Aviation Pricing and Modelling

CARE Meeting 2006
Agenda

1. Introductions

2. Overview and Background of the Aviation Insurance Market

3. Techniques and Methodologies in the Primary Airline Insurance Market

4. Implementing Pricing Models within the Aviation Market

5. Brief comments on non Airline models within the Aviation Market

6. Techniques and Methodologies in the Reinsurance Market

7. Summary and Questions
CARE Seminar: Aviation Pricing and Modelling
Section 2: Overview and Background - Agenda

1. Market Overview
2. Implications of September 11th
3. Characteristics of the Market
## Aerospace Insurance Market (US$)

<table>
<thead>
<tr>
<th>Insureds</th>
<th>Premium</th>
<th>Coverage</th>
<th>Types of Claims</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airlines</td>
<td>2.5bn</td>
<td>Liabilities arising out of the Airline business</td>
<td>Major Catastrophe, Other significant events, Attrition</td>
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<tr>
<td>Manufacturers</td>
<td>1.0bn</td>
<td>Product Liability within the Aviation sector.</td>
<td>Major Catastrophes, Significant Events</td>
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<tr>
<td>General Aviation</td>
<td>2.5bn</td>
<td>More Diverse Group of Insureds / Coverages</td>
<td></td>
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</table>

We will focus our discussion on the Airlines Models within most of this presentation.
Pre-September 11th industry results were not profitable, like many other lines of business.
### September 11<sup>th</sup> – Cost of the Events

<table>
<thead>
<tr>
<th>Event</th>
<th>Initial Costs</th>
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<tbody>
<tr>
<td>Pentagon</td>
<td>661,575,204</td>
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<tr>
<td>North Tower</td>
<td>1,557,469,273</td>
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<tr>
<td>South Tower</td>
<td>1,654,254,653</td>
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<tr>
<td>Shanksville</td>
<td>208,302,337</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4,081,601,467</strong></td>
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</tbody>
</table>
Aftermath - Quantitative Teams

- Increased Capital Provider Scrutiny
- Need for Quantitative Training for Non-Quantitative Staff
- Much More Emphasis on Pricing Tools
  - Enhanced – Better Predictors of Future Claims and Assessments of Required Premium.
  - Expanded – Now in all areas of the business
  - Strengthened – Fundamental to the Underwriting Process
  - Thought about in general and on a higher level – correlation with other lines
- Sounds a lot like cat, no?
Market Characteristics

1. Worldwide, with a center in London

2. Small market
   - Historically a significant reliance on reinsurance
   - Subscription market
   - Not a lot of credible lead Markets
   - Main players are on most risks
   - Four Main brokers
   - Renewals are bunched together

3. Limited number of insureds
   1. Top 150 Airlines account for 88% of Airlines premium
      - Allows practitioners to “see” the entire market

4. Discussion generally at 100% market terms. This has significant implications for the way we satisfy the quantitative needs of the market
The Main Substantive Difference - Top Down Models

1. Most Aviation Pricing Models are top down (particularly in Airlines)
   - Think of event sets in cat models
   - Because the underwriters think in top down terms, this is the obvious way to frame models for them. It also does make sense when we talk about a limited number of players and low frequency of loss per insured.

2. What does it mean for a model to be top down?
   - Still must price risks individually, but the main validation and parameterization of the model is done at the Total Market level
   - Must know what the value the model would produce if we ran every airline in the market through the model and summed the result. “The Total Market Equivalent”
Section 3: Techniques and Methodologies in the Primary Airline Insurance Market

Primary Insurance Pricing Models

• Issues in constructing a model
  • Assessment of Market Losses
  • Individual Risk Attributes – Loss Allocation
  • Non Loss Factors
  • Currency

• Underwriter Review Process
Assessment of Market Losses

- How do you determine the forecast losses for the market?
  - Main Factors to consider
    - Historic Claims
    - Claims Inflation
    - Exposure Change
    - Safety Improvements
Claims Inflation

• Must restate losses to current level in order to incorporate them in pricing.
  • Difficult to quantitatively assess due to the infrequent and heterogeneous nature of the events. Geography is very important.
  • Differences between cover sections (Hull & Liability)
### Claims Inflation

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<th>Operator Area</th>
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<td>2005</td>
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<td>Canada</td>
<td>2005</td>
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<tr>
<td>Europe</td>
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<tr>
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<td>1992</td>
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<td>2003</td>
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<tr>
<td>Latin / South America</td>
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<td>Asia Pacific</td>
<td>2003</td>
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<tr>
<td>Low Award</td>
<td>2003</td>
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<table>
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<table>
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<tr>
<th>Threshold</th>
<th>Min Fatalities</th>
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<table>
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<tr>
<th>Liability Indexed</th>
<th>Liability As-If*</th>
<th>Difference</th>
<th>Implicit Fatalities</th>
<th>Avg Ind. Pax Award</th>
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<td>1,777,500,000</td>
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<td>440,324,400</td>
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<td>Latin / South America</td>
<td>738,736,729</td>
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<td>Asia Pacific</td>
<td>1,360,819,135</td>
<td>765,200,000</td>
<td>56%</td>
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<td>Low Award</td>
<td>124,111,325</td>
<td>67,950,000</td>
<td>55%</td>
<td>453</td>
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</table>

| Total             | 10,825,528,406  | 9,877,050,000 | 91%               | 6829              | 1,585,229         |
| Average           | 902,127.367     | 823,087.500   | 79,039.867        |                   |                   |

* ignores payments for Bodily Injury and TPL
* claims only from Singapore Airlines
* difference driven by TAM and Aero Peru (both in 96) - foreign pax with exceptional awards
** difference driven by

- Developments of Average Awards drivers for liability claims (Avg Seating pretty constant at 72 passengers over last 10-15yrs)
- Difficult to obtain trend factors due to catastrophic nature of claims and variation in passenger mix
- Current Awards are a set of estimates for these regions and are of course subjective.
- Public Compassion driving awards

Awards are only used for illustration

- China 94: 158 Japanese on board
- China 92: got Boeing involved and taken to US Court
- Korean 97
• Limited Catastrophe Potential (Max Hull Values around 250m)
• Ratio Agreed (Insured) to Market Value as an additional dimension (only impacts total losses, constructive total loss)

Source: ACRS / Airclaims
Claims Inflation

Average Hull Losses in USD

Source: Airclaims

3.4% AGR

Avg Aircraft Value

Average Hull Losses in USD

Source: Airclaims

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Claims Inflation

Catastrophic Losses

Average Catastrophic Loss

[Graph showing average catastrophic losses from 1992 to 2003 with different lines for yearly, average, 5yr avg, 10 yr avg, and Expon. (5yr avg). The biggest loss (AA Queens) is noted with the lowest frequency.

Includes indexed Losses bigger than 30m]
Exposure Increases - World Traffic Indicators: Western Built Jets

Source: Airclaims
Traffic growth in more exposed regions

1.3 Jet losses per million departures – world average: 1.3

Traffic Growth Forecast %

- US: 0.4%
- Europe: 0.9%
- North Atlantic: 1.1%
- Euro - Asia: 3.1%
- Transpacific: 3.4%
- China: 2.6%
- US - Latin Am: 3.1%
- Euro - Latin Am: 3.4%
- Latin Am: 2.6%
- Mid east: 3.1%
- Euro - Africa: 3.4%
- NE Asia: 2.6%
Safety Improvements

- Highly Regulated Environment ensures very high Minimum Operating Standards
- Young and Developing Technology
- New Systems like
  - TCAS (Traffic Alert and Collision Avoidance System)
  - EGPWS (Enhanced Ground Proximity Warning System)
  - TAWS (Terrain Awareness and Warning System)
  - RAAS (Runway Awareness Advisory System)
- Increased Safety Awareness after series of losses in mid 90s (e.g. Korean)
Safety Equipment in the World Fleet: Growth of E-GPWS equipped aircraft

worldwide commercial jet fleet

World fleet (25,162 aircraft)

GPWS

E-GPWS (11,000 aircraft)
Frequency Trends

Catastrophic Losses

Absolute Loss Counts

Relative Loss Counts
Risk Attributes

- Region
- Limits / PML
- Loss History
- Management / Safety Culture
- Exposures

<table>
<thead>
<tr>
<th>Airline Profile</th>
<th>Change</th>
<th>2004</th>
<th>2003</th>
<th>2002</th>
</tr>
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<tbody>
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<td># Aircraft (Total)</td>
<td>6.9%</td>
<td>0%</td>
<td>7.9%</td>
<td>7.9%</td>
</tr>
<tr>
<td># Aircraft (In Service)</td>
<td>6.9%</td>
<td>0%</td>
<td>7.9%</td>
<td>7.9%</td>
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<td># Aircraft (Stored)</td>
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<td>0%</td>
<td>0%</td>
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<tr>
<td>Average Fleet Value (Total)</td>
<td>3.6%</td>
<td>26,822,250,000</td>
<td>25,200,000,002</td>
<td>24,280,000,000</td>
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<tr>
<td>Average Fleet Value (In Service)</td>
<td>3.6%</td>
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<tr>
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<td>Maximum Hull Value</td>
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<td>Maximum Seating</td>
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<tr>
<td>Total Seating</td>
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<tr>
<td>Departures</td>
<td>26.0%</td>
<td>1,276,000</td>
<td>1,006,400</td>
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<td>Passengers</td>
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<td>97,410,000</td>
<td>78,500,000</td>
<td>73,800,000</td>
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<td>RPMs</td>
<td>10.3%</td>
<td>182,900,000,000</td>
<td>165,200,000,000</td>
<td>163,200,000,000</td>
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<tr>
<td>RPMc</td>
<td>10.3%</td>
<td>113,610,935,471</td>
<td>102,283,219,291</td>
<td>101,802,361,715</td>
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<td>Total Loss Only Value</td>
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<td>Spares Value</td>
<td>0%</td>
<td>1,200,000,000</td>
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</table>
Risk Attributes

- Aircraft Type (Variant)
- Seats
- Routes

### Fleet Details

<table>
<thead>
<tr>
<th>Operator</th>
<th>Registration</th>
<th>Type</th>
<th>Variant</th>
<th>From</th>
<th>To</th>
<th>Generic Market Value</th>
<th>Agreed Value</th>
<th>Fix</th>
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<tbody>
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<td>Airbus A320</td>
<td>230 (IHE)</td>
<td>41/20/2004</td>
<td>11/22/2005</td>
<td>22,722,267</td>
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<td>156</td>
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<td>41/30/2004</td>
<td>11/22/2005</td>
<td>23,511,019</td>
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<td>Airbus A320</td>
<td>230 (IHE)</td>
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<td>15,700,000</td>
<td>156</td>
<td>1,297</td>
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<td>Bombardier (Canadair)</td>
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<td>41/30/2004</td>
<td>11/29/2005</td>
<td>13,627,406</td>
<td>9,100,000</td>
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<td>In service</td>
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</table>
Parameterizing the Models

- Aggregate versus Individual Model - Due to Aggregate Covers Individual Claims Model not really required (but still often used)
- Studies to determine the extent to which a factor is significant (subject to statistical noise)
- Due to very few accidents very difficult to obtain statistical significance - overlapping attributes.
- Hierarchical Credibility Approaches
- The sum of all factors have to match initial estimate
Non Loss Factors to include in the required premium

Non Loss Factors to incorporate into the required premium

- Standard Items
  - Expenses
    - Brokerage, tax, Internal Costs, etc.
  - Anticipated Investment Income
  - Required Return / Cost of Capital

- Reinsurance Load – due to the large limits that are provided in this class in some measure through the provision of reinsurance, it is important that the market explicitly incorporate the anticipated profit for the reinsurers into our direct pricing. (Cost of Reinsurance Capital)
Underwriter Review Process

• Obtaining Underwriter Feedback and Input

  • **Issues**
    • Gaining their input
    • Wealth of industry knowledge
    • Historically little interaction between the actuarial community and underwriters
    • Vital in assisting in parameterization / assessment of importance of different rating factors

  • **Difficult for UW to express their deep knowledge**
    • New process for them.
    • Takes a lot of Analytical and UW time to learn how to interact
    • There will be pockets of resistance, particularly in a softening market.
Implementation and Control

- More models are built than are used
- Implementation is key to ensuring a model adds value within the company
- Need management process which can ensure that the model is being used
- Underwriters should view the model as a tool rather than a control mechanism
- Output from the pricing model becomes the underpinning of the Renewal strategy for the entire portfolio
Section 5: Brief comments on non Airline models within the Aviation Market

Manufacturers Products

- Few market player have an implemented top down approach to Manufacturers
- Not yet standard in the market

General Aviation

- Standard Practice in the US is a typical rate book approach.
- In the UK, more judgemental underwriting is the norm
Some Appendix Exhibits
Assessment of Coverages / Exposures – Airline Insurance

- **Hull**
  - Ground Risk included
  - War / Terror not covered (separate Hull War policy)
  - Maximum Sum Insured up to $250m per aircraft

- **Liability**
  - War / Terror covered except for airlines with government protection (e.g. USA)
  - Passenger Legal Liability (PLL)
    - Death or injury to passengers
    - Big variation in average awards per passenger by country / region; min/max amount often determined by government/convention
  - Loss or damage to baggage, cargo or mail
  - Third Party Legal Liability (TPLL)
    - Terror / War Limit of (generally) $50m introduced after 9/11 (note some new minimum requirements imposed by legislation)
    - Separate policy for cover excess $50m (War XS Market)
  - Limit often above $1.0bn up to $2.0bn (any one aircraft/occurrence).
    - Personal Injury ($25m)
Aftermath of September 11th - Insurers

- Potential crisis of confidence from capital providers
- Determination to keep the airlines flying
- Insurers Response:
  - Cancellation clauses activated
  - Additional premiums are charged - calculated @ $1.25 per enplaned passenger
  - 7 day notice cancellation clause maintained
  - Policy limits of $1.5bn maintained
  - War risks liability cover to 3rd parties reduced to $50m
  - War risks liability cover to passengers maintained up to $1.5bn
  - New schemes emerge to cover excess war third party liability
  - Potential exhaustion of reinsurance cover
Aftermath of September 11th - Reinsurers

- Primary or ‘working’ level covers disappear
- Company failures or insolvencies declared
- General coverage terms are radically tightened
- LORA vs LOD becomes an issue
- All rates / premiums & payment terms heavily increased
- Future solvency & overall market liquidity remain an open issue
Aftermath of September 11th - Governments

  - Establish victims compensation fund
  - Airlines/others receive immunity from prosecution excess of maintained insurance
  - Single legal forum (S. District of New York)
  - Longer term loan support & immediate compensation to carriers for period of forced grounding
- Other governments worldwide obliged to “step-in” to cover possible liability limit shortfalls for their national aerospace companies