

Problem Set 3, part 1

Introduction to Environmental and Resource Economics, November 8, 2004

Due Nov. 15

1. Suppose that three people live around one of the coal-fired power plants discussed in the last problem set. Because each individual has a different sensitivity to air pollution, each has a different willingness-to-pay (marginal private benefit) for cleaner air:

$$p_1 = 100 - \frac{1}{2}Q \quad (1)$$

$$p_2 = 100 - Q \quad (2)$$

$$p_3 = 100 - 2Q \quad (3)$$

Starting from the status quo level of pollution at $Q = 0$, the marginal cost of cleaning up the air is given by:

$$MC = 200 + \frac{1}{2}Q \quad (4)$$

- (a) Clean air can be considered a public good because its enjoyment is *non-rival* and *non-excludable*. In your own words, define each term. Give two examples of public goods. Is each both non-rival and non-excludable?
- (b) As air quality increases, which individual gains the most benefit? Which gains the least? (It may help you to graph the individual's willingness-to-pay.)
- (c) Construct the marginal social benefit curve for clean air, for $Q < 50$. (You can construct the entire curve if you feel ambitious!)
- (d) What is the socially optimal level of clean air, given your answer from above?
- (e) If provision of cleaner air was left to the free market, how much clean up would occur? (Hint: Would any of the individuals in the market purchase any "clean up" on their own? If not, why not?)
- (f) If the three individuals put a bond initiative on the election ballot of their small village to fund cleanup activities, in theory, would the bond be likely to pass? (Discuss in terms of the free rider problem and Nash equilibrium.)
- (g) If the mayor of the village decided to establish a tax to fund the cleanup efforts, what problems might he face in setting and collecting the socially optimal tax?

2. This problem is a brain-teaser, but fun! Assume that Pat, Chris, and Sasha all live along a dead-end road in upstate New York. Pat lives at the end of the road, 300 meters from the main road. Chris lives next-closest, 200 meters from the main road. Sasha lives closest, 100 meters away. It snows a lot there in the winter. If each individual shovels their own drive, they can do an OK job of it by putting 10 cents of effort per meter into the job. Thus, the *constant* marginal willingness-to-pay of each person is 10 cents a meter. (This means that each person's MPB curve is a horizontal straight line, and their total private benefit curve is an upward-sloping line with slope 0.10.)
- (a) Assume each person shovels the road up to their own house. Respectively, what marginal social benefits do Sasha, Chris, and Pat's activities generate? (Hint: Graph the marginal social benefits, with meters from the main road represented on the X axis. This means Sasha lives at 100, Chris lives at 200, and Pat lives at 300. Graph each individual's marginal private benefit, then figure out and graph the marginal social benefits.) Are externalities generated by their actions? If so, by who and how much?
 - (b) Assume that a plowing service is available which would plow the road for 20 cents a meter. Assume that each resident acts independently, i.e., without waiting to see or trying to figure out what the other residents would do. Would any of the three residents hire this service on their own? If yes, who would hire the firm, and how far would they contract to have the road plowed? If no, why not?
 - (c) Now assume that each resident tries to anticipate the possible actions of the other residents (like the Nash Equilibrium problem we did). Do you think that your answer to the above problem would change? Why or why not? (You do not have to set up and solve this problem formally, like we did in class. Just think it through.)
 - (d) What is the socially optimal distance to have the road plowed? Why? (Note: The answer is a range, not a unique number.)
 - (e) Compare the total costs to having the entire road plowed to the total benefits. Would it ever make sense to have the entire road plowed?
 - (f) If it was proposed that the three neighbors have the entire road plowed and split the costs, do you think that all the neighbors would agree to this proposition? If not, can you propose a pricing scheme that might be acceptable to all? (Hint: think about optimal contributions to public goods.)