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How Catastrophe Models Operate

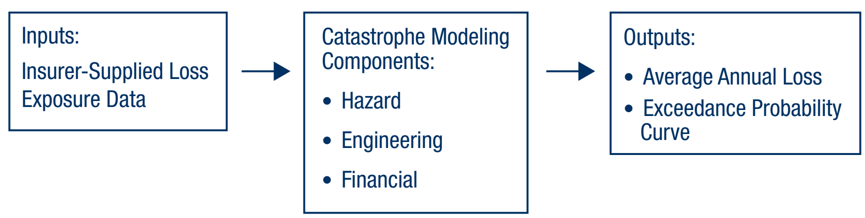
Catastrophe models use insurer-supplied exposure data to produce a range of potential losses that may result from the catastrophes being modeled, along with their associated probability of exceedance (the probability that a loss of a specified size will be equaled or exceeded).

Catastrophe models typically include these three basic components, or modules:

- Hazard
- Engineering
- Financial

The exhibit shows the components of a catastrophe model, along with its inputs and outputs. See the exhibit "Catastrophe Modeling."

Catastrophe Modeling



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Although the computer codes for catastrophe models are generally proprietary, modeling firms provide thousands of pages of detailed documentation in an effort to ensure that model users understand the models and the models' sensitivities, uncertainties, and implications for risk management; as well as that model users understand best practices for using model results. Because both the assumptions behind and results from different catastrophe models vary, a primary insurer often considers information derived from several catastrophe models.

Hazard Component

The first component of a catastrophe model is the hazard component. The hazard component simulates a catastrophic event to determine hazard intensity and is built by teams of scientists, including meteorologists, seismologists, hydrologists, climate scientists, and geophysicists. The hazard component answers these questions:

- Where are future catastrophes likely to occur?
- How large or severe are they likely to be?
- How frequently are they likely to occur?

Large catalogs comprising tens of thousands of computer-simulated catastrophes are generated, representing the broad spectrum of plausible events. For each simulated event, the model calculates the intensity at each location within the affected area. For example, for earthquakes, intensity may be expressed in terms of the degree of ground shaking or the number and intensity of fires spawned by the event; for hurricanes, intensity is expressed in terms of wind speed and storm surge height.

The models incorporate large and detailed databases of geophysical information. For example, windstorm models use high-resolution digital land use and land cover data to calculate the effects of surface friction on wind speed. Earthquake models employ detailed soil data, which determine the degree of seismic wave amplification and the potential for liquefaction at specific sites affected by the event.

Catastrophe models may produce different results because they are based on different theoretical assumptions and variables. For example, over 100 years of data are available on hurricanes, but the early data are not as detailed, sophisticated, or accurate as recent data. Different modeling firms may therefore employ different datasets and consequently develop different theories about the potential frequency and severity of future hurricanes.

Engineering Component

The second component of a catastrophe model is the engineering component. The engineering component uses the intensity information from the hazard component to estimate the extent of structural damage that would occur based on information about the properties that are exposed to a simulated catastrophic event. These estimates incorporate information such as building construction, occupancy, height, age, and building code enforcement. Additional detail, such as roof shape, roof-to-wall connections, and the presence or absence of hurricane shutters can also be used, when available.

Developed by structural engineers, equations called damage functions are used to compute the level of damage that is expected to occur to buildings and their contents and to estimate the time it will take to repair or rebuild affected structures. This last type of damage function is used to produce estimates of business interruption (BI) losses or alternative living expenses (ALE) for residential policies. The catastrophe model's damage functions can incorporate published research, the results of laboratory testing, findings from on-site damage surveys, and detailed claims data provided by insurers.

Another reason that catastrophe models can produce varied results is because they use different engineering research to determine damageability. For example, research and professional opinions vary regarding the effects of hurricane winds and flying debris on different types of structures.

Financial Component

The third component of a catastrophe model is the financial component, wherein estimates of physical damage to buildings and contents are translated into estimates of monetary loss. These estimates, in turn, are translated into insured losses by applying insurance policy conditions to the total damage estimates. In essence, the financial component evaluates the effect of a simulated catastrophe on an insurer's in-force policies and operating results. Depending on the magnitude of the simulated catastrophe, the primary insurer will sustain a range of losses. The financial component usually reflects coverage characteristics of the in-force policies, such as whether they are on an actual cash value (ACV) or a replacement cost basis.

Some catastrophe models include socioeconomic factors, such as the likelihood of fraud or theft following a catastrophe. Demand surge is another factor to consider in calculating the total insured loss. Demand surge occurs when repair costs increase dramatically following a catastrophe because of supply shortages, whether of materials or labor. For example, the price of glass, roof shingles, and plywood could increase significantly in the affected area following a hurricane.

How Catastrophe Models Are Used

Primary insurers use the results of catastrophe models to understand the catastrophe loss potential given their portfolio of in-force policies. Model results are also used as input into pricing decisions, risk selection and underwriting, the design of territories, loss mitigation studies, and risk transfer strategies.

Reinsurers and reinsurance intermediaries use the results of catastrophe models to determine how an existing or proposed reinsurance program will respond under various catastrophe scenarios and to establish a rate for catastrophe reinsurance coverage. Reinsurers also use catastrophe modeling to manage catastrophe exposures assumed from their primary insurer clients and to aid in determining catastrophe retrocessional needs.

Catastrophe models provide detailed output from which various measures of loss potential and risk can be derived. Two key outputs from catastrophe modeling are the average annual loss and the exceedance probability curve.

Average Annual Loss

The average annual loss (AAL) is the long-term average loss expected in any one year for in-force polices for the cause of loss being modeled. AAL is also referred to as the catastrophe loss cost, or pure premium, and is typically expressed as the expected loss per unit of exposure.

When the analysis is performed on a zip code level, the catastrophe model produces AAL values for each zip code. Zip codes with high AAL values are particularly vulnerable to catastrophic loss. Because AAL values reflect all the