Polluted IPOs*

Meng Miao[†] Wei Wang[‡] Zhengyu Zuo[§]

February 28, 2022

Abstract

Using location- and time-specific air pollution data in Beijing, we document that regulators are more likely to approve IPOs in China on hazy days. Our results are robust to specifications that control for listing firms' characteristics, composition of the IPO review committee, and industry, quarter, and firm headquarters location fixed effects, and using wind speed as an instrumental variable. IPOs approved on hazy days perform poorly within one year after initial listing. Textual analysis of the questions raised by the review committee reveals that committee members ask fewer, shorter, and less complex questions on hazy days. This effect is more pronounced among older and non-local reviewers and less pronounced for those who will soon be up for reappointment. The evidence suggests that air pollution weakens the effectiveness of regulatory oversight. Our back-of-the-envelope calculation shows that investors lost close to 48 billion RMB (USD$8 billion) from 2014 to 2020.

Keywords: Air Pollution, IPO, Regulatory Oversight, China, Cognitive Ability, Mood.

JEL classification: G18, G41, D91, Q5

*We thank Kee-Hong Bae, Joshua Madsen, and Zilong Zhang for comments and suggestions. All errors are our own.

[†]School of Finance, Renmin University of China, miaomeng@ruc.edu.cn.

[‡]Smith School of Business, Queen's University, wwang@queensu.ca.

[§]School of Economics, Renmin University of China, zyzuo@ruc.edu.cn.

1 Introduction

Firms going public for the first time must receive regulatory approval before floating their stocks to investors. There is no exception for firms in China, which must obtain approval from the Securities Regulatory Commission of China (CSRC) for initial public offerings (IPOs). The entire process can take several years, and one of the most critical components is a short review meeting during which the firm and its underwriters answer questions posed by a seven-member review committee appointed by the CSRC. The committee will make a final decision on whether to approve the listing shortly after the meeting. The evaluation criteria are often obscure, and committee members are not held accountable for any errors they may make. The system is perceived as vulnerable to political influences and biases (Fan et al., 2007, Liu et al., 2013, Li and Zhou, 2015, Wang and Wu, 2020).

The capital city of China (Beijing, where the CSRC is located) has suffered from severe air pollution for years (Douglas et al., 2009, Chen et al., 2013). High densities of fine particulate matter are hazardous to human health and can affect the quality of high-stakes decision-making in several ways. First, air pollution lowers human cognitive capacity, which in turn reduces productivity (Ebenstein et al., 2016, Chang et al., 2016, Zhang et al., 2018). Second, air pollution imposes psychological pressure and depresses an individual's mood (Fonken et al., 2011, Bondy et al., 2020). Such effects can lead to biases and errors in decision-making (Heyes et al., 2016, Chang et al., 2018, Huang et al., 2020). In addition, individuals often have difficulty in navigating their daily routines on a hazy day and can be overwhelmed and exhausted, leading to a lack of efforts and attention to work.

In this study, we investigate whether transitory air pollution affects regulators' productivity and behavior and thus the effectiveness of their oversight in approving IPOs in China. We posit that air pollution has a deleterious effect on the CSRC review committee's decisions. Less-qualified firms successfully list their stocks due to lax regulatory oversight on polluted days, leading to substantial investor losses.

We construct a comprehensive sample of 1,531 IPOs between 2014 and 2020 using information from the CSMAR database. We obtain the names of the committee members for each review meeting, the names of the IPO firms, and the review decisions from the CSRC website. For each individual review member on each committee, we manually collect their full resume to determine the member's personal characteristics and professional background. Half of the review members are full-time employees of the CSRC, while the rest are affiliated with financial institutions, law firms, and academic institutions. We use levels of fine particulate matter (PM2.5), a pollutant that readily penetrates indoors, to measure air pollution that affects review members. The pollution data are collected from the air quality monitoring station that is closest to the CSRC.

Our analysis starts with a robust and ubiquitous finding: IPO approval rates are significantly higher on polluted days (i.e., days with a higher PM2.5 level) than on clear days. We find that every increase of 100 $\mu g/m^3$ in PM2.5 concentration during working hours on the review day leads to more than five percentage points higher approval probability, representing a 6% increase over the unconditional mean. Our baseline specifications include controls for the listing firm's characteristics; review members' personal attributes and professional backgrounds; weather conditions; and industry, province, and quarter fixed effects.

Two key identifying assumptions for our analysis hold in our setting. First, the review committee composition is randomly determined by the CSRC using a lottery system to ensure the homogeneous quality of the review team for each IPO, and thus there is no endogenous matching between committee member quality and firm quality. Furthermore, reviewers are not allowed to take a leave of absence on the day of the review under normal circumstances. Second, because the timing and the date of the IPO review are predetermined about one week before the review date and the correlation between PM2.5 levels on the review day and a week earlier is close to zero, it is impossible for members of the committee to know what the air quality will be on the review day and thus prepare questions differently ahead of time. Both conditions ensure that the pollution level does not capture unobservable firm quality or committee member heterogeneity.

Indeed, we find that almost all firm and review member characteristics are indifferent between polluted days and clear days.

Nonetheless, for robustness of our results, we first include seasonality fixed effects because air pollution is more severe in winter due to a coal-powered heating system (Douglas et al., 2009, Ito and Zhang, 2020), and the oversight may be more lax toward the end of the year. Second, because the coordinated environmental and economic policies, during either an economic stimulus period or an anti-pollution period, may give rise to a positive correlation between pollution levels and approval rates, we perform subsample tests after excluding the Chinese central government's economic stimulus period and pollution control period and find the same results. To further address potential omitted variable concerns, we perform placebo tests using PM2.5 levels observed at four other distant monitoring stations and the CSRC station, but during non-working hours. The results confirm that the effects of pollution are concentrated within the working hours of the review day as well as for the pollutants observed near the CSRC office. Finally, we perform 2SLS regressions using local wind speed as an instrumental variable. Wind helps to decrease PM2.5 rates, and wind speed is plausibly exogenous to review decisions, which take place indoors. We find that our instrumental regressions yield similar results.

Air pollution on the review day can intensify reviewers' feelings about the hazardous effects of air pollution on health. Hence, we hypothesize that reviewers would naturally loosen (tighten) the passing criteria for green (polluting) industries. We conduct heterogeneity tests by including the interaction between air pollution level and an indicator on whether the firm is in a polluting (versus green) industry. We find that firms operating in polluting industries have lower passing rates than non-polluting industries when the PM2.5 level is high on the review day. However, the coefficient estimate for the variable of interest itself, *PM2.5*, is similar to that in the baseline result. The evidence suggests that the salient effect, while important, is not the main driver for our results.

A natural interpretation for a higher IPO approval rate on polluted days is that the review committee is less productive due to health- and cognition-related reasons and thus approves IPOs that should not be approved. In this scenario, the lax regulatory oversight is detrimental to investors' wealth. Conversely, on non-polluted days, the review committee may be overly critical and reject qualified applications. A higher approval rate associated with air pollution helps marginal firms to raise capital to fund their investments. We examine post-IPO performance to substantiate the two different explanations. Our results show that IPOs approved on polluted days have lower profitability and worse market-adjusted stock returns within one year of listing. Importantly, our back-of-the-envelope calculation suggests that the total investor loss as a result of lax oversight by the review committee amounts to close to 48 billion RMB (USD$8 billion) between 2014 and 2020.

There are a few potential channels through which air pollution affects the decisions of review committees. The first mechanism relates to cognitive ability. Second, air pollution imposes psychological pressure and depresses an individual's mood, leading to errors in decision-making. Third, given the difficulty in navigating their daily routines on a hazy day, review members can be overwhelmed and exhausted and thus are unable to pay attention to their work. Although it is empirically challenging to test for one specific channel, we perform a few tests using the review transcripts and the review committee member heterogeneity to shed light on these potential channels.

First, we obtain questions raised by committee members in all available review sessions between February 2015 and December 2020 from the CSRC website. We use the latent Dirichlet allocation (LDA) model of natural language processing to extract the essence of each question raised during review sessions. We categorize all questions into two groups: complex questions, which require the reviewers to think deeply about the quality and development prospects of the company, and (simple) intuitive questions, which do not require in-depth thinking and analysis. We find that on days with high levels of pollution, committee members ask fewer, shorter, and less complex questions. More importantly, the committee members raise fewer follow-up questions within each topic after the main questions. The evidence reflects the deterioration of reviewers both physically and mentally, as follow-up questions rely more on improvisation than on preparation.

Second, we examine whether the effect of air pollution on decision-making is more salient for members with certain characteristics. Specifically, we expect the effect to be stronger for individuals who are older and likely in poorer health than younger individuals. In addition, we compare decisions made by local reviewers with decisions made by reviewers who are not from Beijing. We expect local committee members to have greater tolerance of air pollution than out-of-town members, who would be more susceptible to fatigue and poor decision-making due to high levels of pollution (Dong et al., 2021). Our firm-reviewer-level regressions show that the positive effect of air pollution on the approval rate is more pronounced for older committee members and members who are not from Beijing.

Finally, we explore whether the higher approval rate on polluted days is a manifestation of reviewers' lack of effort. We identify individuals who have strong observable incentives to exert effort. In particular, reviewers who are close to the end of their term and thus are up for reappointment should have stronger incentives to devote effort to the review. Firms reviewed by those reviewers are less likely to pass, especially on days with high pollution levels. Our firm-reviewer-level regressions confirm this intuition. We further show that our results are not driven by reviewers' levels of experience. The evidence suggests that the lack of effort helps explain reviewers' decisions on days with high pollution.

Our paper contributes to the literature on the effects of transitory air pollution on high-stakes decision-makers in the economic system. Earlier research identifies a causal link between air pollution and poor health outcomes and mood (Pope et al., 2002, Chay and Greenstone, 2003, Currie and Neidell, 2005). Naturally, many papers document that air pollution has significant effects on an individual's decision-making and behavior. For example, air pollution affects workers' productivity (Chang et al., 2016, 2019), judges' sentencing decisions (Kahn and Li, 2020, Hou and Wang, 2020), analysts' forecasts (Dong et al., 2021), and trading behaviors of fund managers and investors (Heyes et al., 2016, Huang et al., 2020, Wu et al., 2020, Li et al., 2021). At the extreme, pollution can make individuals measurably reckless and more likely to commit crimes (Burkhardt et al., 2019, Bondy et al., 2020). Pollution in immediate proximity to the workplace can cause companies to suffer from brain drain and the turnover of senior executives (Levine, Lin, and Wang, Levine et al., Xue et al., 2021, Wang et al., 2021).

Compared to prior studies, our paper provides insight on the detrimental effects of air pollution on the quality of financial regulation. We identify a unique channel through which air pollution affects investors and financial markets. Moreover, given a number of studies on the effects of climate on human cognitive capacity, mood, and behavior (e.g., Loewenstein, 2000, Lu and Chou, 2012, Goetzmann et al., 2015, Dehaan et al., 2017, Heyes and Saberian, 2019), our study suggests that air pollution, as one of the important factors contributing to climate change, has far-reaching effects on capital markets.

Our paper also adds to the literature on the importance of regulatory oversight and the factors that contribute to oversight failure. Regulatory oversight is important for not only safeguarding investors' interest but also ensuring the efficient functioning of financial markets.[1] Oversight failure, which can be due to regulators' resource constraints and biases (Cox et al., 2003, Coffee, 2007, Jackson and Roe, 2009, Correira, 2014), is costly to both investors and the financial markets as a whole. We show that reduced cognitive capacity and effort as a result of air pollution can directly affect the productivity of regulators, resulting in lax oversight that is costly to investors.

2 Background: IPO Approval in China

Firms in China are required to file for regulatory approval to the Securities Regulatory Commission of China (CSRC) to float their stocks on public exchanges. The requirement applies to firms for their listing on either the main board or the high-tech board (i.e., the growth enterprise board). The review process can take two and half years on average, up to a maximum of five years (Luo and Wang, 2013, Song and Xin, 2017). During this period, firms are required to modify application material periodically and to provide supplementary information. Although the procedure can be complex, much of the success of a firm's IPO approval, in fact, depends on the outcome of a Q&A session organized by a formal review committee appointed by the CSRC.[2]

[1]The U.S. Securities and Exchange Commission (SEC), for example, has a three-part mission: protect investors; maintain fair, orderly, and efficient markets; and facilitate capital formation (Source: https://www.investor.gov/introduction-investing/investing-basics/role-sec).

[2]By requirement, the review session should last for 45 minutes. In practice, however, extensions are quite common.

During the review session, a group of experts asks questions of the IPO firm and its underwriters and decides whether to approve the IPO application. A review committee typically consists of seven members, randomly chosen from an expert pool of more than 60 members.[3] Half of the members in that pool are officials working at the CSRC, and the rest are professionals working at financial intermediaries such as securities brokerages, accounting firms, and law firms, as well as academics affiliated with a reputable university (see Appendix Table 2 for details on the composition). Each committee member serves a two-year term, with the possibility of reappointment.[4]

The committee members receive a firm's application material one week ahead of the review session so they may familiarize themselves with the firm's situation. During the review session, the committee generally puts forward three to four big questions after examining the submitted material, with each of them consisting of sub-questions and follow-up questions. After the Q&A session with the firm, the committee reaches a final decision, which is released on the same day. There are four possible outcomes: pass, suspension of voting, review cancellation, and non-approval.[5] Firms need consent from five out of seven members to receive formal approval. Other than a straight pass, the remaining three outcomes are considered failed attempts and require the firm to resubmit the application for approval within the next six months.

The review process is often viewed as subjective because there are no clear criteria or detailed explanations for a decision made by the review committee. The committee typically provides one or two brief reasons for a non-pass decision. But the reasons for rejection are often inadequate or weak.[6] It is important to note that the decision made by the review committee is final and cannot be appealed. Moreover, there are no institutions that provide substantial oversight on the decisions made by committees.

[3] In a 2017 reform on the rules of the IPO review committee of the CSRC, the composition of each review committee was changed from fixed to random, with the members of each review committee chosen by lottery.

[4] The committee members taking office in 2014 finished their terms in 2017 because of the reform.

[5] "Suspension of voting" means a decision will be made in a month. Firms with "review cancellation" and "non-approval" need to resubmit their application materials with substantial revision within six months.

[6] For example, the reason given can be vague, such as "the independence of the firm is in question," "the operational situation of the firm will change dramatically," or "the informational disclosure of the firm is not standardized."

3 Data Sample

3.1 IPO Approval

Our primary data source for IPO filings and approvals is the CSMAR database, one of China's most prominent financial and economic data providers. Our sample consists of 1446 IPO applicants that completed their review sessions between 2014 and 2020, and exclude those observations with missing financial data. For IPOs that were rejected for their first review, we include their multiple reviews, so the number of observations is greater than number of firms. An IPO is regarded as a "pass" if the committee's decision is a straight pass and the remaining three outcomes, including suspension of voting, review cancellation, and non-approval, are noted as failed attempt. Table 2 summarizes the review outcomes by year of review meetings. The approval rate varies from year to year, and the regulation was tightened after 2017.

Detailed information about the review sessions, including the names of the committee members, the names of the IPO firms, and the review decisions, is obtained directly from CSRC. We hand-collect the resumes of the committee members either from their previous employers or from Baidu baike (Chinese Wikipedia). The information collected includes gender, age, education, year of office, professional background, tenure at CSRC, and whether they serve at the CSRC in a full-time capacity.

We obtain the transcripts of the review sessions, which include questions raised by the committee members. All questions were made public for IPOs after 2015, available from CSMAR. However, the identities of the reviewers for specific questions raised during the review are not published. That is, we know what questions are raised but do not know who raised them.

3.2 Air pollution and weather

We obtain air quality monitoring data from the official website of the Ministry of Environmental Protection of China. The agency provides the pollutant concentration ($\mu g/m^3$) in the air for every hour at various monitoring points across several regions in Beijing. We calculate the average hourly PM2.5 levels between 8:00 a.m. and 6:00 pm, a period that covers both working hours and commuting hours. We consider air pollution during commuting hours, in addition to working hours, because pollution during commuting hours should affect the cognitive ability and health of committee members. Specifically, we use air quality data from the monitoring station located in North Xizhimen, the nearest station (approximately 1.5 kilometers) to CSRC, as a measure of the degree of pollution that affects committee members.[7] We also collect data from other monitoring sites from different districts of Beijing (Chaoyang, Shijingshan, Daxing and Haidian) for robustness tests. The geographical locations of the monitoring points are shown in Figure 1. In addition, we obtain other hourly city-level weather data, such as temperature, precipitation, and wind speed, from meteorological station reports.

It is important to note that indoor air quality is directly affected by outdoor air quality in the absence of air purifiers. In China, offices of government officials are required to meet the Government Office Space Standards issued by the National Development and Reform Commission. These standards require offices to be "simple, economical, applicable and resource-saving" and provide detailed standards for basic facilities such as lighting, cooling, and heating systems. Air purifiers are not included in the standard provisions in government offices. To the best of our knowledge, no such facilities exist in the CRSC meeting room, despite the December 2019 proposal by the National Health Commission to equip offices with indoor air purifiers.

3.3 Control variables

We control for a variety of characteristics that may affect IPO approval rates. Considering that IPO firms must disclose their financial information at least three years before the review, we control for a company's financial performance three years prior to the review session (Wang et al., 2021), including total sales, leverage, net profit margin, current ratio, and the share of intangibles. Moreover, we use dummy variables to control for ownership of the firm, whether it is a state-

[7] It is worth pointing out that all the reviews are held at a fixed location, in one of the CSRC's conference rooms. Even during the COVID-19 pandemic in 2020 when firms were reviewed online, the committee members gathered in the conference room to review, ask questions, and vote.

owned enterprise (SOE) or a foreign-funded enterprise (foreign). Firm ownership and financial information are from WIND and CSMAR.

Many studies document that weather conditions affect high-stakes decisions and human behaviors (e.g., Saunders, 1993, Hirshleifer and Shumway, 2003, Loughran and Schultz, 2003, Dehaan et al., 2017, Heyes and Saberian, 2019, Li and Patel, 2021). We therefore control for weather conditions by constructing two variables for the review day: average daily temperature and an indicator variable for whether it rained that day. In addition, we control for average review committee member characteristics such as gender, experience, full-time employee status at the CSRC, and postgraduate degrees. All variables are defined in Table 1.

3.4 Summary statistics

Table 3 presents the summary statistics of our study sample. Our main dependent variable is an indicator for a firm passing the IPO review (*1[Passing review]*), and the independent variable of interest is the air pollution level measured by hourly average PM2.5 level at the nearest monitoring station to the CSRC head office between 8:00 a.m. and 6:00 p.m. on the review day (*PM2.5*).

We find that most IPO firms (more than 80%) pass the review. This suggests that the review committees are in general quite lenient toward IPO applicants. The average pollution level in Beijing on IPO review days during our sample period is 56 $\mu g/m^3$, more than 11 times the annual mean value worldwide 5 $\mu g/m^3$, according to the World Health Organization. The maximum PM 2.5 value is as high as 584 $\mu g/m^3$. Such severe air pollution would significantly affect the physical and mental health of human beings. In Panel B, we show PM2.5 statistics from other parts of Beijing (PM2.5 of East, West, North, and South Beijing) and during non-working hours, between 20:00 p.m. and 12:00 a.m. (night) and between 12:00 a.m. and 5:00 a.m. (dawn). We find a similar pattern. In contrast, the PM2.5 level of the city where the IPO applicant is headquartered is significantly lower than that of Beijing. This is consistent with the fact that Beijing is one of China's most polluted cities. Panel B further shows that the average temperature on review days is 13 degrees Celsius and the average wind speed is 2.6 meters per second, a typical weather condition for northern China.

In Panel C, we report summary statistics of IPO firms. Overall, only 7.9% of firms are state-owned enterprises (SOEs). The average total assets of those listed firms is 16 billion RMB. There is a large variation in the size of the listed firms, with the largest firm's total assets at 9 trillion RMB and the smallest firm's assets at 150 million RMB. We use the natural logarithm value of the total sales to measure firm size. Despite being quite profitable before IPO, the listed firms experience sharp declines in their profitability after IPO. Specifically, ROE declines by 10 percentage points. The decline in performance is also reflected in decreased post-IPO EPS and the negative cumulative abnormal return (CAR).

Panel D shows statistics of the committee members' questions during the review session. The review committee asks on average 15.5 questions that cover 3.5 topics, averaging 4.4 questions for each topic. Some of the questions raised under the same topics are follow-up questions, requesting the applicants to clarify or complement their previous answers. Moreover, we find that a large share, 45%, of questions are relatively complex. Such questions are often related to firms' business risk and profit source. In Panel E, we present the characteristics of the review committee members. We find that the average age of these reviewers is 43.6, about a quarter are women, 88% are full-time employees of the CSRC, and over 46% have a bachelor's degree. They served an average of 1.5 sessions as reviewers.

4 Main Results

In this section, we first perform our baseline analysis that relates the probability of IPO passing to the level of air pollution on the review day. We present a comprehensive set of robustness tests, including placebo tests and instrumental variable (IV) regressions using local wind speed as an instrument for air pollution. We then explore firm heterogeneity to investigate whether the effect of air pollution on IPO passing rate is more pronounced for firms operating in polluting industries.

To shed light on the quality and efficiency of the decision-making of the review committee, we examine post-IPO performance to compare profitability and stock returns of firms whose IPOs are approved on polluted days and those whose IPOs were approved on clear days.

4.1 Baseline results

To investigate the impact of air pollution on the probability of a firm passing an IPO review, we conduct regressions with the following specification:

$$1[Passing\ review]_{i,t} = \beta PM2.5_{i,t} + \delta \mathrm{X}_{i,t} + \mu_i + \gamma_i + \theta_t + \epsilon_{i,t} \quad (1)$$

$1[Passing\ review]_{i,t}$ is a dummy variable that equals one if the IPO applicant passes the review, and zero otherwise. $PM2.5_{i,t}$ represents the average hourly pollution level of PM2.5 from 8:00 a.m. to 6:00 p.m. on the day of the review session at North Xizhimen station, the nearest monitoring point to the CSRC. We scale the PM2.5 value by 100 to help the interpretation of the regression results. X_i is a variety of firm characteristics control variables, including the SOE dummy, foreign firm dummy, profitability, leverage, intangible asset ratio, current ratio, ROE, firm size, and temperature and whether it rained on the review day. μ_i and γ_i represent industry fixed effects and province fixed effects, respectively. They capture any IPO-related regulations that target firms in certain sectors or provinces. For instance, real estate firms are not allowed to issue equity in the domestic market. θ_t represents the calendar quarter fixed effects of the review session, which captures the time-varying economic and market conditions. For instance, the government is not likely to approve new IPOs if the economic growth slows down or stock market value is low, with the concern that new floated stocks would further decrease the index price. $\epsilon_{i,t}$ is the heteroscedasticity-adjusted residual term. The coefficient β measures the effect of air pollution on IPO success.

A key identifying assumption for our study is that the date for IPO review is not endogenously determined by CSRC based on firm or review member characteristics, and the extent of the air pollution that will be present on the day of their review cannot be predicted on the IPO assignment date. First, because the timing and the date of the IPO review are determined about one week before the review date, CSRC cannot predict whether there will be heavy air pollution on the day of the review. Second, the reviewer committee composition is randomly determined through a lottery system to ensure the homogeneous quality of the review team for each IPO, and thus there is no endogenous matching between committee member quality and air quality. Furthermore, the reviewer members are not allowed to take a leave of absence on the day of the review. Both conditions ensure that the pollution level does not capture unobservables related to committee quality.

Nonetheless, an informative test is to compare both firm characteristics and review member characteristics for IPOs reviewed on hazy days versus clear days. Table 4, Panel A, shows that there are no significant differences in firm-level characteristics between firms reviewed on polluted days and those reviewed on clear days, except for firms' leverage. In Panel B of Table 4, we tabulate the patterns of review member characteristics. Again, we find no systematic differences between committee members on a polluted day and a clear day.

Table 5 shows the baseline results using specification 3. Column (1) includes firm-level controls, environment measures, and various fixed effects, while the other specifications include additional review committee membership measures and review committee chairman fixed effects. Column (1) shows that firms are more likely to pass the IPO review on polluted days than clear days. The coefficient estimates suggest that for every 100-point increase in PM2.5 concentration, the probability of a firm passing IPO review increases by more than five percentage points.

Despite no significant difference in committee characteristics between polluted days and clear days, one can argue that the pollution level may be correlated with unobservable characteristics of the committee. Note that we cannot include committee fixed effects because committee members are randomly picked and thus are not fixed for each IPO review. We instead include committee chairman fixed effects in columns (2)–(6). The chairman of the committee is usually a reputable official in the CSRC who plays a critical leadership role and enjoys disproportional power in shaping the final review decisions of the committee. Column (2) shows that the addition of the committee member characteristics and chairman fixed effects do not affect the coefficient estimate of $PM2.5$.

Air pollution in northern China is more severe during winter than other seasons due to burning of coal for heating (Chen et al., 2013). Moreover, committee members may be in a celebratory moody and become more lenient at the end of a year. As a result, the relation of pollution level and passing rate could be driven by seasonality. We address this concern by controlling for an additional month fixed effect (i.e. January, February, etc.). Column (3) presents the results. The coefficient estimate remains unchanged.

Also of concern for spurious correlation are the coordinated policies stipulated by the central Chinese government, which tries to ensure that all policies from its various departments are coordinated and cohesive. For instance, during a stimulus period, when the government is determined to boost its economic growth rate, the CSRC would relax its review standards and allow more firms to float their stocks. At the same time, environmental protection agencies may be ordered to tolerate a higher level of pollution in exchange for growth. To capture the effects of these coordinated government policies, we exclude IPO observations during the economic stimulus period between 2014 and 2016 in column (4). In column (5), we exclude the environmental protection period between 2014 and 2017, when strict anti-pollution measures were released in Beijing. With a much smaller sample, the coefficient for $PM2.5$, indicating statistical significance at the 5% or level and magnitude, is almost twice that in the first two specifications.

To ensure that our results are not driven by extreme values in pollution in the sample, we also employ an indicator variable of high pollution in our analysis, and the result is similar. Furthermore, we decompose the review days into four groups according to PM2.5 level, as defined by the Ministry of Environmental Protection of China: excellent (<35$\mu g/m^3$), good (35–75 $\mu g/m^3$), lightly polluted (75–115 $\mu g/m^3$), heavily polluted (115–150 $\mu g/m^3$), and extremely polluted (>150 $\mu g/m^3$). Consistent with our hypothesis, we find a monotone relationship between air pollution and passing rate in column (7). When air quality is defined as good, the passing rate is indistinguishable from the rate observed on the days when air pollution rates are excellent (the omitted category). However, the passing rate is 1.8, 7.1, and 14.2 percentage points higher when air quality is lightly polluted, heavily polluted, and extremely polluted, respectively, than the passing rate on days with excellent air quality.

Figure 2 graphically demonstrates the positive relationship between PM2.5 and firm passing rate by year. Each dashed or dotted line in the figure represents the fitted line of the effect of air pollution on the passing rate for all IPO applicants within a year. The solid line in the middle represents the fitted line using all observations. Overall, there is a clear positive relation between air pollution level and the passing rate when air pollution levels are high by year, although the relation is stronger in some years than in other years. The evidence helps mitigate the concern that the pollution–pass rate relation is driven by certain observations that are clustered over a short period of time.

4.2 Placebo tests

A remaining concern for the positive relation of air pollution and the IPO passing rate is that the PM2.5 measure may capture some city-time specific heterogeneity. For example, it is possible that air pollution coincides with traffic jams, cancellation of events, or other policy changes by the city that may affect the mood and attitude of the review committee members. That is, it is not the pollution but rather other concurrent events in Beijing on the review day that affect the approval decision. To address this concern, we conduct placebo tests using air pollution levels at four other monitoring stations that are in the far east, west, north, and south of Beijing and using pollution levels measured during non-working hours at the North Xizhimen station. Table 6 presents the results.

In column (1), we find that the coefficient for PM2.5 is statistically significant at the 5% level, while none of the pollution measures at four other monitoring stations is statistically significant. Column (2) shows results when air pollution measured at night and dawn is included. Both measures are statistically insignificant. The results confirm that it is indeed the pollution level recorded closest to the review committee that affects the IPO review decision.

Local pollution is a dynamic process affected by numerous meteorological factors, such as wind and rain, and therefore PM2.5 levels can be somewhat persistent.[8] To show that our findings are primarily driven by the pollution level on the review day, we perform a test using PM2.5 measures on different days around the review day. Figure 3 plots the mean and the 99% confidence interval of the coefficient estimate for $PM2.5$ on the review day as well as on five lagged and five leaped days around the review date (i.e., from five days before to five days after the official review). It shows that only the coefficient for PM2.5 measured on the day of the review session is significantly positive at the 5% level. The pollution levels before or after that have no significant impact on the review committee's decision.

We also examine whether our results are driven by the effects of air pollution on reviewees (i.e., the management team and underwriters) rather than reviewers. A firm's CEO and CFO typically attend the review session, accompanied by their underwriters. Given the importance of the review session, the reviewees devote considerable time to preparing and rehearsing their presentation. Moreover, if air pollution has a negative effect on reviewees' presentation performance, we would expect a lower rather than higher passing rate. However, an institutional change has allowed us to address this concern. Starting in January 2020, the review sessions were moved online due to the COVID-19 pandemic. This means that during the review session, although reviewers are still assembled at the CSRC in Beijing, the reviewees are in the city where the firm is located. Appendix Table 3 shows that any effects on review outcomes would only be related to the review committee members, not the firm and its underwriters.

4.3 Instrumental variables analysis

Although we make several attempts to account for omitted variables that drive both the air pollution and the passing rate, we cannot exhaust all possibilities. For a final robustness test, we follow prior studies (Bondy et al., 2020, Li et al., 2021) to use the natural logarithm of local wind

[8] The autocorrelation of the air pollution between the review date, one day before, and one day after the established review day is about 0.4.

speed as an instrumental variable (IV) for air pollution. The intuition is that a strong wind can effectively dilute the pollutant density in the air, thereby decreasing the PM2.5 level. When compared to other weather conditions, such as rain and snow, wind is plausibly the most effective way in decreasing local pollution, and it is exogenous. More importantly, wind speed satisfies the exclusion restriction. It is hard to imagine that the wind could cause the review decision directly, as all the review sessions take place indoors.

Specifically, we conduct the first-stage regression with the following specification:

$$PM2.5_{i,t} = \beta lnWindspeed_{i,t} + \delta X_{i,t} + \mu_i + \gamma_i + \theta_i + \epsilon_{i,t} \tag{2}$$

In the above specification, $\text{Windspeed}_{i,t}$ is the average wind speed during the working hours of the review day. The data on wind speed in Beijing are from China's meteorological network.

The first-stage result of the instrumental variable regression is reported in column (1) of Table 7. Consistent with our expectations, the PM2.5 concentration decreases by 0.153 when the wind speed increases by one standard deviation on the review day itself, with both statistical and economic significance. The F-statistic is above 34, much greater than the rule-of-thumb level of 10, suggesting that the weak instrument problem is not a major concern in our setup.

As wind speed is mainly determined by meteorological factors, it is unlikely to affect the firms' IPO review through channels other than PM2.5. A self-selection effect is also unlikely to exist. Since the company and committee memberships are decided a week prior to review, it is extremely hard, if at all possible, to predict wind speed at the time. To verify this intuition, we check the correlation between wind speed and a variety of firm- and committee-level characteristics such as a firm's profitability and size, and the committee member's work experience at the CSRC, education, and professional background. Not surprisingly, all characteristics have a low and insignificant correlation with the wind speed on the review day and the day before.

Using wind speed on the day of review and one day prior as an instrument, in column (2) we find that the coefficient for PM2.5 is positive and significant. The fact that the coefficient is more than twice its original size suggests an underestimation of our OLS result. The IV estimation further confirms our baseline result.

4.4 Firm heterogeneity

One potential explanation for the decrease in the applicants' passing rate during polluted days is the salient effect from the reviewers' perspective. On hazy days, reviewers are more likely to perceive the hazards of air pollution and therefore become more stringent (lenient) toward firms in polluting (green) industries. Such a tilt in attitude may directly affect the average passing rate and cause the difference in passing rate between polluted and non-polluted days. While the industry fixed effects could have captured the impact of polluting and green industries on the passing rate, this misses the additional effects of the air pollution.

The polluting industries categorization is from the "Environmental Protection Verification of Listed Companies" issued by the Ministry of Ecology and Environment of China. The following industries are defined as heavy polluting industries: mining, quarrying, and oil and gas extraction; textiles, leather, fur, feather, and their products; shoes; paper and paper products; oil processing and cooking; nuclear fuel processing; chemical raw materials and chemical products manufacturing; chemical fibers; rubber and plastic products; non-metallic mineral products; ferrous metal smelting and rolling; non-ferrous metal smelting and rolling; electric power and heat. The environmental ("green") industries include the following sectors: ecological protection and environmental management; research and experimental development; science and technology and application services; professional technology services; waste management; building decoration; and other construction industries.

We include the interaction of air pollution and the polluting (or green) industry dummy in our baseline specification. Table 8 shows that, as expected, the coefficients of the interaction for polluting (green) industries are negative (positive). Importantly, we find that the coefficient of PM2.5, the main independent variable of interest, stays quantitatively the same compared with the baseline result. The evidence suggests that although air pollution on the review day may intensify reviewers' perception of the hazardous effects of air pollution on health, the salient effect is not the main driving factor for our findings.

4.5 Post-IPO performance

Our results thus far demonstrate that firms are more likely to pass their review and float their stocks on polluted days than on non-polluted days. However, the economic implication of our finding is not clear. On the hand, the review committee may be overly harsh on approving IPOs on average, tending to over-reject "good" IPOs. A higher approval rate associated with air pollution helps marginal firms raise capital to fund their investments, which boosts economic growth. On the other hand, the review committee is not productive on polluted days, leading them to approve IPOs that should not be approved. The lax oversight by the review committee can be detrimental to investors. To shed light on the quality of firms that receive IPO approval on polluted days and the economic implications, we examine post-IPO performance.

We examine three firm-level post-IPO operating performance measures and stock returns using the following OLS regression:

$$Y_{i,t} = \beta PM2.5_{i,t} + \delta \mathrm{X}_{i,t} + \mu_i + \gamma_i + \theta_i + \epsilon_{i,t} \tag{3}$$

$\mathrm{Y}_{i,t}$ represents performance. The three operating performance measures include *Profit margin*, which is the change in net profit margin, ROE, and EPS within three years after IPO. The stock performance measure is the one-year cumulative abnormal stock return deducting the stock market return calculated from the Shanghai Shenzhen Composite 300 Index. We include the same set of control variables and fixed effects as in our baseline regression. The results are presented in Table 9.

We find that the coefficients for air pollution are negative in all four columns, suggesting that firms that pass their review on hazy days perform worse ex post. In particular, investors who buy stocks on their first day of trading lose 5.3% of their investments relative to the market index in the year after the IPO. Figure 4 provides a graphic illustration. Although IPO firms perform poorly on average, consistent with prior literature (Ritter and Loughran, 1995, Brav and Gompers, 1997), IPOs approved on polluted days perform much worse than those approved on clear days.

We conduct the following back-of-the-envelope calculation to quantify the scale of investors' losses on hazy days. The economic value can be expressed as the product of both the change in the firm's pass rate due to air pollution and the firm's economic performance after passing its review. This value can be expressed as follows:

$$\Delta\{1[\text{Passing review}]\} \times [1^{\text{st}} \text{ year } CAR]$$

$\Delta\{1[\text{Passing review }]\}$ is the changes in passing rate during the smoggy days. $[1^{\text{st}} \text{ year } CAR]$ is the firm's CAR during the first year after its IPO.

The estimate from Column (2) of Table 5 shows that for every 100-point increase in PM2.5 concentration, the passing rate increases by 5.3 percentage points. The estimate from Column (4) of Table 9 suggests that firms on average are associated with a 5.3% shrink in their capitalization during the first year after IPO. Given an average market cap of 16.33 billion RMB [9], and 1,041 listed firms included in our sample, the effect of air pollution results in approximately 47.7 billion RMB losses between 2014 and 2020.

5 Exploring Economic Mechanisms

Our main analysis shows that the worsening of air quality significantly affects the behavior of CSRC committee members, causing them to relax their passing standards. In this section, we explore the mechanisms for our main findings.

There are a few potential channels through which air pollution can affect the IPO committee members' review and decision on IPO approval. First, the existing literature suggests that air pollution lowers cognitive performance and therefore decreases the quality of decision-making. Air pollution creates a hazardous working environment and can thus directly affect committee

[9]The statistics are from the China 2017 A-share Stock Market Report.

members' health and cognitive abilities, leading to poor decision-making. Second, air pollution and hazy weather conditions impose psychological pressure and depress individuals' mood. Such effect can be manifested in reviewers' reluctance to work, or they may get work done fast but with a high rate of error. Similarly, poor air quality may prompt individuals to make changes to their daily routines (e.g., keeping children home from school, canceling social events, etc.). The immediate effect is that individuals may feel overwhelmed (i.e., busy) due to the extra efforts required to manage their day and thus do not pay enough attention to their daily work.

It is empirically challenging to test for one channel against the other because all forces could be at work. Nonetheless, we perform a textual analysis of the review transcripts and heterogeneity tests using review members' characteristics to shed light on these potential channels.

5.1 Textual analysis of IPO review questions

To analyze the review content, we obtain transcripts of all available review sessions from the CSRC website in all review meetings between February 2015 and December 2020, and summarize the topic of each individual question. We apply topic modeling with the latent Dirichlet allocation (LDA), an advanced textual analysis technique that extracts underlying topics in a set of documents according to the estimated distribution and correlation of words. Appendix A provides details of the model.

We categorize all questions into eight main topics according to found keywords. We then sort the eight topics into two major groups: complex and (simple) intuitive questions, according to Zhang et al. (2020). Complex questions require the reviewers to think deeply about the quality and development prospects of the company, including business risk, profitability, shareholders, and related transactions. Intuitive questions, on the other hand, do not require in-depth thinking, and include simple inquiries based on existing information. Such topics may include accounts receivable, main business, and accounting standards, for example.

Preparing complex questions and raising follow-up questions on the spot require committee members to stay sharp and make judgments during the review session. As a result, air pollution that impairs committee members' physical and mental conditions could significantly affect the questions raised and thus the review results. Table 10 shows that the total number of questions decreases during polluted days. Moreover, the results are driven mainly by the decreases in the number of follow-up questions within each topic, rather than the total number of topics. This reflects the deterioration of physical and mental conditions of the reviewers, as the follow-up questions, instead of the topics, rely more on improvisation than preparation. We also find that the share of complex questions requiring reviewers to make serious thinking decreases, indicating that the reviewers are less capable of processing complicated information when air pollution is severe. The evidence suggests that reviewers' cognitive capability is negatively affected by air pollution.

5.2 Review members' sensitivity to pollution

If the relaxation of review standards is directly caused by lower cognitive capacity among committee members on average, the extent of the effect on cognitive ability can vary by individual members' characteristics. Specifically, we expect stronger effects among members who are more likely to be affected by pollution—that is, those in poor health (having preexisting health conditions related to respiratory systems, for example) and those who are less adapted to air pollution.

To explore the impact of each individual reviewer's characteristics on the approval decision, we conduct the analysis at the reviewer-firm level. Without detailed information on reviewers' voting results, we categorize each reviewer as voting yes if the firm passes the review session and as voting no if the firm fails. Considering that firms usually need five votes to pass, this method could potentially polarize the voting results, especially when the firm fails. In practice, however, reviewers usually share their opinions openly before making the final decision, such that most voting results are unanimous.

We first consider the effect of the reviewer's origins. We make a plausible assumption following prior studies (Dong et al., 2021): reviewers who are new to Beijing would experience significantly greater difficulty in adjusting, mentally and physically, to air pollution than local reviewers, whose past exposure to pollution helps them to adapt to the hazardous environment.[10] In Table 11, column (1), we present results by including the interaction of an indicator for reviewer members' past exposure to pollution and PM2.5. We find that non-local reviewers show a significant reaction to air pollution. In addition, we use reviewers' age as a proxy for health conditions—older reviewers are assumed to be more sensitive to air pollution than younger reviewers. The result in Table 11 column (2) confirms this conjecture. Elder reviewers' stronger reactions suggest that air pollution's effect on firms' passing rate is most likely due to its detrimental impact on reviewers' physical and mental conditions.

5.3 Incentives of reappointment

Because hazy weather conditions can impose psychological pressure on individuals and extra efforts are taken to prepare for their daily routines, reviewers are reluctant to work or pay enough attention to their tasks. Although it is empirically challenging to pin down this channel, we provide suggestive evidence by examining review members' incentives.

Review members who are close to the end of their term have stronger incentive for performance, as it is closely linked with whether they will be reappointed for another two-year term. The coefficient in column (1) of Table 12 suggests that the incentives do matter for decreasing the passing rate during hazy days. One compounding factor is that reviewers approaching the end of their tenures may be more experienced. In column (2), we further control for review members' experience, measured as the number of terms, to alleviate the concern that our results are a manifestation of their experience rather than reappointment incentives. The coefficient is almost intact, suggesting that the reviewers' attention to work due to incentives for reappointment can mitigate the negative impact of air pollution.

[10]Note that most of the non-Beijing residents typically come to the city to take their positions at the CSRC. As a result, their stay in Beijing is usually too short of a time to allow them to get used to the pollution.

6 Conclusion

In this paper, we investigate the impact of air pollution on China's initial public offering approval process. We find that the IPO passing rate on polluted days in Beijing is five percentage points higher than on non-polluted days. There is no effect when air pollution is measured during non-working hours or far from the workplace of the reviewers, the Securities Regulatory Commission of China. An analysis of the post-IPO performance shows that IPOs approved on polluted days have worse operating performance and stock returns than those approved on clear days. Exploring potential channels, we find that reviewers ask fewer, shorter, and less complex questions, and they are less likely to ask follow-up questions on polluted days. The effect is more pronounced when the review committee is composed of older members and members who are not from the capital city but less salient for teams whose members are up for reelection.

Our results show that air pollution has an effect on the cognitive ability and behavioral biases of regulators. Less-qualified firms go public as a result of lax regulatory oversight on polluted days. Our back-of-the-envelope calculation using stock returns suggests that investors' wealth losses amount to close to $47.7 billion RMB. Our findings highlight an important channel through which air pollution has real effects on investors and financial markets.

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Figure 1: Location of PM2.5 monitoring stations in the central districts of Beijing

This figure shows the locations of monitoring stations in the six central districts of Beijing. The star signifies the location of the CSRC. The circle indicates the monitoring station for baseline analysis, and the plus sign indicates placebo tests.

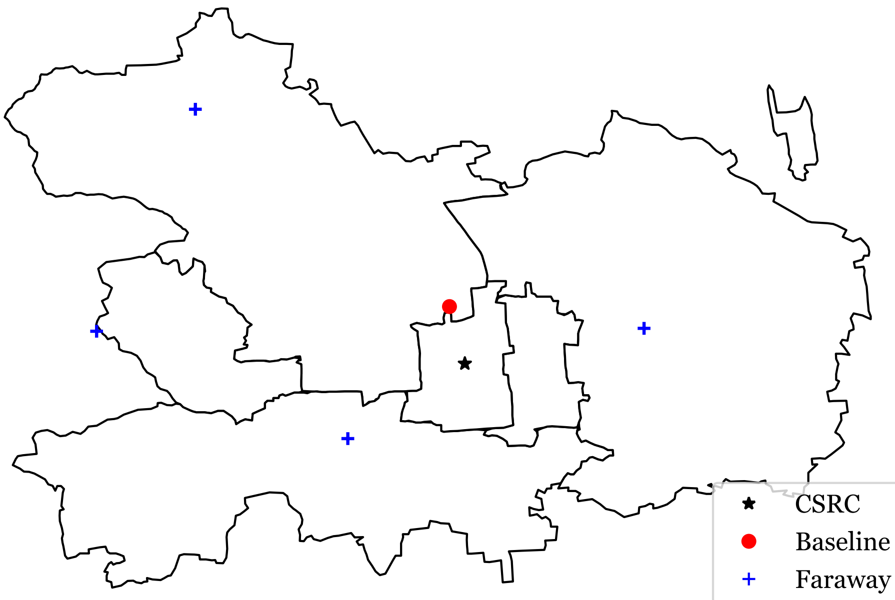


Figure 2: Yearly correlation of PM2.5 on pass rate during 2014–2020

This figure shows the correlation of PM2.5 and pass rate from 2014 to 2020.

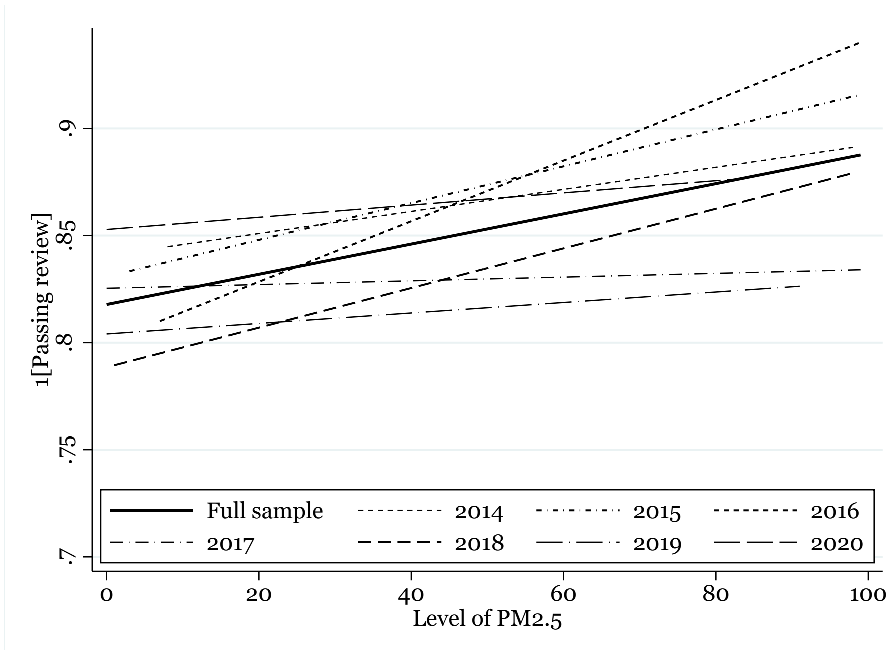


Figure 3: Dynamic effects of PM2.5

The figure shows how the coefficient estimates of PM2.5 vary with the number of days relative to the conference. Each point indicates the point estimate including the full set of controls and lead and lagged PM2.5 levels. The whiskers show the 99% confidence interval of each coefficient estimate.

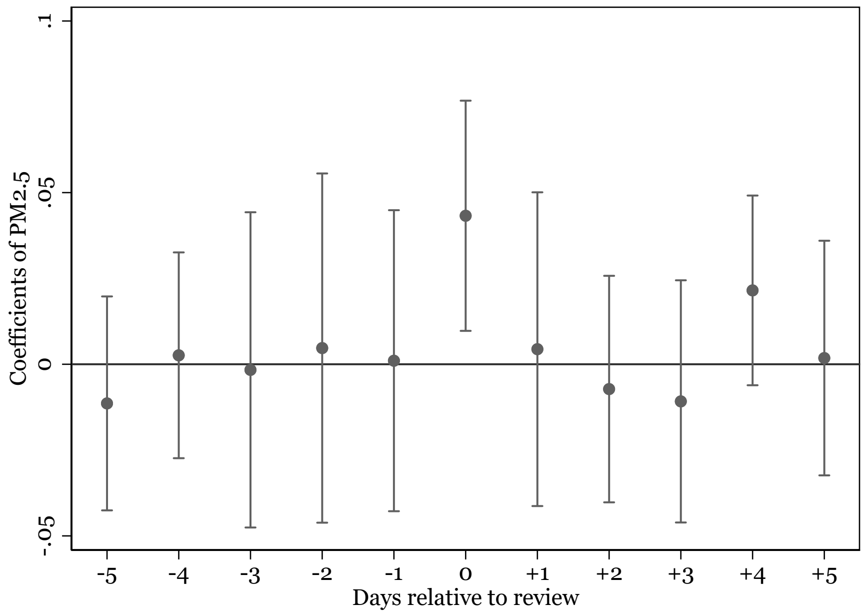


Figure 4: Average stock performance one year after IPO

The figure shows the average cumulative abnormal returns (adjusted by market return) by pollution groups.

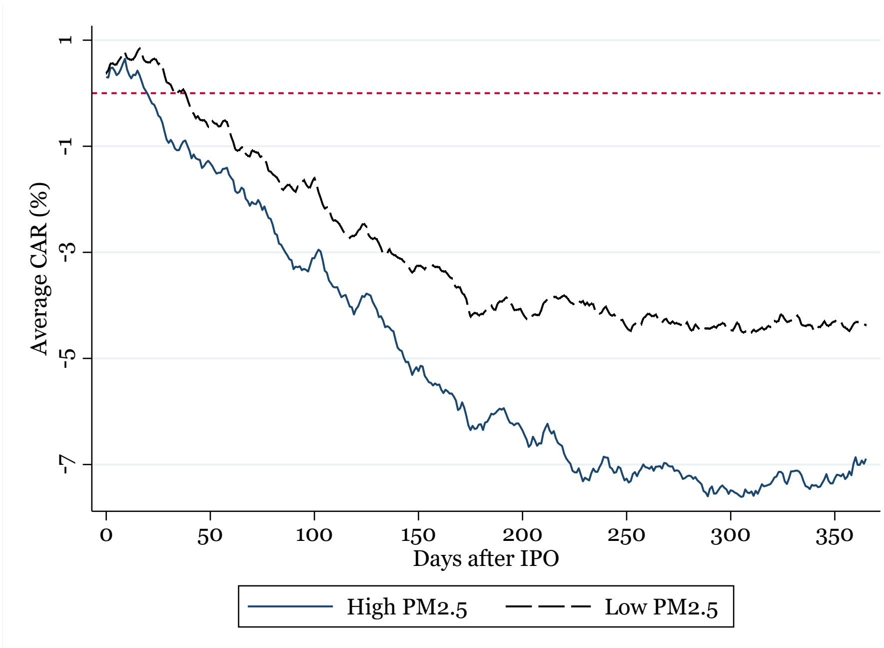


Table 1: Variable descriptions

This table presents definitions of all variables used in the analysis.

Variables:	Description
	Panel A. Key variables
1[Passing review]	1 if firm passes the approval of IPO
PM2.5	Level of PM2.5 around CSRC during working time 8:00-18:00 ($\mu g/m^3$)
1[High pollution]	1 if level of PM2.5 is larger than 75$\mu g/m^3$, defined as high pollution by the Ministry of Environmental Protection of China
	Panel B. Air pollution and weather
PM2.5_East Beijing	Level of PM2.5 in Chaoyang district during working time ($\mu g/m^3$)
PM2.5_West Beijing	Level of PM2.5 in Shijingshan district during working time ($\mu g/m^3$)
PM2.5_South Beijing	Level of PM2.5 in Daxing district during working time ($\mu g/m^3$)
PM2.5_North Beijing	Level of PM2.5 in Haidian district during working time ($\mu g/m^3$)
PM2.5_night	Level of PM2.5 around CSRC during night 20:00-24:00 ($\mu g/m^3$)
PM2.5_dawn	Level of PM2.5 around CSRC during dawn 0:00-5:00 ($\mu g/m^3$)
PM2.5_Firm	Level of PM2.5 in firm's registration city during working time ($\mu g/m^3$)
Temperature	Temperature around CSRC during working time (Degree Celsus)
1[Rain]	1 if precipitation is larger than 0 around CSRC
Windspeed	Wind speed around CSRC during working time (m/s)
	Panel C. Firm characteristics
Assets	Average total assets within 3 years prior to the meeting (Billion RMB)
Sales	Average total sales within 3 years prior to the meeting (Billion RMB)
Profitability	Average net profit margin 3 years prior to the meeting
Leverage	Average leverage ratio within 3 years prior to the meeting
Intangibles	Average intangibles ratio within 3 years prior to the meeting
CurrentRatio	Average current ratio within 3 years prior to the meeting
1[SOE]	1 if firm is state-owned
1[Foreign]	1 if firm is foreign-owned
1[FirstReview]	1 if firm is reviewed by committee for the first time.
Diff [Profit Margin]	Net profit margin difference between 3 years post-IPO and 3 years pre-IPO
Diff [ROE]	ROE difference between 3 years post-IPO and 3 years pre-IPO
Diff [EPS]	EPS difference between 3 years post-IPO and 3 years pre-IPO
Market-adjusted 1yr CAR	1 year cumulative abnormal stock return adjusted by market return.
	Panel D. Questions raised on the meeting
Total number of questions	Total number of questions
Length of questions	Total number of Chinese characters of questions
Number of topics	Number of paragraphs of questions, usually each paragraph a separate topic.
Number of Follow-up questions	Calculated by Total number/Number of topics
1[Complex > Intuitive questions]	1 if there are more complex questions than intuitive questions. Complex and intuitive are defined by question topics generated by LDA topic model.
Complex questions (%)	Percentage of complex questions.
	Panel E. Member characteristics
1[Female]	1 if member is female
1[Fulltime]	1 if member is a full-time CSRC employee
1[Bachelor]	1 if member has at least a bachelor degree.
Experience	Term of the member
Age	Age of the member
1[Non-Beijing Resident]	1 if member's workplace is outside Beijing
1[Elder]	1 if member's age is above median.
1[Before reappointment]	1 if the review is held before reappointment to committee

Table 2: Summary of review outcomes

This table shows the summary of review outcomes by year. "Suspension of voting" means a decision will be made in a month. Firms with "cancellation of the review" and "non-approval" need to resubmit their application materials with substantial revision in six months.

Year	N	Approval	Non-approval	Cancellation of the review	Suspension of voting
2014	107	93.46%	4.67%	0.93%	0.93%
2015	229	92.14%	4.80%	0.87%	2.18%
2016	256	92.19%	5.08%	1.17%	1.56%
2017	442	79.41%	14.71%	1.36%	4.52%
2018	170	62.94%	22.94%	10.00%	4.12%
2019	131	60.31%	34.35%	4.58%	0.76%
2020	196	95.92%	0.51%	1.53%	2.04%
All	1531	83.08%	11.69%	2.48%	2.74%

Table 3: Summary Statistics

This table presents summary statistics of all variables used in the analysis. All variables are defined in Table 1.

Variables:	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(50)	Pctl(75)	Max
Panel A. Key variables								
1[Passing review]	1,531	0.831	0.375	0	1	1	1	1
PM2.5	1,531	56.3	61.4	3.0	17.5	36.3	74.0	584.9
1[High Pollution]	1,531	0.240	0.427	0	0	0	0	1
Panel B. Air pollution and weather								
PM2.5_East Beijing	1,531	60.2	63.2	2.0	19.2	40.1	79.9	430.0
PM2.5_West Beijing	1,531	57.8	64.6	4.6	18.9	37.6	73.3	615.1
PM2.5_South Beijing	1,531	61.7	70.5	2.2	17.9	39.1	75.8	510.4
PM2.5_North Beijing	1,531	44.6	42.6	4.7	15.5	30.3	59.1	290.8
PM2.5_night	1,531	73.8	85.8	2.0	23.7	48.7	90.4	605.3
PM2.5_dawn	1,531	66.1	77.3	3.0	20.0	43.8	81.0	620.0
PM2.5_Firm	1,136	43.3	34.6	3.7	20.4	33.6	53.7	329.5
Temperature	1,531	13.050	11.500	-12.230	1.673	14.270	24.060	34.150
1[Rain]	1,531	0.272	0.445	0	0	0	1	1
Windspeed	1,531	2.655	1.329	0.727	1.727	2.364	3.182	8.364
Panel C. Firm characteristics								
Assets (in Billion RMB)	1,531	16.330	255.300	0.149	0.481	0.842	1.580	9532.000
Sales (in Billion RMB)	1,531	1.620	9.784	0.042	0.264	0.524	1.059	295.100
Profitability	1,531	0.154	0.117	-0.073	0.083	0.129	0.202	1.133
Leverage	1,531	0.415	0.212	0.000	0.272	0.403	0.535	1.000
Intangibles	1,531	0.0482	0.0511	0	0.0134	0.0382	0.0666	0.524
CurrentRatio	1,531	2.319	2.306	0.000	1.280	1.773	2.625	42.000
1[SOE]	1,531	0.079	0.270	0	0	0	0	1
1[Foreign]	1,531	0.034	0.181	0	0	0	0	1
1[FirstReview]	1,531	0.944	0.229	0	1	1	1	1
Diff [Profit Margin]	1,203	0.055	0.197	-1.611	-0.029	0.021	0.099	2.589
Diff [ROE]	1,203	-10.810	9.636	-64.900	-15.370	-9.547	-4.977	23.810
Diff [EPS]	1,133	-0.134	0.507	-2.550	-0.346	-0.157	0.050	4.000
Market-adjusted 1yr CAR	1,041	-0.055	0.600	-0.767	-0.347	-0.148	0.050	6.376
Panel D. Questions raised on the meeting								
Total number of questions	1,178	15.540	8.024	0	8	15	22	35
Length of questions	1,178	767	372	0	454	772	1,056	1,865
Number of topics	1,178	3.517	1.231	0	3	4	4	8
Number of follow-up questions	1,177	4.406	1.840	0.750	3	4.400	5.667	14.500
1[Complex > Intuitive questions]	1,177	0.349	0.477	0	0	0	1	1
Complex questions (%)	1,177	0.454	0.287	0	0.250	0.500	0.667	1
Panel E. Member characteristics								
1[Female]	9,186	0.247	0.431	0	0	0	0	1
1[Fulltime]	9,186	0.880	0.325	0	1	1	1	1
1[Bachelor]	9,186	0.456	0.498	0	0	0	1	1
Experience	9,186	1.509	0.733	1	1	1	2	5
Age	4,275	43.600	3.780	37	41	44	46	55
1[Non-Beijing Resident]	9,186	0.705	0.456	0	0	1	1	1
1[Elder]	4,275	0.466	0.499	0	0	0	1	1
1[Before reappointment]	9,186	0.013	0.113	0	0	0	0	1

Table 4: Balance test

This table shows the balance test of the sample mean and p-value of the mean difference at the firm level, and shows both firm characteristics in Panel A and member characteristics in Panel B. Low pollution is defined as 1 if PM2.5 is below the median for that year. The definitions of variable are listed in Table 1.

	Low pollution		*High pollution*		*Diff (Low-High)*	*p-value*
	N	Mean	N	Mean		
Panel A. Firm characteristics						
Assets (in Billion RMB)	776	12.289	755	20.482	-8.193	0.53
Sales (in Billion RMB)	776	1.324	755	1.924	-0.601	0.230
Profitability	776	0.157	755	0.152	0.005	0.388
Leverage	776	0.424	755	0.405	0.019	0.084*
Intangibles	776	0.049	755	0.047	0.002	0.456
CurrentRatio	776	2.41	755	2.226	0.184	0.118
1[SOE]	776	0.068	755	0.09	-0.022	0.115
1[Foreign]	776	0.03	755	0.038	-0.009	0.344
1[FirstReview]	776	0.938	755	0.951	-0.013	0.273
Panel B. Member characteristics						
1[Female]_mean	776	0.267	755	0.245	0.022	0.118
1[Fulltime]_mean	776	0.872	755	0.877	-0.006	0.587
1[Bachelor]_mean	776	0.692	755	0.674	0.018	0.550
Experience_mean	776	1.312	755	1.321	-0.009	0.69
Age_mean	312	44.183	313	44.222	-0.039	0.857

Table 5: Baseline Results

This table presents the baseline regression results. The dependent variable takes the value of one if the review decision on an IPO review is passed and zero otherwise. PM2.5 is the level of PM2.5 around the CSRC headquarters (scaled by 100). Column (1) examines the relationship between PM2.5 and pass rate. Columns (2) and (3) include member controls and month fixed effects. Column (4) and (5) excludes samples during the policy stimulus period and the era with tight pollution control. Column (6) uses indicator of high pollution, and column (7) includes dummy variables within groups of PM2.5. All regressions include control variables, as well as industry, province, and quarter fixed effects. Standard errors are clustered by industry-year, and reported below the regression coefficients. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable: 1[Passing review]						
	Baseline	Member Controls	Month FE	Excluding Stimulus period	Excluding Pollution Control Period	High pollution	Intensity
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
PM2.5	0.051***	0.053***	0.049***	0.080***	0.079**		
	(0.011)	(0.010)	(0.009)	(0.016)	(0.031)		
1[High Pollution]						0.068***	
						(0.017)	
PM2.5 (35-75)							-0.007
							(0.024)
PM2.5 (75-115)							0.018
							(0.025)
PM2.5 (115-150)							0.071***
							(0.021)
PM2.5 (>150)							0.142***
							(0.038)
lnSales	0.067***	0.063***	0.063***	0.063***	0.075***	0.064***	0.063***
	(0.011)	(0.010)	(0.010)	(0.011)	(0.018)	(0.010)	(0.010)
Profitability	0.648***	0.629***	0.608***	0.649***	0.984***	0.629***	0.621***
	(0.136)	(0.134)	(0.134)	(0.169)	(0.218)	(0.133)	(0.134)
Leverage	0.098*	0.108**	0.107**	0.072	0.054	0.106**	0.105**
	(0.052)	(0.047)	(0.048)	(0.061)	(0.085)	(0.047)	(0.047)
Intangibles	0.942***	0.930***	0.963***	0.976***	0.685	0.930***	0.912***
	(0.163)	(0.159)	(0.168)	(0.253)	(0.452)	(0.160)	(0.159)
CurrentRatio	-0.002	-0.001	-0.001	-0.005	-0.003	-0.001	-0.001
	(0.003)	(0.004)	(0.004)	(0.006)	(0.004)	(0.004)	(0.004)
1[SOE]	-0.017	-0.023	-0.034	0.038	0.122**	-0.022	-0.022
	(0.026)	(0.028)	(0.028)	(0.039)	(0.056)	(0.028)	(0.028)
1[Foreign]	-0.016	-0.009	-0.008	-0.015	0.028	-0.010	-0.011
	(0.041)	(0.039)	(0.037)	(0.053)	(0.048)	(0.040)	(0.039)
1[FirstReview]	-0.049	-0.067*	-0.062*	-0.055	-0.012	-0.070**	-0.067*
	(0.030)	(0.034)	(0.033)	(0.039)	(0.045)	(0.035)	(0.035)
Temperature	0.001	0.002	0.002	0.002	0.003	0.002	0.002
	(0.001)	(0.001)	(0.003)	(0.002)	(0.002)	(0.001)	(0.001)
1[Rain]	0.045**	0.044**	0.030	0.055*	0.051	0.045**	0.042*
	(0.020)	(0.022)	(0.025)	(0.031)	(0.073)	(0.021)	(0.021)
1[Female]_mean		0.021	0.018	0.052	0.130	0.024	0.019
		(0.041)	(0.039)	(0.054)	(0.100)	(0.041)	(0.042)
1[Fulltime]_mean		-0.158	-0.163	-0.591***		-0.163	-0.159
		(0.102)	(0.113)	(0.207)		(0.102)	(0.103)
1[Bachelor]_mean		-0.015	-0.017	-0.018	-0.045	-0.015	-0.015
		(0.013)	(0.014)	(0.018)	(0.033)	(0.013)	(0.013)
Experience_mean		0.082***	0.092***	0.101***	0.131	0.079***	0.083***
		(0.025)	(0.027)	(0.033)	(0.130)	(0.024)	(0.024)
Industry FE	Y	Y	Y	Y	Y	Y	Y
Province FE	Y	Y	Y	Y	Y	Y	Y
Quarter FE	Y	Y	Y	Y	Y	Y	Y
Chairman FE		Y	Y	Y	Y	Y	Y
Observations	1,531	1,526	1,525	936	488	1,526	1,526
Adjusted R-squared	0.324	0.324	0.325	0.344	0.461	0.323	0.325

Table 6: Effect of PM2.5 with different distance and period

This table shows the effect of PM2.5 at different locations and time periods. Column (1) includes PM2.5 at faraway stations in six central districts in Beijing as shown in Figure 1, and column (2) during different periods at the baseline station. The variable definitions are listed in Table 1. All regressions include control variables, as well as industry, province, quarter, and chairman fixed effects. Standard errors are clustered by industry-year, and reported below the regression coefficients. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable: 1[Passing review]		
	Distance	Time
	(1)	(2)
PM2.5	0.108**	0.042***
	(0.046)	(0.015)
PM2.5_East Beijing	-0.008	
	(0.038)	
PM2.5_West Beijing	-0.053	
	(0.045)	
PM2.5_South Beijing	0.006	
	(0.024)	
PM2.5_North Beijing	0.005	
	(0.021)	
PM2.5_night		0.030
		(0.020)
PM2.5_dawn		-0.014
		(0.024)
Control variables	Y	Y
Industry FE	Y	Y
Province FE	Y	Y
Quarter FE	Y	Y
Chairman FE	Y	Y
Observations	1,526	1,526
Adjusted R-squared	0.323	0.325

Table 7: Instrumental variable analysis

This table presents the result from IV identification. Column (1) shows stage 1 results with the level of PM2.5 as a dependent variable, and column (2) shows 2SLS results. lnWindspeed is defined as natural logarithm of the average windspeed on review day, and other variable definitions are listed in Table 1. All regressions include control variables, as well as industry, province, quarter, and chairman fixed effects. Standard errors are clustered by industry-year, and reported below the regression coefficients. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	1st stage	2nd stage
	(1)	(2)
lnWindspeed	-0.379***	
	(0.065)	
PM2.5		0.141**
		(0.066)
Control variables	Y	Y
Industry FE	Y	Y
Province FE	Y	Y
Quarter FE	Y	Y
Chairman FE	Y	Y
Observations	1,526	1,526
Adjusted R-squared	0.206	-
F-stat	34.08***	

Table 8: Effect on firms from pollution or environmental industry

This table presents the result of heterogeneity analysis. Columns (1)–(2) show the effect on firms from pollution industries, and columns (3)–(4) show the effect on those from environmental-friendly industries. All regressions include control variables, as well as industry, province, quarter, and chairman fixed effects. Standard errors are clustered by industry-year, and reported below the regression coefficients. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable: 1[Passing review]				
Key Indicator:	Pollution		Environmental	
	(1)	(2)	(3)	(4)
1[High Pollution]	0.068***	0.086***	0.068***	0.055***
	(0.018)	(0.023)	(0.018)	(0.019)
Key Indicator	-0.007	0.019	0.024	-0.008
	(0.021)	(0.031)	(0.081)	(0.084)
1[High Pollution] * Key Indicator		-0.126**		0.159**
		(0.063)		(0.077)
Control variables	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Province FE	Y	Y	Y	Y
Quarter FE	Y	Y	Y	Y
Chairman FE	Y	Y	Y	Y
Observations	1,526	1,526	1,526	1,526
Adjusted R-squared	0.323	0.325	0.323	0.325

Table 9: Firm performance

This table presents the post-IPO performance of the firms reviewed on polluted days. The dependent variables of columns (1)–(4) are the average change in net profit margin, ROE, EPS, and one-year cumulative abnormal return (adjusted by market return). The variable definitions are listed in Table 1. All regressions include control variables, as well as industry, province, quarter, and chairman fixed effects. Standard errors are clustered by industry-year, reported below the regression coefficients. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable:	Profit Margin	ROE	EPS	1yr CAR
	(1)	(2)	(3)	(4)
PM2.5	-0.016*	-0.631*	-0.034*	-0.053***
	(0.009)	(0.370)	(0.019)	(0.018)
Control variables	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Province FE	Y	Y	Y	Y
Quarter FE	Y	Y	Y	Y
Chairman FE	Y	Y	Y	Y
Observations	1,196	1,196	1,126	1,034
Adjusted R-squared	0.0825	0.185	0.0487	0.141

Table 10: Mechanism: Fewer and Less complex questions

The table shows how pollution affects the number and types of inquiry questions raised during the meeting. Columns (1)–(4) discuss the impact on the number of questions, and (5)–(6) show the complexity. The variable definitions are listed in Table 1. All regressions include control variables, as well as industry, province, quarter, and chairman fixed effects. Standard errors are clustered by industry-year, and reported below the regression coefficients. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable:	Total number of questions	Length of questions	Number of topics	Number of follow-up questions	1[Complex > Intuitive questions]	Complex questions (%)
	(1)	(2)	(3)	(4)	(5)	(6)
PM2.5	-0.460*	-34.730***	-0.009	-0.142**	-0.054**	-0.032***
	(0.259)	(10.933)	(0.061)	(0.060)	(0.022)	(0.010)
Control variables	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y
Province FE	Y	Y	Y	Y	Y	Y
Quarter FE	Y	Y	Y	Y	Y	Y
Chairman FE	Y	Y	Y	Y	Y	Y
Observations	1,173	1,173	1,173	1,172	1,172	1,172
Adjusted R-squared	0.564	0.564	0.564	0.564	0.0862	0.0723

Table 11: Member heterogeneity: worse health condition

The table presents heterogeneous effects on members' health conditions. Columns (1) and (2) includes the interaction term of PM2.5 and the dummy variable indicating whether (1) the member used to work in Beijing before becoming a CSRC reviewer, or (2) the member is older than sample median. All regressions include control variables, as well as industry, province, quarter, and chairman fixed effects. Standard errors are clustered by industry-year, reported below the regression coefficients. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable: 1[Passing review]		
Key Indicator:	Non-Beijing Resident	Elder
	(1)	(2)
1[High Pollution]	0.049***	0.037**
	(0.016)	(0.015)
Key Indicator	-0.011*	-0.014**
	(0.005)	(0.006)
1[High Pollution] * Key Indicator	0.024**	0.031**
	(0.011)	(0.013)
Control variables	Y	Y
Industry FE	Y	Y
Province FE	Y	Y
Quarter FE	Y	Y
Chairman FE	Y	Y
Observations	9,186	4,270
Adjusted R-squared	0.346	0.507

Table 12: Member heterogeneity: Incentive of reappointment

The table presents heterogeneous effects by members' incentives. Columns (1) and (2) include the interaction term of PM2.5 and the dummy variable indicating whether the conference is held just before a member's committee reappointment, and column (2) controls for the interaction with members' experience, i.e., the number of terms a member has been on the committee. All regressions include control variables, as well as industry, province, quarter, and chairman fixed effects. Standard errors are clustered by industry-year, reported below the regression coefficients. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

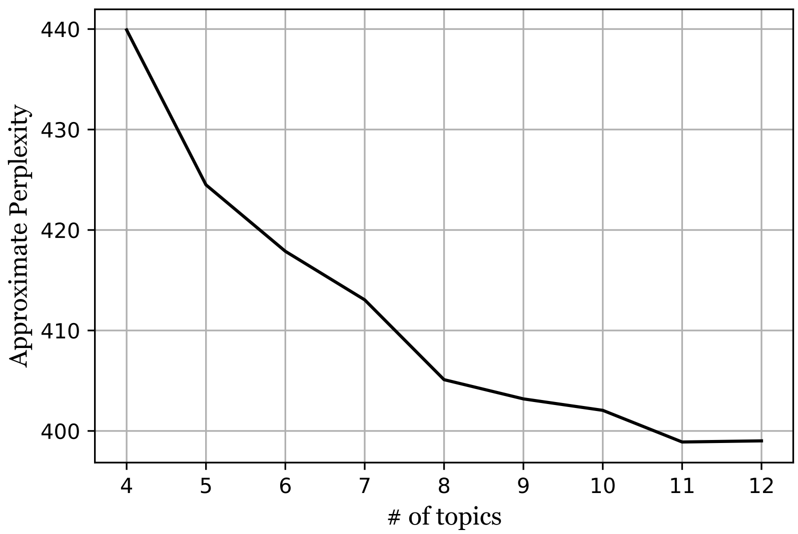
Dependent variable: 1[Passing review]		
Key Indicator:	1[Before reappointment]	
	(1)	(2)
1[High Pollution]	0.066***	0.082***
	(0.017)	(0.030)
Key Indicator	0.022	0.022
	(0.030)	(0.030)
1[High Pollution] * Key Indicator	-0.085**	-0.085**
	(0.039)	(0.039)
Experience		-0.000
		(0.003)
1[High Pollution] * Key Indicator		-0.010
		(0.010)
Control variables	Y	Y
Industry FE	Y	Y
Province FE	Y	Y
Quarter FE	Y	Y
Chairman FE	Y	Y
Observations	9,186	9,186
Adjusted R-squared	0.345	0.345

Appendix A: Applying LDA to review questions

In order to enable the topic model to convey as much information as possible, we pre-processed the text before using the LDA algorithm following several steps: 1. Remove the samples recorded as "no questions," and samples with question length in the 1% and 99% percentiles; 2. Remove all numbers and punctuation marks in the text; 3. Apply word segmentation package (*jieba*) to separate Chinese words. Unlike Latin languages, Chinese has no spaces between words, hence requiring word dictionary and segmentation to process the text. We add some additional financial terms[11] to the defined dictionary. 4. Remove the stop words in the text with the Chinese stop words table, which sorted out a total of 740 frequently used functional words, mainly including adverbs (e.g., some, especially, why) and conjunctions (e.g., although, otherwise, but). 5. We also remove other functional words commonly used in the context of the review question, such as millions, description, above, etc., and remove all company names. 6. Keep only the words with the frequency of the top 2,000 (out of 14,509) for analysis.

These processes remove invalid information in the inquiry process, and improves the efficiency of the LDA algorithm, enabling it to summarize key question topics. Referring to the literature on text analysis algorithms, we determined the number of topics estimated by the model according to the Perplexity score. The lower the parameter, the higher the model's generalization ability and the better fitting degree of text. As can be seen from the figure, when the number of topics increases from 7 to 8, the score decreases sharply, so the number of topics is set to 8. The results of the LDA topic model include the probability distribution of all words in in all topics, as well as all topics in all questions. We define the topic of the question as the topic with the highest probability. Appendix Table 1 lists the top 20 keywords with the frequency of occurrence under the corresponding topic.

[11]The terms added include: information disclosure, controlling shareholder, independence, internal control, administrative penalty, business model, material change, shareholding structure, managerial board, core technology, investment project, raised funds, industrial policy, account receivables, and reporting period. In the default segmentation of *jieba* package, the length of the words is usually 2–3 characters in Chinese, so unless the above words are added separately, they will be processed into more than two words. For example, "information disclosure" is treated as "information" and "disclosure," which makes it difficult to express the meaning of the words themselves.



Appendix Figure 1: Perplexity score for different number of topics

Appendix Table 1: Question type, topics and key words

This table lists inquiry question topics generated by the LDA model. The model sorts questions into 8 topics and lists the frequency of words within each topic. We show the top 20 keywords here.

Type	Label	Keywords
Complex questions	Operating risk	Relevant, verification, production, existence, condition, representation, operation, opinion, impact, risk, material, system, validity, process, environmental protection, regulation, implementation, acquisition, use, compliance
	Profitability	Gross margin, reasons, reasonableness, verification, product, peer, comparable, representative, opinion, difference, above, principal, situation, decline, process, revenue, combination, clarity, variation, cost
	Shareholder	Verification, existence, shareholder, equity, actual controller, representative, opinion, transfer, relevant, cause, share, process, situation, investment, employee, holding, rationality, holding, clarity, enterprise
	Related transactions	Association, existence, transaction, related party, capital, fair, situation, verification, pricing, procurement, group, interest, reasonableness, cause, correlation, representation, opinion, relationship, loan, shareholder
Intuitive questions	Accounts Receivables	Condition, rerification, cause, effect, accounts receivable, operation, existence, revenue, representation, adequacy, risk, opinion, combination, continuance, provision, reasonableness, preparation, rerformance, inventory, material
	Main Business	Sales, customer, existence, distributor, check, condition, principal, cause, mode, rationality, purchase, supplier, representative, revenue, process, opinion, distribution, relationship, product, overseas
	Accounting standards	Verification, recognition, relevance, revenue, representation, situation, compliance, contract, project, opinion, regulation, enterprise, accounting standards, amount, accounting, existence, cause, treatment, process, performance
	Supply-chain	Business, presence, verification, major, customer, technology, representative, related, service, competition, opinion, situation, product, enterprise, risk, cooperation, R&D, industry, combination, supplier

Appendix Table 2: Composition of Committee Members

This table shows the composition of the review committee in our sample. Regulatory institutions include CSRC and its agencies, stock exchanges, and national ministries; market institutions include law firms, accounting firms, securities companies, fund companies, and insurance asset management companies; other institutions include universities and research institutions.

	Employment period	# of members	Regulatory institutions	Market institutions	Other institutions
16th	2014/5/23–2017/9/28	60	24	36	10
17th	2017/9/28–2019/1/29	63	39	16	8
18th	2019/1/29–present	21	13	8	0

Appendix Table 3: Effect of online review

The table shows whether the effect is changed during the online review. Column (1) and (2) include the PM2.5 level of the firm's city, and their interaction term with an online review. All regressions include control variables, as well as industry, province, quarter and chairman fixed effects. Standard errors are clustered by industry-year, and reported below the regression coefficients. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable: 1[Passing review]		
	(1)	(2)
PM2.5	0.062***	0.063***
	(0.012)	(0.013)
PM2.5_Firm	-0.008	-0.012
	(0.028)	(0.029)
Online review		-0.096
		(0.110)
PM2.5 * Online review		-0.084
		(0.085)
PM2.5_Firm * Online review		0.105
		(0.086)
Control variables	Y	Y
Industry FE	Y	Y
Province FE	Y	Y
Quarter FE	Y	Y
Chairman FE	Y	Y
Observations	1,125	1,125
Adjusted R-squared	0.293	0.292