Economics 5250/6250 Dr. Lozada
Fall 2017 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.

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.

For the question involving a figure, you may either draw on the original figure, then remove it from the exam and include it with your answers; or you may redraw the figure on your answer sheet. If you choose the first option, write your first name on each page (to prevent confusion if the page gets separated from the rest of your exam).

Answer all of the following six questions.

1. **[6 points]**

   (a) What is the Theory of the Second Best? Be specific.

   (b) Use a graph with output Q on its horizontal axis and \$/unit of output on its vertical axis to illustrate the Theory of the Second Best in the case of a polluting monopolist.

2. **[6 points]** In class we discussed the solution to

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

   (a) Explain this equation (or "this problem") and all of the variables it uses. Be sure to explain the purpose of this equation/problem.

   (b) Describe what the next step in solving the problem would be, and why. You do not have to mathematically carry out the next step.

3. **[6 points]** Suppose an industry is composed of exactly two polluting firms which have *identical* "marginal abatement cost" curves. Using a graph, show that in this special case, "pollution standards" and "marketable permits" are equally efficient.

   The correct graph is *not* Figure 1, but Figure 1 may help you to figure out some aspects of the correct graph.

4. **[6 points]**

   (a) Why do we expect Willingness to Pay to usually not equal Willingness to Accept? Illustrate your answer with a graph showing a potential *gain* of utility.

   (b) Why do we expect Willingness to Pay to usually not equal Willingness to Accept? Illustrate your answer with a graph showing a potential *loss* of utility.

5. **[5 points]** How could you use the hedonic pricing approach to value a potential improvement of air quality in one part of a city? Assume that that part of the city has worse air quality than other parts of that city.

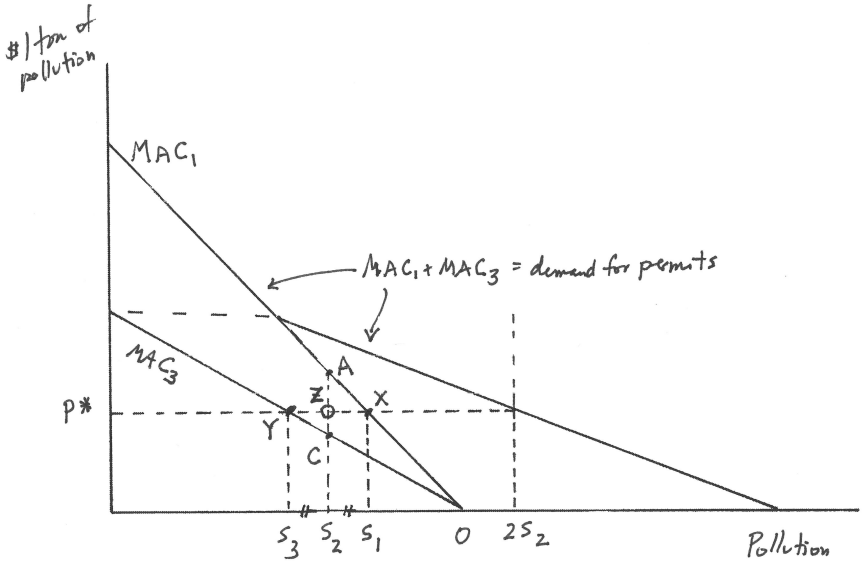

Figure 1

6. **[6 points]** Using mathematics, show that the following is true: "a project which has (net) costs for the present generation and (net) benefits for a future generation will be more likely to pass a cost-benefit test if the social discount rate is small."

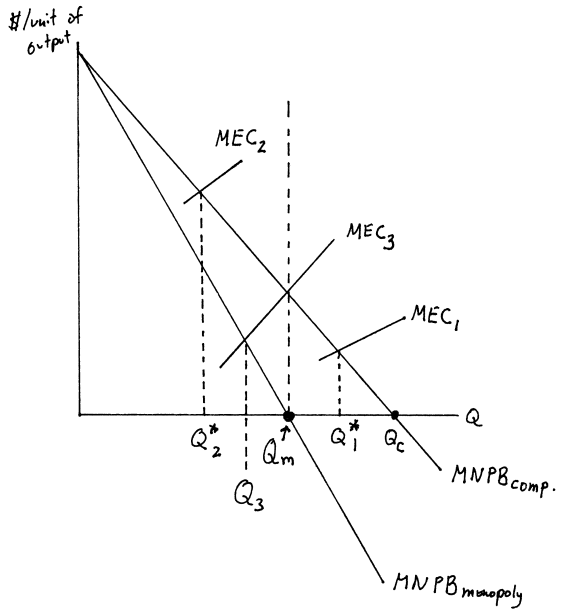

Figure 2

Answers to Midterm Exam, Econ. 5250, Fall 2017

1. (a) If there are N market failures in an economy, and $N > 1$, then eliminating fewer than N of the market failures may make social welfare worse, not better. (Eliminating all N market failures results in efficiency.)

   (b) Figure 2 shows MNPB both for a competitive industry and for a monopolist. The monopolist's MNPB is lower than the competitive industry's MNPB (because while the competitive firm's marginal revenue curve is flat, the monopolist's marginal revenue curve is downward-sloping because the monopolist sees the market's downward-sloping demand curve). The monopolist produces at Q_m^*. A social planner will want production to occur where marginal external cost MEC equals the "true" MNPB curve, which is the MNPB curve for a competitive industry. If the MEC curve is low (for example, MEC_1), the socially-optimal output is above Q_m^* (for example, Q_1^*), whereas if the MEC curve is high (for example, MEC_2), the socially-optimal output is below Q_m^* (for example, Q_2^*).

If the MEC curve is MEC_3, the socially-optimal output coincidentally is Q_m^*. Consider this case (which is unusual but illustrates the point). The polluting monopolist is Q_m^* (because that is where MNPB for the monopolist is equal to zero). The social optimum is also Q_m^* (because that is where MNPB under competition equals MEC). If both of the market imperfections are removed, the firm would stay at Q_m^*. But if only one of the market imperfections is removed, things get worse: either Q shifts from Q_m^* to Q_c (if the monopoly imperfection is removed but the pollution imperfection stays), or Q shifts from Q_m^* to Q_3 (if the pollution imperfection is removed but the monopoly imperfection stays). So *removing just one of the two imperfections has made social welfare worse,* by moving Q away from its socially-optimal level. Removing both of the market imperfections would yield Q_m^*, not making things worse.

2. This equation shows how society benefits from producing Q units of a good and engaging in A units of abatement. There are three components to "society" here: the consumers of the good, the producers of the good, and the pollution victims. Each is represented as follows.

   (a) $[D(\hat{Q}) - \bar{P}]$ is the net consumer surplus for the $\hat{Q}$ unit of output. This is because $D(\hat{Q})$ is what the consumers are willing and able to pay for $\hat{Q}$ (that is, $D(\hat{Q})$ is the gross consumer surplus of $\hat{Q}$: the value of $\hat{Q}$ to consumers) and $\bar{P}$ is what consumers have to pay for it. So $\int_0^Q [D(\hat{Q}) - \bar{P}]\, d\hat{Q}$ is the net consumer surplus for all Q units. It is how *consumers benefit from Q units.*

   The way that *firms benefit from Q units* is the total revenue the firms get, which is $Q\bar{P}$ (quantity times price), minus the total cost the firms have to pay, $TC(Q, A)$. That is the firm's profit.

   Finally, the way that *pollution victims benefit from Q units* is a *negative* number, representing "external costs," *extc.* External costs depend on the amount of pollution released by the firms, which is gross pollution, $pol(Q)$, minus abatement "A."

   (b) The next step would be to set zero equal to the derivative of everything after the "max" operator with respect to output Q, and to set zero equal to the derivative of everything after the "max" operator with respect to abatement A. (Those are the "first-order conditions.")

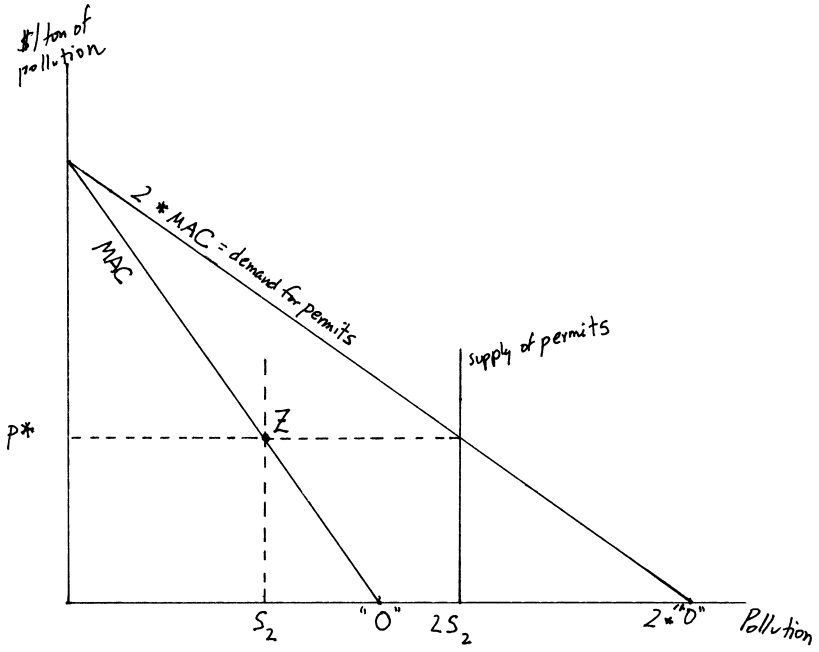
$/ton of pollution
2 * MAC = demand for permits
MAC
supply of permits
p*
Z
S2
"0"
2S2
2 * "0"
Pollution

Figure 3

3. With identical MAC curves, Figure 1 becomes Figure 3. Under the standard of S_2, firms produce at Z, and each firm's total abatement cost is S_2ZO, the area under its MAC curve.

   Under the marketable permit plan, the supply of permits is has to be $2S_2$, as shown in the figure, in order for environmental protection to be the same under permits as it was under standards. The demand for permits by each firm is its MAC curve.[1] The aggregate demand for permits then is $2*\text{MAC} = \text{MAC}+\text{MAC}$, as shown in the figure. Equilibrium in the permit market occurs where the supply and demand for permits are equal to each other: this happens at price P^*. At this permit price, each firm wants to be on its permit demand curve, which is at Z. There, each firm's total abatement cost is S_2ZO, the area under its MAC curve. This is the same as under the standard.

   (This case is unusual. Usually, the firms are not identical, in which case Figure 1 holds and permits are more efficient than standards.)

4. See the answer to Question 4 of Fall 2010's Exam 1.

5. Collect data on house characteristics for many houses, characteristics such as each house's size and age, and also each house's level of air pollution. Also get the price at which each house sold recently (so the sample is of recently-sold houses). Then statistically estimate a mathematical relationship between house price, as the dependent variable, and pollution, age, size, and the other characteristics, as the independent variables; for example,

$$price = f(pollution, size, age, \ldots).$$

   If you next keep the values of size, age, etc. at their original values for each house in the part of the city you are interested in, but improve the level of pollution, the equation will tell you how house values go up. That, summed over all the houses, will be the value of the improvement in air quality.

[1] This is because if MAC were above permit price, the firm is abating too much and would increase its profit by abating less (saving MAC) and buying more permits (paying the permit price, which is less than MAC by assumption). If MAC were below permit price, the firm is abating too little and would increase its profit by abating more (increasing costs by the MAC) and selling permits (receiving the permit price, which is greater than MAC by assumption). So MAC has to be equal to the permit price, which is another way of saying that "the demand for permits by each firm is its MAC curve."

6. Let $C > 0$ be the costs for the current generation and let $B > 0$ be the benefits for the future generation. Then the project's present value to society is

$$-C + \frac{B}{(1+r)^t}$$

where $r > 0$ is the social discount rate and $t > 0$ is the number of years in the future the benefit will accrue. As r falls, $B/(1+r)^t$ rises, making the project's present value more positive.