Harvesting Rules and Intertemporal Forest Dynamics: The Role of Constraints in Convergence to a Normal Forest

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Presentation Structure
I. Related Ideas in 3 Presentations
II. Presentation Introduction
III. Approach
IV. Role of Constraints
V. Examples
VI. Summary
Motivation

Repercussions of the Gilleleje meeting
- Dynamics of full-scale forests
- The Volvo Theorem
- Discussion of inheritance taxes

II. Presentation Introduction

How do linear and non-linear constraints impact convergence behavior of a forest?

How does the shape of the utility function impact convergence behavior of a forest?
III. General Approach

- Introduce linear and non-linear constraints
- Forward DP procedure
- Numerical Simulation
- Introduce non-linear utility function and repeat

Modeling Approach

- Standard simplifying assumptions
  - Single landowner
  - Fixed land area
  - Homogenous land (site quality, species)
  - Single output (product)
  - ‘No thinning’
  - Deterministic system (growth, market)
Dynamic Programming Model

- Objective Function: Maximize NPV function
- Ordered age class structure
- Choice/Control Variable: ‘Stand’ Harvests
- Parameters:
  - Discount Factor, Price Function, Volume Function
  - M stands, N periods

IV. Role of Constraints

- Convergence and potential chaos
  - Convergence diagrams
  - Speed of convergence or potential chaos
- Constraints
  - Hard/Linear Constraints
  - Multiple Hard/Linear Constraints
  - Soft/Non-Linear Constraints
Impacts of constraints

- Impacts are broader than previously demonstrated
  - Dramatic differences in speeds of convergence
  - Apparent ‘chaotic’ behavior in simple situations

- Hard/Linear Constraints
  - Shorter convergence times
  - Cycles

- Multiple Hard/Linear Constraints
  - Longer convergence times
  - Cycles and potential chaos

V. Examples

![Graph showing cash flow over time with upper and lower bounds and range](#)
Dynamics / constraints (1)

Lower bound 6625, range 1000

Dynamics / constraints (2)

Lower bound 7625, range 1000
Dynamics / constraints (3)

Lower bound 9625, range 1000

Converged?

Full range (standard) 
Initially: 4 age classes, Faustmann rotation age: 3 
Area: 400, unit area: 1E-12, tolerance: 0.001 
Quadratic price function
Reduced range
Initially: 4 age classes, Faustmann rotation age: 3
Area: 400, unit area: 1E-12, tolerance: 0.001
Quadratic price function

Full range, resolution reduced
Initially: 4 age classes, Faustmann rotation age: 3
Area: 400, unit area: 10, tolerance: 0.001
Quadratic price function
Full range, tolerance expanded
Initially: 4 age classes, Faustmann rotation age: 3
Area: 400, unit area: 1E-12, tolerance: 10
Quadratic price function

Full range, dynamic constraints
Initially: 4 age classes, Faustmann rotation age: 3
Area: 400, unit area: 1E-12, tolerance: 0.001
Quadratic price function

Unresolved
Reduced range, dynamic constraints
Initially: 4 age classes, Faustmann rotation age: 3
Area: 400, unit area: 1E-12, tolerance: 0.001
Quadratic price function

Unresolved

Unresolved
Effect of age class structure, resolution reduced
Initially: 3 age classes, Faustmann rotation age: 3
Area: 300, unit area: 10, tolerance: 0.001
Quadratic price function, lower 0, upper 10000

Effect of age class structure (standard)
Initially: 3 age classes, Faustmann rotation age: 3
Area: 300, unit area: 1E-12, tolerance: 0.001
Quadratic price function, lower 0, upper 10000
Effect of age class structure, tolerance expanded

Initially: 3 age classes, Faustmann rotation age: 3
Area: 300, unit area: 1E-12, tolerance: 10
Quadratic price function, lower 0, upper 10000

Effect of age class structure (standard)
Initially: 3 age classes, Faustmann rotation age: 3
Area: 300, unit area: 1E-12, tolerance: 0.001
Logistic price function, lower 0, upper 10000
VI. Summary

- Constraints are important determinants of convergence, speed of convergence, type of dynamics, and age class distribution
- Other determinants:
  - Initial age class distribution
  - Price function (functional form)
  - Resolution and tolerance
- We will be back again tomorrow morning