

# ECN 275/375 Environmental and natural resource economics

## Exercise set 17– Forestry & forest management

### Exercise 17.1 – The timber (stumpage) forestry model: Even aged stand management

In the basic forest model for even aged stand management, all the forest owner benefits of harvesting (clear cutting an area) comes at the end of the forest rotation,  $T^*$ .

- Given that the expected timber price at the time of harvest is  $\hat{P}_{T^*}$ , write down an equation for forest owner profits from timber harvesting when initial planting costs are  $k_0$ . Explain the terms in the equation, and briefly explain the reasoning behind your profit equation.
- Solve for the optimal rotation age  $T^*$ , and interpret your solution.
- Suppose that planting at the costs  $k_0$  in (a) shortens the optimal rotation age by 20 years. How would you determine if planting increases or decreases the net benefits to three owners.
- Moose primarily graze on on younger aged tree stands or recent clear cuts. How is the inclusion of moose hunting revenues going to affect the decision to plant or not in (c)? Respond verbally, but provide a short reasoning for your answer.
- If the benefits of carbon sequestration are added, how would that influence the planting decision relative to (d)? Respond verbally, but provide a short reasoning for your answer.

### Exercise 17.2 – Numerical example of the single stand forest management problem

A stand of eucalyptus grows according to the following Cobb-Douglas function in  $t$  per hectare:

$$S(t) = A(bt)^\alpha = 10\left(\frac{1}{3}t\right)^{\frac{2}{3}}$$

where  $S(t)$  is the tree volume in  $\text{m}^3$  at time  $t$  (in years), and  $A=10$  is a scale parameter. The expected cost of replanting a hectare of forest is  $\hat{k}_{T^*}=2000$ , the expected net price of timber (harvest value less harvest costs) per  $\text{m}^3$  at the optimal time of is  $\hat{P}_{T^*}=200$ , and the forest owner's individual discount rate  $i = 3\%$ .

- Write down an expression for the expected per hectare profits (rents) at time  $T^*$ .
- Graph the expected nominal per hectare revenues (gross income) as an expression of tree age,  $t$ .
- With the individual discount rate  $i = 3\%$ , show graphically that the optimal rotation age is about 22 years.
- Solve for the optimal rotation age.

Remark: At the first look this exercise seems to involve a lot of calculations, but many items cancel out quite nicely. My advice is to work with the letter symbols as long as possible to avoid numeric mistakes. Also, for processing data on a computer, working with letter symbols that one attaches values to later, makes it easier to enter correctly, makes the program (or spreadsheet) more transparent, and increases flexibility for later use (easier reparameterization).