Economics 5250/6250 Dr. Lozada
Fall 2012 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]** Define "assimilative capacity" and draw a graph of a Marginal External Cost Curve if the environment has a (strictly positive) assimilative capacity for a pollutant. Be sure to explain your graph.

2. **[6 points]**

   (a) Placing the output Q of a polluting commodity on the horizontal axis, graph a typical marginal net private benefit curve ("MNPB") and marginal external cost curve ("MEC").

   (b) If the polluter possesses all the property rights, show the value of Q. Assume no bargaining.

   (c) The position of the MEC curve shows how changes in Q affect marginal external cost holding everything else fixed, where "everything else" includes the pollution victims' income. How would you guess MEC would change if pollution victims' income were to fall? Why? [By the way, we did not discuss this in class, but you should be able to figure it out anyway.]

   (d) In class, we argued that if the polluter possessed all the property rights, Coasian bargaining would result in Q going to where the *original* MNPB and MEC curves intersect. Why does your answer to part (c) of this question throw doubt on that conclusion? [Again, we did not discuss this in class, but you should be able to figure it out anyway.]

3. **[6 points]** "Marginal Cost" is the derivative of Total (internal) Cost with respect to output Q. Argue that giving a subsidy to polluting firms to decrease their output can be interpreted as an *increase* in such firms' marginal cost. Use the following equation in your answer (and explain this equation):

$$\text{Post-subsidy NPB}(Q) = \text{NPB}(Q) + \sigma(Q_{\max} - Q).$$

4. **[5 points]** Contrast the efficiency of a tax and of a marketable permit scheme, using Figure 1.

5. **[5 points]** On October 24, 2012, the *Denver Post* carried an article under the headline "NOAA: Ozone hole at 2nd smallest size in 20 years." The first three paragraphs of the article were:

> The ozone hole over the Antarctic is the second smallest it has been in the last 20 years, according to data from NASA and National Oceanic and Atmospheric Administration satellites.
>
> Scientists who work on the ozone-monitoring project believe slightly warmer temperatures in the lower stratosphere contributed to the smaller hole in the ozone layer this fall, but the results also indicate progress in reducing harmful chlorine compounds in the atmosphere.
>
> "It shows that we're on the right track," said Bryan Johnson, an atmospheric chemist for NOAA in Boulder and project manager for ozonesonde, the program that measures ozone over Antarctica. "We're going to be getting smaller and smaller ozone holes for the next 30 or 40 years until, in 50 years, we won't have any ozone hole to speak of."

State as many reasons as you can for why "progress in reducing harmful chlorine compounds in the atmosphere" has happened.

6. [**6 points**] What does the interest rate have to do with intergenerational equity?

Suppose $S_3 S_2 = S_2 S_1$.

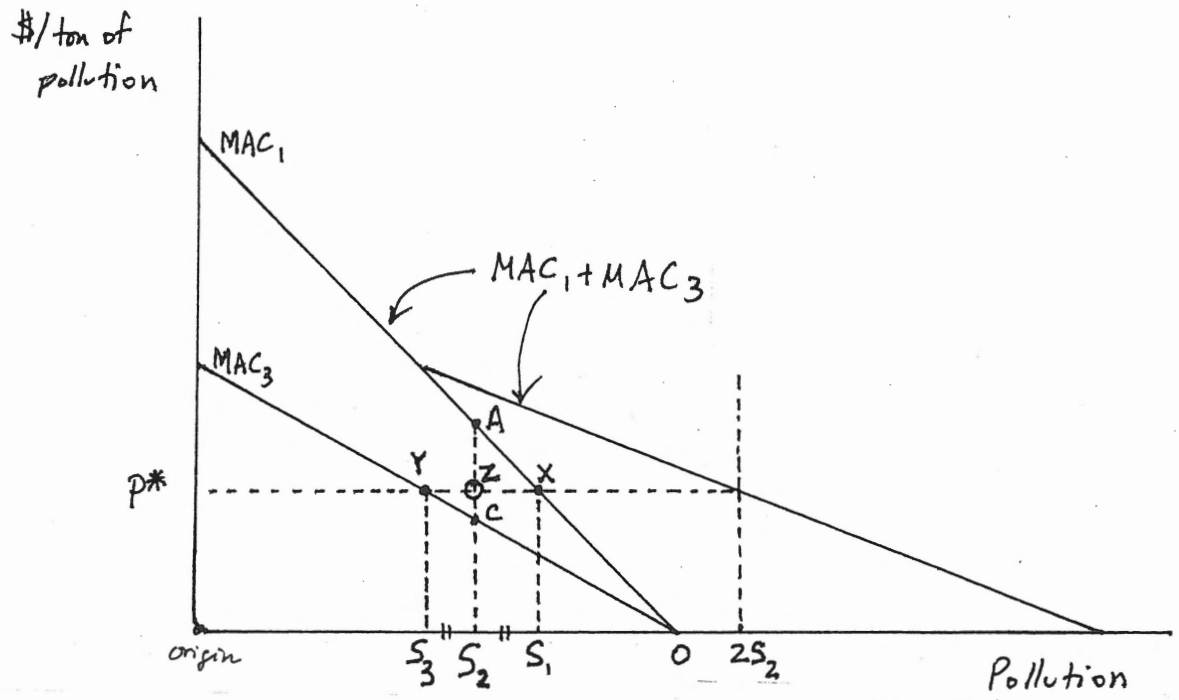
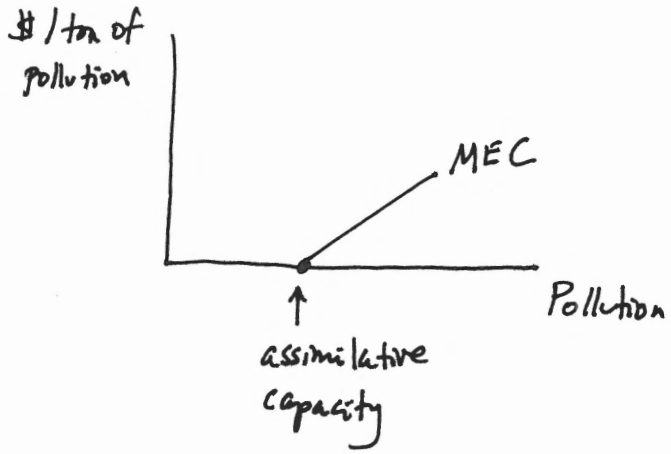


Fig. 1

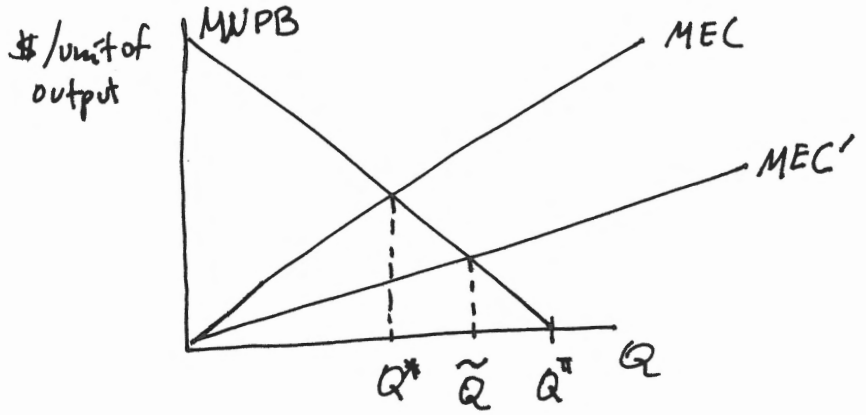
Answers to Fall 2012 Midterm Exam for Econ. 5250

(1) "Assimilative capacity" is the amount of a pollutant which the environment can clean up, or absorb, without causing any damage.



In this graph, if Pollution < Assimilative Capacity, MEC = 0 because the pollution does no harm. (You could also have drawn this graph with "Output" on the horizontal axis and "$/unit of output" on the vertical axis; then "the quantity of output which produces pollution equal to the assimilative capacity" would be the label for the point on the horizontal axis where MEC starts to rise from zero.)

(2)



a) MNPB falls with ↑ Q (because MR is either constant (if the firm is competitive) or falling); MEC typically rises with ↑ Q ("each unit of pollution causes more harm than the previous unit" is a common assumption, though not always made).

b) The polluter goes to Q^{π}, where MNPB = 0, maximizing NPB.

c) If pollution victims' income fell, their ability to pay to reduce pollution would fall, so the MEC curve, which measures this ability, would fall, for example to MEC'.

d) In class we argued that Coasian bargaining would lead to Q^*. However, if the firm has the property rights, getting the firm to voluntarily go from Q^{π} to the left requires paying the firm — so in this process, the victims lose money, so their income falls, so MEC falls. As Q↓, MEC↓. The Coasian bargaining ends at a point like $\tilde{Q}$ which is > Q^{π}. (this →

is a result of "the income effect" on pollution victims.)

(3)

Post-subsidy $NPB(Q) = NPB(Q) + \underbrace{\sigma(Q_{max} - Q)}_{\text{Subsidy}}$

σ: This is the subsidy per unit decrease in output.

$(Q_{max} - Q)$: This is the decrease in output.

Differentiating,

$$\text{Post-subsidy } MNPB(Q) = MNPB(Q) + \frac{d}{dQ}\left[\sigma(Q_{max} - Q)\right]$$

$$= MNPB(Q) + \sigma \frac{d}{dQ}(Q_{max} - Q)$$

$$= MNPB(Q) + \sigma(0 - 1)$$

$$= MNPB(Q) - \sigma.$$

So MNPB ↓, implying MC ↑ (since there are no changes on the revenue* side).

Optional: Now, for every increase in output of one unit, the firm loses $\$\sigma$ in subsidies: it's like an ↑ in MC.

* that is, on the part of consumers. [It is also possible to interpret the subsidy as a change on the revenue side, in which case MNPB ↓ would be interpreted to mean MR ↓ with MC unchanged.]

(4) Suppose the tax is at P^*. Firms 1 and 3 will go to points X and Y respectively. (Reason: if a particular level of pollution has MAC > P^*, it's cheaper to pay the pollution tax P^* than to abate; if a particular level of pollution has MAC < P^*, it's cheaper to abate than to pay the pollution tax — so those units of pollution will not be created.) We have:

$$\text{Total Pollution} = S_1 + S_3 = S_1 + S_3 - S_2 - S_2 + 2S_2$$
$$= (S_1 - S_2) - (S_2 - S_3) + 2S_2$$
$$= 2S_2 \text{ since } S_1 - S_2 = S_2 - S_3 .$$

$$\text{Total Abatement Costs} = (\text{area under MAC curves})$$
$$= 0XS_1 + 0YS_3 .$$

Next, suppose the supply of permits is $2S_2$. The MAC curve is the demand for permits: for example, if the permit price were P^*, Firm 1 would want X permits ("permits for X pollution"), since polluting more than X generates more cost ($= P^*$) than not polluting ($=$ abating, so MAC) there. Polluting less than X generates higher MAC than the permit price P^*, so you should not abate, you should pollute. Hence

The permit price is where supply equals demand*, namely at P^*. With permit price of P^*, Firm 1 goes to X and Firm 3 goes to Y.

Total pollution = $S_3 + S_1 = 2S_2$, same as before.

Total abatement costs = $0XS_1 + 0YS_3$ as before.

X and Y are where the firm's individual D curves (MAC, and MAC_3) intersect what the firms consider to be the supply for marketable permits, which they think is horizontal at P^* since they take the market price of permits as fixed.

So the two schemes generate equal pollution and equal abatement costs: they are equally efficient.

* Demand is the sum of the MAC's.

(5)

Because it was felt that find substitutes to CFC's and (many) other ozone-depleting chemicals would be relatively easy and relatively inexpensive, nations were able to agree to the Montreal Protocol to limit production of ozone-depleting chemicals.

Since indeed it has been relatively easy and inexpensive to find those substitutes, the Montreal Protocol has not been abandoned.

Optional: Developing countries agreed to the Montreal Protocol because its restrictions were weaker for them.

(6)

The most common objective among economists studying intergenerational issues is (for only two generations) $U_1 + \frac{U_2}{1+r}$ where U_i is the utility of generation "i" and "r" is the discount rate (= the interest rate here). The higher r, the lower $\frac{U_2}{1+r}$ is compared to U_1, so a social planner using $U_1 + \frac{U_2}{1+r}$ as his objective will, as $r \uparrow$, pay less attention to U_2 and more to U_1, adversely affecting intergenerational equity (or at least: making the first generation better off at the expense of the second generation).

Optional: Many policies advocated by environmentalists have costs now and benefits later. The present value of such a policy is

$$\text{cost} + \frac{\text{benefit}}{1+r}$$

where cost < 0 and benefit > 0 and "r" is the discount rate from now to "later." As $r \uparrow$, the positive part of this expression gets smaller while the negative part is unchanged, causing its present value to fall, and so causing the environmentally-beneficial policy to be less likely to be carried out. This hurts the people living "later" and it helps any people living now who don't care much about the people living "later." →

Macroeconomic growth theorists who think that future generations will be better off than we are recommend using a high rate of social time preference to help us and hurt future generations because that would increase intergenerational equity (given their assumption that future generations will be better off than we are).