A Formal Model of Lakefront Development in Northern Wisconsin, 1959-2000

1)Purpose/Objectives of the research

2)Presentation of Theoretical Model

3)The Data

4)Empirical Model to be Estimated

5)Issues in Estimation

6)Fit with other Biocomplexity Work (Cross-Fertilization)

Purpose/Objectives

- Construct a model of lakeshore development to be integrated with ongoing biocomplexity work
    - Model ultimately seeks to uncover negative interactions (direct and indirect) associated with development; and the effect of one policy tool --zoning --on development
- Today, we are seeking feedback on theoretical model, empirical model, and how to integrate the model with other biocomplexity work

The Theoretical Model (1)

- Measure of development is driven by available data
  - Possible measures of development: Number of structures per linear mile of shoreline; number of parcels per mile of shoreline
  - Here, we use the proportion of private shoreline in small vs. large tracts, as defined by plat maps published by Rockford Map Co.
  - Correlation between this measure and WDNR's data on structures per linear mile…

The Theoretical Model (2)

- Explicitly underlying the model are decision problems faced by private shoreline owners:
  - Owners of large property: convert at least part of the property to small property? (the problem of land subdivision)
  - Owners of small property: convert it to large property (the problem of land assembly)
  - Decision rule: convert the land if the gains from conversion exceed the costs

The Theoretical Model (3)

- The decisions of lakefront owners concerning shoreline conversion is reflected in the proportion of private shoreline in small vs. large tracts
- Thus the proportion of shoreline in small tracts is the measure of development modeled in the analysis

The Theoretical Model (4)

- We have developed a likelihood function of the proportion of private shoreline in small tracts
  - To repeat: the model is founded on the conversion decisions of shoreline owners (i.e., it has microfoundations); over time land is assembled and subdivided, depending on a number of economic and ecological factors; this assembly and subdivision is manifest in the proportion of private land in small vs. large tracts
  - The model recognizes that unobserved variation in development (the proportion of private shoreline in small tracts) may be serially correlated

The Empirical Model (1)

Data:

- 150 randomly chosen Vilas County lakes
- 17 periods of plat map data extending from 1959-2000 (a new map roughly every two years)
- WDNR data on structures per linear mile of shoreline, lake sensitivity scores
- Other constructed variables (e.g. distance to the nearest town and from the south)

The Empirical Model (2)

- Variables explaining land assembly
  - Simple modeling; assembly depends on time and sets of dummy variables denoting the establishment of zoning regulations
    - Time-indexed constant term captures exogenous economic factors
    - Dummy variables capture state and town zoning ordinances (permanent vs. adjustment dummies)

STATE or TOWN	ZONING REQUIREMENT
STATE	1968(100ft)
Arbor Vitae	None
Boulder Junction	1972(200ft)
Cloverland	None
Conover	1977(200ft)
Flambeau	1994 (200ft)
Land O' Lakes	1972(200ft)
Lincoln	None
Manitowish	1986(200ft)
Plum Lake	None
Presque Isle	1959(200ft)
St. Germain	None
Washington	None
Winchester	1995(200ft)

The Empirical Model (3)

- Variables explaining land subdivision
  - Similar set of time-indexed constants and dummy variables as for land assembly
  - Also:
    - Variables suggested by a Von Thunen model
    - Variables suggested by a Ricardian model
    - Variables denoting the negative interactions associated with development

The Empirical Model (4)

- Variables associated with the Von Thunen model
  - Von Thunen model of growth from a central city
  - Relevant variables:
    - Distance from “the south”
    - Distance from towns providing major services (Eagle River, Minocqua-Woodruff)

The Empirical Model (4)

- Add Ricardian elements to the model
- Relevant variables:
  - Size of the lake
  - Amount of shoreline;
  - Maximum depth;
  - Soil class used by WDNR (?)
  - Water source class used by WDNR (?)

The Empirical Model (5)

- Add **direct** interaction effects to the model
- Relevant variables:
  - Proportion of shoreline tribal;
  - Proportion of shoreline private small tract;
  - Proportion of shoreline private large tract;
  - Proportion of public shoreline;

The Empirical Model (6)

- Add **indirect** interaction effects to the model
- Relevant variables involve interaction terms:
  - "Score" x Proportion of shoreline in private large
  - "Score" x Proportion of shoreline in private small
  - These same interactions multiplied by time itself

The Empirical Model (7)

- Finally, include interaction term that is not development-dependent; namely, a dummy variable indicating whether a boat ramp provides public access to the lake

Issues in Estimation (1)

- Identification Problem involving interaction effects
- Should we introduce heterogeneity in the development model (via, for instance, finite mixture modeling) to reflect lake “types”?

Relating the Model to the Biocomplexity Work (1)

- How can we put into the model the new ecology data being collected (and, for that matter, LTER data, or the data collected by the WDNR on water clarity)?…can we use the large number of lakes, and long history of development, to get a fix on many of the model parameters, and then regress residuals on the ecology parameters collected?

Relating the Model to the Biocomplexity Work (2)

- Can we use the model to "find" our canoe vs. jet-ski lakes? That is, can we look for evidence of self-sorting of lake users?
  - This issue is relevant to the previous one about explicit lake heterogeneity in the model
  - Alternatively, we can examine residuals from the model and begin a more comprehensive, comparative study of the lakes with positive vs. negative residuals.
  - Other ideas?