Optimal Timber Stock in Nonindustrial Private Forests: Evidence from Finnish Panel Data

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Outline

- Introduction
- Theoretical and empirical model of timber stock
- Data and variables
- Econometric analyses
- Empirical results
- Discussion
Introduction

✓ Motivations
  • Is there any gap between observed and optimal stock levels in NIPF?
  • If yes, how fast (or slow) forest owners are bridging the gaps?

✓ Earlier studies on timber stock:
  • Kuuluvainen 1989.
  • Kuuluvainen and Tahvonen 1997.
  • Gan et al. 2001.

✓ Aim of the study
  • To examine short term timber stocking behaviour of NIPF owners.
  • Objectives:
    – To identify factors affecting short term optimal stock level, observed stock level and speed of adjustment.
    – To compare over time evolution of optimal stock, observed stock and speed of adjustment.
Theoretical model

Maximize  \( U = (1 - \alpha)[u(c_1) + \beta u(c_2)] + \alpha[g(S_1) + \beta g(S_2)] \)  \( (1) \)

s.t.
\( S_1 = S_0 - h_1 \)  \( (1a) \)
\( S_2 = S_0 - h_1 + G(S_0 - h_1) - h_2 \)  \( (1b) \)
\( c_1 = p_1 h_1 + m_1 + B \)  \( (1c) \)
\( c_2 = p_2 h_2 + m_2 - (1 + r)B \)  \( (1d) \)
\( B \leq B^u. \)  \( (1e) \)

Theoretical model

- Cutting rule or equilibrium conditions for first period harvest.

\[ [1 + F(v_1)](p_2/p_1) = u'(c_1)/\beta u'(c_2) - \alpha g'(S_1)/(1 - \alpha)u'(c_2)p_1 \]  \( (2) \)
Theoretical model

• Behavior timber supply equation

\[ h_1 = h(p_1, p_2, r, s_0, m_1, m_2, \delta, B', \alpha) \quad (3) \]

(Kuuluvainen et al. 1996)

• Second period optimal timber stock.

\[ s_1 = s(p_1, p_2, r, s_0, m_1, m_2, \delta, B', \alpha) \quad (4) \]
Empirical model

- Optimal stock

\[ S_{it}^* = G(V_{it}, Z_i, Z_t) \quad (5) \]

- \( V_{it} \): owner and time variant variables
- \( Z_i \) and \( Z_t \): owner- and time-specific effects.

Empirical model

- Full adjustment (normal conditions):

\[ S_{it} = S_{it}^* \quad (6) \]

\[ S_{it} - S_{it-1} = S_{it}^* - S_{it-1} \quad (7) \]

Actual change = desired change
Empirical model

- Partial adjustment:

\[ S_{it} - S_{it-1} = \delta_{it} \left( S^*_i - S_{it-1} \right) \]  

\[ 0 < \delta_{it} \leq 1 \]  

- Speed of adjustment: \( \delta_{it} \)

\[ \delta_{it} = F(W_{it}, D_i, D_t) \]  

Empirical model

- Accounting for misspecification

\[ S_{it} - S_{it-1} = \delta_{it} \left( S^*_i - S_{it-1} \right) + \varepsilon_{it} \]  

\[ S^*_i = \alpha_0 + \sum_j \alpha_j V_{jit} + \sum_k \alpha_k Z_k + \sum_l \alpha_l Z_l \]  

\[ \delta_{it} = \beta_0 + \sum_m \beta_m W_{mit} + \sum_k \beta_k D_k + \sum_l \beta_l D_l \]
Data and variables

Data description

- Sample of 122 farmers in Southern Finland.
- Data size: 1098 observations (122x9).
- Positive observations= 731.
- zero observations=367.
- Previous use (Kuuluvainen and Tahvonen 1999).

Variables:

- Determinants of optimal timber stock

<table>
<thead>
<tr>
<th>Variables</th>
<th>Expected sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stumpage price</td>
<td>+/-</td>
</tr>
<tr>
<td>Loan</td>
<td>-</td>
</tr>
<tr>
<td>Initial stock</td>
<td>+/-</td>
</tr>
<tr>
<td>Nonforest income</td>
<td>+</td>
</tr>
<tr>
<td>Owner age</td>
<td>+/-</td>
</tr>
<tr>
<td>Unobs. Heterogeneity</td>
<td>+/-</td>
</tr>
</tbody>
</table>
Data and variables

- Determinants of speed of adjustment

<table>
<thead>
<tr>
<th>Variable</th>
<th>Expected sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute distance</td>
<td>+/-</td>
</tr>
<tr>
<td>Stumpage price</td>
<td>+/-</td>
</tr>
<tr>
<td>Nonforest income</td>
<td>+</td>
</tr>
<tr>
<td>Loan</td>
<td>+</td>
</tr>
<tr>
<td>Owner age</td>
<td>+/-</td>
</tr>
<tr>
<td>Forestland dummies</td>
<td>+/-</td>
</tr>
<tr>
<td>Times dummies</td>
<td>+/-</td>
</tr>
</tbody>
</table>

Econometric analyses

✓ Elimination of zero obs: Probit analysis
✓ Inverted Mill’s ratio

\[
S^*_t = \alpha_0 + \sum_j \alpha_j V_{jit} + \sum \alpha_i Z_i + \sum \alpha_{im} MR + y_{it} \quad (13)
\]

✓ Estimable equation

\[
S_t = \delta_t \left( \alpha_0 + \sum_j \alpha_j V_{jit} + \sum \alpha_i Z_i + \sum \alpha_{im} MR + u_{it} \right) +
(1 - \delta_t)S_{t-1} + \varepsilon_{it} \quad (14)
\]
Econometric analyses

- 3 types of models estimated:
  - Static model \( (\delta_{it} = 1) \)
  - Dynamic restricted adjustment model \( \delta_{it} = \text{const.} \)
  - Dynamic unrestricted adjustment model \( \delta_{it} = \text{function} \)

- Fixed effects model: LSDV

Empirical results

Table 3. Probit estimates

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Estimate</th>
<th>Std error</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \eta_{\text{constant}} )</td>
<td>Constant</td>
<td>2.543(^a)</td>
<td>0.802</td>
</tr>
<tr>
<td>( \eta_{\text{rmatuk}} )</td>
<td>Timber price</td>
<td>-0.007(^c)</td>
<td>0.004</td>
</tr>
<tr>
<td>( \eta_{\text{drma}} )</td>
<td>Timber price change</td>
<td>0.010(^b)</td>
<td>0.005</td>
</tr>
<tr>
<td>( \eta_{\text{metsa}} )</td>
<td>Forest land</td>
<td>0.007(^a)</td>
<td>0.001</td>
</tr>
<tr>
<td>( \eta_{\text{rtulot}} )</td>
<td>Nonforest income</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>( \eta_{\text{rmi}} )</td>
<td>Interest</td>
<td>-0.051(^a)</td>
<td>0.014</td>
</tr>
<tr>
<td>( \eta_{\text{rika}} )</td>
<td>Owner age</td>
<td>-0.016(^a)</td>
<td>0.003</td>
</tr>
<tr>
<td>( \eta_{\text{vuoo84}} )</td>
<td>Dummy 1984</td>
<td>0.068</td>
<td>0.174</td>
</tr>
</tbody>
</table>
## Empirical results

### Table 4. Static and dynamic model parameter estimates

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Static model</th>
<th>Restricted dynamic model</th>
<th>Unrestricted dynamic model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Estimate</td>
<td>Std error</td>
<td>Estimate</td>
</tr>
<tr>
<td>( \alpha_{\text{constant}} )</td>
<td>Constant</td>
<td>130.009 \textsuperscript{a}</td>
<td>8.315</td>
<td>182.234 \textsuperscript{a}</td>
</tr>
<tr>
<td>( \alpha_{\text{rtmatuk}} )</td>
<td>Timber price</td>
<td>-0.022</td>
<td>0.046</td>
<td>-0.193</td>
</tr>
<tr>
<td>( \alpha_{\text{rvelat}} )</td>
<td>Loan</td>
<td>-0.44</td>
<td>0.003</td>
<td>-0.022 \textsuperscript{b}</td>
</tr>
<tr>
<td>( \alpha_{\text{rtulot}} )</td>
<td>Nonforest Income</td>
<td>-0.011</td>
<td>0.009</td>
<td>-0.0002</td>
</tr>
<tr>
<td>( \alpha_{\text{ikav}} )</td>
<td>Owner age</td>
<td>1.803 \textsuperscript{a}</td>
<td>0.329</td>
<td>1.219</td>
</tr>
<tr>
<td>( \alpha_{\text{lambda}} )</td>
<td>Mill’s ratio</td>
<td>1.496</td>
<td>4.449</td>
<td>11.911</td>
</tr>
</tbody>
</table>

### A. Determinants of Optimal stock level

### B. Determinants of speed of adjustment

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**Figure 1. Optimality of Timber Stock and Speed of Adjustment**

- **X-axis:** Year (1983-1991)
- **Y-axis:** Optimal and Observed Timber Stock
- **Legend:**
  - Observed timber stock
  - Optimal timber stock
  - Optimality ratio
  - Speed of adjustment

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May 12-15, 2004 Scandinavian Forest Economics Conference, Järvenpää, Finland
Empirical results

Table 7. Mean overall elasticities

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Short run</th>
<th>Long run</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>Std error</td>
</tr>
<tr>
<td>$\alpha_{rmatuk}$</td>
<td>Timber price</td>
<td>-0.186$^a$</td>
<td>0.006</td>
</tr>
<tr>
<td>$\alpha_{rvelat}$</td>
<td>Loan</td>
<td>-0.003$^a$</td>
<td>0.0001</td>
</tr>
<tr>
<td>$\alpha_{rtulot}$</td>
<td>Nonforest income</td>
<td>-0.006$^a$</td>
<td>0.0002</td>
</tr>
<tr>
<td>$\omega_{ikav}$</td>
<td>Owner</td>
<td>0.391$^a$</td>
<td>0.010</td>
</tr>
</tbody>
</table>

Discussion

- Timber stocking behaviour of forest owners
- Partial adjustment hypothesis supported.
- Dynamic unrestricted adjustment model
- Short-run elasticities
  - Stumpage price (-0.186)
  - Owner age (0.391)
Discussion

✓ Limitations:
  • Absence of non-farmer owners
✓ Policy implications
✓ Recommendation
  • Replication of study

Acknowledgement

Thanks to Academy of Finland and Graduate School in Forest Sciences.