

SET 5 (2007)

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3. Fishery Dynamics & Market Structure

a) The PV max problem for the monopoly:

$$\max_{H_t, S_t} V_0 = p(H_0)H_0 - C(H_0, S_0) \\ + \beta [p(H_1)H_1 - C(H_1, S_1)] + \beta^2 [\dots] + \dots \\ \text{s.t. } S_{t+1} = S_t - H_t + F(S_t)$$

$$\text{We have: } H_0 = F(S_0) - (S_1 - S_0) \\ H_1 = F(S_1) - (S_2 - S_1)$$

Substitute into V_0 to get:

$$\frac{\partial V_0}{\partial S_1} = -[p'(H_0)H_0 + p(H_0)] + C_H(H_0, S_0) \\ + \beta \{ [p'(H_1)H_1 + p(H_1)](1 + F'(S_1)) - C_H(H_1, S_1)(1 + F'(S_1)) - C_S(H_1, S_1) \} = 0.$$

$$\Rightarrow \frac{[p'(H_1)H_1 + p(H_1) - C_{H1}](1 + F'(S_1)) - [p'(H_0)H_0 + p(H_0) - C_{H0}] - C_{S1}}{p'(H_0)H_0 + p(H_0) - C_{H0}} = 1$$

This is the optimality condition in its "financial" equivalent form. Leaving a marginal unit of fish in the water has an opportunity cost of $p'(H_0)H_0 + p(H_0) - C_{H0}$ because that amount is forgone.

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Along the optimal path, this means that $1 + F'(S_t)$ extra units can be fished out the following year, while the marginal benefit of one unit is $p'(H_t)H_t + p(H_t) - C_H$.

The first two terms in the numerator then represent the net gain from the invested sum.

The last term, $-C_S$, denotes the reduction in harvest costs due to the larger fish stock.

In equilibrium, the return from the marginal harvest must be equal to the interest rate.

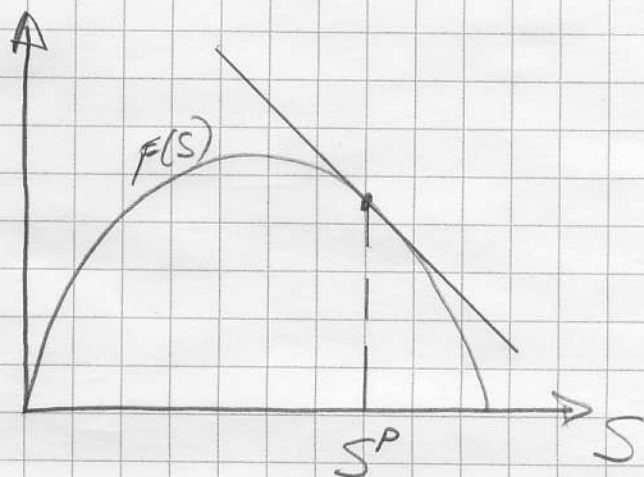
b) The difference with a price-taking firm is due to the terms $p'(H_t)H_t$ which are not accounted for by the price takers.

c) Steady-State: $F(S_t) = H_t \quad \forall t$.

$$\Rightarrow \boxed{F'(S^M) = \frac{C_S}{p'(H^M)H^M + p(H^M) - C_H} + r}$$

d) With price-taking firms, we have:

$$F'(S^P) = \frac{C_S}{p(H^P) - C_H} + r$$



Since $p'(H) < 0$, at S^P , we have

$$F'(S^P) = \frac{C_S}{p(H^P) - C_H} + r > \frac{C_S}{p'(H^P)H^P + p(H^P) - C_H} + r.$$

Since $F''(S) < 0$, the monopolist will increase the stock in order to reestablish its optimality condition. Hence,

$S^M > S^P$. This is intuitively appealing: the monopolist prefers to harvest less in order to keep prices high. This results in a higher S-S stock level.

e) From a conservationist's point of view, the monopoly is a good thing since it puts less pressure on the resource by lowering harvest rates.