The Economics of Maritime Security; Optimization, Implementation, and Markets

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“We will bankrupt ourselves in the vain search for absolute security”

Dwight D. Eisenhower

“Uncertainty is the only certainty there is, and knowing how to live with insecurity is the only security”

John Allen Paulos

“The user's going to pick dancing pigs over security every time.”

Bruce Schneier
“The existence of the sea means the existence of pirates”

Malayan Proverb

“They who would give up an essential liberty for temporary security, deserve neither liberty or security”

Benjamin Franklin
The economic features of shipping

- Economies of scale in ship size and of scope and density in operations
- Economies of “market presence” on demand side
- Diversity of markets requiring diverse equipment
- Part of larger supply chain including
  - Ports
  - Inland logistics
  - Ship builders
  - Consolidators
- International shipping is largely deregulated other elements in chain are often not
- Potentially serious externality issues
Economic issues involving shipping

• Growth in world trade and new markets
  – Asymmetric trade patterns
• Port capacity constraints
  – Inland capacity problems
• Emergent new lines, especially China
• Monopoly power of large lines
• Role of shipping in regional markets
  – European Union enlargement
• Environmental concerns
  – Scale of maritime activities
  – Issues of responsibility
• Needs of developing countries
  – Developed countries: freight costs – 5.77% of import costs
  – Developing countries: freight costs – 8.81% of import costs
Maritime supply chain
## Costs of major security incidents

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost on the entire supply chain of a WMD shipped via container</td>
<td>$1 trillion</td>
</tr>
<tr>
<td>Cost of the September 11 attacks on the World Trade Center buildings</td>
<td>$83 billion</td>
</tr>
<tr>
<td>Cost of global cyber attacks against companies in 2003</td>
<td>$12.5 billion</td>
</tr>
<tr>
<td>Cost to the Canadian beef industry of a case of mad cow disease found in Alberta in 2003</td>
<td>$2.5 billion</td>
</tr>
<tr>
<td>Drop in the FTSE immediately following the Madrid bombings</td>
<td>$55 billion</td>
</tr>
</tbody>
</table>

Source: Eggers, 2005
Cost components of Somali Piracy 2011 –2012

<table>
<thead>
<tr>
<th>Component</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ransoms</td>
<td>$160 million</td>
<td>$63.5 million</td>
</tr>
<tr>
<td>Military Operations</td>
<td>$1.27 billion</td>
<td>$1.09 billion</td>
</tr>
<tr>
<td>Security Equipment and Guards</td>
<td>$1.064-$1.16 billion</td>
<td>$1.65 - $2.06 billion</td>
</tr>
<tr>
<td>Re-Routing</td>
<td>$486-$681 million</td>
<td>$290.5 million</td>
</tr>
<tr>
<td>Increased Speed</td>
<td>$2.71 billion</td>
<td>$1.53 billion</td>
</tr>
<tr>
<td>Cost to Labor</td>
<td>$195 million</td>
<td>$471.6 million</td>
</tr>
<tr>
<td>Prosecutions and Imprisonment</td>
<td>$15.4 million</td>
<td>$14.89 million</td>
</tr>
<tr>
<td>Insurance</td>
<td>$635 million</td>
<td>$550.7 million</td>
</tr>
<tr>
<td>Counter-Piracy Organizations</td>
<td>$21.3 million</td>
<td>$24.08 million</td>
</tr>
<tr>
<td>Total cost</td>
<td>$6.6-$6.9 billion</td>
<td>$5.7-$6.1 billion</td>
</tr>
</tbody>
</table>

*Source: Bellish (2013); Bowden and Basnet (2012)*
Press reports on port's container security charges

<table>
<thead>
<tr>
<th>Example of average terminal security fees</th>
<th>$/TEU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian ports (those operated by P&amp;O Ports)</td>
<td>3.8</td>
</tr>
<tr>
<td>Belgian ports</td>
<td>10.98</td>
</tr>
<tr>
<td>Denmark</td>
<td>61</td>
</tr>
<tr>
<td>Dutch ports</td>
<td>10.37</td>
</tr>
<tr>
<td>French ports</td>
<td>10.98</td>
</tr>
<tr>
<td>Italian ports</td>
<td>9.76</td>
</tr>
<tr>
<td>Latvian ports</td>
<td>7.32</td>
</tr>
<tr>
<td>Norwegian ports</td>
<td>2.44</td>
</tr>
<tr>
<td>Spanish ports</td>
<td>6.1</td>
</tr>
<tr>
<td>Irish ports</td>
<td>8.54</td>
</tr>
<tr>
<td>Swedish ports (Gothenburg)</td>
<td>2.6</td>
</tr>
<tr>
<td>Felixstowe (HPH)</td>
<td>19 for import and 10 for export</td>
</tr>
<tr>
<td>Harwich</td>
<td>19 for import and 10 for export</td>
</tr>
<tr>
<td>Thames port</td>
<td>19 for import and 10 for export</td>
</tr>
<tr>
<td>Tilbury</td>
<td>12.7</td>
</tr>
<tr>
<td>Canada</td>
<td>2.7% increase in harbour dues</td>
</tr>
<tr>
<td>TSI Terminal handling charges</td>
<td>1.5</td>
</tr>
<tr>
<td>Charleston, Houston, Miami</td>
<td>5</td>
</tr>
<tr>
<td>USA</td>
<td>Gulf seaports marine terminal conference</td>
</tr>
<tr>
<td>Shenzhen</td>
<td>6.25</td>
</tr>
<tr>
<td>Others</td>
<td>6.41</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>10</td>
</tr>
</tbody>
</table>

Source: Bichou (2014)
Changes in perception

- Traditionally involved theft
  - Pirates
  - Including theft of transport services in hijacks (Cubans to US)
- Damage/vandalism
- Used as a political tool
  - Hostages
- Used as weapon
  - USS Cole
Traditional piracy
Modern piracy
Nature of security

• Personal versus property security
• Objectives of attacks
  – Personal gain
  – Economic disruption
  – Terrorism
  – Symbolic
• Nature of terrorism
  – Psychological effect not physical
• Why transport
  – Visible
  – Vulnerable
  – Economically and socially important
  – Useful weapon for delivery
Security challenges

• Motivations
  – Crime; traditional issue going back to antiquity. Over 400 acts of piracy a year.
  – Supply chain interruption. Traditional instrument in military conflicts.
  – Use as a weapon. Mobile capital as a means of delivering a terrorist attack.
    Long history!

• Weaknesses
  – Large fragmented networks
  – Complex system; both physical and in terms of support infrastructure such as communications
  – International; issues of global coordination of policies
  – Highly visible

• The supply chain has been the subject of frequent attacks
Policy Actions

• Prevention
  – Intelligence
  – Inspections
  – Hardware (barriers; defensive weapons)
  – Deterrence (penalties)

• Minimization
  – Insulation/armor
  – Design
  – Reaction (communications/response plans)

• Recovery
  – Back-up systems
  – Repair system
Private sector incentives

- **Image**
  - Loss of business

- **Financial costs**
  - Costs of attacks
  - To vessels/port
  - To network

- **Government stimuli**
  - Government divestiture
  - Legal requirements (administrative costs)
  - Loss of control over to government

- **Reduced insurance costs**
  - Moral hazard issues
  - Additional pay to employees
US security programs in place
The complexities

• Uncertainty versus risk
  – Risk as in safety arguments has a “known” probability and can be insured for
  – Uncertainty has no known probability and cannot be handled using conventional actuarial techniques
  – Risk usually involves a large number of similar past incidents and a “passive” cause in that perpetrators do not react to measures to limit their activities.
  – Most major terrorist threats involve uncertainty.
  – Uncertainty is normally modeled in economics using some form of simulation analysis. The Government often acts as the secure of last resort to maintain public confidence.
The complexities

• Public versus private good aspects and externalities
  – Most security measures are both rival and excludable hence are not public goods; e.g. faster sailing, inspections.
    • Use of vessels in attacks or for carriage of weapons maybe an exception
  – Private suppliers have commercial incentives to be secure; simple insurance cost considerations but also their customers’ confidence.
  – National intelligence systems may have quasi public good elements to them.
  – There are external costs and benefits of supply chain security; e.g. making one link more secure educes the costs of making the next node/link secure because it reduces the risk/uncertainty that the consignment will arrive safely.
  – Public confidence that a system is secure is a form of intangible externality that has some public good elements.
The complexities

• Measuring the benefits
  – How do you know that you have prevented a crime or terrorist attack?
  – What is the monetary value of preventing an attack?

• Measuring the costs
  – What are the complete costs of security measures; e.g. the time costs of inspections of cargo or checking workers credentials?
  – Who should pay the costs?
  – How can the costs be minimized; i.e. how can X-inefficiency be avoided?
The complexities

• Deterrence
  – Normally Becker’s theory of deterrence applies; i.e. high detection rates with lenient punishment rather than harsh punishment and low detection.
  – Normal deterrence theory breaks down when transport involves a suicide attacker.
  – No agreement on how to handle the suicide bomber issue but it is a generic and not transport issue.
## Benefit-Cost Models of Transport Security Initiatives

<table>
<thead>
<tr>
<th>Issue/Model</th>
<th>Recommended Action</th>
<th>Key Variables for Estimation</th>
</tr>
</thead>
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<tr>
<td>Allocating a fixed expenditure amount among independent sites</td>
<td>Equate the marginal expected social costs avoided (MESCA)</td>
<td>Social costs avoided and their change with expenditures, probabilities, and costs of implementation</td>
</tr>
<tr>
<td>Displacement of probability of attack</td>
<td>Determine the net MESCA, net of probability increasing effects at other sites</td>
<td>As above, plus adjustments in probability for diverted attacks</td>
</tr>
<tr>
<td>Constraint on probability or cost reductions</td>
<td>Results in an optimal inequality among sites even where investment occurs</td>
<td>As above, but break-even will be different at sites with constraints</td>
</tr>
<tr>
<td>Both prevention and mitigation reducing activities</td>
<td>Equate the marginal social cost avoided of each type of expenditure</td>
<td>As above, but also separates effect of each activity</td>
</tr>
<tr>
<td>General rules: public goods</td>
<td>Invest until the sum of marginal damages avoided equals the individual site MESCA</td>
<td>As above, but identify the multiple sites that are positively linked</td>
</tr>
<tr>
<td>All hazards: multiple sources of probability and cost</td>
<td>The form of decision is the same (e.g., equate MESCA), but all costs and probabilities are taken into account</td>
<td>As above, but more complex probabilities</td>
</tr>
<tr>
<td>Dynamic uncertainty and irreversibility</td>
<td>There can be an optimal “overinvestment” in security</td>
<td>More complex uncertainties</td>
</tr>
</tbody>
</table>

Source: Farrow and Shapiro (2009)
Issues with applying CBA to maritime security

• The large scale impacts of a major security breach have extensive income/effects
• There are many complements and substitutes that are not fully marginally cost priced; hence serious second best issues
• Shipping is not a perfectly competitive industry (in either the Marshallian or Austrian sense) hence without security considerations prices are not set to MC
• There are issues of uncertainty that traditional, Guassian based, CBA does not take into account.
• The extensive network effects make comprehensive tracing out both direct and indirect effects difficult.
Issues in defining optimal maritime security

• C: Drawn to separate-out the minimum marginal costs of incremental units of security, including inconvenience costs to all parties concerned, as well as financial outlays.
• C*: Drawn to reflect the lack of incentive to provide security at the lowest cost; e.g. because the agency involved is a monopoly or their may principal-agent problems if it is a public undertaking leading to X-inefficiency may be present in providing the security measures.
• B: Drawn to reflect the immediate benefits of security; e.g. “cost savings” from less incidents
• B*: Drawn to reflect non-monetary benefits of greater sense of security
The determinants of optimal security provision
Outcome of policy/calculations?

- **S**: optimal level of security in social terms
- **S***: Optimal in purely commercial terms
- **S**: Optimal if the psychological aspects of security are ignored
- **S##**: Outcome if inefficiencies due to institutional failings and psychological benefits are ignored.
Conclusions

- It is important to optimize the security of the maritime supply chain
- Need for a solid economic framework to decide on actions
- Partial equilibrium economic analysis (e.g. CBA) is not sufficient