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Effects of carbon sequestration rewards on forest management - an empirical application of adjusted Faustmann-Formulas

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Background

- Carbon sequestration capacity of forests
- Considerations to implement reward schemes in individual countries
  (potential schemes e.g. certificates, subsidies)
- Accounting approaches not yet decided

Aim of the study

Analysis of the effects of carbon sequestration rewards on forest management

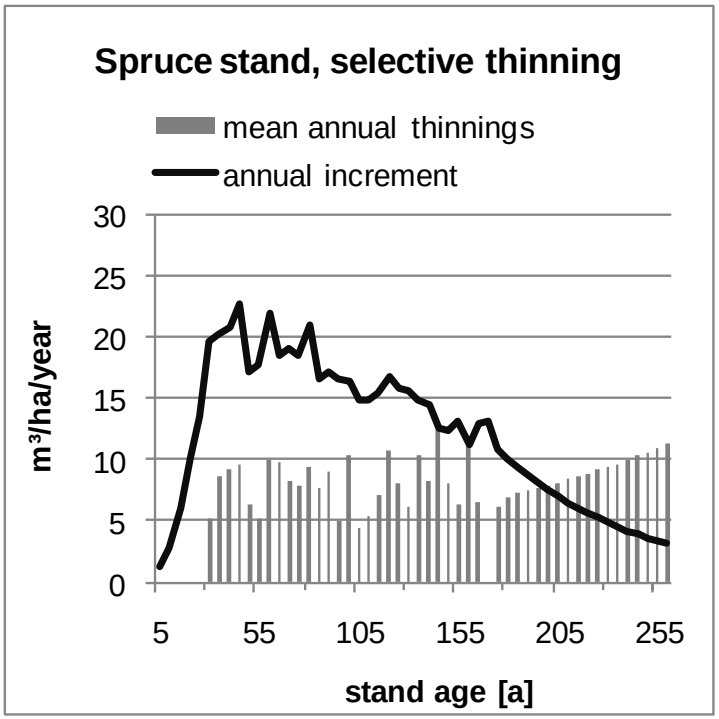
Exemplary analysis

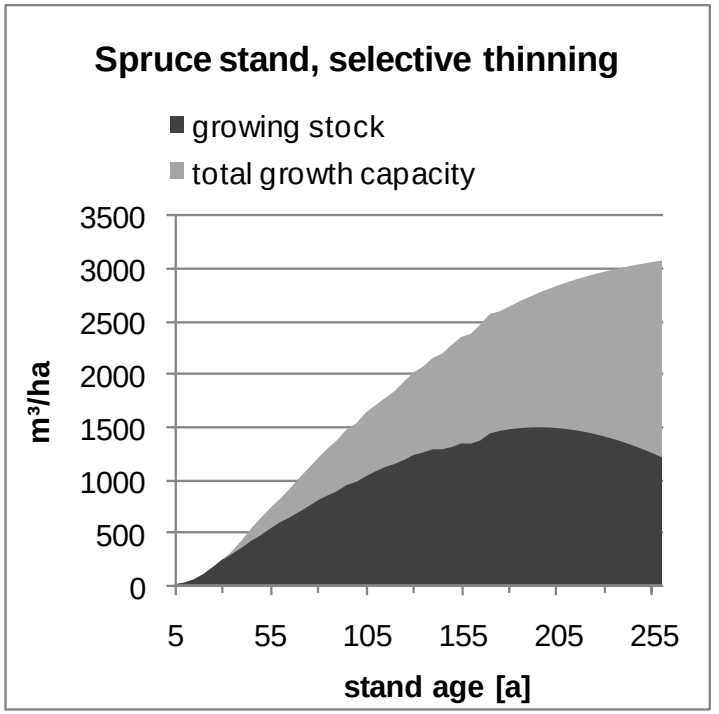
Main focus:

- **Certificates as reward scheme**
- **Different accounting approaches**
- **Effects on optimal rotation period and land expectation value (LEV)**

Method

- **Adjusted Faustmann-Formula**
- **Comparative static analysis of single stands (here spruce stand)**





Reward scheme certificates: Carbon accounting approaches

- Performance based instrument (accounting per t C sequestered/emitted)
- Reward for carbon sequestration (credits)
- Penalization of carbon emission (debits)
- Differentiation in the allocation of the duty to account for the emission (inclusion of harvested wood products)

Carbon accounting approaches

Carbon accounting approach	Credits	Debits
No Cert	/	/
Cert1	For increment volume (annually)	For harvest volume at time of harvest
Cert2	For increment volume (annually)	/
Cert3	For increment volume (annually)	For harvest volume at the end of life of harvested wood

Forest valuation

Land expectation value (LEV) with carbon crediting

$$LEV = \frac{Vh_T + \sum_{a=1}^{T} (Vt_a * (1 + r/100)^{T-a}) - c * (1 + r/100)^T + \mathbf{Vc}}{(1 + r/100)^T - 1}$$

Vc: net value of carbon crediting [€/ha]
Vh: net value of final timber harvest (free from harvesting costs) [€/ha]
Vt: net returns from thinning (free from harvesting costs) [€/ha]
c: regeneration cost [€/ha]
r: interest rate
T: rotation age [years]
a: period under consideration [years]

Forest valuation

Cert1 (debit at time of harvest)

$$Vc = \sum_{a=1}^{T} i_a * cp * (1 + r/100)^{T-a} - \sum_{a=1}^{T} e_a * cp * (1 + r/100)^{T-a}$$

Cert2 (no debit)

$$Vc = \sum_{a=1}^{T} i_a * cp * (1 + r/100)^{T-a}$$

Cert3 (debit at end of lifespan)

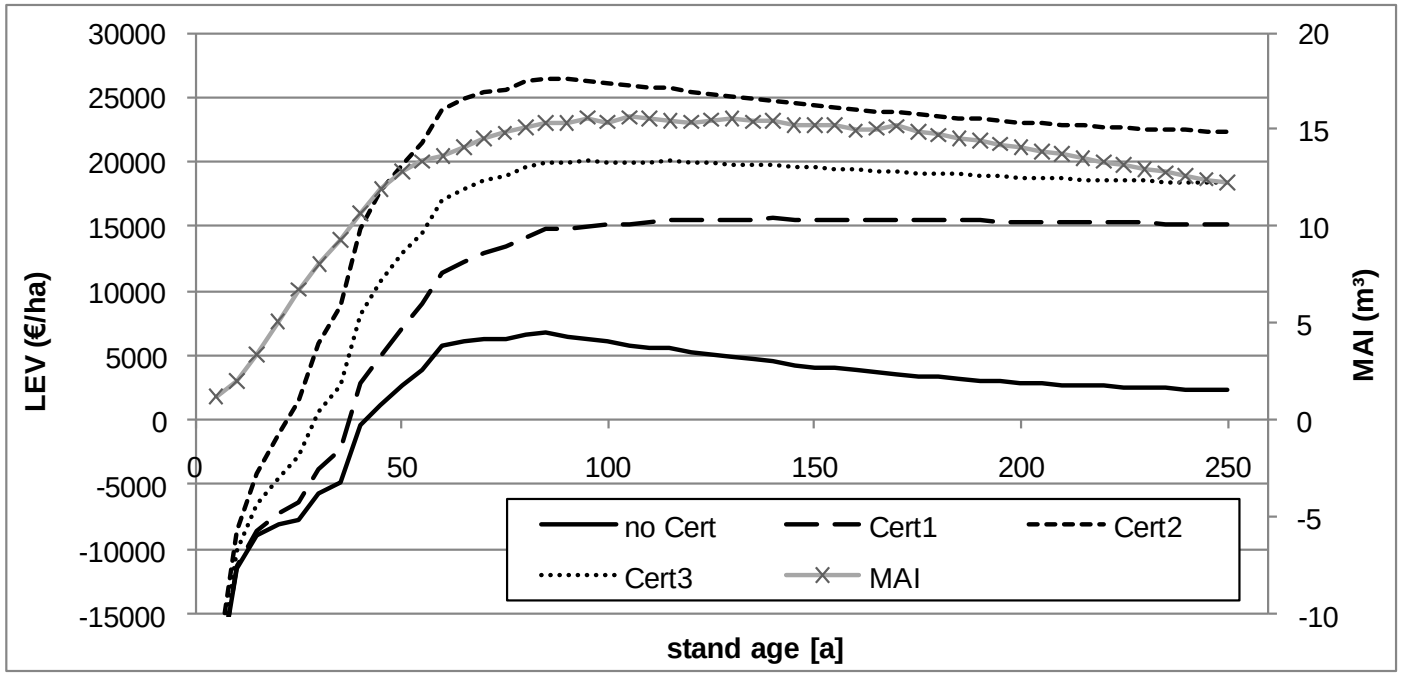
$$Vc = \sum_{a=1}^{T} i_a * cp * (1 + r/100)^{T-a} - \sum_{a=1}^{T} e_a * cp * (1 + r/100)^{T-(a+w)}$$

Vc: net value of carbon crediting [€/ha]
i: gross annual carbon increment [t C/ha/year]
e: carbon content of annual wood removal (thinning, harvest or mortality) [t C/ha/year]
cp: carbon price [€/t C]
r: interest rate
T: rotation age [years]
a: period under consideration [years]
w: lifespan of harvested wood (products) [years]

Development of the LEV

The LEV under different carbon accounting schemes and development of the mean annual increment (MAI)

Spruce stand, carbon price 34€/t CO_2, interest rate 2%



Cert1: debit at time of harvest

Cert2: no debit

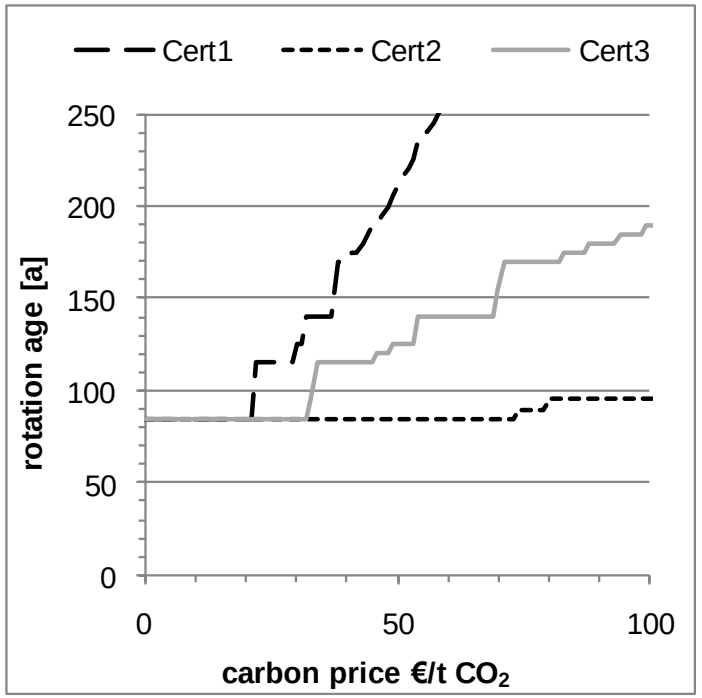
Cert3: debit at end of lifespan (here average 30 years)

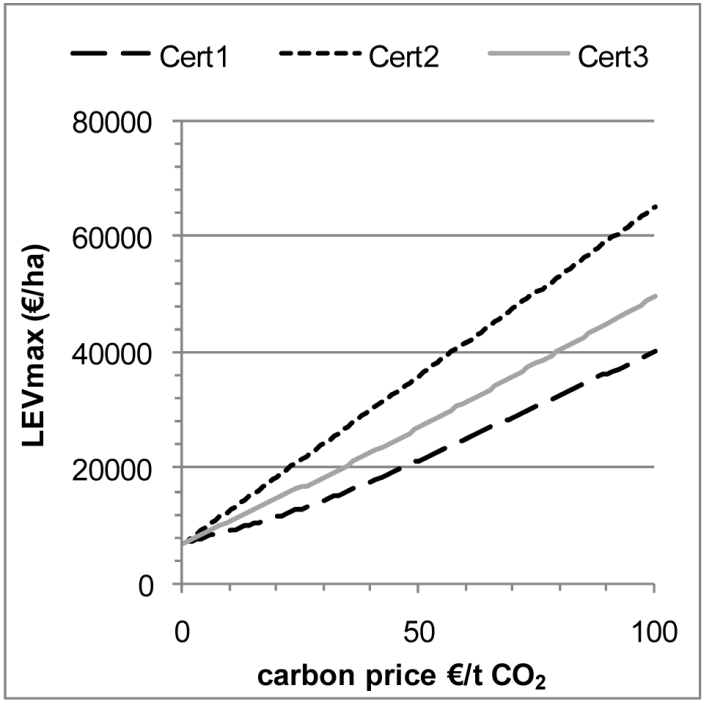
The effect of carbon prices…

…on the optimal rotation age

…and the maximum land expectation value (LEVmax).

Spruce stand, interest rate 2%





Cert1: debit at time of harvest

Cert2: no debit

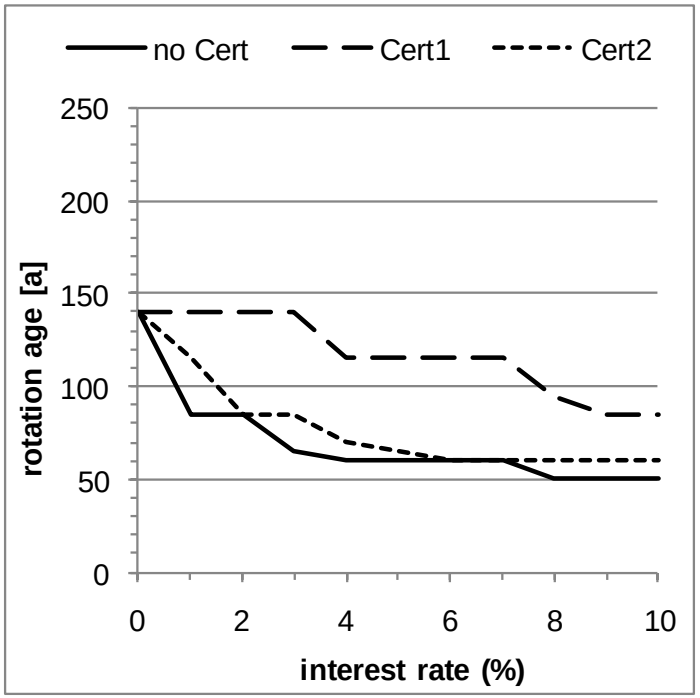
Cert3: debit at end of lifespan (here average 30 years)

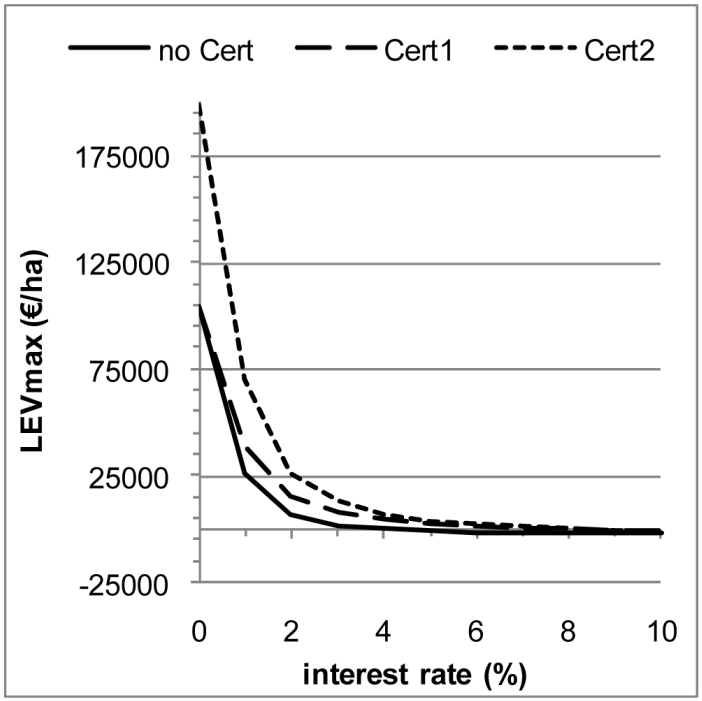
The effect of the interest rate…

…on the optimal rotation age

…and the maximum land expectation value (LEVmax).

Spruce stand, carbon price 34€/t CO_2



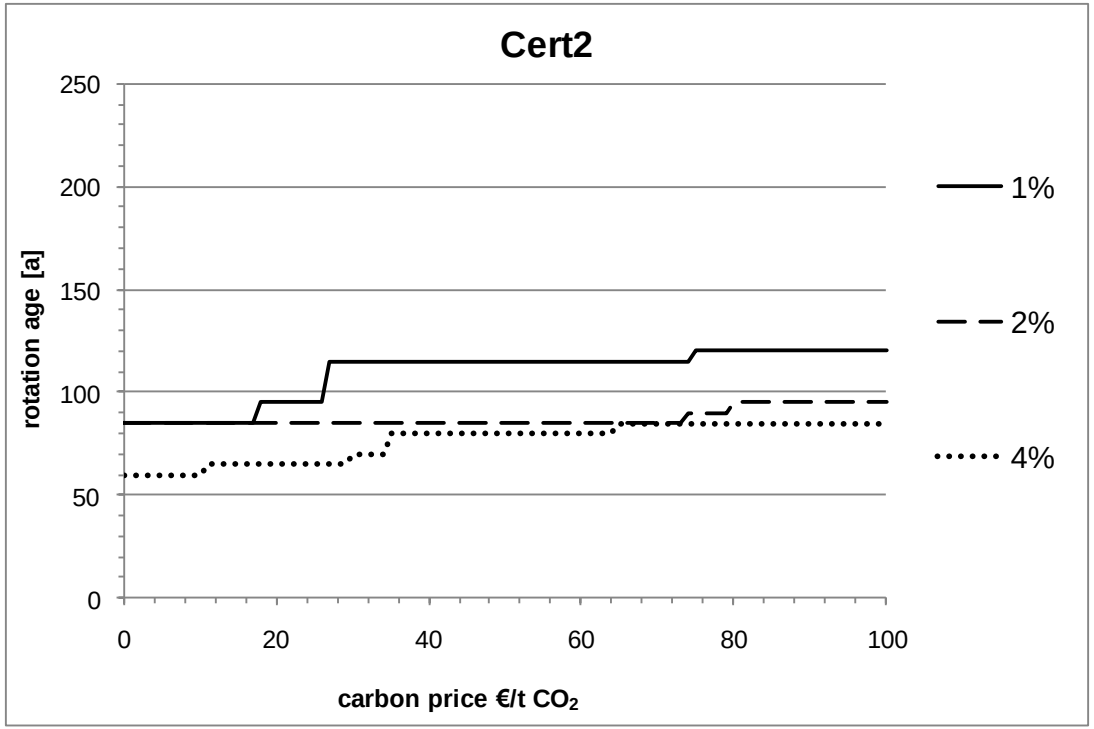


Cert1: debit at time of harvest

Cert2: no debit

Interrelation between carbon price and interest rate

The effect of carbon prices on the optimal rotation age for different interest rates

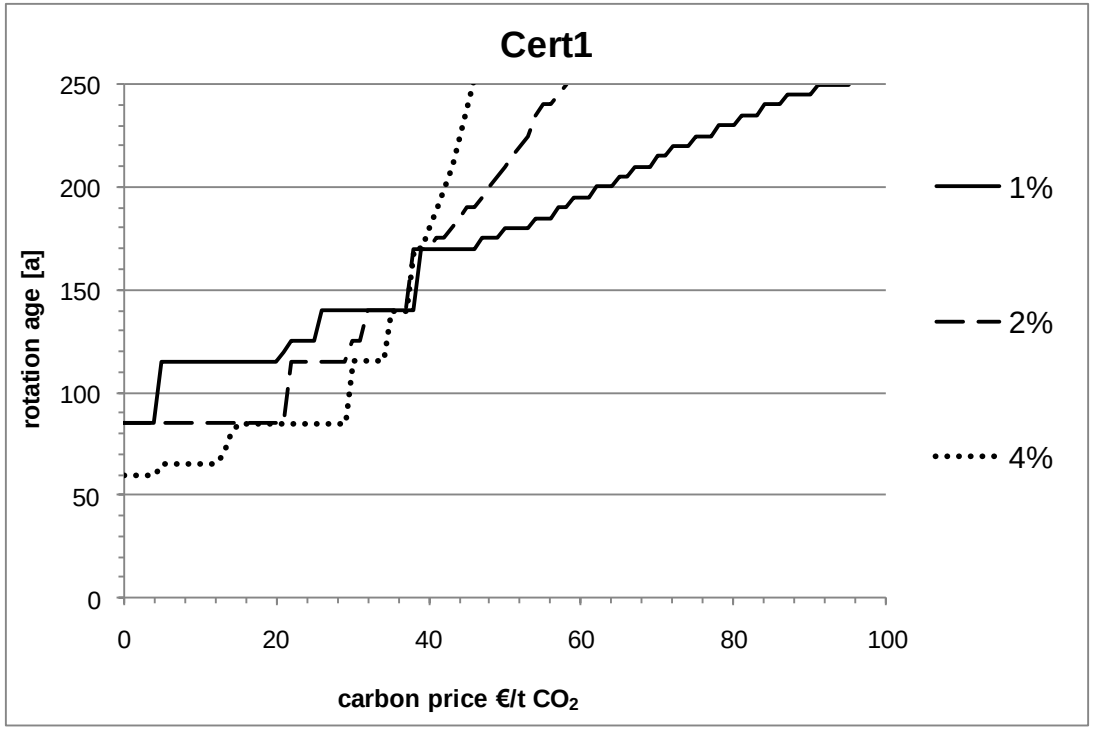


Cert2: credit for increment volume, no debit

Spruce stand

Interrelation between carbon price and interest rate

The effect of carbon prices on the optimal rotation age for different interest rates



Cert1: credit for increment volume, debit for harvest volume at time of harvest

Spruce stand

Conclusions (1)

Rewarding carbon sequestration by certificates

- **raises profitability**
- **leads to shifts in optimal rotation age**
  - **Charge of harvest volume with emission debits postpones the optimal rotation age (emission debits offset revenues from wood use)**
  - **The lower and later the debit is charged, the lower is the postponing effect on the rotation age**
  - **Interrelation of interest rates and carbon prices: the interest rate may have a shortening or prolonging effect on the optimal rotation period subject to the level of carbon prices**

Conclusions (2)

Policy implication

Performance based rewarding instruments potentially change

- rotation periods
- related forest services (timber production, contribution to biodiversity conservation, climate change mitigation etc.)

Conclusions (3)

Restrictions

- Finding applies for profit-oriented forest owners only
- Actually existing unequal age class distribution may lead to differing results

➢ Dynamic modelling for specific case studies

Thank you for your attention!

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