Cost-Effectiveness and Cost-Benefit Analysis for Public Policy Decision-Making

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Risks and Benefits

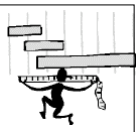
Figure 5. Drawing by S. Harris, © 1979 The New Yorker Magazine.

From page 479, **Judgement Under Uncertainty**, Edited by Daniel Kahneman, Paul Slovic, and Amos Tversky. Cambridge University Press, 1982.

MS&E 290 Health Policy Lectures

- Jan. 6 Cost-Effectiveness and Cost-Benefit Analysis
- Jan. 11 Prof. Doug Owens on HIV/AIDS
- Jan. 13 Introduction to Decision Analysis
- Jan. 18 Prof. Margaret Brandeau on Bioterrorism
- Jan. 20 Helicobacter pylori Vaccines
- Feb. 1 Student Presentations

Reference Policy and Situation

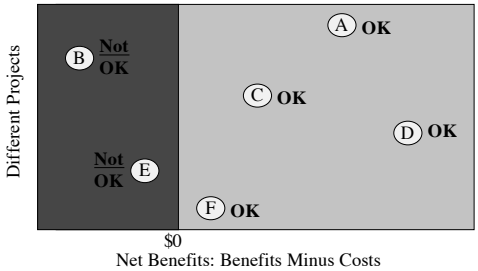


- Changes are considered relative to a particular **reference policy and situation**
- Normally this is assumed to be the **status quo**, the current policy and situation in effect.
- Alternatively, it could be a particular policy projected to be in place, or a particular situation of concern

Cost-Benefit Rationale

- A policy change is a **Pareto improvement** if some people are better off and no one is worse off after the change.
- Some policy changes benefit some at the cost of others. An exchange could have those who benefit compensate those who suffer, and thus make everyone better off.
- A policy change is a **potential Pareto improvement** if an exchange *could* be made among people that would make it a Pareto improvement, even if that exchange never occurs.
- A policy change is considered desirable if it is a real or potential Pareto improvement. This is determined by accumulating its direct and indirect benefits and costs.

Cost-Benefit Examples Which Projects Should Be Done?



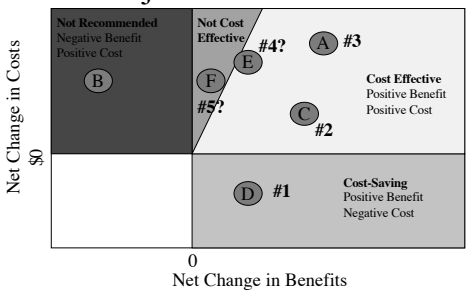
Cost-Benefit Examples
Which Projects Should Be Done?

Project	Cost	Benefit	Net Benefit	OK?
A	$200K	$250K	$50K	OK
B	$280K	$250K	-$30K	Not OK
C	$75K	$100K	$25K	OK
D	$280K	$350K	$70K	OK
E	$90K	$80K	-$10K	Not OK
F	$90K	$100K	$10K	OK

Cost-Effectiveness Rationale

- Consider a set of n projects that can be implemented independently, in parallel.
- Each project i has a cost $\$c_i$ and a benefit b_i (not usually in dollars) and there is a total budget of $\$C$.
- This can be represented as a mathematical program:
  - maximize $\sum_i x_i b_i$
    subject to $\sum_i x_i c_i \le C$
    $0 \le x_i \le 1$ for all $i = 1, \ldots, n$
  - (assuming that some of the projects can be completely partially).

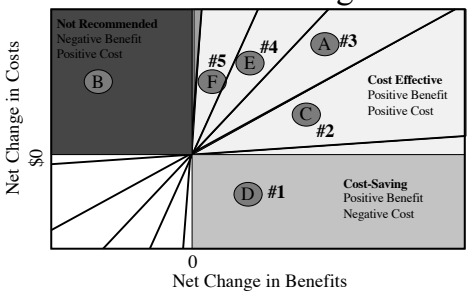
Cost-Effectiveness Example
Which Project is Most Attractive?



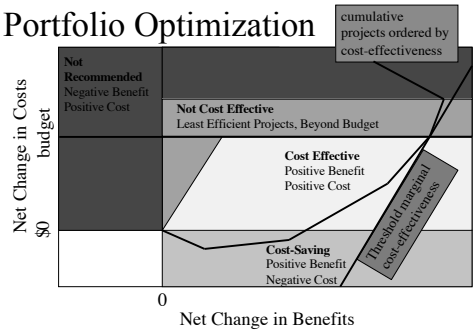
Cost-Effectiveness Example
Which Project is Most Attractive?

Project	Cost	Benefit	Ratio	Cumulative	
				Cost	Benefit
D	-$40K	3	-$13K	-$40K	3
C	$20K	6	$3.3K	-$20K	9
A	$120K	7	$17K	$100K	16
E	$100K	3	$33K	$200K	19
F	$80K	1	$80K	$280K	20
B	$80K	-5	-$16K	$360K	15

Cost-Effectiveness Example
Threshold Based on Budget



Cost-Effectiveness as Portfolio Optimization



QALY
Quality-Adjusted Life Year

- The Quality-adjusted life year is the period of time in perfect health that a patient considers indifferent to one year in a particular health state.
- For example,

QALY	Health State
1.00	Perfect health
0.95	Chronic atrophic gastritis
0.50	Gastric cancer
0.00	Surgical death

- Assessment might be different before, during, or afterwards, e,g, pain, incontinence, impotence, ostomy.

Soviet Decision to Build an Anti-Ballistic Missile System

- Soviets spent ~$100B in early 1960's to defend cities and strategic assets
- Ineffective against well-designed bomber attacks and ICBM's
- Cost contributed to collapse of Soviet Union
- BAD Decision
  NOT cost effective

Cost-Effectiveness Threshold in Medicine

- When there is no explicit budget
- Projects must all pass cost-benefit threshold
- For benefits in terms of QALY's
  - Current Standard Practice in Medical Technology Assessment in USA
  - Benefit of 1 QALY is $50,000
  - Project is cost-effective if
    Cost/QALY < $50,000

Operating Expense and Capital Expenditure

- Capital project is evaluated once for cost-benefit, relative priority--flood control, airport expansion, bridge/highway, strategic defense, technology development, opening bases and closing others
- Operating expense expected to be ongoing decision--reimbursable medical procedures, equipment maintenance, supporting troops
  - Want consistency from year to year
  - Value of $50K/QALY standard
    - Threshold necessary but not sufficient for policy!

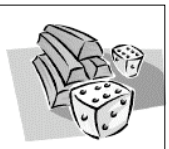
Time Value of Costs and Benefits

- How do we compare costs and benefits in one year to costs and benefits in another?
  - Spending now to protect air quality
  - Spending now to prevent future cancers
  - Spending now to immunize against future epidemics
  - Spending now on new technologies, capabilities
  - (We are trading current benefits for future benefits.)
- How far out should an analysis be performed when there is great model uncertainty?

Time Value of Costs and Benefits

- How do we compare costs and benefits in one year to costs and benefits in another?
  - Options--what choices do our current actions leave for the future?
    - Some legacy (global climate , depleted resources, disease, international security and stability, treaty obligations, debt)
    - Potential new information and technology
  - Within a generation, discount at current market rates (capital cost)
    - 3% interest rate assumed for USA medical technology assessment
  - Across generations, how to maintain intergenerational equity?
- How far out should an analysis be performed when there is great model uncertainty?
  - As far as necessary to assess impacts of current decisions in the space of costs and benefits--HIV/H. pylori vaccines

Utilities for Losses and Gains

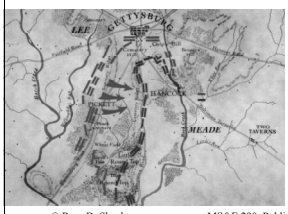


- Which is preferred?
  - Spend $1M to save 100 QALY's for sure
  - or Spend $1M to save 200 (or 0) QALY's with prob 0.5
    - New therapy with cost-effectiveness $10K/QALY
- Which is preferred?
  - Save $10M by giving up 100 QALY's for sure
  - or Save $10M by giving up 0 (or 200) QALY's with prob. 0.5
    - Old therapy with cost-effectiveness $100K/QALY

Choice depends on problem frame!
We tend to be risk-averse toward gains, risk-seeking toward losses.

General Meade's Decision to Stand at Gettysburg

"I will stand and fight it out."
General Meade overrules his commanders at Gettysburg.



General Meade's Decision to Stand at Gettysburg

- Poor intelligence available to Meade and Lee
  - Meade overestimated Lee's strength
  - Meade's commanders recommended retreat to Washington like McClellan at Richmond
- Consequence: War might well have ended with Confederate independence
- Right decision despite wrong information and bad process
- The Risk Worth Taking

Perceived versus Actual Risk

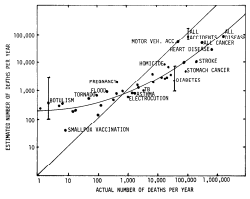


Figure 2. Relationship between judged frequency and the actual number of deaths per year for 41 causes of death. If judged and actual frequencies were equal, the data would fall on the straight line. The points, and the curved line fitted to them, represent the averaged responses of a large number of laypeople. As an index of the variability across individuals, vertical bars are drawn to depict the 25th and 75th percentiles of the judgments for botulism, diabetes, and all accidents. The range of responses for the other 37 causes of death was similar.

From page 466, **Judgement Under Uncertainty**, Edited by Daniel Kahneman, Paul Slovic, and Amos Tversky. Cambridge University Press, 1982.

Summary

- Costs and benefits are discounted for time value, and adjusted for uncertainty and risk-attitude.
- A capital project is evaluated on its net benefits--total benefits minus costs and whether it is a potential Pareto improvement.
- An ongoing decision, especially one where the benefit is not monetary, is evaluated for its marginal cost-effectiveness