Norges teknisk-naturvitenskapelige universitet
Institutt for samfunnsøkonomi

EKSAMENSOPPGAVE I SØK3524

MILJØ- OG RESSURSØKONOMI

ENVIRONMENTAL AND RESOURCE ECONOMICS

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Question 1

A landowner controls a wildlife stock which grows according to $dX_t / dt = F(X_t) - q_t$. Suppose that the value per unit animal hunted is p and that the hunting cost depends only on the harvest, $C_t = C(q_t)$, such that $C'(q_t) > 0$, $C''(q_t) > 0$ and $C(0) = 0$. The landowner profit per unit of time is thus $\pi_t = pq_t - C(q_t)$.

a) Formulate the optimal management strategy of the landowner. Find the optimality conditions. Substitute away the shadow price, and find the differential equations of the system in the variables q_t and X_t. Find next the isoclines and analyze the dynamics using phase plane diagram. (hint: The marginal profit must be positive all the time; $\pi'_t = p - C'(q_t) > 0$)

b) Characterize the steady-state, and show how the price p and the discount rent δ influence the optimal steady-state stock and the number of animals hunted.

c) Assume that natural growth is governed by $F(X_t) = rX_t(1 - X_t / K)$. Interpret the parameters of this function, and find how these parameters influence the above optimal steady-state.

d) The wildlife causes a negative externality due to crop and grazing damages for the farmers living in the area. Assume that the damage function may be written as $D_t = D(X_t)$ with

$D'(X_t) > 0$, $D''(X_t) \geq 0$ and $D(0) = 0$. Formulate the social planner problem, and characterize the steady state. Compare with the landowner optimization problem.

Question 2

a) Explain your understanding of a tradable emission permit system ('cap and trade').

b) Discuss the Environmental Kuznets Curve concept and the prospects of 'decoupling' economic growth and environmental degradation.

Question 3

a) Consider a hydropower project. I is the investment cost and $D > 0$ is the operating profit (electricity sale minus operating costs), assumed to be fixed through time. With δ as the discount rate and when investment takes place instantaneously, the present-value of the project is defined by $PV = -I + \int_0^T De^{-\delta t} dt$ when. Calculate PV.

Next, calculate PV when the operating time of the project is infinite such that $T = \infty$. Will the company carry out the project?

Study the same problem when also including environmental costs ('destroying pristine land') given by P_t. Analyze first the situation when these costs are fixed through time. Next, discuss some extensions of the analysis when these costs increase over time ('Krutilla assumption').

b) Consider an even aged stand of trees planted at a piece of land at $t = 0$. The biomass at time $t \geq 0$ is given as V_t. How may the time profile of V_t look like?

The planting cost is c_0 and the net sale price (net of logging costs) of the biomass is given by p_t. Characterize and interpret the optimal logging time when the land has no opportunity value after logging. What is the effect of the discount rate?

Assume now instead that the land after logging has an opportunity value Q_t at every point of time. Characterize the optimal logging time when this opportunity value is included. Compare with what you found without this value.