Transport Networks and Internal Trade Costs
Quantifying the Gains from Repealing the Jones Act

Scott N. Swisher IV and Woan Foong Wong

University of Cambridge and University of Wisconsin-Madison

December 2, 2015
We quantify the effect of repealing the Jones Act (Merchant Marine Act of 1920), a current trade restriction in the United States. Requires that all ships carrying freight between US ports (Jones Act ships) satisfy the following rules:

- Ship was built in the US
- 75% of the ship’s crew are US citizens
- Ship is 75% owned by US citizens

To ensure the existence of a US merchant fleet that can assist in national defense in the case of a war or national emergency.
Unintended Consequences of Jones Act

- US shipbuilding and shipping industries are thus highly protected and uncompetitive
- Jones Act ships are more expensive
  - Construction costs 3 times more than abroad
  - Daily operations cost at least 2 times more than foreign vessels
- Jones Act ships are older
  - 3 times older than foreign ships (on average 11-12 years)
- Jones Act ships are too few relative to demand
  - 17% fall in oceangoing Jones Act ships from 2006 to 2011
  - Crude oil forced to take riskier modes of transport, more accidents and oil spills
- Oct 2015: Jones Act ship El Faro, four times older than the global average, disappeared in the Caribbean with its 33 crew members
Recent History of Jones Act

- **2005:** President Bush temporarily waives the Jones Act to assist in Hurricane Katrina disaster relief
- **2010:** President Obama refuses to temporarily suspend the Jones Act to aid in cleanup of *Deepwater Horizon* oil spill
- **2012:** Jones Act temporarily suspended for oil tankers on East Coast in aftermath of Hurricane Sandy
- **2014:** Hawaii, Alaska, Puerto Rico and Guam seek Congress exemption to Jones Act
- **2015:** Senator McCain (R-AZ) fails to repeal the Jones Act
- **Ongoing:** Jones Act mentioned as a negotiating point in the Trans-Atlantic Trade and Investment Partnership (TTIP)
Benefits of Repealing Jones Act

➤ **Question:** What are the savings and welfare benefits from repealing the Jones Act?

➤ Depends on **cost gap**, US **transport network** restructuring, and internal **trade flows**
  
  ➤ Cost gap: Jones Act ships are 2-5 times as costly
  ➤ Transport network: Multimodal system with 5 modes, 2 types of freight terminals
  ➤ Trade flows: From 2012 Commodity Flow Survey (CFS)

➤ We find substantial gains from repealing the Act

  ➤ Repeal saves **$1.91 billion per year** in shipping costs
  ➤ Usage of maritime shipping increases to 24.01% of routes
  ➤ Los Angeles-Long Beach CFS area saves the most, $US 158.9 million per year
We build a network model of the current multimodal transport system of the US, including Alaska and Hawaii.

Assume that all internal trade flows follow least-cost routes.

Repealing the Jones Act allows for:

1. Cheaper foreign ships to enter—maritime route costs will be lower
2. More efficient usage of transport routes

Baseline counterfactual holds the transportation network fixed with fall in maritime costs.
Related Literature

- Ours is first study on effect of Jones Act with explicit network structure of transport system

- Studies from US International Trade Commission (USITC)

- Regional studies

- Fogel (1964), Donaldson and Hornbeck (2015)

- Internal trade costs: we add modern network structure
Data Overview

- US Transportation Network: 5 modes, 2 terminal types
- Modes of transport: connections between terminals
  - Truck: roads
  - Train: railroads
  - Container ship: waterways
  - Barge: inland waterways
  - Pipeline (petroleum only)
- Freight terminals: allow switching between modes
  - General terminal: all modes except container ship
  - Seaport: all modes
- Switching modes called **transshipment** or **transloading**
- TEU: **Twenty-foot equivalent unit**, one container, assumed to weigh 12 tons
What is a Twenty-Foot Equivalent Unit (TEU)?
Freight Shares by Mode (Intercity Ton-Miles)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rail</td>
<td>41.4%</td>
<td>37.5%</td>
<td>37.7%</td>
<td>40.4%</td>
<td>39.3%</td>
<td>42.7%</td>
</tr>
<tr>
<td>Truck</td>
<td>22.0%</td>
<td>22.3%</td>
<td>25.4%</td>
<td>27.0%</td>
<td>31.0%</td>
<td>30.9%</td>
</tr>
<tr>
<td>Inland Waterway</td>
<td>16.0%</td>
<td>16.4%</td>
<td>16.4%</td>
<td>14.6%</td>
<td>14.9%</td>
<td>13.1%</td>
</tr>
<tr>
<td>Pipeline</td>
<td>20.5%</td>
<td>23.6%</td>
<td>20.2%</td>
<td>17.6%</td>
<td>14.5%</td>
<td>13.1%</td>
</tr>
<tr>
<td>Air</td>
<td>0.1%</td>
<td>0.2%</td>
<td>0.4%</td>
<td>0.4%</td>
<td>0.4%</td>
<td>0.4%</td>
</tr>
</tbody>
</table>

Source: Association of American Railroads, *Railroad Facts*
Roads

- **Mode:** Trucks driving on a variety of roads
- We calculate cost of $1.69 per TEU-mile
  - Matches revenue per ton-mile of trucking companies
- Guarantees connectivity between CFS regions
- Typically used at start and end of freight routes
Example: Containerized Truck
Railroads

- **Mode:** Freight trains moving on railroad lines
- We calculate cost of $0.28 per TEU-mile
  - Matches revenue per ton-mile of railroad companies
- Cheaper than trucks, more expensive than rest of modes (absent Jones Act)
- Must board and exit at freight terminal
- Source: National Transportation Atlas Database 2014, Oak Ridge National Laboratory Center for Transportation Analysis
Example: Containerized Train

Source: Todd Lappin
Railroads: Network
Container Ships

- **Mode:** Oceangoing container ships moving across inland waterways and sea lanes
- We calculate the following cost per TEU-mile
  - Jones Act: US shippers only, cost 3.71 cents per TEU-mile
  - No Jones Act: foreign shippers, cost 0.78 cents per TEU-mile
  - This gives a US-foreign cost ratio of 4.75 for container ships
- Cheapest mode, but requires seaport access at both ends
- Source: National Waterway Network
Container Ships: Calculating US-Foreign Cost Gap

- Hourly operating cost: US $956; foreign $432
- Average TEU per ship: US 2,000; foreign 3,744
- Ship construction cost
  - US: $200 mil. for 3,600 TEU
  - Foreign: $185 mil. for 18,000 TEU
- Speed: 27.6 miles per hour
- Ship lifespan: 27.5 years
- Annual profit + depreciation rate: 5%
- Final computed **US / foreign cost ratio**: 4.75

Sources used: US Department of Transportation Maritime Administration “Comparison of US and Foreign-flag Operating Costs” (2011), various
Example: Container Ship
Barges

- **Mode:** Smaller ships moving across inland waterways
- We calculate the following cost per TEU-mile
  - Jones Act: US shippers only, cost $0.21 per TEU-mile
  - No Jones Act: foreign shippers, cost $0.11 per TEU-mile
  - This gives a US-foreign cost ratio of 1.93 for barges
- Cheaper than railroads, preferred if both available
- Can load at any terminal bordering a waterway
- Source: National Waterway Network
Barges: Calculating US-Foreign Cost Gap

- Hourly operating cost: **US** $406; **foreign** $184
  - 42.5% of container ship, set to match revenue per mile
- Average TEU per ship: 200
- Ship construction cost
  - **US**: $10 mil.
  - **Foreign**: $2 mil.
- Speed: 11.5 miles per hour
- Ship lifespan: 30 years
- Annual profit + depreciation rate: 5%
- Final computed **US** / **foreign** cost ratio: 1.93
  - Sources used: US Department of Transportation Maritime Administration “Comparison of US and Foreign-flag Operating Costs” (2011), various
Example: Containerized Barge
Barge Waterways: Network
Pipelines

- **Mode:** Liquid flowing through pipes
- **We calculate cost of $0.15 per TEU-mile**
  - Matches revenue per ton-mile of pipeline companies
  - Source: *Oil and Gas Journal: Transportation Special Report*, Association of Oil Pipe Lines
- **Only usable for petroleum products**
- **Two types: crude oil and refined products**
- **Cheaper than any other mode, except oil tankers**
  - Source: Energy Information Agency (2014)
Pipelines: Network
Pipelines: Firms

Source: Canadian Association of Petroleum Producers
General Terminals

- **Freight terminals** that allow for switching between any mode except container ships
- Includes a variety of transshipment points and facilities
- We assume it costs $60 per TEU to pass through a general terminal
  - Pay every time you pass through a terminal
  - Source: reported transshipment fees
- Fixed cost of switching equivalent to 214 miles on a railroad, 35 miles on a truck
- Source: National Transportation Atlas Database 2014, Oak Ridge National Laboratory Center for Transportation Analysis
Example: Road-Rail Terminal Transshipment

Source: NW Systems Group
Example: Barge Terminal Transshipment

Source: Industrial Real Estate Partners
General Terminals: Data
Seaports

- **Freight terminals** that allow for switching between any two modes
- Top 150 ports by freight volume
- We assume it costs $175 per TEU to pass through a seaport
  - Pay twice for any port-to-port ship movement
  - Source: fee schedules of major US ports
- More costly than general terminals, only used to access container ships for ocean shipping
- Source: US Army Corps of Engineers
Example: Seaport Transshipment
Multimodal Transport System: Network
Commodity Flow Survey 2012

  - 102,565 establishments selected from universe of 716,000 in-scope establishments
  - Report for four weeks, one in each quarter of 2012
  - Respondents provide information on of all shipments made in the reporting week
- Data: type, origin, destination, value, weight, mode
- Frequency: every five years
- Level of aggregation: 132 CFS regions
- Total of $132^2 = 17,424$ unique O-D pairs
Multimodal Transport System: Data, CFS Regions
Multimodal Transport System: Data, Traffic Volume

Tonnage on Highways, Railroads, and Inland Waterways: 2007

Annual Freight Tonnage by Mode
- National Highway System
- U.S. Class I Railroad
- Inland Waterways

Volume Scale (Tons/Year)
- 250,000,000
- 125,000,000
- 62,500,000

Sources: Highways: U.S. Department of Transportation, Federal Highway Administration, Freight Analysis Framework, Version 3.4, 2012. Rail: Based on Surface Transportation Board, Annual Carload Waybill Sample and rail freight flow assignments done by Oak Ridge National Laboratory. Inland Waterways: U.S. Army Corps of Engineers (USACE), Annual Vessel Operating Activity and Lock Performance Monitoring System data, as processed for USACE by the Tennessee Valley Authority; and USACE, Institute for Water Resources, Waterborne Foreign Trade Data, Water flow assignments done by Oak Ridge National Laboratory.
Example Route: New York City to Chicago

Total cost of route: $252 per TEU
Example Route: NYC to Chicago, Chicago Detail
Example Route: New York City to Los Angeles

Total cost of route: $586 per TEU
Example Route: NYC to LA, LA Detail
Cost Savings Methodology

- Compute cost of least-cost path between 132 CFS regions: \( c_{ij} \)
  - Status quo under Jones Act: only US shippers can serve internal maritime routes, use US costs, result \( c_{ij}^{JA} \)
  - After Jones Act repeal: foreign firms enter and lower internal transport costs, use foreign costs, result \( c_{ij}^{NJA} \)
  - Repeal results in cost reduction \( \Delta c_{ij} = c_{ij}^{JA} - c_{ij}^{NJA} \) per TEU between O-D pair \( ij \)

- Take internal trade flows from 2012 CFS: \( x_{ij} \)
- Units: \( c_{ij} \) in $ per TEU, \( x_{ij} \) in TEU
- Calculate total cost savings as total reduction in transport costs once Jones Act is repealed

\[
TCS = \sum_{ij \in CFS} \Delta c_{ij} x_{ij}
\]
Results

- We develop two scenarios of Jones Act repeal
  - **Baseline:** foreign entry is allowed for both oceangoing container ships and barges on inland waterways
  - **Container ships only:** Jones Act rules are relaxed only for container ships between seaports

- We find the following total cost savings for each scenario
  - Baseline: $1.91 billion per year
  - Container ships only: $739 million per year

- These cost savings are annualized and accrue over time
## Results: O-D Pairs, Total Savings

<table>
<thead>
<tr>
<th>Rank</th>
<th>Origin (CFS region)</th>
<th>Destination (CFS region)</th>
<th>Value ($ mil.)</th>
<th>Tons (1000s)</th>
<th>Sav. / Ton ($)</th>
<th>Tot. Sav. ($ mil.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Remainder of Wyoming</td>
<td>Remainder of Illinois</td>
<td>572</td>
<td>40,208</td>
<td>2.69</td>
<td>108</td>
</tr>
<tr>
<td>2</td>
<td>Remainder of Minnesota</td>
<td>St. Louis-St. Charles-Farmington, MO-IL</td>
<td>887</td>
<td>6,906</td>
<td>3.78</td>
<td>26</td>
</tr>
<tr>
<td>3</td>
<td>Corpus Christi-Kingsville-Alice, TX</td>
<td>Houston-The Woodlands, TX</td>
<td>7,131</td>
<td>8,016</td>
<td>3.10</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>Remainder of Wyoming</td>
<td>Remainder of Indiana</td>
<td>270</td>
<td>10,434</td>
<td>2.30</td>
<td>24</td>
</tr>
<tr>
<td>5</td>
<td>Remainder of Wyoming</td>
<td>Remainder of Kentucky</td>
<td>161</td>
<td>9,493</td>
<td>2.30</td>
<td>22</td>
</tr>
<tr>
<td>6</td>
<td>New Orleans-Metairie-Hammond, LA-MS</td>
<td>Savannah-Hinesville-Statesboro, GA</td>
<td>4,337</td>
<td>8,137</td>
<td>2.53</td>
<td>21</td>
</tr>
<tr>
<td>7</td>
<td>Remainder of West Virginia</td>
<td>Pittsburgh-New Castle-Weirton, PA-OH-WV</td>
<td>3,506</td>
<td>16,644</td>
<td>1.20</td>
<td>20</td>
</tr>
<tr>
<td>8</td>
<td>Remainder of Kentucky</td>
<td>New Orleans-Metairie-Hammond, LA-MS</td>
<td>1,815</td>
<td>12,048</td>
<td>1.63</td>
<td>20</td>
</tr>
<tr>
<td>9</td>
<td>New York-Newark, NY-NJ-CT-PA</td>
<td>New York-Newark, NY-NJ-CT-PA</td>
<td>59,780</td>
<td>31,872</td>
<td>0.51</td>
<td>16</td>
</tr>
<tr>
<td>10</td>
<td>New York-Newark, NY-NJ-CT-PA</td>
<td>Los Angeles-Long Beach, CA</td>
<td>8,343</td>
<td>981</td>
<td>14.26</td>
<td>14</td>
</tr>
</tbody>
</table>
Results: O-D Pairs, Savings per Ton

<table>
<thead>
<tr>
<th>Rank</th>
<th>Origin (CFS region)</th>
<th>Destination (CFS region)</th>
<th>Value ($ mil.)</th>
<th>Tons (1000s)</th>
<th>Sav./Ton ($)</th>
<th>Tot. Sav. ($ mil.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Remainder of Iowa</td>
<td>Remainder of Alaska</td>
<td>n/a</td>
<td>54</td>
<td>25.91</td>
<td>1.40</td>
</tr>
<tr>
<td>2</td>
<td>Indianapolis-Carmel-Muncie, IN</td>
<td>Remainder of Alaska</td>
<td>n/a</td>
<td>1</td>
<td>25.74</td>
<td>0.03</td>
</tr>
<tr>
<td>3</td>
<td>Milwaukee-Racine-Waukesha, WI</td>
<td>Remainder of Alaska</td>
<td>n/a</td>
<td>1</td>
<td>25.71</td>
<td>0.03</td>
</tr>
<tr>
<td>4</td>
<td>Grand Rapids-Wyoming-Muskegon, MI</td>
<td>Remainder of Alaska</td>
<td>46</td>
<td>6</td>
<td>25.71</td>
<td>0.15</td>
</tr>
<tr>
<td>5</td>
<td>Remainder of Alaska</td>
<td>Remainder of Wisconsin</td>
<td>n/a</td>
<td>2</td>
<td>25.71</td>
<td>0.05</td>
</tr>
<tr>
<td>6</td>
<td>Chicago-Naperville, IL-IN-WI</td>
<td>Remainder of Alaska</td>
<td>212</td>
<td>13</td>
<td>25.71</td>
<td>0.33</td>
</tr>
<tr>
<td>7</td>
<td>Remainder of Ohio</td>
<td>Remainder of Alaska</td>
<td>10</td>
<td>1</td>
<td>25.56</td>
<td>0.03</td>
</tr>
<tr>
<td>8</td>
<td>Remainder of Illinois</td>
<td>Remainder of Alaska</td>
<td>n/a</td>
<td>3</td>
<td>24.98</td>
<td>0.07</td>
</tr>
<tr>
<td>9</td>
<td>Columbus-Marion-Zanesville, OH</td>
<td>Remainder of Hawaii</td>
<td>n/a</td>
<td>1</td>
<td>24.84</td>
<td>0.02</td>
</tr>
<tr>
<td>10</td>
<td>Indianapolis-Carmel-Muncie, IN</td>
<td>Urban Honolulu, HI CFS Area</td>
<td></td>
<td>49</td>
<td>24.66</td>
<td>0.05</td>
</tr>
</tbody>
</table>
Results: Example Route with High Savings per Ton
Results: Distribution of Savings over CFS Areas
## Results: CFS Regions, Total Savings

<table>
<thead>
<tr>
<th>Rank</th>
<th>Region</th>
<th>Total Savings ($US millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Los Angeles-Long Beach, CA CFS Area</td>
<td>158.9</td>
</tr>
<tr>
<td>2</td>
<td>Remainder of Illinois</td>
<td>126.2</td>
</tr>
<tr>
<td>3</td>
<td>Houston-The Woodlands, TX CFS Area</td>
<td>106.1</td>
</tr>
<tr>
<td>4</td>
<td>San Jose-San Francisco-Oakland, CA CFS Area</td>
<td>79.2</td>
</tr>
<tr>
<td>5</td>
<td>New York-Newark, NY-NJ-CT-PA CFS Area (NY Part)</td>
<td>73.6</td>
</tr>
<tr>
<td>6</td>
<td>New Orleans-Metairie-Hammond, LA-MS CFS Area (LA Part)</td>
<td>68.1</td>
</tr>
<tr>
<td>7</td>
<td>New York-Newark, NY-NJ-CT-PA CFS Area (NJ Part)</td>
<td>61.0</td>
</tr>
<tr>
<td>8</td>
<td>Atlanta-Athens-Clarke County-Sandy Springs, GA CFS Area</td>
<td>53.4</td>
</tr>
<tr>
<td>9</td>
<td>Chicago-Naperville, IL-IN-WI CFS Area (IL Part)</td>
<td>52.6</td>
</tr>
<tr>
<td>10</td>
<td>Laredo, TX CFS Area</td>
<td>42.6</td>
</tr>
</tbody>
</table>
Results: Distribution of Savings, Container Ships Only
<table>
<thead>
<tr>
<th>Rank</th>
<th>Region</th>
<th>Total Savings ($US millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Los Angeles-Long Beach, CA CFS Area</td>
<td>149.0</td>
</tr>
<tr>
<td>2</td>
<td>San Jose-San Francisco-Oakland, CA CFS Area</td>
<td>76.3</td>
</tr>
<tr>
<td>3</td>
<td>Portland-Vancouver-Salem, OR-WA CFS Area (OR Part)</td>
<td>40.3</td>
</tr>
<tr>
<td>4</td>
<td>Seattle-Tacoma, WA CFS Area</td>
<td>37.3</td>
</tr>
<tr>
<td>5</td>
<td>Remainder of Pennsylvania</td>
<td>24.9</td>
</tr>
<tr>
<td>6</td>
<td>Remainder of California</td>
<td>24.8</td>
</tr>
<tr>
<td>7</td>
<td>Atlanta-Athens-Clarke County-Sandy Springs, GA CFS Area</td>
<td>24.2</td>
</tr>
<tr>
<td>8</td>
<td>Chicago-Naperville, IL-IN-WI CFS Area (IL Part)</td>
<td>23.2</td>
</tr>
<tr>
<td>9</td>
<td>New York-Newark, NY-NJ-CT-PA CFS Area (NJ Part)</td>
<td>22.4</td>
</tr>
<tr>
<td>10</td>
<td>New York-Newark, NY-NJ-CT-PA CFS Area (NY Part)</td>
<td>20.2</td>
</tr>
</tbody>
</table>
Conclusion

- Develop network model of US multimodal transport system
- Run two counterfactuals where the Jones Act is repealed
  - **Baseline:** repeal for both container ships, barges
  - **Container ships only:** repeal only for container ships
- Total cost savings of repeal
  - Baseline: **$1.91 billion per year**
  - Container ships only: $739 million per year
- Welfare Calculations (Eaton & Kortum 2002)
- Possible model extensions
  - Increase in internal trade flows, productivity
  - Spillovers to international trade
  - Effect on network structure and cost of other modes
  - Capacity of transport links and terminals