HS 232

Lecture 14 12th February 2025

Cost and Benefit Analysis

Recap

- Coupled Human-Environment Systems
- Positive and negative feedback loops
- IPAT equation and its relevance in climate science
- Environmental Kuznets curve
- Malthusian catastrophe
- The demographic transition model

Can we avoid climate change?

No

Can we reduce climate change ?

Yes

Adaptation and Mitigation

Dealing with Climate Change

Mitigation (reduce GHG)

- To decrease the intensity or force
- To lower the risk
- To move from very bad to less bad
- To reduce emission (clean energy) and enhance the sinks (forest)

Adaptation (prepare for impacts)

- To manage the change that occurs irrespective of the mitigation efforts
- To reduce the sensitivity
- To enhance the capacity to adapt /adjust with the change
- To reduce the unavoidable risks associated with climate change

Cost and Benefit Analysis

Cost Benefit Analysis/ Benefit Cost Analysis

- Cost-Benefit Analysis (CBA) for Climate Change is a tool used to assess the trade-offs between the costs of implementing policies or actions to mitigate or adapt to climate change and the benefits they provide over time.
- It aims to guide decision-makers in evaluating whether the benefits of addressing climate change outweigh the associated costs.
- It is the methodical and analytical process of comparing the desirability of a project or programme by comparing benefits and costs
- Because approaches vary depending on the study, there is no universally acknowledged methodology for conducting a cost-benefit analysis.

Foundation of Cost Benefit Analysis

- Based in the theory of welfare economics
- Welfare economics is a branch of economics that focuses on the well-being or welfare of individuals and society as a whole.
- It seeks to evaluate and guide how economic activities, resource allocations, and policy decisions affect the overall happiness, utility, or social welfare of people.
- Welfare effects of consumers are evaluated as changes in consumers' surplus - *Consumer surplus is the economic benefit consumers receive when they are willing to pay more for a good or service than the actual price they pay. It represents the difference between what consumers are willing to pay (their maximum willingness) and what they actually pay in the market.*

Consumer Surplus=Willingness to Pay−Market Price

- For example, if an energy tax increases the price of electricity, we can estimate the welfare effect of this on the representative consumer by the fall in their consumers' surplus.
- a rise in energy prices leads to a significant reduction in consumer surplus as households pay more for fewer units of electricity, reducing the overall economic benefit they derive from the energy market.

Key Objectives of Welfare Economics

- **Efficient Resource Allocation**: Welfare economics evaluates whether resources are being used in the most efficient way to maximize overall benefits.
- **Fair Distribution of Resources**: It considers how resources and wealth are distributed among individuals and whether this distribution is equitable or just.
- **Improvement of Social Welfare**: Welfare economics aims to identify policies or changes that can improve the collective well-being of society.

Use of CBA

- **Examples of Changes**:
  - Improvement in air quality due to pollution control measures.
  - Enhanced landscape quality from urban greening projects.
  - Construction of new infrastructure, such as a public park or a highway.
- These changes may occur due to policy interventions, regulations, or investments.
- CBA helps in **Measuring Welfare Changes**
- Welfare changes due to these interventions can be assessed using monetary measures:

Measuring Welfare Changes

From Consumers' Perspective

- **Willingness to Pay (WTP)**:
  - The amount individuals are willing to pay for an improvement in a public good (e.g., cleaner air).
  - Reflects the value they place on the benefit.
- **Willingness to Accept Compensation (WTA)**:
  - The amount individuals require as compensation for a loss or degradation of a public good.
  - Reflects the value of what they would lose.
- **Fall in consumers surplus**

From Producers' Perspective

- **Producers' Surplus**:
  - The difference between what producers are paid and their costs of production.
  - Measures the benefit to producers from an intervention (e.g., a subsidy for clean technology).
- **Opportunity Cost**:
  - The value of the next-best alternative that is forgone when resources are used for one purpose.
  - For example, the opportunity cost of land used for a solar farm could be the agricultural revenue it might have generated.

Tangible and Intangible Costs and Benefits

- **Tangible**: Easily measurable, such as construction costs or increased revenue.
- **Intangible**: Harder to quantify, such as improved aesthetic value or community well-being.
- CBA acknowledges the challenges in measuring all costs and benefits but aims to capture as much as possible to make informed decisions.

Basis in Welfare Economics

- CBA is rooted in welfare economics, which evaluates overall gains and losses to individuals and society. Key considerations:
- **Aggregate Welfare**:
  - Measures the net change in welfare by comparing gains (benefits) and losses (costs) across society.
- **Distributional Weights**:
  - Different weights may be assigned to benefits or costs experienced by different groups to reflect social priorities (e.g., giving more weight to benefits for marginalized communities).

Community-Level Implications

- Unlike analyses that focus solely on individuals, CBA considers the collective welfare of a community or society.
- **Example**: A new highway may bring economic benefits (reduced travel time, increased trade) but also impose costs (displacement, environmental damage). CBA evaluates both to determine the net impact.

The **Kaldor-Hicks criterion (**Nicholas Kaldor and John Hicks in 1939)

- The **Kaldor-Hicks criterion** is an economic concept used to evaluate whether a policy or action leads to a more efficient allocation of resources, even if it does not make everyone better off. It is often used in cost-benefit analysis and welfare economics to assess changes in social welfare.
- **Key Points of Kaldor-Hicks Criterion:**
- **Potential Compensation**: The criterion states that a change is considered an improvement if the gains to the beneficiaries are large enough that they could, in theory, compensate the losers and still have some benefits left over. Actual compensation does not need to occur; it's about the *potential* for compensation.
- **Efficiency Over Equity**: Kaldor-Hicks focuses on increasing total welfare, rather than ensuring fairness or equitable distribution of gains and losses.
- **Contrast with Pareto Efficiency**:
  - Under the **Pareto criterion**, a change is only considered an improvement if it makes at least one person better off without making anyone worse off.
  - Kaldor-Hicks relaxes this strict requirement by allowing for some to be worse off, as long as the overall gains outweigh the losses.

Example:

- Suppose a government wants to build a dam:
- The project benefits nearby residents by improving irrigation and electricity access, generating $10 million in value. However, it displaces a community, causing $4 million in losses. According to the Kaldor-Hicks criterion, the project is considered an improvement because the $10 million gain is enough to compensate the $4 million loss (even if compensation isn't actually paid).
- **Limitations:**
  - **No Guarantee of Fairness**: The criterion does not require that compensation is actually given, so some may end up worse off.
  - **Ethical Concerns**: It prioritizes efficiency over equity, which can lead to socially controversial outcomes.
  - **Practical Application**: In real-world scenarios, it can be challenging to measure and compare gains and losses accurately.
- The Kaldor-Hicks criterion is a useful tool for evaluating policies where trade-offs exist, but it must be applied with an awareness of its limitations and potential for inequity.

Key Components of CBA for Climate Change:

- Costs:

  Costs in climate change initiatives are often high and can include:

- Mitigation Costs: Expenses associated with reducing greenhouse gas emissions (e.g., transitioning to renewable energy, carbon capture technologies, improving energy efficiency).
- Adaptation Costs: Costs to adjust to climate impacts (e.g., building resilient infrastructure, flood defenses, or crop diversification).
- Opportunity Costs: Economic activities forgone due to implementing climate policies (e.g., reduced fossil fuel production or economic shifts).
- Transaction Costs: Costs for policy implementation, monitoring, and enforcement.

Benefits:

- The benefits of addressing climate change are often long-term and include:
- **Avoided Damages:** Prevention of economic, environmental, and social harm caused by climate impacts (e.g., reduced flooding, fewer heatwaves, and droughts).
- **Improved Public Health**: Reduced air pollution and its associated health costs.
- **Economic Benefits:** Job creation in renewable energy and green technology sectors.
- **Biodiversity Preservation:** Protection of ecosystems and their services, such as water purification and pollination.
- **Global Stability**: Reduced risks of climate-induced migration and conflicts over scarce resources.

Methodology for CBA in Climate Change:

Stage one: definition of project/policy

- Example : climate mitigation project
- Define the objective and identify corresponding mitigation options to be assessed
- Determine the geographic and temporal boundaries.

Stage two: identification of project/policy impacts – costs and benefits

- Once the project is defined, the next step is to identify all those impacts resulting from its implementation.
- Consider case of mitigation project/ policy
- Stage two would include an estimate of all changes in the economy brought about by the policy (for example, a fall in energy use), and estimates of changes in emission
- levels for different pollutants (both air-borne and solid wastes).
- The aim of CBA is to select projects and policies which add to the social utility
- with" and "without" the specific mitigation action
- Positive impacts (benefits) vis-a-vis negative impacts (costs) (using scarce resources)
- Must also include the environmental impacts of projects/policies - relevant for CBA
- Identify all costs and benefits over a set timeline, generally the lifetime of a mitigation/ adaptation measure or the time horizon of climate impact scenarios

Stage three: monetary valuation of relevant effects

- A common unit – money !
- Markets generate the relative values of all traded goods and services as relative prices: prices are therefore very useful in comparing impacts
- Costs include the costs for physical resources needed, cost of the human effort involved in all phases of a project as well as any quantifiable social, environmental or economic disbenefits.
- Assign a monetary value to the benefits: quantifying benefits can be less straightforward. It is often more difficult to predict benefits accurately, especially for new innovative options. Secondly, along with the financial benefits, there are often intangible, or soft, benefits related to a measure.
- The central focus of environmental applications of CBA, however, is the difficulty of placing a value on resources or services not traded in markets.
- In this case, there are a number of techniques available which seek to estimate the economic value of such goods

Stage four: discounting of cost and benefit flows

- Once all relevant cost and benefit flows that can be expressed in monetary amounts have been so expressed, it is necessary to convert them all into present value (PV) terms by discounting.

- **What is a Discount Rate?**
- The discount rate is a concept used in **cost-benefit analysis (CBA)** to account for the time value of money, which reflects the idea that money or benefits available today are more valuable than the same amount in the future. It is used to convert future costs and benefits into their present value, enabling comparisons between investments or projects with benefits and costs that occur at different points in time.
- **Why is the Discount Rate Important?**
- **Future vs. Present Value**: A higher discount rate reduces the present value of future benefits and costs, prioritizing immediate gains over long-term outcomes.
- **Policy Decisions**: In climate change, the choice of a discount rate significantly affects how much weight is given to benefits for future generations.

Stage five: applying the net present value test

- The main purpose of CBA is to help select projects and policies which are efficient in terms of their use of resources.
- The criterion applied is the Net Present Value (NPV) test. This simply asks whether the sum of discounted gains exceeds the sum of discounted losses.
- If so, the project/policy can be said to represent an efficient shift in resource allocation, given the data used in the CBA.
- The criterion for project/policy acceptance is; accept if the NPV>0.
- Any project passing this NPV test is deemed to be an improvement in social welfare.

Stage six: sensitivity analysis

- The NPV test provides the relative efficiency of a given project, given the data input to the calculations.
- If this data changes, then clearly the results of the NPV test will change too.
- The main reason concerns uncertainty. For CBA, the analyst must make predictions concerning future physical flows (for example, sea level rise) and future relative values (for example, the value of agricultural land).
- None of these predictions is made with perfect foresight, and climate change predictions are clearly a very good illustration of the magnitude and multiple sources of uncertainty about the future.
- An essential final stage of any CBA is therefore to conduct sensitivity analysis.
- This means recalculating NPV when the values of certain key parameters are changed. These parameters will include physical changes brought about by a resource allocation, the marginal social values of these changes (or consumers and producers surplus values), the time period over which costs and benefits are considered, and the discount rate.

Challenge remains!

- A limitation of CBA is that it requires all benefits to be measured and expressed in monetary terms, which is often either difficult to achieve or is seen as morally questionable (e.g. assigning monetary value to human lives or "discounting" future benefits).

Challenges in Climate Change CBA:

- Long Time Horizons:
  - Climate impacts and benefits of action often extend far into the future, making predictions uncertain.
  - The choice of the discount rate is critical and contentious; a lower rate gives more weight to future generations.
- Non-Monetary Benefits:
  - Many benefits, like biodiversity conservation or cultural heritage preservation, are hard to quantify in monetary terms.
- Global vs. Local Impacts:
  - Climate change has global effects, but costs and benefits are often distributed unevenly, leading to equity concerns.
- Uncertainty:
  - Future climate conditions, technological advancements, and economic changes introduce uncertainties in both costs and benefits.
- Ethical Considerations:
  - Balancing the needs of current vs. future generations and rich vs. poor countries complicates decision-making.

Applications of CBA to climate change and climate change policy

- Costs' are usually expressed as the costs of reducing emissions of greenhouse gases, and typically focus on carbon dioxide.
- These costs are usually a function of:
  - the level of emission reduction;
  - the timing of this reduction;
  - which country/countries is/are responsible for the reduction;
  - and how the reduction is achieved
- 'Benefits' are typically thought of as avoided damages, although in some cases climate change can be beneficial to a country or a sector, in which case some element of benefits will be negatively signed (change in cropping patterns)