Midterm Exam
Introduction to Environmental and Resource Economics, November 8, 2004
150 points total

You have until 7:10 to complete this exam. Please use your own paper, use a separate sheet of paper to start each question, and put your name on each page. Ask if you need clarification about any question. If I can answer, I will. Mark off each section of each question on your exam as you complete it, to be sure that you answer all parts of all questions. Good luck!

1. Graphically and verbally analyze the impact of each of the following changes on the competitive free-market equilibrium for a particular good. Assume that no positive or negative externalities are generated by either production or consumption of the good. Trace each impact to a shift in the demand or supply curve and the subsequent impact on market-clearing quantity and price (ie, will the quantity increase or decrease, and will the market-clearing price increase or decrease, and why?)

   (a) News that consuption of the good being purchased generates positive health benefits for the consumers (10 points),

   (b) An improvement in production technology that allows the same amount of production using less of each production input (10 points).

2. While the landscaping around my house, which includes native perennials, open compost bins, brush piles, infrequent mowing, and bird-feeding stations, provides needed habitat for bird populations, this landscape also creates very friendly habitat for rats. These rats may not stay only on my property, but may also migrate to the neighbors' houses. Thus, my landscaping choices generate negative external costs for my neighbors. The included graph represents the market for landscaping, similar to the one I discussed in class. However, today we are ignoring the positive external benefits of the landscaping, and are focusing on the negative external costs–rat habitat. Use the graph and points marked to answer the following questions:

   (a) Explain (in general, conceptual terms) the difference between the marginal private cost (supply) curve and the marginal social cost curve (5 points).

   (b) Identify the competitive free-market solution (5 points).

   (c) Identify the socially optimal solution. Why wouldn't this solution be a market equilibrium? (5 points)

   (d) When negative externalities are present, is the free market likely to over or under produce the good? Why? (5 points)

   (e) Moving from Q_2 to Q_1, what does area $cdef$ represent? Explain. (5 points)

   (f) Moving from Q_2 to Q_1, what does area cde represent? Explain. (5 points)

   (g) Which area represents the net gain to society in moving from the market solution to the socially optimal solution? (5 points)

   (h) Using the graph, and assuming that my neighbors have the right to a rat-free neighborhood, demonstrate how Coasean bargaining between myself and my neighbors may allow me to invest in the socially optimal amount of landscaping. (5 points)

   (i) The way this problem has been formulated, some rat habitat is allowed at the social optimum. Do you think that this formulation is reasonable? Why or why not? (Either side can be argued.) (5 points).

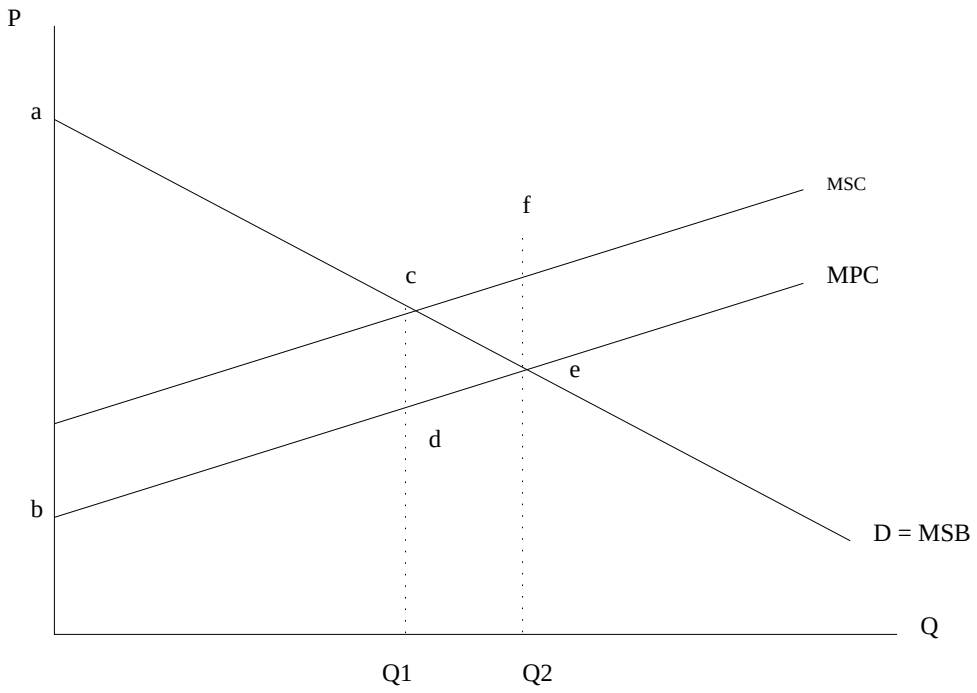

Figure for problem 2, midterm fall 2004

3. Homeowners in Fairfax City plant trees in order to shade their houses and improve the beauty of their lots. Assume the marginal private benefit (demand) curve from tree planting is:

$$P = 14 - Q$$

and homeowners' marginal private cost curve (supply curve) is:

$$P = 2 + \frac{1}{2}Q$$

(a) Assuming a perfectly competitive free market, how many trees will be planted, and what will the market price of a planted tree be (5 points)?

(b) Each tree that is planted in an urban area generates external benefits in the form of air quality improvement and reductions in summertime temperatures, among other things. These per-tree marginal external benefits are estimated to be:

$$MEB = 3$$

with a corresponding total external benefit of:

$$TEB = 3Q$$

Use this information to construct the marginal social benefit curve (5 points).

(c) What are the free-market values for consumer surplus, producer surplus, and total external benefits at the free-market solution? (5 points)

(d) Given the information about external benefits, what is the socially optimal quantity of trees that should be planted? Explain why this value is socially optimal. (5 points)

(e) What are the values for consumer surplus, producer surplus, and total external benefits at the socially optimal solution? (5 points)

(f) Graph the problem, labeling each level of output and indicating which area represents the net gain from moving to the social optimum (5 points).

(g) Explain why residents might not respond favorably if the City of Fairfax simply ordered each of them to plant more trees. (5 points)

(h) If the City of Fairfax were to pay a constant per-tree subsidy to residents, in order to induce the socially optimal level of tree planting, what would the value of this subsidy be? Explain, using numbers and/or your graph, how this subsidy would change the free market equilibrium. (5 points)

(i) Calculate the net gain to society (improvement in total welfare) from moving from the competitive solution to the social optimum (shown on your graph above). (5 points).

(j) The National Arbor Day foundation distributes tree seedlings to city residents around the country free of cost. Individuals can join this foundation through a small yearly membership fee. Discuss the foundation's role in terms of Coasean bargaining theory. How might the foundation overcome some of the theoretical problems with Coasean bargaining? (5 points)?

4. We have temporarily entered an alternate universe (like Star Trek). In this universe, the senate has ratified the Kyoto protocol, calling for establishment of limits on carbon dioxide emissions and establishment of a market for carbon emissions trades. As an expert in environmental policy, you have been asked by the city of Stuckeyville to establish a regulatory program to manage its two main polluting industries, the bowling ball plant and the pie factory. The two industries are currently emitting 20 units of pollution each (40 total units), and you decide that the total should be reduced to 20 units in all. You initially allocate 10 permits to each firm, which allow 1 unit of emissions per permit. This implies that 20 units of pollution abatement are required in total. Firm 1's abatement cost functions are given by:

$$TAC_1 = 10 + \frac{3}{4}A_1^2 \quad (1)$$

$$MAC_1 = \frac{3}{2}A_1 \quad (2)$$

Firm 2's costs are given by:

$$TAC_2 = 5 + \frac{1}{2}A_2^2 \quad (3)$$

$$MAC_2 = A_2 \quad (4)$$

(a) Describe three conditions that must hold for the trading market to be successful. (5 points)

(b) Assuming that the conditions you describe above hold and the trading market is successful, find the theoretical equilibrium level of abatement for each firm after trading. (5 points)

(c) Graph this solution using a box diagram with Firm 1's marginal abatement cost on the left axis, and Firm 2's marginal abatement cost on the right. (5 points)

(d) Report a trading price which will achieve this solution. Note that a unique permit price cannot be determined, but there is a range of possible prices. (You can either report a possible total payment for the entire transaction, or a per-unit price for each unit of abatement traded.) (5 points)

(e) Using either your graph or the abatement cost functions provided (or both if you like), illustrate and/or calculate the total cost savings from the trading program, relative to the equal permit allocation. (5 points)

(f) It can be shown that the aggregate marginal abatement function is:

$$MAC = \frac{3}{5}A$$

If the aggregate marginal damage function is:

$$MDC = 33 - \frac{1}{2}A$$

Is the total abatement target that you have set allocatively efficient? Why or why not? (5 points)

(g) Given your answers to the last two questions, discuss the cost and allocative efficiency of the trading outcome. (5 points)