Chapter 18 Cost-Effectiveness Analysis (CEA)

Cost-Effective Analysis (CEA) is a widely used alternative to CBA, especially health and defense policy. CEA compares (mutually exclusive) alternatives in terms of the ratio of their costs and a single quantified, but not monetized, effectiveness measure.

Three common constraints to doing CBA

- > If CBA is not possible, CEA may give useful information concerning the relative efficiency of alternatives.
- 1. Unwilling or unable to monetize the most important policy impact.
- 2. A particular effectiveness measure does not capture all of the social benefits of each alternative, and some of these other social benefits are difficult to monetize.
- 3. Dealing with intermediate goods whose linkage to preferences is not clear.

Cost-Effectiveness Ratios

Costs (**C**) are measured in monetary terms. **Effectiveness** (**E**) may be measured in units such as lives saved, tons of carbon dioxide reduction, children vaccinated.

Two ways: Cost-Effectiveness ratio (CE ratio) more commonly used. Effectiveness-Cost ratio (EC ratio)
Incremental CE ratio: Alternatives policy i and policy j
i:policy implementation(with), j:status quo(without)

$$CE_{ij} = \frac{C}{E} = \frac{C_i - C_j}{E_i - E_j}$$

Application of Cost-Effectiveness Ratio

Student achievement Scores

2:100	C (dollars per student)	E (average test score)	C/E (relative to no schooling)	S _j (basis for comparison)	ΔC (relative to S _j)	ΔE (relative to S _j)	ΔC/ΔE (incremental cost-effectiveness ratio)
S ₃₀	2000	60	33.3	TOSAND	A 1-22	NTT/T	0998-1900
S25	2400	68	35.3	S ₃₀	400	8	50
S20	3000	74	40.5	S ₂₅	600	6	100
S ₁₅	4000	76	52.6	S_{20}^{20}	1000	2	500
Sc	3000	72	41.7	S ₃₀	1000	12	83.3



Frontier: best possible outcome southeast as possible S_c : Extended (weak) dominance ...to eliminate from considered alternatives. located at northwest of the frontier

If assigning a shadow price to average test score, how about NPV?

Cost-Effectiveness Analysis in Same Scale

	Alternatives			
Cost and Effectiveness	A	B	С	
Cost measure (budget cost)	\$10M	\$10M	\$10M	
Effectiveness measure (number of lives saved)	5	10	15	
CE ratio (cost per life saved)	\$2.0M	\$1.0M	\$0.67M ^a	
EC ratio (lives saved per million dollars)	0.5 life	1.0 life	1.5 lives ^a	

^a CE ratio or EC ratio of the most cost-effective alternative.

Fixed cost: Maximize effectiveness (lives saved) Fixed effectiveness: Minimize cost (dollars)

Imposing Constraints to deal with Scale Differences

	Alternatives		
Cost and Effectiveness	A	В	
Cost measure (budget cost)	\$1M	\$100M	
Effectiveness measure (number of lives saved)	4	200	
CE ratio (cost per life saved)	\$250,000 ^a	\$500,000	
EC ratio (lives saved per million dollars)	4.0 lives ^a	2.0 lives	

ⁿ CE ratio or EC ratio of the most cost-effective alternative.

Min C_i Min CE_i Max E_i Min CE_i $s.t. E_i \geq \overline{E}$ $s.t. E_i \geq \overline{E}$ $s.t. C_i \leq \overline{C}$ $s.t. C_i \leq \overline{C}$

- \overline{E} : Minimum acceptable level of effectiveness
- \overline{C} : Maximum acceptable level of cost

Illustration of the Different CE Rules

	alts frost aben bill former torst		<i>E</i> ≥ 50		<i>C</i> ≤ 250		
Projects (1)	Lives Saved (2)	Budget Cost (\$M) (3)	CE Ratio (cost per life saved) (\$M/life saved) (4)	Budget Cost of Projects That Save at Least 50 Lives (5)	CE Ratio of Projects That Save at Least 50 Lives (6)	Lives Saved of Projects That Cost No More than \$250M (7)	CE Ratio of Projects That Cost No More than \$250M (8)
А	100	250	2.5	250	2.5 ^a	100 ^a	2.5
В	20	44	2.2	no sur Turves		20	2.2
С	100	300	3.0	300	3.0		_
D	50	300	6.0	300	6.0	in h <u>an</u> uch	e a -
E	10	20	2.0 ^a	AND I IS IN	erel - er hi	10	2.0 ^a
F	100	900	9.0	900	9.0	- 1 S -	-
G	60	210	3.5	210	3.5	60	3.5
Н	50	200	4.0	200 ^a	4.0	50	4.0
Ι	40	100	2.5		and and m	40	2.5
J	45	110	2.4	NY TOIL AND	bot-od a	45	2.4

^a CE ratio, budget cost, or effectiveness of the most preferred alternative

Chapter 20 How Accurate is CBA?

Sources of Error in CBA Studies

1.<u>Omissions</u>: to exclude some impact category completely.

by "uncertainty of the fundamental scientific relationship"

2. <u>Forecasting Differences</u>: to arise due to the difficulty of predicting technological change, cognitive biases, changing project specifications, etc. by "uncertainty" and "over optimism".

3. <u>Valuation Differences</u>: Difficulty of accurate monetary estimates of the social value.

4. <u>Estimation/ Measurement Differences</u>: Impact are often observed, recorded or interpreted inaccurately.

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

a directo per directo de 1 redicional directo di constante	Costs (millions of dollars)	Benefits (millions of dollars)	Net Benefits (millions of dollars)	Benefits/Costs
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).