# B.E. International Program

Faculty of Economics, Thammasat University

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## EE 465/463 Project Evaluation

Semester 2/2014

**Homework Assignment 2 – Suggested Answers**

*There are four questions in total; each is worth 10 points. Use diagrams to illustrate your answers when needed.*

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.

Hint

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. The initial cost of constructing a permanent dam (i.e., a dam that is expected to *last forever*) is $500 million. The annual net benefits will depend on the amount of rainfall: $18 million in a “dry” year, $29 million in a “wet” year, and $52 million in a “flood” year. Meteorological records indicate that over the last 100 years there have been 86 “dry” years, 12 “wet” years, and 2 “flood” years. Assume the annual benefits, measured in real dollars, begin to accrue at the end of the first year.

   a. Using the meteorological records as a basis for prediction, what are the net benefits of the dam if the real discount rate is 5 percent?

Answer

(i) The first step is to calculate the expected value of the annual net benefits:

(.86)($18 million) + (.12)($29 million) + (.02)($52 million) = $20 million

(ii) The second step is to find the present value of the stream of annual net benefits. As the dam is assumed to be permanent, the formula for the present value of a perpetuity can be used:

PV = ($20 million)/(.05) = $400 million.

(iii) The final step is to subtract the cost of construction from the present value of the annual benefit stream to obtain the overall present value of expected net benefits (PVENB):

PVENB = $400 million - $500 million = -$100 million. Thus, the dam does not pass the net benefits test.

b. Instead of assuming the real discount rate is 5 percent, use several alternative discount rate values to investigate the sensitivity of the present value of net benefits of the dam. What is the breakeven value of the discount rate?

Answer

The following table shows the present value of expected net benefits for different real discount rates:

| Real Discount Rate | Present Value of Expected Net Benefits (millions of dollars) |
|---|---|
| .01 | 1,575.00 |
| .02 | 575.00 |
| .03 | 241.67 |
| .04 | 75.00 |
| .05 | -25.00 |
| .06 | -91.67 |
| .07 | -139.29 |

| | |
|---|---|
| .08 | -175.00 |
| .09 | -202.78 |
| .10 | -225.00 |

The "breakeven" value of the discount rate, $d_{BE}$, can be found by solving for the rate at which the present value of the stream of expected annual net benefits just equals the cost of construction: ($20 million)/$d_{BE}$ = $500 million ➔ $d_{BE}$ = .04

Thus, the discount rate would have to be no larger than .04 for the present value of expected net benefits for the dam to be positive.

3. 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.

4. 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.