Final Oral Presentation

M1-Economics (international track), Group 13
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Context & Motivation

Economic Question

- What is the impact of pollution policies on firms' Total Factor Productivity (TFP) in China?

Context

- Rapid industrialization in China led to severe pollution
- Stricter environmental policies introduced in recent years
- Firms must balance compliance costs with productivity

Context & Motivation

Economic Question

- What is the impact of pollution policies on firms' Total Factor Productivity (TFP) in China?

Motivation

- Pollution from firms: a major environmental, health and economic issue
- It is possible to keep a sustainable growth with severe measures against pollution ?
- Leads to a trade-off

Literature Review and Contribution

- Muller and Mendelsohn (2009): Efficient pollution regulations aligning costs and damages improved overall welfare and economic efficiency
- Alpay, Kerkvliet, and Buccola (2002): Environmental regulations in food manufacturing **positively affected productivity** by fostering innovation **(Porter Hypothesis)**
- Leiter, Parolini, and Winner (2011): Stricter environmental regulations led to **increased investments** in cleaner technologies, indirectly **enhancing productivity**
- **How does this study contribute ?**

Literature Review and Contribution

How does this study contribute ?

- Regional Differences in China: Analyze how variations in environmental regulation across regions affect TFP
- Industry-Specific approach: Study the overall impact of environmental policies, controlling for industry
- Causal Evidence with DID: Use the difference-in-differences (DID) method to measure the causal effect of regulation on TFP, comparing regions with different levels of regulatory stringency over time

Literature Review and Contribution

China's Unique Context

- Focus on China as a rapidly growing economy balancing industrial growth with environmental goals, offering lessons for other developing countries
- The study will be based on **policies on atmospheric pollution applied in 2017**, such as Hebei Air pollution prevention and control program, aiming to restrain PM2.5 emissions
- Hebei pollution program: Non complying firms were **sanctionned** or shutted down, **financial incentives** applied...

Dataset Description

The database was found in the study "How air pollution affects corporate total factor productivity?" by Jialiang Yang and Wen Yin

- **Data Source mainly derived from:**
  - The Guotaian CSMAR database
  - Macroeconomic data from the China Urban Statistical Yearbook
  - Patent data from the State Intellectual Property Office on the technical complexity of cities

- **Nature of Data:** Panel Data (2015-2019)

Dataset Description

- **Collection Method:** Data collected from financial reports of firms and government-published AQI reports

- **Sample**

  An observation corresponds to a company listed on the Shanghai and Shenzhen stock exchanges (A-shares) for a given year

  - **Before selection:** 13 738 observations and 29 variables (2015-2019)
  - **After selection:** 875 observations and 26 variables (2015-2019)
  - **Variables added by ourselves:** "Administrative division", "Treated", "Post" and "ATT"

Main variables Description

- **Treated:** equal to 1 if the firm is located in **Hebei, Beijing or Tianjing**, 0 otherwise (508 control observations, 367 treated observations)

- **Post:** equal to 1 after 2017 (introduction of the policy) and 0 for 2015-2016

- **Dependent variable: TFP**
  - **TFP** determined by the Levinsohn & Petrin (LP) method, it is an **index**
  - In the econometric models of the study, **TFP is log transformed**

Variables Description

- **Main variables of interest**
  - **Number of Employees (NumbEmp)** $\rightarrow$ In individuals
  - **Investment in R&D by listed companies (CRD)** $\rightarrow$ Annual R&D expenses in Chinese yuan (CNY)
  - **Gross Domestic Product (GDP)** $\rightarrow$ The GDP of the listed company's local city in thousands of Chinese yuan (K CNY)
  - **Government Concerns (GS)** $\rightarrow$ Total annual government subsidies for listed companies in Chinese yuan (CNY)
  - **Average treatment effect on treated (ATT)** $\rightarrow$ 1 if the firm is treated and the year is strictly after 2016, 0 otherwise
  - **Free Cash Flow (FCF)** $\rightarrow$ Cash flow from operating activities divided by balance sheet total at the end of the financial year

Propensity Score Estimation and Firm Matching

- **Objective:** Estimate the probability of receiving the treatment (`policy`) using logit regression
- **Explanatory variables :** Firm characteristics (before policy) such as `TFP`, `R&D expenses`, `AQI`, `Size in assets`, `Free Cash Flow`, `Cash amount`, `town GDP`, `liabilities`, `Industry`...
- **Matching procedure:** Nearest Neighbor Matching with a caliper of 0.2, matching on year pre-treatment, and **with replacement** (maximum 2)
- **Outcome:** 875 observations from 180 firms (105 control, 75 treated)

Correlation to treatment (pre-treatment)

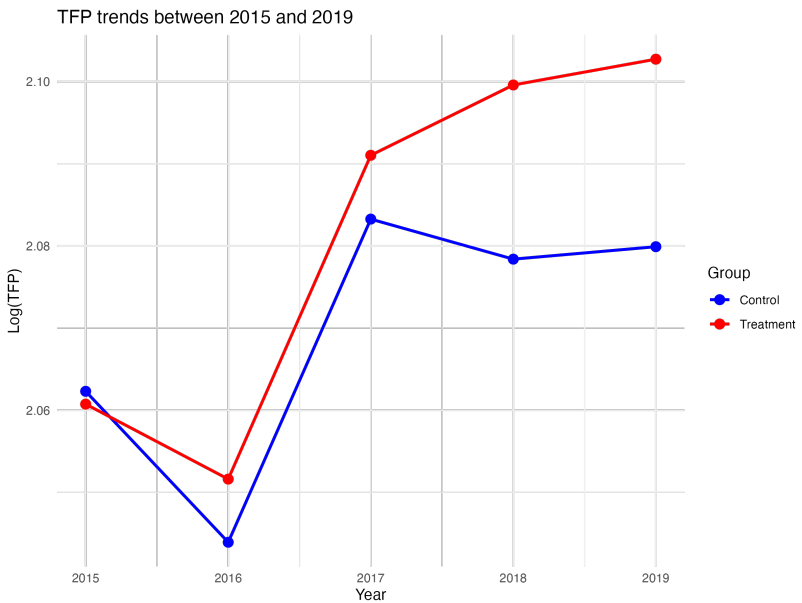

Figure 1: TFP trends: treated vs non-treated

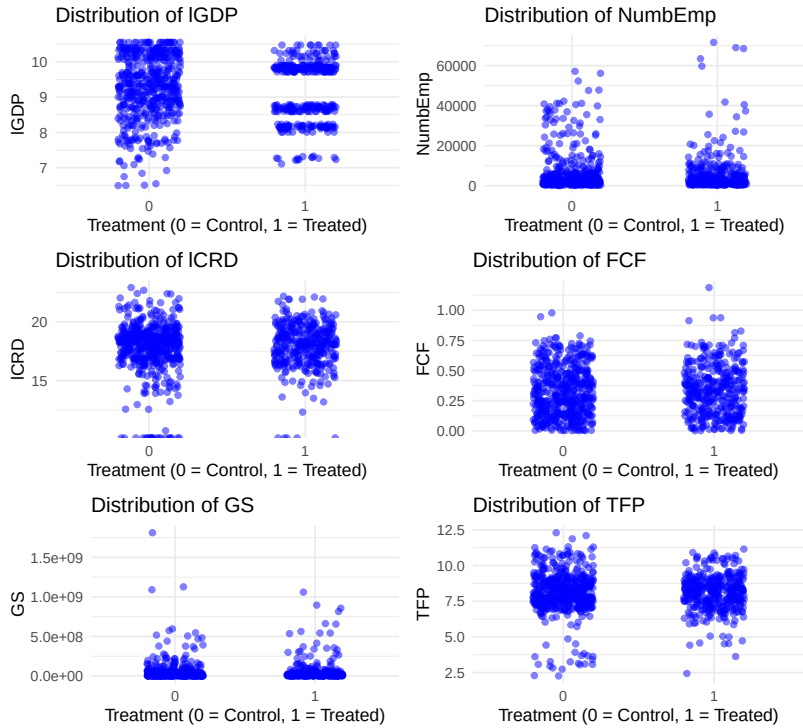

Figure 2: Distribution of key variables with treatment

- Successive T tests on covariates indicated **no significant mean differences** between groups **before treatment**
- **Parallel trends assumption** seems respected

Regression Specifications

- **Main regression equation (controlling for year FE):**

$$\log(\text{TFP})_{it} = \beta_1 \text{att}_{it} + X_{it}\beta + \sum_j \gamma_j \mathbf{1}(\text{year}_i = j) + \varepsilon_{it} \quad (1)$$

- **Auxiliary equations:**

$$\log(\text{TFP})_{it} = \beta_1 \text{att}_{it} + X_{it}\beta + \text{Industry FE} + \text{Year FE} + \varepsilon_{it} \quad (2)$$

$$\log(\text{TFP})_{it} = \beta_1 \text{att}_{it} + X_{it}\beta + \text{Firm FE} + \varepsilon_{it} \quad (3)$$

- **Where X_{it} contains the control variables**

Residuals and heteroscedasticity

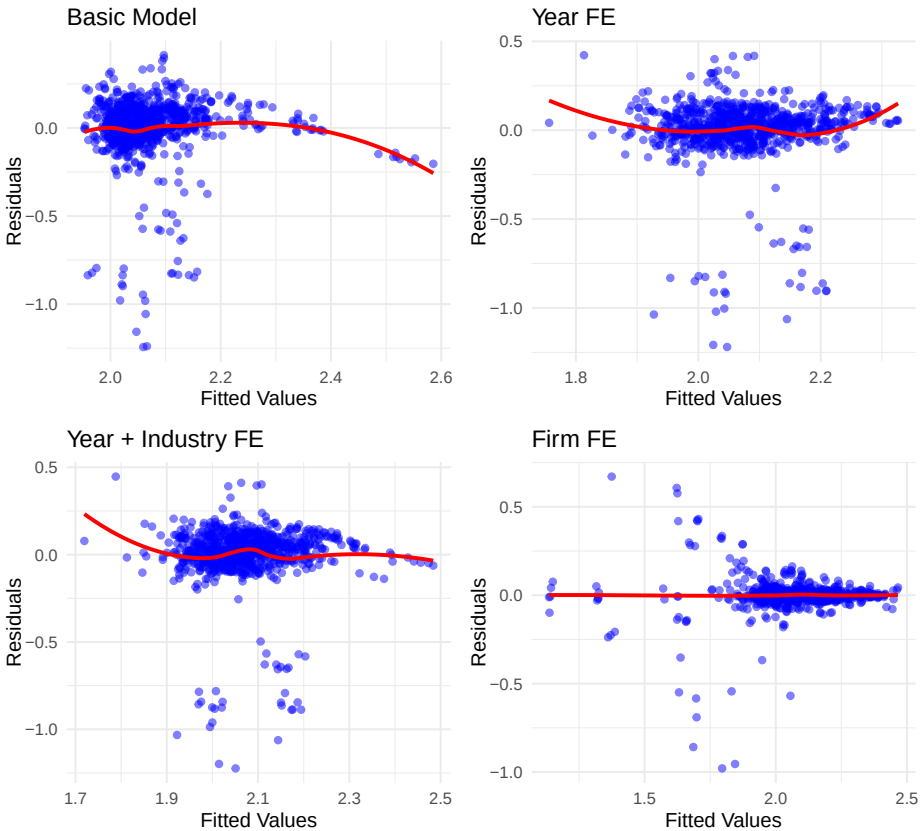

Figure 3: Residuals vs. Fitted values

- Light heteroscedasticty suspicion for Firm FE, and strong suspicion for the others

Table 1: Breusch-Pagan Test Results

Model	BP Statistic	p-value
Basic Model	18.033	0.00291
Year FE	20.860	0.00753
Y + I FE	28.284	0.02924
Firm FE	7.8624	0.04894

- P-value < 0.05, so we reject homoscedasticty
- We need robust errors to estimate

Regression results

Dependent variable log(TFP)

	No Control	Year FE	Industry & Year FE	Firm FE
ATT	0.024 08*	0.018 36**	0.021 24***	0.032 19*
	(0.011 91)	(0.002 41)	(0.001 47)	(0.013 91)
log(NumbEmp)	0.049 82***	0.051 54***	0.043 56**	0.037 97**
	(0.007 41)	(0.003 90)	(0.005 97)	(0.012 00)
log(CRD)	0.017 69**	0.017 26*	0.020 10**	-
	(0.006 25)	(0.005 49)	(0.004 28)	
log(GDP)	0.012 49	0.013 45	0.003 25	−0.003 82
	(0.009 27)	(0.007 38)	(0.007 26)	(0.054 28)
log(FCF)	0.007 55	-	-	-
	(0.005 37)			
GS	-	-	0.000 01	-
			(0.000 01)	
Intercept	1.452 73***	-	-	-
	(0.098 90)			
Num. Obs.	875	875	875	875
R^2	0.2881	0.175	0.218	0.760
R^2 Within Adj.	0.2512	0.166	0.159	0.026

Table 2: Regression results with robust errors

Key results

- **Interpretation:** The introducing of a policy is associated to a 2.124% increase in TFP on average, when controlling for year and industry FE
- Robustness check:
  - **Subsector control:** ATT(*) = 0.03036
- Main takeaway: The relationship is positive and statistically significant. **ATT varies between 1.8% and 3.2%**
- Policy implications: Encouraging policies that include pollution in production cost can positively impact firm's efficiency

Key results

- **Conclusion:** According to these results and in alignement with existing literature, environmental regulation has a positive impact on TFP
- **Limits and suggestions:**
  - Having data on previous year to 2015 could **have provided more significant matching**
  - Having a clearer idea of **how policies were applied**
  - Extend the analysis to **other type of policies** targeting other type of pollutions than gas emission (ex: Food and Catering industry)
  - Extend the analysis of the **impact of policies on emission quotas** implemented in 2021 in China and in recent years