Optimal resource allocation for defending multiple targets

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Background and Motivation

• Homeland-security funding is widely criticized:
  – “States like Wyoming…get more per capita in terrorism grants than New York”
  – “At the end of the day, blowing off New York and L.A. so that you can make sure Wyoming is safe just makes no sense” (Flynn)

• An official from one rural county stated:
  – “We’re getting stuff we won’t use. This equipment could have gone to Seattle”
Urban Area Security Initiative

• The Urban Area Security Initiative was initially intended to address this type of problem

• But the list of cities receiving funding grew from seven to 80:
  – Currently scaled back again
What Is Risk-Based Preparedness?

• At a minimum, it should take into account attacker behavior
• However, game-theoretic models of security investment generally advise defenders to put all their eggs in a few baskets:
  – Those assets that are most vulnerable, most valuable, or most attractive to attackers
What Is Risk-Based Preparedness?

- This is obviously unrealistic in practice:
  - Real-world decision makers will want to hedge their bets
- Nobody would recommend that the U.S. invest only in defense from smallpox:
  - No matter how devastating smallpox might be
- So, a realistic method must account for uncertainty about attacker goals and motivations!
What Is Risk-Based Preparedness?

• Moreover, defenders may not have the same valuations for targets as attackers
• The value of a given target to an attacker may depend on factors such as:
  – The propaganda value of the target
  – The cost or difficulty of the attack
• Risk-based investment in preparedness must take such considerations into account too!
• Recent work addresses these considerations
Assumed Attacker Behavior

• If attackers are assumed to choose targets based on the expected value of an attack:
  – Undefended locations may not be attacked
  – It depends on the attacker’s preferences!

• If the defender increases the resources allocated to one location:
  – It becomes more likely that the attacker will target some other location
Summary of Results

• If the values of the targets are sufficiently different, low-value targets may be unlikely to be attacked:
  – Defenses should be allocated only to valuable targets
  – Even in the face of significant uncertainty!
• It can be optimal to leave some targets undefended, particularly when:
  – The defender is highly budget constrained
  – The values of the targets differ widely
• This is exactly the situation in the real world!
Summary of Results

• The weakest-link hypothesis does not always hold!
  – Attacker preferences are relevant

• Some highly vulnerable targets may be left largely undefended:
  – If they are of little interest to attackers
Sample Results for 10 UASI Cities

Caveats

• These results are based on the assumption that the defender wants to minimize expected property losses (as estimated by Rand):
  – And the attacker preferences are based on expected property losses plus an “error term”

• Other objective functions (e.g., fatalities, infrastructure damage) would lead to slightly different resource allocations
Caveats

• Even if some cities get zero resources in a city-level analysis:
  – They may still have targets worth defending in a target-level analysis
• This is consistent with recent guidance:
  – The highest-risk jurisdictions compete for a majority of the funds
  – The remaining UASI areas compete for the remaining funds
Interpretation of Results

• Optimal investment strategies depend critically on cost effectiveness of investment:
  – High cost effectiveness allows the defender to spend more on defense of less valuable targets
  – At low cost effectiveness, the defender has to devote most resources to the more valuable targets

• However, we currently do not have a good way to measure the cost effectiveness of our investment!
Decentralization

• With decentralized decision making:
  – Some targets receive too many resources

• For instance:
  – Security measures by the Postal Service may deflect risk onto private carriers
  – Measures to make aviation more secure may deflect risk onto other modes of transportation

• Greater coordination would be preferred!
Large Numbers of Targets

• It is a hopeless task to defend large numbers of individual targets

• It is optimal to invest in security only if investment can be focused on a relatively small number of targets:
  – And the remainder are relatively unlikely to be attacked
Large Numbers of Targets

- The difficulty of defending extremely large numbers of assets also suggests that psychological factors may play an important role
- If the public demands protection against any possible terrorist attack:
  - Then security investment may have harm the economy
- A successful defense strategy may need to reshape public perceptions:
  - To focus defensive resources on the most serious risks
Conclusions

• When facing the threat of an intentional attack:
  – It is important to model the behavior of the attacker
• Making security funding more risk-based will be difficult
• In particular, an effective terrorism defense must involve:
  – Hard choices about what not to defend,
  – Overarching protections (like border security), or
  – Changes in the incentives faced by potential terrorists
• This creates some challenges for security research
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