Economics 3250 Dr. Lozada
Spring 2017 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 (80 minutes) to take this test.

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 "dollars per unit of abatement" on the vertical axis and "pollution abatement" on the horizontal axis. (Do *not* put "quantity of output" on the horizontal axis, and do *not* put "pollution" on the horizontal axis.)

   (a) Draw a "marginal abatement cost" ("MAC") curve on the graph. Explain why you have drawn it the way you have.

   (b) Draw a "marginal external cost" ("MEC") curve on the graph. Explain why you have drawn it the way you have.

   (c) Show on the graph the socially-optimal Pigouvian tax on "non-abatement." Explain why the tax you have shown is socially-optimal.

   (d) If the government imposes the socially-optimal Pigouvian tax, show on your graph the amount of tax revenue the government collects. (Note that "tax revenue" is measured in dollars, not in dollars per unit of abatement.)

2. **[5 points]**

   (a) Why do many economists prefer auctions to grandfathering as a method of distributing pollution permits in a "tradeable permit" system (also known as a "cap and trade" system)? (Of course you should define "auctions" and "grandfathering" and "tradeable permit system" in your answer.)

   (b) One objection to a "tradeable permit" system is "hot spots." What is a "hot spot" in this context? Why could they be problematic in a tradeable permit system? What could be done in such a system to make hot spots less problematic?

   (c) Another objection to a "tradeable permit" system is market power and barriers to entry. What do "market power" and "barriers to entry" mean in this context? Why could they become problematic in a tradeable permit system? What could be done in such a system to make "market power" and "barriers to entry" less problematic?

   (d) To what extent might solutions to the problem discussed in part (b) make the problem discussed in part (c) worse? To what extent might solutions to problem (c) make problem (b) worse?

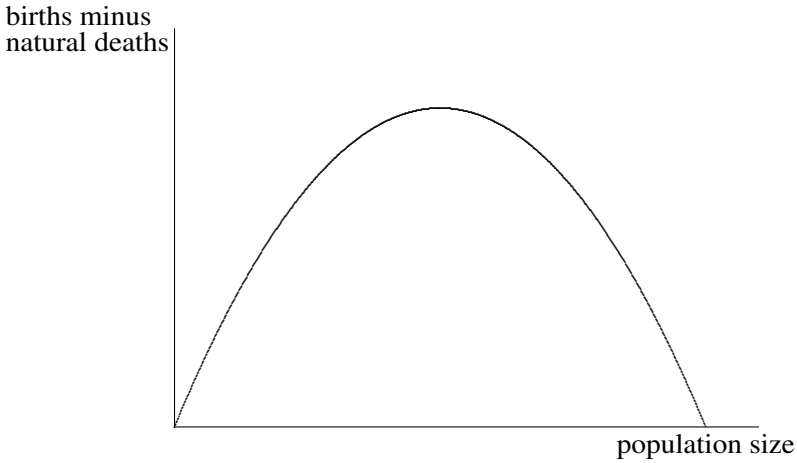

Figure 1.

3. **[4 points]** Suppose Figure 1 describes the growth of a fish stock. Derive from this a new graph which shows "fishing effort" (on the horizontal axis) versus "steady-state yield" (on the vertical axis). Explain your reasoning.

4. **[4 points]** Suppose Figure 2 describes the profit earned at time t by a mining firm that comes about from extracting the corresponding ore at a rate of q_t.

   (a) Criticize the following position: "the mining firm will stay at the short-run profit-maximizing point $\hat{q}$ forever."

   (b) Describe the Hotelling-Rule alternative to the extraction plan described in part (a).

5. **[4 points]** Name one government policy (not necessarily a U.S. government policy) which has encouraged deforestation. Explain.

6. **[4 points]** In what way might illegal dumping of garbage be a reason not to adopt a "waste disposal charge" (or "user charge") for municipal solid waste?

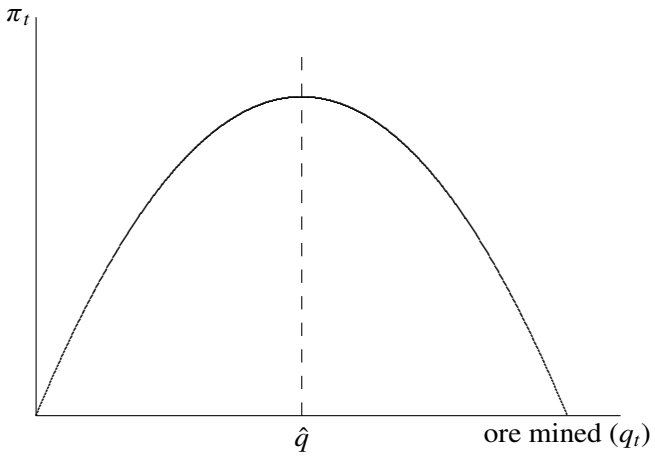

Figure 2.

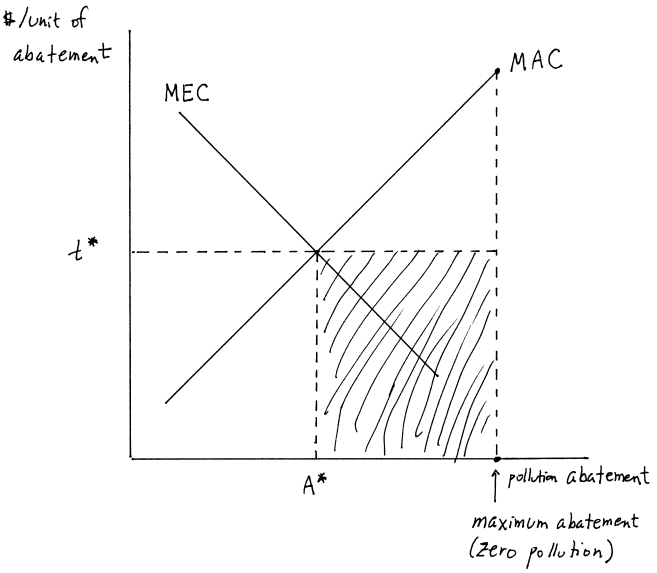

Figure for Problem 1.

Answers to Exam 2, Econ. 3250, Spring 2017

1. (a) As *pollution abatement* increases, total abatement cost certainly rises. We typically assume that marginal abatement cost ("MAC") also rises, as shown in the attached diagram. (This would imply that total abatement cost rises at a a rising rate, that is, that it is convex.)

   (b) As *pollution* increases, total external cost (which are the costs inflicted on pollution sufferers) certainly rises. We typically assume that marginal external cost ("MEC") also rises. (This would imply that total external cost rises at a a rising rate, that is, that it is convex.) However, in this question's diagram, the horizontal axis is the opposite of pollution: it is pollution abatement. So in this question's diagram, MEC falls as one goes from left to right and pollution abatement increases.

   (c) First, determine the socially-optimal pollution abatement level. I claim it is "A^*." If pollution abatement "A" were less than A^*, the MAC to society for abating pollution would be less than the MEC to society of that pollution, so it ought to be abated (on the margin), and one should move right. On the other hand, if

pollution abatement "A" were more than A^*, the MAC to society for abating pollution would be greater than the MEC to society of that pollution, so that pollution ought to exist (on the margin), not be abated, and one should move left.

Second, I argue that with a goal of A^*, society should impose a tax of t^*. The reason is that if the tax on non-abatement is t^*, the firm will choose an abatement level of A^*. This is because if it didn't, then it would choose either a higher level of A or a lower level of A. If it chose a higher level of A, then it would be abating at an MAC that was larger than t^*, so it would save money by reducing abatement (saving MAC) and paying the tax instead (spending t^*). On the other hand, if it chose a lower level of A than A^*, then it would be abating at an MAC that was smaller than t^*, so it would save money by marginally increasing abatement (spending MAC) and not paying the tax on the marginal unit (saving t^*).

(d) The amount of pollution tax revenue is the amount of non-abatement (since non-abatement is what is being taxed) times the tax rate (dollars per unit of non-abatement). The amount of non-abatement is the horizontal distance between A and the maximum level of abatement. (The amount of *abatement* is the horizontal distance between the origin and A, but the tax is not on abatement, it is on how much abatement falls short of its maximum possible level, where pollution is zero.) The tax rate is the vertical distance from the origin to t^*. The product of the horizontal and vertical distances is the tax revenue, and it is shown in the diagram by the hatched area.

2. (a) A "tradeable permit" system (also known as "cap and trade") limits pollution by having the government issue licenses to emit a certain amount of pollution, licenses which can be freely bought and sold by private parties. The licenses could be distributed by selling them to the highest bidders ("auctions"), or by giving them away for free on the basis of how much each firm polluted in the past ("grandfathering"). Many economists prefer auctions because with an auction, the money flows from the polluters to the government, meaning that the government owns the property rights to clear air (or water), echoing the "polluter pays principle."

(b) A "hot spot" is a small area of highly concentrated pollution. With, for example, a nation-wide tradeable permit system, it would be possible for most or all of the permits to be purchased by polluters in one small part of the country. That small area would become a pollution hot spot, with pollution levels above the socially-optimal level there, even though the nationwide pollution total would be equal to the nationwide socially-optimal level. Dividing the tradeable permit markets into smaller geographical areas—for example, having separate pollution licenses valid only in single U.S. states—could eliminate hot spots.

(c) "Market power" here refers to the non-perfectly-competitive power of existing pollution permit holders to influence the price of permits, or to whom permits are sold. "Barriers to entry" are costs incurred by a new firm which is trying to enter a market. In a tradeable permit system, incumbent firms could conspire to use their market power to greatly increase their industry's barriers to entry by refusing to sell pollution permits to potential entrants. One way to lessen this would be for the government to prosecute these firms for breaking anti-trust laws; another would be to have licenses expire on a regular basis and distribute the licenses by auctions instead of grandfathering. Yet another would be to widen the geographical scope of the pollution trading markets, thus increasing the number of incumbent firms, thus making it harder for all of them to collude (because the greater the number of firms, the harder it is for them to collude—recalling that it would be in each firm's individual selfish interest to sell permits to an entrant willing to pay a sufficiently high price, rather than to honor a collusive agreement not to sell to entrants).

(d) One solution to (b) (hot spots) is to decrease the geographical size of the pollution license market, but that decreases the number of incumbent firms, and so increases the likelihood that they will illegally collude to erect the "no one will sell a potential entrant a permit" barrier to entry. One solution to (c) (denying potential entrants pollution permits) is to increase the geographical size of the pollution license market, but that increases the possibility of hot spots.

3. First claim: "births minus natural deaths" is equal to "steady-state yield." For suppose "births minus natural deaths" is 100 per year. If there were no human intervention, the population would be 100 larger

next year than it is this year. If fishermen[1] caught 100 fish that year, then the population next year would be the same as it was this year: it would be in a steady state.

Second claim: As fishing effort increases, population size falls. With zero fishing effort, the population would be at the carrying capacity (where the curve of Figure 1 hits the horizontal axis on the right). With more than zero fishing effort, the fish population size will move to the left.

The result is that as one moves, in the top part of the attached diagram, from "A" to "B" to "C," effort increases (because of the leftward motion), while steady-state yield first increases (from A to B), and then decreases (from B to C). This is shown in the bottom part of the attached diagram.

4. (a) It is not possible for the mining firm to extract $\hat{q}$ forever, because with that extraction rate the resource stock will become zero in finite time, forcing q to be zero from then on.

   (b) The Hotelling Rule states that in an exhaustible resource industry, marginal profit should rise at the rate of interest. Marginal profit is the slope of the total profit curve. In the graph corresponding to this answer, I have drawn in tangent lines, whose slopes represent marginal profit. Marginal profit would rise as one moves from 1 to 2 to 3 to 4, because the tangent lines are getting steeper. This corresponds to a leftward motion, so extraction q_t would fall over time.

5. One example would be the 19th century U.S. government policy of giving federally-owned land away for free to families who agreed to turn the land into a farm. This required removing most of the land's trees. Other such policies would be any type of subsidy for agriculture, such as fertilizer subsidies (for instance, in Mexico), water subsidies (including subsidizing the construction of water infrastructure, as in the U.S.), and tariffs against food imports (as in the European Union). Expansion of agriculture along what David Ricardo called "the extensive margin"—that is, increasing the amount of land used

[1]The gender-neutral term is "fishers," which is older than the word "fisherman"—for example, "fishers" used in the King James Bible, Matthew 4 : 19—but "fishers" also refers to a small North American member of the weasel family, and surveys in the past have shown that most (though not all) women working in the industry in the U.S. and Canada preferred to be called "fishermen."

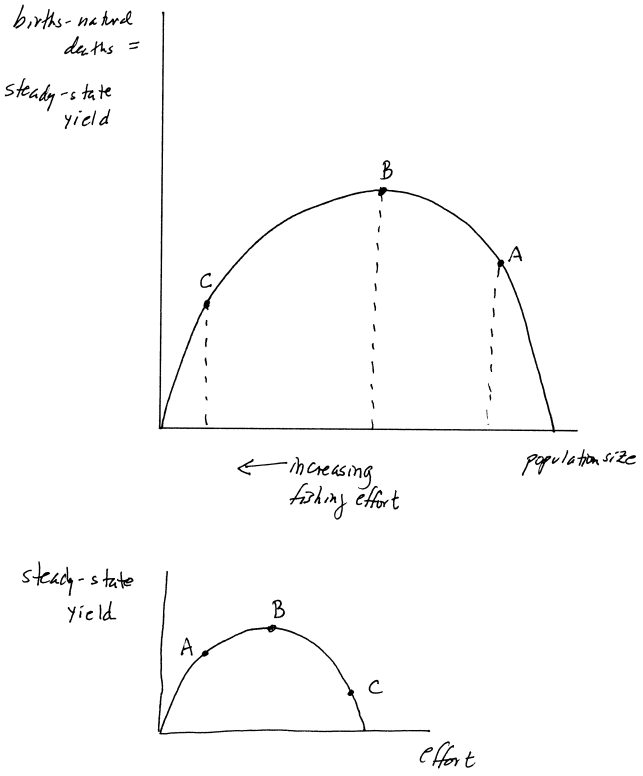

Figure 1's answer.

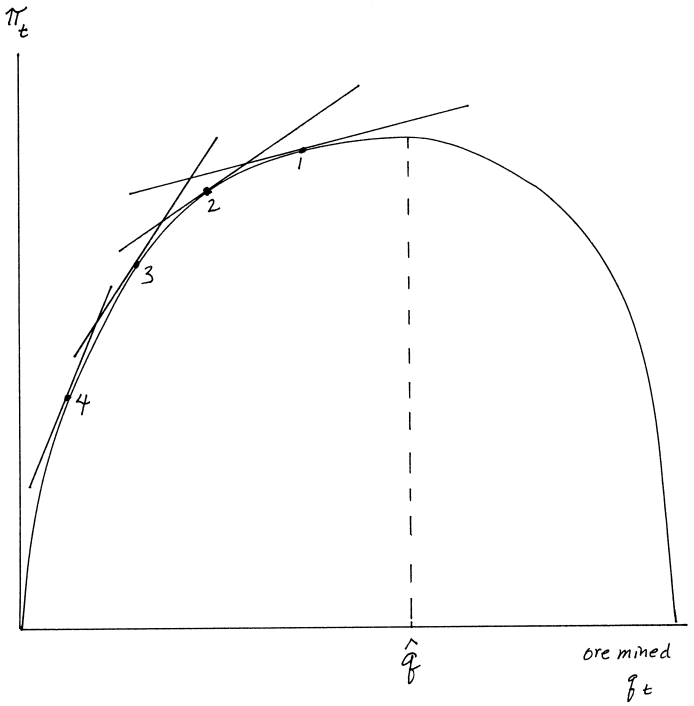

Figure 2's answer.

for agriculture—entails removing most of the land's trees, regardless of whether the land is to be used for crops or for grazing.

Some students gave examples of *lack* of government policies which *allowed* deforestation to happen, for example, cutting down rain forest in Brazil to extend range for cattle grazing. However, the question asked for deforestation caused by policies, not for lack of (protective) policies or for lack of enforcement of protective policies.

6. A "waste disposal charge" is like a tax on garbage disposal. It will only be effective if it can be enforced. Since illegal dumping of garbage is often hard to detect, imposing a high waste disposal charge might be ineffective in reducing municipal solid waste ("MSW") because the charge will often be evaded. In fact, imposing a waste disposal charge may well make things worse than they are currently, by increasing the amount of garbage that is disposed of outside of "sanitary landfills," where the garbage does the least environmental harm.