Abatement Thresholds:
How Merger Prospects Affect Green Investments

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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.
  - Orsted invested $1.5 billion to 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.
  - BP and Lightsource in 2017, $200 million in ER&D.
  - Hitachi and ABB PowerGrids in 2020, $1.9 billion in ER&D.

Motivation

- Firms often portray these investments as part of their sustainability goals.
  - But can there be another reason?
- We show that these investments influence antitrust evaluations,
  - and 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.

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.
- Current debate about merger guidelines:
  - E.U., Australia, and Japan.
  - *Partial*, not full, regulatory alignment between agencies is the most effective at increasing abatement.

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).
  - Env. externalities: Montero (2002) and Fowlie and Reguant (2018).
  - Mergers and pollution: Fikru and Gautier (2016, 2024).

Literature-II

- Threshold public goods
  - Palfrey and Rosenthal (1984) and Barbieri and Malueg (2008).
  - Attenuation of free-riding effects.
- Policy coordination between diff. agencies.
  - Bohringer et al. (2017), Fischer and Newell (2008)
  - 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.
  - What if abatement happens after the merger evaluation?
  - What if emission fee is chosen after the merger evaluation?
- Extensions.
  - Spillover e§ects, 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 output from q_i^{NM} to q_i^{M}.

Equilibrium Analysis

- **Fourth stage - Merger approval**
  - The merger is welfare improving if and only if

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

    where cutoff $\overline{d}_{AA}(t, Z)$ 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 $d_{AA} \geq \overline{d}_{AA}(t, Z)$, 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 $d_{AA} \geq \overline{d}_{AA}(t^M, Z)$ holds, the EPA sets fee $t^M = \frac{(2d-1)(1-c)-4dZ}{2d+1}$.
  - Otherwise, the EPA sets fee $t^{NM} = \frac{(4d-1)(1-c)-6dZ}{2(2d+1)}$.
- Condition $d_{AA} \geq \overline{d}_{AA}(t^M, Z)$ 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}.
- As agencies become more symmetric (higher d_{AA}), Z^{Min} decreases:
  - expanding the region where EPA sets t^M and the AA approves.

Equilibrium Analysis

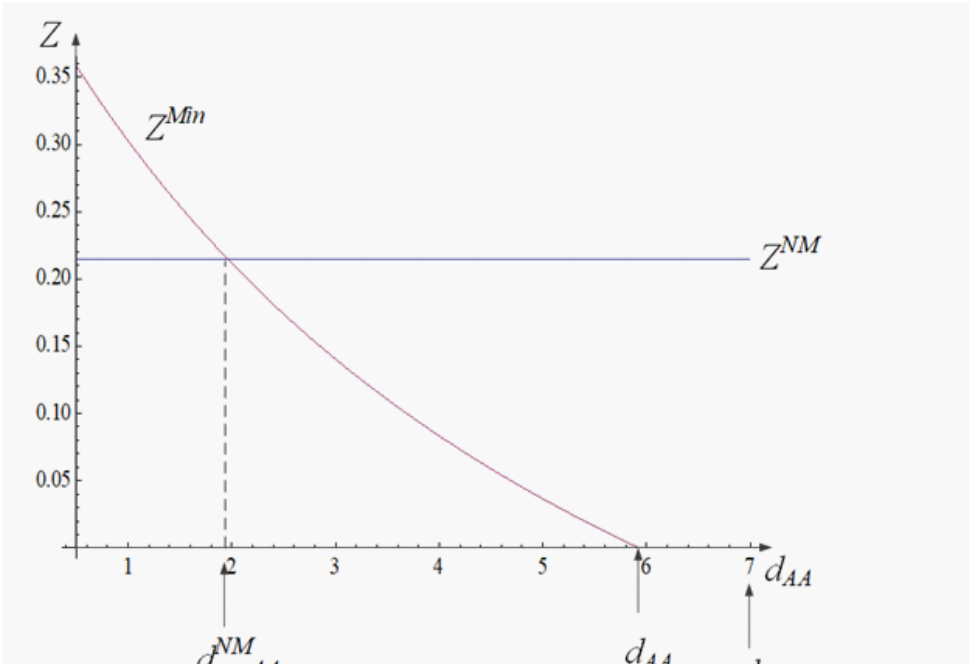
- **First stage - Abatement**
- Firms' aggreg. abatement, Z, dictates the market structure:
  - Merger if $Z \geq Z^{Min}$.
  - No merger if $Z < Z^{Min}$.
- As in public good games with threshold effects.
  - More time consuming (next slide).

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

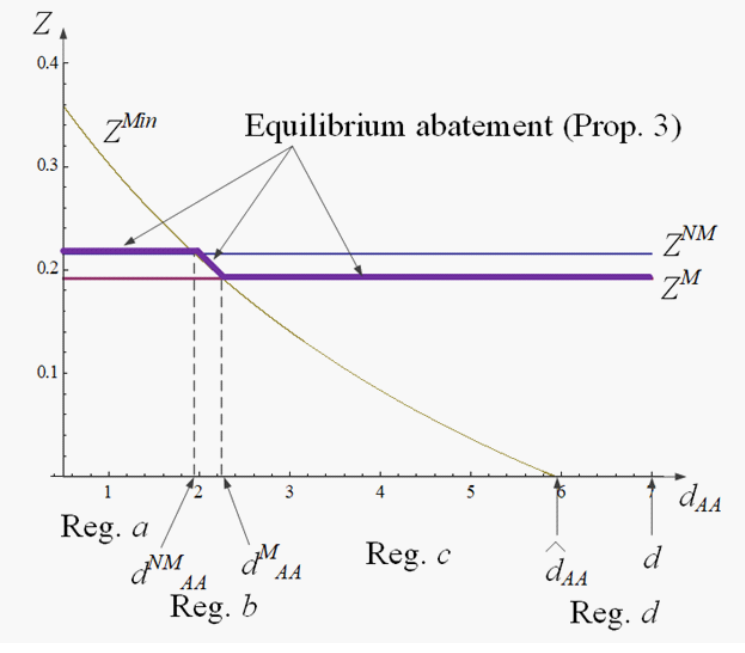
Equilibrium Analysis

- **First stage - Abatement**
  - $z_i^{NM} = \frac{(1-c)[4d(2d+1)-1]}{2(18d^2+13d+1)}$, *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.
  - d_{AA} is bounded.



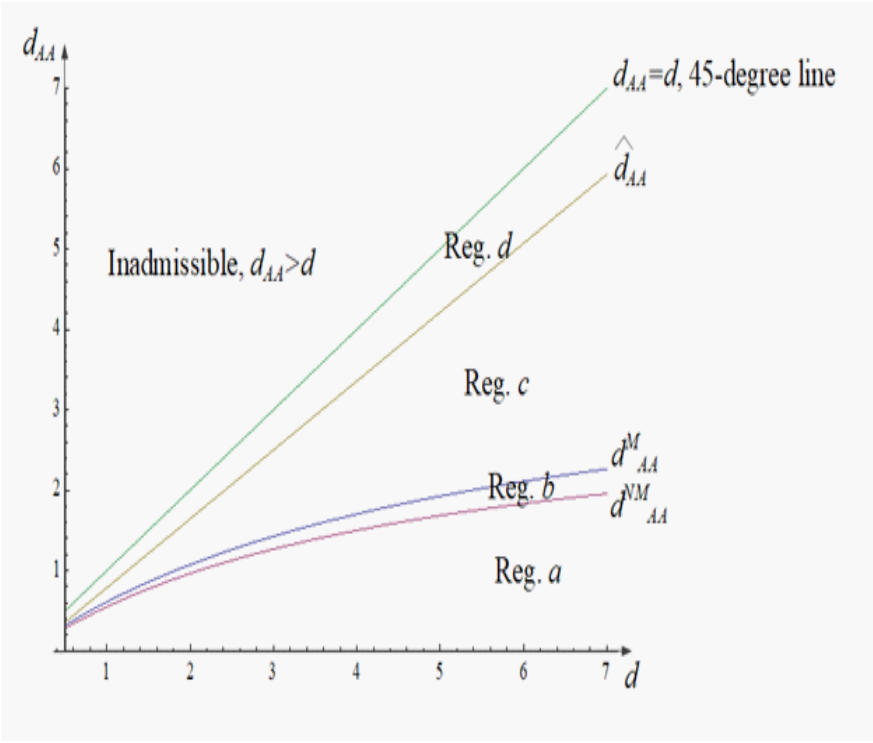
Equilibrium Analysis

- **First stage - Abatement**
  - $z_i^M = \frac{(1-c)[2d(2d+1)-1]}{4d(4+5d)+1}$, *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 - Abatement**
  - 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.*

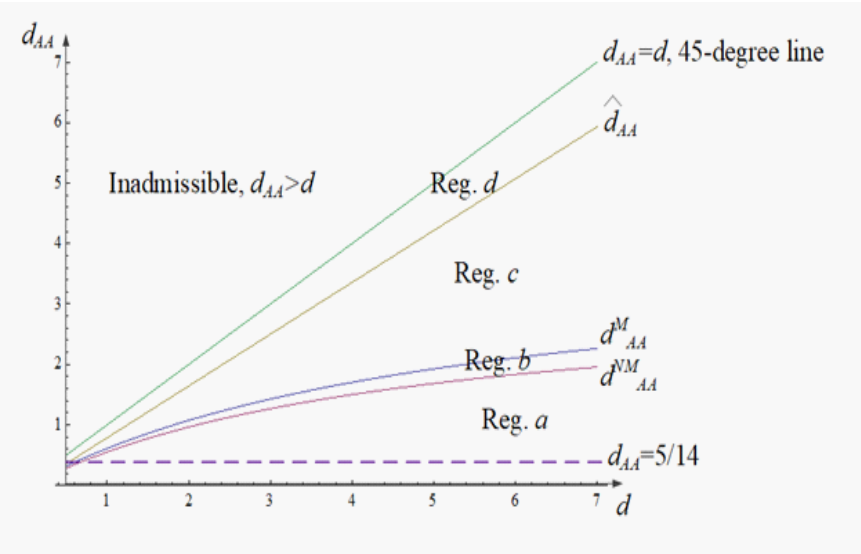
Other regulatory settings

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



  - Very likely merger approvals.

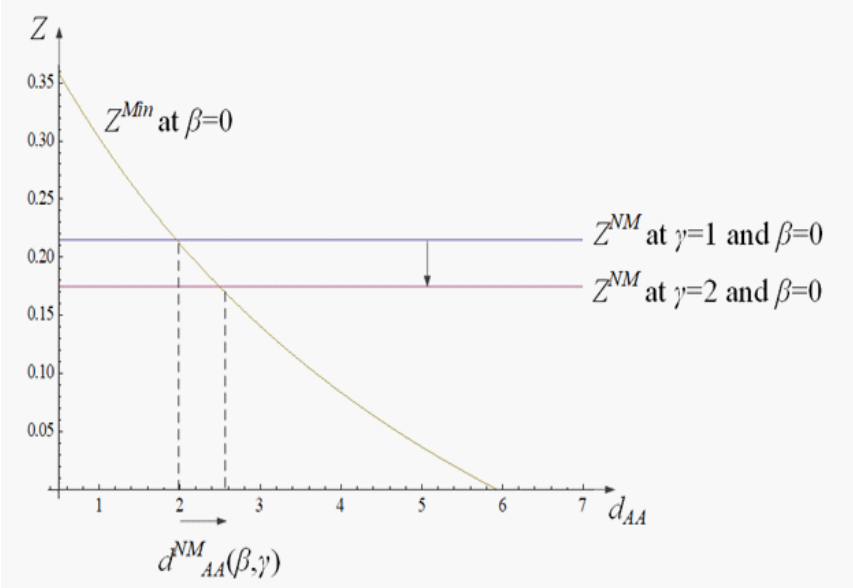
Other regulatory settings

- **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.

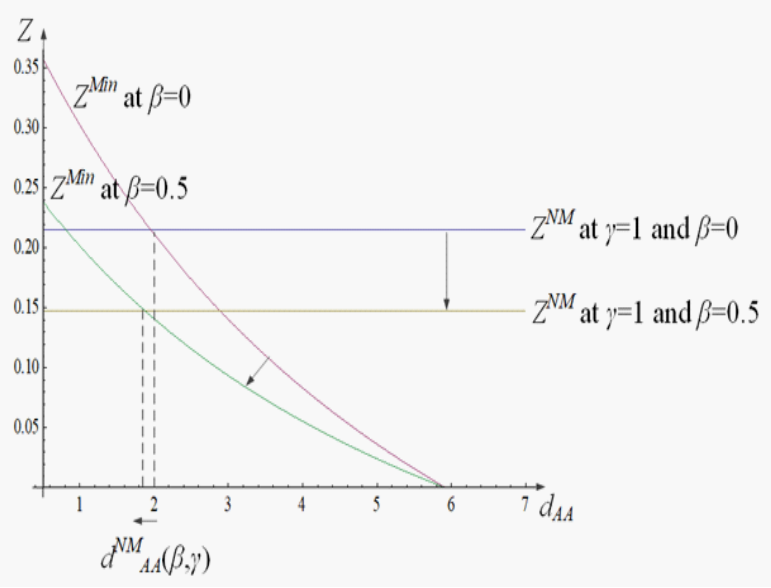
Extensions

Extensions

- **Allowing for 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 $\gamma > \gamma^{NM} \equiv \frac{d(1+\beta)^2(4d-3)}{2d(3+4d+2\beta)-1}$, where cutoff γ^{NM} increases in

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

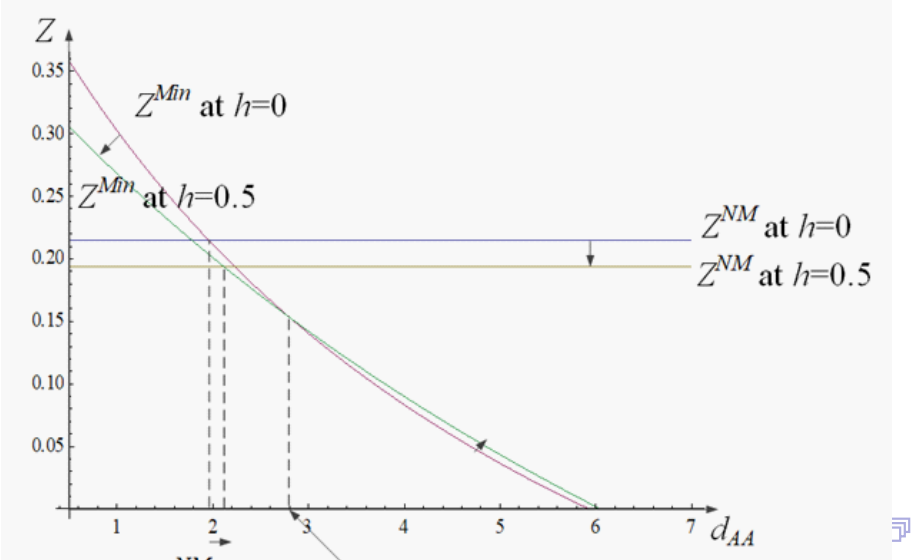
- **Allowing for ERCs**
- Merger:
  - Firms invest more in abatement under ERCs than in the baseline model.
  - They internalize both output and abatement externalities.
- Merger Approval Threshold:
  - ERCs reduce the minimal abatement threshold needed for merger approval.
  - This expands the region 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 $\overline{d}_{AA}(t, Z, h)$ increases in h.

Extensions

- **Allowing for cost convexities**
  - Cutoff $Z^{Min}(h)$ rotates counterclockwise while Z^{NM} decreases in h.
  - Which effect dominates?
  - Appendix 3 shows that 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

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 disimilar 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.

Discussion

- **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 (because firms do not observe the AA's weight, d_{AA}).
  - Emission fees (because 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!