Economics 5250 Dr. Lozada
Fall 2009 Final Exam

This exam has 67 points. There are seven questions on the exam; you should work all of them. Most of the questions are worth 10 points each, but Question 4 is only worth 8 points and Question 5 is only worth 9 points.

Put your answers to the exam in the blue books you have brought (if you remembered to bring blue books).

Answer the questions using as much precision and detail as the time allows. Correct answers which are unsupported by explanations will not be awarded points. Therefore, even if you think something is "obvious," do not omit it. If you omit anything, you will not get credit for it. You get credit for nothing which does not explicitly appear in your answer. If you have questions about the adequacy of an explanation of yours during the exam, ask me.

You have two hours to finish this test.

Answer all of the following seven questions.

1. [**10 points**] Tell me everything you know about Figure 1 (in particular, where it comes from and what it means). Also explain why it implies that "more effort does not always yield more harvest."

2. [**10 points**] Please look at Figure 2, which is one page of a class handout. Another way of expressing Figure 2's equation (10) is:

$$(1+r)M\Pi_7 = (1+F_8')M\Pi_8 - C_{X8}\,.$$

   Write down the mathematical formulation of the problem for which this is the answer. Also give the economic interpretation of that formulation.

3. [**10 points**] Consider this claim: "Exhaustible resource firms set marginal revenue equal to marginal cost, just like all other firms." Argue that this claim is false (whether or not you believe it to be false is irrelevant.)

4. [**8 points**] Criticize the significance of exponential exhaustion indexes.

5. [**9 points**] Page 15 of Chapter 1 of your textbook contains the passage:

   > Easterlin's 'paradox' (i.e. survey data indicating that material affluence and human happiness were not closely correlated), Hirsch's 'positional goods' concept (i.e. that the enjoyment of a range of commodities is necessarily restricted to a small group of high income earners, despite the illusion given that all sections of society might one day participate in such consumption), and Scitovsky's 'joyless economy' analysis (again emphasising human need for more than mere material affluence) are representative of 'social limits' thinking.

   What are the implications of such ideas (for the people who think they are true) for environmental economics?

6. [**10 points**] Give a thorough explanation of the Coase Theorem.

7. [**10 points**] Interpret Figure 3.

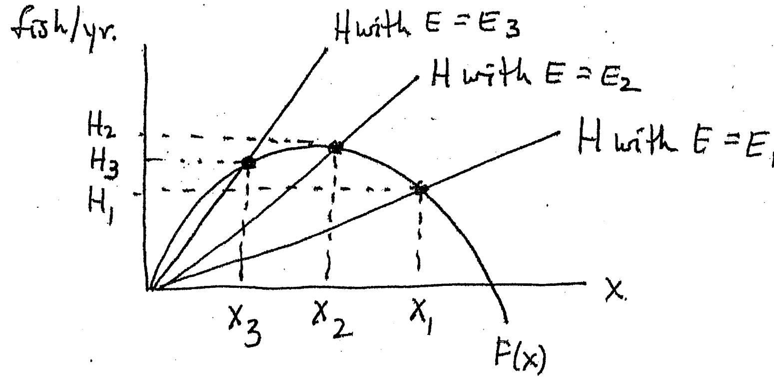


Figure 1.

Figure 2

"r" should be "δ" everywhere on this page

(6) and (7) can easily be solved for k_9 and k_8. Substituting these values into (5) yields

$$0 = \frac{\partial \Pi_8/\partial X_8}{(1+r)^8} - \frac{\partial \Pi_7/\partial H_7}{(1+r)^7} + \frac{\partial \Pi_8/\partial H_8}{(1+r)^8}\left[1 + F'(X_8)\right], \tag{8}$$

so

$$0 = \frac{\partial \Pi_8}{\partial X_8} - (1+r)\frac{\partial \Pi_7}{\partial H_7} + \left[1 + F'(X_8)\right]\frac{\partial \Pi_8}{\partial H_8}. \tag{9}$$

From (1), $\Pi_8 = TR(H_8) - TC(H_8, X_8)$, so $\frac{\partial \Pi_8}{\partial X_8} = -\frac{\partial TC}{\partial X_8}$; call this $-C_{X8}$ for short. By definition, $\frac{\partial \Pi_7}{\partial H_7} = M\Pi_7$ and $\frac{\partial \Pi_8}{\partial H_8} = M\Pi_8$. Also, let $F'(X_8)$ be abbreviated by F_8'. Then substituting these results into (9) yields

$$0 = -C_{X8} - (1+r)M\Pi_7 + \left[1 + F_8'\right]M\Pi_8 \tag{10}$$

which can be rewritten as

$$1 + r = \frac{-C_{X8}}{M\Pi_7} + \left[1 + F_8'\right]\frac{M\Pi_8}{M\Pi_7} \tag{11}$$

or as

$$M\Pi_7 = \frac{-C_{X8} + M\Pi_8 + F_8' M\Pi_8}{1 + r}. \tag{12}$$

Yet another way of writing this equation begins by writing the '1' on the LHS of (11) as $M\Pi_7/M\Pi_7$. Then

$$\frac{M\Pi_7}{M\Pi_7} + r = \frac{-C_{X8}}{M\Pi_7} + F_8'\frac{M\Pi_8}{M\Pi_7} + \frac{M\Pi_8}{M\Pi_7} \tag{13}$$

and

$$r = \frac{-C_{X8}}{M\Pi_7} + F_8'\frac{M\Pi_8}{M\Pi_7} + \frac{M\Pi_8 - M\Pi_7}{M\Pi_7}. \tag{14}$$

If, in (14), there is a steady state, then this equation becomes

$$r = \frac{-C_X}{M\Pi} + F' + 0. \tag{15}$$

By definition, $C_X = \partial TC/\partial X$. Your book, in (16.13), assumes that $TC = c(X)H$. (Your book uses C instead of c, but I think c is less confusing.) Maintaining this assumption, $C_X = \partial\big(c(x)H\big)/\partial X = c'(X)H$. In a steady state, $X_{t+1} = X_t$, so from (3), in a steady state, $F(X) = H$. Making this substitution results in

$$C_X = c'(X)F(x). \tag{16}$$

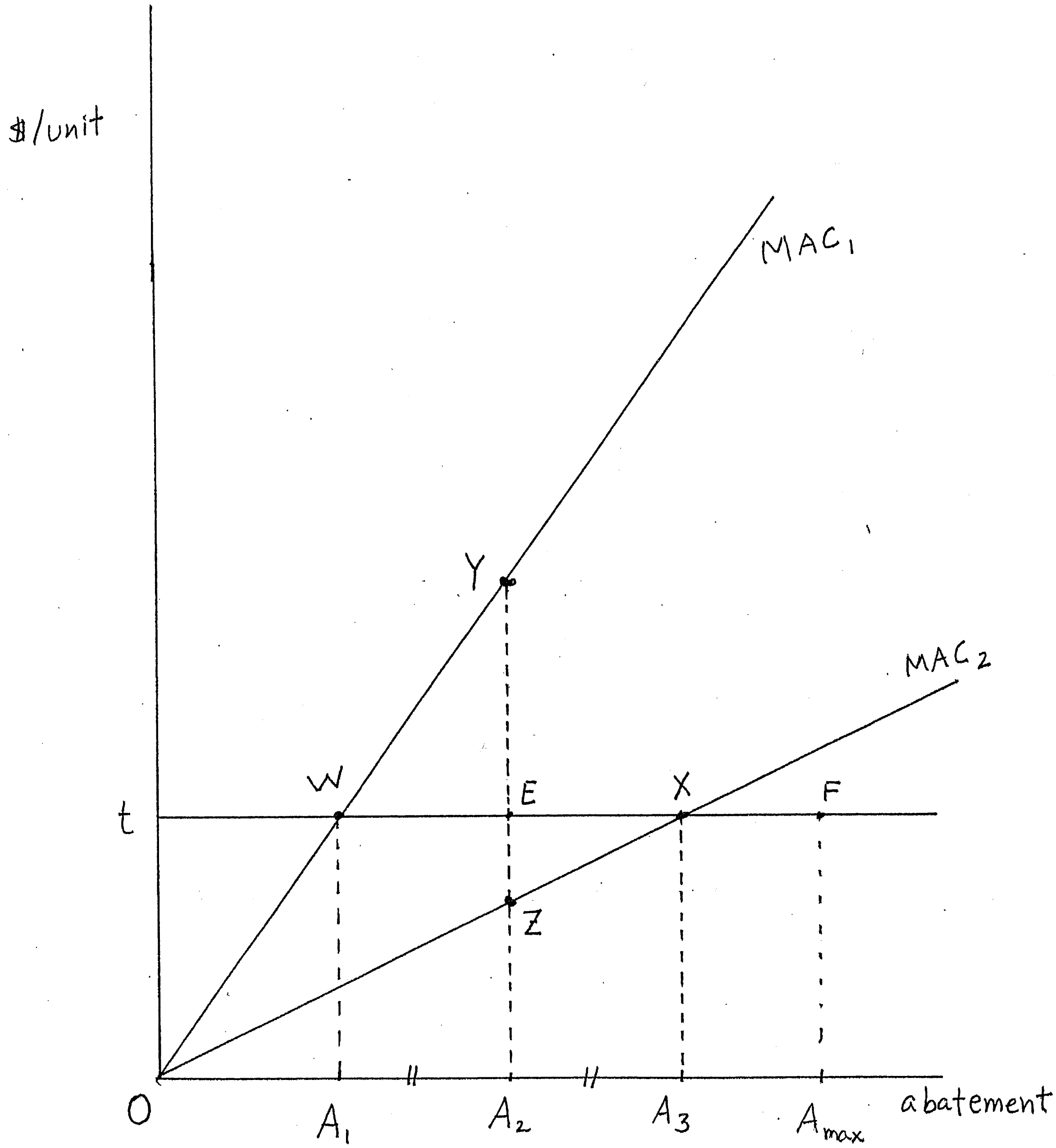
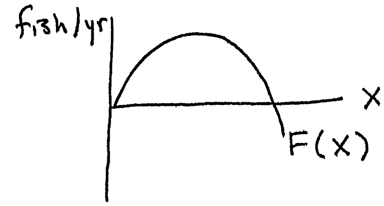


Figure 3

Econ. 5250, Fall 2009, Final Exam Answers.

① 

F(X) is the biological growth function, giving the excess of births over natural deaths. Here it takes the logistic form of a parabola.

Harvest "H" depends on effort "E" and <u>stock size "X</u>." For effort fixed, this assumes that H increases linearly with X. For X fixed, H increases with E. (For a given stock size, more effort yields greater harvest.) So E_3 must be $> E_2$, which must be $> E_1$.

(For a given effort, more fish in the ocean leads to more fish caught.) That's why the H-versus-X lines are straight and upward-sloping.

If a steady state exists, then $0 = \dot{X} = F(X) - H \Rightarrow H = F(X)$. The three dots in the graph show three steady-state points. In the steady state (or rather, comparing steady states), as E goes from E_1 to E_2 to E_3, steady-state harvest goes from H_1 to H_2 to H_3. So the increase in effort from E_2 to E_3 led to a decrease in steady-state harvest. So "more effort does not always yield more harvest" in the steady state. (This does not contradict the much less interesting statement above, that "for a given stock size, more effort yields greater harvest.")

(2) The problem is to maximize the present discounted value of profit,

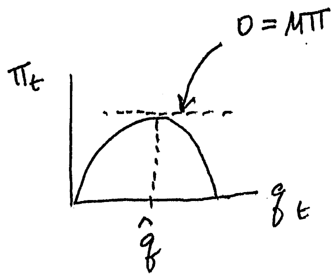
$$\max \sum_{t=0}^{\infty} \frac{\pi_t}{(1+r)^t}$$

such that

$$\underbrace{X_{t+1} - X_t}_{\text{change in fish stock "X" from one year to the next}} = \underbrace{F(X_t)}_{\text{births - natural deaths}} - \overbrace{H_t}^{\text{extra deaths due to "harvesting"}}$$

where

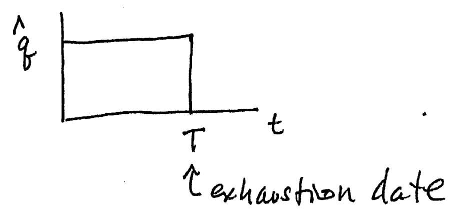
$$\pi_t = \underset{\uparrow \text{ total revenue}}{TR(H_t)} - \underset{\uparrow \text{ total cost}}{TC(H_t, X_t)}.$$

(3) 

If they did, then $q_t = \hat{q}$ for all t.

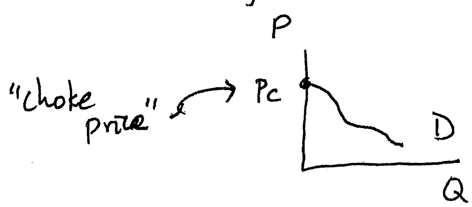
But this is not feasible; eventually the firm will run out of resource stock.

Another possibility is that the firms set $MR = MC$ for as long as possible. Then the time path of quantity would be



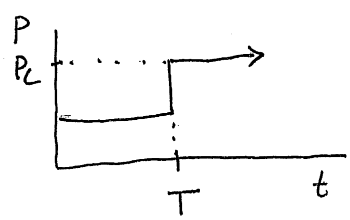
(Graph 1)

With a demand curve by consumers of



(Graph 2)

Graph 1 would lead to



(Graph 3)

But the price-taking firms, seeing Graph 3, would not stick with Graph 1 (but would rather keep some resource for sale shortly after the price jumps at T).

So Graph 1 does not produce an equilibrium price path.

(4)

Exponential exhaustion indexes assume:

1) quantity extracted and used increases at an exponential rate until the resource is exhausted; and

2) the resource stock is fixed and qualitatively homogeneous.
(not necessarily known) (because it's expensive to find out resource locations, so some of that expense is best put off into the future)

Then these indexes calculate how long resource stocks will last.

Assumption 2 does not take into account resource heterogeneity (as shown, say, in a McKelvey Box). (However, this could be taken care of by adjusting the assumed resource stock.)

Assumption 1 is highly suspect. It ignores supply and demand and prices. In particular, it seems plausible that as a resource becomes scarce, its price will rise, causing quantity demanded to fall, not to continue rising exponentially. Exponential Exhaustion Indexes hence overestimate consumption, thus underestimating how long resources will last.

(5)

Easterlin's Paradox implies we don't need lots of resource depletion / economic affluence to make us happier.

Hirsch's "Positional Goods" concept implies well-being is relative to other people, and so doesn't depend on a high average level of economic affluence / resource depletion, but rather on one's relative standing, regardless of what the average level is.

Scitovsky's "Joyless Economy" implies that affluence / resource depletion does not bring happiness.

All these ideas imply that resource depletion is neither sufficient nor necessary to increase human happiness.

(6) See other old exams for detailed explanation.

Optional: Suppose victims have to pay firms (firms have the property rights). Those payments, through an income effect, may cause the victims to be less "willing and able" to pay for pollution reductions. That would cause the MEC curve to shift down.

(7)

First I claim that Firm 1, who has MAC_1 ("Marginal Abatement Cost" is "MAC") is faced with a tax on non-abatement of t, it will choose A_1 level of abatement. If it abated less than A_1, it would only save itself MAC, but it would have to pay t, and since $t > MAC$ there, the firm would be worse off. If, on the other hand, the firm abated more than A_1, this would cost it MAC, and would only save it t; since $MAC > t$ there, the firm would not want to do this. Conclusion: Firm 1 would abate at A_1 with tax t.

Suppose t is a tax imposed for non-abatement. Firm 1 goes to A_1 and Firm 2 goes to A_3, so total abatement is $A_1 + A_3$. But since by construction

$$A_3 - A_2 = A_2 - A_1, \text{ one has}$$

$$A_3 = 2A_2 - A_1$$

$$A_1 + A_3 = 2A_2 .$$

If instead of the tax there were a command-and-control standard, both firms would abate at A_2, so total abatement would be $2A_2$. This is identical to total abatement with a tax "t" instead of the standard.

Total abatement costs are the area under the MAC curves. If you switch from a standard to a tax, Firm 1's total abatement costs go from OYA_2 to OWA_1, a savings of YWA_1A_2. Firm 2's total abatement costs go from OZA_2 to OXA_3, an increased cost of XZA_2A_3. But

$$YWA_1A_2 > EWA_1A_2 = XEA_2A_3 > XZA_2A_3$$

shows that Firm 1's savings are greater than Firm 2's cost increase. So the tax results in the same level of total abatement and fewer total abatement costs ∴ the tax is a Pareto improvement over the standard.