Review: Final Challenge
Environmental Economics: ECO 345
Fall 2009

The following questions review only the class notes since the last homework. The formulas provided below will also be provided on the challenge. All questions come from the notes. Also review the third homework, problems done in class, this review sheet, and chapters 15.2, 13.2, 16.2, 12.5, 20.1, and 20.2.

Graphs to know:

a. Monitoring. Tax on total pollution or audit/fine (Figure 44).

b. Initial permit allocations. Welfare loss from allocating permits to a monopolist (Figure 46).

c. Double Dividend.

    (a) Welfare loss from a tax on hours (Figure 47).

    (b) Welfare gain and tax revenue from a Pigouvian tax (Figure 48).

    (c) Revenue recycling effect (Figure 49).

    (d) Tax interaction effect (Figure 50).

d. EKC.

    (a) Luxury good (Figures 55-56).

    (b) Corner solution (Figure 58).

    (c) Poor institutions (Figure 59).

    (d) Fixed costs (Figure 60).

e. The case of the Buffalo: Harvest after opening to international trade (Figure 61).

The following formulas will be provided.

Taxes and Permits under uncertainty

$$\bar{t} = MD(E) = \bar{M}C(E), \quad MD(\bar{E}) = \bar{M}C(\bar{E}), \quad \bar{t} = MC_H(E_H) \tag{1}$$

$$MC_H(E_H^*) = MD(E_H^*), \quad \text{loss} = \frac{1}{2}(\text{loss}_H + \text{loss}_L) \tag{2}$$

$$\text{loss}_H = \frac{1}{2}(E_H - E_H^*)(MD(E_H) - MC_H(E_H)) \tag{3}$$

$$\text{loss}_H = \frac{1}{2}\left(E_H^* - \bar{E}\right)\left(MC_H\left(\bar{E}\right) - MD\left(\bar{E}\right)\right) \tag{4}$$

Monitoring and Compliance costs

$$\text{CC} = \frac{1}{2}(E_0 - E)(MC(E) - 0), \quad \text{Total Ave fines} = \pi f(E - E_{std}) \tag{5}$$

$$\text{Marginal Average fine} = \pi f, \quad \text{Total Firm Costs} = \text{CC} + \text{Tot Ave fines} \tag{6}$$

Double Dividend

$$MC = MD, \quad MC + TIE = MD, \quad MC + TIE = MD + RRE. \tag{7}$$

Initial Permit Allocation

$$P' = D = MWTP = MC_F(E_F), \quad MR = MC_L(E_L), \quad E_F + E_L = E. \tag{8}$$

$$\pi_L = P'E_F - \frac{1}{2}(E_{0,L} - E_L)MC_L(E_L). \tag{9}$$

$$CC = \frac{1}{2}(E_{0,F} - E_F)MC_F(E_F) + \frac{1}{2}(E_{0,L} - E_L)MC_L(E_L). \tag{10}$$

EKC

$$\text{Scale}_{LM} = E_M(MC_L) - E_L, \quad \text{Tech}_{LM} = E_M(MC_L) - E_M \tag{11}$$

Question 1

For each of the following, does the revenue recycling effect tend to increase, decrease, or have no effect on optimal emissions? Also, for each does the tax-interaction tend to increase, decrease, or have no effect on optimal emissions? Finally, for each let E solve $MC(E) = MD(E)$. Is optimal emissions greater than, less than, or equal to E, or is the answer ambiguous?

    a. An emissions standard for CO_2.

    b. A gasoline tax to reduce CO_2 emissions.

    c. A permit market on SO_2, a pollutant known to cause increased asthma attacks which results in more sick days. Permits are initially given away.

Question 2

Explain the tax interaction effect.

Question 3

Which of the following are consistent with the World Bank idea that increasing growth will eventually reduce pollution? Explain.

    a. Environmental quality is a necessity.

    b. Environmental quality is a luxury good.

    c. Ukraine has high pollution because it's EPA is easily bribed.

    d. CO_2 mixes evenly across the world, so all countries are damaged when any country emits.

Longer Questions

Question 4

Suppose:

$$MC = 30 - e \tag{12}$$

$$MD = e \tag{13}$$

Here e is emissions in tons. Suppose further that the tax interaction effect corresponds to a welfare loss of $10 per ton of emissions reduced. That is, each ton of reduced emissions results higher electricity prices, a decrease in labor supply, a decrease in labor tax revenues, and therefore an increase in labor taxes which reduces welfare by $10. Finally, suppose each $1 of labor tax revenues collected causes a welfare loss of $0.50.

a. Graph the marginal costs and damages, and the efficient emissions and emissions tax, ignoring the revenue recycling effect and tax interaction effect.

b. Suppose now we use a permit system in which the permits are allocated for free. What is the efficient number of permits, accounting for the tax-interaction effect? Show on the graph.

c. Suppose instead the permits are auctioned, with the resulting revenue used to reduce labor taxes. Note that total revenues from the auction are:

$$\text{REV} \ = P \cdot e = MC \cdot e = (30 - e)\, e. \tag{14}$$

Therefore, marginal revenues from the auction are:

$$MR = 30 - 2e \tag{15}$$

What is the efficient number of permits, accounting for the tax-interaction effect and revenue recycling effect?

d. Does the double dividend hypothesis hold here?

Question 5

This problem is identical to the one done the day before Thanksgiving. Suppose the government allocates all permits to a large firm competing with a competitive fringe. The marginal costs and damages are:

$$MC_L = 20 - e_L, \tag{16}$$

$$MC_F = 20 - \frac{1}{2}e_F, \tag{17}$$

$$MD = 4 + e. \tag{18}$$

a. Solve for the efficient quantity of permits.

b. Suppose the market for permits was perfectly competitive. Solve for the price of permits, emissions of each firm type, and total compliance costs.

c. Calculate the profits of the large firm, including revenue from selling permits and compliance costs.

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Now suppose the large firm acts as a monopolist. One can calculate the marginal revenue of the large firm for selling permits to the fringe is:

$$MR = 20 - e_F. \tag{19}$$

Here e_F is the number of permits sold to the fringe, which equals the emissions of the fringe.

    c. How many permits will the monopolist sell to the fringe?

    d. Calculate the emissions of the large firm, marginal costs of the large firm, and marginal costs of the fringe. Does the equimarginal principle hold? Explain.

    e. Calculate the total compliance costs.

    f. Calculate the profits of the large firm.

    g. Graph the permit market under imperfect competition. Show the marginal revenues, marginal costs of both firms, and the compliance costs of both firms.

Question 6

Suppose now

$$MC = 3 + y - e \tag{20}$$

$$MD = \frac{2}{4 - y}(e + y - 3). \tag{21}$$

Here y is income and $y = 1$ corresponds to an LDC, $y = 2$ corresponds to a developing country, and $y = 3$ a developed country.

    a. Calculate the efficient emissions for the LDC, the developing country, and the developed country.

    b. Show the marginal costs, marginal damages, efficient emissions, and the relationship between emissions and income on the EKC graph.

    c. Does an EKC exist?

    d. Show on the graph and calculate the scale effect and technique effect for moving from developing to developed.

    e. Suppose now that the LDC and developing country have weak instutions and so $e = e_0$. Redo a-c.

f. Does the World Bank/IMF idea of using development as a means to reduce pollution hold in part e?