The Effects of Environment Regulation on Small Low-profit Enterprises

Evidence from the "Air Pollution Prevention and Control Action Plan"

Chen FANG

Department of Economics, SEM, THU

November 26, 2024

Outline

Motivation

Motivation Questions

- What are the **direct** and **indirect** effects of an external shock on SLEs?
- How do SLEs **adapt** and **adjust** their behavior correspondingly?
- Extreme weather events ⇔ Environmental Regulations
  - sharp/gradual variables ⇔ cleaner identification

Research Gap

- SLEs → more attention on subsidies (positive shock) (Wang et al., 2020)
- Environment Regulation → less attention on SLEs (Chen et al., forthcoming)
- Both → lack of analysis on **intensive margin** (Li et al., 2022)

Literature

the Development of SLEs

- the challenges under the COVID (Zhu et al., 2020)
- incentives from **tax cuts** (Wang et al., 2020, Li, 2021, Feng et al., 2023)
- improve financing by **tax credit** bank loans (Yang et al., 2021)
- micro finance/credits/insurance for SLEs in low-income countries

  (Angelucci et al., 2015, Attanasio et al., 2015, Banerjee et al., 2015a,b, Blattman et al., 2016, Brooks et al., 2018, Bruhn et al., 2018, De Mel et al., 2008, Field et al., 2013, Meager, 2019, Groh and McKenzie, 2016)

the Effects of Environment Regulations (on firms)

- **water quality** standards: reduced TFP of upstream firms (He et al., 2020)
- **air pollution** control: upgrade production technology and lower labor demand (Liu et al., 2021)
- **pollution fee** collection: private firms contribute more (Cai et al., 2016)
- **energy conservation** program: regulated firms shifted production (Chen et al., forthcoming)

the Adaptation Behavior under External Shock

- rural households (Cui and Tang, 2024, Lane, 2024)
- firms' production networks (Barrot and Sauvagnat, 2016)

Background: About the SLEs in China

Large Contribution

- **Main body of market-based economy**
  - 81.56 million (including self-employed households)
  - more than 96.5% of total enterprises (Sep. 2024)
- **Highly active** ("blood capillary")
  - "**56789**"
    - 50% of tax revenue, 60% of GDP, 70% of technological innovation
    - 80% of urban employment: each small enterprise can create employment for 7 to 8 people
  - employees reported for payroll increase at 7.6% annually
    - faster than large (4.1%) and medium (2.4%) enterprises
- **Targeted Policies**
  - tax refunds and reductions and fee cuts
  - deferred payment of social insurance premiums
  - open and smooth logistics services (COVID)

Source: The State Council of PRC (1, 2) and National Bureau of Statistics.

Background: About the SLEs in China

Low Sustainability

- **Short life-span**
  - 3 years (probability of SLEs still operating normally 3 years after registration is only 1/3)
  - 8 years (the US), 12 years (Japan)
- **High potential finance demand**
  - huge **finance gap** (1.9 trillion), ≈ 17% of total GDP
  - less adequate collateral or guarantees, lower creditworthiness, higher investment risks
- **High cost of financing**
  - 60% from private financing
  - high **interest rate**: 15-20% (3 times than formal financial institutions)
- **Distorted Structure**
  - current liabilities that require repayment of principal and interest **within the year** reached 97.5% (2014)
  - significant short-term debt pressure, higher debt risk (Wang et al., 2020)

Source: World Bank and the People's Bank of China.

Background: About the APPCAP

the "Air Pollution Prevention and Control Action Plan" (APPCAP)

- **Background and Objectives**
  - Chinese "Clean Air Act"
  - **Sep. 2013**, the first action plan document for pollution control
  - **by 2017**, reduce **PM10** concentrations by over 10% nationwide
  - significant improvements in air quality in special regions
- **10 key measures** ("Ten Measures for Air")
  1. Reduce Emissions
  2. Optimize Energy Structure
  4. Improve Industrial Pollution Control
  8. Strengthen Environmental Enforcement

  ...
- **Implementation Results**
  - compared to the same period in 2013, in 2017, **PM2.5** dropped by
  - 38.2% (Beijing-Tianjin-Hebei region)
  - 31.7% (the Yangtze River Delta)
  - 25.6% (the Pearl River Delta)

Source: Ministry of Ecology and Environment and State Council of PRC.

Background: About the APPCAP

国务院关于印发大气污染防治行动计划的通知

国发〔2013〕37 号

各省、自治区、直辖市人民政府，国务院各部委、各直属机构：

现将《大气污染防治行动计划》印发给你们，请认真贯彻执行。

国务院

2013 年 9 月 10 日

（此件公开发布）

奋斗目标：经过五年努力，全国空气质量总体改善，重污染天气较大幅度减少；京津冀、长三角、珠三角等区域空气质量明显好转。力争再用五年或更长时间，逐步消除重污染天气，全国空气质量明显改善。

具体指标：到 2017 年，全国地级及以上城市可吸入颗粒物浓度比 2012 年下降10%以上，优良天数逐年提高；京津冀、长三角、珠三角等区域细颗粒物浓度分别下降 25%、20%、15%左右，其中北京市细颗粒物年均浓度控制在 60 微克/立方米左右。

Source: Ministry of Ecology and Environment.

Data Sources

National Tax Investigation Data (2007-2016)

- from the Chinese State Administration of Tax (SAT)
- $\approx$ 700 k **stratified sampled** enterprises different sizes each year
- highly **representative**: key tax-source, export-oriented, others
- variables related to the energy consumption, employee, revenue and profit, liability and asset...
- **Definition of a SLE** (Wang et al., 2020)
  - **industry**: annual taxable income $\leqslant$ 300k RMB, employees $\leqslant$ 100, total assets $\leqslant$ 30 million RMB
  - **non-industry**: annual taxable income $\leqslant$ 300k RMB, employees $\leqslant$ 80, total assets $\leqslant$ 10 million RMB

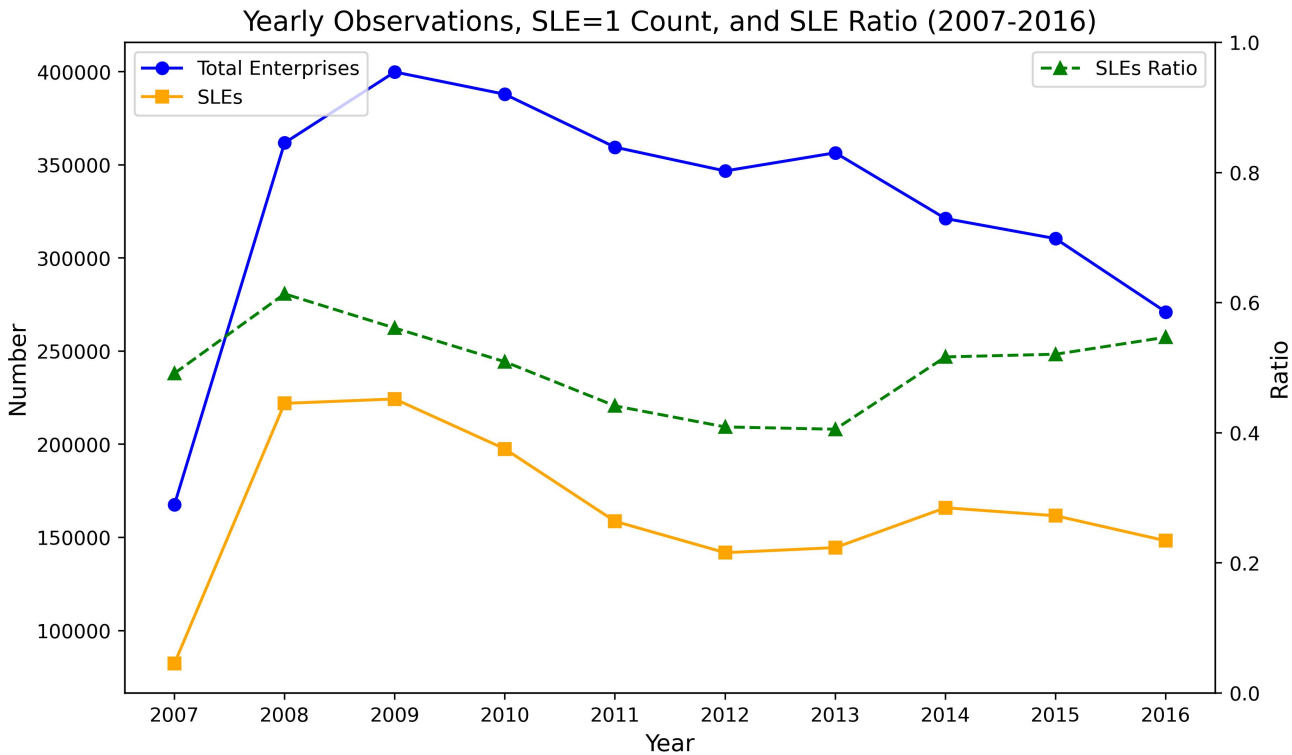
City Level Controls

- from China City Statistical Yearbook

Sample Characteristics

The ratio of SLEs in sample

- **relative stable** during 2007-2016

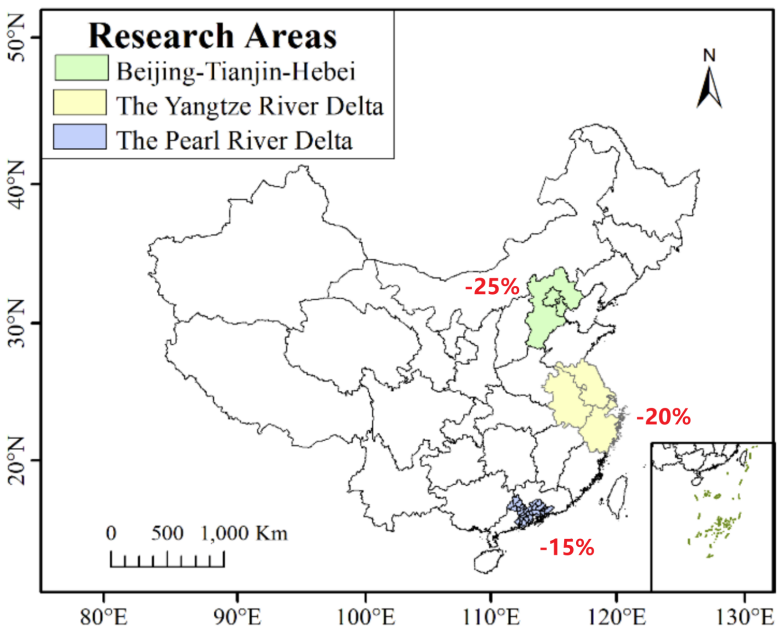


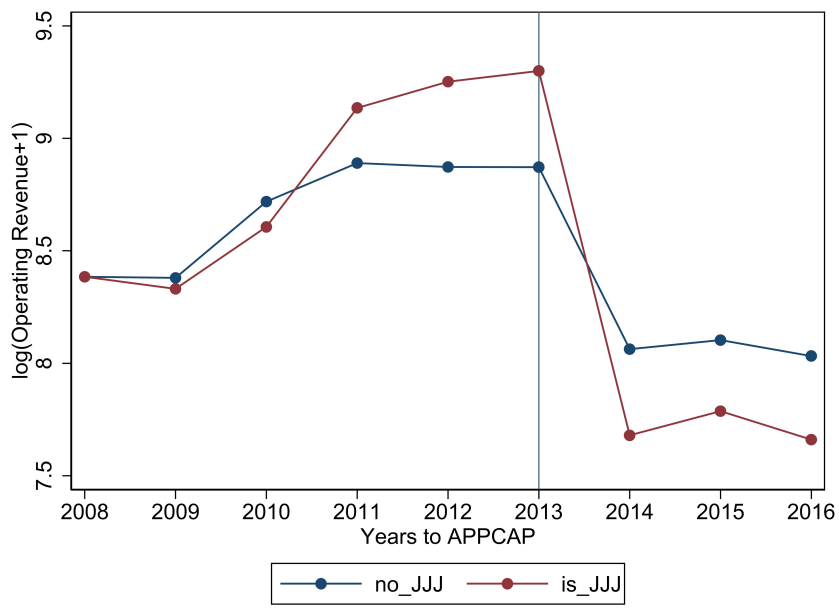
Notes: I screened the enterprises with the self-reported taxable revenue equals to 0.

Treatment & Control Group

Different Intensity of Pollution Control

- ✔ Beijing-Tianjin-Hebei vs. others (not include other two key regions)
  - follow Li et al. (2019)
- Three key regions vs. others





Source: The left figure is taken from here.

Regulated vs. Unregulated Industries

Regulated under APPCAP

- **Mining industry** (4)
  - **coal** mining and washing (B06), **oil and natural gas** extraction (B07), ferrous metal ore mining (B08), and non-ferrous metal ore mining (B09)
- **Manufacturing industry** (19)
  - **petroleum, coal, and other fuel** processing (C25)
  - chemical raw materials and chemical product manufacturing (C26)
  - non-metallic mineral product manufacturing (C30)
  - ferrous metal smelting and rolling processing (C31)
  - non-ferrous metal smelting and rolling processing (C32)
  - ...
- **Construction industry** (1)
  - residential building construction (E47)
- **Others** (2)
  - **transportation** industry (G54) and catering industry (H62)

Notes: The classification refers to the industrial gas emission in 2012 from NBS (1 and 2). Other industries are unregulated.

Baseline: TWFE DiD Model

the Average Treatment Effect of APPCAP on Operating Revenue

$$\ln Operating\_Revenue_{ijt} = \alpha + \beta_1 APPCAP_{jt} \times Treat_j + \gamma X_{it} + \mu_j + \eta_t + \varepsilon_{ijt}$$

- $\ln Operating\_Revenue_{ijt}$: natural logarithm of operating revenue + 1 for **SLE i** in **city j** and **year t**
- $Treat_j$: binary, 1 if **city j** belongs to the treatment group
- $APPCAP_{jt}$: binary, 1 if after 2013
- X_{ijt}: time-varying control variables
  - **city-level**: temperature, rainfall, ratio of tertiary, infrastructure, FDI...
  - **firm-level**: assets, liability, cash payment for purchasing goods and services...
- μ_j: city FE; η_t: year FE
- β_1: **not guaranteed** to recover an interpretable causal parameter (e.g. heterogeneity)

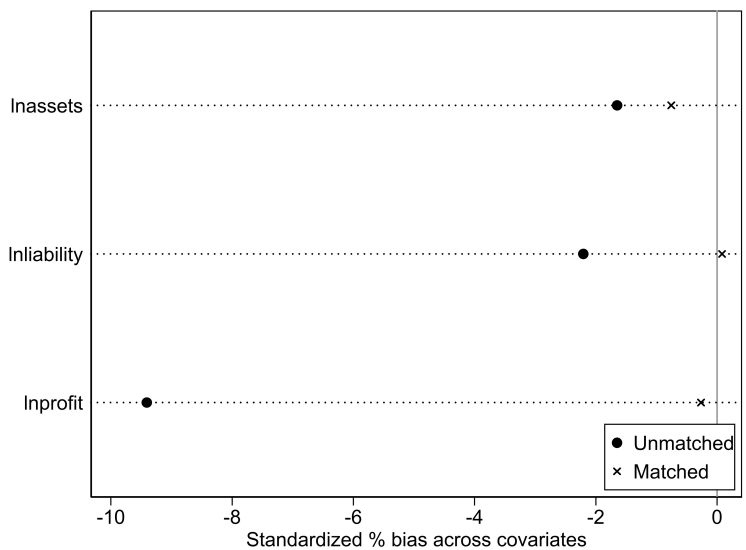
Robustness Check

Intensity-based DiD

- *treat* × *post*, then times the **concentration of PM2.5 (current year)**
- capture the varying levels of enforcement under regulation

PSM-DiD

- **Identification Concerns**: sample selection bias
- Whether a SLE belongs to a treatment/control group is **endogenous**
- **Matching** by assets, liability and profit of firms



Specification Results

APPCAP

- leads to a **8%** drop in operating revenue for **regulated** SLEs
- has **no significant effects** on **unregulated** SLEs

Table: Baseline Estimates **w/o and w/ PSM**

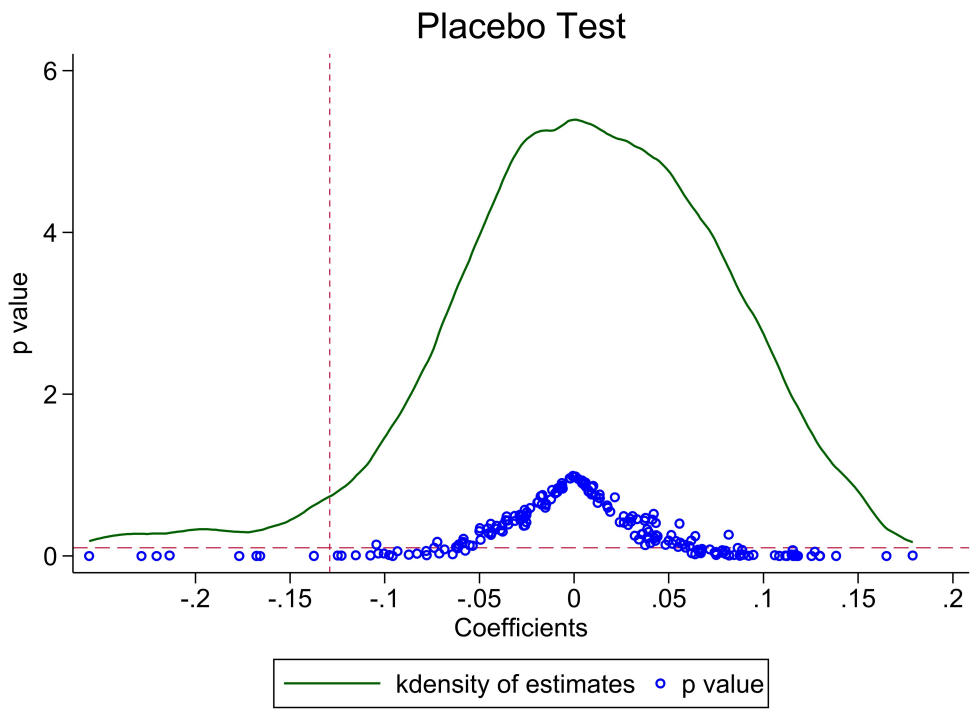
	Dependent variable: Log (Operating Revenue)			
	Two-way FE		**PSM-DiD**	
	(1) Regulated	(2) Unregulated	(3) Regulated	(4) Unregulated
APPCAP×Treat	**-0.129*** **	-0.014	**-0.080***	-0.005
	(0.037)	(0.043)	(0.041)	(0.046)
Controls	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	89,343	266,828	39,258	116,203
R-squared	0.578	0.599	0.458	0.466

Notes: The dependent variable is the natural logarithm of operating revenue (+ 1). Robust standard errors are in parentheses, clustered at the industry-year level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Placebo Test

Permutation

- **randomly assign** treatment vs. control groups, and repeat 200 times
- **p-values of most estimates**: greater than 0.1
  - the results unlikely to be obtained by chance or influenced by other policies or random factors
- **our estimate**: significant **outlier**



Empirical Setting

TWFE specification for Cross-section data

$$\ln Operating\_Revenue_{ijt} = \alpha + \sum_{y=\underline{y}, y\neq -1}^{y=\bar{y}} \beta_y APPCAP_t \times Year_y + \gamma X_{ijt} + \mu_j + \eta_t + \varepsilon_{ijt} \tag{1}$$

- $[\underline{y}, \bar{y}] = [-6, 3]$ and the **base year** is $y = -1$ ($\beta_y = 0$)
- $Year_y$: binary, 1 when the **city j** would be treated after y years
- $y \geqslant 0$: **average accumulation effects of operating revenue** relative to the former year
- β_y expected to be **negative** when $y \geqslant 0$
- **"dynamic treatment effects"**

Event Study

Dynamic Effects (on SLEs)

- **pre**: nearly parallel trends
- **post**: significant, with a little sign of reverting back

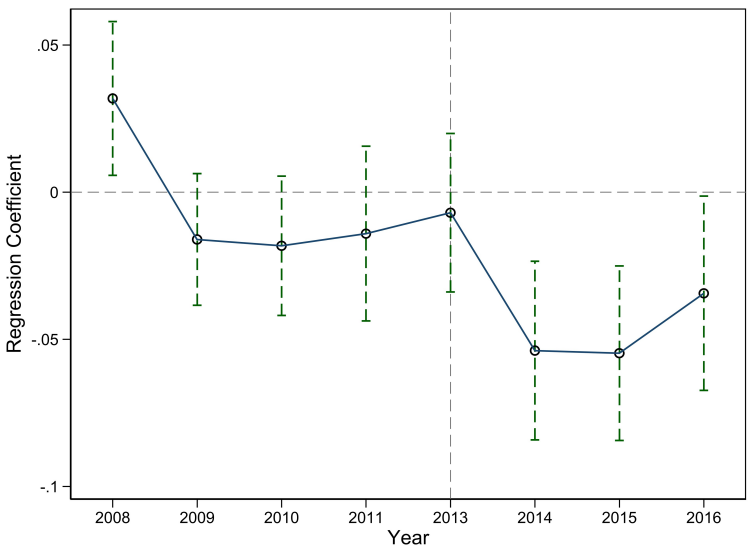


Figure: **Panel A**: Intensity DiD

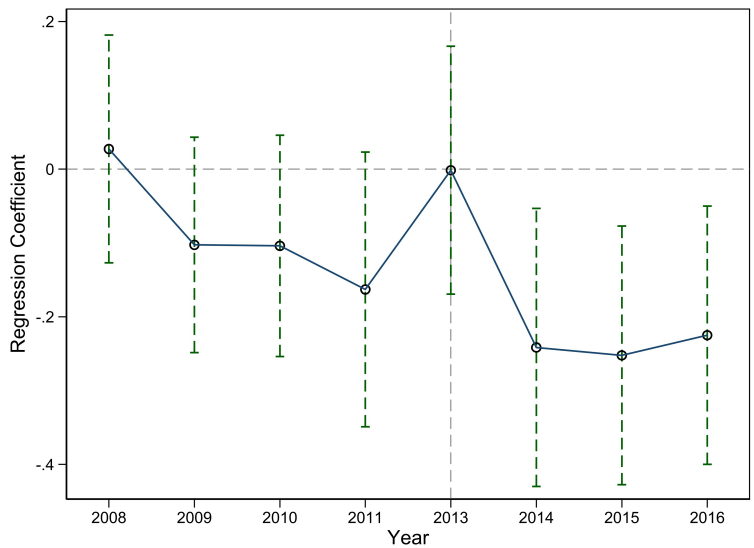


Figure: **Panel B**: PSM-DiD

Notes: Scatter plots with error bars of 95% CI. 2012 is the base year dropped in regression.

Negative Effects on TFP

To Derive TFP (Giannetti et al., 2015)

- regress the SLE's **operating revenue** on the number of employee, total assets, cash payment on goods and services (all in logarithm)
- generate the **residual**, denoted as *TFP*

Table: the TFP Estimates **w/ PSM**

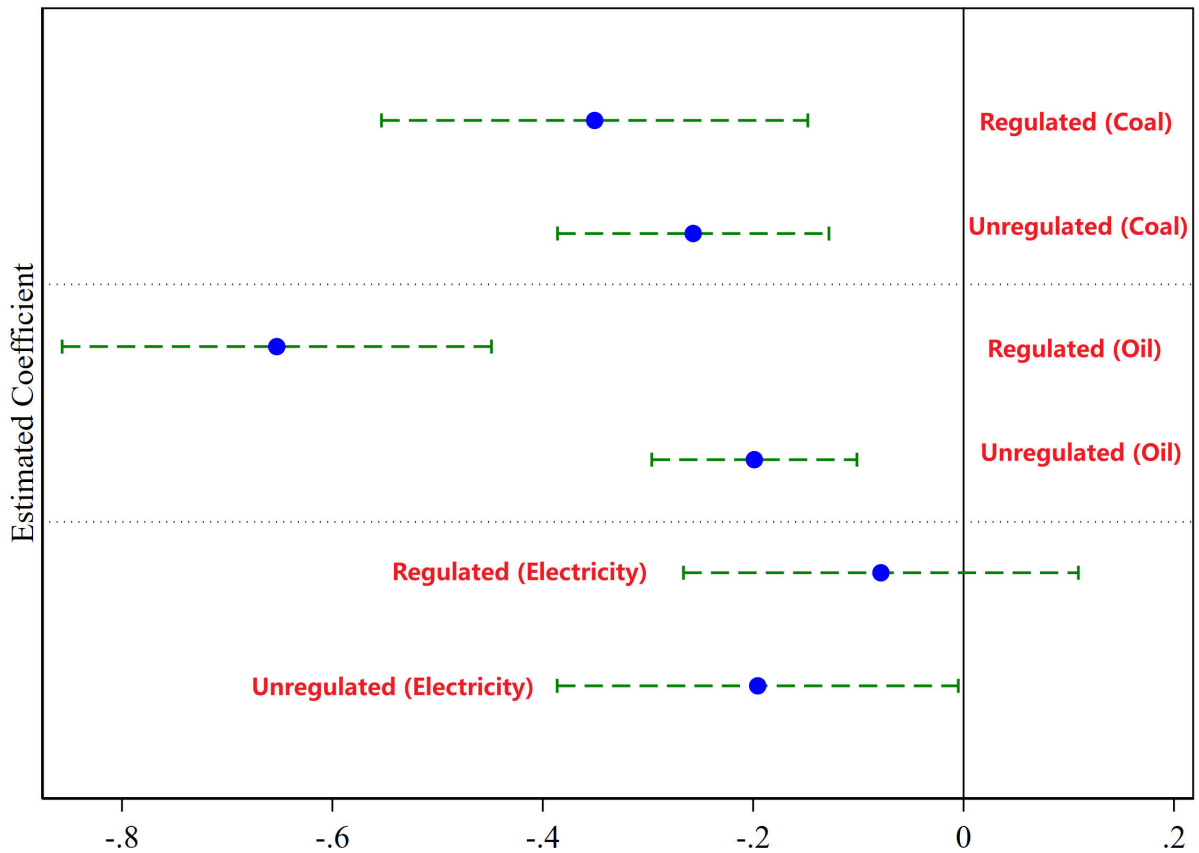
	Dependent variable: TFP	
	(1) Regulated	(2) Unregulated
APPCAP×Treat	**-0.073*** **	**-0.056*** **
	(0.035)	(0.029)
Controls	Yes	Yes
City FE	Yes	Yes
Year FE	Yes	Yes
Observations	21,032	69,272
R-squared	0.103	0.081

Notes: The dependent variable is the residual term (TFP). Robust standard errors are in parentheses, clustered at the industry-year level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Energy

Reduce the use of Fossil Fuel

- consumption of **coal and oil** decreased significantly
- **electricity**: not significant (not directly related to air pollutants)



Notes: Scatter plots with error bars of 95% CI.

Labor

- No significant effects on the **labor demand** of SLEs

Table: Estimates of Three Channels **w/ PSM**

	Employment	
	(1) Regulated	(2) Unregulated
APPCAP×Treat	-0.064	-0.012
	(0.051)	(0.040)
Controls	Yes	Yes
City FE	Yes	Yes
Year FE	Yes	Yes
Observations	21,032	69,272
R-squared	0.357	0.243

Notes: The dependent variable is the natural logarithm of employees (+ 1). Robust standard errors are in parentheses, clustered at the industry-year level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Capital

- **positive effects** on SLEs' **assets accumulation**
  - for both regulated and unregulated firms
- **insignificant effects** on SLEs' **debt burden**
- the **financial risk** reduced

Table: Estimates of Three Channels **w/ PSM**

	Liabilities-to-Assets Ratio		**Assets**		**Liability**	
	(1) Regulated	(2) Unregulated	(3) Regulated	(4) Unregulated	(5) Regulated	(6) Unregulated
APPCAP×Treat	0.001	0.000	**0.131*** **	**0.126*** **	0.008	-0.006
	(0.051)	(0.040)	(0.042)	(0.039)	(0.069)	(0.059)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	39,491	116,153	39,258	116,203	39,258	116,203
R-squared	0.637	0.625	0.444	0.400	0.294	0.286

Notes: The dependent variable is the natural logarithm of liabilities-to-assets ratio, assets and liabilities at the end of the year (+ 1). Robust standard errors are in parentheses, clustered at the industry-year level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Current Progress

Basic Conclusion

- **Direct Effects**: on operating revenue ($\approx 8\%$) and TFP ($\approx 7\%$)
  - long and lasting
- **Adjustments**: in assets, energy consumption, not in labor

Policy Implication

- **cost**: production and TFP decreased
- **benefit**: less pollutants, reduced related diseases and mortality
- how to balance between **local cost** and **global/social benefit**?

Limitation

- **Reliability**: self-reported data (manipulation?)
- **Business switch**: cross-section sampling data (within/among sectors)
- **Informal adaptation**: hide their production and pollution behavior
- **Heterogeneity Analysis**: what kinds of industries are affected more?

Further Research

Introduce more data?

- **patent application data**
  - from State Intellectual Property Office
  - measure the innovation performance (more or greener) (Cui et al., 2023)
  - possible risk: not enough data points
- **CMES data**
  - China Micro and Small Enterprise Survey
  - only 2015 accessible (no information about the address of firms)
- **insurance data**
  - if the resilience of SLEs can be improved?

Proactive/Passive Adaptation

- how to define and identify?

Thank You!

Appendix: More about the APPCAP

（十二）控制煤炭消费总量。制定国家煤炭消费总量中长期控制目标，实行目标责任管理。到 2017 年，煤炭占能源消费总量比重降低到 65%以下。京津冀、长三角、珠三角等区域力争实现煤炭消费总量负增长，通过逐步提高接受外输电比例、增加天然气供应、加大非化石能源利用强度等措施替代燃煤。

京津冀、长三角、珠三角区域以及辽宁中部、山东、武汉及其周边、长株潭、成渝、海峡西岸、山西中北部、陕西关中、甘宁、乌鲁木齐城市群等“三区十群”中的 47 个城市，新建火电、钢铁、石化、水泥、有色、化工等企业以及燃煤锅炉项目要执行大气污染物特别排放限值。各地区可根据环境质量改善的需要，扩

（三十四）强化企业施治。企业是大气污染治理的责任主体，要按照环保规范要求，加强内部管理，增加资金投入，采用先进的生产工艺和治理技术，确保达标排放，甚至达到“零排放”；要自觉履行环境保护的社会责任，接受社会监督。

Source: Ministry of Ecology and Environment.

Appendix: More about the APPCAP

（二十四）加大环保执法力度。推进联合执法、区域执法、交叉执法等执法机制创新，明确重点，加大力度，严厉打击环境违法行为。对偷排偷放、屡查屡犯的违法企业，要依法停产关闭。对涉嫌环境犯罪的，要依法追究刑事责任。落实执法责任，对监督缺位、执法不力、徇私枉法等行为，监察机关要依法追究有关部门和人员的责任。

（三十）制定完善应急预案。空气质量未达到规定标准的城市应制定和完善重污染天气应急预案并向社会公布；要落实责任主体，明确应急组织机构及其职责、预警预报及响应程序、应急处置及保障措施等内容，按不同污染等级确定企业限产停产、机动车和扬尘管控、中小学校停课以及可行的气象干预等应对措施。开展重污染天气应急演练。

京津冀区域城市建成区、长三角城市群、珠三角区域要加快现有工业企业燃煤设施天然气替代步伐；到 2017 年，基本完成燃煤锅炉、工业窑炉、自备燃煤电站的天然气替代改造任务。

对布局分散、装备水平低、环保设施差的小型工业企业进行全面排查，制定综合整改方案，实施分类治理。

Source: Ministry of Ecology and Environment.

Theoretical Framework

Possible Components

- **Firms**: size, manager quality, ownership structure
- **Sectors**: reallocation, informality

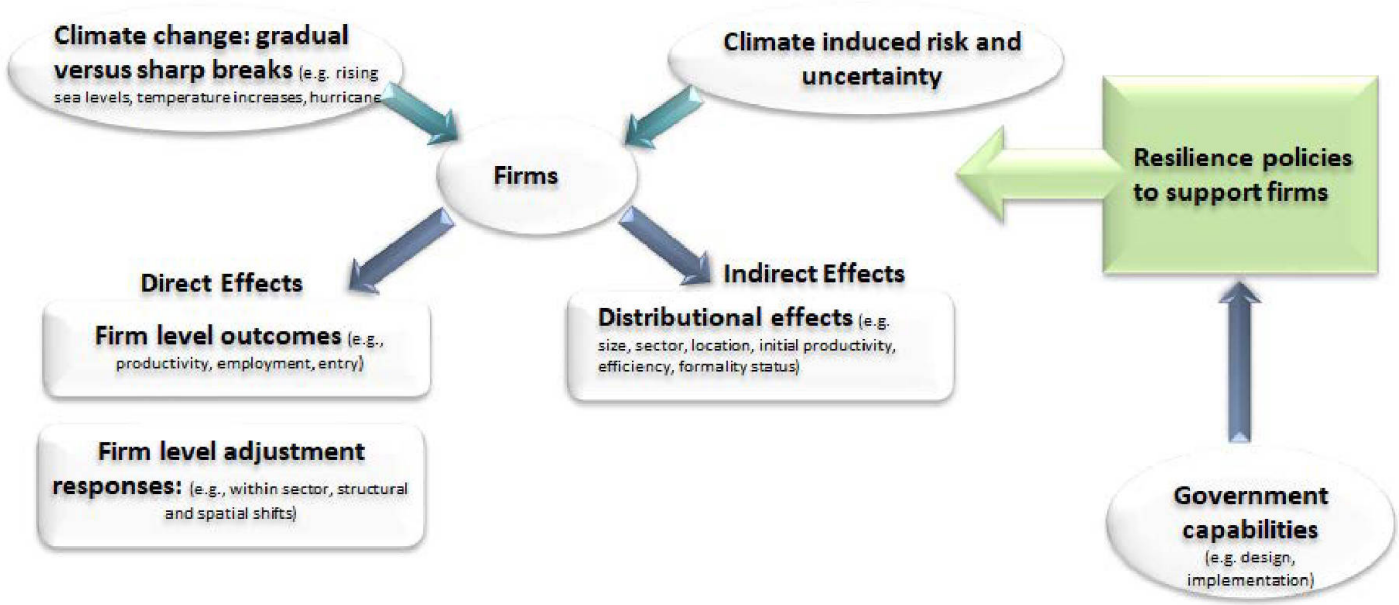


Figure: Key themes for firms in the context of climate change adaptation

Notes: This page is inspired and borrowed from the NBER working paper Grover and Kahn (2024).

Angelucci, Manuela, Dean Karlan, and Jonathan Zinman, "Microcredit impacts: Evidence from a randomized microcredit program placement experiment by Compartamos Banco," *American Economic Journal: Applied Economics*, 2015, *7* (1), 151–182.

Attanasio, Orazio, Britta Augsburg, Ralph De Haas, Emla Fitzsimons, and Heike Harmgart, "The impacts of microfinance: Evidence from joint-liability lending in Mongolia," *American Economic Journal: Applied Economics*, 2015, *7* (1), 90–122.

Banerjee, Abhijit, Dean Karlan, and Jonathan Zinman, "Six randomized evaluations of microcredit: Introduction and further steps," *American Economic Journal: Applied Economics*, 2015, *7* (1), 1–21.

__ **, Esther Duflo, Rachel Glennerster, and Cynthia Kinnan**, "The miracle of microfinance? Evidence from a randomized evaluation," *American economic journal: Applied economics*, 2015, *7* (1), 22–53.

Barrot, Jean-Noël and Julien Sauvagnat, "Input specificity and the propagation of idiosyncratic shocks in production networks," *The Quarterly Journal of Economics*, 2016, *131* (3), 1543–1592.

Blattman, Christopher, Eric P Green, Julian Jamison, M Christian Lehmann, and Jeannie Annan, "The returns to microenterprise support among the ultrapoor: A field experiment in postwar Uganda," *American economic journal: Applied economics*, 2016, *8* (2), 35–64.

Brooks, Wyatt, Kevin Donovan, and Terence R Johnson, "Mentors or teachers? Microenterprise training in Kenya," *American Economic Journal: Applied Economics*, 2018, *10* (4), 196–221.

Bruhn, Miriam, Dean Karlan, and Antoinette Schoar, "The impact of consulting services on small and medium enterprises: Evidence from a randomized trial in Mexico," *Journal of Political Economy*, 2018, *126* (2), 635–687.

Cai, Hongbin, Yuyu Chen, and Qing Gong, "Polluting thy neighbor: Unintended consequences of China's pollution reduction mandates," *Journal of Environmental Economics and Management*, 2016, *76*, 86–104.

Chen, Qiaoyi, Zhao Chen, Zhikuo Liu, Juan Carlos Suárez Serrato, and Daniel Yi Xu, "Regulating conglomerates: Evidence from an energy conservation program in china," forthcoming.

Cui, Jingbo, Shaoqing Huang, and Chunhua Wang, "The impact of air quality on innovation activities in China," *Journal of Environmental Economics and Management*, 2023, *122*, 102893.

Cui, Xiaomeng and Qu Tang, "Extreme heat and rural household adaptation: Evidence from Northeast China," *Journal of Development Economics*, 2024, *167*, 103243.

Feng, Chen, Bing Liu, and Yongwei Ye, "Tax Cuts Incentives and Heterogeneous Investment Responses: Evidence from Micro and Small Enterprises (in Chinese)," *Journal of Management World*, 2023, *11*.

Field, Erica, Rohini Pande, John Papp, and Natalia Rigol, "Does the classic microfinance model discourage entrepreneurship among the poor? Experimental evidence from India," *American Economic Review*, 2013, *103* (6), 2196–2226.

Giannetti, Mariassunta, Guanmin Liao, and Xiaoyun Yu, "The brain gain of corporate boards: Evidence from China," *the Journal of Finance*, 2015, *70* (4), 1629–1682.

Groh, Matthew and David McKenzie, "Macroinsurance for microenterprises: A randomized experiment in post-revolution Egypt," *Journal of Development Economics*, 2016, *118*, 13–25.

Grover, Arti and Matthew E Kahn, "Firm adaptation to climate change," Technical Report, National Bureau of Economic Research 2024.

He, Guojun, Shaoda Wang, and Bing Zhang, "Watering down environmental regulation in China," *The Quarterly Journal of Economics*, 2020, *135* (4), 2135–2185.

Lane, Gregory, "Adapting to climate risk with guaranteed credit: Evidence from Bangladesh," *Econometrica*, 2024, *92* (2), 355–386.

Li, Haonan, "The Way to Improve the Efficiency of Tax Reduction: The Evidence from the Elasticity of Taxable Income of Small and Micro Enterprises in Structural Tax Reduction Period (in Chinese)," *Journal of Management World*, 2021, *11*.

Li, Shuo, Min Wang, and dandan Zhang, "Environmental Inspection and Firm Entry: Evidence from Firm Registration Data (in Chinese)," *The Journal of World Economy*, 2022, *45* (1), 110–132.

Li, Xiao, Yuanbo Qiao, and Lei Shi, "Has China's war on pollution slowed the growth of its manufacturing and by how much? Evidence from the Clean Air Action," *China Economic Review*, 2019, *53*, 271–289.

Liu, Mengdi, Ruipeng Tan, and Bing Zhang, "The costs of "blue sky": Environmental regulation, technology upgrading, and labor demand in China," *Journal of Development Economics*, 2021, *150*, 102610.

Meager, Rachael, "Understanding the average impact of microcredit expansions: A Bayesian hierarchical analysis of seven randomized experiments," *American Economic Journal: Applied Economics*, 2019, *11* (1), 57–91.

Mel, Suresh De, David McKenzie, and Christopher Woodruff, "Returns to capital in microenterprises: evidence from a field experiment," *The Quarterly Journal of Economics*, 2008, *123* (4), 1329–1372.

Wang, Weitong, Xiuhua Li, and Yi Lu, "Tax Reduction Incentives and Corporate Debt Burden: Evidence from the Policy of Halving the Income Tax on Small Low-profit Enterprises (in Chinese)," *Economic Research Journal*, 2020, *55* (8), 105–120.

Yang, Longjian, Binzhen Wu, Shigang Li, and Fanjia Peng, "Can Using Tax Credit for Financing Help Small Businesses Access Bank Loans? Empirical Evidence from the Policy of Tax Credit Bank Loans (in Chinese)," *Economic Research Journal*, 2021, *56* (7), 96–112.

Zhu, Wuxiang, Ping Zhang, Pengfei Li, and Ziyang Wang, "Firm Crisis, Government Support and Policy Efficiency under the Epidemic Shock: Evidence from Two Waves of Questionnaire on SMEs (in Chinese)," *Journal of Management World*, 2020, *4*.