Did Scrubbing the Government Clean Up the Air? Polluter Responses to China's Anticorruption Campaign

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Abstract

Do efforts to improve the quality of governance in a nation affect environmental outcomes? We investigate this question by studying whether a nationwide anticorruption campaign targeting government officials and industry leaders in mainland China affected local air quality. We exploit quasi-random variation in the timing of official investigations in cities across China to evaluate their effects on the polluting behavior of coal-fired power plants in the weeks surrounding investigation announcements. We report three main findings. First, we show striking short-term improvements in air quality around coal-fired power plants during the pre-investigation audit phase when polluting industry officials are targeted. Second, we find the magnitude of the improvement varies with the strength of the government's connection to emitting plant(s). Investigations of polluting industry leaders exhibit the strongest effect, while changes are generally not statistically significant for investigations of local officials (mayors and party secretaries). Third, we show that once an investigation is formally announced, air quality around plants returns to normal. Our findings lend new quantitative insight into the potential and limits of political scrutiny to reduce pollution in a rapidly-developing economy where compliance with formal environmental policy has been historically poor and uneven.

Keywords: firms, corruption, air quality, China

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1 Introduction

The environmental performance of industrial firms has been linked to a wide range of factors: stakeholder pressure [1, 2], regulations and associated costs [3], enforcement capacity and incentives [4, 5], transparency requirements [6], and firm characteristics [19], among others. While accountability to the state and society has been identified as an important mediator of a firm's environmental performance, most prior work has focused on developed country settings. In developing countries, the drivers of environmental protection behaviors in firms may be very different. An emphasis on short-run economic outcomes combined with weak authority of laws and regulations can complicate targeted policy efforts to improve environmental performance in these settings [7]. Despite strong environmental laws on the books, implementation of protective measures may be weak or uneven across firms [8, 9]. The relationship between the state and industry, as well as the influence of civil society, may also differ significantly between developed and developing country settings.

In this paper, we ask how variation in the strength of state scrutiny of local city officials and firm leaders over time affects the polluting behavior of firms. We find that increasing scrutiny can lead to surprisingly large, albeit temporary, improvements in local air quality that, if sustained, would be consistent with reductions required by official targets for 2017. To our knowledge, we provide the first empirical evidence of how changing political incentives affect environmental performance at the firm level over time in a rapidly developing country, disaggregating these effects at the level of weeks on either side of the announcement of an official anticorruption investigation. We find evidence that these effects can be large, albeit short lived.

While our characterization of how heightened state scrutiny affects polluter behavior may have broad relevance in other contexts, it is in its own right essential to understand how the dynamics of environmental performance work in mainland China, the world's largest fossil energy using and CO_2 emitting nation. China has a authoritarian government with a multi-layered governing bureaucracy, with a distinct set of governance channels relative to well-

studied contexts. Many of its urban centers suffer from severely-degraded air. Our results help to explain the types of short-lived improvements in air quality that follow concerted government efforts to clean up the environment in advance of flagship national events. For instance, air quality improvements were documented over short periods during the Olympics [10] and the Asia Pacific Economic Cooperation (APEC) Summit [11], before returning to its previously heavily polluted state. We contribute to an early research agenda that is starting to quantify how political incentives affect environmental pollution [12], and extends earlier literature on the contributions of regulatory regimes and stakeholder pressure in explaining firms' environmental performance to the Chinese institutional context [3, 2, 13]. We provide strong empirical evidence for what Chinese environmental scholars have long documented anecdotally—selective good behavior in response to short-term, top-down central government pressure, followed by a return to business-as-usual conditions [14, 15, 16, 17, 9]. However, past studies have focused almost exclusively on central environmental mandates, which would be expected to affect pollution. Our study advances a relatively young line of inquiry [12] that focuses on the role of political incentives, for which the predicted effect on environmental outcomes is more ambiguous.

Our analysis allows us to describe a new mechanism for explaining environmental performance as a consequence of a political campaign in a setting where state authority supersedes civil society, plausibly limiting traditional channels of stakeholder influence that have been well documented in developed countries [2]. Our results paint a picture of the state as an important firm stakeholder that can influence behavior over time depending on state priorities, attention, and scrutiny. Although we find that state scrutiny can be narrowly effective in improving environmental performance, it also has its limits. The improvements we document are generally not sustained beyond a few weeks. We discuss the possibility that short-term, high-cost compliance strategies do not destroy but simply defer productive (and polluting) activities in time, postponing and potentially exacerbating sustainability impacts. Our paper shifts the focus of search for effective air quality interventions from stable, static incentives

to recognizing their dynamic character and the need for public and private management strategies that operate on relevant time scales. While increasing scrutiny (what we later term the "microscope effect") might unlock large improvements, such strategies may only be workable precisely because they are short lived.

Finally, our findings at present are descriptive. To further understand the underlying mechanisms of air quality change as responses to the anticorruption campaign, we are currently incorporating results that resolve plant-level responses by ownership and oversight level.

The remainder of the paper is organized as follows. Section 2 situates our research in the literatures on law and society, management, and environmental economics. Section 3 describes our data and empirical setup. Section 4 presents our three main findings, using both empirical data and regression analysis. Section 5 draws several preliminary conclusions from our work thus far, and suggests future directions.

2 Literature

At the broadest level, this paper asks how temporally uneven state scrutiny affects the polluting behavior of industrial firms in a rapidly-growing developing country. Our paper advances the existing literature in two new directions. First, we focus on how the impact of heightened scrutiny varies as a function of the individual and/or organization targeted. Chinas anticorruption campaign investigated industry leaders as well as on local government officials. Our empirical setting thus allows us to isolate the effect of these distinct targets of scrutiny, as well as further differentiate effects based on the type of government official (mayor, party secretary, or other) or industry leader. Second, by aligning anticorruption events with air quality measures resolved at the level of weeks, we are able to detect effects on polluting behavior that would be obscured when using more conventional (e.g. annual) time scales. In the case of air quality, using annual averages can obscure not only large fluctuations

in emissions over time as a result of variation in the operation of control technology, but these large shifts are responsible for some of the most acute health consequences associated with degraded air. Taken together, our analysis reveals important institutional mechanisms that, quite apart from targeted policy initiatives focused on air quality, cause large shifts in an important local environmental outcome. In a setting where environmental policy is difficult to implement, these mechanisms could offer new control options.

The insights from our paper speak to three literatures: (1) research on the effectiveness of public organizations, law, and government bureaucracies within the Law and Society literature, (2) an emerging body of management scholarship focused on institutional explanations for the outcomes of mandatory and voluntary environmental initiatives, and (3) the empirical economics literature that quantifies the impacts of environmental regulation on economic, pollution, and health dimensions. While our research is set in China, and our insights tell a story of how regulation operates in China, we feel that our insights may be cautiously generalized beyond this setting. The paragraphs that follow provide a (far too short) summary of the open questions in these literatures, as motivation for our analysis. Later, we draw on these distinct literatures to aid in the interpretation of our empirical findings.

Within the Law and Society literature, an important dimension is to what extent regulation accounts for the environmental behavior of firms. [3] show that "social license" pressure (particularly from local communities and activists) explains why firms at times exceed requirements for compliance, despite the additional costs. An implicit assumption in this work is that social license pressure is stable over time, and indeed the settings examined in most past work are liberal democracies with stable institutions and rule of law. A major open question is what mechanisms govern firm behavior in developing countries with very different state and business institutions that are constantly adapting to changing economic conditions. Understanding these, and what drives differences compared with better-understood Western contexts, will be important given that firm behavior in the largest, rapidly-growing economies will be critical to efforts to advance global environmental and population health.

Connecting to the Law and Society literature, management scholars have focused on explaining environmental decision-making in firms, driven by both state and private sources of pressure via both rules and norms. Also set mainly in Western contexts, this literature has elaborated how external stakeholder pressure, mediated by internal firm dynamics, explains environmental decision-making. [2] provides a framework for thinking about how characteristics of firms respond to stakeholder influences. [13] suggest that corporate departments prioritize environmental action in response to pressure imposed by their external stakeholders. Analysis to date has not considered the possibility of scrutiny and behavior changing over time.

The economics literature has largely taken an empirical approach to evaluating the impact of environmental policies on firms and the economy, as well as associated societal costs and benefits. This tradition includes work to quantify the effects of the regulatory pressure on firms [18], focusing on the Clean Air Act in the United States, and the influence of firm characteristics on responses [19]. The field has relatively recently entertained behavioral as well as rational cost explanations for behavior [20]. An emerging body of work in this area focuses on developing countries, largely focusing on the health effects of degraded air quality and the role of policy [21, 22, 23, 24]. A randomized controlled trial reported in [5] demonstrated the importance of incentivizing truthful reporting among third-party auditors evaluating compliance with environmental standards in a two in the Indian state of Gujarat. This work so far paints a picture of weak bureaucratic implementation capabilities, uneven enforcement, and unintended consequences for human development as prevailing in developing country settings.

Our work also connects with the literature on political incentives and outcomes in China. Prior studies have shown that environmental spending is uncorrelated with official promotion odds, while transportation infrastructure spending positively correlates with promotion [25]. Evidence that polluting behavior even increases the likelihood of promotion was found in [12]. Other work considers the relationship between corruption and environmental performance

in China. A large body of literature theorizes about the positive and negative impacts of corruption, but corruption is difficult to observe, making its impacts difficult to measure empirically. [26] find that over the period 1999 to 2012 increases in a province's corruption are correlated with higher SO_2 emissions, controlling for economic activity and energy use. Our work is the first to study the dynamics associated with changing political incentives on time scales that are meaningful for assessing acute human health consequences.

At the broadest level, our empirical setup asks how stronger state scrutiny of the behavior of government officials and industry leaders affects firm's environmental performance. We hypothesize that a firm's pollution will vary with (1) the strength of state scrutiny over time and (2) the extent of an investigated individual's ability to influence polluting firm behavior through agency relationships. We test the first hypothesis by evaluating how pollution levels change over time, and in particular how they respond to an audit prepared immediately before an investigation is officially announced. We test the second hypothesis by comparing across official types, focusing on a comparison among city party secretaries, city mayors, industry leaders, and—as a control group—university professors investigated by the campaign. City party secretaries and mayors are the most senior of all the official types we investigate, in principle possessing authority to influence environmental behavior through issuing direct orders to firms or, in the case of mayors, via the local environmental protection bureau, which reports to the mayor's office. Annual performance evaluations conducted by the personnel department of the Chinese communist party evaluate both official types according to environmental criteria. Industry leaders are generally considered less senior relative to city officials. However, because they are part of the same business group or firm, these officials may be able to more directly influence behavior by through the layers of a single, more cohesive organizational reporting hierarchy By contrast, city officials must transmit instructions across the state-firm organizational boundary. Industry leaders, by their authority over operations, are arguably closer to decisions to pollute, or at least pollution could be among the criteria investigators might focus on in an audit. We expect

our results will be able to reveal the relative importance of these channels. We are currently also evaluating how specific accountability relationships (e.g. ownership, oversight) affect outcomes.

3 Data and Empirical Setup

Mainland China offers a uniquely rich opportunity for us to study the interaction between government scrutiny and pollution. In March 2014, China's Prime Minister Li Keqiang declared a War on Air Pollution, signaling a policy of zero tolerance toward government officials and industry leaders who were found to be polluting the environment. At the same time, central leaders were in the process of launching a nationwide anticorruption campaign, its scope, targeting a wide variety of leaders with communist party appointments. Leaders from industry as well as every level of Chinas state hierarchy were among those investigated. Investigations occurred for a wide variety of reasons; none of the investigations we consider was explicitly prompted by environmental violations. Reasons given for investigation ranged from misappropriation of funds to taking bribes to immoral behavior. Our empirical design benefits from the fact that officials suspected of corruption were subject to a standardized audit process. It is the external pressure to behave well during this audit process that we exploit to examine the effect of government scrutiny on polluter behavior.

3.1 China's anticorruption campaign: An overview

President Xi Jinping launched a nationwide anticorruption campaign after taking office in 2012, characterized as the most sweeping of its kind in at least 25 years [26]. It has since targeted officials and industry leaders across every province in China, both powerful "tigers" and mundane "flies." Unlike prior campaigns, nearly every city in China had one or more officials investigated and removed from the office and/or had their Communist Party membership revoked over the past four years. The campaign began with the release of eight

governance principles (the "Eight-Point Regulation"), which have since been used as the benchmark for assigning culpability.

Scholars debate the motivation behind the campaign, with some seeing its ultimate aim as removing political enemies [27], while others find evidence that it is an effort to promote meritocratic principles of governance [28, 26]. Given that the campaign is relatively recent, only limited scholarly work has been conducted to characterize its rationale, targets, and impact. We rely heavily on official government documents and news articles published in Chinese and overseas outlets to describe the program here. Individuals are targeted by the campaign for a variety of reasons. Behavior at odds with the "Eight-Point Regulation" issued by President Xi can become cause for an inquiry. Inquiries lead almost without exception to official investigation and conviction.

3.2 Data

We assemble a data set that covers the full period of Chinas national anticorruption campaign, spanning the period from late 2013 through 2016. These data allow us to match the time line of anticorruption investigations to observations of air quality at the week level. To our knowledge, no data set of this kind has been assembled previously.

3.2.1 Investigated officials

We scrape all of the names, official positions, resumes (including hometown, age, and prior work experience), and dates of investigation and removal (defined at the day/month/year level) from the Chinese Commission on Discipline and Inspection website (http://www.ccdi.gov.cn/) for six Chinese provinces (Hebei, Shanxi, Hubei, Guangdong, Shandong, and Henan), which are all large industrial provinces spanning both developed coastal urban centers and industrial bases. Information was scraped using Python code and manually checked for accuracy. Cases were cross-checked against a data base assembled from the ChinaFile web site (http://www.chinafile.com/). All inspections and removals recorded at least once in either source

were merged into the final data set.

3.2.2 Air quality

We assemble hourly air quality data for multiple pollutants (SO_2, NO_X, and $PM_{2.5}$) at the level of individual monitors, and average observations from multiple monitors at the city level. The monitor-level data with national coverage were only made widely available since 2013 based on observations from a monitoring network with national coverage. To reduce noise, we average air quality measurements at the weekly level. A limited number of missing observations are ignored when computing monitor and city weekly averages. We do not think that the missing observations are likely deliberate responses to anticorruption events, because most officials or industry leaders had no direct linkages to the local environmental monitoring bureau. Later, we use our data to empirically examine this concern.

3.3 Factors predicting city anticorruption investigations

In order to attribute a change in air quality to an anticorruption probe, the selection of targeted officials and the timing of investigation must be uncorrelated with factors that affect a city's environmental management. In our sample, 86 out of the 89 cities experienced an anti-corruption investigation at some point during 2012 to 2016, suggesting that virtually no city was left untouched. Table 1 shows the mean characteristics for all cities as well as by treatment and control groups, which, despite the small number of cities lacking investigations, are not different from one another in a statistical sense.

The small number of cities lacking an investigation leaves us to rely on the different timing of anticorruption investigations to distinguish the effects. Here we rely on evidence from official news outlets and statistical analysis that suggests the timing of investigations and removals was sequenced in a quasi-random fashion; we find no evidence of statistical differences in cities that were investigated in the first versus in the second half of the period. The distribution of anticorruption investigations over time is shown in Figure 1, and by

Table 1: Descriptive statistics for the 89 cities in the full sample, and the 86 cities with a corruption investigation.

Summary	All Cities		Cities with Invest		Cities without Invest	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Population (1000s)	5293	2817	5270	2823	5944	3111
GDP (billion CNY)	247.09	254.54	246.54	257.37	263.06	187.53
Per-capita GDP	46231	26388	46440	26721	40246	15414
SO_2 emissions(1,000 t)	67.18	47.54	67.21	47.51	66.3	59.1

official type in Table 2. There is some evidence of seasonality, although overall we find no clear pattern in the timing of investigations. Many cities experienced multiple investigations and removals. The order in which cities were investigated is determined by the central government. We find no correlation in the timing of investigations and removals across different official categories. If investigations were directed to the most corrupt areas first, and corruption is correlated with poor environmental management, then we might expect an attenuation of any effect on environmental measures over time. We remain vigilant to the possibility of these unobserved confounding factors when interpreting our results.

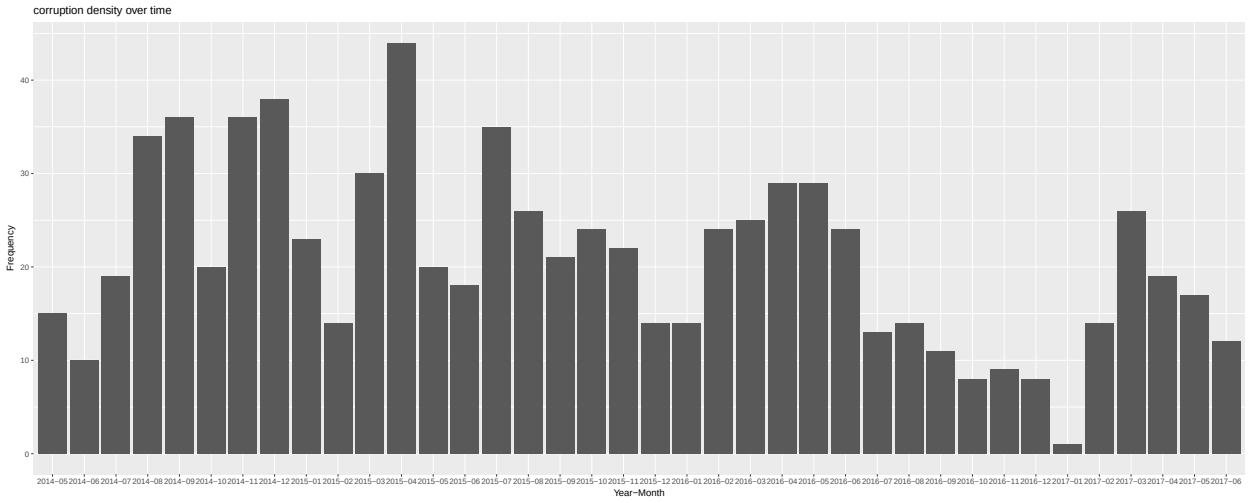


Figure 1: Distribution of anticorruption investigations for all official types over time.

Table 3 tests for the predictive effects of a set of factors on removals of various types of targeted individuals. Cities that had industry leaders of large polluting industry plants (size larger than 200 MW) or state-owned plants targeted tended to have slightly higher

Table 2: Corruption density over time for different investigated position types by month (columns) and year (rows).

GDP as well as SO_2 emissions. While significant, the coefficient magnitudes are relatively small. This is unsurprising because cities with large coal power plants will tend to be located in relatively large economic centers with higher GDP. Interestingly, mayors tend to be investigated in places where GDP growth is lower than other cities at statistically significant levels. This is consistent with a meritocratic explanation for the anticorruption campaign, if central officials were punishing cities for misusing power or funds at the expense of local growth [26]. Otherwise, we do not see strong evidence of city characteristics predicting the targeting of officials. The remaining statistically significant coefficients can be readily explained: polluting industry leaders are found in cities with slightly higher than average SO_2 emissions. Conditioning on leaders linked to large plants (capacity >200 MW) increases the magnitude of the coefficient, and increases significance for state-owned enterprises (SOEs). None of these differences is found to be large, and we control for city-specific variation in the fixed-effects regression specification described below.

3.4 Anticorruption case time line

Anticorruption cases proceed according to the "Regulations on the Inspection of Cases by the Discipline Inspection Committees of the Chinese Communist Party." These guidelines are to be strictly followed by the Central Commission for Discipline Inspection (CCDI) and local Commission for Discipline Inspection (CDI) branches. Cases proceed in stages. The first stage is "Acceptance and Preliminary Investigation." Tip-offs on the identity of officials in violation of published standards of behavior are provided to various levels of the CDI, resulting in official registration of the case. At this stage, the inspected person is not aware that they have been targeted. It is rare but possible that news of the tip-offs may be circulated through online channels such as Weibo, QQ, or other online sources. If the CDI chooses to accept the case, it moves into the "Preliminary Inspection Stage." It is during this period that the discipline committee collects evidence and determines whether or not evidence is sufficient to mount a case, and is supposed to take no more than two months.

Table 3: Logistic Regression Results of City Characteristics on Corruption

	Dependent variable: Occurrence of Corruption Investigation						
	All	party_secretary	mayor	polluting_industry	polluting_industry_200mw	polluting_industry _soe	university
GDP	0.0002	0.003	0.001	0.003	0.004**	0.003*	0.001
	(0.003)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)
Population	−0.0001	−0.0001	0.0002	0.00002	0.0001	−0.00002	0.0002**
	(0.0003)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0001)
SO2 Emission(Kton)	−0.009	−0.002	0.003	0.017*	0.022*	0.024**	0.008
	(0.017)	(0.008)	(0.007)	(0.010)	(0.011)	(0.011)	(0.008)
GDP Growth Rate	−13.734	2.231	−20.571**	1.246	−21.295	0.631	−0.479
	(24.303)	(8.566)	(9.108)	(13.575)	(17.889)	(14.873)	(9.498)
Power Plant Capacity	0.0002	0.0001	−0.0004**	0.0001	−0.0002	0.00000	0.00004
	(0.0004)	(0.0001)	(0.0002)	(0.0002)	(0.0003)	(0.0002)	(0.0001)
Constant	4.959*	0.295	1.435	−4.756***	−4.072**	−5.117***	−2.961***
	(3.009)	(1.021)	(1.052)	(1.564)	(1.793)	(1.683)	(1.140)
Observations	89	89	89	89	89	89	89
Log Likelihood	−12.710	−54.168	−53.085	−25.847	−16.694	−22.351	−46.847
Akaike Inf. Crit.	37.420	120.335	118.169	63.693	45.387	56.702	105.694
Note:							*p<0.1; **p<0.05; ***p<0.01

The result of this phase can be: 1) there is no case; 2) there is a discipline violation, but the case is minor and therefore there is no need to file; and 3) the case is significant enough to merit filing. The detailed procedures for filing a case are described on the CDI web site (hard copies available upon request).

The subsequent stage, "Filing cases," results in the issuance of a case report. This file submitted includes all of the evidence collected in the preliminary investigation, which we refer to as the main "audit" to assess culpability. Cases are then assigned to the central or local branch of the CDI. The conclusion of this stage usually occurs after one month, and involves issuing an official announcement that the suspected official is under investigation. Investigation announcements are posted on the discipline committees web site and may be covered in the popular press. However, the phases involving the collection of evidence require on-site visits and audits of the individuals employer or affiliated organization in advance of the announcement. Rumors may also circulate locally or on the internet, bringing the investigation to the attention of the official concerned. It is almost impossible that an official would not know he or she is being audited by the campaign.

Once an official is designated for investigation, he or she may be taken into custody and/or removed from their official government positions. Other officials continue to remain in office while a comprehensive investigation is conducted. Party disciplinary measures include five levels of increasing severity (warning, serious warning, removal from Party posts, probation from the party, and expulsion from the party) and are taken on the basis of investigation results. The investigation process is supposed to take no more than three months, while the subsequent transfer to trial, if needed, takes approximately one month. We find that all officials announced as investigated and not still under investigation at the end of our sample were removed from office, and for the cases with removals before the end of 2017, the average length of time from investigation to removal is several months.

3.5 Empirical strategy

Our empirical strategy exploits the different timing of investigations across cities. Using an event study design, we compare air quality in the weeks preceding and following the official announcement of an anticorruption investigation between cities that have earlier investigation cases against cities where investigations came later. We estimate Equation 1:

$$Q_{it} = \sum_{n=\bar{T}-20}^{\bar{T}+12} \phi_n D_{it}^n + \gamma_i + \theta_t + \epsilon_{it} \tag{1}$$

where Q_{it} denotes the average air quality measure as ambient concentration ($\mu g/m^3$) from pollution monitor i in week t. Here we focus only on SO_2, because it is the most short-lived of all monitored pollutants and therefore ambient concentrations can be directly related to the emitting behavior of neighboring plants. We use $n = \{\bar{T} - 20, ..., -1, 0, 1, .., \bar{T} + 12\}$ to denote the *event study weeks* relative to the first treatment week for each pollution monitor. For example, $n = -1$ is the week prior to an investigation, $n = 0$ is the week of investigation, and $n = 1$ is the week after investigation. Pollution monitors in the same city have the same event time. We include monitor-level fixed effects (γ_i) to absorb time-invariant variation at the monitor and city level, and week fixed effects (θ_t) to capture common time shocks such as weather, national events or policies, etc.

The primary coefficients of interest are ϕ_n, which measure mean SO_2 concentration for event week n. The excluded week is the $n = 0$. We thus interpret ϕ_n. as the difference in mean SO_2 concentration between event week n and the week in which investigation occurred.

In our analysis below, we estimate Equation (1) for each type of investigated individual separately: party secretaries, mayors, and polluting industry officials associated with facilities of various sizes. As a placebo test, we also examine the impact of removing a university professor, which is assumed to bear no relationship to city governance or firm decision-making. In our data, we observe the investigation of 38 party secretaries, 61 mayors, 28 polluting industry officials, and 11 university professors.

4 Results

4.1 Polluting Industry

We focus first on the investigation of leaders in polluting industry. Our sample is comprised of twelve leaders who were officially announced as under investigation between May 2014 and December 2016. We display in Figure 2 the effect of an investigation by graphing the ϕ_n that result from event time estimates using Equation 1, resolving air quality trends in the weeks before and after the investigation is announced. We focus in particular on the air quality trends observed in the weeks leading up to the announcement of the investigation. Interestingly, we see an improvement in air quality at two points: (1) 15 to 17 weeks and (2) 2 to 6 weeks prior to the investigation's announcement. The largest of these drops coincides with the audit that must be prepared prior to the filing of the case report and official announcement of an investigation. Following the official investigation's release, we see pollution levels gradually return to pre-investigation levels. The magnitudes observed are large: at five weeks prior to the announcement of an investigation (largest air quality improvement), we find that mean air pollution levels drop to a striking 55% below baseline levels. Interestingly, we also see a statistically-significant reduction in pollution levels at around 15 to 17 weeks prior to the official investigation announcement. This may reflect rumors about the impending investigation of an official that may have leaked in the early information-gathering stage.

While none of the cases against industry officials focused on polluting behavior as grounds for investigation, we might still expect to see changes in air pollution in the lead up to the announcement of an investigation for at least two reasons: (1) the audit performed by investigators includes a wide range of criteria, including environmental measures in the case of pollution-intensive industry, and (2) the audit may draw energy and effort away from production, lowering equipment utilization rates and associated pollution.

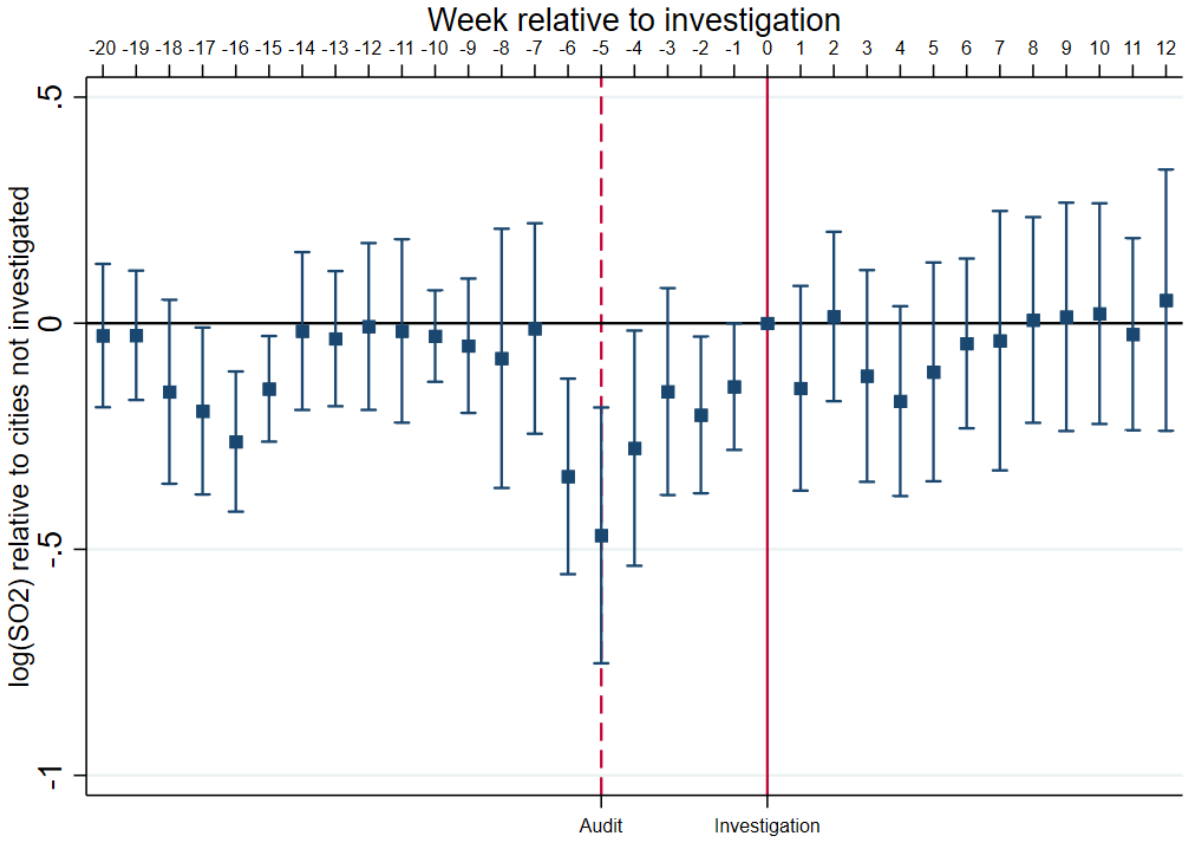


Figure 2: Air quality measured as SO_2 concentration in treated cities before and after investigations of polluting industry officials are officially announced.

4.2 Local Government Leaders

We find no statistically-significant effects for city leaders—party secretaries and mayors. Party secretaries are the most senior decision-makers in a city, outranking mayors, who oversee bureaucratic functions. Party secretaries and mayors are evaluated via the national cadre evaluation system on a range of criteria related to the quality of governance, including environmental criteria. Individuals in these categories who were investigated in the national anticorruption campaign may have been performing poorly on economic growth or other measures, to have abused their positions, and/or to have demonstrated extravagant or corrupt behavior.

The effects of investigating a party secretary are shown in Figure 3. Interestingly, we find

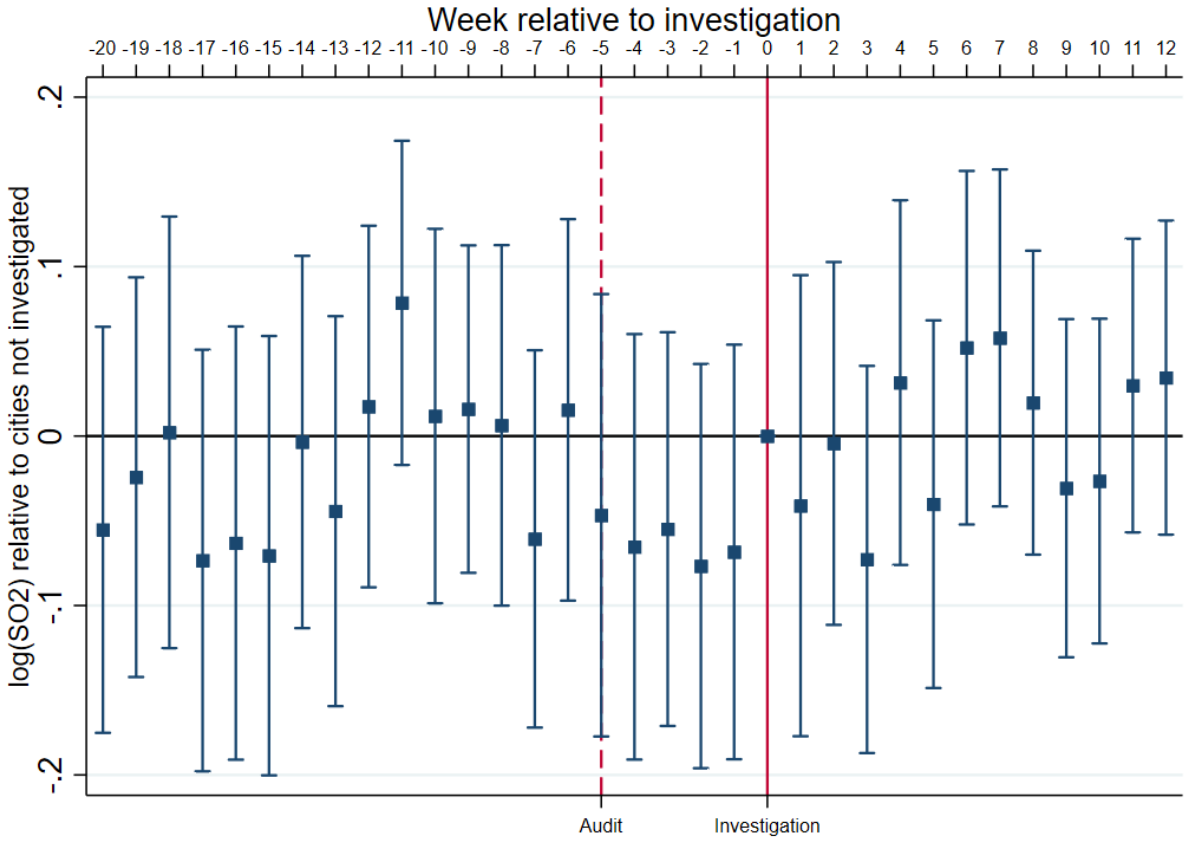


Figure 3: Air pollution in treated cities before and after investigations of party secretaries are officially announced.

that during the audit, we find evidence that air quality improves over multiple successive weeks prior to the official announcement of investigation. The magnitudes of the reductions seen for party secretaries are smaller than for polluting industry officials, in the range of 8-10% above baseline levels; however, the reductions are only marginally statistically significant (at the 10% level) for some weeks. Any improvement appears not to last following the announcement of the official's investigated status.

Similarly, pollution levels do not seem to respond strongly or sharply to investigations of mayors (see Figure 4). Interestingly, while there is some evidence of a short-lived reduction in air quality during the week of the audit, it is not statistically significant. Interestingly, the official announcement of an investigation is followed by signs of gradual improvement. Lower-

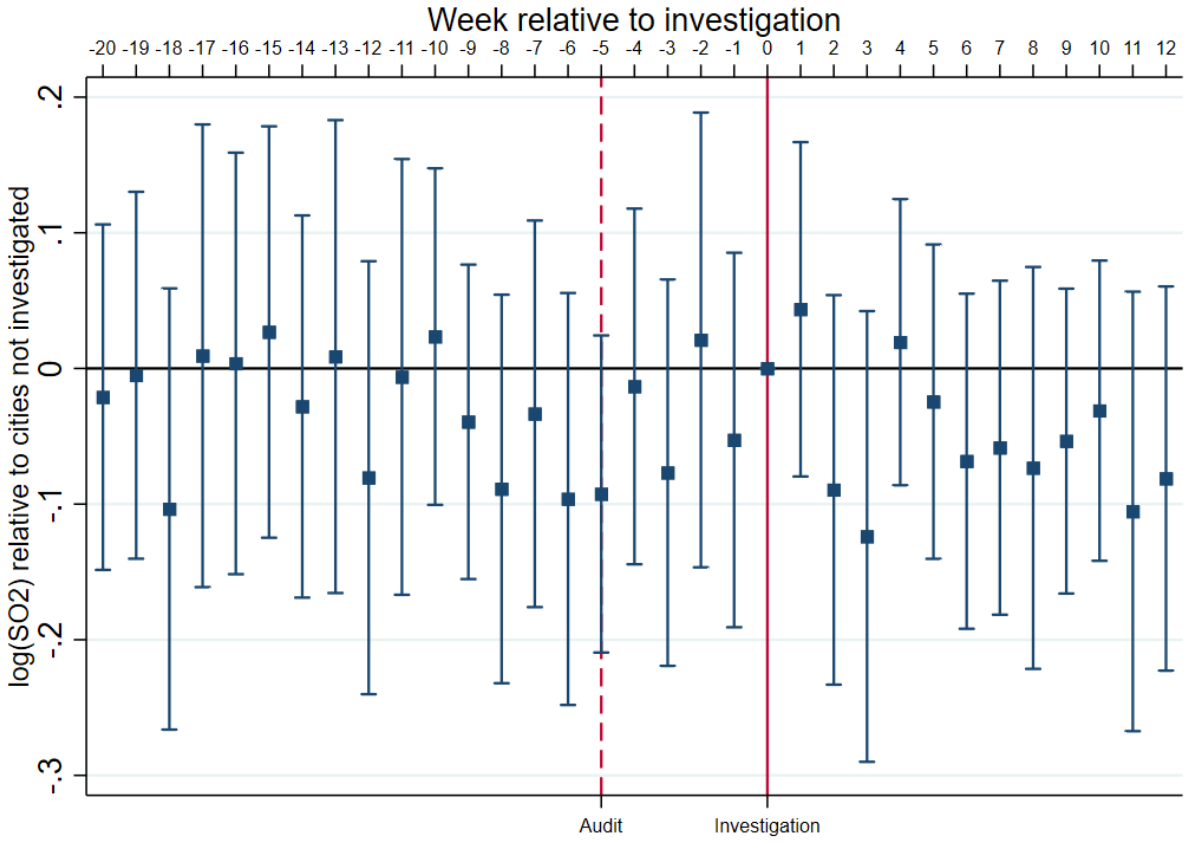


Figure 4: Air pollution in treated cities before and after investigations of mayors are officially announced.

than-average pollution levels are found in ten out of the 12 weeks following an investigation announcement; however, none of these changes is statistically significant.

4.3 Placebo Test: University Professors

To test for the possibility that spurious correlations exist between investigations and local pollution, we test for an effect from targeting individuals that arguably have the least ability to directly influence air quality in a city: university professors. As shown in Figure 5, we find the mildest effects of any official type we investigate. Air quality improves gradually over the period prior to the announcement of an investigation, before stabilizing at average levels, and none of the observed patterns are statistically significant. The pattern in the weeks

prior to investigation is reminiscent of that seen for mayors—multiple weeks of better-than-average air quality—but the effects for mayors are larger and enter the realm of statistical significance at the 10% level in multiple weeks. These results strengthen our confidence that the effects we observe for other official types reflect true relationships between top-down central government scrutiny and air quality.

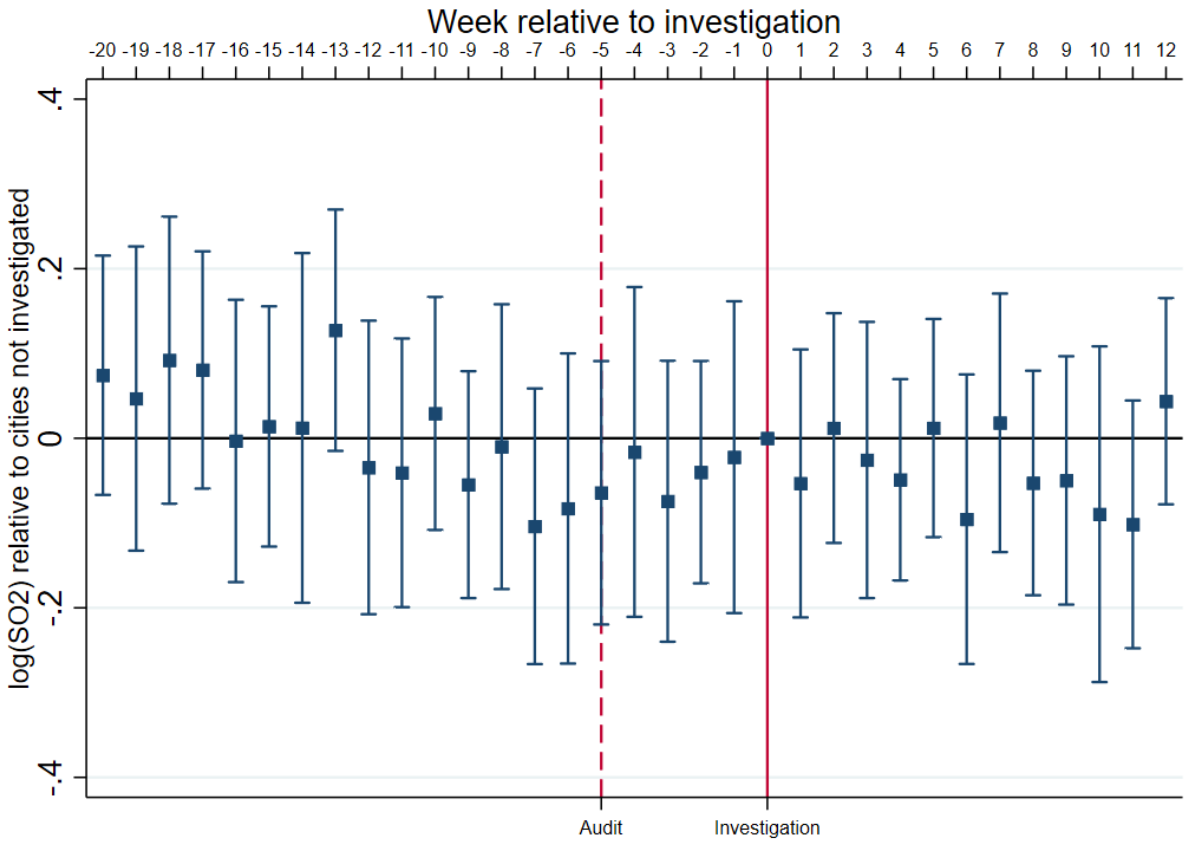


Figure 5: Air pollution in treated cities before and after investigations of university professors (placebo test) are officially announced.

5 Conclusion

We have presented evidence that an increase in central government scrutiny of local cadres of different types results in distinct air quality responses in Chinese cities. Our results can be summarized into three main empirical findings: (1) heightened scrutiny of officials coincides

with large, short-lived improvements in local air quality, with the strongest improvement for investigations of officials affiliated with polluting industry, (2) we find limited evidence of significant improvements for investigations of mayors and party secretaries, and (3) air quality levels return to normal after investigations are announced, although there is some evidence of long-run improvement in the case of mayors. Implications of these findings for theory and practice are discussed below.

Our preliminary findings demonstrate the importance of considering short-term variations in air quality in response to changing incentives. There are many ways a plant can change its air emissions on a time scale of days to weeks: turning on or shutting off pollution control equipment, increasing or lowering capacity utilization, and switching between high and low sulfur coal feedstock sources. While we cannot determine what actions occurred in particular plants, we can observe the net effect of changes in close proximity to plants as well as via the average reading of air quality monitors at the city level. By focusing on sulfur dioxide (SO2), a short-lived local air pollutant with adverse respiratory and cardiovascular effects, we are able to relate air quality outcomes to milestones in anticorruption investigation time lines. The significant fluctuations over the periods of interest suggest that high temporal resolution is essential; using annual averages for cities experiencing anticorruption events would have obscured short-term and target-specific effects. Over the coming months, the analysis above will be elaborated using hourly air pollution data at the plant level, which will allow us to be more precise about the linkages between targeted individuals and the pollution responses of the plants they oversee. For now, our main contribution is to provide evidence of a strikingly large and sharp effect prior to investigation for industry officials.

The differences in the air quality responses associated with different official types are striking, but follow a clear logic: the closer an individual is to firm decision-making, the larger is the effect on air quality of targeting them via the anticorruption campaign. We find evidence that improvements in polluting industry were sharp and occurred precisely during the weeks that firms were subject to the two audits performed to establish culpability.

At their peak, these reductions are around 50% of baseline levels during the audit that occurs approximately five weeks prior to the announcement of an investigation, and last for approximately three weeks. These peak reductions, if sustained, would be beyond what is estimated to be required to meet China's Air Pollution Action Plan (2013-2017). This is the first empirical evidence, to our knowledge, of the "microscope" effect in an organizational setting. It is well known and understood that individuals perform better when they know they are being evaluated. Our research setting allows us to directly observe this effect in firms. We find that air quality improvement during audit periods are surprisingly sharp, and are followed by an increase to normal or above average levels. While it may not show up in annual evaluations, this cyclical nature of polluting behavior can have dire health consequences for the individuals living in the neighborhood of the plant. It also points to the possibility that some level of sustained scrutiny could achieve substantial improvements in air quality in these settings. A combination of formal rules and informal norms, driven by stakeholder scrutiny, provide this pressure in developed country contexts. Our findings thus provide a starting point for thinking about how to cultivate similar sources of sustained societal pressure in China's authoritarian context, an important topic for future work. Such an effort is already underway in a recent campaign to enlist citizens in identifying polluting industrial sites and reporting them to the Ministry of Environmental Protection via a reporting "hotline."

Targeting local government officials, who have arm's-length relationships to plant operators, has no statistically-significant effect on air quality. However, these effects may still be meaningful, and are worthy of further investigation. City party secretaries do not directly oversee the local environmental protection bureaus, the organization officially responsible for monitoring polluters' behavior and curbing excesses by levying warnings or penalties. Removing a party secretary may draw government personnel time and attention away from governance functions related to pollution control, leading to higher levels of emissions post-investigation, while removing a mayor may result in closer scrutiny directed at his or her subordinates, prompting relevant offices to lean harder on polluting firms once a mayor is

thrown into jeopardy.

Our analysis thus far points to several important directions for future work to flesh out the mechanisms underpinning each of the effects we observe. In future work, we will examine more detailed categories of officials, as well as the effects in cities with multiple investigations, to evaluate the durability of our findings. A differential signal would allow us to say more about how industrial accountability relationships matter in an authoritarian setting. The Chinese government has also very recently begun to enlist citizens in efforts to hold polluting firms accountable and to punish them accordingly. Specifically, short windows were created in which citizens in each province could directly report observations of pollution to the local bureaucracy, prompting an investigation. Future study of this program would expand our understanding of the relative effectiveness of civil society pressure as compared to government scrutiny in holding polluters to account in developing country settings.

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