Pollution Haven Next Door: Evidence from China

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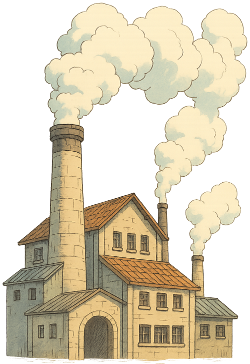
A Story of Reallocation



Location 1 **Location 2**

A Story of Reallocation

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A Story of Reallocation

Reallocation

Location 1 **Location 2**

Stricter regulation could lead to spatial reallocation.

Motivation

Environmental regulations stop at political borders, but economic activity and pollution do not.

Firm responses:

- Shift production across regions (substitution)
- Relocate plants to less-regulated areas

Pollution Haven Hypothesis (PHH):

- Environmental regulation results in the spatial reallocation of dirty production
- Limited causal evidence on PHH

This paper: Can city-level regulation create PHH-style outcomes across neighboring regions?

Research Question

Main Question: How does the Key Cities for Air Pollution Control (KCAPC) policy reshape economic activity across polluting and less-polluting sectors, in treated and neighboring cities?

Sub-questions:

- What is the **magnitude** of regulation-induced reallocation?
- How do firms **respond or circumvent** regulation?
- Are shifts driven by **market forces** or by **non-market (political) mechanisms**?

Why China?

- Rapid growth alongside severe environmental degradation
- Vast geographic and economic diversity
- Incentive-driven governance system $\rightarrow$ selective enforcement and circumvention of regulation

Main Findings

- **Neighboring cities:**
  - Polluting sectors: $\uparrow SO_2$ emissions and output
- **Treated cities:**
  - Polluting sectors: $\downarrow SO_2$ intensity and total emission
  - Less-polluting sectors: $\uparrow$ output
- **Mechanisms:**
  - Firms adjust product mix $\rightarrow$ lower SO_2 intensity
  - **SOEs drive heterogeneity across cities**
- **Takeaway:**
  - Regional regulation induces reallocation, shaped by **non-market forces**

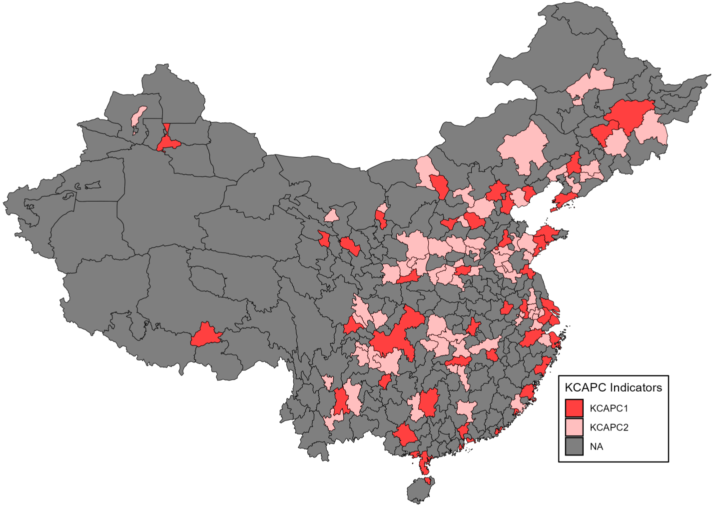
Contribution

- Pollution Haven Hypothesis (PHH) & Leakage
  - (Duan et al., 2021; Levinson, 2023; Cai et al., 2016; Copeland et al., 2022; Curtis et al., 2025)
  - **Contribution:** Causal evidence of regulation-induced reallocation to neighbors at the sector level consistent with PHH.
- Firm Response to Environmental Regulation
  - (Chen et al., 2025; Gibson, 2019; Hanna, 2010; He et al., 2020; Shapiro and Walker, 2018)
  - **Contribution:** Firms adjust product mix by pollution intensity to circumvent regulation.
- Environmental Governance & Principal–Agent Problems
  - (Duflo et al., 2013; Du and Li, 2023; Cai et al., 2016; Chen et al., 2018; Jia, 2017)
  - **Contribution:** Local governments rely on connected firms (SOEs) to absorb regulatory pressure.
- Policy Relevance: Similar selective enforcement in U.S.
  - Clean Air Act $\rightarrow$ firms increase discharges in other plants (Gibson, 2019)
  - Good Neighbor Plan targeted selected upwind states/industries for NO_X

KCAPC Policy

- National program to improve urban air quality (setting SO_2 concentration targets)
- One of a broader set of acid rain and SO_2 control policies
- First round in 1998 (47 cities), second round in 2002 (66 additional cities)
- Selection criteria:
  1. Overall economic development and pollution levels
  2. Presence of important cultural and historical sites
- Main policy actions:
  - Phase out dirty production and promote clean technology/fuels
  - Central government collects and publicly reports performance data
  - Certain high-emission industries are targeted more aggressively
- This paper focuses on the 2002 expansion (66 cities) due to data availability

First and Second Round of the Policy



Data

- Annual Environmental Survey of Polluting Firms (AESPF) dataset 1998-2007
  - Firms are included in the survey until their emissions cumulatively make up 85% of the pollutant's total emissions in the county
  - Emission data are initially self-reported by firms but are subject to random audits and verification
  - Info on both SO_2 emissions and total (pre-abatement) generation
- Annual Survey of Industrial Firms (ASIF) datasets from 1998-2007
  - All state-owned enterprises (SOEs) and non-state-owned enterprises with annual sales above 5 million RMB
  - Location and sector information to pin down treatment
  - Other firm financial information
- China City Statistical Yearbook (CCSY)

Merging the Dataset

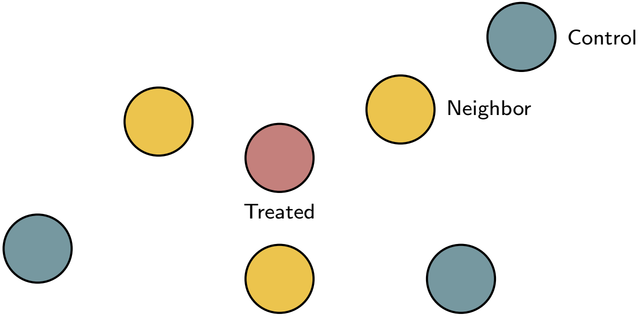
- Used to calculate sectoral intensity
- Firms are matched using imperfect identifiers (legal person code + firm names)
- 40 % gross value output (GVO) and 25 % of SO_2 emission matched
- Merged dataset skewed towards big firms in polluting sectors

Research Strategy: Aggregate Effects

I estimate the following models with SDID weight:

$$\ln(Y_{ct}) = \delta + \gamma_1 \mathbb{1}\{\text{Nb}\}_c \times Post_t + \sigma_c + \tau_t + \eta_{ct} \tag{1}$$

- For spillover effect on **non-treated neighbors**
- c for city, t for year, Y_{ct} are outcomes of interest
- Standard errors clustered at the treatment level (city)

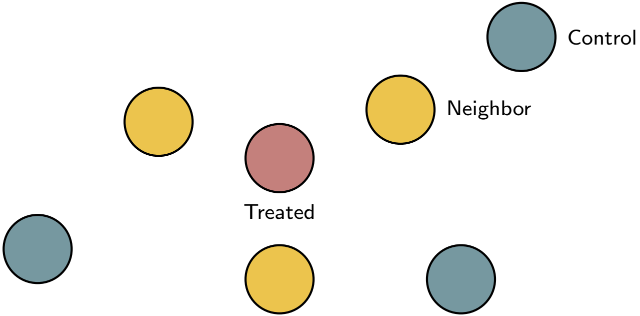


Research Strategy: Aggregate Effects

I estimate the following models with SDID weight:

$$\ln(Y_{ct}) = \delta + \gamma_1 \mathbb{1}\{\text{Treat}\}_c \times Post_t + \sigma_c + \tau_t + \eta_{ct} \tag{1}$$

- For policy effect on **treated cities**
- c for city, t for year, Y_{ct} are outcomes of interest
- Standard errors clustered at the treatment level (city)



Research Strategy: Sector Heterogeneity

I estimate the following models with SDID weight:

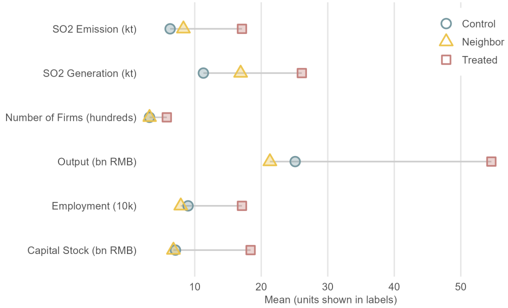
$$ln(Y_{sct}) = \alpha + \beta_1 \mathbb{1}_c \times Post_t + \beta_2 Pol_s \times Post_t + \beta_3 \mathbb{1}_c \times Post_t \times Pol_s + \sigma_{sc} + \tau_t + \epsilon_{sct} \quad (2)$$

- s for (aggregate) sector; $Pol_s = 1$ for top quintile polluting sector

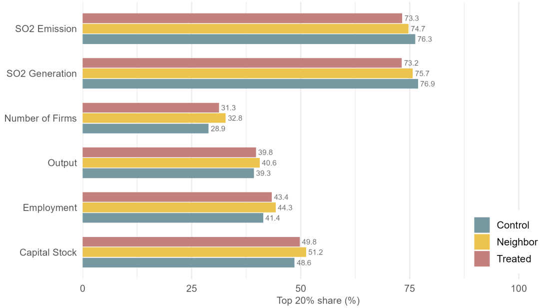
Define Polluting Sector:

- Stable **relative ranking** of pollution intensity: SO_2/output (1998 baseline).
- The policy targeted the **top quintile** polluting sectors more aggressively
- This classification is consistent with official government documents

Summary Statistics



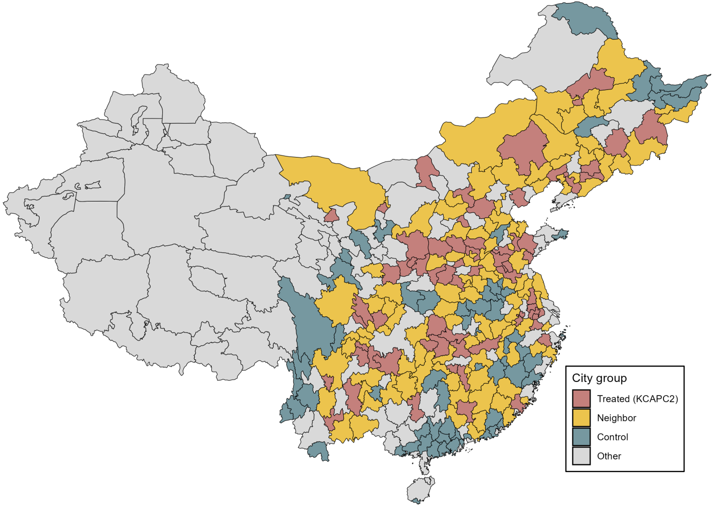
Differences Between Groups



Share from the Top Quintile

- Match Rate
- Distribution
- Parallel Trend

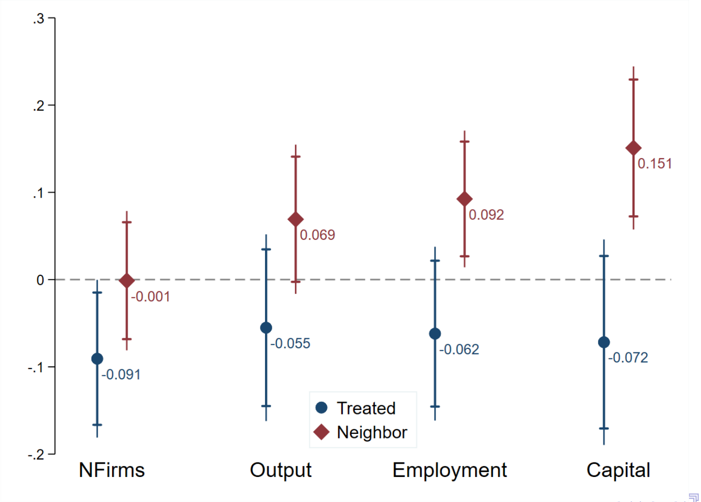
Map of Cities by Treatment Status



Specialization in Polluting Sector (Location Quotient Index)

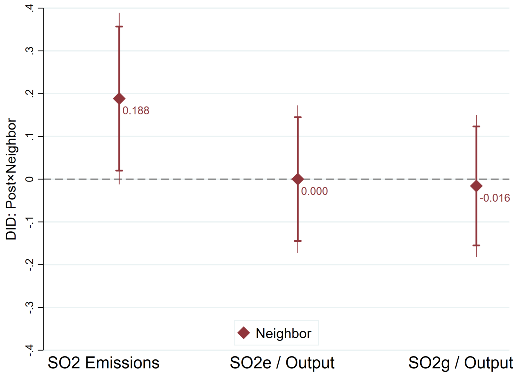
- $LQ_{rs} = \frac{X_{rs}/X_r}{X_s/X}$ as a measure for industrial specialization in polluting sector

$$\tilde{Spec}_{ct} = \alpha + \beta_1 \mathbb{1}\{W_c\} \times Post_t + \sigma_c + \tau_t + \epsilon_{ct} \quad (3)$$



Aggregate Effect on Pollution Outcomes

$$\ln(Y_{ct}) = \delta + \gamma_1 \mathbb{1}_c \times \textbf{\textit{Post}}_t + \sigma_c + \tau_t + \eta_{ct} \tag{4}$$



- **Neighbor Cities:**
  - Rise in total emissions

▸ Table

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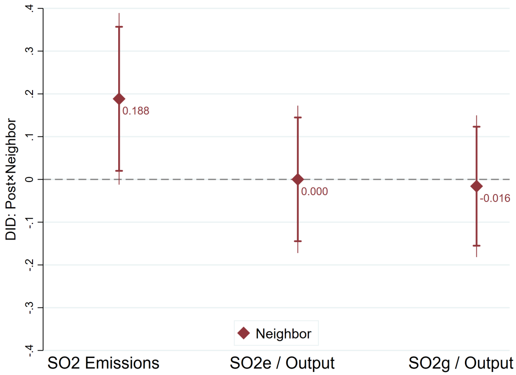
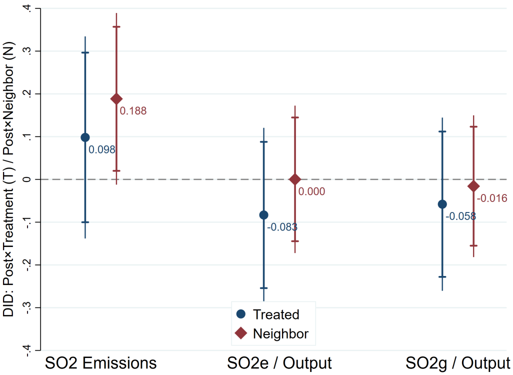


- **Neighbor Cities:**
  - Rise in total emissions
  - No change in emission intensity

Table

Aggregate Effect on Pollution Outcomes

$$\ln(Y_{ct}) = \delta + \gamma_1 \mathbb{1}_c \times \boldsymbol{Post_t} + \sigma_c + \tau_t + \eta_{ct} \quad (4)$$

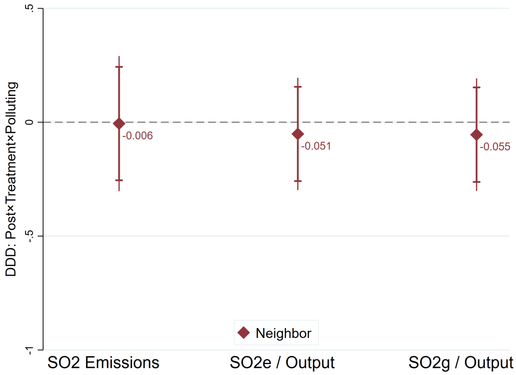


- **Neighbor Cities:**
  - Rise in total emissions
  - No change in emission intensity
- **Treated Cities:**
  - No effect on total emissions or intensity

Table

Heterogeneous Effect on Pollution Outcomes

$$ln(Y_{sct}) = \alpha + \beta_1 \mathbb{1}_c \times Post_t + \beta_2 Pol_s \times Post_t + \boldsymbol{\beta_3 \mathbb{1}_c \times Post_t \times Pol_s} + \sigma_{sc} + \tau_t + \epsilon_{sct} \quad (5)$$



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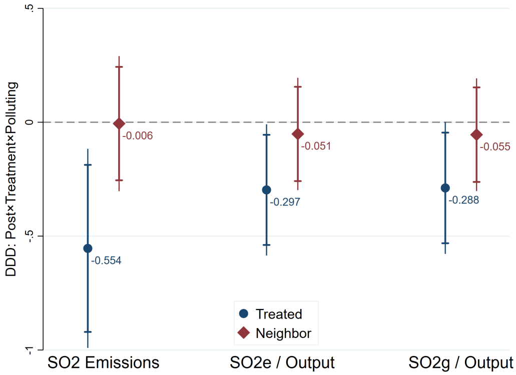

- **Neighbor Cities:**
  - No effect on total emissions or intensity
- **Treated Cities:**
  - Drop in intensity (emission- and generation-based)

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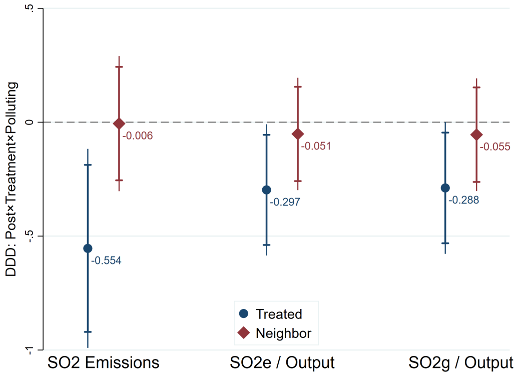
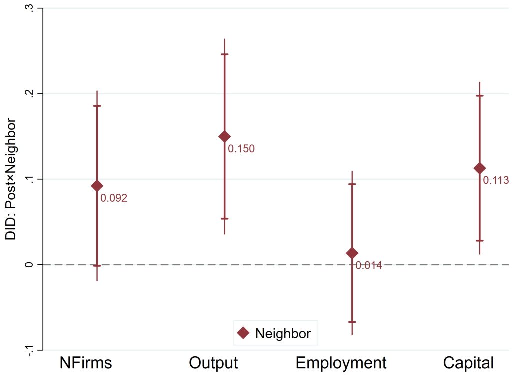


- **Neighbor Cities:**
  - No effect on total emissions or intensity
- **Treated Cities:**
  - Drop in intensity (emission- and generation-based)
  - Drop in total emissions
  - **Takeaway:** Evidence of a shift in the source of pollution

▸ Table

Aggregate Effect on Economic Outcomes

$$\ln(Y_{ct}) = \delta + \gamma_1 \mathbb{1}_c \times Post_t + \sigma_c + \tau_t + \eta_{ct} \quad (6)$$



- **Neighbor Cities:**
  - Rise in output and capital stock

Table

Aggregate Effect on Economic Outcomes

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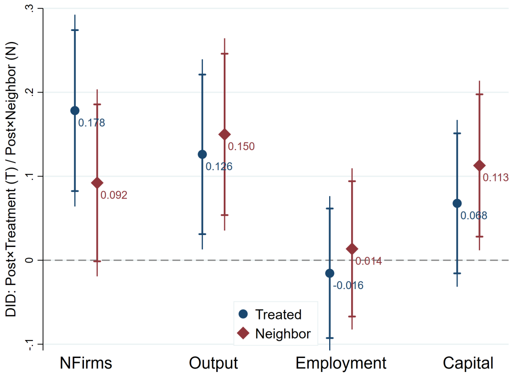
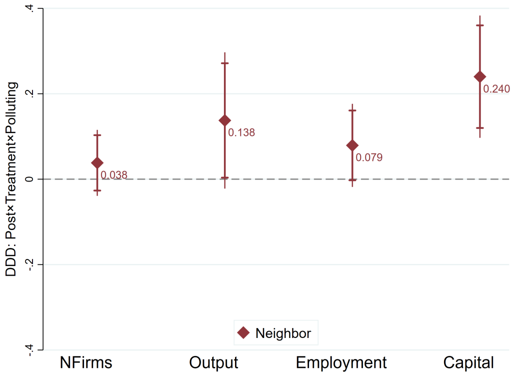


- **Neighbor Cities:**
  - Rise in output and capital stock
- **Treated Cities:**
  - Rise in the number of firms and output

Table

Heterogeneous Effect on Economic Outcomes

$$ln(Y_{sct}) = \alpha + \beta_1 \mathbb{1}_c \times Post_t + \beta_2 Pol_s \times Post_t + \boldsymbol{\beta_3 \mathbb{1}_c \times Post_t \times Pol_s} + \sigma_{sc} + \tau_t + \epsilon_{sct} \quad (7)$$



- **Neighbor Cities:**
  - Effects are driven by polluting sectors

Table

Heterogeneous Effect on Economic Outcomes

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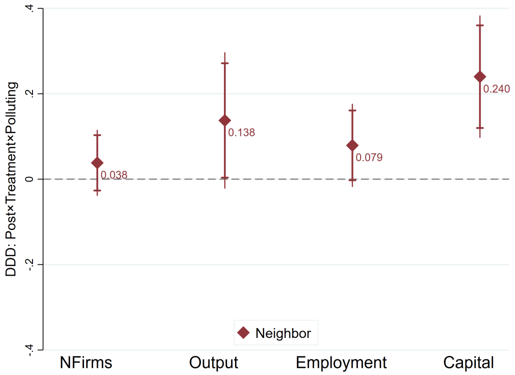
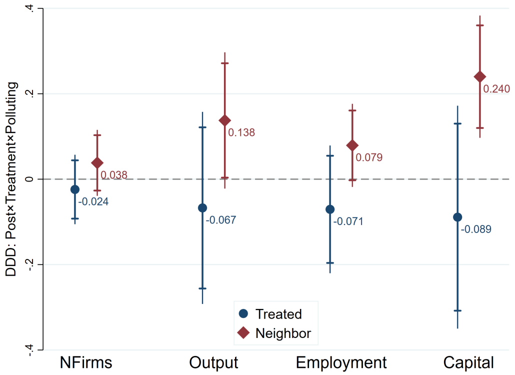


- **Neighbor Cities:**
  - Effects are driven by polluting sectors
  - Changes in the number of firms are small
  - **Takeaway:** specialize toward polluting activities—consistent with the PHH.

▸ Table

Heterogeneous Effect on Economic Outcomes

$$ln(Y_{sct}) = \alpha + \beta_1 \mathbb{1}_c \times Post_t + \beta_2 Pol_s \times Post_t + \boldsymbol{\beta_3 \mathbb{1}_c \times Post_t \times Pol_s} + \sigma_{sc} + \tau_t + \epsilon_{sct} \quad (7)$$



- **Neighbor Cities:**
  - Effects are driven by polluting sectors
  - Changes in the number of firms are small
  - **Takeaway:** specialize toward polluting activities—consistent with the PHH.
- **Treated Cities:**
  - No significant difference in growth patterns.
  - **Takeaway:** no meaningful shift in specialization.

▸ Table

Robustness Check

- Effect from other pollutant: chemical oxygen demand (COD)
- Randomly assigned treatment
  - Randomly assigned cities
  - Randomly assigned sectors
- Outliers (Leave-one-out)
  - Drop one treated/neighbor city
  - Drop one treated sector
- Model Specification

Channel 1: Firms adjust product mix

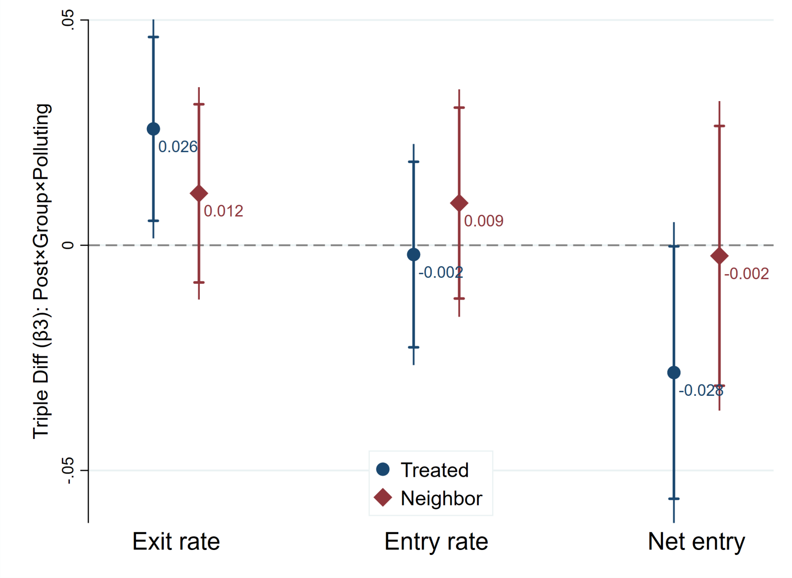
Firms frequently adjust their product mix in response to changes in market conditions and policy incentives (Bernard et al., 2010), including environmental regulation (Gibson, 2019)

- I track firms that switch their principal 4-digit sector over time
- Switching firms are concentrated in highly polluting industries and largely do so within 2-digit sector divisions
- Treated cities have a more salient pattern for switching firms
- Big treated firms are more likely to switch
- Within-firm adjustment does not drive the result

Channel 2: Entry and Exit

- Define entering and exiting firms:
  - Entry: A firm's first appearance, with birth year restrictions
  - Exit: A firm's last appearance
  - A firm needs to be observed for at least 2 years to be counted
- Incumbents drive the results

Channel 2: Entry and Exit



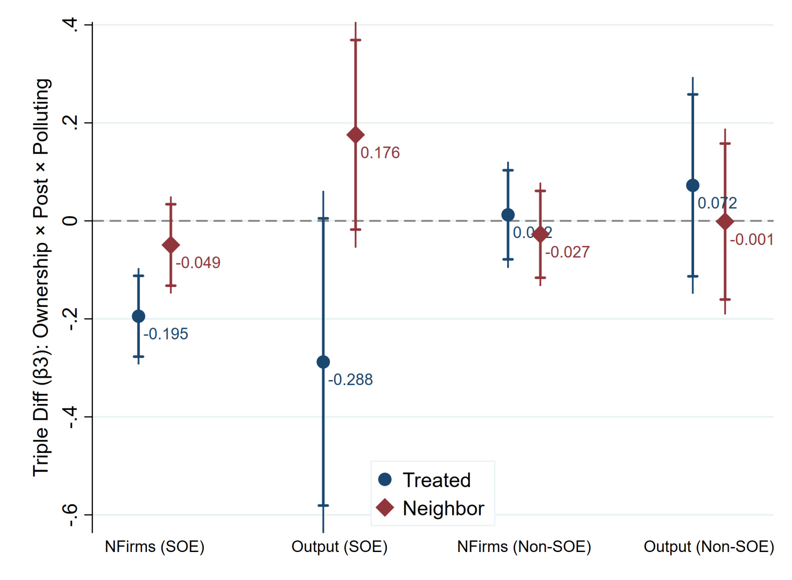
Table

Channel 3: SOEs are driving the change

SOEs drive the different patterns between polluting and less polluting sectors.

- Local governments set aggressive growth targets to demonstrate compliance with central mandates (Chang et al., 2025), which may come at the cost of environmental protection (Jia, 2017)
- SOEs constitute a substantial share of the local economy
- SOEs are expected to facilitate the local government in fulfilling policy targets (Berkowitz et al., 2017)
- SOEs might be directly controlled or under policy incentive

Channel 3: SOEs are driving the differential pattern



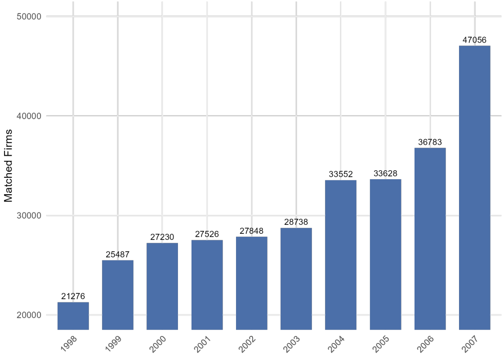
▸ Table

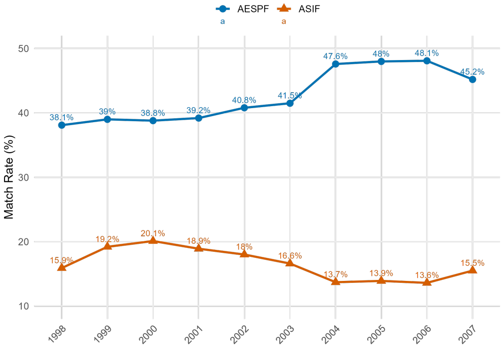
Conclusion

This paper investigates the spatial consequences of regional environmental regulation

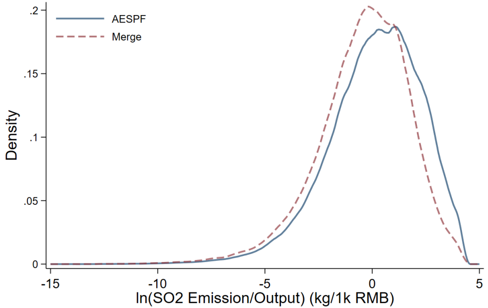
- Treated cities: decrease in SO_2 intensity for polluting sectors, increase in output for less polluting sectors
- Neighboring cities: increasingly specialize in polluting activities
- Mechanisms
  - Firms in treated cities adjust product mix to reduce SO2 intensity
  - Local governments rely on SOEs to circumvent regulation
- Regional regulation induces reallocation, driven by SOEs.
- Well-intended regional regulation might have unintended consequences

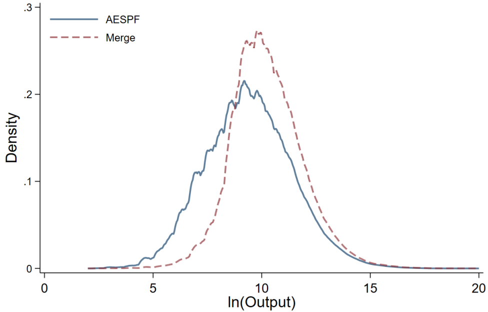
Descriptive Stats: Match Rate



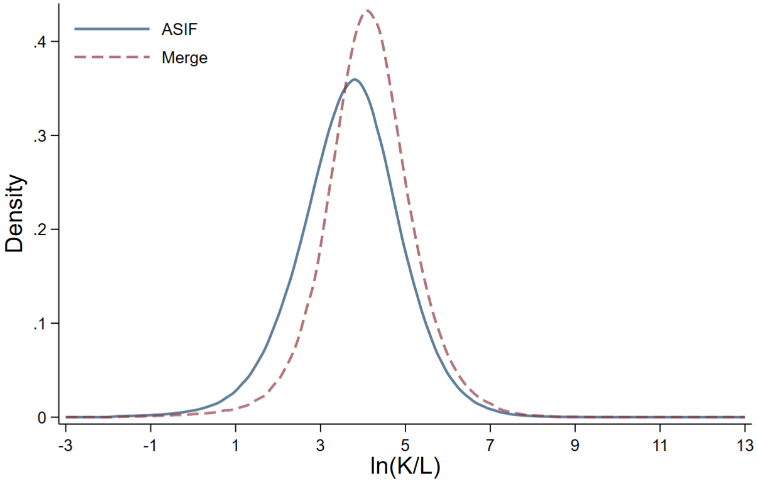


Distribution: Output and SO_2 Intensities

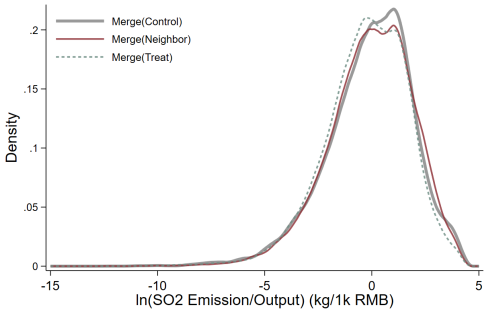


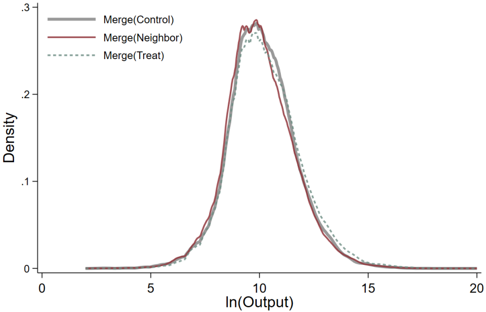


Distribution: real capital stock / employment

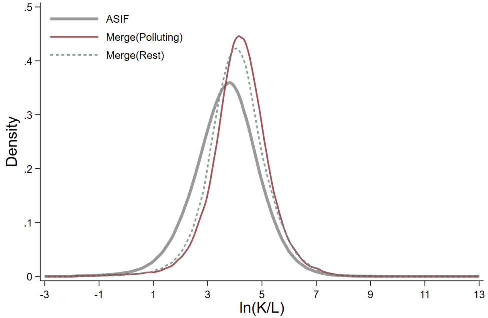


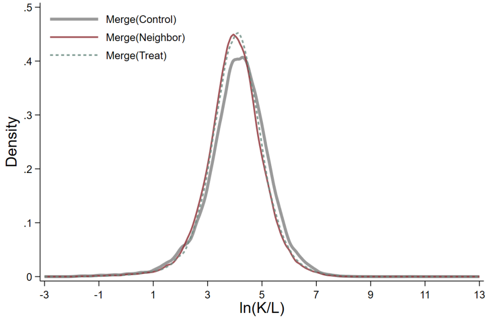
Distribution: Output and SO_2 Intensities by Region





Distribution: Real Capital Stock / Employment by Sector & Region





Synthetic Difference-in-Difference

SDID (Arkhangelsky et al., 2021) combines Synthetic Control and DID to estimate treatment effects causally:

- Extends DID by relaxing parallel trends assumption
- Assigns weights to control units to synthesize a counterfactual for treated units.

$$(\hat{\tau}^{\text{sdid}}, \hat{\mu}, \hat{\alpha}, \hat{\beta}, \hat{\gamma}) = \arg\min_{\tau,\mu,\alpha,\beta} \left\{ \sum_{c=1}^{N} \sum_{t=1}^{T} (Y_{ct} - \mu - \alpha_c - \beta_t - W_{ct}\tau - X_{ct}\gamma)^2 \, \hat{\omega}_c^{\text{sdid}} \hat{\lambda}_t^{\text{sdid}} \right\} \tag{8}$$

- W_{ct} : treatment indicator
- $\hat{\omega}_c^{\text{sdid}}$ and $\hat{\lambda}_t^{\text{sdid}}$: weights for units and time periods

Synthetic Difference-in-Difference

For triple-diff:

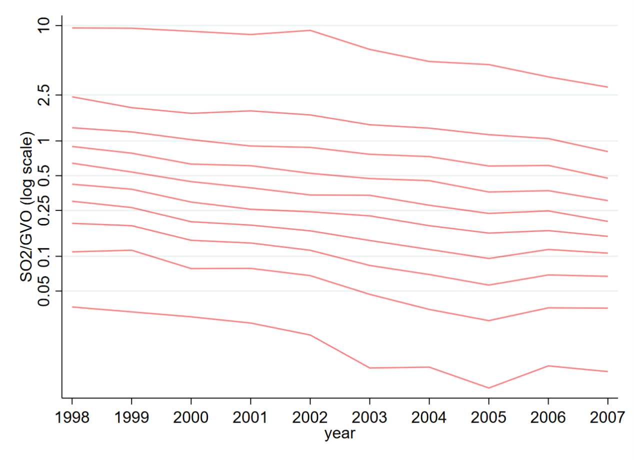
- Previous weight only matches parallel pre-trend at the whole city level
- Construct the control group such that the relative shares of polluting and less polluting sectors are similar

$$(\hat{\tau}^{\text{sdid}}, \hat{\mu}, \hat{\alpha}, \hat{\beta}, \hat{\gamma}) = \arg\min_{\tau,\mu,\sigma,\gamma,\beta} \left\{ \sum_{c=1}^{N} \sum_{t=1}^{T} \left(\ln\left(\frac{Y1_{ct}}{Y0_{ct}}\right) - \mu - \sigma_c - \tau_t - W_{ct}\tau - X_{ct}\gamma \right)^2 \hat{\omega}_c^{\text{sdid}} \hat{\lambda}_t^{\text{sdid}} \right\} \tag{9}$$

- W_{ct} : treatment indicator
- $\hat{\omega}_c^{\text{sdid}}$ and $\hat{\lambda}_t^{\text{sdid}}$: weights for units and time periods

Rank in SO_2 intensity

Figure: Trends in Sectoral SO_2 Intensity by Decile Bins (1998–2007)



Effect of the Policy on Pollution Intensity by Quintile Sectors

VARIABLES	(1) ln(SO2e/Out)	(2) ln(SO2e/Out)
$\mathbb{1}\{T\} \times$ Post	0.137	
	(0.481)	
$\mathbb{1}\{T\} \times$ Post $\times$ Q2	-0.173	-0.184
	(0.449)	(0.434)
$\mathbb{1}\{T\} \times$ Post $\times$ Q3	-0.333	-0.340
	(0.161)	(0.161)
$\mathbb{1}\{T\} \times$ Post $\times$ Q4	-0.095	-0.149
	(0.693)	(0.537)
$\mathbb{1}\{T\} \times$ Post $\times$ Q5	-0.408*	-0.403*
	(0.065)	(0.068)
City FE	Y	
City-Year FE		Y
Sector-Year FE	Y	Y
Observations	4,573	4,560
R-squared	0.563	0.668

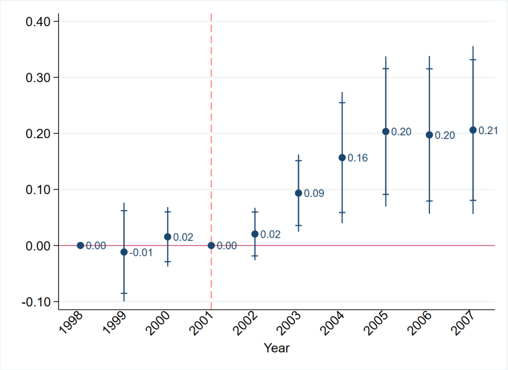
Match Rate Issue

I check whether treated, neighboring, and distant cities have different match rates by estimating the following equation:

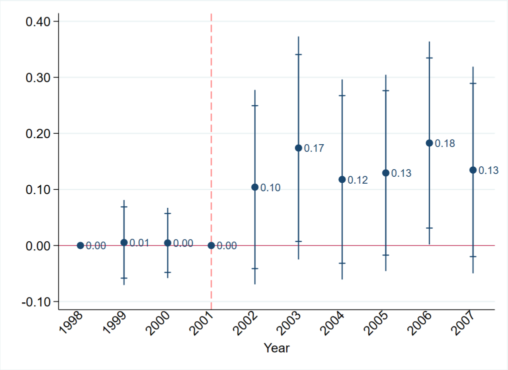
$$match_{sct} = \alpha + \beta_1 \mathbb{1}\{Treat\}_c + \beta_2 \mathbb{1}\{Nb\}_c + \tau_t + \sigma_s + \epsilon_{sct} \tag{10}$$

VARIABLES	(1) match
$\mathbb{1}\{T\}$	-0.019
	(0.247)
$\mathbb{1}\{N\}$	0.005
	(0.739)
Sector FE	Y
Year FE	Y
Observations	5,752
R-squared	0.321

Effect on Neighboring Cities: Parallel Trend

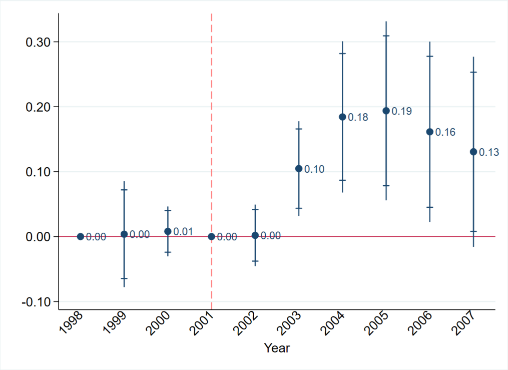


DID (Output)

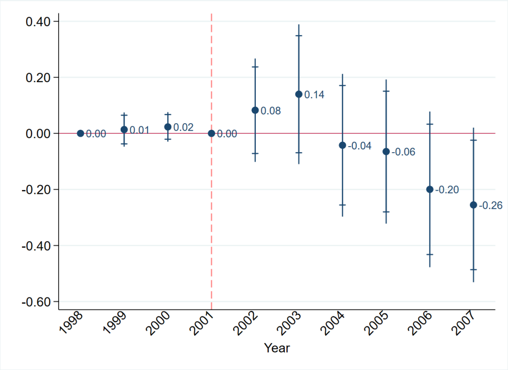


DDD (Output)

Effect on Treated Cities: Parallel Trend



DID (Output)



DDD (Output)

Effect of Policy on Neighboring Cities (Pollution Outcomes)

	(1) ln(SO2e/Out)	(2) ln(SO2g/Out)	(3) ln($SO2e_{tot}$)
Panel A. Aggregate Effects			
$\mathbb{1}\{N\} \times$ Post	0.000	-0.016	0.188*
	(0.999)	(0.851)	(0.067)
City FE	Y	Y	Y
Year FE	Y	Y	Y
Obs	1,558	1,558	1,907
R^2	0.754	0.760	0.799
Panel B. Heterogeneous Effects			
$\mathbb{1}\{N\} \times$ Post	0.013	0.003	0.158
	(0.907)	(0.977)	(0.278)
Pol $\times$ Post	0.272***	0.282***	0.097
	(0.006)	(0.006)	(0.429)
$\mathbb{1}\{N\} \times$ Post $\times$ Pol	-0.051	-0.055	-0.006
	(0.683)	(0.665)	(0.968)
$\hat{\beta}_1 + \hat{\beta}_3$	-0.038	-0.052	0.152
City-Sector FE	Y	Y	Y
Year FE	Y	Y	Y
Obs	3,090	3,091	3,778
R^2	0.798	0.806	0.798

Agg Het

Effect of Policy on Neighboring Cities (Economic Outcomes)

	(4) ln(Nfirms)	(5) ln(Output)	(6) ln(Emp)	(7) ln(Cap)
Panel A. Aggregate Effects				
$\mathbb{1}\{N\} \times$ Post	0.092	0.150**	0.014	0.113**
	(0.106)	(0.011)	(0.782)	(0.030)
City FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Obs	1,950	1,755	1,950	1,755
R^2	0.947	0.967	0.969	0.961
Panel B. Heterogeneous Effects				
$\mathbb{1}\{N\} \times$ Post	0.065	0.066	-0.035	-0.018
	(0.303)	(0.381)	(0.541)	(0.782)
Pol $\times$ Post	-0.008	-0.263***	-0.229***	-0.271***
	(0.791)	(0.000)	(0.000)	(0.000)
$\mathbb{1}\{N\} \times$ Post $\times$ Pol	0.038	0.138*	0.079	0.240***
	(0.334)	(0.093)	(0.113)	(0.001)
$\hat{\beta}_1 + \hat{\beta}_3$	0.103	0.204	0.044	0.222
City-Sector FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Obs	3,900	3,510	3,900	3,510
R^2	0.948	0.951	0.959	0.939

Agg Het

Effect of Policy on Treated Cities (Pollution Outcomes)

	(1) ln(SO2e/Out)	(2) ln(SO2g/Out)	(3) ln($SO2e_{tot}$)
Panel A. Aggregate Effects			
$\mathbb{1}\{T\} \times$ Post	-0.083	-0.058	0.098
	(0.425)	(0.576)	(0.417)
City FE	Y	Y	Y
Year FE	Y	Y	Y
Obs	1,054	1,054	1,295
R^2	0.718	0.723	0.828
Panel B. Heterogeneous Effects			
$\mathbb{1}\{T\} \times$ Post	0.087	0.109	0.441**
	(0.500)	(0.396)	(0.017)
Pol $\times$ Post	0.253**	0.254**	-0.024
	(0.045)	(0.047)	(0.873)
$\mathbb{1}\{T\} \times$ Post $\times$ Pol	-0.297**	-0.288*	-0.554**
	(0.045)	(0.053)	(0.014)
$\hat{\beta}_1 + \hat{\beta}_3$	-0.210	-0.179	-0.113
City-Sector FE	Y	Y	Y
Year FE	Y	Y	Y
Obs	2,089	2,089	2,563
R^2	0.798	0.806	0.792

Agg Het

Effect of Policy on Treated Cities (Economic Outcomes)

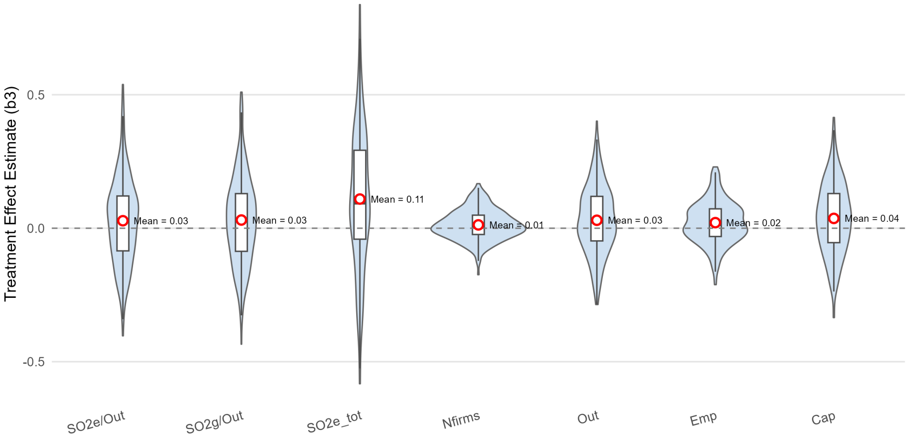
	(4) ln(Nfirms)	(5) ln(Output)	(6) ln(Emp)	(7) ln(Cap)
Panel A. Aggregate Effects				
$\mathbb{1}\{T\} \times$ Post	0.178***	0.126**	-0.016	0.068
	(0.003)	(0.031)	(0.741)	(0.184)
City FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Obs	1,320	1,188	1,320	1,188
R^2	0.965	0.979	0.982	0.979
Panel B. Heterogeneous Effects				
$\mathbb{1}\{T\} \times$ Post	0.181***	0.142*	0.002	0.125
	(0.006)	(0.073)	(0.974)	(0.135)
Pol $\times$ Post	-0.011	-0.300***	-0.242***	-0.311***
	(0.719)	(0.000)	(0.000)	(0.000)
$\mathbb{1}\{T\} \times$ Post $\times$ Pol	-0.024	-0.067	-0.071	-0.089
	(0.562)	(0.559)	(0.356)	(0.505)
$\hat{\beta}_1 + \hat{\beta}_3$	0.157	0.075	-0.069	0.036
City-Sector FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Obs	2,640	2,376	2,640	2,376
R^2	0.967	0.961	0.970	0.948

Agg Het

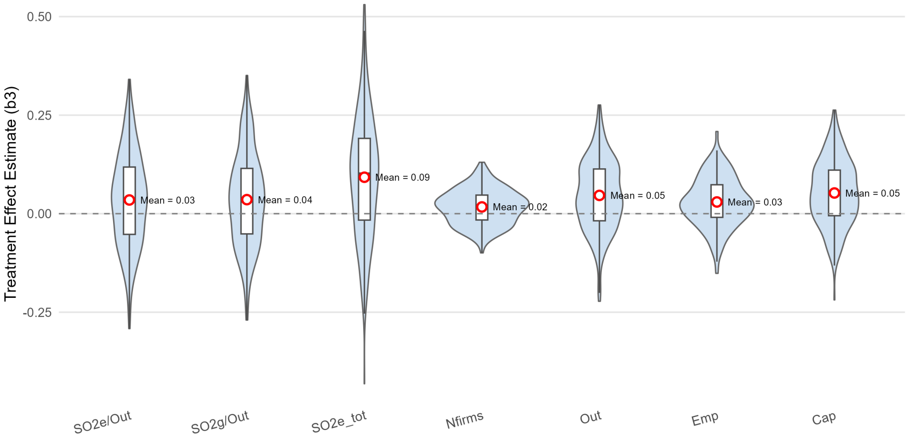
Robustness: Effect on COD

	(1) Treated	(2) Neighbor
$\mathbb{1} \times$ Post	0.029	0.090
	(0.878)	(0.545)
Pol $\times$ Post	-0.061	-0.060
	(0.683)	(0.682)
$\mathbb{1} \times$ Post $\times$ Pol	-0.102	-0.172
	(0.626)	(0.343)
$\hat{\beta}_1 + \hat{\beta}_3$	-0.073	-0.082
Observations	2,257	3,323
R-squared	0.722	0.671
City-Sector FE	Yes	Yes
Year FE	Yes	Yes

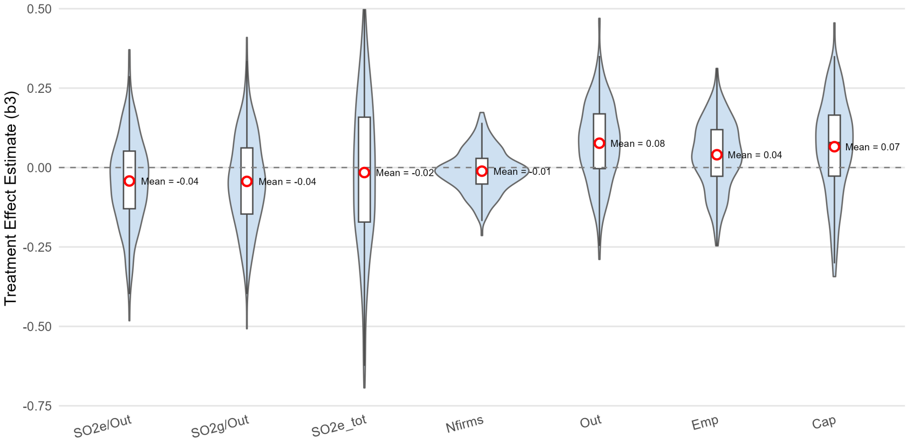
Randomly assigned treated cities



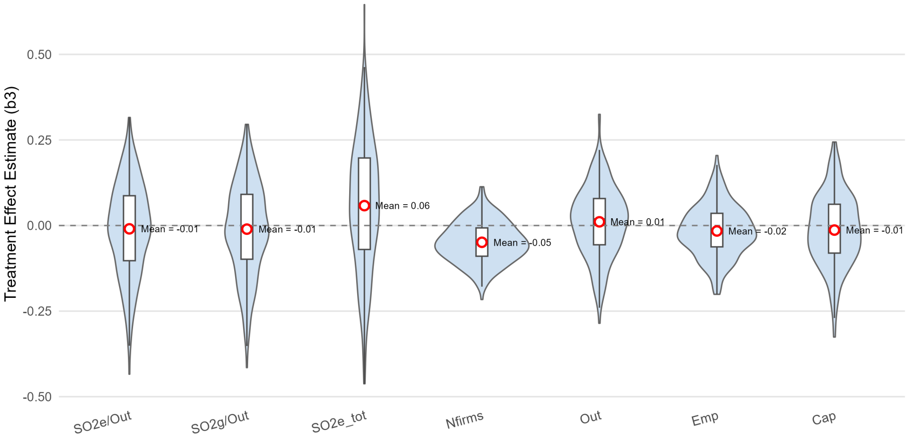
Randomly assigned neighboring cities



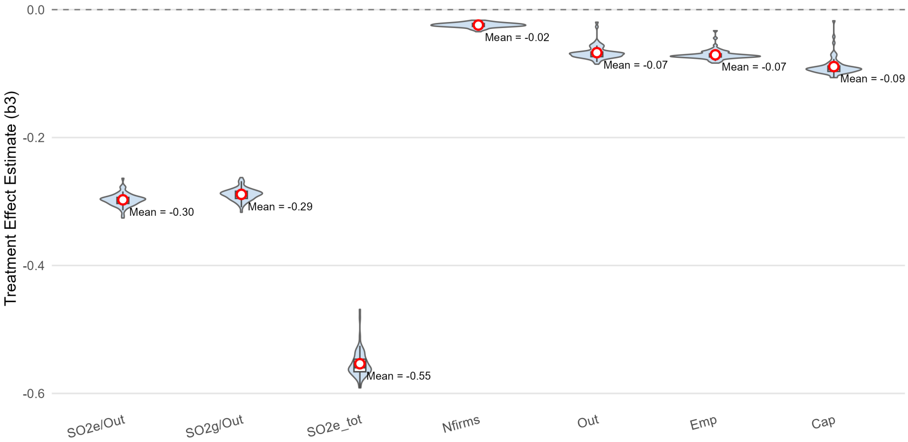
Randomly assigned polluting sectors in treated cities



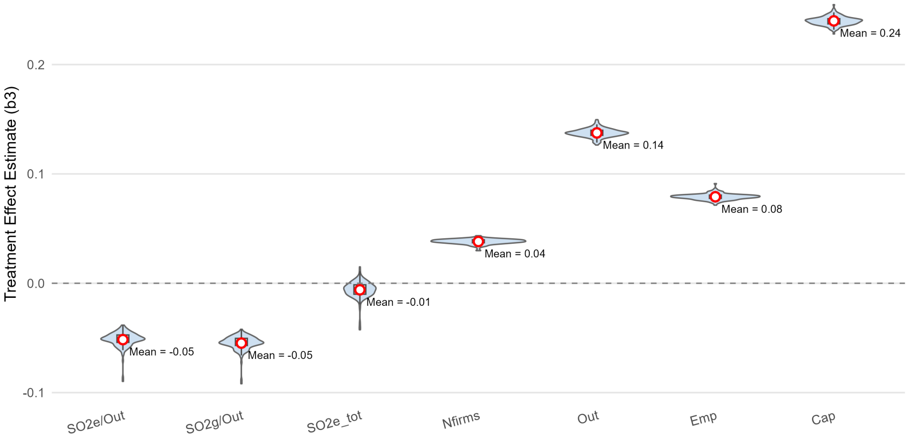
Randomly assigned polluting sectors in neighboring cities



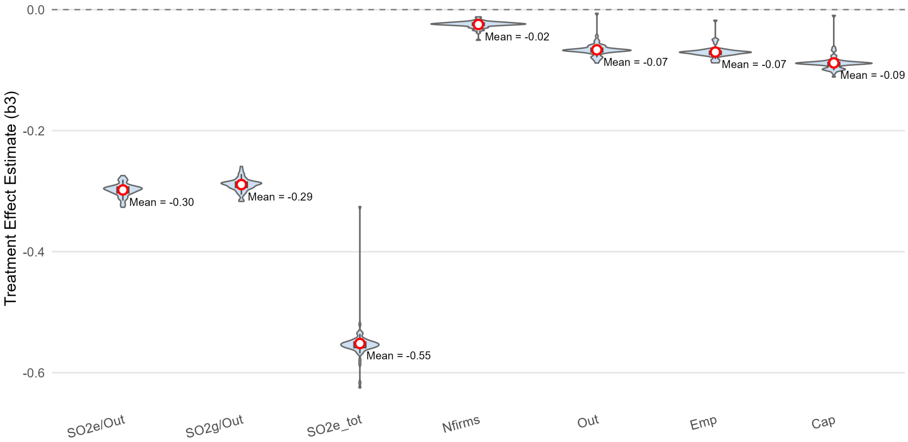
Leave one treated city out



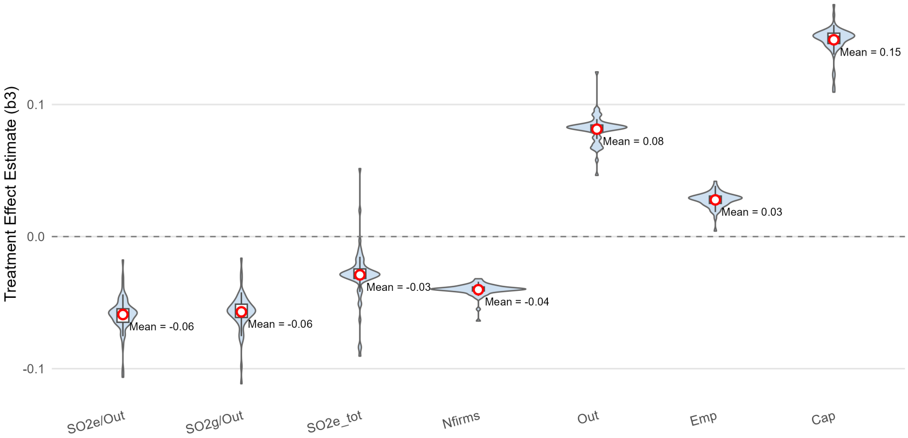
Leave one neighboring city out



Leave one treated sector out in treated city



Leave one treated sector out in neighboring city



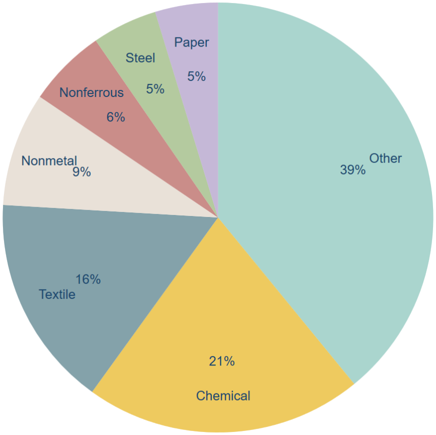
Effects on Treated Cities with City-Sector and Sector-Year FEs

	SO_2 Outcomes			Economic Outcomes			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	ln($SO2e_{tot}$)	ln(SO2e/Out)	ln(SO2g/Out)	ln(Nfirms)	ln(Output)	ln(Emp)	ln(Cap)
$\mathbb{1}\{T\} \times$ Post	0.442**	0.086	0.108	0.181***	0.142*	0.002	0.125
	(0.017)	(0.502)	(0.398)	(0.006)	(0.074)	(0.974)	(0.136)
$\mathbb{1}\{T\} \times$ Post $\times$ Pol	-0.556**	-0.297**	-0.288*	-0.024	-0.067	-0.071	-0.089
	(0.014)	(0.046)	(0.053)	(0.563)	(0.559)	(0.357)	(0.506)
$\hat{\beta}_1 + \hat{\beta}_3$	-0.114	-0.210	-0.180	0.157	0.075	-0.069	0.036
City-Sector FE	Y	Y	Y	Y	Y	Y	Y
Sector-Year FE	Y	Y	Y	Y	Y	Y	Y
Observations	2,563	2,089	2,089	2,640	2,376	2,640	2,376
R-squared	0.795	0.798	0.806	0.967	0.962	0.972	0.950

Effects on Neighboring Cities with City-Sector and Sector-Year FEs

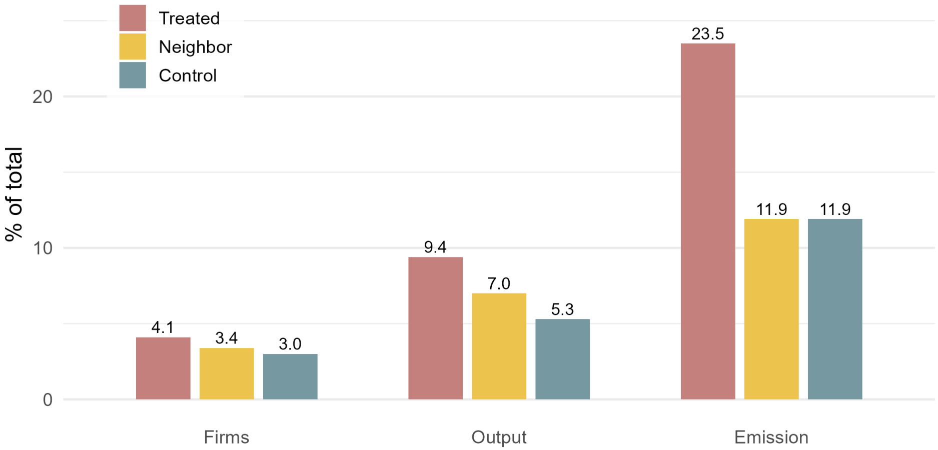
	SO_2 Outcomes			Economic Outcomes			
	(1) ln($SO2e_{tot}$)	(2) ln(SO2e/Out)	(3) ln(SO2g/Out)	(4) ln(Nfirms)	(5) ln(Output)	(6) ln(Emp)	(7) ln(Cap)
$\mathbb{1}\{N\} \times$ Post	0.158	0.013	0.003	0.065	0.066	-0.035	-0.018
	(0.278)	(0.907)	(0.978)	(0.303)	(0.381)	(0.542)	(0.783)
$\mathbb{1}\{N\} \times$ Post $\times$ Pol	-0.006	-0.051	-0.055	0.038	0.138*	0.079	0.240***
	(0.967)	(0.684)	(0.667)	(0.335)	(0.093)	(0.113)	(0.001)
$\hat{\beta}_1 + \hat{\beta}_3$	0.152	-0.038	-0.052	0.103	0.204	0.044	0.222
City-Sector FE	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y
Observations	3,778	3,090	3,091	3,900	3,510	3,900	3,510
R-squared	0.799	0.798	0.807	0.949	0.952	0.960	0.940

Sectoral Distribution of Switching Firms

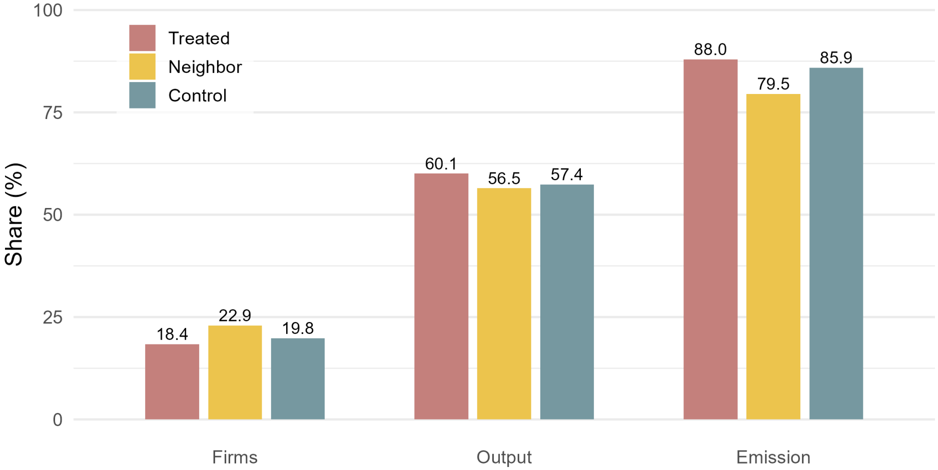


Notes: The pie chart shows the share of two-digit sectors among all switching firms; for example, 21 % are in chemical sectors. Roughly 75 % of switching firms remain within their original 2-digit sector.

Share of Switching Firms by Region



Share of Switching Firms by Region from SOEs



Firm-level correlation

To further examine whether firms respond to the the policy by changing their principal line of production, I estimate the following two equations:

$$Switch_{it} = \beta_1 \mathbb{1}\{Treat\}_c \times Post_t + \gamma X_{ct} + \sigma_i + \tau_t + \epsilon_{it} \tag{11}$$

$$ln(Y_{it}) = \beta_1 \mathbb{1}\{Treat\}_c \times Post_t \times Switch_{it} + \gamma X_{ct} + \sigma_i + \tau_t + \epsilon_{it} \tag{12}$$

Firm-level correlation

Table: Results for Firms Switching Products

VARIABLES	(1) Switch	(2) ln(Output)	(3) ln(Emp)	(4) ln(Cap)
$\mathbb{1}\{T\} \times$ Post	0.003**			
	(0.030)			
$\mathbb{1}\{T\} \times$ Post $\times$ Switch		0.067***	0.011	0.104***
		(0.000)	(0.520)	(0.000)
Firm FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Observations	565,226	564,951	565,226	565,226
R-squared	0.192	0.866	0.897	0.919

Notes: P-values in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Standard errors clustered at the city level.

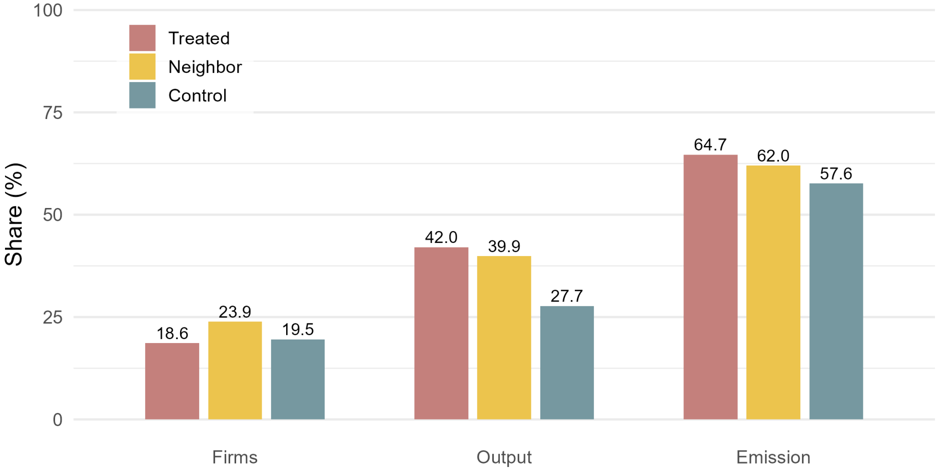
Channel 2: Treated Cities

	(1) Exit Rate	(2) Entry Rate	(3) Net Entry
$\mathbb{1}\{T\} \times$ Post	-0.027**	-0.007	0.021
	(0.023)	(0.568)	(0.194)
Pol $\times$ Post	-0.013	-0.012	0.002
	(0.216)	(0.282)	(0.897)
$\mathbb{1}\{T\} \times$ Post $\times$ Pol	0.026**	-0.002	-0.028*
	(0.039)	(0.869)	(0.100)
$\hat{\beta}_1 + \hat{\beta}_3$	-0.001	-0.009	-0.009
Observations	2,112	2,376	2,112
R-squared	0.330	0.642	0.510
City-Sector FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

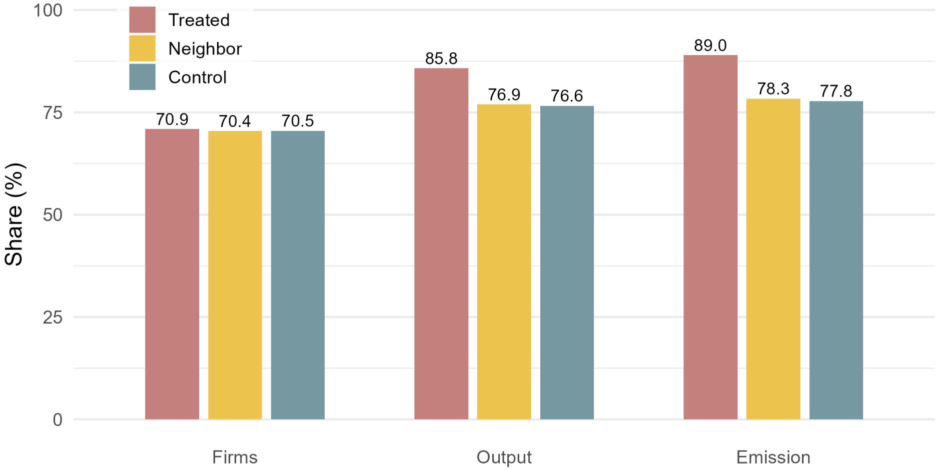
Channel 2: Neighboring Cities

	(1) Exit Rate	(2) Entry Rate	(3) Net Entry
$\mathbb{1}\{N\}$ × Post	-0.017	-0.013	0.004
	(0.186)	(0.285)	(0.804)
Pol × Post	-0.014	-0.014	0.001
	(0.180)	(0.203)	(0.949)
$\mathbb{1}\{N\}$ × Post × Pol	0.012	0.009	-0.002
	(0.339)	(0.469)	(0.893)
$\hat{\beta}_1 + \hat{\beta}_3$	-0.005	-0.004	0.002
Observations	3,120	3,510	3,120
R-squared	0.306	0.626	0.500
City-Sector FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Share of SOEs by Region



Share of non-Privatized SOEs by Region



SOEs are driving the change: Treated Cities

	SOEs		Non-SOEs	
	(3)	(4)	(5)	(6)
	ln(Nfirms)	ln(Output)	ln(Nfirms)	ln(Output)
$\mathbb{1}\{T\} \times$ Post	0.307***	0.495***	0.023	0.020
	(0.000)	(0.000)	(0.751)	(0.818)
Pol $\times$ Post	0.245***	-0.224*	-0.047	0.009
	(0.000)	(0.053)	(0.253)	(0.913)
$\mathbb{1}\{T\} \times$ Post $\times$ Pol	-0.195***	-0.288	0.012	0.072
	(0.000)	(0.109)	(0.823)	(0.522)
$\hat{\beta}_1 + \hat{\beta}_3$	0.112	0.207	0.035	0.092
Observations	2,064	2,580	2,520	2,268
R-squared	0.950	0.911	0.960	0.953
City-Sector FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

SOEs are driving the change: Neighboring Cities

	SOEs		Non-SOEs	
	(3)	(4)	(5)	(6)
	ln(Nfirms)	ln(Output)	ln(Nfirms)	ln(Output)
$\mathbb{1}\{N\} \times$ Post	0.052	0.050	0.113*	0.200**
	(0.362)	(0.597)	(0.089)	(0.024)
Pol $\times$ Post	0.242***	-0.188*	-0.054	0.038
	(0.000)	(0.062)	(0.168)	(0.625)
$\mathbb{1}\{N\} \times$ Post $\times$ Pol	-0.049	0.176	-0.027	-0.001
	(0.332)	(0.137)	(0.611)	(0.989)
$\hat{\beta}_1 + \hat{\beta}_3$	0.003	0.226	0.086	0.199
Observations	3,040	3,800	3,760	3,384
R-squared	0.930	0.890	0.943	0.942
City-Sector FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Effect on Capital Stock by State-Ownership and Region

	Treated Cities		Neighbor Cities	
	(1) SOEs	(2) Non-Soes	(3) SOEs	(4) Non-Soes
$\mathbb{1}\{T\} \times$ Post	0.406***	0.054	-0.041	0.183**
	(0.000)	(0.485)	(0.648)	(0.032)
Pol $\times$ Post	-0.193*	0.062	-0.149*	0.085
	(0.066)	(0.463)	(0.090)	(0.319)
$\mathbb{1}\{T\} \times$ Post $\times$ Pol	-0.187	-0.077	0.289***	-0.017
	(0.315)	(0.530)	(0.007)	(0.872)
$\hat{\beta}_1 + \hat{\beta}_3$	0.219	-0.023	0.248	0.166
Observations	2,322	2,268	3,420	3,384
R-squared	0.900	0.940	0.883	0.921
City-Sector FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

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