Forestry harvesting decisions in contrast to theory? Evidence from an economic experiment

Philipp Sauter and Oliver Mußhoff

Contributed paper prepared for presentation at the 59th AARES Annual Conference,
Rotorua, New Zealand, February 10-13, 2015

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Forestry harvesting decisions in contrast to theory? Evidence from an economic experiment

- Philipp Sauter and Oliver Mußhoff –

59th AARES Annual Conference, Rotorua, New Zealand, February 10-13, 2015
Starting point

• Classical forestry investment theory: Faustmann (1849) formula
  – Incorporates scarcity of land and capital
  – Applied as a decision criteria by Pressler (1860) and Ohlin (1921)
  ⇒ Faustmann-Pressler-Ohlin (FPO) theorem hardly applied in forest management (cf. Samuelson, 1976, Moog and Borchert, 2001)

• New investment theory: real options approach (ROA)
  – In addition to the FPO theorem, ROA incorporates fluctuating returns (e.g. lumber prices) and managerial flexibility
  ⇒ Application in forest management rather unknown (e.g. Manley 2013)
Which investment theory best describes the forest harvesting behavior?

Source: www.forstcast.waldradio.de
Derivation of hypotheses

**H1:** In harvesting decisions, foresters show tendencies to value the option to wait and, therefore, rather act according to the ROA than to the approach of FPO.

**H2:** Deviations between observed harvesting behavior and investment theory can be explained by forester's socio-demographic and forest-enterprise-related parameters.
How do we examine these hypotheses?

Source: www.losrobos.lima-city.de
The experimental approach

• Benefits of economic experiments:
  – Investigation of a specific situation while blanking out “disturbing” variables
  – Data generation adapted to the question

• Disadvantages of economic experiments:
  – Provision of financial incentives
  – Partially weak external validity
Experimental design

Stand age: 30 years

GM: 0 EUR

wait

harvest

+ compensation payment
+ interest

Source: www.pixelio.de

Stand age: 40 years

GM: 20.000 EUR

or

GM: -12.000 EUR

wait

harvest

+ compensation payment
+ interest

Source: www.pixelio.de

Source: www.ihdocs.com

Source: www.ihdocs.com
Experimental design

Figure: Binomial tree of the experiment (gross margin in EUR printed in bold, below probability reaching this specific value)
Calculation of benchmarks

- FPO trigger

\[ v^*_{FPO,t} = \frac{f'(v)}{\tilde{r}} - \frac{z}{r} \]

- ROA trigger

\[ V_t = v_t + z \cdot \frac{(1 + r)^{(T-t)} - 1}{(1 + r)^{(T-t)} \cdot r} \]

\[ E(V_{ROA,t+1}) \cdot (1 + \tilde{r})^{-1} = (p \cdot V_{ROA,u,t+1} + (1 - p) \cdot V_{ROA,d,t+1}) \cdot (1 + \tilde{r})^{-1} \]

\[ V_{ROA,t} = \max[V_t, E(V_{ROA,t+1}) \cdot (1 + \tilde{r})^{-1}] \]
Calculation of benchmarks

Figure: Benchmark trigger values for optimal time to harvest according to the FPO theorem and the ROA, exemplarily using a risk neutral interest rate.
Results (Hypothesis 1)

Figure: Comparison of observed behavior in the experiment and optimal behavior according to FPO and ROA
Results (Hypothesis 1): Survival analysis

Figure: Comparison of observed behavior in the experiment and optimal behavior according to FPO and ROA
# Results (Hypothesis 2): Multinomial logit model

<table>
<thead>
<tr>
<th>Variables</th>
<th>ROA</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Harvesting too early</td>
<td>Harvesting too late</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.952**</td>
<td>0.951</td>
<td>(0.843)</td>
</tr>
<tr>
<td>Constant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Socio-demographic variables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender (male: 0, female: 1)</td>
<td>0.891**</td>
<td>0.260</td>
<td>(0.422)</td>
</tr>
<tr>
<td>Participants' age (years)</td>
<td>0.013</td>
<td>-0.005</td>
<td>(0.010)</td>
</tr>
<tr>
<td>HL value</td>
<td>-0.051</td>
<td>0.053</td>
<td>(0.033)</td>
</tr>
<tr>
<td>Apprenticeship in forestry (no: 0, yes: 1)</td>
<td>0.257</td>
<td>0.187</td>
<td>(0.365)</td>
</tr>
<tr>
<td>University degree (no: 0, yes: 1)</td>
<td>-0.874*</td>
<td>-0.066</td>
<td>(0.495)</td>
</tr>
<tr>
<td>Economical education (no: 0, yes: 1)</td>
<td>0.118</td>
<td>-0.046</td>
<td>(0.294)</td>
</tr>
</tbody>
</table>

Standard errors in brackets, * p<0.1, ** p<0.05, *** p<0.01
## Results (Hypothesis 2): Multinomial logit model

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<table>
<thead>
<tr>
<th>Forest enterprise related variables</th>
<th>ROA</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Working for private forestry enterprise</td>
<td>-0.784**</td>
<td>-0.451</td>
<td>(0.303) (0.331)</td>
</tr>
<tr>
<td>Working for forestry service provider (no: 0, yes: 1)</td>
<td>0.370</td>
<td>0.880</td>
<td>(0.839) (0.590)</td>
</tr>
<tr>
<td>Other forest knowledge carrier (no: 0, yes: 1)</td>
<td>-1.499***</td>
<td>-0.637</td>
<td>(0.402) (0.413)</td>
</tr>
<tr>
<td>Forest owner (no: 0, yes: 1)</td>
<td>-0.013</td>
<td>-0.182</td>
<td>(0.455) (0.566)</td>
</tr>
<tr>
<td>Forest size of responsibility (hectares)</td>
<td>0.0000006</td>
<td>0.0000002</td>
<td>(0.0000007) (0.0000004)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attitude towards main function of forest enterprise</th>
<th>ROA</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Regard forest enterprise as bank account (no: 0, yes: 1)</td>
<td>0.199</td>
<td>0.202</td>
<td>(0.310) (0.297)</td>
</tr>
<tr>
<td>Regard forest enterprise as subsidy dependent organization (no: 0, yes: 1)</td>
<td>-0.687</td>
<td>0.003</td>
<td>(0.581) (0.427)</td>
</tr>
</tbody>
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Results (Hypothesis 2): Multinomial logit model

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<tr>
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</tr>
<tr>
<td>Experimental variables</td>
<td></td>
</tr>
<tr>
<td>Framing (neutral: 0, forestry: 1)</td>
<td>0.038 (0.194)</td>
</tr>
<tr>
<td>Order of experimental parts (neutral first: 0, forestry first: 1)</td>
<td>0.178 (0.285)</td>
</tr>
<tr>
<td>Parameter set (2: 0, 1: 1)</td>
<td>0.070 (0.193)</td>
</tr>
<tr>
<td>Observed repetition</td>
<td>-0.027 (0.017)</td>
</tr>
<tr>
<td>Time needed in the experiment (minutes)</td>
<td>-0.006 (0.004)</td>
</tr>
<tr>
<td>Observations (repetitions)</td>
<td></td>
</tr>
<tr>
<td>Log pseudo-likelihood</td>
<td></td>
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Philipp Sauter and Oliver Mußhoff, University of Goettingen, 13th of February 2015
Conclusion

We accept hypothesis 1!

• Forestry decision-makers act only partially in line with the regarded investment theories (FPO and ROA)
  → Opportunity costs are undervalued
• ROA is significantly more in compliance with observed behavior than FPO
  → To some extend, foresters value the option to wait
Conclusion

We accept hypothesis 2!

• Harvesting too late seems to be a common behavior
• Education decreases the probability for harvesting too early
  → Forest companies and agencies should put more focus on education
• Participants working for private forest companies exhibit a lower probability for harvesting too early
Conclusion

• The experimental approach forms a bridge between theory and practice
• Further experiments with additional variables can improve the explanatory power of the model
• For transferring conclusions, further experiments on the comparison of the behavior in different groups and countries should be carried out
Thank you!

Source: www.diepresse.com
Literature


