ETH
Eidgenössische Technische Hochschule Zürich
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IED
Institut für Umweltentscheidungen
Institute for Environmental Decision

The Economics of Climate Change

Lecture 2: An Economics Primer

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Last week we:

- Discussed the scientific problem of global climate change.
- Discussed the targets for greenhouse gas reduction
- Explained the distinction of an economist's view on climate change

In this lecture we will:

- Outline what we mean by **efficiency** and social optimality
- Discuss how a market economy can be efficient and socially optimal
- The problems with free markets: public goods and externalities

Utility and Indifference curves

Animation:

- Indifference curves and utility

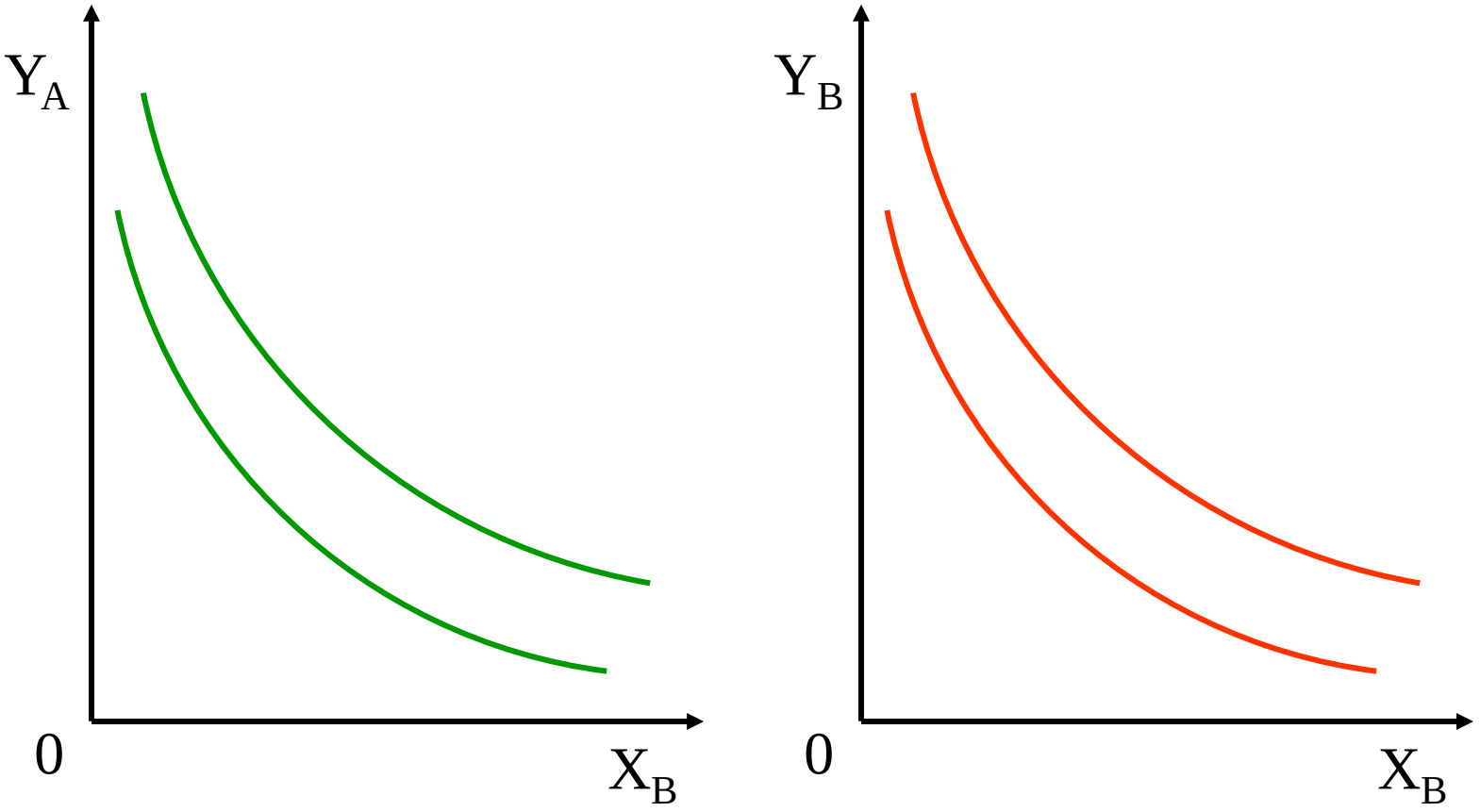
(German version, English comments provided during lecture)

Efficiency and Optimality

Let us assume a simple economy:

- 2 individuals (A,B),
- 2 goods (X,Y) which are produced using two inputs (L,K)
- An "allocation" or "allocation of resources" describes what goods are produced and in what quantities they are produced, which combinations of resource inputs are used and the outputs of those goods are distributed between persons
- **Consumers**
- Individuals' Utility:
  - $U^A = U^A(X^A,Y^A)$
  - $U^B = U^B(X^B,Y^B)$
- for both, utility depends on consumption of goods X and Y

Constructing an Edgeworth Box



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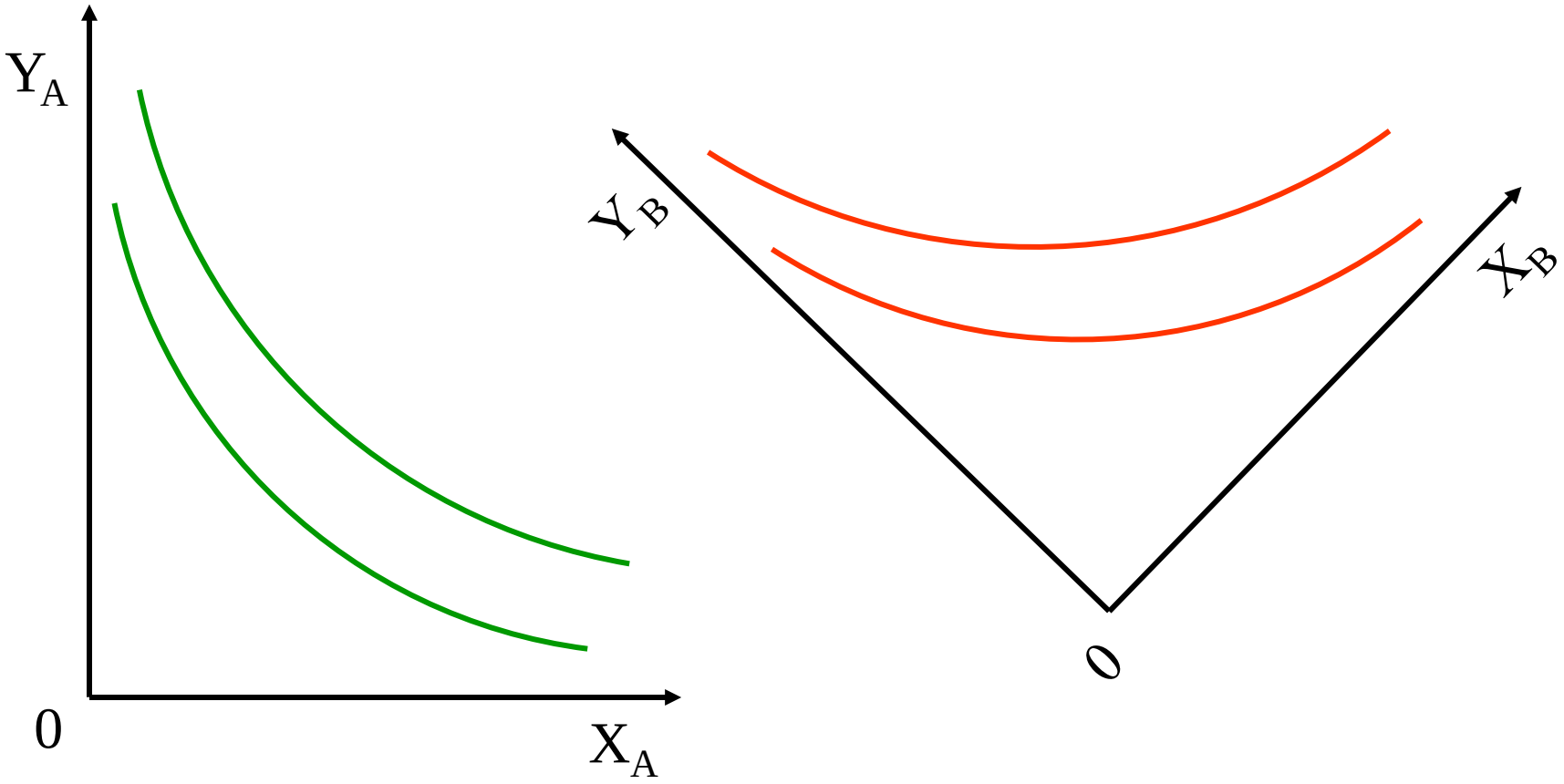

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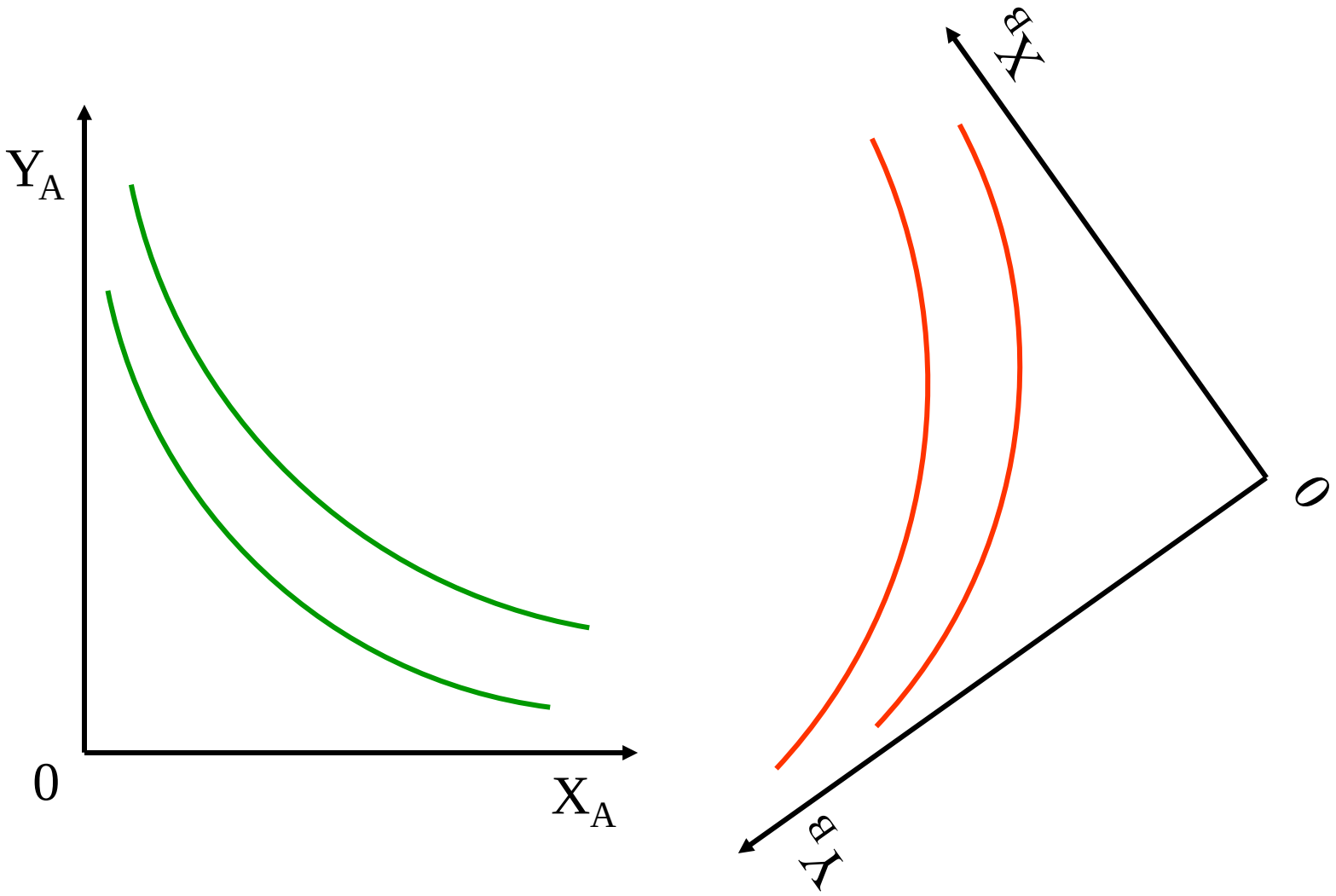

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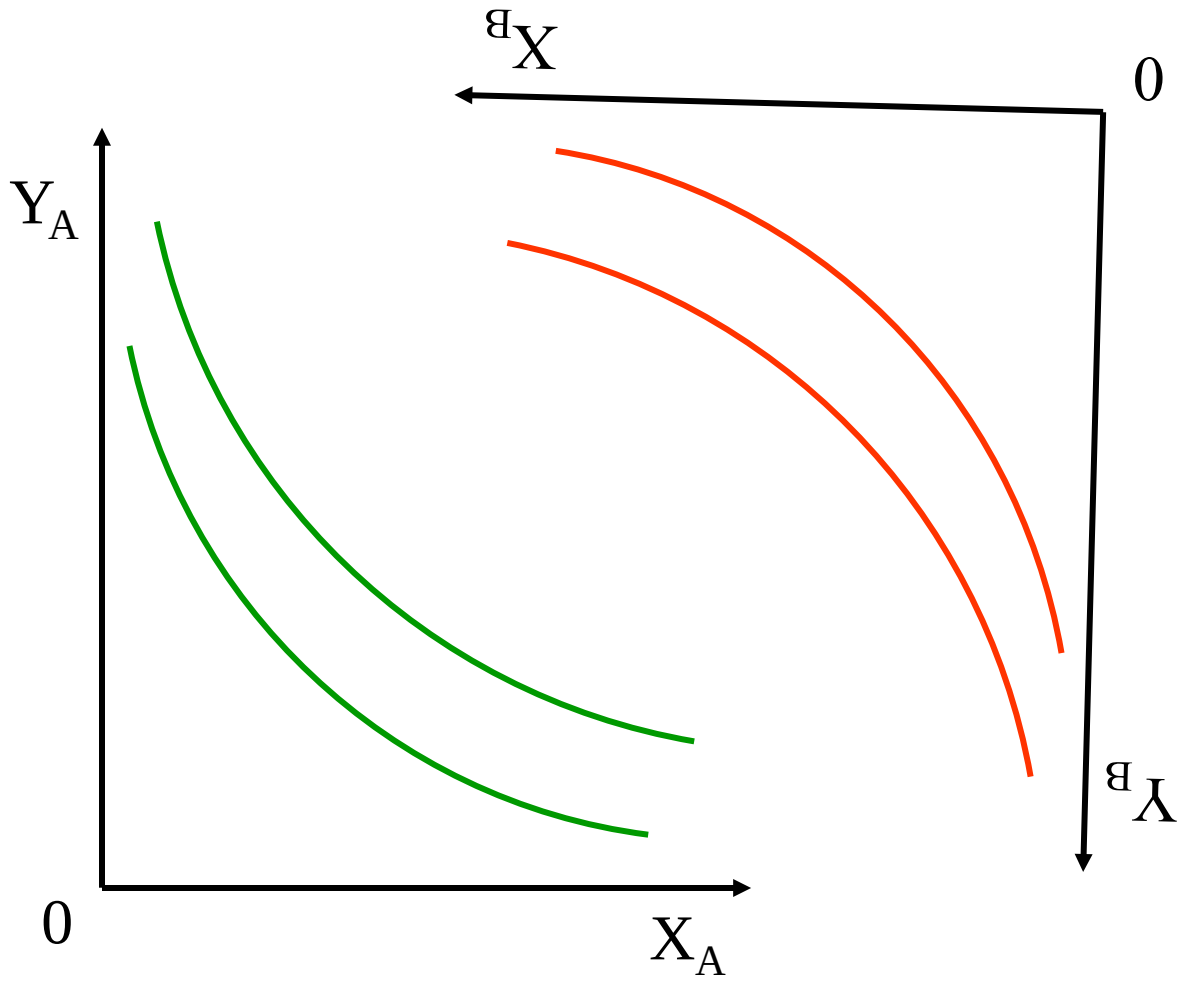

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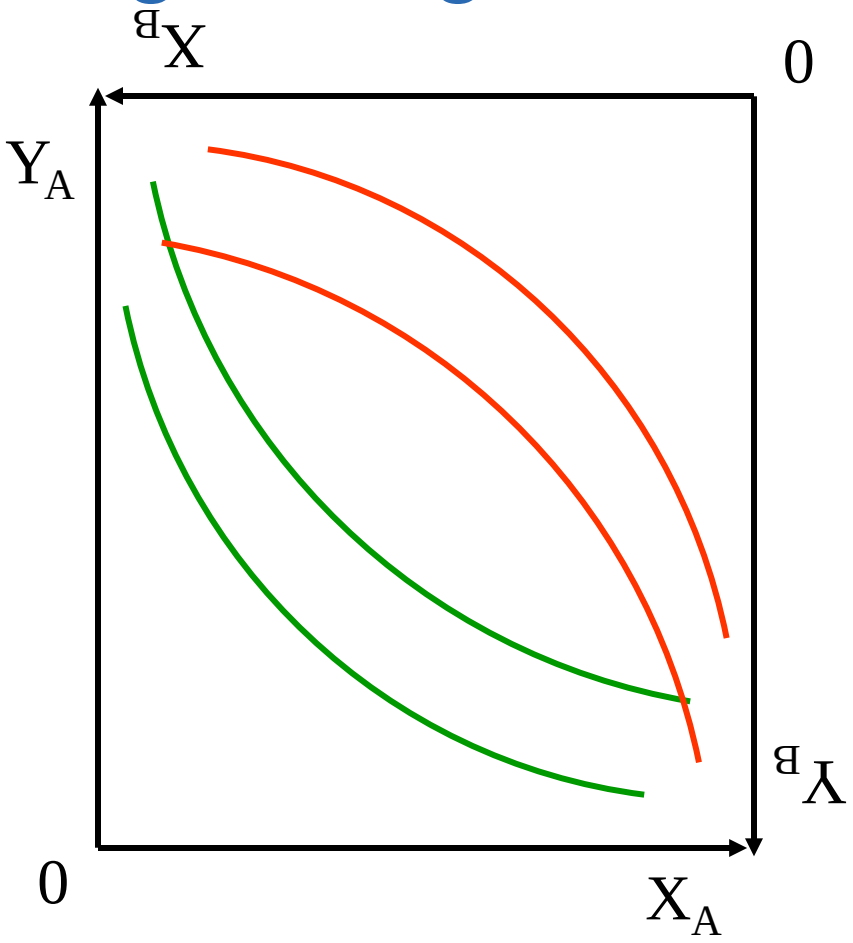
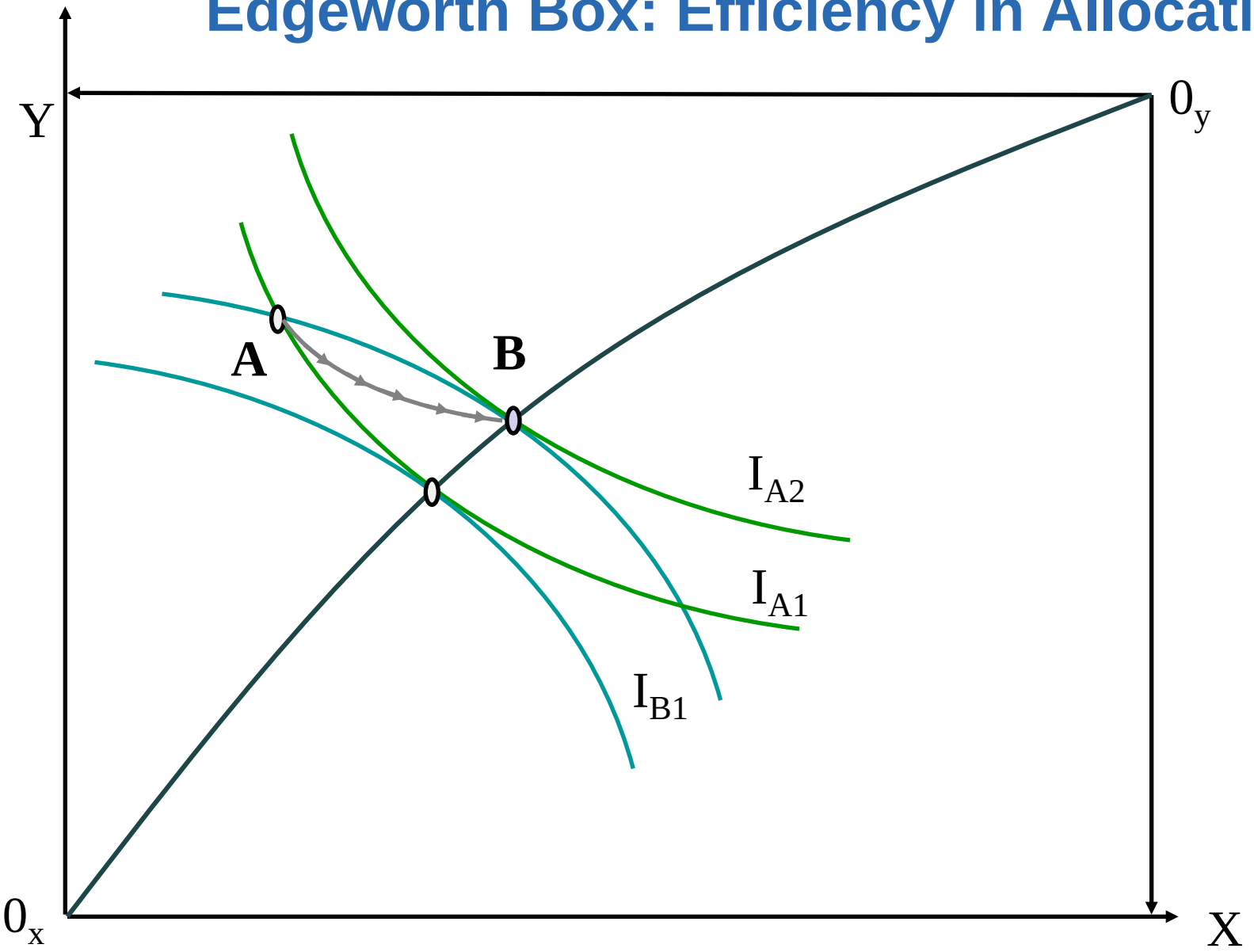


Edgeworth Box: Efficiency in Allocation



Consumption Efficiency

- Marginal rate of substitution for an individual is the rate at which one good can be exchanged for another (slope of indifference curve)
- Efficiency occurs when the marginal rates of utility substitution are equal among the individuals:
- $MRS_A = MRS_B$

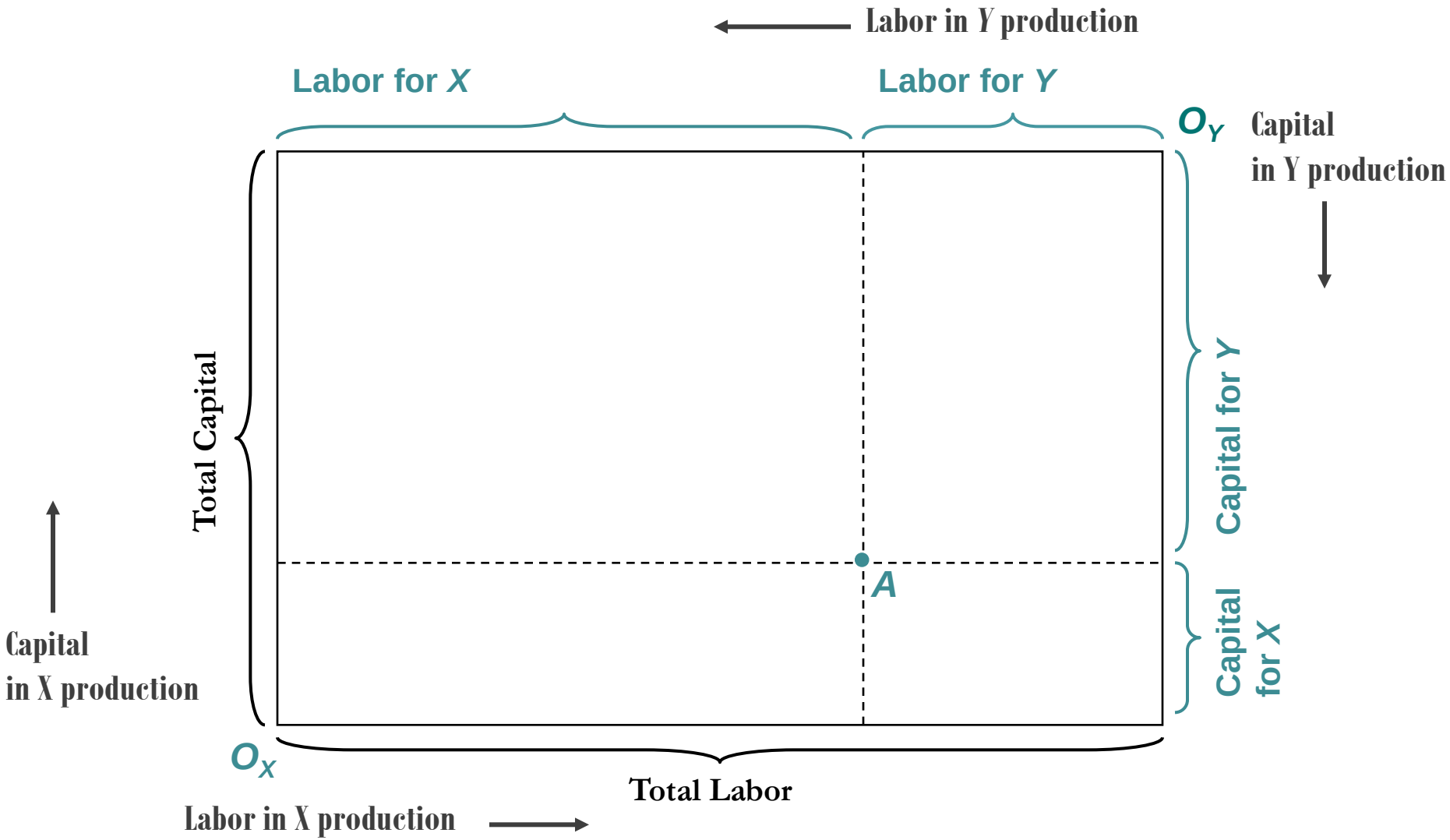
MRS is the slope of their indifference curve for the X-Y space.

- What would happen if this condition did not hold?
- if this was not equal, it would be possible for the allocation of goods (X and Y) to be re-allocated to make someone better off (without making someone better off)

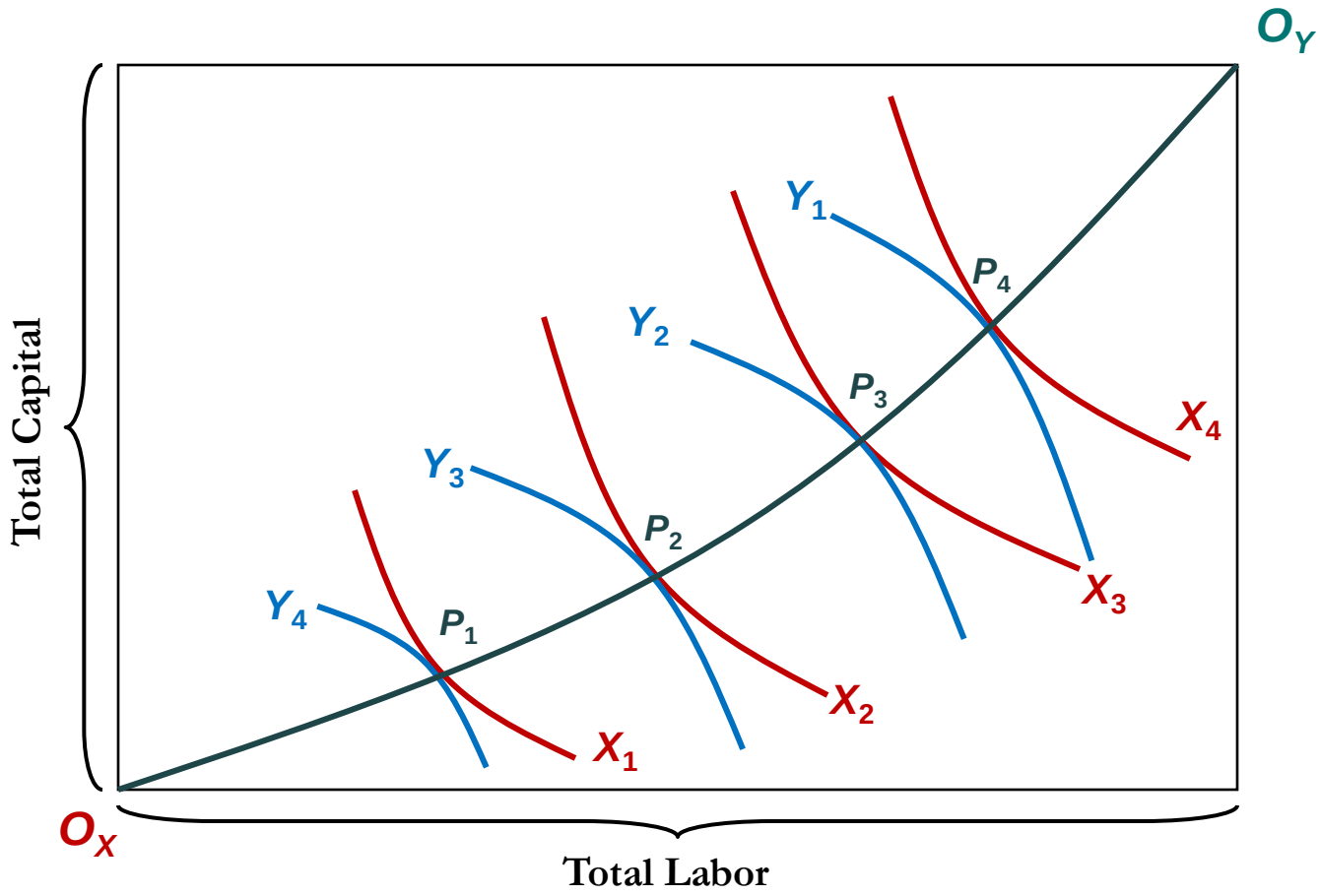
Pareto-Efficiency

- **Efficiency: An allocation (e.g. of X and Y) is efficient if it not possible to make one or more persons better off by changing the allocation.**
- Known as Pareto optimality or Pareto Efficiency
- This type of efficiency in allocation requires efficiency in:
- Consumption
- Production

Allocation of Production Factors



Efficiency in Production



Efficiency in Production

Similar to consumption:

- Efficiency will hold when the **marginal rate of technical substitution (MRTS)** (between the goods X and Y) are identical for both goods:
- $MRTS_X = MRTS_Y$
- If this was not the case it would be feasible to reallocate L and K in such a way to increase the production of one of the goods without reducing the other.

Economy-wide allocations

- Many efficient allocations are possible (for production and consumption)
- Can simply use the utility of agent to describe allocations
- Given a particular allocation (L,K) between X and Y and given this output a particular allocation between A and B consumers. Given these allocations each consumer will have a utility level U^A, U^B

Aggregation of Utilities to a Social Welfare function

- Given a set of efficient allocations, a social optimal allocation is one that maximises social welfare
- Social welfare is given by the preferences $W = W(U^A, U^B)$ with
- $\frac{\partial W}{\partial U^A}, \frac{\partial W}{\partial U^B} > 0$
- Similar to a utility function for the whole society
- Welfare is determined by the utility of both our individuals in the economy
- Efficiency conditions must hold at optimum ($MRS_A = MRS_B$, etc)

Example: The idea of "optimal" pollution

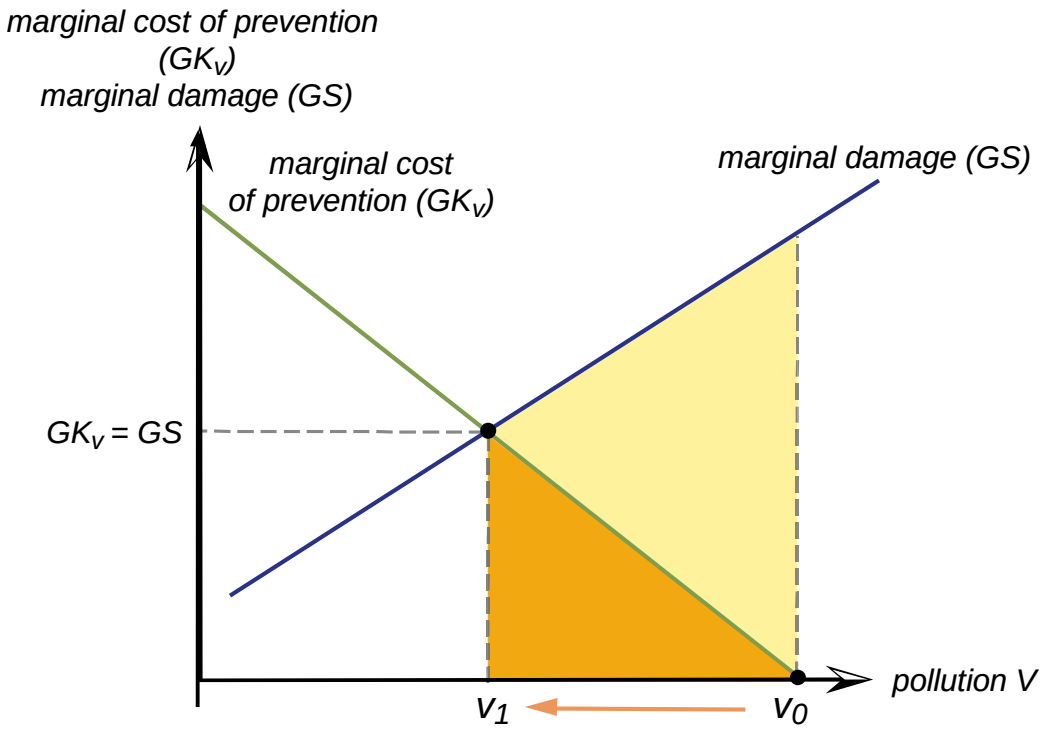
Maximizing Net gains from emission level e:

Benefits B(e) and
Costs C(e) from achieving
a specific emission level e:

$$\max_{e} B(e) - C(e)$$

First Order Condition:

$$\frac{dB(e)}{de} - \frac{dC(e)}{de} = 0$$



$\Rightarrow$ Marginal Damages = Marginal Abatement Costs

Kaldor-Hicks Efficiency

- Under Kaldor–Hicks efficiency, an outcome is considered more efficient if a Pareto optimal outcome can (**but does not necessarily have to**) be reached by arranging sufficient compensation from those that are made better off to those that are made worse off so that all would end up no worse off than before.
- Also known as potential Pareto-efficiency.

The Free Market Allocation

- Majority of societies use free market system to distribute allocations
- Markets are institutions which bring buyers and sellers together.
- Voluntary
- Decentralised information i.e. only relevant information is only needed to be known by buyers and sellers

Efficient decentralised market systems

- Free market system can be shown to meet all the "efficiency“ conditions, i.e. a market system is efficient (and socially optimal) when we assume:
- Markets exist for all goods and services in economy (environmental services?)
- All markets are perfectly competitive
- There exist perfect information (everybody knows everything)
- property rights are assigned to all resources and commodities
- no externalities or public goods
- All behaviour is "well behaved" (firms profit maximise and consumer utility maximise)

Why do markets fail?

- Strong assumptions needed for market system to be efficient and socially optimal.
- Often the market "fails", i.e. the allocation of resources in the economy are not ecient and hence not socially optimal
- Reasons for failure:
- Public goods
- Externalities
- Asymmetric information (moral hazard and adverse selection)

Public Goods

- Let us define two useful phrases. A good (or service) is:
- **Rivalrous:** when an agent's consumption of the good is at the expense of another's consumption
- **Excludable:** when agents can be prevented from consuming the good.

- "Normal" goods experience both of these e.g. groceries, plane ticket
- A pure public good: is non-rivalrous and non-excludable e.g. defence, lighthouses, street lighting.
- However there are a spectrum of types of goods and services:
- Rivalrous and non-excludable: e.g. Open access fisheries, e.g. "Tragedy of the Commons"
- Non-rivalrous and excludable: e.g. national parks (up to a congestion threshold)

How do public goods affect efficiency?

- In a market economy, pure public goods are never produced:
- Intuition: If a private firm was to supply a pure public good, it would pay the costs of provision, but could not charge for the benefits, since it cannot exclude non-payers as no incentive for private supply even if public demand exists.
- Other institutional arrangements have to be set up to provide public goods, i.e. governments.

Free-riding Behavior

- Everyone profits from public goods even if he or she does not contribute to the production costs

  $\Rightarrow$ A rational actor (Homo oeconomicus) has no incentive to contribute to the public good

  $\Rightarrow$ Supply < demand

  $\Rightarrow$ Collectively optimal (efficient) solution and individually optimal behavior diverge (Prisoners' Dilemma)

The Prisoners‘ Dilemma -
collectively versus individually best strategies

player 2 / player 1	confess	not confess
confess	(4 ,4)	(1 ,5)
not confess	(5 ,1)	(2 ,2)

In the environmental context…

user 2 / user 1	participation	non-participation
participation	(20 , 20)	(-10 , 30)
non-participation	(30, -10)	(0 , 0)

Incentive Problem with Public goods

- Sum of individual distributions of the public good does not yield the social optimum

$$\underbrace{\max_{Q} \sum_{i=1}^{n} u(Q) - c(Q)}_{\text{Social Optimum over aggregate Q}} \neq \underbrace{\sum_{i=1}^{n} (\max_{q_i} [u_i(q_i + \sum_{k \neq i} (q_k^*)) - c_i(q_i)]}_{\text{Sum of individual net utilities from providing share } q_i}$$

$$\text{where } Q = \sum_i q_i$$

- Incentive for „Free-Riding“
- Result: Underprovision of Public Goods
- Problem of „collective action“

Externalities

- Definition:

"An externality is present whenever some individual's utility or production relationships include real. . . variables, whose values are chosen by others. . . without particular attention to the effects on that person's welfare." (Baumol and Oates, 1988)

Important points:

- Real variables - a shift in production/consumption possibilities
- Externality is produced without consideration for others-it is
- No compensation to victim or beneficiary of externality.

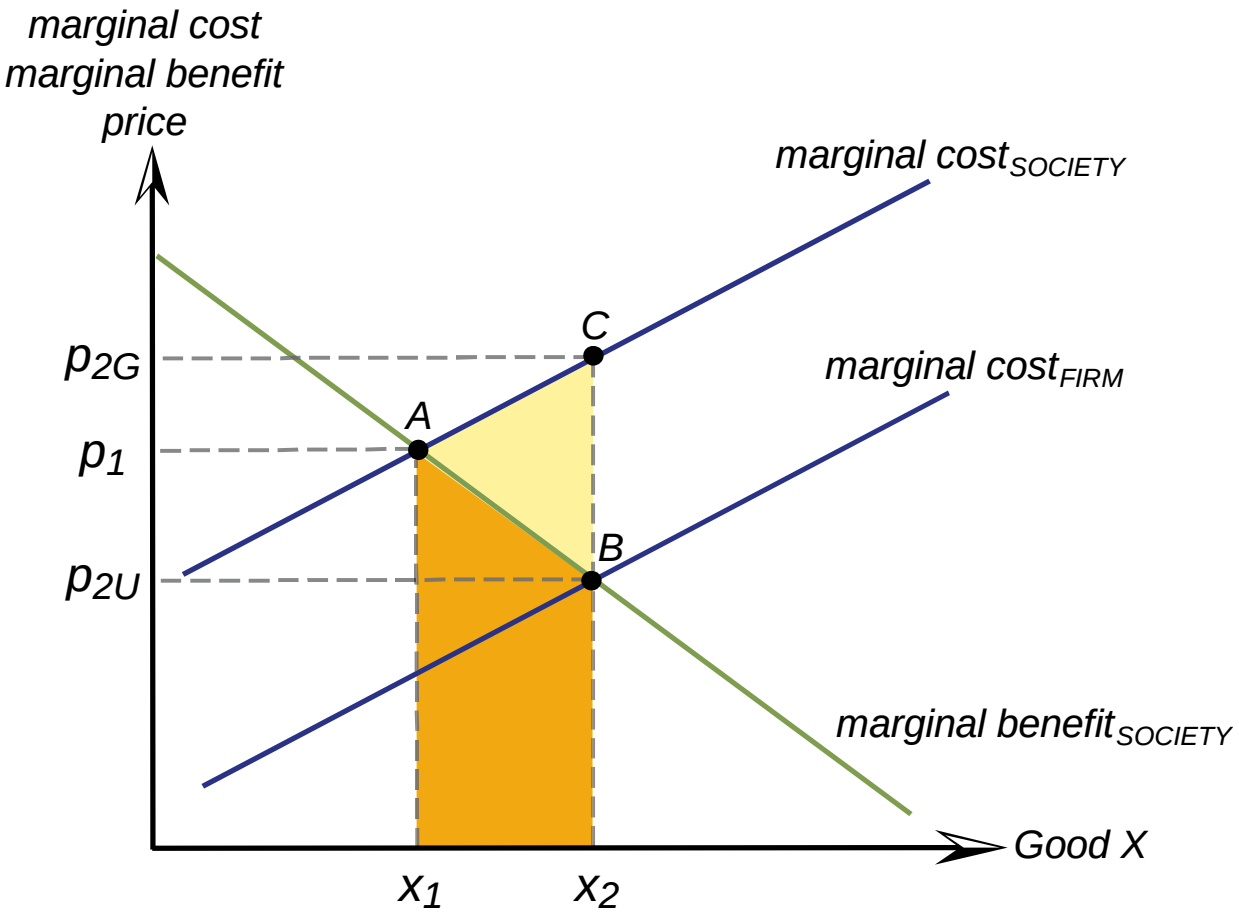
Externalities can be:

- Positive (external benefit)e.g. Vaccinations protect against disease for individual but also help prevent the spread of the disease too - benefit to wider society
- Negative (external cost), e.g. pollution
- Again note that in both cases, no compensation or payment exists between the two parties
- Externalities can be either public or private goods, however, most likely they are public goods (will assume this throughout this course).

Why do externalities create inefficiencies in markets

- Costs/Benefits of externalities are not borne by decision makers so therefore not taken into account when decisions are made. (allocatively inefficient)
- Externalities causes allocative inefficiency:
- Positive externality- not enough externality is produced compared to the allocative efficient outcome
- Negative externality - too much externality is produced compared to
- the ecient outcome.

Internalization of external costs



Note:
Apart from the here-depicted loss in **static** efficiency, external effects can effectively distort investment inventives, entailing losses in dynamic efficiency as well.

Climate change as an externality

- Climate change or the accumulation of GHG is a negative externality on all citizens of the world.
- Agents choose actions such as driving cars, producing goods which produce pollution as a by-product.
- pollution being emitted compared to the allocatively efficient outcome. (we show this diagrammatically next lecture)
- The effect of GHG is a public "bad" (good).