Future Trends and Pressures on Inland Waterway

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Background

- Most work with Army Corps Started
  - 9/11 Conference on Transportation Demand Modeling
  - NAVIGATION AND ECONOMIC TECHNOLOGIES (NETS) Program administered by Keith Hofseth of the Institute for Water Resources
    - Analyze demands
    - Lock efficiency
    - Port efficiencies and Port Choice
    - Forecasting
    - Railroad Pricing
    - Coal Procurement, Transportation Demand and Clean Air Act
    - Spatially Generated Transportation
  - www.corpsnets.us

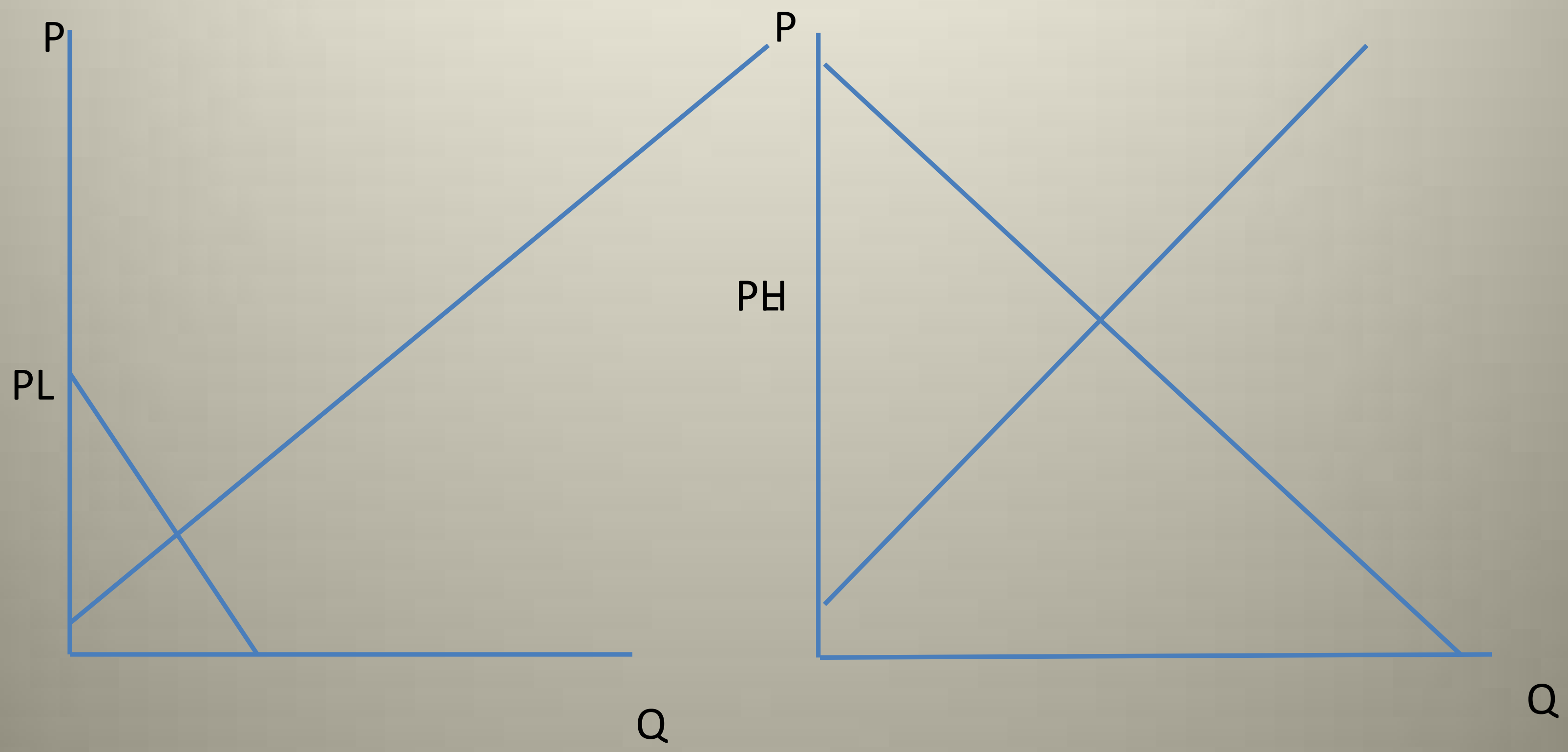
Objectives

- Look at trends in the market and pressures on the waterway. To accomplish, a brief introduction to modeling barge markets
  - Spatial Models
  - Infrastructure
  - Effects of Congestion
  - Growth
    - Structural Modeling
    - Non-structural modeling
  - Facts and Figures

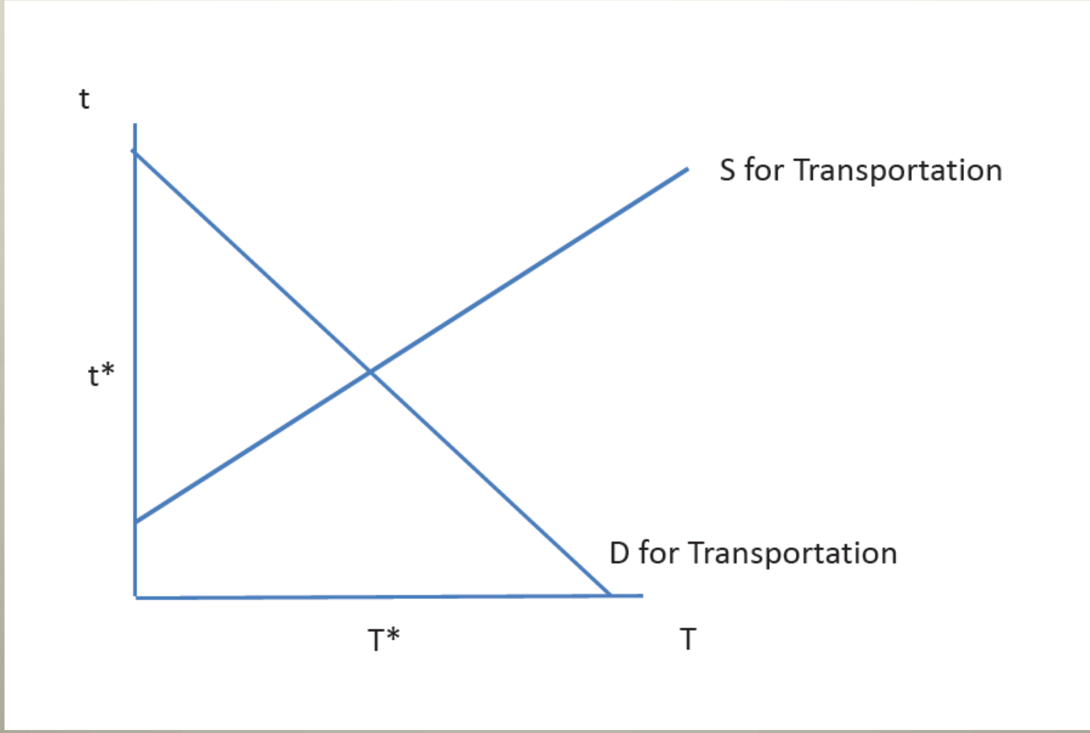
Spatial Modeling

- The basic reason goods move is that there are differences in value across location.
- Primary model is by Paul Samuelson (1952) *American Economic Review.*

Samuelson Trade Model



Transport Space and Samuelson

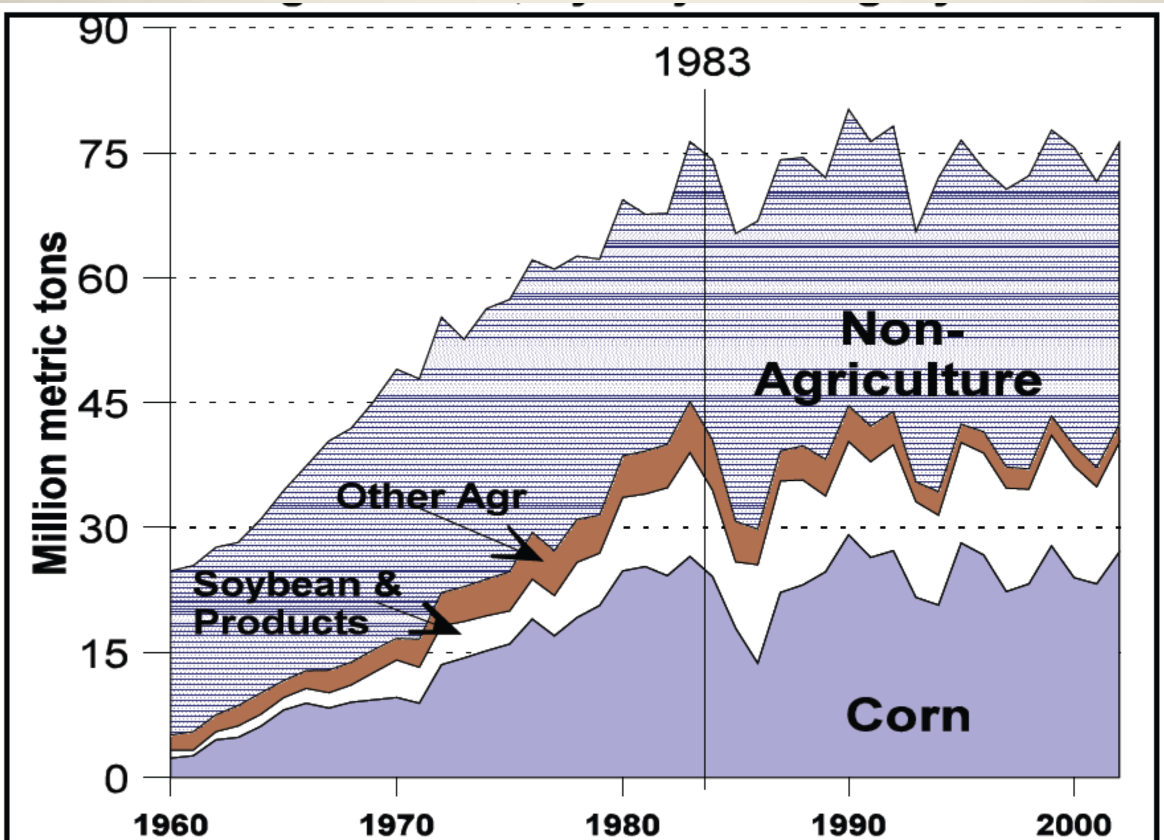


- Demand: Depends on demand (supply) at the receiving region (e.g., Portland, New Orleans)
- Supply: Depends on the cost of shipping by barge (this cost reflects the cost of fuel, barges, labor, transit times and therefore congestion and the condition of locks).

Upper Mississippi

Source: U.S. Army Corps of Engineers, Rock Island District, Jerry A. Skalak, Regional Project Manager, Upper Mississippi River Comprehensive Plan, Presentation at Tulane University, November 14, 2002.

Upper Miss & Ill



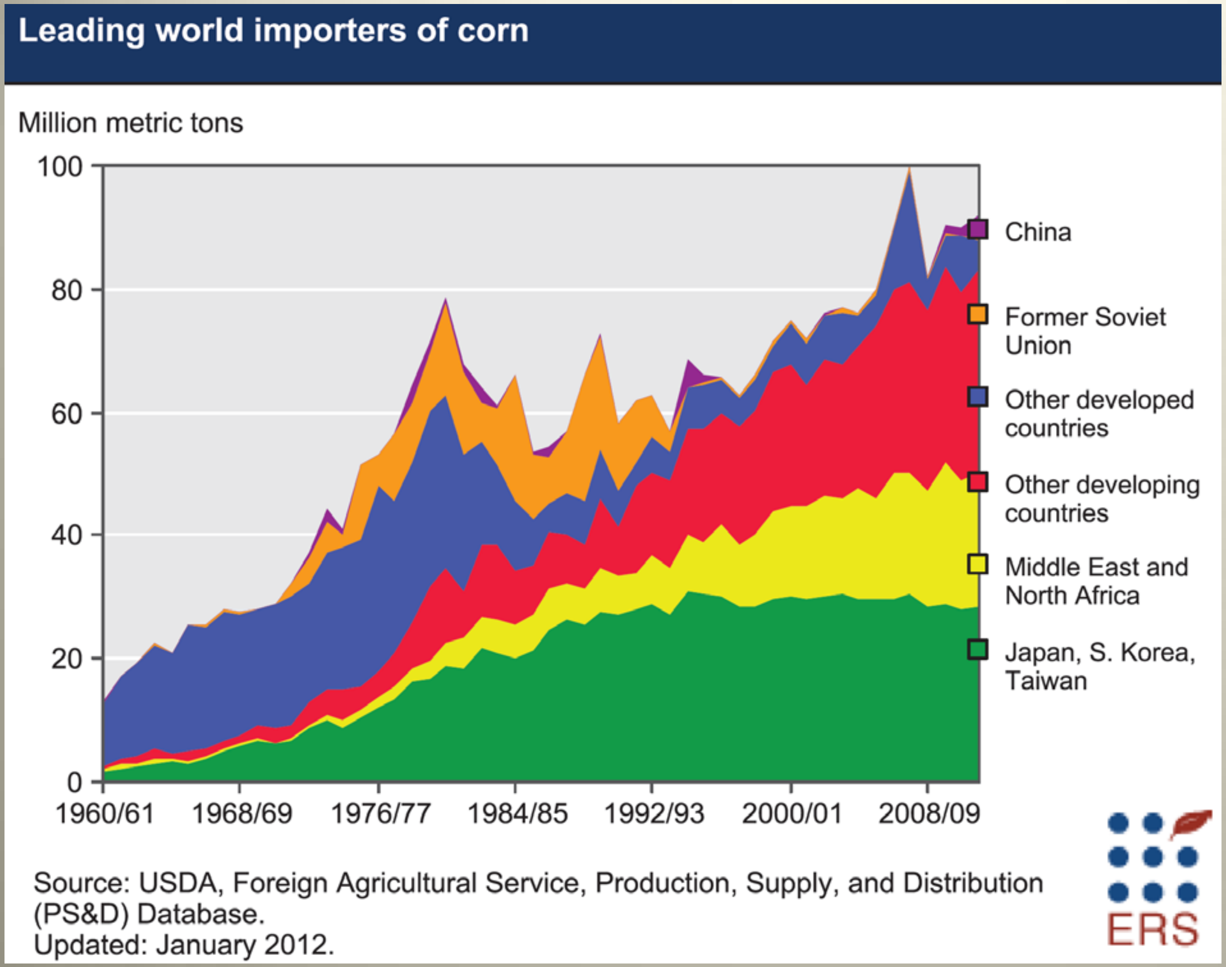
[a]Traffic includes upward and downward freight movement on the Mississippi River and its tributaries between Minneapolis and the mouth of the MissouriRiver.
Source: U.S. Army Corps of Engineers, Waterborne Commerce of the United States.

Moving Agricultural Commodities Upper Mississippi

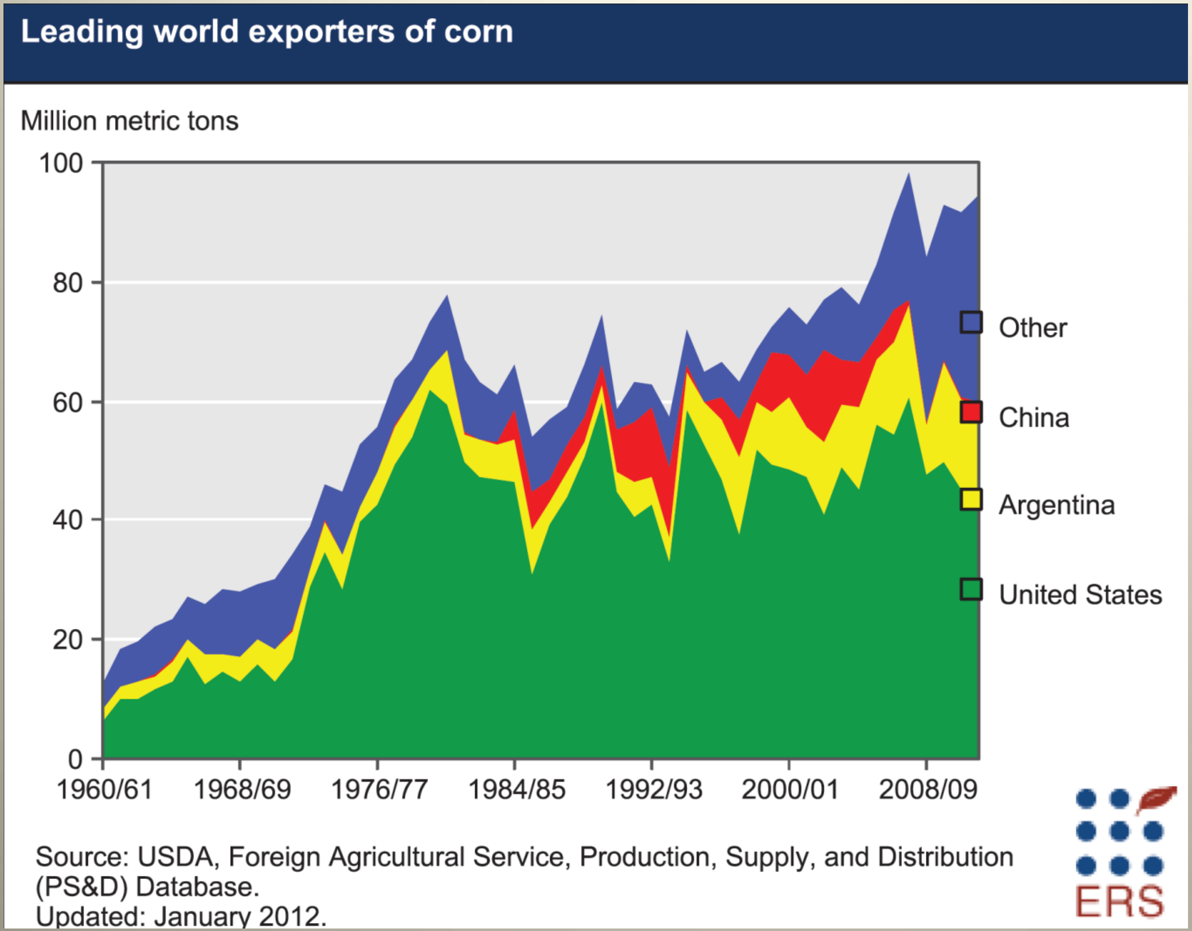
- Traffic has grown through time substantially, but in recent years has leveled (capacity point reached, rail rates lower, demand slackened?)
- Five of the nation's top agricultural production states--Iowa, Illinois, Minnesota, Missouri, and Wisconsin--have traditionally relied on the Upper Mississippi River-Illinois Waterway (UMR-IWW) navigation system as their principal conduit for export-bound agricultural products, mostly bulk corn and soybeans.
- The low-cost, high-volume capability of barge transportation has long provided an important competitive advantage for U.S. agricultural products in international markets.
- Agricultural barge freight on the UMR-IWW grew rapidly for several decades in the post-WWII era, but has leveled off since the early 1980s.
  - Lack of growth in barge demand.
  - Aging infrastructure

Demand

- There is a lot of demand for waterway traffic and, of course, they share a public good – the provision of lock services.
- Agriculture Dominates-and corn dominates agriculture and virtually all is exported.
- Demand for corn exports from New Orleans is drawn from
  - Major customers (importers)
  - Major supplies (other exporters)



- Demand for US
  - Foreign needs (income population), price and transportation and competition from other producers



- US largest exporter
- Lots of growth in 1970s, leveled but volatile since
- Other outlets – Ethanol
- Policy of foreign countries drive results-hard to predict

Other Considerations

- Rail and Barge Compete over space for movements to the gulf.
  - Barge is very cheap but takes a while
  - Rail is more expensive, and while faster, sometimes there is a long wait for equipment (service issues)
  - Truck is most expensive and usually only hits on local market, movements to river
  - Note: The Samuelson model does not work well in that barge and rail costs drive the regionality of movements (Train and Wilson).

Infrastructure

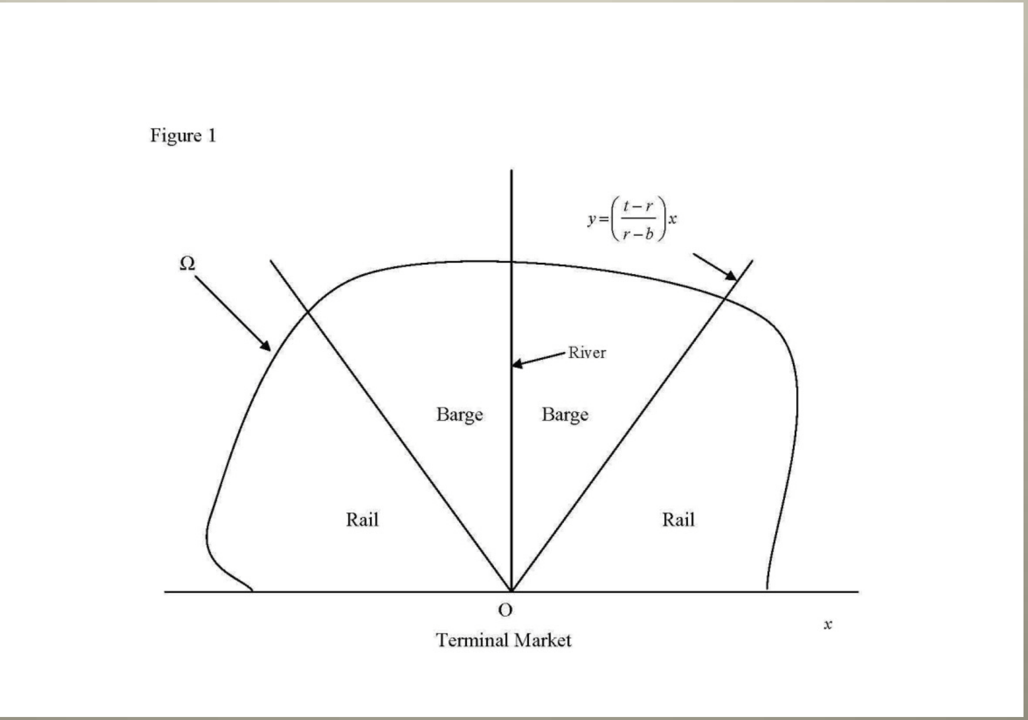
- Production occurs over space
  - Map of Corn
  - Map of Wheat
  - Map of Soybean
- They travel over road/rail to barge and then down the river passing through a system of locks. With demand growth there are delays.
  - Graph of Delays
- They travel by rail to final market, most often today by shuttle trains. But, rail cars can be short and there may be a queue to get rail cars.

Discussion

- Show you a simple model that accommodates bottlenecks.
- Review growth by commodity and mode with an eye towards:
  - Structural and Non-structural forecasts
- Discuss implications of growth in terms of model

Modal of Regional Allocations

- Anderson and Wilson
  - If barge rates fall gathering area expands
  - If rail rates fall gathering area is smaller
    - Shuttle trains, contracts, mergers, growing efficiency of rail, and congestion at locks have shifted the gathering area inwards over time.



Supply of Transportation

- The primary factors
  - Cost of operating barges
    - Fuel
    - Labor
    - Cost of barges/tow
    - CONGESTION LOOMS LARGE-DELAYS TO USE A SINGLE LOCK CAN BE VERY EXPENSIVE, AND THESE COSTS NEED TO BE PAID AND ARE PAID THROUGH A HIGHER COST OF TRANSPORTATION. THIS SHRINKS THE GATHERING AREA FOR BARGE.

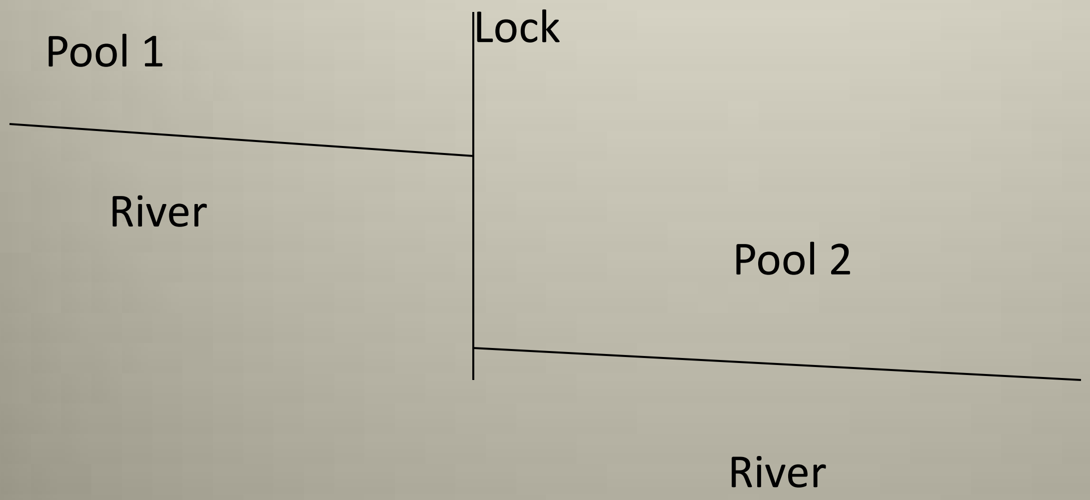
SUPPLY AND INFRASTRUCTURE

- The inland waterway consists of the river and a series of locks and dams that allow the river to be navigated.
- The capacity and use of the waterway depends on lock performance.
- Growing congestion and obsolescence have led to studies promoting the use of
  - Structural measures (build newer and bigger locks)
  - Non-structural measures (congestion pricing, scheduling, tradeable permits, access fees).

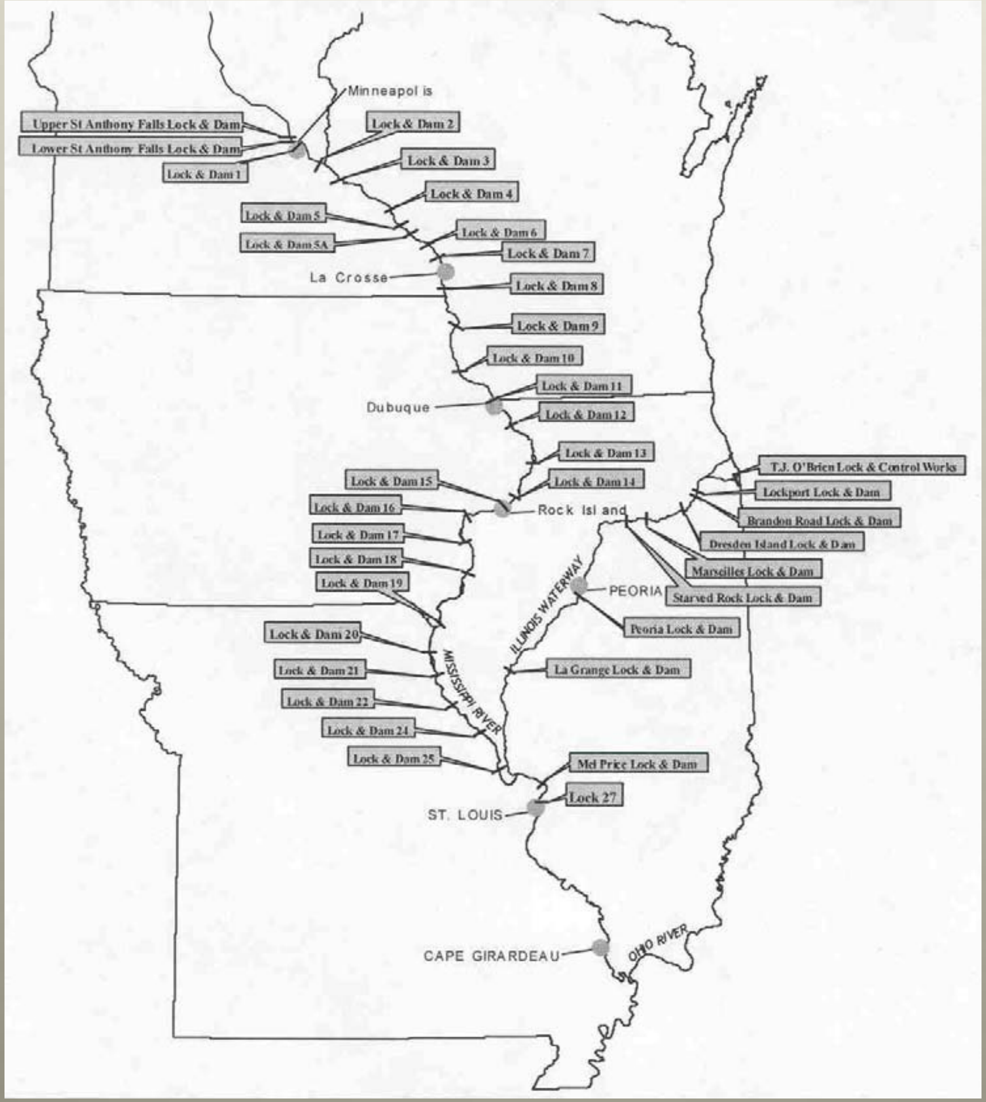
Evaluating the choice of alternatives and the use of alternatives requires a determination of how much time different users of locks require to pass the locks.

Locks

- Locks: Often necessary to make the river navigatable.



UMISS-ILL Locks



Lock Characteristics

Age (year lock was opened)
- 23 in 1920s and 30s
- 1 in 1940s
- 3 in 1950s
- 1 in 1960
- 1 in 1990

Chambers
- 24 have one chamber
- 5 have two chambers

Dimensions (main chambers)
- 22 are 110x600 feet
- 3 are 110x1200 feet
- 2 are 56x400 feet
- 1 is 56x500 feet

- “Brother Ole”

Locks Characteristics

- There are 29 locks on the UMISS.
  - 24 have one chamber
  - 5 have two chambers
- Dimensions (main chambers)
  - 22 are 110x600 feet
  - 3 are 110x1200 feet
  - 2 are 56x400 feet
  - 1 is 56x500 feet

Flotilla Characterisics

- Length of Flotilla:
  - 14,634 less than 600 feet (mean=426 feet)
  - 44,313 greater than 600 (mean=1053 feet)
- Width
  - All are less then 110 feet
  - 84 % greater than 56 feet

Lockage Characteristics

Flotillas generally are too large to fit into the lock. They often must pass the lock in multiple cuts.

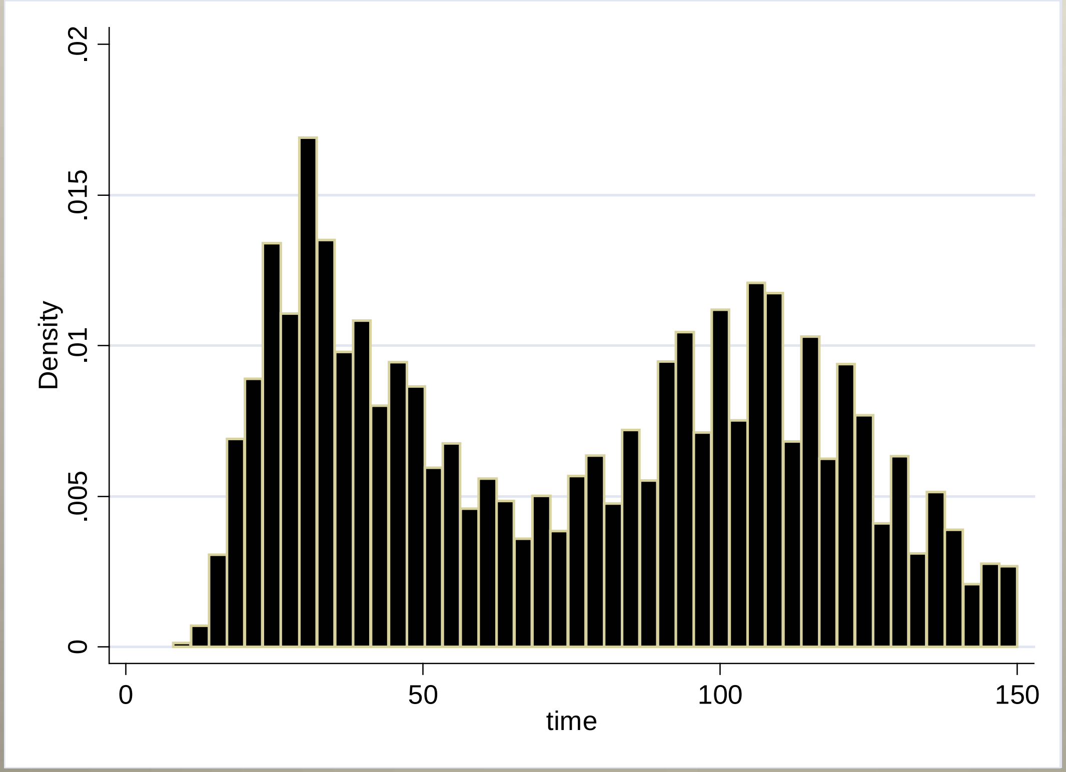
Cuts

- One cut
  - 29,263 lockages, mean time=42 minutes
- Two cuts
  - 29,969 lockages, mean time=107 minutes

Lock Length

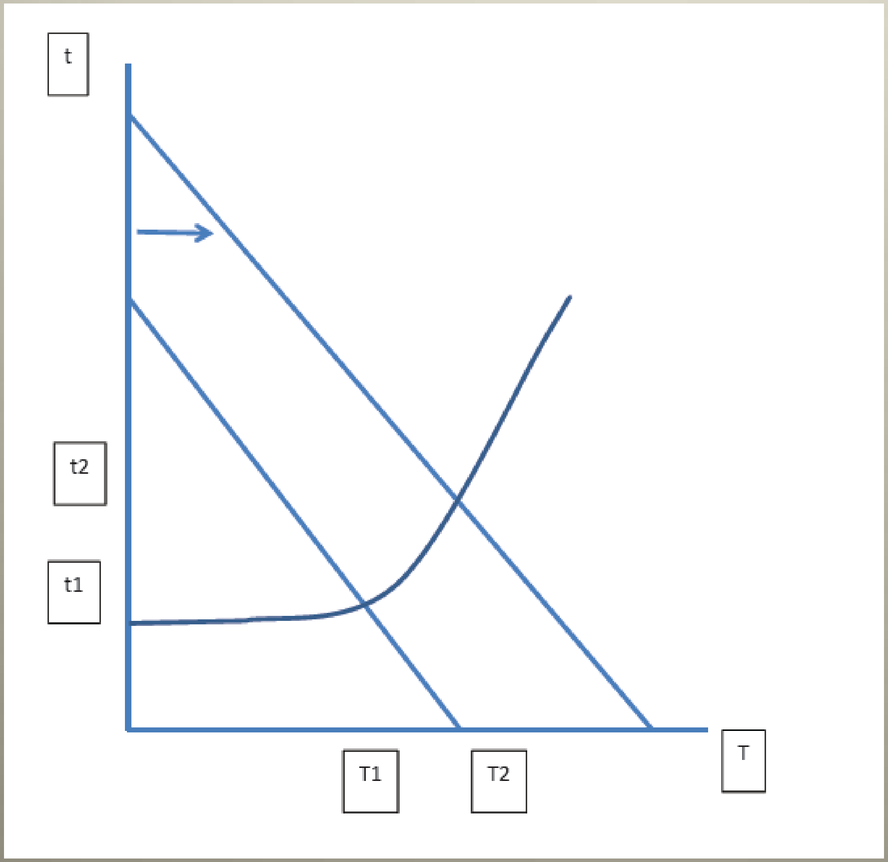
- 600 Foot Locks
  - 45,984 lockages, mean time=82 minutes
- 1200 Foot locks
  - 13,242 lockages, mean time=48 minutes

Processing Time
(End of lockage-Start of Lockage)



Back to Samuelson

- Growth in demand
- Old-outdated locks
- Growing Congestion



Forecasting

- Lots of approaches to forecasting

  -Non-structural: Use time series analysis to estimate changes in a variable through time. This can be done as a univariate analyis or by including other variables (Thoma & Wilson- www.corpsnets.us).

  Tons=f(variables(t))=tons(time)

  Advantage:

  relatively easy to apply

  Disadvantage:

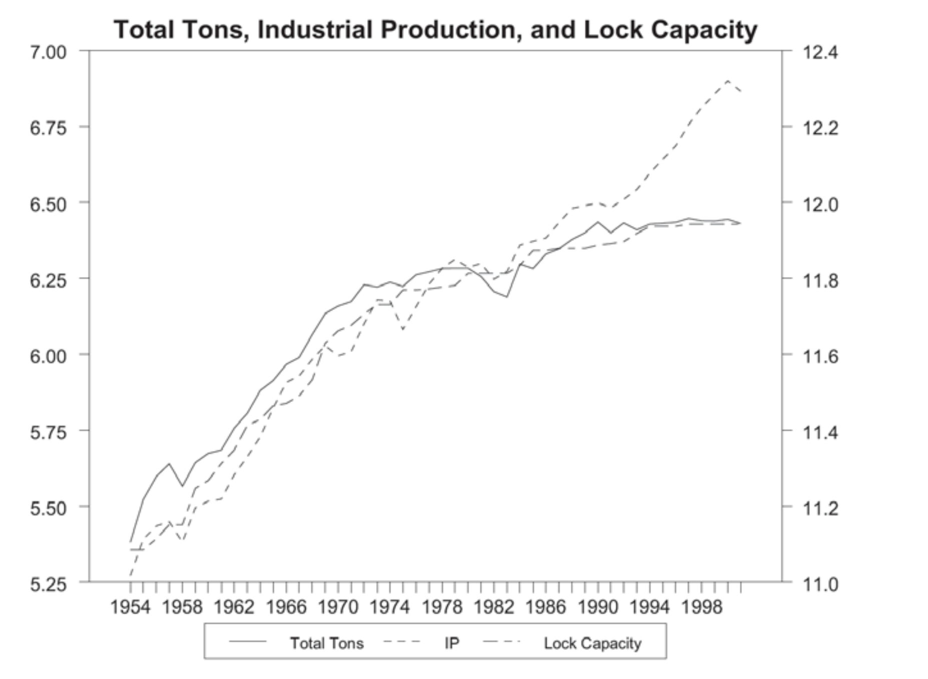
  no “structural” changes

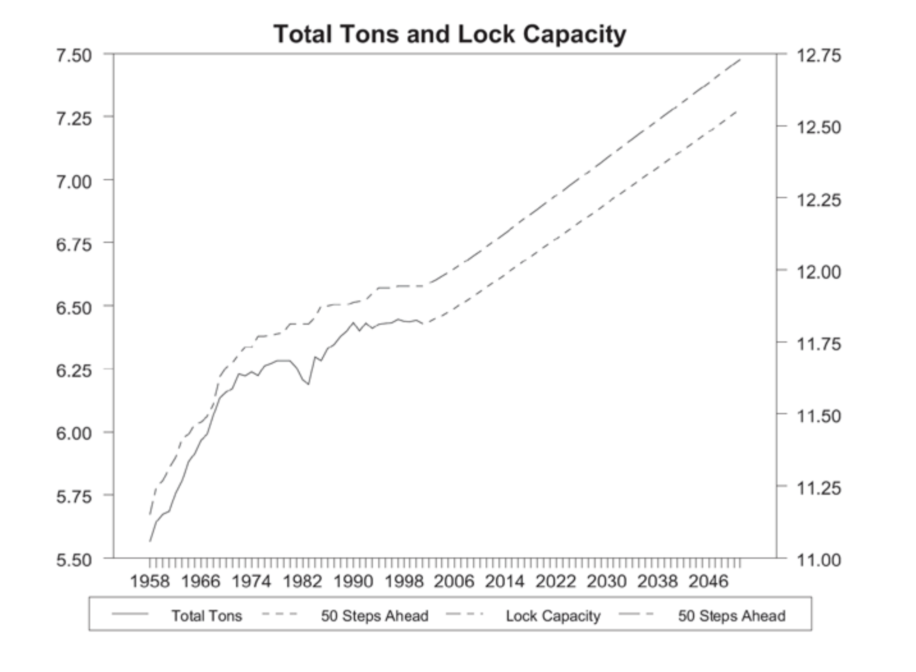
  -Structural

  write down an equilibrium model, forecast determinants of demand and supply (typically with a non-structural approach) and simulate the equilibrium values (e.g., William Wilson – www.corpsnets.us)

Non-structural to Upper Miss

- Growth Rates:
  - System: 1.68%
    - Upper: 1.45%
    - Middle 3.33%
    - Lower   2.97%


Total Tons, Industrial Production, and Lock Capacity
7.00
6.75
6.50
6.25
6.00
5.75
5.50
5.25
12.4
12.2
12.0
11.8
11.6
11.4
11.2
11.0
1954 1958 1962 1966 1970 1974 1978 1982 1986 1990 1994 1998
Total Tons
IP
Lock Capacity


Total Tons and Lock Capacity
7.50
7.25
7.00
6.75
6.50
6.25
6.00
5.75
5.50
12.75
12.50
12.25
12.00
11.75
11.50
11.25
11.00
1958 1966 1974 1982 1990 1998 2006 2014 2022 2030 2038 2046
Total Tons
50 Steps Ahead
Lock Capacity
50 Steps Ahead

Structural

- Estimate and Forecasts future demands in various countries (vertical demans)
- Estimate and Forecast future supplies in various countris
- In the context of Samuelson-this gives excess demand and excess supplies.
- Forecast transportation costs by mode, and allows for congestion on the waterway.
- Does different forecasts for different scenarios (e.g., ethanol, foreign country policies)
- Advantages: Allows for flows to/from countries, within US to ports by mode.
- Disadvantage is that if the structure or assumptions are wrong, the solutions may be wrong (very data intensive)

Result-structural

- Growth markets:
  - Consumption: China, North Africa, South Africa, and Middle East
  - Corn used in ethanol is expected to increase until 2020 then level **but policy and world oil markets matter.**
  - Productivity enhancement in rail, increases in delay by barge point to more rail without investment.

Summary/Conclusion

- The economics of networks is hard.
- Goods flow from point to point as a function of the price differences and the total cost of transportation
- Total cost of transportation increases in congestion, and the lock and dam system is old, outdated, and congested.
- Yet, waterways are central to keeping rail rates down.
- Forecasts point to continued growth, reductions in rail costs, and increased congestion levels on the waterway