Strategic Capture of Monitors:
Evidence from Pollution Control in China

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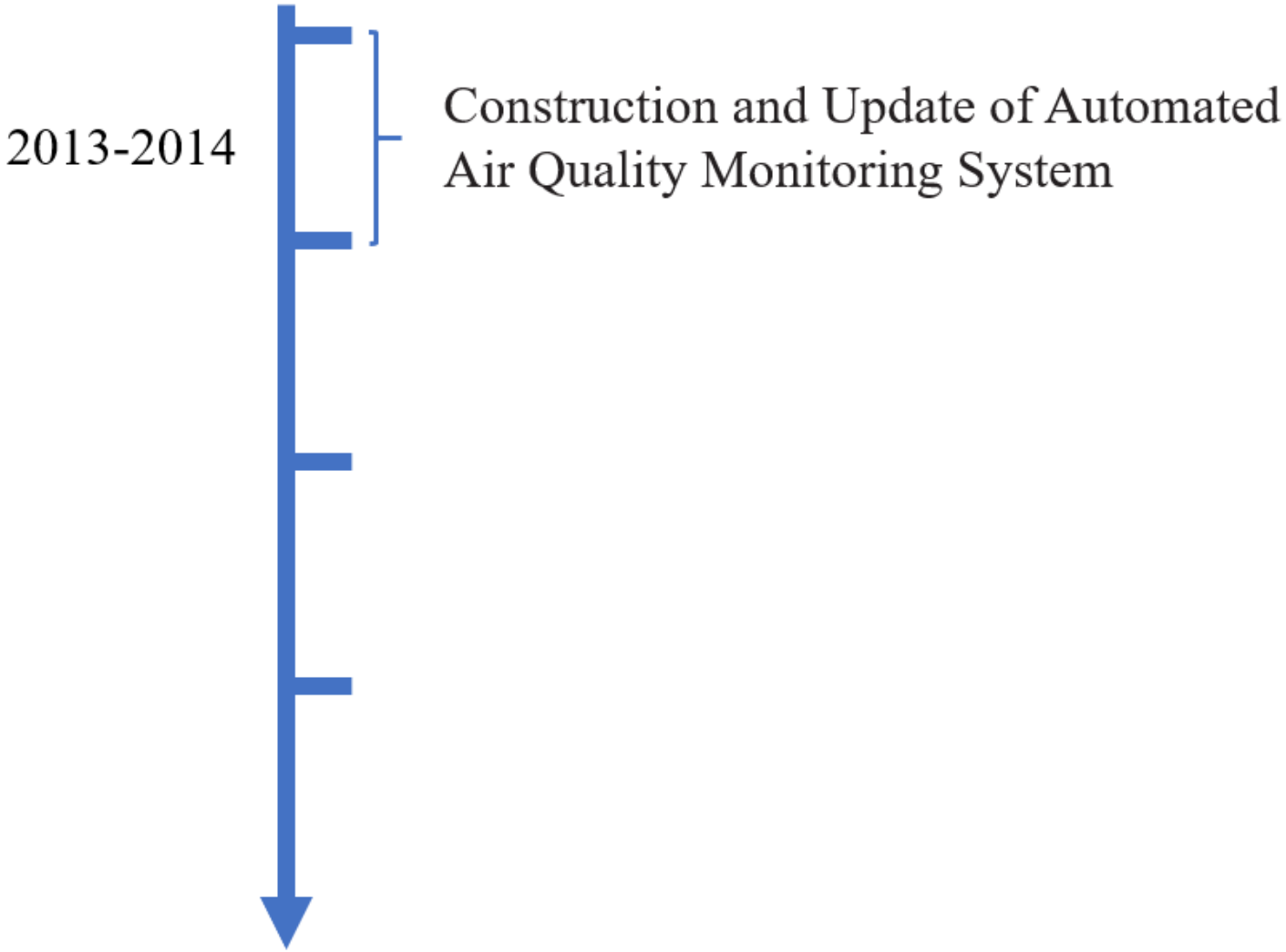
Motivation

- Ensuring compliance with central government policies in decentralized systems remains a core challenge (Martinez-Bravo et al., 2022).
- Decentralization $\Rightarrow$ Principal-agent Problems between Central and Local Governments (Maskin, Qian, and Xu, 2000).
- Delegated third-party monitors are a common means of mitigating agency problems (Duflo et al, 2013; Olken and Pande, 2012).
- Can delegated monitors themselves be captured by local governments?

Setting


2013-2014
Construction and Update of Automated
Air Quality Monitoring System

Setting

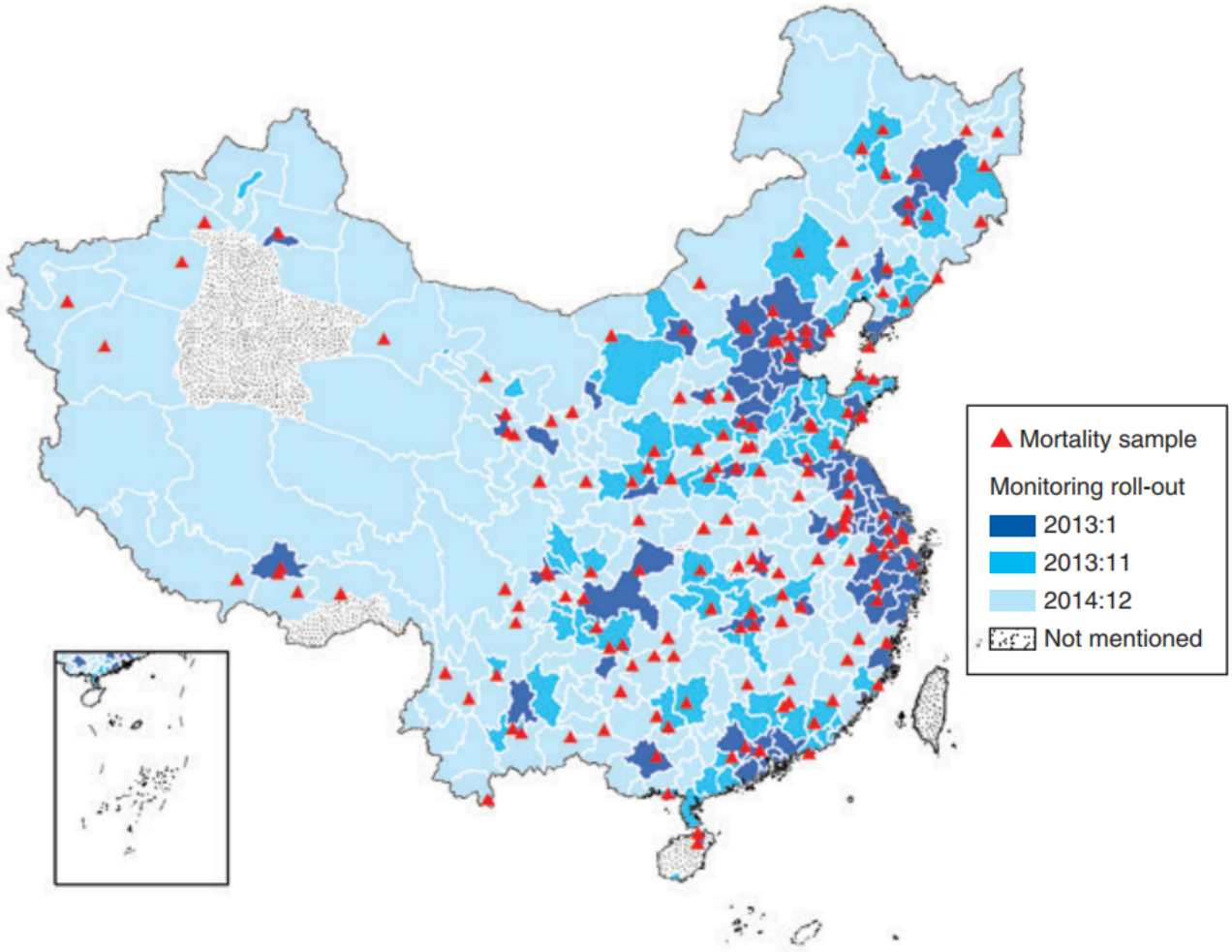
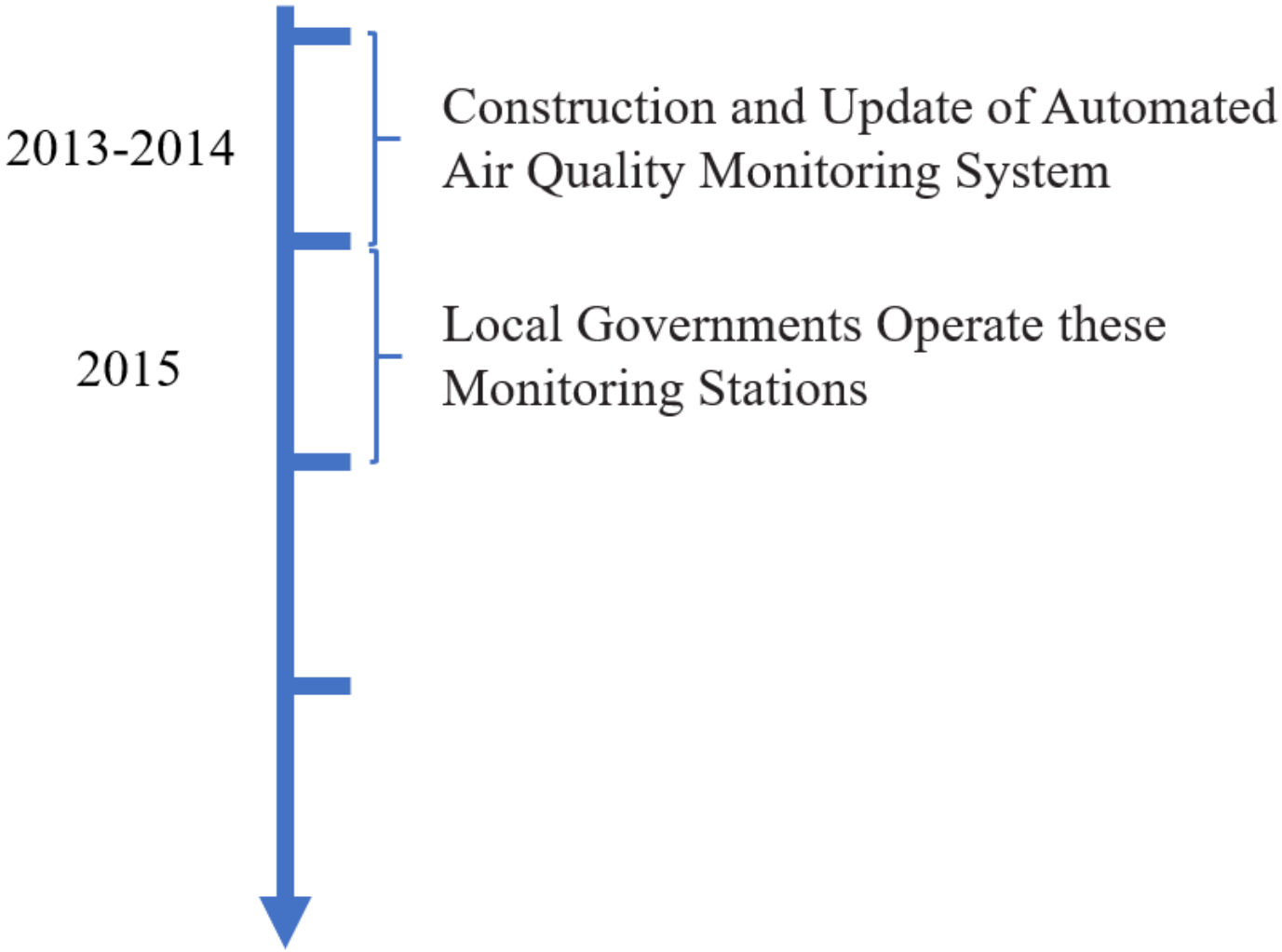


Figure: Monitoring Program Rollout (Source: Barwick et al., 2024)

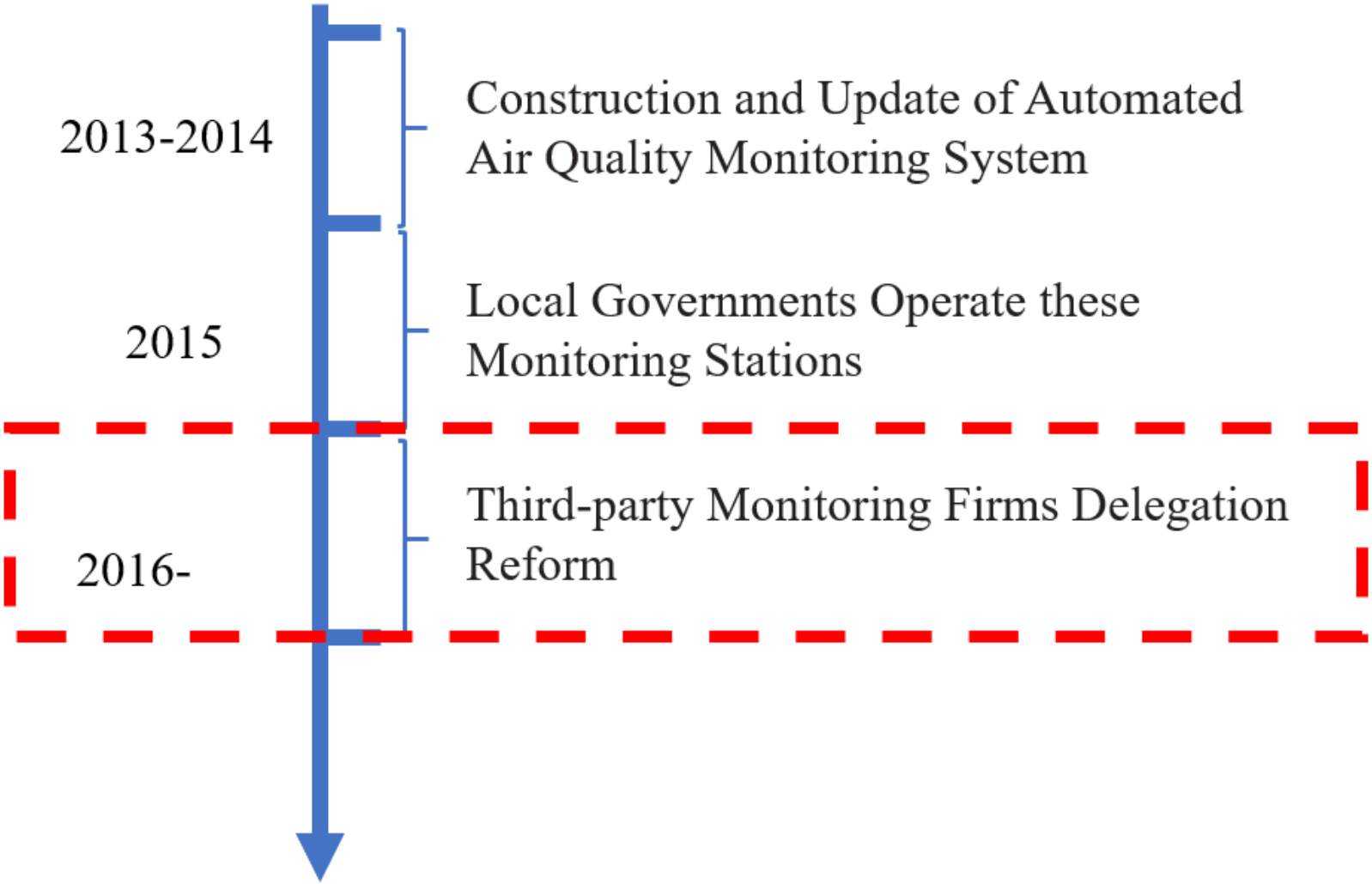
Setting


2013-2014
Construction and Update of Automated Air Quality Monitoring System
2015
Local Governments Operate these Monitoring Stations

Setting

Figure: Water Spraying on Monitoring Station

Setting


2013-2014
Construction and Update of Automated Air Quality Monitoring System
2015
Local Governments Operate these Monitoring Stations
2016-
Third-party Monitoring Firms Delegation Reform

Setting

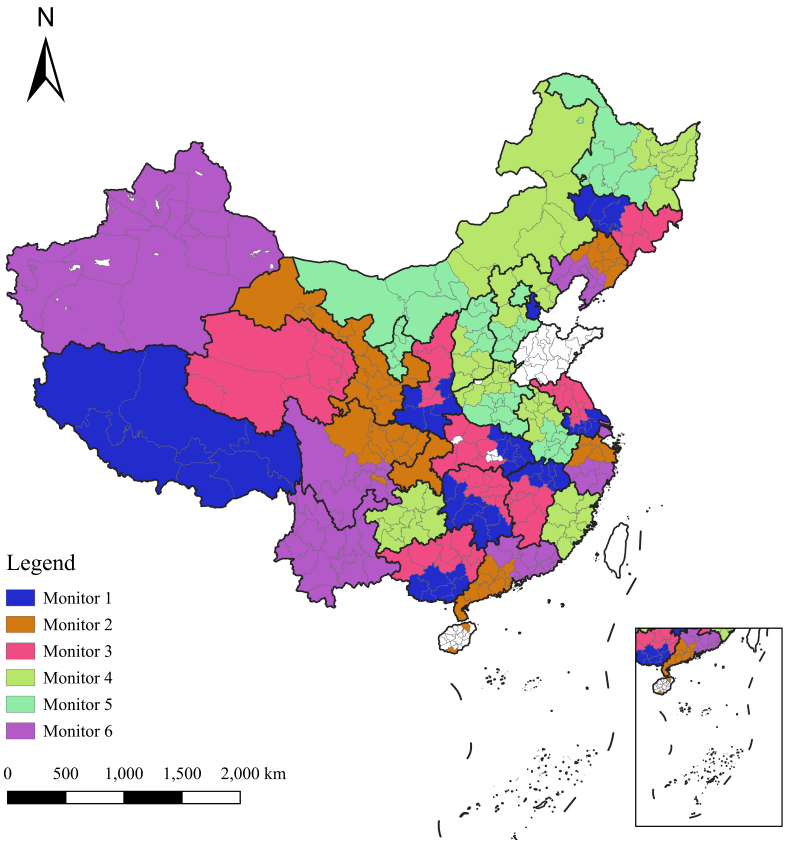


Figure: Geographic Distribution of Monitoring Firms Assignment

- Monitors were procured by central government (MEP) through twelve contracts.
- Six companies were selected, and each of them won two contracts.
- All the operation costs would be covered by the MEP.

Research Questions

- Could third-party monitors be captured by local government?
- How does local governments capture third-party monitors?
- What is the implication for real outcomes?

Main Findings

- Increase of "Related Procurement"
  - After the reform, monitoring firms were more likely to win procurement contracts from the local governments they monitor, with the probability increasing by 16.6 percentage points, a very large impact relative to the base rate of 12.5%.
  - Promotion incentive of local officials drives the results.

- Declined Reported Air Pollution from Monitoring Stations after "Related Procurement"
  - Reported $PM_{2.5}$ decreased by 6% following "Related Procurement".
  - No change in satellite-based air pollution measures.

- Reduced Environmental Enforcement Intensity around National Monitoring Stations after "Related Procurement"
  - The probability of a nearby polluter receiving enforcement on excessive air pollution decreases by 44%, relative to polluters farther away from the station.

Contributions

- The Risk of Collusion between Monitors and the Agents they oversee
  - Imperfect Monitoring and Repeated Interaction (e.g., Tirole, 1986; Prendergast, 1993; Laffont and Martimort, 1997)
  - Distortions in Information Transmission (Duflo et al., 2013; Chu et al., 2021; Vannutelli, 2022)
- Environmental Regulation and Pollution Control in Developing Countries (Duflo et al., 2013; Greenstone et al., 2022; Barwick et al., 2024; Yang et al., 2024)
- Reciprocal Exchange between Government and Private Firms (Shleifer and Vishny, 1994; Faccio, 2006; Di Tella and Franceschelli, 2011; Blanes i Vidal, Draca and Fons-Rosen, 2012; Bertrand, Bombardini and Trebbi, 2014)

Data: O&M Firms Delegation

- Focusing on the first round of O&M outsourcing during 2016 - 2018. (The second round covered 2019-2021, which was affected by the COVID-19 pandemic.)
- From the China Government Procurement Database, we collect the MEP's announcement in the end of 2015, which specifies the assignment of monitoring station operations to these firms across different cities.

Data: Local EPBs' Procurement Contracts

- China Government Procurement Database, 2015–2018.
- High disclosure rate since 2015.
- 431 contracts between local governments and the six O&M firms.

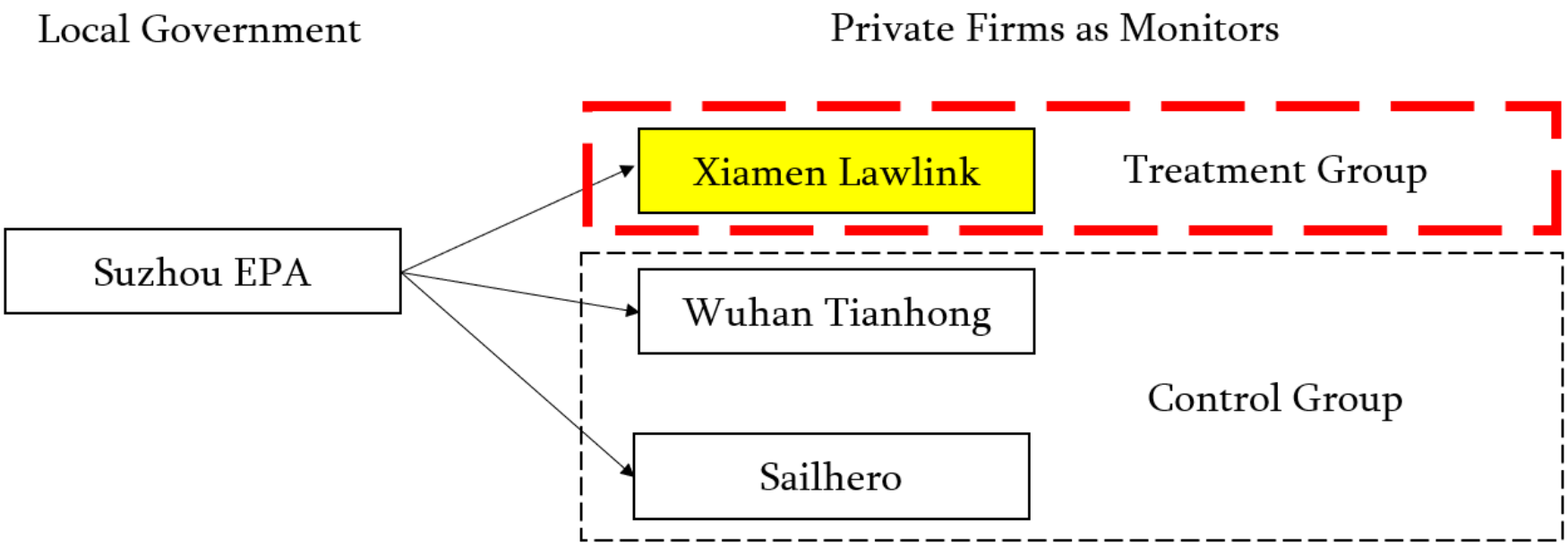
Data: Air Pollutant Levels

- Reported pollution data
  - Focusing on $PM_{2.5}$, PM_{10}, and AQI.
  - Source from China National Environmental Monitoring Center.
- Satellite-based benchmark
  - Hourly $PM_{2.5}$ data from NASA's Global Modeling and Assimilation Office.
  - For each ground station, we construct daily satellite-based $PM_{2.5}$ within a 10-kilometer radius.
  - Robustness checks use MODIS AOD data and ACAG satellite-derived surface $PM_{2.5}$ estimates.

Data: Environmental Regulatory Enforcement

- Obtaining environmental enforcement records issued by local Environmental Protection Bureaus (EPBs) from PKULaw.
- Identifying penalties related to air pollution from these enforcement documents.
- Matching penalized firms to the 2013 Annual Survey of Industrial Firms (ASIF).

Outsourcing Reform and Related Procurement: Empirical Design



Outsourcing Reform and Related Procurement: Empirical Design

- We collapse contract-level data about transactions between local governments and monitoring firms into city-by-firm-by-quarter level.
- We estimate the following DiD specification:

$$\begin{aligned} AnyContract_{c,f,q} = \beta \cdot Related_{c,f} \cdot Post2016_q \\ + \delta_{c,f} + \theta_q + \mu_{c,y} + \nu_{f,y} + \lambda_c q + \kappa_f q + \epsilon_{c,f,q} \end{aligned} \quad (1)$$

DV	Any Contract				
	(1)	(2)	(3)	(4)	(5)
Treat×Post2016	0.104***	0.104***	0.166***	0.166***	0.207***
	(0.034)	(0.034)	(0.039)	(0.040)	(0.037)
Treat	-0.049*				
	(0.029)				
Post2016	-0.018				
	(0.023)				
Firm-City Pair FE	N	Y	Y	Y	Y
Yr-Qrt FE	N	Y	Y	Y	Y
City-Year FE	N	N	Y	Y	Y
Firm-Year FE	N	N	Y	Y	Y
City Yr-Qrt Trend	N	N	N	Y	Y
Firm Yr-Qrt Trend	N	N	N	Y	Y
Firm-City Control×Post2016	N	N	N	N	Y
Observations	2,048	2,048	2,048	2,048	2,048
R-squared	0.006	0.185	0.336	0.389	0.390
Pre-reform DV Mean	0.125	0.125	0.125	0.125	0.125
Pre-reform DV SD	0.331	0.331	0.331	0.331	0.331

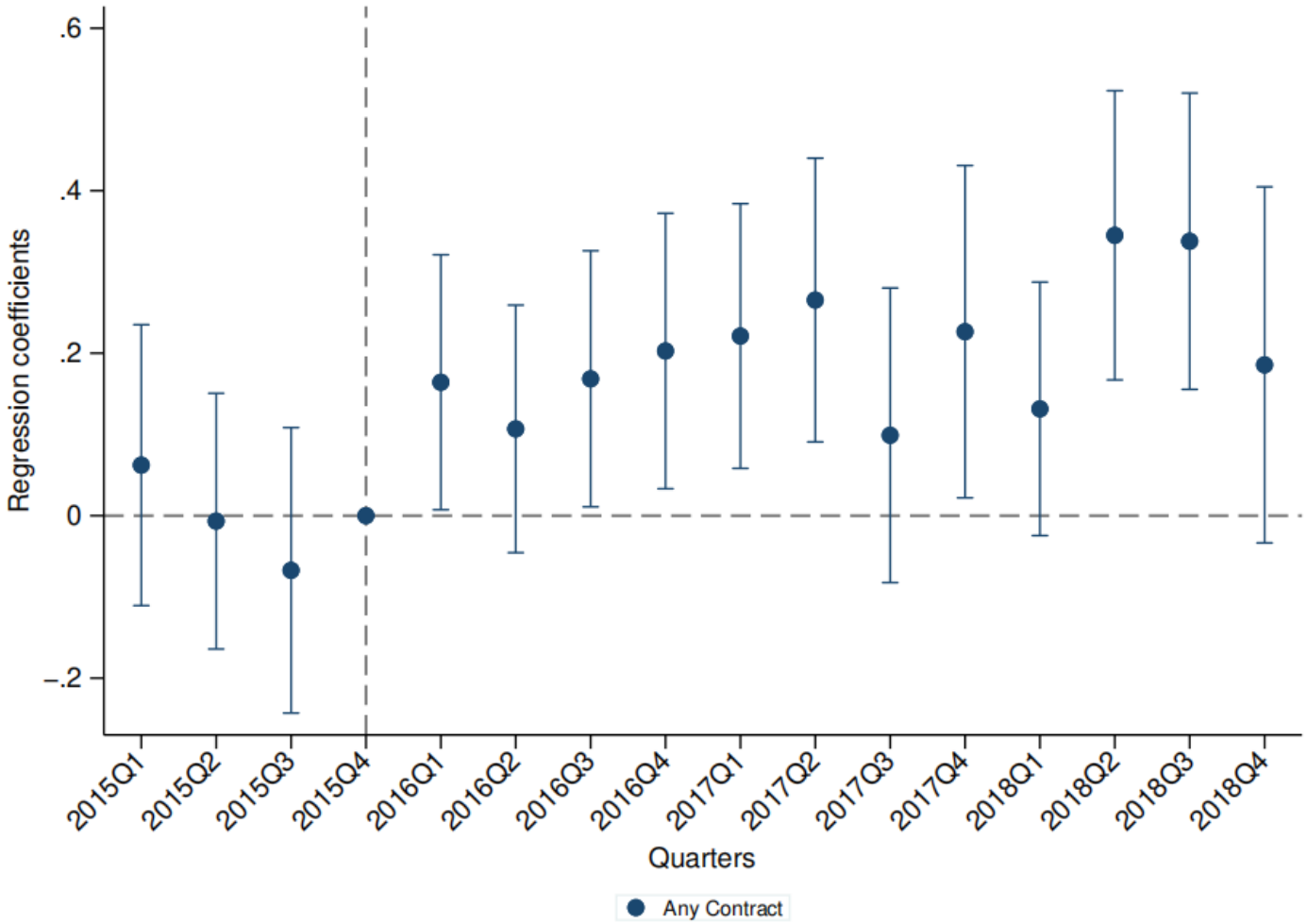


Figure 2: Dynamics of Related Procurement Around the Outsourcing Reform

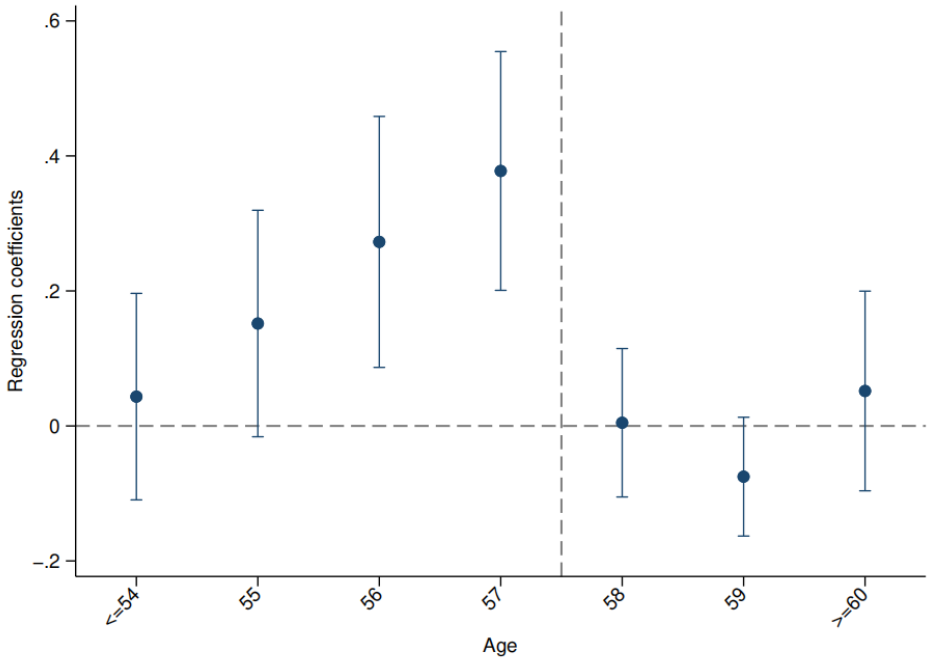
Alternative Explanation: Reduced Information Frictions?

- This explanation cannot account for the divergence between reported and satellite-based pollution after the procurement.
  - Reported pollution declines, while satellite-based pollution remains largely unchanged.
- The increase in related procurement occurs sharply around the reform date.
  - Reduced information frictions would likely generate a more gradual increase in related contracting over time.
- We do not find stronger post-reform related contracting for city–firm pairs that are geographically distant.
  - If information frictions were central, distance between a city and an O&M firm's headquarters should play a role structuring the effect.

Alternative Explanation: Asset-Specific Investments?

- One alternative explanation is that local governments purchased from O&M firms to ensure compatibility with the equipment used at national monitoring stations.
- We examine the equipment requirements in one MEP contract with one of the six O&M firms.
  - The contract specifies the equipment and brands that the firm could use in operating national monitoring stations.
  - None of the listed equipment was manufactured by any of the six O&M firms.
  - A substantial share of the listed brands were foreign firms.

Political Incentive



- We use the city party secretary's age during the 2018 NPC to measure political incentive.
- We look at the interaction terms between $Treat \times Post$ and each age dummies.
- We expect to see a more pronounced increase in cities where the party secretary was 57 or younger during the 2018 NPC.

Related Procurement and Reported Air Pollution

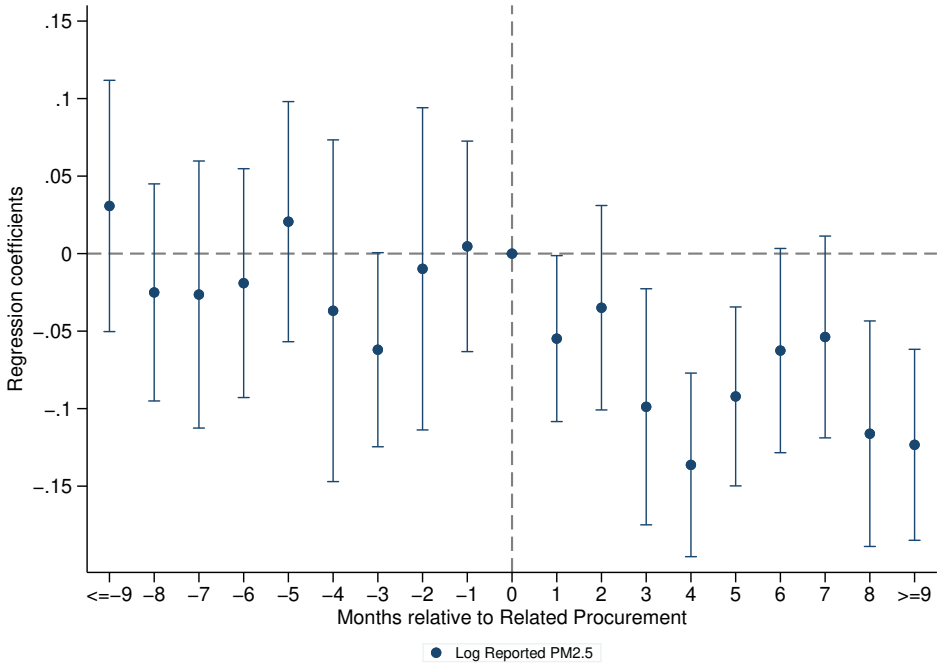


Figure: Event Study on Log Reported $PM_{2.5}$ (Average Effect = -0.056 (s.e.=0.018))

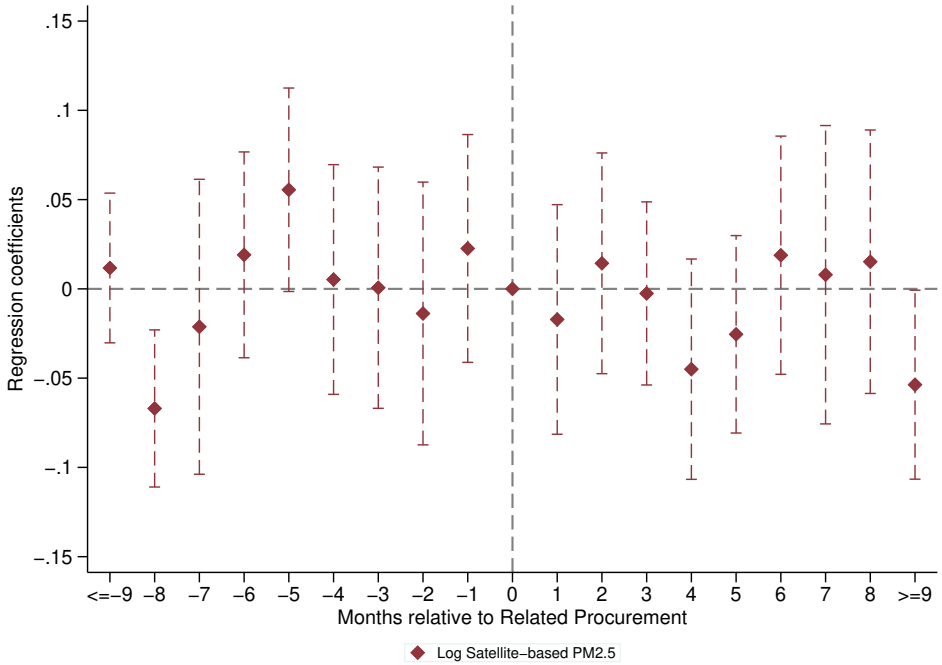
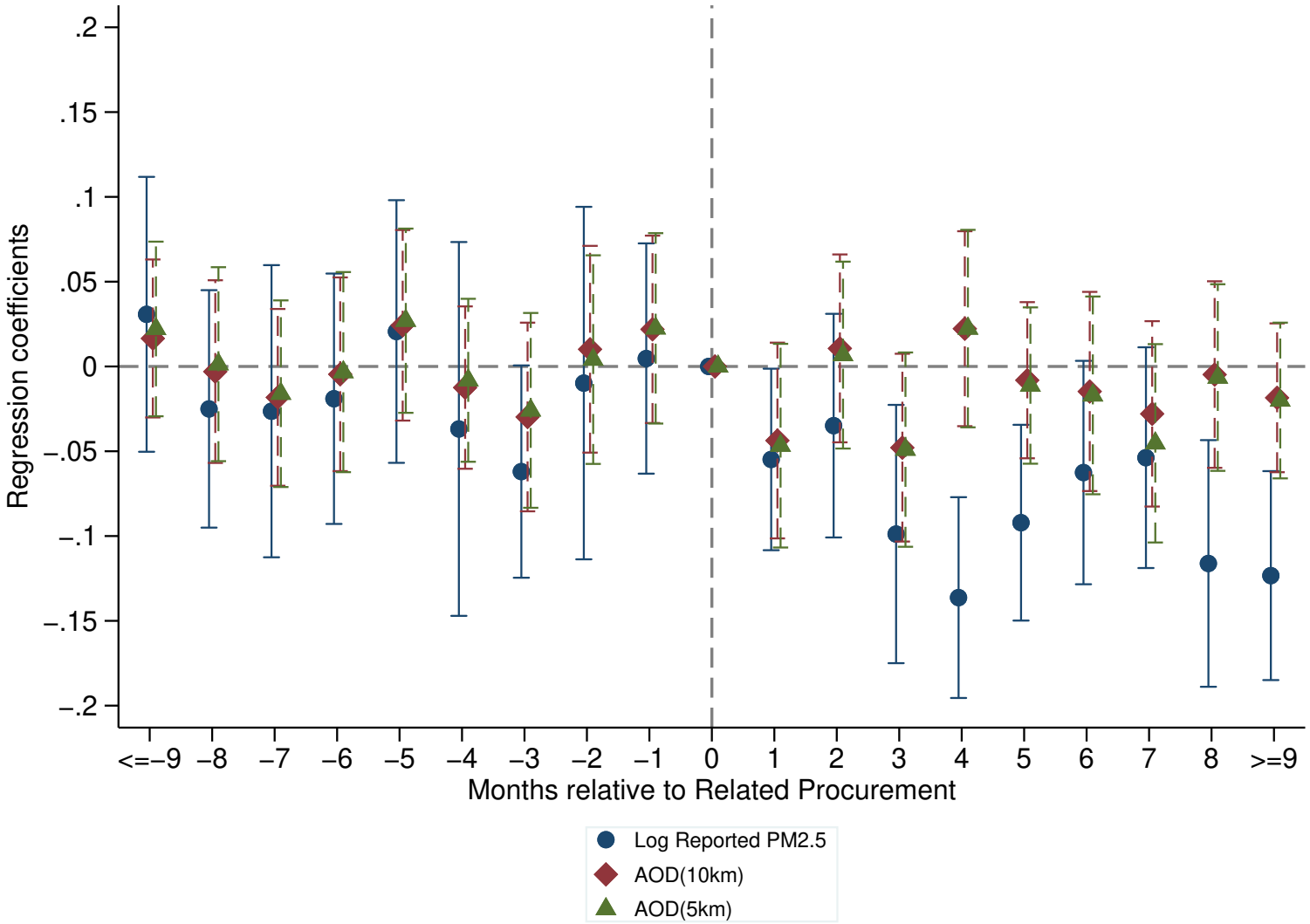


Figure: Event Study on Log Satellite-based $PM_{2.5}$ (Average Effect = 0.001 (s.e.=0.016))

Robustness Checks: Aerosol Optical Depth (AOD)



Robustness Checks: Reported $PM_{2.5}$ Deviation from Satellite-Based $PM_{2.5}$ (Atmospheric Composition Analysis Group)

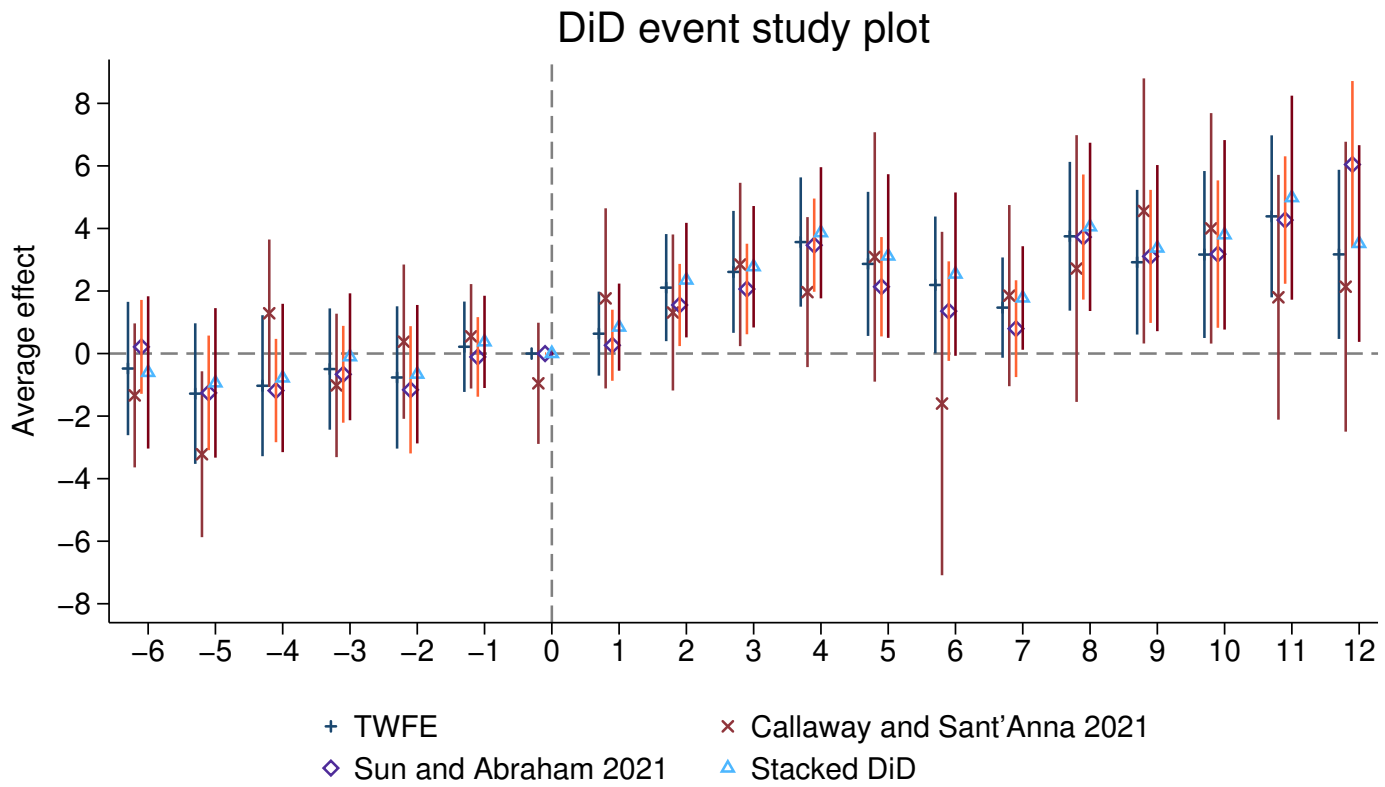


Figure: DV: Satellite-based $PM_{2.5}$ Minus Reported $PM_{2.5}$

Endogenous Selection Discussion

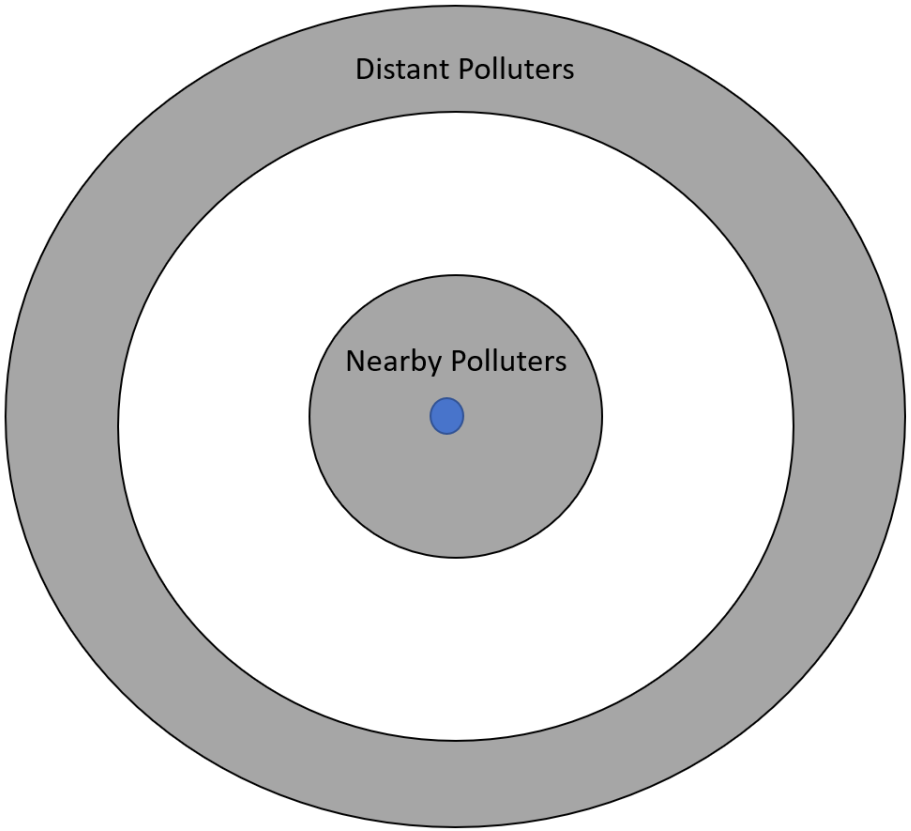
- One concern is that local governments may reward O&M firms that had already shown a willingness to report lower pollution readings.
  - This form of selection would imply lower reported pollution even before the related procurement contract.
  - As a result, the post-minus-pre difference would be mechanically attenuated.
  - Our estimates would therefore likely provide a lower bound on the true effect.
- A different concern is that O&M firms may inflate reported pollution to pressure local governments into signing procurement contracts.
  - We do not observe any increase in reported pollution before the contract.
  - Such hold-up behavior would violate the firm's contract with the central government.
  - Local governments could report such misconduct to central authorities.
  - It is also unlikely that a private firm could credibly extort a city-level government, given the latter's administrative power.

Comparing Related and Non-related Procurement

- For each city with a related procurement contract at time t, we construct a control group of cities that signed procurement contracts with one of the six O&M firms at the same time, but not with their assigned O&M firm.
- This design compares related procurement to otherwise similar procurement activity involving the same set of firms.

	Ground-based Data						Satellite-based Data		Difference	
DV	$\log PM_{2.5}$		$\log PM_{10}$		logAQI		$log PM_{2.5}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
PostProcure	-0.056***	-0.082***	-0.042**	-0.059**	-0.031**	-0.052**	0.002	0.005	-0.057**	-0.087***
	(0.020)	(0.030)	(0.018)	(0.023)	(0.015)	(0.020)	(0.019)	(0.031)	(0.024)	(0.032)
Meteorological Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Station FEs	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Day FEs	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Matched × YrQrt FEs	N	Y	N	Y	N	Y	N	Y	N	Y
Operator × YrQrt FEs	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Province × YrQrt FEs	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
City Time Trends	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	334,738	334,738	334,932	334,932	335,343	335,343	334,602	334,602	333,784	333,784
R-squared	0.600	0.606	0.633	0.637	0.606	0.610	0.565	0.568	0.450	0.456

Real Implications: Government-Monitor Collusion and Air Pollution Enforcement



$$
\begin{aligned}
&AnyEnforce_{f,q} = \\
&\beta\, PostProcure_{c,q} \times I(Distance_f \leq 15km) \\
&\quad + \delta_f + \theta_{c,q} + \kappa_{i,q} + \gamma_q \times Size_{f,2013} \\
&\quad + \gamma_q \times Lev_{f,2013} + \gamma_q \times ROA_{f,2013} + \varepsilon_{f,q}
\end{aligned} \tag{2}
$$

- Nearby polluters: located within 15 kilometers of the monitoring station.
- Distant Polluters: located 30 to 45 kilometers from their nearest monitoring station.

DV	Enforcement				
	Air Pollution				Other Pollution
	(1)	(2)	(3)	(4)	(5)
PostProcure×I(distance≤15)	-0.022**	-0.027**			-0.001
	(0.009)	(0.011)			(0.016)
PostProcure×I(distance≤10)			-0.028***		
			(0.010)		
PostProcure×I(distance≤20)				-0.027**	
				(0.011)	
PostProcure	0.013*				
	(0.008)				
Polluter FE	Y	Y	Y	Y	Y
Province-by-Yr-Qrt FE	Y	N	N	N	N
City-by-Yr-Qrt FE	N	Y	Y	Y	Y
Ind-by-Yr-Qrt FE	Y	Y	Y	Y	Y
Size-by-Yr-Qrt FE	Y	Y	Y	Y	Y
Lev-by-Yr-Qrt FE	Y	Y	Y	Y	Y
Roa-by-Yr-Qrt FE	Y	Y	Y	Y	Y
Observations	119,664	119,664	92,304	140,760	119,664
R-squared	0.118	0.151	0.161	0.144	0.139
Pre-event DV Mean	0.029	0.029	0.029	0.029	0.071
Pre-event DV SD	0.168	0.168	0.169	0.168	0.257

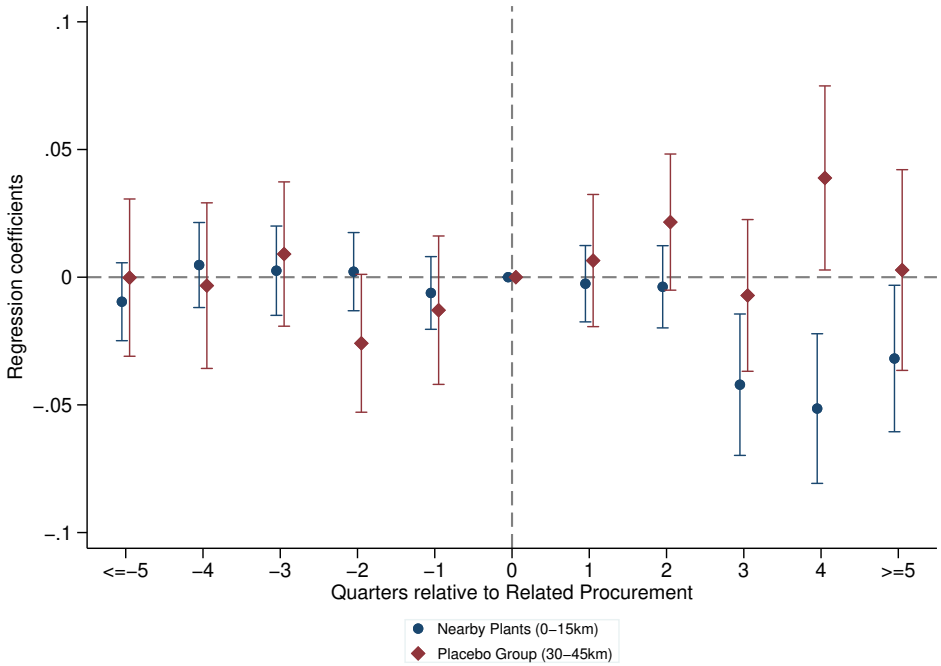


Figure: Enforcement on Air Pollution (Nearby Polluters Versus Distant Polluters)

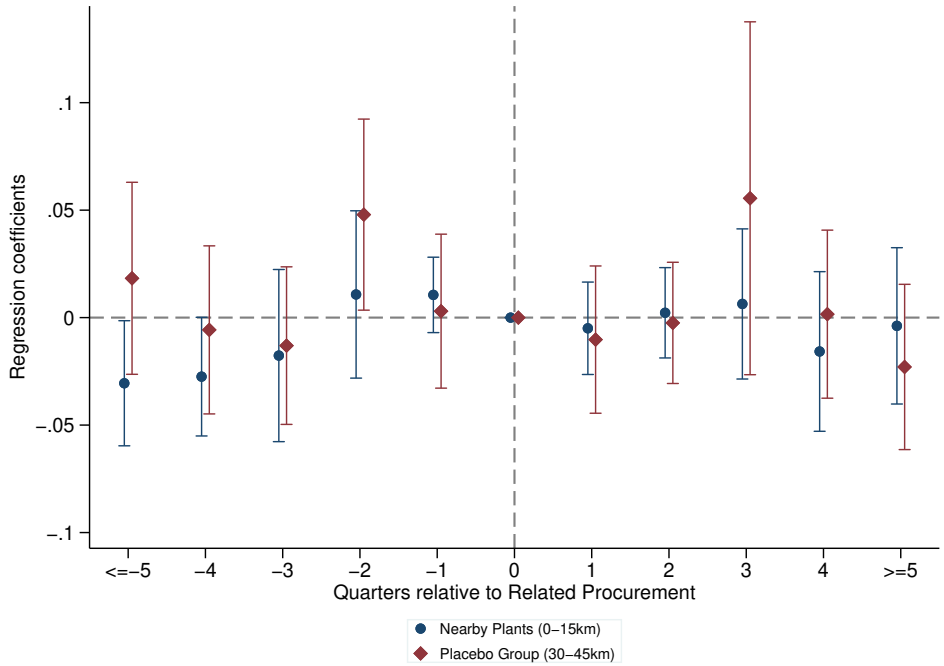


Figure: Enforcement on Other Types of Pollution (Nearby Polluters Versus Distant Polluters)

Real Implications: Government-Monitor Collusion and Air Quality Improvement

DV	2018Q4 - 2015Q4 Diff	
	(1)	(2)
	Heavy Initial Pollution	Light Initial Pollution
Procure	0.558**	-0.195
	(0.228)	(0.763)
$PM_{2.5}$ in 2015Q4	Y	Y
Firm FE	Y	Y
Province FE	Y	Y
Observations	160	161
R-squared	0.931	0.876
DV mean	-1.905	-1.142
DV SD	5.861	3.959

- Dependent variable is change of satellite-based $PM_{2.5}$ in 2018 Q4 relative to 2015 Q4.
- Related procurement is associated with less improvement in air quality in cities with higher initial pollution levels.

Conclusions

- We document that Chinese local governments would increase their procurement transactions with their third-party air monitoring firms after the O&M outsourcing reform.
- Declined reported air pollution and air pollution regulatory enforcement following the related procurement
- Future Research: Should related procurement be restricted?
  - Trade-off between monitor capture and bidding competitiveness