Forest Management and Certification

Stand-Level Management – The Forest Value of Land and Trees

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Land Expectation Value (LEV)

Analytical Methods for Valuation

- Given the difficulties in using market data for a valuation, **analytical methods** are those more frequently used in practice
- They are based on the potential production capacity of a piece of land for accommodating a plantation, so that one should talk about an expected value of the land as a function of that production capacity (site quality) for the species being analyzed, which also depends on
  - Rotation age
  - Discount rate
  - Intensity and cost of the management actions
  - Market price of the forest products

Land Expectation Value (LEV)

- The estimation of the value of a piece of land for an even-aged forest stand is known by the name of **Land Expectation Value (LEV)**
- The LEV gives an estimate of the value of forest land (excluding the value of the standing timber) **for land that is used primarily for growing timber**
- When primary objective of the landowner is to maximize financial return, the LEV –or various generalizations of it– is the main tool used to identify optimal even-aged management regimes, including rotation decisions, thinning regimes, stand establishment effort and intermediate treatments

Definition of LEV

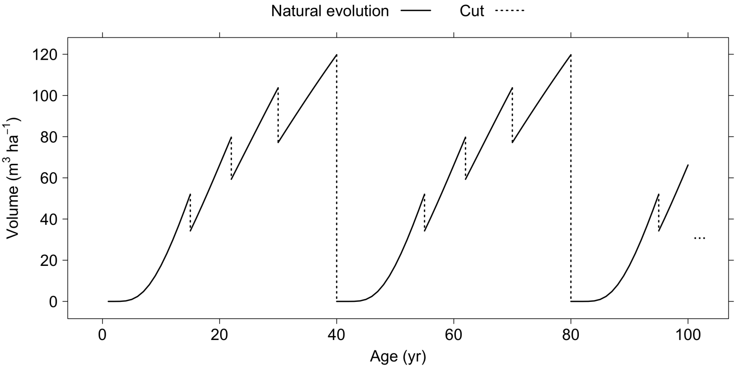
The **Land Expectation Value (LEV)** *is the present value, per unit area, of the projected costs and revenues from an infinite series of identical forest rotations, starting initially from bare land*

LEV assumptions

1. The forest land is used primarily for growing timber on an even-aged basis
2. Each rotation is of equal length
3. The sequence of events within each rotation is the same
4. The net revenue associated with a particular event within the rotation is the same for all rotations

LEV assumptions

- A series of identical even-aged rotations, illustrating the fundamental assumptions underlying the LEV



LEV Calculation

- Calculating the LEV is a straightforward application of the financial analysis techniques
- Main difficulty: keep track of all of the different cash flows associated with a single rotation of the stand
- Since each rotation in the infinite time horizon of the management unit is assumed to be the same, the LEV calculation deals first with a single, typical rotation

LEV Calculation

Basic **types of costs and revenues** associated with most even-aged forest rotations

1. An establishment cost
2. A final net revenue from the sale of the timber at the time the stand is harvested
3. Annual costs or revenues
4. Intermediate costs and revenues that occur in the middle of the rotation

LEV Calculation

- For any management prescription, the total costs (C_t) and revenues (I_t) at any age (t) can always be summarized in a table

Year	I_t	C_t
0	I_0	C_0
1	I_1	C_1
2	I_2	C_2
.	.	.
.	.	.
.	.	.
R	I_R	C_R

LEV Calculation

- The cash flows $(I_t - C_t)$ must be either **discounted** or **compounded** and combined into a single **present** or **future** value representing all the values for this single rotation
- After it, the **infinite (perpetual) periodic series formula** is applied to account for the fact that the LEV is the present value of an infinite series of these typical rotations

LEV Calculation

- The present value of an infinite periodic series that pays p every t years forever, with the first payment in year t, and assuming an interest rate i, is

$$V_0 = \frac{p}{(1+i)^t} + \frac{p}{(1+i)^{2t}} + \frac{p}{(1+i)^{3t}} + ... + \frac{p}{(1+i)^{\infty}}$$

- Multiplying both sides by $(1+i)^t$ gives

$$V_0 (1+i)^t = p + \frac{p}{(1+i)^t} + \frac{p}{(1+i)^{2t}} + ... + \frac{p}{(1+i)^{\infty - 1}}$$

- Subtracting the top equation from the bottom equation gives us

$$V_0 (1+i)^t - V_0 = p - \frac{p}{(1+i)^{\infty}}$$

LEV Calculation

- Since any number discounted for an infinite amount of time will be infinitely small, we can disregard $p/(1+i)^{\infty}$, leaving

$$V_0 (1+i)^t - V_0 = p$$

- or

$$V_0 \left[(1+i)^t - 1\right] = p$$

- or

$$V_0 = \frac{p}{(1+i)^t - 1}$$

LEV Calculation

- Therefore, the equation to assess LEV involves the net revenue at the end of the first rotation ($p = \text{NFV}$) and the length of the rotation ($t = R$)

$$\text{LEV} = \frac{\text{NFV}}{(1+i)^R - 1}$$

where

$$\text{NFV} = \sum_{t=0}^{R} (I_t - C_t)(1+i)^{R-t}$$

LEV Calculation

- LEV can also be obtained by calculating first the net present value of the first rotation (NPV) and then converting this to a future value at the end of the rotation

$$\text{LEV} = \frac{\text{NPV}\,(1+i)^R}{(1+i)^R - 1} = \frac{\text{NPV}}{1 - \dfrac{1}{(1+i)^R}}$$

where

$$\text{NPV} = \sum_{t=0}^{R} \frac{I_t - C_t}{(1+i)^t}$$

LEV Calculation

- If annual costs or revenues (A) are considered, they can be ignored in the calculation of the LEV (LEV_{wanr}, LEV without annual net revenue) and added subsequently (after computing their present value using the infinite annual series formula)

$$\text{LEV} = \text{LEV}_{\text{wanr}} + \frac{A}{i}$$

Examples

LEV Calculation: Example 1

- Assume that regeneration cost of a pine specie in a given bare land are 1,500 €/ha, pre-commercial thinning at age 10 will cost 300 €/ha, and standing timber is expected to be sold for 14,000 €/ha. What is the LEV for a 50 year rotation at a 4% interest rate?
  Answer
- First, we calculate NFV by compounding all costs and revenues to the end of the rotation

  $$\text{NFV} = -1,500 \cdot 1.04^{50} + (-300) \cdot 1.04^{40} + 14,000 = 1,899.67 \text{ €/ha}$$

- Then we compute the LEV as

$$\text{LEV} = \frac{1,899.67}{1.04^{50} - 1} = 311.08 \text{ €/ha}$$

LEV Calculation: Example 2

- The previous LEV computation assumed that the initial regeneration cost was incurred immediately and that subsequent regeneration costs occurred in the same years that stands were harvested
- This implied that the age of harvest stands was equal to the rotation age (R years)
- In actual forest practice, there is often a delay between the harvest of one stand and the regeneration of the next
- The economic effects of such delays can be expressed and evaluated through appropriate use of the equations already seen

LEV Calculation: Example 2

- Considering the same data as before, assume that the regeneration cost is composed of 1,000 €/ha for site preparation plus 500 €/ha for planting. On the average, site preparation takes place 1 year following harvest and planting occurs 2 years after harvest.
- In this case, if the rotation age continues to be 50 years, the rotation length will be 52 years
- What is the bare land value for this plantation sequence?

LEV Calculation: Example 2

Answer

- The NFV must now be computed as

$$\begin{aligned} \text{NFV} &= -1,000 \cdot 1.04^{51} + (-500) \cdot 1.04^{50} + \\ &+(-300) \cdot 1.04^{40} + 14,000 = 1,615.40 \text{ €/ha} \end{aligned}$$

- The LEV is now

$$\text{LEV} = \frac{1,615.40}{1.04^{52} - 1} = 241.59 \text{ €/ha}$$

- The corresponding value with immediate regeneration is 311.08 €/ha, so that, in this case, per-hectare reduction in the net present value of an infinite series of rotations arising from regeneration delay is 311.08 - 241.59 = 69.49 €/ha

LEV Calculation: Example 3

- A hardwood stand regenerates naturally (there is no regeneration cost). For a rotation of 80 years, it can be harvested to yield 300 m^3 of sawtimber at 50 €/m^3 and 100 m^3 of pulpwood at 15 €/m^3. If annual property taxes are 10 €/ha, while annual management expenses are 5 €/ha, what is the per hectare value of the land assuming a discount rate of 3%?
  Answer
- Because all we have are annual costs and the final harvest revenues, the NFV_{wanr} is calculated as

$$\text{NFV}_{\text{wanr}} = 300 \cdot 50 + 100 \cdot 15 = 16,500.00 \text{ €/ha}$$

- Applying the infinite periodic payment formula for NFV_{wanr}, and the infinite annual series formula for the net annual revenue

$$\text{LEV} = \frac{16,500}{1.03^{80} - 1} - \frac{(-10 - 5)}{0.03} = 1,211.46 \text{ €/ha}$$

LEV Calculation: Example 4

- Consider a management prescription with a plantation cost of 1,500 €/ha, a scrub control cost of 200 €/ha, and an expected revenue at final harvest (15 years rotation) of 9,000 €/ha. For an interest rate of 3%, calculate the LEV in a per hectare basis
- Break also the calculation of the payoff from the series of rotations into its component parts, i.e., calculate the contribution to NPV for each rotation individually (consider only the first 10-15 rotations or until the percent difference between the LEV and the accumulated NPV is less than 1%)

LEV Calculation: Example 4

Answer

$$\text{LEV} = 11,415.26 \text{ €/ha}$$

- This example is very interesting! It helps to understand the contribution of the different rotations to the LEV, which is strongly reduced as time passes
- It may also be useful to recognize particular features of each rotation in the future, e.g., if a reduction in site quality is expected due to an excessive removal of biomass at final harvest
- In these cases, this way of calculating the LEV may allow you to defend your calculations to a critical audience more easily!
- Play with the spreadsheet to change the interest rate. Examine how many rotations account for more than 95% of the LEV value with the different i values

LEV Calculation: Example 5

- Consider the following per hectare expected incomes and costs associated with managing a hypothetical stand of radiata pine

Concept	Amount (€)	Year
Plantation cost	1,170	0
Property tax	30	Annual
Scrub control cost	300	2
Pre-commercial thinning cost	600	10
Thinning revenue	1,645	17
Thinning revenue	2,460	25
Final harvest revenue	22,360	35

- Calculate the LEV for this stand assuming that the real alternative rate of return is 3%

LEV Calculation: Example 5

- To solve the problem, organize the information in tabular form to calculate both the present and future values of the first rotation
- Note that if the present value of the first rotation is compounded forward to the rotation age the result is equal to the future value of the first rotation that may be calculated directly
- Calculate the LEV using the three approaches mentioned (from NFV, NPV, and LEV_{wanr}), both by hand and using a spreadsheet
Answer

$$\text{LEV} = 11,747.58 \text{ €/ha}$$

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