Future Trends and Pressures on Inland Waterway

By

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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
• 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.
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 navigable.
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 Characteristics

- **Length of Flotilla:**
  - 14,634 less than 600 feet (mean=426 feet)
  - 44,313 greater than 600 (mean=1053 feet)

- **Width**
  - All are less than 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 analysis or by including other variables (Thoma & Wilson - www.corpsnets.us).
    
    \[ \text{Tons} = f(\text{variables}(t)) = \text{tons}(\text{time}) \]

  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%
Structural

• Estimate and Forecasts future demands in various countries (vertical demands)
• Estimate and Forecast future supplies in various countries
• 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