

ECN 275/375 – Natural resource and environmental economics
12:15-15:15 April 17, 2026

All help aids are allowed except assistance from others.

This test consists of three questions, for a total score of 100 points.

All questions are to be answered. You may answer in English or Norwegian.

In case you find a question that is unclear or you are uncertain about what it means, state the clarifications you need to enable you to answer the question.

This test has been designed to limit the benefits of using artificial intelligence (AI). If AI use is detected beyond reasonable doubt, unreported use leads to a zero-score on that sub-question. Students may use AI if they self-report such use on specific sub-questions at a cost: A question with self-reported AI use reduces the given score by 40%.

When I submit my answers on this test, I confirm that I have worked alone on my answers and not cooperated with others. I am aware that cooperation with others is considered an attempt or a contribution to cheating.

I am aware of the consequences of cheating (cfr. Academic regulations for NMBU).

Your name: NN (+ ECN 275 or ECN 375)

Question 1 (30 points – 10 points for each sub-question a-c)

Even aged single rotation forest stand management with extensions.

(a) Suppose the interest rate, r , increases from r' to r'' . How will that affect the expected optimal rotation age? Explain briefly.

Answer: write here

(b) Single rotation forestry with and without planting: Planting per hectare costs are K and takes place at time 0 if planting takes place. W and N are the respective optimal rotation ages with and without planting (natural regeneration of the forest) where $N > W$. $S(W)$ and $S(N)$ are the respective harvested timber volumes (quantities). Moreover, \hat{P}_W and \hat{P}_N are the expected net timber prices at times W and N . Finally, r is the interest rate. Based on this information, what is the net present value condition for it to be more profitable to plant than not to plant?

Answer: write here

(c) Suppose there are yearly climate benefits, $B(t) > 0$ for the lifetime of the forest stand, and that these benefits increase as the age of the stand grows, i.e. $\dot{B}(t) > 0$.

(i) Explain why this increases the optimal rotation age **under single rotation** from the private optimal rotation age T^P to the social optimal rotation age T . Draw a graph of the impact and write down the revised profit function (be careful to indicate the proper time indexes). Explain the reasoning behind your answer.

(ii) What is the size of the minimum payment for forest owners to increase the rotation age from T^P to T **under single rotation**, and why is this welfare enhancing from a societal perspective? Explain the reasoning behind your answer.

Answer (i): write here

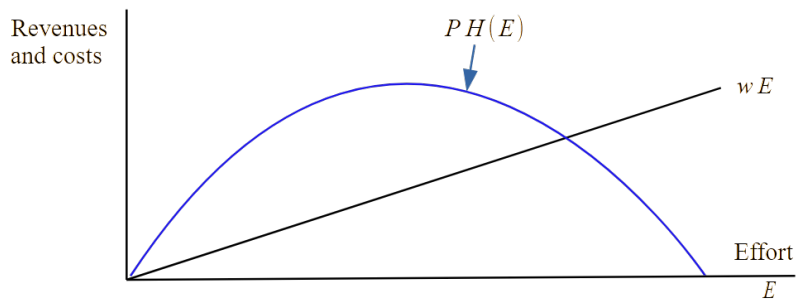
Answer (ii): write here

Question 2 (30 points – 10 points for each sub-question a-c)

Fisheries – open access and regulation.

The graph to the right shows a standard picture of the harvest-effort model where:

- E is effort
- P is fish price per kilo
- w is real wage per effort
- $H(E)$ is harvest as a function of effort measured in kilo.



- (a) (i) Use the figure above as a basis to identify the open access effort, E_{OA} . Explain.
 (ii) Show why the open access effort, E_{OA} , cannot give the lowest costs per harvested kilo of fish.

Answer (i): write here

Answer (ii): write here

- (b) There are some direct regulatory implications given the premise in question (a) that E_{OA} cannot be a cost minimum effort. State what you deem the most direct regulation to reduce effort **without lowering total revenues per effort level**.

Answer: write here

- (c) Explain how you would set initial aggregate quotas on effort, and how you would award these quotas to buyers. Mention possible challenges with your suggestion. These challenges may include undesirable effects on fish markets.

Answer: write here

Question 3 (40 points – 10 points for each sub-question a-d)

Non-renewable resources and models. While these models share some common features, they come in many variants. Consider a non-renewable model with the following attributes:

- Utility originates from consumption.
- Production uses one non-renewable resource N_t from the natural resource base R_t , and man-made capital, K_t .
- There is a direct negative externality, $E(N_t)$, from consuming N_t .
- Immediate negative impacts of the negative externality $E(N_t)$ from consuming N_t and expenditures $V(E(N_t))$ to reduce these external impacts.

- (a) Write down the objective function, the choice variables, and the capital and resource constraints that correspond to the problem description. Define terms that have not been previously defined. Briefly describe the reasoning behind your chosen formulations.

Answer: Objective function:

Constraints:

- (b) What is the economic interpretation of the change over time of the Lagrangian multiplier on the capital change constraint giving the co-state variable $\dot{\omega}_t = \delta \omega_t - Q_K \omega_t$? Explain briefly.

Answer: write here

- (c) The depletion of a resource with no apparent backstop solution implies that scarcity may become an issue.

(i) How is scarcity reflected in the equation for the Hotelling price path? It suffices to write the reformulated Hotelling price path equation.

(ii) Draw a four corners graph where you show the impact of a scarcity factor on the price path, then from prices onto quantity demanded, and finally for the stock of the resource or the time it takes for the resource to be fully utilized. Clearly mark the scarcity impacts.

Answer (i): write here

Answer (ii): write here

- (d) Suppose that the resource N_t is land with no previous commercial use that gradually is transformed for sites to build cabins in mountain areas. The loss of undeveloped area is of concern in the Norwegian public debate for two primary reasons. First, because it entails loss of wildlife habitat. Second, because it reduces the recreational value of Norwegian outbacks.

(i) How well suited is the above model for describing the welfare losses from the current expansion of areas used for mountain cabins? Explain briefly.

(ii) What kind of adjustments need to be made in the model for it to be fully compatible with this land use case?

Answer (i): write here

Answer (ii): write here