HS 232

Lecture 15 13th February 2025

Cost and Benefit Analysis

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
- with" and "without" the specific mitigation action
- The aim of CBA is to select projects and policies which add to the social utility
- 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 *(to be discussed)*

Stage four: discounting of cost and benefit flows

- **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.

Calculating discount rate

Formula:

$$PV = \frac{FV}{(1+r)^n}$$

Where:

- PV = Present Value
- FV = Future Value
- r = Discount rate (expressed as a decimal)
- n = Number of years into the future

Nicholas Stern and William Nordhaus on the appropriate **discount rate**

- Both scholars agree on the urgent need to address climate change, but their perspectives on how much current generations should invest to mitigate future damages diverge significantly due to differences in their chosen discount rates.

The Stern Review (2006)

- **Discount Rate:** Stern advocates for a **low discount rate** of approximately **1.4% per annum**.
- **Reasoning:**
  - **Ethical Basis:** Stern argues that future generations should be valued nearly as much as the current generation. A low discount rate reflects intergenerational equity, implying that we should not heavily discount the well-being of people in the future.
  - **Catastrophic Risks:** He emphasizes the high likelihood of severe and irreversible impacts of climate change, which justifies immediate and substantial investments in mitigation.
  - **Policy Implication:** A low discount rate leads to the conclusion that the costs of inaction on climate change are much greater than the costs of taking action now. He recommends investing 1% of global GDP annually to stabilize greenhouse gas concentrations.

William Nordhaus and the DICE Model

- **Discount Rate:** Nordhaus uses a **higher discount rate** of approximately **4% per annum** in his Dynamic Integrated Climate-Economy (DICE) model.
- **Reasoning:**
  - **Market Perspective:** Nordhaus bases his discount rate on observed market interest rates and returns on capital. He argues that this reflects society's actual preferences for present versus future consumption.
  - **Economic Growth:** He assumes that future generations will be wealthier due to economic growth, so the marginal utility of consumption will decline over time. This justifies giving less weight to future costs and benefits.
  - **Policy Implication:** A higher discount rate suggests a slower, more measured investment in climate mitigation, as immediate and aggressive action would impose significant costs on current generations.

the marginal utility of consumption will decline over time

- This statement reflects a key assumption in economics regarding how **wealth** and **utility** (satisfaction or benefit from consumption) are related over time: **Breaking It Down:**
- **Economic Growth and Wealth Increase:**
  - Nordhaus assumes that future generations will experience economic growth, meaning they will be wealthier than the current generation due to advancements in technology, productivity, and capital accumulation.
  - As wealth increases, people are better able to meet their basic needs and afford more goods and services.
- **Marginal Utility of Consumption:**
  - **Marginal utility** refers to the additional satisfaction or benefit a person derives from consuming one more unit of a good or service.
  - The principle of **diminishing marginal utility** states that as people become wealthier, the benefit they derive from each additional unit of consumption decreases. For example:
    - For a poor person, ₹1,000 might mean access to essential goods like food or medicine, providing substantial benefit.
    - For a wealthy person, ₹1,000 might be used for luxury or non-essential items, offering much less additional satisfaction.
- **Discounting Future Costs and Benefits:**
  - If future generations are wealthier, the **relative value of money** or resources for them will be lower than it is for the current generation.
  - As a result, the cost of climate mitigation borne by the current (less wealthy) generation is seen as more burdensome compared to the benefits future (wealthier) generations would receive.
  - Therefore, Nordhaus justifies applying a **higher discount rate**, which places less weight on future costs and benefits. This approach suggests that investing less now is acceptable because future generations will have more resources to address climate impacts.

Example of Impact on Decision-Making

Let's say mitigating climate change costs ₹1,000 crore today, and the benefits 50 years from now are estimated to be ₹10,000 crore. Using the **present value (PV)** formula:

$$PV = \frac{\text{Future Value}}{(1+r)^t}$$

- With **Stern's low discount rate (1.4%)**:

$$PV = \frac{10,000}{(1+0.014)^{50}} \approx 6,645 \text{ crore}$$

  The benefit of mitigation is worth ₹6,645 crore today, making the investment worthwhile.

- With **Nordhaus's high discount rate (4%)**:

$$PV = \frac{10,000}{(1+0.04)^{50}} \approx 1,406 \text{ crore}$$

  The benefit of mitigation is worth only ₹1,406 crore today, suggesting the investment may not be justified immediately.

A higher discount rate means a greater preference for things now rather than later.

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.

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.

Readings

- Stern, N. (2006). What is the Economics of Climate Change? World Economics 7 (2).
- The World Bank (2010). Economics of Adaptation to Climate Change Synthesis Report, The World Bank, Washington DC
- IPCC 2022 (AR6) and IPCC 2014 (AR5) Chapter 7