

Chapter 6 Discounting Benefits and Costs in Future Time Periods

Projects/policies have time periods over many years.
How to compare among them across time?

Net Present Value

is a way of comparing the value of money now with the value of money in the future. In the CBA, we compare the projects or policies with benefits and costs that arise in different time periods by using discount rate. Social discount rate is normally used at the CBA.

Discount Rate

Discount rate reflects the time value of money. In financial analysis, the rate is determined in the market rate of interest (interest rate). In cost benefit or public project analysis, the rate is **social time preference** which accounts for intergenerational equity concerns with the view that government has an obligation to provide welfare of unborn generations.

*1 dollar k years from now = $\$(1+r)^{-k}$ now

Example of Social Discount Rate of Public Projects

- US: 7% (after 1993) < 10% (1972-1992)
- UK: 3.5% (after 2003) < 6% (1989-2002) < 5% (1976-1988)
- France: 4% (after 2005) < 8% (1985-2004)
- Canada: 8% (after 2007) < 10% (1976-2006)
- EU: 3.5% (after 2008) < 5% (1997-2007)
- Germany (Transport): 3% (after 1992)
- Japan (Transport): 4% (after 2000)
- Many ODA projects: 12-14%

based on **Social Time Preference** which represented by Long-Term National Bond, Opportunity Cost on Capital, etc.

Net Present Value (NPV) of a Project

The discount sum of all future benefit less than the discount sum of all future costs over the appraisal period.

$$NPV = \sum_{t=0}^{t=n} \frac{B_t - C_t}{(1+i)^t} = \sum_{t=0}^{t=n} \frac{B_t}{(1+i)^t} - \sum_{t=0}^{t=n} \frac{C_t}{(1+i)^t} = PV(B) - PV(C)$$

Project life runs from 0 to n

B: Undiscounted benefit in time period t

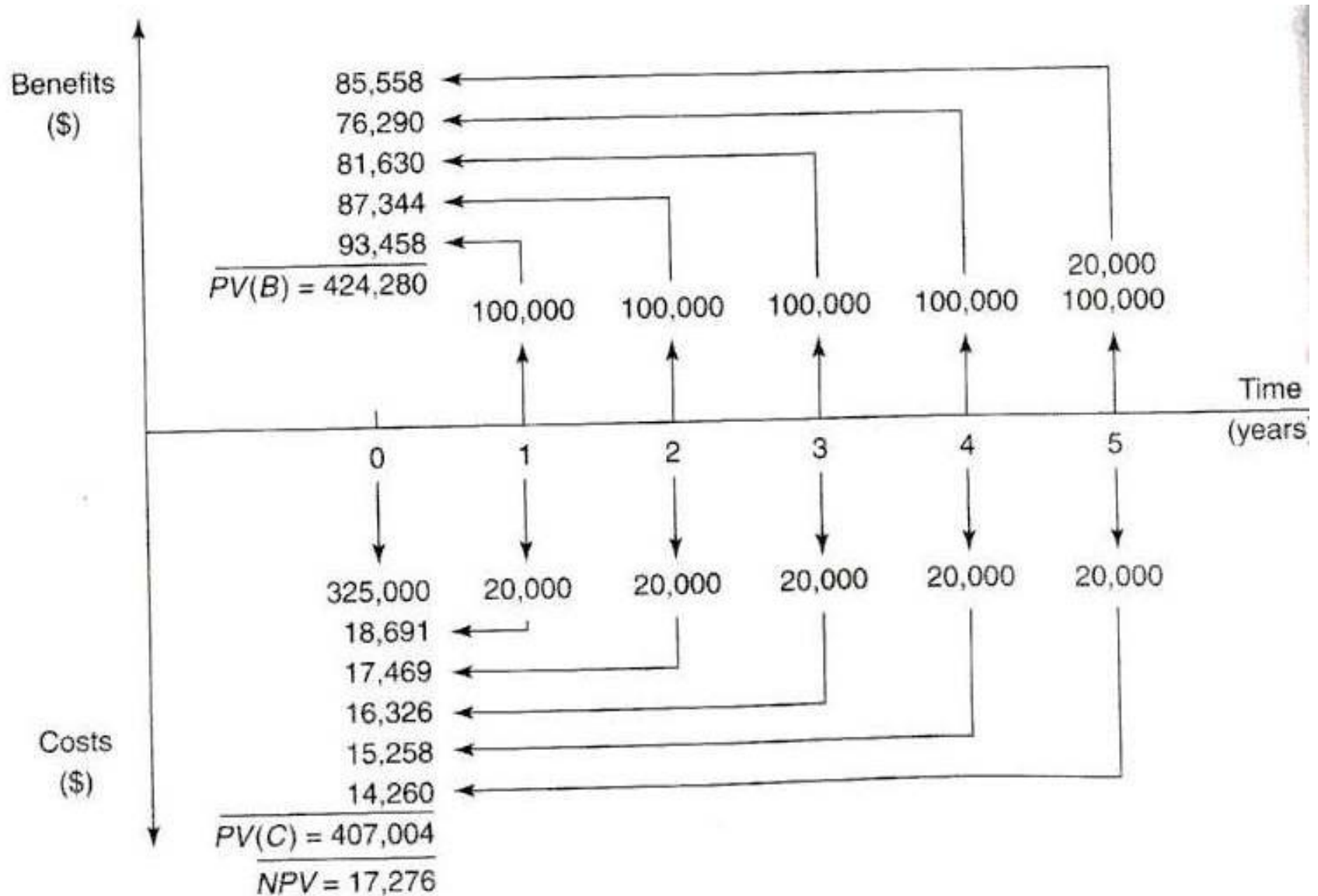
C: Undiscounted cost in time period t

i : Social discount rate

* NPV is the prime indicator of social benefit, where project alternatives are mutually exclusive.

Ex. Library Information System Accounting

Social discount rate is 7%.



Methods for Estimating Horizon Values

Useful Life (discounting period) + present value of Horizon Values.

$$NPV = \sum_{t=0}^k \frac{NB_t}{(1+i)^t} + PV(H_k) \quad \text{Value at the end of discounting horizon}$$

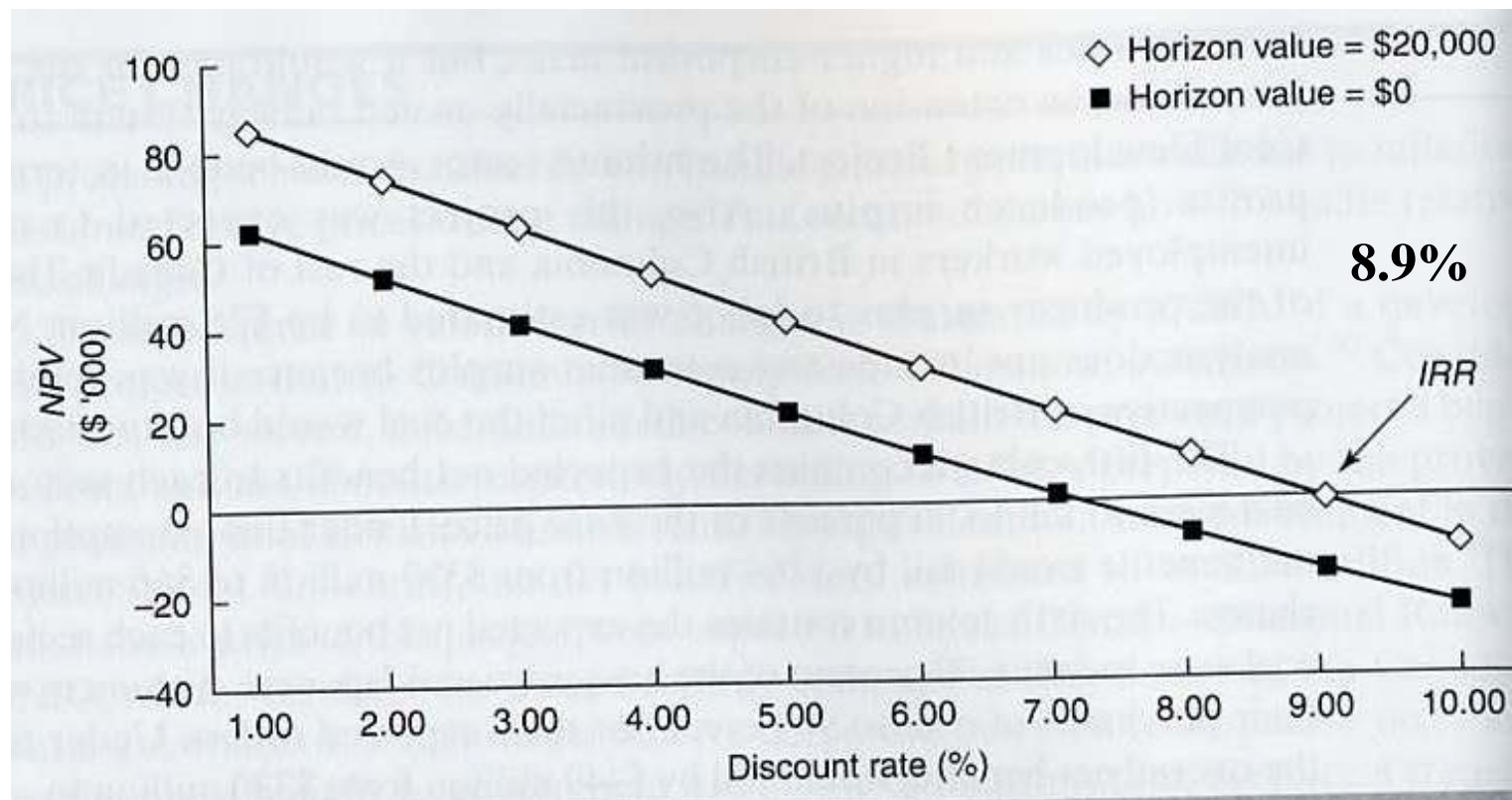
1. Simple Projection
2. Salvage Value (or Liquidation Value)
3. Depreciated Value
4. Initial Construction Cost
5. Equal to Zero

Sensitivity Analysis in Discounting

Internal Rate of Return (IRR) $IRR: \sum_{t=0}^{t=n} \frac{B_t - C_t}{(1+i)^t} = 0$ i found by trial and error

Average rate of return on investment costs over the discount period.

* IRR is the prime indicator of social benefit, where there is only one alternatives to the status quo.



Choosing among Projects (in Chapter 2)

Net Present Value $NPV = \sum_{t=0}^{t=n} \frac{B_t - C_t}{(1+i)^t} = \sum_{t=0}^{t=n} \frac{B_t}{(1+i)^t} - \sum_{t=0}^{t=n} \frac{C_t}{(1+i)^t} = PVB - PVC$

Cost Benefit Ratio $CBR = \sum_{t=0}^{t=n} \frac{B_t}{(1+i)^t} / \sum_{t=0}^{t=n} \frac{C_t}{(1+i)^t} = PVB / PVC$

	<i>Costs (millions of dollars)</i>	<i>Benefits (millions of dollars)</i>	<i>Net Benefits (millions of dollars)</i>	<i>Benefits/Costs</i>
No project	0	0	0	–
Project A	1	10	9	10
Project B	10	30	20	3
Project C	4	8	4	2
Project D	3	5	2	1.7
Projects C and D	7	21	14	3
Project E	10	8	–2	0.8

(1) No constraints: Choose A, B, and combination C and D (net benefits equal \$43 million).

(2) All projects mutually exclusive: Choose B (net benefits equal \$20 million).

(3) Total costs cannot exceed \$10 million: Choose A and combination C and D (net benefits equal \$23 million).

Example

Determine NPV, IRR and CBR

Discount rate $r = 5\%$

Base year: 0 year

Year	Benefit	Cost
1	0	10,000
2	0	5,000
3	0	10,000
4	8,000	10,000
5	9,000	12,000
6	10,000	11,000
7	11,000	5,000
8	12,000	5,000
9	13,000	5,000
10	14,000	5,000
11	15,000	5,000
12	16,000	5,000
13	17,000	5,000
14	18,000	5,000
15	18,000	5,000

investment period
opening year

Chapter 9 Existence Value

Nonuse Value or Passive Use

People may place a value on the very existence of “unique phenomena of nature”. e.g. Wilderness Area

Possible motivations for nonuse value: **Altruism**

TABLE 9-1 Taxonomy of Benefits: Possible Partitioning of Willingness-to-Pay

<i>Type of Use</i>	<i>Benefit Category</i>	<i>Example</i>
<i>Active use</i>	Rivalrous consumption	Logging of old-growth forest
	Nonrivalrous consumption: direct	Hiking in wilderness
	Nonrivalrous consumption: indirect	Watching a film of wilderness area
<i>Passive use (nonuse)</i>	Option value	Possibility of visiting wilderness area in the future
	Pure existence value: good has intrinsic value	Perceived value of natural order
	Altruistic existence value: gift to current generation	Others hiking in wilderness
	Altruistic existence value: bequest to future generation	Future others hiking in wilderness

Measurement of Existence Value

Annual Benefits:		\$3.36 million
Job creation	\$0.48 million	
Out-of-stadium incremental taxes	\$1.25 million	
Incremental admission tax	\$1.20 million	
Sales tax on incremental stadium spending	\$0.43 million	
Annual Costs:		\$14.00 million
Annual Net Benefits:		−\$10.64 million

Net Cost (= negative net benefit)

\$ 10,640,000 = \$14.20 per household

However, it may place a value on the stadium because people get pleasure from simply having the Orioles in Baltimore.

> **“Public Consumption Benefits”**