Prioritization of Climate Change Adaptation Options

The Role of Cost-Benefit Analysis

Session 6: Conducting CBA Step 5

Accra (or nearby), Ghana
October 25 to 28, 2016

8 steps

Empowered lives.
Resilient nations.

Step 1: Define the scope of analysis.

Step 2: Identify all potential physical impacts of the project.

Step 3: Quantify the predicted impacts: With and without project

Step 4: Monetize impacts.

Step 5: Discount to find present value of costs and benefits.

Step 6: Calculate net present value.

Step 7: Perform expected value and/or sensitivity analysis.

Step 8: Make recommendations.

Outline of presentation

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1) General methodology

2) 4 questions

2.1 What is T?

2.2 What if T is infinite?

2.3 What about inflation? (nominal vs. real)

2.4 Which discount rate to use: Theory and Practice

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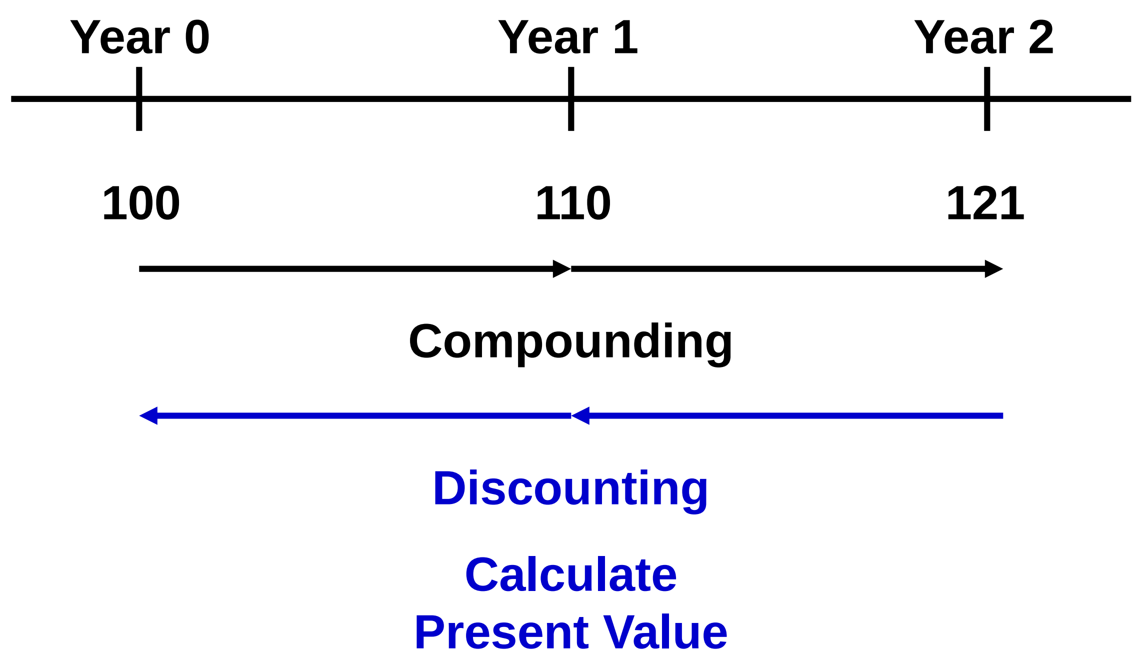
Principle of discounting

Discounting is simply a technique that allows us to compare costs and benefits that happens at different point in time into a common unit of measurement.

Assume 10% return on investment:



General methodology

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Typically, the flows of costs and benefits of a project look like this:

Costs	**C0**	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**
		Investment costs				**Operational costs**		
Benefits	**0**	**0**	**0**	**B3**	**B4**	**B5**	**B6**	**B7**

General methodology

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Costs	C0	C1	C2	C3	C4	C5	C6	C7
Benefits	0	0	0	B3	B4	B5	B6	B7

PV of Costs

PV of Benefits

General methodology

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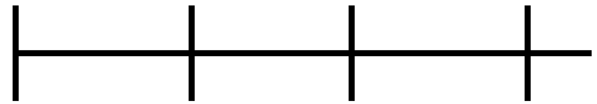
Technique of discounting



Costs C0 C1 C2 C3

PV of Costs =

$$C_0 + \frac{C_1}{(1+r)} + \frac{C_2}{(1+r)^2} + \frac{C_3}{(1+r)^3}$$

r **is referred to as the discount rate (in real terms).**

$$\frac{1}{(1+r)^t}$$ **is referred to as the discount factor.**

General methodology

More generally

Suppose a flow of benefits (or costs) B_t from t = 0 until t = T, then the present value of this flow is:

$$\mathbf{PV} = B_0 + \frac{B_1}{(1+r)} + \frac{B_2}{(1+r)^2} + \frac{B_3}{(1+r)^3} + \ldots + \frac{B_T}{(1+r)^T}$$

$$= \sum_{t=0}^{t=T} \frac{B_t}{(1+r)^t}$$

General methodology

So, for any given project or policy, we will have:

PV of costs $= C_0 + \frac{C_1}{(1+r)} + \frac{C_2}{(1+r)^2} + \frac{C_3}{(1+r)^3} + \ldots + \frac{C_T}{(1+r)^T}$

$= \sum_{t=0}^{t=T} \frac{C_t}{(1+r)^t}$

PV of benefits $= B_0 + \frac{B_1}{(1+r)} + \frac{B_2}{(1+r)^2} + \frac{B_3}{(1+r)^3} + \ldots + \frac{B_T}{(1+r)^T}$

$= \sum_{t=0}^{t=T} \frac{B_t}{(1+r)^t}$

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What is T?

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In theory, all benefits and costs of a project should be measured, even when they extend indefinitely.

However, at least in the case of infrastructure project, the common practice is set the time horizon of the analysis (T) to coincide with the expected lifetime of the key (most important) component of the infrastructure project. For example:

- Expected lifetime of a road (before it needs major repair – so major that it may as well be considered a new road): 40 years
- Expected lifetime of a bridge: 75 to100 years
- Expected lifetime of a coal-fired power plant: 25 to 40 years

And so, the time horizon of the analysis is set to coincide with these expected lifetimes.

What is T?

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Or in situation where the Government will provide a concession to build and run a project (e.g. a power plant, a forestry or mining concession), then very often the time horizon of the cost-benefit analysis is set to coincide with the duration of the concession. For example if

Duration of a concession of a build and operate power plant 25 years.

Or if

Duration of a mining concession: 40 years.

Then the time horizon of the analysis is set to coincide with these durations (25 years or 40 years respectively)

What is T?

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Warning:

As a principle, this approach for setting the time horizon of the economic analysis is wrong.

The selection of the time horizon for the CBA should be guided by one question: How long will the impacts (positive or negative) last? And the answer to this question may or may not coincide with the lifetime of the infrastructure or duration of the concession.

This may or may not matter in terms of assessing the economic desirability of the project or policy. If the infrastructure lifetime or duration of the concession is long enough, and if the discount rate being used is relatively high, then whatever happens after the CBA is truncated (after say 40 years) may not matter very much.

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What if T is infinite?

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Suppose the following:

Year	0	1	2	3	4	5	…	∞
	\$A	\$A	\$A	\$A	\$A	\$A	\$A	\$A

PV = $$A + \frac{A}{(1+r)} + \frac{A}{(1+r)^2} + \frac{A}{(1+r)^3} + \ldots + \frac{A}{(1+r)^\infty}$$

PV = $$A * \frac{(1+r)}{r}$$

For example, if A = \$100 and if r = 10%, then the present value of A is: 100*(1.1)/0.1 = \$1,100.

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What about inflation?

Should we include inflation in this work? If we do, then what discount rate to use?

So, suppose that prices are expected to rise at rate ‘g’ for the duration of the project.

Suppose that the nominal discount rate is m (the real discount rate is r).

What about inflation?

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Then, the present value of a flow of benefits from t = 0 to t = T is

$$\textbf{PV} = B_0 + \frac{B_1(1+g)}{(1+m)} + \frac{B_2(1+g)^2}{(1+m)^2} + \frac{B_3(1+g)^3}{(1+m)^3} + \dots + \frac{B_T(1+g)^T}{(1+m)^T}$$

According to Fisher's Law: (1 + m) = (1 + r)(1 + g). So we have:

$$\textbf{PV} = B_0 + \frac{B_1(1+g)}{(1+r)(1+g)} + \frac{B_2(1+g)^2}{(1+r)^2(1+g)^2} + \frac{B_3(1+g)^3}{(1+r)^3(1+g)^3} + \dots + \frac{B_T(1+g)^T}{(1+r)^T(1+g)^T}$$

Which is the same as:

$$\textbf{PV} = B_0 + \frac{B_1}{(1+r)} + \frac{B_2}{(1+r)^2} + \frac{B_3}{(1+r)^3} + \dots + \frac{B_T}{(1+r)^T}$$

What about inflation?

Message is:

If all costs and benefits are measured in nominal values, then use nominal discount rate. If all costs and benefits are measured in real values, then use real discount rate. It does not matter.

However, in practice, most of the time we do the analysis in real terms. In doing so, there is one less variable we need to make projections for, the annual inflation rate for each year of the time horizon of the analysis.

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Which discount rate to use: Practice

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MDBs:

MDBs	Discount rates
World Bank	10%
Asian Development Bank	12%
Inter-American Development Bank	12%
European Bank (EBRD)	10%

Note: All projects, irrespective of sectors (be it transport, energy, environment, health, water supply, agriculture, etc.) and irrespective of countries, must use the same discount rate.

Which discount rate to use: Practice

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MDBs:

MDBs	Discount rates
World Bank	10%
Asian Development Bank	12%
Inter-American Development Bank	12%
European Bank (EBRD)	10%

ADB: "Given the difficulty of estimating country-specific economic opportunity costs of capital (EOCC), the EOCC for all ADB DMCs is 12%."

World Bank: " It is justified as a notional figure for evaluating Bank-financed projects. This notional figure is not necessarily the opportunity cost of capital in borrower countries, but is more properly viewed as a rationing device for World Bank funds" (Operational Core Services Network Learning and Leadership Center, 1998).

Which discount rate to use: Practice

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Some countries:

Countries	Discount rates
Philippines	15%
India	12%
Pakistan	12%

Which discount rate to use: Practice

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Line ministries (or operational departments in MDBs) would prefer to have their policies or projects accepted.

Incentives to over-estimate benefits and under-estimate costs.

Strategic reaction from those who allocate resources:

Set a high discount rate.

Which discount rate to use: Practice

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Some countries:

Countries	Discount rates
Philippines	15%
India	12%
Pakistan	12%
New Zealand	10% (until 2008); now 8%
United States	OMB: 10% (until 1992); 7% (until now); 3% for sensitivity (since 2003); NOAA: 3%: EPA: 3%
European Union	6% (until 2006); now 5%
Germany	4% (until 2004); now 3%
France	8% (until 2005); now 4%

Which discount rate to use: Practice

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Canada:

TBS currently recommends the use of 3% (“social” rate) and 7% (“real” rate) as CBA discount rates.

TBS now allows for the option to use 3% discount rate as a central value for health and environmental CBAs.

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