Minimum Performance Targets, Multitasking, and Incentives: Theory and Evidence from China's Air Quality Controls*

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Abstract

This paper examines how local Chinese officials respond strategically to minimum air quality control targets when they care more about pursuing regional economic development, which is closely linked to their career prospects. Using a novel prefecture-day level dataset on air quality and applying a regression discontinuity design, we find strong evidence that air quality tends to improve when the air quality target is doomed to fail, but deteriorates significantly after the early fulfillment of the target is guaranteed. These "asymmetric" strategic responses are mainly driven by "outsiders" – local officials with no previous exposure to the regions to which they are assigned. Greater pressure to promote local economic development reinforces outsiders' asymmetric responses. For "non-outsiders" who have been promoted from the local area and who are more likely to intrinsically value the local environment, air quality performance is stable in both cases of target fulfillment. We build a simple theoretical model to rationalize these key findings. Our study sheds light on how minimum air quality targets have functioned in China's context and highlights the role of intrinsic motivations in mitigating strategic responses to minimum performance targets in a multitasking environment.

Keywords: Minimum Target, Intrinsic Motivation, Incentives, Multitasking, Air Quality Controls, China

JEL code: D78, H76, Q58

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*We thank Bowen Deng and Xinyu Tan for their excellent research assistance. All remaining errors are our own.

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1 Introduction

As the world's largest emitter of carbon dioxide, China has launched serious efforts to tighten its environmental regulation and curb air pollution in the past decade. A distinctive feature of China's environmental regulation is the critical role played by local governments in complying with central directives (Zheng and Kahn, 2013). Chinese local officials have traditionally pursued local economic development and largely overlooked environmental protection (Li and Zhou, 2005; Xu, 2011; Wu et al., 2013). Yet as the central government shifted officials' promotion criteria from a checklist centered on GDP growth to a more comprehensive set of performance standards and increasingly emphasized environmental protection[1], local officials started to take the trade-off between economic growth and environmental protection more seriously. The presence of dual conflicting objectives for local officials creates a classical multitasking principal-agent problem that has been well studied in economics (Holmstrom and Milgrom, 1991; Baker, 1992; Hart et al., 1997). To resolve this multitasking challenge, China has recently introduced minimum targets for air quality controls to discipline local officials while continuing to link their promotion prospects to local economic performance (such as GDP growth). Local officials are not rewarded for fulfilling the minimum air quality targets, but their career prospects are jeopardized if they do not.

Theoretically, the minimum air quality targets provide only limited incentives for Chinese local officials to curb air pollution since they simultaneously face strong pressure to promote economic performance. Several interesting questions related to this delicate balance arise: To what extent do the minimum targets influence local officials' efforts to control pollution? What happens if they achieve the minimum targets ahead of time in a given year (a situation we call *early fulfillment*)? Do they give up completely if they realize there is no way to fulfill the minimum targets in a given year (which we refer to as *doomed failure*)? How do the intensity of political incentives or pressure to pursue economic growth affect local officials' strategic responses to early fulfillment or doomed failure?

This paper aims to address these questions and investigate the extent to which minimum air quality targets have been effective in China, a country facing the severest air pollution challenge in the world. More specifically, we investigate how local officials strategically respond to such targets in a multitasking context, and how differences in their affinity for the environment and the intensity of the political incentives they face affect these responses. Addressing these issues is critical for evaluating how incentive schemes influence the effectiveness of China's environmental regulation, which in turn

[1]Chinese local officials have been generally evaluated using a set of performance indicators such as GDP and fiscal revenue growth, social stability, and environmental protection. See Xu (2011) and Li et al. (2019) for more details on local officials' personnel evaluations.

has important implications for addressing global climate change. It can also help us understand how best to design minimum targets-based contracts to make them most effective at addressing multitasking agency problems.

It is inherently difficult to empirically investigate strategic responses to minimum air quality targets due to the endogenous target assignment and matching between local officials and prefectural cities. We exploit a unique feature of China's air quality targets and employ discontinuity regression designs (RDD) to tackle potential identification challenges. The targets typically specify a minimum number of days (e.g., 250 days) in a year with good or moderate air quality (measured by the *Air Quality Index*, *AQI*). Since daily AQI performance data are publicly released, it is fairly straightforward to identify the exact date when a prefectural city hits either of the two statuses of target completion, doomed failure or early fulfillment. On this date, local bureaucrats will find out whether they have achieved their targets early or whether they will be unable to meet them in the time remaining. This allows us to observe their immediate and potentially discontinuous responses when they find out the status.

Before 2012, prefectural government officials were known to manipulate air quality data and cheat their superiors. Yet beginning in 2012, the central government mandated the nationwide installation of a centrally controlled air quality monitoring system, which has been supplemented by a full battery of policies to crack down on data manipulation. These measures allow us to investigate real performance changes in different target fulfillment statuses without concerns that the data have been falsified.[2]

Our study exploits a novel dataset that contains (1) prefecture-day-level air quality observations from January 1, 2015 to December 31, 2019 matched with (2) data on prefectural-level air pollution targets assigned by provincial governments as well as (3) weather conditions and (4) information on incumbent party secretaries. We employ an RDD approach, in which the running variable is time relative to the threshold date of doomed failure or early fulfillment, to investigate local bureaucrats' responses to the completion status of AQI targets. The baseline results show that a prefecture's air quality performance tends to improve significantly after a doomed failure occurs, which indicates that after finding out it is impossible to meet the annual air quality target, local bureaucrats do not give up completely; they continue to exert efforts to protect the environment. This result is consistent with our finding that the likelihood that an official will be punished increases with the severity of the failure. However, when it is clear that the minimum target has been met early, the air quality deteriorates immediately afterwards. This evidence points to the limitation of minimum targets: local officials do not exert extra effort if the targets are met early, since there is no reward for over-fulfillment. Our empirical specifications

[2]We will formally check the credibility of the AQI during our sample period in Section 3.3.

control for local weather conditions, flexible time fixed effects, and local leader fixed effects to capture unobservable seasonal patterns and local leaders' potential impacts. Our findings remain robust to a full battery of alternative econometric specifications.

Next we conduct heterogeneity analysis of local officials' strategic responses based on the duration of their experiences in a specific prefectural city. Persson and Zhuravskaya (2016) present empirical evidence that working for an extended period in a specific locality increases Chinese local officials' attachment to local public goods. They argue that local affinity, probably driven by local connections, motivates local officials to (at least partly) internalize the welfare of local communities. Inspired by their evidence and argument, we divide the sample of local officials into two groups – "outsiders" and "non-outsiders." "Outsiders" are prefectural party chiefs who were appointed from elsewhere (either from higher-level governments or other prefectural cities) and had no previous experience working in the prefectures to which they were assigned, while "non-outsiders" were promoted from inside the prefectures and have experience working in the area (e.g., ex-mayor of the same prefecture). Further empirical analysis shows that the asymmetric responses to the doomed failure and early fulfillment of air quality targets reported above are mainly driven by "outsiders." "Non-outsiders" demonstrated considerable stability in their responses to both target completion statuses. We interpret the differential responses as a result of differences in outsiders' vs. non-outsiders' intrinsic motivations to preserve the local environment.[3] Non-outsiders' extensive experience in their current localities – and thus greater affinity for the local environment – largely mitigates the "gaming" incentives to decrease their efforts if the air quality target is met early.

To deepen our understanding of the above empirical findings, we construct an illustrative model that formally specifies the mechanisms under which minimum targets function in a multitasking setting. We introduce intrinsic motivations for local environmental quality and investigate the interactions among minimum targets, intrinsic motivations, and political (career) incentives. Our model rationalizes the empirical patterns reported above regarding asymmetric responses to doomed failure and early fulfillment, and demonstrates the role of intrinsic motivations in mitigating the gaming incentives in case of early fulfillment. The model also yields two new predictions to test with our data. First, our model predicts that for outsiders, who have very low intrinsic motivations to preserve local air quality, higher-intensity career concerns make them more sensitive to the target completion status than those with lower-intensity career concerns. We find evidence consistent with this prediction. If we restrict our

[3]In this paper, we use the term "intrinsic motivations" in contrast with extrinsic motivations (more precisely local officials' political or career incentives). We are agnostic about the sources of intrinsic motivations for environmental protection, which might derive from inherent preferences, or affinities driven by local connections (Persson and Zhuravskaya, 2016).

sample to outsiders[4], we find that in prefectures governed by officials with higher-intensity career incentives, air quality performance improves more significantly if doomed failure is detected and deteriorates more sharply in case of early fulfillment compared to those governed by officials with lower-intensity career incentives. Second, consistent with the model's predictions, the empirical results show that if officials are under less pressure to promote local economic growth or are subject to stricter central government supervision, the air quality performance improvement after doomed failure is strengthened and deterioration after early fulfillment is weakened.

This paper contributes to the literature on performance target-based incentive contracts, especially in the public sector (Heckman et al., 1997; Courty and Marschke, 2004; Prendergast, 2007; Heckman et al., 2011; Newman and Azevedo, 2013).[5] This literature has extensively examined agents' gaming incentives when performance targets are narrowly measured or tied to a specific timetable. In a recent study on China's environmental regulation of water pollution, He et al. (2020) present evidence that local officials enforced tighter regulation on polluters immediately upstream of water monitoring stations than on those immediately downstream since the stations only measure emissions from upstream. Several other studies have detected evidence that local officials manipulate data to "game" air pollution targets imposed by the central government (Chen et al., 2012; Greenstone et al., 2020). We also find evidence of local officials' gaming behavior in response to the early fulfillment of targets, but we make an important departure: we explicitly examine the gaming behavior under a broader context of multitasking, intrinsic motivations, and political incentives. We find empirical evidence that both intrinsic motivations to preserve air quality and lower pressure to promote local economic growth help mitigate their gaming incentives under the minimum targets.

Importantly, we find that even though a minimum target-based contract induces gaming behavior if targets are met early, it delivers positive results under two conditions. First, compared to no contract, a minimum target-based contract will force local officials to exert more effort to protect the environment and to make trade-offs to promote economic growth. This is partly confirmed by the continued efforts in case of doomed failure when the minimum targets are supplemented by a warning of a severe punishment for a big failure. Second, the gaming incentives in case of early fulfillment are largely contained for those with a strong local affinity or intrinsic motivations, which mitigates the drawback of the minimum targets. These findings help us better grasp the rationales for installing a minimum performance

[4]Since the presence of intrinsic motivations complicates interactions between political incentives and minimum targets, it is difficult to empirically test how career incentive intensity affects non-outsiders' strategic responses to target fulfillment statuses.

[5]See Finan et al. (2017) for an extensive literature review of the experimental evidence on the role of performance incentives in the public sector.

standard for environmental regulation despite its limited incentive effect, which include maintaining a minimum amount of effort for air quality improvement without seriously undermining the incentives to promote local economic performance, the need to link the intensity of punishment to the severity of failing to meet the minimum targets, and the presence of agents with intrinsic motivations to help mitigate the downside of the minimum targets. These insights can shed new light on designing the most effective minimum targets in a multitasking environment.

Our study also adds significantly to a large and growing literature on the political economy of environmental regulation, especially in the context of China (List and Sturm, 2006; Burgess et al., 2012; Chen et al., 2012; Zheng et al., 2014; Kahn et al., 2015; Jia, 2017; Karplus and Wu, 2019; He et al., 2020; Greenstone et al., 2020).[6] The study closest to ours is Chen et al. (2018a). They use a difference -in-differences identification strategy and find evidence that Chinese prefectural cities located in the Two-Control Zone, an area subject to stricter environmental regulation, reduced their pollution emissions at the cost of local economic growth. While we share a common theme about multitasking local officials' responses to environmental regulation in China, our study differs from theirs in three important ways. First, we focus on the effects of the obligatory AQI-based targets, which have gradually replaced the Two-Control Zone policy as China's main regulatory scheme of air quality control over the last decade. Second, in contrast to their focus on the overall effect of environmental regulation on pollution emissions, our paper emphasizes local officials' strategic responses to the early fulfillment or doomed failure of minimum targets and explicitly studies interactions between minimum targets and the intensity of political incentives for local officials. Third, our analysis introduces intrinsic motivations into the context of environmental regulation and highlights their important role in shaping Chinese local officials' incentives to comply with air quality regulations.

Finally, our paper is closely related to the economics literature on interactions between intrinsic and extrinsic motivations. Although a lot of existing theoretical studies have discussed the effect of intrinsic motivations (Murdock, 2002; Bénabou and Tirole, 2003, 2006, 2016b; Besley and Ghatak, 2005, 2006; Prendergast, 2007), empirical evidence is rare and mostly comes from experimental studies (Gneezy and Rustichini, 2000a,b; Ashraf et al., 2014). If we interpret local affinities as intrinsic motivations and political incentives as extrinsic motivations, our paper provides real-context evidence of how interactions between intrinsic and extrinsic motivations affect local strategic reactions to the minimum targets. Consistent with theoretical predictions, we show supportive evidence that non-outsiders' intrinsic motivations help remedy the lack of incentives to exceed the minimum targets if they are fulfilled

[6] See Zheng and Kahn (2013) for an extensive review of the literature on the political economy of China's urban environmental regulation.

early.

The remainder of the paper is organized as follows. Section 2 provides institutional background on China's target setting in air pollution control and incentive schemes for local officials in environmental regulation. It also discusses the central government's recent crackdown on the manipulation of air pollution data. Section 3 introduces our data and sample construction and presents some supportive evidence of punishments for failing to achieve AQI targets. Section 4 describes our empirical identification strategy, RDD, and presents the baseline empirical results. Section 5 builds a simple theoretical model to pin down the mechanisms under which minimum AQI targets interact with intrinsic motivations and political incentives. Section 6 conducts additional empirical tests derived from the model. Section 7 briefly concludes.

2 Institutional Background

2.1 Target Setting in Air Pollution Control

China's multiple levels of government have regularly set top-down targets since the planned economy period. During the reform era, mandatory targets were replaced by (non-binding) guiding targets, and those related to economic and social development were regularly released in *Five-Year Plans* and annual *Reports on the Work of Government* by multiple levels of government.[7]

In the case of air pollution control, AQI has been adopted as a specific target released in both types of reports by the State Council since 2016. As stated in the *Ambient Air Quality Standards (GB 3095-2012)*, AQI is a composite index constructed from the concentration of six major pollutants: sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), fine particulate matter ($PM_{2.5}$) and inhalable particulate matter (PM_{10}). AQI is first computed hourly at the monitoring station level according to a deterministic function and then averaged on the prefecture-day basis to depict a city's overall daily air quality.[8] It takes values in the range of [0,500] and air quality grades are defined as shown in the first two columns below:

[7]See Kennedy and Johnson (2016) and Li et al. (2019) for more detailed descriptions of China's target setting scheme.

[8]See *Technical Regulation for Ambient Air Quality Index (on trial) (HJ 633-2012)* for a detailed description of the functional relationship between AQI and concentration of the six pollutants.

AQI Value Range	Air Quality Grade	NAQI Value Range
0∼50	Good	450∼500
51∼100	Moderate	400∼449
101∼150	Lightly Polluted	350∼399
151∼200	Moderately Polluted	300∼349
201∼300	Heavily Polluted	200∼299
300∼500	Severely Polluted	0∼200

The AQI target is typically specified as *a minimum number of days with good or moderate air quality in a year*, or *a minimum number of days with* $AQI \leq 100$. Monitoring stations publicly release hourly readings of AQI and pollutant concentrations. Since the total number of days in a calendar year is fixed (either 365 or 366), a simple comparison of the AQI target and current AQI values can precisely monitor the target completion status on a daily basis. Each day, officials can observe whether their city is likely to demonstrate one of two distinctive states of target fulfillment: (1) doomed failure – the number of days remaining in the year is insufficient to meet the target even if air quality remains good or moderate for the rest of the year or (2) early fulfillment – the AQI target is met before the end of the year regardless of air quality readings in the remaining days of the year. As will be shown in our subsequent analysis, the continuous and punctual detection of air quality and target completion status enable us to employ an RDD to resolve identification issues.

2.2 Incentive Scheme in Environmental Regulation

China's local governments have played an important role in promoting regional economic growth and enforcing environmental regulation using their discretionary power (Xu, 2011; Zheng and Kahn, 2013). As a result, city-level air quality has been substantially affected by the decisions and efforts of local bureaucrats, independently of the impacts of exogenous factors like weather conditions. Local governments have the authority to adopt measures to control regional pollution to some extent even in a short time period, such as urging high-polluting factories to terminate production, banning the burning of crop straw, ordering construction companies to water building sites and reduce fugitive dust, and so on.

Economic growth has traditionally dominated Chinese local officials' performance evaluations (Li and Zhou, 2005; Xu, 2011; Yao and Zhang, 2015). Environmental protection thus received little attention from local officials until 2005, when the central government set obligatory environmental regulation targets in the five-year plan for the first time in response to deteriorating ecological conditions. Regulatory agencies mainly focused on indicators such as energy consumption per GDP or CO2 emissions from 2005 to 2010. Air pollution control gradually gained attention from the Chinese government, domestic citizens, and international communities, and culminated in the sudden burst of haze in 2013, which represented the most severe air pollution in a half-century.

Beginning in 2006, the Chinese central government launched a series of pollution-controlling policies and designed incentive schemes to motivate local officials to enforce environmental regulation. This effort mainly involved setting environmental protection targets (in either five-year plans or annual reports on the work of government) as *obligatory* indicators, in contrast to *anticipatory* indicators such as growth targets of GDP and fiscal revenues. These two types of indicators correspond to different incentive schemes. Anticipatory indicators serve as guiding signals with no binding power, but represent the key concerns of local officials, whose promotion is closely linked to the performance of these indicators (Li et al., 2019). Obligatory indicators, such as pollution emission reduction and poverty alleviation, set bottom lines and binding constraints. If local officials fail to fulfill their obligatory targets, they lose their chance of promotion or are even removed from their posts during the evaluation year. But over-fulfilling the obligatory indicators is not rewarded. Given the multitasking regime in which local officials must simultaneously promote economic growth and enforce environmental protection, and the efforts to complete these two tasks are substitutes, there is no incentive for them to do more than barely meet the environmental protection targets.

In recent years the central government has heightened its disciplinary measures to prevent the moral hazard of local governments in environmental regulation. There is abundant anecdotal evidence that local officials who performed poorly in environmental protection received warnings or disciplinary actions from higher-level governments, which would leave a blot on their career records. For instance, the Ministry of Ecology and Environment (MEE)[9] reportedly took disciplinary actions against 1,140 local officials after one round of environmental inspections in 2017.[10] Local governments also followed suit and launched supervisory campaigns against subordinate jurisdictions. Local governments also followed suit and launched supervisory campaigns against subordinate jurisdictions. For example, the Jiangsu provincial government summoned local leaders from four prefectures for a face-to-face admonition (*yuetan*) to criticize them for "a lagging progress in the task of air quality improvement" in August 2019.[11]

Yet punishments are not imposed indiscriminately on any degree of failure to meet targets. A barely fulfilled case may be tolerated, but a severe failure may trigger a serious warning or punishment. In other words, in the case of failure, local officials' punishment is based on the gap between the target and

[9] The MEE was established after the reconstruction of the ministries under the State Council in 2018. The previous Ministry of Environment Protection (MEP) was merged into this new ministry. We refer to both ministries as the MEE.

[10] See report on `https://www.thepaper.cn/newsDetail_forward_1868071` (accessed on January 15, 2021).

[11] See report on `http://www.jiangsu.gov.cn/art/2019/8/8/art_64750_8661903.html` (accessed on January 15, 2021).

actual AQI performance. We traced cases of warnings or criticism by the MEE or local governments online and in government documentation, and found that for serious warnings or criticism, such as publicizing the names of local officials who failed to fulfill the targets on the government websites or circulated documents, the stated reasons for criticism or punishment usually involved expressions such as "severely lagging behind," or "failing by a large margin," or "ranked last among all cities."[12] In Section 3.4, we will provide more supportive evidence of the correlation between the likelihood of punishment and the severity of the failure to meet the target. The dependence of punishment on the severity of the failure in air quality controls implies that local officials cannot simply give up completely in the case of doomed failure: they have to demonstrate further efforts in order to avoid a serious failure.

In summary, the incentive scheme in China's environmental regulation differs from the ones usually considered in the performance standards literature in two respects. First, prior studies (Murphy, 2000; Zhou and Swan, 2003) usually consider performance targets as thresholds for receiving incentive awards. For example, the contract specifies the following wage payment:

$$W(y) = \begin{cases} w_0 + w(y - y_0), & \text{if } y \geq y_0 \\ w_0 \quad\quad\quad\quad , & \text{if } y < y_0 \end{cases}$$

where y_0 is a performance target, w_0 is a fixed wage, and the increasing function, $w(\cdot)$, is the incentive award paid when the threshold is met. We instead consider performance targets as minimum requirements to avoid punishment: the contract specifies the following probability of being punished (i.e., retirement or investigation):

$$P(y) = \begin{cases} 0 \quad\quad\quad\quad , & \text{if } y \geq y_0 \\ p(y_0 - y), & \text{if } y < y_0 \end{cases}$$

where the increasing function, $p(\cdot)$, is the probability of being punished when the threshold is not met.

The second way in which China's incentive scheme differs is that previous studies usually assume that the agent cannot observe whether the performance target is met or not until all of their efforts have been exerted. In our case, as described in Section 2.1, local officials can continuously observe their target fulfillment status and decide whether to continue to exert effort (and how much). This feature, together with the incentive scheme described above, implies that there could be a discontinuous change in effort incentive at the time an official learns that their target status is early fulfillment or doomed failure. If the target is met early, officials may reduce their efforts in environmental protection given

[12]For example, there was a news report that the MEE summoned prefectural leaders of three prefectures for "ranking the last three among cities under special monitoring." For more details, see `https://www.sohu.com/a/230340946_120802` (accessed on January 15, 2021).

that they also have to promote economic growth, and improving air quality is costly.

2.3 Crackdown on Data Manipulation

It has been well documented that China's air pollution data have been subject to widespread fraud (Chen et al., 2012; Ghanem and Zhang, 2014; Greenstone et al., 2020). This fraud was enabled by the fact that local governments installed their own air-quality monitoring devices and self-reported air-quality data to the central government. The situation has changed dramatically since the administrative and legislative branches have devoted considerable efforts to cracking down on data manipulation over the last several years in three main ways.

First, the MEE upgraded its monitoring technology and adjusted the management modes to improve data quality. It introduced a real-time remote quality assurance and control system in stages from 2013 to 2015. Greenstone et al. (2020) observed a sudden jump in pollutant concentration after the adoption of real-time automated monitoring technology, which they interpreted as a signal of improvement in the quality of air pollution data collection. The MEE gradually took control of the 1,436 state-controlled environmental air quality monitoring stations from local governments by the end of 2016. Second, the MEE supplemented these technological and managerial upgrades with stricter surveillance. For instance, it regularly dispatched a Central Environmental Inspection Team to provinces to supervise local law enforcement and detect any signs of data manipulation. Third, the National People's Congress revised the *Environmental Protection Law* in 2014 by adding Article 17, which states that "monitoring institutions and the persons in charge thereof shall be responsible for the truth and accuracy of monitoring data."

This great progress means that data manipulation in our sample period of 2015–2019 should not be a key concern. However, as a double check, we would provide direct empirical evidence in Section 3.3 to corroborate the reliability of the air pollution data in our sample.

3 Data and Summary Statistics

3.1 Data Collection

The data used in this paper were mainly collected from the following sources.

Prefectural Targets for Air Pollution Control. – We first collected prefecture-level, AQI-based targets from the publicly available documents issued by provincial governments. If related documents were not accessible on the Internet, we submitted applications for information disclosure to the relevant government departments such as the general office of the provincial government or the provincial-level Department of Ecology and Environment.[13] These targets are most commonly expressed as a minimum number of days with AQI $\leq$ 100 in a year; alternative expressions include the relative increase in the number days with AQI $\leq$ 100 or scheduled improvement of air quality in multi-year contracts. To facilitate comparison, we standardized these targets into a common expression based on the rules described in Table C1.

Air Quality Index and Normalized Version. – The AQI indices employed in this paper were compiled by the China Air Quality Online Monitoring and Analysis Platform,[14] which utilizes a web crawler to fetch historical air quality records published by the MEE and releases them for free. We fill in missing values resulting from temporary failures of the web crawler with data from another independent source that copies MEE data using similar crawler technology.[15]

Meteorological Conditions. – Weather data were acquired from a public website that posts prefecture-day-level meteorological conditions,[16] including maximum and minimum temperatures, a category variable for wind speed, and two dummy variables for rainfall and snow, respectively.

Information of Prefectural Party Secretaries. – To account for the effects of local bureaucrats on environmental regulation, we digitized the resumes of prefectural party secretaries from media reports and other related sources such as Baidu Baike for cross-validation. We first extracted the dates they assumed office to confirm which party secretary was in charge on a particular day. We also constructed a series of variables to capture differences in bureaucrats' political incentives and personal closeness to the jurisdictions they governed, including the age at the time of their appointment, a proxy for the intensity of career concerns (Wang et al., 2020), and dummies for whether an incumbent has worked in the same prefecture before or whether he was locally promoted.

3.2 Sample Construction

To construct our sample, we combine the data from the above-mentioned sources into a prefecture-day panel and make the following selections. First, we exclude the four provincial-level municipalities (Beijing, Tianjin, Shanghai and Chongqing) from our sample since they are mainly composed of city

[13] We are required to properly preserve the documents and data acquired through application procedures and cannot circulate them without the permission from relevant government departments. Therefore, we cannot disclose the target numbers. However, local governments are obligated to reply to applications for information from Chinese citizens, so readers who are interested in the original data could directly submit applications for data release to provincial governments or departments of ecology and environment.

[14] Air quality data can be accessed at `https://www.aqistudy.cn/historydata/` (accessed on January 15, 2021).

[15] The website is `https://quotsoft.net/air/` (accessed on January 15, 2021).

[16] The website is `http://www.tianqihoubao.com/lishi/` (accessed on January 15^{th}, 2021).

districts and counties without prefectural jurisdictions. Hainan Province is also excluded for a similar reason because it mainly consists of province-managing-counties. Second, we drop Tibet and Hebei Province from our sample due to their special roles in the campaign against air pollution. Tibet is located in Qinghai-Tibet Plateau, which has little exposure to air pollution, and is thus exempt from the pressure of pollution alleviation. Hebei Province surrounds Beijing and is regarded as the one of the primary sources of air pollution in the capital. The MEE has thus set special regulatory rules for Hebei to improve Beijing's air quality, which makes Hebei incomparable with other provinces in the context of environmental regulation. We end up with a sample of 311 prefectures in 24 provinces during 2015–2019. A total of 788 party secretaries served in those prefectures during the study period. Table 1 reports detailed summaries of the main variables.

It should be noted that not all provincial governments simultaneously started to assign AQI-based targets from the very beginning. Only two provinces (Shaanxi and Qinghai) issued AQI targets in 2015. The number increased to 20 in 2016, finally reached to 24 in 2017 and has remained stable since then (i.e., no province stopped setting AQI targets during the sample period). However, we do not further refine our sample according to the availability of targets, because observations in province-year units without targets could still be useful for the first-step estimation of RD, which would be clarified in the next section.

3.3 Summary Statistics for AQI Targets and Completion

We first document stylized facts about AQI targets at prefecture-year level. Figure 1 plots the distribution of AQI targets and completion rates along with estimated kernel density. Completion rates are computed at prefecture-year level and equal to the actual number of days with AQI ≤ 100 divided by the targeted number. Rates equal to or larger than 100 indicate target fulfillment. Figure 2 plots the geographic distribution of completion status by year on a map, indicating prefectures that fail (streak) or succeed (color) to meet their targets. Figure 1 Panel B and Figure 2 illustrate that target achievement varies considerably in both cross-sectional and time dimensions. This implies that the AQI targets assigned by most provinces are both challenging and attainable.[17]

Figure 1 Panel B also shows that prefectural completion rates ranged from 47–133%, with considerable dispersion but bunching to the right of 100%, which denotes exact fulfillment. An intuitive explanation for this bunching is that local bureaucrats falsified the air quality data when they failed to meet their targets. An intuitive explanation for this bunching is that local bureaucrats gamed the air

[17]We have 1,154 prefecture-year observations for which targets and actual performance are both available; 669 are fulfillment year, which means that the average rate of completion is 59%.

quality data when they failed to finish their targets. To rule out the possibility of data manipulation, we therefore plot the McCrary (2008) test of our AQI data in Panel A of Figure 3. Panel B extracts the same test from Chen et al. (2012), which examines Chinese local officials' widespread manipulation of air quality data during 2000–2009. Chen et al. (2012) interpreted the discontinuity around 100 in Panel B as manipulation of the API.[18] However, Panel A demonstrates that our AQI data exhibit no significant jump around 100. This is not surprising because, as introduced in Section 2.3, the central government has implemented a battery of policies to crack down on data manipulation and imposed severe punishments for this misbehavior. If data manipulation is not a driving force behind the bunching around 100%, then it may be caused by a lack of incentives for over-fulfillment if the target is met early. We explore this explanation further in Section 4.

3.4 Supportive Evidence for Punishment on Failing AQI Targets

For AQI targets to serve as an effective minimum performance standard, failing to meet them must incur a punishment, and the probability or severity of punishment should increase with the severity of the failure. Figure 4 and Table 2 provide supportive evidence for this incentive scheme. We focus on two main forms of punishment implemented by MEE. The first is administrative talk (*yuetan*), in which the MEE summoned prefectural leaders for a face-to-face criticism of their failures in environmental protection. In 2016, the MEE began regularly dispatching environmental inspection teams to provinces (*ducha*) and to "name and shame" specific prefectures for failures (*dianming*).[19] We collected public information about those two kinds of supervision, and construct a prefecture-year level dummy that denotes whether prefectural leaders were summoned for an administrative talk or name picked during inspection in the next year. Figure 4 displays the relationship between performance in AQI targets and the probability of being punished. The prefecture-year differences between the actual percentage of days with AQI $\leq$ 100 and the targeted percentage are displayed on the horizontal axis; values equal to or larger than 0 indicate fulfillment. It is noteworthy that the fitted line in fulfillment region is quite flat and remains close to zero, while the fitted line in failure region is much steeper and the probability of being punished increases with the failure margin.[20]

To further account for potential confounding factors, Table 2 presents regression-based evidence.

[18] API was calculated from the concentration of SO_2, NO_2 and PM_{10} according to *Ambient Air Quality Standards (GB 3095-1996)*, which is the former version of AQI and has been replaced by AQI since 2012.

[19] Previous studies have closely examined those policies. See Shi et al. (2017) for a review of the first and Karplus and Wu (2019) for the second.

[20] The probability is not exactly equal to zero because the AQI target is only one of environmental protection targets; those who succeed in this target could still fail in other dimensions of environmental protection (e.g., curbing water pollution) and be punished.

Based on the severity of failures compared with the AQI targets, we split the failure cases into two categories at the median value of failure margin: moderate or severe failures. Using fulfillment cases as the control group, the empirical results show that if local officials fail by a margin above the median, the probability of being punished nearly doubles (i.e., 0.116 versus 0.067). In summary, we find some supportive evidence of the association between a failure to achieve the AQI targets and the likelihood of punishment.

4 Econometric Strategy and Baseline Results

4.1 Definition of Threshold Date in RD

The RDD we employ is a modified version of the classic RDD that has been increasingly popular in environmental economics due to the availability of high-frequency data.[21] The running variable is time relative to the threshold date. More specifically, for prefecture c and year y, date d would be defined as the threshold in RD if either of the following two conditions have held since date d:

$$(\#\text{ of days with AQI } \leq 100 \text{ until } d-1) + (\#\text{ of days remaining since } d) < Target,$$
$$\text{or, } (\#\text{ of days with AQI } \leq 100 \text{ until } d-1) \geq Target.$$

Target denotes "the target number of days with AQI $\leq$ 100" and "# of days remaining" is computed by subtracting the number of days that have passed from the total number of days in the year (365 or 366). The first inequality indicates the status of *doomed failure*: prefecture c performs so poorly from January 1^{st} to date $d-1$ that it is impossible to meet the target in year y even if AQI $\leq$ 100 in all remaining days in the year. The second inequality indicates *early fulfillment*: prefecture c meets the target ahead of schedule on date $d-1$ regardless of what happens to the air quality in all remaining days in the year.[22]

Based on the rule introduced above, for prefecture c and year y, local bureaucrats would exert efforts to improve the air quality from January 1^{st} until a sudden change in incentives on the threshold date d, after which the target completion status shifts to either *doomed failure* or *early fulfillment.* To

[21] See Hausman and Rapson (2018) for a comprehensive review.

[22] For example, a prefecture with a target of 250 days with AQI $\leq$ 100 met that standard on 199 of the first 314 days of the year. If the air quality on the 315^{th} day was still bad, the prefecture would be faced with a situation of doomed failure starting from the 316^{th} day until the end of the year. That is, even if air quality remained good or moderate in all the remaining 50 days (365 – 315 = 50), the total number of days up to standard would be 199 + 50 = 249, which would fail to meet the target. Alternatively, assume the prefecture already had 249 days up to standard during the first 314 days of the year. If air quality on the 315^{th} day was also good or moderate (thus 250 in total), the prefectural government would face early fulfillment starting from the 316^{th} day, because the target has already been achieved; it does not matter if all remaining 50 days are heavily polluted.

examine the heterogeneous responses to different completion statuses, we categorize the data into two subsamples at the prefecture-year level according to whether the target assigned to prefecture c in year y has been met; we call these the *failure year* and *fulfillment year* subsamples, respectively.

4.2 Estimation Procedure

Following the empirical design suggested by Hausman and Rapson (2018) and Li et al. (2019), we implement RDD analyses in two steps. First, we estimate the following equation using the full sample:

$$NAQI_{cyd} = \alpha + \mu_c + \lambda_d + \gamma' X_{cyd} + \zeta_{cyd}. \tag{1}$$

We then use the residual $NAQI\_Res_{cyd}$ obtained from equation 1 as the outcome variable for a subsample RDD estimation as follows:

$$NAQI\_Res_{cyd} = \pi + \beta D_{cyd} + f(t_{cyd}) + D_{cyd} \times f(t_{cyd}) + \epsilon_{cyd}. \tag{2}$$

NAQI (normalized AQI) equals 500−AQI. This normalization helps facilitate our interpretation since a larger NAQI represents a higher level of air quality.[23] The main idea behind the two-step procedure is that we first regress $NAQI$ against prefecture and calendar date fixed effects (denoted by μ_c and λ_d) along with a series of controls (X_{cyd}) to purify the outcome variable. Since the relationship between $NAQI$ and regressors holds for all observations, we could utilize the whole sample in this step and make full use of the dataset in hand, regardless of whether the prefecture receives a target from the provincial government in that year. We then use the less noisy outcome variable (i.e., the residual) for subsequent RD analyses, which can be free of complex specifications and focused on estimating the discontinuous changes in air quality around the threshold date.

Subscripts c, y and d denote prefecture c, date d and year y, respectively. $NAQI_{cyd}$ and $NAQI\_Res_{cyd}$ represent normalized AQI and residuals obtained from equation 1. X_{cyd} consists of a series of control variables and fixed effects. First, since weather conditions have profound effects on air pollution, we add the following variables to control for *daily weather conditions*: maximum and minimum temperatures, rainfall indicator, snow indicator, and a categorical variable for wind speed coded 1–4. Second, since cities may exhibit distinctive yearly and seasonal patterns of air quality, we interact prefecture fixed effects with the following dummies to address *prefecture-specific seasonality*: $\mu_c \times Day\ of\ Week_d$, where $Day\ of\ Week_d = \{\text{Monday, Tuesday, ..., Sunday}\}$; $\mu_c \times Week\ of\ Month_d$, where $Week\ of\ Month_d =$

[23]The original expression of AQI targets, i.e., *a minimum number of days with* $AQI \leq 100$ will be changed to *a minimum number of days with* $NAQI \geq 400$.

{Week1, ..., Week6}; $\mu_c \times Month\ of\ Year_d$, where $Month\ of\ Year_d$ = {January, ..., December} and $\mu_c \times Year_d$, where $Year_d$ = {2015, 2016, 2017, 2018, 2019}. The third component of X_{cyd} is leader fixed effects of incumbent prefectural party secretaries. The personal characteristics of Chinese local leaders, such as abilities, motivation and expertise, affect regional development (Yao and Zhang, 2015) as well as air pollution control. Since city party secretaries often move laterally between prefectures, we are able to assign a unique ID to a party secretary who may have worked for multiple prefectures. Including person fixed effects helps rule out the unobserved heterogeneity for prefectural leaders.

t_{cyd} is the running variable, and a negative (positive) value denotes the number of relative days before (after) the threshold date. D_{cyd} is a dummy variable for completion status that takes a value of 1 if $t_{cyd} \geq 0$ and 0 otherwise. $f(t_{cyd})$ is polynomial functions of the running variable; its interaction with D_{cyd} further allows for distinctive trends of the outcome variable on different sides of the threshold. In the baseline setting, bandwidths are 40 and 15 for failure year and fulfillment year subsamples, and the functional form of $f(t_{cyd})$ is specified as locally linear with a uniform kernel. Standard errors are clustered at the prefecture level. We would also demonstrate the robustness of our baseline estimates to alternative bandwidths, kernel functional forms, and heteroscedasticity-robust standard errors.

Two additional issues arise from the definition of threshold dates. First, recall that the completion status of prefecture c on date d is derived from air quality between January 1^{st} and date $d-1$. Therefore the AQI on the day before the threshold date is mechanically determined by the following definition: prefecture c will always change to the status of *doomed failure* (*early fulfillment*) after a polluted (unpolluted) day. To solve this problem and ensure the validity of the RD design, we follow the "donut RD" method proposed by Barreca et al. (2011) and Hausman and Rapson (2018) and exclude observations in the immediate vicinity of the cutoff date. That is, we drop observations with $t = 0$ or -1, which correspond to the threshold date and the previous day. The second additional issue is that the number of remaining days after the threshold day until the end of the year is systematically different in failure vs. fulfillment years. As displayed in Figure 1 Panel A, except for some special cases with extremely low targets, most targets are larger than a half-year (i.e., 183 days); some even approach 360 or more. Generally speaking, the number of remaining days is usually greater in the failure year subsample, which allows for wider ranges of bandwidth selection. As a result, we set bandwidths as 40 and 15, respectively, in a baseline estimation and we would also show that our results are robust to using alternative bandwidths.

4.3 Baseline Empirical Results

In this section we investigate local bureaucrats' responses after the threshold date. Panels A and B of Figure 5 show the graphic evidence from baseline RD settings for the failure year and fulfillment year subsamples, respectively.

We begin by probing the situation in which prefectures failed to achieve their targets. Panel A shows that doomed failure did not cause the official to completely give up. On the contrary, the air quality performance sharply improved after the threshold date. This is not surprising, given that the extent of the failure affects the likelihood or severity of punishment. Local leaders were thus incentivized to narrow the gap between outcomes and minimum targets to reduce the likelihood of warnings or criticism from their superiors.

Panel B clearly shows that if the target is met early (early fulfillment), the air quality deteriorates afterwards. This finding is perfectly consistent with the obligatory nature of AQI targets in a multi-tasking environment: the over-fulfillment of targets gains little, but costs much by crowding out the efforts of promoting economic development, which contributes significantly to local officials' career advancement. We interpret such responses as the result of the salient feature of obligatory targets – the goal of "hitting the target only but no more."

Table 3 reports the estimates of the regression analyses. The results from the failure year and fulfillment year subsamples are displayed in the first three and last three columns, respectively. Empirical specifications in Columns (1) and (4) are the same as the baseline settings introduced in Section 4.2 and correspond to the graphic evidence discussed above. In Columns (2) and (5), kernel functions are changed into triangular ones that weight observations based on their distance from the threshold date. Columns (3) and (6) allow for quadratic polynomials instead of local linear ones to account for more flexible trends on both sides of the cutoff (Gelman and Imbens, 2019), and the corresponding RD plots are displayed in Panels C and D of Figure 5. Standard errors (in parentheses) are clustered at the prefecture level; we also report heteroscedasticity-robust standard errors (in brackets), as suggested by Lee and Lemieux (2010). The RD estimates in Table 3 remain highly robust under different specifications and deliver findings similar to what we observed in Figure 5.[24]

Since there is no consensus on the criterion of bandwidth selection in the econometric literature, we experiment on a range of bandwidths and show the robustness of our findings. The range is centered on bandwidths in baseline settings with a length of 20, i.e., 30∼50 for the failure year sample and 5∼25 for the fulfillment year sample. Figure 6 plots the point estimates and 95% confidence intervals with

[24] Since standard errors clustered at the prefecture level are generally larger, for the sake of prudence, we would implement statistical inference with them by default in the following analyses.

bandwidths on the horizontal axes. Both panels show that our key estimates remain stable in both magnitude and significance level, though the magnitude of point estimates in the right panel escalates as bandwidths narrow, which may partially result from the decrease in the size of observations and statistical power.

As previously discussed, Chinese local bureaucrats may exhibit different levels of intrinsic motivation to provide local public goods (Huang, 1999; Bai et al., 2008; Persson and Zhuravskaya, 2016). Persson and Zhuravskaya (2016) motivate us to explore how local officials' intrinsic motivation to improve the air quality affect their strategic responses to the completion statuses of AQI target fulfillment. We follow Persson and Zhuravskaya (2016) and introduce a proxy for (a lack of) intrinsic motivations for environmental quality – whether the local official is an outsider. Since Persson and Zhuravskaya (2016) only present evidence for the positive effect of local experience on local public goods such as basic education, it is unclear whether this effect holds for local environmental protection. To support our proxy for local officials' intrinsic motivations to improve environmental quality, Appendix B provides more evidence for the positive effect of bureaucrats' local experience on local environmental protection.

We define the party secretary of prefecture c as an outsider if he or she is appointed from other prefectures or departments of provincial governments, and as a non-outsider if he or she is promoted within prefecture c.[25] Furthermore, considering that some local bureaucrats may be repeatedly moved among jurisdictions repeatedly during their careers, even if the party secretary of prefecture c was laterally moved from prefecture b, he may still have worked in prefecture c earlier in his or her career. To account for this possibility, we compute the total length of time the incumbent party secretary has served in prefecture c throughout his/her career before being appointed the party secretary, and further define those with no previous work experience in the prefecture as outsiders, which is a stricter version of outsiders.

We further split the subsamples of failure and fulfillment years according to whether the incumbent party secretary is an outsider, which generates four subsamples: failure year & outsider, failure year & non-outsider, fulfillment year & outsider, fulfillment year & non-outsider. Table 4 reports the results from subsample regressions where outsiders in Panels A and B are defined differently as described above. The results show that local bureaucrats defined as outsiders exhibit responses similar to our baseline results. The estimated coefficients in Columns (1) and (3) in both panels are significant at the same level

[25] Please note that we refer to those bureaucrats in contrast with outsiders as "non-outsiders" instead of "insiders" or "locals." The definition of an outsider is relatively clean-cut in the sense that the incumbent party secretary has never worked in the prefecture before and thus has little local connection. However, we could not simply regard the other ones as insiders, since it is hard to measure the extent to which they are locally-connected or oriented. Therefore use the broad term "non-outsiders."

with greater magnitude compared with Columns (1) and (4) in Table 3. However, those non-outsiders change little in the intensity of air pollution control, which is reflected by the insignificant estimates in Columns (2) and (4). The estimate in Column (2) of Panel B is somewhat smaller in magnitude (4.269 versus 5.712), perhaps partially due to the heterogeneity of non-outsiders. Taken together, we find strong evidence that outsiders respond more sensitively or strategically to target fulfillment statuses than non-outsiders. This stark difference can be understood as supportive evidence of the mitigating effect of intrinsic motivations à la Persson and Zhuravskaya (2016) on "gaming" incentive of local officials to regulate air quality.

To summarize, both the graphic evidence and regression results from the RD analyses indicate that local bureaucrats continue to exert efforts to improve air quality rather than completely give up after reaching the doomed failure threshold, while they do not engage in further efforts after early fulfillment. These asymmetric responses under different statuses of target fulfillment are mainly driven by outsiders, who probably have low intrinsic motivations to improve local environmental quality. These empirical results seem quite intuitive as a result of the obligatory nature of AQI targets. But they also raise interesting questions that merit further exploration: How would multitasking (e.g., the pressure to boost local economic growth) affect strategic responses to doomed failure or early fulfillment? More importantly, given local officials' varying career concerns and intrinsic motivations, how would political incentives and intrinsic motivations interact with the obligatory AQI targets? In the next section we develop a theoretical model to rationalize the empirical findings documented so far and address questions regarding the interactions among minimum targets, intrinsic motivations and political incentives in a multitasking context.

5 Theoretical Model

We seek to develop the simplest model possible to explain how Chinese local officials respond strategically to minimum air quality targets, and how outsiders and non-outsiders behave differently. To illustrate, our benchmark model takes local officials' incentive schemes as given and considers their optimal efforts in a multi-period and multitasking setup.

5.1 Model Setting

There is a representative agent who can exert effort in two periods $t = 1, 2$. The effort choice in each period t is two-dimensional: (x_t, z_t), where x_t denotes the effort exerted to promote economic growth and z_t denotes the effort exerted to protect the environment. We use this two-period model as a shortcut to investigate the change in incentives from the initial uncertain stage to the early fulfillment/doomed failure stage within the year. Hence, we do not impose any discounting between these two periods.

We make two assumptions about how air quality is determined. First, there are two states of the world $s = g, b$. When $s = g$ (good), the air quality is so high that the agent can fulfill the environmental target y_0 without exerting any effort; when $s = b$ (bad), the air quality is so low that the agent fails to meet the environmental target y_0 for sure. The prior belief is that $s = g$ and $s = b$ occur with probability α and $1 - \alpha$, respectively. We can interpret these two states as weather conditions, which are not known to the agent at period 1 but are perfectly revealed at threshold date, which marks the the beginning of period 2. In other words, at the beginning of period 2, the agent knows for sure whether the status is early fulfillment or doomed failure.

Second, we denote y_t as the air quality in period t when $s = b$. We assume that $y_1 = z_0 + z_1 - x_1$ and $y_2 = y_1 + z_2 - x_2$. Basically, the exogenous parameter z_0 corresponds to the initial air quality at the beginning of the model, which reflects the stock of pollutants in the air. If the agent does nothing in either period (i.e., $z_1 = x_1 = z_2 = x_2 = 0$), the air quality will stay at z_0. The agent's efforts in period 1 will change the stock of pollutants in such a way that high efforts to protect the environment will reduce the stock while high efforts to promote economic growth will increase the stock. The net effect is measured as $z_1 - x_1$; hence the air quality in period 1 becomes $y_1 = z_0 + z_1 - x_1$. Similarly, the air quality in period 2 is given by $y_2 = y_1 + z_2 - x_2$. Notice that this specification also applies to the $s = g$ case by changing to a higher initial value z_0. Since the agent can easily fulfill the environmental target for sure when $s = g$, we do not explicitly model the air quality in this case to save notations.

Next, we make the following assumptions about how the agent's final payoffs are determined to capture important features of local officials' incentive schemes. First, if the agent fulfills environmental target y_0, then his or her expected reward is $f(x_1+x_2)v$, where x_1+x_2 is interpreted as the performance in economic growth. This assumption is consistent with the empirical literature on the promotion of China's local officials: those in prefectures with higher GDP growth rates are more likely to be promoted (see, e.g., Li and Zhou (2005)). So we can interpret $f(x_1+x_2)$ as the probability of promotion, satisfying $f' > 0$ and $f'' \leq 0$. Moreover, the pre-determined constant v measures the value of promotion.

Second, if the agent fails to meet the environmental target y_0, then he or she has zero probability of promotion. Moreover, there is a probability p of being punished (i.e., retirement or being investigated). If the agent is punished, his loss of utility is a pre-determined constant u. Therefore, in this case, the agent's expected loss is $-pu$. As discussed in Section 2.2, the probability p depends on the distance between the realized air quality and the target: $\Delta_y = y_0 - y_1 - y_2$. We further assume that p is convex and strictly increasing in Δ_y.

Third, the agent may receive intrinsic value from improving air quality. In period 1, the improvement is given by $y_1 - z_0$ while in period 2, it is denoted as $y_2 - z_0$. Therefore, the total utility is modeled as $\theta[\varphi(y_1 - z_0 + y_2 - z_0)]$, where θ measures the relative importance of environmental protection in the agent's utility function, and φ is a strictly increasing and concave function. Given the specification of air quality $y_1 = z_0 + z_1 - x_1$ and $y_2 = y_1 + z_2 - x_2$, we can rewrite $y_1 - z_0 + y_2 - z_0$ as:

$$y_1 - z_0 + y_2 - z_0 = 2(z_1 - x_1) + z_2 - x_2.$$

Finally, the agent's total effort cost is a function of total efforts $(x, z) = (x_1 + x_2, z_1 + z_2)$, written as $C(x_1 + x_2, z_1 + z_2)$. As in Holmstrom and Milgrom (1991) and Bénabou and Tirole (2016a), we assume that $C_{xz} \geq 0$, meaning that the two efforts are substitutes. For simplicity, we focus on the following convenient specification of the cost function throughout this paper: $C(x, z) = \frac{1}{2}c_x x^2 + \frac{1}{2}c_z z^2 + kxz$ with $k \geq 0$.

To summarize, each agent faces two possibilities: in the good state, his total utility is written as:

$$f(x_1 + x_2)v + \theta[\varphi(2(z_1 - x_1) + z_2 - x_2)] - C(x_1 + x_2, z_1 + z_2);$$

in the bad state, it is:

$$-p(\Delta_y)u + \theta[\varphi(2(z_1 - x_1) + z_2 - x_2)] - C(x_1 + x_2, z_1 + z_2).$$

5.2 Model Analysis

In this section, we solve the agent's optimal effort choices. We start with the extreme case of $\theta = 0$ and then generalize to the $\theta > 0$ case.

Case I: $\theta = 0$

In this case, the agent's total utility becomes $f(x_1 + x_2)v - C(x_1 + x_2, z_1 + z_2)$ in the good state and $-p(\Delta_z, \Delta_x)u - C(x_1 + x_2, z_1 + z_2)$ in the bad state. We solve the agent's optimal decision by backward induction. We first solve the agent's optimal decisions in period 2 depending on whether the state is revealed to be good or bad, and then solve the agent's optimal decision in period 1 given his or her prior belief about good and bad states.

Applying the above procedure yields the following claim:

PROPOSITION 1. *The optimal efforts satisfy $x_1 = x_2^b = z_2^g = 0$. Moreover, when $\alpha \geq \frac{1}{2}$, we must have $z_2^b > 0$.*

The intuition of this proposition is straightforward. First, in our model, the optimal solution satisfies $z_2^g = 0$: since the target can always be met in the good state, it is optimal to exert zero effort on environmental protection. Since the change in air quality in the good state is $y_2 - y_1 = z_2^g - x_2^g$, we expect to see a deterioration in air quality as long as the optimal solution x_2^g is interior.

Second, in the bad state, the optimal solution satisfies $x_2^b = 0$: since exerting effort on economic growth has no impact on promotion but increases the probability of getting punished in the bad state, it is optimal to exert zero effort on economic growth. Since the change in air quality in the bad state is $y_2 - y_1 = z_2^b - x_2^b$, we expect to see an improvement in air quality as long as the optimal solution z_2^b is interior.

The above reasoning implies that the critical issue is to determine the signs of x_2^g and z_2^b. The sign of z_2^b depends on two opposing effects. On the one hand, it is natural for a political incentive-driven agent to use a "wait-and-see" strategy – i.e., to exert very little effort in period 1, but huge effort on environmental protection after the threshold date when the state is revealed to be bad. On the other hand, since the first effort z_1 has a long-lasting improving effect on air quality, it is more beneficial to exert a greater effort in period 1. As the two efforts z_1 and z_2 are perfect substitutes, a higher z_1 will crowd out z_2^b. It turns out that when $\alpha \geq \frac{1}{2}$ (that is, the probability of failing to meet the target is sufficiently low), the first effect is strong enough; hence it is always suboptimal for the agent to exert an extremely high effort z_1 to completely crowd out z_2^b. Therefore, the agent exerts positive effort z_2^b in period 2 when the state turns out to be bad.

In our subsequent analysis, we focus on the case where $\alpha \geq \frac{1}{2}$ because it is consistent with our data.[26] Moreover, for most of our results, $\alpha \geq \frac{1}{2}$ is just a sufficient condition. Therefore the results still hold if α is slightly below $\frac{1}{2}$.

Proposition 1 says nothing about the signs of z_1 and x_2^g. Indeed, if k is very large, it is possible that either z_1 or x_2^g is zero. However, our next result shows that when k is sufficiently small, we can always get both $z_1 > 0$ and $x_2^g > 0$.

PROPOSITION 2. *Assume $\alpha \geq \frac{1}{2}$. If k is sufficiently close to zero, we must have $z_1 > 0$ and $x_2^g > 0$.*[27]

In the literature, it is common to assume that k is small. For example, Holmstrom and Milgrom (1991) assume that $k < \sqrt{c_x c_z}$. In this case, the interior solutions of x_2^g and z_2^b explain our observations

[26] As shown in footnote 17, the average rate of completion is 59%. As a result, if local bureaucrats' expectation of the difficulty in target fulfillment is based on overall performance, it is reasonable to deduce that the ex ante value should be larger than 1/2.

[27] In the poof of Proposition 5, we show the exact requirements on the parameter value of k in a simple numerical example.

after early fulfillment and doomed failure. After early fulfillment, the net effect of efforts is $z_2^g - x_2^g < 0$ and hence there is a deterioration in air quality. Yet after doomed failure, the agent knows that the state is bad and has to exert greater efforts to protect the environment. The net effect of efforts is $z_2^b - x_2^b > 0$, and hence there is an improvement in air quality.

The parameter value of v is highly correlated with political incentives. For example, a younger agent will expect to receive more rents from promotions and hence have a higher v. Based on the first-order conditions, we can immediately derive how a change in air quality depends on political incentives.

PROPOSITION 3. *Suppose $\alpha \geq \frac{1}{2}$ and $k < \sqrt{c_x c_z}$ is small enough such that the optimal solutions z_1, x_2^g and z_2^b are interior. Then the optimal solutions satisfy that $\frac{\partial x_2^g}{\partial v} > 0$ and $\frac{\partial z_2^b}{\partial v} > 0$.*

The intuition of the above result is as follows. As v increases, an agent would like to exert more effort to promote economic growth when the state is good. This naturally leads to a decrease in z_1 because a lower z_1 decreases the marginal cost of exerting x_2^g. Then in the bad state, the agent will exert greater effort z_2^b because (1) a lower z_1 implies that the agent must exert greater effort in period 2 to decrease the probability of punishment; and (2) a lower z_1 also decreases the marginal cost of exerting z_2^b. Therefore, as political incentives increase, both the improvement in air quality after doomed failure and the deterioration in air quality after early success will increase.

Case II: $\theta > 0$

Next we analyze the general case of $\theta > 0$. We also solve the problem through backward induction and find that, similar to the $\theta = 0$ case, our first result establishes the optimality of corner solution.

PROPOSITION 4. *Assume that $\alpha \geq \frac{1}{2}$. The optimal efforts satisfy $x_1 = z_2^g = x_2^b = 0$.*

At first glance, Proposition 4 derives the same results as Proposition 1. However, the existence of intrinsic motivations significantly changes the equilibrium values of z_1, x_2^g, and z_2^b. From the expression of intrinsic motivations, $\theta[\varphi(2(z_1 - x_1) + z_2 - x_2)]$, we can see that z_1 has a greater impact on intrinsic value due to the long-lasting effect of environmental protection effort exerted in period 1. Therefore, as θ increases, it is natural to increase z_1 accordingly. Compared with the $\theta = 0$ case, the first derivative with respect to x_2^g implies a sharp decrease in x_2^g for two reasons: First, the intrinsic value of environmental protection makes the agent less willing to exert effort to promote economic growth. Second, a higher z_1 increases the marginal cost of exerting effort on economic growth when $k > 0$. Therefore, when θ becomes large enough, it is possible that the optimal x_2^g becomes zero.

As θ increases, there are two opposing effects on z_2^b. On the one hand, the higher intrinsic value of environmental protection forces the agent to exert greater effort; on the other hand, a higher z_1 makes the effort more costly. The long-lasting effect of environmental protection effort exerted in period 1 implies a crowd-out of z_2^b by z_1 since the effort z_1 is relatively cheaper. As a result, we also expect to see $z_2^b = 0$ when θ becomes sufficiently large.

We use a simple numerical example to formally illustrate the above intuitions. In this example, we assume that all of f, p, and φ are linear, and denote $\lambda_f = f'$, $\lambda_p = p'$, and $\lambda_\varphi = \varphi'$. Then the first derivatives with respect to z_1, x_2^g, and z_2^b are given by:

$$\alpha(2\theta\lambda_\varphi - c_z z_1 - kx_2^g) + (1-\alpha)(2u\lambda_p + 2\theta\lambda_\varphi - c_z(z_1 + z_2^b));$$

$$v\lambda_f - \theta\lambda_\varphi - c_x x_2^g - kz_1;$$

and

$$u\lambda_p + \theta\lambda_\varphi - c_z(z_1 + z_2^b).$$

Notice that each of the above first derivatives equals zero when the corresponding optimal solution is interior, and is less than zero otherwise. Our next proposition shows that for any fixed parameters $\alpha \geq \frac{1}{2}$ and $k < \sqrt{c_x c_z}$ such that the optimal solutions x_2^g and z_2^b are interior when $\theta = 0$, there always exists $\bar{\theta} > 0$ such that the optimal solutions x_2^g and z_2^b are zero when $\theta \geq \bar{\theta}$.

PROPOSITION 5. *Fix any $\alpha \geq \frac{1}{2}$ and $k < \sqrt{c_x c_z}$. Suppose that $k < \frac{\alpha}{1-\alpha}\frac{\lambda_f v}{\lambda_p u}cz$. Then there exists $\bar{\theta} > 0$ such that $x_2^g > 0$ and $z_2^b > 0$ when $\theta = 0$; and $x_2^g = z_2^b = 0$ when $\theta \geq \bar{\theta}$.*

Proposition 5 justifies our intuitive discussions stated below Proposition 4. In particular, starting from optimal solutions $z_1 > 0$, $x_2^g > 0$ and $z_2^b > 0$, if we keep increasing θ, then z_1 will increase while x_2^g and z_2^b will decrease. Eventually, when θ becomes sufficiently large, the optimal solutions satisfy $x_2^g = z_2^b = 0$.

To summarize, our benchmark model establishes the following testable implications when the probability of good state $\alpha \geq \frac{1}{2}$:

1. For an agent with zero intrinsic value θ, there is an improvement in air quality after doomed failure and a deterioration in air quality after early success;

2. For an agent with zero intrinsic value θ, political incentives will increase both the improvement and the deterioration;

3. If the intrinsic value θ becomes sufficiently large, neither doomed failure nor early success affects air quality.

Findings 1 and 3 are consistent with our previous empirical results that outsiders and non-outsiders behave differently in both good and bad states. In particular, both the improvement in air quality after doomed failure and the deterioration in air quality after early success are indeed driven by outside agents with zero intrinsic value θ. Moreover, we have one additional testable prediction for outside agents: political incentives will increase both the improvement of air quality after the failure and the deterioration after the early success.

5.3 Model Extensions

In this section, we extend the benchmark model to include the interaction between economic growth and environmental protection as well as supervision and surveillance. These extensions yield more testable implications.

5.3.1 The Interaction between Economic Growth and Environmental Protection

Since we consider a multitasking setup in which the agent attempts to generate economic growth *and* protect the environment, it is natural to investigate the interaction between these two efforts. In this extension, the interaction is modeled by introducing uncertainty regarding the difficulty in achieving economic growth. Similar to our specification on the incentive scheme in environmental protection, we assume there is also an implicit target x_0 on economic growth.[28] We denote the distance between the realized growth rate and the target as $\Delta_x = x_0 - x_1 - x_2$. We assume that both the promotion probability f and the punishment probability p depend on Δ_x in the following way: $f = f(\Delta_x)$ if $\Delta_x > 0$ and $= f_0$ otherwise; $p = p(\Delta_y, \Delta_x)$ if $\Delta_x > 0$ and $= p(\Delta_y, p_0)$ otherwise. If the agent fails to achieve the growth target, a smaller gap between the realized growth rate and the target will increase the probability of being promoted or punished. But if the agent fulfills the target, we assume there is no additional effect from an increase in x.

Two additional states characterize the difficulty of achieving economic growth: e (easy) and d (difficult). We assume that state e occurs with probability γ and that both states are independent of the states in weather conditions. Moreover, under state e, the target x_0 can be achieved for sure, and under state d, the target x_0 cannot be achieved for sure.

We therefore have four different states in period 2: ge, gd, be, and bd. Obviously, in state ge, the agent does not need to exert any effort: $x_2^{ge} = z_2^{ge} = 0$, and hence there is no change in air quality; in

[28] Although x_0 is not publicly announced, the principal usually forms expectations about the potential of economic growth in a prefecture and judges the agent's performance based on whether that potential has been achieved.

state gd, $z_2^{gd} = 0$ and the agent chooses x_2^{gd} to maximize

$$f(\Delta x)v - C(x_1 + x_2, z_1 + z_2),$$

and if the resulting solution x_2^{gd} is interior, we observe a deterioration in air quality; in state be, $x_2^{be} = 0$, and the agent chooses z_2^{be} to maximize

$$-p(\Delta_y, p_0)u - C(x_1 + x_2, z_1 + z_2),$$

and if the resulting solution z_2^{be} is interior, there is an improvement in air quality; in state bd, the agent may exert positive efforts on both x_2^{bd} and z_2^{bd} and hence the change in air quality $z_2^{bd} - x_2^{bd}$ is ambiguous.

The above discussions imply that we can further explore the interaction between economic growth and environmental protection, as shown by the following proposition:

PROPOSITION 6. *Assume that both x_2^{gd} and z_2^{be} are interior. In state ge, there is no change in air quality; in state gd, there is a deterioration in air quality; in state be, there is an improvement in air quality; in state bd, the change is ambiguous.*

This proposition implies that the deterioration in air quality after early fulfillment should mostly occur when there is pressure to promote economic growth. Without such pressure, the agent exerts zero effort on either economic growth or environmental protection, and hence we do not expect such a deterioration. Similarly, improvement in air quality after doomed failure should definitely occur when there is no pressure to promote economic growth, since such pressure forces the agent to balance economic growth against environmental protection; hence the overall effect is ambiguous.

5.3.2 The Effects of Supervision and Surveillance

In our benchmark model, we assume that only the overall environmental performance $y = y_1 + y_2$ matters. Therefore, the agent can manipulate his or her efforts depending on whether there is early fulfillment or doomed failure. In this section, we consider another case: the principal is able to continuously monitor the agent. This monitoring technology allows the principal to punish the agent based not only on *overall* environmental performance, but also on his or her performance in each period. This can substantially change the agent's incentives to manipulate their efforts.

To formally illustrate this idea, we consider a simplified version of our benchmark model where $\theta = k = 0$ and both f and p are linear. We revise the agent's utility function as follows: when the state is good, the agent's utility is:

$$f(x_1+x_2)v+\pi_g(z_2-x_2)-\frac{1}{2}c_x(x_1+x_2)^2-\frac{1}{2}c_z(z_1+z_2)^2;$$

when the state is bad, it is:

$$-p(\Delta_y)u+\pi_b(z_2-x_2)-\frac{1}{2}c_x(x_1+x_2)^2-\frac{1}{2}c_z(z_1+z_2)^2.$$

The functions π_g and π_b can be interpreted as rewards/punishments based on the agent's performance in period 2. For example, in the good state, if an agent is caught slacking on environmental protection, he or she can be punished even if they meet their environmental target; in the bad state, if the agent is found to work hard on environmental protection, they may be punished less severely for failing to meet the target. Our next result shows that under certain assumptions, introducing π_g and π_b improves the agent's performance in environmental protection in the second period regardless of the state.

PROPOSITION 7. *Suppose both π_g and π_b are linear satisfying $\pi_g' = \lambda_g$ and $\pi_b' = \lambda_b$. If λ_g and λ_b satisfy*

$$-\alpha\lambda_g+(1-\alpha)(\lambda_p u-\lambda_b)<0.$$

Then compared with the benchmark model, the introduction of π_g and π_b leads to a larger $z_2^g - x_2^g$ and a larger $z_2^b - x_2^b$.

This proposition implies that if the incentive scheme can be designed to incorporate continuous supervision and surveillance, then the agent will strategically respond to this oversight by delivering a greater (lesser) improvement in air quality after doomed failure (early fulfillment).

6 Additional Empirical Tests Derived from the Model

Our theoretical model rationalizes the empirical findings reported in Tables 3 and 4 (including Figure 5) and generates new insights about the effects of political incentives, intrinsic motivations, pressures to achieve local economic growth, and central monitoring on local officials' responses to different target fulfillment statuses. In this section, we empirically test these new theoretical predictions in turn.

6.1 Effects of Political Incentives in the Absence of Intrinsic Motivations

The theoretical model highlights the role of local officials' political incentives. Proposition 3 predicts that if we focus on local officials with no intrinsic motivations, both air quality improvements after doomed failure and deterioration after early fulfillment increase with the intensity of bureaucrats' political motivation. To empirically test this prediction, we construct two measures to capture the intensity of bureaucrats' political incentives. First, we follow the method proposed by Yu et al. (2016) and He et al. (2020) and define high-incentive officials as those younger than 57, which utilizes the informal rule in China that the probability of promotion drops dramatically after this age. Second, we compute career-concern intensity for every party secretary in the same way as Wang et al. (2020). For each province in each year, we pool all incumbent party secretaries and obtain the median career-concern intensity; we consider those above the median to be high-incentive officials. This measure is based on the locality of political tournaments in China, in which prefectural party secretaries mainly compete with their peers in other prefectures in the province, which has been the case since the personnel control reforms launched in 1984 empowered provincial governments to appoint prefecture-level officials in their provinces.

In the theoretical model, we discuss the role of political incentives in the case of $\theta = 0$ for simplicity. To keep the empirical design consonant with it, we first bifurcate local bureaucrats into high-/low-incentive subsamples and then restrict regression analyses to outsiders who have never worked in the prefectures where they are currently taking office (i.e., the stricter definition of outsiders introduced in Section 4.3). Again, we create four subsamples for heterogeneity analysis: failure year & low-incentive, failure year & high-incentive, fulfillment year & low-incentive, fulfillment year & high-incentive.

Table 5 reports estimates from the subsample regressions. High-incentive bureaucrats are defined as those younger than 57 in Panel A and those with above-median career-concern intensity in Panel B. If we compare estimates in Columns (1) and (3) with those in Columns (2) and (4), it is obvious that high-incentive officials react much more intensely than their low-incentive counterparts when faced with either doomed failure or early fulfillment, as implied by the estimates in Columns (2) and (4), which dominate in both magnitude and significance level, regardless of how "high incentive" is defined.

6.2 Pressures of Local Economic Performance

Extending our theoretical model offers insights about how the pressure to exhibit economic growth interacts with local officials' responses to completing AQI targets. In this subsection, we would like to directly test the prediction derived in Section 5.3.

There is no obvious way to measure the pressure to demonstrate strong economic performance faced by Chinese local officials, who compete with their peers for promotions based on regional economic growth. Prefectural officials' economic performance is usually benchmarked against that of their peers in the same province (Chen et al., 2005; Landry et al., 2018). For instance, prefectural governments' quarterly work reports often contain statements such as "our quarterly growth rate ranked highly among prefectures within the same province" or "our growth rate was above the provincial level." Based on these observations, we constructed two measures to capture the burden of economic growth experienced by prefectural leaders. First, prefecture c in quarter q would be classified as "having a low burden of GDP growth" if its quarterly growth rate in quarter $q-1$ was above the median growth rate of all prefectures in the province. The second measure is whether the prefecture's quarterly growth rate in quarter $q-1$ was above the provincial growth rate.[29]

To measure the pressure on local officials to demonstrate progress in economic performance, we manually collected prefecture-level quarterly GDP growth rates from the official websites of prefectural governments or bureaus of statistics. We supplemented this information with provincial quarterly growth rates from the National Bureau of Statistics. Table 6 reports the estimation results when we bifurcate the sample according to the relative burden of economic growth. The first two columns in each panel provide supportive evidence of the conflict between economic development and environmental protection, which is rooted in the assumption that efforts exerted in them are substitutes for each other. That is, if prefectural leaders performed poorly in economic growth in the last quarter and are thus under greater pressure to demonstrate growth, the motivation to improve air quality after doomed failure would be weaker. This result is reflected in a smaller magnitude of the estimated coefficient in Column (2). Correspondingly, Column (4) implies that prefectural-level officials under more pressure to meet economic growth targets would shift their efforts to economic development immediately after fulfilling their AQI targets, and air quality would deteriorate by large margins. The estimate in Column (3) is smaller in magnitude and statistically insignificant, suggesting that officials from prefectures with good GDP performance are less motivated to shift their efforts away from air quality controls when their AQI targets are met early.

6.3 Effects of Central Surveillance

Proposition 7 predicts that stricter central government surveillance will motivate prefectural leaders to exert more effort in case of doomed failure and to alleviate the deterioration in the case of early fulfillment. The central government surveillance campaigns allow us to test this prediction. In 2013, the MEE issued a list of 79 cities that have been closely watched by the central government since then.

[29] The provincial GDP growth rate is approximately a weighted average of prefectural growth rate where weights are the level value of prefectural GDP in the province. In essence, we identify prefectures with a low burden to demonstrate economic growth by comparing their performance with the median or weighted average of prefectures in the same province, respectively.

As stated in a publicly accessible document, the MEE evaluates those cities on a monthly basis and discloses the bottom 10 cities every month, which imposes a heavy burden on cities on the watchlist. The watchlist was expanded to 164 cities in the second half year of 2018.[30] We classify prefectures on the watchlist as "strictly supervised" and those not on the list as "loosely supervised."

Table 7 shows that the regular surveillance from central government has effectively constrained bureaucrats' strategic shirking on air pollution control. Comparing the estimates in the first and last two columns clearly indicates that the improvement after doomed failure is strengthened (and the deterioration after early fulfillment is weakened) in prefectures under stricter supervision. Furthermore, consistent with the assumption made in Section 5.3.2 ($\theta = k = 0$), the results from subsample regressions in Panels B and C suggest that the empirical findings are mainly driven by outsiders, who derive little intrinsic value from air quality improvement and are thus more sensitive to central supervision.

7 Conclusion

This paper examines how Chinese local officials respond strategically to minimum air quality standards when they care more about pursuing regional economic development because it is closely linked to their career prospects. We exploit several institutional features of China's environmental regulation, such as top-down target setting, the obligatory and quantitative nature of air pollution control targets, and the government's recent crackdown on data manipulation to tackle the empirical challenges associated with measuring the impact of such targets. Our results, obtained using a modified version of RDD, highlight the double-edged effects of obligatory targets: local bureaucrats continue to engage in environmental protection efforts rather than completely give up after doomed failure, but are not incentivized to devote extra effort if they meet their targets before the end of the year.

Our theoretical and empirical analyses highlight the role of bureaucrats' heterogeneity in intrinsic motivations and political incentives. Those who exhibit a low affinity for local environmental protection and a high level of political incentives react more intensely to the completion status of obligatory targets. Air quality improvement after doomed failure is also strengthened (and the deterioration after early fulfillment is weakened) if officials are under less pressure to demonstrate economic growth or stricter supervision from the central government. Our study sheds light on how minimum air quality targets worked in China and highlights the role of intrinsic motivations in mitigating the strategic responses to the minimum performance targets in a multitasking environment.

[30]See Shi et al. (2019) for a comprehensive introduction of institutional details and an evaluation of the effectiveness.

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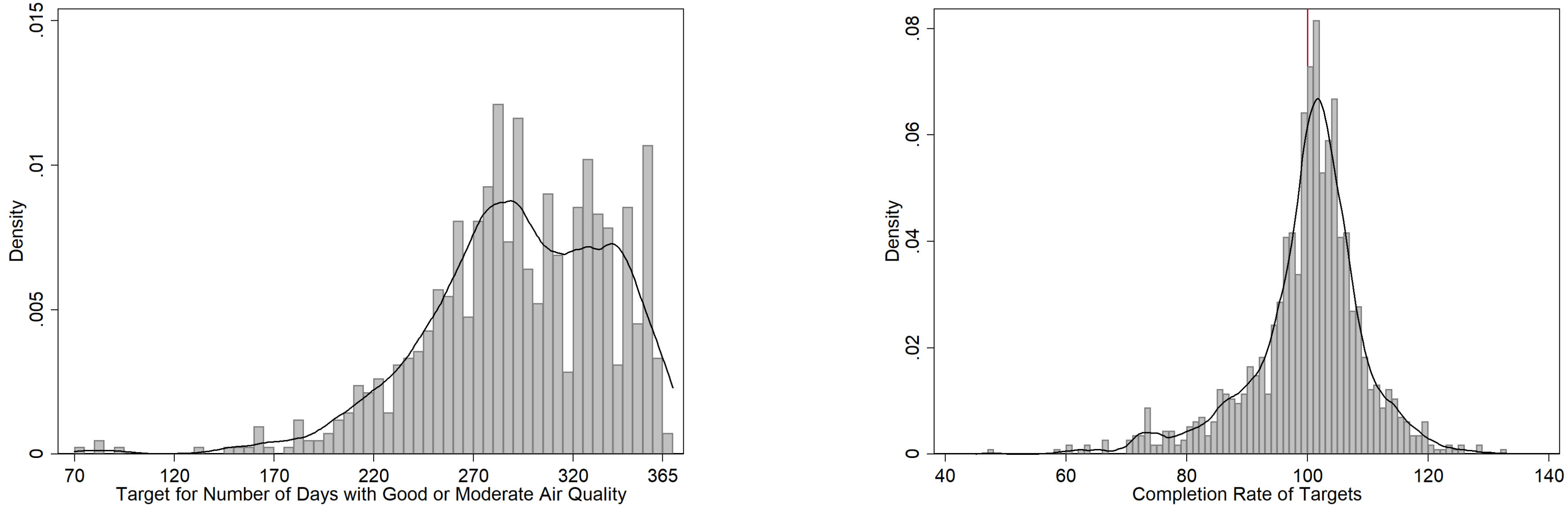
Figure 1: Distribution of Targets and Completion Rates

Panel A Distribution of Targets

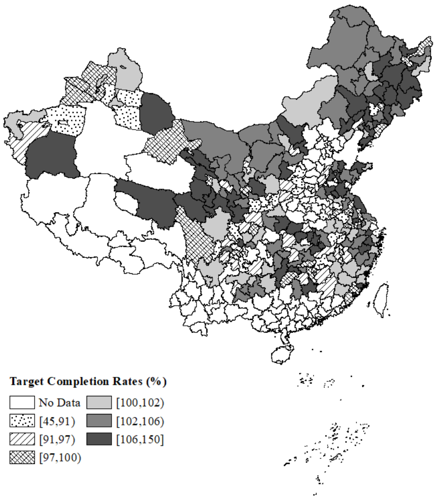
Panel B Distribution of Completion Rates



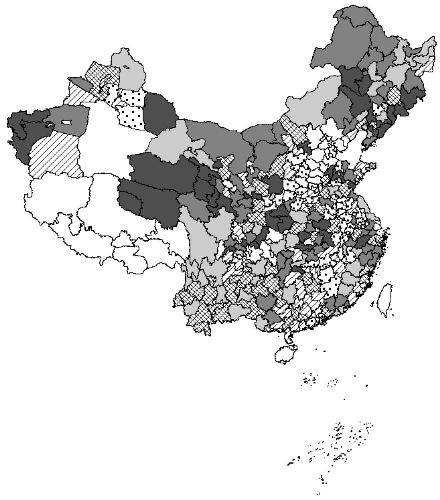
Notes: This graph plots the histogram of prefecture-year targets and completion rates along with the estimated kernel density. The completion rate equals to (actual percentage of days with AQI $\leq$ 100 / target percentage of days with AQI $\leq$ 100) $\times$ 100. That is, completion rates no less than 100 imply that the targets have been fulfilled.

Figure 2: Geographical Distributions of Target Completion Rates

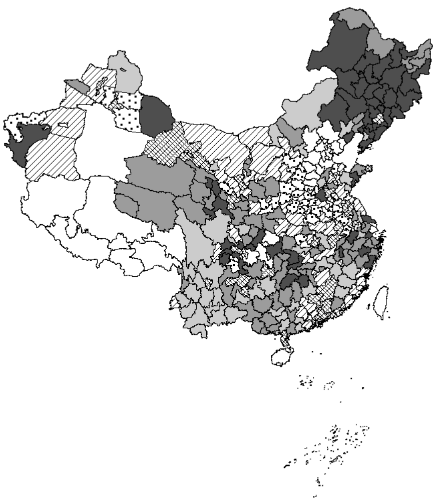
Panel A 2016



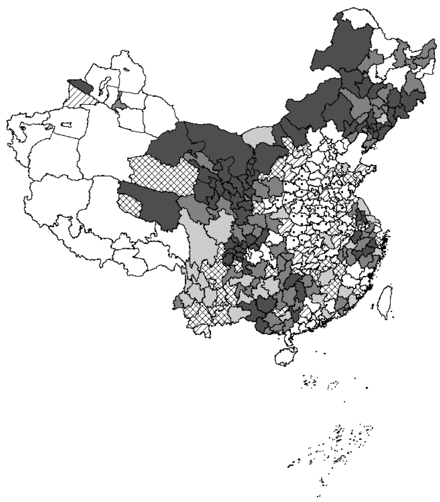
Panel B 2017



Panel C 2018



Panel D 2019

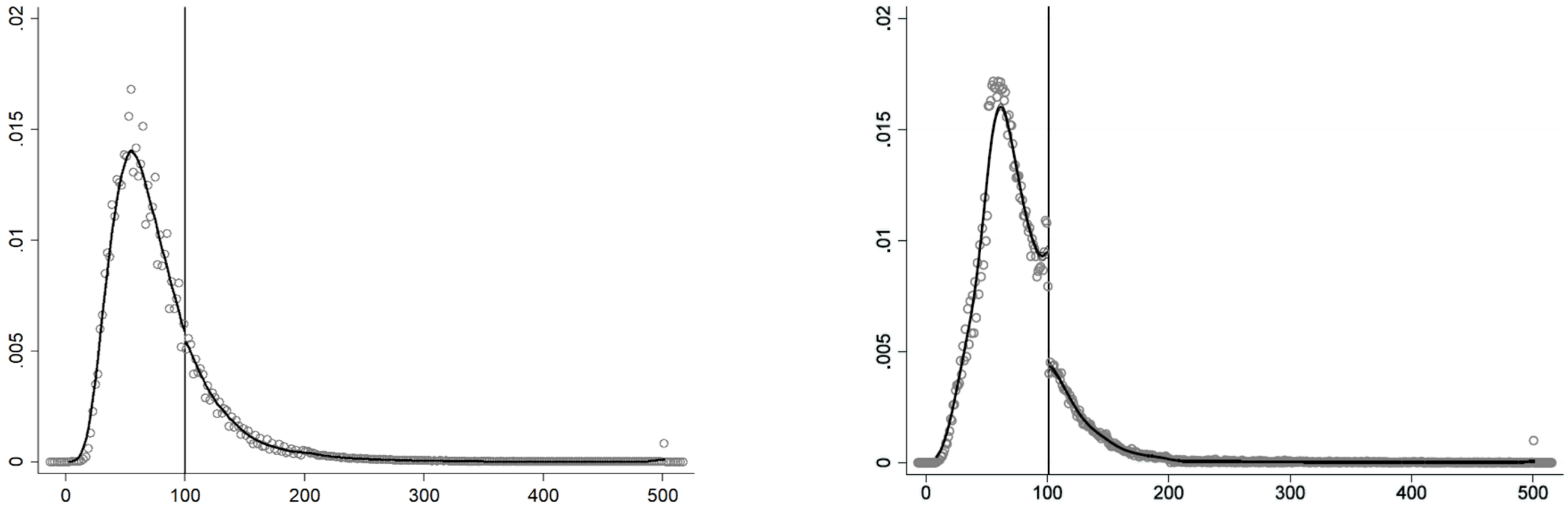


Notes: This graph plots the prefectural completion rates of targets on China's map by year. It shows that completion statuses vary considerably both cross-sectionally and over time.

Figure 3: McCrary Test of AQI and Discontinuity around 100

Panel A McCrary Test of AQI in Our Sample

Panel B McCrary Test of API in Chen et al. (2012)



Notes: Panel A plots the graph of McCrary test of the AQI data used in this paper and Panel B is extracted from Chen et al. (2012). The obvious discontinuity around 100 in Panel B was interpreted as the clue for manipulation of API in Chen et al. (2012) while it is not observed in our AQI data.

Figure 4: Supportive Evidence for the Incentive Scheme

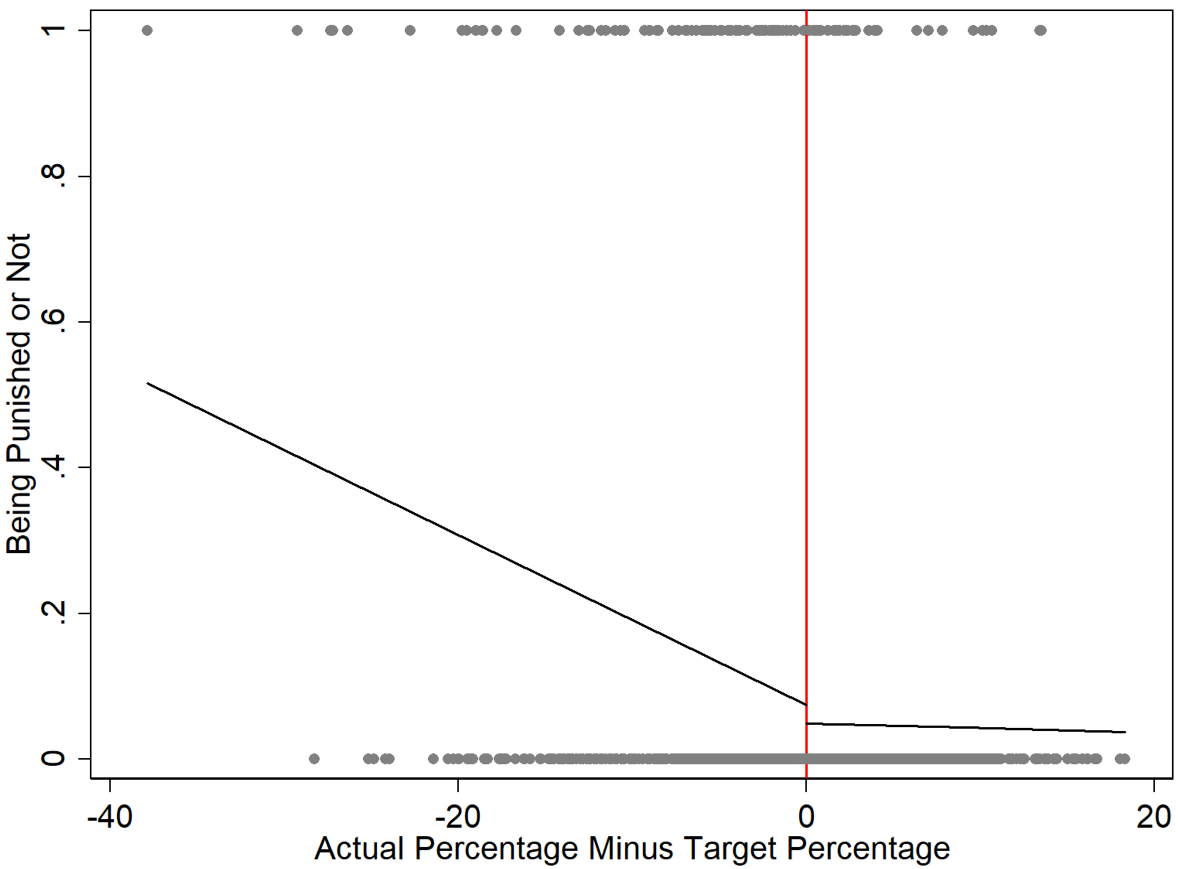


Figure 5: Graphic Evidence from RD

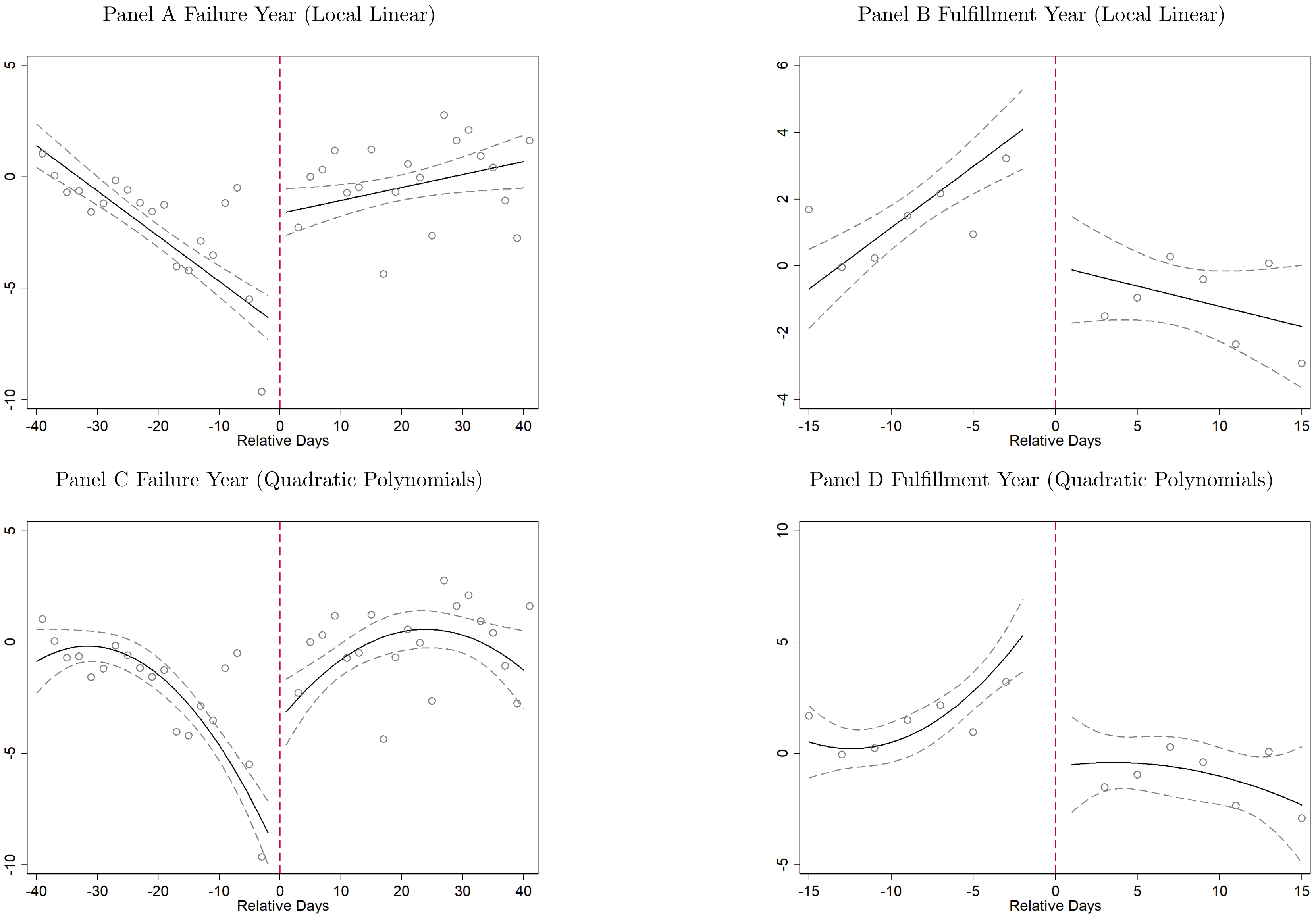
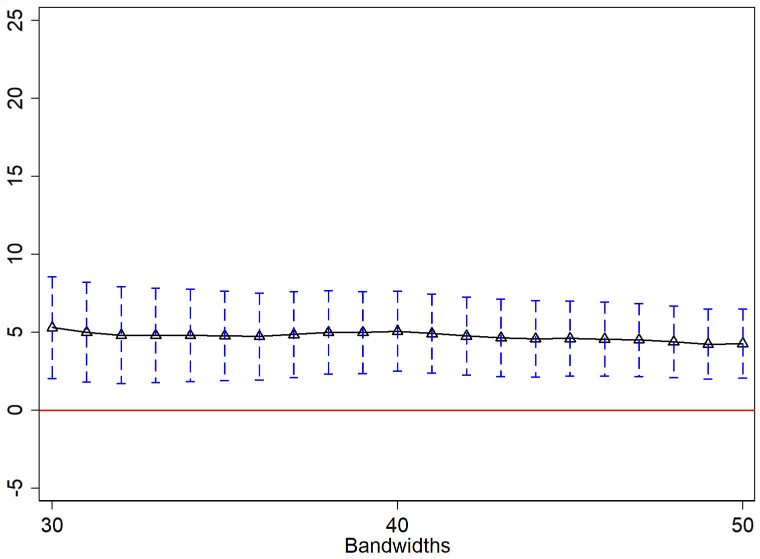
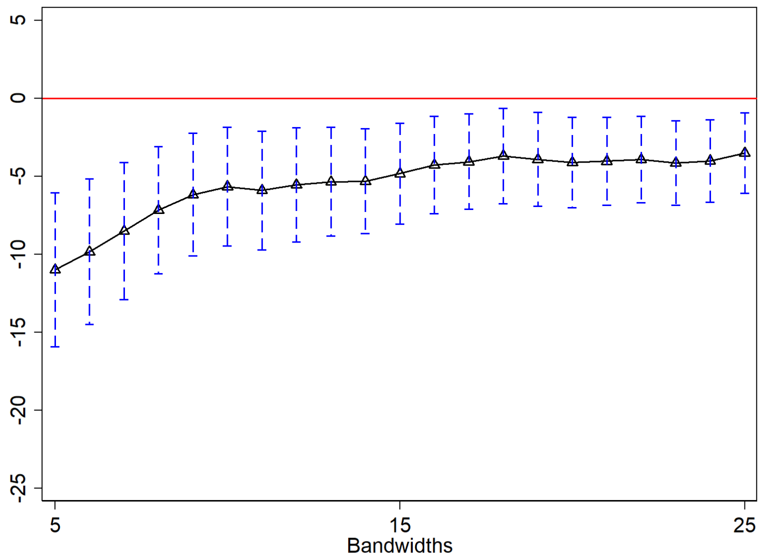


Figure 6: Robust Checks of Bandwidth Selection

Panel A Failure Year



Panel B Fulfillment Year



Notes: This graph shows point estimates along with 95% confidence intervals from RD under different bandwidths. We experiment on bandwidths within a range with a length of 10 which is centered around the bandwidth in baseline setting (i.e., 40 and 15 for failure and fulfillment subsamples). The optimal bandwidths computed from the method proposed by Calonico et al. (2014) are also covered, which are 45 and 13 for each subsample, respectively. Standard errors are clustered at prefecture level.

Table 1: Summary Statistics

	N	Mean	Std. Dev.	Min	Max
Panel A Prefecture-Year Variables					
Actual Percentage of Days with AQI $\leq$ 100	1554	79.93	15.94	19.73	100
Target Percentage of Days with AQI $\leq$ 100	1154	79.99	13.09	20	100
Completion Rates of Targets	1154	99.84	9.63	47.68	132.51
Panel B Prefecture-Day Variables					
AQI	538889	78.09	46.32	3	500
Normalized AQI(NAQI)	538889	421.91	46.32	0	497
Residuals of NAQI	538889	0	32.86	-447.9	275.28
Daily Minimum Temperature	538889	10.6	11.49	-42	35
Daily Maximum Temperature	538889	20.07	10.92	-34	47
Dummy for Precipitation	538889	0.35	0.48	0	1
Dummy for Snow	538889	0.03	0.16	0	1
Category of Wind Speed	538889	1.43	0.7	1	4
Panel C Characteristics of Prefecture-Party Secretaries					
Dummy for Outside Promoted Bureaucrats	788	0.652	0.477	0	1
Dummy for Bureaucrats without Local Work Experience	788	0.59	0.492	0	1
Age of Incumbent Party Secretaries	788	52.25	2.99	41.67	58.58
Career-Concern Intensity	788	0.285	0.127	0	0.816

Table 2: Supportive Evidence for the Incentive Scheme

Dependent Variable	*Being Named or Summoned for Administrative Talk in the Next Year*
Moderate Failure	0.067**
	(0.03)
Severe Failure	0.116**
	(0.049)
Prefecture Fixed Effects	YES
Year Fixed Effects	YES
Number of Observations	877

Notes: This table reports estimates from a prefecture-year level regression to provide supportive evidence for the incentive scheme. The outcome variable is a dummy variable denoting whether the prefecture is summoned for administrative talk or name-picked during the inspection in the next year. Explanatory variables are two dummies indicating whether the prefecture has failed by a moderate or large margin this year, with fulfillment cases as a control group.

Table 3: Regression Discontinuity Estimates and Robustness Checks

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	*Residual of Normalized AQI*					
Target Completion Status	*Failure*			*Fulfillment*		
Post	5.079	5.474	6.262	-4.814	-5.942	-8.015
	(1.307) ***	(1.590) ***	(2.296) ***	(1.637) ***	(1.746) ***	(2.511) ***
	[0.832] ***	[0.964] ***	[1.375] ***	[1.126] ***	[1.245] ***	[1.928] ***
Dep. Var. Mean	-1.625	-2.463	-1.625	0.576	0.576	0.576
Bandwidth	40	40	40	15	15	15
Kernel Function	Uniform	Triangular	Uniform	Uniform	Triangular	Uniform
RD Specification	LLR	LLR	Quadratic Polynomials	LLR	LLR	Quadratic Polynomials
Number of Observations	32446	31698	32446	15701	15701	15701

Notes: This table reports estimates from RD estimation described by equation (1) and (2). "LLR" stands for local linear regression. Standard errors clustered at prefecture level and heteroscedasticity-robust standard errors are reported in parentheses and brackets respectively with ***, **, * denoting significance at the 1%, 5%, 10% level.

Table 4: Effects of Intrinsic Motivations: Outsiders versus Non-Outsiders

	(1)	(2)	(3)	(4)
Dependent Variable	*Residual of Normalized AQI*			
Target Completion Status	*Failure*		*Fulfillment*	
Subsample	*Outsiders*	*Non-Outsiders*	*Outsiders*	*Non-Outsiders*
Panel A Outsiders Defined According to Previous Working Location				
Post	6.715***	2.159	-6.517***	-1.465
	(1.666)	(2.093)	(2.095)	(2.538)
Dep. Var. Mean	-1.589	-1.69	0.776	0.181
Number of Observations	20800	11646	10431	5270
Panel B Outsiders Defined According to Work Experience throughout the Career				
Post	5.712***	4.269**	-6.509***	-2.398
	(1.69)	(2.049)	(2.219)	(2.404)
Dep. Var. Mean	-1.408	-1.919	1.118	-0.194
Number of Observations	18660	13786	9224	6477
Bandwidth	40	40	15	15
Kernel Function	Uniform	Uniform	Uniform	Uniform
RD Specification	LLR	LLR	LLR	LLR

Notes: This table reports results from subsample regressions which investigate different responses by outsiders versus non-outsiders. In Panel A, outsiders are defined as party secretaries who were appointed from other prefectures or provincial departments rather than locally promoted from the prefecture. In Panel B, outsiders are defined as those who had never worked in the prefecture before.

Table 5: Effects of Political Incentive Intensities

	(1)	(2)	(3)	(4)
Dependent Variables	*Residual of Normalized AQI*			
Target Completion Status	*Failure*		*Fulfillment*	
Subsample	*Low-Incentive*	*High-Incentive*	*Low-Incentive*	*High-Incentive*
Panel A Political Incentive Measured by Age				
Post	2.367	6.634***	-4.54	-6.933***
	(2.632)	(1.955)	(5.604)	(2.424)
Dep. Var. Mean	-1.776	-1.302	3.578	0.607
Number of Observations	4174	14486	1585	7639
Panel B Political Incentive Measured by Career-Concern Intensity				
Post	5.326**	6.173**	-4.029	-9.126***
	(2.147)	(2.566)	(3.122)	(3.125)
Dep. Var. Mean	-1.58	-1.205	1.565	0.673
Number of Observations	10115	8545	4599	4625
Bandwidth	40	40	15	15
Kernel Function	Uniform	Uniform	Uniform	Uniform
RD Specification	LLR	LLR	LLR	LLR

Notes: This table reports results from subsample regressions to shed light on the role of political incentive. In Panel A, we follow the method proposed by Yu et al. (2016) and He et al. (2020) and define the high-incentive group as those younger than 57, the cutoff age for a discontinuous drop in promotion probability. In Panel B, the criterion for splitting subsample is whether the career-concern intensity is above the median of all incumbent party secretaries within the same province in that year. The career concern intensity is computed according to Wang et al. (2020).

Table 6: Effects of Economic Performance Pressures

	(1)	(2)	(3)	(4)
Dependent Variables	*Residual of Normalized AQI*			
Target Completion Status	*Failure*		*Fulfillment*	
Subsample	*Low Burden of Economic Growth*	*High Burden of Economic Growth*	*Low Burden of Economic Growth*	*High Burden of Economic Growth*
Panel A Subsample Criterion: Above/Below the Median Growth Rate within the Province				
Post	6.574***	4.588**	-1.455	-7.822***
	(2.004)	(1.803)	(2.437)	(2.584)
Dep. Var. Mean	-2.474	-0.708	0.462	0.732
Number of Observations	16837	14407	7123	6826
Panel B Subsample Criterion: Above/Below the Provincial Growth Rate				
Post	6.089***	4.159**	-2.062	-7.992***
	(1.886)	(1.94)	(2.382)	(2.623)
Dep. Var. Mean	-1.916	-1.206	0.558	0.754
Number of Observations	18952	12803	7801	6988
Bandwidth	40	40	15	15
Kernel Function	Uniform	Uniform	Uniform	Uniform
RD Specification	LLR	LLR	LLR	LLR

Notes: This table reports results from subsample regressions to incorporate economic performance pressures into the analysis. In Panel A, a heavier economic performance pressure refers to the situation that the GDP growth rate of the city in last quarter is below the median growth rate of all prefectures within the province. In Panel B, a heavier economic pressure is defined as a situation where a prefecture's quarterly growth rate is below the provincial one, which is a weighted average of prefectural growth rates.

Table 7: Effects of Supervision and Surveillance

	(1)	(2)	(3)	(4)
Dependent Variables	*Residual of Normalized AQI*			
Target Completion Status	*Failure*		*Fulfillment*	
Subsample	*Loosely Supervised*	*Strictly Supervised*	*Loosely Supervised*	*Strictly Supervised*
Panel A Full Sample Regression				
Post	3.988**	6.189***	-5.355**	-3.428
	(1.939)	(1.714)	(2.07)	(2.243)
Dep. Var. Mean	-2.28	-0.87	0.661	0.361
Number of Observations	17375	15071	11284	4417
Panel B: Subsample Regression Using Outsiders				
Post	3.414	8.075***	-7.372**	-4.874*
	(2.48)	(2.419)	(3.076)	(2.644)
Dep. Var. Mean	-2.009	-0.73	1.178	1.001
Number of Observations	9901	8759	6093	3131
Panel C: Subsample Regression Using Non-Outsiders				
Post	4.725	3.762	-3.027	0.068
	(3.043)	(2.576)	(2.762)	(4.172)
Dep. Var. Mean	-2.64	-1.065	0.054	-1.197
Number of Observations	7474	6312	5191	1286

Notes: This table reports results which examine the effects of supervision and surveillance. The strictly supervised subsample refers to those cities closely watched by the central government, which were selected by MEE in 2013. The number of cities in this group was expanded from 79 to 164 in the second half year of 2018.

Appendix A Mathematical Appendix

Proof of Proposition 1

Proof. In period 2, if the state is revealed to be good, then the agent solves the following maximization problem:

$$h_g(x_1, z_1) = \max_{x_2, z_2}\{f(x_1, x_2)v - C(x_1 + x_2, z_1 + z_2)\}.$$

Obviously, the optimal solution satisfies $z_2^g = 0$. The first derivative with respect to x_2 is

$$f'(x_1 + x_2)v - c_x(x_1 + x_2) - kz_1.$$

If there is an interior optimal solution x_2^g, then the first order condition implies:

$$f'(x_1 + x_2^g)v - c_x(x_1 + x_2^g) - kz_1 = 0.$$

Otherwise, the optimal x_2^g is the corner solution $x_2^g = 0$ and hence we should have

$$f'(x_1)v - c_x x_1 - kz_1 \leq 0.$$

Moreover, from the envelope theorem, we have:

$$\frac{\partial h_g}{\partial x_1}(x_1, z_1) = f'(x_1 + x_2^g)v - c_x(x_1 + x_2^g) - kz_1 \leq 0$$

and

$$\frac{\partial h_g}{\partial z_1}(x_1, z_1) = -c_z z_1 - k(x_1 + x_2^g) \leq 0.$$

In period 2, if the state is revealed to be bad, then the agent solves the following maximization problem:

$$h_b(x_1, z_1) = \max_{x_2, z_2}\{-p(\Delta_y)u - C(x_1 + x_2, z_1 + z_2)\}.$$

Obviously, the optimal solution $x_2^b = 0$ and the first derivative with respect to z_2^b is:

$$p'u - c_z(z_1 + z_2^b) - kx_1.$$

We can also apply the envelope theorem, and obtain:

$$\frac{\partial h_b(x_1,z_1)}{\partial x_1} = -2p'u - c_x x_1 - k(z_1 + z_2^b) < 0;$$
$$\frac{\partial h_b(x_1,z_1)}{\partial z_1} = 2p'u - c_z(z_1 + z_2^b) - kx_1.$$

Finally, in period 1, the agent solves the following problem:

$$\max_{x_1,z_1}\{\alpha h_g(x_1,z_1) + (1-\alpha)h_b(x_1,z_1)\}.$$

We have already shown that $x_2^b = z_2^g = 0$. To prove $x_1 = 0$, denote $\Omega(x_1,z_1) = \alpha h_g(x_1,z_1) + (1-\alpha)h_b(x_1,z_1)$. From the envelope theorem, we obtain the first derivative of Ω with respect to x_1:

$$\frac{\partial \Omega(x_1,z_1)}{\partial x_1} = \alpha\left[f'(x_1 + x_2^g)v - c_x(x_1 + x_2^g) - kz_1\right] - (1-\alpha)\left[2p'u + c_x x_1 + k(z_1 + z_2^b)\right] < 0, \quad \forall x_1 \geq 0.$$

Therefore, it is always optimal to set $x_1 = 0$. Moreover, $x_1 = 0$ implies the first derivative of Ω with respect to z_1:

$$\frac{\partial \Omega(x_1,z_1)}{\partial z_1} = -\alpha(c_z z_1 + kx_2^g) + (1-\alpha)\left[2p'u - c_z(z_1 + z_2^b)\right].$$

Suppose by contradiction that the optimal $z_2^b = 0$. This implies that $p'u - c_z z_1 \leq 0$ or $2p'u - c_z z_1 \leq c_z z_1$. As a result, $\alpha \geq \frac{1}{2}$ implies that

$$\frac{\partial \Omega(x_1,z_1)}{\partial z_1} \leq -\alpha(c_z z_1 + kx_2^g) + (1-\alpha)c_z z_1 \leq 0, \quad \forall z_1 \geq 0.$$

So, it is always optimal to set $z_1 = 0$ as well. But then the first derivative with respect to z_2^b becomes $p'u > 0$, a contraction! Therefore, we conclude that $z_2^b > 0$. □

Proof of Proposition 2

Proof. If $k = 0$, the first derivative with respect to x_2^g becomes $f'(x_2^g)v - c_x x_2^g > 0$ at $x_2^g = 0$. Since the inequality is strict, it still holds for k sufficiently small. Hence, we have $x_2^g > 0$ for k sufficiently close to zero.

Similarly, if $k = 0$,

$$\frac{\partial \Omega(x_1,z_1)}{\partial z_1} = -\alpha c_z z_1 + (1-\alpha)c_z(z_1 + z_2^b) > 0$$

at $z_1 = 0$. So, we conclude that $z_1 > 0$ for k sufficiently close to zero. □

Proof of Proposition 3

Proof. If the optimal solutions z_1, x_2^g and z_2^b are interior, the first order conditions imply that:

$$f'(x_2^g)v - c_x x_2^g - kz_1 = 0;$$

$$p'u - c_z(z_1 + z_2^b) = 0;$$

and

$$-\alpha(c_z z_1 + kx_2^g) + (1-\alpha)c_z(z_1 + z_2^b) = 0.$$

When $k = 0$, x_2^g is purely determined by the equation $f'(x_2^g)v = c_x x_2^g$ while (z_1, z_2^b) are determined by equations $p'u = c_z(z_1 + z_2^b)$ and $(2\alpha - 1)z_1 = (1-\alpha)z_2^b$. Based on the assumptions of f, it is straightforward to see that $\frac{\partial x_2^g}{\partial v} > 0$, and $\frac{\partial z_2^b}{\partial v} = 0$.

When $k > 0$, total differentiation with respect to the first order conditions yields that

$$-(c_x - f''v)\frac{c_z}{\alpha k}\frac{(\alpha c_z + p''u)dz_1}{c_z + p''u} + kdz_1 = f'dv.$$

The assumptions of $f'' \leq 0$ and $p'' \geq 0$ together with the assumption $k < \sqrt{c_x c_z}$ imply that

$$k - (c_x - f''v)\frac{c_z}{\alpha k}\frac{\alpha c_z + p''u}{c_z + p''u} < 0,$$

and hence $\frac{\partial x_1}{\partial v} < 0$. Consequently, we obtain $\frac{\partial x_2^g}{\partial v} > 0$, and $\frac{\partial z_2^b}{\partial v} > 0$. □

Proof of Proposition 4

Proof. With a little abuse of notations, we define

$$h_g(x_1, z_1) = \max_{x_2, z_2} f(x_1 + x_2)v + \theta[\varphi(2(z_1 - x_1) + z_2 - x_2)] - C(x_1 + x_2, z_1 + z_2);$$

$$h_b(x_1, z_1) = \max_{x_2, z_2} -p(\Delta_y)u + \theta[\varphi(2(z_1 - x_1) + z_2 - x_2)] - C(x_1 + x_2, z_1 + z_2);$$

and

$$\Omega(x_1, z_1) = \alpha h_g(x_1, z_1) + (1-\alpha)h_b(x_1, z_1).$$

Obviously, the optimal solution x_2^b should be zero. From the envelope theorem, it is straightforward to see that $\frac{\partial h_b(x_1,z_1)}{\partial x_1} < 0$ and $\frac{\partial h_g(x_1,z_1)}{\partial x_1} < 0$. Therefore, $\frac{\partial \Omega(x_1,z_1)}{\partial x_1} < 0$ and it is optimal to set $x_1 = 0$.

Now suppose by contradiction that z_2^g is interior. There are two cases to consider. In the first case, both z_2^g and z_2^b are interior. Then the first order conditions imply:

$$\theta\varphi' = c_z(z_1 + z_2^g) + kx_2^g \quad \text{and} \quad p'u + \theta\varphi' = c_z(z_1 + z_2^b). \tag{3}$$

Apply the envelope theorem and we can get:

$$\frac{\partial h_g(x_1, z_1)}{\partial z_1} = 2\theta\varphi' - c_z(z_1 + z_2^g) - kx_2^g > 0; \tag{4}$$

and

$$\frac{\partial h_b(x_1, z_1)}{\partial z_1} = 2(p'u + \theta\varphi') - c_z(z_1 + z_2^b) > 0. \tag{5}$$

Therefore, we must have

$$\frac{\partial \Omega(x_1, z_1)}{\partial z_1} > 0, \quad \forall z_1. \tag{6}$$

Hence, the optimal z_1 goes to infinity. But this cannot be optimal as it implies a payoff of $-\infty$.

In the other case, $z_2^b = 0$, then we can similarly apply the envelope theorem and get

$$\frac{\partial \Omega(x_1, z_1)}{\partial z_1} = \alpha \left[c_z(z_1 + z_2^g) + kx_2^g\right] + (1-\alpha)\left[2(p'u + \theta\varphi') - c_z z_1\right] > 0, \tag{7}$$

as $\alpha \geq \frac{1}{2}$. This cannot be optimal as well.

So we conclude by contradiction that $z_2^g = 0$. □

Proof of Proposition 5

Proof. We first show that both $x_2^g > 0$ and $z_2^b > 0$ when $\theta = 0$. Since $z_2^b > 0$ has been proved in Proposition 1, it suffices to show the first derivative

$$\lambda_f v - c_x x_2^g - kz_1 > 0$$

at $x_2^g = 0$. Suppose on the contrary that $\lambda_f v - kz_1 \leq 0$. This implies that $z_1 > 0$, and hence the first derivative with respect to z_1 holds as an equality:

$$-\alpha c_z z_1 + (1-\alpha)c_z(z_1 + z_2^b) = 0.$$

Moreover, from the first order condition with respect to z_2^b, we obtain $c_z(z_1 + z_2^b) = \lambda_p u$. So we have $z_1 = \frac{1-\alpha}{\alpha}\frac{\lambda_p u}{c_z}$, which implies that

$$\lambda_f v - kz_1 = \lambda_f v - \frac{1-\alpha}{\alpha}\frac{\lambda_p uk}{c_z} > 0$$

as $k < \frac{\alpha}{1-\alpha}\frac{\lambda_f v}{\lambda_p u} cz$. Therefore, we must have $x_2^g > 0$.

To show that $x_2^g = z_2^b = 0$ when θ is sufficiently large, we need to consider two cases. In the first case, k also satisfies $k < \frac{1-\alpha}{\alpha}\frac{\lambda_p u}{\lambda_f v} cx$. This similarly implies that $z_1 > 0$ when $\theta = 0$. Therefore, when *theta* is sufficiently close to zero, we have $z_1 > 0$, $x_2^g > 0$ and $z_2^b > 0$. Hence, the first order conditions imply:

$$\alpha(2\theta\lambda_\varphi - c_z z_1 - kx_2^g) + (1-\alpha)c_z(z_1 + z_2^b) = 0;$$

$$v\lambda_f - \theta\lambda_\varphi - c_x x_2^g - kz_1 = 0;$$

and

$$u\lambda_p + \theta\lambda_\varphi - c_z(z_1 + z_2^b) = 0.$$

Solving this system of equations yields

$$z_1 = \frac{\frac{1-\alpha}{\alpha}c_x(\lambda_p u + \lambda_\varphi\theta) + 2c_x\lambda_\varphi\theta - k(\lambda_f v - \lambda_\varphi\theta)}{c_x c_z - k^2};$$

$$x_2^g = \frac{c_z(\lambda_f v - \lambda_\varphi\theta) - \frac{1-\alpha}{\alpha}k(\lambda_p u + \lambda_\varphi\theta) - 2k\lambda_\varphi\theta}{c_x c_z - k^2};$$

and

$$z_2^b = \frac{\lambda_p u + \lambda_\varphi\theta}{c_z} - z_1.$$

It is straightforward to see that z_1 is linearly increasing in θ while both x_2^g and z_2^b are linearly decreasing in θ. Therefore, when θ becomes sufficiently large, either x_2^g or z_2^b has to be zero.

If the optimal solutions satisfy $x_2^g = 0$ and $z_2^b > 0$, then the first derivative with respect to z_1 is strictly positive at $z_1 = 0$. Hence, we get

$$\alpha(2\theta\lambda_\varphi - c_z z_1) + (1-\alpha)c_z(z_1 + z_2^b) = 0;$$

and

$$u\lambda_p + \theta\lambda_\varphi - c_z(z_1 + z_2^b) = 0.$$

The solutions are

$$z_1 = \frac{(1+\alpha)\lambda_\varphi\theta + (1-\alpha)\lambda_p u}{c_z}$$

and

$$z_2^b = \frac{\lambda_p u + \lambda_\varphi \theta}{c_z} - z_1.$$

It is also the case that z_1 is linearly increasing in θ while z_2^b is linearly decreasing in θ. Therefore, when θ becomes sufficiently large, z_2^b has to be zero as well.

If the optimal solutions satisfy $x_2^g > 0$ and $z_2^b = 0$, we also get $z_1 > 0$ because otherwise the first derivative with respect to z_2^b is strictly positive at $z_2^b = 0$. Hence, we solve the following system of equations:

$$\alpha(2\theta\lambda_\varphi - c_z z_1 - kx_2^g) + (1-\alpha)(2u\lambda_p + 2\theta\lambda_\varphi - c_z z_1) = 0;$$

and

$$v\lambda_f - \theta\lambda_\varphi - c_x x_2^g - kz_1 = 0.$$

It is straightforward to see that z_1 is linearly increasing in θ while x_2^g is linearly decreasing in θ. As a result, we conclude that when θ becomes sufficiently large, it must be the case that $z_1 > 0$ and $x_2^g = z_2^b = 0$.

In the second case, $k \geq \frac{1-\alpha}{\alpha}\frac{\lambda_p u}{\lambda_f v} cx$ and hence $z_1 = 0$ when $\theta = 0$. So we solve the following system of equations when θ is sufficiently close to zero:

$$v\lambda_f - \theta\lambda_\varphi - c_x x_2^g = 0;$$

and

$$u\lambda_p + \theta\lambda_\varphi - c_z z_2^b = 0.$$

Notice that the optimal solution

$$x_2^g = \frac{v\lambda_f - \theta\lambda_\varphi}{c_x}$$

is linearly decreasing in θ and hence $x_2^g = 0$ when θ is sufficiently large. Once $x_2^g = 0$, the first derivative with respect to z_1 is strictly positive at $z_1 = 0$ and hence the optimal solution z_1 becomes interior. Then we are back to the first case discussed above, under which $z_1 > 0$ and $x_2^g = z_2^b = 0$ as we keep increasing θ. □

Proof of Proposition 7

Proof. In the new problem, the first derivative with respect to z_2^g is $\lambda_g - c_z(z_1 + z_2^g) \leq 0$; the first derivative with respect to z_2^b is $\lambda_p u + \lambda_b - c_z(z_1 + z_2^b) \leq 0$; and hence the first derivative with respect to z_1 satisfies

$$-\alpha c_z(z_1 + z_2^g) + (1-\alpha)(2\lambda_p u - c_z(z_1 + z_2^b)) \leq -\alpha\lambda_g + (1-\alpha)(\lambda_p u - \lambda_b) < 0.$$

Thus, it is optimal to set $z_1 = 0$. Then, we have the optimal $z_2^g = \frac{\lambda_g}{c_z} > 0$, and the optimal $z_2^b = \frac{\lambda_p u + \lambda_b}{c_z}$, which is larger than the one in the benchmark model. Meanwhile, the optimal x_2^g decreases to $\frac{\lambda_f v - \lambda_g}{c_x}$ and the optimal x_2^b stays at zero. Hence, both $z_2^g - x_2^g$ and $z_2^b - x_2^b$ become larger. □

Appendix B Additional Evidence for the Effect of Bureaucrats' Local Experience on Environmental Protection

In this appendix we aim to provide more evidence to corroborate the linkage between the extent of prefecture officials' local experience (as a proxy for bureaucrats' intrinsic motivations for local environmental quality à la Persson and Zhuravskaya (2016)) and their efforts devoted to environmental protection. Specifically, we collected two sets of outcome variables that may reflect officials' differential preferences over local environment and examine their correlation with the duration of officials' local experience. The first one is the intensity of policies on environmental regulation, which is constructed from manually collected annual reports on work of prefectural governments. Following the same method as Chen et al. (2018a) and Chen et al. (2018b), we search for a list of keywords related to environmental protection in the transcripts of government work reports and identify sentences containing these words as environmental-regulation-related content.[31] Then we compute the total number of words in these sentences as a proxy for the intensity of attention with environmental protection. The second set includes green coverage rate and completed investment in landscaping at prefecture-year level, which are extracted from *China Urban Construction Statistical Yearbook* and depict effectiveness of and expenditure in environmental policies, respectively.

All estimates in Table B1 collectively deliver similar findings. That is, prefectural leaders with local work experience (i.e., non-outsiders) exhibit stronger preference over environmental regulation, regardless of the specific outcome variables. Furthermore, if we decompose the dummy for non-outsiders into two separate ones according to the length of local experience, those with longer duration of local experience seem to pay more attention to environmental protection than those with shorter local experience. We have controlled for prefecture fixed effects, province-year fixed effects, personal characteristics of party secretaries and time-variant city attributes in those regressions. Those results provide supportive evidence that the distinction between outsiders and non-outsiders at least partially captures some heterogeneity of local officials in intrinsic motivations for environmental protection.

[31] We experiment with two different lists of keywords. First we follow the practice in existing literature and utilize a relatively narrow list: *low carbon (Ditan)*, *energy consumption (Nenghao)*, *protecting environment (Baohu Huanjing)* and *environmental protection (Huanjing Baohu)*. Considering that we use data as late as 2019 and there have been some newly invented political expressions, we further expand the list and add *environmental law enforcement (Huanjing Zhifa)*, *lucid waters and lush mountains (Lvshui Qingshan)* and *beautiful China (Meili Zhongguo)*.

Table B1: Bureaucrats' Heterogeneity in Intrinsic Motivations for Environmental Protection: Supportive Evidence

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	*Log (Size of Sentences Containing Key Words)*		*Log (Size of Sentences Containing Key Words)*		*Green Coverage Rate of Built District*		*Completed Investment in Landscaping*	
Non Outsider	0.278*		0.275**		1.181***		0.825	
	(0.153)		(-0.118)		(-0.387)		(-0.529)	
Non Outsider-Weak		0.206		0.257*		1.123**		-0.094
		(0.197)		(-0.148)		(-0.526)		(-0.565)
Non Outsider-Strong		0.377**		0.300**		1.246***		1.861**
		(0.154)		(-0.132)		(-0.447)		(-0.800)
Dep. Var. Mean	4.772	4.772	5.081	5.081	37.723	37.723	4.125	4.125
Control Variables	YES	YES	YES	YES	YES	YES	YES	YES
Prefecture Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES
Province-Year Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES
Number of Clusters	296	296	296	296	273	273	273	273
Number of Observations	1142	1142	1142	1142	819	819	819	819

Notes: (1) Outcome variables in the first four columns are logarithmic total words of sentences that contain the keywords listed in footnote 31, with Columns (1) and (2) for the narrowly defined version and (3) and (4) for the extended list. (2) *Non-Outsider* is a dummy variable indicating that the incumbent party secretary has worked in the prefecture before. We further categorize *Non-Outsider* into two separate dummies indicating whether the work experience is longer than median (strong) or not (weak). (3) We control for the following personal characteristics in all columns: dummy for a native, age, dummy for older than 57, educational level, dummies for work experience in departments of provincial or central governments. We further include logarithmic total number of words of government reports in Columns (1) - (4) and population density in Columns (5) - (8) to account for potential scale effects on outcome variables.

Appendix C Rules of Unifying Target Presentations

Table C1: Rules of Unifying Target Presentations

Expression of Targets	Rules of Presentation Transfer	Notes
The number of days with good or moderate air quality in prefecture c and year y should be no less than X.	X	"# of days with good or moderate air quality" is the default expression and does not need adjustment.
The percentage of days with good or moderate air quality in prefecture c and year y should be no less than W%.	$W\% \times 365$	365 would be replaced by 366 in 2016.
The number of days with good or moderate air quality in prefecture c and year y should further increase by V days on the basis of year y-1 (assuming the actual number in year y-1 to be U).	U + V	The actual number of days with good or moderate air quality in prefecture c and year y-1 is computed from air quality data and cross-validated with officially published local environmental bulletin.
The number of days with good or moderate air quality in prefecture c should increase to Q in y+5, on the basis of year y, with yearly progress no slower than 20%, 40%, 60%, 80% and 100% (assuming the actual number in year y to be P).	P + (Q-P)/5×k (k = 1,2,3,4,5)	The actual number of days with good or moderate air quality in city c and year y is computed from air quality data and cross-validated with officially published local environmental bulletin. Targets for year y+1, y+2,..., y+5 are implied by the left equation with k = 1,2,..., 5 respectively.