ECO6143 Natural-Resource Economics
Second mid-term exam
November 9 2007
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Time allowed: 2 hours

1.(50 points) Non-renewable resource exploitation and anticipations over demand

Compare how an otherwise similar increase in the demand for a non-renewable resource can affect its price and extraction paths when it is anticipated to when it is not anticipated. (NB The use a four-quadrant graph will help. Assume that the choke price increases also with the demand curve.) In the first case, assume that you are now at time 0 and that the change is anticipated to occur at a future specific date, say at date t_0. In the second case, you are now at date 0 and the change occurs at that same future time t_0, but it is a total surprise. Compare the two cases and interpret.

2.(50 points) Common property resources, cooperation, repeated interactions and asymmetric users

A common-property resource is accessed by two users A and B. The total output is given by quadratic output function

$$f(x) = (2 - x)x,$$

where x denotes the sum of individual input effort, i.e. $x = x_A + x_B$. The users may differ by the cost of their effort. The respective total costs are given by

$$\begin{aligned} c_A(x_A) &= \frac{1}{2}x_A^2, \\ c_B(x_B) &= \alpha\frac{1}{2}x_B^2, \text{ with } \alpha > 0. \end{aligned}$$

Those costs are given in units of the resource.

a) **Efficiency** Give the conditions that characterize the efficient allocation of efforts x_A^* and x_B^* between the two users. Provide a brief economic interpretation.

b) **Free access** Derive the conditions for the non-cooperative Nash equilibrium individual level of effort x_A^{FA} and x_B^{FA} assuming a free access regime. Assume that each user's average product of effort is equal to the global average product of effort $f(x)/x$. Compare with the efficient allocation conditions found in (a) and interpret briefly.

c) **Repeated interactions** Suppose now that both users have the same cost structures, i.e. $\alpha = 1$. Calculate total and individual profits in both (a) and (b). Suppose that the CPR is still subject to free access as in (b) but that instead of meeting just once, the game in (b) is just *one stage* in an infinitely repeated game. Each user has a discount factor between period equal to $\beta \in (0, 1)$. Show how the following "trigger strategy" can re-establish cooperation on the CPR:

- At any period $t = \tau$, I cooperate fully *if* we have both been cooperating in the past;
- *If not*, revert to the free-access input level.

Explain and interpret.

d) **Asymmetric users** Suppose now that user B has higher costs than user A such that $\alpha = 2$. Calculate total and individual profits in both (a) and (b). Can you propose a *trigger strategy* that each user can adopt in order to re-establish efficiency on the CPR? What does this say about cooperation on CPR between asymmetric users? Explain and interpret.