

# **Timberland ownership and urbanization in the US South**

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# Introduction

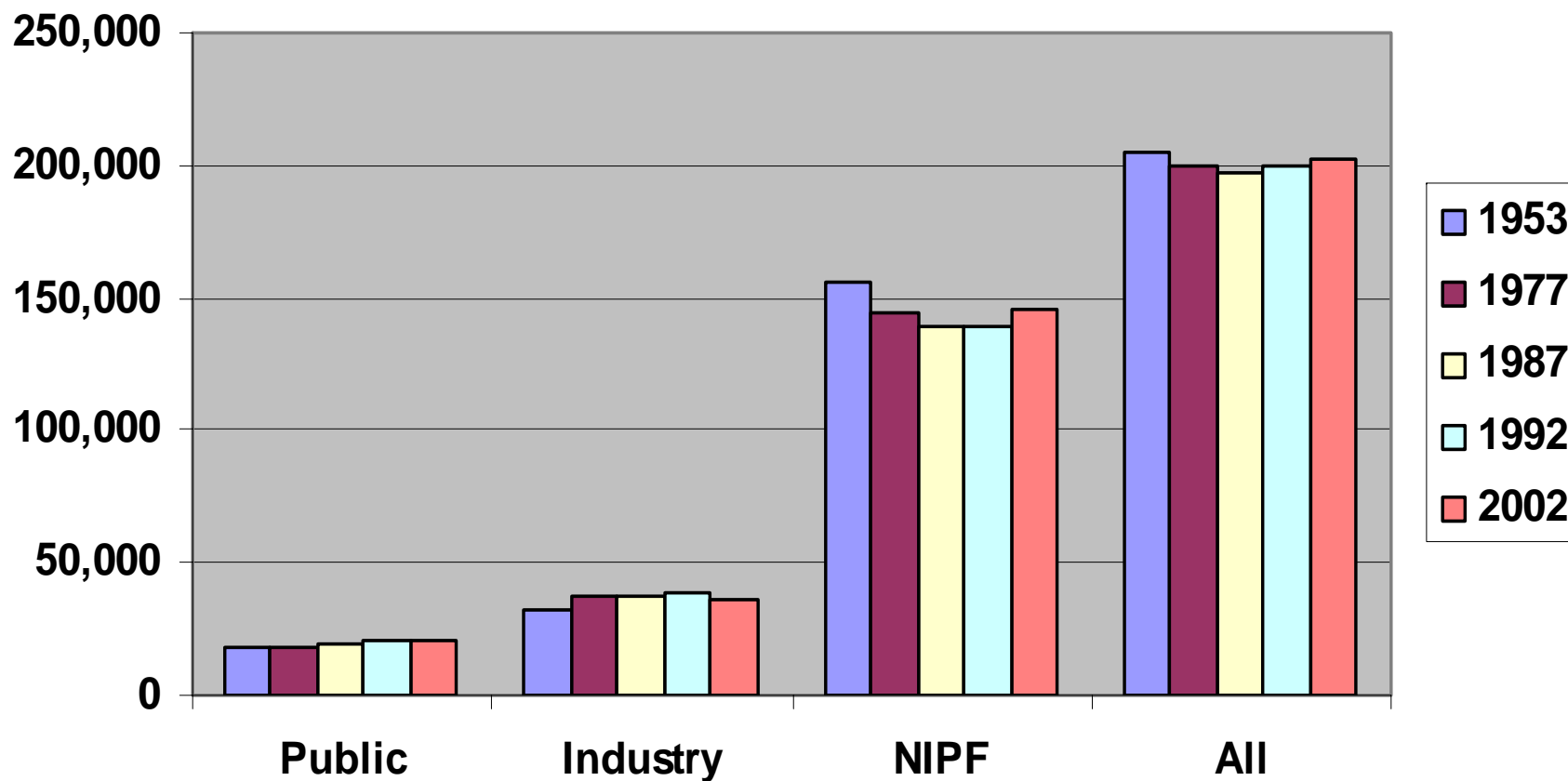
- Changing land use
  - Urbanization (Wear and Greis 2002)
  - Recreation (Cordell and Tarrant 2002)
  - Bio-diversity (Maestas et. al. 2001)
  - Water quality (Basnyat et al. 2000)
  - Govt. policy & regulations (carbon sequestration, tax treatment, aesthetics, ecological, environmental, etc.)
- Q: Response to all forest ownerships similar?
  - Data pooling by ownership and forest types may have imposed unrealistic restrictions
- We need projections for various purposes
  - Projections may differ based on analytical model used

# Changes in land use in the US South

Ownership/use (1,000 Acres)	1953	1992	2002	% $\Delta$ 1953-2000
Public	17,443	20,900	21,226	21.7
Industry	31,795	38,859	35,916	13.0
NIPF	155,308	139,782	145,531	-6.3
<b>Individuals</b>	99,259	39,485	???	???
<b>Priv. corp.</b>	56,049	411,297	???	???
<b>Timberland</b>	<b>204,546</b>	<b>199,297</b>	<b>202,673</b>	<b>-0.9</b>
Agriculture	261,686	264,855	252,673	-3.4
Urban & Other	46,447	66,597	80,019	72.3

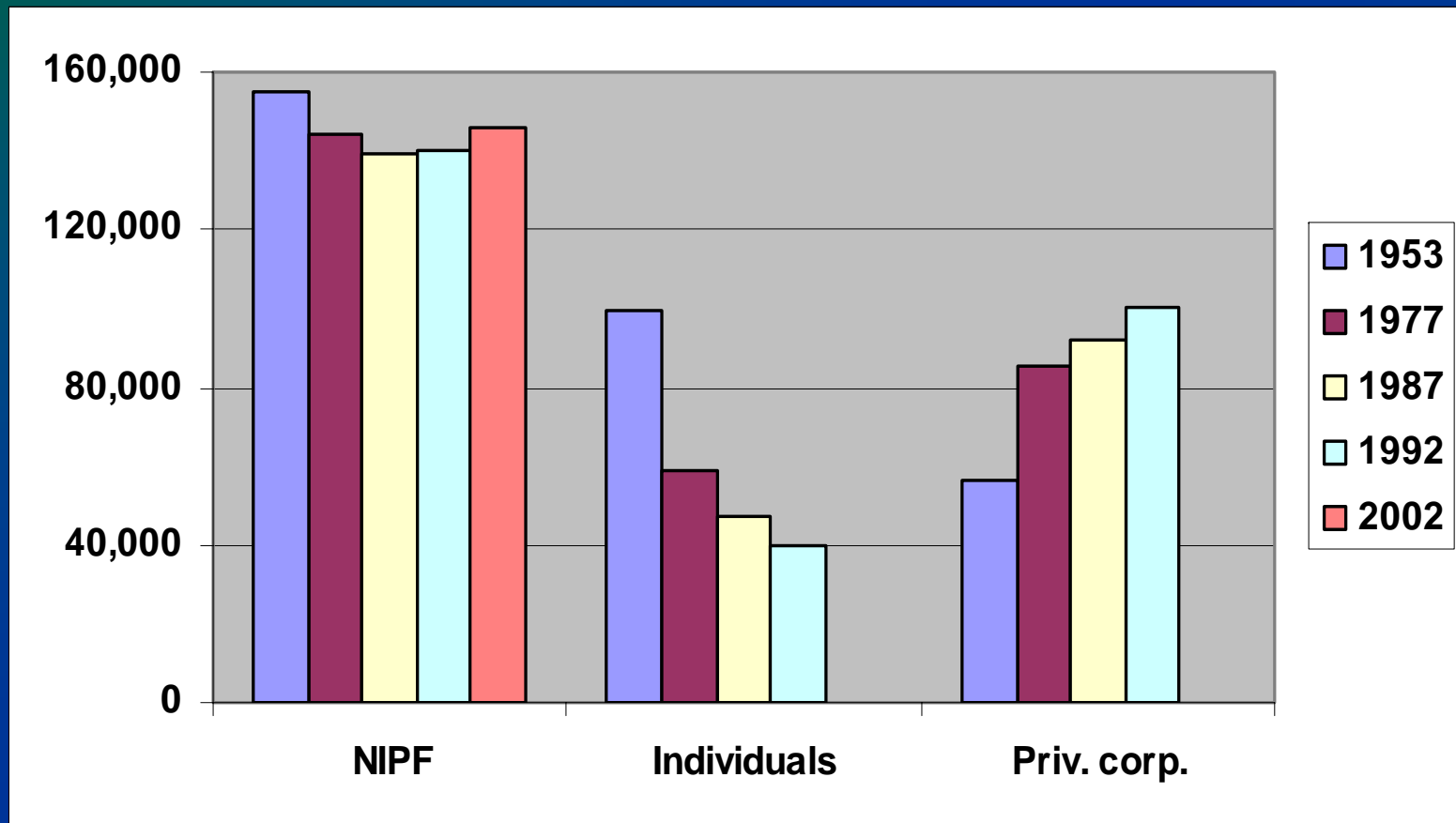
# Timberland by major ownership class

(thousand acres)

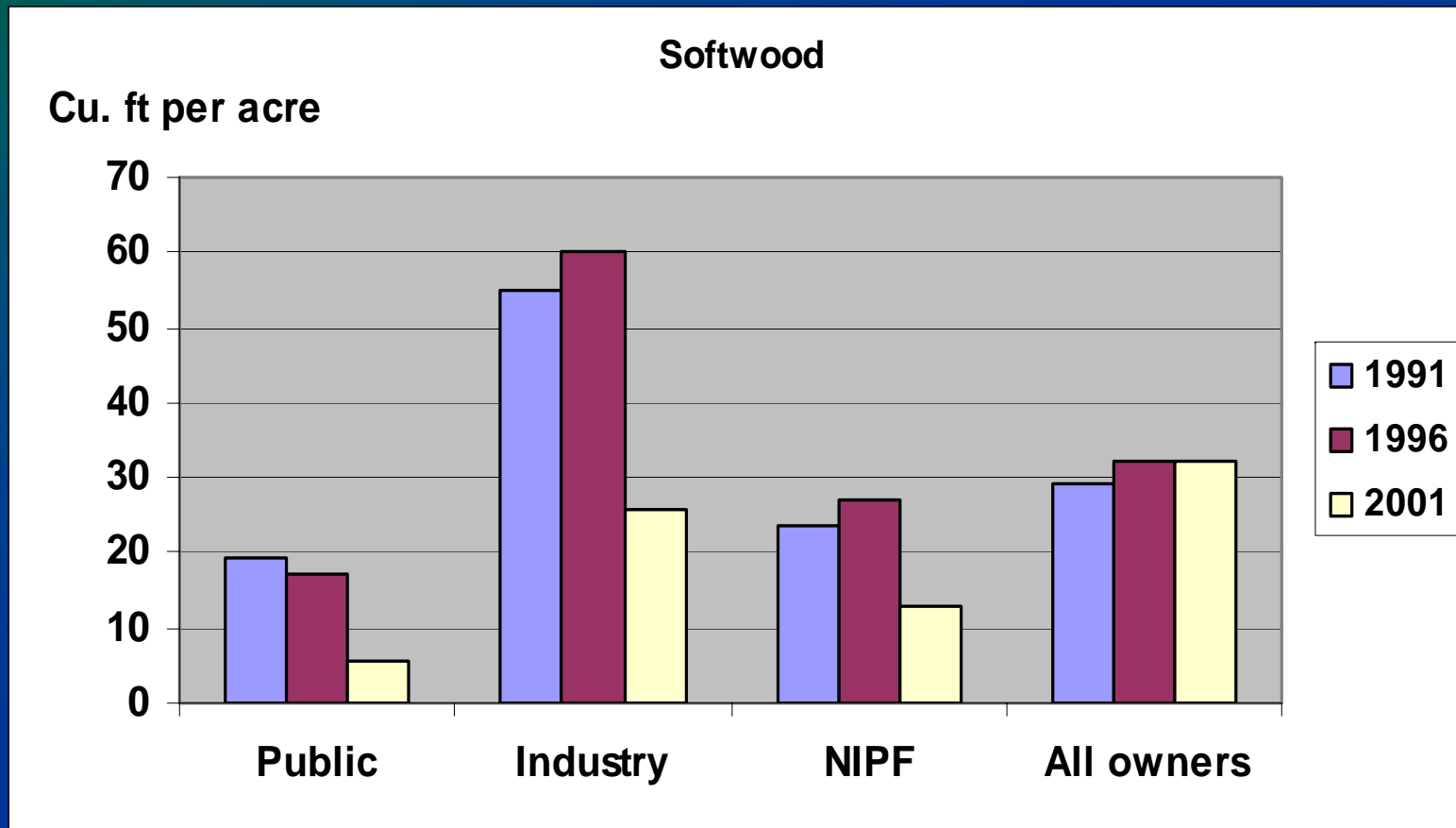


# Timberland ownership within NIPF

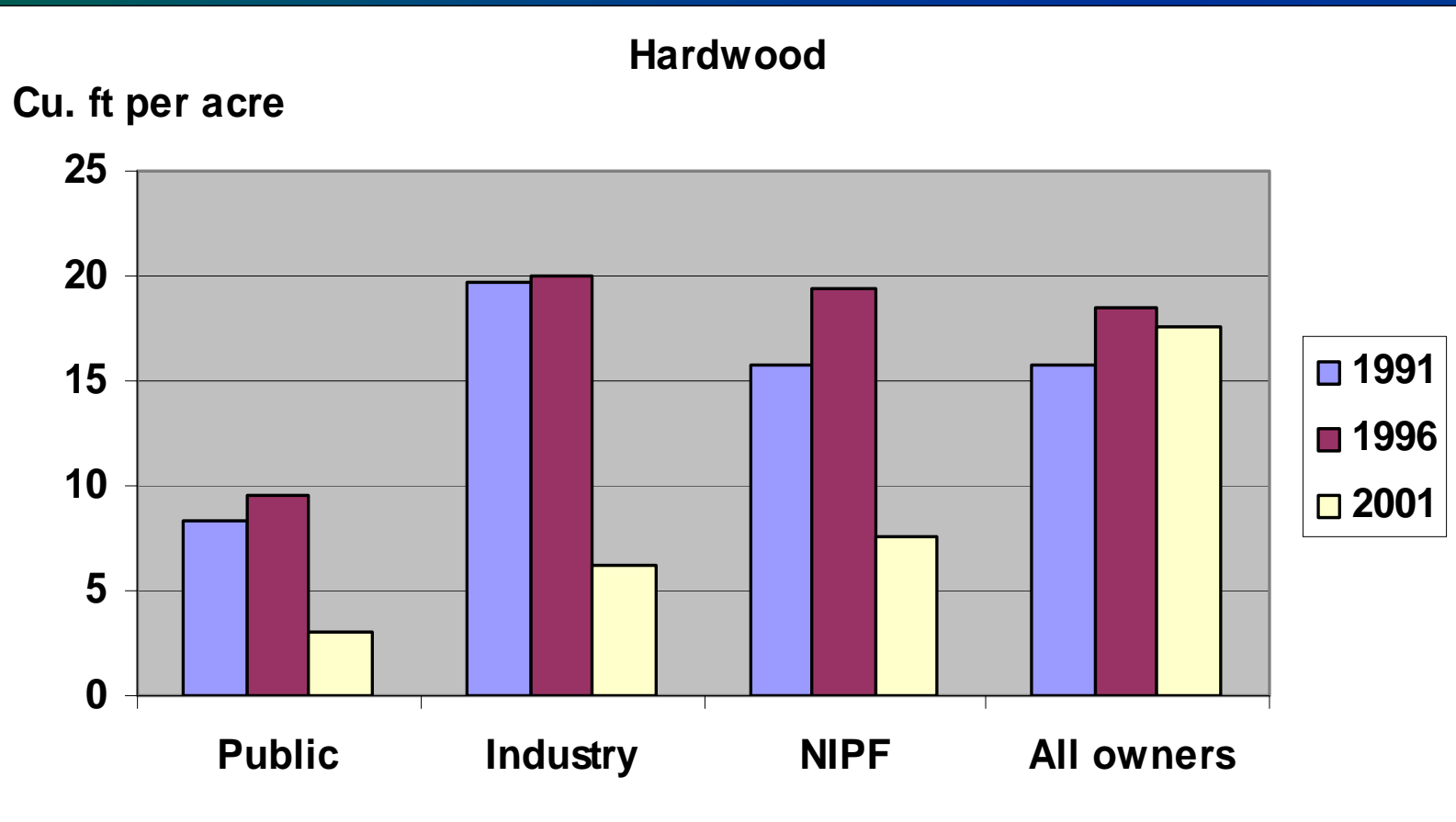
(thousand acres)



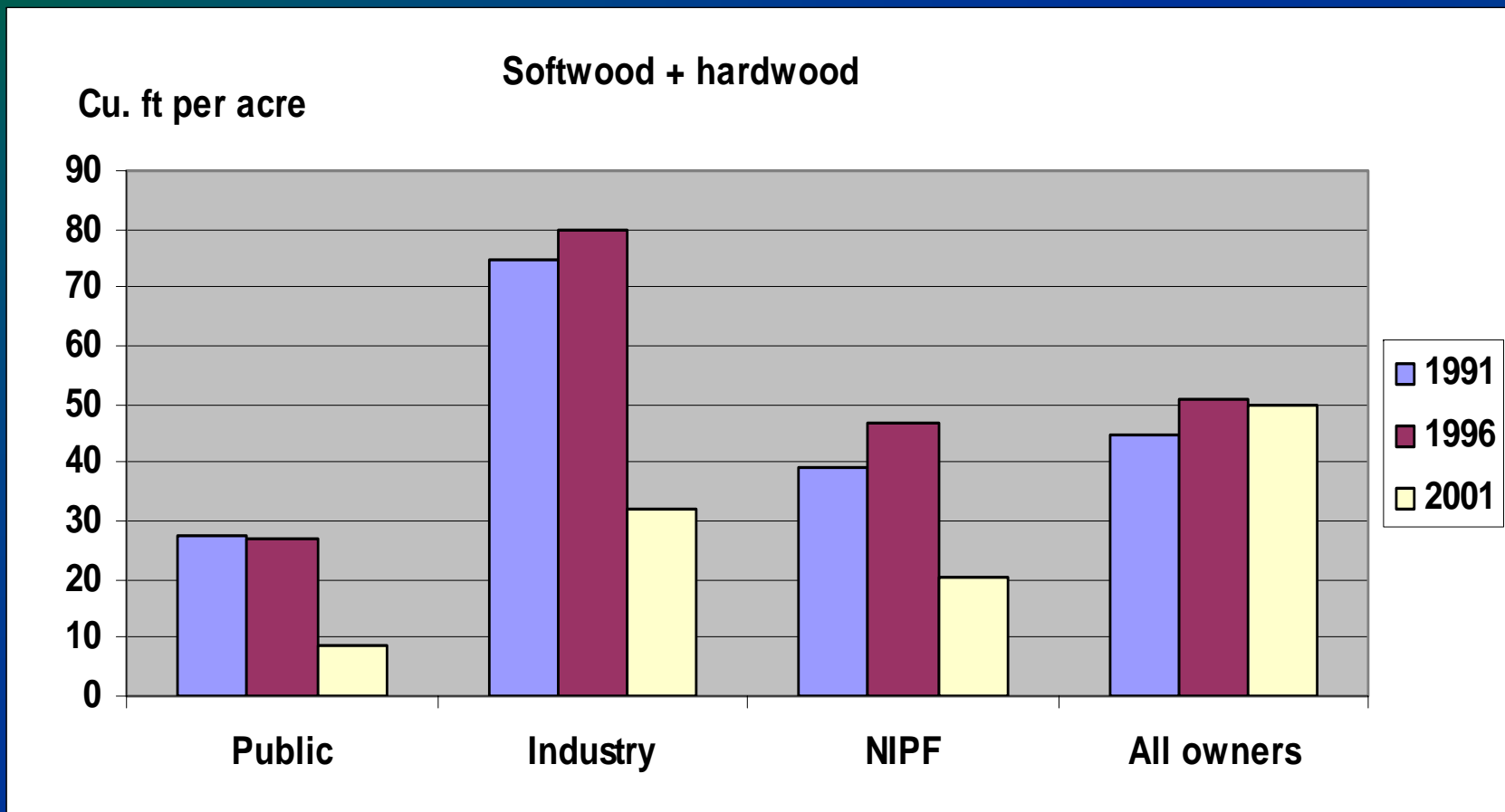
# Softwood removals by owner-type ( = supply behavior?)



# Hardwood removals by owner-type



# All removals by owner-type



# Literature review

Previous studies:

Ricardo **land rent** theory (rural land use)

von Thünen **location rent** theory (urban land use)

- Alig (1986) *For. Sci.*
- Plantinga, Buongiorno and Alig (1990) *J. W. For. Resource Mgmt.*
- Hardie et al. (2000) *Land Economics*
- Ahn, Abt, & Plantinga (2001) *SOFEW Proceedings*
- Nagubadi and Zhang (2005) *J. Ag. & Appl. Econ.*
- Zhang and Nagubadi (2005) *For. Pol. & Econ.*
- Nagubadi and Zhang (2007) *in Dubé & Schmithüsen, FAO*

# Objective

**Determinants of changes in timberland use:**

Our Focus is:

- **Timberland use by different ownership categories**
- **We examine the effect of various urban related variables**

# Analytical framework

## Multinomial Logit Model

$$P_{ikt} = \frac{\exp(\beta'_k X_{it})}{\sum_{k=1}^4 \exp(\beta'_k X_{it})}$$

$P$  = probability of land use in a category,

$K$  = land owner type,

$i$  = county,             $t$  = time,

$\beta$  = coefficient vector,

$X$  = vector of independent variables.

# Framework

After normalizing with  $k=4$ , and  
constraining  $\beta_4=0$

$$P_{ikt} = \frac{\exp(\beta'_k X_{it})}{1 + \sum_{k=1}^3 \exp(\beta'_k X_{it})}$$

Omitted land use share obtained as:

$$P_{i4t} = \frac{1}{1 + \sum_{k=1}^3 \exp(\beta'_k X_{it})}$$

## Framework

We use land-use proportions ( $Y_{ikt}$ ) for land-use probabilities ( $P_{ikt}$ ).

Logarithmic transformation yields a linear function in parameters:

$$\ln \left( \frac{y_{ikt}}{y_{i4t}} \right) = \beta'_k X_{it} + \varepsilon_{ikt}$$

## Framework

County-level cross-sectional data causes  
Heteroskedasticity problem

Multiplicative heteroskedastic correction with  
multiple variables or their forms causing  
heteroskedasticity (Harvey 1970 & Limdep)

Estimated by Maximum Likelihood Method

# Statistical Model

**Timberland use is a function of variables:**

Economic: Returns, income

Demographic: Population, housing density,  
high school education

Land quality: Land capability classes  
(AVLCC, LCC1N2)

Urbanization: MSA, house values, rural-urban  
continuity, poverty ratio

# Data

Years (11 Southern states):

AL:	1972,	1982,	1990,	2000	
AR:	1969,	1978,	1988,	1995,	2001
FL:	1969,	1980,	1987,	1995	
GA:	1972,	1982,	1989,	1997,	2000
LA:	1964,	1974,	1984,	1991,	2003
MS:	1967,	1977,	1987,	1994	
NC:	1974,	1984,	1990,	2002	
SC:	1978,	1986,	1993,	2000	
TN:	1971,	1980,	1989,	1999	
TX:	1965,	1975,	1986,	1992,	2002
VA:	1977,	1984,	1992,	2001	

# Data

- Number of obs. 2847 (**Balanced sample**)
  - For each FIA year, data observations should be available with respect to all counties
- Public timberland excluded because of different decision-making process
- Data for variables not available for FIA years: Suitable interpolations were used, for example:
  - net agricultural returns,
  - housing values,
  - housing units per land area,
  - poverty ratio
  - proportion of HS grads, etc.

# Variables & sources

Timberland:	Forest Inventory Analysis (FIA)
Crop/pasture land:	Agri. Census-NASS, USDA
Stumpage prices:	Timber Mart-South
Net Ag. returns:	Agri. Census-NASS, USDA
Popu. density:	Bureau of Economic Analysis
Per-capita income:	Bureau of Economic Analysis
Land quality:	USDA, NRCS
Urban-rural conti.:	USDA
Metro. Stat. Area:	Census Bureau
House units/land area:	Census Bureau
Median house value:	Census Bureau
High School edu:	Census Bureau
Poverty ratio:	Census Bureau

# Results

- **Four categories of land use:**
  1. Private industry owned timberland
  2. NIPF owned timberland
  3. Agriculture
  4. Urban/other
- Urban/other land use was used for normalization
- There are three equations;
- In each eqn. coefficients are to be interpreted relative to urban/other land use - Difficult
- For easy interpretation: **marginal effects** and **elasticities** are estimated

# Results

1) Private Industry timberland: Adj. R<sup>2</sup> = 0.35

Variable	Coeff.	Marg.effects	Elasticity
Wtd. sawtimber price	0.004***	0.002***	0.267***
Net agri. returns	-0.00003	-0.000001	-0.0004
Popu. density	-0.002*	-0.0002**	-0.307**
Per capita income	-0.100***	-0.008***	-0.784***
Av. LCC	-0.084	-0.007	-0.294
Prop. LCC 1&2	-0.591*	-0.060**	-0.163**
Metro. Stat. Area	0.073	0.007	0.019
House units/land area	-0.001	0.0002	0.101
Median house value	-0.034***	-0.003***	-1.033***
Rural-urban conti.	0.062***	0.004***	0.257***
Prop. HS grads	0.013***	0.002***	1.142***
Poverty ratio	-0.004	-0.001**	-0.220**

(details for state dummy variables & intercept are omitted in all)

# Results

2) NIPF owned timberland:

Adj. R<sup>2</sup> = 0.29

Variable	Coeff.	Marg.effects	Elasticity
Wtd. sawtimber price	0.003***	0.0004***	0.109***
Net agri. returns	0.0001	0.00004***	0.007***
Popu. density	0.0004	0.0001	0.028
Per capita income	-0.035***	-0.008**	-0.151**
Av. LCC	0.071**	0.045***	0.332***
Prop. LCC 1&2	-0.079	-0.053	-0.026
Metro. Stat. Area	0.021	0.013	0.006
House units/land area	-0.004**	-0.0002	-0.015
Median house value	-0.007***	-0.0004	-0.029
Rural-urban conti.	0.018*	0.0006	0.007
Prop. HS grads	-0.009***	-0.001*	-0.111*
Poverty ratio	0.0002	-0.003***	-0.128***

# Results

## 3) Agriculture land use:

Adj. R<sup>2</sup> = 0.40

Variable	Coeff.	Marg.effects	Elasticity
Wtd. sawtimber price	0.001***	-0.0003***	-0.173***
Net agri. returns	-0.0002***	-0.00005***	-0.018***
Popu. density	0.0008	0.0001	0.084
Per capita income	0.042***	0.013***	0.603***
Av. LCC	-0.192***	-0.039***	-0.728***
Prop. LCC 1&2	0.559***	0.116***	0.144***
Metro. Stat. Area	-0.102*	-0.021**	-0.025**
House units/land area	-0.006***	-0.0005	-0.121
Median house value	0.004*	0.002***	0.386***
Rural-urban conti.	0.004	-0.003	-0.070
Prop. HS grads	-0.017***	-0.002***	-0.515***
Poverty ratio	0.030***	0.005***	0.510***

# Results

	<u>Actual</u>	<u>Predicted</u>
<u>Ownership-based analysis:</u>		
Industry-owned	0.15	0.10
NIPF-owned	0.48	0.54
<b>Timberland</b>	<b>0.63</b>	<b>0.64</b>
Agriculture	0.23	0.22
Urban/other	0.12	0.15
<u>Major-use based analysis:</u>		
<b>Timberland</b>	<b>0.63</b>	<b>0.70</b>
Agriculture	0.23	0.17
Urban/other	0.12	0.13

# Summary

- Impact of variables different for **Industry** and **NIPF** owned timberland- Is it because of different objectives?
- Urban variables play key role in timberland ownership changes
- Industry is more responsive, but NIPF owners are less responsive
- The response of variables for NIPF is masked

# Summary

- Aggregating different owner groups may lead to unrealistic projections
- What about institutional owners (TIMOs, TREITS, LLPs)?
- We need to continuously monitor their timber supply behavior of these diverse NIPF owners because of their inclusion of timberland as a component of portfolio- diversification to minimize risk with increased return prospects

# Summary

- We need data for various diverse categories within NIPF owners
- Agricultural product based bio-fuels (ethanol)
- Cellulose wood based bio-fuels
- Land use is changing continually, and evolution of better models for better prediction purposes will have to continue