Midterm Exam
Introduction to Environmental and Resource Economics, November 3, 2003
200 points total

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) A decrease in the incomes of the consumers purchasing the good (10 points),

   (b) A decrease in the cost of one of the inputs used to manufacture the good (10 points),

   (c) An increase in the price of a substitute good (one that consumer's might purchase as an alternative to this good) (10 points),

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

2. The included graph represents the market for a good whose production generates external benefits. Use the graph and points marked to answer the following questions:

   (a) Give an example of a good whose production generates a positive externality (5 points).

   (b) Explain the difference between the marginal private benefit (demand) curve and the marginal social benefit curve (5 points).

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

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

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

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

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

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

   (i) Is this movement Pareto improving? Does it meet the Kaldor-Hicks criteria? Explain. (5 points)

   (j) Explain how the government may subsidize production of the firm, and demonstrate using the graph how this subsidy can lead to the socially optimal solution (5 points).

3. As we discussed in class, large livestock operations often generate negative externalities in the form of odor and groundwater contamination that reduce quality of life and health of nearby residents. Assume the livestock industry faces the following marginal private benefit (demand) curve for its product:

$$P = 100 - Q$$

and the livestock industry's marginal private cost curve (supply curve) is:

$$P = 20 + 3Q$$

(a) Graph the supply and demand curves for the market (5 points).

(b) Assuming a perfectly competitive free market, what level of output will the industry supply, and what will be the price? What are the values for consumer surplus, producer surplus, and total surplus? (5 points)

(c) Graduate students from a local agricultural economics department estimate that livestock production results in a constant marginal externality cost of:

$$MEC = 20$$

and a total external cost of:

$$TEC = 20Q$$

Use this information to construct the marginal social cost curve, and add this curve to your graph (5 points).

(d) Given this information, what is the socially optimal level of output for the factory? What would be the price at this level of output? What are the values of consumer and producer surplus? (5 points)

(e) In terms of only consumer and producer surplus, does the move from the competitive to socially optimal solution improve welfare? Why is this comparison insufficient from a policy maker's perspective (5 points)?

(f) What are the total external costs for both the competitive fre-market and socially optimal solutions? Why isn't the total external cost zero at the competitive free-market solution? Why isn't the total external cost zero at the socially optimal solution? Which external cost figure is higher, and why (5 points)?

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

(h) Using the information from the previous two questions OR using your graph, calculate the net gain to society (improvement in total welfare) from moving from the competitive solution to the social optimum (5 points).

(i) Suppose that the livestock farms had the legal right to pollute. Show how bargaining between a unified coalition of neighbors and the livestock operation could

lead to the socially optimal solution. Demonstrate graphically the neighbor's willingness to pay to reduce pollution and the livestock operation's willingness to accept What is a possible price that would be acceptable to you both (5 points)?

(j) Damages from livestock operations are generally scale-dependent. Larger firms tend to produce relatively higher levels of damage. Given this information, how would you evaluate the marginal external cost curve estimated by the agricultural economics graduate students. Is there an alternative formulation that might make more sense (5 points)?

4. We have temporarily entered an alternate universe (like Star Trek). In this universe, the senate has passed the recently proposed carbon emissions regulations, 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 firms have the following marginal control cost functions (MCC), where costs are in thousands of dollars, and e represents the level of pollution emitted in a given time period.

$$MCC_1 = 50 - \frac{1}{4}e_1 \quad (1)$$

$$MCC_2 = 100 - \frac{1}{2}e_2 \quad (2)$$

   The aggregate marginal control cost curve is therefore:

$$\frac{400}{6} - \frac{1}{6}E$$

   The social costs of emissions of carbon dioxide are give by:

$$MDC = \frac{1}{4}E$$

   where E refers to the aggregate level of emissions.

   (a) If you do nothing to regulate the firms, what will be the level of emissions released by each firm? (Hint: Is the firm likely to spend any money on control costs if it doesn't have to?) (10 points)

   (b) What is the efficient level of total emissions? Graphically illustrate this solution. (Hint: Measure emissions, not abatement, on the x axis.) (10 points)

   (c) How much pollution should be released by each firm so that cost of pollution cleanup (abatement) are minimized, given your answer for total emissions from above? (10 points)

(d) What level of tax on emissions would theoretically bring about both the correct level of emissions and the correct distribution of emissions between firms? (10 points).

(e) A typical problem when regulating pollution is that the individual firms' marginal control costs are not known. Assuming now that you don't know these costs, you decide to allow each firm to emit half of the level of pollution found above (the socially optimal level). Would this be an efficient allocation of pollution? Explain and illustrate graphically. (Hint: Focus on the equimarginal principle of optimality.) (10 points)

(f) If there were a uniform emissions allocation, what is the potential for bargaining or emissions trades between the two firms? Use a graph or numerical example to support your argument. What allocation of emissions would you expect to result from the bargaining or trades? Explain (10 points).