

Second Challenge
Environmental Economics: ECO 345
Fall 2011

Good luck! The following formulas may be useful:

Efficient Allocation and market allocation of goods with externalities, Profits

$$P_S = MC(S) + MD(S) \quad , \quad P_S = MC(S) \quad , \quad \pi = p \cdot S - C(S) - \text{payments} \quad (1)$$

Efficient Allocation and market allocation of emissions

$$MD_1(E^*) + MD_2(E^*) = MD(E^*) = MC(E^*) = MC_1(E_1) = MC_2(E_2) \quad (2)$$

$$MC(E_{0,1}) = MC(E_{0,2}) = 0 \quad , \quad E = E_1 + E_2 \quad , \quad E_0 = E_{0,1} + E_{0,2} \quad (3)$$

Pigouvian Tax, Tradable permit

$$t^* = MD_1(E^*) + MD_2(E^*) = MD(E^*) = MC(E^*) = MC_1(E_1) = MC_2(E_2) \quad (4)$$

$$P' = MD_1(E^*) + MD_2(E^*) = MD(E^*) = MC(E^*) = MC_1(E_1) = MC_2(E_2) \quad (5)$$

Monopolist, market and Pigouvian tax

$$MR = MC, \quad P(q^*) = MC(q^*) + MD(q^*) \quad (6)$$

$$t^* = MD_1(q) + MD_2(q) = MD(q) = MC(q), \quad MR = t^* + MC \quad (7)$$

Compliance costs, Pigouvian Tax vs emissions standard

$$\text{Cost} = \frac{1}{2}(E_{0,1} - E)(MC_1(E) - 0) + \frac{1}{2}(E_{0,2} - E)(MC_2(E) - 0) \quad (8)$$

$$\text{Cost} = \frac{1}{2}(E_{0,1} - E_1^*)(t^* - 0) + \frac{1}{2}(E_{0,2} - E_2^*)(t^* - 0) \quad (9)$$

Taxes and Permits under uncertainty

$$\bar{t} = MD(E) = \bar{MC}(E) \quad , \quad MD(\bar{E}) = \bar{MC}(\bar{E}) \quad (10)$$

$$\bar{t} = MC_H(E_H) \quad , \quad MC_H(E_H^*) = MD(E_H^*) \quad (11)$$

$$\text{loss} = \frac{1}{2} (\text{loss}_H + \text{loss}_L) \quad (12)$$

$$\text{loss}_H = \frac{1}{2} (E_H - E_H^*) (MD(E_H) - MC_H(E_H)) \quad (13)$$

$$\text{loss}_H = \frac{1}{2} (E_H^* - \bar{E}) (MC_H(\bar{E}) - MD(\bar{E})) \quad (14)$$

Question 1 (9 points)

Some atmospheric scientists have raised the possibility that if temperatures exceed a threshold, a collapse of the Atlantic ocean circulation patterns will result, causing very high damages to Northwest Europe and Northeast America. Given this possibility, would you recommend tax or tradeable permit regulation for greenhouse gasses which raise temperatures? Explain.

Question 2 (18 points)

Are each of the following satisfied by Pigouvian taxes, tradeable permits, emissions standards, and/or technology standards? List ALL policies that have each property.

- a. Emissions are fixed.
- b. Marginal costs are fixed.
- c. The equimarginal principle is satisfied.
- d. Best if marginal damages are steep.
- e. Best if marginal costs are steep.
- f. Pareto preferred to a technology standard.

Question 3 (8 points)

A “safe harbor” provision is a law which exempts firms from lawsuits if they adopt a particular piece of safety equipment or meet a particular standard. For example, polluters in Arizona cannot be sued by victims getting sick from drinking water if the level of contaminants in the water near the polluter is below a certain standard. Is liability with a safe harbor efficient? Explain.

Longer Questions**Question 4 (35 points)**

Suppose we have two firms that emit pollution. Marginal costs and damages are:

$$MC_1 = 8 - 2e_1 \tag{15}$$

$$MC_2 = 6 - 2e_2 \tag{16}$$

$$MD = 1 + e \tag{17}$$

- a. Implement a Pigouvian tax: calculate the efficient emissions, the Pigouvian tax, marginal costs for each firm, and emissions for each firm.

- b. Calculate the total cost of compliance for the firms given the Pigouvian tax regulation.
- c. Graph the marginal costs for each firm, total marginal costs, and marginal damages. Show on the graph the tax, efficient emissions, and the compliance costs for each firm.
- d. Suppose we have an emissions standard with each firm reducing emissions to $\frac{1}{2}e^*$, where e^* is the efficient emissions. Calculate the marginal costs of each firm.
- e. Calculate the total cost of compliance for the firms given the standard.
- f. Graph the marginal costs for each firm, total marginal costs, and marginal damages. Show on the graph the standard and the marginal costs for each firm.
- g. Which has greater compliance costs? Explain.

Question 5 (30 points)

Suppose pollution in Bangkok, E has marginal damages and marginal costs of reducing emissions given by:

$$MD = 9E \tag{18}$$

$$MC = (6 + r)(4 - E) \tag{19}$$

The regulator is uncertain about the value of r , but guesses that it has a 50% chance of being either 0 or 6. Thus the average value of r is 3.

- a. Graph the marginal damages, the marginal costs if r is low, the marginal costs if r is high, and the average marginal costs.
- b. Calculate the Pigouvian tax, and the emissions, marginal costs, and marginal damages which result if r is low, and the emissions, marginal costs, and damages which result if r is high.
- c. Show the welfare losses for r high and low on the graph.
- d. Calculate the emissions with tradeable permits, the marginal damages, the marginal costs if r is low, and the marginal costs if r is high.
- e. Calculate the average welfare loss with tradeable permits. Show the welfare losses for r high and low on the graph.
- f. Intuitively (that is don't bother to calculate the tax welfare losses), which regulation system gives the lowest welfare loss, when marginal costs are high? Which regulation system is best when marginal costs are low?