Seeing Is Not Believing: Strategic pollution suppression around corporate site visits

Yuchen Wei, Fujing Xue, Bohui Zhang, Xiaofeng Zhao

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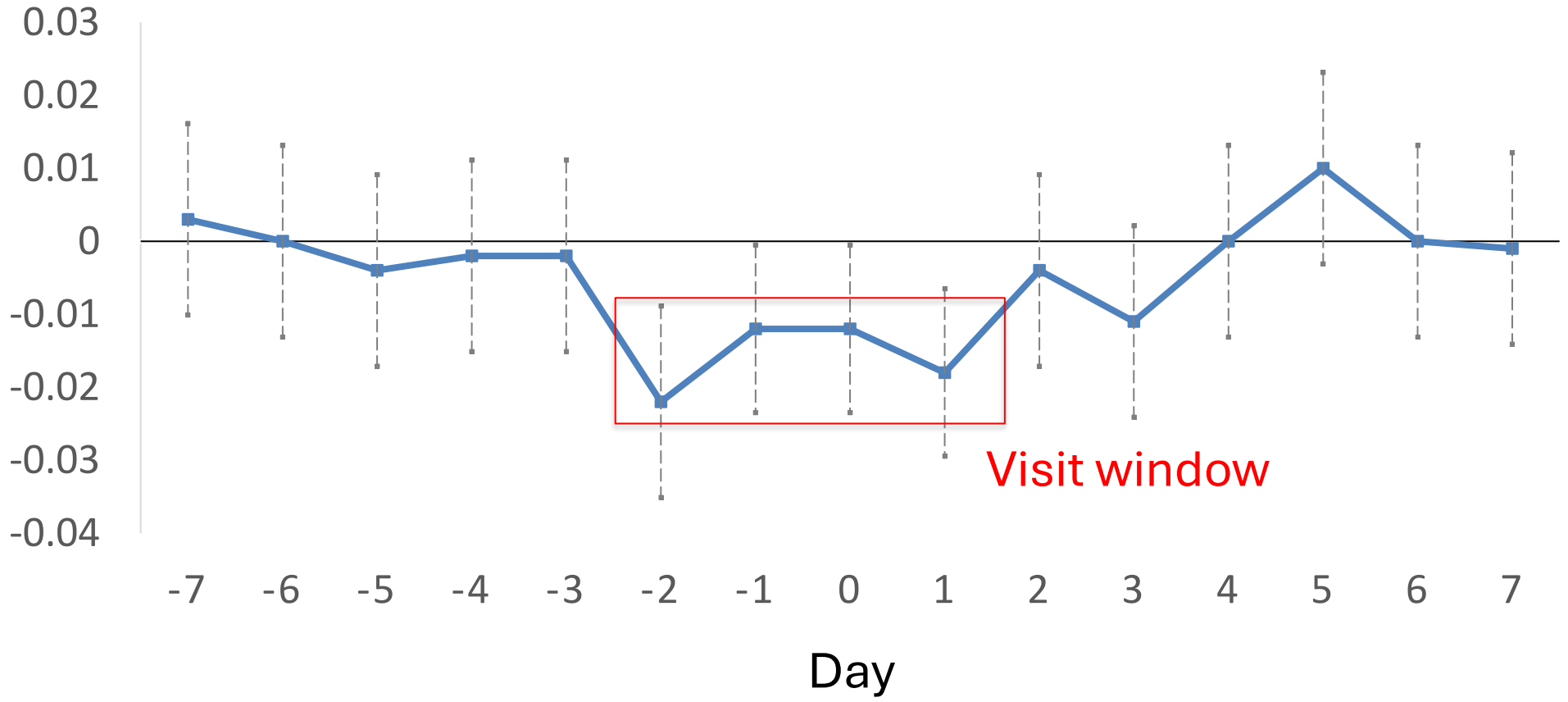
Introduction

- This study examines whether firms strategically "**clean up**" emissions when investors are **watching**.

- Using daily facility-level satellite data from China, we find that manufacturing firms temporarily **suppress pollution** emissions specifically during **investor site visits**.

Introduction

- The average PM2.5 concentration ($\mu g/m^3$) within a 1km radius of the visited site.



Introduction

Why does this matter?

- **A new form of green washing**: Firms temporarily reduce visible pollution without improving persistent environmental performance.
- The current reliance on episodic “on-the-ground” ESG due diligence could be flawed.

- **Endogenous private meetings**: the physical reality observed may not be an immutable truth, but a signal strategically managed by the firm.

Introduction

- Investors increasingly rely on **private meetings** to obtain firm-specific information (Brown et al., 2015).

- **Corporate site visits** are a prevalent practice of due diligence (Bowen et al., 2018; Cheng et al., 2019; Zhang et al., 2025).

- Investors view site visits as a way to obtain **hard information** through direct observation of firms' operations.

Introduction

- In this study, we argue that this “hard information” may itself be **endogenous** when firms know they are under **investor scrutiny**.

- “**Observer effect**”: the act of observation alters the state of the system being observed (Landsberger, 1958).

- **Hypothesis**: Firms actively manipulate their physical environment in anticipation of investor scrutiny.

Introduction

- Examining the question is challenging due to a lack of:
  1. precise records on private corporate meetings;
  2. high-frequency measures of physical firm outcomes.

Address challenging #1:

- The mandatory disclosure of site visits in China.
- Listed firms disclose the precise timing and attendees of investor site visits within two trading days.

Introduction

Address challenging #2:

- Use high-resolution satellite data that tracks air pollution concentrations **at the facility level**.

- Unlike financial data which is reported quarterly, pollution is a continuous physical flow that can be **measured daily via remote sensing**.

Methodology

Sample:

- **Manufacturing firms** listed on the **SZSE** from January 1, 2012, to December 31, 2019.

- Manufacturing operations represent major sources of industrial emissions (Shapiro & Walker, 2018).

- Manufacturing industries have higher asset tangibility (Cheng et al., 2016).

Methodology

Data

- Identify the universe of subsidiaries and production plants associated with SZSE-listed manufacturing firms.
- Extract site-specific air quality measures.
- Map with site visit records.

Final dataset: A site-day panel

Methodology

Identify plants

- Controlled & Participated Company Database of Listed Companies (CPCD) provided by the Chinese Research Data Services (CNRDS).

- Include plants where the listed firm holds at least 50% control.

- For each facility, we obtain the exact geographic coordinates.

Methodology

Site visit events

- Site visit records from the “Records of Investor Relations Activities” in the China Stock Market & Accounting Research (CSMAR).

- Identify site visits based on the “meeting method” field, manually reviewing records to confirm **physical tours**.

- Map a visit to **a particular facility or subsidiary location**. If the information is unavailable, we assume the visit occurred at the firm's headquarter.

Methodology

Measuring air pollution

- Daily measures of PM2.5 concentrations derived from the China High Air Pollutants (CHAP) dataset.

- Using machine learning algorithms that integrate ground-based pollutant measures, satellite remote sensing products, and atmospheric reanalysis data (Wei et al., 2021).

- Provide **daily 1 km ground-level PM2.5** data for China from 2000 to the present.

Methodology

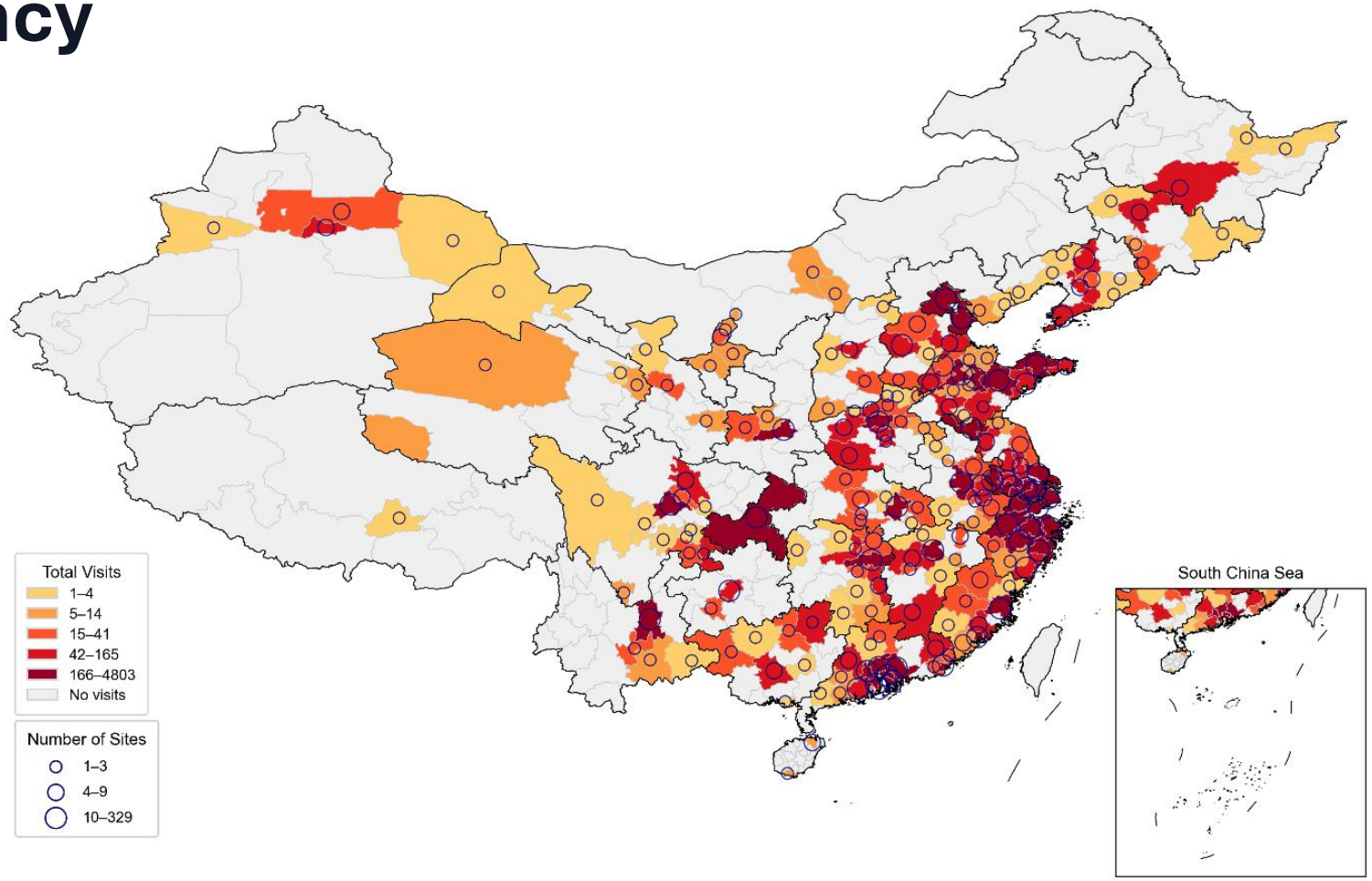
Final sample

- Focus on sites that received at least one visit during the sample period.
- 2,366 distinct geographic sites associated with 1,350 unique manufacturing firms.

- The final panel comprises **6.9 million** (i.e., 2,366 sites × 365 days × 8 years = 6,908,720) site-day observations covering **30,948 distinct site visit events**.

Methodology

Geographic distribution of sample sites and visit frequency



Methodology

Key variables

Each grid cell = 1km × 1km CHAP PM2.5 estimate

Raw local pollution

$Pollution_{i,t}$ = average PM2.5 within 1 km of site i on day t.

Background pollution

$Pollution_{i,t}^{ring}$ = average PM2.5 in the 1–3 km surrounding ring.

Abnormal pollution

$$Pollution_{i,j,t}^{abn} = Pollution_{i,t} - Pollution_{i,t}^{ring}$$

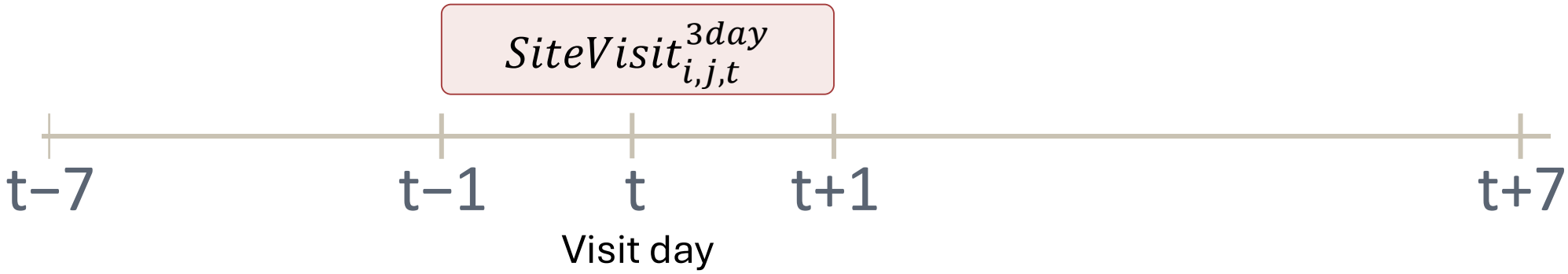
Abnormal pollution removes broader air-quality conditions and isolates the idiosyncratic pollution component around the specific facility.

Methodology

Key variables

- $SiteVisit_{i,j,t}$, which equals one if site *i* , located in city *j*, receives a visit on day *t*, and zero otherwise.

- $SiteVisit_{i,j,t}^{3day}$, which equals one if site *i* receives a visit within a 3-day window (i.e., day *t*, day *t*-1, or day *t*+1).



Methodology

The distribution of visits by visitor type

Type	Number	Percentage
Total number of site visits (*SiteVisit*)	30,948	100.00
Visits by type:		
- Securities firm (*Securities*)	24,769	80.03
- Funds	19,068	61.61
- Assets management companies (*Assman*)	12,909	41.71
- Foreign institutions (*Foreign*)	4,427	14.30
- Insurance companies (*Insurance*)	2,815	9.10
- Individuals (*Individual*)	972	3.14
- Banks (*Bank*)	815	2.63
- Investment advisor companies (*Advisor*)	617	1.99
- Media	571	1.85
- Others	401	1.30
- Futures companies (*Futures*)	162	0.52

Methodology

The summary statistics of key variables

Variable	N	Mean	SD	P25	Median	P75
Outcome variables:						
Pollution (μg/m^3)	6,908,720	49.573	34.539	26.50	40.43	61.55
Pollution^{abn} (μg/m^3)	6,908,720	0.093	1.209	-0.42	0.03	0.55
Pollution^{lag} (μg/m^3)	6,908,720	49.857	28.378	30.01	43.05	62.24
Pollution^{ring} (μg/m^3)	6,908,720	49.479	34.383	26.49	40.37	61.40
Key independent variables:						
SiteVisit	6,908,720	0.004	0.067	0.00	0.00	0.00
Sitevisit^{3day}	6,908,720	0.013	0.111	0.00	0.00	0.00

Methodology

Baseline model:

$$Y_{i,j,t} = \alpha + \beta \times VisitEvent_{i,j,t} + \gamma \times X_{i,j,t} + \eta_i + \mu_{j,t} + \varepsilon_{i,j,t} \quad (1)$$

(*i* = firm; *j* = city, *t* = day)

- $\boldsymbol{Y_{i,j,t}}$ represents either the raw pollution level (*Pollution*) or the abnormal pollution level (*Pollution*^{abn}).
- $\boldsymbol{VisitEvent_{i,j,t}}$: either the single-day indicator $SiteVisit_{i,j,t}$ or the three-day window indicator $SiteVisit_{i,j,t}^{3day}$.
- Controls ($\boldsymbol{X_{i,j,t}}$): the average pollution level at site *i* over the window [*t*-14, *t*-7] ($\boldsymbol{Pollution_{i,j,t}^{lag}}$); and the concurrent pollution level in the 1km-3km buffer zone surrounding the site ($\boldsymbol{Pollution_{i,j,t}^{ring}}$).
- Site fixed effects ($\boldsymbol{\eta_i}$) and city-by-date fixed effects ($\boldsymbol{\mu_{j,t}}$).

Main results

1. The impact of site visits on local pollution

	(1)	(2)	(3)	(4)
Dependent variable	*Pollution*^{abn}		*Pollution*	
SiteVisit	-0.015**		-0.015*	
	(0.007)		(0.008)	
SiteVisit^{3day}		-0.016***		-0.017***
		(0.006)		(0.006)
Pollution^{ring}	0.026***	0.026***	1.030***	1.030***
	(0.001)	(0.001)	(0.002)	(0.002)
Pollution^{lag}	0.011***	0.011***	0.013***	0.013***
	(0.001)	(0.001)	(0.002)	(0.002)
Site FE	Yes	Yes	Yes	Yes
City-date FE	Yes	Yes	Yes	Yes
N	6,908,720	6,908,720	6,908,720	6,908,720
Adj. R-sq	0.156	0.156	0.957	0.957

A 16.1% reduction from the mean (0.093 $\mu g/m^3$) on the day with a site visit.

Main results

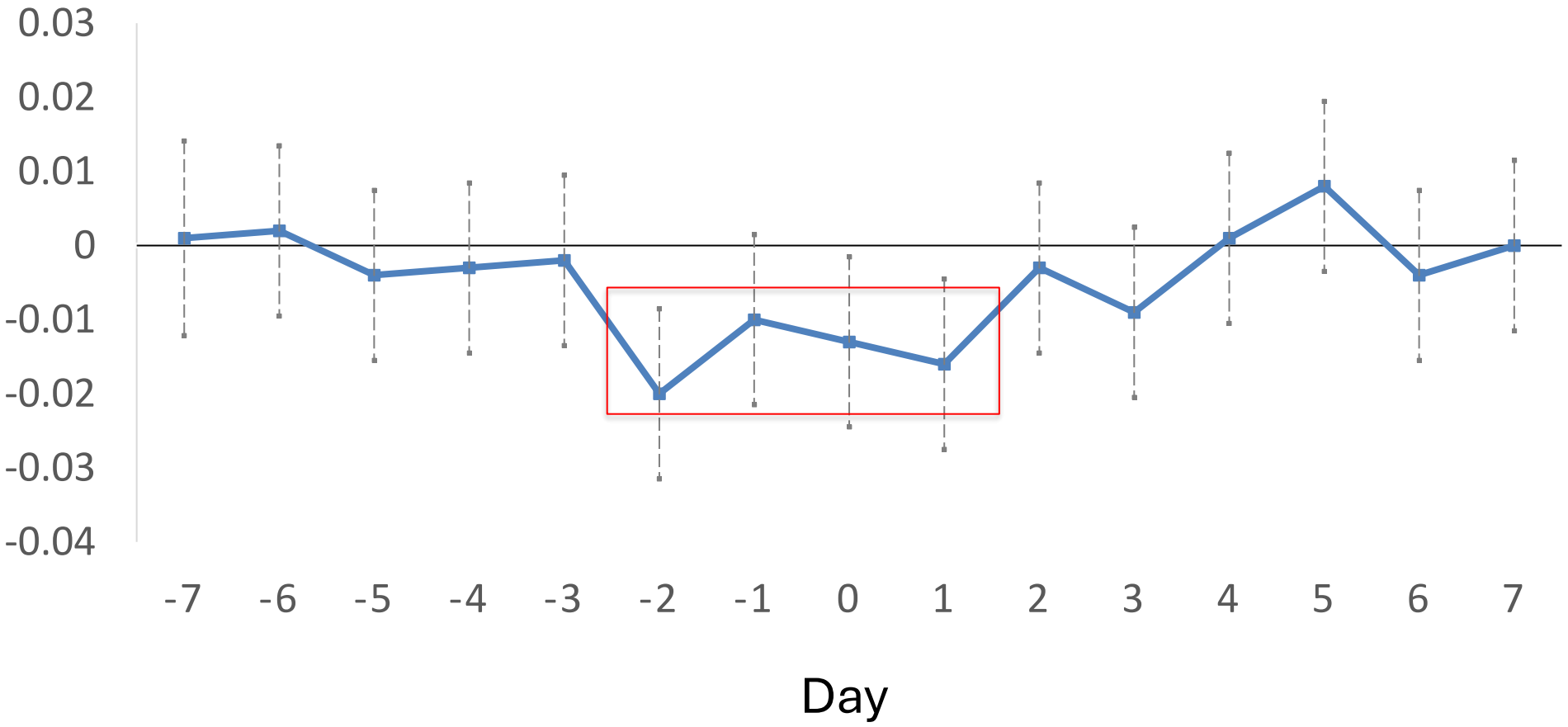
2. Dynamic model:

$$Y_{i,j,t} = \alpha + \sum_{n=-7}^{7} \beta_n \times VisitWindow_{i,j,t+n} + \gamma \times X_{i,j,t} + \eta_i + \mu_{j,t} + \varepsilon_{i,j,t} \quad (2)$$

- $\boldsymbol{VisitWindow_{i,j,t+n}}$ is an indicator variable equal to one if site i is visited on day $t + n$.
- We estimate the model for a two-week window ranging from 7 days before (n = -7) to 7 days after (n = 7) the visit.
- The points outside the 14-day window serve as the reference period.

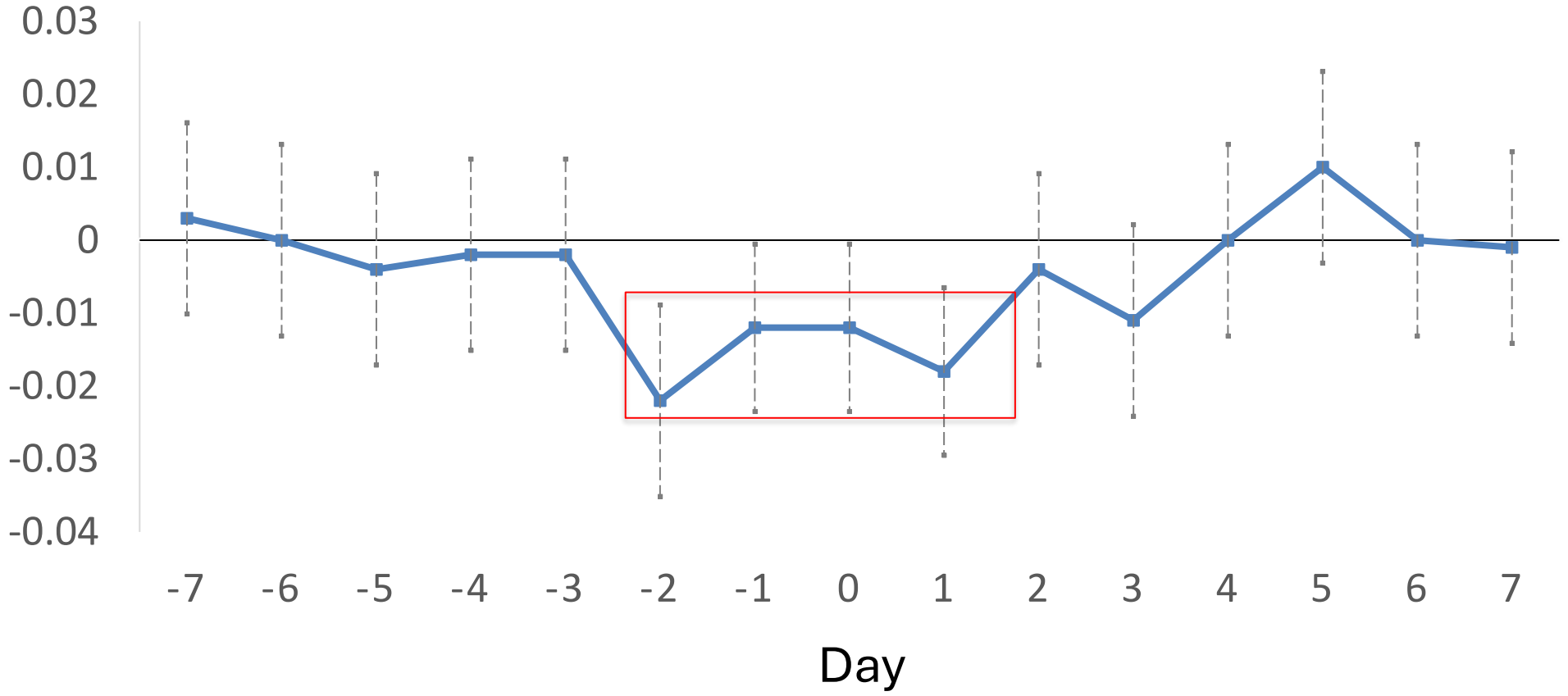
Main results

2.1. Pollution (*Pollution*^{abn}) around the site visit event



Main results

2.2. Raw pollution (*Pollution*) around the site visit event



Heterogeneity and mechanism

1. Stronger effects in more-polluted industries

Dependent variable	(1)	(2)	(3)	(4)
	Pollution^{abn}		*Pollution*	
Subsample	Low-pollution industries	High-pollution industries	Low-pollution industries	High-pollution industries
SiteVisit^{3day}	-0.013*	-0.024**	-0.013*	-0.028**
	(0.007)	(0.011)	(0.007)	(0.013)
Difference between the coefficients of *SiteVisit*^{3day}	(2)-(1): **-0.011** P-value: **0.070**		(4)-(3): **-0.015** P-value: **0.020**	
Controls	Yes	Yes	Yes	Yes
Site FE	Yes	Yes	Yes	Yes
City-date FE	Yes	Yes	Yes	Yes
N	4,715,800	2,192,920	4,715,800	2,192,920
Adj. R-sq	0.150	0.195	0.957	0.956

Heterogeneity and mechanism

2. Stronger effects in firms with high valuation

Dependent variable	(1)	(2)	(3)	(4)
	Pollution^{abn}		*Pollution*	
Subsample	Low *Tobin's Q*	High *Tobin's Q*	Low *Tobin's Q*	High *Tobin's Q*
SiteVisit^{3day}	-0.000	-0.027***	-0.000	-0.030**
	(0.010)	(0.007)	(0.010)	(0.008)
Difference between the coefficients of *SiteVisit*^{3day}	(2)-(1): **-0.027** P-value: **0.000**		(4)-(3): **-0.030** P-value: **0.000**	
Controls	Yes	Yes	Yes	Yes
Site FE	Yes	Yes	Yes	Yes
City-date FE	Yes	Yes	Yes	Yes
N	3,001,757	3,906,963	3,001,757	3,906,963
Adj. R-sq	0.185	0.171	0.958	0.956

Heterogeneity and mechanism

3. ESG performance

- **Low E/S firms**: Higher regulatory or reputational risks create stronger incentives to mask poor baseline environmental performance.

- **High G firms**: Strong governance may make managers more disciplined—and more “jittery”—in preparing for investor scrutiny.

Heterogeneity and mechanism

3.1. Stronger effects in firms with low E rating

	(1)	(2)	(3)	(4)
Dependent variable	*Pollution*^{abn}		*Pollution*	
Subsample	Low E Rating	High E Rating	Low E Rating	High E Rating
SiteVisit^{3day}	-0.016***	0.010	-0.017***	0.011
	(0.006)	(0.024)	(0.006)	(0.024)
Difference between the coefficients of *SiteVisit*^{3day}	(2)-(1): **0.026** P-value: **0.010*** **		(4)-(3): **0.028** P-value: **0.010*** **	
Controls	Yes	Yes	Yes	Yes
Site FE	Yes	Yes	Yes	Yes
City-date FE	Yes	Yes	Yes	Yes
N	5,814,807	1,093,913	5,814,807	1,093,913
Adj. R-sq	0.163	0.188	0.957	0.956

Heterogeneity and mechanism

3.2. Stronger effects in firms with low S rating

	(1)	(2)	(3)	(4)
Dependent variable	*Pollution*^{abn}		*Pollution*	
Subsample	Low S Rating	High S Rating	Low S Rating	High S Rating
SiteVisit^{3day}	-0.013***	-0.011	-0.015***	-0.011
	(0.006)	(0.008)	(0.008)	(0.009)
Difference between the coefficients of *SiteVisit*^{3day}	(2)-(1): **0.002** P-value: **0.400**		(4)-(3): **0.004** P-value: **0.290**	
Controls	Yes	Yes	Yes	Yes
Site FE	Yes	Yes	Yes	Yes
City-date FE	Yes	Yes	Yes	Yes
N	3,439,024	3,469,696	3,439,024	3,469,696
Adj. R-sq	0.183	0.168	0.954	0.960

Heterogeneity and mechanism

3.3. Stronger effects in firms with high G rating

	(1)	(2)	(3)	(4)
Dependent variable	*Pollution*^{abn}		*Pollution*	
Subsample	Low G Rating	High G Rating	Low G Rating	High G Rating
SiteVisit^{3day}	-0.009***	-0.020***	-0.004	-0.022***
	(0.013)	(0.006)	(0.013)	(0.007)
Difference between the coefficients of *SiteVisit*^{3day}	(2)-(1): **-0.011** P-value: **0.220**		(4)-(3): **-0.018*** P-value: **0.060**	
Controls	Yes	Yes	Yes	Yes
Site FE	Yes	Yes	Yes	Yes
City-date FE	Yes	Yes	Yes	Yes
N	1,341,366	5,567354	1,341,366	5,567,354
Adj. R-sq	0.235	0.161	0.956	0.957

Heterogeneity and mechanism

3.3. Stronger effects in firms with low managerial payment

	(1)	(2)	(3)	(4)
Dependent variable	*Pollution*^{abn}		*Pollution*	
Subsample	Low *ExePay*	High *ExePay*	Low *ExePay*	High *ExePay*
SiteVisit^{3day}	-0.019***	-0.011	-0.022**	-0.010
	(0.009)	(0.008)	(0.010)	(0.008)
Difference between the coefficients of *SiteVisit*^{3day}	(2)-(1): **0.008** P-value: **0.110**		(4)-(3): **0.010*** P-value: **0.070**	
Controls	Yes	Yes	Yes	Yes
Site FE	Yes	Yes	Yes	Yes
City-date FE	Yes	Yes	Yes	Yes
N	3,111,248	3,797,472	3,111,248	3,797,472
Adj. R-sq	0.178	0.166	0.957	0.956

Heterogeneity and mechanism

3.3. Stronger effects in firms with high institutional ownership

	(1)	(2)	(3)	(4)
Dependent variable	*Pollution*^{abn}		*Pollution*	
Subsample	Low *IO*	High *IO*	Low *IO*	High *IO*
SiteVisit^{3day}	-0.008	-0.019**	-0.009	-0.019**
	(0.008)	(0.008)	(0.009)	(0.009)
Difference between the coefficients of *SiteVisit*^{3day}	(2)-(1): **-0.011*** P-value: **0.080**		(4)-(3): **-0.010*** P-value: **0.010**	
Controls	Yes	Yes	Yes	Yes
Site FE	Yes	Yes	Yes	Yes
City-date FE	Yes	Yes	Yes	Yes
N	3,038,865	3,869,855	3,038,865	3,869,855
Adj. R-sq	0.190	0.166	0.958	0.956

The *necessity* to reduce pollution is driven by environmental liability (Low E), while the *ability* and *discipline* to do so are facilitated by strong governance (High G).

Heterogeneity and mechanism

4. How do these factors transmit to specific firm behaviors?

- **Reputation channel**: Firms clean up for environmentally conscious visitors who may publicize pollution concerns, increasing regulatory scrutiny or the cost of capital.

- **Ownership channel**: Firms clean up for visitors with existing equity stakes because these investors have direct voting power and can exit after observing poor environmental practices.

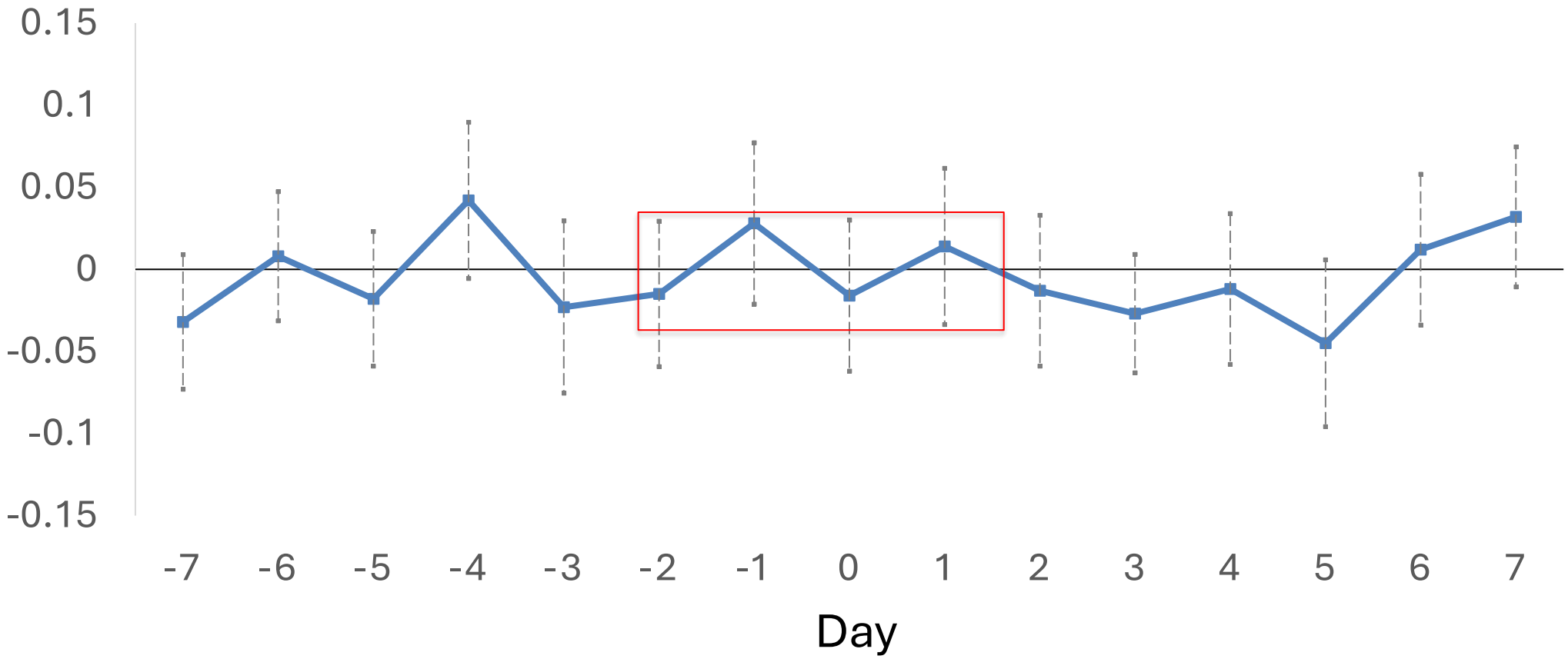
Heterogeneity and mechanism

Firms clean up to protect managerial standing in front of owners, rather than to achieve genuine environmental sustainability.

	(1)	(2)
Dependent variable	*Pollution*^{abn}	*Pollution*
Stake Visitors with ownership stake	-0.046**	-0.044**
	(0.019)	(0.022)
nonStake Visitors without ownership stake	-0.014	-0.012
	(0.011)	(0.013)
PRI Visitors who are signatories to the **Principles for Responsible Investment**.	0.008	0.006
	(0.014)	(0.016)
Difference between *Stake* and *nonStake*	**-0.032**	**-0.032**
	p-value: **0.074**	p-value: **0.117**
Controls	Yes	Yes
Site FE	Yes	Yes
City-date FE	Yes	Yes
N	6,908,720	6,908,720
Adj. R-sq	0.156	0.957

Additional analysis

1. Placebo analysis: *Pollution* around online visits



Additional analysis

2. The effects of sister non-visited sites

- ***Rule out regional shocks***: Examine non-visited facilities of the same firm located in the same city (*SameCity*).

- ***Rule out firm-wide shocks***: Examine non-visited facilities of the same firm located in different cities (*DiffCity*).

Heterogeneity and mechanism

2. Comparison with sister non-visited sites

Panel A: Sites of the same company in the same city

	(1)	(2)
Dependent variable	*Pollution*^{abn}	*Pollution*
SameCity	0.006	0.008
	(0.008)	(0.008)

Panel B: Sites of the same company in different cities

	(1)	(2)
Dependent variable	*Pollution*^{abn}	*Pollution*
DiffCity	-0.007	-0.010
	(0.013)	(0.014)

Additional analysis

3. Channels of pollution reduction

How do firms achieve the observed reduction in pollution?

1) A temporary **suspension of production activities**.

2) Strategic **deployment of pollution control technologies**: e.g., turning on scrubbers or filters that are otherwise left idle)

Additional analysis

3.1. No impact on production activities

- We use satellite-derived **thermal infrared radiation (TIR)** as a proxy for real-time production activities (Xue et al., 2026).

	(1)	(2)	(3)	(4)
Dependent variable	*TIR*		*AR*	
SiteVisit	0.012		-0.005	
	(0.018)		(0.016)	
$SiteVisit^{3day}$		0.000		-0.004
		(0.012)		(0.010)
Controls	Yes	Yes	Yes	Yes
Site FE	Yes	Yes	Yes	Yes
City-date FE	Yes	Yes	Yes	Yes
N	712,027	712,027	712,027	712,027
Adj. R-sq	0.987	0.987	0.668	0.668

Additional analysis

3.2. Stronger effects in firms with high installed-abatement capacity (IAC).

- Use the frequency of pollution-control keywords (e.g., “desulfurization,” “denitrification,” “dust collector”) in the annual report.

	(1)	(2)	(3)	(4)
Dependent variable	*Pollution*^{abn}		*Pollution*	
Subsample	Low *IAC*	High *IAC*	Low *IAC*	High *IAC*
SiteVisit^{3day}	-0.010*	-0.039**	-0.012*	-0.038**
	(0.006)	(0.017)	(0.007)	(0.019)
Difference between the coefficients of *SiteVisit*^{3day}	(2)-(1): -0.029 P-value: 0.000		(4)-(3): -0.026 P-value: 0.000	

Instead of shutting down operating activities, firms leverage their installed environmental infrastructure to temporarily sanitize visible emissions.

Conclusion

- Firms temporarily suppress pollution during investor site visits, creating a transitory "**green**" impression.
- The effect is stronger among high-pollution, high-valuation, and well-governed firms, and is driven by existing shareholders.
- Firms do not suspend production; they activate abatement capacity, consistent with physical signal management.
- Overall, we document a new form of **greenwashing**, suggesting that **seeing may not be believing**.