Global Climate Games: How Pricing and a Green Fund Foster Cooperation

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Price Carbon

Kyoto and Copenhagen failed

Design global negotiations to promote cooperation

Roadmap to Global Cooperation

1. **Avoid cap-or-tax fight**
2. **Global Public-Goods Game — uncooperative**
3. **Global Cap-and-Trade Game — uncooperative**
4. **Global Quantity- and Price-Target Games**
   - **Symmetric world — both cooperative**
   - **Asymmetric — price ➔ cooperative**
   - **With poor countries — uncooperative**
5. **With Green-Fund — cooperative and cheap**

Pricing Is Not Taxing

- **International Commitment to a Cap**
  - **Does NOT mean nations must have caps**
- **International Commitment to a Price**
  - **Does NOT mean nations must have carbon taxes**
- **Cap & Trade = Carbon Pricing**
  - **That's why we like it**
  - **There are many ways to make this work**

THE INTERNATIONAL CAP-AND-TRADE GAME

International ≠ National

- National cap-and-trade game works
  - Government → cooperation
  - Price → Efficiency
- International cap-and-trade game
  - Coal-burning countries act like

    Coal-burning power plants without a government

Two International Games

- Public-Goods Game:
  - Each country chooses its abatement, A_j
- Cap-and-trade Game
  - Each country chooses its target, T_j
  - Sells carbon credits for $P \times (A_j - T_j)$
  - P = marginal cost of each country j
- Countries acts in their self interest

The Public Goods Game

- Suppose
  - 4 countries benefit $5/ton
  - 4 countries benefit $20/ton
  - The world benefits $100/ton
- Four set domestic price = $5 and
  four set domestic price = $20
- Optimal price is $100
- Some abatement, but much too little

Payoff = Net-Benefit

$$\mathbf{NB_j = b_j\, A - c_j\, A_j^2 + P\,(A_j - T_j)}$$

- Climate benefit = $b_j \times$ (Total abatement)
- Abatement cost = $c_j \times$ (country abatement)^2
  - Marginal cost = $2\, A_j = P$
- Carbon Trade Revenue = $P \times (A_j - T_j)$
  - Only under cap-and-trade

Cap & Trade Can Beat Public Goods

Game #1	Public Goods		Cap and Trade		
Country	A_j	P	T_j	A_j	P*
1	0.5	$1	0.38	0.75	$1.5
2	0.5	$2	0.75	0.38	$1.5
Total	1.0		1.13	1.13	

- Country 1: $b_j = 1$, $c_j = 1$
- Country 2: $b_j = 2$, $c_j = 2$

Or Not

Game #2	Public Goods		Cap and Trade		
Country	A_j	P	T_j	A_j	P*
1	0.17	$1	– 0.08	0.25	$1.5
2	1.00	$2	1.08	0.75	$1.5
Total	1.17		1.00	1.00	

- Country 1: $b_j = 1$, $c_j = 3$
- Country 2: $b_j = 2$, $c_j = 1$
- Negative Target → Cap > BAU emissions

How to Cheat

- In Cap-Trade Game #1
  - Country 1 has public good price = $1.00
  - But, the global P* = $1.50
- So Country 1 would like to abate less, but still sell as many carbon credits, so
  - Subsidize carbon ➔ ΔA_j less abatement
  - Increase T_j by ΔA_j
- Country 2 will do the same in reverse

Cap and Trade with Price Cheating

Game #3	Public Goods		Cap and Trade w/ Cheating			
Country	A_j	P	T_j	s_j	A_j	P*
1	0.5	$1	0.33	0.67	0.5	$1.67
2	0.5	$2	0.67	–0.33	0.5	$1.67
Total	1.0		1.00		1.0	

- Country 1: $b_j = 1$, $c_j = 1$
- Country 2: $b_j = 2$, $c_j = 2$
- NB_1: 0.75 → 1.03 NB_2: 1.50 → 1.22
- The "nice" country loses

Cap and Trade Conclusions

- **National carbon prices & subsidies**

  must be monitored to prevent cheating under cap and trade, just as under any carbon pricing scheme

With linear climate benefits:

- **P* = (1/N) (optimal price),** N = # of countries
- Just as bad with diminishing benefits

THE GLOBAL QUANTITY-TARGET, AND PRICE-TARGET GAMES

Global-Target Games

- N identical countries in the world
- The **quantity**-target game
  - Each country names a target Q^T_j
  - Q^T = maximum (weakest) Q^T_j
  - National caps = Q^T / N
- The **price**-target game
  - Each country names a target P^T_j
  - P^T = minimum (weakest) P^T_j
  - National carbon prices = P^T
  - Currency = Global index of major currencies (USD, euro, …)

Identical Countries ➔ Identical Games

- Every P^T matches some Q^T that would cause global price P^T
- Vote for P^T or its matching Q^T
- The same holds in each identical country

Optimal Cooperation

- If you vote for a high P and win,

  then you will cause all countries to set a high price, and all their high prices benefit you
- That's N-times better than with public goods
- So you set an N-times higher price, and that's optimal
- So voting for Q also works optimally

Trouble in Paradise

- Country 1: Temperate w/ renewable resources
- Country 2: Hot with only coal
- The Q-target game gives the same P, so the same abatement happens either way
- But with a Q-target,
  - Country 2 must pay country 1 a lot of money (to buy carbon credits = fancy paper)
- Country 2 (rightly) won't play this game

Price Is Better

- With a price target, the same abatements happen, but no country pays any other
- Price determines roughly how much “effort” you put into abatement
- Quantity determines who’s good and who’s guilty; the bad guys pay; no one likes to be told they’re bad, and especially if they must pay

Pricing Needs Help

- Poor countries
  - Have a lower cost/ton of abatement

    ➔ a greater social cost of abatement
  - Have a higher discount rate

    ➔ less benefit from future climate
- Poor countries will vote for a low global P^T
- And the lowest price wins

LINK THE GREEN FUND TO PRICE

Keep the Green Fund Simple

- Green Fund Payment Received =

  $G \cdot \Delta E_j \cdot P^T$

- ΔE_j = (World emission) – (Country emission)

  on a per-capita basis.

- G = the strength of the Green Fund

Green-Fund Game Payoff Function:

$$\mathbf{NB_j = b_j A - c_j A_j^2 + G \cdot \Delta E_j \cdot P^T}$$

Green-Fund Game

- Example Game with Three Countries
  - "U.S." = High, "China" = Average, "India" = Low emissions / capita
  - So China neither pays nor is paid Green Funds
  - India wants a low global price
  - As with other games,

    Self interest and no cheating

Green-Fund Game Rules

1. China picks G
2. Then, all three vote for P^T
3. All get the Net-Benefit payoff

Strategy

- China will raise India's vote for P^T by picking G>0, but not too high because the U.S. would vote for a lower P^T than India

Without the Green Fund

Country	pop	*e*	Voted P	*P**	A_j %
	billions	ton/cap.	$/ton	$/ton	%
U.S.	0.3	18	$31	$10	6.7%
China	1.2	5	$31	$10	6.7%
India	1.0	1.1	$10	$10	9.1%

The Green-Fund Game

Country	pop	e	Voted P	A_j %	A_j Cost	G. F. Benefit
	billions	ton/cap.	$/ton	%	¢/capita/day	
U.S.	0.3	18	$26	18%	11.5¢	–4¢
China	1.2	5	$31	18%	3.2¢	0.0¢
India	1.0	1.1	$26	24%	1.0¢	1.2¢
World	2.5	5	$26	18%	3.3¢	0.0¢

- Poorest countries gain even ignoring climate benefits!

The Green-Fund Game vs. Cap and Trade

Game	Global price, P	P as a % optimal	A as a % optimal
Green-Fund Game	**$26.40**	**93%**	**93%**
Global Cap and Trade	**$9.51**	**33%**	**33%**
Optimal Outcome	**$28.52**		

- Cap-and-trade has individual caps, no Green Fund, and same physical world

Green-Fund Game Mechanisms

- The Green-Fund is also **a climate incentive**
  - Reduce your E/capita and pay less / get more
  - This works equally on every country
- Green Pay reduced as you miss the P target
  - **Incentive** for payees; **Assurance** for payers
- Let near-average E/capita country vote for G
  - Then pick the **median vote for G**
- Trading **carbon-revenue credits** could make compliance more agreeable

Conclusion

- Ignore numerology — 80% by 2050
- A cap is no stronger unless it's price is higher
- Assigning caps = assigning blame
- Equal pricing = equal effort
- Green Fund is a huge incentive, but for what?
  - must be linked to performance
  - not to Green projects = bait for corruption
- Design for cooperation to get strong policies

Price Carbon