Casualty Actuarial Society

2013 In Focus Seminar: Elephants in the Room

Aviation Risk

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Agenda

Airlines Loss Modeling Framework

- The Insurance & Reinsurance Markets
- Insurance & Reinsurance Pricing
- Typical Features of Airlines Models

The Insurance Markets

- Airlines
  - Hull: up to $355 million
  - Passenger and third party liability: up to $2.25 billion
  - Coverage on per aircraft basis
  - Typically written a percentage of total limit

- Products
  - Airframe, engine, and parts manufacturers, airports, etc.
  - Protects product manufacturers or airports when found wholly or partially liable in claims
  - Limits up to $2 billion
  - Major products typically written a percentage of total limit

- General Aviation (GA) - Mike to discuss in his slides

The Reinsurance Markets

- Types of Products
  - Reinsurance
    - Proportional (QS, Surplus)
    - Risk Excess
    - Excess of Loss
  - Retrocession
    - UNL XOL
    - Industry Loss Warranty (ILW)

- Notable features: double triggers
  - Floating retention in a primary XOL cover: e.g., $10m xs $5m or $100m whichever the lesser
  - Industry loss warranty in a retro UNL XOL cover: e.g., $20m xs $10m with $750m industry loss warranty

Reinsurance Pricing - Questionnaire

- Schedules A (Non-US airlines), B (US airlines), C (Manufacturers), D-J
- Roughly 70 non-US airlines, 20 US airlines, 30 product manufacturers

Schedule	Insured	Inception	Expiry	Ccy	Hull Limit	Hull Excess	Client % Line	Ccy	Liability Limit	Liability Excess	Client % Line
A	Airlines 1	1-Apr-10	31-Mar-11	USD	150,000,000	0		USD	1,750,000,000	0	
A	Airlines 1	1-Apr-11	31-Mar-12	USD	150,000,000	0		USD	1,750,000,000	0	
A	Airlines 1	1-Apr-12	31-Mar-13	USD	150,000,000	0		USD	1,750,000,000	0	
A	Airlines 2	1-Dec-10	30-Nov-11	USD	180,000,000	0		USD	1,500,000,000	0	
A	Airlines 2	1-Dec-11	30-Nov-12	USD	180,000,000	0		USD	1,500,000,000	0	
A	Airlines 2	1-Dec-12	30-Nov-13	USD	180,000,000	0		USD	1,500,000,000	0	
A	Airlines 3	1-Dec-10	30-Nov-11	USD	275,000,000	0		USD	2,250,000,000	0	
A	Airlines 3	1-Dec-11	30-Nov-12	USD	275,000,000	0		USD	2,250,000,000	0	
A	Airlines 3	1-Dec-12	30-Nov-13	USD	275,000,000	0		USD	2,250,000,000	0	
B	Airlines 4	1-Jul-10	4-Aug-11	USD	75,000,000	0		USD	1,500,000,000	0	
B	Airlines 4	5-Aug-11	4-Aug-12	USD	75,000,000	0		USD	1,500,000,000	0	
B	Airlines 4	5-Aug-12	4-Aug-13	USD	75,000,000	0		USD	1,500,000,000	0	
B	Airlines 5	1-Jul-10	30-Jun-11	USD	165,000,000	0		USD	1,750,000,000	0	
B	Airlines 5	1-Jul-11	30-Jun-12	USD	165,000,000	0		USD	1,750,000,000	0	
B	Airlines 5	1-Jul-12	30-Jun-13	USD	165,000,000	0		USD	1,750,000,000	0	
B	Airlines 6	21-Dec-10	20-Dec-11	USD	200,000,000	0		USD	1,750,000,000	0	
B	Airlines 6	21-Dec-11	20-Dec-12	USD	200,000,000	0		USD	1,750,000,000	0	
B	Airlines 6	21-Dec-12	20-Dec-13	USD	200,000,000	0		USD	1,750,000,000	0	
C	Manufacturer 1	1-Jan-10	31-Dec-10	USD	10,000,000	0		EUR	1,000,000,000	0	
C	Manufacturer 1	1-Jan-11	31-Dec-11	USD	10,000,000	0		EUR	1,000,000,000	0	
C	Manufacturer 1	1-Jan-12	31-Dec-11	USD	10,000,000	0		EUR	1,000,000,000	0	
C	Manufacturer 2	1-Apr-10	31-Mar-11	GBP	80,000,000	0		USD	1,500,000,000	0	
C	Manufacturer 2	1-Apr-11	31-Mar-12	GBP	80,000,000	0		USD	1,500,000,000	0	
C	Manufacturer 2	1-Apr-12	31-Mar-13	GBP	80,000,000	0		USD	1,500,000,000	0	
C	Manufacturer 3	1-Jul-10	30-Jun-11	USD	355,000,000	0		USD	2,000,000,000	0	
C	Manufacturer 3	1-Jul-11	30-Jun-12	USD	355,000,000	0		USD	2,250,000,000	0	
C	Manufacturer 3	1-Jul-12	30-Jun-13	USD	355,000,000	0		USD	2,250,000,000	0	

Retro Pricing – Retro Questionnaire (Aggregates)

- Necessary info for a reinsurer's risk management
- Critical info for retro pricing

		Industry Loss by Insured							
Schedule	**Insured**	**$250MM**	**$500MM**	**$750MM**	**$1000MM**	**$1250MM**	**$1500MM**	**$1750MM**	**$2000MM**
A	Aegean Airlines	1,960,200	8,257,343	14,901,898	21,564,441	28,862,087	37,011,588	45,737,779	54,381,109
A	Aeroflot	1,960,200	8,257,343	14,901,898	21,564,441	28,862,087	37,011,588	45,737,779	54,381,109
A	Aerolineas Argentinas	1,960,200	8,257,343	14,901,898	21,564,441	28,862,087	37,011,588	45,737,779	54,381,109
A	Aeromexico	1,960,200	8,257,343	14,901,898	21,564,441	28,862,087	37,011,588	45,737,779	54,381,109
A	Air Algerie	1,960,200	8,257,343	14,901,898	21,564,441	28,862,087	37,011,588	45,737,779	54,381,109
A	Air Asia	1,960,200	8,257,343	14,901,898	21,564,441	28,862,087	37,011,588	45,737,779	54,381,109
A	Air Berlin	1,960,200	8,257,343	14,901,898	21,564,441	28,862,087	37,011,588	45,737,779	54,381,109
A	Air Canada	1,773,647	5,152,059	10,236,908	15,417,528	17,559,868	18,622,759	18,622,759	19,159,068
B	Alaska Air Group	556,875	4,577,513	8,796,768	13,218,050	15,163,904	16,136,831	16,136,831	17,109,758
B	American Airlines	791,690	5,547,588	11,446,565	17,426,475	23,720,090	30,474,138	34,614,261	35,535,525
B	Delta Air Lines	581,378	4,521,825	9,589,388	14,842,575	20,225,700	25,513,340	28,890,675	28,890,675
B	DHL International	198,062	4,716,731	10,309,613	15,937,763	21,913,960	27,356,170	31,135,519	31,135,519
C	ABC Scheme	356,400	2,208,938	5,552,990	9,721,069	14,316,840	18,194,009	21,400,170	21,400,170
C	ATR	273,686	1,641,315	4,550,376	8,300,897	12,915,365	17,061,536	21,816,706	22,559,661
C	Avio	142,560	3,005,876	7,445,331	12,742,960	18,337,499	22,754,918	28,650,651	34,150,640
C	BAA	14,256	826,514	3,323,910	6,287,219	10,441,807	12,531,544	12,531,544	12,531,544
C	BAE Systems	-	718,222	2,623,766	5,942,637	9,333,767	12,120,318	15,623,699	18,360,614
C	Boeing/MDC	-	1,350,479	4,264,484	7,735,837	9,296,603	9,296,603	9,296,603	9,296,603
C	Bombardier/Canadair/Learjet	-	2,031,183	5,299,146	8,990,493	13,034,155	17,004,029	22,244,300	27,092,390
C	Dassault Aviation	81,527	1,654,362	4,831,331	8,504,399	10,189,357	10,189,357	10,189,357	10,189,357
C	EADS	106,920	2,058,025	4,545,400	7,464,006	10,821,763	13,598,138	17,214,473	20,410,603

Airlines Loss Modeling – Typical Features

- All airlines models are similar to some extent
  - A major goal of modeling is to build an industry major loss event set
- Data is transparent and of high quality
  - Fleet and loss data can be subscribed and downloaded from a third party data provider
  - Many publicly available websites
- Data is detailed
  - Every major loss event
  - Every single western built jet and most western built turbo prop aircraft in service worldwide
    - About 20,000 jets (18,000 for passengers), and
    - About 5,000 turbo props (3,300 for passengers)
- Loss modeling is typically exposure based
  - The historical & current fleet and utilization information play key roles
  - Loss modeling is at aircraft level
  - Key parameters are either derived from experience or selected by actuarial judgement and are constantly monitored to reflect the current operating conditions

Airlines Loss Modeling – at Aircraft Level

- Frequency Factors
  - Operator Domicile Country, Region, Size
  - Aircraft Type, Aircraft Age, Usage, Utilization (cycles, hours)

- Severity Factors (best summarized in the following formula):

$$\text{Loss Size} = [\text{Hull Insured Value}] + [\text{Seats}] \times [\text{Load Factor}] \times [\text{Fatality Rate}] \times [\text{Award Per Passenger}]$$

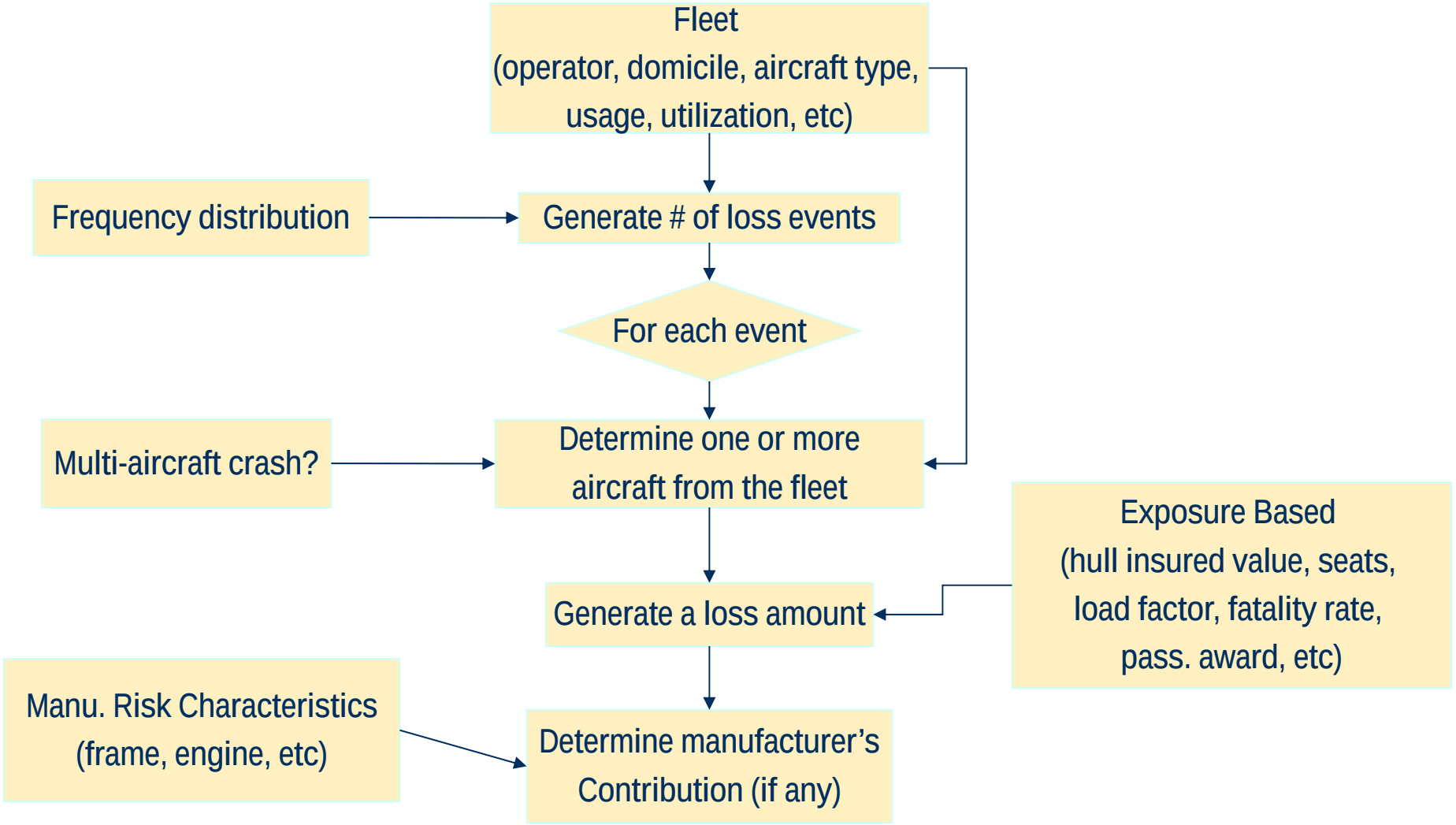
- Other Considerations
  - Product manufacturers involvements
    - Region differential
    - Type of product (Airframe, Engine, etc)
  - Awards fare class/country differential, passenger mix, non-injured passengers
  - Third party liability on the ground
  - Multi-aircraft crashes
    - Frequency: rare but many mid-air near-miss events near airports
    - Severity: may be skewed in such headline events

- Selection of Probability Distributions for Stochastic Simulation

Airlines Loss Modeling – A Sample Fleet

Operator	Operator Country	Insured	Hull Limit ($m)	Liab Limit ($m)	Aircraft Type	Aircraft Variant	Serial No.	Aircraft Manu.	Engine Manu.	Seat First	Seat Business	Seat Econ	Award First ($m)	Award Business ($m)	Award Economy ($m)	Aircraft Usage	Year of Build	Market Value ($m)	Insured Value ($m)	Cycles Budgeted	Load Factor	Freq Per Million Cycle	Freq
Operator A	Country A	Airlines A	275	2,250	A380	860 (EA)		Airbus	GP7200	9	80	449	3	1.75	0.5	P	2009	161	173	507	0.7550	0.281	0.00014
Operator A	Country A	Airlines A	275	2,250	A380	860 (EA)		Airbus	GP7200	9	80	449	3	1.75	0.5	P	2009	161	214	507	0.7550	0.281	0.00014
Operator A	Country A	Airlines A	275	2,250	A380	860 (EA)		Airbus	GP7200	9	80	449	3	1.75	0.5	P	2009	161	182	507	0.7550	0.281	0.00014
Operator A	Country A	Airlines A	275	2,250	A380	860 (EA)		Airbus	GP7200	9	80	449	3	1.75	0.5	P	2010	169	215	507	0.7550	0.281	0.00014
Operator B	Country A	Airlines A	275	2,250	A380	860 (EA)		Airbus	GP7200	9	80	449	3	1.75	0.5	P	2010	169	228	507	0.7550	0.281	0.00014
Operator B	Country A	Airlines A	275	2,250	A380	860 (EA)		Airbus	GP7200	9	80	449	3	1.75	0.5	P	2010	169	189	507	0.7550	0.281	0.00014
Operator B	Country A	Airlines A	275	2,250	A380	860 (EA)		Airbus	GP7200	9	80	449	3	1.75	0.5	P	2011	179	233	507	0.7550	0.281	0.00014
Operator B	Country A	Airlines A	275	2,250	A380	860 (EA)		Airbus	GP7200	9	80	449	3	1.75	0.5	P	2011	179	208	507	0.7550	0.281	0.00014

Airlines Loss Modeling – A Simulation Schematic



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Airlines Loss Modeling – A Sample Event Set

Iter ID	Seq. ID	Hull Loss	Liab Loss	Product (%)	Operator	Manu.	Aircraft Type	Serial No.	Load Factor	Fatality Rate	Award First	Award Business	Award Economy	Seats First	Seats Bus.	Seats Econ.
1296	24	105,000,000	464,301,277	12.8%	Operator A	Manu 10	Type 1	1	92.8%	100.0%	3,702,224	2,159,630	617,037	8	98	420
4408	16	184,739,770	787,160,787	23.0%	Operator A	Manu 16	Type 10	3	57.6%	100.0%	8,621,413	4,310,707	2,155,353	14	76	426
5827	2	199,000,000	396,912,769	27.4%	Operator A	Manu 3	Type 2	1	99.0%	100.0%	1,876,775	1,313,742	750,710	12	60	399
7958	10	206,340,000	399,713,726	0.0%	Operator A	Manu 11	Type 17	8	99.9%	100.0%	1,873,280	1,311,296	749,312	12	60	399
9155	5	198,550,000	2,697,299,668	89.0%	Operator A	Manu 2	Type 29	200	100.0%	100.0%	12,627,808	8,839,465	5,051,123	12	60	399
10289	14	216,000,000	432,354,655	91.7%	Operator A	Manu 15	Type 1	15	92.5%	100.0%	3,582,272	2,089,659	597,045	9	80	449
14171	1	191,390,000	594,720,527	0.0%	Operator A	Manu 6	Type 20	20	95.9%	100.0%	2,903,831	2,032,682	1,161,532	12	60	399
16547	18	168,590,000	351,982,664	0.0%	Operator A	Manu 3	Type 30	90	82.1%	100.0%	3,283,418	1,915,327	547,236	9	80	449