

Environmental Economics (AAE / ECON / Env. St. 343)

Final Exam. Thursday December 18, 2008

Suggested Solutions

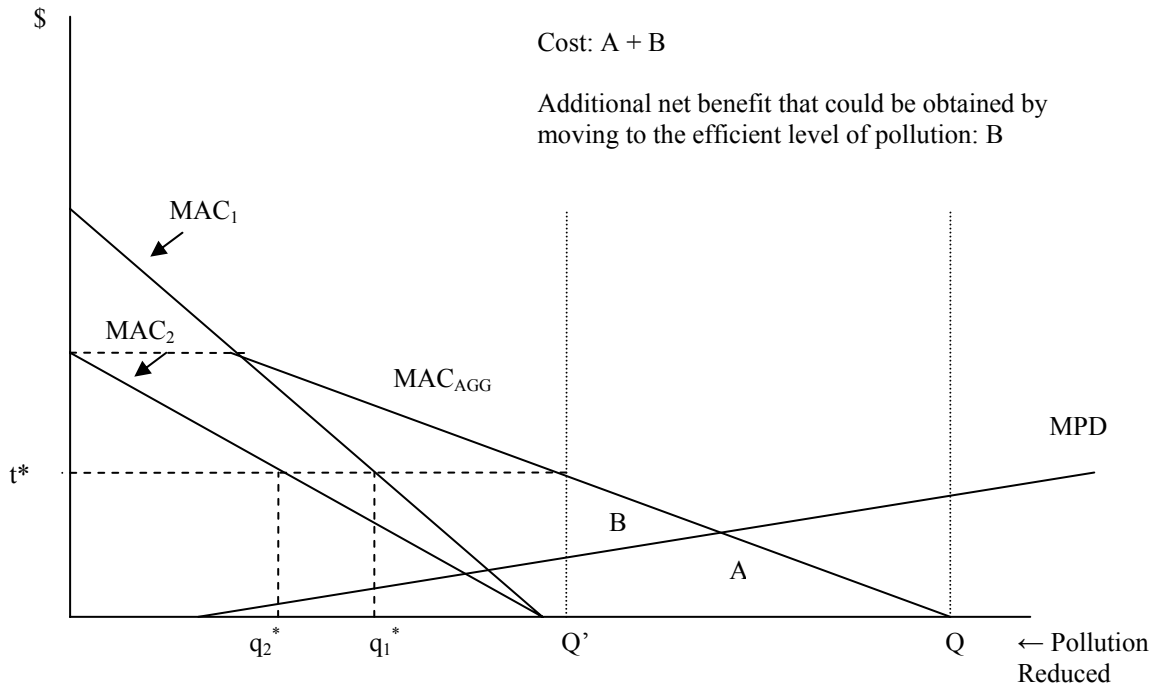
Provide short answers (2-5 sentences) to the following questions. Each of the 8 questions is worth 4 points for a total of 32 points. There is also one extra credit question worth 2 points. You will receive points for clear, thorough, and persuasive answers. Good Luck!

1. The state of Wisconsin offers payments to owners of forestland (in the form of property tax reductions) in exchange for the following: i) not developing their property for a set amount of time (e.g. 25 years), and ii) allowing public access to their property for activities such as hunting, fishing, and cross-country skiing. What is the economic rationale for such government policies? Explain.

Ensuring less development can increase the amount of open space in an area, while allowing public access to land can improve recreational opportunities for citizens. To the extent that open space and outdoor recreation opportunities provide non-excludable benefits to citizens, the payments can be viewed as providing public goods. Such goods will be inefficiently allocated by the market because public good benefits will accrue to people other than the landowners themselves. So, government payments can improve the efficient allocation of such goods.

2. Suppose a government decides to reduce pollutant A by 40%. In the diagram below, this is a reduction from Q to Q' . There are two firms generating the pollutant, firm 1 and firm 2. The government obtains the reduction with a pollution tax t^* .

- Identify t^* on the diagram. *1 pt.*
- Denote by q_1^* and q_2^* the amount of pollution generated by each firm under the tax. *1 pt.*
- Use lettering on the diagram to identify the cost of reducing pollution. *1 pt.*
- Does the pollution reduction achieve the efficient level of pollution? If so, use lettering on the diagram to identify the net benefit obtained from the pollution reduction. If not, use lettering on the diagram to identify the additional net benefit that could be obtained by moving to the efficient level of pollution. *1 pt.*



3. President-elect Barack Obama favors a mandatory reduction in U.S. CO₂ emissions of 80% by 2050, with a tradable permit system used to allocate CO₂ emissions across firms. By comparison, former Vice President Al Gore favors a green tax on CO₂ emissions to reduce US emissions. Parts a through d can be answered with one word (yes or no).

a. In principle, can both the tradable permit system favored by Obama, and the tax system favored by Gore, reduce pollution at least-cost? $\frac{1}{2}$ pt.

Yes

b. Given a fixed pollution reduction goal, does the optimal tax rate equal the price that would arise from allowing firms to trade permits? $\frac{1}{2}$ pt.

Yes

c. If a policy to reduce pollution is least-cost, does it necessarily achieve the efficient level of pollution? $\frac{1}{2}$ pt.

No

d. If a policy achieves the efficient level of pollution, does it necessarily make everyone better off? $\frac{1}{2}$ pt.

No

Under Obama's plan, firms would not be given an allocation of permits based on their historical CO₂ emissions. Rather, all allowances will be auctioned off by the government, with the auction proceeds going to the research and development (R&D) of renewable energy technology.

e. Under Obama's method for initially allocating permits, which would the polluting firms prefer: a system of tradable permits or a tax? In answering, assume that the aggregate reduction in CO₂ is the same and that the firms involved in CO₂ abatement are *not* the firms that receive the tax dollars for renewable energy R&D. Explain your answer in one to two sentences. *1 pt.*

Firms would be indifferent between TPPs or a tax, because each unit of pollution would cost the same under either program.

f. Suppose that rather than auctioning permits to the highest bidder, permits were allocated free of charge to firms based on their historical CO₂ emissions. Would the final allocation of permits after trading differ from the allocation achieved with Obama's method? Explain your answer in one to two sentences. *1 pt.*

The final allocation of permits would be the same regardless of the method to initially allocate permits, because the permit price will be the same with either method and firms will reduce pollution until their MAC equals the permit price.

4. a. The Right Whale is threatened with extinction. Currently there are about 300 left in the world. The main threat to the survival of the Right Whale are ship collisions. Currently there is a proposal to alter shipping lanes in the North Atlantic to reduce collisions with Right Whales. Unfortunately, this change in shipping lanes would be extremely costly. Right Whales are rare enough that they are rarely seen. They are never hunted. On what *economic* grounds could you argue that society may be better off saving Right Whales from extinction, even if it means changing shipping lanes in the Atlantic? What method is most appropriate for measuring the benefit of Right Whale preservation? Briefly answer in one to two sentences.

The existence value of Right Whales may be sufficiently large that changing shipping lanes is an economically efficient outcome, i.e., the social benefit of changing shipping lanes would exceed the social cost. Since existence value is a non-use value, the contingent valuation method can be used to measure benefits of Right Whale preservation.

- b. In lieu of paying property taxes on government-owned national forest land, the U.S. Forest Service typically gives 25% of all net revenues received from timber harvesting to local and state governments. As quoted in a New York Times article, Holistic Cascade Consultants, Inc. points out that this payment is left out of benefit-cost calculations of timber harvests, and observes that including it would cause most timber sales to fail a benefit-cost test. They observe, “no business would fail to account for taxes when calculating profits”. Should the Forest Service include the cost of taxes in benefit-cost analyses of timber sales? Briefly explain your answer in one to two sentences.

No, this payment is simply a transfer from one part of society to another. The payment does not reflect the “using up” of inputs (labor, capital, energy, natural resources).

5. True, False, Uncertain. Briefly explain your answer.

- a) Consider the case of a fixed non-renewable resource stock with constant marginal extraction costs. When the discount rate is positive, the marginal user cost falls over time as the resource is extracted.

Uncertain. If demand is fixed or increasing, Hotelling's rule indicates that MUC is growing over time at the rate of interest when MEC is constant. However, if demand is declining fast enough, marginal user cost might be falling over time.

- b) Since minerals are non-renewable resources, there is no way their extraction can be considered a sustainable use of resources.

False. If we use weak sustainability for a rule, then income from extracting the non-renewable resource stock (e.g. from depleting natural capital K_n) can be invested in either man-made capital (K_m) or human capital (K_h), such that the total capital stock ($K = K_m + K_h + K_n$) is unchanging over time.

6. In class, we discussed “the bet” between ecologist Paul Ehrlich and economist Julian Simon. Reconcile the outcome of “the bet” with the price path of non-renewable resources predicted with Hotelling’s rule.

Hotelling's rule states that resource prices will grow over time at the rate of interest, while “the bet” indicated that resource prices fell over time. These can be reconciled by considering the following assumptions of Hotelling's rule: 1) competitive markets, 2) a constant economic reserve, and 3) no new substitutes for the resources. Each of these assumptions was violated in “the bet”: 1) an international tin cartel broke up, 2) technology made the extraction of ore less costly and increased the economic reserve, and 3) fiber-optics substituted for copper on products like telephone lines.

The following information applies to questions 7 and 8, and the extra credit question 9. Suppose three countries (A,B,C) are each considering a simple policy of whether to reduce a pollutant or not. Country A directly borders B and C, but B and C do not share a border. Pollution only affects neighbors, so A's pollution causes damage to B and C, and the pollution from both B and C causes damage to A. However, the pollution from B does not affect C, and the pollution from C does not affect B.

7. If country A only considers the presence of country B, the table below reflects the net benefits of reducing pollution:

		Country B	
		Reduce	Don't Reduce
Country A	Reduce	0, 0	-10, 20
	Don't Reduce	10, -5	-5, -2

What would be the outcome of this game if they only interact once (a one-shot game)? What would be the lowest tax imposed by a third party that would make pollution reduction a dominant strategy for country A?

Both countries have a dominant strategy to not reduce, as they are both better off not reducing no matter the strategy of their opponent. So, in a one-shot game, the Nash equilibrium is for neither country to reduce. For A, the largest difference in payoffs between reducing and not reducing is 10 (if B reduces). So, "reduce" would be a dominant strategy with a tax of at least 10 on "not reducing".

8. If country A only considers the presence of country C, the table below reflects the net benefits of reducing pollution:

		Country C	
		Reduce	Don't Reduce
Country A	Reduce	10, 20	10, 15
	Don't Reduce	20, 10	5, 5

What would be the outcome of this game if it is only played once? If the game is infinitely repeated, can a grim trigger strategy by country C support an outcome in which A reduces pollution? (Be explicit regarding the "credible threat of retaliation").

C's dominant strategy is to reduce, while A is better off reducing if C doesn't reduce, and not reducing if C does reduce. Therefore, since A knows C's dominant strategy, A will not reduce and C will reduce. The grim trigger strategy is not a credible threat for country C since "reduce" is their dominant strategy, so the grim trigger strategy will likely not support an outcome in which A reduces.

Extra Credit (continuation of questions 7 and 8)

9. Now suppose that A considers the actions of *both* B and C and decides whether to reduce or not to reduce in a one-shot game. Using the above data, the net benefits to A from a particular strategy comprise the *sum* of net benefits considering the strategy of both B and C. For example, if both B and C reduce, then A's payoff from reducing is $0+10=10$; if B doesn't reduce and C does, then A's payoff from reducing is $-10+10=0$; if both B and C don't reduce, then A's payoff from reducing is $-10+10=0$; etc. Should A reduce or not reduce? What's the final outcome in a one-shot game (behavior of all 3 countries)?

In considering both B and C, country A knows that B has a dominant strategy of "don't reduce", and C has a dominant strategy to "reduce". So, A's payoffs are $-10+10=0$ if they reduce, and $-5+20=15$ if they don't reduce. So A will not reduce, and the final outcome will be:

A: "don't reduce"

B: "don't reduce"

C: "reduce"