A Practical Approach to Risk Margins in the Measurement of Insurance Liabilities for Property & Casualty (General Insurance) under Developing International Financial Reporting Standards

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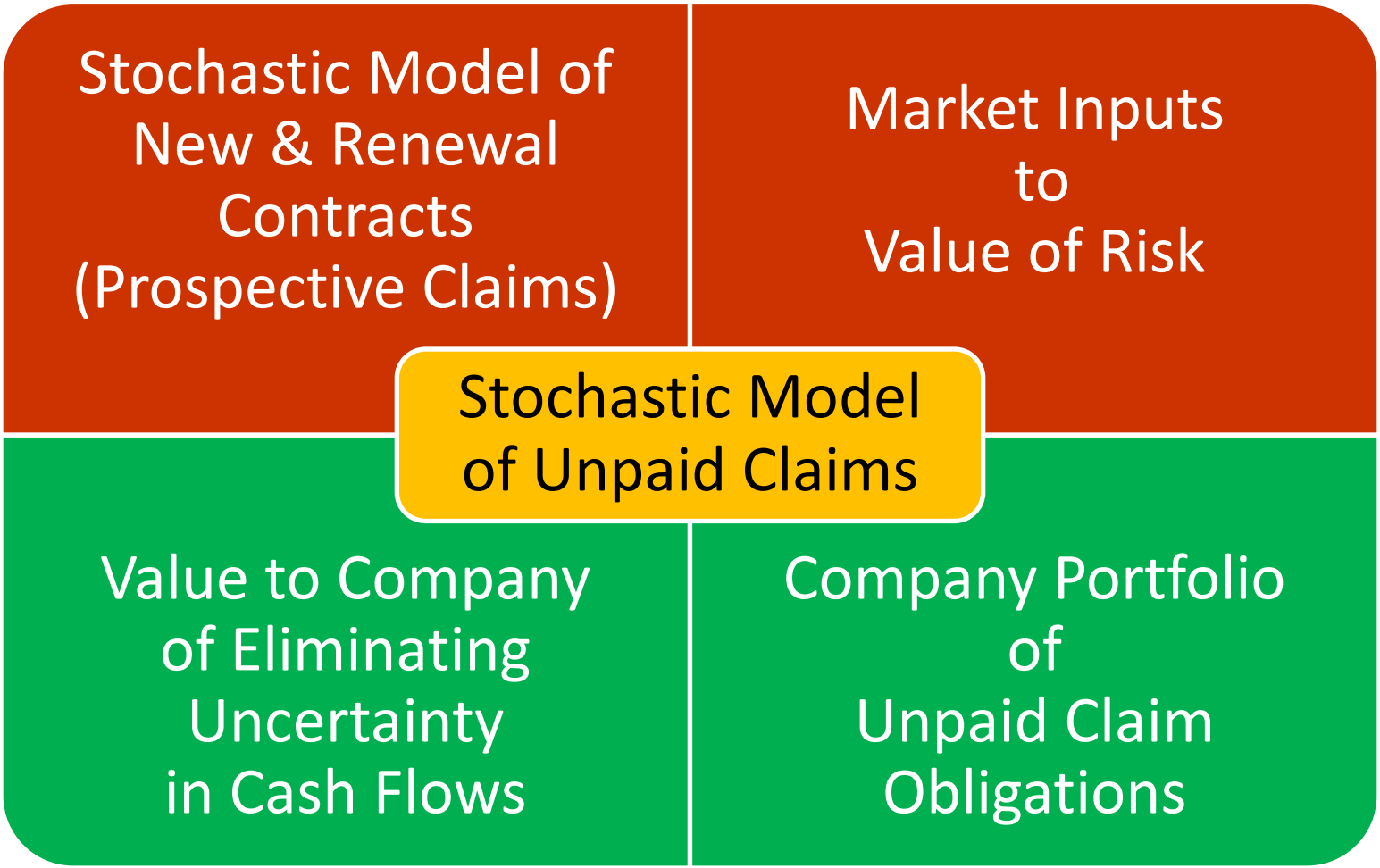
Risk Margins - proposed IFRS

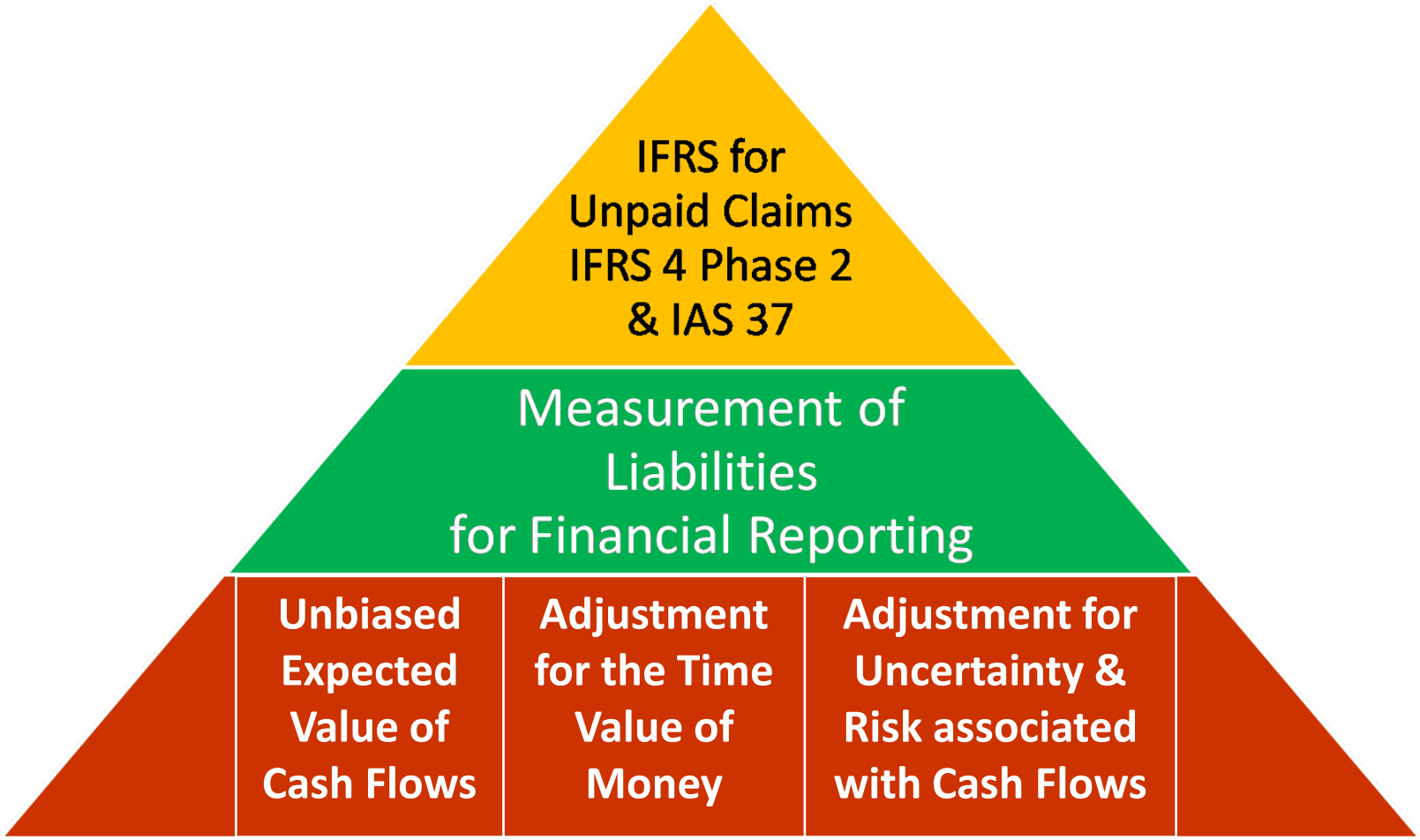
- Risk Adjustments
- in the Valuation of Insurance Liabilities
- to reflect Risk & Uncertainty
- associated with Liability Cash Flows
- both Amount and Timing
- for IFRS (GAAP) Reports
- not for Regulatory Reports (may be different)

Core Concepts for IFRS Risk Margins



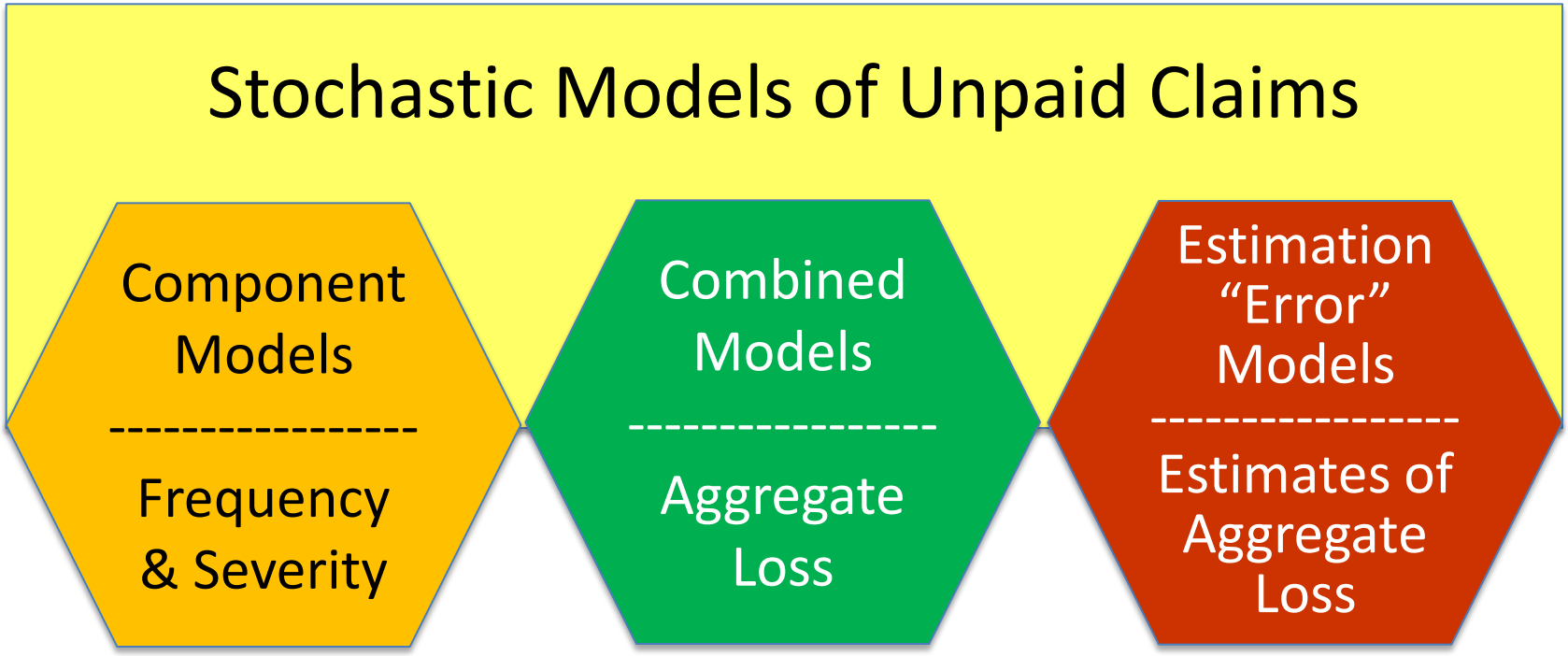
2012 CLRS: Risk Margins under IFRS (Miccolis and Heppen)

IFRS Building Blocks



2012 CLRS: Risk Margins under IFRS (Miccolis and Heppen)

Alternative Actuarial Models for P&C Risk



Estimation Error Model

- Model data is successive re-estimates of ultimate aggregate claim values
  - Development triangle of estimated ultimate values
  - By accident year or by underwriting (policy) year
- Measurement of Risk & Uncertainty
  - Fitting a probability distribution to the estimate errors
  - Lognormal fits very well in tested cases
- Distribution of development risk by age
  - Probability of the errors in the estimates
  - Correlations of errors in the estimates
  - Paper by Zia Rehman and Stuart Klugman

Risk Margins for IFRS

- Consideration of Various Types of Risk
  - Process, Parameter, Model, Specification, etc.
- Measurement of Risk & Uncertainty
  - Risk Measurement as Captured by Model(s)
  - Relationship among “type of risks”
- Valuation Concepts for Risk & Uncertainty
  - Cost of Risk
  - Price to Transfer Risk
  - Value of Mitigation of Risk

Insurance Contract Pricing

- Basic Valuation of Uncertain Outcomes
- Expected Value (portfolio basis)
- Value (Price) for the Risk that:

  Σ actual outcomes > Σ expected outcomes

- Pricing Levels: one basis for the "value" of risk
- Value of Risk: calibrate value of unpaid claims risk considering price/risk for prospective claims

Market Data for Risk Margins

- Market Inputs
  - No real “trading” of portfolio of unpaid claims
  - But active markets exist for new insurance contracts
- Market Profitability to calibrate risk margins
  - Observable in some markets (aggregate or sample data)
  - Competition in markets drives profit levels
  - Profit levels (company or market level) reflect:
    1. Risk & Uncertainty of insurance portfolios
    2. Capital needed to compete in marketplace
    3. Risk vs. Return Probabilities

Value of Risk Parameter

- Variable to reflect profitability (company or market) associated with risk of profit/loss from an insurance/claim portfolio
- Modeled using a Risk Preference Function (transformed probability distribution function)
- *Wang Transform* - good example of such function
  - addresses spectrum of profit & loss outcomes
  - desirable risk measure attribute(s): e.g., “coherent”
  - consistent with Bühlmann’s economic premium principle
  - easy to use, particularly for lognormal probability function

Computing the Risk Margin using the Wang Transform

$F(x)$ = Aggregate Loss probability function

$S(x) = 1 - F(x)$

$E[x]$ = expected value using $F(x)$

$F^*(x)$ = Transformed probability function

$\Phi(x)$ = Normal Probability Function

$S^*(x) = \Phi(\Phi^{-1}(b \cdot S(x) + \lambda)$ (λ = risk preference)

$E^*[x]$ = expected value using $F^*(x)$

Risk Margin = $E^*[x] - E[x]$

Testing of Risk Margin Estimation

- Largest 100 US Insurers (groups)
- 5 Lines of Insurance
- Value of Risk Parameters (λ)
  - Calibration by line of insurance
  - Used US industry aggregate profitability (long term)
  - Probability distribution of ultimate loss estimates
- By Line By Company
  - Probability distribution of Unpaid Loss Estimate
  - Applied λ for line to estimate risk margin

Example of Risk Margin Estimation

- Commercial Auto Liability
- Estimation Error from Schedule P, Part 2C
- Industry Aggregate Profitability from Schedule P, Part 1 C
- Payout Pattern and Duration from Schedule P, Part 3C
- Present Value Factor from Payout Pattern and US Treasury Yield Curves

Net Booked Loss & ALAE (from Schedule P, Part 2C)

	Months of Maturity										Latest
Accident Year	12	24	36	48	60	72	84	96	108	120	Evaluation
1987	8,195,868	8,093,702	8,083,907	8,104,034	8,091,634	8,078,034	8,092,658	8,068,131	8,042,289	8,034,872	8,034,872
1988	8,546,503	8,526,611	8,704,877	8,640,221	8,604,829	8,640,454	8,615,483	8,585,459	8,569,110	8,543,928	8,543,928
1989	9,420,085	9,246,724	9,279,795	9,287,502	9,281,584	9,229,632	9,176,851	9,148,599	9,120,928	9,101,236	9,101,236
1990	9,479,650	9,309,099	9,157,573	9,091,177	9,048,280	8,968,213	8,928,567	8,880,305	8,848,278	8,818,434	8,818,434
1991	9,031,017	8,853,171	8,575,945	8,381,188	8,289,001	8,216,473	8,154,828	8,123,474	8,060,272	8,016,358	8,016,358
1992	8,961,355	8,611,372	8,452,185	8,287,988	8,214,002	8,115,928	8,044,178	7,995,733	7,933,280	7,956,577	7,956,577
1993	8,747,317	8,633,221	8,606,389	8,523,034	8,455,054	8,390,747	8,334,471	8,285,543	8,269,077	8,284,094	8,284,094
1994	8,916,700	8,989,530	9,043,590	8,996,625	8,999,628	8,963,009	8,918,034	8,903,041	8,907,712	8,904,679	8,904,679
1995	9,057,286	9,029,922	9,028,225	9,086,186	9,082,557	9,084,951	9,057,872	9,044,750	9,040,049	9,031,717	9,031,717
1996	9,237,853	9,301,506	9,526,504	9,640,014	9,704,147	9,739,643	9,739,177	9,719,047	9,726,167	9,743,683	9,743,683
1997	9,485,776	9,537,708	9,741,479	9,974,342	10,180,228	10,225,662	10,221,048	10,198,180	10,214,647	10,205,685	10,205,685
1998	9,314,608	9,515,038	9,893,894	10,301,757	10,454,597	10,500,268	10,459,277	10,448,868	10,414,728	10,418,275	10,418,275
1999	9,408,335	10,043,371	10,549,185	10,945,497	11,101,670	11,091,395	11,123,348	11,099,762	11,078,047	11,075,835	11,075,835
2000	9,937,589	10,371,444	10,806,917	11,113,678	11,291,016	11,406,325	11,376,726	11,359,384	11,362,381		11,362,381
2001	10,290,153	10,277,719	10,632,589	10,891,786	11,051,340	10,993,292	10,953,987	10,943,423			10,943,423
2002	10,561,049	10,267,872	10,529,484	10,607,142	10,615,790	10,598,778	10,555,623				10,555,623
2003	11,210,956	10,801,169	10,753,873	10,779,804	10,708,701	10,659,927					10,659,927
2004	11,556,476	11,009,047	10,947,095	10,882,503	10,786,513						10,786,513
2005	11,717,674	11,407,000	11,258,547	11,239,808							11,239,808
2006	11,908,448	11,531,946	11,419,000								11,419,000
2007	11,944,741	11,819,461									11,819,461
2008	11,444,660										11,444,660

2012 CLRS: Risk Margins under IFRS (Miccolis and Heppen)

Net Booked Loss & ALAE - Link Ratios

COMMERCIAL AUTO LIABILITY
INDUSTRY NET BOOKED ULTIMATE LOSS & ALAE
LINK RATIOS

	Months of Maturity								
Accident Year	12-24	24-36	36-48	48-60	60-72	72-84	84-96	96-108	108-120
1987	0.988	0.999	1.002	0.998	0.998	1.002	0.997	0.997	0.999
1988	0.998	1.021	0.993	0.996	1.004	0.997	0.997	0.998	0.997
1989	0.982	1.004	1.001	0.999	0.994	0.994	0.997	0.997	0.998
1990	0.982	0.984	0.993	0.995	0.991	0.996	0.995	0.996	0.997
1991	0.980	0.969	0.977	0.989	0.991	0.992	0.996	0.992	0.995
1992	0.961	0.982	0.981	0.991	0.988	0.991	0.994	0.992	1.003
1993	0.987	0.997	0.990	0.992	0.992	0.993	0.994	0.998	1.002
1994	1.008	1.006	0.995	1.000	0.996	0.995	0.998	1.001	1.000
1995	0.997	1.000	1.006	1.000	1.000	0.997	0.999	0.999	0.999
1996	1.007	1.024	1.012	1.007	1.004	1.000	0.998	1.001	1.002
1997	1.005	1.021	1.024	1.021	1.004	1.000	0.998	1.002	0.999
1998	1.022	1.040	1.041	1.015	1.004	0.996	0.999	0.997	1.000
1999	1.067	1.050	1.038	1.014	0.999	1.003	0.998	0.998	1.000
2000	1.044	1.042	1.028	1.016	1.010	0.997	0.998	1.000	
2001	0.999	1.035	1.024	1.015	0.995	0.996	0.999		
2002	0.972	1.025	1.007	1.001	0.998	0.996			
2003	0.963	0.996	1.002	0.993	0.995				
2004	0.953	0.994	0.994	0.991					
2005	0.973	0.987	0.998						
2006	0.968	0.990							
2007	0.990								

2012 CLRS: Risk Margins under IFRS (Miccolis and Heppen)

Cumulative Development in Ultimate Loss & ALAE from Log of Link Ratios

COMMERCIAL AUTO LIABILITY
INDUSTRY NET BOOKED ULTIMATE LOSS & ALAE
CUMULATIVE DEVELOPMENT IN ULTIMATE LOSS ESTIMATES BASED ON LOG OF LINK RATIOS

	Months of Maturity								
Accident Year	12-24	24-36	36-48	48-60	60-72	72-84	84-96	96-108	108-120
1987	-1.254%	-0.121%	0.249%	-0.153%	-0.168%	0.181%	-0.304%	-0.321%	-0.092%
1988	-0.233%	2.069%	-0.746%	-0.410%	0.413%	-0.289%	-0.349%	-0.191%	-0.294%
1989	-1.857%	0.357%	0.083%	-0.064%	-0.561%	-0.574%	-0.308%	-0.303%	-0.216%
1990	-1.816%	-1.641%	-0.728%	-0.473%	-0.889%	-0.443%	-0.542%	-0.361%	-0.338%
1991	-1.989%	-3.181%	-2.297%	-1.106%	-0.879%	-0.753%	-0.385%	-0.781%	-0.546%
1992	-3.984%	-1.866%	-1.962%	-0.897%	-1.201%	-0.888%	-0.604%	-0.784%	0.293%
1993	-1.313%	-0.311%	-0.973%	-0.801%	-0.763%	-0.673%	-0.589%	-0.199%	0.181%
1994	0.813%	0.600%	-0.521%	0.033%	-0.408%	-0.503%	-0.168%	0.052%	-0.034%
1995	-0.303%	-0.019%	0.640%	-0.040%	0.026%	-0.299%	-0.145%	-0.052%	-0.092%
1996	0.687%	2.390%	1.184%	0.663%	0.365%	-0.005%	-0.207%	0.073%	0.180%
1997	0.546%	2.114%	2.362%	2.043%	0.445%	-0.045%	-0.224%	0.161%	-0.088%
1998	2.129%	3.904%	4.040%	1.473%	0.436%	-0.391%	-0.100%	-0.327%	0.034%
1999	6.532%	4.914%	3.688%	1.417%	-0.093%	0.288%	-0.212%	-0.196%	-0.020%
2000	4.273%	4.113%	2.799%	1.583%	1.016%	-0.260%	-0.153%	0.026%	
2001	-0.121%	3.395%	2.409%	1.454%	-0.527%	-0.358%	-0.096%		
2002	-2.815%	2.516%	0.735%	0.081%	-0.160%	-0.408%			
2003	-3.724%	-0.439%	0.241%	-0.662%	-0.457%				
2004	-4.853%	-0.564%	-0.592%	-0.886%					
2005	-2.687%	-1.310%	-0.167%						
2006	-3.213%	-0.984%							
2007	-1.054%								
Average	-0.773%	0.797%	0.550%	0.181%	-0.200%	-0.339%	-0.292%	-0.229%	-0.079%
	12-108	24-108	36-108	48-108	60-108	72-108	84-108	96-108	108-120
Cumulative Average	-0.385%	0.388%	-0.409%	-0.959%	-1.139%	-0.939%	-0.600%	-0.308%	-0.079%

2012 CLRS: Risk Margins under IFRS (Miccolis and Heppen)

Variance-Covariance Matrix of Log of Incremental Link Ratios

Months of Maturity	12-108	24-36	36-48	48-60	60-72	72-84	84-96	96-108	108-120	120-Ultimate
12-108	**0.071%**	0.047%	0.036%	0.020%	0.010%	0.005%	0.003%	0.004%	0.001%	0.000%
24-36	0.047%	**0.048%**	0.034%	0.018%	0.010%	0.004%	0.003%	0.004%	0.002%	0.000%
36-48	0.036%	0.034%	**0.030%**	0.016%	0.007%	0.004%	0.002%	0.003%	0.001%	0.000%
48-60	0.020%	0.018%	0.016%	**0.010%**	0.004%	0.002%	0.001%	0.002%	0.000%	0.000%
60-72	0.010%	0.010%	0.007%	0.004%	**0.003%**	0.001%	0.001%	0.001%	0.000%	0.000%
72-84	0.005%	0.004%	0.004%	0.002%	0.001%	**0.001%**	0.000%	0.001%	0.000%	0.000%
84-96	0.003%	0.003%	0.002%	0.001%	0.001%	0.000%	**0.000%**	0.000%	0.000%	0.000%
96-108	0.004%	0.004%	0.003%	0.002%	0.001%	0.001%	0.000%	**0.001%**	0.000%	0.000%
108-120	0.001%	0.002%	0.001%	0.000%	0.000%	0.000%	0.000%	0.000%	**0.000%**	0.000%
120-Ultimate	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	**0.000%**
Variance (σ^2)	**0.656%**	**0.336%**	**0.139%**	**0.042%**	**0.014%**	**0.005%**	**0.002%**	**0.002%**	**0.000%**	**0.000%**

2012 CLRS: Risk Margins under IFRS (Miccolis and Heppen)

Long-Term Profitability (from Schedule P, Part 1C)

Accident Year	Net Earned Premium (1)	Net Ultimate Loss & LAE (2)	Net Ultimate Loss & ALAE (3)	Net Paid Loss & ALAE (4)	Net Unpaid Loss & ALAE (5)	Net Ultimate Loss & LAE Ratio (6)	Net Ultimate Loss & ALAE Ratio (7)	ULAE Factor (8)	Underwriting Expense Ratio (9)	100% - Expense Ratio (10)
1987	11,303,497	8,421,138	8,034,872	7,798,508	236,364	74.5%	71.1%	1.048	26.3%	73.7%
1988	11,137,272	8,925,276	8,543,928	8,270,462	273,466	80.1%	76.7%	1.045	28.1%	71.9%
1989	11,640,663	9,601,129	9,101,236	8,914,519	186,717	82.5%	78.2%	1.055	29.0%	71.0%
1990	11,885,710	9,359,215	8,818,434	8,673,421	145,013	78.7%	74.2%	1.061	29.5%	70.5%
1991	11,400,334	8,552,810	8,016,358	7,917,278	99,080	75.0%	70.3%	1.067	30.0%	70.0%
1992	11,487,315	8,522,527	7,956,577	7,823,914	132,663	74.2%	69.3%	1.071	30.6%	69.4%
1993	11,349,838	8,872,940	8,284,094	8,194,228	89,866	78.2%	73.0%	1.071	30.5%	69.5%
1994	11,391,025	9,556,415	8,904,679	8,813,471	91,208	83.9%	78.2%	1.073	30.7%	69.3%
1995	11,545,377	9,712,995	9,031,717	8,950,911	80,806	84.1%	78.2%	1.075	30.5%	69.5%
1996	12,038,793	10,484,408	9,743,683	9,630,426	113,257	87.1%	80.9%	1.076	30.6%	69.4%
1997	12,188,203	11,031,192	10,205,685	10,097,558	108,127	90.5%	83.7%	1.081	30.2%	69.8%
1998	12,093,751	11,329,093	10,418,275	10,300,393	117,882	93.7%	86.1%	1.087	30.1%	69.9%
1999	11,992,416	12,003,662	11,075,835	10,943,805	132,030	100.1%	92.4%	1.084	31.7%	68.3%
2000	12,844,883	12,325,072	11,362,381	11,176,545	185,836	96.0%	88.5%	1.085	30.2%	69.8%
2001	14,023,859	11,892,234	10,943,423	10,673,375	270,048	84.8%	78.0%	1.087	29.6%	70.4%
2002	15,846,301	11,590,418	10,555,623	10,191,909	363,714	73.1%	66.6%	1.098	28.2%	71.8%
2003	17,595,042	11,723,903	10,659,927	10,039,271	620,656	66.6%	60.6%	1.100	26.6%	73.4%
2004	18,772,204	11,909,100	10,786,513	9,682,114	1,104,399	63.4%	57.5%	1.104	27.7%	72.3%
2005	19,257,834	12,385,157	11,239,808	9,057,583	2,182,225	64.3%	58.4%	1.102	27.4%	72.6%
2006	19,338,884	12,647,829	11,419,000	7,543,503	3,875,497	65.4%	59.0%	1.108	28.5%	71.5%
2007	19,171,676	13,090,247	11,819,461	5,487,654	6,331,807	68.3%	61.7%	1.108	30.6%	69.4%
2008	18,367,084	12,820,906	11,444,660	2,553,063	8,891,597	69.8%	62.3%	1.120	30.5%	69.5%
Selected					**25,632,258**		**62.3%**	**1.106**		**69.5%**

2012 CLRS: Risk Margins under IFRS (Miccolis and Heppen)

Developed Ultimate Loss & ALAE

Accident Year	Net Booked Ultimate Loss & ALAE (1)	Average Development Parameter μ (2)	Variance Development Parameter σ^2 (3)	Net Developed Ultimate Loss & ALAE (4)	Developed vs Booked Ultimate Loss & ALAE (5)	Paid Loss & ALAE (6)	Developed Unpaid Loss & ALAE (7)
1987	8,034,872	0.000%	0.000%	8,034,872	-	7,798,508	236,364
1988	8,543,928	0.000%	0.000%	8,543,928	-	8,270,462	273,466
1989	9,101,236	0.000%	0.000%	9,101,236	-	8,914,519	186,717
1990	8,818,434	0.000%	0.000%	8,818,434	-	8,673,421	145,013
1991	8,016,358	0.000%	0.000%	8,016,358	-	7,917,278	99,080
1992	7,956,577	0.000%	0.000%	7,956,577	-	7,823,914	132,663
1993	8,284,094	0.000%	0.000%	8,284,094	-	8,194,228	89,866
1994	8,904,679	0.000%	0.000%	8,904,679	-	8,813,471	91,208
1995	9,031,717	0.000%	0.000%	9,031,717	-	8,950,911	80,806
1996	9,743,683	0.000%	0.000%	9,743,683	-	9,630,426	113,257
1997	10,205,685	0.000%	0.000%	10,205,685	-	10,097,558	108,127
1998	10,418,275	0.000%	0.000%	10,418,275	-	10,300,393	117,882
1999	11,075,835	0.000%	0.000%	11,075,835	-	10,943,805	132,030
2000	11,362,381	-0.079%	0.000%	11,353,391	(8,990)	11,176,545	176,846
2001	10,943,423	-0.308%	0.002%	10,909,844	(33,579)	10,673,375	236,469
2002	10,555,623	-0.600%	0.002%	10,492,550	(63,073)	10,191,909	300,641
2003	10,659,927	-0.939%	0.005%	10,560,536	(99,391)	10,039,271	521,265
2004	10,786,513	-1.139%	0.014%	10,665,074	(121,439)	9,682,114	982,960
2005	11,239,808	-0.959%	0.042%	11,134,937	(104,871)	9,057,583	2,077,354
2006	11,419,000	-0.409%	0.139%	11,380,317	(38,683)	7,543,503	3,836,814
2007	11,819,461	0.388%	0.336%	11,885,368	65,907	5,487,654	6,397,714
2008	11,444,660	-0.385%	0.656%	11,438,105	(6,555)	2,553,063	8,885,042
Total	218,366,169			217,955,495	(410,674)	192,733,911	25,221,584

2012 CLRS: Risk Margins under IFRS (Miccolis and Heppen)

Historical Ultimate Loss & ALAE Ratios

Accident Year	12 month Booked Ultimate Loss & ALAE Ratio (1)	PV Factor (2)	1 - Exp Ratio (3)	Loss Ratio Prior to Adjustment (4)	Loss Ratio Adjustment (5)	Adjusted Loss Ratio (6)	Log of Adjusted Loss Ratio (7)	12 Month Booked Ultimate Loss (8)	Latest Evaluation Ultimate Loss (9)	Ratio Latest to 12 Month Booked (10)	Log of Ratio (11)
1987	72.5%	0.845	73.7%	59.4%	0.846	50.3%	-68.8%	8,195,868	8,034,872	0.980	-0.020
1988	76.7%	0.845	71.9%	64.5%	0.846	54.5%	-60.6%	8,546,503	8,543,928	1.000	0.000
1989	80.9%	0.845	71.0%	68.8%	0.846	58.2%	-54.0%	9,420,085	9,101,236	0.966	-0.034
1990	79.8%	0.845	70.5%	68.3%	0.846	57.8%	-54.8%	9,479,650	8,818,434	0.930	-0.072
1991	79.2%	0.885	70.0%	71.6%	0.846	60.6%	-50.2%	9,031,017	8,016,358	0.888	-0.119
1992	78.0%	0.887	69.4%	71.2%	0.846	60.3%	-50.6%	8,961,355	7,956,577	0.888	-0.119
1993	77.1%	0.897	69.5%	71.1%	0.846	60.1%	-50.8%	8,747,317	8,284,094	0.947	-0.054
1994	78.3%	0.841	69.3%	67.8%	0.846	57.4%	-55.5%	8,916,700	8,904,679	0.999	-0.001
1995	78.4%	0.884	69.5%	71.3%	0.846	60.3%	-50.5%	9,057,286	9,031,717	0.997	-0.003
1996	76.7%	0.871	69.4%	68.8%	0.846	58.2%	-54.1%	9,237,853	9,743,683	1.055	0.053
1997	77.8%	0.877	69.8%	69.9%	0.846	59.1%	-52.5%	9,485,776	10,205,685	1.076	0.073
1998	77.0%	0.898	69.9%	70.8%	0.846	59.9%	-51.3%	9,314,608	10,418,275	1.118	0.112
1999	78.5%	0.866	68.3%	71.1%	0.846	60.1%	-50.8%	9,408,335	11,075,835	1.177	0.163
2000	77.4%	0.888	69.8%	70.3%	0.846	59.5%	-51.9%	9,937,589	11,362,381	1.143	0.133
2001	73.4%	0.918	70.4%	68.3%	0.846	57.8%	-54.8%	10,290,153	10,943,423	1.063	0.058
2002	66.6%	0.948	71.8%	62.9%	1.000	62.9%	-46.4%	10,561,049	10,555,623	0.999	-0.007
2003	63.7%	0.941	73.4%	58.4%	1.000	58.4%	-53.9%	11,210,956	10,659,927	0.951	-0.060
2004	61.6%	0.924	72.3%	56.2%	1.000	56.2%	-57.7%	11,556,476	10,786,513	0.933	-0.080
2005	60.8%	0.902	72.6%	54.0%	1.000	54.0%	-61.6%	11,717,674	11,239,808	0.959	-0.051
2006	61.6%	0.894	71.5%	55.0%	1.000	55.0%	-59.8%	11,908,448	11,419,000	0.959	-0.045
2007	62.3%	0.925	69.4%	59.3%	1.000	59.3%	-52.3%	11,944,741	11,819,461	0.990	-0.005
2008	62.3%	0.973	69.5%	62.3%	1.000	62.3%	-47.3%	11,444,660	11,444,660	1.000	-0.001
(12) Average						58.3%	-54.1%				
(13) Variance							0.261%				0.577%
(14) Covariance (log of Adjusted Loss Ratio, log of Ratio of Latest to 12 month Booked)							0.061%				
(15) Total Variance of Adjusted Loss Ratio (log) and Ratio of Latest to 12 month Booked (log)							0.960%				

2012 CLRS: Risk Margins under IFRS (Miccolis and Heppen)

Market Value of Risk (λ)

MARKET VALUE OF RISK (λ)		Notes			
1 - ER	69.5%	100% - Expense Ratio			From Exhibit 5, Column 10 Selected
1 + ULAE	1.106	1 + ULAE Factor			From Exhibit 5, Column 8 Selected
PV	0.973	Present Value Factor			From Exhibit 8, Column 4 Total
ULR12	62.3%	Estimated Ultimate Loss Ratio (at 12 months) of Latest Accident Year			From Exhibit 5, Column 7 Selected
μ	-0.385%	Sample mean of development of estimated ultimate losses			From Exhibit 10, Column 2, 2008
σ^2	0.656%	Variance of development of estimated ultimate losses			From Exhibit 10, Column 3, 2008
σ	8.099%	Standard deviation of development of estimated ultimate losses			= square root of σ^2
D	2.466	Duration			From Exhibit 9, Total Duration
λ	0.290	= [ln (1-ER) - ln (1+ULAE) - ln (PV) - ln (ULR12) - μ - ½σ^2] / [σ·√(D)]			
$\mu_{AY\ ULR}$	-54.1%	Sample mean of logarithm of Accident Year Ultimate Loss Ratio			From Exhibit 11, Row 12, Average
Combined μ	-54.5%	= μ + $\mu_{AY\ ULR}$			
$\sigma^2_{AY\ ULR}$	0.261%	Sample variance of logarithm of Accident Year Ultimate Loss Ratio			From Exhibit 11, Row 13, Variance of Column 7
$\sigma^2_{12\text{-ult}}$	0.577%	Sample variance of logarithm of developed accident year ultimate			From Exhibit 11, Row 13, Variance of Column 11
Cov(AY ULR, 12-ult)	0.061%	Covariance of Accident Year Loss Ratio and Development			From Exhibit 11, Row 14, Covariance
Combined σ^2	0.960%	= $\sigma^2_{AY\ ULR}$ + $\sigma^2_{12\text{-ult}}$ + 2 · Cov(AY ULR, 12-ult)			From Exhibit 11, Row 15
λ adj for pricing risk	0.671	= [ln (1-ER) - ln (1+ULAE) - ln (PV) - $\mu_{AY\ ULR}$ - ½ · combined σ^2] / [combined σ · √(D)]			

2012 CLRS: Risk Margins under IFRS (Miccolis and Heppen)

Risk Load
Based on Market Value of Risk (λ)

								Total
		Industry	Company	Company	Company	Company		Top 100
	Simulated 1997-2008 Unpaid Claims	Aggregate	A	B	C	D	· · ·	Companies
(1)	25th Percentile	22,907,649	2,011,722	1,711,198	772,647	196,974		
(2)	50th Percentile	23,681,474	2,094,278	1,853,721	844,922	206,468		
(3)	75th Percentile	24,574,559	2,169,446	1,984,969	919,666	216,956		
(4)	Average	23,749,611	2,097,979	1,860,372	849,217	206,773		
(5)	Standard Deviation	1,308,386	117,066	206,560	105,276	14,753		
(6)	Simulated Sample μ	16.982	14.555	14.431	13.645	12.237		
	= Average[log(simulated unpaid claims)]							
(7)	Simulated Sample σ	0.0546	0.055	0.110	0.124	0.071		
	= Standard Deviation[log(simulated unpaid claims)]							
(8)	Expected Unpaid Claims	23,757,283	2,098,698	1,861,442	850,040	206,870		21,802,469
	$= \exp(\mu + \frac{1}{2}\cdot\sigma^2)$							
(9)	Industry Market Value of Risk (λ_1)	0.671	0.671	0.671	0.671	0.671		
(10)	Duration of Unpaid Claims (D)	1.793	1.785	1.818	1.846	1.807		
(11)	Risk Adjusted Expected Unpaid Claims	24,951,313	2,205,050	2,056,185	951,469	220,460		23,997,086
	$= \exp(\mu + \frac{1}{2}\cdot\sigma^2 + \lambda_1\cdot\sigma\cdot\sqrt{D})$							
(12)	Risk Margin	1,194,030	106,353	194,744	101,429	13,590		2,194,617
	= (11) - (8)							
(13)	Risk Margin % of Expected Unpaid Claims	5.0%	5.1%	10.5%	11.9%	6.6%		10.1%
	= (11) / (8)							

2012 CLRS: Risk Margins under IFRS (Miccolis and Heppen)

Risk Margins using a Value of Risk model calibrated to Industry Average Combined Ratios

Line of Insurance	Results for Total of Largest 100 U.S. Insurers by Line of Insurance (as of 12/2008)				
	% of Expected Unpaid Loss				% of Booked
	Average Risk Margin	Average Present Value	Net Impact: Risk Margin & Pres Value	Booked vs. Expected Reserves	Net Impact: vs. Booked Reserves
Commercial Auto Liability	10.1%	(1.7%)	8.4%	101.8%	6.3%
Commercial Multiple Peril	13.3%	(3.0%)	10.3%	100.9%	8.8%
Personal Auto Liability	9.2%	(1.4%)	7.8%	112.6%	(4.3%)
Workers Compensation	7.7%	(8.9%)	(1.2%)	95.5%	2.7%
Other Liability	13.6%	(3.8%)	9.8%	99.5%	9.8%

Risk Margins using a Value of Risk model calibrated to Industry Average Combined Ratios

Line of Insurance	Results for Total of Largest 100 U.S. Insurers by Line of Insurance (as of 12/2008)		
	Average Risk Margin	Approx. Equivalent Confidence Level	Approx. Equivalent Conditional Tail Expectation (CTE)
Commercial Auto Liability	10.1%	83.4%	58%
Commercial Multiple Peril	13.3%	85.1%	62%
Personal Auto Liability	9.2%	88.0%	69%
Workers Compensation	7.7%	81.5%	55%
Other Liability	13.6%	83.5%	57%

Note: CTE relates the risk margin to the expected loss in the tail above the indicated percentile

Risk Margins using a Value of Risk model calibrated to Industry Average Combined Ratios

Line of Insurance	Results for Total of Largest 100 U.S. Insurers by Line of Insurance (as of 12/2008)		
	Average Risk Margin	Lower Quartile of Risk Margins for 100 Insurers	Upper Quartile of Risk Margins for 100 Insurers
Commercial Auto Liability	10.1%	7.3%	16.0%
Commercial Multiple Peril	13.3%	9.7%	24.8%
Personal Auto Liability	9.2%	7.2%	16.1%
Workers Compensation	7.7%	6.0%	11.0%
Other Liability	13.6%	9.1%	23.4%

Note: CTE relates the risk margin to the expected loss in the tail above the indicated percentile

Risk Margins using a Value of Risk model calibrated to Industry Average Combined Ratios

Line of Insurance	Results for Total of Largest 100 U.S. Insurers by Line of Insurance (as of 12/2008)								
	Average Risk Margin	Confidence Level Risk Margin (%)				CTE Risk Margin (%)			
		80	90	95	99	55	80	90	95
Commercial Auto Liability	10.1%	9	14	18	27	9	15	20	24
Commercial Multiple Peril	13.3%	10	16	23	40	11	20	27	35
Personal Auto Liability	9.2%	6	10	13	19	7	11	14	17
Workers Compensation	7.7%	7	12	15	24	8	13	17	21
Other Liability	13.6%	11	19	25	42	12	22	29	36

Note: CTE relates the risk margin to the expected loss in the tail above the indicated percentile

Research Paper (2010)

A Practical Approach to Risk Margins in the Measurement of Insurance Liabilities for Property and Casualty (General Insurance) under Developing International Financial Reporting Standards

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29th International Congress of Actuaries
March 2010, Cape Town, South Africa
ICA Reference No. 71 Track: Non-Life Insurance (ASTIN)

Available under CLRS Seminar Presentations on CAS website

IASB Developments as of 8/2012

- Risk Adjustment – “measurement objective”
  - Compensation that each entity requires for bearing risk
  - Uncertain fulfillment cash flows vs. certain cash flows
  - Indifferent between uncertain flows vs. expected PV
- Underlying Concepts
  - Uncertainty in cash flows affects economic value:
    1. cash inflows are assets; cash outflows are liabilities
    2. lowers value of an asset; increases value of a liability
  - Uncertainty in insurance contract cash flows:
    1. Insurer has best understanding of its risks and uncertainties
    2. Value adjustment for risk reflect insurer’s risk preferences

IASB Developments - Discussion

- Risk / Uncertainty – Impact of Risk Preference
  - A risk averse insurer puts more weight on unfavorable outcomes than on favorable outcomes
- Higher (vs. Lower) Risk Adjustments
  - low frequency / high severity vs. high frequency / low severity
  - Longer duration contracts vs. shorter duration
  - Wide probability distribution vs. narrow distribution
  - Lack of data/knowledge vs. extensive data/analysis
  - Emerging experience that increases vs. decreases uncertainty

2012 CLRS: Risk Margins under IFRS (Miccolis and Heppen)

IASB Developments - Discussion

- Risk / Uncertainty – identify, assess, measure
  - Cash flow risks: uncertainty in actual vs. expected
  - Uncertainty in estimate of expected value (unbiased)
  - Use of models to represent uncertainty in cash flows
  - Use of scenarios to represent uncertainty in cash flows
- Selecting Risk Adjustment Method(s)
  - Represents economic value to the specific insurer:
    1. Compensation insurer needs to be indifferent about the risk
    2. Level of aggregation consistent with amount to be indifferent
  - Not limited to VaR, CTE or Cost of Capital methods
    1. Select method(s) to support compensation for bearing risk

IAA Monograph on Risk Adjustments

- Educational material for actuaries and others
  - comprehensive review of principles and concepts
  - practical methods for an explicit adjustment for risk
  - general purpose financial reporting (vs. solvency)
- Example of chapter titles
  - Principles Underlying Risk Adjustments
  - Risk Adjustment Methods (e.g. VaR, CTE, Cost of Capital)
  - Probability Distributions and Statistical Techniques
  - Effect of Risk Mitigation Techniques (e.g. reinsurance)
  - Approximations and Validation Approaches
  - Communications and Disclosures

IAA Monograph on Risk Adjustments

- Funded by CAS, SOA, CIA and other actuarial organizations globally
- Authors: team of actuaries and accountants from Deloitte in US, Canada, Europe, Asia, Africa
- Applications to P&C, Life and Health insurance
- Outreach activities to provide input to authors:
  - Various actuarial committees (globally)
  - A few insurers in different parts of the world
  - Views on specific questions about risk adjustment issues
  - Request for real examples for case studies (still needed)
- Monograph exposure draft planned 1st quarter 2013