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Optimal Design of Climate Disclosure Policies: Transparency versus Externality

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1. Introduction

1.1 Research Questions

- Why do we need more transparent climate disclosures?
- Does more transparent climate disclosure mandate induce lower emissions?
- How to design climate disclosure policies?

This paper studies the welfare implications of enhanced transparency in climate disclosure mandates, and aims to shed light on the policy design.

1.2 Key assumptions

1. Regulator has full authority over disclosure policies: No other way (e.g., voluntary disclosure) to certify (low) emissions
2. Market is rational, forming beliefs based only on regulatory disclosure (ruling out cheap talk / greenwashing)

Results Summary

1. Transparency is needed mainly for adverse selection, rather than moral hazard.
2. More transparency could induce *higher* emission.
3. More transparent disclosure mandates always make the firm weakly better off.
4. Maximal transparency is no different from maximizing firm's private benefit, while disregarding the ensuing externality.
5. If efficiency is considered as a precondition, then full disclosure is the *worst* in terms of internalizing externality.
6. Under some conditions, Pareto-efficient disclosure policies can be implemented by threshold policies—fully revealing if emissions fall below a threshold and pooling otherwise.

2. Model

2.1 Setup

- Agents: a firm, a market, and a regulator
- The firm seeks investment for a project, which involves choosing an emission level $e \in [0, \bar{e}] =: E \subset \mathbb{R}$
- A *disclosure policy* is a partition of E. It can be represented by a function $d : E \to E$, where $d(e)$ represents the disclosed emission level
- Given d prescribed by the regulator, the firm chooses e to maximize its profit $\bar{\pi}(\theta, e, \tilde{e})$, where $\tilde{e}$ is the market's belief about firm's emission level upon observing $d(e)$
- Firm's private type θ has continuous density $f(\theta)$ on $\Theta \subset \mathbb{R}$
  - e.g., θ represents abatement cost: $\bar{\pi}(\theta, e, \tilde{e}) = R - \theta(\bar{e} - e) - C(\tilde{e})$
- Assumptions:
  - $\bar{\pi}(\theta, e, \tilde{e})$ increasing in e and decreasing in $\tilde{e}$: Emission reduction is costly, and the firm prefers to be perceived as green

2.2 Timeline

1. Regulator commits to a disclosure policy d
2. Firm observes its type θ
3. Firm chooses emission level $e \in E$
4. Firm discloses $d(e)$, inducing a market belief $\tilde{e}$
5. Firm earns a profit $\bar{\pi}(\theta, e, \tilde{e})$

2.3 Equilibrium Notion

Given d, an equilibrium is a PBE in which

1. firm with type θ chooses $\mathbf{e}(\theta)$ to maximize its profit
2. market forms belief $\tilde{\mathbf{e}}(d(e))$ according to Bayes' rule, with forward induction refinement off-path
3. belief is correct: $\tilde{\mathbf{e}}(d(\mathbf{e}(\theta))) = \mathbf{e}(\theta)$ for all $\theta \in \Theta$

Observation: In equilibrium, $\tilde{\mathbf{e}}(d(e))$ must be the highest emission level consistent with $d(e)$—these emission levels are called "*belief-compatible*".

3. Illustration

Given d, the firm with θ maximizes $\bar{\pi}(\theta, \cdot, \tilde{\mathbf{e}}(d(\cdot)))$:

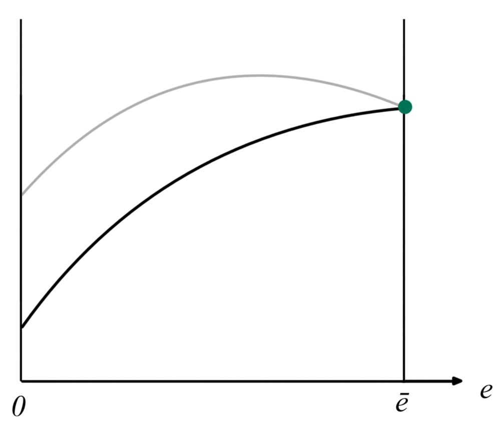

Figure 1: No Disclosure: $d(e) = \bar{e}$

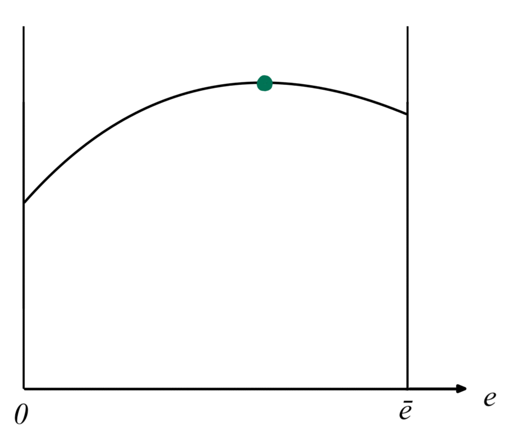

Figure 2: Full Disclosure: $d(e) = e$

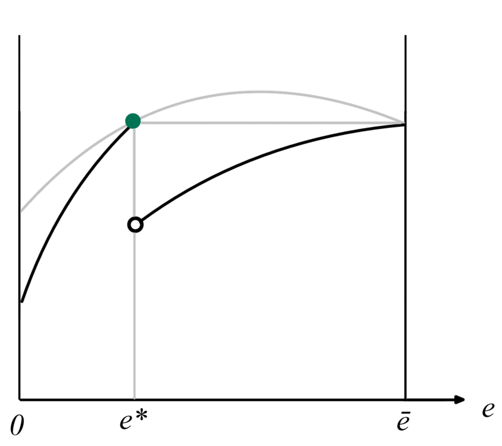

Figure 3: Binary Disclosure: $d(e) = e^*$ if $e \le e^*$, otherwise $d(e) = \bar{e}$

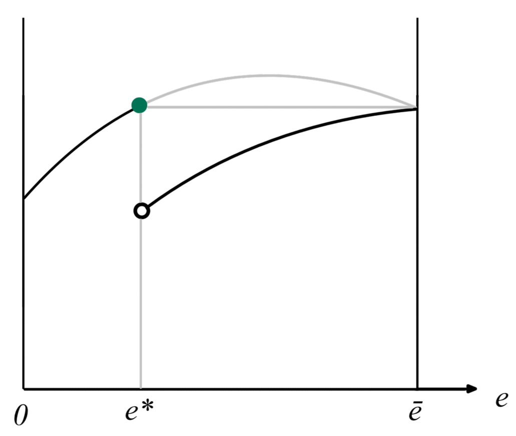

Figure 4: Threshold Disclosure: $d(e) = e$ if $e \le e^*$, otherwise $d(e) = \bar{e}$

Observation: Transparency beyond binary disclosure is not needed in the first best, which gives **Result 1**.

4. Welfare Analysis

- $\Pi(d)$: equilibrium expected profit under d
- $\Gamma(d)$: equilibrium expected emission under d

Definition 1 (Transparency). d is *more transparent than* d' if the partition associated with d is finer than the one associated with d'.

Definition 2 (Efficient Policy). d is *Pareto efficient* if there is no disclosure policy d' such that $\Pi(d') \ge \Pi(d)$ and $\Gamma(d') \le \Gamma(d)$, with at least one inequality strict.

- **Result 2.** Expected emission Γ is not monotone with respect to transparency:
  - Full disclosure (Figure 2) is the most transparent policy, inducing lower emission than no disclosure (Figure 1), but higher emission than binary disclosure (Figure 3)
- **Result 3.** Expected profit Π is weakly increasing in transparency
  - For each E_i in the partition, only $\max E_i$ is "belief-compatible"
  - A finer partition creates additional belief-compatible emission levels, thus essentially enlarges the feasible set of the firm's maximization problem

Intuition: Transparency facilitates the communication between the firm and the market.

Observation: Transparency ("belief-compatible" levels) serves as a screening device in the second best.

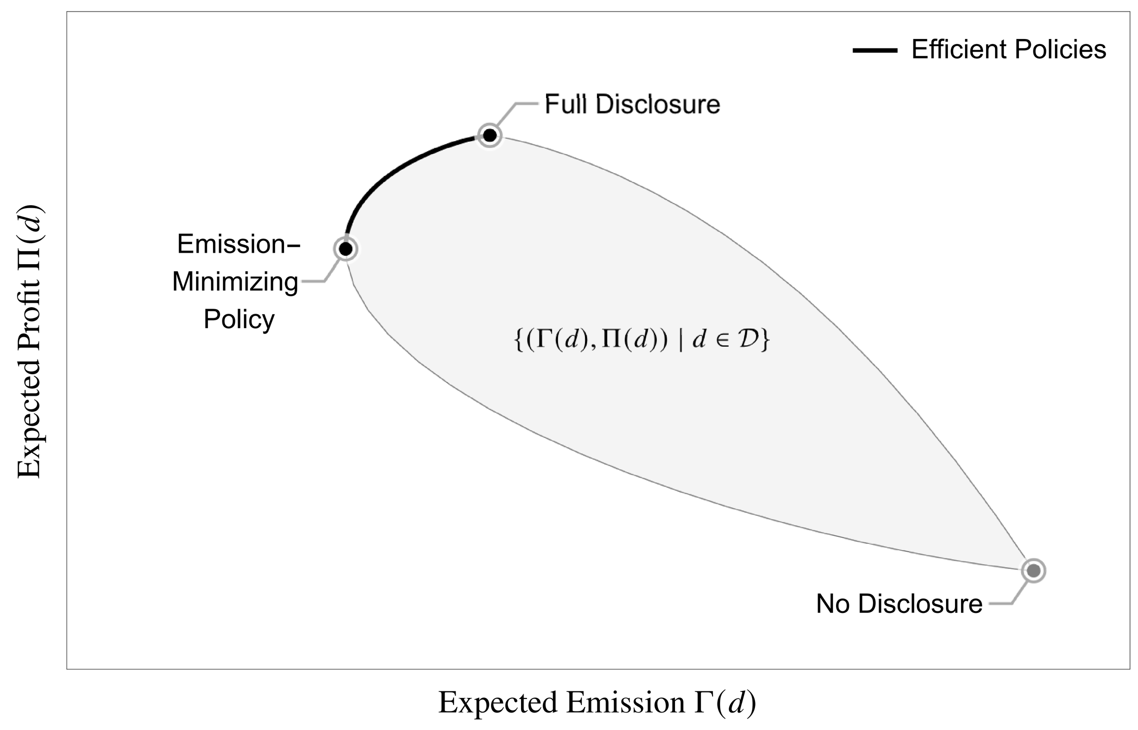

Figure 5: Emission-Profit Possibility Set

When should the regulator increase disclosure transparency to combat carbon emissions?

Proposition 1. *If d' is more transparent than d and d is efficient, then $\Gamma(d') \ge \Gamma(d)$.*

- Increasing transparency would never lower emission if efficiency has already been achieved

Proposition 2 (Result 4 and 5). *Full disclosure is efficient. It induces the highest expected profit among all policies, and the highest expected emission levels among all efficient policies.*

5. Optimal Design

Assumption 1. *$\pi(\theta, e) := \bar{\pi}(\theta, e, e)$ takes the form of $\pi(\theta, e) = \pi_0(e) + \theta \cdot (ae + b)$, $a, b \in \mathbb{R}$.*

Theorem 1 (Result 6). *Suppose Assumption 1 holds. If f is continuously differentiable and $\ln(f(\theta))'' \le 0$ on $\operatorname{int}\Theta$, then for any efficient disclosure policy, there exists a threshold policy that induces the same expected emission and expected profit.*