Problem Set 2

ENVIRON805K

October 1, 2017

Notes: The problems below mainly come from the book *Environmental Economics* by Charles D. Kolstad.

1. (3.6) Suppose you have a society of n identical individuals and the environment. Each individual likes his or her material possessions as well as access to parks and wilderness areas. In fact, the utility function of each individual is $U(x, H) = x + H - \frac{1}{x} - \frac{1}{H}$, where x is consumption goods and H is environmental health. H attains its highest level when it is pristine: $H = 100$. Consumption of goods degrades the environment but the environment has some ability to heal itself. In fact, the environment has health $H_t = H_{t-1} + g(100 - H_{t-1}) - nx$, where H_t is today's H and H_{t-1} is yesterday's H. The environment's ability to clean itself, g, is fixed.
(a) Simply focusing on the utility function (ignoring the evolution of H), discuss the extent to which the utility function is consistent with biocentrism or anthropocentrism.
(b) Suppose we start at $H = 100$. Assume $g = 0.1$ and $n = 1$. Plot how H would evolve for $x = 0.01, 0.1$ and 1.
(c) Repeat part (b) except this time plot U instead of H. Feel free to try other values of x. Can you reach any conclusions about the level of consumption that maximizes utility?

2. (3.7) Society consists of two individuals, Tucker and Finch; there are two goods, food and water sport (recreation); and there are three social choices, A, B, and C, involving different amounts of the two goods for Tucker and Finch:
Tucker's preference are a bit different than Finch's. Let $(2.0, 1.0)$ represent an bundle of food (first argument) and sport (second argument). Tucker likes the following bundles, in order from best to worst: $(2.1, 1.0) \succ (1.0, 2.0) \succ (2.4, 0.7) \succ (1.7, 1.3) \succ (2.0, 1.0)$. Furthermore, all bundles containing less than 0.9 units of sport are inferior to $(1.0, 2.0)$. For Finch, the bundles, from best to worst, are $(1.4, 1.4) \succ (1.0, 2.0) \succ (1.6, 1.3) \succ (1.8, 1.1) \succ (2.0, 1.0)$. For Finch, all bundles with less than 1.2 units of sport are inferior to $(1.0, 2.0)$.

Social Choices	Tucker		Finch	
	Food	Sport	Food	Sport
A	2.0	1.0	2.0	1.0
B	1.7	1.3	1.8	1.1
C	1.0	2.0	1.0	2.0

(a) In a graph with food on the horizontal axis and sport on the vertical axis, draw an

indifference curve for Finch and one for Tucker, through the point $(1.0, 2.0)$. Apply the specific bundles for which we know ranking. Do individual preferences appear to be problematic?
(b) Between social choices A and B, which does our two-person society prefer? Why?
(c) Is there a way to shuffle around the total amount of food and sport in choice A (between Tucker and Finch) so than your answer to (b) is reversed?
(d) Why does this result suggest the compensation principle is flawed? That is, to be meaningful, winners actually have to compensate losers for the social choice judgment to be valid.

3. (4.6) Suppose an environmental regulation requires all polluters to reduce emissions by 50%, even though the cost of pollution control differs widely from one polluter to another. Why might this be inefficient, using the definition of efficiency developed in this chapter?

4. (4.7) Suppose Humphrey and Matilda live together. Humphrey currently smokes 20 packs of cigarettes per month; Matilda hates the smoke. They currently have no agreement restricting smoking.Their only joint expense is monthly rent, which they split 50:50. Draw an Edgeworth box with two goods-smoke and rental payments. Make up some reasonable indifference curves. Show the initial endowment. What Pareto efficient points might result from bargaining to restrict smoke? How does the graph show what price per pack Matilda might pay to buy down Humphrey's smoking (i.e., show the relative prices on your figure)? How would your answers change if the status quo is that the two have an agreement for no smoking and Humphrey would like to smoke as much as 20 packs per month? He must seek Matilda's permission to do so.
(*Hint*: For Matilda, redefine Humphrey's smoking as smoke reduction.)

5. (5.2) Consider an airport that produces noise that decays as the distance (d), in kilometers, from the airport increases: $N(d) = \frac{1}{d^2}$. Fritz works at the airport. Fritz's damage from noise is $\$1$ per unit of noise and is associated with where Fritz lives. His costs of commuting are $\$1$ per kilometer (each way). The closest he can live to the airport is $d = 0.1$km.
(a) Write an expression for Fritz's total costs (noise and transportation).
(b) What is the distance Fritz will live from the airport in the absence of compensation for the noise? What are his total costs?
(c) Suppose Fritz is compensated for his damage, wherever he may live. How close to the airport will he choose to live? How much will he be compensated?
(*Hint*: Solve graphically or using calculus.)

6. (5.5) Two types of consumers (workers and retirees) share a community with a polluting cheese factory. The pollution is nonrival and nonexcludable. The total damage to workers is p^2 where p is the amount of pollution and the total damage to retirees is $3p^2$. Thus marginal damage to workers is $2p$ and marginal damage to retirees is $6p$. According to an analysis by consulting engineers, the cheese factory saves $20p - p^2$ by polluting p, for a marginal savings of $20 - 2p$.
(a) Find the aggregate (including both types of consumers) marginal damage for the public bad.
(b) Graph the marginal savings and aggregate marginal damage curves with pollution

on the horizontal axis.
(c) How much will the cheese factory pollute in the absence of any regulation or bargaining? What is this society's optimal level of pollution?
(d) Starting from the uncontrolled level of pollution calculated in part (c), find the marginal willingness to pay for pollution abatement, A, for each consumer class. (Abatement is reduction in pollution; zero abatement would be associated with the uncontrolled level of pollution.) Find the aggregate marginal willingness to pay for abatement.
(e) Again starting from the uncontrolled level of pollution, what is the firm's marginal cost of pollution abatement? What is the optimal level of A?
(f) Are the problems of optimal provision of the public bad (pollution) and the public good (abatement) equivalent? Explain why or why not.

7. (5.6) Consider the problem of carbon dioxide emissions. We will abstract away from the problem slightly, assuming there are polluters and consumers in two regions, the OECD (O) and the rest of the world (R). Suppose the marginal cost of controlling CO_2 emissions is $\$10$ per ton of emissions. Let the marginal willingness to pay for pollution reduction be $13 - Q$ for region O and $12 - 2Q$ for region R, where Q is the amount of pollution reduction. The United Nations is considering two proposed methods for controlling CO_2 emissions, both involving polluters paying for the damage they cause. Proposal A involves the polluters paying damages to each region for the pollution generated. Proposal B involves the polluters in each region independently negotiating pollution reductions, assuming the other region is not undertaking pollution reduction.
(a) Graph the marginal abatement cost and the total marginal willingness-to-pay schedules. What is the socially efficient level of emission reductions, Q?
(b) How much total pollution reduction will occur under proposal A and what will be the total compensation received by regions O and R? If those payments were instead placed in the general coffers of the UN, would the outcome be any different from an efficiency point of view? Why or why not?
(c) How much pollution would be generated under proposal B? Explain any differences between this answer and the answer to parts (a) and (b).

8. (6.4) An investment of $\$100$ today will avoid $\$1,000,000$ of environmental damage in 100 years.
(a) At a discount rate of 10%, is this investment a good idea?
(b) At a discount rate of 1%, is this investment a good idea?
(c) At a discount rate of 2%, what is the maximum we would be willing to pay to avoid the million dollars of environmental damage in 100 years?

9. (6.5) Consider the twin communities of Tuckerville and Matildastan. These are seaside resorts that neighbor each other a nd attract many tourists. Matildastan wants to raise some money to clean up the streams in town; their approach to this is to levy a "bed tax"– a per night tax on every visitor to a hotel. There are 3,500 hotel rooms in Matildastan and 1,500 hotel rooms in Tucherville. The rooms are identical and tourists do not really mind which town they stay in. There are no other nearby towns.

The variable cost of providing a hotel room (electricity, maid service, other labor costs, etc.) is $30 per room: $20 for labor (maids, clerks, etc.) and $10 for nonwage expenses like electricity. (Labor and electricity prices are set in a larger, regional market.)

About the only cost for hotel managers is building construction and maintenance costs, including mortgage payments (costs that are independent of the number of rooms rented). The (linear) demand is such that a price of $100 per room, demand is for 6,000 per day. If the price goes to $200, the demand would be cut in half. Assume the bed tax is $10 per room per night in Matildastan only.
(a) Identify the groups of people who might be positively or negatively impacted directly by the tax (not by the cleanup). Include tourists, hotel owners, workers, others.
(b) Identify the groups of people who might be positively or negatively impacted directly by the cleanup. Include tourists, hotel owners, workers, residents of Matildastan, and others. Discuss the nature of their impact.
(c) Show graphically the effect of a $10 tax on beds covering both communities on prices of hotels. This involves showing the supply of hotel rooms as well as the demand. Be as accurate as possible, using as much of the proceeding information as you can.
(d) Show graphically the effect of the $10 tax on beds on Matildastan (no tax elsewhere) on the price of hotels in Matildasan (compared to no tax).
(e) In terms of the direct incidence of the tax (i.e., excluding the benefits of stream cleanup), identify who ultimately pays for the tax. Try to be as quantitative as possible and support your arguments.