- **Kursi intensiv: Climate and Green Finance Agenda in EU**

The economics of CC and Sustainability Policies

Jean Monnet Module **"Promoting knowledge on EU policy in fiscal administration, climate, and energy topics – PRO-Facts"**

Presentation outline

- Sustainable development
- Market failures and climate change
- Valuation of CC impacts
- Decision making and CBA
- Case Study

Sustainable development (SD)

- SD concerned with conserving environmental resources or "natural capital"

- For any generation, having more environmental capital means more options for society.

Sustainable development (SD)

- Most definitions concerned with preventing the loss of natural capital

- SD associated with non-declining wellbeing between generations

- Leaving capital stock for future generations

Sustainable development (SD)

- Maintain growth options (current generation)
- Some economists suggest that we should preserve the value of all capital stocks
- Natural + man-made capital
- We should undertake projects that at least compensate for damage to natural capital

Climate change…

- An ethical concern?
    - Inequality
    - Poverty
    - Social impacts
    - Responsibility

- An economic concern?
    - Values
    - Costs
    - Benefits

Some economic concepts

- Externalities
- Market failure
- Public Goods
- Marginal costs
- Public Policies
- Welfare
- Cost benefit analysis

Climate change – A market failure

- Climate is a public good:
    - those who fail to pay for it cannot be excluded from enjoying its benefits and one person's enjoyment of the climate does not diminish the capacity of others to enjoy it too.
- Climate change is an externality:
    - Those who produce greenhouse-gas emissions are bringing about climate change
    - Costs on the world and on future generations
    - Who face the full consequences of the costs of their actions?
    - No economic incentive to reduce emissions
    - Not 'corrected' through any institution or market, unless policy intervenes.

What type of externality

- Global

- Persistent and escalating impacts

- Uncertainties

- Impact on global economy

Welfare and climate change

- Inequality:
  - poor countries, and poor people in any given country, suffer the most
  - the rich countries are responsible for the bulk of past missions.
- Ethical issues
  - how people in one country or region should react to the impacts of their actions on those in another.
  - how consequences for people in very different circumstances should be aggregated must be faced directly.

Valuing the impacts of climate change
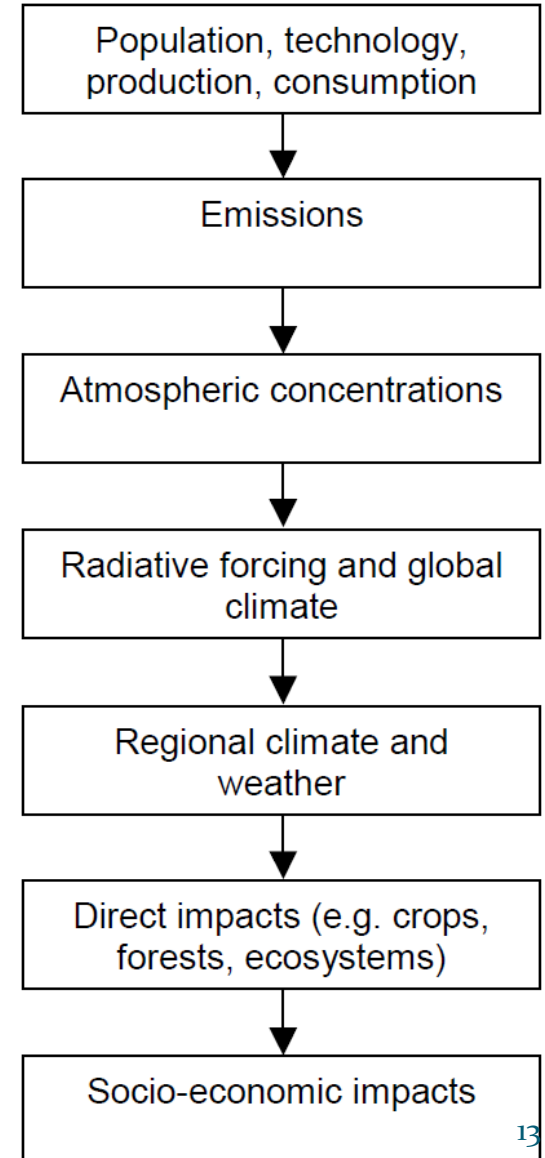
- Some issues:
  - Scale
  - Costs
  - Benefits
  - Methods
  - Discounting
  - Decision making
  - Investing

Scale of Impacts

- Extreme weather events
- Health
- Agriculture
- Poverty

- Local vs global
- Developing countries vs Developed countries

- Growth and GDP

Global impacts of CC

- Integrated Assessment Models (IAMs)
- Uncertainty and risk
- Time value of money
- Market values vs Non-Market values
- Comparing cost of CC with Cost of Adaptation and Mitigation
- Different Models

Population, technology, production, consumption

↓

Emissions

↓

Atmospheric concentrations

↓

Radiative forcing and global climate

↓

Regional climate and weather

↓

Direct impacts (e.g. crops, forests, ecosystems)

↓

Socio-economic impacts

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Valuing The Environment

- What does 'economic value of the environment' mean?
- How do we measure it, in principle?
- Why measure environmental values?
- Which methods to be used?

Why Measure Environmental Values?

- Use in environmental cost-benefit analysis for *policy* and *project* appraisal
- environmental management: e.g. coastal management increases recreational visits
- eco-tax setting: e.g. landfill tax, quarrying tax, carbon tax
- use in environmental adjustments to national accounts
- damage assessments

"Investing" in the climate

- Governments protect the environment in a number of ways
- Laws and regulations
- Environmental standards for production
- But how much should we spend on environmental protection?
  - Cost vs Benefits

Costs & benefits of environmental protection

- Cost-benefit analysis (CBA)
- Decision making tool to identify investments
- E.g. building new roads, hospitals or schools
- But also: to spend on environmental protection e.g. water quality standards, or protected areas
- Do benefits outweigh costs?

Challenges.....

- What challenges do we face in measuring costs and benefits ?
- A hospital : costs?
- But what are the benefits ?
- A school: costs/benefits?
- A new road: costs/benefits?
- Protecting an existing wetland: costs/benefits?
- The environment : non-market impacts

The environment : non-market benefits

- Most environmental projects deliver non -market goods e.g. biodiversity, clean environments, good health

- These are non-market goods

- Fish, timber, drinking water – these are market goods – e.g. prices exist to value them

Measuring Environmental Values: Principles

- Theory behind environmental valuation is the same as that used to identify and understand demand curves for market goods

- What we measure:
  - Willingness to pay (WTP): the most you would be willing to give up to have something good (or avoid something bad)
  - Willingness to accept compensation (WTAC): the least you would accept in compensation to forego something good (or put with something bad)

What valuation method to use?

- You will often be able to identify some environmental impacts that can be related directly to market prices (e.g. lost fish catch , timber harvesting or non timber forest products.

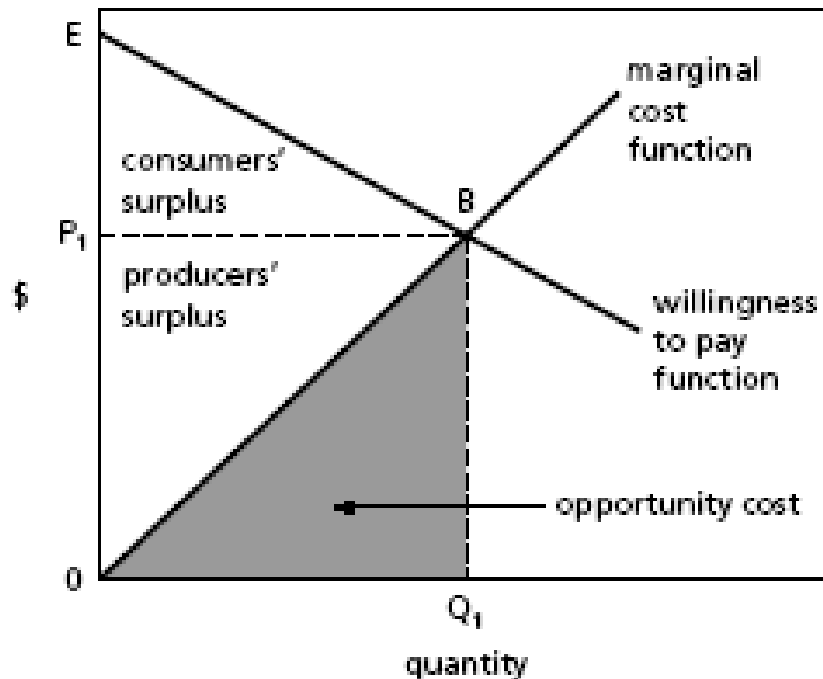- More elaborate valuation methods may be required for bigger projects;

Keep it simple!

What is value?

- First, the economic view of "value" is anthropocentric.
- This means value is determined by people and not by either natural law or government.
- Second, value is determined by peoples' willingness to make trade-offs.
- When an individual spends money on one good, there is less available for other goods.

Value for market goods

- For market goods, the demand and supply curves can be observed and derived

- Consumers surplus and producer surplus

- Net value for a market good is equal to the sum of CS + PS

E

consumers'
surplus

marginal
cost
function

B

P_1

producers'
surplus

$

willingness
to pay
function

opportunity cost

0

Q_1

quantity

Value and Non-market Goods

- We do not observe prices for non-market goods, so it is hard to estimate supply/demand functions
- Non-market goods may have both direct use, indirect use and non use values.
  - Direct use values are associated with tangible uses of environmental resources
  - Indirect use values are associated with indirect benefits from ecological services
  - NUV are those associated with more intangible uses of the environment
  - Not mutually exclusive

Non-use values

- Bequest values
  - Bequest value refers to the fact that an individual values having an environmental resource or general environmental quality available for his/her children or grandchildren to experience.
- Existence value
  - Existence value refers to the fact that an individual's utility may be increased by the knowledge of the existence of an environmental resource even though the individual has no current or potential direct use of the resource.
- Altruistic value
  - Altruistic value occurs out of one individual's concern for another. A person values the environment not just because that person benefits from the environmental quality but because the person values the opportunity for other people to enjoy high environmental quality.

ECONOMIC VALUE OF THE ENVIRONMENT

Environmental impact - e.g. deforestation

Use value

Non-use/passive use value

Direct use value

Indirect use value

Option use value

Bequest value

Existence value

e.g. timber revenues

e.g. recreation (various forms) carbon fixing

e.g. future personal recreation

e.g. future generations' recreation, or nature preservation wants

e.g. preserving biodiversity

from development

from conservation

Total Development benefits

Total conservation benefits

Techniques for Measuring the Value of Non-market Goods

- 3 major categories for measuring the value of non-market goods include:
  - Revealed preference techniques, which look at decisions people make in reaction to changes in environmental quality.
  - Stated preference techniques, which elicit values directly through survey methods.
  - Benefits-transferred techniques, which look at existing studies for value of analogous environmental change.

Revealed Preference Approaches-
1. Hedonic Pricing Technique

- Market prices - many environmental goods can have a market price (e.g. Fish catch)

- Hedonic pricing techniques are based on the theory of consumer behavior that suggests that people value a good because they value the characteristics of that good rather than the good itself.

- An examination of how the price of the good varies with change in the levels of these characteristics can reveal the prices (value) of the characteristics.

Hedonic Pricing Technique

- Assume that all the characteristics of houses and neighborhoods are the same throughout the city.

- Houses with higher air quality would have higher prices.

- This positive relationship can be represented by the following equation:

  - $H = a + bQ$,

  - where H is housing price, Q is air quality and "b" tells the researcher how many units H will increase with each unit of air quality.

Revealed Preference Approaches- 2. Travel Cost Model

- The travel cost model is a method for valuing environmental resources associated with recreational activity and was first proposed by Harold Hotelling in 1947.
- The basic premise is that travel cost to a site can be regarded as the price of access to the site.
- Multiple observations on travel cost and quantity of visits can be used to estimate a demand curve.
- Composition of a demand curve for visits to the area

Travel Cost Model

- Methodological issues :
  - How to incorporate the opportunity cost of travel time.
  - How to properly account for substitutes (multiple sites).
  - How to account for a variety of sampling biases (over-response by frequent visitors, under-response by infrequent visitors)
  - How to properly measure recreational quality and relate this to environmental quality.

Stated Preference Techniques- 1. Contingent Valuation

- The questions used in contingent valuation can take both open-ended and close-ended form.

- In open-ended questions, respondents are asked to state their maximum WTP.

- In close-ended questions, respondents are asked to say whether or not they would be WTP a particular amount.

- The questions must also specify the mechanism by which payment will be made.

Contingent Valuation: Problems

- Information is provided about cause and effect.
- The payment vehicle is clearly stated and is appropriate to the particular problem.
- Care must be taken so that the contingent valuation exercise does not become a referendum on the payment vehicle, for example the choice to raise taxes.
- WTP vs WTA
- Carefully consider the responses

Stated Preference Techniques- 2. Choice experiments

- Determining individual preferences across different levels of characteristics of a multi-attribute choice.

- Consumers are asked to state which of 2 hypothetical goods they prefer, each having a stated level of different characteristics.

- These choices can be made in a pair-wise fashion or by ranking a number of alternatives.

- Statistical techniques are used to establish a relationship between characteristics and preference.

Benefit Transfer Approaches

- The process of estimating values using revealed preferences or stated preferences approaches can be quite expensive.
- Taking values from studies that were previously completed in other areas, and applying them to the area where the new decision must be made.
- It is important to use a reference study that is congruous.
- If many reference studies are available, the process becomes much easier.
- The appropriate reference study can be chosen, or a weighted average of the values can be employed, where weights are chosen according to similarity between the reference study and the problem at hand.

Non-willingness to Pay Based Value Measures

- Avoidance cost – the cost people incur to avoid the negative consequences of an environmental change.

- Replacement cost – the cost of recreating what was lost to environmental change.

- Restoration cost – the cost of repairing the environmental damage.

Stages of CBA

- Definition of Project
- Identification of project impacts
- Physical quantification of relevant impacts
- Which impacts are economically relevant? .
- Monetary valuation of relevant effects
- Discounting the cost and benefit flows
- Applying the Net Present Value Test
- Sensitivity Analysis

CBA for Climate change action

- CBA and climate change:
  - Mitigation
  - Adaptation
- We should treat adaptation and mitigation investments like other projects
- Adaption/mitigation investments are a cost
- But they mean we avoid impacts
- In other words they provide benefits

Definition of Project

- For a given cost how big are the benefits of an adaptation ?

- Let's look at managed realignment of coastal defences
- Suppose we are considering a project that has a life of 10 years

Managed realignment

Landward restoration of saltmarsh
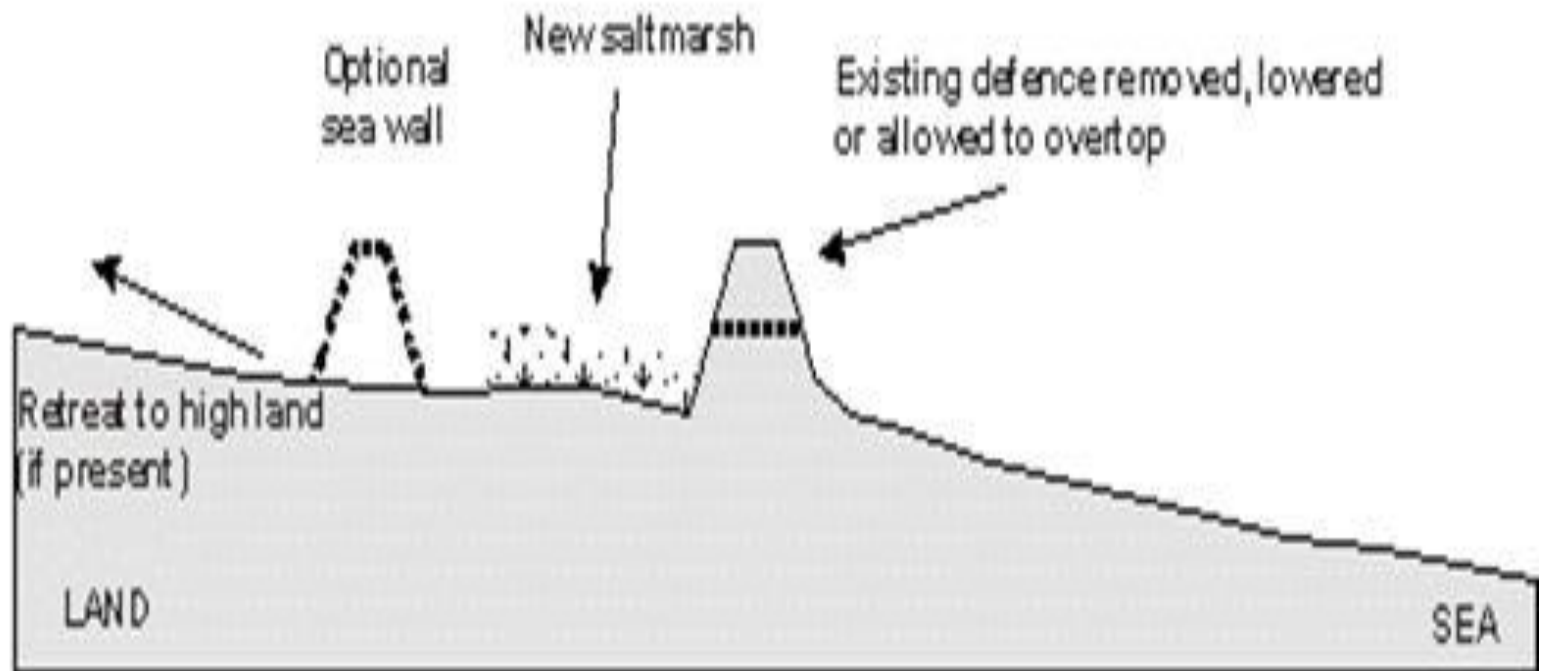
Identification of project impacts

- Costs of moving sea defences
- Costs of managing land around existing defence
- Loss of some land and productive possibilities - e.g. loss of agricultural production

Identification of project impacts

- Benefits?
    - Reduction of damaging floods
    - Creation of new wildlife habitats
    - Recreational visits

- Decision making: are benefits >costs ?

Physical quantification of relevant impacts

- Investment costs –e.g. labour & materials

- Costs of foregone agricultural production

- Land purchase or simply the value of foregone crop revenues

Physical quantification of relevant impacts

- <u>Benefits</u>:
- Biodiversity   ?
- Fish catch (quantity * price)
- Fewer flooding episodes (avoided cost)
- Recreational visits? (quantity of visits * value)

Which impacts are economically relevant?

- Translate the prices and quantities into values that can be entered into a spreadsheet as a cost or benefit

- E.g. annual increased fish catch
- Before 600 tonnes * $40/tonne = $24000
- After 750 * 40 = 30000
- Benefit = 30000 – 24000 = 6000
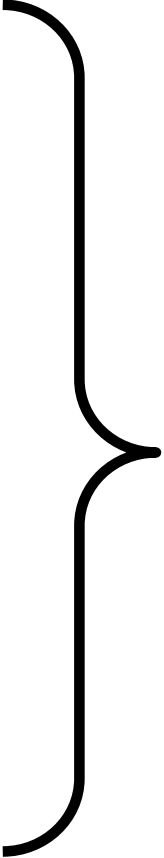
How to deal with values which occur through time?

- The time value of money - we prefer goodies now rather than later

- Discounting - provides a means to collapse different flows to their present value equivalent for comparison.

- The discount rate - Indicates how much more a society values a $1 today compared with a #1 next year.

- Opportunity Costs, i.e. the sacrifice made for not investing in another project.

- The net present value – the discounted value of chash flows from a project minus the project cost

Discounting

- Why Discounting?

- Ramsey equation:
  - $r = \rho + \eta \cdot g$
  - ρ – Time preference ; η – coefficient related to utility; and g – growth rates .

- 0.1 - 2.5%

- Declining discount rates

Net Present Value

Year	Cash flows
Year 0	$-C_0$
Year 1	$C_1 \times \dfrac{1}{(1+r)^1}$
Year 2	$C_2 \times \dfrac{1}{(1+r)^2}$
Year 3	$C_3 \times \dfrac{1}{(1+r)^3}$
Year 4	$C_4 \times \dfrac{1}{(1+r)^4}$
Year ...	....
Year n	$C_n \times \dfrac{1}{(1+r)^n}$

$$\sum \quad NPV = \sum_{n=1}^{N} \frac{C_n}{(1+r)^n} - C_0$$

Sensitivity Analysis

- Apply to all projects with quantified benefits and costs
- Involves recalculating project results for different values of major variables and combinations of variables.
- Developing "what if" scenarios
- In this way, the CBA becomes more robust concerning any challenges to its original assumptions.

Readings

- King, D. and M. Mazzotta (no date). "Ecosystem Valuation": www.ecosystemvaluation.org

- Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Chapter 17

- Stern Review (2006):
  - Chapter 2 and 6