The Challenges of Modeling the Risk from Terrorism

By Jack Seaquist

Last September's attack on the World Trade Center (WTC) revealed that insurance companies are heavily exposed to potential catastrophic losses from man-made perils, as well as from natural ones. The WTC attack also showed that large losses could be simultaneously sustained across multiple lines of business, including commercial property, workers compensation, life, health, disability, aircraft hull, and general liability. The magnitude of these losses has driven the insurance market to a critical juncture and has had an enormous impact on the global economy. Insurers, reinsurers, and corporations must resolve issues surrounding terrorism-related coverage, exclusion, deductible and pricing in order to restore a stable risk management market.

As the insurance industry prepares for the next extreme event catastrophe modeling companies are developing sophisticated tools to help quantify potential losses. Modeling is intended to evaluate potential outcomes, assess their relative likelihood and to estimate loss probabilities for insured exposures across multiple lines of business. The models themselves are typically composed of three primary components: hazard, engineering and loss estimation. Insurers should evaluate these new tools carefully, particular with respect to the hazard component, which undoubtedly presents the greatest challenge for the modeler.

Hazard: Event Generation and Severity

The hazard component of a fully probabilistic catastrophe model generates the location, frequency and severity of potential future events, or attacks. The resulting catalog of events must be sufficiently comprehensive to account for the full range of potential events, including the most extreme events that make up the tail of the distribution.

In the case of natural catastrophes, models incorporate extensive historical databases to develop probability distributions for location and other physical parameters, such as the central pressure in the case of hurricanes or magnitude in the case of earthquakes. For man-made events, the historical data, which is quite scarce in the first place, may not be representative of the current threat. Specific targets and weapons must be postulated. The list must be comprehensive. Probability distributions must be derived to determine the likelihood of each possible event.

There are four aspects to estimating event frequency and intensity: the number of attacks per year, the target type, the weapon/attack type and the specific target of each potential attack. The first step is to identify the potential types of targets (governmental, military,

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commercial, industrial, religious, etc.) of possible attack. A database containing a very wide range of potential terrorist targets is developed.

Because of the lack of relevant historical data, estimating the frequency and severity of potential future attacks is the most challenging aspect of developing a terrorism model. One approach to overcome this challenge is to utilize expert opinion. A structured approach, such as the Delphi Method, enables a statistical synthesis of the opinions of, in this case, experts with hands-on counterterrorism experience at the highest national and international levels.

The Delphi Method is a well-known and accepted approach for developing probability distributions from expert opinion. Developed by the RAND Corporation at the start of the cold war, the Delphi Method has been used to generate forecasts in many subjects including inter-continental warfare and technological change. It was also used by Applied Technology Council (ATC-13) to derive the damage functions in the first generation of earthquake models.

The result is an assessment of the attack likelihood for each of a robust spectrum of possible terrorist targets. This allows the generation of thousands of potential outcomes for the next twelve months, weighted by the collective opinions of some of the most knowledgeable experts in the country to generate loss distributions.

Engineering: Building Damage and Injuries

The engineering component of a comprehensive terrorism model estimates the damage to property resulting from each simulated event. In the case of natural catastrophes, models evaluate a building's response to wind or ground shaking. For modeling terrorist attacks, the damage mechanisms are rather different: bomb blasts, airplane crashes, and other weapons effects.

In addition to calculating damage to structures, terrorism models can also be designed to estimate human casualties. Based on estimates of building damage, the model calculates the number of injuries and fatalities that result, as well as the severity of injuries. These injury states are used to calculate losses for workers' compensation, life, and disability lines.

Damage to buildings and injuries to people in a terrorist attack using conventional weapons can occur from the primary effects of the bomb blast or air crash and from secondary effects to surrounding buildings. These may result, for example, from the pressure and shock waves of the explosion, as well as the spread of fire from the target building. In addition, falling debris, projectiles, additional pressure waves, and dust are generated. All of these potential damage mechanisms should be captured.

Regarding input data requirements, modelers realize that insurers do not typically have access to the detailed data on workers' compensation, life, and disability exposures, that are commonly available for property lines. Insurers do not necessarily know the location

of the building in which the insured are located, or the construction type – information needed for a reliable estimation of losses from a specific terrorist event. While the industry is moving to collect the detailed data needed, modelers can create reasonable estimates from the extensive industry exposure databases that they have developed for use in modeling natural catastrophes.

The possible use of chemical, biological, radiological, and nuclear (CBRN) weapons should also be considered in any comprehensive discussion of potential losses from terrorist activity. These weapons of mass destruction introduce other causes of loss, including contamination. One particularly disturbing scenario, perhaps because of its relative likelihood, is the use of a so-called dirty bomb, which is a conventional bomb outfitted to spread radioactive material.

While most experts believe that an effective deployment of non-conventional weapons resulting in mass casualties is probably not imminent, these are concerns that must be addressed by the insurance industry and, therefore, by modelers.

Insured Loss

The third component of a comprehensive catastrophe model is the insured loss calculation. As in the case of natural catastrophes, models must account for limits, deductibles, and exclusions. For the terrorism peril, these are not necessarily clearly defined. Models, however, will enable alternatives to be evaluated and sensitivity analyses to be performed.

Correlation of losses across multiple lines of business must be addressed. It is important to model the losses to each of the lines for the same events using the same data, thus allowing the cumulative effects of an event to be calculated.

The Use of Terrorism Models

In addition to traditional exceedance probability curves, insurers and reinsurers are interested in using the new terrorism models that have become available to analyze exposure concentrations and correlation of losses. The best models are helping companies to:

- analyze concentrations of exposures and their proximity to landmark properties
- run deterministic scenarios affecting specific exposures
- perform fully probabilistic analyses on portfolios

These new tools enable the quantification of risk from terrorist attacks and, in so doing, facilitate pricing, portfolio management, and overall risk management. Model results provide a quantitative basis for all parties to begin the process of restoring stability the terrorism insurance market.