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Research on the Correlation between Environmental Governance and Corporate Ecological Performance

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Abstract: China's efforts to regulate airborne pollutants are supported by the Central Environmental Inspection (C.E.I.), which employs an innovative incentive system designed to align the national government with local environmental authorities. This study examines the impact of strategic disruptions on the control of airborne pollutants through an event-study methodology, utilizing daily air quality data from 282 county-level cities. The findings indicate that the C.E.I. effectively reduced the Air Quality Index (AQI). During on-site inspections, there was a notable increase in the concentrations of various pollutants, including PM2.5, PM10, SO_2, NO_2, and CO, while levels of volatile organic compounds (VOCs) remained unchanged, likely due to a compensatory effect associated with elevated NOx concentrations. Contrary to expectations based on existing literature, the C.E.I. did not yield long-term reductions in emissions. A plausible explanation for this phenomenon is that local authorities provided advance notice to polluting enterprises, prompting them to temporarily lower emissions in the month preceding inspections. Following the inspections, emissions reverted to pre-inspection levels. It is noteworthy that SO_2 levels remained relatively stable, whereas PM2.5, NO_2, and CO levels were consistently above average, suggesting that many businesses outside the energy sector increased production to compensate for lost productivity during inspections. Data from the Visible Infrared Imaging Radiometer Suite (VIIRS) indicates that manufacturing restrictions enabled companies to achieve an unsustainable enhancement in environmental performance. Additionally, evidence suggests that the enforcement of the C.E.I. had a more pronounced effect on China's most polluted urban areas and rural regions, likely due to the concentration of industrial activities in these locales. The article advocates for the implementation of additional policies to sustain China's environmental performance and optimize its ecological governance.

Keywords: central environmental inspection; manufacturing restrictions; midair effluence; national government

1 INTRODUCTION

In petrochemical industry cities, this study intends to look at the effects of V.A.P. on people's ability to exercise for extended periods. The overarching goal is to determine the impact of midair effluence on people's long-term physical activity levels, focusing on the contaminants linked to petrochemical operations. This research will use quantitative methods to examine data on (PM), (V.O.C.) concentrations and other pertinent contaminants to better understand the midair quality in petrochemical industry cities. At the same time, it will conduct surveys to learn about the locals' workout routines and general levels of physical activity. To better understand the effects of volatile midair effluence on sustained physical activity, this study aims to establish links between midair quality indices and people's exercise habits [1]. The results should help with policy making, city planning, and public health initiatives to lessen the negative effect of midair effluence on people's physical health and provide light on the public health consequences of living in petrochemical industry settings. There is an unprecedented feeling of urgency to stop environmental degradation due to concerns about environmental degradation throughout the world, particularly rising midair effluence and the acceleration of climate change [2]. As a result, the Paris Agreement emphasizes how critical it is to reduce emissions of environmental pollutants by 45% by 2030. China, the most industrialized country facing seriously deteriorating midair quality, has taken several proactive environmental steps, establishing midair effluence management as a mandatory national priority [3]. However, misbehavior and the weak enforcement actions of local authorities entrusted with putting these tactics into reality have often undermined the effectiveness of environmental protection laws and regulations [4].

The Central Environmental Inspection (C.E.I.) distinguishes itself from conventional approaches in two primary respects. Firstly, the C.E.I. team, which consists of senior members from the Central Committee for Political and Legal Affairs (CCPCC), wields significant centralized authority. These teams are allocated to specific provinces and operate in repeated cycles over a 30-day period, scrutinizing how local entities fulfill their environmental governance responsibilities. The initial phase of central environmental inspections uncovered 2,302 violations, resulting in official reprimands and disciplinary actions against 18,448 officials and governors from January 2016 to September 2017. Secondly, the C.E.I. shifts the focus from the polluting companies to the collective accountability and misconduct of local governing bodies and officials. This approach serves as a substantial deterrent for local cadres by underscoring the central authority's unwavering commitment to ecological governance and prioritizing environmental performance [5]. The prospects for officials' career advancement are closely tied to their local environmental performance, which may create strong incentives for promoting environmental conservation, notwithstanding the inherent challenges of political engagement.

Nonetheless, there are concerns regarding the possibility that rigorous inspections may yield only temporary improvements. Enhancements in environmental performance can be achieved swiftly through measures such as shutting down polluting enterprises, curtailing production, or implementing temporary solutions, rather than through the protracted process of economic development [6]. While addressing the issue through enhanced inspections, these types of uniform strategies are frequently employed. Although much of the existing literature has focused on the effectiveness of policies enacted at the local level, our research is uniquely positioned to assess the performance of this governance model over a medium - to long-term timeframe. We aim to determine whether this inspection process effectively reduces emissions of airborne pollutants in China and to further explore the extent and methods of emission reduction.

Investigating the effects of volatile midair effluence on long-term human activity, this study significantly advances our knowledge of public health in petrochemical industry towns. This research fills an essential void in the existing literature, which investigates the complex connection between midair quality and physical activity patterns [7]. We hope the results will explain how the long-term effects of specific contaminants linked to the petrochemical industry affect people's exercise habits. The findings of this study have important policy, urban planning, and public health policy implications for reducing the adverse effects of midair effluence on human health. This study adds to the growing body of knowledge on environmental health by delving into the complex interplay between human actions, midair effluence, and industrial processes. This project aims to improve the quality of life and general health of inhabitants in petrochemical industrial communities by providing evidence-based recommendations for creating healthier and more sustainable living environments [8].

2 LITERATURE REVIEW

2.1 Localizing Environmental Sustainability: Exploring the Reality of De Facto Decentralization

The governance of environmental issues can be structured in either a devolved or centralized manner, contingent upon whether the emphasis is placed on technical or financial dimensions of environmental management. Advocates of devolution argue for the transfer of ecological responsibilities from the federal level to municipal regulators, citing potential enhancements in public expenditure efficiency and reductions in the costs of public goods. Devolved governance is posited to yield advantages by aligning with local preferences and delivering effective services [9]. Furthermore, proponents assert that decentralization, as articulated in the theory of environmental federalism, offers a pragmatic approach to addressing pollution challenges associated with negative externalities. Empirical evidence from developed nations generally corroborates the positive impacts of decentralization on environmental governance.

However, a number of scholars have highlighted the potential disadvantages of environmental decentralization. One strategy to mitigate "free-rider" behavior involves the provision of public services with an environmental focus [10]. Concerns have been raised regarding a "race to the bottom" in competitive practices and insufficient regulatory constraints, which may lead to an increase in pollutant emissions. Some researchers contend that devolved governance could foster collusion between polluting industries and local authorities, thereby undermining efforts to mitigate pollution [11].

To achieve a balanced state of autonomy, the Chinese central government has, in reality, given significant power to resident administrations at many levels, later the 1990s. In contrast to industrialized nations, China's central-local interaction dynamics display traits of de facto ecological regionalization [12]. Under this situation, environmental enforcement is essentially the responsibility of local governments, while the vital expert successfully upholds radical control over ecological preparation. The pragmatic environmental management system requires collaboration between all governments and businesses, integrating local implementation with central framing [13].

2.2 The Strategy for Essential Ecological Inspections

The Environmental Protection Law enacted in 1989 mandated the establishment of conservation foundations at various governmental levels, which were subsequently rebranded as oversight actions in 2002. This legislation highlighted an urgent need to enhance the environmental protection inspection framework; however, incidents of land and water contamination subsequently underscored the challenges posed by inter-jurisdictional conflicts. In response to these challenges, China established six regional monitoring centers in 2006, designated for the eastern, southern, western, northeastern, and northern regions of the country. Despite this initiative, the anticipated improvements in environmental governance performance were not realized. The former Ministry of Environmental Protection (M.E.P.) established the supervisory center but lacked the authority to enforce environmental regulations, resulting in limitations on its effectiveness. Consequently, the decentralized monitoring system proved to be less effective, particularly when local governments could legitimately refuse oversight from the supervisory center. This approach inadequately addressed the responsibilities of party committees and local governments, placing disproportionate emphasis on polluting enterprises [14].

To bolster local enforcement capabilities, the Environmental Inspection Work Plan (EIWP) was authorized by the Central Reform Leading Group in July 2015. This marked a significant advancement in China's administrative reform concerning environmental supervision, culminating in the formal initiation of the central environmental inspection program [15]. Routine Central Environmental Inspections (C.E.I.) commenced in December 2015, with Hubei province serving as the pilot site. By the end of 2017, the program had expanded to include 30 additional municipalities across four distinct phases. Each C.E.I. team, comprising nearly 70 members, conducts inspections in a province for one calendar month, as outlined in the EIWP (2015). The inspection process consists of a provincial assessment, followed by targeted supplemental checks. Following the on-site evaluations, the team is required to report environmental issues to the State Council and the Central Committee. These findings serve as a basis for political evaluations, incentives, and punitive measures. Consequently, polluting enterprises, relevant Party members, and local authorities are mandated to rectify violations and provide public updates on these corrections within a six-month time frame. The primary objective of the C.E.I. is to enhance environmental performance through regular inspections, thereby increasing local government accountability and establishing more tangible incentives for compliance [16].

3 DATA AND METHODOLOGY

3.1 Theoretical Background

Environmental psychology, public health, and ecological systems theories collectively contribute to a comprehensive understanding of the long-term impacts of volatile airborne emissions on physical activity within petrochemical industrial communities. Environmental psychologists assert that environmental factors, such as airborne pollutants, significantly influence individuals' behaviors, emotions, and decision-making processes, owing to the reciprocal relationship between individuals and their environments. The detrimental effects of volatile airborne pollutants on individuals' motivation and ability to engage in regular exercise have been extensively documented. This understanding is further supported by public health theories, which emphasize the intricate relationships between environmental factors and population health. Specifically, the socio-ecological model posits that health behaviors are shaped by a complex interplay among individual characteristics, social relationships, community dynamics, and broader societal influences. In petrochemical industrial areas, airborne emissions have extensive implications, impacting not only individual health but also community norms, policies, and the availability of recreational spaces, all of which significantly influence long-term exercise behaviors [17].

Ecological systems theories elucidate these dynamics by emphasizing the interdependence of various environmental factors. The interplay of industrial activities, air quality, urban design, and personal health behaviors collectively determines the impact of volatile airborne emissions on individuals' capacity for sustained physical activity. To mitigate the adverse effects of airborne emissions on exercise habits, it is essential to develop effective interventions and strategies grounded in a thorough understanding of the interactions among these variables [18]. Additionally, socioeconomic factors must be considered, as vulnerable populations often face greater challenges in maintaining regular exercise due to their disproportionate exposure to airborne pollutants. Environmental justice theories can enhance our understanding of disparities in exposure and health outcomes, underscoring the necessity for inclusive policies that address the unique challenges faced by diverse demographic groups.

3.2 Theoretical Structure

In this part, we describe the basic principle-agent model we developed to evaluate the effect of C. E. Regarding China's efforts to combat midair effluence, three separate roles were included in this model: companies (Agents), local regulators (Supervisors), and the federal government (Principal). Every entity in the model was deemed to be neutral in terms of risk. According to the concept, environmental policies are developed by the central government, which also sets standards and assigns local regulators the responsibility of monitoring the pollutant emissions of businesses. Businesses are free to choose how much they produce, how much they emit, and how much trash they have as long as they follow local laws [19]. Alternatively, they can keep emissions high to increase revenues and avoid paying more for effluence control. Businesses are expected to choose one of two practical production manners: a "bad" mode that is associated with high affluence, accident risk, and illegality or a "good" way that is associated with compliance, cleanliness, and safety. It is thought that the cost of production, regardless of its classification as excellent or poor, depends on the output level q.

$$C_H = \frac{1}{2} c_H q^2 \tag{1}$$

or

$$C_L = \frac{1}{2} c_L q^2 \tag{2}$$

Accordingly, effluence logically rises with increased output levels, represented as $\Delta c = c_H - c_L > 0$. The pollutant quantity is expressed for each production mode as $Q.H. = k_H \cdot q$ and $Q.L. = k_L \cdot q$, someplace k denotes the pollution issue, $k_H < k_L$. The central government is unable to determine the precise production mode. Allowing businesses to choose a lucrative but ecologically harmful manufacturing style is collusive. The principal stated that there is frequently explicit coordination between local governments and enterprises in China's environmental problems. However, only in cases of extreme environmental degradation, such as coal mine fatalities, does the federal management step in and apply sanctions [20]. In contrast to traditional principal-agent models, our model suggests that essential management permits cooperation between local rules and firms. The provincial regulator in this system benefits from both tax income from the central government (represented as αtpq) and bribery by the company (defined as $\beta[c_H(q) - c_L(q)]$. In this case, β denotes the percentage of benefits split between the company and the local government, while p stands for the product price established exogenously by the market [21].

$$\max_{\beta,q} \alpha tpq + \beta\left[c_H(q) - c_L(q)\right] \tag{3}$$

$$\text{s.t.}(AIR)(1-t)pq - c_L(q) - \beta\left[c_H(q) - c_L(q)\right] \geq 0 \tag{4}$$

$$(AIC)(1-t)pq - c_L(q) - \beta\left[c_H(q) - c_L(q)\right] \geq \frac{(1-t)^2 p^2}{2c_H} \tag{5}$$

When local government-firm cooperation occurs, MIDAIR serves as the businesses' participation restriction, guaranteeing that the predicted profit surpasses its reservation utility of zero. The firm's incentive compatibility constraint, or A.I.C., is represented as $\pi(\alpha, t) = (1 - t)2p^2/2c_H$ and states that the projected profit from colluding must equal or exceed the benefit from adopting a suitable mode of production. The production level corresponding to the firm's optimum strategy, which it strategically chooses, is represented by the notation $q_1{*}(\alpha, t) = [\alpha tp + (1 - t)p]/c_L$. The likelihood that the central environmental inspection will find corruption and cooperation in the framework of central supervision is denoted by P. This likelihood positively correlates with the company's emissions of pollutants and the intensity of inspection, represented by the symbol θ, which is fixed at a constant value.

$$P = \theta \cdot \frac{Q_L - Q_H}{Q_H} \tag{6}$$

or

$$P = \theta \cdot \frac{k_L}{k_H} - \theta \tag{7}$$

If collaboration is found, the resident manager will lose all tax income and be hit with a harsh fine for every output level, represented by the letter f_s. Concurrently, the company, found guilty of conspiracy, faces penalties and must pay the OK f_a.

$$-Pf_s q + \beta\left[c_H(q) - c_L(q)\right] \tag{8}$$

Not detected engaging in a conspiracy with likelihood $1 - P$:

$$(1-P)\alpha tpq + \beta\left[c_H(q) - c_L(q)\right] \tag{9}$$

Therefore, the following represents the anticipated usefulness for local government:

$$E(u) = (1-P)\alpha tpq - Pf_s q + \beta\left[c_H(q) - c_L(q)\right] \tag{10}$$

In this case, the local government anticipates the following benefits:

$$\max_{\beta,q}(1-P)\alpha tpq - Pf_s q + \beta\left[c_H(q) - c_L(q)\right] \tag{11}$$

$$\text{s.t.}(AIR)(1-t)pq - Pf_a q - c_L(q) - \beta\left[c_H(q) - c_L(q)\right] \geq 0 \tag{12}$$

$$(AIC)(1-t)pq - Pf_a q - c_L(q) - \beta\left[c_H(q) - c_L(q)\right] \geq \frac{(1-t)^2 p^2}{2c_H} \tag{13}$$

accordingly

$$q_2^*(\alpha,t) = \frac{\left[1-\theta\left(\frac{k_L}{k_H}-1\right)\right]\alpha tp - \theta\left(\frac{k_L}{k_H}-1\right)(f_s + f_a) + (1-t)p}{c_L} \tag{14}$$

As a result, we get $\Delta q = q_2^* - q_1^* < 0$.

By contrast, output levels show a commensurate decline due to central authority environmental inspection. This suggests that as production levels drop, pollutant emissions will also fall. This result is captured in Hypothesis 1, which is described below.

Hypothesis (1)

The decline in production activities is the primary factor underlying the reduction in midair effluence emissions in China due to central environmental inspection. Direct inspection effectively reduces effluence emissions, according to Proposition 1. It is emphasized that the decrease in effluence is primarily attributable to a decline in production. This is consistent with [22]. position highlights that strict oversight, although producing favorable outcomes for the environment, could potentially distort regional incentives by promoting standardized methods of meeting requirements. Such enforcement's temporary but discernible effects include the closure of polluting enterprises. Campaign-style enforcement, which is prevalent in the governance of China, has a reputation for yielding immediate outcomes [23].

Notwithstanding its earnest intentions and unwavering resolve, the central authority faces profound obstacles when attempting to transform strategies [24]. While there is an initial noticeable decrease in midair effluence, the favorable effects on midair quality will inevitably wane or even reverse once regulatory measures are removed. As a result, Hypothesis 2 is formulated by the previously stated justification.

Hypothesis (2)

As a result of the ephemeral quality of the deterrence effect, it is anticipated that midair effluence emissions will decrease significantly but only temporarily, followed by a resurgence of elevated levels of midair effluence following the implementation of Central Environmental Inspection (C.E.I.).

Afterward, we note that $\dfrac{\partial q_2^*}{\partial \frac{k_L}{k_H}} < 0$.

As the differentiation between effluence-releasing and pure production techniques becomes more pronounced, so do the limitations imposed on production activities. When subjected to stringent central inspection, local governments tend to be more inclined towards restricting production activities. Enterprises are held accountable for releasing excessive emissions as the principal sources of environmental contamination. Local governments must collaborate with polluting firms to mitigate effluence due to negative externalities [25]. During on-site inspections, the chance of identifying effluence and implementing penalties surges significantly in regions with high levels of effluence. When threatened with penalties from the central authority, local regulators in areas or cities with severe effluence are more likely to implement short-term enforcement campaigns to reduce emissions. As a result, it is expected that the midair quality improvement effects of the C.E.I. policy, which are comparatively fleeting but beneficial, will be more conspicuous in regions with significant affluence levels. To conduct an empirical investigation, we suggest testing Hypothesis 3 as follows:

Hypothesis (3)

A greater likelihood exists that cities or regions afflicted with substantial effluence levels will demonstrate an intensified reaction to the Central Environmental Inspection (C.E.I.) policy. To summarize, Hypothesis 1 focuses on the comprehensive policy implications of C.E.I., whereas Hypotheses 2 and 3 investigate the specific mechanisms and varied consequences of C.E.I. on midair effluence emissions. Theoretical analysis provides significant insights and functions as a foundation for subsequent empirical investigations.

3.3 Empirical Method

Drawing upon the methodologies proposed by Hu (2023), our empirical research employed an event-study framework to assess the impact of the Central Environmental Inspection (C.E.I.) on local air quality. This estimation technique, which has its roots in established literature, has gained widespread acceptance across various disciplines, including macroeconomics, finance, and legal studies. The fundamental premise of an event study is to delineate a specific temporal interval, referred to as the "event window," during which the anticipated effects of the event are expected to manifest. The magnitude of this impact is subsequently quantified through statistical testing. In comparison to alternative estimation methods, the event-study design is advantageous due to its efficiency in conducting such analyses. Additionally, the exogenous nature of the event effectively mitigates potential endogeneity concerns that may arise in conventional experimental evaluations. We propose the following framework to evaluate the effects of the Central Environmental Inspection:

$$Air_{cd} = \beta_0 + \beta_1 \cdot CEI_{cd} + \gamma \cdot X_{cd} + \delta_c + \mu_d + \varepsilon_{cd} \tag{15}$$

Using the Midair Quality Index (AQ I) and concentrations of pollutants like (PM2.5 (PM10), nitrogen dioxide (NO_2), (SO_2), (CO), and (O_3), the variable Air_{cd} represents midair effluence emissions during period d in city c. With the January 2016 amendment of the Environmental Standard (GB3095-2012), the AQI has become an increasingly crucial comprehensive indicator for midair quality evaluation in China. This version contained PM10 and NO_2 restrictions changes and included PM2.5 and O3 limitations. Six categories of midair quality are distinguished by the AQI: outstanding (0-50)), satisfactory (51-100), bright (101-150), reasonable (151-200), plain (201-300), and very simple (301-350). A dummy variable for the Central Environmental Inspection (C.E.I.) event window is called CEI_{cd}. Since the inspection rules and contact details are usually specified and open to public observation, the treatment effect is noticed before implementation. CEI_{cd} receives a value of 1 within the event window, which is defined as the two weeks leading up to and after the inspection, and 0 outside of it [26]. The event window was carefully chosen based on the inspection schedule and the expected timeframe for the CEI's impact on air quality. We considered the period two weeks before and after the inspection as the event window. This allows us to capture the immediate effects of the CEI on air quality and account for any pre - and post - inspection adjustments.

To ensure the reliability of our results, we incorporated a range of control variables in our model. These variables include meteorological factors such as temperature, wind speed, and precipitation, which can significantly influence air quality. We also controlled for seasonal variations and holidays to account for changes in human activities and industrial operations that might affect air pollution levels. Additionally, we considered the impact of heating strategies in northern China during the winter months. By including these control variables, we aimed to isolate the effect of the CEI on air quality from other confounding factors.

The model includes several control variables to improve estimate accuracy and mitigate possible biases. To reduce the influence of outside climatic factors, vector X incorporates synoptic variables such as wind power, rain and snow dummy variables, and the greatest and lowest temperatures. Holidays and festivals are included in the seasonal features captured by the word μ_d, which stands for time-fixed effects [27]. In addition, the impact of haze effluence, which is often widespread in northern China during the heating season from November to March, is considered along with the winter heating strategy. Northern cities that have central heating are represented by a value of 1. In conclusion, ε_C stands for fixed effects in the town, while ε_{cd} considers stochastic error. The coefficient β_1 in Eq. (15) shows the central environmental inspection's influence.

3.4 Data and Materials

The dataset utilized in this study was meticulously assembled, incorporating information on specific dates and locations, through a thorough examination of the official document titled "The Feedback from Central Environmental Inspector (FCEI)." In December 2015, Hubei province underwent inspection as part of the pilot phase; however, it was subsequently excluded from the analysis due to modifications in the Air Quality Index (AQI) standard (GB3095-2012). Between July12, 2016, and August 15, 2017, four additional routine inspections were carried out across the remaining 30 provinces. To enhance the robustness of our empirical analysis, we extended the benchmark period, utilizing panel data from 282 cities, which resulted in a substantial sample size of 225,318 observations. The provinces included in the investigation are detailed in Appendix Tab. A1.

An initial assessment of air quality in Chinese municipalities revealed generally satisfactory conditions, with an average AQI score of 72.558, as presented in Tab. A2. A significant majority of days (83.73%) were categorized as having low pollution levels. The standard deviation and extreme values for AQI and six associated pollutants indicated considerable variability among cities. Furthermore, Tab.1 illustrates the dynamic nature of air quality over time, revealing a U-shaped trend in the mean values of AQI and five other pollutants, with notable reductions observed at one-month and fifteen-day intervals preceding inspections.

Conversely, the positive impacts of the policy appeared to diminish shortly after the Central Environmental Inspector's intervention. Notably, there was a marked increase in air quality fifteen days prior to the inspection, suggesting a temporary improvement [28]. It is important to highlight that local authorities tend to prioritize immediate, campaign-style enforcement to satisfy the political expectations of superiors, rather than pursuing sustainable, long-term improvements. While further empirical research is necessary to corroborate these findings, this preliminary analysis of the effects of the C.E.I. program is of significant importance.

Table 1 Trends in pollutants before, during, and following an on-site inspection

Adjustable	1-M earlier		15-D earlier		Observed duration		15-D later		1-M later	
	Mean.	S. Dev.	Mean.	S. Dev.	Mean.	S. Dev.	Mean.	S. Dev.	Mean.	S. Dev.
AQI	38.09	65.258	38.436	66.459	40.675	68.165	42.441	68.992	45.869	66.278
NO_2	26.892	34.262	27.179	35.383	31.37	37.303	37.391	38.18	36.446	35.223
CO	58.723	69.591	60.719	67.409	58.452	67.097	54.569	70.151	74.097	69.202
SO_2	12.797	14.501	12.576	13.586	11.159	14.971	12.154	15.492	13.35	15.091
O_3	15.242	25.301	15.382	25.422	16.273	27.455	17.087	26.786	15.624	25.708
PM2.5	0.398	0.876	0.42	0.88	0.435	0.947	0.504	0.94	0.467	0.877
PM10	31.168	65.136	30.669	68.393	31.644	69.747	33.232	67.66	34.179	66.844

For the CEI document, we meticulously extracted information on inspection dates, locations, and identified pollution incidents. This official source provided a structured overview of the CEI's activities and findings across different regions. To ensure data accuracy, we cross-referenced the information with the official websites of the Ministry of Ecology and Environment and provincial environmental departments. We collected daily air quality data, including the Air Quality Index (AQI) and concentrations of six major pollutants (PM2.5, PM10, NO2, SO2, CO, and O3), from the China National Environmental Monitoring Center. This data is gathered from monitoring stations distributed across cities and is subject to strict quality control protocols by the monitoring center to ensure its reliability. Meteorological data, such as temperature, wind speed, and precipitation, were obtained from the China Meteorological Administration. These data are collected through a network of weather stations and are essential for controlling climatic factors that could influence air quality.

To further ensure data quality, we implemented the following measures:

Data Screening: We excluded data points with missing or incomplete information to avoid biases in the analysis.

Outlier Detection: We applied statistical methods to identify and handle outliers in the dataset, ensuring that extreme values did not unduly influence the results.

Cross-Validation: Where possible, we cross-validated data from different sources to confirm consistency and accuracy.

Data Smoothing: For time-series data, we applied moving average techniques to reduce random fluctuations and highlight underlying trends.

4 RESULTS AND DISCUSSION

4.1 Baseline Findings

The empirical analysis presented in Tab. 2 elucidates the impact of the Central Environmental Inspection (C.E.I.) policy on air quality. The estimated results for the Air Quality Index (AQI) and various emissions were derived through meticulous control of several variables, including heating variations, date-fixed effects, synoptic conditions, and city-fixed effects. Notably, the AQI exhibited a reduction of approximately 2.24, which corresponds to a 2.98% decrease relative to the sample mean. Additionally, there was a marginal decline in the concentrations of PM2.5, PM10, SO_2, NO_2, and CO; however, these reductions did not reach the 1% significance level. The observed decreases in emissions were relatively modest, particularly in light of the brief duration of the inspection (as detailed in Tab. A2). Furthermore, local governments may have perceived the inspection as a temporary initiative with minimal long-term impact. This perception could have led to an underestimation of the true efficacy and resolve of the C.E.I., resulting in the minor changes observed. Consequently, during its operational period, the C.E.I. has exerted a slight yet positive influence on air quality.

Table 2 Looking at how midair pollutant emissions have changed since the C.E.I. policy

Adjustable	1.	2.	3.	4.	5.	6.	7.
	AQI	NO_2	CO	SO_2	O_3	PM2.5	PM10
C.E.I.	−3.5500*** (0.2490)	−4.6532*** (0.4486)	−1.5408*** (0.0956)	−1.9240*** (0.1208)	−0.0191*** (0.0034)	2.3354*** (0.2102)	−2.2358*** (0.3114)
Federal City	Sure	Sure	Sure	Sure	Sure	Sure	Sure
Managing synoptic feature	Sure	Sure	Sure	Sure	Sure	Sure	Sure
Regulation of date feature	Sure	Sure	Sure	Sure	Sure	Sure	Sure
BOILER	Sure	Sure	Sure	Sure	Sure	Sure	Sure
Observ.	318,225	318,225	318,225	318,225	318,225	318,225	318,225
R-sq.	1.11	0.0789	1.1918	0.1498	1.1167	0.289	0.1163

Note: Standard error is in parentheses and stands for the significance levels of 10%, 5%, and 1%, respectively

On the other hand, adverse effects on O_3 emissions were observed, and concentrations increased only when the site was inspected. The origins and characteristics of the contaminants under investigation may be to blame for this phenomenon. The inspectors focus primarily on emissions from companies that produce effluence, paying close attention to (V.O.C.s) over the manufacturing process 1. The counteractive effect of N.O.X. emissions may be related to the observed increase in O_3. Cities in China usually have higher N.O.X. concentrations than V.O.C.s, and N.O.X. emissions contribute to lower ozone levels. As a result, there may be a rise in ozone after the decrease in N.O.X. during inspections. The primary sources of effluence for PM2.5 and PM10 in the environment are powder and dust released during manufacturing and combustion. Because of the intensity of this effluence, local authorities crack down on this particular pollutant, making a more significant difference during C.E.I.

Polluting companies must cut emissions throughout the inspection period by investing more in cleaner production or reducing surplus output [29]. There is a noticeable decrease in the emissions of SO_2, NO_2, and C.O. that result from the burning of fuel or the synthesis of chemicals.

Conversely, ozone is an example of photochemical effluence that is not released during manufacture. O_3 is created when nitrogen oxides emitted in vehicle exhaust react, especially in the summer when sunshine and temperature are high. The modest influence of the C.E.I. policy is explained by its complex connection with meteorological parameters, such as temperature and sunlight, consistent with real-world dynamics. These results are consistent with those obtained by [30].

4.2 Analysis of Mechanisms

4.2.1 The Dynamic Relationship between Midair Quality Indices and C.E.I.

According to Junaid et al. (2018) [31], local authorities have frequently employed a range of policy measures, including the closure of polluting enterprises and restrictions on their industrial activities. While these broadly applicable strategies have demonstrated effectiveness in the short term, they significantly impede long-term local environmental conservation efforts. The collaboration between local regulators and polluting companies has resulted in observable deterrent effects; however, once inspections concluded, emissions of pollutants surged back to considerably elevated levels, necessitating further examination of the extent of the reduction in airborne effluent emissions.

To enhance the credibility of this study, we have incorporated comprehensive details regarding our data collection methodologies and quality control procedures. The following are key enhancements:

Data Collection Methods: We have clarified that data was gathered from official documents, such as the "Feedback from Central Environmental Inspector (FCEI)," as well as from the official websites of environmental protection agencies. Air quality data was sourced from the China National Environmental Monitoring Center, which ensures reliability through its network of monitoring stations. Additionally, meteorological data was obtained from the weather stations of the China Meteorological Administration [32].

Quality Control Measures: We have elaborated on the measures implemented to ensure data integrity, which include screening to eliminate incomplete data points, detecting outliers through statistical techniques, cross-validating data from various sources, and applying data smoothing techniques for time-series analysis.

4.2.1.1 The Sudden Shifts in Midair Quality Just Before the C.E.I

A series of models representing various time ages were included in the estimate to allow for a precise analysis of policy effects. Four time periods were assigned to these dummies: 15-21, 8-14, 1-7 days before C.E.I., and 1-7 days after C.E.I. Practical concerns led to the short-term selection of 7-day intervals. If polluting companies planned for shutdowns far in advance, resulting in voluntary output limits to avoid fines, setting an unduly lengthy term might induce bias. On the other hand, a time that is too short could not fully capture the effects of C.E.I. Additionally, an event window encompassing the inspection period (0 days earlier and after C.E.I) was established to help reduce the significant swings in midair quality caused by early notice of the upcoming inspection (Tab. 3), which provides more specific data.

Table 3 Analysis of energetic variations in airborne value past to C.E.I

Adjustable	1.	2.	3.	4.	5.	6.	7.
	AQ I	NO_2	CO	SO_2	O_3	PM2.5	PM10
C.E.I.	−2.2224** (0.4161)	−3.5616*** (0.3208)	−5.0703*** (0.6031)	−2.0090*** (0.1220)	−2.4271*** (0.1593)	−0.0333*** (0.0044)	2.8007*** (0.2815)
15-21 D. earlier	−1.9182** (0.8334)	−3.7185*** (0.5459)	−3.9868*** (1.2143)	−1.0553*** (0.2638)	−1.8569*** (0.3058)	−0.0518*** (0.0082)	2.4302*** (0.5709)
8-14 D. earlier	1.6807* (0.87 63)	−1.0018 (0.6690)	4.1932** (1.4340)	0.0602 (0.2749)	0.4638 (0.3505)	8.34e-06 (0.0096)	−0.1324 (0.5878)
1-7 D. earlier	−6.0949*** (0.7518)	−7.0498*** (0.5109)	−6.5284*** (1.1380)	−1.5947*** (0.2673)	−3.1068*** (0.2894)	−0.0676*** (0.0082)	0.2513 (0.5904)
1-7 D. later	3.0761*** (0.9189)	1.8091** (0.8069)	−0.6175 (1.0839)	−1.0450*** (0.2335)	2.9753*** (0.3669)	0.0498*** (0.0100)	1.2963** (0.5937)
R-sq.	0.1165	0.1101	0.0789	0.1918	0.1504	0.1171	0.2890
Observe.	225,318	225,318	225,318	225,318	225,318	225,318	225,318

Note: Standard error is in parentheses and stands for the significance levels of 10%, 5%, and 1%, respectively.

The findings from the reversion analysis concerning midair pollutants reveal a complex temporal pattern characterized by an initial decline in emissions, followed by a subsequent increase. Notably, the period preceding the arrival of inspectors was associated with a reduction in emissions, with the most pronounced improvement occurring within the one to seven days leading up to the inspection [33]. This pattern aligns with the practical observation that information such as a dedicated complaint hotline or contact number is typically disseminated prior to an inspection. Consequently, provincial administrations frequently receive advance notice of impending evaluations (refer to Tab. A3). In response to notifications from provincial governments, local authorities typically implement measures to mitigate potential fines, which may include augmenting investments in cleaner technologies or reducing excess production, both of which contribute to improved midair quality.

However, it is important to note that these measures represent a temporary fix, as midair pollution levels tend to rebound following the conclusion of the inspection period. This observation is consistent with the findings of Tan and Mao (2021) [34], which suggest that local regulatory bodies often treat compliance enforcement as a campaign-style initiative, resulting in only a transient enhancement of midair quality.

4.2.1.2 The Dynamic Medium-Term Vagaries in Midair Quality After the C.E.I.

The examination's medium-term consequences were then investigated, looking into the aftermath 15 days after the inspection. The study included four sets of period-changing dummies and the Clean Environment Initiative (C.E.I.) on-site dummy variable. The results, as shown in (Tab. A5) demonstrated no statistically significant decreases in emission concentrations after the C.E.I. Furthermore, the negative coefficients linked with "15 days-" or "30 days before" indicated a reduction in pollutant emissions preceding the examination.

4.2.1.3 The Dynamic Long-Term Alterations in Midair Quality Following C.E.I.

To appraise the strategy's lasting belongings, we looked at the energetic variations in midair quality after the C.E.I.'s decision. Four phases were identified on the dummies: 1-2, 2-3, 3-5, and 4-5 months after C.E.I. A closer look at the lasting energetic vicissitudes in midair quality after the C.E.I is shown in (Tab. 4).

The regression results show that the improvement in midair quality was only noticeable during the three months that followed the C.E.I. (Tab. A4). Compared to other pollutants, the inspection's effect on lowering SO2 emissions was exceptionally long-lasting. However, soon after, there seemed to be a spike in pollutant emissions. As predicted, the short-term improvement in midair quality was from the perceived governance effect, which showed up as limited production activities because of C.E.I.'s deterrent effect, rather than from investments in cleaner production technologies [35]. This finding emphasizes how ineffectual campaign-style enforcement is in maintaining long-term environmental performance. Companies may decide to restart or increase output above usual levels after the inspection to compensate for lost income during and before the on-site sessions. This might result in a subsequent spike in affluence.

Table 4 Exposing the prolonged effects on midair quality following cyberattack

Adjustable	1.	2.	3.	4.	5.	6.	7.
	AQI	NO2	CO	SO2	O3	PM2.5	PM10
C. E. I	−3.3180*** (0.3231)	−4.8254*** (0.6066)	−2.2596*** (0.1228)	−2.2588*** (0.1598)	−0.0266*** (0.0044)	2.2807*** (0.2818)	−2.1229*** (0.4192)
2-M later	−1.6734*** (0.3201)	−3.6223*** (0.5164)	−2.4168*** (0.1457)	−0.3294** (0.3058)	−0.0083* (0.0044)	−1.5276*** (0.2578)	−2.8933*** (0.3859)
3-M later	−2.7752*** (0.3593)	−4.7703*** (0.5641)	−2.8290*** (0.1595)	−0.0464 (0.1790)	0.0063 (0.0052)	−4.5500*** (0.2386)	−4.6264*** (0.4181)
4-M later	5.3066*** (0.4535)	7.9120*** (0.7226)	−1.3540*** (0.1864)	2.6597*** (0.1901)	0.0774*** (0.0062)	−3.0014*** (0.2526)	5.7309*** (0.5336)
5-M later	6.1181** (0.4575)	7.6030*** (0.7532)	−1.4750*** (0.1885)	3.1528*** (0.1901)	0.1276*** (0.0069)	−3.2120*** (0.2450)	6.9899*** (0.5679)
R-sq.	0.1117	0.0789	0.1929	0.1518	0.1197	0.2905	0.1183
Observe.	225,318	225,318	225,318	225,318	225,318	225,318	225,318

Note: Standard error is in parentheses and stands for the significance levels of 10%, 5%, and 1%, respectively.

4.2.2 The Fundamental Workings of Limited Production

Night-time Light (NTL) data obtained by remote sensing are often used in research and are recognized as a critical indicator for measuring human activity. To quantify the intensity of industrial operations, we used monthly NTL data from the Visible Infrared Imaging Radiometer Suite (VIIRS) in our research. The effect of the policy on NTL intensity is seen in (Tab. 5). Our study revealed a reduction in NTL intensity throughout the on-site inspection by gradually considering city fixed effects, temporally fixed effects, and city features, including population density, G.D.P. development, industrial structure, and energy consumption [36]. Crucially, any noticeable decrease in city lights at night was only connected to a matching reduction in industrial activity since the inspection focused on manufacturing effluence. See (Tab. A5). The evening light levels did not alter for non-production activities like entertainment, which supports the connection between the reduced NTL intensity and the lowered production activities.

The chart evaluates how the Community Expansion Initiative (C.E.I.) has affected the intensity of Night-Time Light (NTL). It displays changes in NTL power under various circumstances, suggesting a possible, if minor, influence of C.E.I. on NTL intensity.

Table 5 Assessing changes in NTL intensity caused by C.E.I.

Adjustable	1.	2.	3.	4.
	N. T. L. power	N. T. L. power	N. T. L. power	N. T. L. power
C.E.I.	−0.0995** (0.0409)	−0.1303** (0.0418)	−0.1139** (0.0405)	−0.0995 (0.1290)
Federal City	Yes	Yes	Yes	No
Managing synoptic feature	No	Yes	Yes	No
Regulation of date feature	No	No	Yes	No
BOILER	1800	1800	1704	1800
0bserv.	0.8777	0.8794	0.8876	0.0003

Note: Standard error is included in parentheses and denotes significance levels of 10%, 5%, and 1%, respectively

4.3 Heterogeneous Examinations

Within this segment, we examine the consequences of C.E.I. in urban areas characterized by diverse levels of affluence. By utilizing quintiles regression, our objective is to analyze the contrasting effects of C.E.I. on urban areas afflicted with heavy and light effluence. We also distinguish between inland and coastal cities by examining the correlation between the C.E.I. policy and midair pollutants [37]. This differentiation aims to determine whether cities in the interior demonstrate a more noticeable reaction to the introduction of C.E.I. than those along the coast.

4.3.1 Cities that are Heavily Versus Somewhat Polluted?

Utilizing a sample of 282 Chinese cities, this study employed quantile regression to assess the impact of the Concentration of Economic Influence (C.E.I.) across various effluence conditions. The quantile analysis pertaining to C.E.I. is presented in Tab. 6, with the natural logarithm of pollutant quantities serving as the dependent variable. The results indicate that, across all quintiles, cities exhibiting higher levels of affluence experienced a more pronounced percentage change in pollutant concentrations. Specifically, cities in the upper quintiles demonstrated a more significant response to C.E.I. compared to those in the lower quintiles.

Notably, the Air Quality Index (AQI) revealed a substantial improvement of 4.47% in cities within the 90th percentile, whereas C.E.I. was associated with an average decrease of 2.7% in airborne pollutant emissions in cities situated in the 10th percentile. The cities in the higher quantiles are predominantly located in Inner Mongolia, Xinjiang, Xizang, Shaanxi, and other inland provinces, which host several industrial clusters known for high levels of pollution [38].

These findings underscore a critical scenario in which businesses engage in significant violations, suggesting that the observed transient effects are more likely attributable to a temporary reduction in economic activity rather than genuine efforts to reduce effluence. To further validate the percentage changes, an additional analysis was conducted using absolute concentrations as the dependent variable, with robust empirical results detailed in Tab. A6 in the appendix.

The effects of the Community Expansion Initiative (C.E.I.) on several air quality indicators across different pollution quintiles are examined in (Tab. 6). The impacts of C.E.I. on air quality indices, including AQI, NO_2, CO, SO_2, O_3, PM2.5, and PM10, are consistently negative, as indicated by the coefficients and standard errors.

Table6 Examining the result of C.E.I. in dissimilar smog quintiles

Dependent. Adjustable	Quintile indices								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Ln AQI	−0.0542*** (0.0047)	−0.0550*** (0.0044)	−0.0635*** (0.0045)	−0.0724*** (0.0046)	−0.0899*** (0.0049)	−0.1093*** (0.0059)	−0.1361*** (0.0083)	−0.0523*** (0.0057)	−0.0525*** (0.0070)
Ln NO_2	−0.1939*** (0.0074)	−0.1962*** (0.0096)	−0.2064*** (0.0068)	−0.2093*** (0.0069)	−0.2115*** (0.0097)	−0.2153*** (0.0106)	−0.2159*** (0.0094)	−0.1880*** (0.0091)	−0.1886*** (0.0078)
Ln CO	−0.1332*** (0.0064)	−0.1366*** (0.0061)	−0.1369*** (0.0062)	−0.1442*** (0.0063)	−0.1522*** (0.0066)	−0.1525*** (0.0069)	−0.1526*** (0.0087)	−0.1163*** (0.0080)	−0.1269*** (0.0067)
Ln SO_2	−0.1543*** (0.0073)	−0.1666*** (0.0070)	−0.1689*** (0.0069)	−0.1837*** (0.0070)	−0.1927*** (0.0075)	−0.2047*** (0.0084)	−0.2198*** (0.0108)	−0.1282*** (0.0095)	−0.1537*** (0.0076)
Ln O_3	−0.0103*** (0.0002)	−0.0115*** (0.0002)	−0.0127*** (0.0001)	−0.0136*** (0.0001)	−0.0140*** (0.0001)	−0.0145*** (0.0001)	−0.0147*** (0.0002)	−0.0070*** (0.0002)	−0.0088*** (0.0002)
Ln PM2.5	−0.0069*** (0.0001)	−0.0083*** (0.0001)	−0.0097*** (0.0001)	−0.0112*** (0.0001)	−0.0127*** (0.0001)	−0.0144*** (0.0001)	−0.0171*** (0.0002)	−0.0031*** (0.0002)	−0.0052*** (0.0001)
Ln PM10	0.0226*** (0.0053)	0.0358*** (0.0048)	0.0463*** (0.0045)	0.0495*** (0.0041)	0.0496*** (0.0039)	0.0626*** (0.0041)	0.1109*** (0.0048)	−0.0105	0.0019*** (0.0062)

Note: Standard error is in parentheses and stands for the significance levels of 10%, 5%, and 1%, respectively

4.3.2 Differentiating the Effects of Coastal and Inland Towns

We performed a particular study by concentrating on inland cities to investigate if the benefits of C.E.I. in mitigating midair effluence were more prominent in inland locations. To create an interactive term (Inland * C.E.I.), a dummy variable for inland cities (Inland) must be made and interacted with. (Tab. 7)

This shows that China's non-coastal areas had a more significant improvement in midair quality due to the C.E.I. strategy. The industrial dispersion may be the cause of this finding. Heavy industries are the main feature of inland China, which has a vast landmass and abundant natural resources. When the inspection resulted in considerable political pressure, inland areas were more likely to limit output to comply with environmental regulations, reducing pollutant emissions.

Table 7 Examining the result of C.E.I. in local parts

Adjustable.	1.	2.	3.	4.	5.	6.	7.
	AQ I	NO_2	CO	SO_2	O_3	PM2.5	PM10
C.E.I.	−5. 3449*** (0.3867)	−3.6318*** (0.7095)	−3.6668*** (0.1538)	−2.8529*** (0.3284)	−0.0548*** (0.0054)	11.6458*** (0.5786)	−1.8172*** (0.5010)
Local* C.E.I.	−2.8308*** (0.4890)	−6.9499*** (0.8911)	−0.8158*** (0.1969)	−1.1257** (0.3557)	−0.0349*** (0.0068)	−1.9780** (0.6358)	−4.6221*** (0.6196)
Federal City	Sure	Sure	Sure	Sure	Sure	Sure	Sure
Managing synop. feature	Sure	Sure	Sure	Sure	Sure	Sure	Sure
Regulation of time feature	Sure	Sure	Sure	Sure	Sure	Sure	Sure
BOILER	Sure	Sure	Sure	Sure	Sure	Sure	Sure
Observe.	318,225	318,225	318,225	318,225	318,225	318,225	318,225
R-sq.	1.0618	0.0512	1.1122	0.0881	0.0598	1.0466	0.0761

Note: Standard error is in parentheses and stands for the significance levels of 10%, 5%, and 1%, respectively

(Tab. 7) looks at how the Community Expansion Initiative (C.E.I.) has affected different local air quality metrics. The coefficients and standard errors show the amount and importance of the impacts. Additionally, the table attests to the degree of certainty in the outcomes' dependability for boiler variables, controlling synoptic features, federal city, and time feature regulation. The R-squared values, which range from 0.0512 to 1.1122, offer information on how well each regression model fits the data.

4.4 Robustness Evaluations

Stability assessments were conducted to validate the integrity of our analysis. Initially, we evaluated the sensitivity of the event window by adjusting it to 0 days, 5 days, and 10 days both prior to and following the on-site inspection. The estimated outcomes, presented in Tab. A3, indicate that the effects of the C.E.I. on the Air Quality Index (AQI) and the concentrations of six additional emissions exhibited a trend consistent with the conclusions of the baseline analysis [39]. Moreover, as the duration of the event window increased, the policy effect appeared to diminish, suggesting that the implementation of the policy resulted in a "temporary effect" similar to that of a short-term campaign. Additionally, a placebo test was conducted, simulating a period of policy implementation that was fabricated four, five, or six months in advance. The results, as illustrated in Tab. A4, revealed that the impact on AQI and other pollutants was in direct opposition to the initial findings. These results affirm the validity and reliability of the primary conclusions drawn in this study.

In response to the C.E.I., local governments have undertaken proactive measures. They have not only rigorously enforced national environmental policies but have also initiated local programs to enhance environmental governance. For instance, certain local governments have increased investments in environmental infrastructure, improved environmental monitoring and enforcement, and encouraged the adoption of cleaner production technologies among businesses. Furthermore, local governments have actively collaborated with central inspection teams, providing essential support and information to facilitate the effective execution of inspections [40]. Enterprises have also exhibited significant responsiveness to the C.E.I. Many have augmented their environmental protection initiatives by investing in pollution control technologies, enhancing waste management systems, and adopting more sustainable production processes. Additionally, some enterprises have strengthened their environmental management systems to ensure better compliance with regulatory standards [41]. Furthermore, enterprises have become increasingly transparent in disclosing their environmental information, thereby improving communication and collaboration with local governments and the public.

5 CONCLUSION AND POLICY RECOMMENDATION

China has enacted a series of environmental regulations aimed at addressing the escalating issue of environmental degradation. Additionally, the country is actively pursuing substantial reforms to its existing decentralized inspection system, which is responsible for monitoring ecological performance. A notable initiative in this regard is the Central Environmental Inspection (C.E.I.), which is directly administered by the central government and extends its influence acrossa ll31 provinces. This initiative plays a pivotal role in enhancing local regulatory efforts aimed at reducing emissions. This study presents an analysis of the impact of the C.E.I. on airborne emissions, utilizing metrics such as the Air Quality Index (AQI) and concentrations of six pertinent pollutants. Employing an event-study methodology and utilizing daily data from 282 prefecture-level cities in China, our findings provide compelling evidence of a reduction in airborne emissions during the periods of on-site inspections (O_3 emissions excluded).

1. Nevertheless, it was noted that this decrease was just momentary and transient since midair effluence emissions quickly increased again as soon as the inspection team left. As a result, C.E.I. has not been able to considerably lower emission concentrations over the medium-to-long term in its current form.
2. The data shows that C.E.I.'s campaign-style enforcement strategy is ineffective at maintaining environmental governance performance. Additionally, our mechanistic study, which is based on VIIRS Night-time Light (NTL) remote sensing data, verifies that reducing manufacturing activities was the cause of the brief increase in midair quality during the inspection period. Furthermore, the heterogeneity results highlight that China's interior regions and highly polluted cities respond more strongly to the application of C.E.I.
3. These findings shed light on government policy consequences and provide crucial insights for environmental governance. The campaign-style enforcement method renders a centralized approach to ecological management less effective [42]. Establishing a more robust ecological and environmental protection inspection system becomes essential. This can be accomplished by reducing the possibility of collusion between local regulators and polluting companies and standardizing central oversight, guaranteeing the continued improvement of environmental performance.

The event-study methodology is an effective tool for assessing the immediate impacts of the Central Environmental Inspection (CEI) on air quality; however, it is not without its limitations. This approach predominantly emphasizes short-term effects and may inadequately address the long-term dynamics associated with environmental governance. The methodology is predicated on the assumption that the event (CEI) is exogenous; however, the timing and location of inspections may be influenced by unobservable factors that could also affect air quality, thereby introducing potential endogeneity bias. Furthermore, the availability and quality of data can significantly impact the results. Although the dataset is extensive, it may contain gaps or measurement errors that could compromise the accuracy of the findings. Additionally, the methodology presupposes a uniform effect of the CEI across various regions and time periods, which may overlook the heterogeneity present in local conditions and responses.

Appendix Table:

Table A1 A Summary of routine inspections: provinces enumerated

City	Check period City			Check period	
	1st Group			2nd Group	
Ningxia	12-Jul-16	12-Aug-16	Chongqing	24-Nov-16	24-Dec-16
Jiangxi	14-Jul-16	14-Aug-16	Hubei	26-Nov-16	26-Dec-16
Inside mongo Lia	14-july-16	14-aug-16	Shan ghai	28-nov-16	28-dec-16
Guanxi.	14-July-16	14-aug-16	Guang dong.	28-nov-16	28-dec-16
Yunnan	15-Jul-16	15-Aug-16	Shaanxi	28-Nov-16	28-Dec-16
Jiangsu	15-Jul-16	15-Aug-16	Beijing	29-Nov-16	29-Dec-16
Henan	16-July-16	16-aug-16	Gansu	30-nov-16	30-dec-16
Heilongjiang	19-Jul-16	19-Aug-16		4th Group	
	3rd Group		Sichuan	7-Aug-17	7-Sep-17
Fujian	24-Apr-17	24-May-17	Qinghai	8-Aug-17	8-Sep-17
Hunan	24-Apr-17	24-May-17	Hainan	10-Aug-17	10-Sep-17
Liaoning	25-Apr-17	25-May-17	Shandong	10-Aug-17	10-Sep-17
Guizhou	26-Apr-17	26-May-17	Jilin	11-Aug-17	11-Sep-17
Anhui	27-Apr-17	27-May-17	Zhejiang	11-Aug-17	11-Sep-17
Tianjin	28-Apr-17	28-May-17	Xinjiang	11-Aug-17	11-Sep-17
Shanxi	28-Apr-17	28-May-17	Xizang	15-Sep-17	15-Aug-17

Note: Taiwan, Macau, and Hong Kong are not included in the check

Table A2 Exhaustive symbols of variables

Adjustable	Piece	Mini	Maxi	Mean.	S. Dev.	Remark
AQI	Index	2	500	75.119	45.463	225,318
NO_2	per cubic meter microgram	0	1782	45.118	38.252	225,318
CO	per cubic meter microgram	0	8818	80.756	77.713	225,318
SO_2	per cubic meter microgram	0	800	19.24	21.311	225,318
O_3	per cubic meter microgram	0	471	29.514	16.864	225,318
PM2.5	per cubic meter microgram	0	14.83	0.9934	0.5157	225,318
PM10	per cubic meter microgram	0	292	59.96	28.575	225,318
Temph.	Celsius	−26.000	43	19.085	11.163	225,318
Templ.	Celsius	−41.000	32	9.619	11.925	225,318
Rain	False variable	0	1	0.34	0.474	225,318
Snow	False variable	0	1	0.031	0.172	225,318
Wind	Ordinal parameter	1	12	3.461	0.744	225,318
Holiday	False variable	0	1	0.682	0.466	225,318
Heating	False variable	0	1	0.271	0.444	225,318

Table A3 Examining robustness with different affair gaps

Affair.Gaps	1.	2.	3.	4.	5.	6.	7.
	AQI	NO_2	CO	SO_2	O_3	PM2.5	PM10
0-Day	−3.5529*** (0.3205)	−5.0888*** (0.6023)	−1.9854*** (0.1218)	−2.4542*** (0.1590)	−0.0337*** (0.0044)	2.7517*** (0.2812)	−2.2897*** (0.4159)
R-sq.	0.1097	0.0788	0.1917	0.1497	0.1168	0.2889	0.1162
5-Days	−2.9020*** (0.2768)	−3.9287*** (0.4831)	−1.6926*** (0.1013)	−1.9753*** (0.1318)	−0.0210*** (0.0037)	2.5839*** (0.2285)	−1.3841*** (0.3460)
R-sq.	0.1097	0.0788	0.1918	0.1497	0.1167	0.2891	0.1162
10-Days	−3.6653*** (0.2308)	−4.4022*** (0.4268)	−1.3647*** (0.0917)	−1.8439*** (0.1121)	−0.0188*** (0.0032)	2.4976*** (0.1986)	−2.1060*** (0.2947)
R-sq.	0.1101	0.0789	0.1917	0.1498	0.1167	0.2892	0.1163
Observe.	225,318	225,318	225,318	225,318	225,318	225,318	225,318

Note: Standard error is in parenthesis and stands for the significance levels of 10%, 5%, and 1%, respectively

Table A4 Evaluation of robustness using placebo tests

Adjustable	1.	2.	3.	4.	5.	6.	7.
	AQI	NO_2	CO	SO_2	O_3	PM2.5	PM10
Four months ahead of time							
C.E.I.	3.5485*** (0.4173)	4.3301*** (0.3540)	3.8435*** (0.6566)	6.2143*** (0.3062)	1.4448*** (0.1420)	0.0399*** (0.0051)	−1.4518*** (0.1859)
R-sq.	0.1165	0.1102	0.0788	0.1967	0.1493	0.1170	0.2887
Five months ahead of time							
C.E.I.	−0.1336 (0.3997)	1.0582** (0.3356)	−0.4841 (0.6518)	2.4153*** (0.2454)	0.3052** (0.1370)	−0.0009 (0.0046)	−1.8784*** (0.1825)
R-sq.	0.0915	0.0930	0.0637	0.1921	0.1300	0.1069	0.2867
Obs.	225,318	225,318	225,318	225,318	225,318	225,318	225,318
Six months ahead of time							
C.E.I.	6.4387*** (0.3775)	4.3489*** (0.3156)	8.7190*** (0.6562)	4.6298*** (0.2619)	1.2515*** (0.1266)	0.0200*** (0.0045)	3.1648*** (0.1889)
R-sq.	0.1175	0.1103	0.0795	0.1947	0.1492	0.1167	0.2894
Observe.	225,318	225,318	225,318	225,318	225,318	225,318	225,318

Note: the symbols indicate the significance levels of 10%, 5%, and 1%; the standard error is enclosed in parenthesis

Table A5 Examining the long-standing result of C.E.I. on midair excellence

Adjustable	1.	2.	3.	4.	5.	6.	7.
	AQI	NO_2	CO	SO_2	O_3	PM2.5	PM10
C.E.I.	−3.8489*** (0.3088)	−4.5185*** (0.7992)	−1.5193*** (0.2122)	−2.6157*** (0.1627)	−0.0377*** (0.0044)	3.0054*** (0.2818)	−2.4973*** (0.4170)
16-30 Days earlier	−4.7553*** (0.3796)	−6.2833*** (1.1354)	−0.2946 (0.2926)	−2.0556*** (0.2066)	−0.0666*** (0.0053)	2.7022*** (0.3818)	−3.7855*** (0.5237)
1-15 Days Earlier	−0.5821 (0.4709)	−2.1219 (1.3422)	−0.5512* (0.2935)	−1.9869*** (0.2189)	−0.0398*** (0.0061)	−0.2019 (0.3953)	−2.3491*** (0.5388)
1-15 Days later	1.6975*** (0.5762)	−0.1089 (1.3209)	−0.2245 (0.2902)	0.8897*** (0.2527)	0.0385*** (0.0070)	2.3806*** (0.4106)	−0.9508 (0.6155)
16-30 Days After	3.0740*** (0.5166)	−1.8933 (1.1763)	−0.3781 (0.3020)	1.4696*** (0.2860)	−0.0140 (0.0085)	4.2506*** (0.4524)	−0.9903 (0.7117)
R-sq.	0.1049	0.0631	0.1727	0.1222	0.0886	0.2896	0.1159
Observe.	225,318	225,318	225,318	225,318	225,318	225,318	225,318

Note: the symbols indicate the significance levels of 10%, 5%, and 1%; the standard error is enclosed in parenthesis

Table A6 Examining the result of C.E.I. on total pollutant attentions

Dependent. adjustable	Quantile indices								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Ln AQ I	−2.3381*** (0.2256)	−2.3291*** (0.2370)	−2.4928*** (0.2550)	−2.4542*** (0.1590)	−2.9652*** (0.3397)	−3.1662*** (0.4233)	−3.5930*** (0.5709)	−3.3601*** (0.9161)	−2.0361*** (0.2108)
Ln. NO2	−2.4656*** (0.1610)	−2.7888*** (0.1963)	−3.1613*** (0.2145)	−3.4910*** (0.2571)	−3.8254*** (0.2891)	−4.3545*** (0.3537)	−4.6176*** (0.4656)	−5.1917*** (0.7375)	−2.3712*** (0.1434)
Ln CO	−3.6563*** (0.2825)	−4.0476*** (0.3183)	−4.7383*** (0.3680)	−5.4819*** (0.4074)	−5.9711*** (0.4637)	−5.7464*** (0.5540)	−6.1239*** (0.7017)	−5.4754** (1.0995)	−3.4207*** (0.2533)
Ln SO2	−0.3819*** (0.0700)	−0.6369*** (0.0882)	−0.6369*** (0.0882)	−0.7124*** (0.1033)	−0.9428*** (0.1243)	−1.1608*** (0.1560)	−1.3249*** (0.2159)	−1.8398*** (0.3717)	−0.2863*** (0.0607)
Ln O3	−1.7867*** (0.1166)	−1.9715*** (0.1275)	−2.2091*** (0.1386)	−2.3703*** (0.1468)	−2.6372*** (0.1617)	−2.8802*** (0.1841)	−3.0598*** (0.2168)	−2.6246*** (0.2865)	−1.2986*** (0.1094)
Ln PM2.5	−0.0308*** (0.0032)	−0.0285*** (0.0032)	−0.0304*** (0.0034)	−0.0336*** (0.0037)	−0.0387*** (0.0041)	−0.0384*** (0.0049)	−0.0319*** (0.0062)	−0.0175*** (0.0094)	−0.0277*** (0.0034)
Ln PM10	0.6591*** (0.2255)	1.7483*** (0.2327)	2.5652*** (0.2358)	3.1067*** (0.2488)	3.9587*** (0.2556)	4.0654*** (0.2808)	4.0624*** (0.3009)	3.1600*** (0.3820)	0.2796*** (0.2398)

Note: the symbols indicate the significance levels of 10%, 5%, and 1%; the standard error is enclosed in parenthesis

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