GIRO Conference and Exhibition 2012
Juggling uncertainty the actuary’s part to play

September 11, 2012
The Need for Casualty Catastrophe Models: A Way to Prepare for the ‘Next Asbestos’

Matthew Ball, Landon Sullivan
Agenda

- Evolution of catastrophe models
- Features of casualty catastrophes
- Comparison of casualty vs. natural catastrophe models
- Casualty catastrophe modeling process
- Case study
- Conclusions
Evolution of catastrophe models
History of windstorm catastrophe models

- 1987: AIR introduces first modern, computer-based catastrophe model.
- 2000: Models grow ever more sophisticated, incorporating ever more meteorological and engineering expertise.
- 2005: Hurricane Katrina renews focus on managing catastrophic exposure.

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Major catastrophe events have provided the catalyst for increased sophistication in natural and man-made catastrophe modeling and their use.

<table>
<thead>
<tr>
<th>Event</th>
<th>Year</th>
<th>Insured Loss*</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hurricane Andrew</td>
<td>1992</td>
<td>26</td>
<td>Windstorm</td>
</tr>
<tr>
<td>Northridge Earthquake</td>
<td>1994</td>
<td>21</td>
<td>Earthquake</td>
</tr>
<tr>
<td>WTC</td>
<td>2001</td>
<td>24</td>
<td>Terrorism</td>
</tr>
<tr>
<td>Thailand Floods</td>
<td>2011</td>
<td>12</td>
<td>Flood (fresh water)</td>
</tr>
<tr>
<td>Japan Earthquake</td>
<td>2011</td>
<td>35</td>
<td>Tsunami</td>
</tr>
</tbody>
</table>

* 2011 prices in $billions. Source Swiss Re, Sigma No 02/2012

“[Andrew] awakened some larger companies to the fact that their reinsurance protection against catastrophes was far from adequate. It’s only when the tide goes out that you learn who’s been swimming naked.”


What will be the watershed event for casualty catastrophe modeling?
But two of the top three most costly insurance events were casualty catastrophes

<table>
<thead>
<tr>
<th>Insured Loss ($bn) *</th>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>2005</td>
<td>Hurricane Katrina</td>
</tr>
<tr>
<td>71</td>
<td>1975</td>
<td>U.S. Asbestos</td>
</tr>
<tr>
<td>36</td>
<td>1990</td>
<td>U.S. Pollution</td>
</tr>
<tr>
<td>35</td>
<td>2011</td>
<td>Japan Earthquake</td>
</tr>
<tr>
<td>26</td>
<td>1992</td>
<td>Hurricane Andrew</td>
</tr>
<tr>
<td>24</td>
<td>2001</td>
<td>WTC</td>
</tr>
<tr>
<td>21</td>
<td>1994</td>
<td>Northridge Earthquake</td>
</tr>
<tr>
<td>21</td>
<td>2008</td>
<td>Hurricane Ike</td>
</tr>
<tr>
<td>15</td>
<td>2004</td>
<td>Hurricane Ivan</td>
</tr>
<tr>
<td>14</td>
<td>2005</td>
<td>Hurricane Wilma</td>
</tr>
<tr>
<td>338</td>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>107</td>
<td></td>
<td>Casualty Total</td>
</tr>
</tbody>
</table>

So why isn’t casualty catastrophe modeling more widespread?

* Sources:
  - Natural /man-made catastrophes - Swiss Re, Sigma No 02/2012, 2011 prices.
  - Casualty catastrophes – Towers Watson analysis of financial statement data compiled by A.M. Best and SNL, undiscounted ultimate losses.
In some respects casualty catastrophe modeling has been with us for a while now.

Natural/Man-Made Catastrophe Models

Underwriting Risk

- Policy-event based loss models, e.g.:
  - Windstorm
  - Earthquake
  - Flood
  - Tsunami
  - etc.

Andrew focused insurers on the premium loading for tail events for property lines.

To what extent are the tail events allowed for in casualty premiums?

Casualty Catastrophe Models

- Casualty cat models exist and are evolving in this area...our focus today

Reserving Risk

- Policy-event based loss models, e.g.:
  - Asbestos
  - Pollution
  - Credit crisis
  - etc.

Range of estimated ultimate claims

- Traditional reserving methods (aggregate or by contract)

Slower “velocity” of risk gives companies enough time to borrow some swimming trunks perhaps...??

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Benefits of modeling casualty catastrophe very similar to natural catastrophes

• Better understanding of loss process and management of exposure to catastrophes
  – Tailor results to individual company / policy profiles
  – Assist brokers as they inform customers about exposures and risks
• Scenario testing e.g. realistic disaster scenarios
• Understanding variation and use in economic capital models
  – Estimate and evidence the binary event adjustment (Solvency II)
• Validation of empirical scenarios developed based on underwriting, claim and risk experts’ judgment
• Prospectively measure the impact of different underwriting or risk management strategies
Features of casualty catastrophes
How to prepare for the ‘Next Asbestos’

• Studying the features of historical casualty catastrophes may yield some clues about the characteristics of the next industry-changing mass tort

• For example, asbestos:
  – Widespread use
  – Involvement in multiple industries
  – Large population exposed
  – Signature disease, mesothelioma
  – Long latency
  – Decades of exposure
  – High propensity to sue, union organization
  – Hospitable judicial environment over time
  – Extensive exposure of insurance policies
The evolution of the risk may also yield some clues
Example - history of asbestos

- 1924: First diagnosis of asbestosis
- 1930-41: Linked to cancer. Laws passed to make workers safer. $300 million in lawsuits from workers. Many companies tried to cover-up health affects.
- 1939: EPA attempts to ban entirely asbestos products in U.S. However, the ban was struck down.
- 1973: U.S. Asbestos manufacture peaks at nearly 1 million tons. Borel vs Fibreboard verdict opens up liability of manufacturers
- 1970: OSHA creates strict workplace standards.
- 1917-18: Several studies show link asbestos workers with early deaths
- Asbestos manufacture increases towards end of industrial revolution
- Pliny the Elder notes that locals exposed to white dust don’t live long in Roman Britain
- 1989: EPA attempts to ban entirely asbestos products in U.S. However, the ban was struck down.
- Today: Asbestos use still legal in U.S., but only a fraction of what it once was. Major consumers: Russia, China, Brazil, India and Thailand.

1900s: Over 100 million people occupationally exposed in U.S. Pool of defendants increased from 300 in early 80s to over 8,000 in 2000s spanning around 70 industry types
What makes a casualty catastrophe, anyway?

• Hard to get a concrete definition
• Common response: “I know it when I see it”
• Example A
  – A mass tort must be caused by a specific type of event or product and typically involves multiple defendants, multiple insureds or class action lawsuits. A newly identified type of claim will be considered a mass tort if the insurer’s expected ultimate loss and expense exceeds $50 million.
• Example B
  – Any claim covering multiple general liability policies
• The specific cause of a mass tort will almost never repeat itself
• Large underlying costs (actual damages and legal fees combined) result from
  – Large exposed population ...
  – ...who develop a serious problem that can be associated with the exposure ...
    – with latency or inaction, exposed population grows before awareness
  – ... and who are inclined to sue for damages
Examples – Past, Present, Future (?)

- Agent Orange
- Asbestos
- Avian influenza pandemic (aka bird flu)
- Bed bugs / Cimex Lectularius
- Bisphenol A (BPA)
- BP Oil Spill
- Carpal tunnel
- Cell phones
- Chemicals – Benzene, formaldehyde
- Chinese Drywall
- Construction defect
- DES including third generation claims
- EMF (electromagnetic fields)
- Environmental / pollution / hazardous waste sites
- Fire retardant plywood
- Food contamination, recall
- Formaldehyde in FEMA trailers from Hurricane Katrina
- Global warming
- Hand guns
- Hearing loss, noise induced
- HIV-tainted blood products
- Indoor air quality – sick building syndrome
- Latex gloves
- Lead paint
- Lead in Toys
- Lung – white lung, black lung, baker’s lung, farmer’s lung, popcorn packer’s lung
- Mad cow disease
- Mold
- Nanotubes
- Petroleum products – MTBE
- Perfluorooctanoic Acid (PFOA)
- Pharmaceuticals and medical devices
- Polybutylene systems
- Repetitive motion – carpal tunnel
- SARS (severe acute respiratory syndrome)
- Sexual molestation
- Silica
- Silicone breast implants
- SUV rollover
- Tires
- Tobacco
- Thimerosol Vaccine
- Trans fats
- Welding rods
- WTC first responders
- Y2K
Comparison of casualty vs. natural catastrophe models
Introduction

General Catastrophe Model

- A catastrophe model is made of various calibrated **modules** and **policy data**

- The challenges are similar for natural, man-made and casualty catastrophe models:
  - Limited Data
  - Sensitivity to Assumptions
  - Accuracy
  - Precision
  - Transparencies
  - External processes and data

  “The actuarial literature does not deal with firewall movement in off-center automobile crashes, the relationship of central pressure to windspeed in Atlantic hurricanes, the demographics of drywall installers, or the migration of contaminant plumes in groundwater.” – From “Disability Income to Mega-Risks: Policy-Event Based Loss Estimation”, Bouska
Introduction

Hurricane Catastrophe Model

- The **key areas** of a hurricane model are physical science (meteorological, engineering)

  *Central Pressure, Radius, Track direction, Forward speed*

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**Hazard**

- Wind Speed at Zip

**Vulnerability**

- Construction Type, Age of Building, Building Value

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**Damage Factor**

- Insured Proximity

**Total Loss**

- Zipcode

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**Insurance Loss**

- Deductible, Coverage A

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**Coverage**

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Introduction

Casualty Catastrophe Model

- While the structure is similar to other catastrophe models, the relative size and complexity of the various modules are different

<table>
<thead>
<tr>
<th>Total Legal Damages, Number of Claims</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazard</td>
</tr>
<tr>
<td>Number of Entities Sued by Claimants</td>
</tr>
<tr>
<td>Damage Factor</td>
</tr>
<tr>
<td>Insured Proximity</td>
</tr>
<tr>
<td>Line of Business, Legal Domicile, Business Geography, Industry</td>
</tr>
<tr>
<td>Vulnerability</td>
</tr>
<tr>
<td>Allocation of Legal Damages/ Search for Deep Pockets</td>
</tr>
<tr>
<td>Total Loss</td>
</tr>
<tr>
<td>Insurance Loss</td>
</tr>
<tr>
<td>Coverage</td>
</tr>
<tr>
<td>Triggering must be considered</td>
</tr>
<tr>
<td>Revenue, Equity, Private or Public?</td>
</tr>
</tbody>
</table>

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Casualty catastrophe modeling process
Modeling process

How to create a casualty catastrophe model

1. Gather historical information on casualty catastrophe events
2. Adjust the ultimate cost of historical events to a common future point in time
3. Parameterize the frequency and severity of historical casualty catastrophes by line of business
4. Simulate future casualty catastrophes by line of business using a frequency-severity approach
5. For each simulated casualty catastrophe, allocate the industry-level ultimate losses to policy year and insurer
6. Review the results in total and along various dimensions
7. Conduce sensitivity testing of the model’s assumptions and parameters, and compare with other empirical estimates from expert judgment.
Modeling process – step 1

Gather historical information on casualty catastrophe events

Number of Events: 291
Estimated Costs: $542 billion

<table>
<thead>
<tr>
<th>Types of Allegations/ Causes</th>
<th>Lines of Business</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antitrust</td>
<td>Aviation</td>
</tr>
<tr>
<td>Asbestos</td>
<td>Directors and Officers</td>
</tr>
<tr>
<td>Automobile accident</td>
<td>Employment Practices Liability</td>
</tr>
<tr>
<td>Breach of contract</td>
<td>Errors and Omissions</td>
</tr>
<tr>
<td>Collapsed structure</td>
<td>General Liability — Excluding Products</td>
</tr>
<tr>
<td>Director negligence</td>
<td>Marine</td>
</tr>
<tr>
<td>Discrimination</td>
<td>Medical Malpractice</td>
</tr>
<tr>
<td>Drugs for mothers, infants or children</td>
<td>Pollution</td>
</tr>
<tr>
<td>Explosion</td>
<td>Products — Excluding Pharmaceuticals</td>
</tr>
<tr>
<td>Fire</td>
<td>Products — Pharmaceuticals</td>
</tr>
<tr>
<td>Firm causes financial damages</td>
<td></td>
</tr>
<tr>
<td>Negligent care</td>
<td></td>
</tr>
<tr>
<td>Oil spill</td>
<td></td>
</tr>
<tr>
<td>Plane crash</td>
<td></td>
</tr>
<tr>
<td>Poisoning/contamination</td>
<td></td>
</tr>
<tr>
<td>Pollution/chemical exposure</td>
<td></td>
</tr>
<tr>
<td>Product causes medical damage</td>
<td></td>
</tr>
<tr>
<td>Product causes property damage</td>
<td></td>
</tr>
<tr>
<td>Product unsafe</td>
<td></td>
</tr>
<tr>
<td>Securities fraud</td>
<td></td>
</tr>
<tr>
<td>Securities negligence</td>
<td></td>
</tr>
<tr>
<td>Train collision</td>
<td></td>
</tr>
<tr>
<td>Vehicle unsafe</td>
<td></td>
</tr>
</tbody>
</table>

Source: Towers Watson Casualty Catastrophe database. Data gathered over last few decades
Adjusting Thalidomide: A case study in trending casualty catastrophe events into present day

Initial Estimate of Thalidomide’s Worldwide Losses

<table>
<thead>
<tr>
<th>Claims</th>
<th>Losses</th>
<th>Avg Loss</th>
<th>ALAE</th>
<th>Median Date of Sale</th>
<th>Trend</th>
<th>Length</th>
<th>Trended Losses and ALAE</th>
</tr>
</thead>
<tbody>
<tr>
<td>15,000</td>
<td>30,000,000</td>
<td>2,000</td>
<td>12,000,000</td>
<td>1959</td>
<td>5%</td>
<td>53 years</td>
<td>557,547,844</td>
</tr>
</tbody>
</table>

Thalidomide, launched by Grünenthal on 1 October 1957, was found to act as an effective tranquilizer and painkiller, and was proclaimed a "wonder drug" for insomnia, coughs, colds and headaches. It was also found to be an effective antiemetic that has an inhibitory effect on morning sickness, so thousands of pregnant women took the drug to relieve their symptoms.

How much liability would this event produce if it occurred today?

- Has market for drug expanded since 1959, resulting in more claims now than before?
- What would the average settlement be today?
- Would the cases need to be more rigorously defended today, resulting in a higher ALAE load?
- Would the harmful effects of the drug have been noticed earlier, limiting the number of people exposed to the drug?
  - Very likely for Thalidomide.

<table>
<thead>
<tr>
<th>Present Day Population</th>
<th>Claims</th>
<th>Present Day Avg Loss</th>
<th>Total Losses</th>
<th>ALAE</th>
<th>Trended Losses and ALAE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30,000</td>
<td>26,550</td>
<td>796,496,921</td>
<td>318,598,768.25</td>
<td>1,115,095,689</td>
</tr>
<tr>
<td>Present Day Legal Environment</td>
<td>30,000</td>
<td>1,000,000</td>
<td>30,000,000,000</td>
<td>18,000,000,000</td>
<td>48,000,000,000</td>
</tr>
<tr>
<td>Effect Would be Discovered Sooner</td>
<td>5,000</td>
<td>500,000</td>
<td>2,500,000,000</td>
<td>1,500,000,000</td>
<td>4,000,000,000</td>
</tr>
<tr>
<td>FDA Would Block Drug</td>
<td>-</td>
<td>1,000,000</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Best Estimate?</td>
<td>10,000</td>
<td>500,000</td>
<td>5,000,000,000</td>
<td>3,000,000,000</td>
<td>8,000,000,000</td>
</tr>
</tbody>
</table>
Modeling process – steps 3 and 4

Parameterize model and simulate industry-wide losses

GL Claims Source: Towers Watson Casualty Catastrophe Database
Allocate industry-level losses to policy year and insurer

- **Market-Share Approach**
  - Use market share of insurers by policy year
  - Vary market share to fit a distribution of potential allocations

- **Policy-Level Approach**
  - Simulate more details of the event. Some of which may be correlated.
    - Number of claims
    - Number of entities found liable
    - Number of policies / years triggered
    - Gross severity of each individual claim
Case study assumptions

- We created a simple fictitious company with the following base assumptions:
  - Two lines of business
    - General liability
    - Products liability
  - Began writing business ten years ago
  - Only writes primary, ground-up policies
  - Writes 25% of the entities in these industries
  - Business written with a 20% coinsurance share of the losses
- Then, some of the base assumptions were varied…
Case study results

Figure 2. Case study

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Policy terms</th>
<th>Share</th>
<th>Coverage period</th>
<th>Classes</th>
<th>Number of insureds per year</th>
<th>Number of entities in market</th>
<th>Mean in $millions</th>
<th>50th</th>
<th>90th</th>
<th>95th</th>
<th>99th</th>
<th>99.5th</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Primary</td>
<td>20%</td>
<td>2001 – 2010</td>
<td>GL + Products</td>
<td>250</td>
<td>1,000</td>
<td>1,021</td>
<td>0.41</td>
<td>2.57</td>
<td>3.88</td>
<td>8.02</td>
<td>10.15</td>
</tr>
<tr>
<td>2</td>
<td>Primary</td>
<td>20%</td>
<td>2001 – 2010</td>
<td>GL + Products</td>
<td>500</td>
<td>1,000</td>
<td>2,042</td>
<td>0.55</td>
<td>2.39</td>
<td>3.45</td>
<td>6.37</td>
<td>8.46</td>
</tr>
<tr>
<td>3</td>
<td>10 x 10</td>
<td>20%</td>
<td>2001 – 2010</td>
<td>GL + Products</td>
<td>250</td>
<td>1,000</td>
<td>45</td>
<td>0.31</td>
<td>2.41</td>
<td>4.20</td>
<td>10.56</td>
<td>18.51</td>
</tr>
<tr>
<td>4</td>
<td>Primary</td>
<td>20%</td>
<td>2001 – 2010</td>
<td>GL</td>
<td>250</td>
<td>1,000</td>
<td>113</td>
<td>0.42</td>
<td>2.62</td>
<td>3.85</td>
<td>7.75</td>
<td>9.92</td>
</tr>
<tr>
<td>5</td>
<td>Primary</td>
<td>20%</td>
<td>2001 – 2010</td>
<td>Products Pharma</td>
<td>250</td>
<td>1,000</td>
<td>300</td>
<td>—</td>
<td>2.84</td>
<td>5.58</td>
<td>14.82</td>
<td>21.16</td>
</tr>
<tr>
<td>6</td>
<td>Primary</td>
<td>20%</td>
<td>1981 – 2010</td>
<td>GL + Products</td>
<td>250</td>
<td>1,000</td>
<td>1,203</td>
<td>0.40</td>
<td>2.53</td>
<td>3.84</td>
<td>8.32</td>
<td>10.67</td>
</tr>
<tr>
<td>7</td>
<td>Primary</td>
<td>100%</td>
<td>2001 – 2010</td>
<td>GL + Products</td>
<td>50</td>
<td>1,000</td>
<td>1,021</td>
<td>0.08</td>
<td>2.45</td>
<td>4.76</td>
<td>13.37</td>
<td>21.63</td>
</tr>
</tbody>
</table>

- Scenario 2 doubles the mean losses and “diversifies” the risk
- Excess layers in scenario 3 mean lower losses, but higher risk
- Scenarios 4 and 5 show effect of only writing different lines of business
- The longer history of policies in scenario 6 leads to slightly higher risks
- In scenario 7, by taking 100% of the share of losses, but writing fewer insureds, the insurer has accepted the same mean loss, but drastically increased the overall risk in extreme percentiles
Case Study – Policy-Level Results
Case study assumptions

- **Six policy types:**
  - Base: 4m xs 1m, 20% coinsurance share, written for 10 years, only GL
  - Large account policy with twice the average exposure for the market
  - Higher excess policy of 10 xs 5m
  - New policy only written for 1 year
  - 100% coinsurance share
  - Only medical products liability

- 30 policies of each type for a total of 180 policies

- Market assumptions the same as first case study
Policy-level approach can create variables needed for quantifying the policy’s risk margin

- Identifies relative risk
- Facilitates the calculation of risk margins and allocation of capital to type
Best practices

- Model results are sensitive to some assumptions. Resist the urge to over-parameterize and over-rely.
- Start collecting historical information now
- Set clear definitions early on
  - Catastrophe threshold
  - Events within definition (governmental liability, suits against insurance companies, suits against companies normally not insured?)
  - Claim/claimant/entity
  - Emergence on occurrence, reported or occurrence-reported basis
  - Emerge as nominal ultimate, discounted ultimate, or actuarial best estimate
- Be careful with exposure - it does not only relate to frequency.
The “evolution” in the evolution of casualty catastrophe modeling
Can we predict black swans?

- Time difference between future event and observation time point determines whether the event is a black swan or not.¹
  - E.g. Internet technology in 1960s vs 1990s
  - Biological evolutionary methods (e.g. phlyogenetics) can assist in identifying prior signals of events.²

² A review of the use of complex systems applied to risk appetite and emerging risks in ERM, Allan et al.
Overlay current environment

Casualty catastrophe database of historical characteristics or DNA of risks e.g.
- Size of loss
- No. of insureds
- Insurance trigger
- Class actions
- Latency

Candidate risks e.g.
- EMF
- Mobile phones
- Etc.

Evolutionary Risk Tree

Candidate risks e.g.
- EMF
- Mobile phones
- Etc.

Underwriting
Reserving
ERM

Credit Crisis
Pollution
Asbestos

Frequency
Loss
Conclusions
Conclusions

• Casualty catastrophes have had major impacts on insurers historically
• Evolution in catastrophe modeling has been driven by major events: Hurricane Andrew, asbestos, pollution, WTC, etc.
• Casualty catastrophe reserving models have been around for a while now: asbestos, pollution, and other policy-event based loss estimation models
• Methods to quantify uncertainty for future casualty catastrophes exist and are evolving
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