

Modeling conflict, with examples from terrorism

Kristian Skrede Gleditsch

Based on joint work with Aaron Clauset (SFI), Lindsay Heger (UCSD), and Maxwell Young (Waterloo)

Department of Government, University of Essex
& Centre for the Study of Civil War, PRIO

<http://privatewww.essex.ac.uk/~ksg/>

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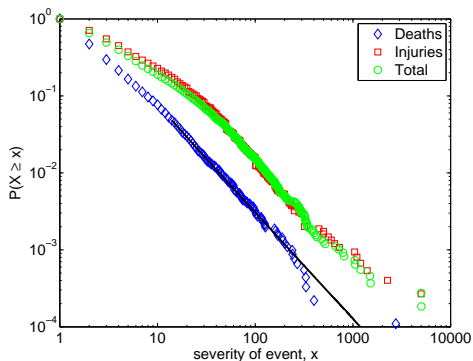
- Scale invariance in conflict data
- Frequency and severity of terrorism (CYG JCR 2007)
- Implications for study of terrorism
- Frequency and severity in Israel-Palestine conflict (CHYG 2007)

Scale invariance in conflict data

- L.F. Richardson 1948 demonstrated the scale invariant distribution of war magnitude/severity
- However, almost all subsequent research considers conflict as incidence or binary events
- Some debate on general vs. separate theories for larger or smaller conflicts (*International Interactions* 1990)
- Specific work on war size: Cioffi-Revilla 1991 JCR forecast of Gulf War magnitude; Lacina 2006 JCR on civil wars
- Cederman 2003 APSR: computer simulation of geopolitical system that reproduces a scale invariant war distribution
- Johnson et al. 2006: scale invariance for a large range of conflicts, including events within conflict; Spirling ND for democide

Scale invariance in terrorism

- Most studies of terrorism focus on incidence, or accounting for location where and when attacks occur
- CYG in *J. Conflict Resolution* **51** (2007): frequency-severity in MIPT data on terrorist events since 1968



Summary of distributions

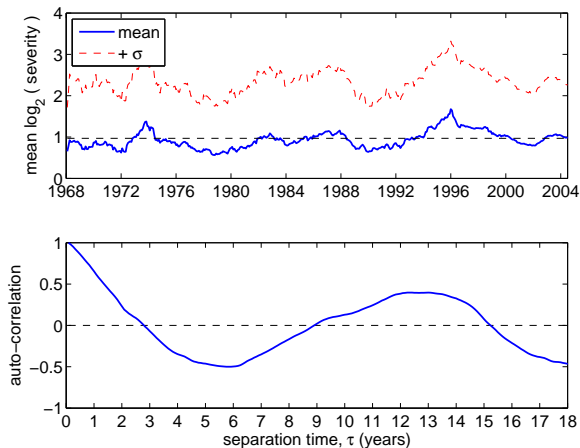
Distribution	N	$\langle x \rangle$	σ_{std}	x_{max}	N_{tail}	α	x_{min}	$p_{\text{KS}} \geq$
Injuries	7456	12.77	94.45	5000	259	2.46(9)	55	0.41
Deaths	9101	4.35	31.58	2749	547	2.38(6)	12	0.94
Total	10878	11.80	93.46	5213	478	2.48(7)	47	0.99

A summary of the distributions with power-law fits from the maximum likelihood method. N (N_{tail}) depicts the number of events in the full (tail) distribution. The parenthetical value depicts the standard error of the last digit of the estimated scaling exponent.

Why is this interesting?

- Terrorist events vary dramatically in their severity
- Terrorist seek media attention and spectacular attacks
- More severe attacks can provide signals of resolve to governments
- Political and economic impact of terrorism a function of severity
 - 11 Sept attack on WTC/Pentagon vs. previous 1993 WTC bombings
 - 7 July London bombings vs. 21 July copy-cat attack
- Suggested predictors in work on terrorist incidence (e.g., Li JCR 2005) unable to account for variation in severity
- Severity offers a complimentary perspective to incidence

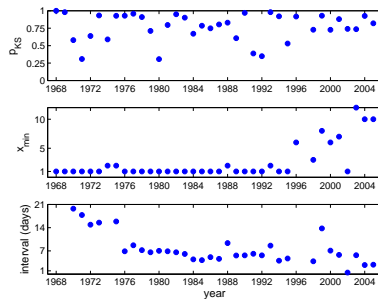
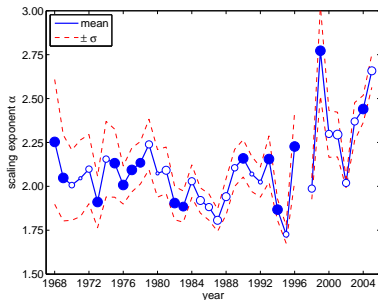
Trends in average log-severity



(upper) average log-severity (deaths), 24 months sliding window

(lower) ACF of average log-severity

Trends in scaling parameter



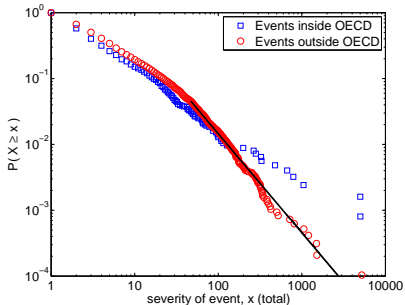
(L) Average scaling exponent α for two-year periods

(R top) significance, one-sided KS test

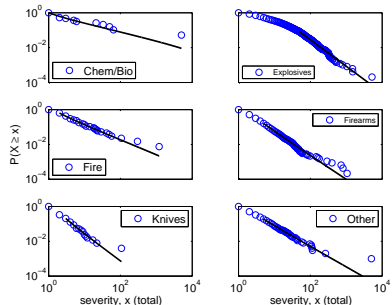
(R middle) estimated x_{min}

(R bottom) average inter-event interval for events in tail

Disaggregating by locus and weapon type



(L) Frequency-severity distributions for OECD and non-OECD nations



(R) Frequency-severity distributions by weapon types

Generative models for scale invariance

- Many generative models can generate scale invariant distributions
- Self-organized criticality model applied to forms of conflict such as interstate wars, strikes
- Limitations
 - Terrorism is not inherently spatial phenomenon
 - Severity not only function of size of explosion
 - Substitution between targets/weapons
- Johnson et al. fragmentation and coalescence model of insurgency
- CYG JCR: Toy model for scale invariance through competitive forces

Toy model for scale invariance

Competition non-state actor (terrorist) and government

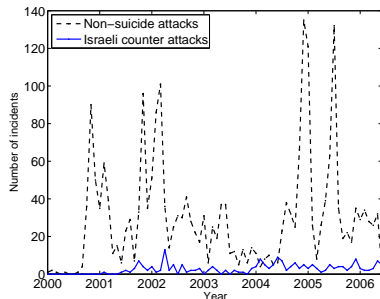
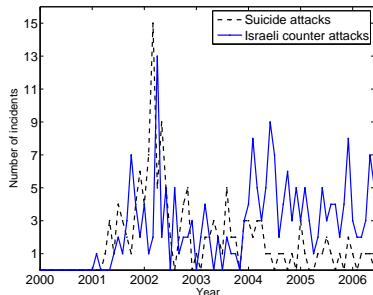
- Severity function of planning and time invested
- Selection mechanism where probability event executed inversely related to planning required
- Payoff of additional planning proportional to time already invested
- Potential severity: $p(t) \propto e^{\kappa t}$
- Severity of real event to planning time of a potential event: $x \propto e^{\lambda t}$
- After selection of realized events:

$$\int p(x) dx = \int p(t) dt \rightarrow p(x) \propto x^{-\alpha} \text{ where } \alpha = 1 - \kappa/\lambda$$

If slight advantage to state $|\kappa| \gtrsim |\lambda|$, then we get a power law with exponent $\alpha \gtrsim 2$

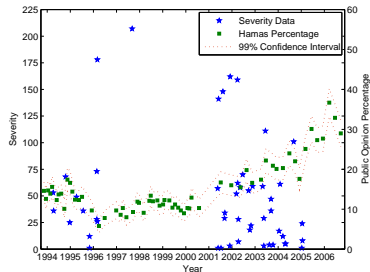
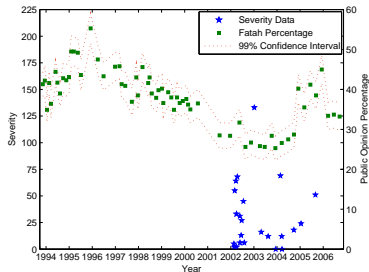
- Standard approach considers substitution of targets (Enders and Sandler 1993, 2002): Countermeasures make alternative targets relatively more attractive
- But, calculus of terrorism much more complicated, e.g.:
 - inter-group competition, political support
 - violence vs. non-violence, severe vs. non-severe
- Data allow evaluating these influences in Israel-Palestine conflict
- Focus on main players: Fatah, Hamas, PFLP, PIJ
- Plus, data on Israeli countermeasures and Palestinian support

Israeli countermeasures



- (L) Counts for suicide attacks and Israeli counter-terrorism events
- (R) Counts for non-suicide and Israeli counter-terrorism events

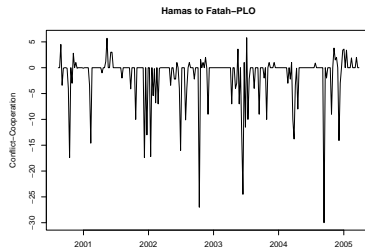
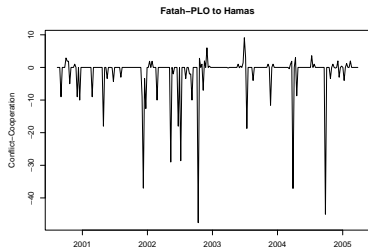
Competition, imitation, and public opinion



(L) Fatah suicide attack severity (left axis) and public approval (right)

(L) Hamas suicide attack severity (left axis) and public approval (right)

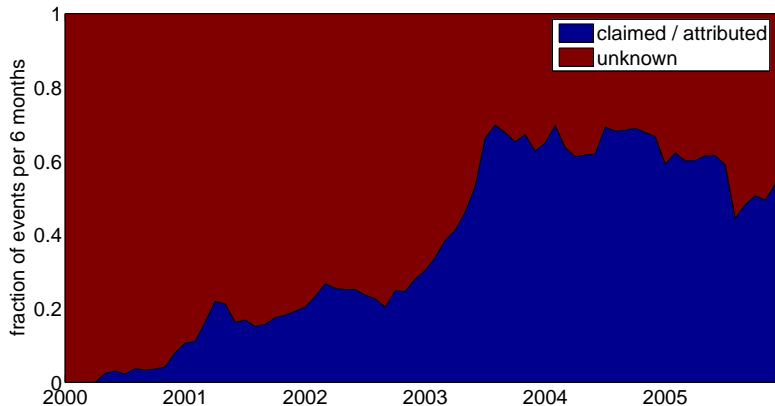
No evidence of coordination



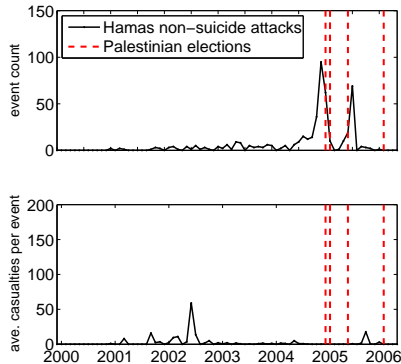
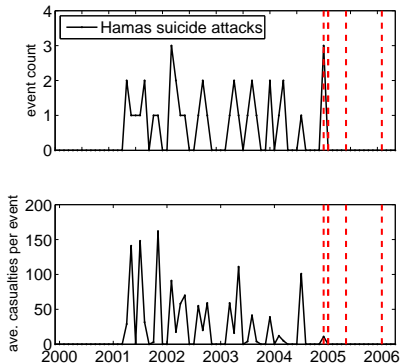
(L) Fatah to Hamas conflict cooperation score, by week

(R) Hamas to Fatah conflict cooperation score, by week

Change in share of claimed attacks



Attack modes and elections



(L) Incident frequency (upper pane) and average casualties per attack (lower), suicides

(R) Incident frequency (upper pane) and average casualties per attack (lower), non-suicides

- Frequency-severity distributions in conflict data
- Thinking about event severity offers important new insights
- Calculus of terrorism is highly complex
 - Many possible strategies
 - Many possible targets and modes
 - Many possible interpretations of data
- In Israel-Palestine conflict evidence of
 - inter-group competition: innovation, imitation
 - interaction with political processes: public support, elections