.022***
	(16.14)	(0.02)	(0.83)	(10.08)
# of Observations	307,579	331,958	322,594	276,393
Adjusted R-squared	0.443	0.473	0.487	0.314
Establishment FE	Yes	Yes	Yes	Yes
Day FE	Yes	Yes	Yes	Yes

Panel C: Regression: Conditional on Different Firms' Responses

This table reports the regression results from estimating the following model using establishment-day-level data:

$$Violation_{i,t} = \alpha + \sum \beta_n R_i * Post_t + \beta_m Post_{i,t} + FE + \varepsilon_{i,t}$$

In these estimations, the outcome variable $Violation_{i,t}$ is a dummy variable that equals 1 if establishment i commits any pollution violation on day t, and zero otherwise. R_i represents the three types of firms' response: (i) *No response* refers to firms providing no response or denying that there is a pollution violation; (ii) *General response* refers to firms mentioning plans to control pollution in general; and (iii)*Targeted response* refers to firms providing a specific explanation for the violation and plans to prevent its reoccurrence in the future. In column (1), we utilize a pooled sample, and in columns (2) to (4) we use a sample consisting of firms in *Baseline/Disclosure/Social Media* or *Control* groups. Establishment FE and Day FE are included in all columns. Standard errors are clustered by day. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable:	Violation			
	(1)	(2)	(3)	(4)
	Pooled	Baseline	Disclosure	Social Media

No response * Post	-0.020***	-0.023***	-0.013***	-0.024***
	(-6.23)	(-6.01)	(-3.14)	(-5.67)
General reponse * Post	-0.018***	-0.030***	-0.013***	-0.006
	(-5.01)	(-6.10)	(-3.21)	(-1.00)
Targeted response * Post	-0.033***	-0.032***	-0.023***	-0.040***
	(-10.00)	(-7.47)	(-5.21)	(-10.16)
Post	-0.000	0.003	-0.001	-0.003
	(-0.15)	(0.86)	(-0.44)	(-0.94)
H0: N-G=0	-0.002	0.007	0.000	-0.018***
	(0.86)	(2.10)	(0.01)	(8.86)
H0: N-S=0	0.013***	0.009**	0.010**	0.016***
	(32.43)	(5.46)	(4.92)	(17.45)
# of Observations	348,485	142,441	141,501	150,325
Adjusted R-squared	0.462	0.454	0.469	0.436
Establishment FE	Yes	Yes	Yes	Yes
Day FE	Yes	Yes	Yes	Yes

Table 6: Online Appeals and Subsequent Disclosure Change in Annual Report

This table presents the frequency of firms' providing additional information about environmental inputs in their next year's annual report. We collect the detailed disclosure of environmental investments or detailed procedures to control pollution in Section 5 from the 2022 annual report. We present the results for the entire sample and by (i) the types of questions and (ii) the types of firm responses on the platform. The three question types are: (i) *Baseline*, (ii) *Disclosure*, and (iii) *Social Media*. We present the results by the three types of firm responses on the platform: (i)*No response*, (ii) *General response*, or (iii) *Targeted response*. Z-statistics of proportion tests are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Conditional on Different Questions

	Total	Firms disclosing environmental inputs in 2022 Annual Report	%	Difference in Percentage
Control	34	1	2.94	T-C
Treatment	424	77	18.16	15.22**
				(2.27)
By different questions:				
Baseline	151	23	15.23	Difference D/S-B
Disclosure	144	35	24.31	9.08**
				(1.96)
Social Media	129	19	14.73	-0.50
				(0.12)

Panel B: Conditional on Different Responses

	Total	Firms disclosing environmental inputs in 2022 Annual Report	%	Difference
By different responses:				
No input response	267	64	23.97	Difference N-R/E
General response	140	31	22.14	0.17
				(0.41)
Targeted reponse	233	31	13.30	10.67***
				(3.03)

Table 7: Spillover Effect Tests (Pollutant Level and Organizational Level)

This table reports the regression results of the following model using firm-establishment-day-level data:

$$Violation_{i,t} = \alpha + \sum \beta_n T_i * Post_t + \beta_m Post_{i,t} + FE + \varepsilon_{i,t}$$

In these estimations, the outcome variable $Violation_{i,t}$ is a dummy variable that equals 1 if establishment i commits any pollution violation on day t, and zero otherwise. T_i represents our randomly assigned treatment groups of establishment i, including the overall *Treatment*, *Baseline*, *Disclosure*, and *Social media*. $Post_{i,t}$ is a dummy variable that equals 1 in the period after establishment i is identified as having a pollution violation for the first time in our sample period. The three question types are: (i) baseline (*Baseline*), (ii) asking for input disclosure (*Disclosure*), and (iii) appealing to social media influence (*Social Media*). In columns (1) and (2), we restrict the emission violations of the pre- and post-event periods to only those involving the same pollutant as in the event period, thereby controlling for any spillover effects in violation across different pollutants. In columns (3) and (4), we include the additional control sample for testing the spillover effect. This additional control sample is a subset of firm-establishments from firms belonging to any of the three treatment groups. In this control sample, we identify the first-time violation but do not send any questions to the firms. In the regression, we include $Spillover_i$, which equals 1 when the establishment of this control sample is identified as having its initial violation and zero otherwise. Establishment FE and Day FE are included in all columns. Standard errors are clustered by day. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable:	Violation			
	(1)	(2)	(3)	(4)
Treat * Post	-0.017***		-0.025***	
	(-2.95)		(-4.78)	
Spillover* Post			-0.021***	-0.021***
			(-3.27)	(-3.27)
Baseline* Post		-0.019***		-0.027***
		(-2.96)		(-4.53)
Disclosure* Post		-0.010		-0.019***
		(-1.57)		(-3.22)
Social Media* Post		-0.022***		-0.030***
		(-3.47)		(-5.22)
Post	-0.006	-0.006	0.001	0.001
	(-1.08)	(-1.09)	(0.17)	(0.17)
H0: T-S=0			-0.004	
			(1.03)	
H0: B-D=0		-0.009**		-0.008*
		(5.68)		(3.55)
H0: B-P=0		0.003		0.003
		(0.36)		(0.61)

# of Observations	348,485	348,485	420,430	420,430
Adjusted R-squared	0.497	0.497	0.463	0.463
Firm-Establishment FE	Yes	Yes	Yes	Yes
Day FE	Yes	Yes	Yes	Yes

Table 8: Cross-sectional Analysis

Panel A: Conditional upon SOE

This table reports the regression results of the following model using firm-establishment-day-level data. In this table, we condition upon whether the firm is ultimately controlled by state:

$$Violation_{i,t} = \alpha + \sum \beta_n T_i * Post_t + \beta_m Post_{i,t} + FE + \varepsilon_{i,t}$$

In these estimations, the outcome variable $Violation_{i,t}$ is a dummy that equals 1 if the establishment i commits any pollution violation on day t, and zero otherwise. T_i represents our randomly assigned treatment groups of establishment i, including the overall *Treatment*, *Baseline*, *Disclosure*, and *Social media*. $Post_{i,t}$ is a dummy variable that equals 1 in the period after establishment i is identified as having a pollution violation for the first time in our sample period. The three question types are: (i) baseline (*Baseline*), (ii) asking for input disclosure (*Disclosure*), and (iii) appealing to social media influence (*Social Media*). Establishment FE and Day FE are included in all columns. Standard errors are clustered by day. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable:	Violation			
	(1)	(2)	(3)	(4)
	Non-SOE	SOE	Non-SOE	SOE
Treat * Post	-0.030***	-0.018**		
	(-3.73)	(-2.12)		
H0: S-NS=0	-0.012			
Chi^2	(0.77)			
Baseline* Post			-0.036***	-0.009
			(-4.18)	(-1.02)
H0: S-NS=0			0.027***	
Chi^2			(4.78)	
Disclosure* Post			-0.022**	-0.015
			(-2.56)	(-1.44)
H0: S-NS=0			0.007	
Chi^2			(0.28)	
Social Media* Post			-0.029***	-0.032***
			(-3.53)	(-3.19)
H0: S-NS=0			-0.033	
Chi^2			(0.04)	
Post	0.002	-0.002	0.002	-0.002
	(0.23)	(-0.23)	(0.23)	(-0.24)
# of Observations	222,589	125,896	222,589	125,896
Adjusted R-squared	0.453	0.477	0.453	0.477
Firm-Establishment FE	Yes	Yes	Yes	Yes

Day FE	Yes	Yes	Yes	Yes

Panel B: Conditional upon Provincial Pollution Level

This table reports the regression results of the following model using firm-establishment-day-level data. In this table, we condition upon the province's yearly pollution emission level:

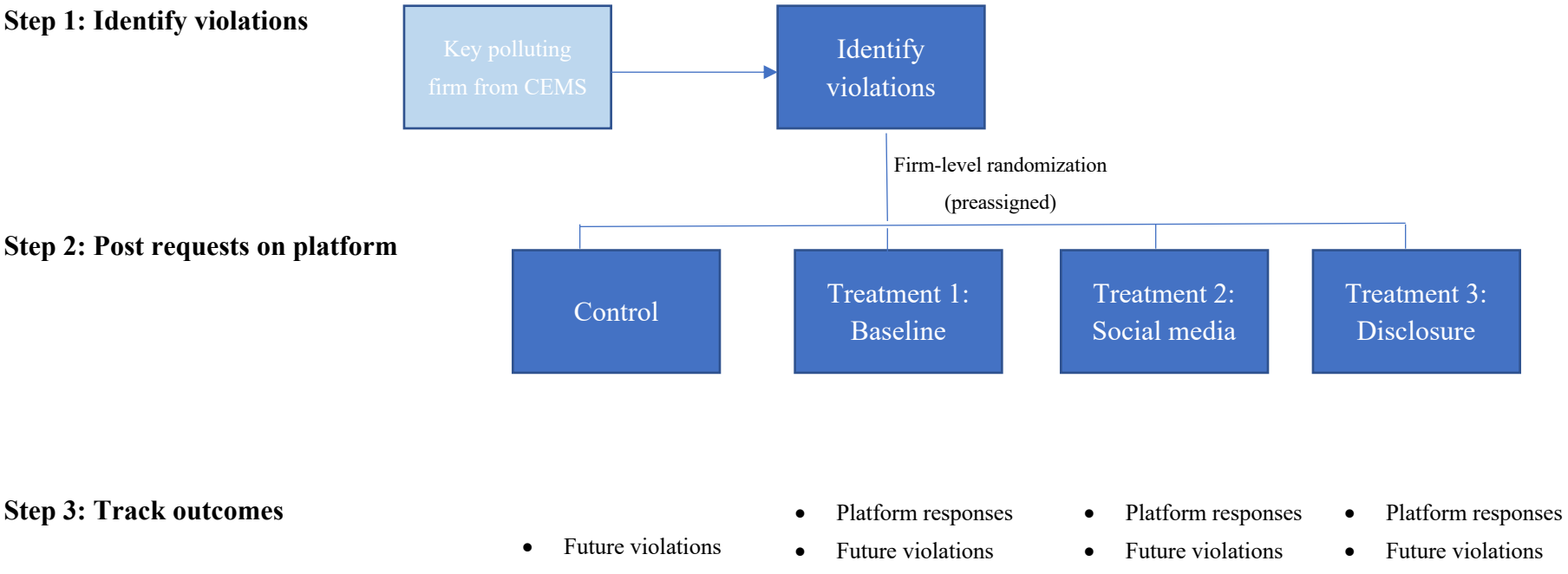
$$Violation_{i,t} = \alpha + \sum\beta_n T_i * Post_t + \beta_m Post_{i,t} + FE + \varepsilon_{i,t}$$

In these estimations, the outcome variable $Violation_{i,t}$ is a dummy variable that equals 1 if Establishment i commits any pollution violation on day t, and zero otherwise. T_i represents our randomly assigned treatment groups of Establishment i, including the overall *Treatment*, *Baseline*, *Disclosure*, and *Social media*. $Post_{i,t}$ is a dummy variable that equals 1 in the period after the establishment i is identified as having a pollution violation for the first time in our sample period. The three question types are: (i) baseline (*Baseline*), (ii) asking for input disclosure (*Disclosure*), and (iii) appealing to social media influence (*Social Media*). Establishment FE and Day FE are included in all columns. Standard errors are clustered by day. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable:	Violation			
	(1)	(2)	(11)	(12)
	Low	High	Low	High
Treat * Post	-0.030***	-0.003		
	(-4.91)	(-0.36)		
H0: H-L=0	0.027***			
Chi^2	(6.64)			
Baseline* Post			-0.031***	-0.005
			(-4.43)	(-0.59)
H0: H-L=0			0.026**	
Chi^2			(5.22)	
Disclosure* Post			-0.022***	-0.001
			(-3.12)	(-0.07)
H0: H-L=0			0.021*	
Chi^2			(3.65)	
Social Media* Post			-0.036***	-0.004
			(-5.29)	(-0.37)
H0: H-L=0			0.032***	
Chi^2			(7.27)	
Post	0.001	-0.014*	0.001	-0.014*
	(0.17)	(-1.65)	(0.17)	(-1.66)

# of Observations	231,235	117,250	231,235	117,250
Adjusted R-squared	0.483	0.254	0.483	0.254
Firm-Establishment FE	Yes	Yes	Yes	Yes
Day FE	Yes	Yes	Yes	Yes

Figure 1 Experiment Design



Appendix A: Examples of Experiment Posts on the Platform

Baseline	Dear Secretary, The establishment X, controlled by your company, has violated the emission standards of pollutants (including XXX) M times in month X. Please check, rectify the violations, and provide specific reasons to us. I hope the firm will pay attention to and control the pollution violations. Thank you.
Disclosure	Dear Secretary, ESG is one of the issues of major concern to investors. I also learned about your firm's investment and efforts in environmental protection from your company's annual report. However, the establishment X, controlled by your company, has violated the emission standards of pollutants (including XXX) M times in month X. Please check, rectify the violations, and provide specific reasons to us, as well as the measures taken to reduce pollutants and control excessive emissions, including your program plans and investment amounts. We also hope you can add these detailed disclosures in your future periodic reports.
Social Media	Dear Secretary, The establishment X, controlled by your company, has violated the emission standards of pollutants (including XXX) M times in month X. These violations have also attracted relevant attention on social media. The Weibo link is as follows: XXX. Please check, rectify the violations, and provide specific reasons to us. We hope the firm will pay attention to and control the pollution violations. Thank you.

Appendix B: Examples of Firms' Responses on the Platform

Types of responses	Examples
No response	Dear investors, Hello, thank you for your attention and suggestions to the company and its subsidiaries.
	Hello, After verifying the company's emission records, the situation you described does not exist. For relevant emission information, please refer to the information released by the ecological and environmental protection department. Thanks for your attention!
	Thank you for your attention and suggestions.
General response	The company attaches great importance to environmental protection work, strictly implements the three simultaneous environmental protection systems, and has built corresponding environmental protection facilities. The company will strictly abide by relevant national environmental protection laws and regulations and local environmental protection regulations, and does a good job in

	environmental protection. For details of the company's environmental protection matters, please see the company disclosures in periodic reports Thank you for your interest in the company.
	Hello, The company has always attached great importance to environmental protection work and strictly abides by environmental protection laws, regulations, and relevant regulatory requirements. In recent years, it has continued to increase investment in environmental protection, continuously improves the level of environmental protection governance, and actively fulfils its social responsibilities. Thank you for your attention and suggestions.
	Hello, Thank you for your attention and support to the company! As the first enterprise in the country to pass the ASI aluminum industry chain certification, the company has been committed to the research, development, and application of energy conservation and carbon reduction, recycling, resource conservation, environmental protection, etc., starting from all aspects of production and utilizing energy resources efficiently and rationally. The company will build a new 100,000-ton recycled aluminum grade maintenance and utilization project in 2021. Together with downstream customers in the industry chain, the company will actively promote the development of the domestic recycled aluminum industry. There are plans to continue to expand production in the future, while at the same time reducing thermal power aluminum production capacity, represented by green power. We will continue to optimize the energy structure through clean energy substitution and other methods, continue to explore the best practices for carbon neutrality in the non-ferrous metal industry, and gradually achieve the goals of energy conservation, emission reduction, and clean production throughout the entire industry chain. This year the company also released its first ESG report. In the future, we will continue to promote the effectiveness of relevant work and continuously improve the company’s internal governance mechanism and level of social responsibility. Thanks!
Targeted response	Hello, Thank you for your question. After verification, Jingtai Power Generation did not have any excessive pollutants in March 2023. Regarding the question you raised, the Jungar Banner Branch of the Ordos Municipal Ecological Environment Bureau has issued the “Letter on Verification of Excessive Pollutant Issues Asked by SSE E Interactive Users of Inner Mongolia Jingtai Power Generation Co., Ltd.” (Ehuan Zhunhan [2023] No. 194). It was verified that Jingtai Power

	Generation was responsible for the blockage of the sampling probe of the online continuous monitoring device of the desulfurization outlet of Unit 1 and the regular work that caused air to enter the sampling management, causing the desulfurization outlet of the unit to be blocked on March 8 and throughout March 2023. The standard was exceeded on the 17th. In accordance with the "Ordos City Ecological Environment Monitoring Center's Notice on Data Marking of the "Automatic Monitoring and Basic Database System of Key Pollutant Discharging Units," Jingtai Power Generation has carried out timely marking and submitted monitoring data abnormality reports and regular maintenance to relevant departments. According to the report, the atmospheric pollutant emissions of Jingtai Power Generation in March were normal. Jingneng Electric Power has always attached great importance to pollution reduction and prevention and control, and has strictly implemented the main responsibilities of corporate environmental management. In accordance with the requirements of the local environmental protection department, all affiliated enterprises promptly disclose the basic environmental protection situation of the enterprise, self-monitoring situation, and solid and hazardous waste information on the pollution discharge permit platform, self-monitoring website, and WeChat public account. Thank you for your attention.
	Dear investors, Hello! Our company attaches great importance to your feedback. Regarding the sewage online monitoring data of its subsidiary China Resources Sanjiu (Huangshi) Pharmaceutical Co. Ltd., the chemical oxygen demand concentration abnormally exceeded the standard in March this year. After verification, the main reason was: interference at the wastewater sampling port that affected the detection. There are too many substances (such as sludge). During the operation of the online monitoring equipment, the sampling pump sucked interfering substances into the online monitoring system, causing the sampling tube to become blocked, the injection valve to get stuck, and the instrument to alarm, causing this abnormal phenomenon in the monitoring data. After discovering the data anomaly, Huangshi Sanjiu took emergency measures as soon as possible and immediately filed a record with the local environmental protection management department. With the approval of the management department, the operation and maintenance personnel cleaned the sampling port, sampling pipeline, and injection valve, and the monitoring data returned to normal. Huangshi Sanjiu Wastewater Laboratory is equipped with a water quality detector, and

	laboratory personnel conduct manual testing of chemical oxygen demand and ammonia nitrogen every day. After inspection, the concentrations of wastewater pollutants discharged during abnormal data periods all met the standards. After the incident, Huangshi Sanjiu commissioned a qualified third-party testing unit to conduct a comparison experiment on the online monitoring equipment. The comparison monitoring report showed that the PH, chemical oxygen demand, and ammonia nitrogen parameter indicators were qualified, and the monitoring equipment was operating normally. Huangshi Sanjiu will continue to strengthen the operation and maintenance management of environmental protection equipment and facilities and online monitoring equipment to ensure the safe and stable operation of equipment and facilities and ensure that pollutants are discharged in compliance with standards. CR Sanjiu will continue to strictly abide by the requirements of national and local environmental protection laws, regulations, standards, and policy documents, attach great importance to the prevention and control of pollutants, strictly control wastewater, waste gas, solid waste, and hazardous waste and other pollutants generated during the production process, vigorously advocate green low-carbon production and lifestyles, and gradually integrate the concept of green and low-carbon development into the entire product life cycle. In recent years, the company has continued to disclose the implementation of green development concepts and continuous improvement of green management systems in regular reports, and disclosed environmental and social responsibility-related information in annual reports, including the company's efforts and achievements in social, environmental, and other aspects. In the future, the company will continue to improve its green management system and information disclosure content to promote green, high-quality, and sustainable development.
	Dear Investors, Shuangle Pigments Taixing Co. Ltd. had two pollutant (PH value) emission data exceeding the standard in January 2023. The company's on-site management personnel and third-party facility maintenance management personnel went to the site to verify and deal with it as soon as possible and reported it to the Environmental Protection Department. After an on-site inspection by the department, it was confirmed that the cause was damage to the testing equipment, resulting in abnormal testing data. The company promptly replaces testing equipment and labels key pollutant discharge units in the automatic monitoring and basic database system (also known as the

	National Development Platform) in accordance with regulatory requirements. The incident has not affected the company's production and operations. The company will further improve the efficiency of the environmental management system, strengthen environmental monitoring and management, ensure the normal operation of production and environmental protection facilities, and continue to meet environmental management requirements. Thank you for your attention!