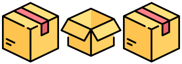
BDP 509: Applied Game Theory



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Lecture Eight: Public Goods

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Today's Tasks

1. Illustrative example
2. Allocative efficiency
3. Private goods
   3.1 Efficiency of the free market
4. Public goods
   4.1 The free rider problem
5. Common goods
   5.1 The tragedy of the commons

Goods with shared value

Consider the following economic interaction: Alice and Bob are neighbors and the street they live on does not have a street light.

One street light costs \$50 and Alice and Bob both value that street light at \$40. If they buy more than one street light they get no additional value.

Questions: Should they buy the street light? Who should buy the street light? Will the socially optimal decision be made without co-ordination?

Example 1: non-cooperative world

		Bob: Buy	Bob: Don't Buy
Alice	Buy	$-10, -10$	$-10, 40$
	Don't Buy	$40, -10$	$0, 0$

What is the Nash Equilibrium? Is it efficient?

Both Alice and Bob have a dominant strategy to not buy the street light. This doesn't seem efficient as the total value of the street light exceeds the total cost.

Can we think of a way of redesigning this game to get the efficient outcome? How do these results change if we adjust the numbers?

Example 2: semi-cooperative or "social" world

Now suppose that if both individuals decide to pay, they share the cost.

		Bob: Buy	Bob: Don't Buy
Alice	Buy	$15, 15$	$-10, 40$
Alice	Don't Buy	$40, -10$	$0, 0$

Now that they share the payment if both decides to pay, what is the Nash Equilibrium? Is it efficient?

Even though we've reduced the inefficiency associated with (Buy, Buy), Alice and Bob still have a dominant strategy to not buy the street light. The Nash equilibrium continues to be inefficient and additionally it is Pareto inefficient.

Example 3: high value (low cost world)

Let's increase the value of the street lights to \$60 each and take away the sharing rule. (Equivalently, we could have reduced the cost of the street lights!)

		Bob: Buy	Bob: Don't Buy
Alice	Buy	$10, 10$	$10, 60$
	Don't Buy	$60, 10$	$0, 0$

What is the Nash Equilibrium now? Is it efficient? Would the answer change if I reintroduced the sharing rule?

Now that the values are higher, there are two new equilibrium (Buy, Don't Buy) and (Don't Buy, Buy). Both of these are efficient in the sense we discussed today as well as being Pareto efficient. But which equilibrium will happen and which equilibrium is *fair*?

Example 4: country neighbours

Finally suppose instead Alice and Bob live very far apart and so aren't effected by each others actions. Let's keep the valuations from Example 3.

		Bob: Buy	Bob: Don't Buy
Alice	Buy	$10, 10$	$10, 0$
	Don't Buy	$0, 10$	$0, 0$

What is the Nash Equilibrium now? Is it efficient?

Now their actions are no longer interdependent, and so there payoffs are only determined by their own action. The Nash equilibrium is now (Buy, Buy) and it is efficient as they both value their street light more than the cost.

Public goods

A public good is a good that is,

- nonexcludable: it is impossible to prevent a person from enjoying its benefits, and
- nonrival: its consumption by one person does not decrease its ability to be consumed by other people.

Question: Is a hamburger a public good? What about fresh air?

Other types of goods

	Excludable	Nonexcludable
Rival	*Private Goods* e.g. food	*Common Goods* e.g. fish in a lake
Nonrival	*Club Goods* e.g. cable television	*Public Goods* e.g. air

Examples

Examples of public goods include:

- fresh air
- knowledge
- national security
- street lighting
- firefighting services

Allocative efficiency

If whenever a resource brings society a larger benefit than it costs that resource is allocated and allocated to those who value it the highest, we say that this allocation is allocatively efficient.

In our examples 1-3, the first street light was valued by Alice and Bob by more than the cost and as such, any outcome that involved the one street light being allocated was allocatively efficient. If no street lights were purchased, or if more than one street light was purchased there is some inefficiency we'd like to fix.

What about example 4?

Free markets

When it comes to private goods, as long as any one persons consumption and production of a good does not effect others, a free market allows consumers to purchase a good if they value it more than it costs a producer to create and deliver it. If the consumer values it at less than the producers costs, they will not be able to find a price with which to trade. As such, voluntarily engagement in the market leads to a allocatively efficient outcome!

This observation and its broader application/consequences was first noted by the Scottish philosopher **Adam Smith** in *The Wealth of Nations* (1776).

We saw this in Example 4.

Valuing public goods

How about public goods and Examples 1-3?

Economists measure the value of a public good as the joint amount that all people are willing to pay for it.

Everyone can consume each unit of a public good which means that the marginal benefit for the economy is the sum of marginal benefit of each person for each quantity.

The Free Rider Problem

Because public goods are nonexcludable, consumers can avoid the cost of purchasing the good and still receive the benefits of consuming the good. They do this by waiting for others to buy the good instead of purchasing the good themselves.

This problem is called the free-rider problem: when a good has shared value, some people will be able to "free-ride" by receiving the benefits without contributing to the cost, resulting in the under provision of the good.

Efficient provision of a public good

Recall that the (allocatively) efficient quantity of any good is the quantity such that the marginal social benefit is equal to the marginal social cost.
$\rightarrow$ Unless we have an externality, the marginal social of a public good is the same concept as that of a private good.
$\rightarrow$ As we have seen, the marginal social benefit of a public good is the sum of each individual's marginal benefit.

So we should suspect, as in our examples, private/non-cooperative actions will lead to an underprovision of public goods. How can we overcome the inefficiency problem associated with public goods?

Public Provision (Government):

- Tax all people in economy i.e. force each citizen to pay, and
- provide the efficient amount of the public good.

Potential issues

A tax policy must satisfy:

1. Budget constraint: each individual pays taxes less than their income.
2. Participation constraint: each individual is better off with public provision (and tax) than without.

Ideally, we would also like the provision policy to have the following features:

3. Truth telling: each individual submits their true valuation of the public good so as to identify the efficient amount of production.
4. Fairness: each individual should pay an amount that is proportional to their valuation.

Satisfying all four constraints is very difficult (potentially impossible) to do! See *Arrow's Impossibility Theorem*, and the *Vickery-Clarke-Groves auction*.

Public goods summary

- Public goods are non-rival and non-excludable.
- It is efficient to provide a public good as long as the sum of individual marginal benefits is greater than the marginal cost.
- The free-market tend to underprovide public goods as individuals don't account for the full benefits of their decisions and have an incentive to "free-ride".
- To achieve efficiency, public goods can be provided by the government and financed through taxes. Taxes however are distortionary and the government has to determine the true benefits of the public good.

Tragedy of the Commons

Recall *Common Goods* are goods (or resources) that are nonexcludable but rival.

A related problem to the free-rider problem is the *Tragedy of the Commons*: when the use of a shared-resource cannot be controlled and its use by one person negatively effects the use of others, the resource tends to be overused and becomes depleted/spoiled.
$\rightarrow$ here the free-rider not only rides for free but crowds out other users!

Examples:

- Fishing and fish populations
- Traffic on public roadways
- People at the beach
- Use of the office refrigerator