The Global Climate Game

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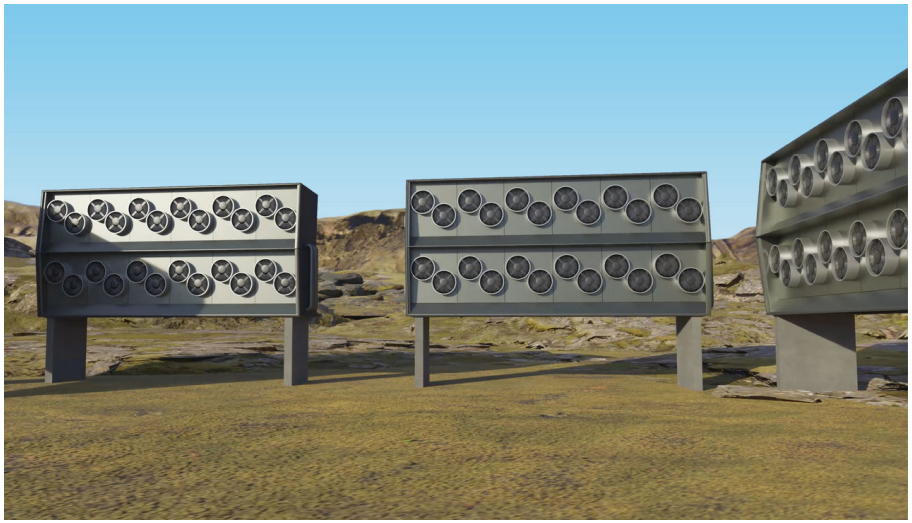
Setup and Problem

Climate change as a coordination failure

Technology 1: Cheap and dirty



Technology 2: Clean but expensive

A Public Good Coordination Game

- N players, acting simultaneously
- Binary action $x_i \in \{0, 1\}$
- Interpretation: player i invests dirty ($x_i = 0$) or clean ($x_i = 1$)
- Let $x = (x_1, x_2, ..., x_N)$ be an action vector.
- Parameter b is a "fundamental" of the environment/technology – higher b makes the clean technology more attractive, ceteris paribus
- Define $n(x) = \sum_{i=1}^{N} x_i$.
- Payoffs:

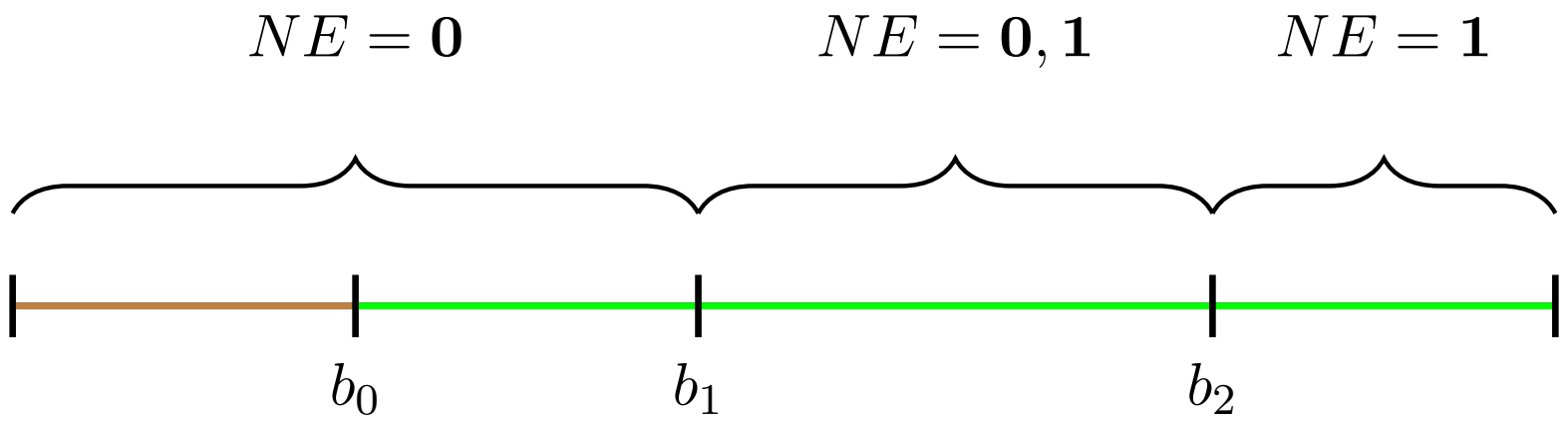
$$u_i(x_i, x_{-i} \mid b) = b \cdot n(x) - d \cdot (1 - x_i) - c(n(x)) \cdot x_i,$$

where d is the cost of the dirty technology, $c(n) > d$ the cost of the clean technology, decreasing in $n \rightarrow$ technological spillovers

Structure

- Two key properties:
  1. Clean investment benefits the environment
  2. Clean investment is more attractive if $n(x)$, the number of players investing in the clean technology, is higher
- Two externalities:
  1. Environmental externality
  2. Network externality
- Two types of coordination failure:
  1. Failure to coordinate actions at all (some go dirty, others go clean)
  2. Coordination on inefficient outcome (all go dirty, clean would be better)

Coordination (Failure)



Problem

- Multiple strict equilibria $\rightarrow$ coordination problem
- Solutions // complications
  - Equilibrium refinements // cannot eliminate strict equilibria
  - Hand-pick particular equilibrium // ad hoc
  - Run experiments // external validity
  - Don't try to solve // not a solution
- My proposal: **consider uncertainty**
- Question: does coordination remain problematic after equilibrium selection?

The Global Climate Game

Uncertainty and Signals: The Global Climate Game

- Players do not observe the true fundamental b
- Common knowledge that b drawn from the uniform distribution on $[\underline{B}, \overline{B}]$
- Each i receives a private noisy signal b_i^ε of b, given by:

$$b_i^\varepsilon = b + \varepsilon_i,$$

  where ε_i is idiosyncratic noise in i's signal
- Common knowledge that ε_i drawn i.i.d. from the uniform distribution on $[-\varepsilon, \varepsilon]$
- Game is a **global game** (Carlsson & Van Damme, 1993)
- Solution concept: iterated elimination of strictly dominated strategies (IESDS)

Unique Equilibrium

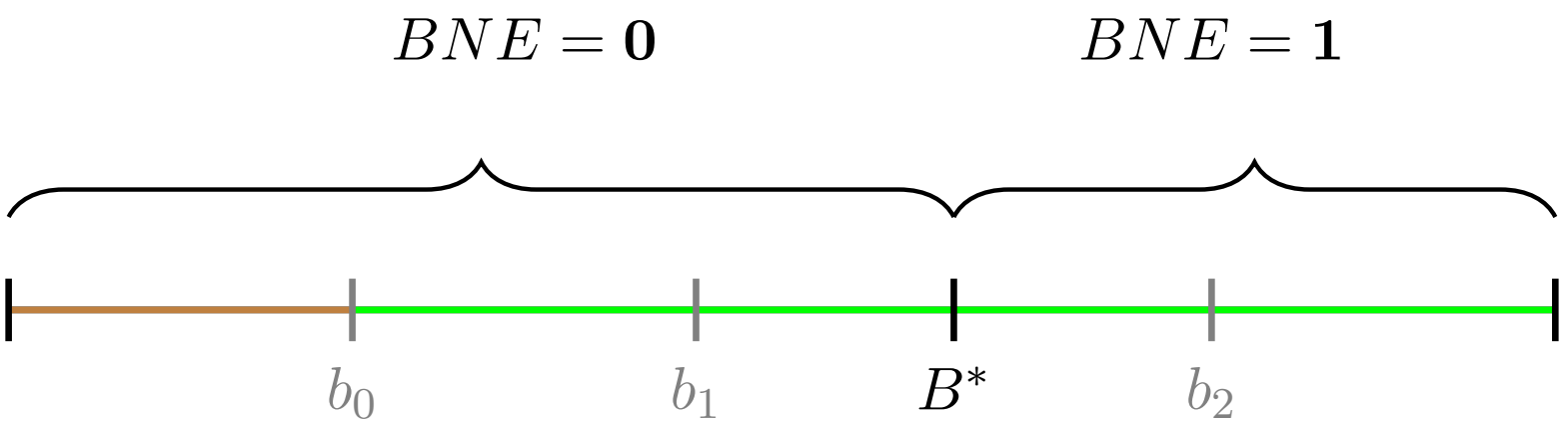
Proposition 1

There is a **unique** *strategy profile p^* that survives IESDS. In p^*, each player i adopts the dirty technology for all signals $b_i^\varepsilon < B^*$ while i adopts the clean technology for all signals $b_i^\varepsilon > B^*$. The point B^* is given by:*

$$B^* = \sum_{n=1}^{N} \frac{c(n)}{N} - d. \tag{1}$$

Follow-up result: p^* is the unique Bayesian Nash equilibrium of the game $\rightarrow$ **equilibrium selection**!

Coordination (Failure)



- Good: type 1 coordination failure (coordinate at all) solved
- Bad: for $b \in (b_1, B^*)$, efficient equilibrium eliminated!

Network Subsidies

Inefficiency and Policy

- Two externalities
- One, the environmental externality, can be solved using standard taxes or subsidies
- The other, the network externality, can too
- However, "smart" **network subsidies** can correct it much more cheaply

Network Subsidies

- Suppose x is played.
- Let the policymaker offer each player i who adopts the clean technology in x the following **network subsidy**:

$$s^*(x) = c(n(x)) - c(N)$$

- Reward for doing good, but what you get depends on others
- $\neq$ Pigouvian subsidy $=$ get the externality your action creates
- Rather: get compensation if others fail to generate an externality on you $\rightarrow$ "protection against defection" $\rightarrow$ clean technology adopted if $b > b_1$
- Hence $b > b_1 \implies x = (1, 1, ..., 1) \implies s^*(x) = c(N) - c(N) = 0$
- Network subsidy $s^*()$ solves the coordination problem at zero cost!

Summary of Results

- Constructive approach toward equilibrium selection in the presence of technological spillovers
  - Efficient outcome not generally selected!
- A network subsidy scheme can solve the **coordination problem** without cost
- Exploits the strategic co-dependence of best-replies
  - Environmental externality = "I improve your environment irrespective of what you're doing" = is independent of others' behavior $\rightarrow$ network subsidy doesn't work
- Coordination problem common in economics: network subsidies contribution to economics more broadly

Thank you!

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