

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

Practice Final Exam.

Suggested Answers

1. In many cities across the U.S. residents pay for water use via their property tax bill; that is, residents pay a fixed annual water fee (e.g. \$150-200 per year per household). Given this payment mechanism for water use, is it possible that residents wash cars and water lawns more frequently than is economically efficient? What would be the effect on the rate of lawn watering of an increase in the annual water fee? Explain.

In this situation, individuals are facing a marginal cost of water consumption equal to zero, so an efficient allocation of water is not assured if the actual marginal cost is positive. An increase in the annual fee would have no effect on the rate of watering. From the perspective of the user, the marginal cost of consumption remains zero, so water consumption will not increase or decrease.

2. Markets for trading water *quantity* are beginning to take shape in the western United States. Many of the largest water trades involve large municipal water districts as buyers and individual farmers as sellers. Some have argued that allocating the initial property rights for water to individual farmers is more likely to lead to an efficient market outcome than allocating the property rights to municipal water districts. Why might this be? Explain your answer.

The Coase Theorem states that two parties will bargain to an efficient allocation as long as one party receives the unilateral property right to the resource. One key assumption of the Coase Theorem is that transactions costs are small. In this case, since municipal water districts are already 'organized', their transactions costs are likely lower than the individual farmers. Therefore, allocating the property rights to the farmers will probably lower transactions costs overall, and increase the likelihood of an efficient market outcome.

3. It is a fact that Pacific Salmon runs in the Northwest U.S. have fallen dramatically over the past twenty years. Pacific Salmon are prized by recreational anglers and by the commercial fishing industry. Would you guess that the real market price for Pacific Salmon has increased or decreased over the last twenty years? Does the market price of Pacific salmon correctly capture the economic scarcity of these fish? Explain your answer.

If there were no viable substitutes for Pacific Salmon, no major technological advances to lower fishing costs, and if demand didn't shift down, then the physical scarcity of salmon should increase the price. However, since there are likely substitutes for salmon (e.g. aquaculture), it would not be surprising if the price of salmon remained constant or declined over this period. Since salmon are popular with recreational anglers, there are likely to be non-market values associated with this fish separate from the market price. Therefore, the market price will not fully capture the economic scarcity of salmon.

4. Explain how non-market valuation methods can be used in determining a green tax rate which reduces pollution efficiently.

The efficient green tax is found at the intersection of the marginal abatement cost (MAC) and marginal pollution damage (MPD) curves. The MAC curve typically measures market values but MPD can be based on both market and non-market values. Thus non-market valuation techniques help us estimate the MPD curve.

5. Consider the allocation of a fixed nonrenewable resource over two periods. What assumptions are required for a competitive market to allocate this resource in an efficient *and* sustainable manner? Explain.

Hotelling's rule tells us that a fixed resource is efficiently allocated over time when the price of the resource rises at the rate of interest. Since demand is assumed constant and price rises, consumption will be lower in period 2 than in period 1. Therefore, in order for this allocation to be weakly sustainable, there must be sufficient investment or savings from period 1 such that the total value of using the resource in period 2 (sum of consumer and producer surplus) is not lower than period 1. In addition, the investment must be considered a substitute for the decline in natural capital.

The following information applies to questions 6 and 7. Two countries (A and B) are deciding whether or not to reduce an international pollutant. The payoffs for the countries are given as follows:

	B	
A	Don't Reduce	Reduce
Don't Reduce	0-0=0, 0-0=0	50-0=50, 50-120= -70
Reduce	80-100= -20, 80-0=80	130-100=30, 130-120=10

6. If this pollution game is treated as a one-shot game, what is the Nash Equilibrium? What tax imposed by an external regulator would ensure that both countries reduce pollution? Explain why these countries would be interested in having a tax imposed on them.

The Nash Equilibrium is for neither country to reduce, since each country can always achieve higher payoffs by not reducing, regardless of the other country's strategy. A tax of 71 on any country that doesn't reduce would result in the following payoff matrix:

	B	
A	Don't Reduce	Reduce
Don't Reduce	-71, -71	-21, -70
Reduce	-20, 9	30, 10

The Nash Equilibrium with this tax is for both countries to reduce. Both countries would be interested in the tax because the outcome where both reduce is a Pareto Improvement over the Nash Equilibrium in the absence of the tax.

7. Suppose the game above is repeated indefinitely and that each country employs the grim trigger strategy. The countries cooperate with each other until one country cheats (i.e. doesn't cooperate). If one country cheats, each country plays a Nash Equilibrium strategy from a one-shot game for the remaining time periods. Can a grim-trigger strategy ensure that both countries will reduce pollution? Show your work.

If the countries employ the grim trigger strategy, then each country will cooperate if the present value of cooperating exceeds the present value of cheating once and playing a Nash strategy in every future period. Consider country A's calculation:

$$PV(\text{Cooperate}) = 30 + 30/r$$

$$PV(\text{Deviate}) = 50$$

$\Rightarrow A \text{ will cooperate if } r < (3/2)$

Now consider country B's calculation:

$$PV(\text{Cooperate}) = 10 + 10/r$$

$$PV(\text{Deviate}) = 80$$

$\Rightarrow B \text{ will cooperate if } r < (1/7)$

Since r is always less than one, the grim-trigger strategy always ensures that A will cooperate. So, as long as $r < (1/7)$, the grim-trigger strategy ensures that B will cooperate as well.

8. Consider the case of multiple countries deciding whether or not to cooperate in an international environmental agreement for provision of a non-excludable good. Suppose the costs of not cooperating are \$0 *per country* and the costs of cooperating are \$12,000 *per country*. The benefits of cooperating are \$5000 *for each country that cooperates* and \$0 if no countries cooperate. For example, if three countries cooperate, they pay \$12,000 *each* in costs and they receive \$15,000 *each* in benefits. If four countries cooperate, they still pay \$12,000 *each* in costs but they receive \$20,000 *each* in benefits. What is the maximum number of countries that will cooperate? Explain your answer.

Since the good is non-excludable, all countries receive the benefits of any other country's decision to cooperate, and there is an incentive to free-ride. First, note that at least three countries have to cooperate before the net payoffs from cooperation are positive. Second, notice that there is no incentive for a fourth country to cooperate in the agreement because there is no credible threat of retaliation from the other three. If country A is the fourth country, the payoff matrix below illustrates the incentives:

	B,C,D	
A	Don't Reduce	Reduce
Don't Reduce	0, 0	15000, 3000
Reduce	-7000, 5000	8000, 8000

In this case, A can free-ride and get payoffs of 15000 as opposed to 8000. There is no incentive for B,C, and D to retaliate because they can still receive a net payoff of 3000 by cooperating, whereas the game would devolve to a zero payoff for all countries if they retaliated. So, the maximum number of countries that will cooperate is 3.

Extra Credit

9. The 'broad then deep' strategy is advocated by many as an approach to reducing risks of climate change. Are advocates of this strategy making any implicit assumptions regarding discounting?

The broad then deep strategy suggests getting a broad coalition of countries to make small cuts in greenhouse gases (ghgs) today and progressively deeper cuts in the future. The rationale for this strategy is that abatement costs are high today and will decrease over time, and that benefits from reduction occur mostly in the future. At the heart of this strategy is the acknowledgement that the benefits from reduction are very high, but since they occur far in the future, then it is still not optimal to make deep reductions today. So, the assumption is that the discount rate is high enough such that the future benefits do not outweigh the costs of making deep cuts in ghgs today.