NTNU
Det skapende universitet

Institutt for samfunnsøkonomi

Eksamensoppgave i SØK3524 – Miljø- og ressursøkonomi

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Eksamenstid: 6 timer (09.00-15.00)

Sensurdato: 22. juni 2015

Tillatte hjelpemidler: Flg formelsamling: Knut Sydsæter, Arne Strøm og Peter Berck (2006): Matematisk formelsamling for økonomer, 4utg. Gyldendal akademiske. Knut Sydsæter, Arne Strøm, og Peter Berck (2005): Economists' mathematical manual, Berlin. Enkel kalkulator Casio fx-82ESPLUS, Citizen SR-270x, HP 30S eller SR-270X College

Målform/språk: Engelsk

Antall sider: 3 (inkl. forside)

Antall sider vedlegg: 0

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, $C_t = C(q_t)$, where $C'(q_t) > 0$, $C''(q_t) > 0$ and $C(0) = 0$. The landowner profit per at time t is thus $\pi_t = pq_t - C(q_t)$.

a) Give first an interpretation of the equation $dX_t / dt = F(X_t) - q_t$

b) 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.

c) Characterize the steady-state, and show how the price *p* and the discount rent δ influence the optimal steady-state stock and hunting.

d) 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.

e) 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 and discuss some basic elements of a tradable emission permit system ('cap and trade').

b) The CO2 emission in a given country at a given point of time (year) may be written through the so called PAT identity $E_t \equiv P_t \cdot (X_t / P_t) \cdot (E_t / X_t)$ with P_t as the human population size, (X_t / P_t) as GDP/capita and (E_t / X_t) as the emission intensity (CO2 /GDP). The last factor is usually referred to as technology. Assume the population growth rate to be 1 % per year, and GDP/capita growth to be 2.5 % per year (this can possible be Norway). Assume that the emission should be halved during 20 years. By how much must the emission intensity (CO2 /GDP) be reduced in % per year to meet this target?

Question 3

a) Consider a hydropower project. I is the investment cost and $D_t = D > 0$ 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 $PV = -I + \int_0^T De^{-\delta t} dt$. Calculate PV.

Next, calculate PV when the operating time of the project is infinite such that $T = \infty$. Under what conditions will the project be carried out?

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? Illustrate with a figure.

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.