Environmental Economics for Environmental Sciences (ENR-21306)

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International Environmental Problems I (Perman et al. 9.1)

Last week

- C&T game summary...
  - C&T should lead to >= profits vs Cap only
  - May make more if endowment > requirements (e.g., “Russians”)
  - Lumpy supply and demand, TCs and information costs are facts
  - Carbon taxes are MUCH faster to use!
- Interesting discussion of green jobs, etc.

Incomplete information, risk and uncertainty

- We rarely know everything, even about ourselves
- **Risk** about future actions of others or outcomes may be known with a probability, e.g., heads on 100 flips
- **Uncertainty** can refer to "known unknowns" or "unknown unknowns." These cannot be managed and may not even be subject to planning

Imperfect information problems

- Pollution impacts: local risk; global uncertainty
- Environmental values and MACs: asymmetric information on values can be reconciled in markets (controversial), but not regulations (normal)
- Pollution targets
  - Benefits subject to risk and uncertainty
  - Costs subject to asymmetric information
  - Expected values (risk) of benefits can be very wrong, and costs may be higher if cost model is wrong
- "Precautionary Principle" says must prove no harm, which is not falsifiable. PP, therefore, may imply Q=0

Choosing an instrument

- Quantity (permits) and price controls (taxes) are the same with perfect information, but we don't have that!
- Both can/will go wrong with imperfect information, but the calculation of the variation in their impacts is academic (we do not know real D&S curves)
- Discuss winners and losers in H/W

Instruments as implemented...

- The choice of pollution-reduction instrument will reflect the balance of power among taxpayers, polluters, suppliers (of technology and fuels), customers, and so on.
- It's rare to see instruments chosen for economic efficiency or social equity. They are more often chosen to suit special interests (money and power)
- That said, try for flexibility, humble beginnings, and short term bribes to get things going

Summary to date

- MBIs (emissions tax, abatement subsidy or C&T):
  - usually cost-effective
  - provide incentives to develop clean technologies
  - should be chosen according to TCs and information
  - may not be as good as CAC
  - there are ALWAYS problems with information, asymmetries, burden-sharing and lobbying
  - wrong instrument or parameters leads to harm, sometimes in excess of benefits

International environmental problems (IEPs)

- IEPs are from transboundary pollution
  - One country's emissions affect other countries
  - Strategic interaction of decisions affecting emissions
- Examples: climate change, ozone depletion, acid rain, biodiversity loss (transboundary + global commons), and infectious diseases
- No international organization can enforce an outcome
- We can use game theory to understand problem and think about solutions

Game theory

- Analysis of potential for cooperation among countries
- **Game theory** is used to analyze choices where the outcome of a decision by one player depends on the decisions of the other players, and where decisions of others are not known in advance
  - **Players**: people/countries in a strategic relationship
  - **Strategies**: possible decisions taken by each player
  - **Pay-offs**: earnings/costs for a certain strategy

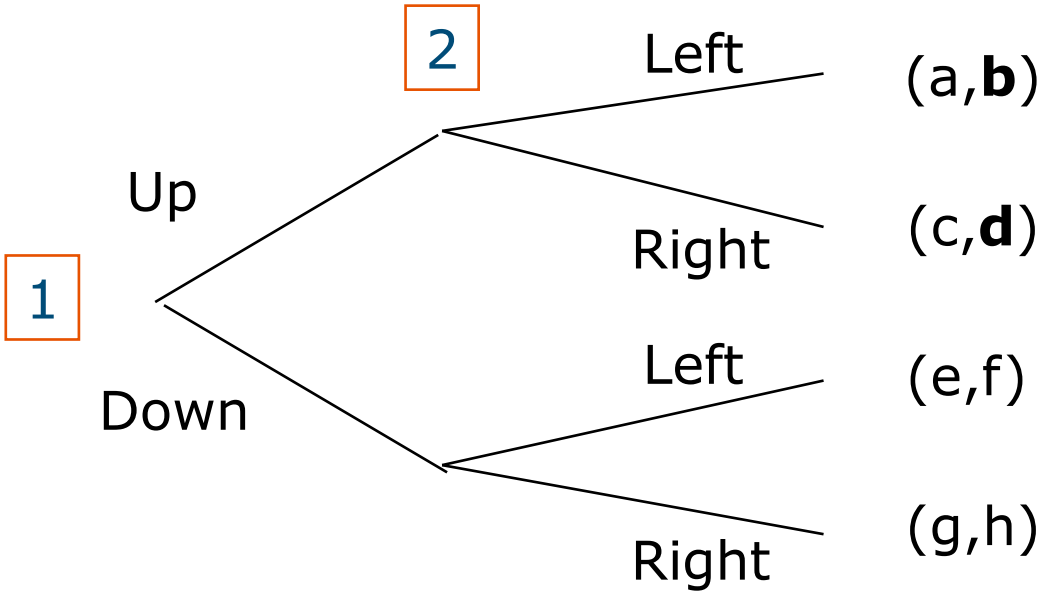
Two-player simultaneous game

- Pay-off matrix shows payoffs to (player 1, player 2)

		Player 2	
		Left	Right
Player 1	Up	(a,b)	(c,d)
	Down	(e,f)	(g,h)

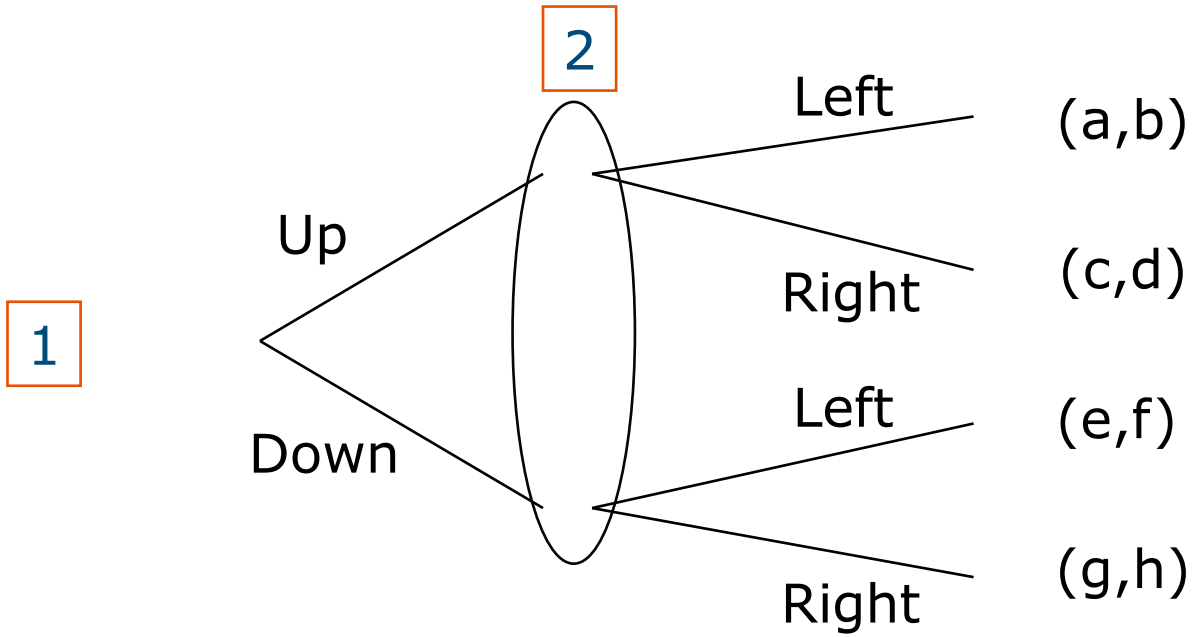
Two-player sequential game

- This is called the "extensive form"
- "Backwards induction:" Assume profit maximization, and look at payoffs from end to start, e.g., b vs d to 2 leads to a or c to 1, who also compares e & g.



Two-player simultaneous game

- Players 1 and 2 do not know each other's actions, i.e., same as simultaneous box.



Terminology

- Dominant strategy
  - A player has a **dominant strategy** when one strategy offers a higher pay-off *no matter* the choice of the other player
- Nash Equilibrium
  - A set of player choices is a **Nash equilibrium** if each player receives the best possible outcome, **given the other players' choices**, i.e., neither player would benefit from changing his action.

Applying game theory to CC

- Maximize **own benefits** in a **non-cooperative** game
  - Two countries, X and Y
  - Abatement costs 7 to one but creates benefits of 5 for **both**
  - If both abate at a cost of 7 to each, then both get a benefit of 10, or 10-7=3, net
  - Payoff for non-abatement (status quo) is 0
- Let's see what this looks like...

CC PD in simultaneous form

- Solve: What should 1 do if 2 chooses 'Pollute' etc.

		Country 2	
		Pollute	Abate
Country 1	P	(0,0)	(5-0,5-7) = (5,-2)
	A	(5-7,5-0) = (-2,5)	(10-7, 10-7) = (3,3)

PD applied to CC

- A Prisoner's Dilemma...
  - has is a single Nash-equilibrium ('Pollute', 'Pollute')
  - in which both players would be better off with Abate
  - but ('Abate', 'Abate') is not an equilibrium, because it's better to choose when other chooses Abate
- Underlying problem (Tragedy of the Commons)
  - Pollution abatement has public good characteristics (nonrival; nonexcludable)
  - Nonexcludability induces free rider behaviour
- Bad (good?) news: This explanation is wrong
- Why listen to Harding when Ostrom was right? There are MANY examples of common pool dilemmas that do NOT result in a tragedy of the commons!

Game theory, PD and IEPs

- Can game theory explain IEPs?
  - Yes, interdependent payoffs means interdependent moves
  - Yes, some decisions are simultaneous, but most are sequential
  - No, rules are endogenous (i.e., conflict theory)
- Can PD explain IEPs?
  - No, IEPs are resolved over time (sequential), so PD does not apply
  - No, sequential games with endogenous rules allow for adjustment, **tit for tat** confidence building and verification
  - Yes, a Core can deliver results but everyone wants others to join the core while they freeride
  - Most people are reciprocators (fair is fair), who wait for "leaders" to move first. Are those leaders cooperators or free riders?

Why are there too many free riders?

- It's possible to address CC with a Core, *but*
  - A move that benefits a nation may not benefit interest groups that will block the move (lobbying, FUD), e.g., NL g/w tax
  - China and Australia prefer cheap energy and growth; US believes in God; Canada may benefit from "warmth", etc.
  - Special interest politics, in other words, makes it easier for the losers to block change that will benefit the winners
- Cannot even assemble a Core ☹
- The move from mitigation to adaptation changes the "good" from common pool (atmospheric pollution) to private, i.e., NL has dikes but Bangladesh does not
- Dutch will pay more, but costs and benefits aligned