AAE 343 Discussion Section 9

April 5th, 2019

I. Review of Hotelling's Rule

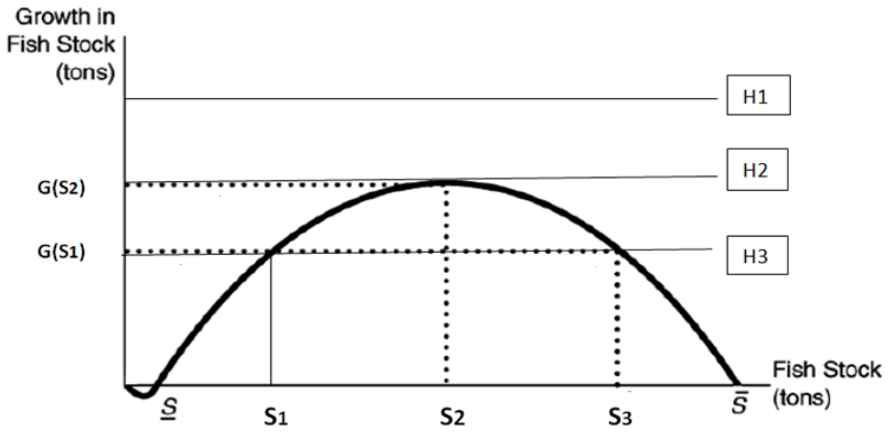
- When does Hotelling's Rule apply? Only when a finite resource constraint affects firm/household/agent's decision-making!
  - If there is enough of the resource that the firm/household/agent would select total extraction below amount available (due to profit maximization and market price), then Hotelling does not apply. (For clear example, review HW6 Q3d)
- Recall: when there are positive extraction costs, equating the present value of MNB across periods will maximize a firm's net benefits and thus lead to the economically efficient extraction rate.
- Precisely: firms choose extraction quantities Q* such that marginal benefits are equal over time
- This rule of thumb is often "violated" due to several factors that change over time and cause demand to shift up or down. (Firms do best they can with info they have.)
  - Technological advance: extraction costs, resource demand could fall from more efficient tech, affecting firm's decision-making
  - Resource substitutes: resource demand falls as use of substitute becomes more feasible
  - Resource discoveries: increases the firm's resource constraint, leading to re-optimization and selection of new Hotelling extraction path

Problem 1 Suppose you own an iron mine and will be extracting this resource in two time periods, "today" and "tomorrow". Demand for iron ore in the current period is $P_0 = 200 - Q_0$. Suppose a new product for which iron is an input will be produced tomorrow, and so the demand for iron in next period also increases, to the following: $P_1 = 300 - Q_1$. The marginal extraction costs are $20 per unit, the discount rate is 10 percent, and the total stock is 400 units. Provide the allocation of iron ore extraction across the two periods in this case. What about when the total stock of the resource is 500?

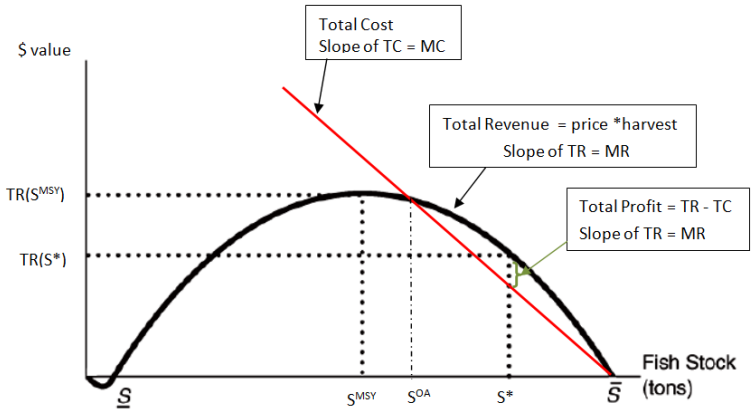
II. Renewable resources: (fishery example)

- **Biological perspective**: inverted U-shape relationship between the growth of a fish population and the size/stock of the fish population.
- **Economic perspective**: the relationship between cost and revenue.
  - Total cost increasing as we move away from carrying capacity ($\bar{s}$): TC(s) = MEC(s)*h(s)
  - Total revenue is inverted-U shape: TR(s) = P(s)*h(s)
- **Sustained yield harvest** is a harvest where the stock doesn't change over time. In words: extracted amount is equal to the amount of regenerated stock each period.
- **Maximum sustained yield (MSY):** largest possible sustained yield (top of inverted-U curve)
- **Conditions for econ. efficient sustained yield (ESY)**: $P=MC(S^{ESY})=MUC(S^{ESY})+MEC(S^{ESY})$ and $G(S^{ESY})=h^{ESY}$.
- **Open access** (*OA*) fishing leads to stock level that is "too low"
- The efficient sustained yield stock level (S^{ESY}) is greater than the open access sustained yield stock level (S^{OA}) because it accounts for the **marginal user cost of fishing**.

Problem 2 In the long run, what happens to the fish stocks at the harvest levels H1, H2 and H3?



Problem 3 What's the S^{ESY} level as compared to S*, S^{MSY} and S^{OA} when r = 0, r > 0 and r = ∞?



Problem 4 *(From old exam…)* A groundwater aquifer receives substantial recharge R each year. The water pumped from the aquifer is used in irrigated agriculture by a large number of farmers, and 20% of the water used in irrigation percolates back to the aquifer (the rest is absorbed by crops or evaporates from the field). Assume lateral movement of water in the aquifer is immediate, so there is no "cone of depression" around wells (in other words, the aquifer is like a large underground bathtub, shared by all local farmers). Answer the questions below.

a. Is it possible for the aquifer to reach a sustained yield stock level? If so, provide an expression that relates the annual extraction to the annual recharge at the sustained yield stock level.
b. Standard economic analysis would indicate that in the absence of government the extraction of water from the aquifer over time would not be economically efficient. Explain why in one or two sentences.
c. Suppose government desires to obtain the efficient rate of groundwater extraction over time using a per-unit pumping tax, where each unit of water pumped from the ground is taxed. To obtain the efficient amount of groundwater pumping at any point in time, the pumping tax should be set equal to what?
d. This question stated that there was no cone of depression around wells. In a couple of sentences explain why this distinction is important to the issue of government intervention to obtain the efficient allocation of groundwater over time is necessary

Question 1 A sustainable yield stock level always maximizes profits. (answer graded).

Question 2 The Open Access stock level will cause the fish to go extinct. (answer graded).