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Economics of Environmental Policy

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Take Home Exam 2
Spring 2013

Due by 5 pm on Monday 4/29 if submitted on paper or by midnight if sent by email.
Do not open this exam until you are ready to begin.

Instructions

1. Please write your answers on regular paper. You do NOT need to type your answers.

2. Write your **SUID** on your exam. Please **DO NOT** write your name.

3. There's no hard time limit but try to do it in one sitting of no more than about 3 hours.

4. Show all your work. Answers without supporting work will receive little or no credit.

5. The exam is "open book/open notes": you are welcome to refer to your notes, to the exercises and their answer sheets, or to readings listed on the syllabus.

6. It is NOT "open friend": you must do the exam yourself MAY NOT talk with anyone about it until after the due date.

7. Please do not use Google: you can use materials that you already have on hand but please don't go hunting for more.

8. Using a spreadsheet is OK as long as you attach a printout showing the details of your calculations. However, you should have no problem doing the exam with a calculator.

Question 1: Multiple Source Pollution

A regulator wants to reduce pollution from three firms. Each firm is currently emitting 1000 tons for a total of 3000. The marginal costs of abatement for the firms are given below, where each *Q* is the corresponding firm's quantity of abatement:

$$MCA_1 = 2 * Q_1$$
$$MCA_2 = 3 * Q_2$$
$$MCA_3 = 6 * Q_3$$

The marginal benefit of total abatement, Q_T, is given by $MBA = 1800 - Q_T$.

(1) Compute the efficient total amount of abatement and the amount that should be done by each firm. What is the total cost of abatement at this allocation?

(2) Suppose the regulator wishes to use an emissions tax to control the pollutant. What should the tax rate be? What will the total cost of the policy be to each firm, including both abatement costs and tax payments?

Regulators sometimes want to keep compliance costs for some sectors low or zero for political reasons. The remainder of this problem will examine two ways that could be done.

(3) Suppose the regulator wanted to use a tradable permit policy. Please design a permit system that would achieve the efficient level of pollution while keeping total compliance costs equal to 0 for firm 1 (including revenue from permit trades) and causing total compliance costs to be equal for firms 2 and 3. What would the equilibrium permit price be? How many permits should be initially distributed to each firm?

(4) A lobby group has argued that the scheme in part 3 is too complex. It proposes that firm 1 simply be exempted from all regulation and that sources 2 and 3 alone should do the abatement found in part 1. (That is, if you found that the optimal abatement in part 1 is X tons, use X tons here.) Please calculate the total abatement cost under this policy. What will the price of a permit be? What will be the marginal cost of abatement? How should the permits be distributed (to firms 2 and 3 only) if each firm is to be given exactly the number it will need to in order to comply?

(5) Now compare your results from parts 3 and 4. Which is a better approach for keeping the burden on firm 1 zero? Why? If one is more efficient than the other, please calculate any deadweight loss that arises.

Question 2: Effects of a Hybrid Policy

A pollutant is currently uncontrolled and 4000 tons are being emitted. The marginal benefits and marginal costs of abatement are believed to be the following:

$$MBA = 500 - \left(\frac{1}{10}\right) * Q_a$$
$$MCA_e = 100 + \left(\frac{1}{10}\right) Q_a$$

(1) Determine the efficient amount of abatement, the efficient amount of pollution, and the marginal cost and marginal benefit of abatement at that point provided that the curves above are correct.

The regulator would like to use a hybrid policy to control the pollutant and establishes a regime with the following features: (a) the initial quantity of permits distributed is equal to the efficient amount of pollution from part 1, and (b) the price of additional permits is set to the expected marginal cost from part 1.

(2) Suppose the actual marginal costs of abatement turn out to be higher than expected: $MCA_H = 150 + (1/10) * Q_a$. Please determine the equilibrium price of a permit and the number of extra permits purchased from the government, if any.

(3) Finally, now suppose that instead the actual marginal costs of abatement turn out to be lower than expected: $MCA_L = 50 + (1/10) * Q_a$. Please determine the equilibrium price of a permit and the number of extra permits purchased from the government, if any.

Question 3: Banking and Borrowing

A regulator wishes to control cumulative emissions over three periods (0, 1 and 2) using a tradable permit system with full banking and borrowing. In the absence of the policy, total emissions over the three periods are expected to be 4500. The regulator would like to reduce that to 2700 and plans to distribute 900 permits per period. Each period's initial emissions, marginal abatement cost curve, and permits allocated under the policy are shown in the table below. Note that the MCA curve is changing over time (technical change is reducing the cost of abatement). The interest rate between the periods is 100%.

Period	Initial Emissions	MCA	Allocated Permits
0	1000	$MCA_0 = 3 * Q_0$	900
1	1500	$MCA_1 = 2 * Q_1$	900
2	2000	$MCA_2 = 1 * Q_2$	900
Total	4500		2700

(1) Please compute the outcome that would occur if banking and borrowing were NOT allowed (that is, if each period were constrained to use exactly the number of permits it was allocated). What would the price be in each period? What would each period's total abatement cost be? What would be the present value of abatement costs?

(2) Now determine equilibrium in the permit market when full banking and borrowing are allowed. What will the price of a permit be in each period? How many permits will be used in each period? How many will be banked or borrowed (or repaid) in each period? What will each period's abatement costs be? What is the present value of abatement costs?

Question 4: Exhaustible Resource with a Backstop

Consider the allocation of an exhaustible resource across three generations. The following information is available about demand and MEC in the three periods:

Period	Demand	MEC
0	WTP0 = 1000 – 4*Q0	400
1	WTP1 = 1200 – 2*Q1	400
2	WTP2 = 1400 – 1*Q2	400

Initially, there are 920 units of the resource available. The interest rate between generations is 100%.

(1) Please calculate the equilibrium royalty, extraction cost, price and quantity that would occur in each period, and summarize your results in a table.

Now suppose that a backstop is available at a marginal cost of $800.

(2) Please calculate: the new equilibrium royalty, extraction cost, price and quantity in each period, summarizing your results in a second table. Finally, calculate the total amount of the resource produced via the backstop.