Economics 3250 Dr. Lozada
Spring 2014 Exam 2

This exam has 25 points. There are six questions on the exam. Most of the questions are worth 4 points, but one is worth 5 points.

Put your answers to the exam in a blue book or on blank sheets of paper.

You have the entire class period (that is, until **1:10pm**) to take this test.

Figure 1 appears at the end of the exam.

Answer the questions using as much precision and detail as the time allows. Correct answers which are unsupported by explanations will not be awarded points.

Answer all of the following six questions.

1. [**4 points**] Draw a graph with "pollution abatement" on the horizontal axis and \$/"unit of abatement" on the vertical axis. Draw a typical "marginal abatement cost" curve on your graph.

   Suppose the government imposes a tax on pollution. Show on your graph the total amount of tax (in dollars, not in dollars per unit) paid by this firm.

   Hint: Identify the "zero pollution" point on the horizontal axis.

2. [**5 points**] Using a numerical example, show that "command and control" is Pareto-inferior to "cap and trade." ("Cap and trade" is also called "tradable permits.")

3. [**4 points**] Locate the open-access equilibrium in Figure 1, explain why you located it where you did, and then explain why the open-access equilibrium is inefficient.

4. [**4 points**] The following sentence appears in your textbook's chapter on Non-renewable Resources:

   > The basic rule for a renewable resource was:
   >
   > Biological Rate of Growth+Growth in Capital Value = Discount Rate

   What relevance does this have for non-renewable resources? What does it imply about how the amount of a non-renewable resource mined will change over time?

5. [**4 points**] In class, we discussed several ways in which private firms might benefit from voluntarily adopting "green" technologies or policies. Describe two such ways.

6. [**4 points**] What is a "deposit-refund system" and why might it be adopted?

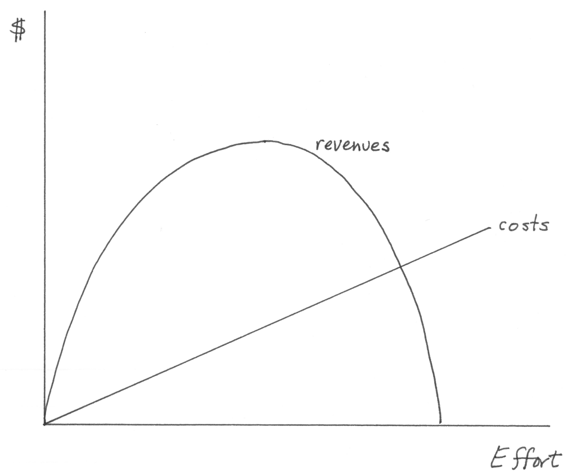
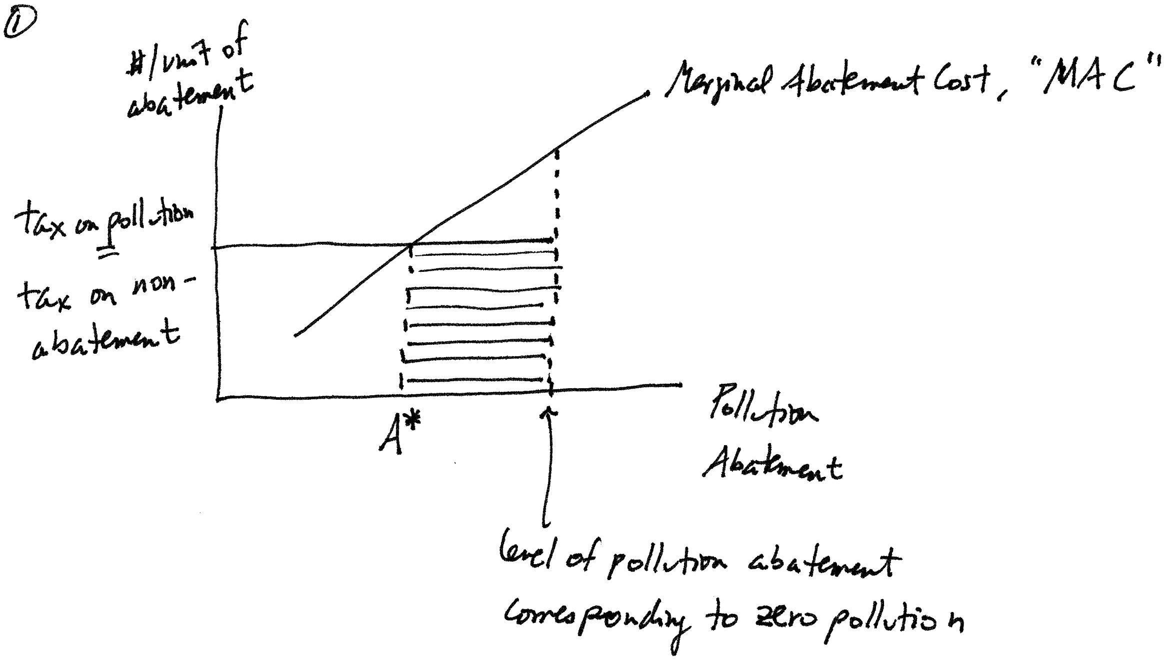


Fig. 1

Answers to Exam 2, Econ. 328,

Spring 2014

①



MAC is typically upward-sloping: abatement is more expensive, the more abatement was previously done.

The tax is zero if Pollution Abatement equals the zero pollution level. When abatement is less than that, the tax becomes non-zero.

The firm chooses to be at A*. To its right, MAC > tax, so that much abatement is too expensive. To its left, MAC < tax, so abating is cheaper than paying the tax, so the firm abates more.

The area marked ☰ has:

- a width equal to the amount of non-abatement; and
- a height equal to the cost (at the margin) of not abating, namely the tax.

Hence the area shows the dollars of taxes paid.

(2) ← Different students will use different numbers, so I'll use algebra so I can analyze whatever number students use. Students won't use algebra; only I am doing that.

Let: current emissions for two firms be E_1 and E_2, respectively

Marginal Abatement Costs be MAC_1 and MAC_2, with

$\boxed{MAC_1 < MAC_2}$. Suppose the MAC's are constant.

Socially desired emissions be E^* with $E^* < E_1 + E_2$

and $E^* = \alpha(E_1 + E_2)$ with $\alpha < 1$.

<u>Command-and-Control:</u>

Suppose both firms have to reduce emissions to "α" of their previous level.

Old emissions :	E_1	E_2
New emissions :	αE_1	αE_2
Abatement :	$E_1 - \alpha E_1$	$E_2 - \alpha E_2$
Abatement Costs :	$MAC_1 * (E_1 - \alpha E_1)$	$MAC_2 * (E_2 - \alpha E_2)$

Total Abatement Costs :

$$MAC_1 * (E_1 - \alpha E_1) + MAC_2 (E_2 - \alpha E_2)$$

$$= (1-\alpha)\left[MAC_1 * E_1 + MAC_2 * E_2\right].$$

<u>Tradable Permits.</u>

Suppose both firms are given "α" times their previous level of emissions in pollution permits. If they don't trade, the situation is the same as command-and-control.

At a permit price "PP" between MAC_1 and MAC_2:

Firm 1 will want to sell permits, receiving PP, even though it will have to abate more, which costs it MAC_1; $MAC_1 < PP$ since PP is between MAC_1 and MAC_2.

Firm 2 will want to buy permits, costing it PP, so it will save MAC_2 by not having to abate as much; $PP < MAC_2$ since PP is between MAC_1 and MAC_2.

So suppose Firm 1 sells 1 permit to Firm 2. (It'll actually sell more than one permit, unless it only has 1 permit, or unless Firm 2 only needs 1 permit to get back to E_2.)

Old Emissions:	E_1	E_2
New Emissions:	$\alpha E_1 - 1$	$\alpha E_2 + 1$
Abatement:	$E_1 - (\alpha E_1 - 1)$	$E_2 - (\alpha E_2 + 1)$
	$= E_1 - \alpha E_1 + 1$	$= E_2 - \alpha E_2 - 1$

Abatement Costs:

$$MAC_1 * (E_1 - \alpha E_1 + 1) \qquad MAC_2 * (E_2 - \alpha E_2 - 1)$$

Total Abatement Costs:

$$MAC_1 * (E_1 - \alpha E_1 + 1) + MAC_2 * (E_2 - \alpha E_2 - 1)$$

$$= MAC_1 * (E_1 - \alpha E_1) + MAC_1 + MAC_2 * (E_2 - \alpha E_2) - MAC_2$$

$$= [MAC_1 * (E_1 - \alpha E_1) + MAC_2 * (E_2 - \alpha E_2)] + MAC_1 - MAC_2$$

$$= [\text{Command and Control Total Abatement Costs}] + \underbrace{MAC_1 - MAC_2}_{\text{negative}}$$

$$< \text{Command and Control Total Abatement Costs.}$$

over →

This proves that by just trading one permit, Total Abatement Costs under cap-and-trade are less than under command-and-control.

Remark 1. If "X" permits are sold, the reduction in Total Abatement Costs compared with command-and-control would be "X" times $MAC_1 - MAC_2$, as can be verified by re-doing the math on the previous page for this case.

Remark 2. Since I've assumed a constant MAC for both firms, the actual number of permits sold will be $\min(E_1, E_2)$: Firm 1 will sell all of its permits to Firm 2, unless Firm 2 needs fewer permits to get back to E_2.

Remark 3. The above analysis was for the social planner, who only cares about Total Abatement Costs. Here is how each firm benefits from the sale of 1 permit by Firm 1 to Firm 2.

	Firm 1	Firm 2
Abatement without Sale	$E_1 - \alpha E_1$	$E_2 - \alpha E_2$
Abatement Cost without Sale	$MAC_1\,(E_1 - \alpha E_1)$	$MAC_2\,(E_2 - \alpha E_2)$
Abatement Cost With Sale	$MAC_1\,(E_1 - (\alpha E_1 - 1))$	$MAC_2\,(E_2 - (\alpha E_2 + 1))$
Money for Permit Sale	$+PP$	$-PP$

over →

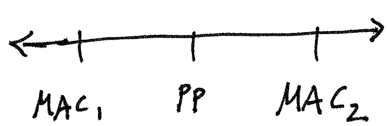
Total Gain from Permit Sale = Gain in Cost Savings + Money from Sale

= [Old Abatement Costs − New Abatement Costs] + Money from Sale.

So

	Firm 1	Firm 2
Total Gain from Permit sale	$MAC_1(E_1-\alpha E_1) - MAC_1(E_1-(\alpha E_1 - 1)) + PP$	$MAC_2(E_2-\alpha E_2) - MAC_2(E_2-(\alpha E_2 + 1)) - PP$
	$= MAC_1(E_1-\alpha E_1) + MAC_1(-E_1+\alpha E_1 - 1) + PP$	$= MAC_2(E_2-\alpha E_2) + MAC_2(-E_2+\alpha E_2 + 1) - PP$
	$= MAC_1(E_1-\alpha E_1 - E_1 + \alpha E_1 - 1) + PP$	$= MAC_2(E_2-\alpha E_2 - E_2 + \alpha E_2 + 1) - PP$
	$= -MAC_1 + PP = PP - MAC_1$	$= MAC_2 - PP$

and from this number line

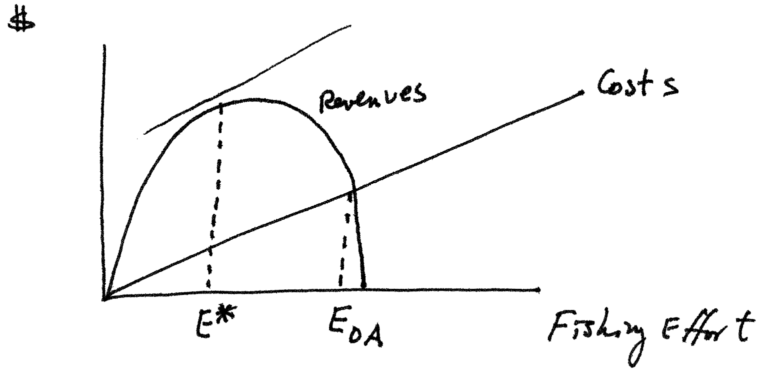


you can see that

$$PP - MAC_1 > 0 \qquad\qquad MAC_2 - PP > 0$$

so both firms benefit. If "X" permits were sold instead of 1 permit, the total gains would become $X(PP - MAC_1) > 0$ and $X(MAC_2 - PP) > 0$ for Firms 1 and 2, respectively.

(3)



The open-access equilibrium is at E_{OA}, where Revenues = Costs, so profit $\pi = 0$. This is because if $\pi > 0$, firms would enter — they can enter because that's what "open access" means, that anyone can enter the fishery — shifting supply out and price down until $\pi = 0$. If $\pi < 0$, firms would leave, shifting supply back and price up until $\pi = 0$. (Recall that the firm is happy with $\pi = 0$ because π stands for "economic profit," that is, taking all opportunity costs into account.)

E_{OA} is inefficient because there are alternatives, such as E^*, which are better. Compared to E_{OA}, E^* has more revenues and less costs, so more profit, and less effort so more fish stock in the ocean. E^* is better for both the fishing industry and the environment than E_{OA}.

Biological Rate of Growth + Growth in Capital Value = Discount Rate

↑ Zero for non-renewable resources

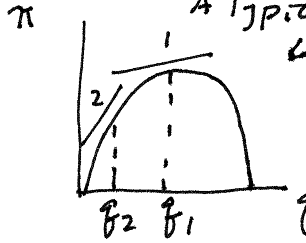
↑ change in price (or, better, marginal profit)

↑ call this "δ"

So for non-renewable resources, the growth in price (or, better, $M\pi$) = δ.

This is the Hotelling Rule.

A Typical Graph of Profit vs. Mine Output



"1" and "2" show two tangent lines to π, that is, they show marginal profit, "$M\pi$." For the growth in $M\pi$ to equal δ, the growth in $M\pi$ needs to be positive, so $M\pi$ needs to grow over time. Hence "1" comes before "2." Since $q_1 > q_2$, this means that q, the "amount of a non-renewable resource mined," will fall over time.

(5) We discussed, among other ideas:

1) Decreasing waste might lead to increased profit, surprising firms who thought they were maximizing profit before, but weren't.

2) A "green" image might attract or help retain some customers and also some environmentally-minded employees.

3) Environmental cleanup firms prosper when "green" policies are adopted because they get more business.

4) Being an early adapter of "green" technologies can give firms a technological advantage over their old-fashioned competitors.

(6)

"Deposit": an extra charge imposed when buying an item (such as a glass bottle)

"Refund": a payment given to someone who discards an item by putting it in the "right" place

In many Deposit-Refund Systems, the refund is equal to the deposit.

Deposit-Refund systems encourage proper discarding of items, thus encouraging recycling and reducing the amount of Municipal Solid Waste going to landfills. These benefits explain why these systems might be adopted.