

## **Final Exam**

Introduction to Environmental and Resource Economics, December 7, 2003

200 points total

1. The general theme of the class has been one of optimal conditions which balance two things (supply and demand, cost and benefit, costs to firms, net benefits across time) at the margin. Pick your favorite two “marginal this equals marginal that” conditions, and for each case, explain (briefly) 1) the economic issue under consideration, 2) its potential policy implications, and 3) why the “marginal this equals marginal that” solution is or is not socially optimal. (50 points, 25 each example)

2. Residents of Farrcroft in Central Fairfax are considering hiring private security personnel to station each of the two entry points to the complex. (Since the rest of the complex is surrounded by a moat and fencing, residents consider the other borders to be secure.) In terms of the benefits that they receive from extra security, residents can be classified into three types. The following private marginal benefit (demand) curves characterize the benefits received by each resident type from having the security personnel on duty (where  $Q$  is the number of hours each evening that the security personnel are on duty):

$$p_1 = 30 - 3Q \quad (1)$$

$$p_2 = 20 - 2Q \quad (2)$$

$$p_3 = 10 - Q \quad (3)$$

The marginal cost (supply) curve for provision of the security personnel is:

$$MC = 20 + 2Q \quad (4)$$

- (a) What kind of good is the security service? From the perspective of the Farrcroft residents, is the security service *non-rival* and *non-excludable*? Explain. (10 points)
- (b) If there was no coordination between residents and each made a private decision whether or not to hire the security service, which groups of residents would hire the service, and how many hours per evening would the service work? (*Hint: You may find it very helpful to graph the marginal cost and marginal private benefit curves.*) (10 points)
- (c) Construct the marginal social benefit curve, using the three marginal private benefit curves. (You may want to add this to your graph.) (10 points)
- (d) What is the socially optimal number of hours for the service to patrol? (10 points)
- (e) Why would we not expect this socially optimal number of hours to occur in a free market setting? *Your answer may in part discuss part b from above, but should go beyond this as well.* (10 points)

3. As we discussed in our last class, a representative of the Russian government recently announced that Russia does not plan to sign the Kyoto protocol, an international treaty that places global limits on emissions of gasses which contribute to global warming. The proposed treaty included an emissions trading program. From the BBC and New York Times articles, it is clear that Russia and the US would have mutually benefited from the other's participation in the treaty. Russia would have a high number of emissions credits to sell, since its economy has contracted substantially since the initial treaty was drafted. Since the US accounts for a disproportionately large percentage of world emissions, it would have most likely purchased a substantial portion of Russia's permits. If one country does not participate but the other does, the first country benefits from cleaner air without having to incur the costs of cleanup. The following stylized game represents the potential payoffs to each nation from signing the treaty, given that the other county does or does not sign.

	US does not sign	US signs
Russia does not sign	(4,4)	(10,3)
Russia signs	(3,10)	(9,9)

- Underline each country's best response, given the action of the other country (sign or not sign). What is the Nash equilibrium? (10 points)
- Is this outcome Pareto optimal? How do total benefits compare to other possible outcomes? Explain. (10 points)
- The global atmosphere is a classic "commons". Very briefly discuss the Hardin/Gordon vs. the Ostrom predictions for sustainable use of the commons. (10 points)
- In your opinion, which paradigm (Hardin or Ostrom) is likely a better description of the future state of our global atmosphere? Why? (10 points)
- Atmospheric health tomorrow depends on our decisions regarding use (or abuse) of the resource today. Under the assumption that discounting will influence the time path of emissions of gasses that harm the atmosphere, would you expect air quality to increase or decrease over time? Why? If a tradable permit market were implemented, would you expect permit prices to increase or decrease? Why? (Careful-second part is tricky!) (10 points)

4. The City of Fairfax is considering using some of their open space acquisition funds to create a new wildflower and native plant habitat project. The majority of the project's costs are up-front fixed costs related to purchasing and landscaping land. Two possible sites are proposed. Site 1 is larger and Site 2 smaller. The estimated per-capita net benefits for four year for each project have been estimated as:

	Year 1	Year 2	Year 3	Year 4
Site 1:	-100	50	50	110
Site 2:	-50	50	50	50

- (a) The city first decides to use its relatively low Fairfax City Bond rate as the interest rate for discounting purposes. The current rate is 5%. At this interest rate, are both projects feasible? Which project is preferred? (10 points)
- (b) One member of the council expresses concerns that the rising US government deficit will lead to much higher interest rates in the near future. She suggests comparing projects at a higher interest rate, 10%. At this rate, are both projects feasible? Which project is preferred? (10 points)
- (c) Can you explain intuitively why you got the results that you did with each interest rate?
- (d) The city council decides to build the habitat site at Site 1. The following year, an ESP master's student decides to undertake a more formal ex-post-cost benefit analysis of the project, by estimating the marginal social benefit and marginal social cost curves (in present discounted value terms). She estimates that the maximum net social benefits (where marginal benefits equal marginal costs) are equal to \$83.80, using a 5% discount rate. Given her results, how does the optimal size of each project compare to the socially optimally sized project? (You can assume that the marginal net benefit and total net benefit functions take the same form as those we reviewed in class, and I will draw them on the board if anyone wants.)
- (e) Because many of the benefits of the park (aesthetics, recreation, biodiversity, ecosystem services) are not traded in the market, the ESP student uses non-market valuation techniques to estimate the marginal social benefit function. Briefly describe one method for estimating non-market values. What are some of the potential difficulties with this method?