Optimal Inspection Strategies For Coast Guard Operations

CREATE Economics Symposium: Economic Costs & Consequences of a Terrorist Attack

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US Coast Guard
US Coast Guard Efforts For Modernization

- **Deepwater Acquisition Program**
  - is a major effort to replace and modernize the aircraft and cutter fleet over the next 20 years.
  - seeks to develop an improved and integrated system of aircraft, cutters and unmanned aerial vehicles that enhance command control, communications, intelligence, surveillance, reconnaissance and logistics.

- **Rescue 21**
  - is the second largest procurement program to update the current coastal communication system.
  - will improve search and rescue and illegal drug and migrant interdiction missions.
Vessel Information

- 24-hour rule
- 96-hour rule
- Foreign Vessels
  - According to Code of Federal Regulations, vessels entering US waters must provide in advance data on cargo, crew members, owners of the vessel and recent ports visited.

- US Flag Vessels
  - There is no regulation that requires vessels less than 300 gross tons to report information about cargo and schedule of arrival.
Previous Literature

- Becker (1968)
- Landsberger and Meilijson (1982), Harrington (1988)
- Livernois and McKenna (1999), Innes (1999), Raymond (1999)
Border Security

Borders
- Maritime
  - Ports
    - Coast
      - Critical Coastal Targets
        - Bridges
          - Nuclear Plants
        - LNG Terminals
        - Urban Centers
      - Pleasure and Fisher Boats
      - Waterways and Underwater
        - North
        - South
      - Passenger
      - Cargo
      - Environmentally Sensitive
        - Other
      - Federal
        - State
        - Indian
        - Private
    - Container
      - General Cargo
  - Access to Secure Areas
    - Cruise Lines
    - Port Perimeter
  - Cargo
    - Access to Secure Areas
  - Passenger and Baggage
  - Cargo and Mail

Land
- Ports of Entry
- Between Ports of Entry

Aviation
Risks

- Illegal importation of weapons and explosives.
- Attacks on coastal targets.
- Attacks on other commercial vessels.
- Laying mines at ports or coastal waterways (Underwater Security).
- Illegal immigration and drug smuggling.
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
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<tbody>
<tr>
<td>$q$</td>
<td>fraction of vessels inspected</td>
</tr>
<tr>
<td>$c(.)$</td>
<td>cost of inspection, $c'(q) &gt; 0$, $c''(q) &gt; 0$</td>
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<tr>
<td>$\pi$</td>
<td>USCG’s belief that weapons/explosives will be smuggled across maritime borders</td>
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<tr>
<td>$p$</td>
<td>probability that weapons/explosives will be used in a successful terrorist attack after smuggling</td>
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<tr>
<td>$E$</td>
<td>economic consequence of a terrorist attack</td>
</tr>
<tr>
<td>$v(.)$</td>
<td>disutility of a terrorist attack that costs $E$ total to the economy</td>
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</tbody>
</table>
Inspection without Risk Classification

\( B \) : monetary payoff of smuggling

\( S \) : years of prison sentence

\( f(.) \) : disutility of prison sentence, \( f(0) = 0 \)

USCG solves,

\[
\min_q c(q) + \pi p(1-q)v(E) \\
\text{s.t. } B(1-q) - f(S)q \leq 0,
\]

\( 0 \leq q \leq 1 \)
Inspection without Risk Classification

- Results consistent with Becker
  - the optimal fraction of vessels inspected is increasing in B and decreasing in S
  - if π=1, then every vessel will be inspected if $c'(1) < pv(E)$

- Under certain conditions, as the disutility function in economic losses exhibits higher degree of risk aversion, the optimal fraction of vessels inspected increases.
Inspection with Risk Classification

\( \pi_i \): USCG’s belief that weapons/explosives will be smuggled in a vessel of risk type \( i \), \( \pi_1 > \pi_2 \)

\( t_i \): fraction of vessels of type \( i \)

USCG solves,

\[
\min_q c(t_1 q_1 + t_2 q_2) + [t_1 \pi_1 (1-q_1) + (1-t_1) \pi_2 (1-q_2)] \text{ pv}(E)
\]

s.t. \( B(1-q_1) - f(S) q_1 \leq 0, \ B(1-q_2) - f(S) q_2 \leq 0 \)

\( 0 \leq q_1, q_2 \leq 1 \)
Inspection with Risk Classification

- The optimal fraction of vessels inspected for high risk types is at least as high as that of low risk types.
- Fraction of vessels inspected are non-decreasing in $\pi_i$, $p$ and $E$.
- Inspections should be performed on both risk types to prevent terrorists from shifting risk from high risk to low risk vessels.
- Results consistent with Becker due to adversarial nature of the risk.
Implications

- Funds should be appropriated to increase the number of cutters and aircraft in USCG fleet and deter terrorists.
- For better surveillance, investment of radar technologies and AIS should be promoted.
- Coastal communication systems should enable effective coordination between command authority and USCG fleet.