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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”



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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



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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



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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!



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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



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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



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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!



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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

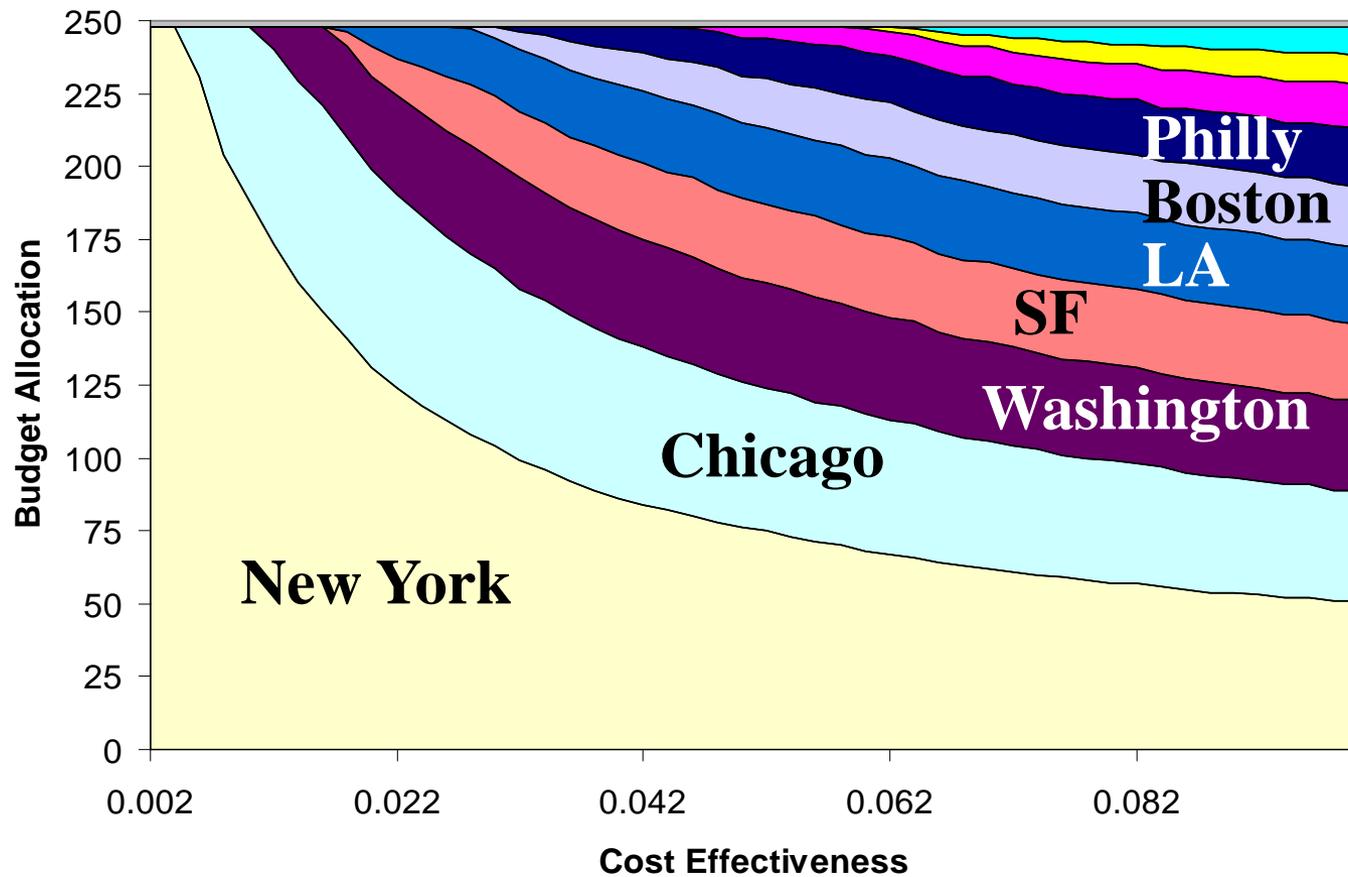


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Sample Results for 10 UASI Cities





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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



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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



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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!



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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!



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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



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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



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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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