Harvest Schedule under Price Endogeneity: Linking Field Operations to Market Decisions

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“I think it’s wrong that only one company makes the game Monopoly”

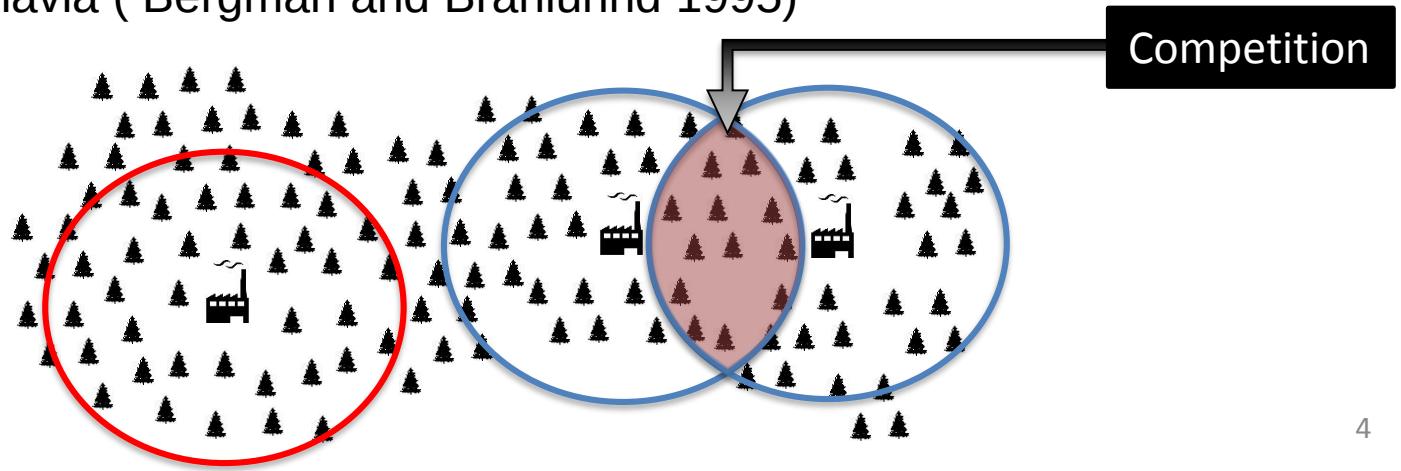
Steven Wright

Introduction

- Harvest schedule modeling has advanced at a fast pace over the last 30 years
  - “There is nothing we could not model, we just need a good data” Dr. Roise
- Optimal allocation of resources:
  - Maximize Net Present Value (NPV) subject to a set of constraints
- Timber prices are normally exogenous
  - Competitive market? All the time?

Introduction

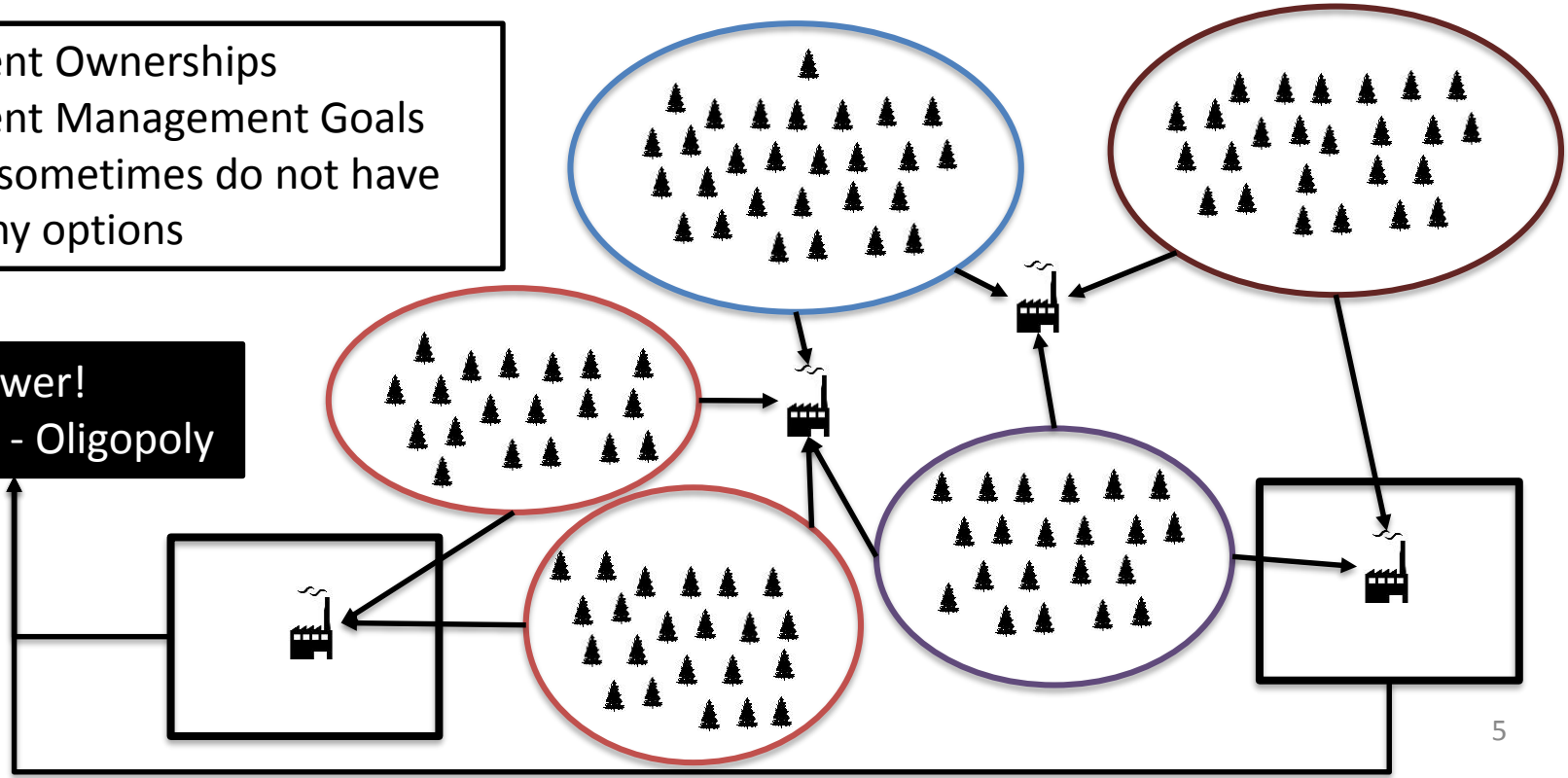
- Timber Markets are commonly dominated by few mills (Oligopsony power)
  - US South (Mei et al 2008, Silva et al 2019)
  - Scandinavia (Bergman and Branlunnd 1995)



Timber Markets:

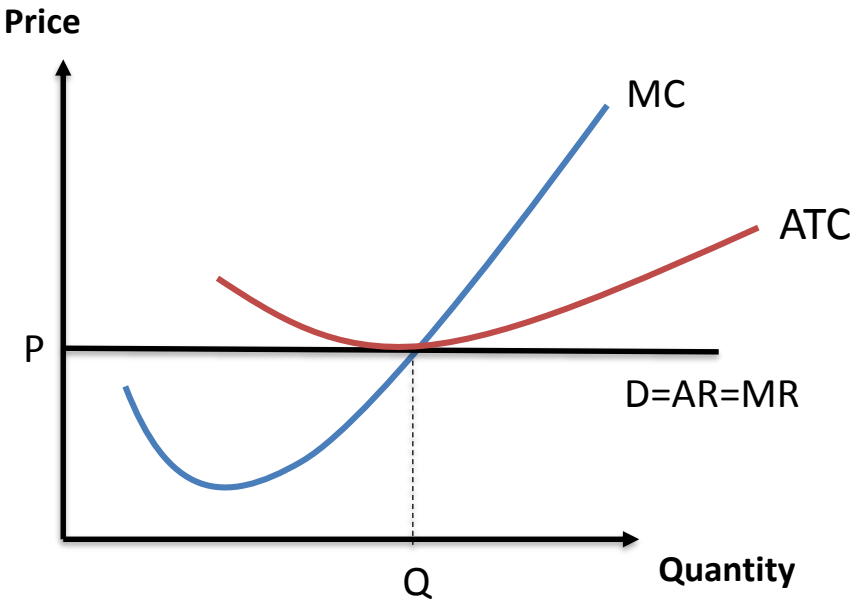
- Different Ownerships
- Different Management Goals
- Buyer sometimes do not have as many options

Market Power!
Monopoly - Oligopoly

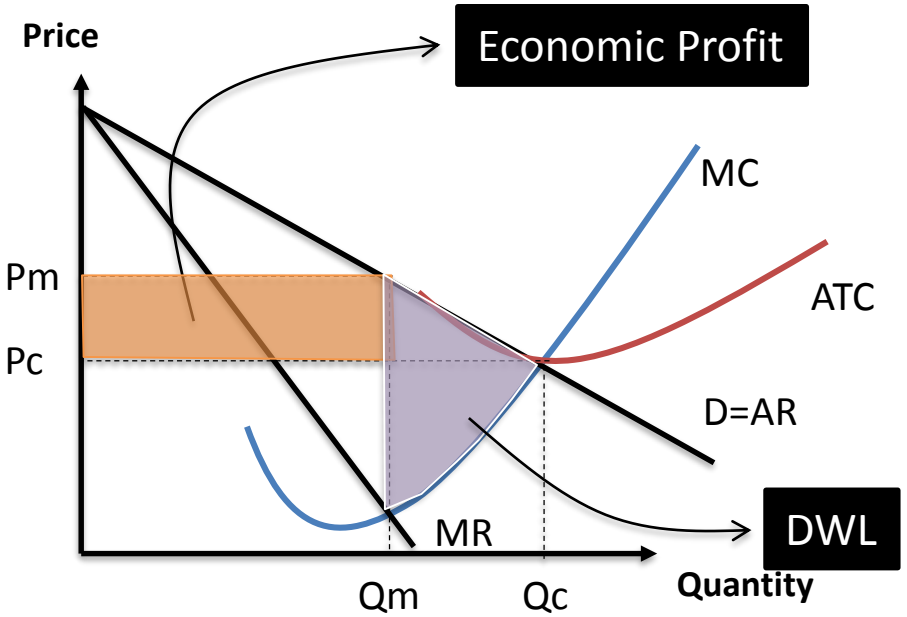


Market Structure

Perfect Competition



Monopoly



Modeling

$$\max \pi_{im} = \sum_{t}^{T} (q_{itm} P_{tm}(Q^s_{tm}) - C_{itm})\delta_t$$

$$st$$

$$Z = A$$

$$P_{tm} = \beta Q^s_{tm} + \alpha I_{tm}$$

$$Q^s_{tm} = Q^d_{tm}$$

$$where$$

$$Q^s_{tm} = q^s_{itm} + W^s_{tm}$$

$$I_{tm} = inv_{itm} + Inv_{tm}$$

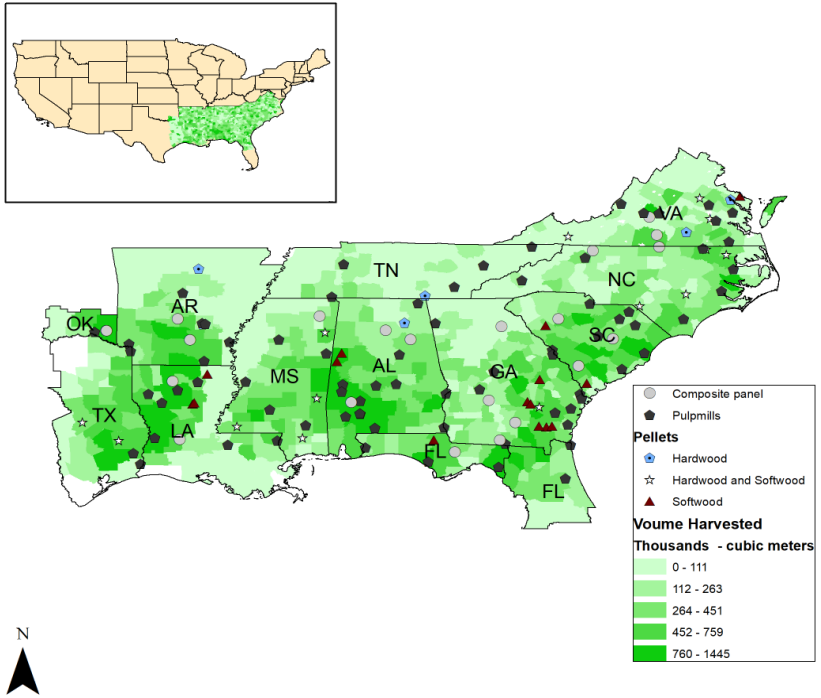
Q^d_{tm}: Exogenous demand

- P_{tm}: Timber Prices at market m during t
- $Q^{s(d)}_{tm}$: Quantity Supplied (Demanded)
  - q^s_{it}: Quantity Supplied by firm i
  - W^s_{tm}: Quantity Supplied by "market"
- C_{itm}: Costs of firm i
- Z and A: Operational Constraints
- I_{tm}: Total inventory at period t.
  - Inv_{itm}: Inventory at firm i
  - Inv_{tm}: "market" inventory
- α and β: Price elasticities.

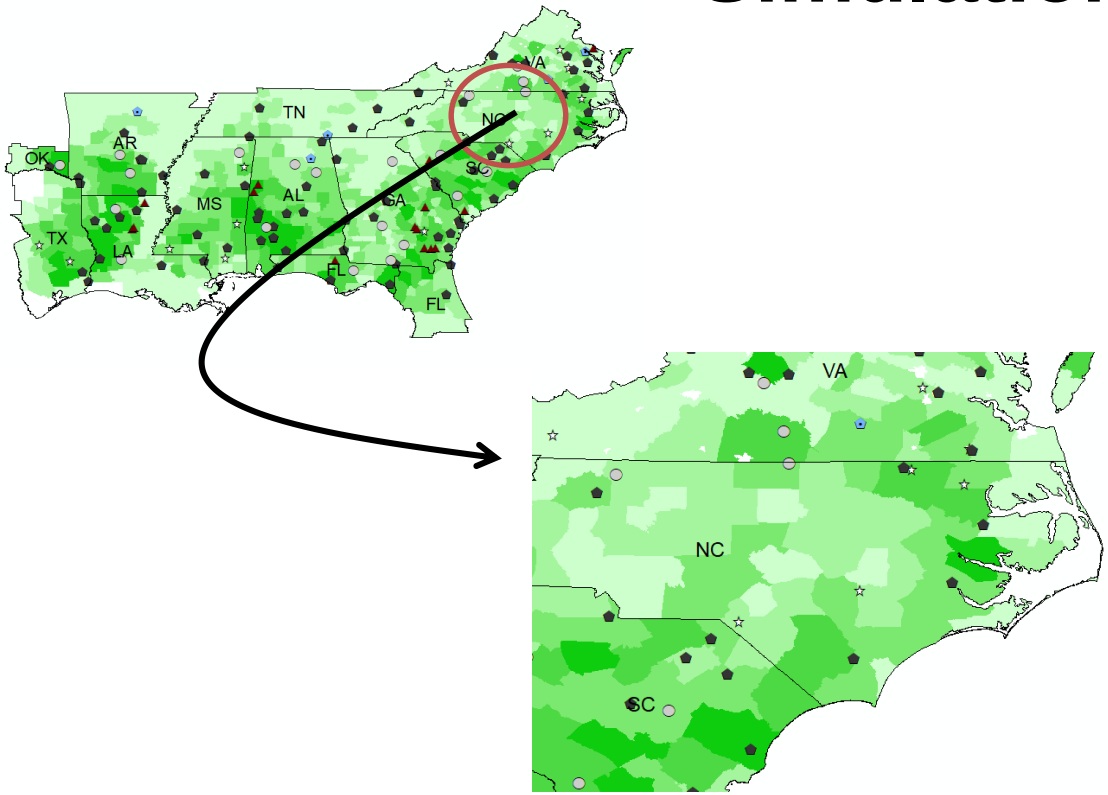
Dataset

Simulation

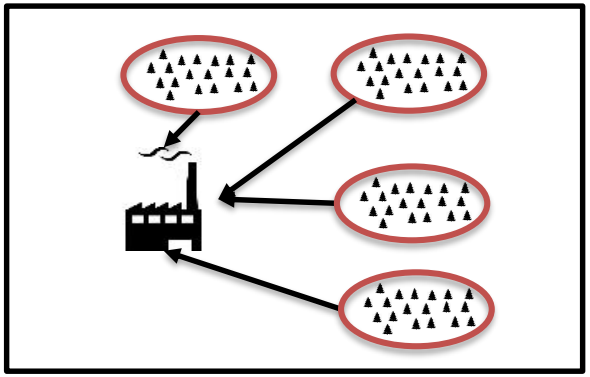
- Stand Characteristics
  - Plot level – Forest Inventory and Analysis (FIA) - Sampling
  - Cost from consulting firms
  - Yield Tables - Forest Vegetation Simulator
- Market Characteristics
  - SubRegional Timber Supply (SRTS)
  - Timber Product Output (TPO) - Demand



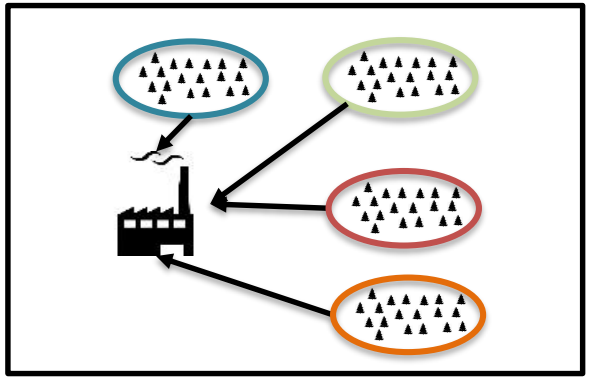
Simulation



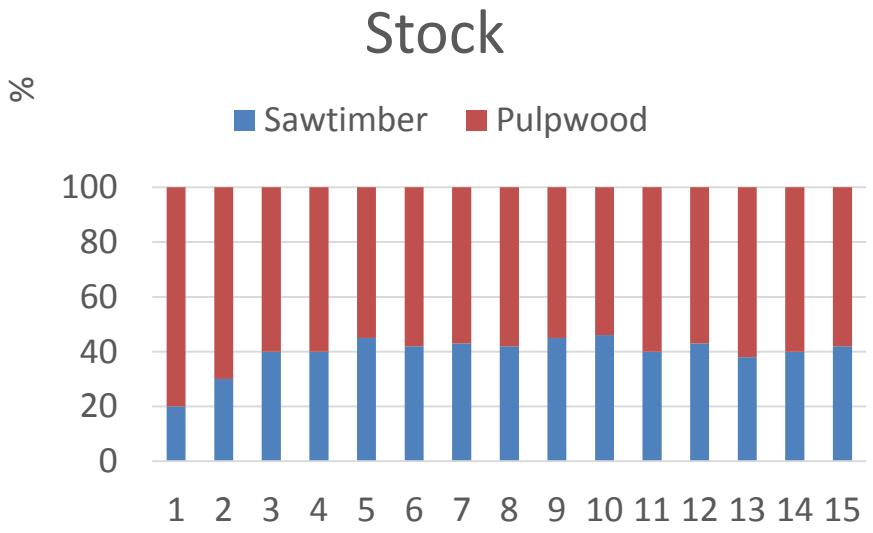
Monopoly

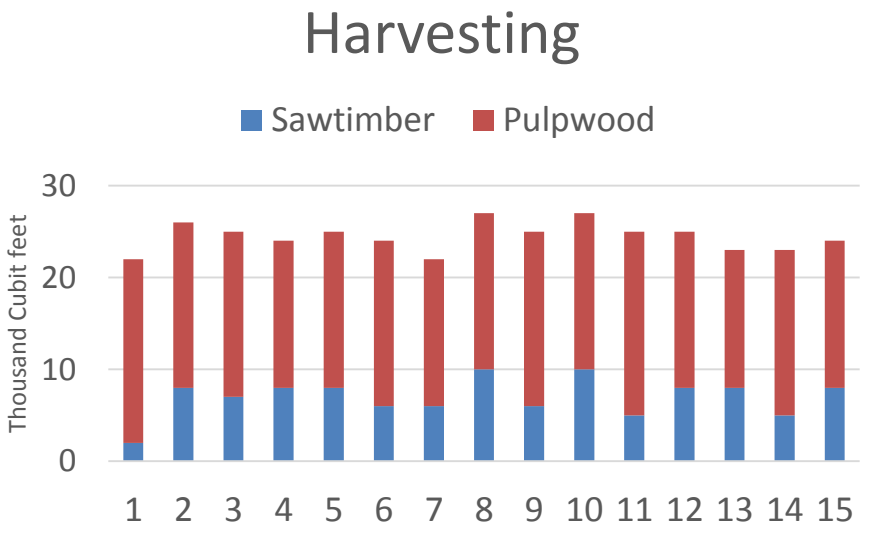


Perfect Competition



Results (Monopoly)





Results

Structure	Difference (Comp - Monopoly)
Price	- 14.5%
Harvesting	-12.5%
Stock	+10.5%

Take home message

- Assuming perfect competition in the timber market is never true; it will have some degree of oligopsony or oligopoly in any place in the world

- In a monopoly, prices will be higher and quantity will be less than in a perfect competitive market

- Initial investments and regulations might affect the entry of new timberland investors

Next Steps

- To use real timberland asset - Hoffman Forest (North Carolina)
- To add Game theory concepts, Nash Equilibrium, into harvest schedule models
- To build a friendly interface

Thank you

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