The Political Economy of Public Policy

Valentino Larcinese

Lecture 2: Public goods and the collective action problem

PUBLIC GOODS

Definition 1: a good is ”*non-rival*” if one person’s consumption does not reduce the amount available to other consumers. (also ”*jointness of supply*”)

Definition 2: a good is said to be ”*non-excludable*” if its consumption by one member of a group makes it available to the other group members, i.e. people cannot be excluded from consuming it.

- **Pure Private Good**: rival + excludable
- **Pure Public Good:** non-rival + non-excludable

Given a group with I members and a good x (total available = X), the consumption feasibility constraint is :

$$\text{if x is private good:} \qquad \sum_i x_i \leq X$$

$$\text{if x is public good:} \qquad x_i \leq X$$

Consider I=2 and $X = x_1 + \alpha x_2$.

$\alpha = 1 \Rightarrow$ private good

$\alpha = 0 \Rightarrow$ public good

$0 < \alpha < 1 \Rightarrow$ mixed

[FIGURE 1]

PUBLIC GOODS ARE UNDERSUPPLIED [FIGURE 2]

Individual optimum: $MB_i = MC$

Social optimum $\sum MB_i = MC$

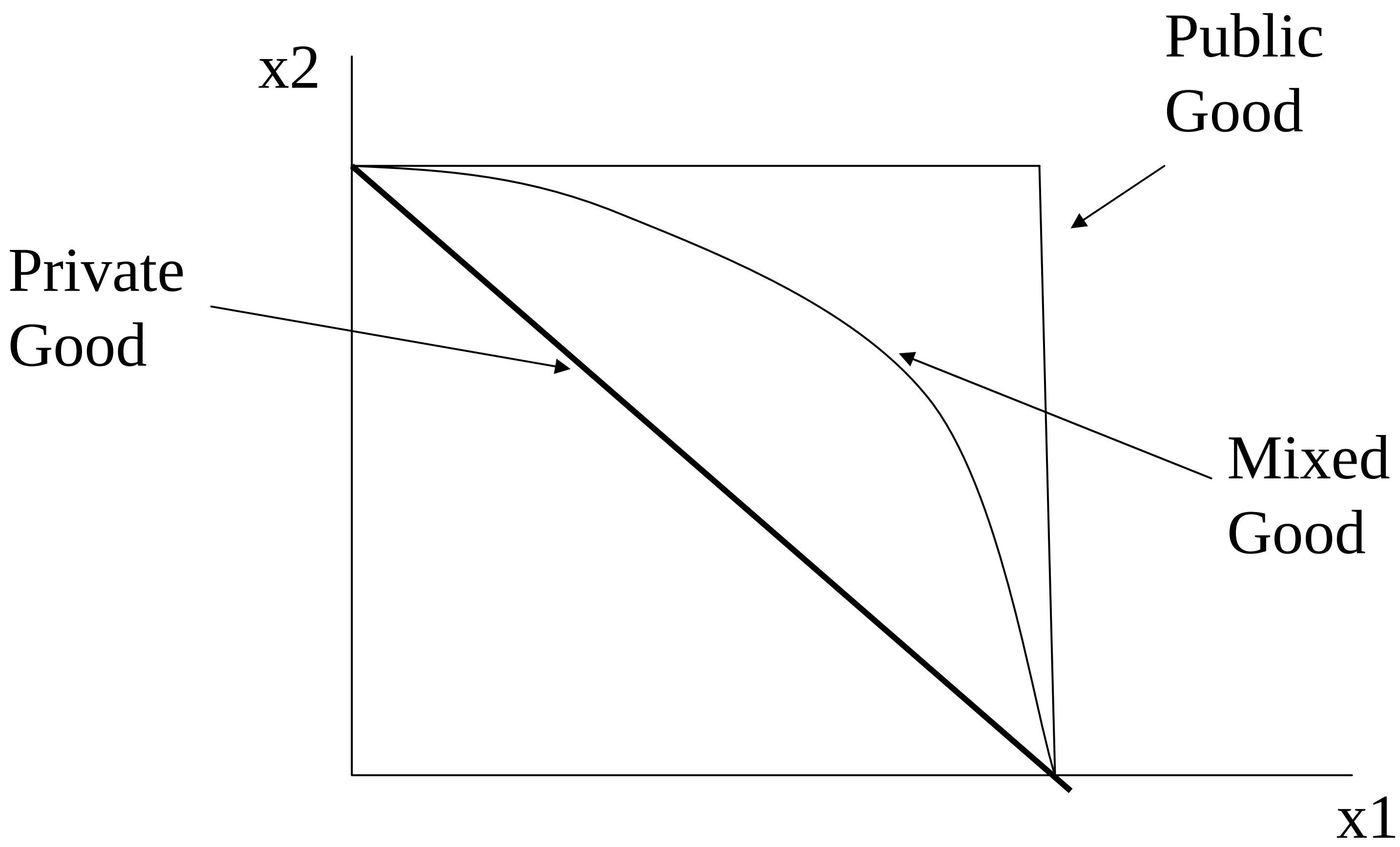


Figure 1: Consumption Possibility Frontier

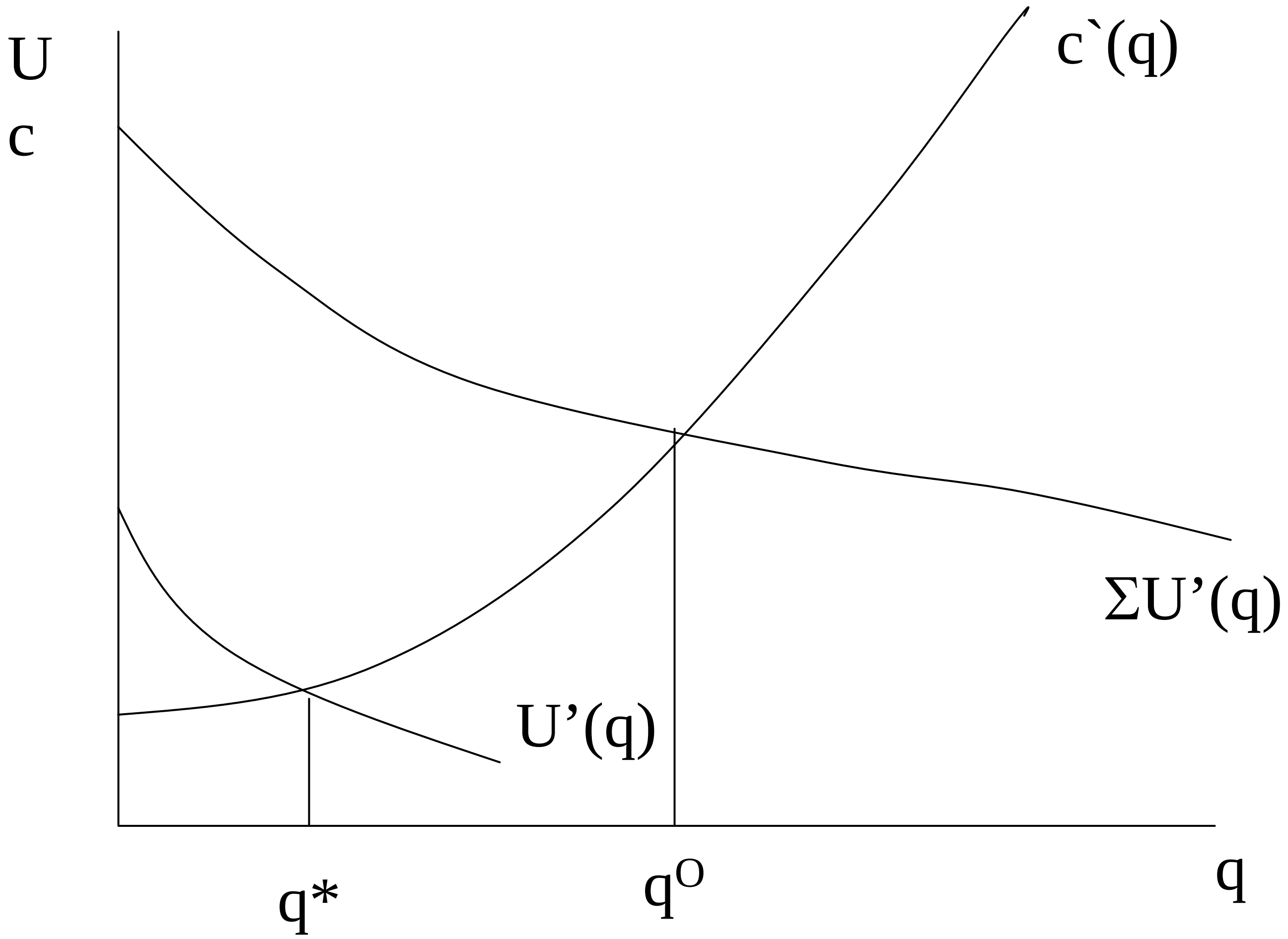


Figure 2:Inefficient Provision of PG

The Prisoner's Dilemma

Two suspects are arrested and charged with a crime. The police lack sufficient evidence to convict the suspects, unless at least one of them confesses. The police hold the suspects in separate cells and explain the consequences of the actions they may take. If neither confesses then both will be convicted for minor offences and sentenced to one month in jail. If both confess then both will be sentenced to jail for six months. Finally, if one confesses but the other does not, then the confessor is immediately released and the other is sentenced to nine months - six for the crime and three more for obstructing justice.

What do the prisoners do? [FIGURE 3]

		Player 2	
		Quiet	Confess
Player 1	Quiet	(-1,-1)	(-9,0)
	Confess	(0,-9)	(-6,-6)

Figure 3: The Prisoner’s Dilemma in Normal Form

EQUILIBRIUM IN DOMINATED STRATEGIES

- If strategy σ_1 *strongly dominates* strategy σ_2 for player one, then that means that it is better for player one to use σ_1 rather than σ_2 irrespective of what player two plays.

- If strategy σ_1 *weakly dominates* strategy σ_2 for player one, then that means that player one can never lose by playing σ_1 rather than σ_2.

The provision of public goods can be regarded as a prisoners' dilemma game.

In Figure 4, the cost of a project (public good) is 150, the benefit is 100 to each player $\Rightarrow$ bad equilibrium

		Player 2	
		Pay	Don’t Pay
Player 1	Pay	(25,25)	(-50,100)
	Don’t Pay	(100,-50)	(0,0)

Figure 4: Private Provision of Discrete PG

THE LOGIC OF COLLECTIVE ACTION [OLSON]

"It is of the essence of an organization that it provides an inseparable, generalized benefit. It follows that the provision of public or collective goods is the fundamental function of organizations generally"

$\Rightarrow$ members' (and non-members') free riding should be a common feature of organizations.

A group is **Privileged** when voluntary provision of the public good (by one member or a sub-group of members) occurs.

A group is **Latent** when voluntary provision does not occur.

"The larger a group is , the farther it will fall short of providing an optimal supply of any collective good, and the less likely that it will act to obtain even a minimal amount of such a good. In short, the larger the group the less likely it will further its common interests".

Larger Groups fail to mobilize common interests because**:**

- Individual contributions are made irrelevant (net benefits are lower)
- Anonimity (no social control) and enforcement problems
- The possibility of being a privileged group is reduced (?)
- Organization costs are larger

In small groups these problems tend to be less severe.

Notice, however, that more heterogeneity could actually increase the likelihood of the group being privileged.

Participation and collective action can be increased by:

- **selective incentives** (Olson's argument)
- **political entrepreneurs**
- **ideology and beliefs**

MORE SOLUTION CONCEPTS IN GAMES

Iterated deletion of strictly dominated strategies (IDSDS) [FIGURES 5 and 6].

This method is appealing but it has two drawbacks;

- each step requires another assumption on the other players' rationality
- may not have a unique solution (or any solution whatsoever), so that we have little predictive power.

[FIGURE 7]

Player 2

Player 1		L	M	R
	U	(1,0)	(1,2)	(0,1)
	D	(0,3)	(0,1)	(2,0)

Figure 5: IDSDS

		Player 2		
		L	M	R
Player 1	U	(1,0)	(1,2)	~~(0,1)~~
	D	(0,3)	(0,1)	~~(2,0)~~

Figure 6: IDSDS continued

Player 1	Player 2	L	M	R
	T	(0,4)	(4,0)	(5,3)
	M	(4,0)	(0,4)	(5,3)
	B	(3,5)	(3,5)	(6,6)

Figure 7: No Solution Using IDSDS

Nash Equilibrium (NE):

The strategies $(\sigma_1^*, \sigma_2^*, .., \sigma_n^*)$ are a **Nash Equilibrium** if, for each player i, σ_i^* is (at least tied for) player i's **best response** to the strategies specified for the $(n-1)$ other players.

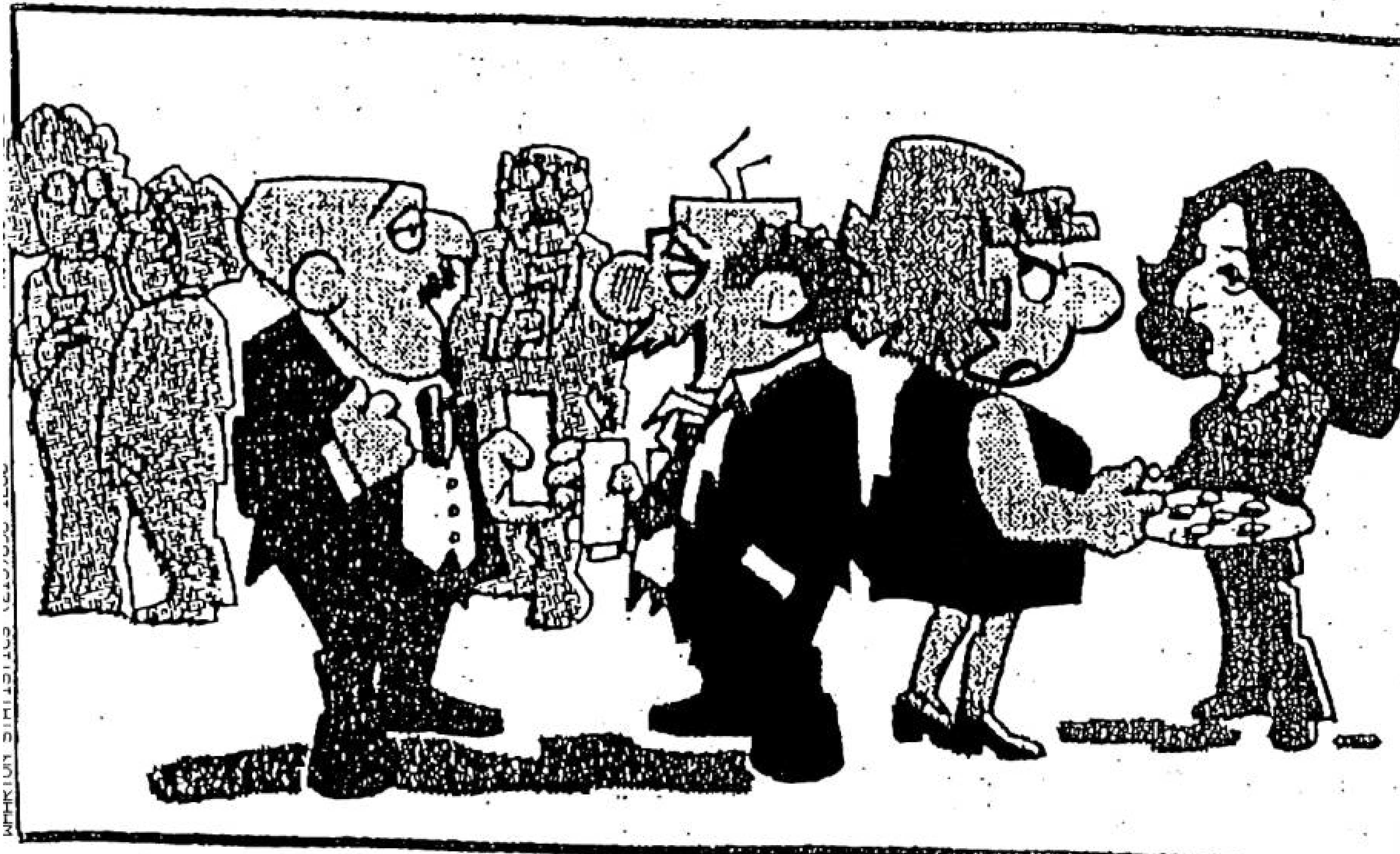
That is, σ_i^* maximizes $u_i(\sigma_1^*, \sigma_2^*, ..., \sigma_{i-1,}^* \sigma_i^*, \sigma_{i+1}^*, ..., \sigma_n^*)$ for each i.

Intuitively, in a two player game with two strategies available to each player, players play their optimal strategy *taking as given* that the other player *also* plays his optimal strategy.

In this sense, NE strategies are *best responses* to each other.

"*It's the best I can do, given that you are doing the best you can do*". [FIGURE 8]

Find the NE strategies in the prisoner's dilemma.



"LORETTA'S DRIVING BECAUSE I'M DRINKING, AND I'M DRINKING BECAUSE SHE'S DRIVING."

About NE

Definition of Pareto Efficiency (PE): A PE equilibrium is one for which each agent is as well as possible, given the utilities of the other agents.

- *A very important result:* Nash Equilibrium may not predict the Pareto Efficient outcome

- Nash equilibrium may give multiple equilibria in games of coordination (battle of the sexes, FIGURE 9)

- Nash equilibrium may sometimes give no equilibrium (matching pennies, FIGURE 10)

		Oriana	
		Cricket	Tate
Imran	Cricket	(2,1)	(0,0)
	Tate	(0,0)	(1,2)

Figure 9: Battle of the Sexes

		Torun	
		Heads	Tails
Keith	Heads	(-1,1)	(1,-1)
	Tails	(1,-1)	(-1,1)

Figure 10: Matching Pennies

RECIPROCITY AND COOPERATION

Repeated games

A repeated game is a game that can be decomposed into a number of periods $t = 1, 2, ..., T$ (where T is finite or infinite) and such that at each date t the players simultaneously choose actions knowing all the actions chosen by everybody at dates 1 through $t - 1$ (*history*). In other words, a simple simultaneous-move game is repeated T times.

Note that in a repeated game there is no link between the periods, i.e. the game that is played in each period is not affected by actions taken in previous period (differently from dynamic games). Current strategies, however, can depend on the past.

The prisoner's dilemma again: provision of a public good

Let's consider the prisoner's dilemma in Fig. 11. Assume now that the players play this same game repeatedly (and learn past moves along the way).

- Each player's payoff is equal to the present discounted value of his per-period payoff over the time horizon: preferences are separable.
- The discount factor is $\delta \in (0, 1)$.

		Gordon	
		Coop	Free Ride
Tony	Coop	(2,2)	(0,3)
	Free Ride	(3,0)	(1,1)

Figure 11: The Prisoner’s Dilemma Again

Solution with T finite

- To solve, work backwards from the end.
- At date T, the strategies must specify a NE for any history. Remember: payoffs at T are not affected by history: strategies must specify a NE for the simple one-period game $\Rightarrow$ both players free ride at T.
- At date $T-1$, strategies must form a two-period NE for any history. However, the last two periods' payoff are independent of history and T's outcome will not depend on what happens in period $T-1 \Rightarrow$ both players free ride.

General Result: if the one period NE is unique, then the T-periods game equilibrium is simply a repetition of this equilibrium T times.

Solution with T infinite

The strategic considerations in an infinitely-repeated game are different from those in a one-shot game because the introduction of time permits the players to reward and punish their opponents for their behaviour in the past.

In the prisoner's dilemma there are now many possible equilibria. Both players free riding at each period is still an equilibrium, but there exist other equilibria.

Tit-for-Tat Strategy

At any date t a player cooperates if and only if both players have always cooperated between periods1 and $t-1$.

Cooperate at time 1.

Both players playing Tit for Tat might form an equilibrium.

Consider a generic period t. If no one has yet confessed the strategy Tit for Tat gives payoff

$$2(1+\delta+\delta^2+...)=\frac{2}{1-\delta}$$

If a player deviates, he gets 3 at time t and then, from time $t+1$, strategies will be "don't cooperate" forever for both players; this gives a payoff

$$3+(\delta+\delta^2+...)=3+\frac{\delta}{1-\delta}$$

Thus, for a player to cooperate we need

$$\frac{2}{1-\delta} \quad > \quad \frac{3(1-\delta)+\delta}{1-\delta} = \frac{3-2\delta}{1-\delta}$$
$$\Rightarrow \quad \delta > \frac{1}{2}$$

Thus, in our prisoner dilemma, players cooperate if they care enough about the future ($\delta > 1/2$).

This is only an example. In the infinite horizon prisoner's dilemma, many other equilibria are sustainable.

The folk theorem

The so-called folk theorem gives an exact characterization of the set of equilibria of repeated games with infinite horizon when players care about the future (more precisely when δ is very near to 1).

Definition: an **individually rational payoff** for player i is the mimimum payoff that other players could force i to get in the one-period game

$$\min_{a_{-i}} \max_{a_i} U^i(a_i, a_{-i})$$

The Folk Theorem: Any feasible payoff above the individually rational payoffs can be sustained on average as a Nash Equilibrium of the infinitely repeated game for $\delta = 1$.

A similar result can be obtained for δ sufficiently close to 1. [FIGURE 12]

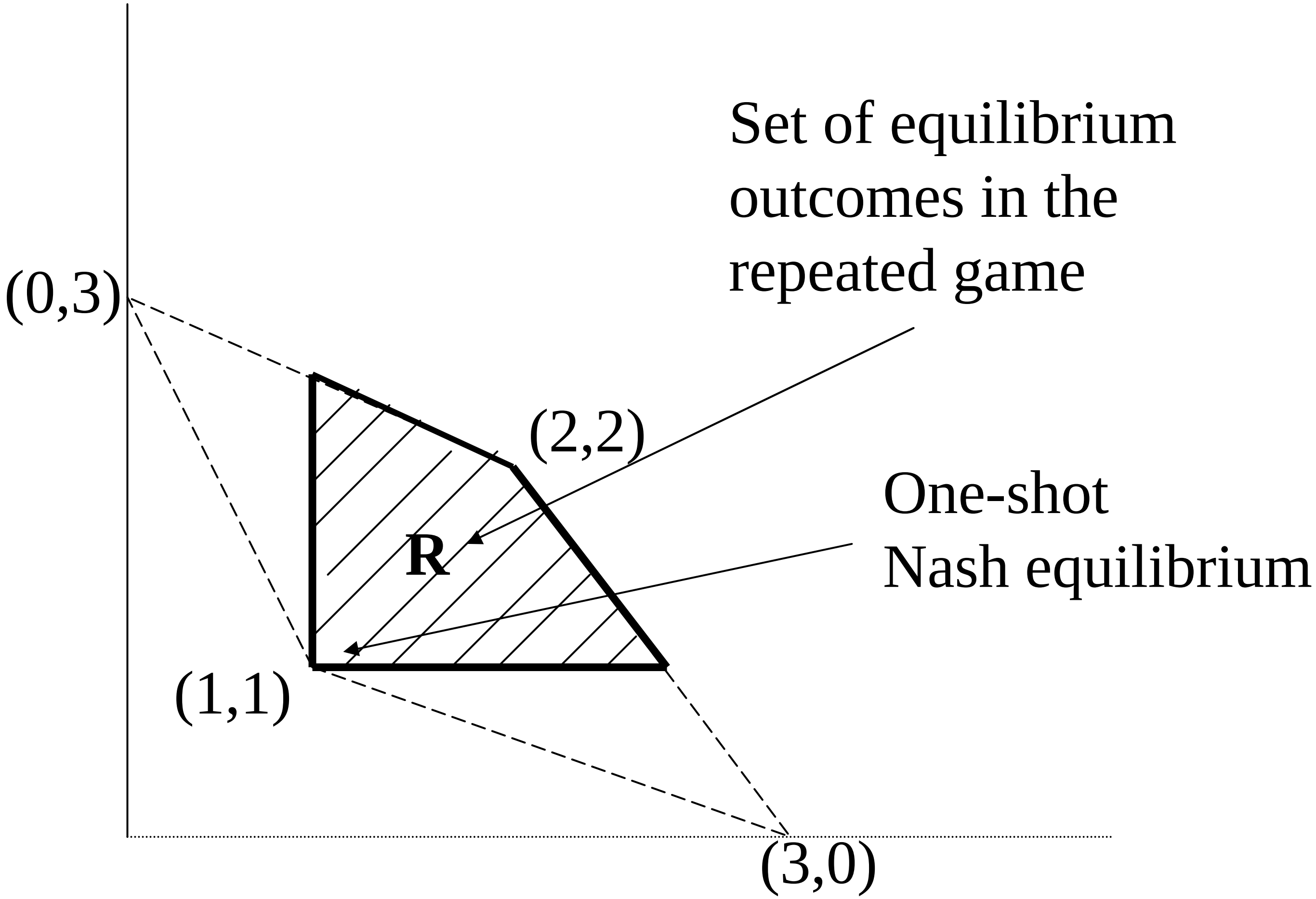


Figure 12: The Folk Theorem

"Once attention has been directed away from the infertile one-shot case, the question ceases to be wheter rational cooperation is possible. Instead, one is faced with a bewildering variety of different ways in which the players can cooperate rationally, and the problem becomes that of deciding which of all the feasible ways of competing should be selected. This observation puts the question of what is the 'right' game to serve as a paradigm for the problem of human cooperation on the sidelines. Once it is appreciated that reciprocity is the mechanism that makes things work, it becomes clear that it is the fact of repetition that really matters. The structure of the game that is repeated is only of secondary importance" [K.Binmore].