GRIPS

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Cost-Effective Analysis

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BGVW Ch.18 Cost-Effective Analysis

Cost-Effectiveness Analysis

- CEA or CUA are often used instead of CBA when analysts are unable or unwilling to monetize the major policy impact (e.g., lives saved or an improvement in national security).
- CEA
  - Ratio of the cost and a **single** quantified effectiveness measure
  - CE=C/E=Cost / Effectiveness measure
  - Example: Social cost of a project / the number of lives saved by the project
- Mad Cow Disease Case Study (Kirikoshi and Sugimoto, 2004):
  - Import suspension of American beef in 2003 after the first case in the US.
  - CBA of the import suspension of American beef
    - Social cost per year: 680 billion yen
    - Decrease in the number of vCJD patients: about 2.93 (the upper-limit estimate, using the statistics from the British epidemic)
    - CE = 232 billion yen / life saved
    - CBA
      - Value of Statistical Life = 540 million yen / life saved
      - B/C = 0.000794
      - May not need to make the VSL explicit in making decisions

Social costs of risk reducing regulations

- Social cost per life saved
  Viscusi, Vernon and Harrington, (1996), p.700.
- Extremely wide variation in the cost per life saved

Regulation	Year and Status	Agency	Initial annual Risk[a]	Annual Lives Saved	Cost per Life Saved (millions of 1984 $)
Pass benefit-cost test:					
Unvented space heaters	1980 F[b]	CPSC	2.7 in 10^5	63.000	$ .10
Oil and gas well service	1983 P	OSHA-S	1.1 in 10^3	50.000	.10
Cabin fire protection	1985 F	FAA	6.5 in 10^8	15.000	.20
Passive restraints/belts	1984 F	NHTSA	9.1 in 10^5	1,850.000	.30
Underground construction	1989 F	OSHA-S	1.6 in 10^3	8.100	.30
Alcohol and drug control	1985 F	FRA	1.8 in 10^6	4.200	.50
Servicing wheel rims	1984 F	OSHA-S	1.4 in 10^5	2.300	.50
Seat cushion flammabihty	1984 F	FAA	1.6 in 10^7	37.000	.60
Floor emergency lighting	1984 F	FAA	2.2 in 10^8	5.000	.70
Crane suspended personnel platform	1988 F	OSHA-S	1.8 in 10^3	5.000	1.20
Concrete and masonry construction	1988 F	OSHA-S	1.4 in 10^5	6.500	1.40
Hazard communication	1983 F	OSHA-S	4.0 in 10^5	200.000	1.80
Benzene/fugitive emissions	1984 F	EPA	2.1 in 10^5	0.310	2.80
Fail benefit-cost test:					
Grain Dust	1987 F	OSHA-S	2.1 in 10^4	4.000	5.30
Radionuclides/uranium mines	1984 F	EPA	1.4 in 10^4	1.100	6.90
Benzene	1987 F	OSHA-H	8.8 in 10^4	3.800	17.10
Arsenic/glass plant	1986 F	EPA	8.0 in 10^4	0.110	19.20
Ethylene oxide	1984 F	OSHA-H	4.4 in 10^5	2.800	25.60
Arsenic/copper smelter	1986 F	EPA	9.0 in 10^4	0.060	26.50
Uranium mill tailings, inactive	1983 F	EPA	4.3 in 10^4	2.100	27.60
Uranium mill tailings, active	1983 F	EPA	4.3 in 10^4	2.100	53.00
Asbestos	1986 F	OSHA-H	6.7 in 10^5	74.700	89.30
Asbestos	1989 F	EPA	2.9 in 10^5	10.000	104.20
Arsenic/glass manufacturing	1986 R	EPA	3.8 in 10^5	0.250	142.00
Benzene/storage	1984 R	EPA	6.0 in 10^7	0.043	202.00
Radionuclides/DOE facilities	1984 R	EPA	4.3 in 10^6	0.001	210.00
Radionuclides/elem. phosphorous	1984 R	EPA	1.4 in 10^5	0.046	270.00
Benzene/ethylbenzenol styrene	1984 R	EPA	2.0 in 10^6	0.006	483.00
Arsenic/low-arsenic copper	1986 R	EPA	2.6 in 10^4	0.090	764.00
Benzene/maleic anhydride	1984 R	EPA	1.1 in 10^6	0.029	820.00
Land disposal	1988 F	EPA	2.3 in 10^8	2.520	3,500.00
EDB	1989 R	OSHA-H	2.5 in 10^4	0.002	15,600.00
Formaldehyde	1987 F	OSHA-H	6.8 in 10^7	0.010	72,000.00

Estimates of risk and their uncertainty

Action	Annual Risk	Uncertainty
Motor vehicle accident (total)	2.4×10^{-4}	10%
Motor vehicle accident (pedestrian only)	4.2×10^{-5}	10%
Home accidents	1.1×10^{-4}	5%
Electrocution	5.3×10^{-6}	5%
Air pollution, eastern U.S.	2.0×10^{-4}	Factor of 20 downward only
Cigarette smoking, one pack per day	3.6×10^{-3}	Factor of 3
Sea-level background radiation (except radon)	2.0×10^{-5}	Factor of 3
All cancers	2.8×10^{-3}	10%
Four tablespoons peanut butter per day	8.0×10^{-6}	Factor of 3
Drinking water with EPA limit of chloroform	6.0×10^{-7}	Factor of 10
Drinking water with EPA limit of trichloroethylene	2.0×10^{-9}	Factor of 10
Alcohol, light drinker	2.0×10^{-5}	Factor of 10
Police killed in line of duty (total)	2.2×10^{-4}	20%
Police killed in line of duty (by felons)	1.3×10^{-4}	10%
Frequent flying professor	5.0×10^{-5}	50%
Mountaineering (mountaineers)	6.0×10^{-4}	50%

Viscusi, Vernon and Harrington, (2000), p.651.

- Wide variation in uncertainty about risk estimates
  - Especially large for environmental risks
- Need to communicate the degree of uncertainty

Cost-Effectiveness Ratio and Policy Choice

- Cost-effectiveness ratio
  - CE＝C/E
  - EC＝E/C
  - Incremental CE ratio＝$(C_N - C_O) / (E_N - E_O)$
- Scale problem
  - Example: Effective but expensive vaccine vs. Inexpensive vaccine with lower E/C
  - No problem if the cost or the effectiveness is the same
  - No problem if superior in both

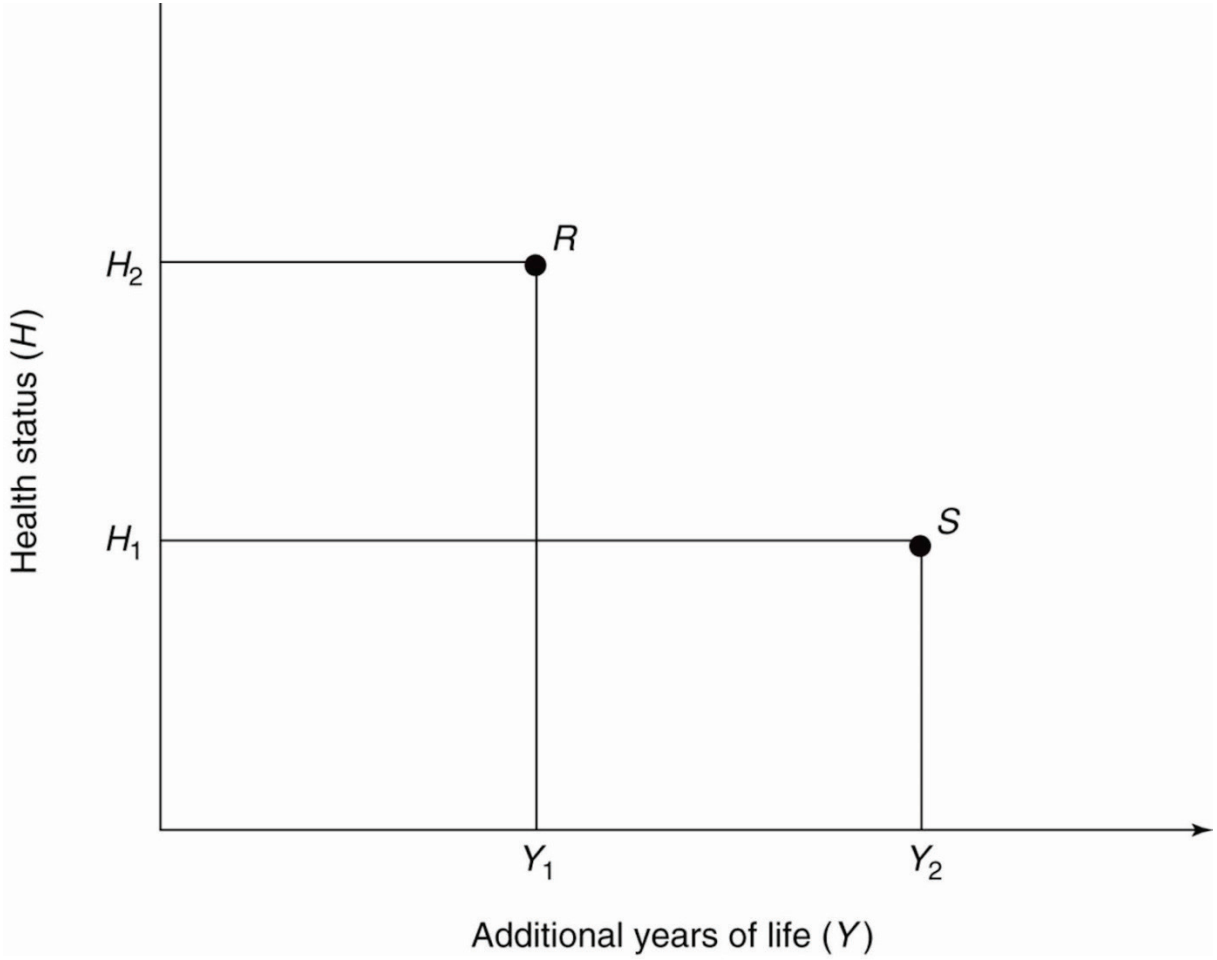
Cost-Utility Analysis

- Cost / (Utility like) Measure of Effectiveness
- Measure of effectiveness
  - Example: QALY (Quality-Adjusted Life-Years)
  - Combines quality (health status) and quantity (years) of health
- The Cost-Benefit Analysis of Hib (Haemophilus influenzae type B) Vaccination（Ishigayasumi, Touma, and Yamamoto) 2007
  - Cost / QALY = 5.95 Million yen
    - Aggregate QALY of deaths by Hib: Number of deaths x (Average（life expectancy)-0)
    - Aggregate QALY of sequelae (aftereffects): Number of sequelae x (1 x Life expectancy of healthy person - Average QALY score of sequelae x Life expectancy of sequelae)
    - Average QALY score of sequelae: 0.88 (Livartowski et al. (1996))

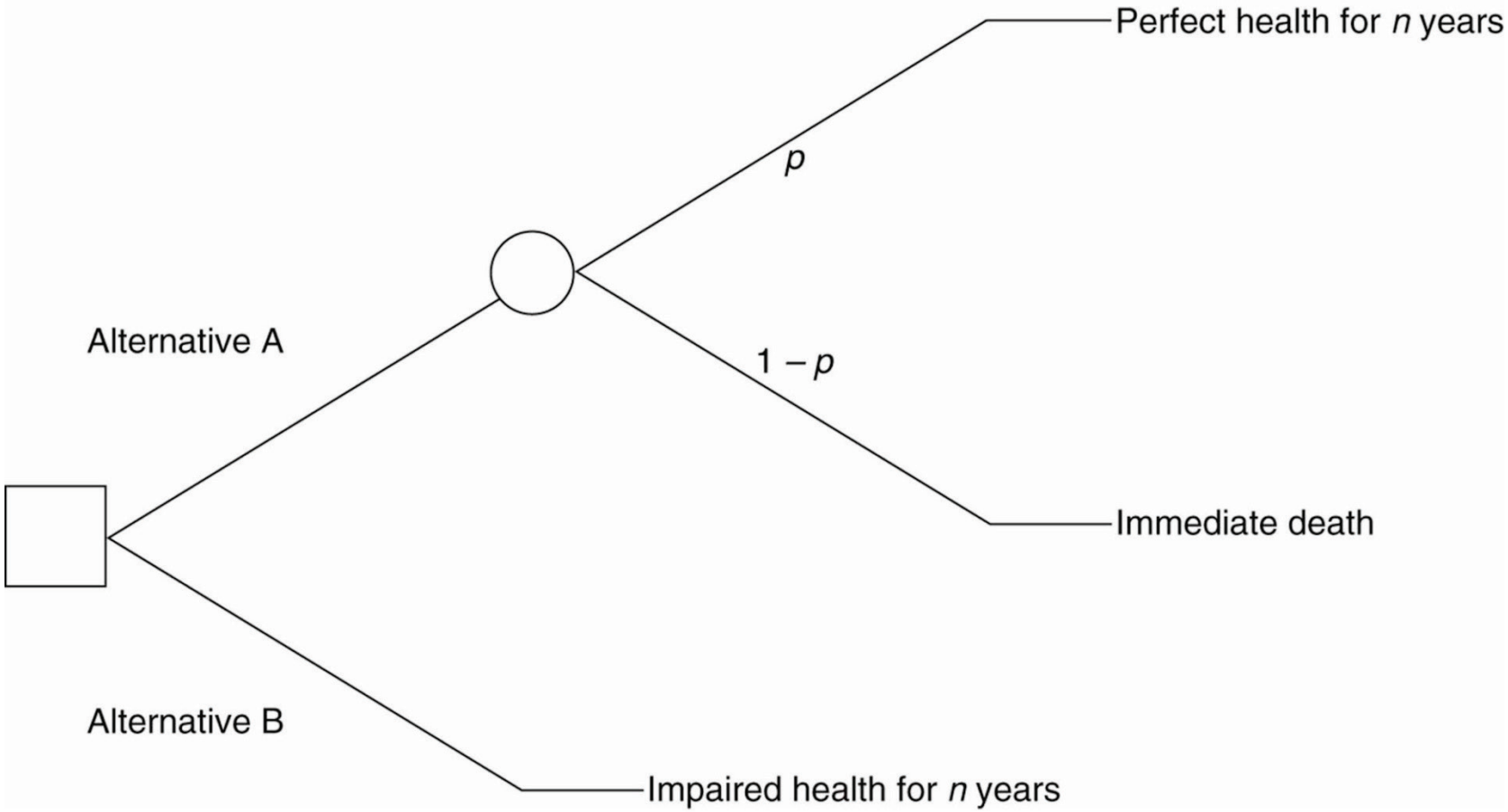
Formulating a Health Status Index and Measuring QALYs

- Four common methods of deriving QALYs
- Health rating method
  - questionnaires with health experts, potential subjects of treatment, or members of society in general
- Time trade-off method
  - asked to compare different combinations of length and quality of life.
- Standard gamble method
  - A decision tree with two alternatives like:
    - impaired health for t years;
    - normal health for n years with probability p or immediate death with probability 1-p.
  - The p at which an individual is indifferent can be interpreted as the respondent's utility of the former alternative.
- Health index method
  - Health index with various dimensions of well-being, such as mobility, absence from pain, etc.
    - SF-36：physical functioning, role limitation due to physical problems, bodily pain, general health, vitality, social function, role limitation due to emotional problems, mental health
    - With several levels of well being on each dimension, the index can distinguish among thousands of health status.

Time trade-off method



Standard gamble method



League Table

- League Table
  - draw upon multiple CUA's and CEA's to rank policies sharing the same cost-effectiveness measure, such as cost per life saved.
  - different data and different methodologies
- Ranking Regulatory Investments in Public Health from the FY 2003 Budget

Regulation	Health or Safety	Net Costs ($2001)	Life-years saved	Cost per life-year saved ($2001)
Petroleum Refining NESHAP (EPA)	Health	<0	<10 per year	<0
Powered Industrial Truck Operating Training (OSHA)	Safety	<0	146 per year	<0
Head Impact Protection (DOT)	Safety	$390 to $516 million per year	8,360 to 10,007 per year	$50,00 to $53,000
Reflective Devices for Heavy Trucks (DOT)	Safety	$65 million (PV)	946 (PV)	$69,000
Child Restraints (DOT)	Safety	$54 to $112 million per year	370 to 515 per year	$105,000 to $331,000
Rail Roadway Workers (DOT)[a]	Safety	$227 million (PV)	434 (PV)	$523,000
Interim Enhanced Surface Water Treatment (EPA)[b]	Health	<0 to $95 million per year	140 to 640 per year	<0 to $679,000
NOx SIP Call (EPA)[c]	Health	$1265 million in 2007	1590 to 3390 per year	$373,000 to $714,000
Methylene Chloride (OSHA)[d]	Health	$112 million per year	96 per year	$1.16 million
Stage I Disinfection By-Products (EPA)[e]	Health	<0 to $764 million per year	0 to 5130 per year	<0 to infinite