INLAND NAVIGATION ECONOMICS WEBINAR SERIES

#8 Elasticity of Demand - Shipper Responsiveness

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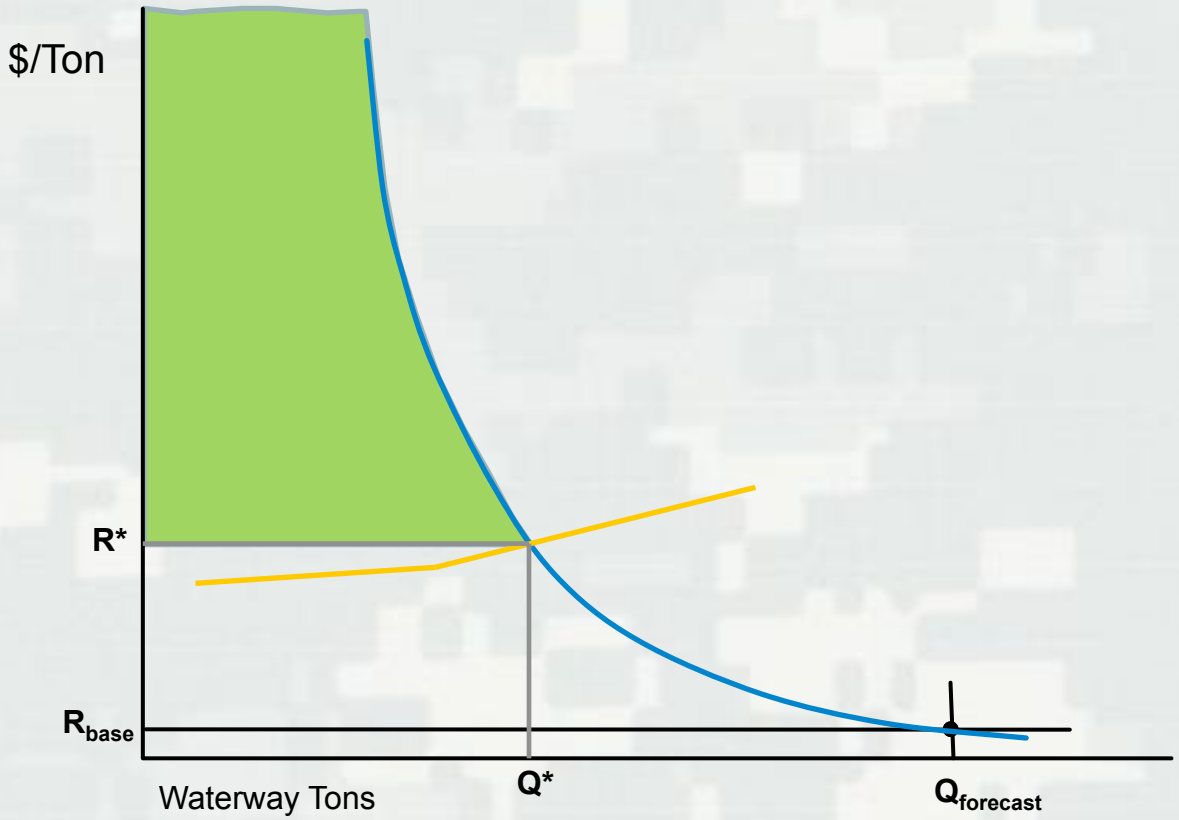
How will inland waterway shipping respond to changes in costs and delay?

1. Transform a forecast into a set of movements. (Define *movement*.)
2. Determine how to model the impact of changes in waterway costs on waterway traffic. (*Demand curves*).
3. Relate congestion, delay, cost and predicted traffic. (*Cost curve*)
4. Define the economic benefit of a predicted traffic level. (*Consumer surplus*)

A visual outline: How does this figure relate to waterway transportation?



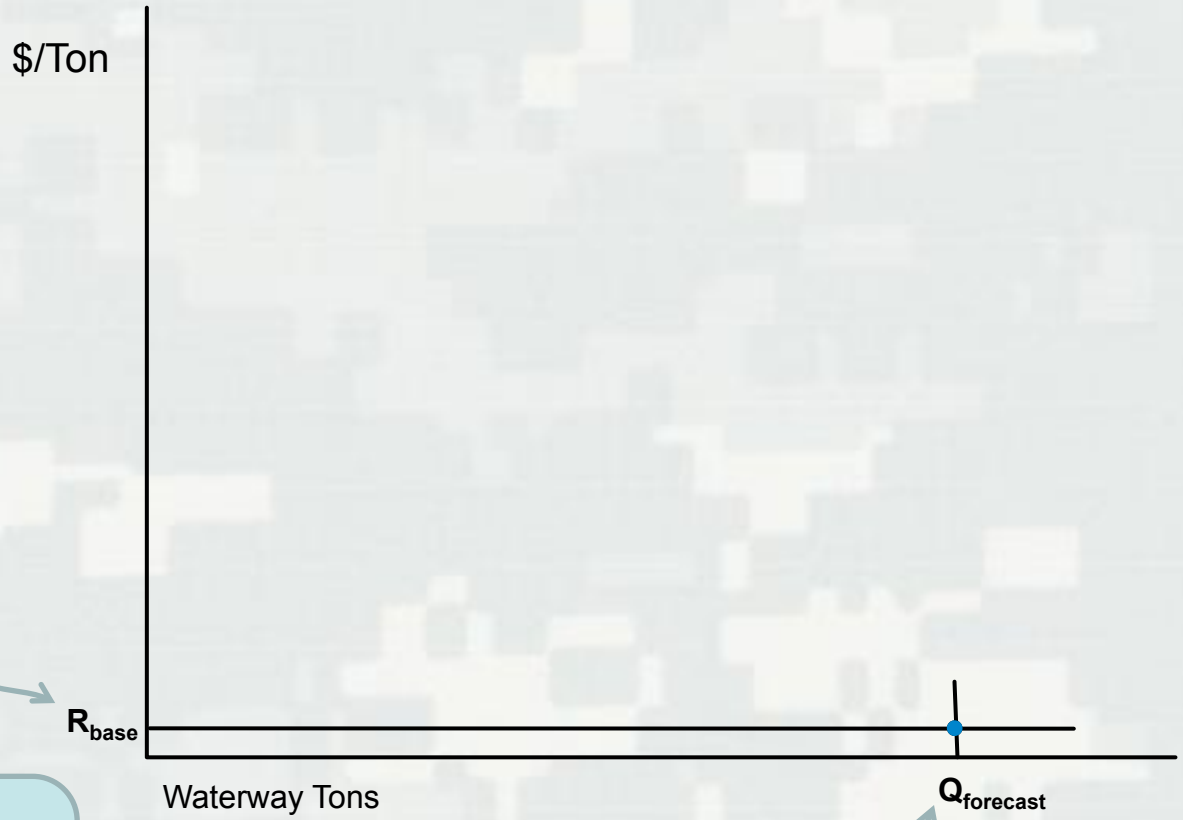
Transforming a forecast into a movement set.

- Movement is a data concept to allow modeling at a reasonable level.
  - ► Not the total for the waterway
  - ► Not an individual shipment (*e.g.* 5 barges on June 3rd.)
- A movement is the total potential annual waterway tonnage of all shipments that share a set of *critical attributes*.

Critical attributes of movements affect the cost of shipments and the response to delays.

- Origin, destination (pool or port complex)
  - distance, locks transited, re-fleeting options
  - regional cost variance, alternative transport/sources
- Commodity
  - holding costs (impact of delay)
- Barge type
  - tow configurations, operating costs, backhaul/empty movements
- Total Potential Waterway Tons (by year)
  - number of trips (not integer)
- NOT---same company, dock, facility

We are considering a single movement in a single future year.

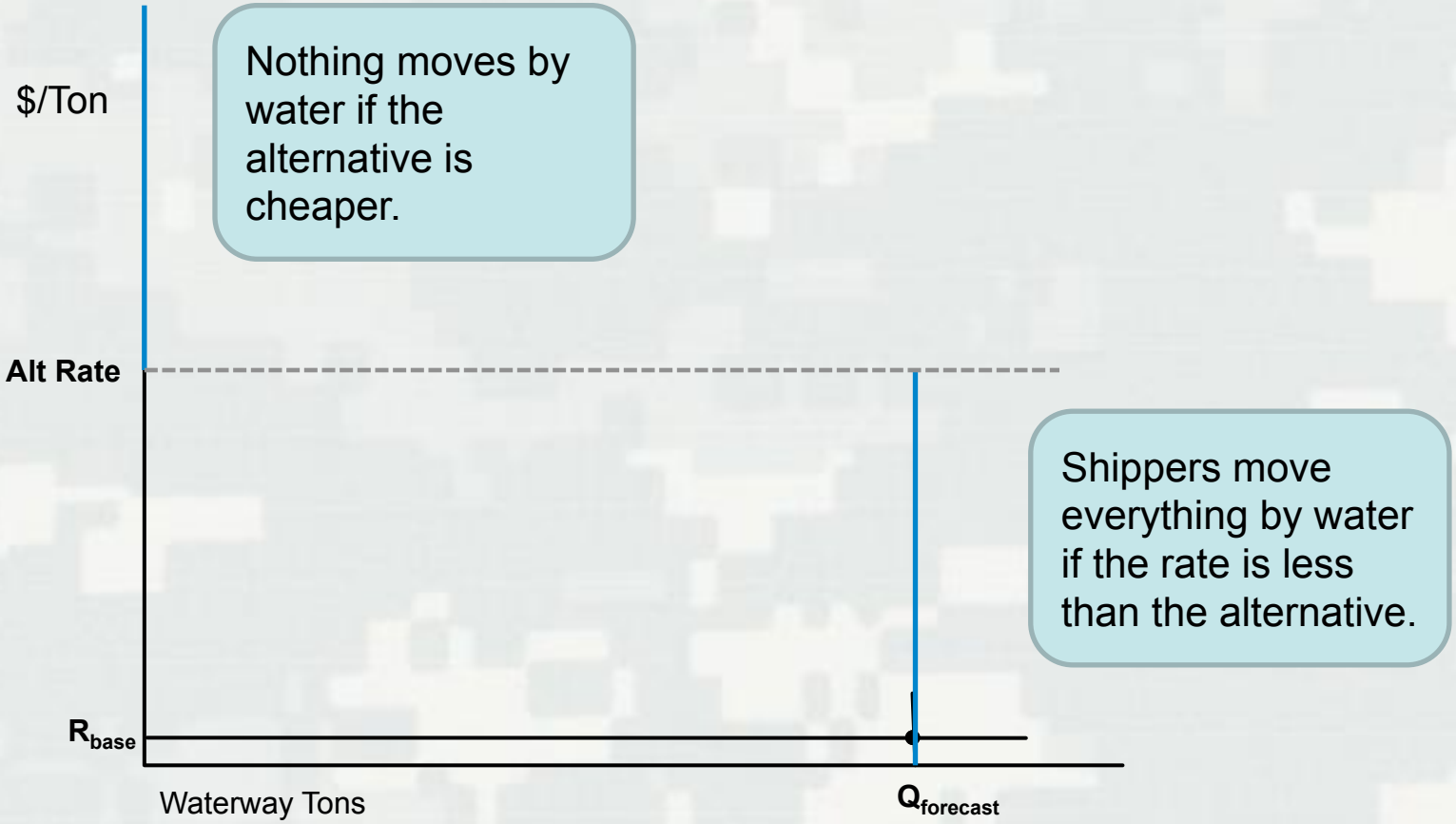


The forecast provides an estimate of potential traffic at the current Rate

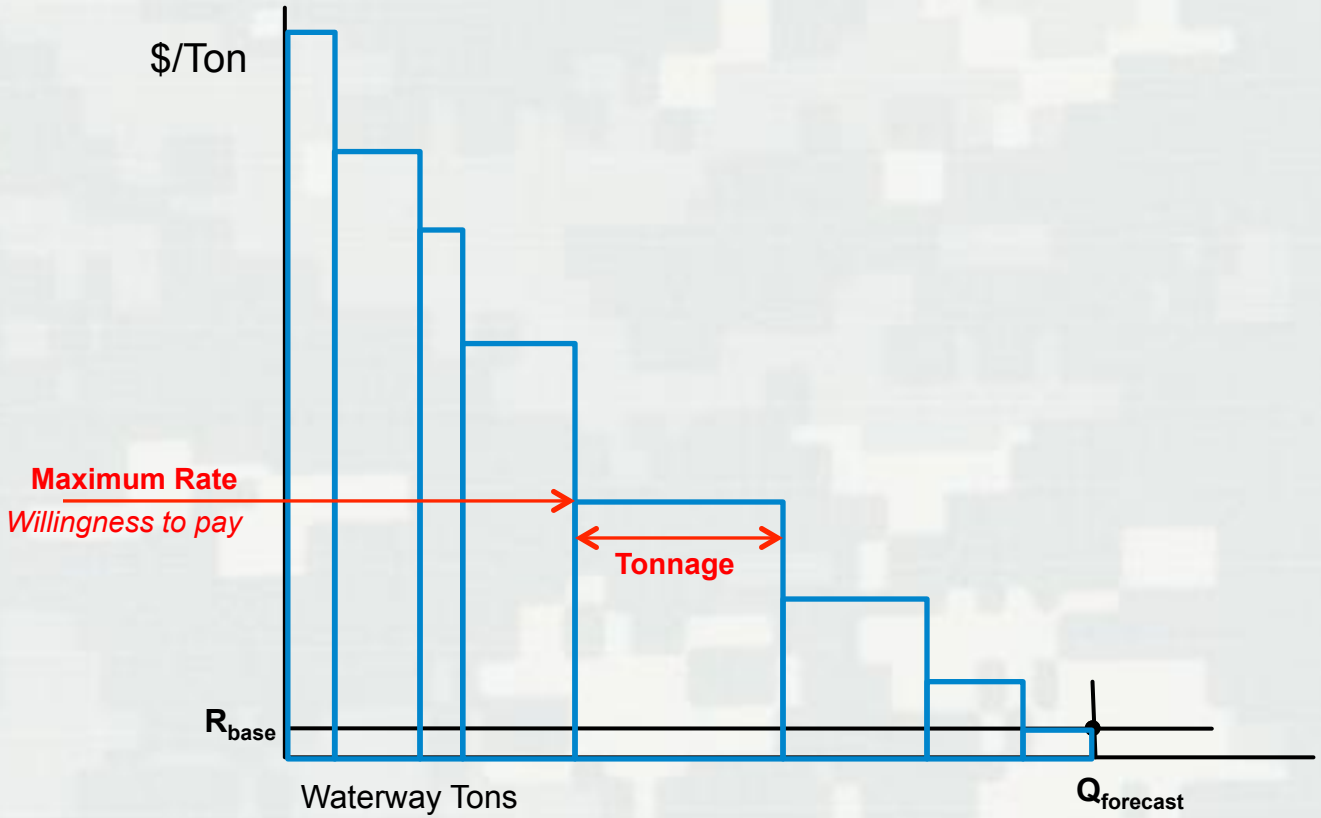
Simple model of demand
Constant Demand

- Total forecasted demand will be moved by either water or an alternative (typically rail).
- Shippers will move by water if it is cheaper.
- Total tonnage is move one way or the other.

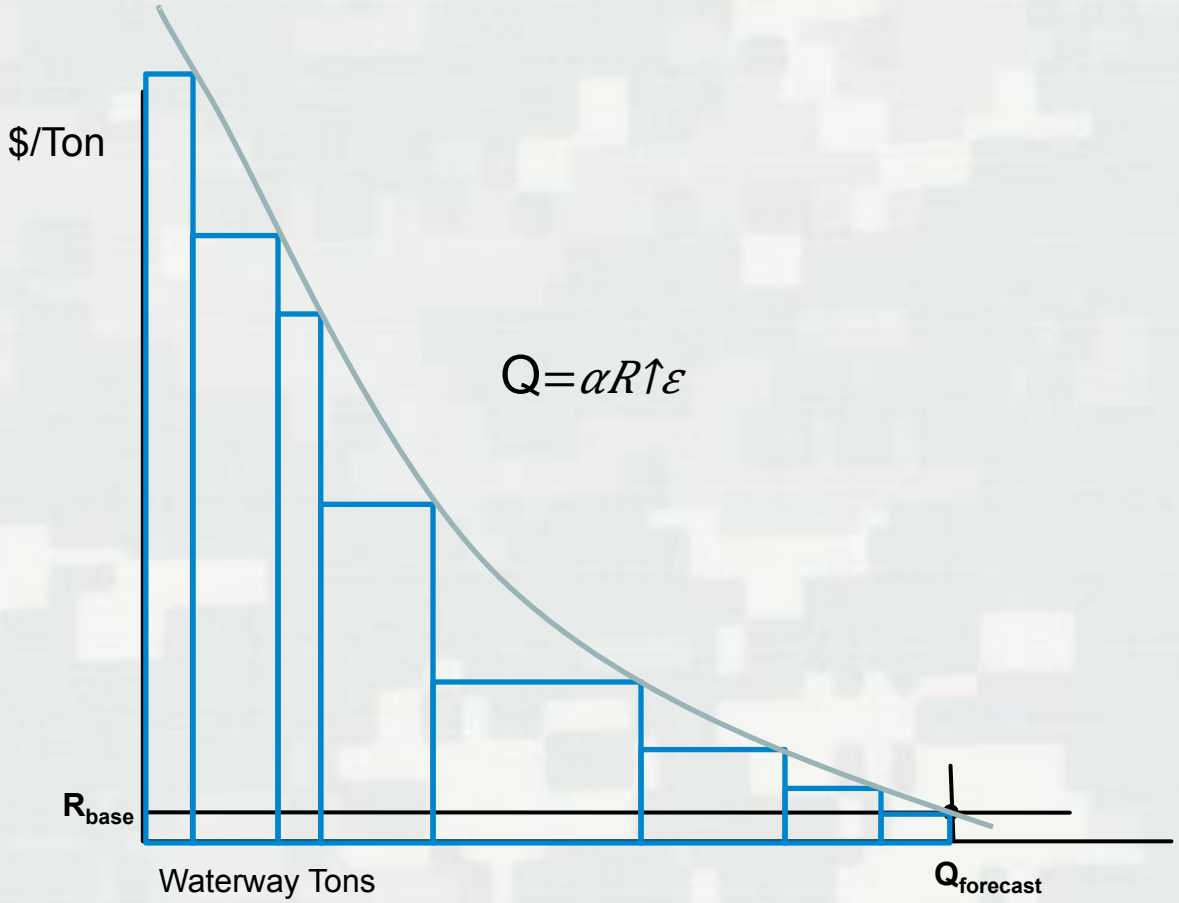
Constant Demand



To be more precise, we can assume different shipments in the movement have different reactions to rates.



We model this relationship mathematically as a demand curve.



Elasticity

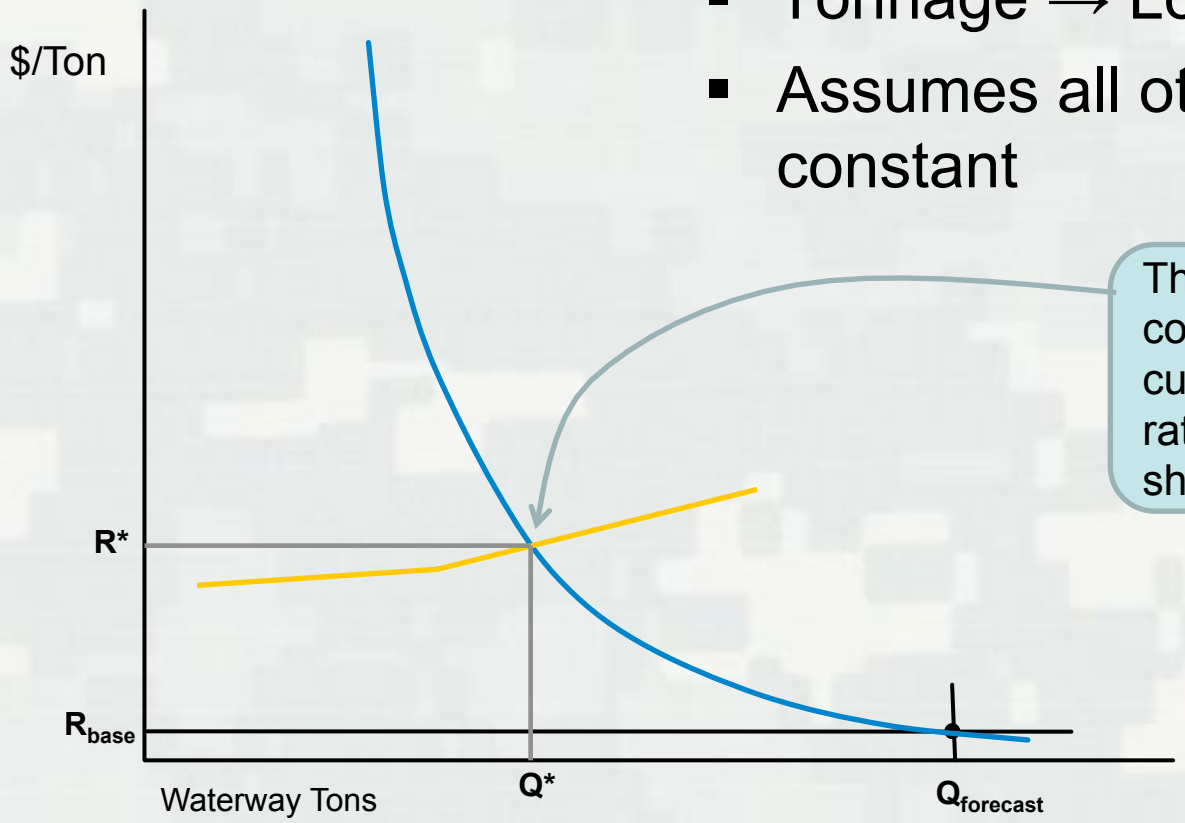
- $\varepsilon = \%\,change\ in\ quantity\ purchased / \%\,change\ in\ price$
- $\varepsilon = \%\,change\ in\ quantity\ shipped\ by\ water / \%\,change\ in\ waterway\ rate$
- $\varepsilon \leq 0$ because an increase in rate should create a decrease in shipping. Typically a small number (-4,0)

Determine a demand curve for <u>each</u> movement.

- Determine an elasticity (ε) based on movement characteristics such as commodity type.
- Determine α based on the forecast and base rate. $Q\downarrow forecast = \alpha Rbase\downarrow\uparrow\varepsilon$

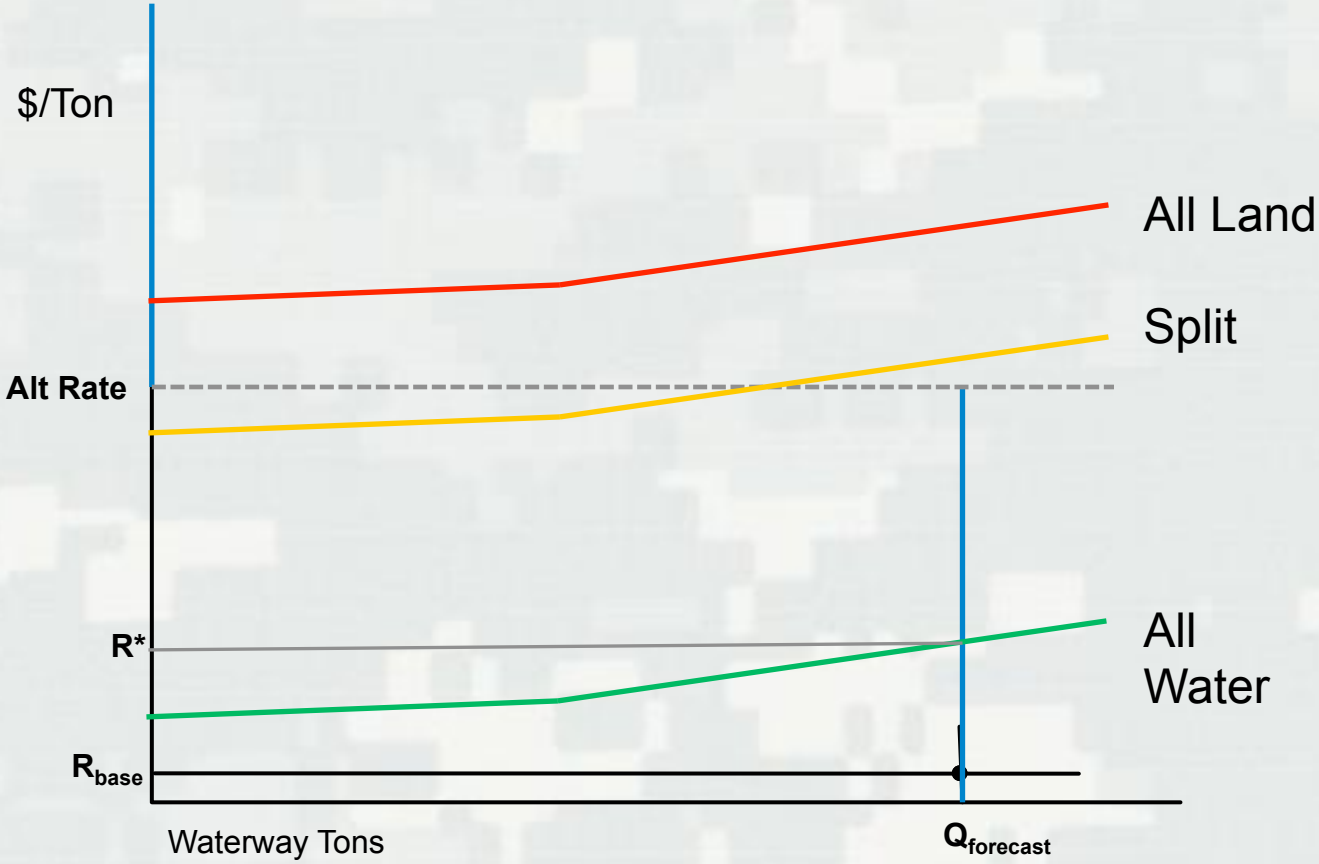
Conditional Cost Curve

- Cost = fixed rate + cost/hour*hours
- Tonnage → Lock Delay → Cost
- Assumes all other movements held constant



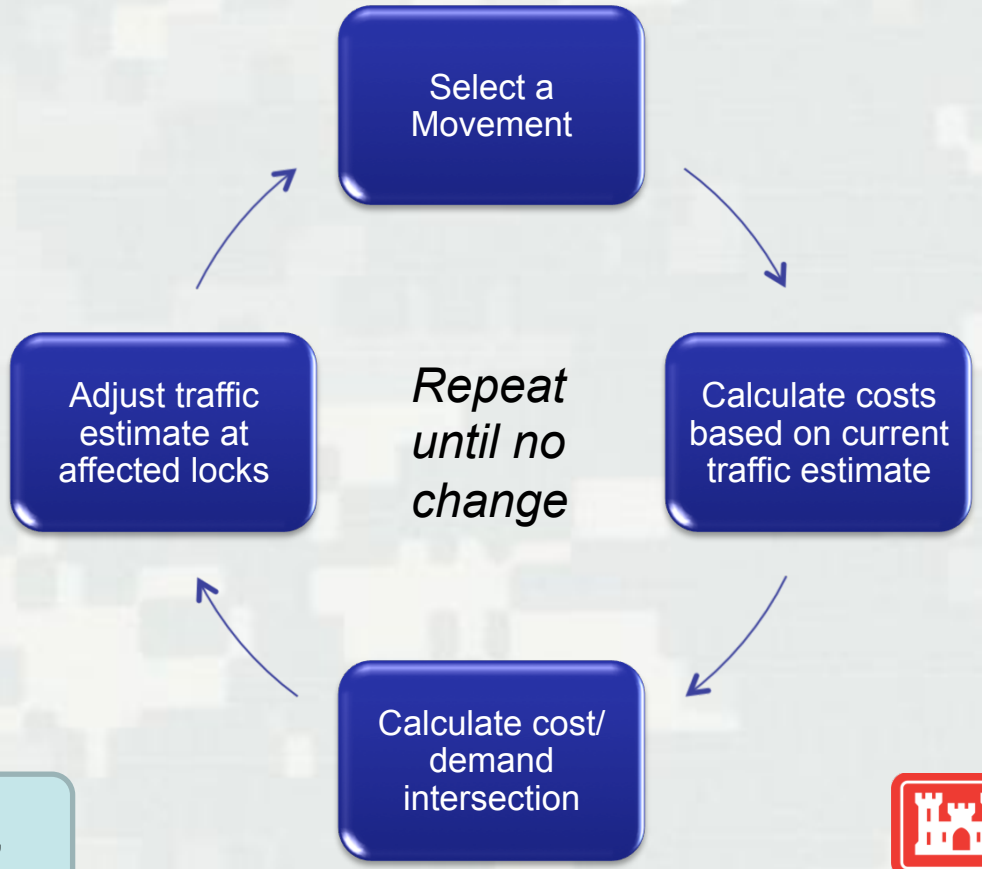
The intersection of the cost and demand curves determines the rate and quantity shipped by water.

Conditional Costs and the Constant Demand Form



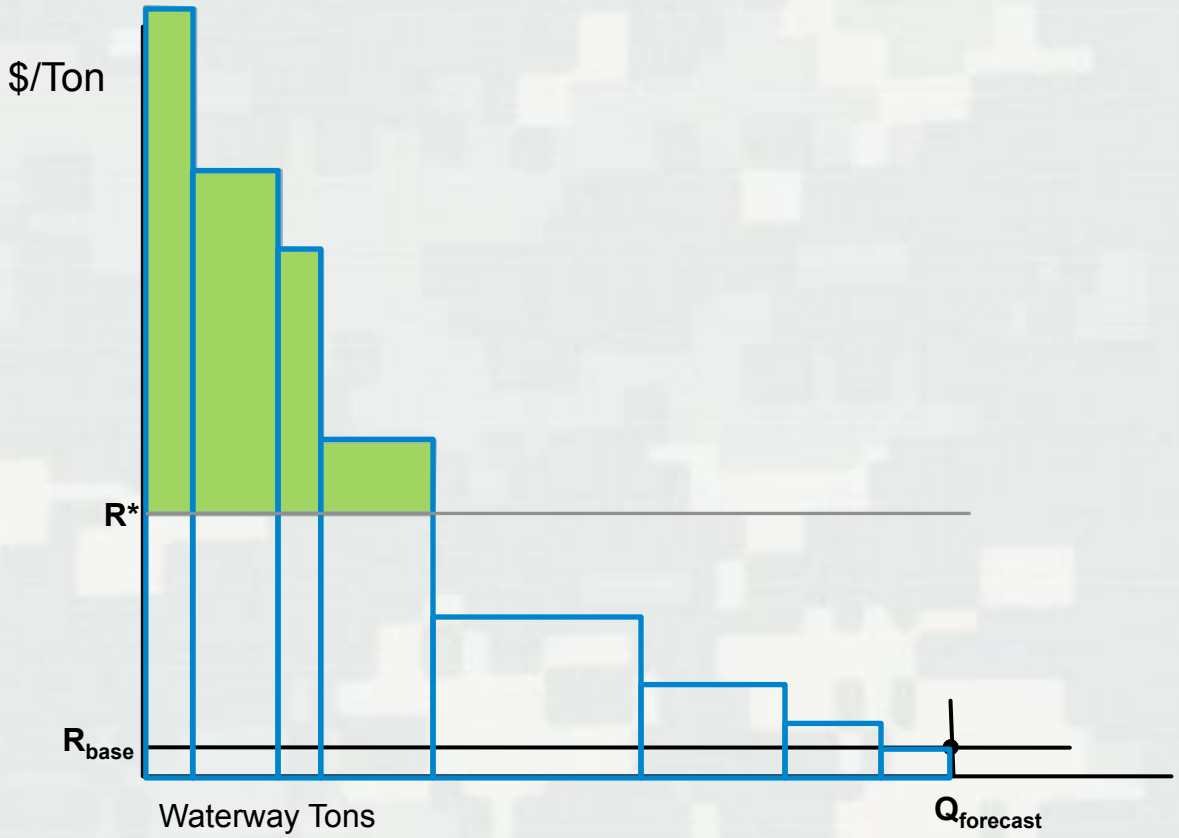
Each movement's costs depend on all the movements that it shares a lock with.

The Navigation Investment Model (NIM) finds the equilibrium traffic level.

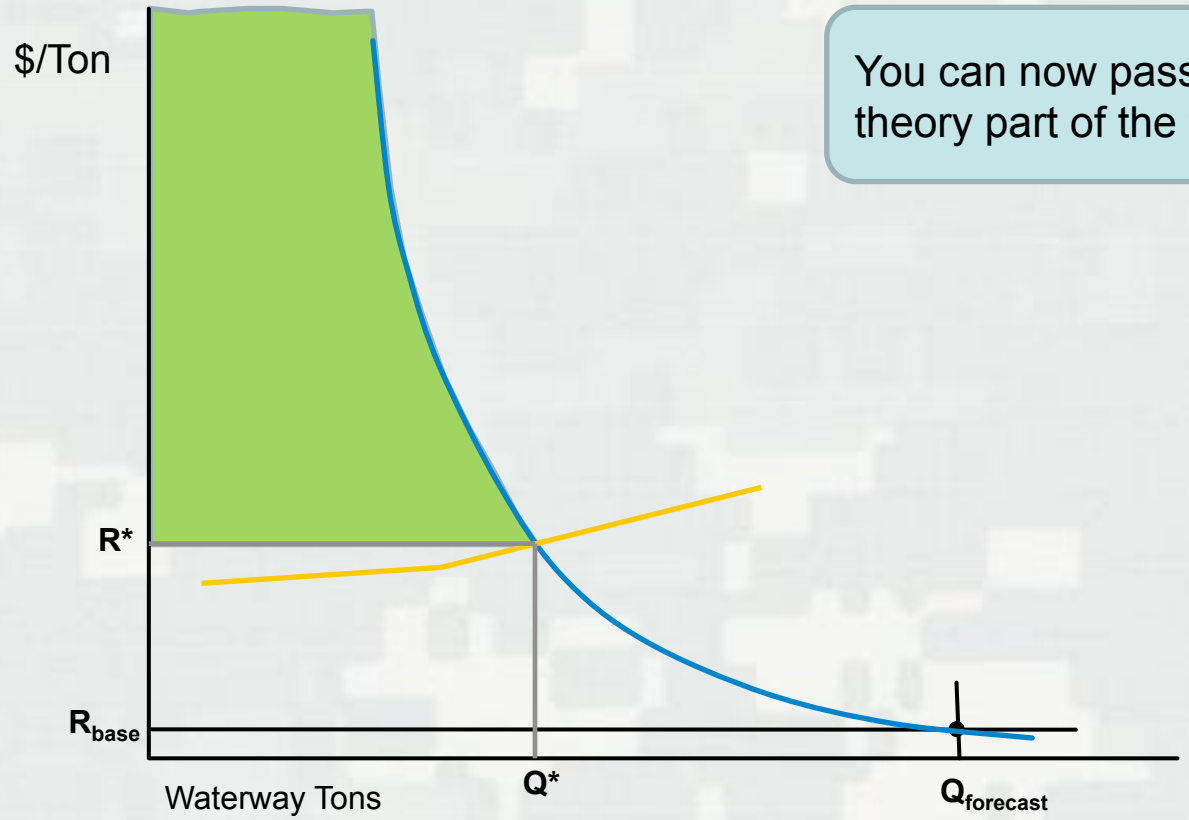


More on NIM in
"Navigation Economic System Modeling"

Once an equilibrium rate is found, we can estimate how much each “shipper” saved vs. their willingness to pay.



For our continuous model, we integrate under the demand curve and above the equilibrium rate.



You can now pass the theory part of the test!

Practical Issues

- How do I estimate elasticity?
- What if my data don't fit a "nice" curve?

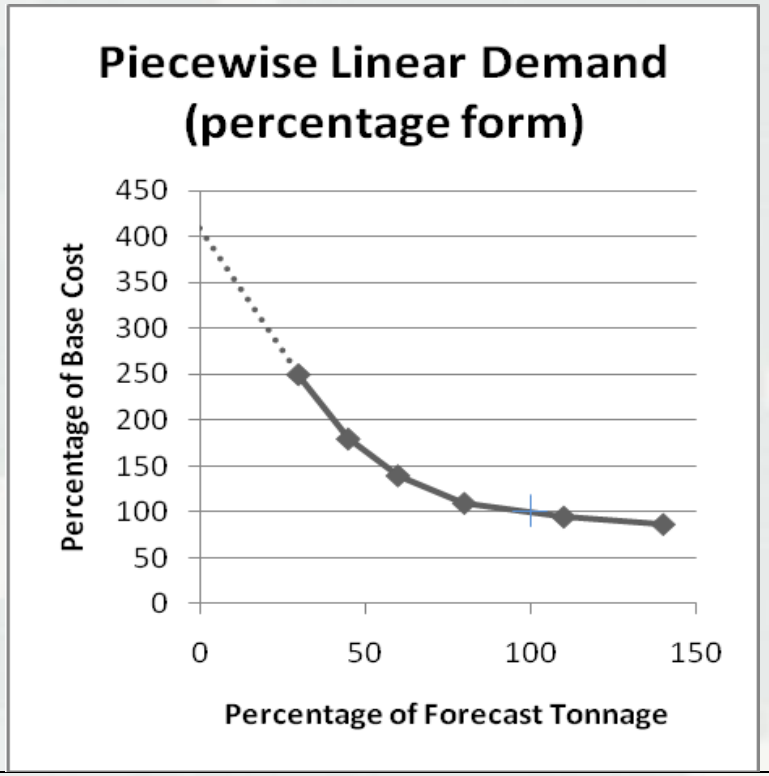
Estimating Elasticity

- Two approaches:
  - Ask shippers what they would do.
  - See what shippers did.
- Usually limited willingness to respond
- Must infer a pattern (model) from a small set of responses.

What if my data doesn't fit a smooth curve?

Create a generic format by commodity. Use the % format to scale the curve to the base rate and forecast tonnage.

% Base Quantity	% Base Rate
30%	250%
45%	180%
60%	140%
80%	110%
100%	100%
110%	95%
140%	87%



Major concepts from this session

1. *Movements represent a set of similar shipments.*
2. *Demand curves relate waterway rates to quantity shipped by water.*
3. *Cost curve captures the impact of all traffic.*
4. *Intersection of cost and demand determines rate and traffic.*
5. *Consumer surplus is the measure of savings for shippers vs. their willingness to pay.*
6. *Demand curves can be represented as:*
    1. *Constant demand*
    2. *Standard elasticity function*
    3. *Piecewise linear function*

Questions?