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Introduction to Swiss Re
Swiss Re

- Re-Insurance Company
- Founded 19th December 1863
- 2010 Premiums earned: 19'652 Million USD
- 2010 net income: 863 Million USD
- Combined Ratio: P&C 93.9% and L&H 88.7%
- Number of employees: 10'362
Insurance Math

An introduction
Example: Insure your friend's car

How much would you charge to insure your friends car?

- Simple questions: How often per year does he have an accident? (=f)
- How much money does it usually cost to repair his car? (=X)

The average loss per year: \( S = f \times X \)

- You also want to make some money, so add a profit percentage (=p).

Price = \( f \times I \times (1+p) \)
Example: Insure your friend's car

- That was easy!
- But, how much money do need to keep aside (=reserves) to pay your friend, in case he has an accident?
- If you insure one car only, you will have to have reserves up to the maximum possible loss, in other words, the value of the car.
More cars...

- But now we want to insure many cars.
- The yearly loss now is ($X$ is the loss, $N$ the number of losses):

$$S = \sum_{i=1}^{N} X_i$$

- It is obvious, that $S$ will not be the same for every year, but has a distribution. The challenge is to find distributions for $X \sim F(x)$ and $N \sim P$. 
Loss distribution

- A often used distribution for the loss is Pareto

\[
F_X(x) = \begin{cases} 
1 - \left(\frac{x}{x_0}\right)^{-\alpha} & x > x_0 \\
0 & \text{else}
\end{cases}
\]

\[
f_X(x) = \begin{cases} 
\alpha x_0^\alpha x^{-\alpha-1} & x > x_0 \\
0 & \text{else}
\end{cases}
\]
Pareto

- The alpha depends on the type of risk.

<table>
<thead>
<tr>
<th>Loss potential</th>
<th>$\alpha$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthquake/storm</td>
<td>$\approx 1$</td>
</tr>
<tr>
<td>Fire</td>
<td>$\approx 2$</td>
</tr>
<tr>
<td>Fire in industry</td>
<td>$\approx 1.5$</td>
</tr>
<tr>
<td>Motor liability</td>
<td>$\approx 2.5$</td>
</tr>
<tr>
<td>General liability</td>
<td>$\approx 1.8$</td>
</tr>
<tr>
<td>Occupational injury</td>
<td>$\approx 2$</td>
</tr>
</tbody>
</table>

![Graph showing Pareto distribution with different alphas](image)

- $F(x)$
- $\alpha = 2$
- $\alpha = 1$
Frequency

- Very commonly used is the Poisson distribution

\[ P[N = k] = \frac{e^{-\lambda} \lambda^k}{k!}, \quad k = 0, 1, \ldots \]

\[ E[N] = Var[N] = \lambda \]

- Poisson works fine if events are rare and independent.
The Result

- We now have a distribution for the loss size and loss number to represent $S$.
- The aggregated cdf is usually calculated with Monte Carlo methods:
  - draw the number of losses per year
  - draw the loss amounts and add them up.
- Ordered by loss amount of the year one can calculate the aggregated CDF.
- The average of these outcomes returns the expected loss.
Aggregated CDF

Probability

Agg Loss
More things to consider

But there is more to think of....

- Long term/short term claims
- Capital costs
- Liquidity
- Profit margin
- Brokerage
- Recovery
- Internal costs
- Taxes
And the reserves?

- How much money do we have to reserve now?
- To hold the MPL for all contracts would be way too expensive!
- Therefore we hold reserves cover two 99% shortfall years:
  
  The shortfall is defined as:
  \[ \text{shf}(S) = <S | S>Q(99\%) > \]

- We calculate distribution of the losses versus the capital we hold for the whole Swiss Re group.
- There is a possibility that we go bankrupt! Otherwise we would be way too expensive.
Research areas

- Correlations! For example Pandemic will not only trigger many life insurances, but the stock market will go down, too!

- Avoid surprises! Swiss Re is constantly looking at possible emerging risks as climate change, nano-particles, cell phone radiation etc.
Nat Cat Modelling

- Hurricanes
Natural Catastrophes

- Swiss Re develops own models for natural catastrophes.
- This covers models for flood, hail, winter storms, earthquakes, bushfires, and tropical cyclones.
Principles of Nat Cat Modelling

Four basic sets of data are needed to be fed into a loss model:

- **Hazard:**
  Where, how often and with what intensity do events occur?

- **Vulnerability:**
  What is the extent of damage at a given event intensity?

- **Value distribution:**
  Where are the various types of insured objects located and how high is their value?

- **Insurance conditions:**
  What proportion of the loss is insured?
Natural Catastrophes - Hurricanes

- There is a lot of historical data about hurricanes:
- Data is recorded since 1891 of more than 1'000 hurricanes.
Natural Catastrophes - Hurricanes

- These historical storms can be used as a basis for hurricane modelling.
- Basic Formula to calculate the loss of hurricane wind speed * vulnerability * insured value * insurance conditions = loss
- These points consist of many sections, for example...
  - wind speed at a distance x from the storm
  - construction type
  - age of building
  - elevation (storm surge)
Hurricanes

- The historical storms are not granular enough....
- ... therefore storms have to be invented.
Hurricanes

- How can you create 'daughter storms'?
  → Random Walk
Hurricanes

- Find border conditions to limit the random walk so that the resulting tracks are realistic.
Hurricanes

- How much can a track deviate from the mother storm?
- How much can the wind speed vary?
- Landfall
- Maximum Intensity
## Hurricanes - LFC

<table>
<thead>
<tr>
<th>Event loss</th>
<th>in millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1</td>
<td>23.5</td>
</tr>
<tr>
<td>No. 2</td>
<td>42.5</td>
</tr>
<tr>
<td>No. 3</td>
<td>74.8</td>
</tr>
<tr>
<td>No. 4</td>
<td>8.9</td>
</tr>
<tr>
<td>No. 5</td>
<td>13.1</td>
</tr>
<tr>
<td>No. 6</td>
<td>69.6</td>
</tr>
<tr>
<td>No. 7</td>
<td>20.8</td>
</tr>
<tr>
<td>No. 8</td>
<td>33.4</td>
</tr>
<tr>
<td>No. 9</td>
<td>17.4</td>
</tr>
<tr>
<td>No. 10</td>
<td>11.2</td>
</tr>
<tr>
<td>No. 11</td>
<td>26.2</td>
</tr>
<tr>
<td>No. 12</td>
<td>58.6</td>
</tr>
</tbody>
</table>

- Sum of all event losses: 400 million
- Number of model years: 200 years
- Expected loss per year: 2 million
Hurricanes - LFC
Natural Catastrophes on the rise?
Insured catastrophe losses 1970–2010

USD bn, at 2009 prices

- Increased insurance penetration
- More values
- More values in high-risk areas
- Higher vulnerability
- Climate change (storm, flood)

1970: Winter storm Lothar
1992: Hurricane Andrew
1994: Northridge EQ
1999: Winter storm Lothar
2001: Attack on WTC
2004: Hurricanes Ivan, Charley, Frances
2005: Hurricanes Katrina, Rita, Wilma
2008: Hurricanes Ike, Gustav
2009: EQs Chile, New Zealand
2009: Ocean Drive, FL, 2000
2009: Ocean Drive, FL, 1926

Source: Swiss Re, sigma No 1/2010; 1/2011, Figure 3
Number of events per year

An event has a loss and victim threshold.
Number of victims per year

- Man-made disasters
- Natural catastrophes
Natural Catastrophes - Hurricanes

![Graph showing the annual count and average of hurricanes from 1850 to 2000. The graph includes lines representing annual counts and averages for different time periods.](image-url)
Thank you
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