

Modeling Forest Investment and Management

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Goals

- Improve characterization of forest investment & management
 - Capture behavioral response to changes in returns to forestry
- Incorporate findings into SRTS to improve projections
 - Link between prices and management
 - Feedback from management to prices, productivity, & inventories

Outline

- Research Questions
- Literature Review & Meta-Analysis
- Econometric Model
- Next Steps

Research Questions

- What are the most important factors influencing forest management?
 - Reforestation
 - Timber Stand Improvements
- What is the direction and magnitude of the influence of these factors?
- How does management intensity affect forest productivity?
- What are the implications for land use, prices, productivity, and inventories?

Research Questions (cont)

- Potential problems with existing studies
 - Omitted factors and variables
 - Type and quality of data used
 - Single equation models (not systems)
 - Transferred parameters from other sites and studies
- Our proposed approach
 - Update and re-evaluate literature using meta-analysis to systematically investigate consistency across studies (2nd Round, Forest Policy & Economics)
 - Estimate joint models of harvesting, management & investment, and habitat
 - Use data and parameters to inform SRTS projections

Literature Review & Meta-Analysis

- Publications in last 20 years
 - Journal articles
 - Working papers
 - Ph.D. and M.S. theses
- Databases
- Journals
- References

Empirical Articles - Harvesting

TIMBER HARVESTING		
Authors (Year)	Description	Lhs and Method
Binkley (1981)	New Hampshire; panel	Harvest, Logit
Bolkesjo and Baardsen (2002)	Norway; panel	Harvest intensity, simultaneous equations Tobit
Boyd (1984)	North Carolina; cross-section (survey of commercial forest landowners)	Harvest, Probit
Conway et al. (2000)	Virginia; cross-section	Harvest, Probit
Dennis (1989)	New Hampshire; panel	Harvest volume, Tobit
Dennis (1990)	New Hampshire; panel	Harvest, Probit
Holmes (1986)	Connecticut, cross-section (survey)	Harvst, Logit
Hyberg and Holthausen (1989)	Georgia; cross-section (survey)	Harvest, Logit
Kuuluvainen and Salo (1991)	Finland; cross-section	Harvest volume, Tobit
Kuuluvainen et al. (1996)	Finland; cross-section	Harvest volume, Tobit
Kuuluvainen and Tahvonen (1999)	Finland; panel	Harvest volume, Tobit
Lee (1998)	North Carolina; cross-section (FIA data)	Harvest, Logit
Lee and Murray (1990)	Georgia; cross-section (FIA data)	Harvested acreage, OLS
Loyland, Ringstad, and Oy (1995)	Norway; cross-section	Harvest, Probit; Volume of harvest, OLS
Newman and Wear (1993)	5 Southern U.S. states; cross-section	Profit, Output Supply, & Regeneration, SUR
Pattanayak et al. (2002)	North Carolina; cross-section (FIA data)	Harvest, Probit
Pattanayak et al. (2002)	12 Southeastern U.S. states; cross-section (FIA data)	Harvest volume, 3SLS
Prestemon and Wear (2000)	North Carolina; panel (FIA data)	Harvest, Probit

Empirical Articles - Reforestation

REFORESTATION		
Authors (Year)	Description	Lhs and Method
Alig (1986)	5 Southeastern states; panel	Share of land allocated to 6 uses, SUR
Brooks (1985)	2 southern U.S. regions (Southeast and Southcentral); panel	Acres planted, OLS (dist. lag on cost-share)
Cohen (1983)	Southern U.S.; panel	Acres planted, OLS
de Steiguer (1984)	10 U.S. southern states.; panel	Tree planting expenditures, OLS (geometric lag for P and r)
Hyberg and Holthausen (1989)	Georgia; cross-section (survey)	Replanting, Logit
Kline, Butler, and Alig (2002)	12 Southern U.S. states; panel	Acres planted, OLS
Kula and McKillop (1988)	Northern Ireland; panel	Softwood acres afforested, OLS (distributed lags)
Lee, Kaiser, and Alig (1992)	13 Southern U.S. states; panel	Pine plantation acres, OLS
Lee and Murray (1990)	Georgia; cross-section (FIA data)	Planted acreage, OLS
Loyland, Ringstad, and Oy (1995)	Norway; cross-section	Planting and seeding, Probit; Share forest area planted, OLS
Miranda (1989)	13 Southern U.S. states; panel	Forest acres regenerated, OLS
Newman and Wear (1993)	5 Southern U.S. states; cross-section	Profit, Output Supply, and Regeneration, SUR
Royer (1987)	12 Southern U.S. states; cross-section (survey)	Replanting, Logit
Royer and Moulton (1987)	9 Southern U.S. states; cross-section (survey)	Reforestation, Logit
Zhang and Flick (2001)	North Carolina and South Carolina; cross-section (survey)	Replanting, Probit
Zhang and Pearse (1997)	British Columbia, Canada; panel	Planting, Logit

Empirical Articles - Silvics

SILVICULTURAL TREATMENTS		
Authors (Year)	Description	Ihs and Method
Boyd (1984)	North Carolina; cross-section (survey)	Timber stand improvement, Probit
Loyland, Ringsstad, and Oy (1995)	Norway; cross-section	Young growth tending, Probit; Share forest area tended, OLS
Romm et al. (1987)	Northern California; cross-section	Investment in forest improvements, Logit
Zhang and Flick (2001)	North Carolina and South Carolina; cross-section (survey)	Private forestry investment expenditures, OLS
Zhang and Pearse (1997)	British Columbia, Canada; panel	Silvicultural investment per hectare, OLS

Empirical Approaches in Articles Reviewed

- Data
 - Primary survey of landowners
 - Secondary data (FIA)
- Methods
 - Reduced form regressions (except Newman & Wear, 1993)
 - Discrete choice (probit / logit): harvest, replanting, TSI
 - OLS: expenditure, acreage
- Explanatory Factors
 - *Market Drivers*: prices, costs, interest rates
 - *Policy Variables*: cost-share, tax incentives, assistance, habitat
 - *Owner Characteristics*: income, age, education
 - *Plot/Resource Characteristics*: site index, size, slope, elevation

Vote-Counting Meta-Analysis

- Define broad categories of factors and identify variables of interest within each
- Determine for each variable of interest
 - Whether the variable is included in the study
 - Whether statistically significant (+ or -)
- Results presented as:
 - % of studies that include variable
 - % of studies that found significance out of those that included variable
 - % of studies that found significance out of all studies

Variables Affecting NIPF Timber Harvesting Behavior

20 Studies	Market Drivers					Policy Variables			Owner Characteristics					Plot/ Resource Conditions					
	Price	Land Value	Harvesting Cost	Planting Cost	Interest Rate	Cost Share	Technical Assist	Tax Rate	Income	Education/ Training	Age	Owner Proximity	Farmer	Plot Size	Growing Stock	Site Quality	Amenities/Rec Opportunities	Road Access	Biodiversity of Trees
Included	19	2	2	3	4	3	4	1	10	5	6	4	3	11	11	6	6	5	3
Significant	12	2	2	2	2	2	3	1	7	3	4	2	3	9	8	4	4	3	3
Pos.	11	0	0	1	1	1	3	0	0	3	0	1	2	9	8	1	4	3	0
Neg.	1	2	2	1	1	1	0	1	7	0	4	1	1	0	0	3	0	0	3
Not Significant	7	0	0	1	2	1	1	0	3	2	2	2	0	2	3	2	2	2	0
% Included	95%	10%	10%	15%	20%	15%	20%	5%	50%	25%	30%	20%	15%	55%	55%	30%	30%	25%	15%
% Significant (Incl Studies)	63%	100%	100%	67%	50%	67%	75%	100%	70%	60%	67%	50%	100%	82%	73%	67%	67%	60%	100%
% Significant (All Studies)	60%	10%	10%	10%	10%	10%	15%	5%	35%	15%	20%	10%	15%	45%	40%	20%	20%	15%	15%

Variables Affecting NIPF Reforestation Behavior

17 Studies	Market Drivers							Policy Variables			Owner Characteristics			Plot/Resource Conditions	
	Saw Price	Pulp Prices	Planting Costs	Real Ag Crop Price Index	Land Value	Interest Rate – Short Term	Interest Rate – Long Term	Cost Share	Technical Assistance	Tax Incentives	Income	Age	Farmer	Plot Size	Site Quality
Included	10	5	11	2	4	5	4	12*	5	3	8	2	3	6	3
Significant	5	4	7	1	3	4	1	12	5	2	4	0	0	3	2
Pos.	5	4	0	0	2	0	1	12	5	2	4	0	0	3	2
Neg.	0	0	7	1	1	4	0	0	0	0	0	0	0	0	0
Not Significant	5	1	5	1	1	1	3	0	0	1	4	2	3	3	1
% Included	59%	29%	65%	12%	24%	29%	24%	80%*	29%	18%	47%	12%	18%	35%	18%
% Significant (Incl Studies)	50%	80%	64%	50%	75%	80%	25%	100%	100%	67%	50%	0%	0%	50%	67%
% Significant (All Studies)	29%	24%	41%	6%	18%	24%	6%	80%*	29%	12%	24%	0%	0%	18%	12%

Variables Affecting NIPF Silvicultural Behavior

5 Studies	Economic Drivers			Policy Variables			Owner Characteristics				Plot/Resource Conditions	
	Saw Prices	Interest Rate – Short Term	Interest Rate – Long Term	Cost Share	Assist	Tax Incentive	Income	Age	Education/ Training	Proximity to Forest	Plot Size	Site index
Included	3	2	1	2*	3	1	3	3	4	3	5	3
Significant	1	1	0	2	2	1	2	1	2	2	2	2
Pos.	1	1	0	1	2	1	2	0	2	2	2	2
Neg.	0	0	0	1	0	0	0	1	0	0	0	0
Not Significant	2	1	1	0	1	0	1	2	2	1	3	1
% Included	60%	40%	20%	50%*	60%	20%	60%	60%	80%	60%	100%	60%
% Significant (Incl Studies)	33%	50%	0%	100%	67%	100%	67%	33%	50%	67%	40%	67%
% Significant (All Studies)	20%	20%	0%	50%*	40%	20%	40%	20%	40%	40%	40%	40%

Summary of Meta-Analysis

	Market Drivers	Policy Variables	Owner Characteristics	Plot/Resource Characteristics
Timber Harvesting (20)				
% Included	95%	25%	65%	90%
% Sig (Inc Studies)	63%	80%	85%	94%
% Sig (All Studies)	60%	20%	55%	85%
Reforestation (17)				
% Included	88%	87%	53%	35%
% Sig (Inc Studies)	87%	100%	44%	50%
% Sig (All Studies)	76%	87%	24%	18%
Silvicultural Treatment (5)				
% Included	60%	60%	80%	100%
% Sig (Inc Studies)	67%	100%	100%	60%
% Sig (All Studies)	40%	60%	80%	60%
Overall (42)				
% Included	88%	53%	62%	69%
% Sig (Inc Studies)	73%	95%	73%	79%
% Sig (All Studies)	64%	50%	45%	55%

Meta-Summary of Management

- Market Drivers most often included, but least likely to be significant when included
 - Type and quality of data
- Policy Variables appear to be very effective, especially for reforestation
 - Significance alone does not provide information about magnitude

North Carolina Empirics

- Test hypothesis and provide parameters
- Integrate multiple data
 - FIA plot
 - Timber Mart South
 - Census of Agriculture
 - Federal Reserve
- Conduct exploratory data analysis (EDA)
 - Focus on North Carolina
 - Non-parametric and probit regression

Investment & Management

- TSI
 - thinning (selective, commercial)
 - timber stand improvement (cleaning, release, hardwood control)
- Regeneration
 - site preparation (clearing, prescribed burning, drainage, chopping, disking, etc.)
 - artificial and natural regeneration

Explanatory Variables

- Economic
 - timber prices, agricultural land values, interest rates, management costs
- Policy
 - tax rates, CRP payments
- Owner
 - nipf, industry, timo
- Plot
 - site class, slope, elevation
- Endogenous management
 - harvest, plant, tsi, regenerate

TSI and Regeneration

- 16% of 4450 plots
 - 4% tsi and 12% regeneration
- Cross-tabulations
 - coastal plains (more likely)
 - industry, timos, non-farm nipf (more likely)
- Correlations
 - harvest (very likely)
 - plant (less likely)
 - joint (never)

Preliminary Regressions

	TSI	Regeneration	Harvest
Management cost	+	+	+
Treasury Bill 1 Year rate	-		+
Federal Fund rate		+	-
Agricultural land value	-	-	-
Timber and pulp price index	+	+	+
NIP (dummy)		+	
Industry (dummy)	+		+
Site Index	+		+
Elevation	-	-	
Slope	-	-	
Mountain eco-region (dummy)	-		+
Tax rate	-	-	
Median Household Income	-		
Sample size	4448	4448	4448
Chi-square statistic (14)	617	1199	2469

Next Steps

Estimate

- Evaluate and specify alternatives
- Estimate joint models

Validate

- Internal – using regression diagnostics
- External – SRTS
 - Incorporate parameters
 - Conduct baseline and new parameter runs