Econ 460: Environmental Economics

Assignment #1

1 Cost Benefit Analysis

Suppose the government of a municipality is trying to determine how to deal with pesticide contamination of its water supply. It wants to undertake a benefit-cost analysis of two alternative policy options for controlling pesticides:

- Upgrading its municipal water treatment plant to remove pesticides, or:
- Banning the use of the offending pesticides in the metropolitan area.

Assume that either technique reduces the pesticides to a level which does not adversely affect human health. The cost of these control options are as follows:

Municipal treatment upgrades

Capital costs = **$13** million. The new plant is constructed over the course of one year. It starts operating at the beginning of year two. Once the plant begins operation, it has an operating cost of **$1.7** million per year. Once constructed the plant lasts a fixed number of years, then must be replaced with a new plant. The scrap value is zero

Pesticide ban

Annual operating costs due to substitution of non-toxic methods of controlling "pests" = **$7** million per year. These costs would last *forever*.

Benefits[1]

The benefits of pesticide control are many. But suppose the only information the government has that is related to the benefits of controlling pesticides is the following:

Households have switched from using tap water for consumption to bottled water because of the contamination. Before the pesticide contamination, the demand for bottled water was given by the following function:

$$Q_t = 8 - 0.5P_t$$

where Q_t is consumption per household, per month, of containers of bottled water, and P_t is the price per container.

After the contamination occurs, the demand curve shifts to:

$$Q_t = 12 - 0.5P_t$$

Assume that the price of bottled water is $3 per container and the price stays constant even after the demand shift[2]. There are $10,000$ households in the community. Further assume that the social discount (interest) rate is 5%.

1. Using an Excel spreadsheet, carefully construct a model that calculuates the Net Present Value of: (a) the pesticide ban, (b) The treatment plant if it operates for 5 years after the year it is built, and (c) The treatment plant if it lasts 10 years after the year it is built. (in both cases, assume the plant takes one year to build and all the construction cost is spent at the beginning of the year)
2. If the Plant lasts 5 years, what control option should the municipality choose? Excel spreadsheet models are acceptable as long as you include an explanation of any discounting formulas etc. that are used in the spreadsheet.
3. If the Plant lasts 10 years, what control option should the municipality choose?
4. Use "Goal Seek" to find the discount rate that makes the regulator indifferent between the Ban and the 5 year plant.
5. Use "Goal Seek" to find the discount rate that makes the regulator indifferent between the Ban and the 10 year plant.

[1] Hint: Look at figure 9.5 on page 190 of the textbook after reading this section

[2] Assume that the bottled water industry is perfectly competitive, therefore profits are zero i.e. $P = AC = \$3$

2 Working with CV and EV

1. Myrtle has \$200 per month to spend on Transit (X) and all other goods (Y). She currently buys a bus pass for \$50 and rides 40 times per month.If she didn't buy the pass, bus rides would cost \$2/ride. Myrtle is offered to join a Transit program that would allow her to pay a membership fee and then could ride the bus for \$1 per trip. The most Myrtle would pay for the membership is \$20. and then she would ride 15 times a month. If she were given the membership for free, she would ride the bus 18 times per month. Myrtle also reveals that she would be indifferent between a free membership (and \$1 per ride) versus simply having the traditional bus pass reduced to \$25 per month (flat rate), where she would again choose to ride the bus 40 times a month.

   (a) Using all the information provided, draw all the relevant budget constraints and indifference curves. Be sure to label all equilibrium points and have a legend that explains each point (in one or two sentences).

   (b) Calculate her CV (compensating variation) difference between the Pass, and the most she would pay for \$1 rides

   (c) Calculate her EV (equivalent variation)

2. Skippy has the following utility function: $u = \sqrt{xy}$ and faces the budget constraint: $M = p_x x + p_y y$.

   (a) Use Lagrange to derive Skippy's demand functions, indirect utility function and expenditure function

   (b) Suppose $M = 48$, $P_y = 1$ and $P_x = 4$. What is Skippy's optimal x, y and utility number? If the price of x was lowered to 2 what would be her x, y and utility number

   (c) What is the most Skippy would pay to have P_x lowered to 2?

   (d) Suppose $M = 48$, $P_y = 1$ and $P_x = 4$. How much additional income would Skippy need to be as well off as if the price of x had fallen to 2?

   (e) Graph your answer carefully, label all ewuilibrium points, intercepts and slopes. Be sure to indicate CV and EV on the graph (graph must be 1/2 page minimum in size)

3 Congestion and the optimal toll

There are 840 people who travel from A to B each day in order to get to work. There are two routes that are available. Route 1 is the faster route but has limited capacity. Route two is slower but has much greater capacity. If travel time is measured in minutes, and is also a function of the number of cars on the road, then the average travel time for each route is:

$$\begin{aligned} AUC_1 &= 30 + 0.5Q_1 \\ AUC_2 &= 60 + 0.1Q_2 \end{aligned}$$

where AUC_i is the average user cost and Q_i is the number of cars on route i (where $Q_1 + Q_2 = 840$). Further, the value of time is calculated to be \$12 per hour.

1. (a) In the absense of any tolls, what is the equilibrium number of cars per day on each route?

   (b) What is the total time cost, (or social cost) per day

   (c) What is the socially optimal number of cars on each route?

   (d) What is the total time cost per day at the social optimum? How much would be saved when compared to your answer to (b)?

   (e) What would be the toll needed to achieve the social optimum?