

Regulating Conglomerates: Evidence from an Energy Conservation Program in China

Chen, Chen, Liu, Suárez Serrato, and Xu

Stanford Marketing for Environmental Sustainability - November 2023

Justin Kirkpatrick (Michigan State University)

Under incomplete regulation...

Quantifies reallocation within a conglomerate

Under incomplete regulation...

Quantifies reallocation within a conglomerate

Quantifies reallocation within a market via prices

Under incomplete regulation...

Quantifies reallocation within a conglomerate

Quantifies reallocation within a market via prices

Implications for

- Energy consumption (policy target)
- Profits
- Welfare

Firms are "directly regulated", "related to regulated", and "unrelated"

Diff-in-Diff on:

Firms are "directly regulated", "related to regulated", and "unrelated"

Diff-in-Diff on:

Directly regulated

- Outcomes:
 - Affiliate-level energy consumption (-**)
 - Revenue (output) (-**)
 - Energy efficiency (~0)

Firms are "directly regulated", "related to regulated", and "unrelated"

Diff-in-Diff on:

Directly regulated

- Outcomes:
 - Affiliate-level energy consumption (-**)
 - Revenue (output) (-**)
 - Energy efficiency (~0)

Related to regulated

- Outcomes:
 - Affiliate-level energy consumption (+**)
 - Revenue (output) (+**)
 - Energy efficiency (~0)

Firms are "directly regulated", "related to regulated", and "unrelated"

Diff-in-Diff on:

Directly regulated

- Outcomes:
 - Affiliate-level energy consumption (-**)
 - Revenue (output) (-**)
 - Energy efficiency (~0)

Related to regulated

- Outcomes:
 - Affiliate-level energy consumption (+**)
 - Revenue (output) (+**)
 - Energy efficiency (~0)

Same industry as regulated but unregulated

- Outcomes:
 - Revenue (output) (+**)

Firms are "directly regulated", "related to regulated", and "unrelated"

Diff-in-Diff on:

Directly regulated

- Outcomes:
 - Affiliate-level energy consumption (-**)
 - Revenue (output) (-**)
 - Energy efficiency (~0)

Related to regulated

- Outcomes:
 - Affiliate-level energy consumption (+**)
 - Revenue (output) (+**)
 - Energy efficiency (~0)

Same industry as regulated but unregulated

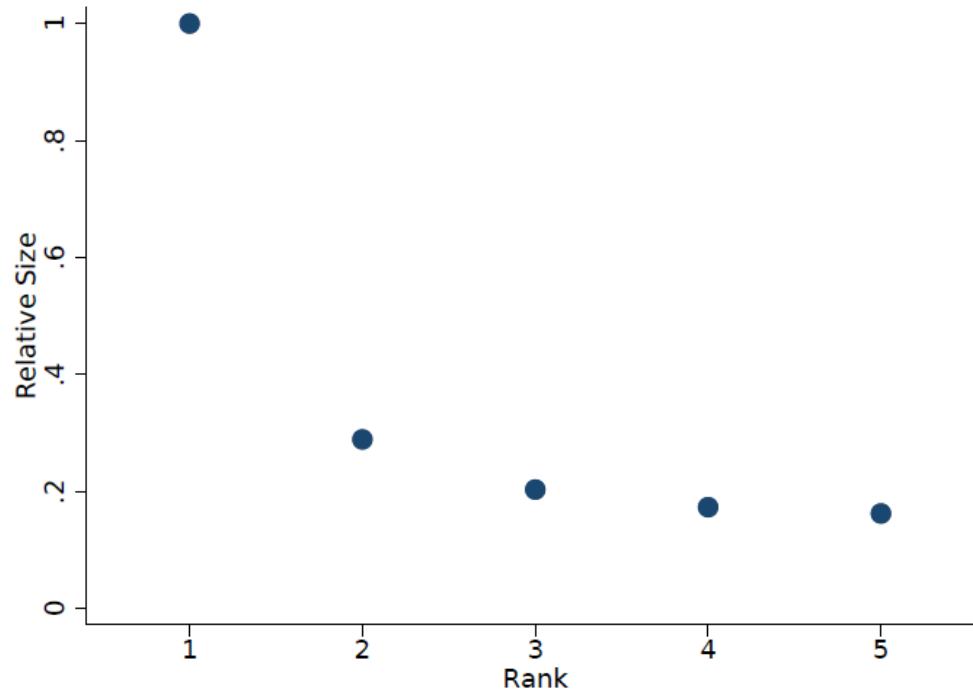
- Outcomes:
 - Revenue (output) (+**)

→ Untreated are affected by treatment, a classic SUTVA violation

- Put structure on the spillover(s)
- Decompose DiD estimates

Disentangling reallocation of production within a conglomerate due to regulation

A. Relative Firm Size



- Size of affiliates must be efficient
 - Conglomerate *can* reallocate capital
- Lets authors infer costs of production at each affiliate
- We don't usually see within-conglomerate, across-affiliate costs of production, but these will determine energy consumption, pollution, profit impacts of reallocation

$$\frac{q_i}{q_1} = \frac{k_i}{k_1} = \frac{l_i}{l_1} = \frac{e_i}{e_1} = \delta^{\frac{i-1}{1-\alpha}}.$$

- δ is the decline in production knowledge
 - "span of control"
- α is the decreasing returns to scale
 - Control the relationship between ranks
 - Taken from literature $\alpha = .9$
- ϕ controls the conglomerate (j) efficiency
- Key to changes in energy, output, profit

$$\frac{q_i}{q_1} = \frac{k_i}{k_1} = \frac{l_i}{l_1} = \frac{e_i}{e_1} = \delta^{\frac{i-1}{1-\alpha}}.$$

- δ is the decline in production knowledge
 - "span of control"
- α is the decreasing returns to scale
 - Control the relationship between ranks
 - Taken from literature $\alpha = .9$
- ϕ controls the conglomerate (j) efficiency
- Key to changes in energy, output, profit

Shadow cost $\lambda(\phi)$

- Shadow cost of regulation (cost of within- i reallocation) is decreasing in ϕ
- Since number of affiliates in a conglomerate is lumpy, shadow costs $\lambda(\phi)$ are a step function of n
 - Equilibrium is determined by a single shadow cost for each n
- Key to welfare calculations

Important questions + contributions

Theory of Incomplete Regulation / Leakage

- Literature has focused on trade (Fowlie (2009), Shapiro and Walker (2018))
- But what happens within a conglomerate?

Important questions + contributions

Theory of Incomplete Regulation / Leakage

- Literature has focused on trade (Fowlie (2009), Shapiro and Walker (2018))
- But what happens within a conglomerate?

Theory of Second-Best Regulation

- Significant contribution in policy analysis section comparing to a energy tax
 - This contribution is understated in the paper
- Rules out fuel-switching as large channel, so energy tax is close to Pigouvian under some assumptions

Why I will assign this paper to my students

- Reduced form estimates + theoretical model are very well linked
 - Model helps decompose the reduced form estimates → bias from spillovers
- Assumptions are clear
- Model is only what is necessary

Why I will assign this paper to my students

- Reduced form estimates + theoretical model are very well linked
 - Model helps decompose the reduced form estimates → bias from spillovers
- Assumptions are clear
- Model is only what is necessary

What I dislike about discussing this paper

- It's already 3rd round R&R at *AER*



Why I will assign this paper to my students

- Reduced form estimates + theoretical model are very well linked
 - Model helps decompose the reduced form estimates → bias from spillovers
- Assumptions are clear
- Model is only what is necessary

What I dislike about discussing this paper

- It's already 3rd round R&R at AER



Looking forward: Do this in US, evaluating Clean Air Act (CAA)

Framing/positioning in the literature

- Two forms of spillovers: trade (external) and domestic reallocation
 - A unifying framework?
 - Market-level spillovers could be connected to trade "leakage" in a (possibly) straightforward manner
 - Compare magnitudes?
- Can you get all the way to Pigouvian (second-best)?
 - Difference between "universal energy tax" (in paper) and pigouvian tax:
 - Can switch to cleaner source
 - Spatial variation in pollution

A few suggestions going forward

$\delta \rightarrow \delta_j?$

- Where j is industry
- Constant (across-industry) span of control argument
 - Bakeries vs. manufacturing

US Clean Air Act (1970, 1990 am.)

- "Attainment" and "nonattainment" areas
 - "nonattainment" required state plan and regulation to improve criteria pollution levels
 - Chay and Greenstone show large effect of CAA of 1970 on infant mortality (2003) and housing price (2005)
 - But no controls for leakage of the sort measured here

US Clean Air Act (1970, 1990 am.)

- "Attainment" and "nonattainment" areas
 - "nonattainment" required state plan and regulation to improve criteria pollution levels
 - Chay and Greenstone show large effect of CAA of 1970 on infant mortality (2003) and housing price (2005)
 - But no controls for leakage of the sort measured here

Holistic measure of effect of CAA

- Decompose effects of CAA on pollution; include reallocation across conglomerates
 - Emissions replace energy consumption
 - Still consider output reallocation
- But CAA "treatment" isn't as direct as in China
 - Nonattainment designation led to varied plans for reducing emissions
 - Most technology-based
 - De facto tradable permits in that new sources could be allowed if offsets were made

Location, location, location

- Spillovers from CAA move towards unregulated areas
- CAA 1970 **Prevention of Significant Deterioration** (PSD) sought to affect the exact sort of spatial spillover hypothesized here
 - Clean areas could not get significantly worse
 - Affects entry in unregulated ("attainment" areas) and expansions (reallocation of capital)
- All this ambiguity is motivation for decomposing mechanisms

Location, location, location

- Spillovers from CAA move towards unregulated areas
- CAA 1970 **Prevention of Significant Deterioration** (PSD) sought to affect the exact sort of spatial spillover hypothesized here
 - Clean areas could not get significantly worse
 - Affects entry in unregulated ("attainment" areas) and expansions (reallocation of capital)
- All this ambiguity is motivation for decomposing mechanisms

Dose-response

- Non-linear damage function from pollution
 - Carbon probably linear
- So there may be some welfare *increase* in pushing pollution out of nonattainment areas, even if the **total overall pollution levels** were the same
- **Assuming some functional form of "curvature" of a dose-response curve, back out degree of curvature that would rationalize aspects of PSD**