Production cost and wood quality in spruce plantations:

In pursuit of economically efficient silvicultural strategies

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Outline

- Introduction
- Background
- Prices, costs, and production cost
- Evaluation of strategies
- Models applied
- Examples
- Conclusion
Background / motivation

- Repercussions from the Gilleleje meeting
- Discussion at Trolleholm

- Profitability is (of course) important
- Product (wood) quality is an issue
- Prices are difficult to predict
- So is the future price structure, but ...

- Optimality is a ’volatile’ concept
- Due to external factors
- Due to management itself

Objectives

- Provide an alternative approach for evaluation of silvicultural strategies

- Explore the efficient set (frontier) of strategies under various conditions
Variation of costs and prices

Distribution of discounted costs
A production cost definition

- The soil expectation value is:

\[
S = \frac{(1+r)^T}{(1+r)^T-1}\left(-C_0 - C_p N_0 + \sum_{t=a}^{T} B(t)\left[V_h(t)(P(t) - C_h(t)) - C_G(t)\right]\right)
\]

- One way of defining production cost is:

\[
\tilde{P}_C = \frac{C_0 + C_p N_0 + \sum_{t=a}^{T} B(t)\left[V_h(t)C_h(t) + C_G(t)\right]}{\sum_{t=a}^{T} B(t)V_h(t)}
\]

- Corresponding to the situation where \( SEV = 0 \)

Product quality metrics

- Product dimension

\[
D_{gW} = \frac{\sum_{t=a}^{T} V_h(t) D_g(t)}{\sum_{t=a}^{T} V_h(t)} \quad \text{or} \quad D_{gW}^* = \frac{\sum_{t=a}^{T} B(t) V_h(t) D_g(t)}{\sum_{t=a}^{T} B(t) V_h(t)}
\]

- Product wood quality

\[
\bar{R}_W = \frac{\sum_{t=a}^{T} V_h(t) R(t)}{\sum_{t=a}^{T} V_h(t)} \quad \text{or} \quad \bar{R}_W^* = \frac{\sum_{t=a}^{T} B(t) V_h(t) R(t)}{\sum_{t=a}^{T} B(t) V_h(t)}
\]
Comparing silvicultural strategies

\[ \Delta = P(D,R) - \text{Prod.

\text{cost} \] 

**Models**

- **Stand growth model (Leary et al. [in review]):**
  
  - **Height:**
    \[ \frac{\Delta H_{100}}{\Delta t} = \Phi H_{100} \exp(-0.1405 \, H_{100}) \]  
  
  - **Basal area:**
    \[ \frac{\Delta D_g}{\Delta t} = \Phi 1.525 \, D_g^{0.2202} \exp(-0.000156 \, D_g^2 \, N) + CH(D_g) \]  
  
  - **Stem number:**
    \[ \frac{\Delta N}{\Delta t} = T_{\text{thin}} \, 0.000002 \, N^{0.7858} \exp(0.001476 \, D_g^2 \, N) + CH(N) \]
### Strategy spectrum / 1

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Rotation ages: 35, 40, ..., 70, 75

### Strategy spectrum / 2

![Graph showing stand height vs. stand diameter and stand area vs. stand diameter](image-url)
The 0.01% quantile (slopes = 0)

Frontier (0.01% quantile)
Discount rate 2%

Soil expectation value distribution
Discount rate: 2%
Frontier
Population
Frontier (slopes = 0)

Anti-frontier (slopes = 0)
Effect of expected price structure

Plant number

Relative diameter

Basal area

Rotation age
Conclusion

- Cost vs. price prediction
- Owners may have an opinion on price structure
- If quality is an issue, production costs may be useful for evaluating silvicultural strategies
- Simple measures of production cost and product quality can be defined
- The frontier strategy set is quite heterogeneous (as usual)