

## PROBLEM SET 2

Due Tuesday, March 9, 1999, in class  
(Late assignments will not be graded)

1. Assume there are two polluting firms in the economy with marginal benefit curves given by:  $MB_1 = 100 - 2q_1$  for firm 1, and  $MB_2 = 100 - (2/3)q_2$  for firm 2, where  $q_i$ ,  $i = 1, 2$ , is the amount of emissions produced by each firm.
  - a) Find the aggregate marginal benefit curve. (Hint: Find the horizontal sum of the individual MB curves). Draw each of the three curves in a single graph.
  - b) Which firm is more efficient in reducing pollution? Explain.
  - c) If the marginal social cost curve is given by  $MSC = 40 + q$ , what is the optimal level of emissions ( $Q^*$ ) to be produced? Show both the MSC curve and  $Q^*$  on the same graph.
  - d) What is the optimal tax to be levied to achieve  $Q^*$ ? Given this tax, find the amount of emissions produced by each firm,  $q^*_1$  and  $q^*_2$ . Show these levels on the same graph.
  - e) Given the optimal tax, what is the total cost of reducing emissions up to  $q^*_1$  and  $q^*_2$ ?
  - f) Suppose that instead of a tax, the government decides to use a uniform standard equal to  $Q^*/2$ . What is the level of emissions produced by each firm? Show it on the graph.
  - g) Compare the level of emission produced by each firm under the tax and under the uniform standard. Which firm produces more/less than before? Comment.
  - h) What is the total cost of achieving the optimal level of emissions under the uniform standard? Compare it to your answer in (e). Which scheme is more efficient in achieving the optimal pollution level? Explain.
  - i) Under what conditions would a tax or a standard be equally efficient in reaching the optimal pollution level? Explain.
  - j) Which scheme (tax or standard), do you think, provides more incentives for investing in cleaner technologies? Explain.
  
2. Assume there are ten firms in the economy, labeled A through J. Each of these firms employs a fixed-proportions technology and produces different quantities of a good (Q). Each firm requires different amounts of labor (L), and each firm produces different amounts of pollution (Z). The following table summarizes this information.

Firm	Output (Q)	Labor (L)	Pollution (Z)
A	21	18	10
B	50	32	10
C	70	35	10
D	60	55	10
E	22	5	10
F	35	15	10
G	18	8	10
H	25	16	10
I	15	5	10
J	95	20	10

The unit price of the good (P) is \$10, the unit price of labor (W) is \$10, and the tax per unit of pollution (V) is \$8. Given the information above, answer the following questions. (Hint: It might be useful to use a spreadsheet)

- Which firm has both the lowest input per output rate and the lowest pollution per output rate. Provide the numerical value of these rates.
- Which firms are not going to be able to compete at the given prices? Determine the total aggregate output of the surviving firms? Determine the total aggregate pollution level of the surviving firms?
- Assume that the price of labor (W) increases by two dollars to \$12 per unit of output. Which firms are not going to be able to compete now? What effect does this increase in W have on the total pollution level of the surviving firms? On the total output level of the surviving firms?
- Continue to assume  $W=12$  and  $P=10$ , but suppose now that you want to eliminate the tax and use a standard (quota) instead. This standard will restrict the pollution per output rate allowed to have by each firm.  
 If you want to have the same aggregate pollution level that you had with the tax, what is the maximum level of pollution per output that you would allow each firm to produce? Which firms are not going to be able to compete under this standard?
- Compare the aggregate output that you would have under each of the two alternative policies. Which policy (tax or standard) produces the most output while achieving the same pollution level found in (c)?

3. You have plenty of information about the social costs of pollution, and you are most certain that the marginal social cost of pollution is given by

$$MSC = 10 + \frac{3}{4}q$$

where  $q$  is the pollution level.

Unfortunately, you do not have enough information about the marginal benefits of pollution. Suppose the true marginal benefit curve is given by

$$MB = 50 - \frac{1}{2}q$$

but you do not know this. Instead, you have a recent estimate of the marginal benefits. The estimated marginal benefit curve is given by

$$MB = 60 - \frac{1}{2}q$$

In other words, you have an overestimation of the true marginal benefits of pollution. In this case,

- a) Would you use a tax or a standard (quota) to control pollution? Explain.
- b) Calculate the deadweight loss under each alternative policy.
- c) Would your answer in (a) be different if the slope of the MB curve were  $5/4$  instead of  $1/2$ ? Explain.
- d) Would your answer in (a) be different if the slope of the MSC curve were  $1/2$  instead of  $3/4$ ? Explain.
- e) Would your answer change if instead of having uncertainty about the MB, we would have uncertainty about the MSC? Explain.