EC371 – Environmental Economics

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Practice Problems for Unit 4: Natural Resources

There is one problem. Please read and think about it carefully, and work through all parts before *looking at the solutions. If you are having trouble, you can seek clarification and help from classmates and during my office hours, but it is highly recommended that you struggle through the questions yourself first. Your goal should be both to learn the mechanics and to grasp the intuition and think more deeply about the issues. Solutions will be posted around the afternoon of Wednesday, November 23, 2011. If you would like comments on your work and solutions, you can submit them to me at any time.*

1. Consider a non-renewable and non-recyclable natural resource that has no substitutes. Society only places value on this resource for the periods specified, and there will be no exploration for this resource over time.

a) If marginal benefits to society are represented by the inverse demand function $P_i = 10 - 0.5Q_i$ for each period $i = 0, 1$ (where Q_i is the quantity of the resource that would be extracted/consumed in period i at price P_i per unit) and marginal extraction costs are \$4.00 per unit in each period, what would be the efficient extraction of this resource in each period if the resource were abundant?

b) Assume that the stock of the resource is fixed at 16 units. Calculate present value marginal net benefit functions from the perspective of period 0 for each period using this same demand and cost information and a discount rate of 7% where necessary. Calculate the dynamically efficient allocation of the resource across the two periods. Does it make sense? Calculate the price in each period that would support the dynamically efficient allocation and the associated marginal user cost in each period.

c) This type of example can easily be altered to account for i) higher demand in the second period due, for example, to population growth and ii) higher marginal extraction costs in the second period due to the technological complications of extracting the last units of a resource relative to earlier units (e.g. digging deeper and in thinner seams for coal, removing oil from de-pressurized wells, etc.). Consider a situation in which $P_0 = 8 - 0.4Q_0$, $P_1 = 10 - 0.3Q_1$, $MC_0 = 2$, $MC_1 = 3$ and there are 25 units of the resource available. Calculate the dynamically efficient consumption of the resource in the first period, first with a discount rate of 5% and second with a discount rate of 10%. Does the change in the efficient level of first-period consumption with the different discount rate make sense?

d) This type of example can also be easily altered to account for a longer time horizon, although the math becomes more tedious. Recall, however, that the relationship between the marginal user costs across periods associated with the efficient allocation (i.e. the Hotelling Rule) is the same in the many-period case as it is in the two-period case. Suppose that the inverse demand function is $P_i = 12 - 0.3Q_i$ and marginal extraction costs are \$3.00 per unit in each period, and that the relevant discount rate is 6%. Now, however, suppose that the planning horizon is much longer and that the resource is scarce in the sense that, while there are several hundred units available, the market equilibrium would lead to exhaustion of the resource before the end of the planning horizon. Assume that policymakers have calculated and implemented the efficient plan of extraction of the resource, and that there will never be a deviation from this plan. You observe that the price of the resource in period 75 is \$5.6474. Calculate the marginal user cost in period 75 and briefly interpret what it means. What was the efficient level of consumption of this resource for period 74?