How many containers to inspect to deter terrorist attack

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Introduction

A device at New York Container Terminal on Staten Island is designed to detect bomb-building ingredients.

- The Department of Homeland Security (DHS) recently announced a policy of 100% container screening at several large overseas ports
- Retailers claimed that the policy will hinder product transportation, resulting in higher product prices
- How many containers should be inspected to deter terrorist attack?
- We develop a method to answer this question using game theory

Assumptions

- We adapted a model by Dighe et al.,* who showed that attacks can be deterred with less than 100% inspection, provided that the defender discloses the overall level of defense
- We consider multiple attackers, each trying to smuggle in a particular weapon type
- Containers are assumed to be homogeneous
- An "attack" is defined to be a smuggling attempt, regardless of whether the attempt succeeds
- The cost of inspecting a container is assumed to be the same regardless of whether it contains a weapon
- The cost of a smuggling attempt is assumed to be the same regardless of whether it succeeds:
  - The cost of unsuccessful smuggling attempts is what makes deterrence with less than 100% possible!

Prior work

* Dighe, S. D., V. M. Bier, and J. Zhuang, "Secrecy in defensive allocations as a strategy for achieving more cost-effectiveness attacker deterrence," submitted to International Journal of Performability Engineering, 2007.

Model

Notation:

N	=	Total number of containers
n	=	Number of containers inspected
m	=	Number of attacker types
p_i	=	Probability of successfully detecting a weapon smuggled by attacker i
V_i	=	Expected damage if attacker i successfully smuggles a weapon into the US
I_i	=	1 if attacker i decides to smuggle a weapon into the US; 0 otherwise
C_i	=	Cost of a smuggling attempt by attacker i
C_d	=	Inspection cost per container

- The defender is assumed to minimize expected losses, as given by:

$$\min_{n=1,\ldots,N}\left\{\sum_{i=1}^{m}\left[V_i\left(1-\frac{n}{N}p_i\right)I_i\right]+nC_d\right\}$$

- The attacker is assumed to maximize expected rewards, as given by:

$$\max_{I_i=0,1}\left\{\left[V_i\left(1-\frac{n}{N}p_i\right)-C_i\right]I_i\right\}$$

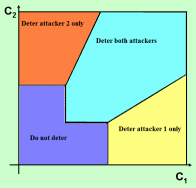
Results

Two-attacker Example

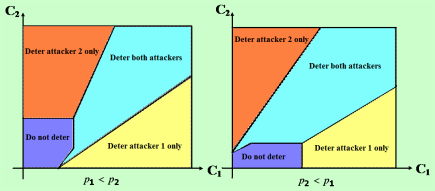
The defender's optimal strategy is to deter any attackers who incur high attack costs

In order of decreasing inspection cost, we have:

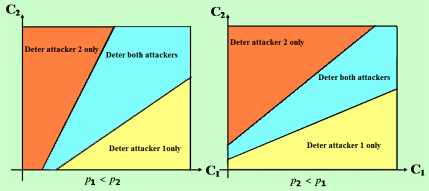
Case 1: $NC_d \geq (V_1+V_2)[\max(p_1,p_2)]$



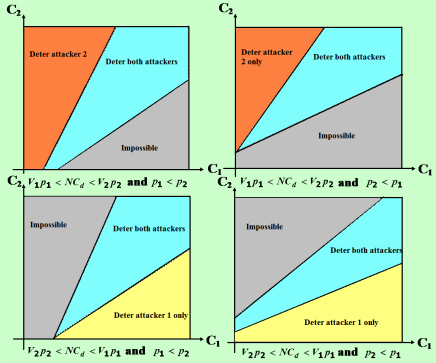
Case 2: $V_1p_1+V_2p_2 \leq NC_d < (V_1+V_2)[\max(p_1,p_2)]$



Case 3: $\max(V_1p_1,V_2p_2) \leq NC_d < V_1p_1+V_2p_2$

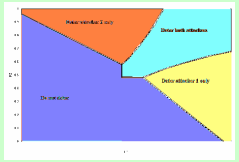


Case 4: $min(V_1p_1,V_2p_2) \leq NC_d < max(V_1p_1,V_2p_2)$



- When NC_d is sufficiently small, we cannot deter any attacker, but can still use inspection to detect weapons

The defender's optimal strategy is to deter any attackers whose weapon choice has a high probability of detection



The results have also been generalized to the case when there are *m* attackers

Results are generally consistent with two attackers

Conclusions

- 100% inspection might not be necessary if the most severe attacks can be deterred with less inspection
- Deterrence will generally be easier to achieve for attackers who face high attack costs:
  - For example, deterring someone attempting to smuggle in a nuclear bomb is likely to require much lower levels of inspection than deterring someone attempting to smuggle in a dirty bomb or assault rifle

Future Directions

- We are currently extending our work to analyze the option of retaliating after a successful attack
- Results indicate that retaliation decreases the number of containers that must be inspected to deter attacks

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