

Abatement Thresholds: *How Merger Prospects Affect Green Investments*

Ana Espinola-Arredondo, Felix Munoz-Garcia, and Luis
Gautier

King Saud University - February, 2026

Motivation

- In several high-profile mergers, firms increased their green investments years before submitting the merger request.
 - Siemens invested \$1.2 billion in offshore wind R&D during 2015-16,
 - prior to its merger with Gamesa in April 2017.
 - Danish Ørsted invested \$1.5 billion in US wind and solar projects in 2016,
 - before merging with Lincoln Clean Energy in Aug 2018.
 - Schneider Electric invested \$800 million in smart grid and energy efficiency in 2017,
 - before merging with L&T in 2018.

Motivation

- Other examples include the merger between:
 - Duke Energy and Progress Energy in 2012
 - \$9 billion in ER&D in 2010-11.
 - BP and Lightsource in 2017
 - \$200 million in ER&D in 2016.
 - Hitachi and ABB PowerGrids in 2020
 - \$1.9 billion in ER&D in 2018-19.

Motivation

- Firms often portray these investments as part of their larger “sustainability goals.”
 - But can there be another reason?
- We show that these investments influence antitrust evaluations,
 - improving the chances of mergers being approved.

Motivation

- We consider a sequential-move game à la Poyago-Theotoky (2007):
 - In the first stage, every firm invests in abatement.
 - In the second stage, the EPA sets a per-unit emission fee.
 - *In the third stage, firms decide whether to submit a merger request to the antitrust authority (AA).*
 - *In the fourth stage, the AA approves/block the merger.*
 - In the fifth stage, firms compete.
- New stages are *in italics*.

Motivation

- We show the presence of “abatement thresholds”:
 - The AA approves the merger only when total industry abatement exceeds a minimum amount.
 - When the AA assigns a moderate weight on pollution.

Motivation

- Results draw a parallel with public good games with threshold effects.
 - Larger abatement induces less stringent emission fees
 - Like donations from one indiv. increase the total public good.
 - Greater abatement facilitates merger approvals.
 - Like contributions are only matched if aggreg. donations meet the threshold.
- Latter effect is new in the environmental econ literature.
 - Ameliorates free-riding incentives in abatement.
 - Robust to extensions.

Implications - Env. policy

- Abatement is higher when firms anticipate a potential merger.
 - Requiring less stringent emission fees.
- In other words:
 - If the EPA ignored merger prospects...
 - it would set socially excessive fees.

Implications - Merger policy

- When the AA places a moderate weight on pollution:
 - Abatement increases.
- If the AA assigns a high weight on pollution:
 - (Still lower than the EPA, but high)
 - investment behavior is unaffected.

Implications - Merger policy

- Our results help inform current debate about merger guidelines.
- What merger guidelines should countries follow?
 - E.U., Australia, and Japan, Hanawalt et al. (2024).
 - *Partial*, not full, regulatory alignment between agencies is the most effective at increasing abatement.
- Saudi's General Authority for Competition (GAC):
 - Newly approved Economic Concentration Review Guidelines, April 2025.
 - In the next guidelines, GAC could adopt explicit welfare criteria...
 - But not assign the same weight as the Energy Ministry (MEWA).
 - Increasing firms' incentives to invest in green technologies.

Literature-I

- We contribute to four branches:
- Firms' abatement decisions.
 - Poyago-Theotoky (2007), Lambertini et al. (2017), and Strandholm et al. (2025), among others.
 - Assumes that abatement decisions do not affect merger incentives.
- Merger policy and imperfect competition.
 - Seminal work: Salant et al. (1983) Farrell and Shapiro (1990).
 - Mergers and pollution: Fikru and Gautier (2016, 2024).
 - No abatement.

Literature-II

- Threshold public goods
 - Palfrey and Rosenthal (1984) and Barbieri and Malueg (2008).
 - Attenuation of free-riding effects.
- Policy coordination between diff. agencies.
 - Fischer and Newell (2008) and Bohringer et al. (2017), on aligning objectives.
 - Acemoglu et al. (2012) and Aghion et al. (2016), on innovation.

Outline of the presentation

- Model
- Equilibrium behavior.
- Merger profiles in other regulatory regimes:
 - EPA without AA.
 - AA without EPA.
- Different timings:
 - What if abatement happens after the merger evaluation?
 - What if emission fee is chosen after the merger evaluation?
- Extensions.
 - Spillover effects, ERCs, and convex production costs.

Model

Model

- **Time structure:**

- Stage 1. Every firm $i = \{1, 2\}$ chooses its investment in abatement, z_i , where $e_i = q_i - z_i$.
 - Stage 2. The regulator responds with emission fee $t \geq 0$.
 - Stage 3. Firms choose whether to submit a merger request to the AA.
 - Stage 4. The AA responds approving or blocking the merger.
 - Stage 5. Firms choose their output levels.
- Inverse demand function $p(Q) = 1 - Q$, and marginal cost $c \in [0, 1]$.

Model

- The EPA considers welfare

$$W = CS + PS + T - ED,$$

where $CS = \frac{Q^2}{2}$, $PS = \pi_1 + \pi_2$, $T = tE$ where $E = Q - Z$, and $ED = dE^2$, where $d \geq \frac{1}{2}$.

- The AA considers welfare

$$W = CS + PS + T - ED_{AA}$$

where $ED_{AA} = d_{AA}E^2$, where $0 \leq d_{AA} \leq d$. It embodies special cases:

- $d_{AA} = 0$ (ignoring pollution).
- $d_{AA} = d$ (full alignment with EPA).
- What about CS criterion? The AA's presence would be irrelevant.

Equilibrium Analysis

Equilibrium Analysis

- **Fifth stage - Output**

- When the merger does not ensue, equilibrium output is $q_i^{NM} = \frac{1-c-t}{3}$, with profits $\pi_i^{NM} = (q_i^{NM})^2 + tz_i$.
- When the merger ensues, equilibrium output is $q_i^M = \frac{1-c-t}{4}$, with associated profits $\pi_i^M = 2(q_i^M)^2 + tz_i$.
- The merger, then, decreases:
 - Individual output from q_i^{NM} to q_i^M .
 - Aggregate output from Q^{NM} to Q^M .

Equilibrium Analysis

- **Fourth stage - Merger approval**

- The merger is welfare improving if and only if

$$d_{AA} \geq \bar{d}_{AA}(t, Z) \equiv \frac{5(1-c) + 7t}{2[7(1-c-t) - 12Z]},$$

where cutoff $\bar{d}_{AA}(t, Z)$ is unambiguously positive and increasing in t , Z , and c .

- The merger produces two well-known welfare effects:
 - less output (\downarrow welfare).
 - less emissions (\uparrow welfare).
- When d_{AA} is sufficiently high, the second effect dominates.
 - Total welfare is not enough! The AA needs to care enough about pollution.
 - Otherwise, all merger requests are declined.
- High t and Z make the "emission-reduction benefit" of the merger less necessary.

Equilibrium Analysis

- **Third stage - Merger request**

- Anticipating $d_{AA} \geq \bar{d}_{AA}(t, Z)$, firms find the merger profitable and submit a request, which is approved.
- Otherwise, no merger request is submitted.

Equilibrium Analysis

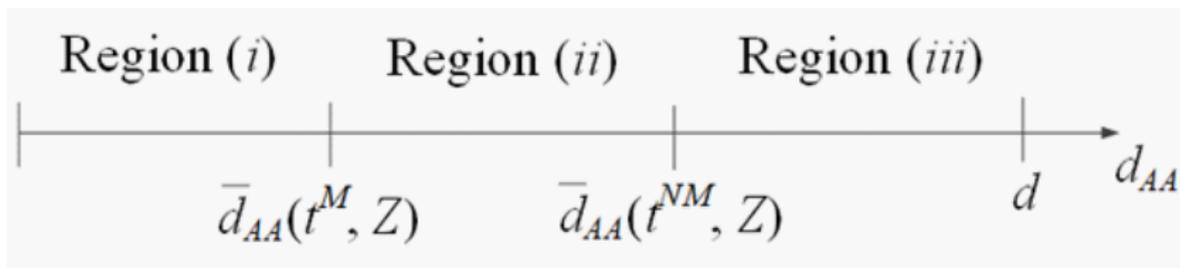
- **Second stage - Emission fee**

- If $d_{AA} \geq \bar{d}_{AA}(t^M, Z)$ holds, the EPA sets fee

$$t^M = \frac{(2d-1)(1-c)-4dZ}{2d+1}.$$

- Otherwise, the EPA sets fee $t^{NM} = \frac{(4d-1)(1-c)-6dZ}{2(2d+1)}$.

- Three regions:



Equilibrium Analysis

- **Second stage - Emission fee**

- Then, the only relevant cutoff is

$$\bar{d}_{AA}(t^M, Z) = \frac{(1-c)(12d-2)-14dZ}{14(1-c)-4Z(3-d)}.$$

- If $d_{AA} \geq \bar{d}_{AA}(t^M, Z)$, the merger is approved.
- If $d_{AA} < \bar{d}_{AA}(t^M, Z)$, the merger is blocked.

- Cutoff $\bar{d}_{AA}(t^M, Z)$ is decreasing in Z .

- Why? $\bar{d}_{AA}(t, Z)$ was increasing in Z .
- Because t^M decreases more-than-proportionally to a marginal increase in Z .
- Then, a larger Z induces a larger drop in t^M , making the merger *more* necessary.

Equilibrium Analysis

- **Second stage - Emission fee**
- Condition $d_{AA} \geq \bar{d}_{AA}(t^M, Z)$ can be rewritten as an "abatement threshold",

$$Z \geq Z^{Min} \equiv \frac{(1-c)(12d - 14d_{AA} - 1)}{2[7d + 2d_{AA}(d - 3)]}$$

where Z^{Min} is increasing in d , but decreasing in d_{AA} .

- *Intuition: Next slide*

Equilibrium Analysis

- **Second stage - Emission fee**
- When $d_{AA} = 0$, Z^{Min} simplifies to

$$Z^{Min} = \frac{(1 - c)(12d - 1)}{14d}.$$

- Increasing in d . Why, if AA ignores pollution?
- Because AA anticipates a more stringent fee, further reducing agg. output.
- In contrast, when $d_{AA} > 0$, more stringent fees are deemed positively by the AA:
 - The AA sees the EPA's decisions as less distortionary when agencies are symmetric than otherwise.

Equilibrium Analysis

- **First stage - Abatement**
- Firms' aggreg. abatement, Z , dictates the market structure:
 - Merger if $Z \geq Z^{Min}$.
 - No merger if $Z < Z^{Min}$.
- As in public good games with threshold effects.
 - More time consuming (next slide).

Equilibrium Analysis

- **First stage - Abatement**

- Five steps:

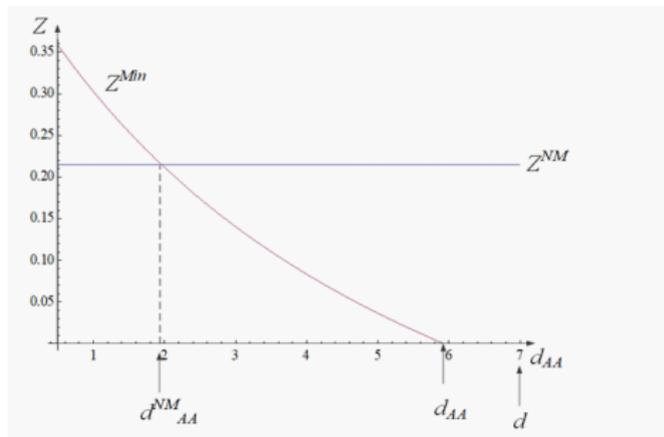
- Consider one of the above cases (e.g., no merger, $Z < Z^{Min}$).
- Find individual abatement in this context, z_i^{NM} .
- Find aggregate abatement, Z^{NM} .
- Confirm that Z^{NM} satisfies $Z^{NM} < Z^{Min}$.
- No unilateral incentives to deviate to "trigger" a different market structure (e.g., increase z_i from z_i^{NM} to reach $Z^{Min} = z_i + z_j^{NM}$).

- If all steps hold, then z_i^{NM} is equilibrium abatement.
- Same steps, but starting with $Z \geq Z^{Min}$.

Equilibrium Analysis

- **First stage - Proposition 1**

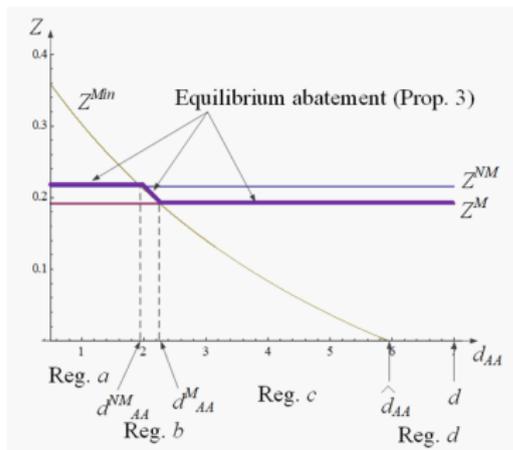
- $z_i^{NM} = \frac{(1-c)[4d(2d+1)-1]}{2(18d^2+13d+1)}$, which satisfies
 $z_i^{NM} + z_j^{NM} < Z^{Min}$ iff $d_{AA} < d_{AA}^{NM} \equiv \frac{d(15+52d)-1}{26+2d(39+8d)}$, where
 $d_{AA}^{NM} < d$.
- Z^{Min} decreases in d_{AA} , but Z^{NM} is constant.



Equilibrium Analysis

- **First stage - Proposition 2**

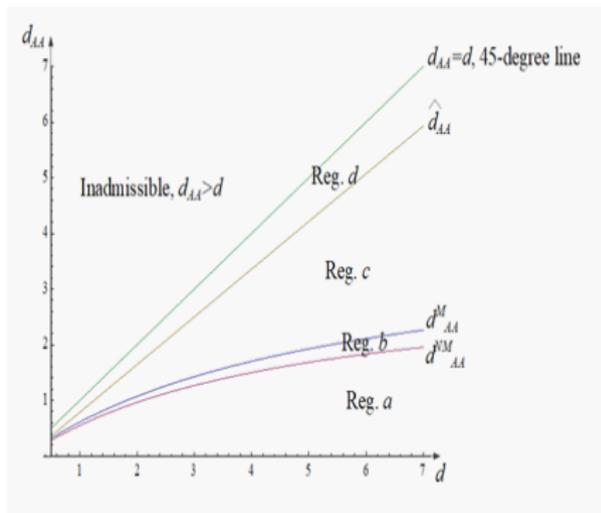
- $z_i^M = \frac{(1-c)[2d(2d+1)-1]}{4d(4+5d)+1}$, which satisfies $z_i^M + z_j^M \geq Z^{Min}$ iff $d_{AA} \geq d_{AA}^M \equiv \frac{d(26+64d)-1}{4d(23+4d)+38}$, where $d_{AA}^{NM} < d_{AA}^M < d$.
- In addition, $z_i^M < z_i^{NM}$.



Equilibrium Analysis

- **First stage - Proposition 3**

- Presenting the above results, but in terms of symmetry/asymmetry between agencies.



Equilibrium Analysis

- **First stage - Abatement**

- **Proposition 3.** *In equilibrium, investments in abatement satisfy:*

- 1 *Region a: If $d_{AA} \leq d_{AA}^{NM}$, every firm chooses z_i^{NM} , and a merger does not ensue.*
- 2 *Region b: If $d_{AA}^M < d_{AA} \leq d_{AA}^{NM}$, every firm chooses $z_i^{Min} \equiv \frac{Z^{Min}}{2}$, and a merger ensues.*
- 3 *Regions c and d: If $d_{AA} > d_{AA}^M$, every firm chooses z_i^M , and a merger ensues.*

Mergers when only
one agency is present

Other regulatory settings

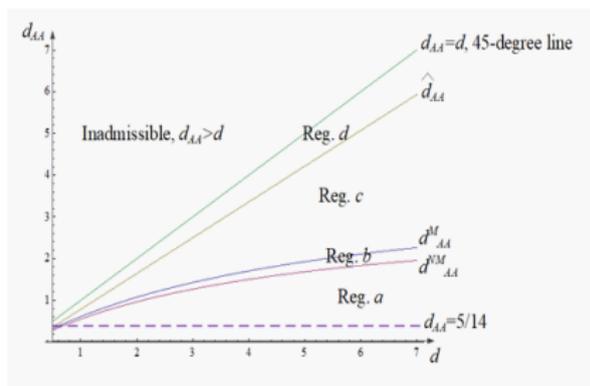
- **No AA**

- Firms can merge without legal constraints.
- They invest z_i^M .
- These results coincide with those when $d_{AA} > d_{AA}^M$ holds.
- Otherwise, firms invest *more* when the AA is present (z_i^{NM} or z_i^{Min}) than absent (z_i^M).

Other regulatory settings

- **No EPA**

- The AA approves if $d_{AA} \geq \bar{d}_{AA}(0, Z) = \frac{5(1-c)}{2[7(1-c)-12Z]}$ since $t = 0$.
- But firms have no incentives to invest in abatement, $z = 0$.
- Then, $d_{AA} \geq \bar{d}_{AA}(0, 0) = \frac{5}{14}$ since $t = 0$.



- More likely merger approvals.

Mergers in alternative time structures

Other time structures

- **Later investments:**

- Firms invest in abatement after the AA evaluates the merger request.
- Then abatement can no longer facilitate merger approvals.

- **Later emission fees:**

- The emission fee is set in the fourth stage.
- The EPA can always "nail" the first best, regardless of what the AA does in previous stages.
- The AA, then, anticipates the same welfare level.
- The AA's role becomes inconsequential.

Extensions

Extensions

- **Allowing for abatement costs, γ :**

- Abatement cost is $\frac{\gamma}{2} (z_i)^2$, where $\gamma \geq 1$.
- (Baseline model normalized $\gamma = 1$.)
- Less incentives to invest in abatement.

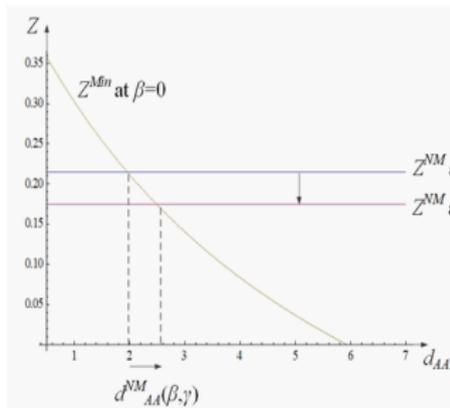
- **Allowing for spillovers, β :**

- Firm i 's net emissions are $e_i = q_i - z_i - \beta z_j$, where $\beta \in [0, 1]$.
- (Baseline model assumed $\beta = 0$.)
- Stronger free-riding incentives.

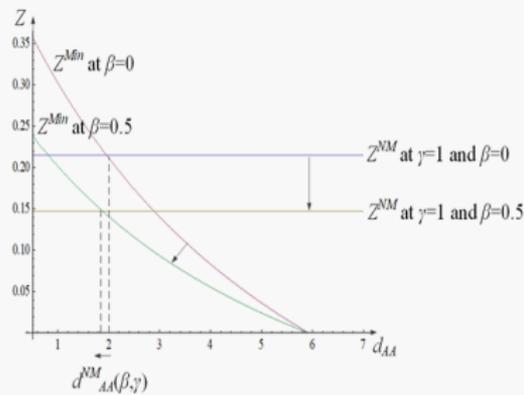
- But how is Z^{Min} affected?

Extensions

- Allowing for γ and β



Role of γ .

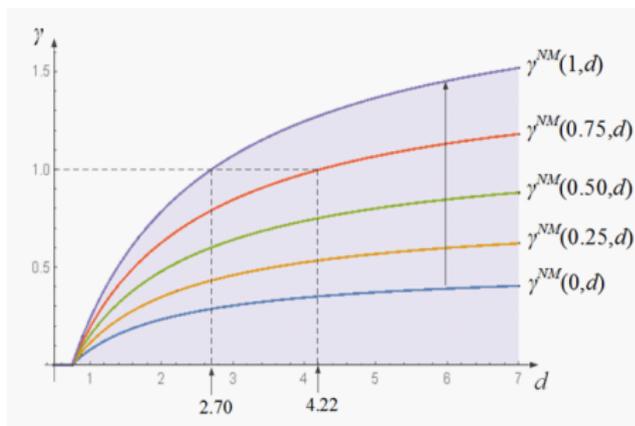


Role of β .

- $d_{AA}^{NM}(\beta, \gamma)$ unambiguously increases in γ .
- $d_{AA}^{NM}(\beta, \gamma)$ decreases in β if and only if $\gamma > \gamma^{NM}$, where γ^{NM} increases in both β and d .

Extensions

- Allowing for γ and β



- Emission fees are stringent (high d) and abatement is inexpensive (high γ).

Extensions

- **Allowing for ERCs**

- Firms coordinate abatement to maximize joint profits.

- No Merger:

- Abatement is higher than in the non-cooperative case if pollution is mild (i.e., when $d < \frac{5}{4}$). Otherwise, it is lower.
- ERCs facilitate mergers when pollution is mild (cutoff d_{AA}^{NM} increases).
- ERCs hinder mergers when pollution is severe (cutoff d_{AA}^{NM} decreases).
- EPA sets more stringent fees under ERCs when pollution is severe due to lower abatement.

Extensions

- **Allowing for ERCs**
- Merger:
 - Firms invest more in abatement under ERCs than in the baseline model.
 - They internalize both output and abatement externalities.
- Merger Approval Threshold:
 - ERCs reduce the minimal abatement threshold needed for merger approval.
 - This expands the region where mergers are approved.
 - EPA sets less stringent emission fees under ERCs due to higher abatement.
- Overall comparison:
 - ERCs amplify the strategic role of abatement in inducing mergers.
 - Facilitate (hinder) mergers when pollution is low (high).

Extensions

- **Allowing for cost convexities**

- Consider $C(q_i) = cq_i + \frac{h}{2}q_i^2$, where $c, h \geq 0$.
- Marginal costs are, then, $MC(q_i) = c + hq_i$.
- Diseconomies of scale.

- What's the role of h ?

- Firms: produce fewer units.
- EPA: sets less stringent fees.
- Less incentives to invest in abatement (Z^{NM} decreases)

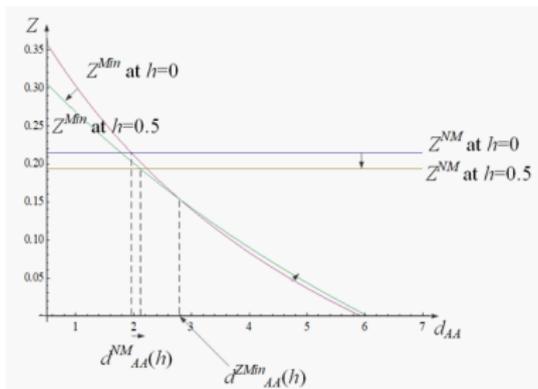
- What about the AA?

- Output reduction of the merger, $q_i^{NM}(h) - q_i^M(h)$, decreases in h .
- Mergers are, then, less necessary to curb pollution when costs are convex than linear.
- Formally, cutoff $\bar{d}_{AA}(t, Z, h)$ increases in h .

Extensions

- **Allowing for cost convexities**

- Cutoff $Z^{Min}(h)$ rotates counterclockwise while Z^{NM} decreases in h .
- Which effect dominates?
- The latter, i.e., cutoff $d_{AA}^{NM}(h)$ increases in h .
- In English: the AA blocks the merger under a wider range of d_{AA} values.



Discussion

- **Future mergers affecting investment.**
 - Comparing the model with and without AA...
 - We find that abatement levels are unaffected when AA and EPA have extremely similar or dissimilar objectives.
 - When the AA assigns a moderate weight to pollution, d_{AA} in region b , firms have incentives to increase their abatement to influence merger approvals.
 - For practitioners: do not make the AA completely ignore pollution or consider it as much as the EPA.

- **Timing of regulation.**

- When abatement occurs before the merger review (main model), firms can strategically use z to influence approvals.
- When it occurs after the merger review...
 - This strategic channel disappears.
- A similar argument applies with emission fees.
 - If they occur before the merger review, firms have incentives to use z to influence approvals.
 - If they occur after the merger review, first-best outcomes arise. No incentives.

Discussion

- **Spillovers:**

- Can either help or hinder merger approvals.
- If spillovers reduce the abatement threshold more than they reduce investment incentives, mergers are more likely.
- Otherwise, free-riding dominates and mergers become less likely.

- **Abatement costs:**

- Higher costs raise the threshold for merger approval.
- This makes it harder for firms to invest enough to trigger a merger.

- **Environmental R&D Cartels (ERCs):**

- Facilitate mergers when pollution is mild, even with regulatory asymmetries.
- Hinder mergers when pollution is severe, requiring closer alignment between agencies.

Further research

- Firm heterogeneity:
 - Allowing for asymmetric abatement efficiencies, γ_1 and γ_2 .
- Multiple firms:
 - Industry with $n \geq 2$ firms, where $k \geq 2$ out of n submit a merger request.
- Uncertainty in:
 - Regulatory thresholds (firms do not observe the AA's weight, d_{AA}).
 - Emission fees (firms do not observe the EPA's weight, d).
 - Effect on strategic abatement and merger approval regions.
- Empirical validation:
 - Test the model's predictions using data on green investments and merger approvals across countries.

Thank you!