Economics 5250/6250 Dr. Lozada
Fall 2011 Midterm Exam

This exam has 33 points. There are six questions on the exam; you should work all of them. Half the questions are worth 5 points each and the other half are worth 6 points each.

Put your answers to the exam in a blue book or on blank sheets of paper. The figure for the exam appears after the questions.

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. Therefore, even if you think something is "obvious," do not omit it. If you omit anything, you will not get credit for it. You get credit for nothing which does not explicitly appear in your answer. If you have questions about the adequacy of an explanation of yours during the exam, ask me.

Answer all of the following questions.

1. [**5 points**] It would be quite wrong to describe Coasian bargaining as an example of a perfectly competitive market. Why?

2. [**6 points**] The first equation below leads to the second and third. Explain this set of equations. What is the economic interpretation of the first equation? What is the economic intuition behind the last two equations (that is, why do they make sense)? You need not explain how to differentiate the integral, and in any case, explaining mathematically how the second and third equations are derived from the first is not the most important part of this question; explaining the economic meanings is.

$$\max_{Q,A} \int_0^Q [D(\hat{Q}) - P]\, d\hat{Q} + QP - TC(Q, A) - extc(pol(Q) - A)$$

$$0 = -\frac{\partial TC}{\partial A} - \frac{d\, extc}{d\, net.pol.}\frac{\partial\, net.pol.}{\partial A} = -MAC + MEC$$

$$0 = D(Q) - P + P - \frac{\partial TC}{\partial Q} - \frac{d\, extc}{d\, net.pol.}\frac{\partial\, net.pol.}{\partial\, Q} = D(Q) - MC - MEC\frac{\partial pol}{\partial Q}.$$

3. [**6 points**] Thoroughly explain Figure 1.

4. [**5 points**] Explain the relationships between "compensating variation," "equivalent variation," "willingness to pay," and "willingness to accept" if the contemplated policy action would result in a welfare *gain.*

   (If the only mistake you make on this question is mixing up compensating variation and equivalent variation, you will only lose 1 point.)

5. [**6 points**] Describe what "acid rain" is, what damage it causes, and what economic policies have been undertaken to control it.

6. [**5 points**] What is the relevance of the fact that humans reproduce sexually to the discussion of intergenerational equity?

Suppose $S_3 S_2 = S_2 S_1$.

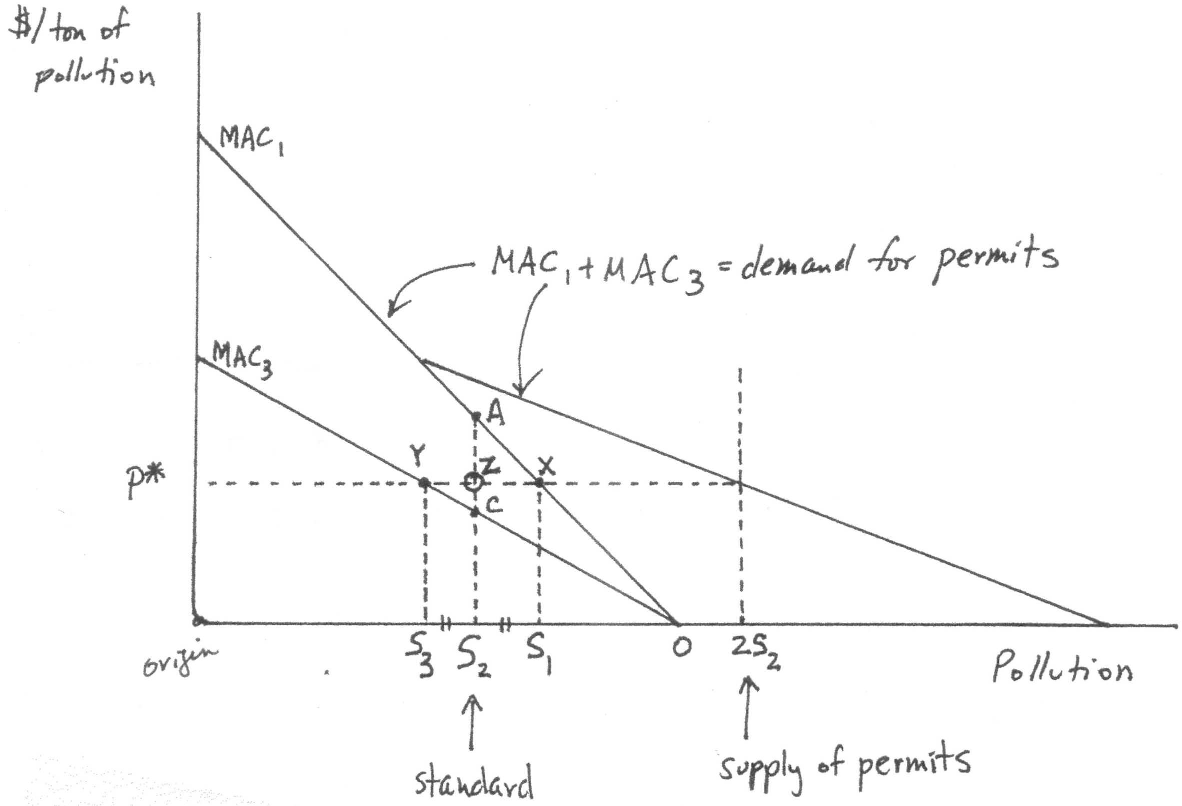
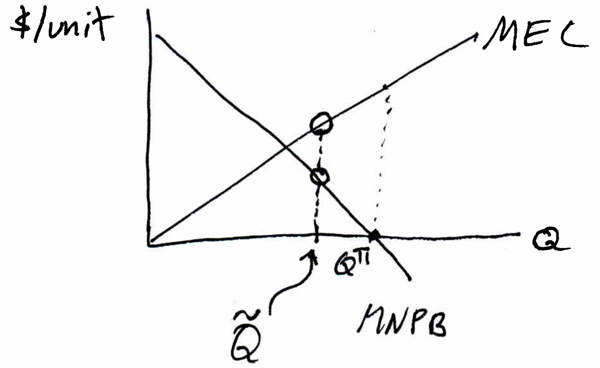


Figure 1

Answers to Econ. 5250 Midterm Exam, Fall 2011

① "Perfect competition" means agents take prices as given. They do not think they can affect prices.



By contrast, the graph on the left illustrates one stage of a Coasian negotiation. (MEC = marginal external cost; MNPB = marginal net private benefit; Q = output; Q^π = profit-maximizing level of output.) Suppose the polluter has the (property) right to pollute.

At $Q = \tilde{Q}$, the victim is willing and able to pay the polluter "MEC or below" to decrease pollution by one unit. The polluter is willing to accept "MNPB or above" to decrease pollution by one unit. So any price between the two open circles in the graph would result in gains to both agents. A high price would give more gains to the polluter than to the victim; vice versa for a low price. They bargain over the price. So each can exert some effect on the price: they do not behave in a (perfectly) competitive manner.

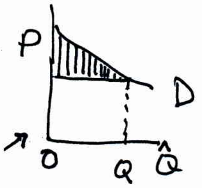
②

P : output price

Q : output

A : abatement (= an activity which decreases pollution)

$$\max_{Q,A} \int_0^Q [D(\hat{Q}) - P]\, d\hat{Q}$$ ← consumer surplus enjoyed by purchasers



$+QP$ ← total revenue

$-TC(Q,A)$ ← total cost

} profit to firm

$-extc(pol(Q)-A)$ ← external costs suffered by pollution victims. These depend on net pollution, which is gross pollution pol(Q) minus abatement A.

Society chooses Q and A to maximize social surplus, which is the benefit that Q and A give to : product purchasers (the first term) ; and the producer (second and third term); and pollution victims (the last term).

The equation above has the following derivatives :

Derivative with respect to	First Term	Second Term	Third Term	Fourth Term
A	0	0	$-\partial TC/\partial A$ $= -MAC$	$-\dfrac{d\ extc}{d\ net\ pollution}\underbrace{\dfrac{\partial\ net\ pollution}{\partial A}}_{-1}$
Q	$D(Q) - P$	$+P$	$\partial TC/\partial Q$ $= -MC$	$-\dfrac{d\ extc}{d\ net\ pollution}\underbrace{\dfrac{\partial\ net\ pollution}{\partial Q}}_{\frac{\partial\ pol}{\partial Q}}$

↑ MEC

So an optimum Q and A entails:

(1) $MEC = MAC$ from the second equation; and

(2) $D(Q) = MC + MEC \frac{\partial pol}{\partial Q}$ from the third equation.

(1) means the marginal cost of abating (MAC) equals the marginal cost of not abating, which is the marginal cost of polluting (MEC) because "not abating" is the same as "polluting." (2) means the marginal value consumers are willing to pay to obtain the output, D(Q), equals the marginal cost to society of producing the marginal unit of output. This is the marginal cost to the producer, MC, plus the marginal cost to the pollution victim, which is how much a marginal increase in Q affects pollution "pol," times the marginal cost (MEC) of that marginal increase in pollution.

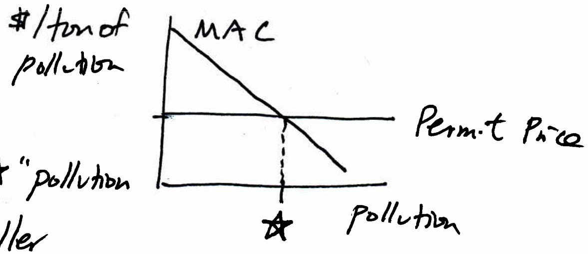
③

MAC is downward-sloping here because as pollution ↑, one abates less, and such diminished abatement is less costly at the margin.

For a pollution standard of S_2, Firm 3 is at C and firm 1 is at A.

Total abatement costs are the area under the MAC curve, so total abatement costs for Firm 3 are OCS_2, and for Firm 1 are OAS_2.

In a marketable permit scheme, MAC_i is the demand curve for permits for firm i $(i=1,2)$.



The reason is that if the firm bought less than "☆" pollution permits, so pollution was <u>smaller</u> than "☆," MAC > permit price, so the firm is paying (MAC) more than it would if it instead bought more permits. On the other hand if the firm bought more than "☆" permits, so pollution was <u>larger</u> than "☆," then MAC < permit price, so the firm is paying (permit price) more than it would if it instead abated more, allowing it to buy less permits.

A horizontal summation of the two individual demand curves for permits gives the aggregate demand curve for permits.

A vertical supply curve for permits at $2S_2$ yields the same pollution as the standard (which was S_2 for each of two firms).

P^* equilibrates supply and demand in the permit market.

Given P^*, Firm 1 goes to X, incurring abatement costs of OXS_1, while Firm 3 goes to Y, incurring abatement costs of OYS_3.

Total abatement costs under marketable permits are less than under the standard, with same pollution as under the standard – hence marketable permits are Pareto superior to a standard – if

$$OCS_2 + OAS_2 > OXS_1 + OYS_3 \iff$$

$$OAS_2 - OXS_1 > OYS_3 - OCS_2 \iff$$

$$AXS_1S_2 > YCS_2S_3$$

which is true because $AXS_1S_2 > ZXS_1S_2 = YZS_2S_3 > YCS_2S_3$.

compensating variation

a gain : If we do this, what would you have to pay to make you as happy as if we hadn't done this?

willingness to pay

equivalent variation

If we don't do this, what would you have to be paid to make you as happy as if we had done this?

willingness to accept

In other words, if the contemplated policy action is a gain, you would be "willing to pay" for it to happen, and if it doesn't happen, there is some amount of money you would be "willing to accept" in return for it not happening.

So for gains : willingness to pay = compensating variation

↑ WTP ↑ CV

willingness to accept = equivalent variation

↑ WTA ↑ EV

⑤

Sulfur is a contaminant of coal. When the coal is burned, the sulfur combines with oxygen to produce SO_2. This causes rain to be more acidic (pure water is neutral, with a pH of 7). The acid rain causes corrosion of building exterior surfaces (especially marble), damage to forests (including death of trees), and acidification of lakes (which can damage aquatic life).

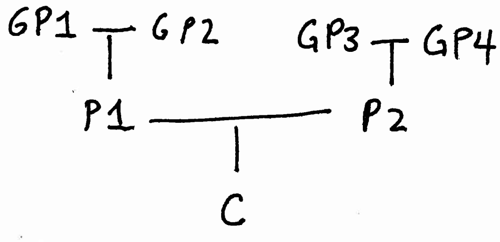
In the USA, SO_2 emissions are limited by the Clean Air Act. Midwest US power plants that burn coal use marketable SO_2 permits under a "cap and trade" system.

In Europe, the First and Second Sulfur Protocols are inter-European agreements to control SO_2 emissions.

SO_2 emissions cause acid rain for a few hundred miles downwind of power plants. "Downwind" means primarily eastward. So countries' eastern neighbors are affected by SO_2 emissions, often necessitating international negotiations to address.

⑥

grandparent = GP
parent = P
child = C



Suppose each GP's utility increases when C's utility increases. Then a gift from one GP to C causes the utility of the other GP's to rise. This is a positive externality, since the GP giving the gift is not paid by the other GP's for causing their utility to increase. Activities generating positive externalities are not done enough in laissez-faire markets. So there are inefficiently small intergenerational transfers to future generations.

(Analysis originally due to Herman Daly.)