USC CREATE
HOMELAND SECURITY CENTER

Measuring Economic Resilience to Terrorism

Adam Rose, Jiyoung Park, and Bumsoo Lee, University of Southern California
adamzros@usc.edu, jiyoungp@email.usc.edu, bumsoo.lee@usc.edu

This project will estimate several of the major types of economic resilience to terrorist attacks that have the potential to greatly reduce business interruption losses.

Brief Description - This project will estimate several of the major types of economic resilience to terrorist attacks. Previous research by Rose and others on the economic impacts of terrorist attacks on electric utilities have measured several types of resilience activities (see Rose et al., 2007). These studies indicate that input substitution and conservation are likely to be rather limited compared with activities such as *import substitution, business relocation, use of excess capacity, production rescheduling,* and *distributed generation* (back-up generators, business-owned conventional power plants, solar panels, etc.), *import substitution,* and *business relocation*. This study will estimate the actual and potential impacts of the latter types of resilience actions. For example, production rescheduling pertains to all businesses affected by terrorist attacks no matter how the property damage is incurred or business interruption is transmitted. Distributed generation pertains to all types of terrorist attacks as well, but in an asymmetric manner. This resilience option helps in the case of an attack on the central power grid, but may disadvantage the firm in the case of a direct attack on it. For the latter case, we will ascertain the ability of firms to switch to and access sufficient electric power from the central grid. The study will provide both a conceptual framework for analyzing production responses and empirical measurement through questionnaire surveys of firms that have been affected by disasters (e.g., September 11, Northridge Earthquake, Hurricane Katrina), as well as responses to questions relating to hypothetical events.

Objectives - This research will develop resilience adjustment factors that can be used with a variety of economic impact models. Previous studies have indicated that business interruption losses from terrorist attacks can be reduced by as much as 90 percent if appropriate resilience actions are taken. This study will provide more definitive measures of these potentials. The analysis will take into account the type of terrorist attack, nature of the target, and general context. For example, the severity and duration of a terrorist can significantly erode resilience as exemplified in the case of Hurricane Katrina. The longer the duration, the greater the likelihood of running out of inventories. At the same time there is a greater potential to identify alternative sources of supply and logistical support for bringing them into the region. Thus, the proposed resilience factors will not simply be scalars, as has been the dominant approach in the past, but functional relationships for adjustments. The usefulness of the resilience factors will be examined in the context of several case studies during Year 2, and investigators will work with DHS staff to transfer the products of this project to DHS for internal use during Year 3.

Interfaces to other Center Projects - This project will be performed with the advice of other economists associated with CREATE. It will be useful input into the risk management area as well.

Interfaces to non-Center Projects - We will be working closely with TSA in their assessment of the resilience of U.S. infrastructure, as well as the Infrastructure Division of DHS.

Major Products and Customers - Project deliverables will consist of peer-reviewed papers that present the empirical methodology and results in case study illustrations. Major customers will include the academic community, DHS staff, and emergency management analysts at the state and local level as well. This study will provide a significant improvement in this resilience adjustment by specifying how this factor is influenced by the severity and duration of the disruption. The products of this project will be transferred to DHS. For example, Rose was responsible for the insertion of “recapture factors” (scalars that provide an estimate of the amount of production that can be recouped from rescheduling after repair and

reconstruction have taken place) into FEMA's original HAZUS disaster loss estimation software. In general it will provide several resilience adjustment factors that can be applied to a broad range of models used by academics and practitioners. Modifications in existing models will also be made.

Technical Approach - For each resilience factor, we will utilize microeconomic and macroeconomic principles to derive estimating equations. For example, Rose and Liao (2005) were able to link such resilience adjustments as conservation and input substitution to key parameters (productivity terms and substitution elasticities) of formal production functions. Another formal approach to analyzing some resilience adjustments is being developed by Smith et al., 2006. Characterizations of the operation of the firm will be used to the extent possible for these additional resilience factors. The next step will be to collect a broad range of data on which to perform statistical analyses. Resilience factors and the analysis of them vary considerably, so an appropriate approach is necessitated for each one. The factors will be calculated on a sectoral basis at a high level of resolution (approximately what was previously knows as the 2-digit SIC level). For example, factors on excess capacity will be based on U.S. Department of Commerce statistics over a 5-year period in addition functional relationship will be developed to adjust these factors with data on magnitude and duration of terrorist events.

Major Milestones and Dates

Year 1
- Derive estimating functions from micro and macro principles, December 2007
  - Collect data on resilience adjustments, February 2008
  - Estimate resilience functions, June 2008

Year 2
- Validate and test resilience factors in the context of needed case studies

Year 3
- Transfer resilience factors to formal models used by other DHS Center researchers and DHS staff. This would include incorporating resilience factors into software such as HAZUS, NEMO, and the REMI Policy Simulation Model

References

Rose, A., Liao, S., "Modeling Resilience to Disasters: Computable General Equilibrium Analysis of a Water Service Disruption," *Journal of Regional Science*, 2005, 45, (1): 75-112.

Rose, A., Oladosu, G., Liao, S., "Business Interruption Impacts of a Terrorist Attack on the Electric Power System of Los Angeles: Customer Resilience to a Total Blackout," *Risk Analysis*, 2007, forthcoming.

Smith, K., Strong, A., Mansfield, C., "A Conceptual Framework for Modeling Economic Resilience," 2006, Arizona State University, Tempe, AZ.