PROBLEM SET 6 (Fall 2008)

1.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. (Assume zero extraction costs to simplify.)

2. A dynamic, discrete-time analysis of a fishery with ecological stock value

The natural growth of a fish stock during any year t is given by a logistic function denoted $F(S_t)$, where S_t is the fish stock size in tons at the beginning of year t. With a year t harvested quantity of H_t tons, the change in stock size between two years is

$$S_{t+1} - S_t = F(S_t) - H_t. \tag{1}$$

The cost of harvest is expressed as $C(H_t, S_t)$, with $C_H(H_t, S_t) > 0$ and $C_S(H_t, S_t) < 0$. The unit selling price of a ton of fish is constant over time and equal to p; this represents its *direct* commercial value.

The fish stock size also contributes to the marine ecological equilibrium. This has repercussions over the commercial value of other species, bio-diversity, amenity values for divers, etc. To make things simple, let us say that the lower our fish stock S_t, the more adversely affected is the ecological equilibrium and thus the *indirect* social value of the fish stock. Formally, we represent this indirect social value by $U(S_t)$, with $U'(S_t) > 0$, $U''(S_t) < 0$.

During any period t, the net flow of social benefits generated by the fish stock is thus given by $b_t = U(S_t) + pH_t - C(H_t, S_t)$.

a) For an infinite number of future periods, solve for the present value maximization of the sum of social benefits that would be chosen by a benevolent social planner. Assume a yearly social discount *factor* equal to $\beta = 1/(1 + r)$. Interpret fully the optimality condition.

b)) Characterize the steady-state stock of the resource which corresponds to present value maximization in a.

c) Analyze and discuss the effect of a technological improvements in harvesting technology by assuming that harvesting costs become negligible, i.e. $C(H_t, S_t) = 0$, and comparing with the previous solution.

d) Discuss how the introduction of an indirect stock social value is likely to affect the steady-state exploitation of the fishery when one compares the problem of a profit-maximizing firm with that of a social planner. (Assume that both use the same discount factor.)

e) How does the steady-state stock level found in b) compare with the MSY stock level? Discuss.