Institutions, Trade & Economic Growth

Days 2-3: Coordination problems and institutions

Summer 2025

King's College London

Summer School

Instructor: Daniele Girardi

Coordination Problems & Institutions

Coordination problems:

- When do economic interactions produce desirable aggregate outcomes? (eg, inclusive economic growth, technological progress, …)
- And when do they lead to societal outcomes that no one would have desired? (eg, underdevelopment, excessive pollution, …)

How can we represent economic interactions in a stylized way and predict their outcomes?

What are institutions and how can they solve (or worsen) coordination problems?

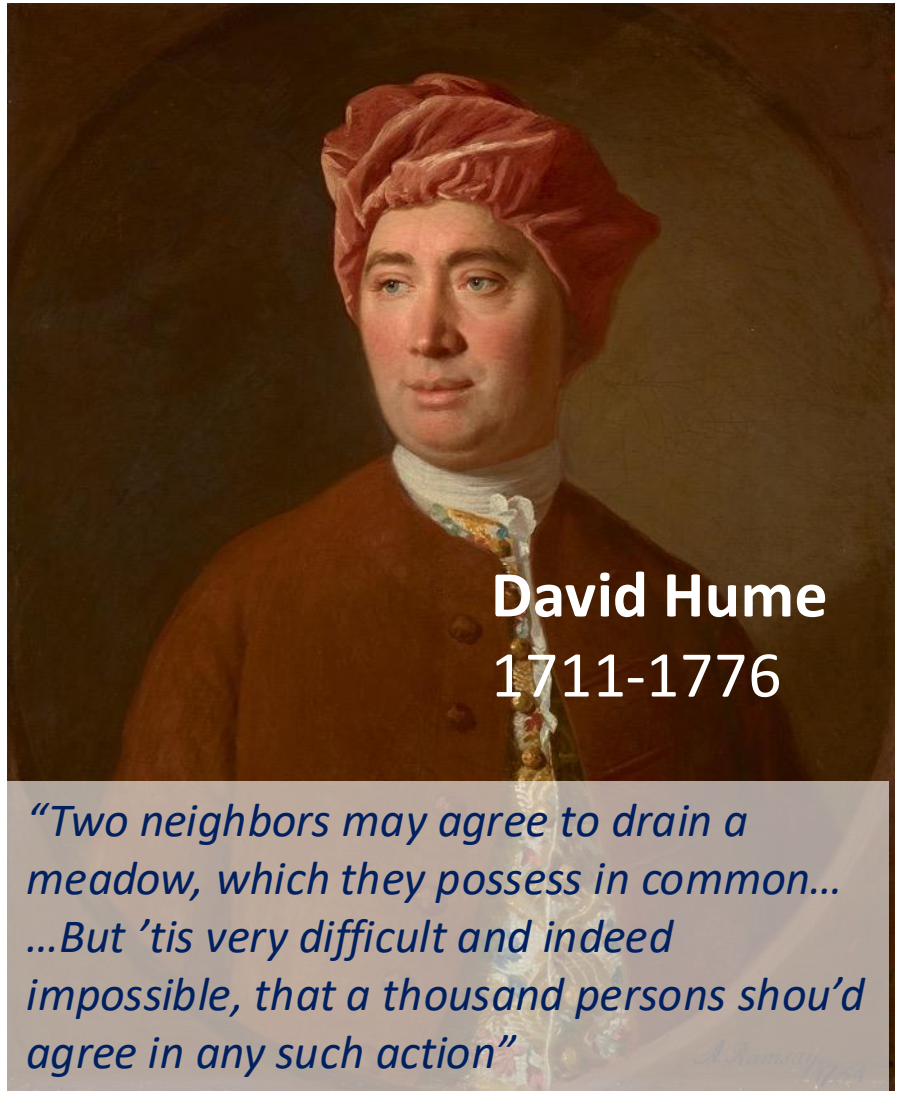
The plan for days 2-3

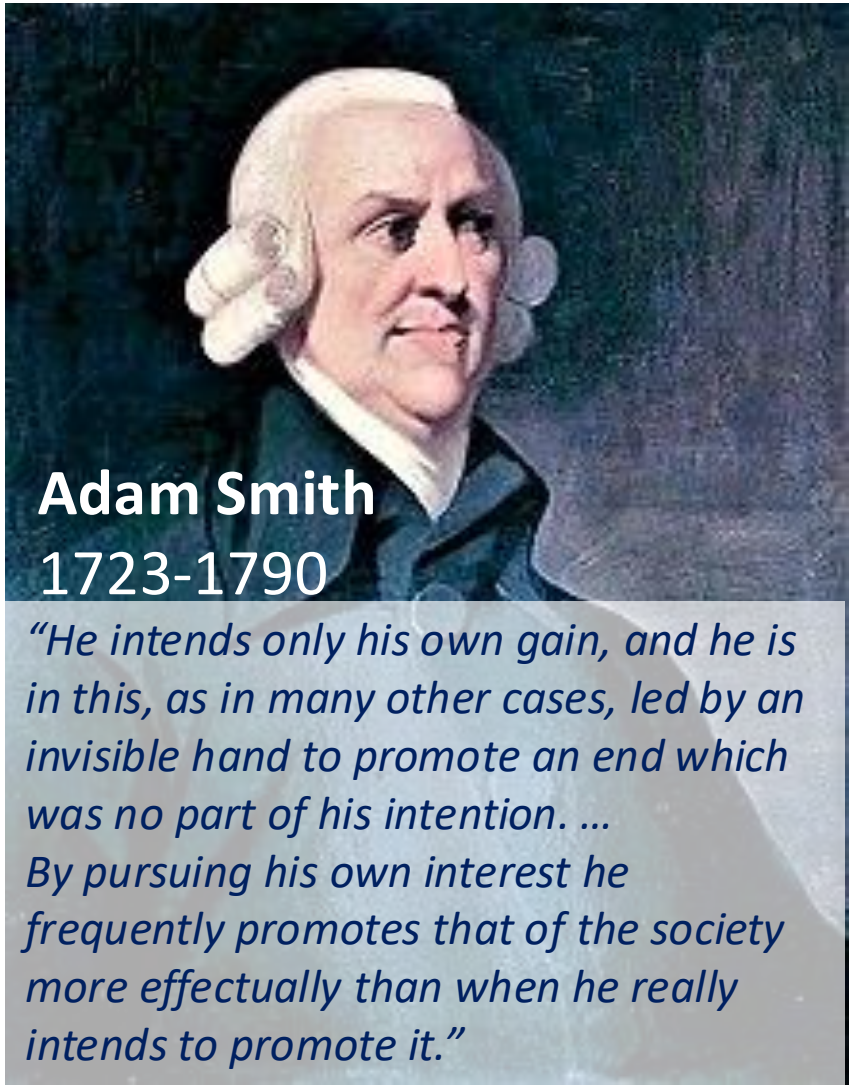
1. Coordination Problems
2. Games
3. Pareto efficiency
4. Types of Games
5. Institutions and Coordination Problems

The main ideas we will explore

- **Coordination problems**: decentralised action can produce outcomes that are bad for society
  - inefficient production, underdevelopment, excessive environmental damage, …
- **"Classical institutional challenge"**: setting rules of the game that leave individuals free to choose their own actions but deliver outcomes that are good for society.
- The 'rules of the game' are also called **institutions**:
  - *The laws, informal rules, and mutual expectations which regulate social interactions among people and between people and the biosphere.*
- Institutions determine which actions are available to economic agents, and the incentives they face.
- Institutions determine whether coordination problems are solved.

Our intellectual guides





Palanpur farmers

They sow their crops several weeks after the date at which they would maximize crop yields.

Why?

"…Palanpur farmers sow their winter crops several weeks after the date at which they could maximize crop yields.

The farmers do not doubt that earlier planting would give them larger harvests, but no one is willing to be the first to plant their seeds, as the seeds on any lone plot would be quickly eaten by birds.

I asked if a large group of farmers, perhaps relatives, had ever agreed to sow their seeds earlier, all planting their seeds on the same day to minimize the losses. "If we knew how to do that, [the farmer] said, we would not be poor".

(from Bowles & Halliday, 2022)

Russeau's stag hunt

- *The stag hunt will succeed only if everyone stays at their place.*
- *But if a participant sees a hare, she will leave her place to catch it, making the stag hunt fail.*

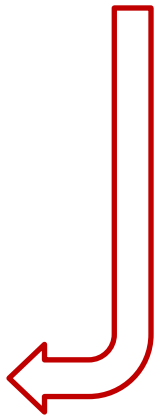
Russeau's stag hunt

"Were it a matter of catching a deer, everyone was quite aware that he must faithfully keep to his post in order to achieve this purpose; but if a hare happened to pass within reach of one of them, no doubt he would have pursued it without giving it a second thought, and that, having obtained his prey he cared very little about causing his companions to miss theirs."

Jean-Jacques Russeau (1755)

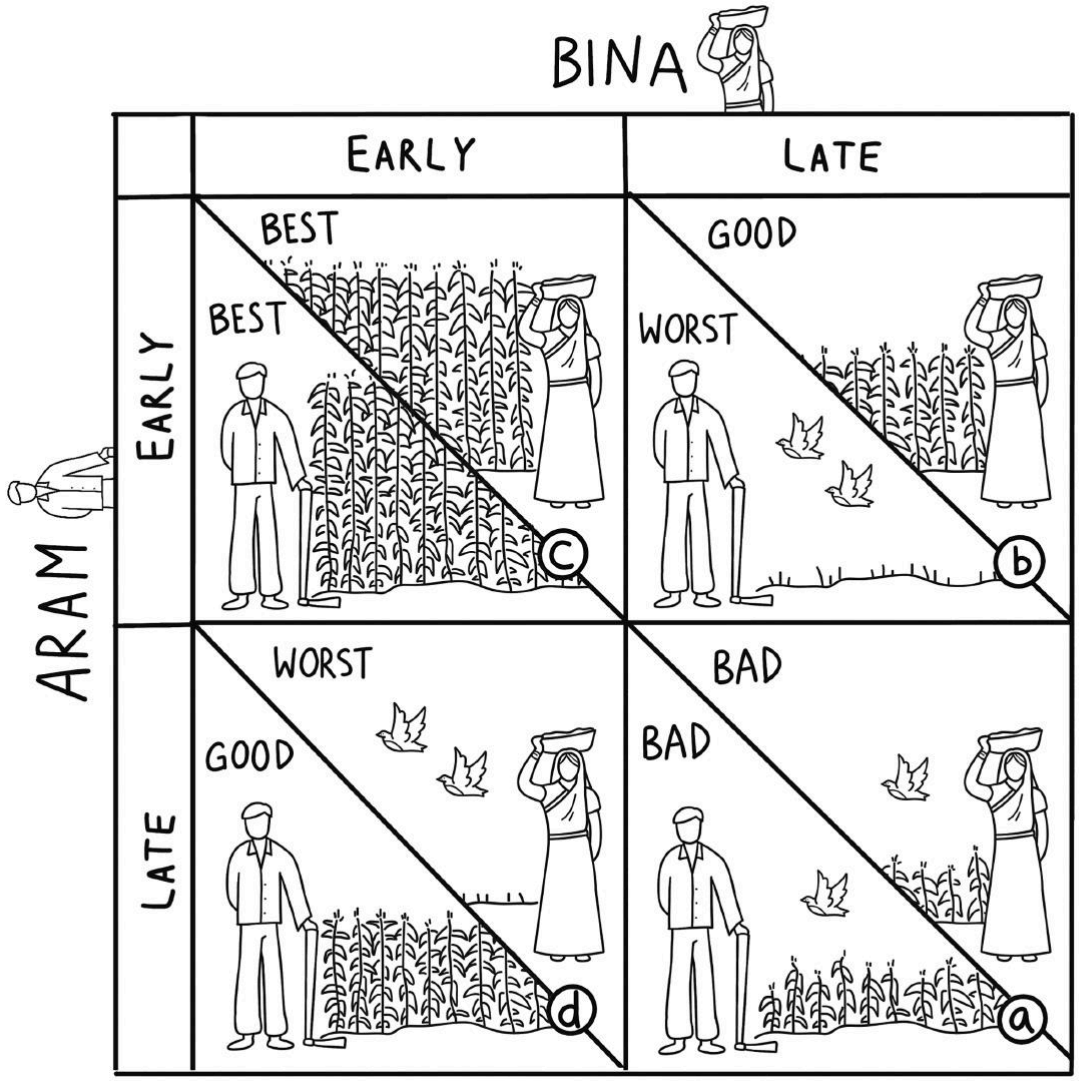
COORDINATION FAILURES: people trying to do their best individually can collectively produce inefficient, undesirable outcomes, because they don't coordinate their actions.

Can you think of a coordination problems (big or small)?

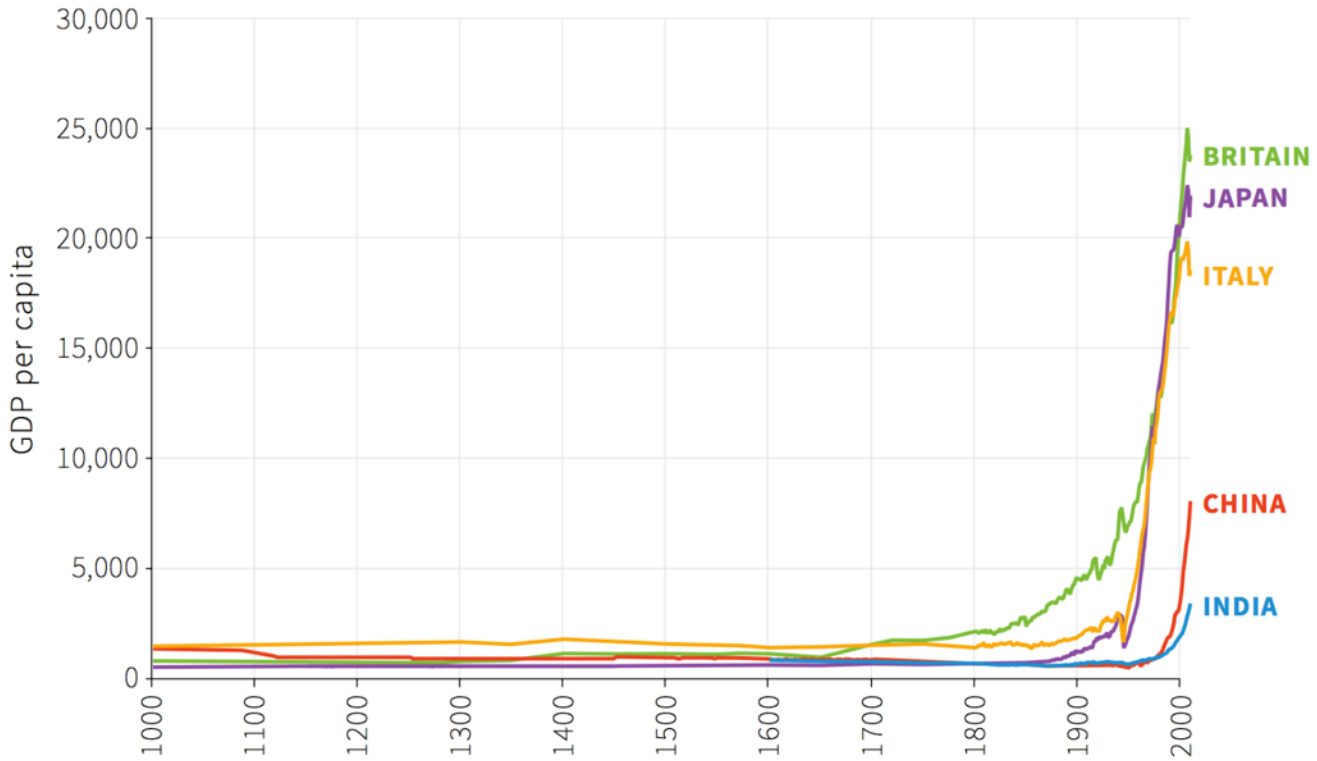


CLASSICAL INSTITUTIONAL CHALLENGE:

- How to get the "rules of the game" right.
- How to design *institutions* such that people can be left on their own devices, independent and free, but at the same time avoid inefficient outcomes. (*David Hume, Jean Jacques Rousseau*)
- How can social interactions be structured so that people are free to choose their own actions while at the same time avoiding outcomes that none would have chosen?


BINA
EARLY
LATE
ARAM
EARLY
LATE
BEST
BEST
c
GOOD
WORST
b
WORST
GOOD
d
BAD
BAD
a

Are coordination failures important in our society?



Are coordination failures important in our society?

- On the one hand, under capitalism, individuals acting mostly independently, seeking their personal objectives, have produced an unprecedented long-term increase in average living standards (the *invisible hand*).
- On the other hand, uncoordinated activities are also producing outcomes that are bad for everyone (*coordination problems*):
  - Overuse of natural resources;
  - Underdevelopment in many countries.
  - Excessive pollution, climate change;
  - Unemployment (underuse of human resources);
  - Financial Crises;
  - Underuse of vaccines - overuse of antibiotics;
  - Teamwork that fail because everyone tries to just rely on the effort of others.

What causes social coordination problems?

externalities → coordination problems

internalize externalities → solution

- *Externalities* (or external effects) are the reason for coordination failures.
- *Each individual* with her actions affects the well-being of others, but does not take that into account when making decisions.
- *Internalizing externalities* = taking adequate account of the effect of our actions on others
- *Internalizing externalities* would solve coordination failures, and fix the classical institutional challenge (easier said than done!)

Coordination Failures

- **Overuse** of certain resources
  → carbon emissions
  → climate change.
- Overuse is a coordination failure due to **negative external effects.**
- People don’t pay for the **cost** of their own actions on others.

Institutions & Coordination Failures

- Institutions determine our ability to solve coordination problems.
- Institutions: the laws, informal rules, and mutual expectations which regulate social interactions among people and between people and the biosphere.
- Institutions are the *rules of the game*:
  - They determine which actions are available to economic agents, and the incentives they face.
- Game theory can be used to understand how the rules of the game (ie, institutions) affect the outcome of strategic interactions.

Games

Game Theory models social interactions as strategic games, to help understand coordination failures more deeply.

In a game:

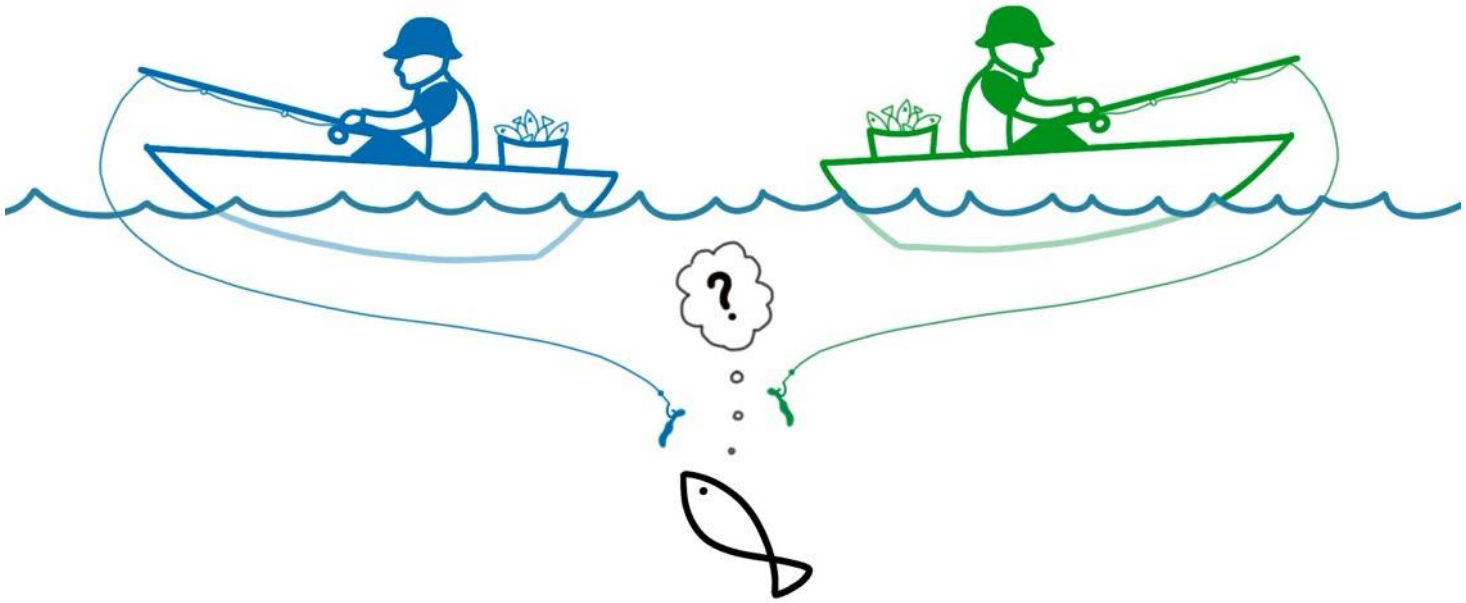
- each player has alternative actions available.
- each player's payoff depends on both her own actions and other players' actions.
- *Interdependence*: what you get depends not only on what *you* do, but also on what *others* do [*social* interaction].
- *Institutions* ("the rules of the game") are the underlying norms that determine which actions are available to whom, and who gets what in each possible outcome.

Games

The basic ingredients of a **game**:

- Players
- Strategy Set (the actions available to players)
- Payoffs (what players get in each possible combination of actions, or *strategy profile*)
- Order of play (simultaneous or sequential)
- Information structure (what do players know)

The Fishermen’s Dilemma



The fishermen’s dilemma

Alfredo & **B**ob share a lake for fishing.

As one catches more fish, the other catches fewer (an externality!)

Each must decide how long to fish for: **10** or **12** hours

Fishing longer costs time & effort, but yields more fish.

If both fish 12 hours, they each catch fewer fishes per hour, while spending a lot of time and effort → Each gets a payoff of 2

If they both fish 10 hours, they spend less hours but catch more fishes per hour → Each gets a payoff of 3

If Alfredo fishes 10 hours and Bob 12 hours, A gets few fishes while B gets a lot → Alfredo gets 1, Bob gets 4.

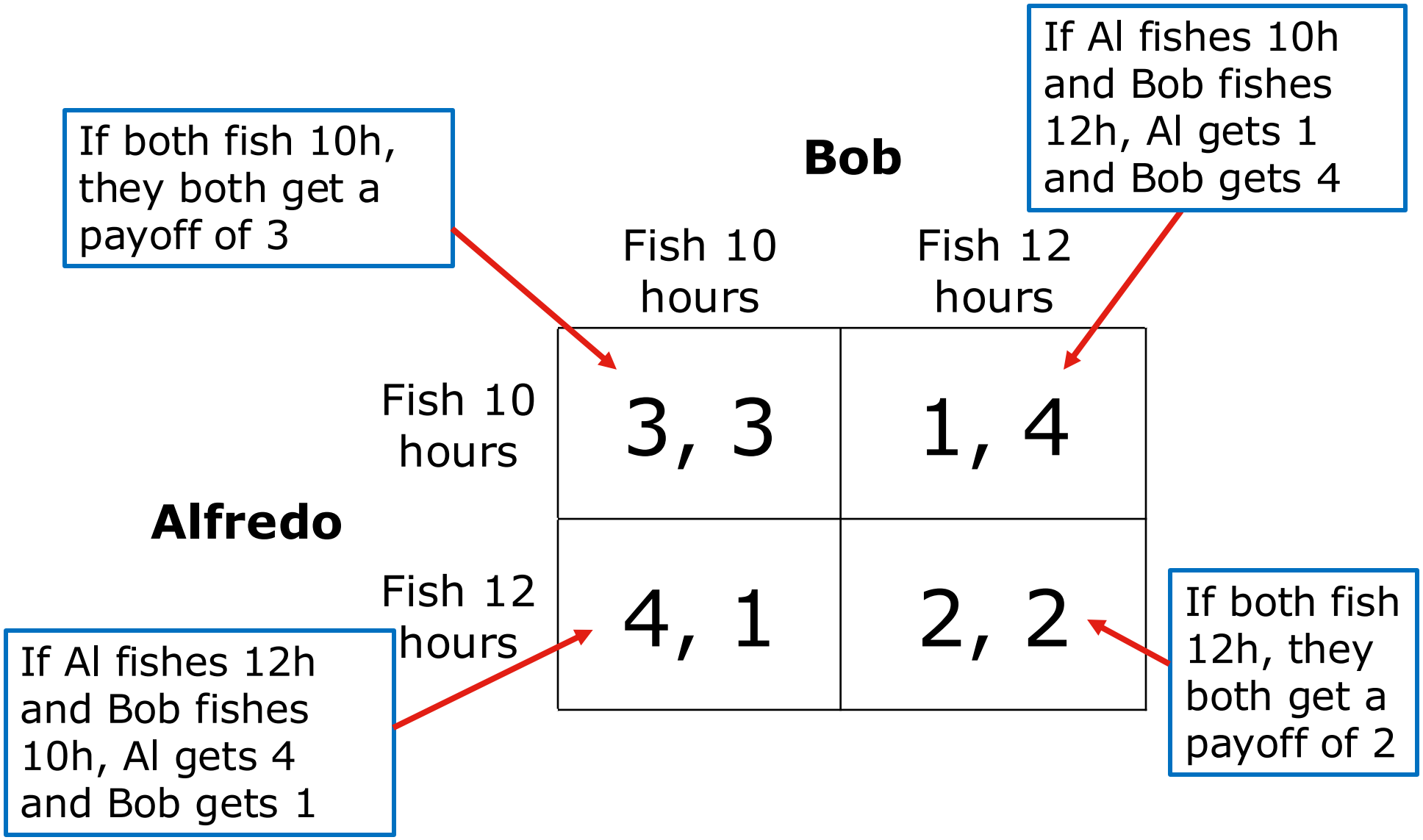
If Alfredo fishes 12 hours and Bob 10 hours → Alfredo 4, Bob 1.

A strategic (or normal) form game: The fishermen dilemma

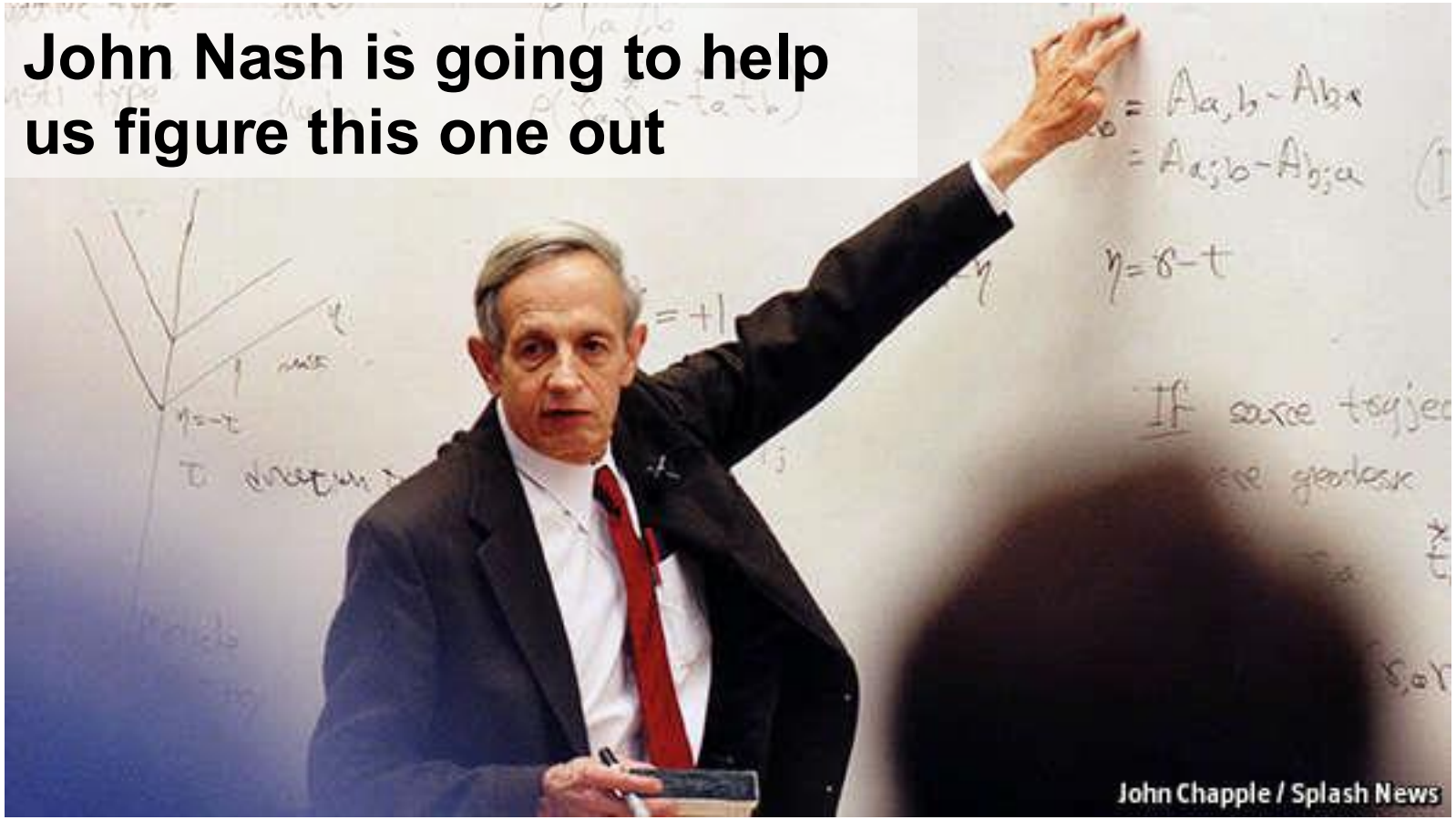
		Bob	
		Fish 10 hours	Fish 12 hours
Alfredo	Fish 10 hours	3, 3	1, 4
	Fish 12 hours	4, 1	2, 2

- If they both fish 10 hours, what is Bob's payoff?
- If Alfredo fishes 10 and Bob fishes 12, what is Alfredo's payoff?
- If Alfredo fishes 12 and Bob fishes 10, what is Bob's payoff?

		Bob	
		Fish 10 hours	Fish 12 hours
Alfredo	Fish 10 hours	3, 3	1, 4
	Fish 12 hours	4, 1	2, 2


If both fish 10h, they both get a payoff of 3
If Al fishes 10h and Bob fishes 12h, Al gets 1 and Bob gets 4
Bob
Fish 10 hours
Fish 12 hours
Alfredo
Fish 10 hours
Fish 12 hours
3, 3
1, 4
4, 1
2, 2
If Al fishes 12h and Bob fishes 10h, Al gets 4 and Bob gets 1
If both fish 12h, they both get a payoff of 2

How do we **predict the outcome** of a game?



➢Best responses:

the *best response of player A to strategy X of player B* is the strategy that gives A the highest payoff when B chooses strategy X.

➢Equilibrium

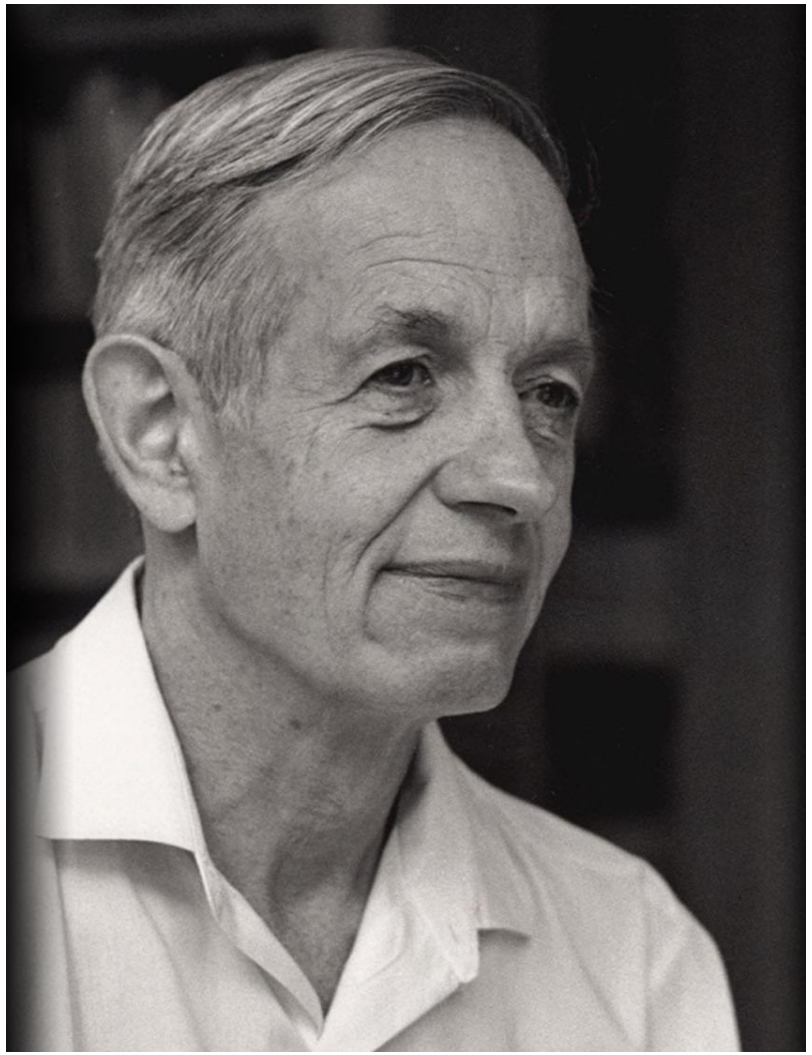
Equilibrium means that no one could do better by individually changing strategy.

An equilibrium is a *stationary* state.

Key idea: A solution must be an *equilibrium.*

If this was not the case, that outcome would never be how the game ends!

Solving a game for its Nash equilibrium



3 steps to find the *Nash Equilibrium*:

1. Find the best responses of A, given each possible strategy of B.
2. Find the best responses of B, given each possible strategy of A.
3. The strategy profiles in which both players are 'best responding' to each other's strategies are the Nash Equilibria
   - (may be one or more).

1 – **Alfredo's *best responses*** to each possible action of Bob:

If B fishes 10h, what is A's best response?

If B fishes 12h, what is A's best response?

Bob

Alfredo	Fish 10 hours	Fish 12 hours
Fish 10 hours	3, 3	1, 4
Fish 12 hours	4, 1	2, 2

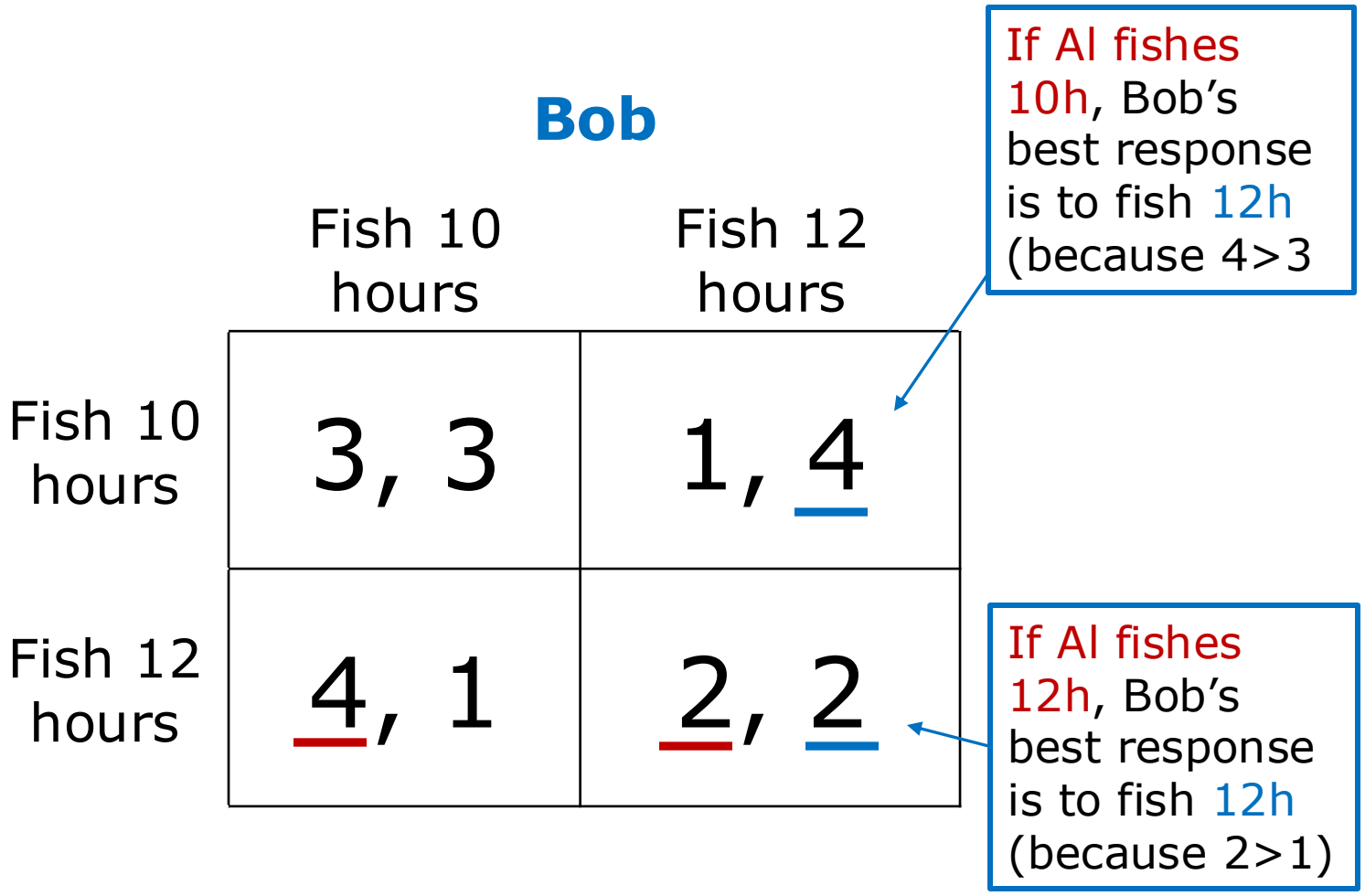
If Bob fishes 10h, Al's best response is to fish 12h (because 4>3)

If Bob fishes 12h, Al's best response is to fish 12h (because 2>1)

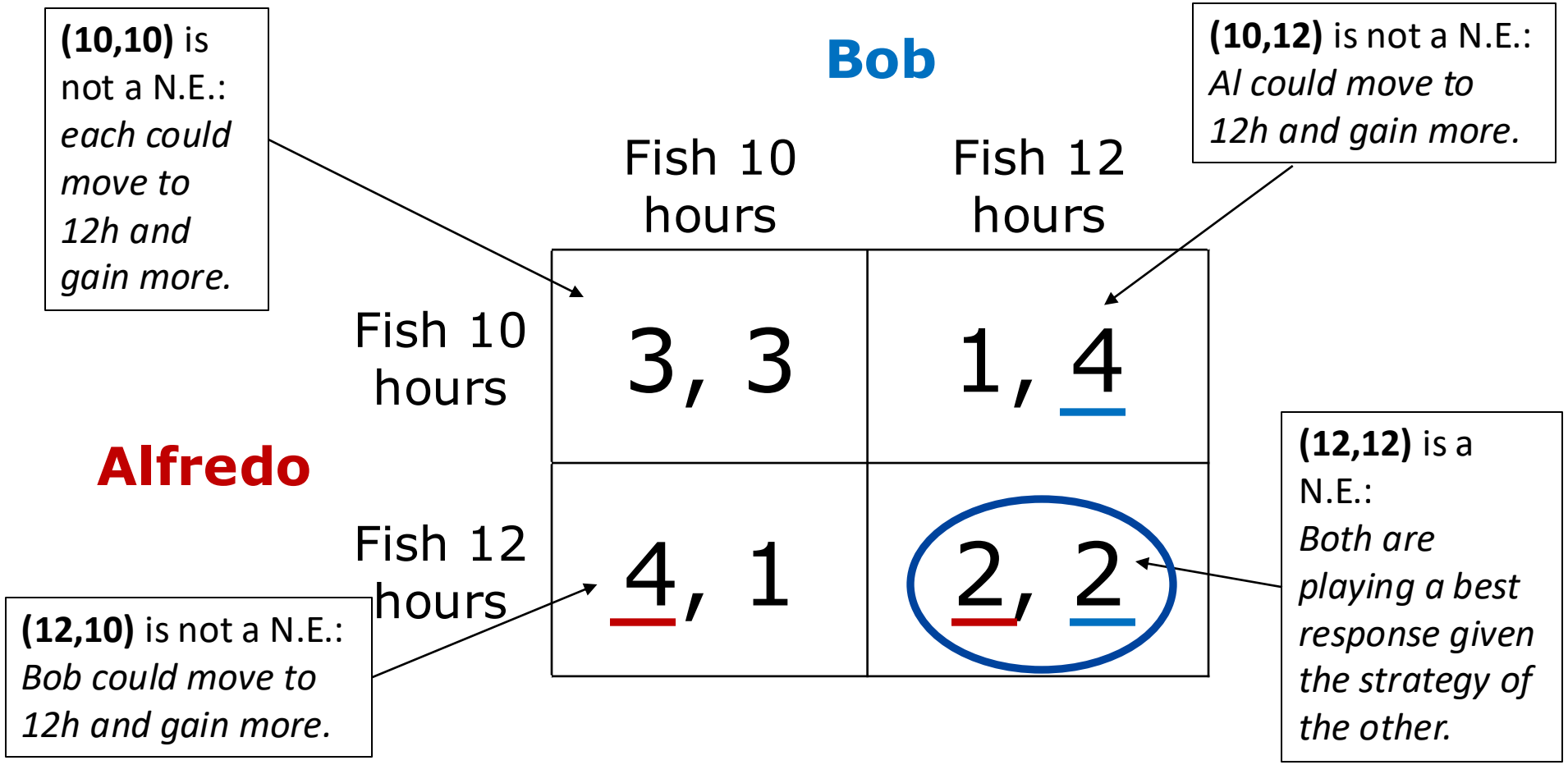
2 –Bob's ***best responses*** to each possible strategy of Alfredo.

If A fishes 10h, what is B's best response?

If A fishes 12h, what is B's best response?



3 – What is the Nash Equilibrium?



The Nash equilibrium

- A Nash equilibrium is a situation in which no player has a reason to change her strategy, as long as the other players do not change theirs.
- No one can increase their payoff by individually changing strategy.
- The strategy of each player is a best response given the strategies of the other players (mutual best response).
- Simply put: *Everyone is doing the best they can, given the actions of the others.*

The Nash equilibrium

- The definition of N.E. leaves unexplained *how the equilibrium will be reached*. But we know that *once we get there*, no one will have an incentive to move away.
- A N.E. is *not* guaranteed to be a ‘good’ solution.

Dominant strategy equilibrium

- A strategy is *strictly dominant* if it is the player's strong best response to all possible strategy profiles of the other player(s).
- if each player has a strictly dominant strategy, we have a dominant strategy equilibrium.
- in a dominant strategy equilibrium, each player has a unique strategy that is optimal, no matter what the others do (little interaction).
- A dominant strategy equilibrium is always a N.E.
- But a N.E. may or may not be a dominant strategy eq.

Is the Nash Equilibrium of the fishermen dilemma a dominant strategy equilibrium?

Yes! For both players, fishing 12 hours is the best response to all possible actions of the other player.

		Bob	
		Fish 10 hours	Fish 12 hours
Alfredo	Fish 10 hours	3, 3	1, 4
	Fish 12 hours	4, 1	2, 2

Your turn! Find the N.E. of this game

A and B are two thieves that have been caught by the police. They are interrogated separately.

- If they both snitch on each other, they both get 10yrs of jail (payoff=1).
- If one snitches and the other stays silent, the snitch gets free (payoff=3), the other goes to jail for 20yrs (payoff=0).
- If both keep quiet, they get away with just six months of prison each (payoff=2).

Player A \ **Player B**	Snitch	Keep quiet
Snitch	1, 1	3, 0
Keep quiet	0, 3	2, 2

(Snitch, Snitch) is the Nash Equilibrium

A and B are two thieves that have been caught by the police. They are interrogated separately.

		Player B	
		Snitch	Keep quiet
Player A	Snitch	1, 1	3, 0
	Keep quiet	0, 3	2, 2

- If they both snitch on each other, they both get 10yrs of jail (payoff=1).
- If one snitches and the other stays silent, the snitch gets free (payoff=3), the other goes to jail for 20yrs (payoff=0).
- If both keep quiet, they get away with just six months of prison each (payoff=2).

Prisoners dilemmas & coordination problems

- The game you solved is a classic game called the ‘prisoners dilemma’.
- Fishermen dilemma & prisoners dilemma have something in common:

  rational self-interest by each player produces an outcome that all players would have preferred to avoid (*Coordination failure*).

Does the N.E. provide a good description of how these kind of *strategic interactions* will unfold in reality?

- Often, it does.
  - especially if players don't have ways to coordinate their actions and don't care about each other.
- But not always!

Possible problems with the N.E.

It overlooks opportunities to coordinate
Imagine the two fishermen could sign a contract agreeing to fish 10h each, with a sizable penalty if one breaks the contract. Two rational fishers would be eager to sign that contract.

It assumes self-interest
If Alfredo and Bob cared about each other, fishing 10h each would be a sustainable equilibrium: none would increase their fishing hours, because none would want to damage the other.

There may be multiple equilibria
In some games, you can have more than one NE. Which one should we expect to be realized?

It ignores dynamics
Does not tell us how the equilibrium would be reached. But sometimes that's the main thing we would like to know.

What makes cooperation difficult in a coordination problem?

- Information: how do you check if the other is respecting the agreement? One could agree to cooperate but actually defect and get the biggest payoff!
- Enforcement: even if you can check on the other, how do you force him to comply?
- Distribution of benefits: Cooperating yields some extra-benefits. How to distribute them?

→ *in situations like the Fishermen Dilemma or the Prisoners' dilemma, the Nash Equilibrium might prevail and persist, even though it's bad for everyone.*

Application: Unlocking the gains from trade

A simple game to represent a possible coordination problem preventing countries to exploit gains from international trade.

- Country with 2 industries must decide whether to open to international trade.
- Will open only if both industries vote in favor (veto power).
- Trade brings net benefits to the country.
- But distributed unequally: a ‘trade winner’ (TW) industry gains, while a ‘trade loser’ (TL) industry loses.
- After gains from trade have been realized, it is possible to redistribute them using taxes and subsidies, *if both industries vote in favor*.

Application: Unlocking the gains from trade

We could try write this as a simultaneous game…

		TW	
		Allow redistribution	Veto redistribution
TL	Allow Trade	2, 2	-1, 5
	Veto trade	0, 0	0, 0

But it would miss an important dimension related to *timing*:

Redistribution can only happen *after* trade has been opened and the gains from trade realized (otherwise there is nothing to redistribute!)

Application: Unlocking the gains from trade

This is a *sequential* game:

1. TL decides whether to allow openness to trade or veto it.
2. If country opens & gains from trade are realized, TW decides whether to allow redistribution or veto it.

3 possible outcomes:

- No trade: (0,0)
- Trade and no redistribution: (-1,5)
- Trade and redistribution: (2,2)

🌍 Unlocking the Gains from Trade

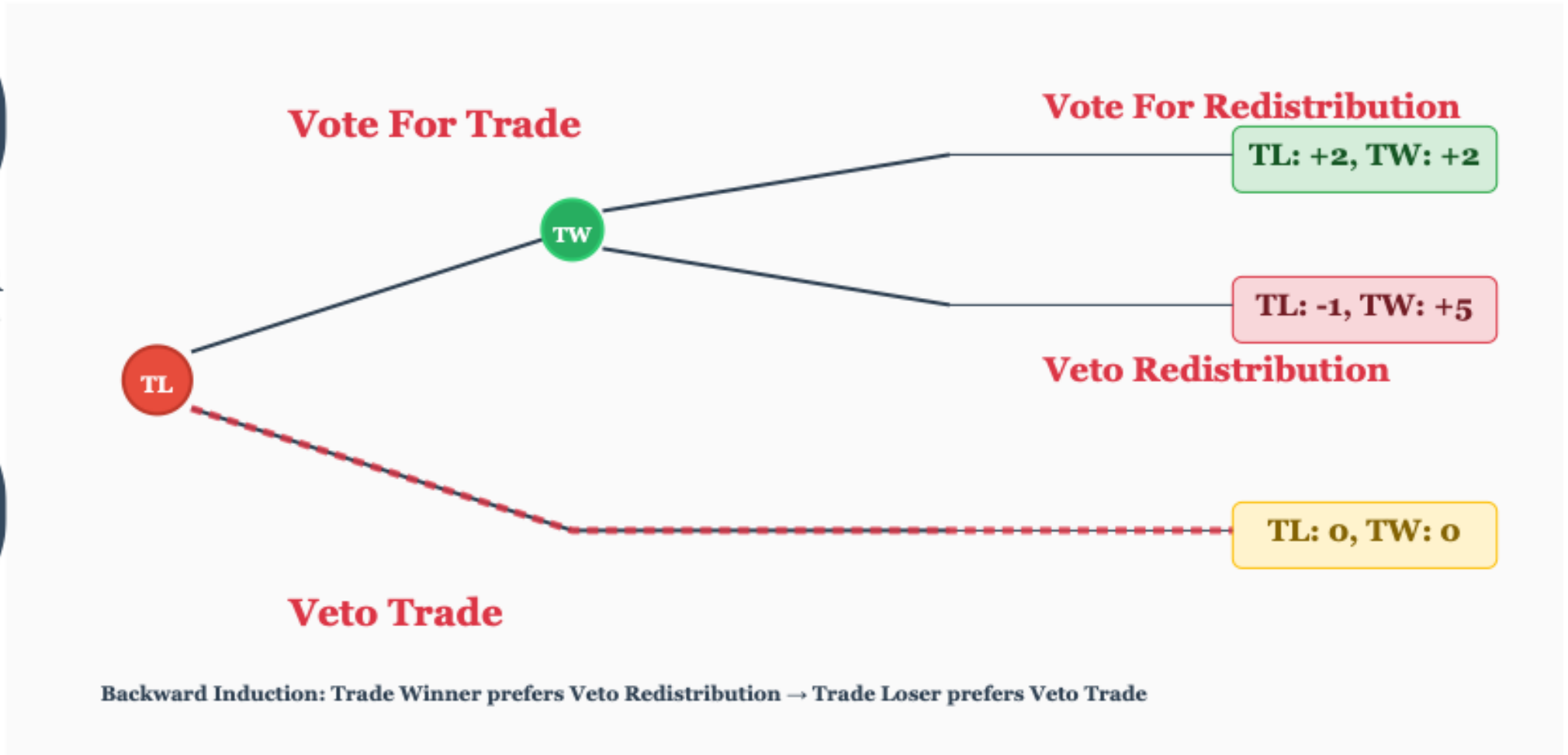
A Sequential Game Illustrating Trade Coordination Problems

TRADE LOSER

Industry hurt by trade

TRADE WINNER

Industry helped by trade



Backward Induction: Trade Winner prefers Veto Redistribution → Trade Loser prefers Veto Trade

Application: Unlocking the gains from trade

How do we solve such a sequential game?

Method of *backward induction*

- TL (1st mover) assumes that TW wants to maximize its own profits
  - If TL allows trade, profit-maximizing TW will veto redistribution (TL payoff: -1)
  - If TL vetoes trade, status quo preserved (TL payoffs: 0).
- Anticipating that TL will block redistribution, TL is better off blocking free trade.
- *Sequential Nash equilibrium*: no trade (0,0).
- TW & TL would both be better off with free trade + redistribution.
- But TW cannot *credibly commit* to vote for redistribution.

Application: Property rights and investment

A main tenet of modern institutional economics: **secure property rights** are necessary for investment & economic growth.

Industrial revolution could happen in England because the bourgeoisie there enjoyed secure property rights guaranteed by the rule of law and a powerful Parliament.

- When the King had absolute power, bourgeoisie would not invest in large-scale innovative machinery for fear that any profits would then be expropriated by the King/nobility.
- After the 1688 Glorious Revolution, Parliament (controlled by bourgeoisie merchants) had primacy over the King.
- The bourgeoisie could then make industrial investments, knowing the King would not be able to expropriate the profits.

🏛️ Property Rights Security and Investment

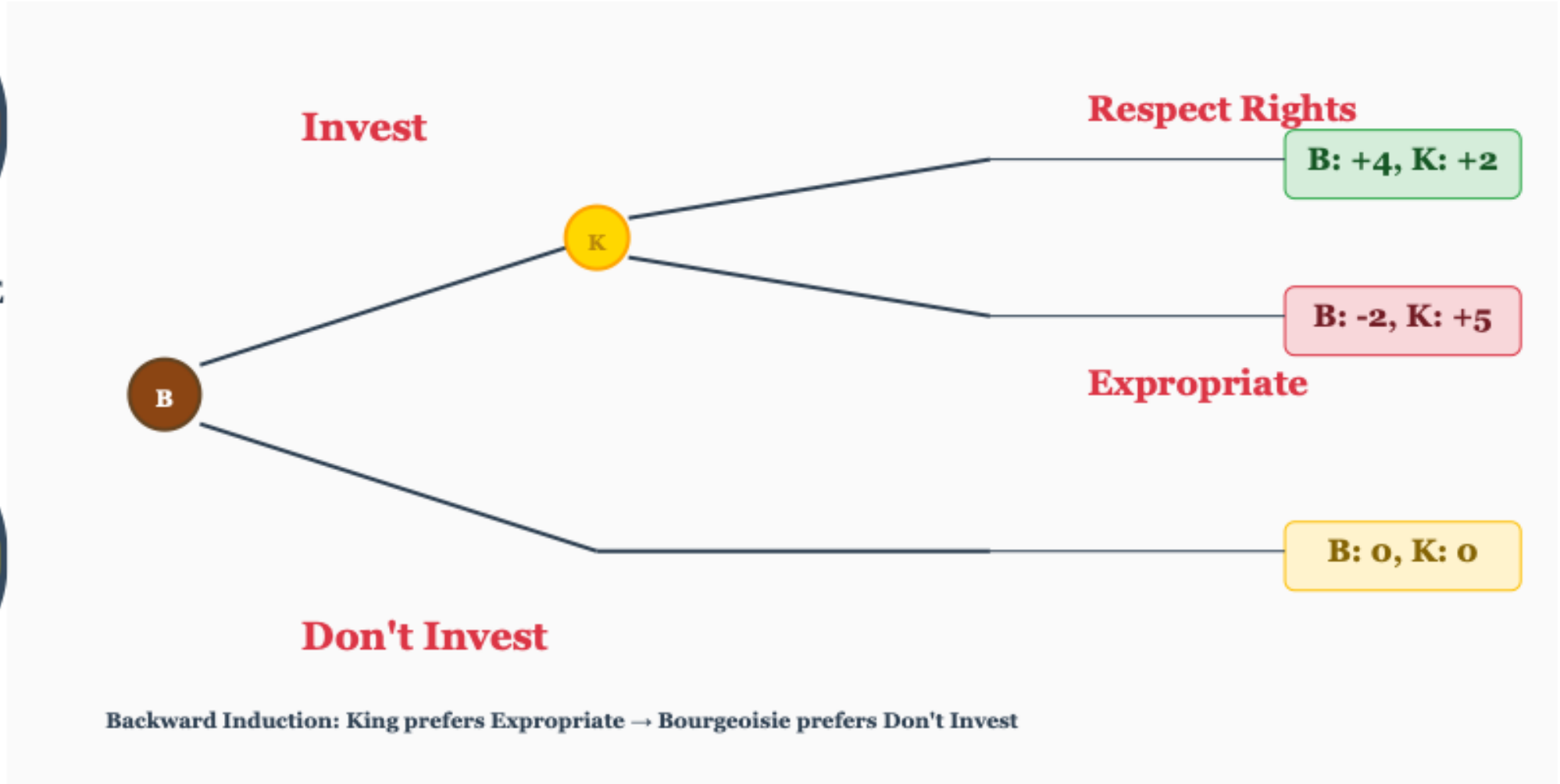
A Sequential Game Illustrating the Credible Commitment Problem

BOURGEOISIE

Merchant class with capital

KING

Sovereign ruler



Backward Induction: King prefers Expropriate → Bourgeoisie prefers Don't Invest

Application: Property rights and investment

Bourgeoisie & King both better off with industrial investment and moderate taxation than in the no-investment/no-growth equilibrium.

But there is a *credible commitment problem:*

- Once the investment is done and the profits realized, nothing can stop the King from expropriating.
- King cannot credibly commit to respect the property rights of merchants & industrialists.

Only solution is for the King to give up its taxation power to a powerful Parliament controlled by the bourgeoisie.

- Glorious Revolution solved the coordination problem!

Pareto efficiency: a way of evaluating outcomes

- Coordination failures → decentralized pursuit of self-interest produces socially inefficient outcomes
- *But how do we determine if an outcome is socially efficient? How do we go about comparing outcomes?*
- One criterion is Pareto efficiency:
- A is Pareto superior to B if no participant prefers B over A, and at least one prefers A (*Pareto comparison*).
- An outcome is Pareto efficient if no other feasible outcome is Pareto superior to it.

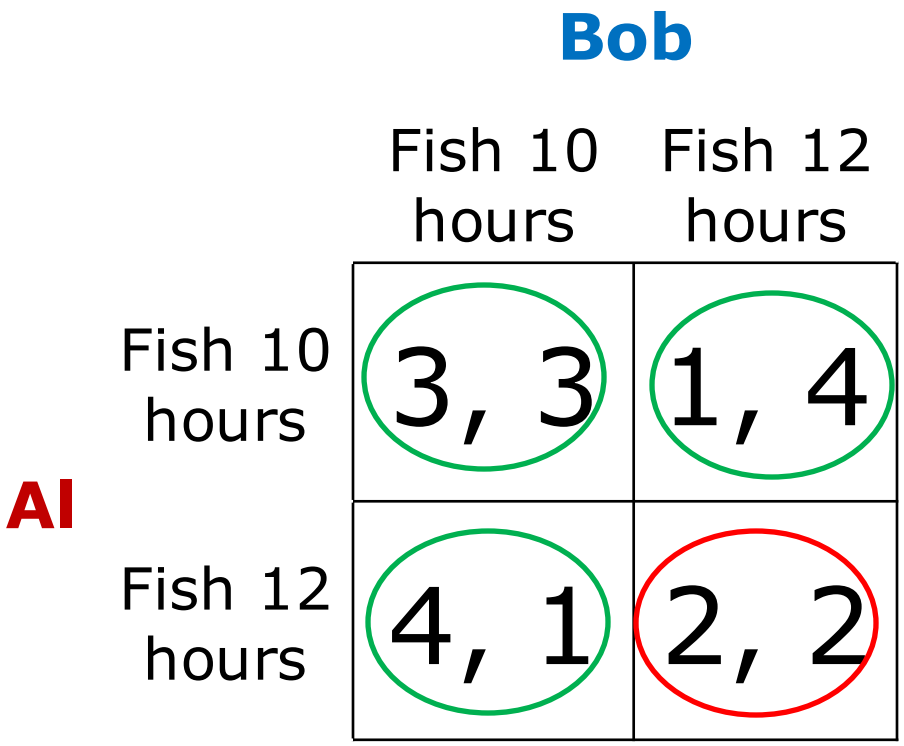
Pareto efficiency in the fishermen dilemma

Bob

Al	Fish 10 hours	Fish 12 hours
Fish 10 hours	3, 3	1, 4
Fish 12 hours	4, 1	2, 2

1. **Is the N.E. (12h, 12h) Pareto efficient?**
2. **Is (12h, 10h) Pareto efficient?**

Pareto efficiency in the fishermen dilemma



PARETO-EFFICIENT

NOT PARETO-EFFICIENT

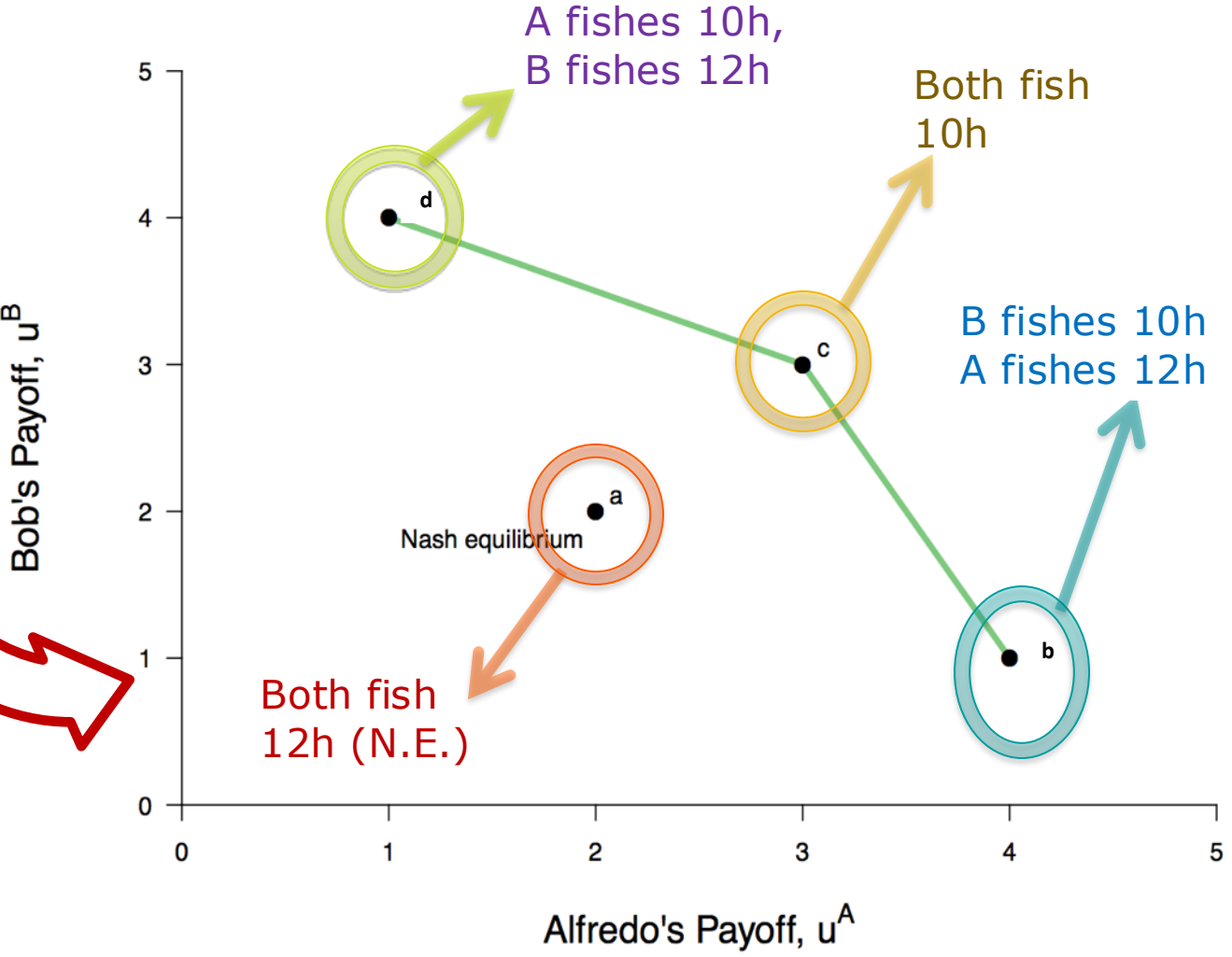
Using a graph to visualize Pareto efficiency

- We can plot the outcomes of a game, to assess Pareto-efficiency visually.

1. **Plot the payoff of Player A on the horizontal axis, and the payoff of Player B on the vertical axis.**
   - Each point in this graph will represent a combination of outcomes for A and B.
2. **Find & mark the points in the graph corresponding to each possible outcome of the game.**

This is the plot of the fishermen dilemma:

Al \ Bob	Fish 10h	Fish 12h
Fish 10h	3, 3 **{c}**	1, 4 **{d}**
Fish 12h	4, 1 **{b}**	2, 2 **{a}**



Outcome X is Pareto-superior to outcome Y if X lies to the north- east of Y in the plot.

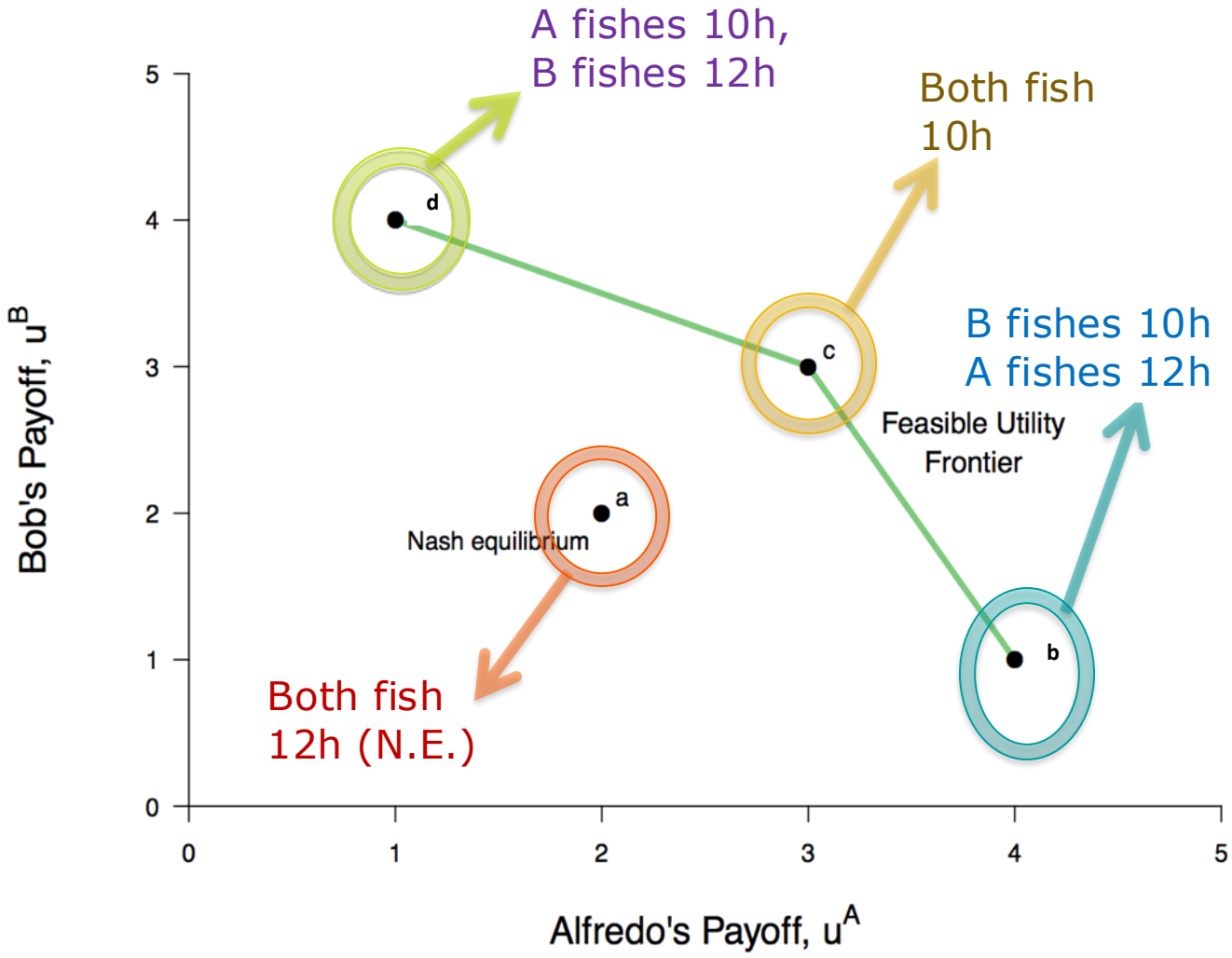
→ if it's northeast, it is better for both (or better for one and indifferent for the other)

Outcome X is Pareto-efficient if there is no feasible outcome that lies to the north-east of X.

c is Pareto-superior to **a**.

d, **c** and **b** are Pareto efficient (can't find an outcome that lies north east).

a is not Pareto efficient (there is an outcome that lies north-east of it).



Strenghts of the Pareto criterion

- The Pareto criterion provides a fairly uncontroversial and objective way to identify the “bad” outcomes.
- Good at identifying outcomes that “none would have chosen”.
- If we are in a Pareto-inefficient outcome, we are foregoing an opportunity to make everyone better off (or at least someone better off and no one worse off).
- That seems bad indeed!

Shortcomings of the Pareto criterion

The Pareto criterion is at the same time too strong and too weak.

Too strong: making only Pareto-efficient changes would bring to inertia.

- *Usually, we have to go against some particular interest in order to benefit society as a whole. (ex.: taxing the super-rich to build schools). Pareto comparisons provide little info about these issues.*

Too weak: it is not able to exclude outcomes that are "bad" because inequitable or unfair.

- *Take the problem of dividing up a pie. All the Pareto criterion says is "don't throw away any of the pie". But it is unable to say that an outcome in which one player gets all the pie while the other starves is unfair.*

Pareto efficiency & the classical institutional challenge

Pareto efficiency is necessary but not sufficient to address the classical institutional challenge:

- Good institutions should generally bring about Pareto efficient outcomes (no good food should be left on the table!).
- But good rules should also address important concerns of distribution and fairness, about which the Pareto criterion can't say anything.

Coordination problems : A game-theoretical definition

A coordination problem occurs when the non-cooperative interaction of two or more agents leads to a Nash equilibrium that is not Pareto efficient, or when there are multiple N.E.

Classification of games

Based on whether they present coordination problems, and of which kind.

Invisible Hand games: unique Pareto-efficient N.E. → no coordination problem

Coordination games: decentralized N.E. not Pareto efficient, or multiple equilibria.

- Prisoners' dilemmas: no Pareto-efficient N.E. → coordination failure
- Assurance games: multiple equilibria, some inefficient → common interest
- Disagreement games: multiple equilibria, all Pareto efficient → conflict of interest

Consider the following game

Arkady & Barbara decide whether to plant corn or tomato

Arkady is better at growing tomato

Barbara is better at growing corn

Arkady \ Barbara	Corn	Tomato
Corn	1, 2.5	2, 2
Tomato	4, 4	2.5, 1

1) What is the Nash Equilibrium?

2) Is the N.E. Pareto efficient?

Invisible Hand Game

Invisible Hand Game:

There is a unique N.E. & it is Pareto efficient.

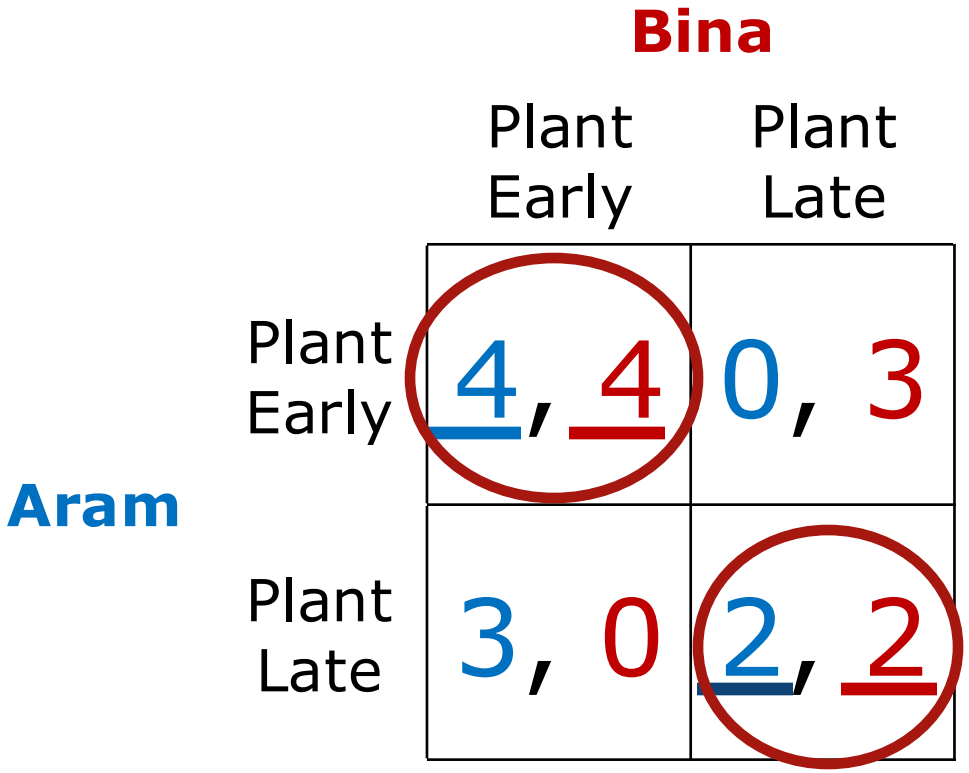
Uncoordinated individual actions lead to socially efficient outcomes.

A \ B	Corn	Tomato
Corn	1, 2.5	2, 2
Tomato	4, 4	2.5, 1

The “planting in Palanpur” game

1) What is/are the N.E.?

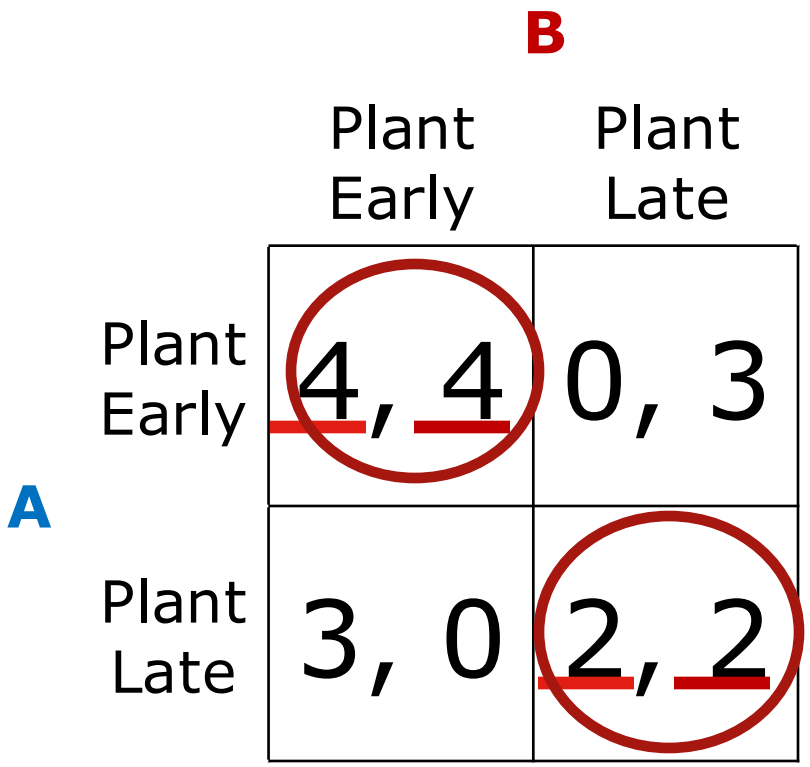
3) Are the two N.E. Pareto efficient?



Assurance game

Coordination game: there is a Pareto inefficient N.E.

Specifically, **Assurance game**: *players agree on which outcome would be best, but they need coordination to get there.*



Two defining characteristics of Assurance Games:

- Multiple equilibria that are Pareto rankable
  one is Pareto-superior to the other(s).
- Strategic complementarity
  the payoff from a strategy is increasing in the number of players adopting it (feedback effects): you want to do what others are doing.

The language game

1) What is/are the N.E.?

2) Are the two N.E. Pareto efficient?

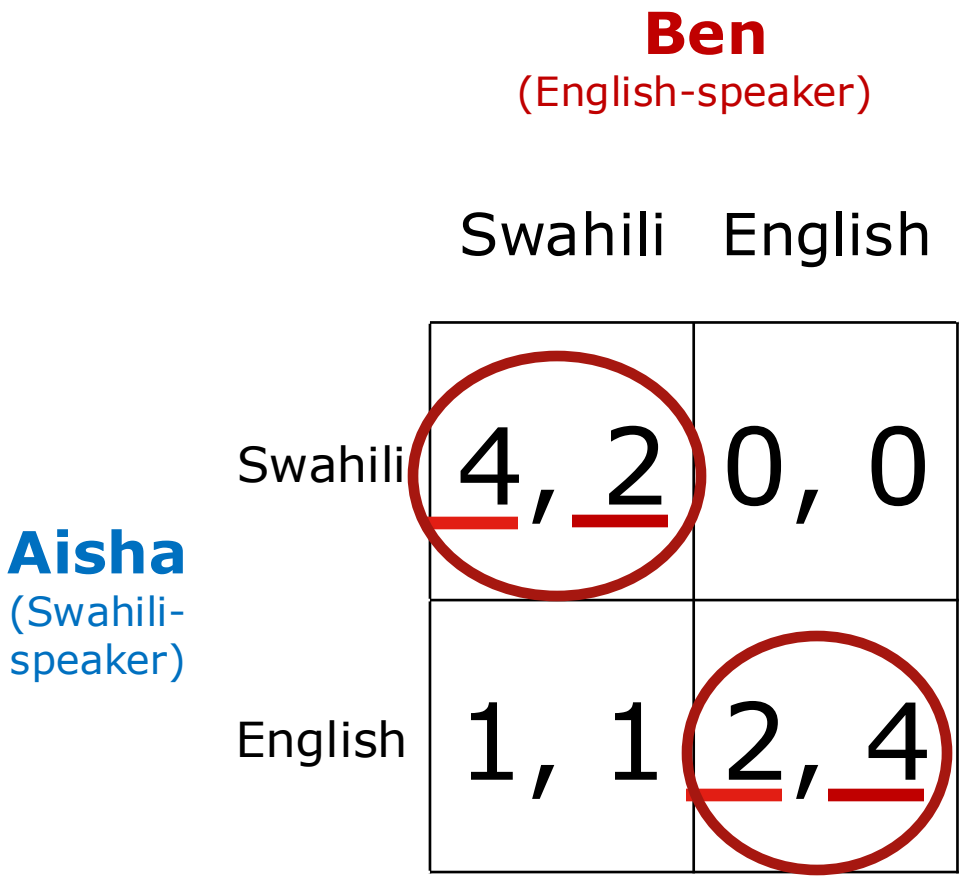
Ben
(English-speaker)

Aisha (Swahili-speaker)	Swahili	English
Swahili	4, 2	0, 0
English	0, 0	2, 4

Disagreement Game

The “Language game” is a coordination game (multiple equilibria)

Specifically, a **disagreement game**: multiple equilibria which are all Pareto efficient.



In disagreement games:

- you cannot move from one N.E. to another without hurting somebody
- Players disagree on which NE is best.

Players agree they should *coordinate* (choose same language)
→ strategic complementarity

But they are in *conflict* over which outcome to coordinate on (Swahili or English?) → *conflict of interests*.

Strategic complementarities

- Sometimes, payoff from an action is higher if others are choosing that action as well.
  - *Any examples in your life?*
  - Communication platforms: You want to be on Whatsapp only if your friends use it too.
- Strategic complementarities often give rise to multiple Nash equilibria
- *Path dependence*: Historical patterns tend to persist.
- The same individuals, playing the same game, can end up in different equilibria depending on the initial situation.

Institutions & Coordination Problems

- Coordination failures = Pareto-inefficient Nash Equilibria.
- To eliminate them, we need to change the *payoff structure* of the game
  - ‘payoff structure’ just means “what payoff each player gets in each possible outcome”.
- We must change the rules of the game.
- The rules of the game are determined by *institutions*: laws, social norms, mutual expectations…

Institutions & Coordination Problems

Institutions are the rules of the game that determine the outcome of coordination problems.

Example: Why do you drive on the left in the UK?

Because otherwise you will be arrested (*laws*).

Because otherwise other people will think you are nuts or despise you (*social norms*).

Because you expect everyone else to drive left, so it is in your best interest to do the same (*mutual expectations*).

Institutions & Coordination Problems

By changing the rules of the game, institutions can address coordination problems.

Two possible problems to be solved:

- *How to get there?* If there is a Pareto efficient N.E., but we are stuck in an inefficient one (e.g. Assurance Game). Then we need a coordination device for people to converge on the efficient equilibrium.
- *How to stay there?* If the efficient outcome is not a N.E. (e.g. Prisoner Dilemma), we need to change the payoff structure to make it a N.E.

How to ‘break’ a Prisoners Dilemma

- Prisoners’ dilemma: a unique and inefficient N.E.
- How can the right institutions transform the payoff matrix to solve the coordination problem?
- Take the fishermen dilemma.
- *Liability rule:* if you defect (fish 12h), you must compensate the other fisher for the harm that you are causing to them.
- The institution of liability rule can turn a Prisoners Dilemma game (like the fishermen dilemma) into an Invisible Hand game.

The fishermen dilemma with a liability rule

Bob

Al	Fish 10h	Fish 12h
Fish 10h	3, 3	1+2, 4-2
Fish 12h	4-2, 1+2	2, 2

What is the N.E. with the liability rule?

The fishermen dilemma with a liability rule

Al \ Bob	Fish 10h	Fish 12h
Fish 10h	3, 3	1+2, 4-2
Fish 12h	4-2, 1+2	2, 2

- This re-definition of property rights succeeded!
- We have internalized the externalities, and now the unique Nash Equilibrium is Pareto efficient.
- A simple example of how institutions can address coordination problems.
- Of course things aren't always that easy: here we assumed that behavior is observable and that contracts are costless to enforce!

Thank you for your attention