B.E. International Program

Faculty of Economics, Thammasat University

EE 465/463 Project Evaluation

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Problem Set 2 – Suggested Answers

1. The prevalence of a disease among a certain population is .40. That is, there is a 40 percent chance that a person randomly selected from the population will have the disease. An imperfect test that costs $250 is available to help identify those who have the disease before actual symptoms appear. Those who have the disease have a 90 percent chance of a positive test result; those who do not have the disease have a 5 percent chance of a positive test. Treatment of the disease before the appearance of symptoms costs $2,000 and inflicts additional costs of $200 on those who do not actually have the disease. Treatment of the disease after symptoms have appeared costs $10,000.

   The government is considering the following possible strategies with respect to the disease:

   S1. Do not test and do not treat early.

   S2. Do not test and treat early.

   S3. Test and treat early if positive and do not treat early if negative.

   Find the treatment/testing strategy that has the lowest expected costs for a member of the population.

   <u>Hint</u>

   The following notation may be helpful: Let D indicate presence of the disease, ND absence of the disease, T a positive test result, and NT a negative test result. Thus, we have the following information:

P(D) = .40, which implies P(ND) = .60

P(T|D) = .90, which implies P(NT|D) = .10

P(T|ND) = .05, which implies P(NT|ND) = .95

This information allows calculation of some other useful probabilities:

P(T) = P(T|D)P(D)+P(T|ND)P(ND) = .39 and P(NT) = .61

P(D|T) = P(T|D)P(D)/P(T) = .92 and P(ND|T) = .08

P(D|NT) = P(NT|D)P(D)/P(NT) = .07 and P(ND|NT) = .93

Answer

The expected cost of each strategy:

E(cost of S1) = (.4)($10000)+(.6)(0) = $4,000

E(cost of S2) = (.4)($2000)+(.6)($2000 + $200) = $2,120

As the expected cost of strategy S2 is less than the expected cost of strategy S1, early treatment should be given in the absence of testing. Thus, the best testing strategy, S3, must have expected costs less than $2,120 to be chosen over not testing.

E(cost of S3) = $250 + P(T)[P(D|T)($2000)+P(ND|T)($2000+$200)] + P(NT)[P(D|NT)($10000)+P(ND|NT)($0)] = $250 + 0.39*[(0.92*$2000)+(0.08*$2200)] + 0.61*(0.07*$10,000) = $1,463

As S3 has a lower expected cost than either S1 or S2, it is the optimal strategy.

2. A worker, who is typical in all respects, works for a wage of 500,000 baht per year in a perfectly safe occupation. Another typical worker does a job requiring exactly the same skills as the first worker, but in a risky occupation with a known death probability of 5 in 1,000 per year, and receives a wage of 600,000 baht per year.
   a. What value of a human life for workers with these characteristics should a cost-benefit analyst use?

   Answer

   The workers require $100,000 to accept a death risk of .005. The value of life implied by this is $100,000/.005 = $20,000,000.

   b. If the death probability associated with the occupation-related risk increases to 10 in 1,000 per year, what is the new value of statistical life?

Answer

The value of life implied by this is $100,000/.01 = $10,000,000.

3. Consider a project that would involve purchasing marginal farmland that would then be allowed to return to wetlands capable of supporting migrant birds. Researchers designed a survey to implement the dichotomous choice method. They reported the following data:

Stated Price (annual payment in dollars)	Fraction of Respondents Accepting Stated Price (percent)
0	98
10	91
20	82
30	66
40	48
50	32
60	20
70	12
80	6
90	4
100	2

What is the mean willingness to pay for the sampled population?

Answer

The mean WTP for the sample is approximately the price increment times the sum of the fractions of acceptance: ($10)[0.98 + 0.91 + ... + 0.02] = ($10)(4.61) = $46.1.

4. Imagine that the net present value of a hydroelectric plant with a life of 70 years is $25.73 million and that the net present value of a thermal electric plant with a life of 35 years is $18.77 million. Rolling the thermal plant over twice to match the life of the hydroelectric plant thus has a net present value of ($18.77 million) + ($18.77 million)/(1 + 0.05)35 = $22.17 million.

Now assume that at the end of the first 35 years, there will be an improved second 35-year plant. Specifically, there is a 30 percent chance that an advanced solar or nuclear alternative will be available that will increase the net benefits by a factor of three; a 60 percent chance that a major improvement in thermal technology will increase net benefits by 50 percent; and a 10 percent chance that more modest improvements in thermal technology will increase net benefits by 10 percent.

a. Should the hydroelectric or thermal plant be built today?

b. What is the quasi-option value of the thermal plant? (optional)

Answer:

a. The present value of the hydro plant remains $25.73 million. The expected present value of two successive 35-year plants is now calculated as follows:

PV(2 35-year plants) = ($18.77 million) + {[(.3)(3)+(.6)(1.5)+(.1)(1.1)]($18.77million)}/(1+.05)35 = $26.29 million

Thus, taking account of the possible improvements in technology, the 35-year thermal plant has a larger expected present value of net benefits than the 70-year hydro plant.

b. The quasi-option value of the 35-year plant is the difference between the present value of net benefits when the decision problem is correctly specified and the present value of net benefits assuming a simple roll-over of the project for the second 35 years:

Quasi-option value = $26.29 million - $22.17 million = $4.12 million

In this problem, the quasi-option value is sufficiently large to change the decision from building the hydro plant to building the thermal plant. Of course, to get the quasi-option value, we must first correctly specify the decision problem. If we can do so, then there is no need to worry about quasi-option value.

5. The construction of a dam that would provide hydroelectric power would result in the loss of two streams: one that is now used for sport fishing; and another that does not support game fish but is part of a wilderness area.

a. Imagine that a contingent valuation method is used to estimate the social cost of the loss of each of these streams. Would you be equally confident in the two sets of estimates?

b. Consider two general approaches to asking contingent valuation questions about the streams. The first approach attempts to elicit how much compensation people would require to give up the streams. The second approach attempts to elicit how much people would be willing to pay to keep the streams. Which approach would you recommend? Why?

Answer:

a. As noted in the chapter, CV studies of use goods appear to give answers generally consistent with methods based on observed behaviors. CV studies of non-use goods have not been validated through comparisons with behavioral methods because the latter are not available. Furthermore, they are especially prone to the many of the CV biases discussed in the text. Consequently, one would likely place more confidence in valuations of use than non-use. In this context, one would likely be more confident in the CV estimate of the value of sport fishing on the first stream than CV estimates of the existence value of either of the two streams.

b. If either WTA or WTP could be estimated by CV methods with the same degree of confidence, then the first approach would be the most appropriate because it corresponds exactly to the project under consideration. However, most experts believe that WTP estimates are so much more reliable than WTA estimates that the former should always be used, even in a case like this where WTA is conceptually more appropriate.

6. A public health department is considering five alternative programs to encourage parents to have their preschool children vaccinated against a communicable disease. The following table shows the cost and number of vaccinations predicted for each program:

Program	Cost ($)	Number of Vaccinations
A	20,000	2,000
B	44,000	4,000
C	72,000	6,000
D	112,000	8,000
E	150,000	10,000

a. Ignoring issues of scale, which program is most cost-effective?

b. Assuming that the public health department wishes to vaccinate at least 5,000 children, which program is most cost-effective?

c. If the health department believes that each vaccination provides social benefits equal to $20, then which program should it adopt?

Answer:

Use the ratio of cost to number of vaccinations as a measure of cost-effectiveness.

a. Ignoring differences in scale, program A is most cost-effective with a cost-effectiveness of $10/vaccination.

b. Of the programs that yield at least 5,000 vaccinations, program C is most cost-effective with a cost-effectiveness of $12/vaccination.

c. Switching to a CBA, we find that program E offers the largest net benefits, $50,000, and should therefore be adopted.

7. Analysts wish to evaluate alternative surgical procedures for spinal cord injuries. The procedures have various probabilities of yielding the following results:

Full recovery (FR) — the patient regains full mobility and suffers no chronic pain.

Full functional recovery (FFR) — the patient regains full mobility but suffers chronic pain that will make it uncomfortable to sit for periods of longer than about an hour and will interfere with sleeping two nights per week, on average.

Partial functional recovery (PFR) — the patient regains only restricted movement that will limit mobility to slow-paced walking and will make it difficult to lift objects weighing more than a few pounds. Chronic pain is similar to that suffered under full functional recovery.

Paraplegia (P) — the patient completely loses use of legs and would, therefore, require a wheelchair or other prosthetic for mobility, and suffers chronic pain that interferes with sleeping four nights per week, on average. Aside from loss of the use of his or her legs, the patient would regain control of other lower body functions.

a. Describe how you would construct a quality-of-life index for these surgical outcomes by offering gambles to respondents. Test your procedure on a classmate, friend, or other willing person.

b. Assume that the index you construct on the basis of your sample of one respondent is representative of the population of patients. Use the index to measure the effectiveness of each of three alternative surgical procedures with the following distributions of outcomes:

	Surgical Procedures		
	A	**B**	**C**
FR	**.10**	**.50**	**.40**
FFR	**.70**	**.20**	**.45**
PFR	**.15**	**.20**	**.10**
P	**.05**	**.10**	**.05**

c. Imagine that the surgical procedures involved different life expectancies for the various outcomes. Discuss how you might revise your measure of effectiveness to take account of these differences.

Answer:

a. Assign a value of 1 to full recovery (FR), the best outcome, and 0 to death (D), the worst outcome. After fully describing the meaning of FR and D, you would offer the respondent choices like the following:

Which would you prefer, full functional recovery with certainty, or a 90 percent chance of full recovery and a 10 percent chance of death?

You would adjust the probabilities (chances) until the respondent is just indifferent between the certain outcome and the gamble. For example, if the respondent were indifferent between the choices given above, then your index would assign the value .9 to the outcome FFR.

The process would be repeated for the outcome PFR. If the respondent were indifferent between partial functional recovery with certainty and a 60 percent chance of full recovery and a 40 percent chance of paraplegia, then you would have the following quality-of-life index:

FR 1

FFR $p_{FFR} = .9$

PFR $p_{PFR} = .6$

P $p_P = .4$

D 0

b. Calculating expected values over outcomes:

Effectiveness(A) = $(.1)(1)+(.7)(p_{FFR})+(.15)(p_{PFR})+(.05)(p_p) = .1+.7p_{FFR}+.15p_{PFR}$

Effectiveness(B) = $(.5)(1)+(.2)(p_{FFR})+(.2)(p_{PFR})+(.1)(p_p) = .5+.2p_{FFR}+.2p_{PFR}$

Effectiveness(C) = $(.4)(1)+(.45)(p_{FFR})+(.1)(p_{PFR})+(.05)(p_p) = .4+.45p_{FFR}+.1p_{PFR}$

c. The most straightforward approach would be to treat quality-of-life and longevity as each contributing independently to utility. Each year of life would be weighted by the quality-of-life index and discounted back to the present. In this way, a new index number would be found for each combination of quality-of-life and longevity. The new index could be used as in part b to measure effectiveness.

If a sufficiently small number of combinations of quality-of-life and longevity appeared as possible outcomes of the alternatives, then it might be feasible to present respondents with choices between them and gambles involving extreme outcomes. This method would avoid the restrictive assumption that quality-of-live and longevity have independent effects on utility. If the possible outcomes included a large number of quality-of-life and longevity combinations, then this alternative method would typically be impractical to implement through the available survey resources.