Environmental Regulation: An Unintended "Booster" of Competition Policy?

Ana Espinola-Arredondo and Felix Munoz-Garcia
Washington State University

Motivation

- Firms investigated for collusive practices often face environmental regulations too.
- Examples:
  - Steel abrasives cartel (Winoa, Ervin, and MTS).
    - Colluded from 2003-2010.
    - Fined with €30 million by the EC.
    - Also regulated by EU Industrial Emissions Directive, which limits pollutants from steel manufacturers.

Motivation

- The freight forwarding cartel (Schenker AG, Panalpina, and Kuhne)
  - Colluded in 2002-2007
  - Fined with $50.27 million by the DOJ.
  - Firms are simultaneously subject to the Clean Air Act, regulating the CO_2 emissions of freight logistics and transport vehicles.

Motivation

- The use of competition policy to deter collusion.
  - Extensively analyzed!
- Interaction of environmental regulation and competition policy.
  - Overlooked!

Motivation

- How does environmental policy affect firms' ability to collude:
  - When no competition policy is present?
    - Depends on PG and PL.
  - When competition policy is present?
    - Environmental regulation "boosts" its effectiveness.
- Environmental policy *enhances* the competition authority's (CA's) ability to deter collusion.
  - The CA typical tools (monitoring, fines, rewards to cooperators) become more effective.

Motivation

- Then, we study how results are differently affected when the CA uses:
  - Audits
  - Leniency programs
  - Whistleblower programs.
- Extensions:
  - Convex production costs.
  - Product Differentiation.
  - N firms.
  - Price competition.

Policy implications

- Audits:
  - CA can reduce auditing efforts (monitoring and fines) if firms are polluting and face environmental regulation.
  - Shifting efforts towards industries that aren't subject to environmental policy.
- Leniency and Whistleblower programs:
  - Leniency programs spread to many countries in the early 2000s, and whistleblower programs after 2015.
  - Politically unpopular.
  - Our results suggest their rewards can be reduced, making them more politically acceptable.

Literature

- Collusion-deterring effects of audits, leniency, and whistleblower programs.
  - Aubert et al. (2006), Chen and Harrington (2007), and Chen and Rey (2013), among others.
- The literature considers extensions from Aubert et al. (2006).
  - Assumes firms are not regulated by other government agencies, such as the EPA.
  - We show that the overlap of EPA and CA can lead to complementarities:
    - making antitrust policy more effective.

Outline of the presentation

- Model
- Equilibrium behavior.
  - Without competition policy (benchmark)
  - With competition policy.
    - Audits
    - Leniency
    - Whistleblower
- Extensions:
  - Non-linear production costs.
  - Product Differentiation.

Model

Model

- Two firms play an infinitely repeated game facing inverse demand $p(Q)$, where $p'(Q) < 0$ and $p''(Q) \geq 0$.
- Cost function $C(q_i)$, where $C^{'}(q_i) > 0$ and $C^{''}(q_i) \geq 0$.
- When firms compete: $q_i^C(t)$ and $\pi^C(t)$.
- When firms collude: $q_i^M(t)$ and $\pi^M(t)$.
- When firms deviate: $q_i^D(t)$, $\pi^D(t)$ (one period) and $\pi^C(t)$ (thereafter, GTS).
- Profits satisfy: $\pi^D(t) > \pi^M(t) > \pi^C(t)$.

Model

- Collusion can only occur if firms communicate.
- Communication generates hard evidence.
- The CA finds evidence with prob. $\rho \in [0, 1]$, yielding a fine $F > 0$.
- Symmetric discount factor, $\delta \in [0, 1]$.
- Env. damage $Env = d\left(Q(t)\right)^2$
  - $d \geq 1/2$ denotes pollution severity.

Model - Time structure

- Following Aubert et al. (2006):
- **Stage 1.** In the first stage, the EPA sets a per-unit fee $t \geq 0$.
- **Stage 2.** every firm chooses whether to communicate.
- **Stage 3**
  - If both firms communicated, evidence is generated and an infinitely-repeated game ensues.
  - Every firm chooses, in each stage, its output level and whether to bring evidence to the CA.
  - If at least one firm chooses not to communicate, evidence does not exist.
  - Firms compete à la Cournot.
- **Stage 4.** If no firm brings evidence to the CA, this agency can still find evidence with probability $\rho \in [0, 1]$, giving a fine $F > 0$.

Model

- **Our goal:**
  - Find the effect of emission fee t, on the minimal discount factor sustaining collusion, $\overline{\delta}$.
  - For each of the CA programs (A, L, and W).
  - And the crossed effects (e.g., $\frac{\partial \overline{\delta}(t)}{\partial \rho}$ with respect to t).

Effects of t on Profits

- **Lemma 1.** *An increase in fee t satisfies $0 \geq \pi_t^C(t) > \pi_t^M(t)$ if and only if*

$$p'(Q^C(t))\frac{\partial q_j^C(t)}{\partial t} > \frac{q_i^C(t) - q_i^M(t)}{q_i^C(t)}. \qquad \text{(C1)}$$

- A more stringent fee produces a price effect under Cournot (left-hand side) that exceeds the percentage output reduction that firms experience when colluding (right-hand side).

Effects of t on Profits

- **Lemma 2.** *An increase in fee t satisfies $0 > \pi_t^M(t) > \pi_t^D(t)$ if and only if*

$$p'(Q^D(t))\frac{\partial q_j^M(t)}{\partial t} < \frac{q_i^D(t) - q_i^M(t)}{q_i^D(t)} \qquad \text{(C2)}$$

implying that $0 \geq \pi_t^C(t) > \pi_t^M(t) > \pi_t^D(t)$.

- Condition C2 implies that the positive externality that firm j generates on firm i's profits is small.
- A more demanding fee affects profits the most when firm i unilaterally deviates from collusion.

- Lemmas 1 and 2 do not imply that more stringent environmental regulation hinders collusion.

- Collusion depends on whether profit gains from deviation, $\pi^D(t) - \pi^M(t)$, are more affected by a marginal change in the emission fee than the associated profit loss.

Benchmark:

No competition policy

Benchmark - No CA

- Collusion is sustained if

$$\frac{1}{1-\delta}\pi_i^M(t) \geq \pi_i^D(t) + \frac{\delta}{1-\delta}\pi_i^C(t)$$

  which yields

$$\pi^D(t) - \pi^M(t) \leq \frac{\delta}{1-\delta}\left[\pi^M(t) - \pi^C(t)\right]$$

- Left-hand: $PG(t) \equiv \pi^D(t) - \pi^M(t)$ and the right-hand side captures the discounted profit from continuing collusion.
- In addition, let $PL(t) \equiv \pi^D(t) - \pi^C(t)$ denote the profit loss from abandoning collusion.

Benchmark - No CA

- Differentiating $PG(t)$ and $PL(t)$ with respect to t, yields

$$0 > PG_t(t) > PL_t(t)$$

- A more stringent t decreases both $PG_t(t)$ and $PL_t(t)$. The profit gain, however, is less hurt than the profit loss, since collusion profits decrease more significantly than Cournot profits after regulation becomes more stringent, that is, $0 \geq \pi_t^C(t) > \pi_t^M(t)$.

Benchmark - No CA

- **Lemma 3.** *Without competition policy, collusion can be supported if* $\delta \geq \overline{\delta}(t) \equiv \frac{PG(t)}{PL(t)}$, *where* $\overline{\delta}(t)$ *satisfies* $\overline{\delta}(t) \in (0,1)$. *In addition,* $\overline{\delta}(t)$ *increases in* t *since* $0 > \varepsilon_{PG,t} \geq \varepsilon_{PL,t}$ *holds under all admissible conditions.*

- $\overline{\delta}(t)$ increases when:
  - Profit gain from deviating becomes more attractive, i.e., higher $\pi^D(t)$ and, in turn, a higher $PG(t)$; or
  - Reverting to competition becomes less threatening, i.e., higher $\pi^C(t)$ and lower $PL(t)$.

CA is present

Audits

- The CA now monitors firms, detecting collusion with probability $\rho \in [0, 1]$, and setting a fine $F > 0$.
  - ρF is the expected fine.
- Profits, then, become:
  - If collusion, $\pi_i^M(t) - \rho F$. (Evidence was generated.)
  - If deviation, $\pi_i^D(t) - \rho F$. (Evidence was generated.)
  - If competition, $\pi_i^C(t)$. (Evidence never existed.)
- The expected fine is not large enough to deter collusion, $\pi_i^M(t) - \rho F > \pi_i^C(t)$, or $\rho F < PL(t) - PG(t)$.

Audits

- Collusion is now sustained if

$$\frac{1}{1-\delta}\left(\pi_i^M(t)-\rho F\right) \geq \left(\pi_i^D(t)-\rho F\right)+\frac{\delta}{1-\delta}\pi_i^C(t)$$

- or, after rearranging,

$$\underbrace{\left(\pi_i^D(t)-\rho F\right)-\left(\pi_i^M(t)-\rho F\right)}_{\pi_i^D(t)-\pi_i^M(t)} \leq \frac{\delta}{1-\delta}\left[\left(\pi_i^M(t)-\rho F\right)-\pi_i^C(t)\right]$$

- Deviation incentives are unaffected (LHS).
- Collusive incentives are reduced (RHS).
- Audits, then, give rise to a cost asymmetry, as we show next.

Audits

- **Proposition 1.** *Under audits, collusion can be sustained if* $\delta \geq \overline{\delta}_A(t) \equiv \frac{PG(t)}{PL(t)-\rho F}$, *where* $\overline{\delta}_A(t)$ *satisfies* $\overline{\delta}_A(t) \in (0,1)$, $\overline{\delta}_A(t) \geq \overline{\delta}(t)$, *and unambiguously increases in* ρ, F, *and* t. *Furthermore, the derivatives* $\frac{\partial \overline{\delta}_A(t)}{\partial \rho}$ *and* $\frac{\partial \overline{\delta}_A(t)}{\partial F}$ *increase in* t *for all admissible parameters.*

Audits

- **Intuition of Proposition 1:**
  - The presence of audits make collusion less likely to arise, i.e., $\overline{\delta}_A(t) \geq \overline{\delta}(t)$, as in Aubert et al. (2006)
  - More stringent fees hinder collusion.
  - The effectiveness of audits at deterring collusion is increasing in t, $\frac{\partial^2 \overline{\delta}_A(t)}{\partial \rho \partial t}$ and $\frac{\partial^2 \overline{\delta}_A(t)}{\partial F \partial t}$ are positive.

Leniency programs

- Upon deviating, the firm also collaborates with investigators, receiving a reward R, where

$$0 > R > -\rho F$$

- Less severe fines than without reporting
  - if $R < -\rho F$ reporting induces more severe punishment.

Leniency programs

- Sustainability condition is now:

$$(\pi_i^D(t) + \underbrace{R}_{\text{New}}) - \left(\pi_i^M(t) - \rho F\right) \leq \frac{\delta}{1-\delta}\left[\left(\pi_i^M(t) - \rho F\right) - \pi_i^C(t)\right]$$

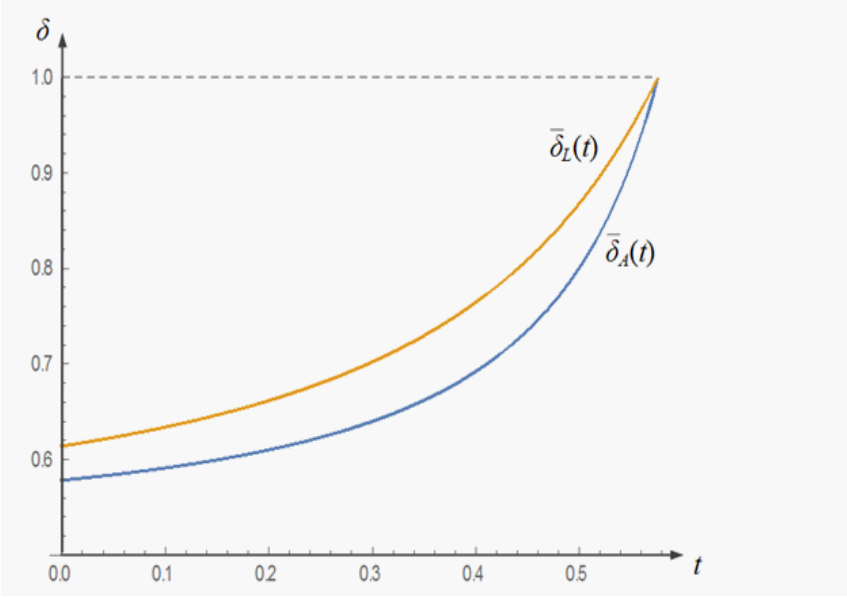
  where only R has changed relative to audits.
- RHS is unaffected, but...
- LHS increases, meaning more incentives to deviate.

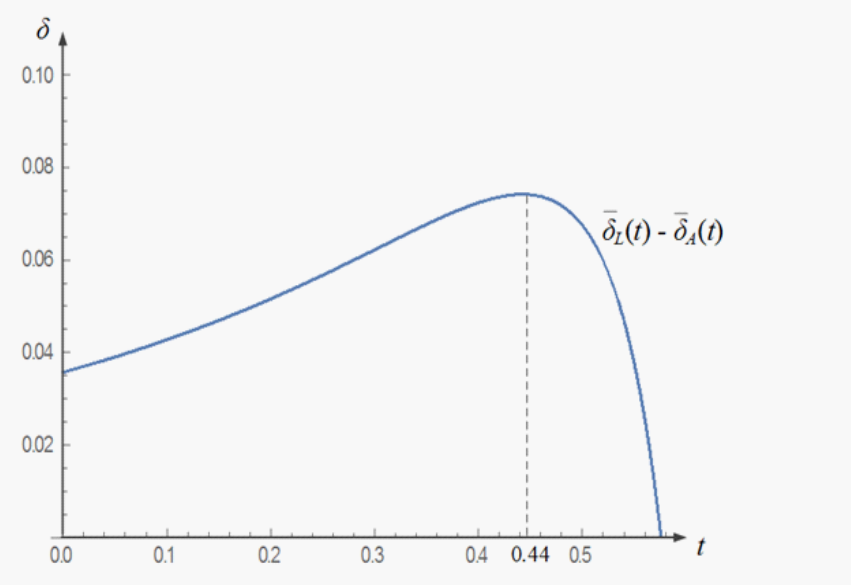
Leniency programs

- **Proposition 2.** *Under leniency programs, collusion can be sustained if* $\delta \geq \overline{\delta}_L(t) \equiv \frac{PG(t)+R+\rho F}{PL(t)+R}$, *where* $\overline{\delta}_L(t)$ *satisfies* $\overline{\delta}_L(t) \in (0,1)$, $\overline{\delta}_L(t) \geq \overline{\delta}_A(t) \geq \overline{\delta}(t)$, *and unambiguously increasing in* ρ, F, R, *and* t. *Furthermore, the derivatives* $\frac{\partial \overline{\delta}_L(t)}{\partial \rho}$ *and* $\frac{\partial \overline{\delta}_L(t)}{\partial F}$ *increase in* t *under all conditions.*

Leniency programs

- Aubert et al. (2006) is a special case of our results when $t = 0$ (vertical axis).





Whistleblower programs

- Relative to audits, the CA offers a compensation B to firm employees providing evidence of collusion.
- The firm must, then, pay B to each employee "in the know" for his/her silence
  - Please don't go to the CA with evidence!
  - B is also referred to as "bribe."

Whistleblower programs

- Collusion can now be sustained if

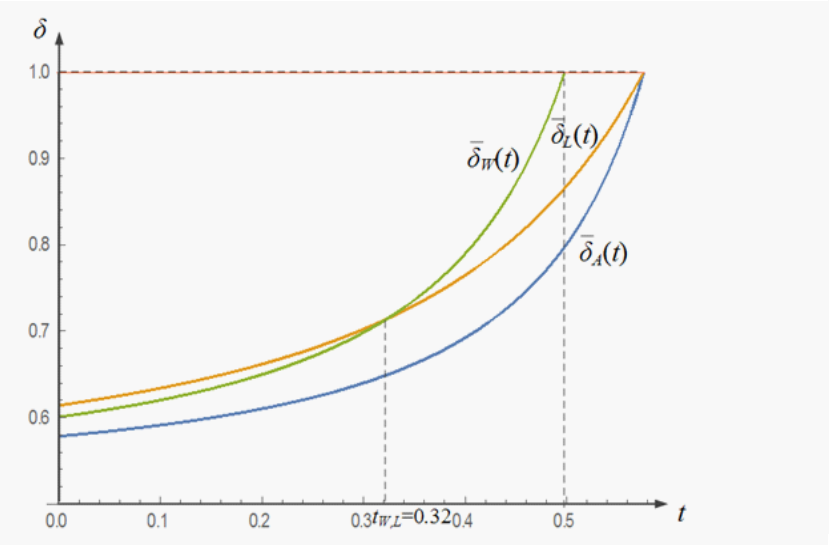
$$\pi_i^D(t) - \pi_i^M(t) \leq \frac{\delta}{1-\delta}\left[(\pi_i^M(t) - \rho F - \underbrace{nB}_{\text{New}}) - \pi_i^C(t)\right]$$

  where only nB has changed, relative to audits.
- LHS is unaffected, but...
- RHS is lower (less incentives to collude).

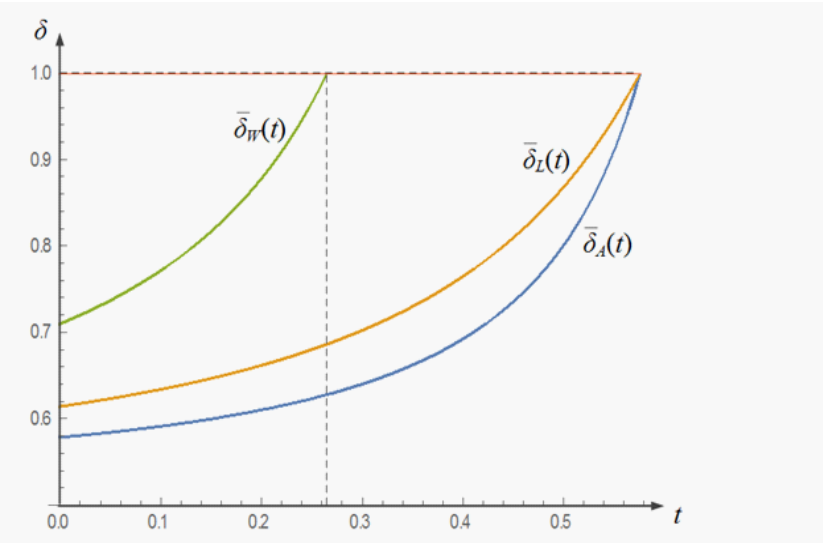
Whistleblower programs

- **Proposition 3.** *With whistleblower programs, collusion can be sustained if* $\delta \geq \overline{\delta}_W(t) \equiv \frac{PG(t)}{PL(t)-(\rho F+nB)}$. *Cutoff* $\overline{\delta}_W(t)$ *satisfies* $\overline{\delta}_W(t) \in (0,1)$, *and unambiguously increases in* ρ, F, n, B, *and* t. *In addition,* $\overline{\delta}_W(t)$ *satisfies* $\overline{\delta}_W(t) \geq \overline{\delta}_A(t) \geq \overline{\delta}$ *for all parameter values, and* $\overline{\delta}_W(t) \geq \overline{\delta}_L(t)$ *if and only if* $nB > \frac{[PL(t)-PG(t)-\rho F](\rho F+R)}{PG(t)+\rho F+R}$. *Finally, the derivatives* $\frac{\partial \overline{\delta}_W(t)}{\partial \rho}$ *and* $\frac{\partial \overline{\delta}_W(t)}{\partial F}$ *increase in* t *for all admissible parameters.*

Whistleblower programs



Low bribes.



High bribes.

Emission fees

Cournot Competition

- If $\delta < \overline{\delta}_k(t)$, where $k = \{A, L, W\}$. The regulator sets an emission fee $t^C = \frac{(1-c)(4d-1)}{2(1+2d)}$, which is positive, increasing in d, but decreasing in c.

- **Proposition 4.** *Minimal discount factor* $\overline{\delta}_k(t^C)$ *is unambiguously increasing in* c, d, ρ, *and* F, *and its cross-partials satisfy* $\frac{\partial \overline{\delta}_k(t^C)}{\partial \rho \partial c} > \frac{\partial \overline{\delta}_k(t^C)}{\partial \rho \partial d} > 0$ *and* $\frac{\partial \overline{\delta}_k(t^C)}{\partial F \partial c} > \frac{\partial \overline{\delta}_k(t^C)}{\partial F \partial d} > 0$ *for every program* $k = \{A, L, W\}$. *In addition,* $\overline{\delta}_W(t^C) \geq \overline{\delta}_L(t^C) \geq \overline{\delta}_A(t^C)$ *for all* $d \leq \overline{d}_{W,L}$, *but* $\overline{\delta}_L(t^C) > \overline{\delta}_W(t^C) \geq \overline{\delta}_A(t^C)$ *otherwise.*

Cournot Competition

- $\overline{\delta}_k\left(t^C\right)$ is increasing in c, d, ρ, and F.

	Direct effect	Indirect effect	Overall on $\overline{\delta}_A\left(t^C\right)$
$\Uparrow c$	$+$	$-$	$+$
$\Uparrow \rho$	$+$	N/A	$+$
$\Uparrow F$	$+$	N/A	$+$
$\Uparrow d$	N/A	$+$	$+$

Table I. Direct and indirect effects on $\overline{\delta}_A\left(t^C\right)$.

Emission fees induce collusion?

- If $\delta \geq \overline{\delta}_A(t)$ then emission fee is $t^M = \frac{(1-c)(2d-1)}{(1+2d)}$, which is positive by definition and since $\overline{\delta}_A(t)$ and $t^C > t^M$,then $\overline{\delta}_A(t^C) > \overline{\delta}_A(t^M)$.
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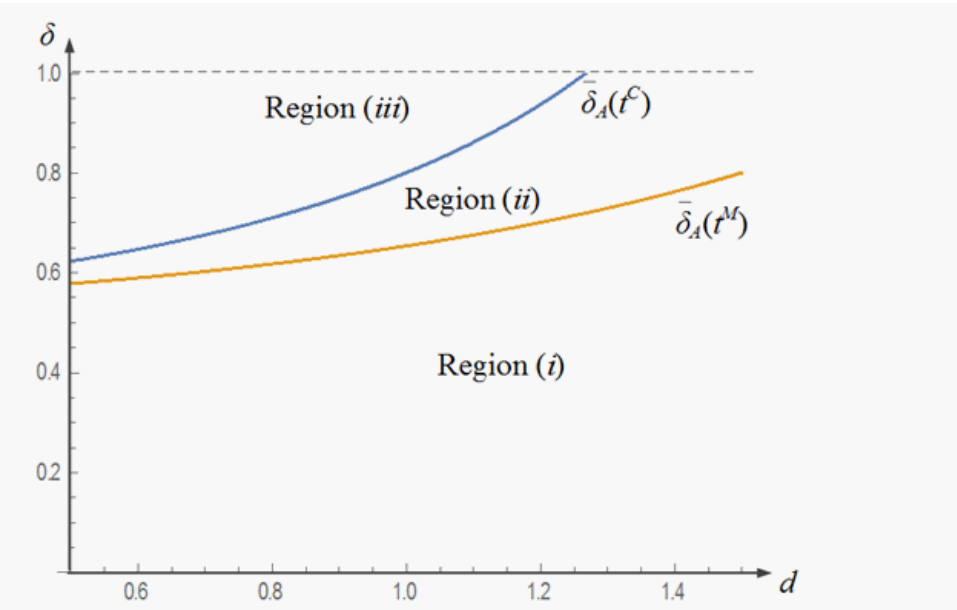

Emission fees induce collusion?

- Endogenous emission fee.
  - Fees induce no changes in collusive behavior in reg. (i) and (iii).
  - In region (ii), however, setting the stringent fee t^C prevents collusion whereas t^M facilitates it.
  - No welfare loss, since t^M induces the same socially optimal output.

Welfare Comparisons

- We measure this inefficiency (regulatory error) with

$$\Delta W^C \equiv W^C(t^C) - W^C(t^M),$$

$$\Delta W^M \equiv W^M(t^M) - W^M(t^C),$$

- Therefore, the welfare change from the EPA setting fee t^M instead of t^C is $\Delta W^{C,M} \equiv W^C(t^C) - W^M(t^M)$.

Welfare Comparisons

- **Corollary 1.** *Inefficiency* $\Delta W^C = \frac{2d^2(1-c)^2}{9(1+2d)}$ *is unambiguously positive and increasing in pollution severity,* d*. Inefficiency* $\Delta W^M = \frac{(1-c)^2}{32(1+2d)}$ *is also positive, but decreasing in pollution severity,* d*; and* $\Delta W^{C,M}$ *is nil for all parameter values.*

- Welfare levels $W^C(t^C)$ and $W^M(t^M)$ coincide, indicating that the EPA seeks to induce the same aggregate socially optimal output in both market structures, thus yielding the same welfare level.

Extensions

- Non-linear costs $C(q_i) = cq_i + \frac{\beta}{2}q_i^2$

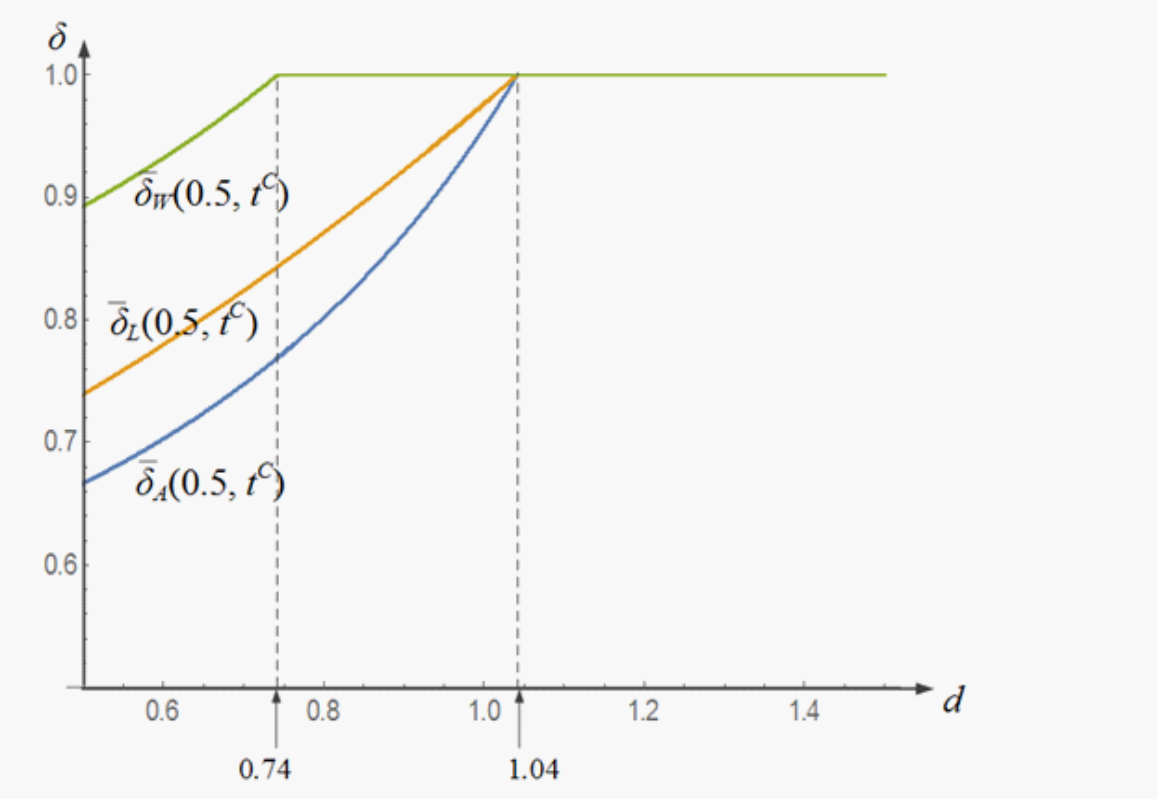

Fig. $\bar{\delta}_k(\beta, t^C)$ as a function of d.

Extensions

- Consider an inverse demand function $p(q_i, q_j) = 1 - q_i - \gamma q_j$, where $\gamma \in [0, 1]$ denotes product substitutability.

- **Lemma 5.** *Cutoff $\overline{\delta}_A(\gamma, t)$ increases in γ if and only if $\rho F < \frac{(1-c-t)^2\gamma^2}{4(1+\gamma)(2+\gamma)^2}\frac{\gamma^2}{2(2+\gamma)}$, cutoff $\overline{\delta}_L(\gamma, t)$ unambiguously increases in γ, and cutoff $\overline{\delta}_W(\gamma, t)$ increases in γ if and only if $\rho F + nB < \frac{(1-c-t)^2\gamma^2}{4(1+\gamma)(2+\gamma)^2}\frac{1}{2(2+\gamma)}$. In addition, $\overline{\delta}_k(\gamma, t)$ coincides with $\overline{\delta}_k(t)$ in Propositions 1-3 when $\gamma = 1$ for every program $k = \{A, L, W\}$; increases in t, c, ρ, and F; and the derivatives $\frac{\partial\overline{\delta}_k(\gamma,t)}{\partial\rho}$ and $\frac{\partial\overline{\delta}_k(\gamma,t)}{\partial F}$ are increasing in t.*

Discussion

- **Emission fees enhancing competition policy.**
  - CAs may require fewer resources for monitoring and prosecuting colluding firms within industries facing emission fees.
  - Our results provide a novel, unintended role to the EPA, namely, making competition policy more effective.

Discussion

- **Prioritizing antitrust efforts.**
  - Environmental regulation could allow the CA to reduce antitrust efforts in regulated markets and, instead, concentrate them in unregulated sectors

Thank you!