Experimental Economics, Environment and Energy '24

Lecture 3, part 1: Commons and public goods: tragedies and solutions

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Social dilemmas

A *social dilemma* happens when the **private** and **common** good clash

- Pollution
- Traffic jams
- Public (i.e. *non excludable*) goods
- Green vs Brown energy sources
- Climate change

A simple example

Should we invest to avoid climate change?

- Imagine there are (just) two countries, France and the USA.
- they can choose to (costly) **invest** in mitigation policies, or **not**
- if they both invest, CO_2 levels are such that there is no climate change
- If just one country invests, it bears the cost & there is mild climate change
- If no-one invests, then no cost but there is dramatic climate change

Let us formalize the game

A climate-change Prisoner Dilemma

One possible formalization

- Cost of investment: 3
- Damage if no/moderate/catastrophic climate change: 0, 2, 4

		USA			
		I		NI	
FR	I	-3	-3	-5	-2
	NI	-2	-5	-4	-4

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A climate-change prisoner dilemma: theory

Definition

Dominant Strategy: an action that gives best payoffs no matter what the other does

Definition

Best reply: a set of actions that give best payoffs to a subject, conditional on the action fo the opponent

Definition

Nash Equilibrium: an action profile (an action for each player) that is a best reply for all players

- It is a **dominant strategy** not to invest
- That is: not to invest is the best reply to each action of the opponent
- (NI; NI) is the only Nash Equilibrium of the game
- (even if it can be noted that it would be better for players to be in the situation (I;I))

The problem of collective action

Individual and collective good might not coincide

- There might exist private gains $\neq$ public gains
- Everyone would be better off if all *cooperate*
- But individually, each person has an incentive to *defect*
- knowing this, no-one will cooperate and everyone will be worse off.
- in our words:
  - *defect* is a dominant strategy...
  - ...so the worse possible outcome is the only equilibrium.
- examples abound.

The public good game

Let us generalize this to N players: public good game

Rules of the game

- Each of you has a (fictitious) endowment of 20 euro
- You play in groups of **4** players (fixed matching)
- each of you has two accounts
  1. a **private** account, that returns 1 euro for each euro invested by you
  2. a **public** acccount, whereby each euro invested there is multiplied by 1.6 and then shared equally with all other players
- The payoff in each period is the sum of the earnings from the two accounts
- your decision is **how much to contribute to the public account**.

play now https://classex.uni-passau.de/ INRAE/M2EEDD pwd: M2EEDD

The public good game

Public Good Game: mechanism

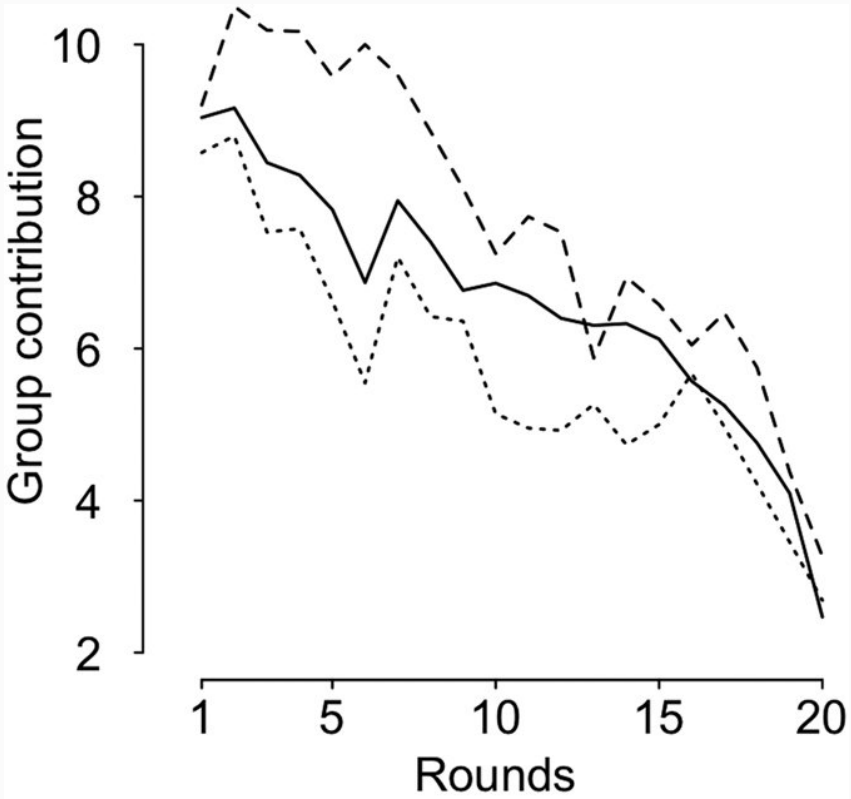
- Mechanism is exactly the same as in Prisoner Dilemma
- There is an action that generates public benefits...
- ...but at a private cost!
- the *social optimum* is given by everyone contributing everything
- yet, *individually* it is a dominant strategy to contribute *less* than the others, for any level of the other players' contribution

The only Nash is for everyone to contribute zero

The public good game

Public Good Game: results

- contributions usually start off quite substantially above 0
- but then decay with repetitions, usually ending at around 0



[Tognetti et al: http://www.nature.com/articles/srep29819]

The decay in contributions

Why this decay in contributions?

- some people are free riders, some cooperators
- but most people are *conditional* cooperators
- happy to contribute, but they do not like being cheated by the others
- if others lower their contributions, they do too
- leading to cascades of negative reinforcement
- and finally to very low contributions

This is the main reason why voluntaristic endeavours are often unstable and short-lived

A common renewable resource

Let us play an extraction game on a renewable resource

Rules of the game

- We all fish in the same pond. You can choose to catch
  1. 1, 2, 3 or 4 fish.
  2. the winner is the person catching more fish.
  3. There are 5*N (N = number of players) in the pond.
- at the end of each period, for each fish left another will be added: the number of fish in the pond will double.
- we play at most six periods
- if the pond is out of tokens, the game ends.

Head to the google form https://forms.gle/ESsLNNGXZePrGBir8

The tragedy of the commons

Picture a pasture open to all. [...] As a rational being, each herdsman seeks to maximize his gain. [...] he asks: "What is the utility to me of adding one more animal to the herd?". This utility has one negative and one positive component. [...] Since the herdsman receives all the proceeds from the sale of the additional animal, the positive utility is nearly +1. The negative component is a function of the additional overgrazing created by one more animal. Since, however, the effects of overgrazing are shared by all the herdsmen, the negative utility for any particular [...] herdsman is only a fraction of -1. [...] the rational herdsman concludes that the only sensible course [...] is to add another animal. And another, and another... But this is the conclusion reached by each and every rational herdsman sharing a commons. Therein is the tragedy.

Garret Hardin, Science, 1968

Shared use rights

The tragedy stems from badly allocated property rights

- A property right is a right of use of a a resource/object
- *plus* a right to exclude others from it.
- owning means use + exclusive use
- in private goods, all is fine (my PC, your mobile phone, his apartment, her purse)
- But public goods are 'publicly' owned: each memebr of the group has the right to use but *not* the right to exclude others.
- in these conditions, resources will be overused

Negative externalities

The tragedy is the result of (not-managed) negative externalities

- An externality is the (economic) effect an economic action has on persons other than the agent
  1. smoking increases utility for the smoker but reduces utility for the passive smokers around him
  2. polluting increases utility for the producer (more production = more pollution, but also not investing in pollution reduction is a source of profits) but decreases utility for the people exposed to the pollution
  3. using a private car occupies public space and public road and produces pollution for the private benefit of the driver and against the interest of the pedestrians
- adding one more cow has a (small) negative externality on the amount of present (and future) grass available
- this cost is imposed on others and not taken into account by the herdsman
- so there will be overgrazing (overfishing, overcollecting token...)

Commons: examples

Note that this is the very same mechanism of PD and PGG

- fishing
- electricity blackouts in California
- water supplies in Sicily
- bank runs
- (...nearly every environmental problem)
- (...nearly every limited resources problem)

Suggested reading: Noussair et al AER 2015

Collecitve action: possible solutions to the tragedy

- Repeated interactions
- (costly) Punishment
- (for the commons case) privatization
- (Elinor Ostrom): culture, norms and institutions

Repeated interactions

In repeated games cooperation can be sustained

- because future non-cooperation is a possible punishment
- (if I'll leave the city tomorrow, I can be anti-social; if I stay forever, I have interests in behaving)
- in real life, most interactions are repeated (good news)
- but they are also anonymous (bad news)

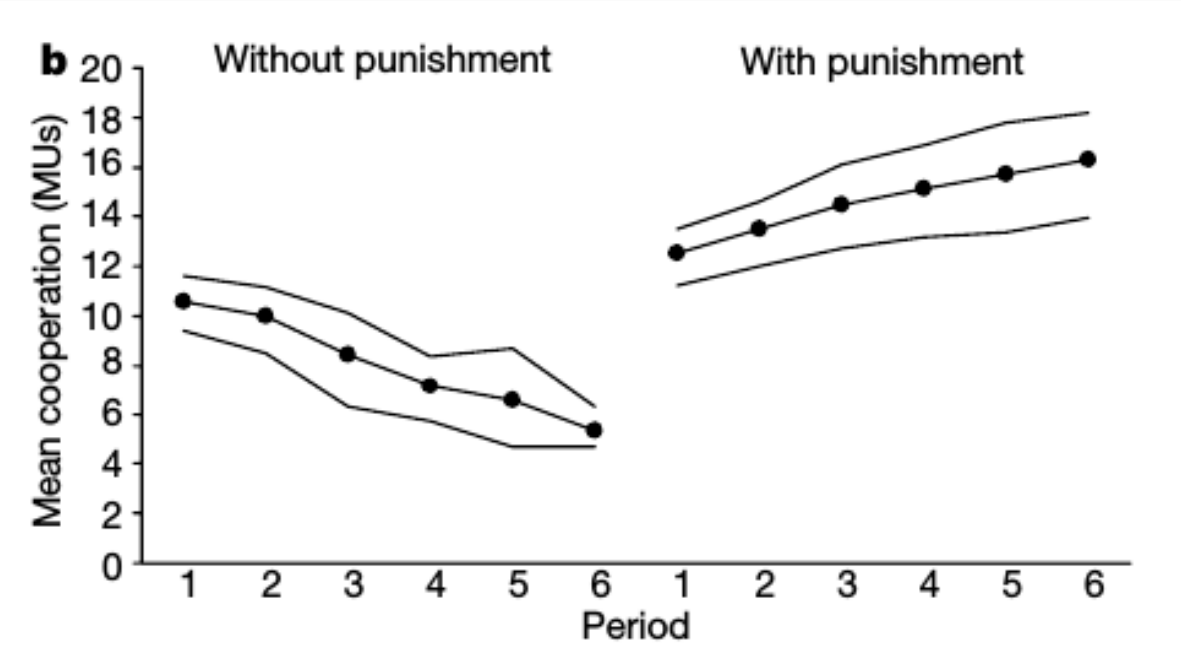
Repeated interactions and dynamic strategies

Small interactive video/game at https://ncase.me/trust/

Punishment

- In society, police exists to enforce rules
- it is costly: we have to pay for it
- would it be possible ot have endogenous punishment – i.e., to have no police but to rely on peers to sanction each other?
- Altruistic punishment: each subject has a right to sanction others
- but this is costly: subjects *pay a fee* to sanction others – i.e. reduce their payoff
- for instance, you can burn another player's money at a cost of 1/3 of euro per each euro burned
- it is *irrational* to do so – it costs you money!

Punishment: results



[Fehr and Gächter, Nature 2002]

Is punishment effective?

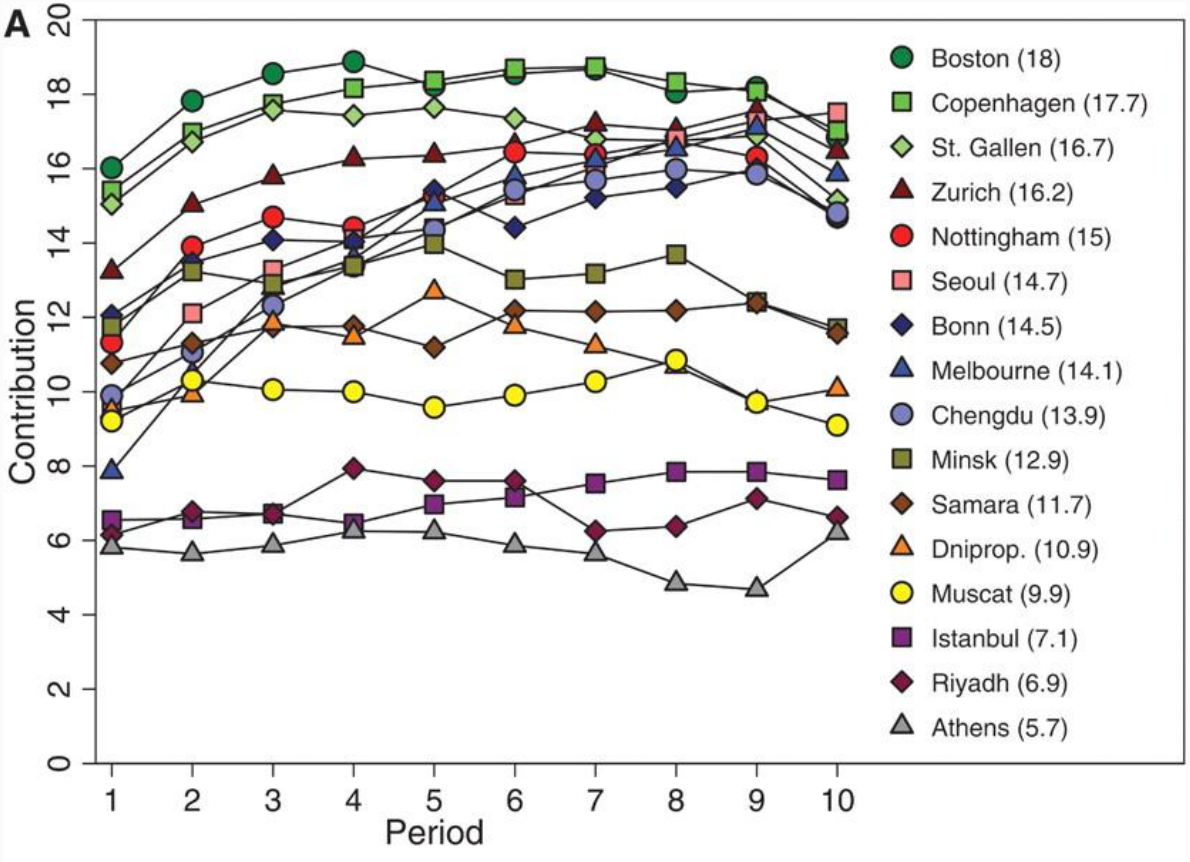
Yes:

- rule self-enforcement works very well
- sometimes without the need of actual enforcement: the threat suffices
- thus only mildly affecting welfare

But:

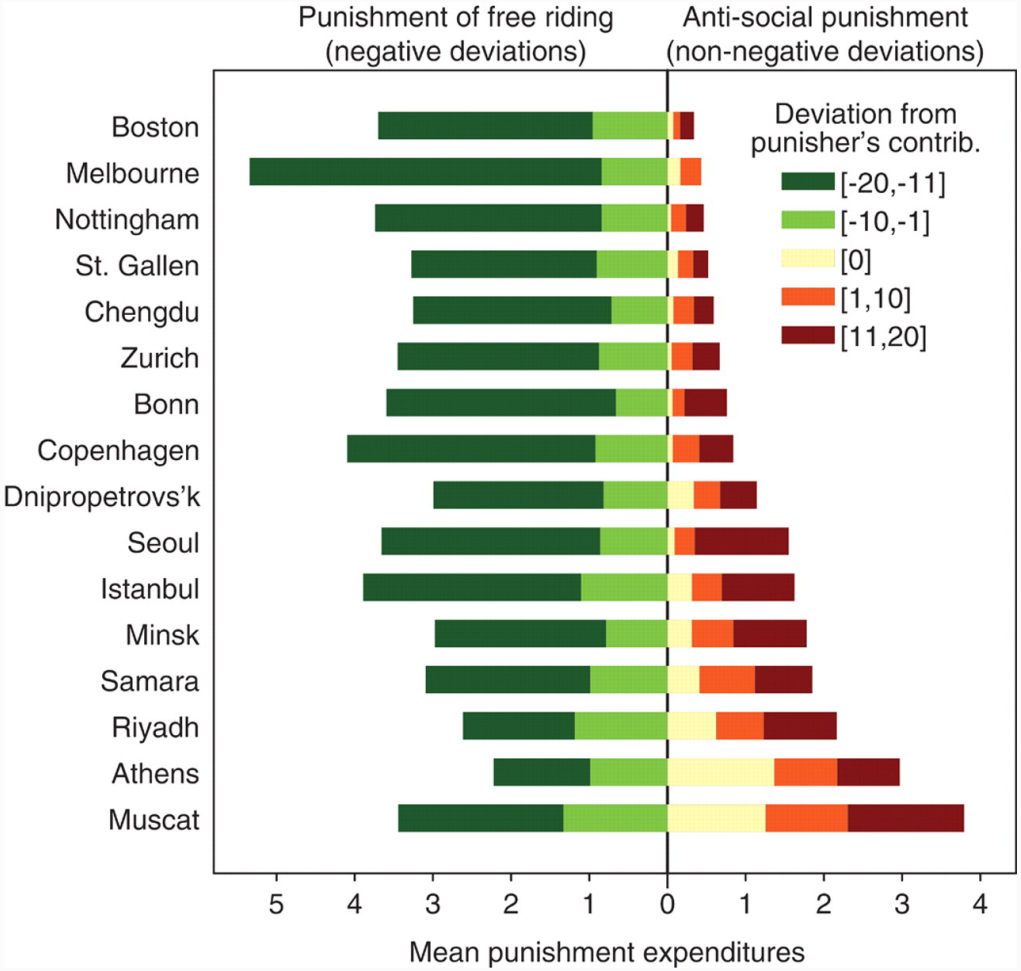
- it depends on *willingness to enforce* on the part of subjects
- ...and it depends on *which rule* subjects want to enforce
- if the rule is anti-social in itself, *that* will be enforced

Punishment not working



Antisocial punishment

What if subjects punish the *good guys*?



Privatization + markets

Privatizing the resource usually solves the problem (duh!)

- if you align the use and exclusion rights, problem solved!
- not all can be privatized though
- sometimes it is not the preferred option


KEEP
CALM
it's
QUESTION
TIME