

Measuring the Risk of Terrorism

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Terrorism Risk

Who Studies Terrorism Risk?

- Government Agencies (to safeguard the public),
- Private Risk Analysts (to assist risk financing),
- Academics.

Risk Financing

- Private risk analysts (vendors to reinsurers, insurers, captives, etc.) include:
 - ✓ Risk Management Solutions (RMS),
 - ✓ Applied Insurance Research (AIR),
 - ✓ Eqecat (EQE).
- For risk-financing purposes, most interested in **Total Losses** (in dollars or human lives) for fixed time period.

Components of Risk

- Total Losses

= Total Event Count (**Frequency**)
x Average Cost per Event (**Severity**).

- For portfolio of many *individual* exposures,
often work with

(Total Losses) / (Number of Exposures).

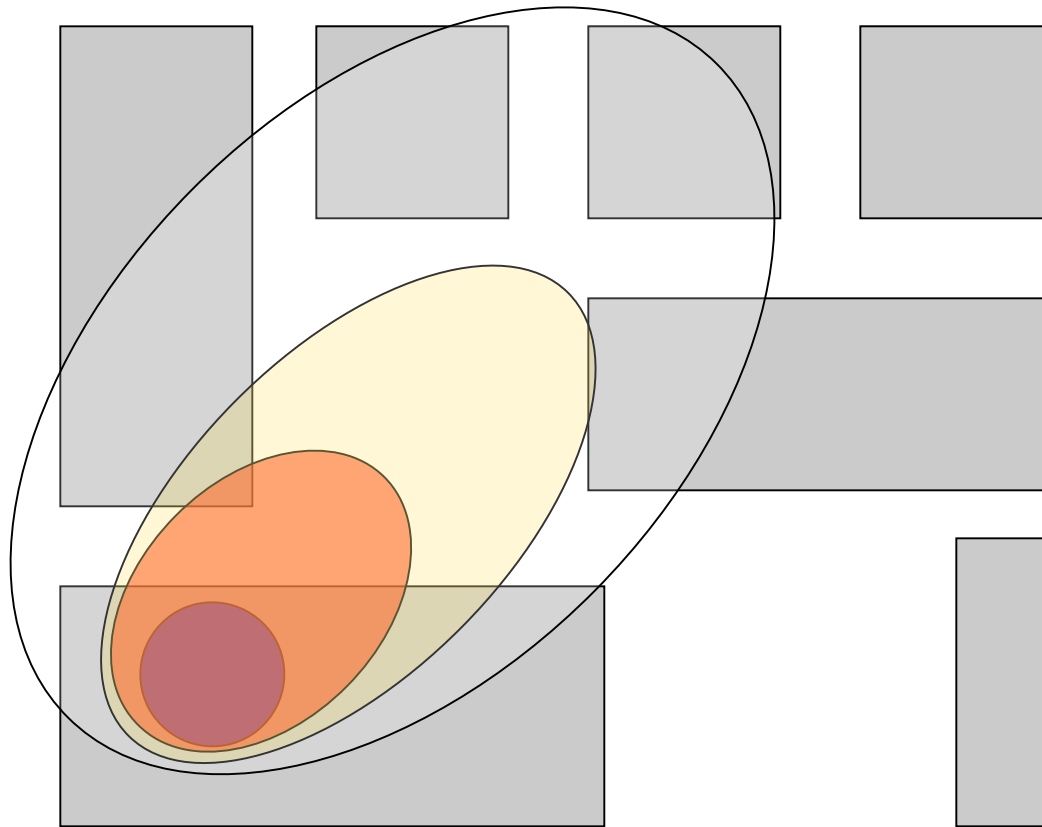
Forecasting Severity

- Identify potential modes of attack:
 - ✓ Conventional bomb (various TNT equivalents),
 - ✓ Arson,
 - ✓ Airplane crash,
 - ✓ Industrial sabotage (chemical, nuclear),
 - ✓ Chemical / biological / radiological / nuclear (CBRN) weapon.
- Relative likelihood and consequences of each attack scenario assessed by security and engineering experts (“**black box**” approach).

Forecasting Severity (cont.)

- Establish damage grid for each type of attack:
 - ✓ Physical processes (blast pressure, dispersion of contaminants, etc.),
 - ✓ Target footprint and construction (office building, power plant, nuclear/chemical facility, etc.),
 - ✓ Human occupancy (on- vs. off-site, shift workers, etc.).

Damage Grid



Forecasting Severity (cont.)

- Apply damage grid to each type of exposure:
 - ✓ Property damage,
 - ✓ Worker fatalities and injuries,
 - ✓ Business interruption.

Forecasting Frequency

- Identify current terrorism “Outlook”;
i.e., underlying level of terrorist activity.
- ϕ_i = Probability of Event at Target i
= “Outlook” Probability of Attack
x Probability i is Selected for Attack
x Probability Attack is Undetected at i
x Probability Attack is Successful at i
= $p_1 p_2 p_3 p_4$.

Forecasting Frequency (cont.)

- Articles by Gordon Woo (RMS) and John Major (Guy Carpenter) in *J. of Risk Finance* (2002) propose **game-theoretic** methods.
- Research “goes underground” in 2003.
- Various probabilities assessed by security experts in “**black box**” approach.

Forecasting Frequency (cont.)

- For Target i , let:

V_i denote the **intrinsic** value of the target;

A_i denote the **intrinsic** amount of resources allocated by the attacker; and

D_i denote the **intrinsic** amount of resources allocated by the defender.

Forecasting Frequency (cont.)

- From **search theory**, we find that

$$p_3 = \exp(-A_i^S D_i^S / V_i^S).$$

- From **gambler's ruin** analogy, we find that

$$p_4 = A_i^C / (A_i^C + D_i^C).$$

- Consequently,

$$\phi_i = p_1 p_2 \exp(-A_i^S D_i^S / V_i^S) [A_i^C / (A_i^C + D_i^C)].$$

Forecasting Frequency (cont.)

- Assume attacker [defender] wants to maximize [minimize] $\sum \phi_i L(V_i)$.

- Let:

$$A = \sum A_i , \quad D = \sum D_i ,$$

$$a = A / \sum V_i^{1/2} , \quad \text{and} \quad d = D / \sum V_i^{1/2} .$$

- Consider two cases:

Model 1 – Simultaneous attacks at all targets.

Model 2 – Random attack at only one target.

Forecasting Frequency (cont.)

Model 1 Results

If $L(V_i) = V_i^{1/2}$ for all i , then:

Strategic equilibrium is formed by

$$A_i = aV_i^{1/2} \text{ and } D_i = dV_i^{1/2} \text{ for all } i, \text{ and}$$

$$\phi_i = p_1 \exp(-ad) (a/d)^c / [1+(a/d)^c],$$

which is approximately $p_1 (A/D)^c$.

Forecasting Frequency (cont.)

Model 2 Results

If $L(V_i) = kV_i^b$ for all i , then:

Strategic equilibrium is formed by

$$A_i = aV_i^{1/2} \text{ and } D_i = dV_i^{1/2} \text{ for all } i, \text{ and}$$

$$\phi_i = p_1 p_2^{(i)} \exp(-ad) (a/d)^c / [1+(a/d)^c],$$

$$\text{where } p_2^{(i)} \propto V_i^{1/2-b} \text{ for all } i.$$

Forecasting Frequency (cont.)

- Note that if $p_2^{(i)}$ is endogenized in Model 2, then strategic equilibrium cannot exist.

Concluding Thoughts

- Framework for measuring terrorism risk is comprehensive and rigorous, but inputs are often subjective judgments.
- On severity side, past-event experience can be used to calibrate “black box” approach.
- On frequency side, more theoretical work needs to be done.

Reference

- Powers, M. R. and Shen, Z., 2005, “Colonel Blotto in the War on Terror: Implications for Event Frequency,” *Fox School Working Paper*.