成 本 效 益 分 析

1 Project Evaluation

- Welfare Economics Approach:
  - ▷ Compute SW function before/after project
  - ? Enormous information required
  - ? Interpersonal utility comparison
- Cost-Benefit Analysis: a practical procedure
  - Stream of benefits and costs:

$$(B_0, B_1, \ldots, B_T), \quad (C_0, C_1, \ldots, C_T)$$

  - Determine net benefit of a projects
  - ! For Pareto/fairness: losers should be compensated
  - ! Intangibles: life, environmental quality

2 Long-term Time Consideratns

- Present value (PV): discount rate r
  - r reflects opportunity cost of funding (market interest rate)
  - Time discounting: \$1 now is worth \$$[1+r]$ in next period
  - Present value of \$1 in t^{th} year:

$$\frac{1}{[1+r]^t}$$

  - Time-varying discount rate:

$$PV \;=\; \frac{1}{[1+r_1][1+r_2]\cdots[1+r_t]}$$

  - Stream of returns:

$$PV \;=\; R_0 + \frac{R_1}{[1+r]} + \frac{R_2}{[1+r]^2} + \cdots$$

- Inflation (通貨膨脹): rate π
  - Nominal return ($\tilde{R}$) v. Real return (R):

$$R \;=\; \frac{\tilde{R}}{[1+\pi]}$$

$$\tilde{R} \;=\; R[1+\pi]$$

  - Expected market interest rate:

$$\tilde{r} \;\approx\; r + \pi$$

  ▷

$$PV \;=\; R_0 + \frac{R_1}{[1+\tilde{r}]} + \frac{R_2}{[1+\tilde{r}]^2} + \frac{R_3}{[1+\tilde{r}]^3} + \cdots$$

3 Private-sector project evaluation

3.1 Single-period Decision

- Choice between 2 projects: X or Y
- Benefits and costs:

$$(B^X, C^X), \ \ (B^Y, C^Y)$$

- Criteria:
  - Net return (淨回收):

$$N^X = B^X - C^X$$

$$N^Y = B^Y - C^Y$$

  - Admissible (可行性):

$$N^X > 0$$

$$N^Y > 0$$

  - Preferable (較佳者): highest net return

3.2 Multiple-period Decision

3.2.1 Net Present Value (NPV)

- Compare: project return v. bank return

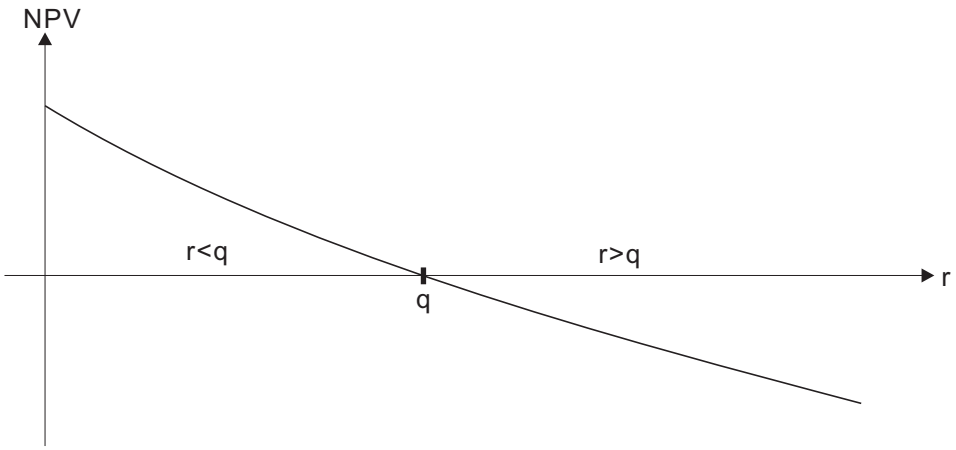
- PV of net income stream: use *post-tax* market interest rate r

$$\mathcal{N}^X = [B_0^X - C_0^X] + \frac{B_1^X - C_1^X}{[1+r]} + \frac{B_2^X - C_2^X}{[1+r]^2} + \cdots$$

$$\mathcal{N}^Y = [B_0^Y - C_0^Y] + \frac{B_1^Y - C_1^Y}{[1+r]} + \frac{B_2^Y - C_2^Y}{[1+r]^2} + \cdots$$

- Criteria:
  - ▷ Admissibility: NPV > 0
  - ▷ Preferable: high NPV

- When $r \uparrow$: NPV $\downarrow$ for all projects.
  - ▷ Early-return project is preferred.



3.2.2 Internal Rate of Return (IRR)

- Compare: project return v. bank return

- Def: ρ solving

$$\text{NPV}(\rho) \;=\; B_0 - C_0 + \frac{B_1 - C_1}{1+\rho} + \frac{B_2 - C_2}{[1+\rho]^2} + \cdots = 0$$

  $\triangleright$ Unique ρ if $B_t - C_t < 0$ before $t = \tau$, and $B_t - C_t > 0$ after

- Criteria:
  - Admissibility: $\rho > r$ (i.e., $\mathcal{N} > 0$)
  - Preferable: high ρ

- Problems:
  1. Not applicable when market r varies in time !
  2. Project scale not considered !

E 2 projects (X, Y) with market r=6%

	C	B	ρ	Nominal Net	Real Profit
X	100	110	10%	\$10	\$4
Y	1000	1080	8%	\$80	\$20

$\triangleright$ Y has higher profit (preferred), but lower ρ ■

3. Timing not considered! (B&W p.193)

	$t=0$	$t=1$	$t=2$	ρ	$\mathcal{N}_{2\%}$	$\mathcal{N}_{5.2\%}$	$\mathcal{N}_{7\%}$
X	-1000	0	1210	0.10	163*	93*	57
Y	-1000	1150	0	0.15*	127	93*	75*

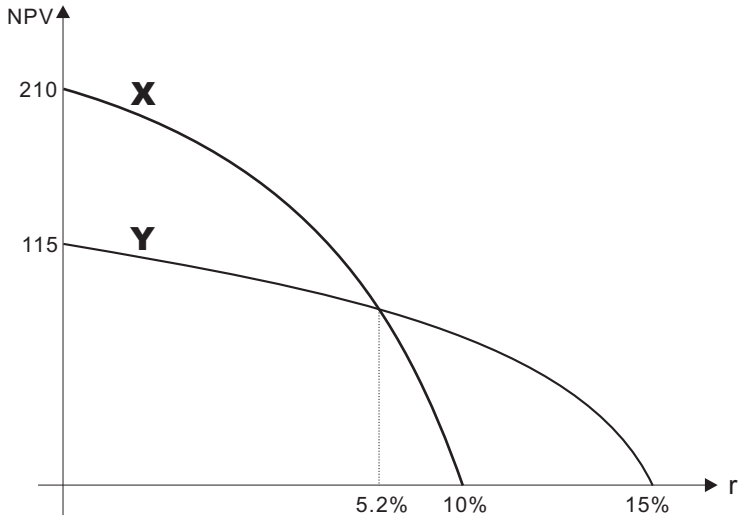
$\triangleright$ Can always do better than Y alone with capital market:

$(t=0)$ Take X. Cost $=-1000$.

$(t=1)$ Borrow \$1150 from bank.

$(t=2)$ Gain \$1210 from X. Pay back bank \$1150$\times$1.02=1173

$\Rightarrow$ Net consumption stream is $(-1000, 1150, 37)$ ■



3.2.3 Benefit-Cost Ratio (BCR)

- B/C ratio:

$$\pi \equiv \frac{\text{PV}(B)}{\text{PV}(C)}$$

- Admissibility: same as NPV

$$\pi > 1 \rightleftharpoons \text{PV}(B) > \text{PV}(C)$$

- Problems:

  1. Project scale ignored:

     – Project X: $C = 100$, $B = 200$, $\pi = 2$, Net=100

     – Project Y: $C = 80$, $B = 170$, $\pi = 2.1$, Net=90 ■

  2. Ambiguity in B/C accounting:

E

	C	B	π
X	100	250	2.5
Y	100	200	2

     ▷ New damage \$40 with X as $\text{B}_X \downarrow$: $\pi'_X = 210/100 = 2.1 > \pi_Y$

     ▷ New damage \$40 with X as $\text{C}_X \uparrow$: $\pi'_X = 250/140 = 1.8 < \pi_Y$ ■

3.3 Optimal project Scale Depends on CBA Criterion

- NPV:

$$\max_C \; B(C) \; - \; C$$

foc:

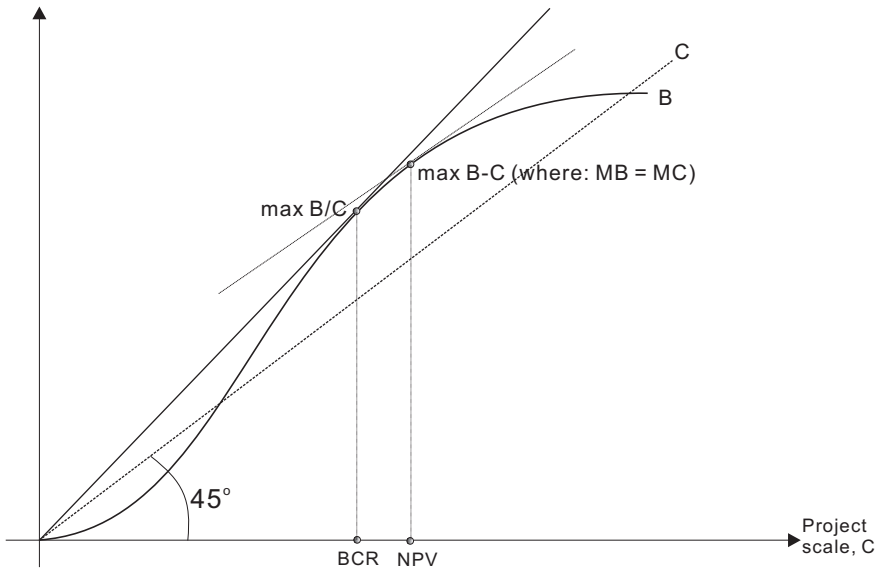
$$\text{MB}(C) \; = \; B'(C) \; = \; 1$$

- BCR:

$$\max_C \; \frac{B(C)}{C}$$

foc:

$$B'(C) \; = \; \frac{B(C)}{C}$$



3.4 Public-sector Discount Rate: r_g

- Measure what society places on sacrificed present consumptn
- Maybe higher than market r:
  - Government r_g: *pre-tax* return
  - Firm r: *post-tax* return
- Maybe lower than market r: future benefits weight more
  - Paternalism: govt has more concern for future generation.[1]
  - Positive investment externality: to induce more investment

[1] Private sector has "defective telescopic faculty".

4 Valuation of Life

5 Valuation of Environmental Quality

- CVM/Survey: open v. closed format

  ▷ Bias: hypothetical, starting-point, etc.

- Inferences from revealed consumer behaviors: travel cost method

  E Michigan Ludington power plant

  E Alaska Exxon Valdez accident

! Psycologival value not included: existence value, option value