Economics 33530: Exam 3 Key

Professor Jensen Fall 2007

Part I: Short-answer Essays (10 points each). Be sure to include enough discussion to explain your answer. **NOTE: Answers below are just an outline. Some additional detail to explain is important in each case.**

1. What is the primary way in which nutrient cycling in the tropical rain forest differs from that in temperate forests?
In temperate forests, nutrients are primarily stored in the soil. In tropical rain forests, due to exceptionally fast rates of organic decay, nutrients are stored in the biomass of plants themselves, especially trees.

2. Briefly describe three benefits of biodiversity, and three causes of loss of biodiversity.
Benefits or biodiversity include:
(1) ecosystem stability
(2) the value of the plants and animals themselves in producing economic goods
(3) the genetic information in plants and animals (in developing new products, such as medicines, developing new disease-resistant varieties, or transferring characteristics across species)
(4) indirect use (existence, bequest, altruistic, and option) values
Causes of biodiversity loss include:
(1) open-access harvesting
(2) loss of habitat
(3) competition from invasive species

3. Briefly describe a comprehensive policy for dealing with toxic waste.
Must take into account the distinction between cleaning up existing sites of toxic waste and prevention of creation of new sites.
(1) Policy for existing sites involves deciding: whether to restore existing sites to pristine levels, or to isolate the sites and minimize damage to surrounding area; which sites to clean, and in what order; and how much to pay to accomplish this.
(2) To prevent future damages, use policies such as deposit-refund systems, performance bonds, or liability systems for specific toxins.

4. What are the two most important problems associated with water resources in the United States, and why?
Problems in the U.S. include:
(1) excessive use that is depleting water resources faster than they can be restored
(2) pollution from both industrial and agricultural sources
(3) ill-defined property rights
(4) quality degradation

Any reasonable discussion of why the two you chose are the worst will suffice. However, any discussion should note that a primary source of the problem is that water is priced below its social opportunity cost, thus subsidizing excessive use. Prices charged typically do not reflect its scarcity value, which should include its value in both alternative current and future uses (as well as any degradation in quality).

5. Describe three adverse effects of agriculture on the environment.
(1) Soil erosion leading to reduced agricultural productivity and reduced water quality.
(2) Excessive use of water for irrigation.
(3) Pollution from use of pesticides and fertilizers.
(4) Loss of habitat and biodiversity when land is converted to agriculture.
(5) Increased emissions of greenhouses gases such as methane and carbon dioxide.

6. Describe four policies commonly employed in developing countries that lead to environmental degradation.
(1) Subsidization of energy inputs.
(2) Subsidization of water used for crop irrigation.
(3) Subsidization of fertilizers and pesticides.
(4) Subsidization of timbering and grazing.
(5) Exemption of public sector pollution.
(6) Inefficient management of public lands.

7. Explain why we expect to see population growth slow in a country as economic development progresses.
In developing countries, the economic benefits of children are that they can be used as labor inputs in production and they provide for parents in their old age. Their costs include food and housing, education, and the opportunity cost of mother's time raising them. As societies move from agrarian to industrialized economies, these benefits tend to decline and these costs tend to rise, so we expect birth rates to decline.

8. Discuss what is meant by "sustainable" development.
Refers to growth of current GDP per capita without sacrifice of future GDP per capita, and typically involves all of the following.
(1) Increases in per capita income.
(2) Improvements in health and nutrition.
(3) Improvements in educational achievement.
(4) Access to resources.
(5) "Fairer" distribution of income.
(6) Increases in basic freedoms.

Part II. Problems (10 points each). Be sure to show your work for partial credit.

Assume that the interest rate is $r = 0.1$, and that the stumpage value of a forest as a function its age t is given by

$$V = 400 + 1000t - 10t^2$$

so that its rate of change over time is

$$\Delta V/\Delta t = 1000 - 20t.$$

1. Determine the optimal rotation R* that maximizes the net benefits of harvesting the forest if the opportunity cost of the land is OCL = 385.
$1000 - 20t = .1(400 + 1000t - 10t^2) + 385$ implies $t^2 - 120t + 575 = 0$,
so roots are t = 5 and t = 115.
Because $V(t=115) = 400 + 1000(115) - 10(115)^2 = -16850$
and $V(t=5) = 400 + 1000(5) - 10(5)^2 = 5150$,
the only sensible answer is R* = 5.

2. Suppose the government adopts a policy of subsidizing agriculture and livestock grazing, so that this land becomes more valuable for farming and ranching, which increases its opportunity cost to OCL = 960. Now determine the new optimal rotation R* that maximizes the net benefits of harvesting the forest. What is the effect of this policy on this forest?
$1000 - 20t = .1(400 + 1000t - 10t^2) + 960$ implies $t^2 - 120t = 0$,
so roots are t = 0 and t = 120.
Because $V(t=120) = 400 + 1000(120) - 10(120)^2 = -23{,}600$
and $V(t=0) = 400 + 1000(0) - 10(0)^2 = 400$,
the only sensible answer is R* = 0.
An optimal rotation of 0 years can only mean that the owners of the land stop planting and harvesting trees (and either sell, or use it, for its opportunity cost).

NOTE: In each of these problems, you will get two answers, as shown by the quadratic formula below. In each case you will be able to determine that one of the roots makes no sense, so the correct answer is the other root. (HINT: check the stumpage value of the forest at each root.)

Given a quadratic equation of the form $at^2 + bt - c = 0$, where a, b, and c are numbers, there are two solutions (roots) for t, namely:

$$t_1 = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

and

$$t_2 = \frac{-b - \sqrt{b^2 - 4ac}}{2a}$$