Chapter 17 Cost-Effective 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

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, others are difficult to monetize.
3. To deal with intermediate goods whose linkage to preferences is not clear.

Cost-Utility Analysis (CUA) for the evaluation of health policies.

Cost-Effectiveness Ratios

Costs are measured in monetary terms.

Effectiveness may be measured in units such as lives saved, tons of carbon monoxide reduction, children vaccinated.

Two ways: *Cost-Effectiveness ratio* (CE ratio) more commonly used

Effectiveness-Cost ratio (EC ratio)

Increment CE ratio: *i* (with), *j* (without) policy alternatives

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

Identical Program Budgets

TABLE 17-2 Cost-Effectiveness Analysis with Fixed (Identical) Costs

	Alternatives		
Cost and Effectiveness	***A***	***B***	***C***
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.*

Imposing Constraints to deal with Scale Differences

TABLE 17-3 The Problem with the CE Ratio When Scale Differs

	Alternatives	
Cost and Effectiveness	***A***	***B***
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

[a] *CE ratio or EC ratio of the most cost-effective alternative.*

$$Min\ C_i \qquad Min\ CE_i \qquad Max\ E_i \qquad Min\ CE_i$$

$$s.t.\ E_i \geq \overline{E} \qquad s.t.\ E_i \geq \overline{E} \qquad s.t.\ C_i \leq \overline{C} \qquad s.t.\ C_i \leq \overline{C}$$

$\overline{E}$: Minimum acceptable level of effectiveness

$\overline{C}$: Maximum acceptable level of cost

Illustration of the Different CE Rules

TABLE 17-4 Cost-Effectiveness Analysis with Constraints

				$E \geq 50$		$C \leq 250$	
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)*
A	100	250	2.5	250	2.5[a]	100[a]	2.5
B	20	44	2.2	—	—	20	2.2
C	100	300	3.0	300	3.0	—	—
D	50	300	6.0	300	6.0	—	—
E	10	20	2.0[a]	—	—	10	2.0[a]
F	100	900	9.0	900	9.0	—	—
G	60	210	3.5	210	3.5	60	3.5
H	50	200	4.0	200[a]	4.0	50	4.0
I	40	100	2.5	—	—	40	2.5
J	45	110	2.4	—	—	45	2.4

[a] *CE ratio, budget cost, or effectiveness of the most preferred alternative*

Chapter 19 How Accurate is CBA?

Major Steps in CBA in Chapter 1 "Highway Example"

1. Specify the set of alternative projects
   road surface, routing, size (lane), tolls, wild animal friendliness, timing
2. Decide whose benefits and costs count
   global, national, provincial, local…
3. Catalogue the impacts and select measurement indicators
   time saving, operation cost saving, horizon value, safety benefit, toll revenue, new users, alternative road benefits, construction cost, maintenance cost, etc.
4. Predicts the impacts quantitatively over the life of the projects
   number of vehicle-trips, vehicle operation cost, number of accidents avoided, number of lives saved, etc.
5. **Monetize all impacts**
   Based on the concept of WTP
   Observed Behavior: Direct Estimation & Indirect Market Method (HPM, TCM)
   Contingent Valuation Method (Stated Preference)
6. Discount benefits and costs to obtain present values
7. Compute the net present value of each alternative
   Discount rate, NPV, IRR, (CBR)
8. Perform sensitivity analysis
9. Make a recommendation

Sources of Errors in CBA Studies

1.Omission Errors: to exclude some impact category completely.

by "uncertainty of the fundamental scientific relationship"

2. Forecasting Errors: to arise due to the difficulty of predicting technological change, cognitive biases, changing project specifications, etc.

by "uncertainty" and "Over optimism: underweight low-probability *bad* events and overweight low-probability *good* events".

3. Measurement Errors: impacts are often observed, recorded or interpreted inaccurately.

4. Valuation Errors: Difficulty of accurate monetary estimates of the social value.

Others: Political and bureaucratic actors not only directly underestimate costs and overestimate benefits of their favored alternative, they also overestimate the costs and underestimate the benefits of alternatives the do not favor.

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

TABLE 2-1 Choosing Among Projects: Net Benefits versus Benefit-Cost Ratios

	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).