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Economics of Environmental Policy

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Take Home Exam 2
Spring 2015

DO NOT open this exam until you are ready to begin.

Due by 5:00 pm on Tuesday 4/28 if submitted on paper.
Due on Tuesday 4/28 by 11:59 pm if sent by email.

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 and you 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. The initial emissions and the marginal costs of abatement for the firms are given below, where each *Q* is the corresponding firm's quantity of abatement:

Firm	Initial Emissions	MCA
1	4000	$MCA_1 = 0.2 * Q_1$
2	3000	$MCA_2 = 0.5 * Q_2$
3	2000	$MCA_3 = Q_3$

The marginal benefit of total abatement, Q_T, is given by $MBA = 5400 - Q_T$.

(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?

(3) Suppose instead the regulator wanted to use a tradable permit policy that would achieve the efficient level of pollution while causing firm 2 to bear 20% of the total compliance cost and firms 1 and 3 each bearing 40% of the cost (that is, the percentages are 40%, 20% and 40%). What would the equilibrium permit price be? How many permits should be initially distributed to each firm?

Question 2: Effects of a Hybrid Policy

A pollutant is currently uncontrolled and 3000 tons are being emitted. The marginal benefits and marginal costs of abatement are believed to be the following:

$$MBA = 1500 - \left(\frac{1}{5}\right) * Q_a$$
$$MCA_e = 500 + \left(\frac{4}{5}\right) * Q_a$$

(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 that can be purchased from the government 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: $MCA_h = 800 + \left(\frac{4}{5}\right) * Q_a$. Please determine the equilibrium price of a permit and the number of extra permits purchased from the government, if any.

Question 3: Emissions Trading with Multiple Sources and Periods

A regulator wishes to control cumulative emissions over three periods (0, 1 and 2) using a tradable permit system. In each period there are two sources, A and B, with the MCA curves shown in the table below where Q_{At} indicates source A's abatement in period *t* and Q_{Bt} is the same thing for source B. In the absence of the policy, total emissions over the three periods are expected to be 9000. As shown in the table below, the pattern of emissions from the two sources is changing over time: emissions from A are growing while emissions from B are constant. The regulator would like to reduce total emissions to 4800 and plans to distribute 800 permits to each source in each period. The interest rate between the periods is 100%.

Firm	MCA Curve	Period	Initial Emissions	Allocated Permits
A	$MCA_{At} = 2 * Q_{At}$	0	1000	800
		1	1500	800
		2	2000	800
B	$MCA_{Bt} = 4 * Q_{Bt}$	0	1500	800
		1	1500	800
		2	1500	800
		Total	9000	4800

Please compute the following information for each of the three cases below: (a) the MCA for each source in each period; and (b) the number of permits that are bought, sold, banked, borrowed or repaid by each source in each period, if applicable.

(1) Within-period trading only: Trading is allowed between sources within each period but no banking or borrowing is allowed between periods. Each *period* will have exactly 1,600 permits to use.

(2) Between-period trading only: No trading between sources at any time but each source can borrow or save for its own use later. That is, each *source* will have exactly 2,400 permits to use over the three periods combined.

(3) Full trading: the sources can trade with each other in each period, and can borrow or save permits for their own use or trading later.

(4) Extra credit. For this situation, which restriction is more inefficient: limiting trading between periods or between firms? Discuss briefly and be sure to be quantitative!

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 – 3*Q0	400
1	WTP1 = 2000 – 2*Q1	500
2	WTP2 = 4000 – 1*Q2	600

Initially, there are 2350 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 $1200.

(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.