Modeling the Economic Impacts of Increased Border Security on Domestic Firms:

Simulations using the NISAC Agent-Based Laboratory for Economics (N-ABLE™)

Department of Homeland Security
Economics Roundtable
August 4, 2005

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Goals and steps

Goals

- Develop high-fidelity microeconomic software and supporting macroeconomic analysis to estimate the economic impacts of potential border security initiatives.
  - To support port security studies
  - To support national economic security
  - To support private industry policy

Steps

- Work to-date
  - Developed initial model of international cargo shipments, their use of ports, and downstream impacts to importing economic firms.
  - Constructed case study of imports through the Port of Tacoma.
  - Investigating extensions of modeled Tacoma delays to all container cargo imports in the U.S.
- Goal for today
  - Discuss how these methodologies and technologies could best evaluate the economic impacts of securing U.S. borders

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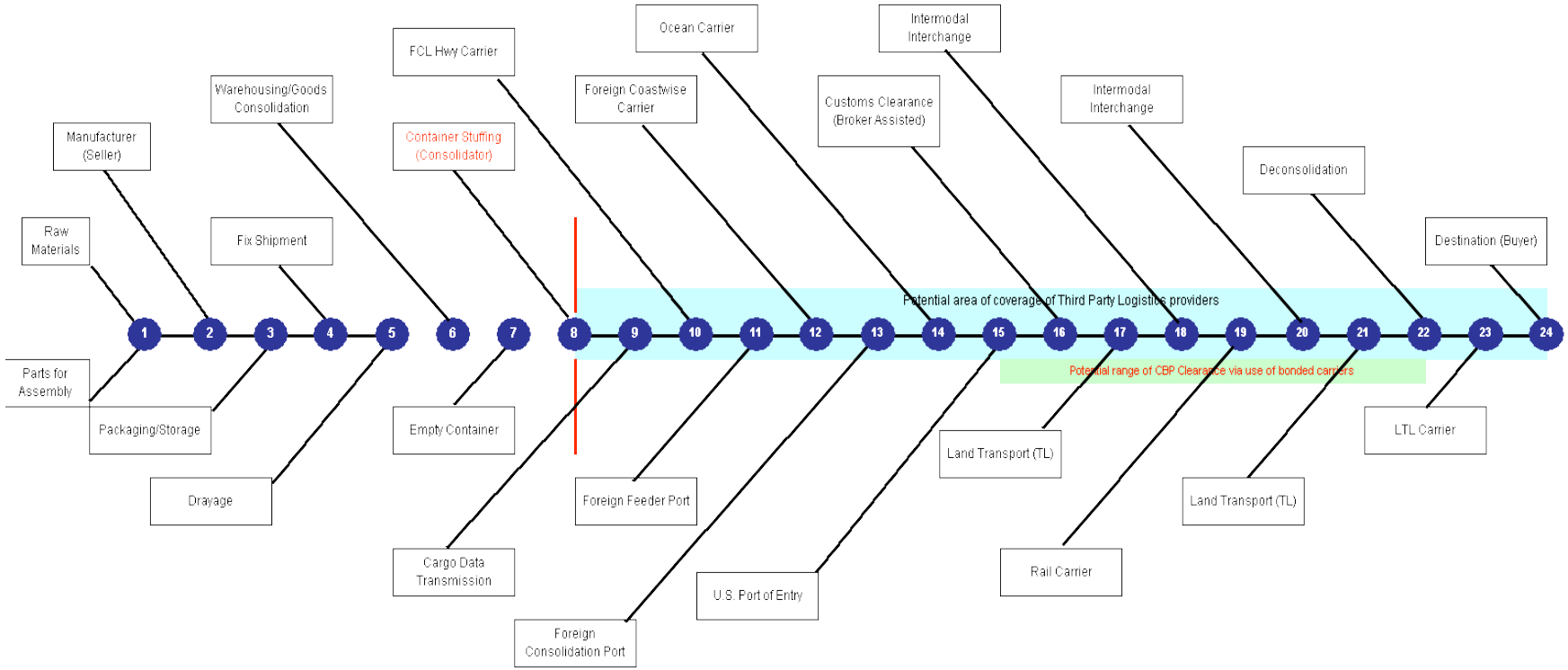
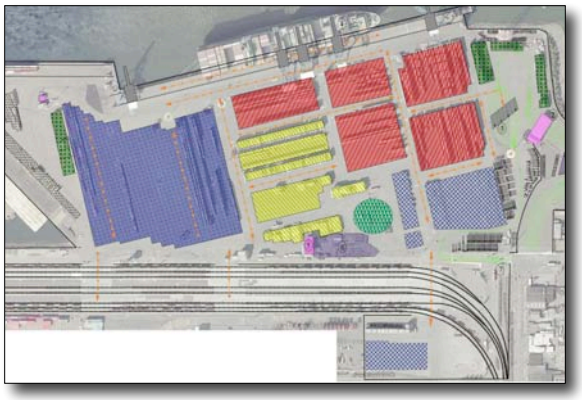
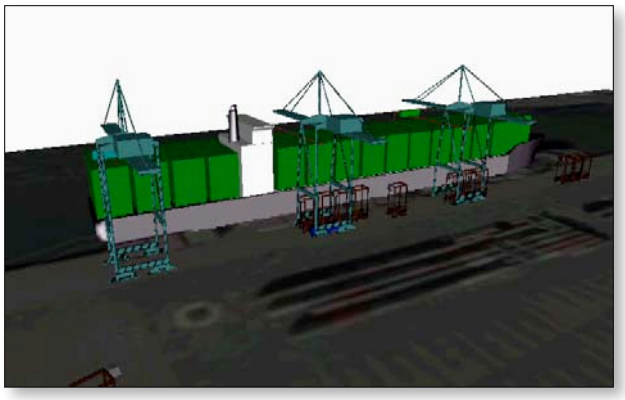
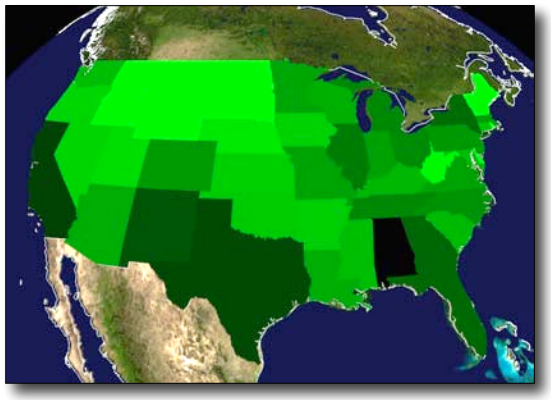
What it takes to import cargo









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What are the right economic methodologies to apply?

- Benefit-cost analysis
  - Investment in alternative security technologies/practices
    - "Do nothing" verses alternative investment strategies
    - Decision makers can be the ports, regional economic development agencies, state governments, federal authorities
- Microeconomic analysis
  - How are firms impacted by changes in security?
    - Changes in sales, operating costs, competitiveness
- Macroeconomic analysis
  - How is the structure of (aggregate) economic activity affected?
    - Changes in output, employment, income, imports/exports
    - Across sectors, regions of the country, and time

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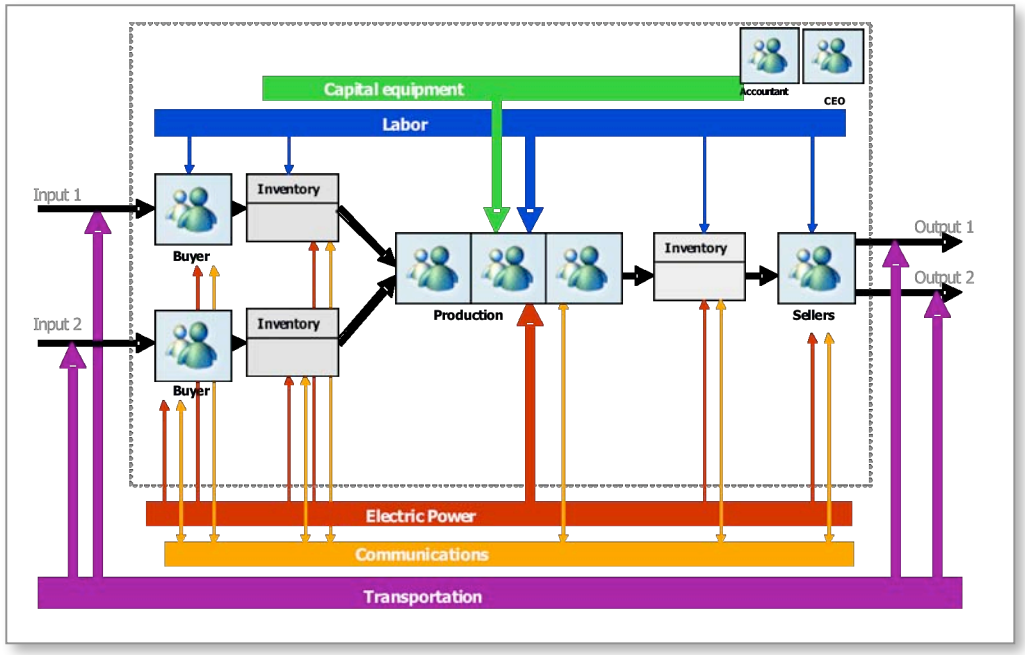
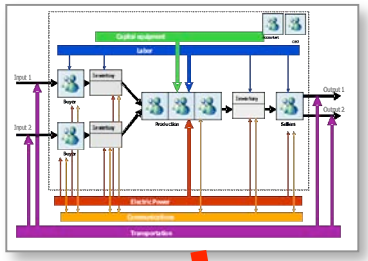
NISAC Agent-Based Laboratory for Economics (N-ABLE™)

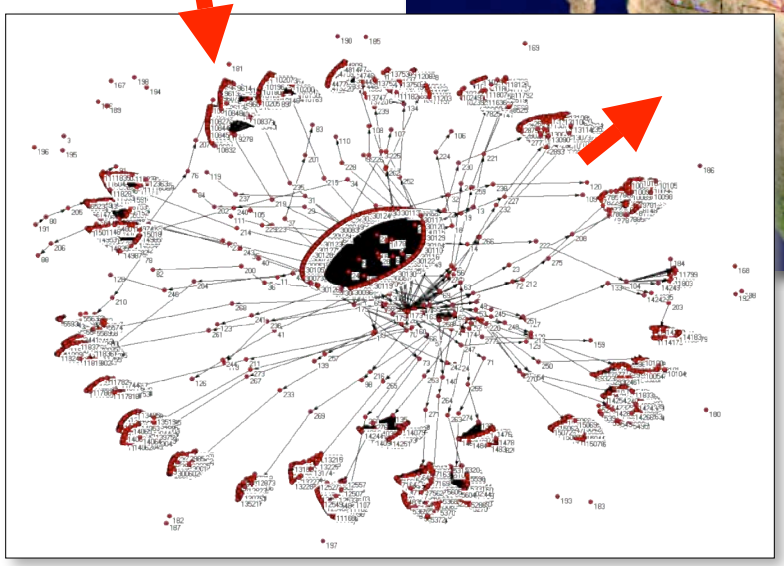
Architecture

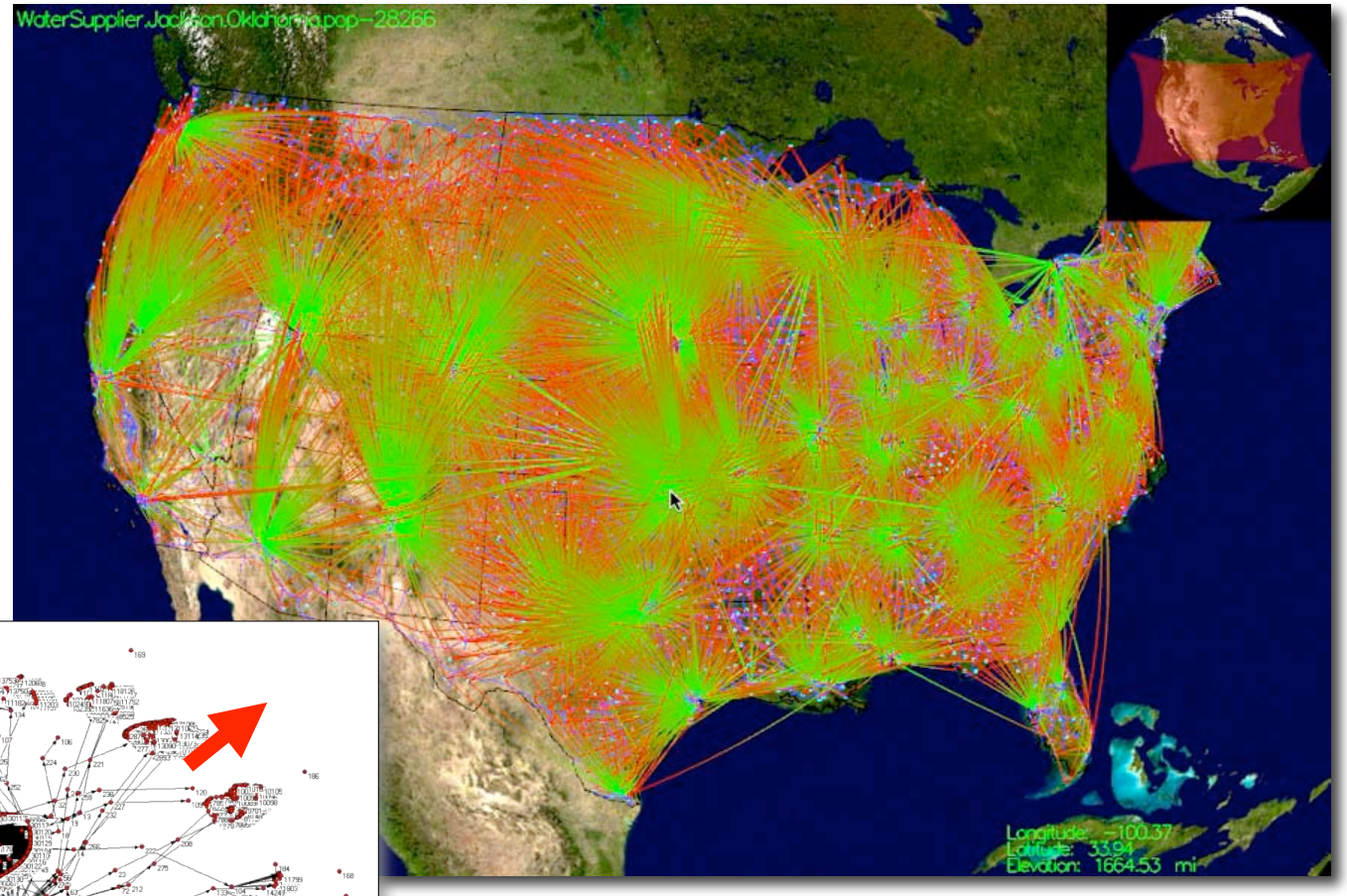
- Data-driven microeconomic "enterprise" firms are created from publicly available data and data-driven architecture; calibrated against other models (e.g., REMI)
- Overall system is designed for simulations running up to 10^6 firms on Sandia's 1024-processor parallel computing clusters.
- Models of how firms use critical infrastructure and collectively adapt to infrastructure disruptions.



Constructing a microeconomic simulation







Markets and supply chains are created using known and modeled regional/national market relationships.

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An example: what are the economic impacts of stopping chemical shipments during elevated threat levels?

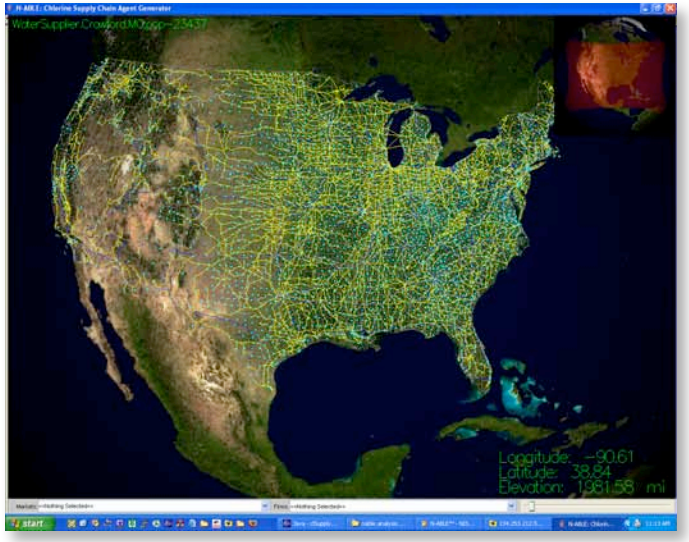
Simulations were conducted of the intra-and inter-firm economic impacts to 3,300 chemical-related firms of disruptions to its rail transport.

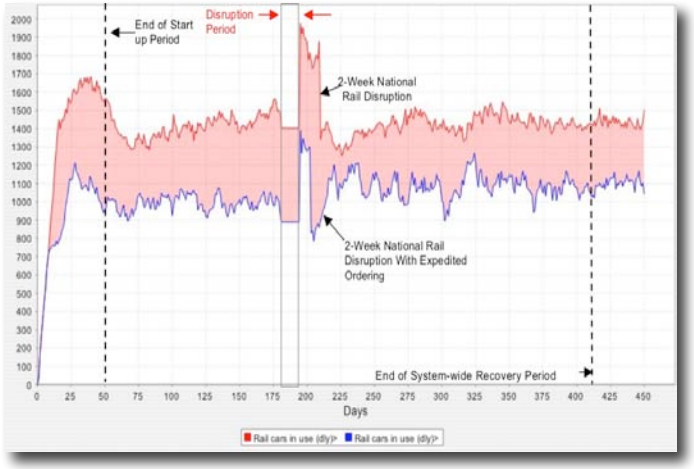
When transport is disrupted

- Less than a week: only inorganic chemicals firms that ship by rail are impacted;
- 1 to 2 weeks: 128 inorganic firms and 2 other large users have production stoppages and revenue losses;
- Greater than 2 weeks: Inorganic and pulp & paper experience market share losses, most organic chemicals and other firms impacted by chemical supply shortages;
- Total impact to national GDP of four-week disruption: $10 Billion.

Larger firms are affected more than small, both in terms of lost output and vulnerabilities to regional chemical supply markets.

A policy of optionally expediting rail cars decreases in-transit inventories of the chemical by 40%, significantly reducing the potential of these railcars being used as weapons of mass destruction.





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REMI model of the U.S.

Dynamic econometric model

- I.O. components for inter-industry "pull"
- Multi-year market disequilibrium conditions
- Trade and employment closure conditions
- CEG, Keynesian, and econometric, historically observed output/employment/price conditions

Most widely used, heavily documented, peer-reviewed dynamic macroeconomic model available

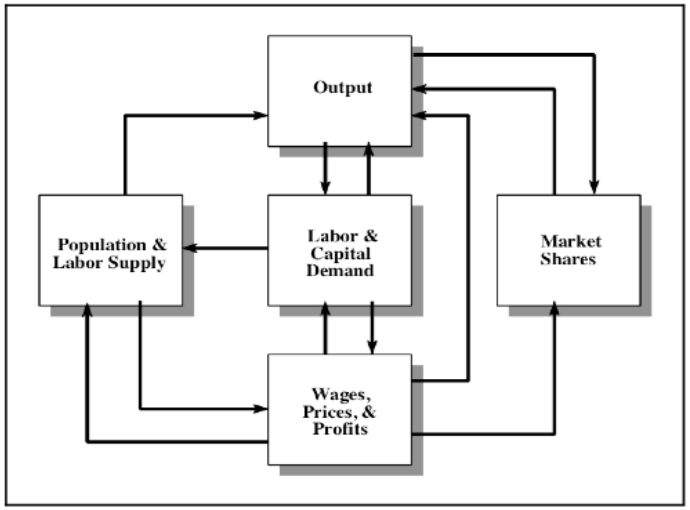
Used within NISAC for analysis of disruptions to

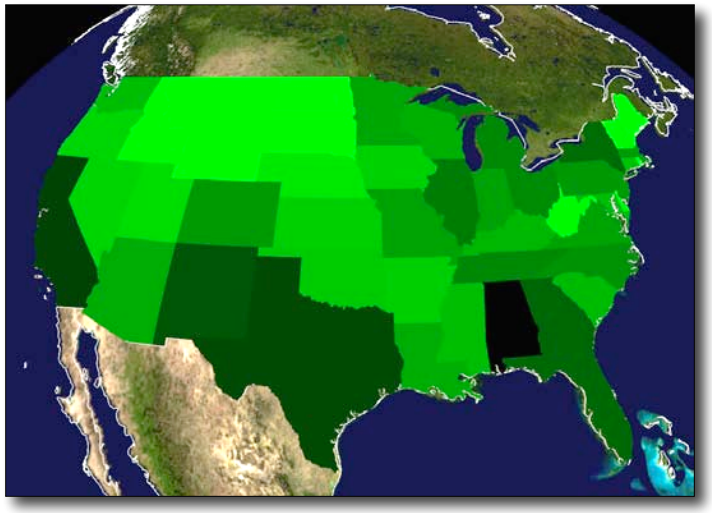
- chemical transportation
- air-freight,
- seaport shutdowns and security
- manufacturing impacts

Used elsewhere for energy, environment, taxation, forecasting, national policy issues

NISAC version:

- 51 regions (50 states plus DC)
- 70 2-digit NAICS industries
- Can be integrated real-time with N-ABLE and other software





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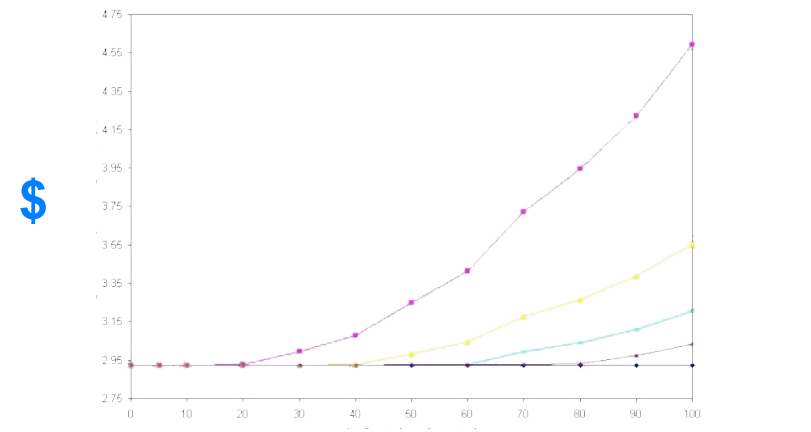
Our approach

Determine the economic impacts of increasing the average travel time of container cargo into the U.S.

- What are the effects of increasing both the average transit time and the variability of the transit time?
- Specifically, is there a increases in transit time over which there are insignificant economic impacts?

Economic impact of additional security



Steps

- Model and simulate the supply chains that are processed through the Port of Tacoma and how the destination firms are affected by these port delays.
- Estimate the direct, firm-level impacts of these delays and indirect, rest-of-economy impacts.

Port of Tacoma Data
↓
Port simulations
↓
N-ABLE: microeconomic firm / supply chain simulations
↓
REMI: regional macroeconomic model of the United States

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Port of Tacoma data set

PIERS (U.S. Customs) dataset

- 20,000 records representing 25% of all imported cargo through Port of Tacoma
- Distilled down to 231 records representing approximately 80% of TEUs in 20,000 records.

Cross-referenced with Dunn & Bradstreet financial data; resulting combined data:

- Foreign port of loading and possible intermediate ports
- Commodity imported
- # TEUs converted to metric tons
- Estimated value of the goods in (per TEU)
- Containers, in TEUs, by quarter (to analyze import patterns)
- Company information
- Employment
- Sales

DOT Freight Analysis Framework, and Transportation Strategies, Inc.

- 25% transferred to truck (point-to-point, shortest path)
- 75% to rail (circuitous; guaranteed in, e.g., 15 days)

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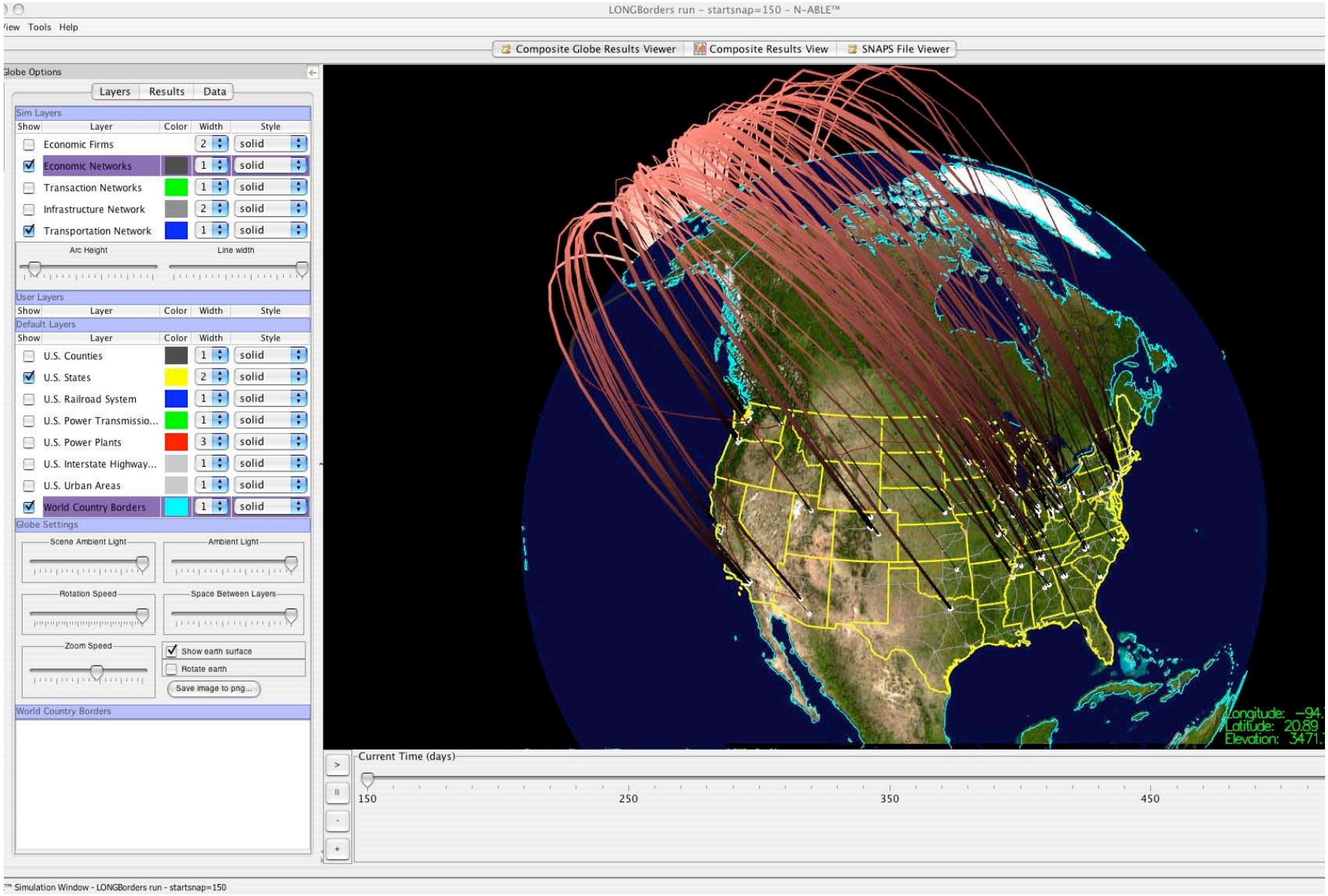
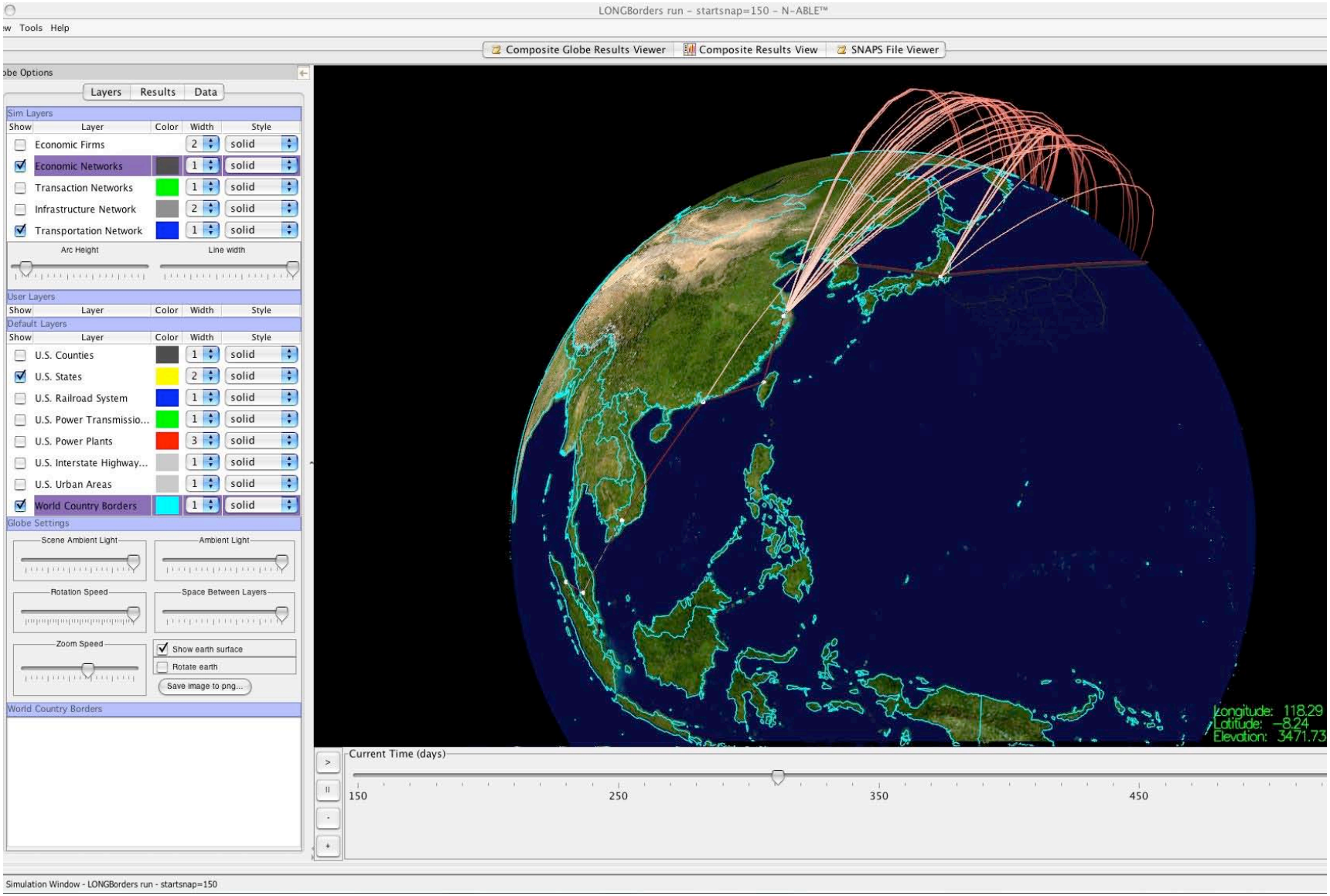
Importing firms



Foreign ports



Preliminary N-ABLE results: on-site and in-transit inventories

Inventories indicate supply chain problems

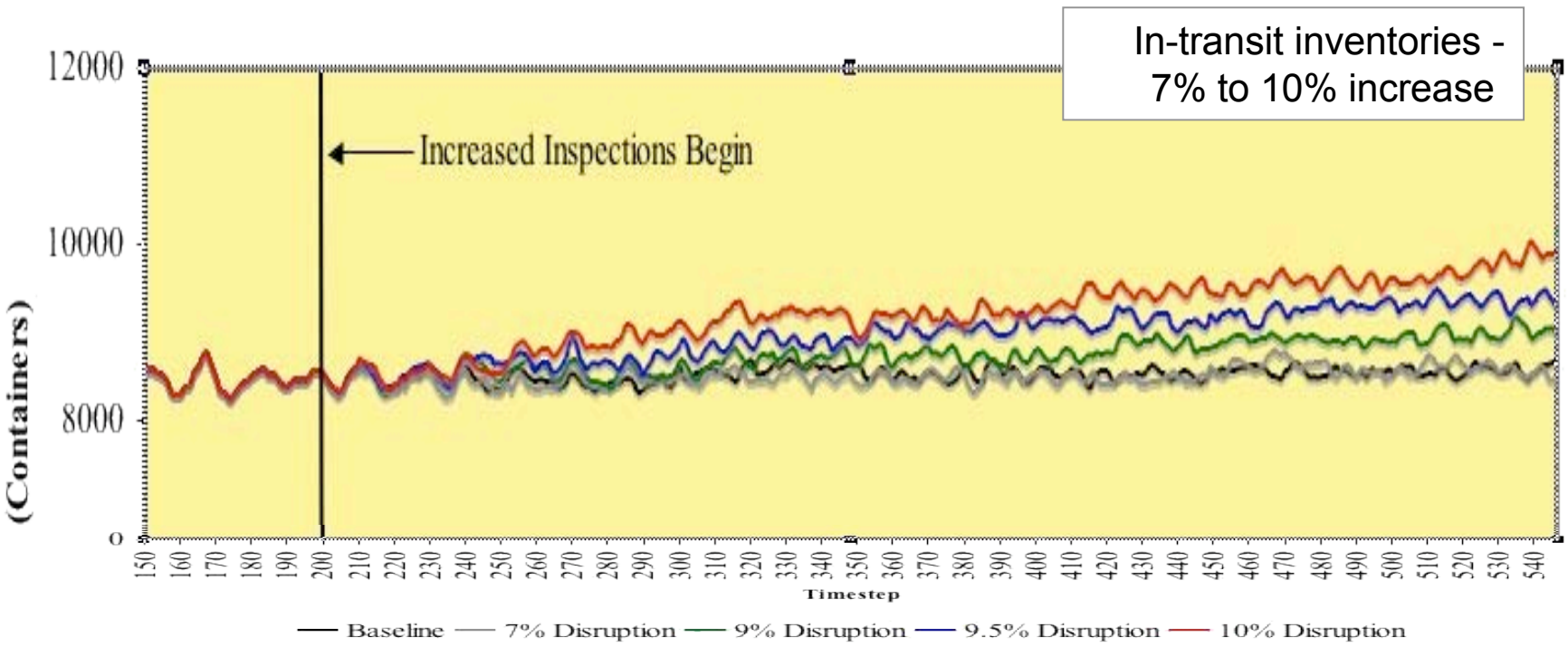
- on-site inventories are constrained by available space; in-transit generally unbounded (except for constraints on infrastructure / shippers)

1% to 6% increases in average travel time cause imperceptible changes in average in-transit

- this suggests that increasing average transit times up to this level would result in imperceptible downstream economic impacts

BUT: a 10% increase in average total travel time increases in-transit by an estimated 17%

- "signal" starts to exceed "noise" that is inherent in system.



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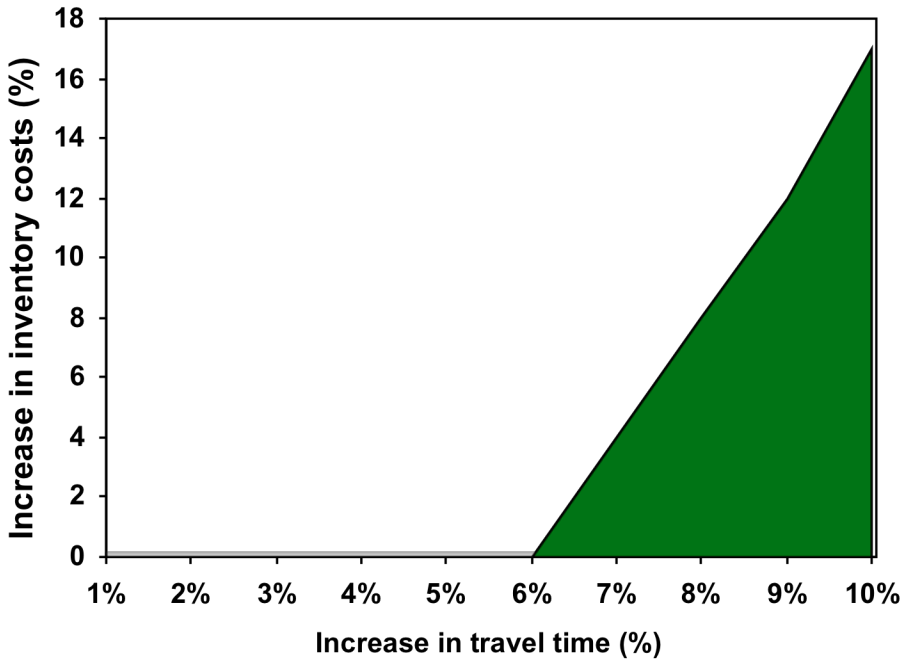
Impacts on importing firms of increasing inspection rate



- Firms importing through Tacoma represent over $50 billion in sales.
- A 10% increase in average travel time increases their in-transit inventories by an estimated 17%, increasing overall operating costs by 1%-2%.
- This can reduce their average sales by 0.5% to 1% ($5 billion)
- REMI analysis will estimate macroeconomic effects of Tacoma and other ports

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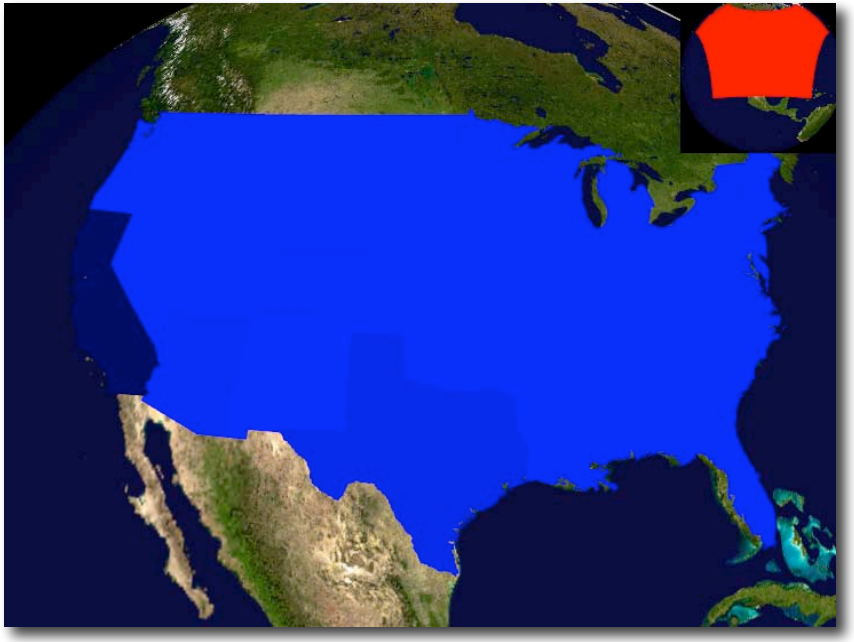
Macroeconomic impacts to retail and manufacturing sectors

What if <u>all</u> U.S. ports implement security protocols that increase average shipment times?

- Retail sector: conducted REMI simulations of increased shipment times in all Tacoma-like imports (i.e., retail goods)
  - Production costs ↑
  - Sales prices ↑
  - Sales ↓
  - Employment/income ↓
  - Induced effects propagate…
- Manufacturing sector: much more complex
  - Fewer imports, but
  - Output goes up in some sectors and down in others (technological shifts)



Retail: California impacted the most, due to large demand based and import fraction.

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Preliminary results

Economic impacts

- A 10% increase in total travel time increases in-transit inventories by an average of 17%; individual shipment times depend on distance of shipment, industry consumption of good, on-site inventories (including JIT, multi-echelon parts "banks")
- May require higher than currently considered inspection levels to have impact on broad retail sector
- Firm size matters:
  - Large firms, e.g., Wal-Mart, have very thin profit margins; a 1% increase on transport costs has significant impacts to them.
  - Small firms generally do not have the staff to monitor & correct increases in shipping time.

Policy implications

- Some increase in container shipments will have an imperceptible economic impact
- For larger impacts, firm size matters:
  - Large firms likely to self-select to CTPAT
  - Small firms (the lion's share of manufacturing) may not; will suffer economically.
- Port operators
  - If Tacoma tries to cover cost by unilaterally increasing premiums, it is generally safe from price effects (LA/LB currently at capacity, but Vancouver is potential option for subset of shipments)

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Roundtable discussion

What are the three biggest borders-related policy questions for DHS right now?

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