B.E. International Program

Faculty of Economics, Thammasat University

EE 465/463 Project Evaluation

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Practice Problem 3 – Suggested Answers

1. Boardman et al., chapter 7 question 6

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?

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.

2. (Optional) Boardman et al., chapter 14 question 3

[Use spreadsheet provided.] Happy Valley is the only available camping area in Rural County. It is owned by the county, which allows free access to campers. Almost all visitors to Happy Valley come from the six towns in the county.

Rural County is considering leasing Happy Valley for logging, which would require that it be closed to campers. Before approving the lease, the county executive would like to know the magnitude of annual benefits that campers would forgo if Happy Valley were to be closed to the public.

An analyst for the county has collected data for a travel cost study to estimate the benefits of Happy Valley camping. On five randomly selected days, he recorded the license plates of vehicles parked overnight in the Happy Valley lot. (As the camping season is 100 days, he assumed that this would constitute a 5 percent sample.) With cooperation from the state motor vehicle department, he was able to find the town of residence of the owner of each vehicle. He also observed a sample of vehicles from which he estimated that each vehicle carried 3.2 persons (1.6 adults), on average. The following table summarizes the data he collected:

Town	Miles from Happy Valley	Population (thousands)	Number of Vehicles in Sample	Estimated Number of Visitors for Season	Visit Rate(Visits per 1,000 People)
A	**22**	**50.1**	**146**	**3893**	**77.7**
B	**34**	**34.9**	**85**	**2267**	**65**
C	**48**	**15.6**	**22**	**587**	**37.6**
D	**56**	**89.9**	**180**	**4800**	**53.4**
E	**88**	**98.3**	**73**	**1947**	**19.8**
F	**94**	**60.4**	**25**	**666**	**11**
Total				**14160**	

In order to translate the distance traveled into an estimate of the cost campers faced in using Happy Valley, the analyst made the following assumptions. First, the average operating cost of vehicles is $0.12 per mile. Second, the average speed on county highways is 50 miles per hour. Third, the opportunity cost to adults of travel time is 40 percent of their wage rate; it is zero for children. Fourth, adult campers have the average county wage rate of $9.25 per hour.

The analyst has asked you to help him use this information to estimate the annual benefits accruing to Happy Valley campers. Specifically, assist with the following tasks:

a. Using the preceding information, calculate the travel cost of a vehicle visit (TC) from each of the towns.

b. For the six observations, regress visit rate (VR) on TC and a constant. If you do not have regression software available, plot the points and fit a line by sight. Find the slope of the fitted line.

c. You know that with the current free admission, the number of camping visits demanded is 14,160. Find additional points on the demand curve by predicting the reduction in the number of campers from each town as price is increased by $5 increments until demand falls to zero. This is done in three steps at each price: First, use the coefficient of TC from the regression to predict a new VR for each town. Second, multiply the predicted VR of each town by its population to get a predicted number of visitors. Third, sum the visitors from each town to get the total number of predicted visits.

d. Estimate the area under the demand curve as the annual benefits to campers.

Using the preceding information, calculate the travel cost of a vehicle visit (TC) from each of the towns.

Answer:

a. The travel cost from each town consists of two components (admission is free). The first is vehicle operating expense, estimated as \$0.12 per mile times the round trip distance. The second is the opportunity cost of time, which is estimated as the travel time of adults multiplied by 40 percent of the wage rate. For example, the travel cost for a visit from Town A, which is 22 miles from Happy Valley (44 miles round trip), is:

(\$0.36/m)(44 m) + (0.40)(\$9.25/h)(1.6 adults)(44 m)/(50 m/h) = \$21.05/vehicle-visit

Because there are 3.2 persons/vehicle, the average travel cost per person is:

\$21.05/3.2 = \$6.50/person.

The costs per person (and the cost/trip) for the towns are thus:

Town	Travel Cost/trip	Travel Cost/person
A	\$21.05	6.58
B	\$32.53	10.17
C	\$45.93	14.35
D	\$53.58	16.74
E	\$84.20	26.31
F	\$89.94	28.11

b. The estimated regression equation (standard errors in parentheses, R^2=0.96) is:

VR = 93.14 - 2.88 TC
(11.15) (-6.47)

The estimated equation indicates that each dollar of additional travel cost reduces the visit rate by 2.88 visits per 1000 residents.

c. Consider, for example, the impact of a \$10 admission fee. The following table summarizes the calculation procedure:

Town	New Visit Rate (with \$10 admission fee)	Predicted Visits (VR times population)
A	77.7-(2.88)(10) = 48.9	2450
B	65.0-(2.88)(10) = 36.2	1263
C	37.6-(2.88)(10) = 8.8	137

D	53.4-(2.88)(10) = 24.6	2212
E	19.8-(2.88)(10) = -9.0	0
F	11.0-(2.88)(10) = -17.8	0

Note that a $10 admission fee leads to a prediction of negative visit rates for Towns E and F. As visit rates cannot be negative, we set these predicted visit rates to zero. Summing the predicted number of visits for the towns gives a total 6,062 visits.

Repeating this procedure leads to the following points on the derived demand curve:

Price	Number of Visits
0	14,160
$5	9,336
$10	6,062
$15	3,406
$20	1,265
$25	286

Demand approximately falls to zero between $25 and $30. (The calculated choke price is $26.98, but the accuracy of the estimation procedure does not justify such a precise prediction)

d. To estimate the area under this demand curve, multiply the average heights of adjacent points times their width, $5, and sum:

area = {[(14160+9336)/2]+[(9336+6062)/2]+[(6062+3406)/2]
+[(3406+1265/2]+[(1265+286)/2]+[(286+0)/2] }($5)
= $27,435x5 = $137,175

Therefore, our estimate of the annual benefits from camping in Happy Valley is $137,175.

3. Boardman et al., chapter 15 question 1

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.

4. Boardman et al., chapter 18 question 1

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.

5. Boardman et al., chapter 18 question 2

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.