UNCERTAINTY

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WHAT ARE THE OUTPUTS OF A CATASTROPHE MODEL AND HOW ARE THEY USED?

Oasis is a framework for the calculation of losses related to catastrophe scenarios. Models of this type are used today for various purposes including;

- setting the premium for catastrophe risk insurance
- assessing capital required for underwriting a portfolio of risks protecting catastrophes
- testing exposure to realistic disaster scenarios and characteristics events
- providing first order estimates of the impact of an actual catastrophe

In terms of what can be calculated, these would typically include:

- Average annual losses - the mean of the distribution of simulated annual losses used as the “base technical rate” for (re)insurance pricing.
- Standard deviations – the variability of the simulated annual losses, often used as a loading factor in pricing of (re)insurance to allow for volatility.
- Quantiles such as 99.5% annual loss for reporting to regulators - representing the capital requirement of the business.

As well as point estimates, the simulation method of Oasis allows the probability distributions of given metrics (standard deviation is often used, for example). Thus, one could use Oasis to calculate the level of confidence in taking a particular price or capital estimate so that users are aware of the “spread” of values.

WHAT ARE THE SOURCES OF UNCERTAINTY IN A CATASTROPHE MODEL?

Oasis works by simulating catastrophic events and their financial consequences. As there are many sources of uncertainty in the models, the models are probabilistic which means that they give the chances of the various levels of loss rather than just a single number.

Before a particular parameterisation of a model is selected there are two fundamental sources of uncertainty:

Model uncertainty - this is uncertainty from the model choice itself, as different models can produce very different outcomes.

Parameter uncertainty – this is a term used within the financial modelling community for uncertainties due to choices of particular parameters which can be chosen for free variables within a model.

Besides model and parameter uncertainty, any given model of this “event-based catastrophe loss model” type involves two principal sources of uncertainty:

Primary uncertainty - The “primary” uncertainty concerns three elements in an event-based catastrophe loss model

1. the definition of events themselves
2. the assignment of their frequency, and
3. their time correlation (sometimes termed “clustering”)

Oasis allows events to be defined irrespective of their timeline of occurrence, and then allows frequency and clustering to be defined by assigning events as “occurrences” to a timeline.

Event assignments to a timeline are chosen by the model developers for the problem in hand to be representative samples from a hypothetically infinite set of events and years consistent with the physical model they wish to portray.

The assignment of events to years (that is to say, their frequency and correlation) is the most important of all the assumptions in the event-based catastrophe loss modelling paradigm. There are so many potential combinations of how events could occur in combination that it can be difficult to select a representative set of event occurrences from which to simulate reality.

The number of simulated "event years" is particularly important as there need to be sufficient years to allow robust calculation of the typical insurance metrics of annual loss. If, for instance, one wanted to estimate the chances of loss for once in 200 years, then it would be sensible to choose a timeline that was at least 200 years and, more likely, at least 10,000 years otherwise the event set would not include sufficient events to estimate the chance of loss exceedance.

Secondary uncertainty - In the case of "secondary uncertainty" the event is assumed to have occurred and the uncertainty is about the losses caused. This might be the actual (termed ground-up) loss or the insured loss or the reinsured loss. There is a variability caused by the expression of the source intensities and damageabilities probabilistically, and this gives rise to probability distributions of losses.

HOW DOES OASIS REPRESENT UNCERTAINTY?

Primary uncertainty – Oasis does not use event occurrences in its kernel modelling as it only calculates losses by event. The way Oasis helps is to allow multiple event occurrence ("event year sets") and selection of subsets of these to estimate robustness of the sample. The cumulative effect of different event occurrence sets is handled after the calculation where it can be compared.

Secondary uncertainty – Oasis represents uncertainty in hazard intensity and damageability with binned probability distributions and discrete, not continuous, variables. Many modellers express their hazard intensities and vulnerabilities using functions as parameterised functions (so-called "closed forms"). Examples of these are normal, lognormal, beta, gamma. A discrete probability distribution can represent these with a suitable choice of discretization, but can also be used to represent multi-modal or empirical distributions, which may be a better representation of reality.

For each event and damageable asset (for example, a building) Oasis calculates a discrete effective damageability distribution which represents both hazard intensity and damage. The method of combining the distributions is a discrete convolution.

Probabilistic loss distributions - The way the probability of loss is estimated by Oasis is simple relative frequency. A measure of loss (such as total, often termed aggregate, annual losses) is calculated by year for a given "event year" set selection as applied to an insurance portfolio of risks, and rank-ordered by decreasing size.

The probability of a loss exceedance calculated using the relative frequency is as follows; in a 1,000 year simulation, the top loss has a probability of exceedance of 1/1000th ((0.1%), the second has a probability of exceedance of 2/1000 (0.2%) and so on.

These numbers are plotted together to estimate the probability distribution of annual losses, usually in the form of "Exceedance Probability" or "EP" curves. Exceedance Probability is also known as "Value at Risk" or "VaR" from the original JP Morgan "Risk Metrics" way of looking at risk. These are also known to mathematicians as "quantiles" or, more precisely, quantile estimates. Thus, for instance, the 1 in 200 year VaR (value for an annual loss EP of 0.05%).