

Exam Environmental and Resource Economics (03.377)

(The maximum score is 100%. You pass if you score 55% or more. The score per question is indicated in red.)

Good luck!

1. There are six different interpretations of sustainability. There are three schools of moral philosophy. Divide the six notions of sustainability into three groups, and link them with the three ethical schools. (10%) Explain your reasons. (10%)

2. Consider a non-renewable resource stock S_t , of which the amount R_t is mined at time t . Suppose the mining company/companies maximise(s) the net present value of its/their annual profits, $P_t R_t$, where P_t denotes the price. The demand curve is $P_t = Ke^{-aR_t}$. Mathematically, this problem can be written as:

(1)
$$\max_R \int_0^T P_t R_t e^{-\rho t} dt \text{ subject to } \frac{\partial S}{\partial t} = \dot{S}_t = R_t$$
 in the case of one company; and

(2)
$$\max_{R_j} \int_0^T P_t R_{j,t} e^{-\rho t} dt \text{ subject to } \frac{\partial S}{\partial t} = \dot{S}_t = \sum_{j=1}^J R_{j,t}$$
 in the case of J companies.

Suppose that competition is perfect in the case of many companies. It can be shown that the solution to problem (2) is as given in Table 1. It can also be shown that the solution to problem (1), the monopoly, is approximately as given in Table 1.

Table 1.

	Perfect competition	Monopoly ^a
Exhaustion time	$T = \sqrt{\frac{2S_0 a}{\rho}}$	$T = \sqrt{\frac{2S_0 a h}{\rho}}$
Initial royalty	$P_0 = Ke^{-\sqrt{2\rho S_0 a}}$	$P_0 = Ke^{-\sqrt{\frac{2\rho S_0 a}{h}}}$
Royalty path	$P_t = P_0 e^{\rho t}$	$P_t = P_0 e^{\frac{\rho t}{h}}$
Initial extraction	$R_0 = \sqrt{2\rho S_0 a}$	$R_0 = \sqrt{\frac{2\rho S_0 a}{h}}$
Extraction path	$R_t = \frac{\rho}{a}(T - t)$	$R_t = \frac{\rho}{ha}(T - t)$

^a $h \approx 2.5$; h is a “calibration” parameter, from the approximation $xe^{-x} + e^{-x} \approx e^{-hx}$

Explain why a non-renewable resource mined by a monopolist would last longer than the same resource mined under conditions of perfect competition (5%), and why the monopoly price eventually falls below the perfect market price. (5%)

Discuss what happens if the discount rate ρ falls, and give an intuitive explanation. (5%)

In the above model, mining is assumed to be costless. In the case of the perfect market, describe what happens if extraction costs are constant but greater than zero. (5%)

3. Consider a fish stock S . The fishing community that harvests the resource is competitive, but successfully prevents newcomers from entering. If left undisturbed, the fish stock grows by $G(S)$; if the amount H is fished, the stock grows by $G(S)-H$. Suppose the fishermen maximise their net present profits. Profits equal revenue $V=PH$ minus fishing cost C . For price P , assume that the fishermen are price-takers. Fishing costs depend on both the harvest and the stock.

This problem can be written as:

$$(3) \quad \max_{H_i} \int_{t=0}^{\infty} [V_{i,t}(H_{i,t}) - C_i(H_{i,t}, S_t)] e^{-\rho t} dt \quad \text{subject to} \quad \frac{\partial S}{\partial t} = \dot{S}_t = G(S_t) - \sum_{j=1}^J H_{j,t}$$

Derive the static and dynamic conditions for optimality. (5% static, 5% dynamic)

Show what happens if the government installs a tax α , that is proportional to the fishing costs (5%). Interpret the result (5%).

4a. Consider flow pollution, that is, the pollution disappears as soon as the polluting activity stops. What determines the socially optimal level of pollution? (5%)

b. Consider stock pollution, that is, the pollution gradually fades after the polluting activity stopped. What determines the socially optimal level of pollution? (5%)

c. Consider a technology that reduces pollution. What determines the socially optimal investments in this technology? (5%)

d. Consider flow pollution. What determines the difference between the social and private optimum level of pollution? (5%)

5a. Taxes and subsidies have the same effect on the environment in the short run, but they have different consequences for the economy. What are these? (5%)

b. Taxes and subsidies have the same effect on the environment in the short run, but they have different consequences in the long run. Explain this. (5%)

c. Under what conditions is environmental regulation with command and control cost-effective? (5%)

d. Environmental regulation with taxes and tradeable permits is cost-effective. What are the differences between these two instruments with regard to total costs and environmental effects? (5%)