Homework 2
Environmental Economics: ECO 403
Due: Wednesday, October 19, 2011

Question 1

Suppose that old cars and new cars are required to pass identical emissions tests in California. Cars that fail must reduce emissions and old cars can reduce emissions at a marginal cost of $10 per kilogram of emissions. New cars can reduce emissions at $5 per kilogram.

a. Does the emissions test regulation reduce emissions in the least costly way? Explain.

b. Explain how to use vintage differentiated regulation to achieve the same emissions at lower cost. Which type of car should have stricter emissions tests?

c. Give one possible problem with vintage differentiated regulation in this context.

Question 2

Below are several ways to reduce gasoline consumption. For each, does a gas tax provide an incentive to reduce gas consumption in this way? For each, do CAFE standards provide an incentive to reduce consumption in this way? If so, explain how.

a. Car-pool.

b. Make sure tires are properly inflated.

c. Buy a new car which is more fuel efficient.

d. Give 3 more ways to reduce consumption and answer the same questions.

Question 3

A monopolist produces a good Q and faces costs, demand, and marginal revenue curves of:

$$TC(Q) = Q^2, \tag{1}$$

$$MC(Q) = 2Q, \tag{2}$$

$$P = 8 - Q, \tag{3}$$

$$MR(Q) = 8 - 2Q. \tag{4}$$

Suppose now that production of Q generates emissions which cause constant marginal damages of $2.

    a. Calculate the efficient production.

    b. Calculate the production of the unregulated monopolist.

    c. Calculate the production of a monopolist subject to the Piguovian tax.

    d. Explain your answer to (b) and (c).

Question 4

This problem builds on the coal mining question (question 4) from the first challange. I have changed a few numbers around, however. Let C is tons of coal produced, the price of coal is $30 per ton, and:

$$MD\left(C\right) = 2C + 2. \tag{5}$$

$$TC\left(C\right) = C^2 + 4C + 6, \tag{6}$$

$$MC\left(C\right) = 2C + 4, \tag{7}$$

Total damages to the household are:

$$TD\left(C\right) = C^2 + 2C - 60. \tag{8}$$

Total damages are the total welfare loss to the households from coal production. Total household surplus is the negative of total damages. Thus, for example, zero coal production corresponds to a total surplus to the household of $TS = -TD = -\left(0 + 0 - 60\right) = 60$.

    a. Calculate the efficient coal production.

    b. Calculate the market provision of coal, coal mining profits, and household surplus assuming the assumptions of the Coase theorem does not hold.

    c. Calculate the provision of coal, mining profits, and total household surplus assuming the assumptions of the Coase theorem hold and the mining company owns the river.

    d. Calculate the provision of coal, mining profits, and total household surplus assuming the assumptions of the Coase theorem hold and the households owns the river.

e. Calculate the provision of coal, mining profits, total household surplus, and total tax revenue assuming the assumptions of the Coase theorem do not hold and the government imposes a Pigouvian tax on coal production.

f. What is the relationship between total surplus (household, firm, and government) in parts c,d, and e? Explain.

Question 5

Arsenic (Ar) is poisonous metal that causes skin damage and is a potential carcinogen in low doses. The chemical occurs naturally in well water in some western states. Consider water producers in two states, Arizona and California, both of which sell to a border town. Arsenic occurs naturally in water, but is more prevalent in Arizona water. The marginal cost of reducing emissions, for firms AZ and CA are:

$$MC_{CA} = 3 - \frac{Ar_{CA}}{10}, \tag{9}$$

$$MC_{AZ} = 4 - \frac{Ar_{AZ}}{20}. \tag{10}$$

The town combines water from the two sources so that total arsenic in the water is $Ar = Ar_{CA} + Ar_{Az}$. There are 2 consumers, one who is older and at risk for cancer. They face marginal health damages of:

$$MD_1 = \frac{1}{2} + \frac{Ar}{10}, \tag{11}$$

$$MD_2 = \frac{1}{2}. \tag{12}$$

a. Graph the individual and total marginal damages, and the individual and total firm marginal costs.

b. Calculate the efficient level of emissions, the Pigouvian tax, each firm's level of emissions, and each firm's marginal costs.

c. Show the Pigouvian tax, the efficient emissions for each firm, marginal costs for each firm given the Pigouvian tax, and the efficient aggregate emissions on the graph.

d. Calculate the efficient level of Ar for a town in California which uses only California water (assume the same two residents).

e. Suppose Ar is measured in parts per billion. The EPA has a standard of 10 ppb, meaning Ar_{CA} and Ar_{Az} must both be less than or equal to 10. Give two inefficiencies for this policy.

f. Will this policy be supported by towns in California which use only California water? Will this policy be supported by border towns? Explain.

Question 6

Goodyear (G) and Firestone (F) produce tons of rubber according to:

$$TC_F = 300 + 2 \cdot Q_F^2, \tag{13}$$

$$MC_F = 4Q_F. \tag{14}$$

$$TC_G = 500 + Q_G^2, \tag{15}$$

$$MC_G = 2Q_G. \tag{16}$$

The price of rubber is $60 and rubber production causes constant marginal pollution damages of $MD = \$12$ per ton of rubber produced.

a. In the absence of regulation, assuming the assumptions of the Coase theorem do not hold, how much rubber is produced by each firm? Calculate the profits of each firm.

b. Suppose the local government imposes a tax on rubber. What is the Pigouvian tax? Compute rubber production and profits for each firm given the Pigouvian tax is imposed.

c. Graph the market for rubber. Show the rubber production in the absence of taxes, the Pigouvian tax, the efficient production, and the marginal damages.

d. Suppose instead of a tax the government, after observing the rubber production in part (a), imposes a subsidy per unit of rubber production abated. Specifically, the government pays each firm an amount equal to the Pigouvian tax for each unit of production below the level in part (a). Calculate the rubber production and profits for each firm.

e. Is long run rubber production between the two policies the same? (hint: what happens to Firestone in part (b)?)