ILHAM-EC

Introduction to Cost-Benefit Analysis

Dr Nicola Favretto n.favretto@leeds.ac.uk

UNIVERSITY OF LEEDS

Co-funded by the Erasmus+ Programme of the European Union

Acknowledgements: Dr Julia Martin Ortega and Prof Jouni Paavola, University of Leeds

Learning goal and outline

LEARNING GOAL

- To understand the welfare-economic basis of Cost-Benefit Analysis (CBA) and be able to conduct a simple CBA

OUTLINE

- Welfare economics and CBA: welfare, well-being, utility, Pareto efficiency
- CBA framework and scenario development under multiple timeframes for analysis
- Discounting and indicators of economic viability
- Discussion on empirical findings
- Sensitivity analysis: how to test the validity of results

Welfare economics and utility

- Branch of economics concerned with the effects that decisions on resource allocation have on **welfare**
- Welfare is the state of **well-being** of an individual or a society
- **Utility & environment**: People increase their utility by consuming services provided by ecosystems …The status of ecosystems affects human well-being

Welfare criteria: efficient allocation

- **Pareto efficiency:** Economic change is desirable if in the new situation **no one** is **worse off than before** and at least one agent is better off
  - difficult to mobilise because few policies or projects have only beneficial or neutral consequences. Somebody is almost surely made worse off by them
  - a "**potential Pareto-improvement**" (PPI) occurs if the gainers could **compensate** the losers and still benefit
  - **Cost-Benefit Analysis** mobilises this idea by quantifying benefits and costs of a change & **testing if the winners could compensate losers**

Vilfredo Pareto
(1848 – 1923)

Cost-Benefit Analysis (CBA)

- CBA is a tool used to **assess the economic feasibility of a public policy or project**
  - *"Is an action, planned change or project worth undertaking?"*
- Based on the principles of **welfare economics**:
  - Individuals behave in a rational way **maximising** their **utility**
  - They express their **preferences (values)** through their choices
  - **Markets** provide the context in which preferences are revealed and measured in terms of **Willingness To Pay** (monetary units)
  - Social preferences are the sum of individual preferences of all members of society
- CBA provides the **rules for aggregating preferences** so that is possible to speak of a **social preference** for or against something

CBA

- CBA helps decide which option **maximises social utility** (well-being)
- Consists of **comparing costs and benefits** of the consequences of a policy or a project **to all members of society**
  - If cost > benefits = don't do it
  - If costs < benefits = do it

CBA

- **Incremental net benefits**: Costs and benefits are quantified in monetary terms and **aggregated across time**

Year	1	2	3	4	5
Benefits from land	$	$	$	$	$
Costs of using land	$	$	$	$	$
Net benefits from action	**$**	**$**	**$**	**$**	**$**
Incremental net benefits	**= net benefits from action minus net benefits from business as usual**				

… If incremental net benefits > 0, we should take action!

Scenario development: with and without change

Without change (business-as-usual) : baseline

With change: what we want to achieve

- Estimate associated costs and benefits for each scenario

Costs of "inaction" (opportunity costs): max benefits from "without change" – max benefits that could be derived from "with change"

Decision-making framework

Starting point:

A given piece of land, for a given legal, political and economic context

Decision-making framework

Starting point:

A given piece of land, for a given legal, political and economic context

3 scenarios for action:

- Improved productivity
- Do nothing (business as usual)
- Alternative livelihoods (economic activities)

Decision-making framework

Starting point:

A given piece of land, for a given legal, political and economic context

3 scenarios for action:

- Improved productivity
- Do nothing (business as usual)
- Alternative livelihoods (economic activities)

Estimate total economic value of economic costs & benefits:

- Net economic benefit from Improved productivity
- Net economic benefit from business as usual
- Net economic benefit from Alternative livelihoods

Decision-making framework

Starting point:

A given piece of land, for a given legal, political and economic context

3 scenarios for action:

- Improved productivity
- Do nothing (business as usual)
- Alternative livelihoods (economic activities)

Estimate total economic value of economic costs & benefits:

- Net economic benefit from Improved productivity
- Net economic benefit from business as usual
- Net economic benefit from Alternative livelihoods

Choose option with **greatest net economic benefit for action** (or inaction) and adapt legal, political and economic context to enable adoption of chosen option

CBA steps

1. CBA Defining the project (alternative scenarios)
2. Identifying project impacts (what to analyse, time period)
3. Physical quantification of impacts
4. Estimation of costs and valuation of benefits
   - predict how value flows extend into future
   - calculate prices where none exist
5. Determination of net present value & other performance indicators
6. Assessing the sensitivity of the results

Discounting and Net Present Value (NPV)

- Projects and policies often have impact over a period of time, so costs and benefits need to be **aggregated over time**
- Future costs and benefits need to be '**discounted**' relative to present values
  - Because money is not worth the same over time

- *Question: what do you prefer, £1000 today or £1000 in one year?*
  - People have a **preference for the present** over the future
  - **Money has it own market**: if you get £1000 today you can invest it and have more money in the future
    - If we had £1000 now and would earn annual interest of 5 percent, our savings would increase to £ 1276 in 5 years

Discounting and Net Present Value (NPV)

- When **comparing costs and benefits over** a period of **time**, we cannot just add them and subtract them (they are **not worth the same**!)
- **Discounting** is the mechanism to adjust the value of something in the future **to today's term**

Year	1	2	3	4	5
Benefits from land	$	$	$	$	$
Costs of using land	$	$	$	$	$
Net benefits from action	**$**	**$**	**$**	**$**	**$**

- **Net Present Value (NPV)** is the value today of a given stream of costs and benefits through time in the future
- **Discount rate** is the factor by which future's costs or benefits are discounted to today's value

Calculating NPV

$$NPV = \sum_{t=0}^{n} \frac{(B_t - C_t)}{(1+r)^t}$$

- A project is **economically feasible** if it has a **positive NPV**
  - Which option does **maximise social utility?**
- The **discount rate** we chose is going to **fundamentally affect the NPV** that we obtain
  - It determines the **factor** by which costs and benefits need to be discounted:

$$DF = \frac{1}{(1+r)^t}$$

- **Question**: what happens with low discount rates? And with high discount rates?
  - Higher discount rates reduce the net present value

Present value of £100…

- There are two approaches to choosing the discount rate:
  - The **opportunity cost of capital** = market rate of interest
  - **Social rate of time preference**, lower than market rate

- Present value of £100 to be received in 1, 5 or 10 years according to different discount rates

Discount factor: $DF = \frac{1}{(1+r)^t}$

r(%)	Present Value			
	Year 0	1 year	5 years	10 years
1%	£100	£99.01	£95.15	£90.53
5%	£100	£95.24	£78.35	£61.39
10%	£100	£90.91	£62.09	£38.55
20%	£100	£83.33	£40.19	£16.15
50%	£100	£66.67	£13.17	£1.73

Other indicators of economic performance

	Net Present Value (NPV)	Internal Rate of Return (IRR)	Benefit-Cost (B/C) Ratio
Computation	Sum of present value of incremental net benefits over several years	Discount rate that leads to NPV=0	Sum of discounted incremental benefits divided by the discounted incremental costs
Go ahead	NPV > 0	IRR > opportunity cost of capital	B/C > 1
Stop	NPV < 0	IRR < opportunity cost of capital	B/C < 1

- **Opportunity cost** of capital is the average rate of return from (other) investments
- The **higher a project's IRR**, the more attractive is the project because it is **less risky** (less exposed to changes in the discount rate)

Group discussion

- Does a higher or lower discount rate favour the environment?

- A **high discount rate penalises projects whose costs are in the present with benefits in the future**. What does this means in terms of climate change?

  - To do something about climate change, we need to incur in lots of costs now but we will only see the benefits in the future…. Therefore **if we apply high discount rates, it won't make it worthwhile to invest in climate change mitigation and adaptation**.

Case study: agroforestry in Mali

Baseline land use
STARTING POINT

→

Agroforestry and reforestation
SCENARIO SETTING

	r = 2.5%	r = 5%	r = 10%
Smallholder farmers	NPV USD/ha/yr: 62.2 B-C ratio / ha: 5.9	NPV USD/ha/yr: 55.6 B-C ratio / ha: 5.4	NPV USD/ha/yr: 17.9 B-C ratio / ha: 5.2
Forest community	NPV USD/ha/yr: 72.1 B-C ratio / ha: 3.0	NPV USD/ha/yr: 58.7 B-C ratio / ha: 2.7	NPV USD/ha/yr: 13.6 B-C ratio / ha: 1.7
Global society	NPV USD/ha/yr: 1,405.4 B-C ratio / ha: 49.5	NPV USD/ha/yr: 428.8 B-C ratio / ha: 13.6	NPV USD/ha/yr: 13.6 B-C ratio / ha: 1.7

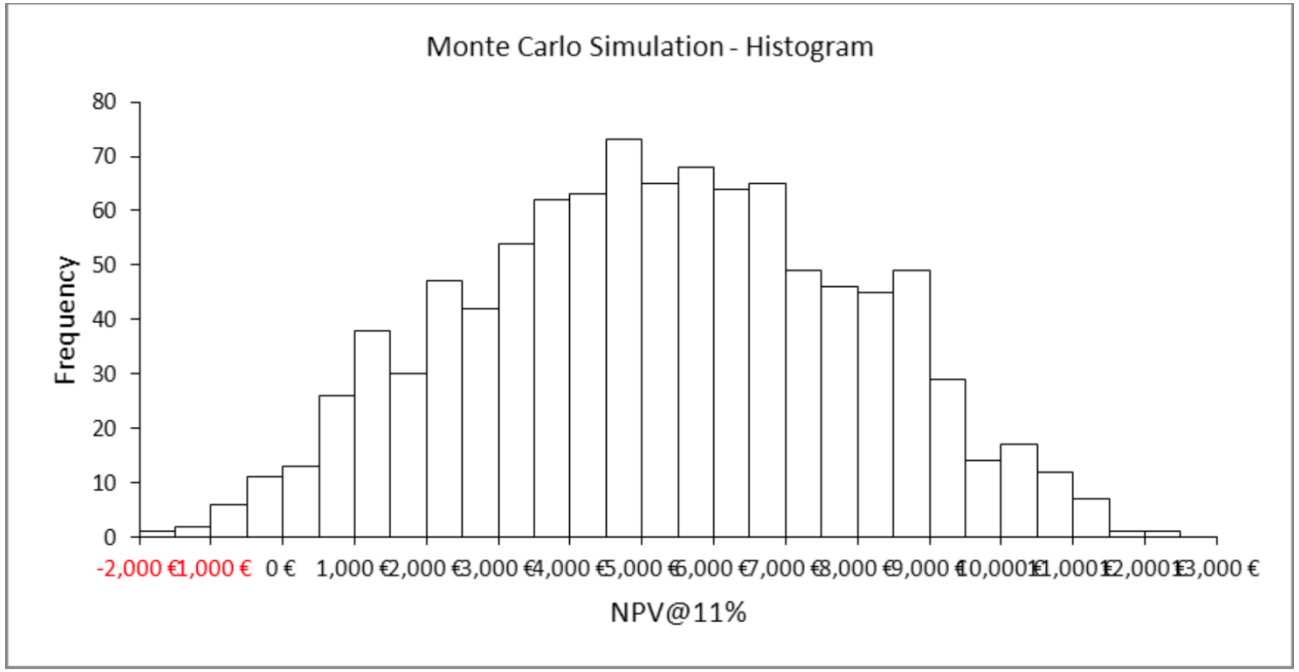
(source: Sidibé et al., 2014)

Net benefits of agroforestry and reforestation scenarios in the Kelka forest, Mali

Sensitivity analysis (SA)

- There is **uncertainty** regarding physical impacts and monetary values
- SA: **changing the values of the parameters** (checking the indicators give the same results)
  - Identifying key **sources of uncertainty**, considering the **range of values** of uncertain factors, and **recalculating NPV** with min & max values

- **SA to discount rates**: recommended for environmental projects: 3 – 5%
  - But good practice to make a SA on different discount rates
  - More elaborate SA (e.g. **Monte Carlo method**) is based on probabilistic approach to values and uses simulations



Empirical relevance of CBA

- Existing studies demonstrate that sustainable land management pays off
- The **benefits of taking action** are **more rewarding** economically **than the costs of inaction** (opportunity cost of business-as-usual)

…Alternative to CBA: Multi-criteria analysis
compares costs to multiple outcome indicators which are not monetised

Conclusions

- **Welfare economics** is concerned with the effects that decisions on resource allocation have on welfare (**maximisation of social utility**)
- **CBA** is an assessment tool that **compares costs and benefits** of the consequences of a policy or a project **to all members of society**
- CBA requires values to be **monetised** and **future values to be discounted**
- The chosen **discount rate** has critical impact on the outcomes of the CBA
  - **Higher discount rates** give less importance to future benefits and costs
- Using **several indicators of economic efficiency** provides a more solid basis for recommendation