Analytic Assessment of Maritime Security Inspection Strategy

MORS HLD-HLS Decision Support Workshop
16 November 2005

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Inspections and Inspection Systems

Inspection: "A formal or official examination"

Goal of individual inspection:
Detect non-compliance

Goal of inspection system:
Deter/dissuade non-compliance as a strategy

Inspection System Elements

Policies (what to inspect)

- **Targeting (red lane / green lane)**
- **Random inspection (percentage of objects)**

Procedures (how to inspect)

- **Layered inspections**
- **Onsite/offsite inspections**

The right mix of targeted and random inspections can balance sunk cost against risk.

Inspection as a Game

The inspector and the owner of the inspected object act intelligently and interdependently.

Non-compliance motives

- **Cost savings (safety/security violations)**
- **Economic payoff (smuggling)**
- **Political advantage (terrorism)**

Inspection policy balances sunk cost vs expected loss.

Both parties choose strategy to maximize payoff / minimize loss.

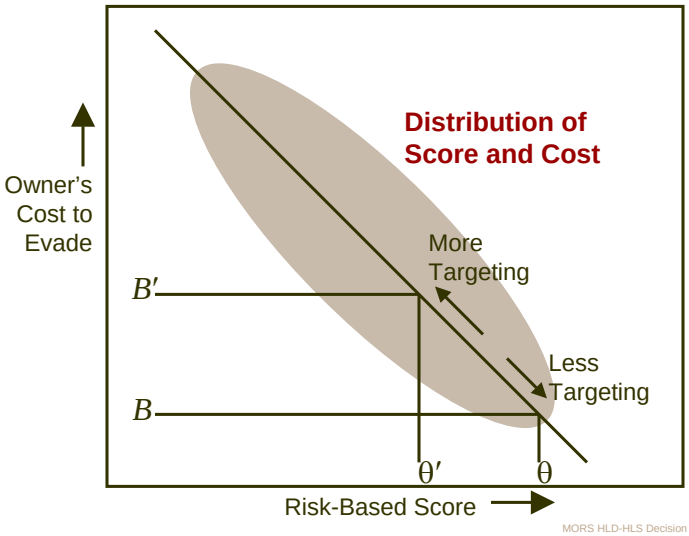
Impact of Targeting and Random Inspection

How do targeted and random inspection impact effectiveness?

Ground rules:

- **Available budget for inspection is fixed**
- **Targeting designed to identify objects associated with greater risk**
- **Owner exploits any known targeting rules**
- **Owner's strategies:**
  Comply, confront targeting, or evade targeting
- **Inspector enforces penalties for non-compliance**

Impact of Targeting



Impact of Random Inspection

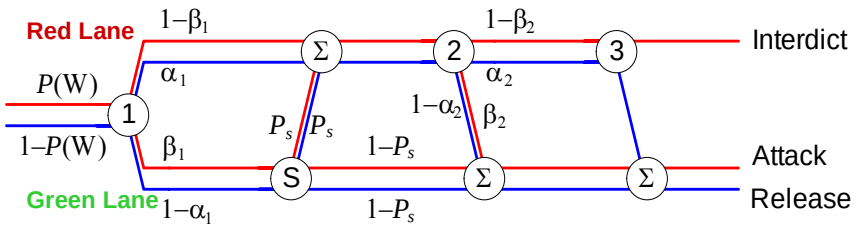
Impact

- **Budget drawn away from targeted inspections**
- **Owner's cost to evade targeting decreases**
- **Advantage owner gains by evading decreases**

Uncertain: Does random inspection lower risk?

Risk assessment requires a sophisticated approach.

Container Inspection: Process Model



(1) Document Inspection
(2) Non-Invasive Inspection (5-10 min)
(3) Physical Inspection (~3 hr)
(S) Random Selection

$P(W)$ = Pr(weapon)
P_s = Pr(random selection)
α_1 = Pr(false alarm given (1))
α_2 = Pr(false alarm given (2))
β_1 = Pr(miss given (1))
β_2 = Pr(miss given (2))

Container Inspection: Payoff

Challenge: Determine the most effective mix of targeted and random inspection rates, given fixed total inspection rate, α

Blue \ Red	Comply	Threaten: Confront	Threaten: Evade
Target	0	A_T $-D_T$	$A - B_\alpha$ $-D$
Randomize	0	$-D_\alpha$	A_α

Red Payoffs

Blue Payoffs

- *Factors taken into account:*
  - A = Assured attack payoff (political)
  - A_T = Expected attempt payoff if targeted
  - A_α = Expected payoff w/random inspection ($A_T < A_\alpha < A$)
  - B_α = Additional cost to evade targeting
  - D = Damage loss from attack
  - D_T = Expected loss from attempt if targeted
  - D_α = Expected loss w/random inspection ($D_T < D_\alpha < D$)

Container Inspection
Pure Strategy Solutions

Blue \ Red	Comply	Threaten: Confront	Threaten: Evade
Target	0	A_T $-D_T$	$A - B_\alpha$ $-D$
Randomize	0	$-D_\alpha$	A_α

Under restricted conditions, pure strategy solutions are possible:

- ($A_\alpha < 0, B_\alpha > A$) or ($A_T < 0 < A_\alpha, B_\alpha > A - A_T$) – "Deterred adversary"
  - Red's losses outweigh any expected gains.
  - Blue must inspect enough to ensure threatening strategies do not pay off.
- ($A_T > 0, B_\alpha > A - A_T$) – "Confronting adversary"
  - Red's gain vs targeting outweighs cost, but evasion is not worth added cost.
  - Blue must inspect enough to ensure evasion is not worth added cost.
- ($A_\alpha > 0, A - B_\alpha > 0$) – "Randomizing inspector"
  - Red gains against random inspection by threatening.
  - Red also gains by evading, so Blue does not target in order to limit damage.

Container Inspection
Mixed Strategy Solutions

Blue \ Red	Comply	Threaten	
		Confront	Evade
Target	0	A_T $-D_T$	$A-B_\alpha$ $-D$
Randomize	0	$-D_\alpha$	A_α

Otherwise, mixed-strategy solutions are recommended:

$(A_\alpha < 0 < A - B_\alpha)$ or $(A_T < A - B_\alpha < 0 < A_\alpha)$ – **"Dissuaded adversary"**

Each chooses to make opponent indifferent to alternatives.

- **Blue mixes strategy to make Red indifferent to comply or evade.**
- **Red mixes strategy to make Blue indifferent to target or randomize.**

What We Can/Should Do

- **Traditional risk analysis is not enough.**
- **Game theory, with risk analysis, can help quantify cost, risk, and tradeoffs.**
- **Game theory can also identify policy decisions that drive an opponent's strategy in a desired way.**
- **What's Next:**
  - **Incorporate data into a game-theoretic model**
  - **Incorporate uncertainty in payoffs**
  - **Expand range of inspection strategies**