Understanding the Relationships Between Logistics Performance and International Trade
November 19, 2011

Dr. H. Donald Ratliff
Regents Professor of Logistics
Executive Director – Supply Chain & Logistics Institute
Georgia Tech
Georgia Tech Supply Chain & Logistics Institute

- A unit of the School of Industrial & Systems Engineering
- Ranked #1 Industrial Engineering Program for 20 consecutive years
- World’s largest supply chain & logistics research and education unit
Evolution of Logistics & Trade

1880 - 1900 - 1920
Assembly Lines

1940 - 1960
Systems

1980 - 2000 - 2020
Logistics & Trade
“Tipping Point”

Japanese Exports

1900
Process Methods & Standards

1940
Container Shipments

1980
China Exports

Supply Chains

“Manufacturing” Focus

“Manufacturing & Logistics” Focus
Expansion of Trade – A Supply Chain Revolution

Total World Export 1990 - 2009
in Billion $

\[ y = 4650.7x + 569.82 \]
\[ R^2 = 0.9935 \]

<table>
<thead>
<tr>
<th>Year</th>
<th>Total World Export in Billion $</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>$5,672,56</td>
</tr>
<tr>
<td>1995</td>
<td>$9,464,16</td>
</tr>
<tr>
<td>2000</td>
<td>$13,846,98</td>
</tr>
<tr>
<td>2005</td>
<td>$19,934,76</td>
</tr>
<tr>
<td>2009</td>
<td>$23,690,55</td>
</tr>
</tbody>
</table>

% increase:
- 67% over 1990
- 46% over 1995
- 43% over 2000
- 18% over 2009
- China exports today about the same as everyone else combined in 1990
- Top ten have more than half of total exports
World’s Largest Container Ports (million TEUs)

<table>
<thead>
<tr>
<th>1989</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hong Kong</td>
<td>Singapore</td>
</tr>
<tr>
<td>4.5</td>
<td>25.8</td>
</tr>
<tr>
<td>Singapore</td>
<td>Shanghai (China)</td>
</tr>
<tr>
<td>4.4</td>
<td>25.0</td>
</tr>
<tr>
<td>Rotterdam (Netherlands)</td>
<td>Hong Kong</td>
</tr>
<tr>
<td>3.9</td>
<td>20.9</td>
</tr>
<tr>
<td>Kaohsiung (Taiwan)</td>
<td>Shenzhen (China)</td>
</tr>
<tr>
<td>3.4</td>
<td>18.2</td>
</tr>
<tr>
<td>Kobe (Japan)</td>
<td>Busan (South Korea)</td>
</tr>
<tr>
<td>2.5</td>
<td>11.9</td>
</tr>
<tr>
<td>Busan (South Korea)</td>
<td>Guangzhou (China)</td>
</tr>
<tr>
<td>2.2</td>
<td>11.2</td>
</tr>
<tr>
<td>Los Angeles (United States)</td>
<td>Dubai (United Arab Emirates)</td>
</tr>
<tr>
<td>2.1</td>
<td>11.1</td>
</tr>
<tr>
<td>New York/New Jersey (United States)</td>
<td>Ningbo (China)</td>
</tr>
<tr>
<td>2.0</td>
<td>10.5</td>
</tr>
<tr>
<td>Keelung (Taiwan)</td>
<td>Qingdao (China)</td>
</tr>
<tr>
<td>1.8</td>
<td>10.2</td>
</tr>
<tr>
<td>Hamburg (Germany)</td>
<td>Rotterdam (Netherlands)</td>
</tr>
<tr>
<td>1.7</td>
<td>9.7</td>
</tr>
<tr>
<td>Long Beach (United States)</td>
<td>Tianjin (China)</td>
</tr>
<tr>
<td>1.5</td>
<td>8.7</td>
</tr>
<tr>
<td>Yokohama (Japan)</td>
<td>Kaohsiung (Taiwan)</td>
</tr>
<tr>
<td>1.5</td>
<td>8.5</td>
</tr>
<tr>
<td>Antwerp (Belgium)</td>
<td>Antwerp (Belgium)</td>
</tr>
<tr>
<td>1.5</td>
<td>7.3</td>
</tr>
<tr>
<td>Tokyo (Japan)</td>
<td>Port Klang (Malaysia)</td>
</tr>
<tr>
<td>1.4</td>
<td>7.3</td>
</tr>
<tr>
<td>Felixstowe (Britain)</td>
<td>Hamburg (Germany)</td>
</tr>
<tr>
<td>1.4</td>
<td>7.0</td>
</tr>
</tbody>
</table>

- China has made huge investments in logistics infrastructure
- Very “export” focused
Logistics and Trade Mega Trends

• Globalization of manufacturing
  – Geographically diverse supply chain networks
  – Intraregional trade increasing faster than interregional trade

• Increasing attention on logistics
  – Focus on lean means less “slack” in supply chains
  – Focus on total landed cost (manufacturing, transportation and inventory)
  – More shipper control of shipment decisions
  – More carrier focus on service (e.g., Maersk Daily)

• Computing advances
  – Increased capability for supply chain visibility
  – Dramatic increase in data
  – Increased availability of decision technology

• Increasingly complex supply chains
  – Dramatic increase in difficulty
  – Increasing need for process standardization and supply chain integration
  – Necessity for modeling and analytics to deal with complexity
  – Lack of logistics knowledge and analytical capability is a major barrier to trade growth
Asia Regional Trade

Origin = Asia
Trade Value (millions $)

- Asia to Asia is growing at a much faster rate the Asia to any other region.
- Asia to Asia is bigger than Asia to all other regions combined.
- Asia to NA and Asia to Europe are growing at approximately the same rates.
- Asia to Asia in 2010 recovered to approximate trend before 2009 downturn.
North America Regional Trade

Origin = NA
Trade Value (millions $)

- NA to NA is growing at a much faster rate than NA to any other region.
- NA to NA is bigger than NA to all other regions combined.
- NA to NA is about half as big as Asia to Asia.
- NA to NA in 2010 only recovered to 2007 level.
US Imports

- Dominated by big retailers

Source: *The Journal of Commerce*
Europe Regional Trade

- Europe to Europe is growing at a much faster rate than Europe to any other region.
- Europe to Europe is bigger than Europe to all other regions combined.
- Europe to Europe is almost twice as big as Asia to Asia.
- Europe to Europe is four times as big as NA to NA.
- Europe to Europe in 2010 has not recovered to 2007 level.
• Prior to 2009 SCAC to SCAC was growing at approximately the same rate as SCAC to NA, Europe and Asia.

• SCAC to Asia recovered to approximately the same trend as before 2009 while SCAC to NA recovered to about 2006 and 2007 levels.

Why is SCAC intraregional trade less than interregional trade?
Latin America and US Container Ports (million TEUs)

Latin America 2009
- #54 Balboa 2.01
- #62 Kingston 1.69
- #70 Buenos Aires 1.41
- #71 Manzanillo 1.41
- #85 Cartagena 1.14
- #87 Manzanillo Mexico 1.11
- #88 Callao Peru 1.09

USA 2009
- #16 Los Angeles 6.75
- #18 Long Beach 5.07
- #21 New York/New Jersey 4.56
- #42 Savannah 2.36
- #53 Oakland 2.05
- #60 Houston 1.80
- #61 Hampton Roads 1.75
- #63 San Juan 1.67
- #64 Seattle 1.58
- #67 Tacoma 1.55
- #82 Charleston 1.18
- #103 Miami 0.81
• Africa to Africa trade is small and not growing as fast as Africa to Europe, NA and Asia.
• Prior to 2009 Africa to Europe and Africa to NA were growing at about the same rates.
Relationships Between Logistics Performance and International Trade

- **Production**
  - Cost
  - Quality

- **Logistics**
  - Logistics Performance Factors
    - Intermediary cost
    - Transport cost
    - Inventory cost
    - Storage cost
    - Quality loss
    - Dependability
    - Time

- **Demand**
  - Price
  - Quality
Different Logistics Perspectives

• Infrastructure/service providers
  – Examples: Ports, Railroads
  – Decision influences: capacity, revenue growth, costs and service

• Carriers
  – Examples: Container lines, trucking companies, airlines
  – Decision influences: competition, revenue, utilization/balance, costs, inertia and ignorance

• Shippers
  – Examples: Retailers, manufacturers
  – Decision influences: transportation cost, inventory on books, speed, reliability, risk, inertia and ignorance

• Government
  – Examples: Customs
  – Decision influences: revenue, regulations and budgets
How has “globalization” changed logistics?

• Transportation – increased
• Inventory – increase and moved
• Warehousing – limited change

• Time to customer – increased
• Variability – increased
• Complexity – increased
• Technology – increased

Logistics performance increasingly more critical to competitiveness!
Supply Chain and Logistics Performance

• Individual enterprise “logistics” performance
  – Usually the focus of each enterprise

• Supply chain “network” performance
  – Major concern of the shippers
  – Key to export competitiveness
Cost – Freight Rates

- Distance
- Time
- Flow balance
- Competition

Ref: “Liner Shipping Connectivity and Port Infrastructure as Determinants of Freight Rates in the Caribbean,” Gordon Wilmsmeier and Jan Hoffmann
Impact of Global Trade on Transportation

Major American Rail Corridors Improved since 2000
Impact of Globalization on Inventory

- Where is the inventory?
- Why is it there?
- How much is where?

- Inventory in every element of the supply chain
- “Waiting” inventory is a particular problem
- Less inventory in warehouses
- Not good visibility of aggregate inventory
How is inventory measured?

- **Days of inventory**
  - Amount of inventory divided by average demand per day
  - 200 cars at dealer
  - Average 5 cars sold per day
  - \( \frac{200}{5} = 40 \) days of inventory

- **Inventory turns**
  - 365 days divided by average days of inventory
  - Average days of inventory = 40
  - Inventory turns = \( \frac{365}{40} = 9.125 \) turns/year

- **Inventory cost**
  - Generally expressed as a percent of inventory value (5% to 50%)
  - A $36,500 car at 10% = \( \frac{(36,500 \times 10\%)}{365} = \frac{3,650}{365} = 10 \) $/day

- Increasingly inventory will drive transportation decisions!
Inventory and Stock Out Costs

- **Components of inventory cost**
  - Capital (% of cost)
  - Insurance (% of cost)
  - Obsolesce (sometimes % of cost)
  - Storage (not % of cost)
  - Handling (not % of cost)

- **Components of stock out cost**
  - Lost sales (may include companion products)
  - Lost customers (may influence other customers)

- **Notes**
  - In-transit inventory cost should not include storage or handling costs
  - Stock out cost are very dependent on the situation
  - Many retailers plan on rarely running out of stock
## Daily Inventory Cost

<table>
<thead>
<tr>
<th>Products</th>
<th>Retail Value per 40 Foot Container</th>
<th>Inventory Cost per Day Low Value Product</th>
<th>Inventory Cost per Day High Value Product</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>High</td>
<td>Rate = 10%</td>
</tr>
<tr>
<td>Clothing (low value)</td>
<td>$225,000</td>
<td>$520,000</td>
<td>$61.64</td>
</tr>
<tr>
<td>Clothing (mid range)</td>
<td>$500,000</td>
<td>$3,600,000</td>
<td>$136.99</td>
</tr>
<tr>
<td>Sport shoes</td>
<td>$350,000</td>
<td>$2,520,000</td>
<td>$95.89</td>
</tr>
<tr>
<td>Bicycles</td>
<td>$240,000</td>
<td>$480,000</td>
<td>$65.75</td>
</tr>
<tr>
<td>Toys (low quality)</td>
<td>$60,000</td>
<td>$720,000</td>
<td>$16.44</td>
</tr>
<tr>
<td>Consumer electronics (small)</td>
<td>$170,000</td>
<td>$430,000</td>
<td>$46.58</td>
</tr>
<tr>
<td>Consumer electronics (large)</td>
<td>$70,000</td>
<td>$140,000</td>
<td>$19.18</td>
</tr>
<tr>
<td>Appliances (small)</td>
<td>$45,000</td>
<td>$100,000</td>
<td>$12.33</td>
</tr>
<tr>
<td>Appliances (large)</td>
<td>$30,000</td>
<td>$65,000</td>
<td>$8.22</td>
</tr>
<tr>
<td>Furniture (assembled)</td>
<td>$20,000</td>
<td>$150,000</td>
<td>$5.48</td>
</tr>
<tr>
<td>Furniture (flat packed)</td>
<td>$70,000</td>
<td>$360,000</td>
<td>$19.18</td>
</tr>
<tr>
<td>Automobile parts</td>
<td>$50,000</td>
<td>$375,000</td>
<td>$13.70</td>
</tr>
</tbody>
</table>

Stock prices are often hurt by increasing inventory on balance sheets. Often inventory is manipulated at end of reporting periods.
Panama Motors Inventory Performance

- Days of Inventory = \( \frac{\text{Inventory}}{\text{(Annual cost of goods sold)}} \times 365 \)
- Inventory turns = \( \frac{\text{Annual cost of goods sold}}{\text{Inventory}} \)

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inventories</td>
<td>14,939</td>
<td>13,921</td>
</tr>
<tr>
<td>Automotive cost of sales</td>
<td>166,259</td>
<td>163,742</td>
</tr>
<tr>
<td>Days of inventory</td>
<td>33</td>
<td>31</td>
</tr>
<tr>
<td>Inventory turns</td>
<td>11.1</td>
<td>11.8</td>
</tr>
</tbody>
</table>

- Note: these are “point” measures
- When would these measures look best?
Cost - “Full Container” Shipments

- Full containers not a problem for large volume exporters
- Decreases competitiveness for start up exporters
- Particularly important for refrigerated products
“Cycle” Inventory

• Example
  – Purchase from single supplier
  – Sell an average of one container of product per day
  – Order cycle = 2 days
  – Average cycle inventory = 1 day of inventory

  ![Graph showing cycle inventory example]

  - Cycle inventory = ½ average production/shipment size
  - Note that cycle inventory quantity is not dependent on demand
Time – In-transit Inventory

A day in transit = a day of inventory
“In-transit” Inventory

• Example
  – Purchase from a single supplier
  – Sell an average of one container of product per day
  – Average transit time = 3 days
  – Average in-transit inventory = 3 days of inventory

In-transit inventory = (ave purchase rate) * (ave transit time)
Impact of Transit Time on Forecasts

- Forecast errors increase with time to the event
  - Forecast B has more information regarding inventory levels
  - Forecast B has more current information regarding demand trends
  - Forecast B should be better and have less safety stock
  - Less transit time means less safety stock
  - Difficult to say exactly how much less (test with simulation)
Safety Stock (demand)
Uncertain demand but known lead time

- The retailer must forecast when they will run out
- The retailer must carry safety stock to protect against variability regarding when the run out will occur
- Longer lead time causes more safety stock
Time – Direct Versus Multi-stop Route

- **Direct ship lanes**
  - Minimize transit time
  - May not utilize ship capacity

- **Multi-stop routes**
  - Longer distance
  - Stops take time
  - Stops increase potential delays
  - May increase utilization
Impact of Multi Stop Routes

<table>
<thead>
<tr>
<th>Port</th>
<th>Arrives</th>
<th>Departs</th>
<th>Transit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotterdam, Netherlands</td>
<td>THU</td>
<td>FRI</td>
<td>--</td>
</tr>
<tr>
<td>Bremerhaven, Germany</td>
<td>SAT</td>
<td>SUN</td>
<td>2</td>
</tr>
<tr>
<td>Hamburg, Germany</td>
<td>MON</td>
<td>TUE</td>
<td>4</td>
</tr>
<tr>
<td>Antwerp, Belgium</td>
<td>WED</td>
<td>THU</td>
<td>6</td>
</tr>
<tr>
<td>Felixstowe, United Kingdom</td>
<td>FRI</td>
<td>SAT</td>
<td>8</td>
</tr>
<tr>
<td>Suez Canal, Egypt</td>
<td>SUN</td>
<td>MON</td>
<td>17</td>
</tr>
<tr>
<td>Singapore, Singapore</td>
<td>SAT</td>
<td>MON</td>
<td>30</td>
</tr>
<tr>
<td>Busan, Korea, South</td>
<td>SAT</td>
<td>SUN</td>
<td>37</td>
</tr>
<tr>
<td>Hakata, Japan</td>
<td>MON</td>
<td>MON</td>
<td>39</td>
</tr>
<tr>
<td>Dalian, China</td>
<td>WED</td>
<td>WED</td>
<td>41</td>
</tr>
<tr>
<td>Xingang, China</td>
<td>THU</td>
<td>FRI</td>
<td>42</td>
</tr>
<tr>
<td>Qingdao, China</td>
<td>SAT</td>
<td>SUN</td>
<td>44</td>
</tr>
</tbody>
</table>

- Impact on shipper?
- Impact on shipping line?
Maersk Daily Service

- Same cut-off time every day, seven days a week.
- Same fixed and promised transportation time.
- If delayed by 1-3 days, Maersk Line will pay back USD 100 per container.
  If delayed by four days or more, Maersk Line will pay back USD 300 per container.

- Four ports in Asia: Ningbo, Shanghai, Yantian and Tanjung Pelepas
- Three ports in North Europe: Felixstowe, Bremerhaven and Rotterdam

- How does this delay impact shipper inventory?
- For no run-out case, safety inventory is reduced by about 7 days
Safety Stock (lead time)
Known demand but uncertain lead time

- To assure no stockouts, safety stock increases with days of variability
Logistics and Trade Observations

• Globalization of manufacturing
  – Dramatic increase in transportation
• Computing advances
  – Dramatic increase in data
• Increasingly complex supply chains
  – Dramatic increase in difficulty
• Trade competitiveness
  – Dramatic increase in need for public sector logistics knowledge
Panama’s Logistics Vision

• Improve logistics performance
  – Integrate Panama’s logistics network
  – Generate new logistics services
  – Expand Panama’s logistics education

• Grow as a transportation hub for the Americas
  – Transshipment hub
  – Distribution hub

• Become a primary regional Trade Hub for Latin America

• Become a logistics and trade thought leader
  – Georgia Tech Panama Logistics Research & Innovation Center
#1 Germany
#2 Singapore
#3 Sweden
#4 Netherlands

#15 United States

#51 Panama
What must Panama do to improve logistics performance?
How can Panama become the trade hub of the Americas?

Panama’s Logistics Business Categories

- Canal transit
- Transshipment
- Re-export
- Export
- Import
- In-country logistics
- In-country employment
- Tourism
Panama’s Logistics Platform
Framework for Analytics

- Logistics Analysis
- Computational & Visualization Tools
- Competitiveness Improvement
- Trade Analysis
- Scenarios Evaluation
- Logistics & Trade Data
- Functions, Rules & Metrics
- Descriptive Models
- Process Models
- Network Models

Composite Modeling
Composite Modeling

Logistics Analysis

Competitiveness Improvement

Trade Analysis

Computational & Visualization Tools

Scenarios Evaluation

Logistics & Trade Data

Functions, Rules & Metrics

Descriptive Models

Process Models

Network Models
Trade Analysis

• Goals
  – Document structure, cost and capacity of current trade routes
  – Determine modes and volumes for each product family on each trade route
  – Determine how trade routes have changed over time
  – Quantify the attraction/value for each trade route
  – Quantitatively compare trade routes
  – Forecast growth of trade routes

• Questions you can answer
  – Country to country imports and exports by year and commodity (US$ and weights)
  – Country to US port imports and exports by year and commodity (US$ and weights)
  – Changes in trade over time

• Questions you would like to answer
  – Global port to port trade routes
  – Containers on each trade route
  – Changes in trade routes over time
  – "Causal" relationships
How can Panama take advantage of the free trade agreement?
Composite Modeling

- Logistics Analysis
- Computational & Visualization Tools
  - Functions, Rules & Metrics
  - Descriptive Models
- Competitiveness Improvement
- Trade Analysis
  - Process Models
  - Network Models
  - Logistics & Trade Data
- Scenarios Evaluation
Logistics and Trade Data

- Publically available
  - e.g., UN Comtrade database
- Commercially available
  - e.g., road travel distances
- Requires collection
  - e.g., road travel times
- Major effort is required to make data usable
Composite Modeling

- Logistics Analysis
- Computational & Visualization Tools
- Scenarios Evaluation
- Functions, Rules & Metrics
- Descriptive Models
- Process Models
- Network Models
- Competitiveness Improvement
- Trade Analysis
- Logistics & Trade Data
Logistics Analysis

• Goals
  – Identify changes in logistics systems requirements and how they are being addressed by stakeholders
  – Document baseline structure and characteristics of existing logistics systems
  – Assess capability and performance of existing logistics systems
  – Enable integration of existing logistics systems
  – Optimize infrastructure/services provider performance
  – Optimize carrier performance
  – Optimize shipper performance
  – Determine where infrastructure and services require improvement
  – Determine the need/opportunity for new technology
Potential for Post-Panamax Congestion

marinetraffic.com
Composite Modeling

- **Logistics Analysis**
- **Trade Analysis**
- **Competitiveness Improvement**

- **Computational & Visualization Tools**
  - **Scenarios Evaluation**
  - **Logistics & Trade Data**

- **Functions, Rules & Metrics**
- **Descriptive Models**
- **Process Models**
- **Network Models**
Computational and Visualization Tools

- Provide visualization
  - Business graphics
  - Maps
  - Geographic Information Systems (GIS)

- Perform computations
  - Spreadsheets
  - Business analytics
  - Simulation
  - Optimization
  - Custom functions
Visualization Tools
Composite Modeling

- Logistics Analysis
- Computational & Visualization Tools
- Functions, Rules & Metrics
- Descriptive Models
- Process Models
- Network Models
- Scenarios Evaluation
- Competitiveness Improvement
- Trade Analysis
- Logistics & Trade Data
Functions, Rules & Metrics

- Provide “functional” relationships to describe operations
- Provide metrics to estimate logistics performance
- Provide evaluation modules to include in computational methods
Composite Modeling

Logistics Analysis → Competitiveness Improvement → Trade Analysis

Computational & Visualization Tools

Scenarios Evaluation

Functions, Rules & Metrics → Descriptive Models → Process Models → Network Models

Logistics & Trade Data
• Facilitate geographic insights with regard to capabilities
• Allow “list” comparisons among similar logistics entities
• Provide input for computational methods
Example Descriptive Model - Seaports
## Example Descriptive Model - Seaports

<table>
<thead>
<tr>
<th>Seaports</th>
<th>Manzanillo International Terminal</th>
<th>Balboa</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Services</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Containers</td>
<td>true</td>
<td>false</td>
</tr>
<tr>
<td>General cargo</td>
<td>false</td>
<td>true</td>
</tr>
<tr>
<td>Ro-Ro</td>
<td>true</td>
<td>true</td>
</tr>
<tr>
<td>Bulk (dry)</td>
<td>false</td>
<td>true</td>
</tr>
<tr>
<td>Bulk (liquid)</td>
<td>false</td>
<td>true</td>
</tr>
<tr>
<td>Special projects</td>
<td>true</td>
<td>true</td>
</tr>
<tr>
<td><strong>Specifications</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total area (hectare)</td>
<td>160</td>
<td>182</td>
</tr>
<tr>
<td><strong>Berths</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Draft alongside</td>
<td>10 – 14</td>
<td>8.1 – 17</td>
</tr>
<tr>
<td>Total berths</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Container berths</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Container berths lengths (m)</td>
<td>310, 310, 310, 310, 400</td>
<td></td>
</tr>
</tbody>
</table>
Panama Canal

- 13,000 ships transit the canal annually or average of 35 ships each day
- Canal water time (CWT) averages 21.1 hours (FY 2010) compared to the 23.06 hours in FY 2009
- Average CWT with reservation is 13.3 hours
- Average CWT without reservation is 24.7 hours

Source: ACP
Panama Canal Expansion

- Completion 2014
- Less waiting
- Bigger ships
• Port Infrastructure
  – Four Container Port Terminals administered by three of most important terminal operators worldwide
  – Fifth container terminal under construction at in the Pacific side of Panama – to be operated by Ports Singapore Authority (PSA)
  – Terminals in the Atlantic and in the Pacific function as transshipment points for of merchandise, moving over 5.5 million TEU’s annually

Source: Panama Ministry of Commerce and Industries – *Investment Opportunities in Panama*
Manzanillo International Terminal

- Located outside of the Atlantic entrance of the Panama Canal
- Adjacent to the Colon Free Trade Zone
- Port services to:
  - Shipping lines transiting the Panama Canal
  - Serving South America and the Caribbean
Manzanillo International Terminal
Manzanillo Value-Added Area
MIT Logistics Park

- Adds value to cargo with new division MIT Logistics

They've opened warehouses to add new options such as labeling, repackaging, assembly, among others.
Colon Container Terminal
Atlantic - Colon

- Colon Container Terminal
- Manzanillo International Terminal
- Colon Free Zone
- Cristobal
Colon Free Trade Zone

- Established on 1948
- Biggest free zone in the Western Hemisphere
- 1680 acres
- $19 Billion commercial activity (import and exports)

Source: Panama Ministry of Commerce and Industries – *Investment Opportunities in Panama*
Colon Free Trade Zone

- No sales tax, no production tax.
- Tax exemption on income derived from abroad.
- No tax or duty on imports to or re-exports from the Free Zone to foreign countries.
- Income tax for the companies established in the Colon Free Zone is the same one that applies at the national level.
- There is no tax on any of the shipments sent to or from the Free Zone to any place in the world.

Source: http://colonfreezone.com/free-zone-information/
Colon Free Trade Zone

<table>
<thead>
<tr>
<th>Period</th>
<th>Total Commercial Activity (in thousand of US Dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003-2010</td>
<td>-</td>
</tr>
<tr>
<td>2003</td>
<td>USD 21,624,215,000</td>
</tr>
<tr>
<td>2004</td>
<td>USD 10,228,285,000</td>
</tr>
<tr>
<td>2005</td>
<td>USD 11,395,930,000</td>
</tr>
<tr>
<td>2006</td>
<td>USD 8,039,412,000</td>
</tr>
<tr>
<td>2007</td>
<td>USD 8,039,412,000</td>
</tr>
<tr>
<td>2008</td>
<td>USD 8,039,412,000</td>
</tr>
<tr>
<td>2009</td>
<td>USD 8,039,412,000</td>
</tr>
<tr>
<td>2010</td>
<td>USD 8,039,412,000</td>
</tr>
</tbody>
</table>

**Commercial Trade (in thousand of US Dollars)**

- **Imports**
  - USD 10,228,285,000

- **Exports**
  - USD 11,395,930,000

**Total Commercial Activity (Jan to Apr 2011)**

- **Imports**
  - USD 3,902,815,000

- **Exports**
  - USD 4,136,597,000
Balboa & Cristobal (Panama Ports Company)

- Panama Ports Company (PPC) is in charge of managing container terminals on each side of the Panama Canal.
  - Port of Cristobal in the Atlantic Ocean
  - Port of Balboa in the Pacific
- Member of the Hutchinson Group
- Provides links and strategic access in the Transatlantic and Transpacific routes.
Cristobal

Port of Cristobal

Seaport Layout
- Port Limits
- Road
- Railway
- Rail Access
- Road Access
- Inland Transport Lanes

Cranes
- Panamax
- Post-Panamax

Yards
- Container
- Bulk

Berths
- Name | Depth (m) | Length (m)
- Berth 6 North 14.5 | 325.0
- Berth 6 South 14.5 | 321.7
- Berth 7 Ramps 14.5 | 297.0
- Berth 9 Ramps 14.5 | 326.5

Georgia Tech
Balboa
PSA Panama

<table>
<thead>
<tr>
<th>Specifications</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total area (hectare)</td>
<td>22</td>
</tr>
<tr>
<td>Berths</td>
<td></td>
</tr>
<tr>
<td>Draft alongside</td>
<td>14.5</td>
</tr>
<tr>
<td>Total berths</td>
<td>1</td>
</tr>
<tr>
<td>Container berths lengths</td>
<td>330 m</td>
</tr>
<tr>
<td>Equipment</td>
<td></td>
</tr>
<tr>
<td>Quay Cranes (Post Panamax) (up to 17 cnts)</td>
<td>3</td>
</tr>
<tr>
<td>Rubber Tyred Gantry Cranes (6 tiers + 1)</td>
<td>6</td>
</tr>
<tr>
<td>Gates</td>
<td></td>
</tr>
<tr>
<td>Inbound lanes</td>
<td>1</td>
</tr>
<tr>
<td>Outbound lanes</td>
<td>1</td>
</tr>
</tbody>
</table>
### Percentage of Business Distribution

<table>
<thead>
<tr>
<th></th>
<th>MIT</th>
<th>CCT</th>
<th>Cristobal</th>
<th>Balboa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transhipment (%)</td>
<td>80%</td>
<td>85%</td>
<td>83.60%</td>
<td>92.80%</td>
</tr>
<tr>
<td>CFZ (%)</td>
<td>15%</td>
<td>10%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>National (%)</td>
<td>5%</td>
<td>5%</td>
<td>16.40%</td>
<td>7.20%</td>
</tr>
</tbody>
</table>
## Special Economic Zones

### Comparison

<table>
<thead>
<tr>
<th>Description</th>
<th>Colon Free Zone</th>
<th>Panama Pacífico Area</th>
<th>City of Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All activities</td>
<td>Specific Activities</td>
<td>Affiliated Users</td>
</tr>
<tr>
<td>1 - Fiscal Regime (38 Items)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exempt from Income Tax</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Exempt from Dividends Tax / Complementary Tax</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dividends Tax (discounted at 5%)</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Complementary Tax (discounted at 2%)</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Annual Tax (1% of company capital)</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Exempt from tax on remittances or withholding</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Exempt from import taxes, tariffs or any fees</td>
<td>✓</td>
<td>✓</td>
<td>(1) (2)</td>
</tr>
<tr>
<td>Exempt from export taxes</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exempt from reexport taxes</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exempt from invoicing, selling and production taxes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exempt from ITBMS</td>
<td>✓</td>
<td>(1)</td>
<td>(1)</td>
</tr>
<tr>
<td>Exempt from tax, tariff, fees or any charges to the movement of hydrocarbons</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free from commercial or industrial license</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exempt from Registration Tax</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exempt from Stamp Duty</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exempt from Property Taxes</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exempt from tax on property transfer</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exempt from taxes on reexport incomes</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exempt from taxes on incomes earned from foreign sources</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exempt from Dividend Tax to shareholders residing abroad</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Composite Modeling

Logistics Analysis

Computational & Visualization Tools

Scenarios Evaluation

Trade Analysis

Logistics & Trade Data

Functions, Rules & Metrics

Descriptive Models

Process Models

Network Models
• Provide process maps of physical, financial and information flows
  – Identify opportunities for process improvement
  – Identify infrastructure and services gaps
  – Identify opportunities for improved integration
  – Identify opportunities for automation
  – Identify delays
• Develop time distributions for processes
• Provide structures for computational methods
Network Models

- Provide representations of transportation connectivity and capability among logistics components (e.g., ports, economic zones, etc.)
- Provide structures for computation methods (e.g., road networks, shipping lanes, air lanes)

Example: http://logistics.gatech.ac.pa/en/assets/airports/connectivity
North-South Port Connectivity

- Railroad
- Roads
- Canal
Railroad

- Panama Railway Company
  - From the Atlantic to the Pacific in one hour
  - 500,000 TEU capacity
  - $14 M projected investment in infrastructure
  - Main users: Maersk, MSC, APL/MOL (multimodal operation)

Source: Panama Ministry of Commerce and Industries – *Investment Opportunities in Panama*
Panama’s Logistics Platform: Ground Connectivity

Connection to Central and North America

Central Provinces

Colón

Panamá
Ground Transportation Network
Development of a Port Connectivity Network

- Scheduled service from port of origin to any port of destination
Composite Modeling

- Logistics Analysis
- Computational & Visualization Tools
- Logistics & Trade Data
- Functions, Rules & Metrics
- Descriptive Models
- Process Models
- Network Models

Competitiveness Improvement

Trade Analysis

Scenarios Evaluation
Scenario Evaluation

- The Panama Canal expansion will be completed in 2014
- The expanded Canal will permit post panamax ships
- What will be the impact of these big ships
  - On the Canal?
  - On carriers?
  - On shippers?
Increase in Post-Panamax Ships

*CSAV orders two post-panamax containerships at Samsung* - December 2010

*Technomar Shipping to order four post-panamax ships* - May 2011

*Evergreen Orders 10 Post-Panamax Ships* - July, 2010

*Neptune Orient Orders 10 14,000 teu container ships* – June, 2011

*Maersk orders as many as 30 18,000 teu container ships* – February 2011
Current Containership Fleet

Global Containership Fleet, Size (TEUs) V. Draft, Year-End 2009

Clarkson Research
### Estimated Service Cost for a Full Container vessel from Asia to East Coast United States (one way)

<table>
<thead>
<tr>
<th>Vessel</th>
<th>Fuel</th>
<th>Charter</th>
<th>Ports</th>
<th>Canal</th>
<th>Cargo Handling</th>
<th>Service Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>4,500 TEU</td>
<td>$1,179,129.35</td>
<td>$443,432.06</td>
<td>$86,005.24</td>
<td>$412,450.00</td>
<td>$1,513,446.35</td>
<td>$3,634,463.01</td>
</tr>
<tr>
<td>5,000 TEU</td>
<td>$1,289,807.96</td>
<td>$491,697.06</td>
<td>$92,161.30</td>
<td>$449,930.00</td>
<td>$1,681,607.06</td>
<td>$4,005,203.37</td>
</tr>
<tr>
<td>8,000 TEU</td>
<td>$2,002,349.53</td>
<td>$840,310.71</td>
<td>$129,097.65</td>
<td>$696,410.00</td>
<td>$2,690,571.30</td>
<td>$6,358,739.19</td>
</tr>
<tr>
<td>12,000 TEU</td>
<td>$2,400,395.39</td>
<td>$1,053,378.23</td>
<td>$178,346.12</td>
<td>$1,016,650.00</td>
<td>$4,035,856.95</td>
<td>$8,684,626.69</td>
</tr>
</tbody>
</table>

### Estimated Unit Cost per TEU for a Full Container vessel from Asia to East Coast United States (one way)

<table>
<thead>
<tr>
<th>Vessel</th>
<th>Fuel</th>
<th>Charter</th>
<th>Ports</th>
<th>Canal</th>
<th>Cargo Handling</th>
<th>Cost per TEU</th>
</tr>
</thead>
<tbody>
<tr>
<td>4,500 TEU</td>
<td>$278.75</td>
<td>$104.83</td>
<td>$20.33</td>
<td>$97.51</td>
<td>$357.79</td>
<td>$859.21</td>
</tr>
<tr>
<td>5,000 TEU</td>
<td>$274.43</td>
<td>$104.62</td>
<td>$19.61</td>
<td>$95.73</td>
<td>$357.79</td>
<td>$852.17</td>
</tr>
<tr>
<td>8,000 TEU</td>
<td>$266.27</td>
<td>$111.74</td>
<td>$17.17</td>
<td>$92.61</td>
<td>$357.79</td>
<td>$845.58</td>
</tr>
<tr>
<td>12,000 TEU</td>
<td>$212.80</td>
<td>$93.38</td>
<td>$15.81</td>
<td>$90.13</td>
<td>$357.79</td>
<td>$769.91</td>
</tr>
</tbody>
</table>

Note: Utilization - 87% full and 7% empty.
Source: ACP Route Competitive Analysis Model, February 2011
Impact of Post Panamax Ships

- Not likely to reduce freight rates
  - 12,000 TEU ships are about 10% per slot cheaper to operate
- Not enough freight for direct lanes
- Biggest ships can only access one east coast US port
- There is likely to be a transshipment hub in the triangle
- What is the potential for Panama to be this hub?
- What should Panama do to increase this potential?

Ref: Hofstra University, Dr. Jean-Paul Rodrigue Factors Impacting North American Freight Distribution in View of the Panama Canal Expansion 2010
Final Thoughts

• Intraregional trade
  – Growth trends will likely continue in Asia, North America and Europe
  – Potential for logistics improvement (short sea shipping) in Latin America and Africa

• Container shipping
  – Game changing trend toward service in container shipping
  – Big ships are inconsistent with better service
  – Big ships of less value in intraregional trade

• Improving logistics performance
  – Requires more structure
  – Requires more analytics

• Trade competitiveness drivers
  1. Availability and cost of capital
  2. Time and dependability
  3. Transportation cost