

The Dynamics of Public Response to a Terrorist Strike: Recommendations for Data Collection, Analysis, and Modeling

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1. Overview

The central objectives of this research are to describe and model the dynamic complexity that underlies a community’s response to a terrorist strike and to estimate how behavioral responses affect economic impacts. Emergency response systems, information and communication channels, and social support organizations are likely to interact with the particular characteristics of a terrorist event in a nonlinear fashion to produce a wide range of physical, social, and economic impacts. Building on the theoretical framework of the social amplification of risk, and guided by systems thinking, this study will address the following questions: 1) What are the requisite factors to adequately forecast the impacts of a disaster and most particularly a terrorist strike? 2) How can risk perception be incorporated into an economic model that predicts regional or national impacts? 3) How does resilience (the ability of a community to maintain function when shocked) affect predicted responses to catastrophic events? 4) How do these factors change and interact over time reflecting the dynamic nature of community response? 5) What are the important structural mechanisms that drive such change, especially system feedbacks and delays? 6) How do different responses to risk across gender, age, ethnicity, and income affect these mechanisms? 7) What perspectives and assumptions does a community bring to such a crisis that helps or hinders its ability to prepare, respond and recover? 8) What policies can be implemented that may mitigate the long-term impacts of such an event?

Over the last year, a system dynamics model has been constructed that addresses questions 1, 2, 4, 5 and 8. Essentially, the model captures the diffusion of fear in a community following different terrorist attacks and looks at the impact of community intervention. In addition, work has begun on a CGE model of Los Angeles that would allow the economic impact of different terrorist attacks to be estimated. Still to be worked out, is how emotions like fear can be incorporated into the CGE model.

Likewise, longitudinal survey data was collected that tracks subject’s responses to different disasters (anthrax, bomb blast, cyber-terrorism and earthquake) over time. Surprisingly, cyber-terrorism is perceived to be as threatening to quality of life as anthrax. Additionally, a nationwide panel was put together to study the on-going impact of the financial crisis on perceived risk, emotional reactions, media influence and risk-related behaviors. While this latter study does not involve terrorism, it should shed light on how perceived risk changes in the midst of a real-time crisis.

2. Research Accomplishments

2.1 System Dynamics Modeling

Consistent with the above objectives, a system dynamics model has been developed that models community response to different types of disasters. Among other things, the model incorporates event risk signal, media coverage, risk perception and community intervention as a means of simulating the diffusion of fear following different types of disasters (especially terrorism). Simulations of community response have been conducted. One of the end goals of this model is to provide input into a Computable General Equilibrium Model (CGE) to examine the economic impacts following these types of disasters.

2.2 CGE Modeling

Regarding economic modeling, activity on the project during the past year has involved a computable general equilibrium (CGE) analysis of risk amplification. This began with the development of a taxonomy of the various ways that a major example of risk amplification—the “fear factor”—can be incorporated into this type of model. Major reactions include:

- Government-ordered evacuation of people from threatened areas.
- Public and private shutdowns of facilities or office buildings potentially contaminated.
- Avoidance behavior of people (e.g., fear of interaction with others in the case of an infectious disease contamination that affects people traveling to work or making shopping trips, or using a vulnerable good or service such as airline travel).
- Substitution away from goods that represent a threat (e.g., contaminated food types).
- Conservation or hoarding of goods likely to be in short supply.

Related work involved attempting to develop a bounded rationality framework for business and household decision functions. This included the specification of testable hypotheses for survey and experimental work on the project.

Another area of activity was updating the Los Angeles County CGE models with the most recent date possible and converting it to a modeling platform best suited to economic cost consequence analysis. The initial modeling problem to overcome relates to the incorporation of constraints reflecting damage to production facilities and infrastructure, and price increases for goods and services rendered increasingly scarce. Experiments with the model indicated it is ready for application to estimating the direct and indirect consequences of risk amplification.

At present, certain types of responses can be modeled for all five categories above in a crude manner. The next step is to explicitly model behavioral responses in decision functions and to incorporate them into the model. Ideally, this will involve elements of bounded rationality relating to objective functions (non-optimal and multiple), risk aversion, time horizons, etc. Additional work will be needed to ensure that these specifications are compatible with the CGE solution algorithm.

2.3 Surveys

Preliminary work has been done that examines how risk perceptions and risk related behaviors translate into economic impacts. Specifically, disaster scenarios and surveys have been developed that look at how risk perceptions, risk aversion, and a number of economic behaviors (e.g. willingness-to-pay, tradeoffs between privacy and security, postponement of purchases) differ across threat scenarios. Two preliminary

longitudinal surveys (i.e., three waves of data over a 30 day period) have been conducted involving over 300 respondents. The first survey compared responses to an earthquake, bomb blast and anthrax release while the second survey compared responses to an earthquake, cyber-attack and anthrax attack. Finally, analysis is nearly complete regarding risk perception data collected in 2004 and 2006 involving 357 respondents. This study compares responses to 16 different threat scenarios.

2.4 Results So Far

Regarding the system dynamics model, for three scenarios (anthrax attack, bomb blast and propane tank explosion) intensity of investigation, media coverage, public risk perception, diffusion of fear and community intervention were simulated over a six month period. Terrorist attacks generated intense media coverage initially resulting in high perceptions of risk and diffusion of fear. Delays in community intervention contributed to higher and more prolonged levels of fear. Perceptions of risk rose very quickly but declined quite slowly. Likewise, implicit goals for the reduction of fear in a community may be worth examining more closely. These findings should prove useful to those wishing to predict public response to a variety of different contingencies involving terrorism.

Work for the CGE model has been briefly mentioned above but more work is yet needed to connect the system dynamics model with the CGE model.

Preliminary results from the two longitudinal surveys indicate that terrorism creates higher levels of perceived risk, fear, worry, avoiding public places, willingness-to-pay to reduce risk and greater tradeoffs of privacy for security than earthquakes, even when the latter results in more deaths. Surprisingly, cyber-terrorism generated at least as much perceived risk as an anthrax release (though not nearly as much fear). Respondent comments suggest that this may be due to a high perceived likelihood that a cyber-attack could occur and that many people would be affected.

Regarding the 2004-2006 data, a hierarchical (i.e. multi-level) model has been developed to examine the importance of terrorism, mechanism, target or victim, motive behind disaster, negligence and casualties. Terrorism looms large with respect to perceived risk. The type of event (e.g., anthrax vs. propane tank explosion), target (e.g., tourist vs. government official), motive (e.g., accident vs. crime), and negligence are also important. Number of casualties does not appear to matter. There are also pronounced differences across individuals, which can partly be explained by gender. These findings underscore the importance of event characteristics when attempting to anticipate public response to hazards. They also point to the need to better understand contributing factors to individual differences in response.

3. Applied Relevance

The system dynamics model mentioned above can be used to examine the impact of delays in community response to levels of fear and perceived risk in the midst of a terrorist attack. Examining the diffusion of fear patterns for different threats over time can inform first responders and community leaders regarding risk communication. Once we are able to incorporate risk perception and risk related behaviors into the CGE model we will be able to estimate the economic costs of fear and perceived risk.

4. Collaborative Projects

As mentioned above, the above systems and CGE modeling is benefiting from collaborative research on the financial crisis being conducted at Decision Research. The six month longitudinal survey concerning people's reaction to the financial crisis should shed light on how risk perception changes over time and how it is influenced by the media.

5. Research Products

5.1 Research Papers

Publications	Ref	Not Ref
1. Burns, W., "Modeling the Social Amplification of Risk Following a Terrorist Strike: Methodological Challenges," working paper presented at the Behavioral Economics Workshop hosted by CREATE, USC, August 2008		x
2. Burns, W., Slovic, P, "Public Response to a Terrorist Strike," Risk Analysis, submitted, reviewed, and being revised	x	
3. Burns, W., Slovic, P., "The Diffusion of Fear: Modeling Community Response to a Terrorist Strike," Journal of Defense Modeling and Simulation, Vol.5 (1), 2008	x	

5.2 Research Presentations

Conferences

- Burns, W., "Public Response to Terrorism: Perceived Risk and Economic Impacts," *Society for Risk Analysis Conference*, Boston, MA, December 9, 2008
- Burns, W., "Modeling the Social Amplification of Risk Following a Terrorist Attack," *Behavioral Economics and Terrorism Conference*, CREATE, USC, Los Angeles, CA, August 2008
- Burns, W., "Risk Perception and Communication Regarding Terrorist Events," MIT Cyberterrorism workshop, MIT, July 2008
- Burns, W., "Managing Fear: Business Models for Managing Disasters," presented NSF projects findings to date and their implications, *CSUSM Research Colloquium*, March 20, 2008
- Burns, W., "Modeling the Impact of Community Intervention Following a Terrorist Strike," *Society for Risk Analysis (SRA)*, San Antonio, TX, December 9-12, 2007

Outreach

- Burns, W., "Crisis: Public Perception and Response," presented to Business Group, Syracuse, NY, December 5, 2008
- Asay, G., "Does negative Campaigning Necessarily Lead to more news Coverage. An Analysis with Applications to Risk perception on Politics and Health. Presentation given to Health Services Research and Evaluation Branch, CDC, May 2008.
- Burns, W., "Perceived Risk and the Diffusion of Fear: Anticipating Public Response to Terrorist Attacks in Urban Areas," presented at *Czech Republic Pyro Meeting*, Brno, Czech Republic, May 2008
- Burns, W., "Managing Fear: The Role of Business in Preparing for Urban disasters," presented at *BERI Conference*, San Diego, April 2008
- Asay, G, "Introduction to Economic Impact Analysis and risk perception of Terrorist Events". Presentation given to Economics Department at Willamette University, February, 2008.
- Burns, W., "Predicting Public Response to a Terrorist Strike," Community Emergency Response Team (CERT) class, 2007
- Burns, W., "RDD Scenario: Events and Communications of the First Seven Days" (see Burns-RAW). Risk communication researchers (including scholars from several DHS centers) and officials from

DHS participated in this exercise during a Department of Homeland sponsored Gordon workshop. The exercise demonstrated both the difficulty and utility of developing effective risk communication strategies, 2007.

- Burns, W., “The Dynamics of Public Response to a Terrorist Strike: Recommendations for Data Collection, Analysis, and Modeling” 2007 Society for Risk Analysis Conference, San Antonio, Texas, 2007

5.3 Models, Websites and Scenarios

5.3.1 Web/Internet Site

<http://www.decisionresearch.org/people/burns>

Description: This webpage lists relevant papers, presentations, models and risk communication tools associated with the NSF project.

5.3.2 URL

A password protected data collection website has been corrected. It is regularly updated. For anyone interested, the URL and password can be provided.

Description: This website consists of disaster scenarios and survey questions. It allows data to be collected online.

5.3.3 Other Specific Products

System Dynamics Simulation Model
(see <http://www.decisionresearch.org/people/burns>).

Risk Communication Exercise for a Dirty Bomb Attack in Urban Area
(see <http://www.decisionresearch.org/people/burns>).

6. Education and Outreach

6.1 Training and Development

Hundreds of undergraduate students have participated in these surveys and debriefings. Also, many students have helped analyzed and interpret these findings as part of class exercises in a upper division statistics course.