ECON/FRE 374 – Final Exam Solutions

Final Exam, December 05, 2006, 3:30 PM, Angus 104 Total Points: 100

Student Name:__________________________ Student Number____________________

Instructions:

1) Write your name and student number on the exam, and on the answer booklet.
2) Keep a picture ID out on your desk. Someone will verify your identity.
3) Please write all answers on your answer booklets.
4) You have 120 minutes to complete your exam so budget your time accordingly.
5) Hand in both this exam and your answer sheet together at the end of the exam.

Questions (points in brackets):

1) Essay Question (all parts are 7 points - please be brief)

a) What are Individual Transferable Quotas (ITQ's)? Write down the steps the regulatory authority needs to take to ensure that the ITQ's are correctly determined and functioning appropriately.

Answer: Individual Transferable Quotas (ITQ's) are designed to reduce access to a fishery and discourage overcapitalization. The basic idea behind a ITQ is to set a Total Allowable Catch (TAC) and divide it into quotas for individuals and make the quotas transferable.

Steps for a regulatory authority (do not deduct points on the following portion if they have at least four out of the following five steps)

- Establish TAC's that are both economically and biologically meaningful
- Divide the TAC into a number of individual catch limits or catch quotas
- Allow individual quotas to be bought or sold, and keep track of ownership
- Enforce catch quotas – fishers cannot harvest excess quantities
- Monitor the performance of ITQ market to spot and manage problems related to concentrated ownership, community impacts and biological uncertainties

b) Define Quasi Rent. Provide some examples where quasi rent arises.

Answer: Quasi Rent is defined as any payment made to a capital asset that is fixed in supply for the time being. It is commonly defined as the difference between total revenue and total variable costs

Examples of quasi rents are investment in capital improvements in a factory, investment in capital equipment that is necessary to get a forestry license, silvicultural investment in trees etc.

c) Describe the Rothery formula for calculating stumpage rates that was used in British Columbia before 1987. Describe one potential economic distortion that could arise due to the use of this formula for calculating stumpage.

Answer: The simplified Rothery formula used in BC for calculating stumpage was: S=P-C-R, where S is stumpage, P is timber price, C is operating costs, R is allowance for risk and a normal rate of profit

There were two stumpage rates calculated. One for coastal forestry, and the other for forestry in the interior of BC. The difference in the two rates came from the fact that the government set the price (P) on coastal forestry higher than the price for interior units.

Since the stumpage was a uniform stumpage rate irrespective of the species harvested, and also irrespective of the size of tree harvested, one obvious distortion caused was: High grading – where firms had incentive to harvest only trees that provide a net return equal or greater than average stumpage. The remaining trees were often left on the ground. (Students can provide other potential distortions as well)

2) Consider the problem of recycling discussed in class. For our question, the marginal cost for production using virgin material is $MC_v = 5$, and the marginal cost for production using recycled material is $MC_r = 2+3q$. Demand is given by $P = 10 – q$.

   a) Illustrate this problem using a well labelled graph (5 points – no solution provided).

   b) How many units of the good will come from recycled materials? What is the recycling ratio (the proportion of total goods made from recycled material)? (4 points)

   Answer: The number of goods produced using recycled materials is $q_r=1$. The total number of goods produced is: $q=5$. The recycling ratio is: $\frac{q_r}{q}=\frac{1}{5}$. Students should explain how they got this answer.

   c) Suppose demand for the good decreases by shifting inwards (in other words the slope remains constant). Provide the equation for a new demand curve where the recycling ratio equals one? (3 points)

   Answer: We are looking for a new demand curve that shifts inwards but has the same slope as the old demand curve. From the two marginal cost curves we can find the point of intersection. $MC_v = MC_r$ when q=1. We also know that at all quantities below 1 it is cheaper to produce with recycled inputs. This implies that if the total quantity produced equals 1 the entire quantity produced will equal 1, and the recycling ratio will also be 1. This occurs when the demand curve is : $P = 6– q$.

   d) Describe one change that could occur to one of the curves that would <u>decrease</u> the recycling ratio. (2 points)

   Answer: Three potential such changes are: the demand curve shifts outwards, it becomes more expensive to recycle (MC_r shifts upwards), or it becomes cheaper to produce using virgin materials (MC_v shifts downwards).

3) Consider a popular specification for the logistic growth function where growth of the natural resource (stock is denoted *s,* and *k* is a positive constant) is denoted by $g(s)=s\left(1-\frac{s}{k}\right)$. Also assume that that yield (harvest) of this resource is given by the production function $y = qes$, where *e* is the effort exerted, and *q* is a positive technological constant.

a) What is the carrying capacity of this natural resource? Explain how you got this answer. (2 points)

Answer: The carrying capacity is the natural maximum stock in the absence of harvesting. It is found at the highest level of the stock for which the growth rate is zero. Here $g(s) = 0$ when $s=0$ or $s=k$. Therefore the carrying capacity is $s=k$.

b) Now recall the sustainable effort-yield relationship we discussed in class (if we harvest according to the sustainable effort-yield relationship, the stock of the natural resource remains constant). Using the growth and yield specification given earlier derive the sustainable effort-yield relationship. (8 points)

Answer: Intuitively, the growth in stock = natural growth – harvest. A sustainable stock, and hence yield, is when stock remains constant, or the growth in stock equals zero. $ds/dt = s(1-s/k) - qes$. Thus, $(1-s/k) - q e=0$, so $s = k(1 - qe)$. In the yield formula: $y = qes$, so $y = qe(1-qe)k$.

c) Let p (a constant) denote the price per unit of yield (harvest), and let the price per unit of effort be a constant c. Assume that there are no external costs, or benefits from harvesting. Also assume that there are not fixed costs of harvesting, in other words, the harvester only incurs costs on effort. Given this notation write out the total revenue and total cost functions using the sustainable effort-yield relationship you derived above.

Total revenue (TR) is price x quantity, $TR = py$. As a function of effort then $TR = pqe(1-qe)k$. Total cost (TC) = ce.

i) Explain how you can find the open access effort level for the above specification. Calculate this open access level of effort in terms of the notation (p and c) given above. (4 points)

Open access is where profits are zero (i.e. where $TR = TC$) because if profits are positive more effort will be exerted to try to capture more of the profits. Here that means $pek(1-qe) = ce$ will determine the open access effort level. Solving for $\hat{e}$: $pqk(1-q\hat{e}) = c$, so $1- q\hat{e} = c/pqk$, so $q\hat{e} = 1- c/pqk$, so $\hat{e} = \frac{pqk - c}{pq^2k}$.

ii) Explain how you will find the socially optimal effort level for the above specification. Calculate the socially optimal effort level in terms of the notation (p and c) given above. (5 points)

The socially optimal effort level is where profits are maximized (i.e. where $MR = MC$). First we need to get MR and MC by taking the first derivative of TR and TC with respect to e. $MR = pqk(1-2qe)$ and $MC = c$.

Second, set $MR = MC$ and solve for e^*. $pqk(1 - 2q\,e^*) = c$, so $1 - 2q\,e^* = c/pqk$, so $e^* = \dfrac{pqk - c}{2pq^2k}$.

iii) Compare the two effort levels, which is larger than the other. (1 points)

The open access effort level ($\hat{e}$) is twice as big as the socially optimal effort level (e^*).

d) The government wishes to reduce effort to the socially optimal level by imposing a <u>tax per unit of effort exerted</u>. Calculate the tax the government needs to impose per unit of effort to ensure that the open access level of effort equals the socially optimal level of effort. (5 points)

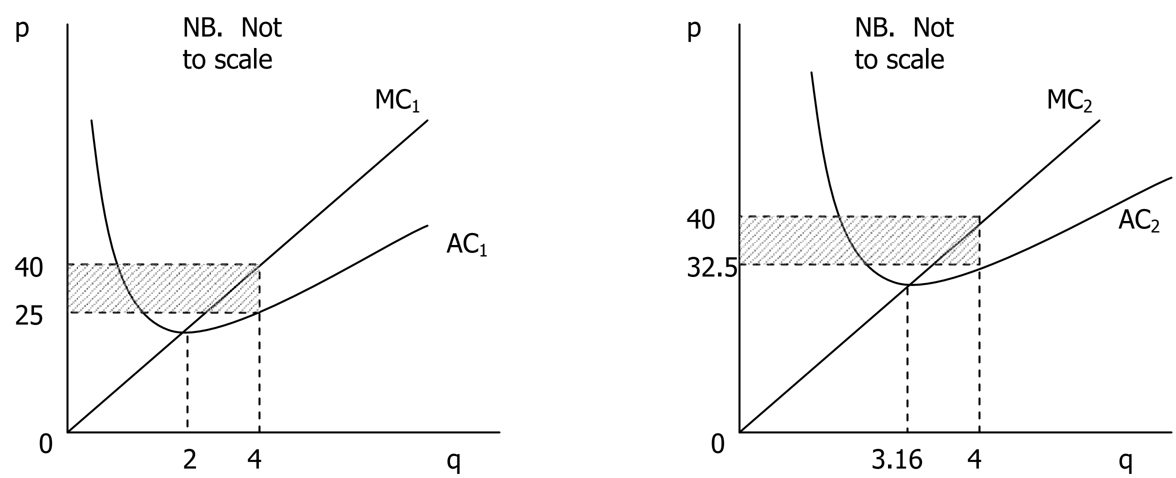
Let t denote the tax per unit of effort. The private individual now faces a cost of effort: $c+t$. To find the optimal tax the government requires $\hat{e} = e^*$ which implies that $\dfrac{pqk - c - t}{2pq^2k} = \dfrac{pqk - c}{2pq^2k}$. which requires $t = \dfrac{pqk - c}{2}$.

4) Karine is a landowner in Quebec. She owns two fields and grazes cows on both. Field 1 has a natural pond; in Field 2 Karine must pump in water. The total cost of producing tankers of milk (q) in each field is represented by: $TC_1 = 20 + 5q^2$ and $TC_2 = 50 + 5q^2$. The price of milk is set at $p = 40$.

a) Write down the formulas for average and marginal cost in each field. Plot AC_1 and MC_1 on one diagram and AC_2 and MC_2 on another. (8 points)

Answer:

$AC_1 = 20/q + 5q$ $MC_1 = 10q$ $AC_2 = 50/q + 5q$ $MC_2 = 10q$



b) Calculate, and show on your diagrams, the quantity Karine will produce in each field. (5 points)

Answer: Profit is maximized at p = MC in each field, 40 = 10q, and find $q_1 = q_2 = 4$.

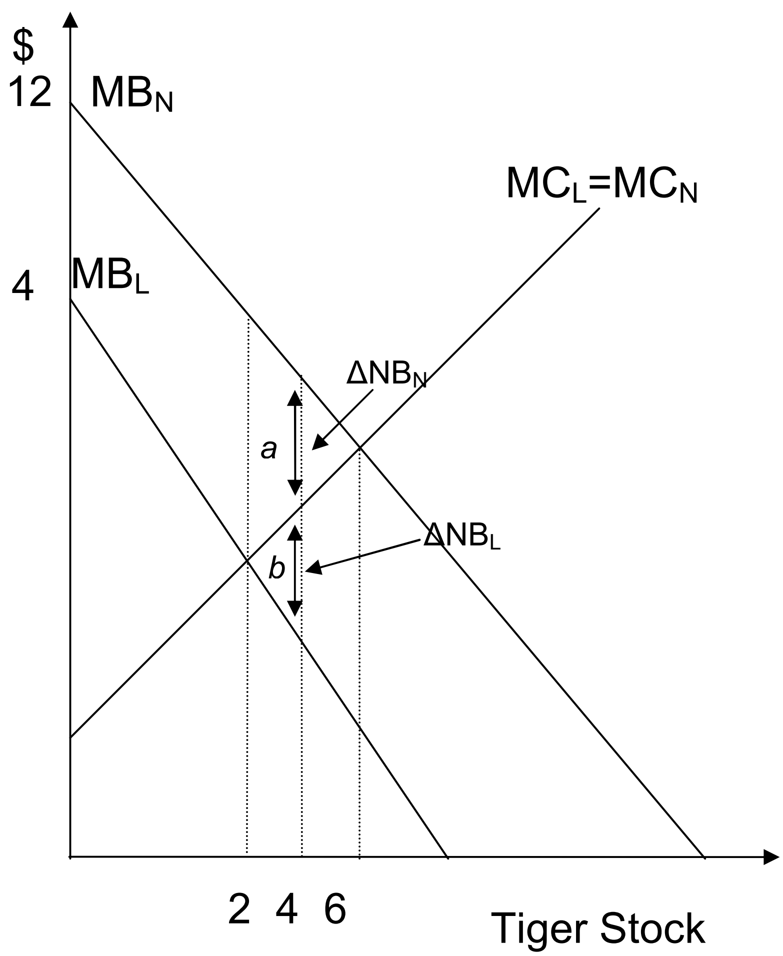
c) Calculate, and show on your diagrams, the Ricardian rent Karine gets from each field. (5 points)

Answer: Ricardian rent is p – AC at the quantity produced multiplied by quantity produced; the shaded areas in the diagrams. In Field 1 = (40 – 25) x 4 = 60. In Field 2 = (40 – 32.5) x 4 = 30.

5) Project Tiger is a government sponsored programme in India designed to ensure a viable population of tigers (for those interested please see http://projecttiger.nic.in). One of the national reserves earmarked under project tiger is the Ranthambhore Tiger Reserve in Rajasthan. To the north of the Ranthambhore Tiger Reserve lies the village of Bhaopura.

The administrators of project tiger would like you to recommend an optimal number of tigers that should be preserved in the Ranthambhore tiger reserve. They give you the following information. The Marginal Benefit to the villagers of Bhaopura from preservation of tigers is given by $MB_L = 4-q$, where q is the number of tigers preserved with a unit of 10 (thus if q=1, 10 tigers are preserved). The Marginal Benefit to the rest of India from preservation of tigers is given by $MB_N=12-q$. Assuming that the tigers do not attack the villagers, or their property, the Marginal Cost of tiger preservation for both locals and non-locals is $MC_N=MC_L=MC=q$.

a) Illustrate these curves on a suitably marked graph (7 points – the following graph is not to scale).



b) What is the number of tigers that the villages or Bhaopura would like preserved in Ranthambhore? (3 points)

Set $MB_L = MC$ which gives you an answer of 2, thus 20 tigers.

c) What is the number of tigers that the rest of India would like preserved in Ranthambhore? (3 points)

Set $MB_N = MC$, which gives you an answer of 6, thus 60 tigers.

d) What is the socially optimal number of tigers (which maximizes the net benefits for both groups) that you recommend to be preserved in Ranthambhore? (5 points)

Set the change in net benefits for both groups equal to each other. This implies setting the marginal net loss from increasing tigers preserved beyond 20 for the villagers, to the marginal net gain from increasing tigers preserved beyond 20 for the rest of India.

$\triangle NB_L = -\left[4-2q\right]$, $\triangle NB_N = \left[12-2q\right]$, setting them equal we get $q^* = 4$, or 40 tigers should be preserved.

e) Can the people from the rest of India compensate those in the village of Bhaopura for their losses from the optimal preservation? Explain why, or why not? (4 points)

Such a compensation can be easily carried out. For every tiger preserved between 2 and 4, the marginal net loss to the villagers is strictly smaller than the marginal net gain to the rest of India. Thus, the net benefit gained by the rest of India (area marked *a* in the graph) from the increase from 20 to 40 tigers is strictly greater than the area lost by the villagers from this increase (area marked *b* in the graph). The government of India could institute a tax to return the losses to the villagers from the extra preservation of tigers and there would still be benefits left over for the rest of India.