Solvency II: Reserving Risk, Risk Margins and Technical Provisions

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Casualty Loss Reserve Seminar, Las Vegas

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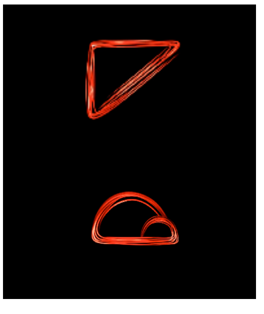
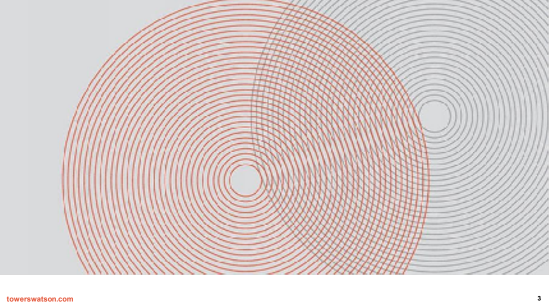
- Solvency II Risk Margins using Internal Models
- Conclusion – From Article 101 to Room 101
- (With a couple of examples along the way…)



Solvency II Background



Solvency II – What is it?

- A Europe-wide initiative for risk-based regulation and risk management of insurance entities to facilitate the development of a single market in insurance services in Europe, whilst at the same time securing an adequate level of policyholder protection
- Insurers are required to hold sufficient capital (Solvency Capital Requirement – SCR) to:
  - Reduce the risk that an insurer would be unable to meet claims
  - Reduce the losses suffered by policyholders in the event that a firm is unable to meet its obligations fully
  - Provide early warning to supervisors so that they can intervene promptly if capital falls below the required level
  - Promote confidence in the financial stability of the insurance sector

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Solvency 2 Overview

- Requirements are encapsulated in **DIRECTIVE 2009/138/EC OF THE EUROPEAN PARLIAMENT**
- Principles based
- Prospective and risk-based approach
- Strong emphasis on governance
- Requires Actuarial function and Risk Management function
- Requires an “Own Risk and Solvency Assessment” (ORSA)
- Requires a published “Solvency and Financial Condition Report”

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Solvency 2 Overview

- Solvency II is being implemented in accordance with a “Lamfalussy” four-level process, in consultation with the insurance industry
  - Level 1 – framework principles
  - Level 2 – implementing measures
  - Level 3 – guidance and convergence of supervisory practices
  - Level 4 – enforcement
- The **Committee of European Insurance and Occupational Pensions Supervisors** (CEIOPS) is involved in Level 2 and 3 activities
- CEIOPS will become part of (and eventually transition into) the new European Insurance and Occupational Pensions Authority (EIOPA) on 1.1.2011

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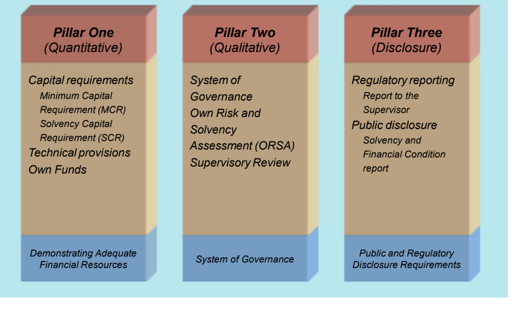
Context - CEIOPS Reading List

Scoreboard

This paper(s)	173
Running Total	2903

…and then level three

The Three Pillars of Solvency II



Key Developments

2003 Apr	EU Insurance Committee endorses supervision proposal
2007 Jul	EU Commission adopts Solvency II proposal
2007 Nov	CEIOPS issues QIS3 report
2008 Sep	The Path to Solvency II
2008 Nov	CEIOPS issues QIS4 report
2009 Mar	CEIOPS releases first set of Level 2 papers
2009 Jul	CEIOPS releases second set of Level 2 papers
2009 Nov	CEIOPS releases third set of Level 2 papers
2009 Dec	Final text of Solvency II Directive is published
2010 Jan	CEIOPS releases first set of Level 3 papers
2010 Apr	CEIOPS releases final advice on Level 2 measures
2010 May	EU proposes to delay date of entry until 1.1.2013
2011 Jul	EU proposes a further delay to start of 2014

Estimating Capital Requirements "101"

101 – "The first course in a subject taught at a university in the United States, Canada, Australia, or South Africa".

Source: Wikipedia

Theoretical requirements for estimating capital

- **Risk Profile** ← A distribution of profit/loss? A distribution of (some definition of) net assets?
- **Risk Measure** ← Standard Deviation? Value-at-Risk? Tail Value-at-Risk? Etc…
- **Risk Tolerance** ← 3 x SD, 99.5% VaR, 95% TVaR
- **Time Horizon** ← One year? Ultimate?

DIRECTIVE OF THE EUROPEAN PARLIAMENT
Article 101

- "The Solvency Capital Requirement shall be calibrated so as to ensure that all quantifiable risks to which an insurance or reinsurance undertaking is exposed are taken into account. With respect to existing business, it shall cover unexpected losses.
- It shall *correspond* to the Value-at-Risk of the basic own funds of an insurance or reinsurance undertaking subject to a confidence level of 99.5% over a one-year period."

- *So it seems straightforward to estimate the SCR using a simulation-based model: simply create a simulated distribution of the basic own funds over 1 year, then calculate the VaR @ 99.5%.*

DIRECTIVE OF THE EUROPEAN PARLIAMENT
Articles 88 and 75

- Article 88
- “Basic own funds shall consist of the following items:
- (1) the excess of assets over liabilities, valued in accordance with Article 75 and Section 2 ;
- (2) subordinated liabilities.”

- Article 75
- “Member States shall ensure that, unless otherwise stated, insurance and reinsurance undertakings value assets and liabilities as follows:
- (a) assets shall be valued at the amount for which they could be exchanged between knowledgeable willing parties in an arm's length transaction;
- (b) liabilities shall be valued at the amount for which they could be transferred, or settled, between knowledgeable willing parties in an arm's length transaction.”

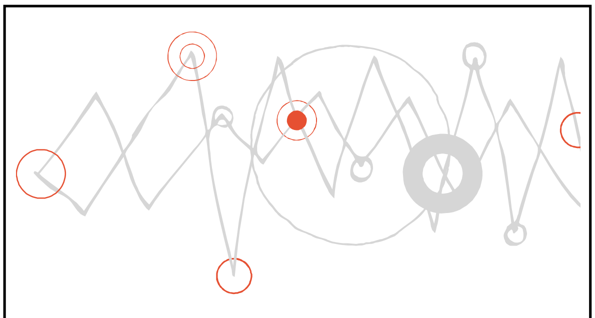
Solvency II: Overall SCR
Article 101

Risk Profile
Distribution of 'basic own funds'

Risk Measure
Value-at-Risk

Risk Tolerance
99.5%

Time Horizon
One year



Solvency II Quantitative Requirements

Overview and Standard Formula

Solvency 2 Capital Requirements

Minimum Capital Requirement (MCR)
- Absolute minimum
- Allows 'sliding scale' of regulatory intervention
- Aim to avoid a 'cliff-edge' situation such as under Solvency I
- Simple linear factor-based formula calculated quarterly

Solvency Capital Requirement (SCR)
- Main regulatory capital measure
- Calculated at least annually
- Going-concern assumption
- Calculated by the 'standard formula', partial internal model, or full internal model

- **Own Risk and Solvency Assessment (ORSA)**
  - A separate solvency calculation taking account of the specific risk strategy of the undertaking

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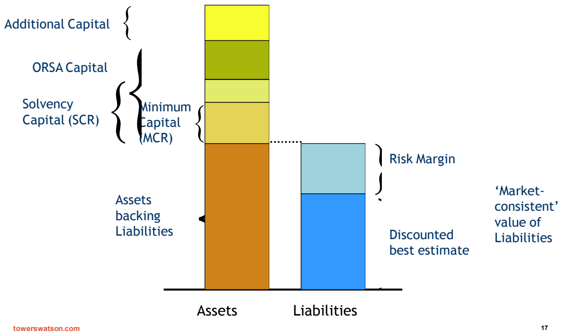
Solvency II Balance Sheet
In the usual course of business…



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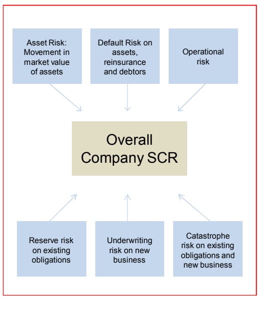
Solvency Capital Requirements
Non-Life Companies



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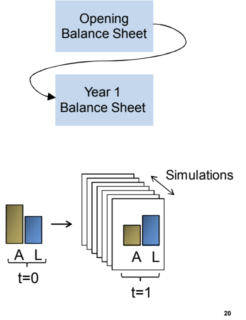
Standard Formula Approach

- Attempts to estimate "capital requirements" for each risk type
  - Risk profiles are not very well defined
- Capital requirements are combined, taking account of "diversification" effects
  - Hidden assumptions are not clear
  - Conceptually, it doesn't make sense to calculate capital requirements by risk type, then aggregate. Capital is an overall measure (which can be allocated to risk type if required).
- It gives an 'SCR' which is compared to the available capital
- By necessity, it is a compromise
  - It is difficult to capture nuances such as catastrophe exposures and effects of reinsurance programmes using a standard formula based approach
- For premium and reserve risk, standard parameters or "undertaking specific parameters" may be used
- There is a leap of faith using the standard formula
  - Does it *correspond* to the Value-at-Risk of the basic own funds of an insurance or reinsurance undertaking subject to a confidence level of 99.5% over a one-year period?
- Various incarnations have been tested through the Quantitative Impact Study (QIS) initiatives

A Projected Balance Sheet View

- From Article 101, the SCR is calculated from a distribution of net assets over a 1 year time horizon
- When projecting Balance Sheets for solvency, we have an opening balance sheet with expected outstanding liabilities
- The bulk of those liabilities are the "reserves" (provisions) set aside to pay unsettled claims that have arisen on policies sold in the past
- We then project one year forwards, simulating the payments that emerge in the year, and require a closing balance sheet, with (simulated) expected outstanding liabilities conditional on the payments in the year, together with the market value of assets at the end of the year



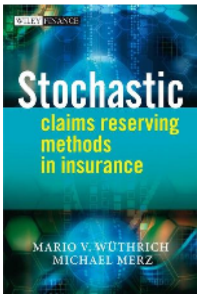
Solvency II

- So, for Solvency II, a 1 year perspective is taken, requiring a distribution of the *expected* value of the liabilities after 1 year, for the 1 year ahead balance sheet in internal capital models
- If the standard formula is used, a 1 year-ahead "reserve risk" standard deviation % is required.
  - The 1 year-ahead "reserve risk" standard deviation is the SD of the distribution of profit/loss on reserves after 1 year
- Important Note: this is a different definition of reserve risk from the traditional actuarial view

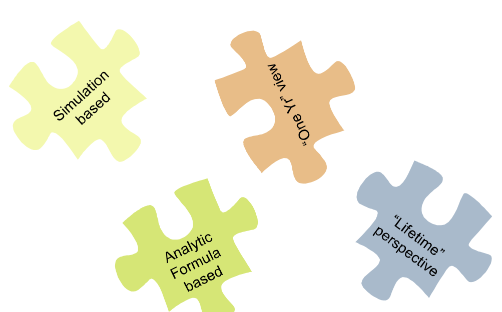
Reserving Risk "101"

Stochastic claims reserving in non-life insurance

- This has become a new academic discipline
- It has spawned several PhDs
- Numerous papers appearing in academic journals
- Presentations at every actuarial conference
- A book has appeared
- There is a Wikipedia page



The Reserve Risk Puzzle



Conceptual Framework
The traditional actuarial view over the lifetime of the liabilities

- **Reserve Estimate (Measure of Location)** ← Traditional deterministic methods
- **Variability (Prediction Error)** ←
  - Statistical assumptions required
  - Prediction Error = SD of Forecast
  - Can be estimated analytically. This is HARD.
- **Predictive Distribution** ←
  - Usually cannot be obtained analytically
  - Simulation methods required. Bootstrap or Bayesian MCMC methods. This is EASY

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Simulation vs analytic approaches to reserve risk

"We can do this the easy way, or we can do it the hard way"

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Example - Motor Bodily Injury
Incremental paid amounts

Accident Year	12m	24m	36m	48m	60m	72m	84m	96m	108m	120m	132m
1999	7,185,063	23,114,030	17,099,540	6,095,048	2,508,783	1,588,586	743,951	219,649	5,120	71,000	-125
2000	7,712,943	25,053,293	13,309,928	6,500,901	2,615,062	696,429	708,878	97,250	180,000	5,000	
2001	9,919,189	25,267,894	17,803,347	8,366,029	4,074,408	1,269,109	510,456	288,592	219,711		
2002	9,255,293	27,108,268	19,457,836	8,236,074	4,019,152	1,543,527	524,004	225,250			
2003	8,947,654	28,325,282	16,637,370	9,925,613	4,783,800	1,147,191	483,887				
2004	12,369,143	35,628,244	21,599,356	12,104,408	3,789,480	1,274,137					
2005	11,738,150	34,735,782	20,525,759	10,943,921	3,263,491						
2006	12,268,922	33,012,934	20,211,212	8,519,260							
2007	10,922,657	27,557,788	16,158,046								
2008	13,646,271	26,551,084									
2009	11,247,860										
Total	**115,213,145**	**286,354,599**	**162,802,394**	**70,691,254**	**25,054,176**	**7,518,979**	**2,971,176**	**830,741**	**404,831**	**76,000**	**-125**

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Example - Motor Bodily Injury
Cumulative paid amounts

Accident Year	12m	24m	36m	48m	60m	72m	84m	96m	108m	120m	132m
1999	7,185,063	30,299,093	47,398,633	53,493,681	56,002,464	57,591,050	58,335,001	58,554,650	58,559,770	58,630,770	58,630,645
2000	7,712,943	32,766,236	46,076,164	52,577,065	55,192,127	55,888,556	56,597,434	56,694,684	56,874,684	56,879,684	
2001	9,919,189	35,187,083	52,990,430	61,356,459	65,430,867	66,699,976	67,210,432	67,499,024	67,718,735		
2002	9,255,293	36,363,561	55,821,397	64,057,471	68,076,623	69,620,150	70,144,154	70,369,404			
2003	8,947,654	37,272,936	53,910,306	63,835,919	68,619,719	69,766,910	70,250,797				
2004	12,369,143	47,997,387	69,596,743	81,701,151	85,490,631	86,764,768					
2005	11,738,150	46,473,932	66,999,691	77,943,612	81,207,103						
2006	12,268,922	45,281,856	65,493,068	74,012,328							
2007	10,922,657	38,480,445	54,638,491								
2008	13,646,271	40,197,355									
2009	11,247,860										
Total	**115,213,145**	**390,319,884**	**512,924,923**	**528,977,686**	**480,019,534**	**406,331,410**	**322,537,818**	**253,117,762**	**183,153,189**	**115,510,454**	**58,630,645**

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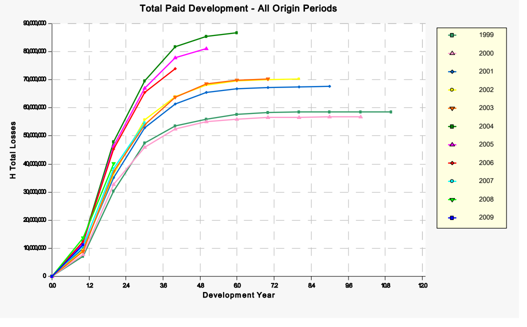
Example - Motor Bodily Injury
Cumulative paid amounts



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Example - Motor Bodily Injury
Estimated Reserves

Origin Period	Latest Paid	Estimated Reserve	Estimated Ultimate Values
1999	58,630,645	0	58,630,645
2000	56,879,684	-121	56,879,563
2001	67,718,735	44,440	67,763,175
2002	70,369,404	202,167	70,571,571
2003	70,250,797	433,816	70,684,613
2004	86,764,768	1,347,472	88,112,240
2005	81,207,103	2,815,969	84,023,072
2006	74,012,328	6,783,546	80,795,874
2007	54,638,491	14,208,374	68,846,865
2008	40,197,355	34,004,830	74,202,185
2009	11,247,860	66,703,096	77,950,956
Total	**671,917,170**	**126,543,590**	**798,460,760**

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Example - Motor Bodily Injury
Projection for 2008 origin year

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Example - Motor Bodily Injury
Reserve Variability – "Mack's Model"

Accident Year	Latest Paid	Expected Reserve	Analytic Prediction Error	Analytic Prediction Error %	Bootstrap Prediction Error	Bootstrap Prediction Error %
1999	58,630,645	0	0	0.00%	0	0.00%
2000	56,879,684	-121	63,942	52,728.45%	63,394	52,276.19%
2001	67,718,735	44,440	96,177	216.42%	95,502	214.90%
2002	70,369,404	202,167	169,896	84.04%	168,120	83.16%
2003	70,250,797	433,816	188,642	43.48%	188,698	43.50%
2004	86,764,768	1,347,472	329,921	24.48%	328,420	24.37%
2005	81,207,103	2,815,969	549,066	19.50%	552,678	19.63%
2006	74,012,328	6,783,546	1,111,083	16.38%	1,120,143	16.51%
2007	54,638,491	14,208,374	1,645,108	11.58%	1,651,177	11.62%
2008	40,197,355	34,004,830	3,161,824	9.30%	3,130,820	9.21%
2009	11,247,860	66,703,096	9,248,676	13.87%	9,340,689	14.00%
Total	**671,917,170**	**126,543,590**	**10,288,086**	**8.13%**	**10,276,627**	**8.12%**

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Example - Motor Bodily Injury
Simulated forecast payments

	12m	24m	36m	48m	60m	72m	84m	96m	108m	120m	132m	Reserve
1999												
2000											28,467	72,757
2001										138,286	78,982	143,221
2002									339,234	53,382	68,928	401,644
2003								367,853	-29,846	138,468	102,080	567,424
2004							1,836,650	332,878	248,588	88,686	86,602	1,392,828
2005						2,886,883	1,226,502	368,865	284,783	138,938	188,889	3,032,534
2006					4,226,858	1,665,262	886,842	289,702	423,949	-83,938	158,623	7,277,961
2007				8,258,753	3,283,657	1,975,982	690,640	238,886	186,806	-26,023	-28,966	14,021,155
2008			16,896,658	10,686,629	3,878,962	1,400,860	1,280,068	268,946	257,898	-82,926	67,355	35,447,238
2009		38,867,988	20,508,958	10,825,805	2,866,262	1,988,858	858,308	279,827	178,309	167,926	102,660	72,988,117
												135,344,879

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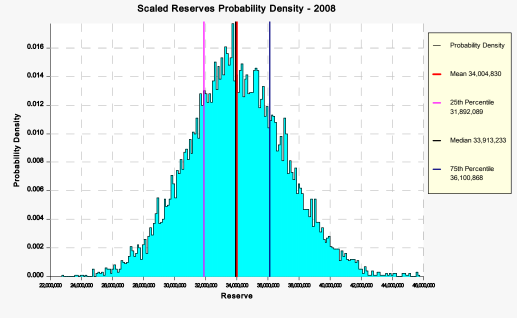
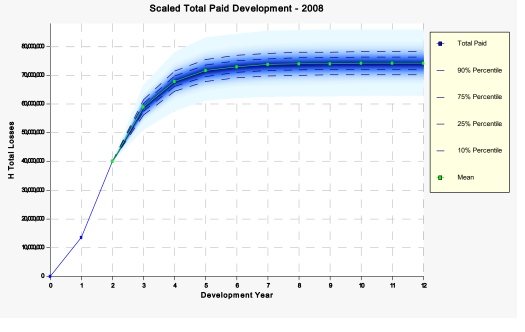
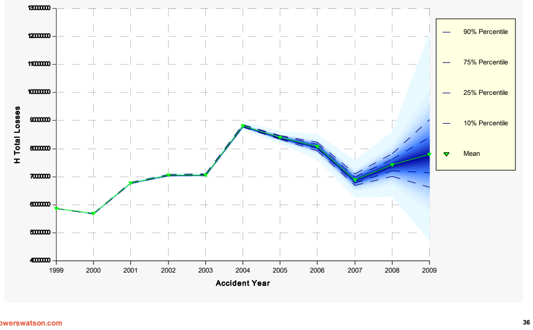
Example - Motor Bodily Injury
Reserve distribution for 2008 origin year



Example - Motor Bodily Injury
Simulated projection for 2008 origin year



Example - Motor Bodily Injury
Distribution of "ultimates" (all origin years)



Reserve Risk: The traditional actuarial view
Summary

- The traditional actuarial view of reserve risk looks at the uncertainty in the outstanding liabilities over their lifetime
  - We have to start talking statistics
  - Given a statistical model, we can derive analytic formulae for the standard deviation of the forecasts
  - Given a statistical model, we can also generate distributions of outstanding liabilities, and their associated cash-flows, using simulation techniques (eg bootstrap or MCMC techniques)
  - We can do this in a way that reconciles the analytic and simulation approaches

Reserve Risk: The one-year view of Solvency II
Summary

- Under Solvency II, reserving risk takes on a different meaning. It considers the distribution of the profit/loss on the (estimated) reserves over a 1 year time horizon
- On an undiscounted basis for a single origin period (ignoring risk margins), the profit/loss is the change in the (estimated) ultimate claims over a 1 year time horizon
- Clearly, this is different from the traditional actuarial view of reserve risk, which considers the distribution of the outstanding liabilities over their lifetime
- However, the two views can be reconciled…

The one-year run-off result (undiscounted)
(The view of profit or loss on reserves after one year)

- For a particular origin year, let:
  - The opening reserve estimate be R_0
  - The reserve estimate after one year be R_1
  - The payments in the year be C_1
  - The run-off result (claims development result) be CDR_1
- Then

$$CDR_1 = R_0 - C_1 - R_1 = U_0 - U_1$$

  - Where the opening estimate of ultimate claims and the estimate of the ultimate after one year are U_0, U_1

The One-year Run-off Result
(the view of profit or loss on reserves after one year)

- Merz & Wuthrich (2008) derived analytic formulae for the standard deviation of the claims development result after one year assuming:
  - The opening reserves were set using the pure chain ladder model (no tail)
  - Claims develop in the year according to the assumptions underlying Mack's model
  - Reserves are set after one year using the pure chain ladder model (no tail)
  - The mathematics is quite challenging. This is the HARD way
- The M&W method is gaining popularity, but has limitations. What if:
  - We need a tail factor to extrapolate into the future?
  - Mack's model is not used – other assumptions are used instead?
  - We want another risk measure, not just a standard deviation (*eg* VaR @ 99.5%)?
  - We want a distribution of the CDR?

Merz & Wuthrich (2008)
Data Triangle

Accident Year	12m	24m	36m	48m	60m	72m	84m	96m	108m
0	2,202,584	3,210,449	3,468,122	3,545,070	3,621,627	3,644,636	3,669,012	3,674,511	3,678,633
1	2,350,650	3,553,023	3,783,846	3,840,067	3,865,187	3,878,744	3,898,281	3,902,425	
2	2,321,885	3,424,190	3,700,876	3,798,198	3,854,755	3,878,993	3,898,825		
3	2,171,487	3,165,274	3,395,841	3,466,453	3,515,703	3,548,422			
4	2,140,328	3,157,079	3,399,262	3,500,520	3,585,812				
5	2,290,664	3,338,197	3,550,332	3,641,036					
6	2,148,216	3,219,775	3,428,335						
7	2,143,728	3,158,581							
8	2,144,738								

Merz & Wuthrich (2008)
Prediction errors

	Analytic Prediction Errors	
Accident Year	1 Year Ahead CDR	Mack Ultimate
0	0	0
1	567	567
2	1,488	1,566
3	3,923	4,157
4	9,723	10,536
5	28,443	30,319
6	20,954	35,967
7	28,119	45,090
8	53,320	69,552
Total	81,080	108,401

Expressed as a percentage of the opening reserves, this forms a basis of the reserve risk parameter under Solvency II (QIS 5 Technical Specification)

The one-year run-off result in a simulation model
The EASY way

- For a particular origin year, let:
  - The opening reserve estimate be R_0
  - The expected reserve estimate after one year be $R_1^{(i)}$
  - The payments in the year be $C_1^{(i)}$
  - The run-off result (claims development result) be $CDR_1^{(i)}$
- Then

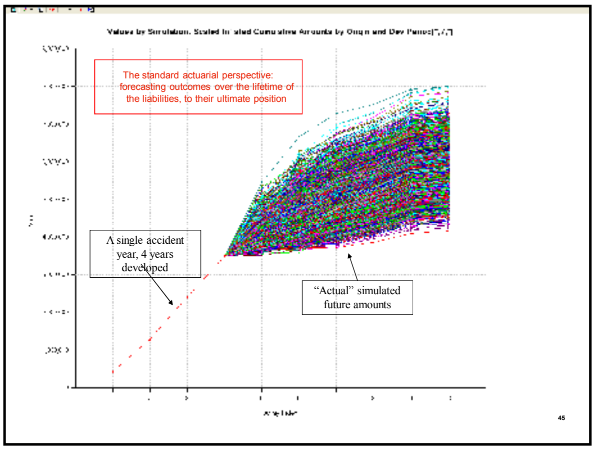
$$CDR_1^{(i)} = R_0 - C_1^{(i)} - R_1^{(i)} = U_0 - U_1^{(i)}$$

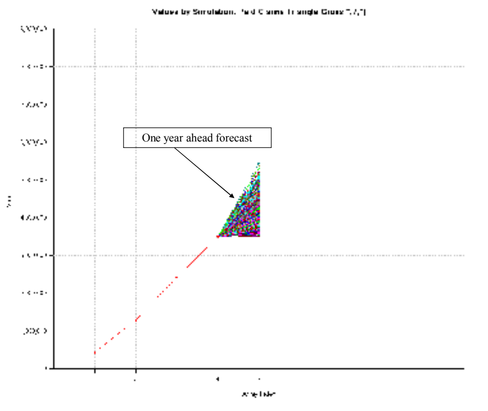
  - Where the opening estimate of ultimate claims and the expected ultimate after one year are $U_0, U_1^{(i)}$
  - for each simulation i

The one-year run-off result in a simulation model
The EASY way

1. Given the opening reserve triangle, simulate all future claim payments to ultimate using bootstrap (or Bayesian MCMC) techniques.
2. Now forget that we have already simulated what the future holds.
3. Move one year ahead. Augment the opening reserve triangle by one diagonal, that is, by the simulated payments from step 1 in the next calendar year only. An actuary only sees what emerges in the year.
4. For each simulation, estimate the outstanding liabilities, conditional only on what has emerged to date. (The future is still “unknown”).
5. A reserving methodology is required for each simulation – an “actuary-in-the-box” is required*. We call this re-reserving.

** The term “actuary-in-the-box” was coined by Esbjörn Ohlsson*





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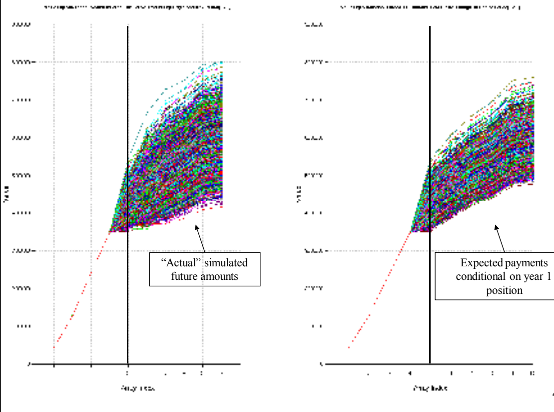

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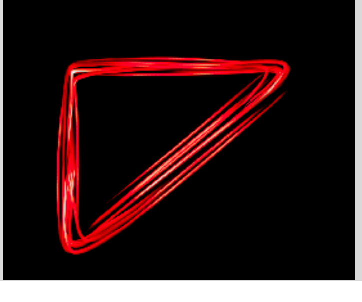
Example



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Multiple 1 yr ahead CDRs
An interesting result

- Creating cascading CDRs over all years gives the following results:

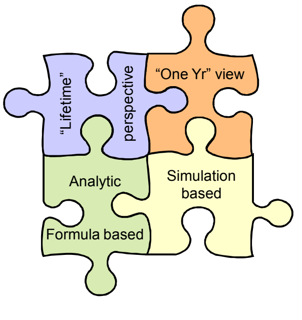
Accident Year	Number of years ahead 1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs	Sqrt(Sum of Squares)	Mack Ultimate
1	0	0	0	0	0	0	0	0	-	0
2	568	0	0	0	0	0	0	0	568	568
3	1,486	487	0	0	0	0	0	0	1,564	1,564
4	3,916	1,306	431	0	0	0	0	0	4,151	4,147
5	9,745	3,837	1,277	425	0	0	0	0	10,560	10,569
6	28,428	9,679	3,824	1,272	425	0	0	0	30,303	30,296
7	20,986	27,438	9,343	3,693	1,226	409	0	0	35,998	35,951
8	28,110	20,404	26,922	9,162	3,613	1,208	402	0	45,055	44,996
9	53,406	27,798	20,236	26,687	9,111	3,600	1,203	402	69,600	69,713
Total	81,226	52,344	38,513	29,010	10,120	3,879	1,285	402	108,543	108,992

- The sum of the variances of the repeated 1 yr ahead CDRs (over all years) equals the variance over the lifetime of the liabilities
  - Under Mack's assumptions/chain ladder, this can be proved
- Therefore we expect the risk under the 1 year view to be lower than the standard "lifetime" perspective

Re-reserving in Simulation-based Capital Models

- The advantage of investigating the claims development result (using re-reserving) in a simulation environment is that the procedure can be generalised:
  - Not just the chain ladder model
  - Not just Mack's assumptions
  - Can include curve fitting and extrapolation for tail estimation
  - Can incorporate a Bornhuetter-Ferguson step
  - Can be extended beyond the 1 year horizon to look at multi-year forecasts
  - Provides a *distribution* of the CDR, not just a standard deviation
- But it is not without its difficulties, so we need simpler alternatives
  - Simply allow the "ultimo" variability to emerge steadily over time (but there is the problem of calibration)

The Reserve Risk Puzzle
Harmony has been restored



Risk Margins and Solvency II

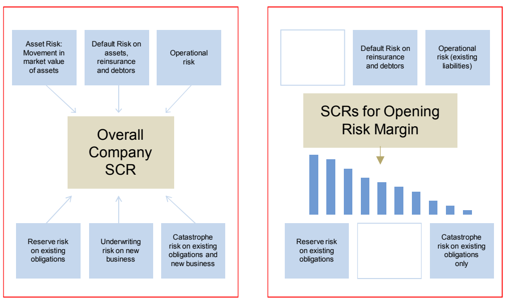
Best Estimate Technical Provisions

- The technical provisions comprise a best estimate of future liabilities (BEL) and a risk margin
- The best estimate of future liabilities is defined as a probability-weighted average of discounted future cash-flows, and should:
  - Take account of all the cash in- and out-flows required to settle the obligations
  - Take account of the time value of money
  - Be based upon up-to-date and credible information and realistic assumptions
  - Be performed using adequate, applicable and relevant actuarial and statistical methods
  - Be calculated gross, with a separate calculation for the amounts recoverable from reinsurance contracts and special purpose vehicles
- The risk margin should be calculated using a "cost-of-capital" approach

The Risk Margin

- The risk margin is designed to ensure that the value of technical provisions is sufficient for another insurer to take over and meet the insurance obligations
- It is calculated by determining the cost of providing an amount of eligible own funds equal to the SCR necessary to support the obligations over their lifetime
- Approach
  - Establish net best estimate technical provisions at each point over the lifetime of the liabilities
  - Estimate the appropriate corresponding SCR at each point
  - Apply the cost-of-capital charge factor
  - Discount and sum
- It is calculated at the portfolio level, net of reinsurance only
- The risk margin should take into account underwriting risk, reinsurer default risk, operational risk and 'unavoidable' market risk
- In practice for most non-life insurers, market risk can be ignored

Solvency Capital Requirements
Non-Life Companies



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Calculating the Risk Margin
TP5.9

$$COCM = COC.\frac{\sum_{t\geq 0} SCR_{RU}(t)}{(1+r_{t+1})^{t+1}}$$

where

COCM = risk margin for the whole business
COC = cost of capital rate
$SCR_{RU}(t)$ *= the SCR for year t as calculated for the reference undertaking*
r_t *= risk-free rate for maturity t*

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Risk Margin Example

Time	Best-Estimate Reserve	(SCR) Capital	Capital Charge (assuming 6% CoC rate)	Discounted Capital Charge (assuming flat 2% discount rate)
0	100	20	1.2	1.18
1	60	15	0.9	0.87
2	40	10	0.6	0.57
3	20	4	0.24	0.22
4	10	3	0.18	0.16
5	5	1	0.06	0.05
Total	-	-	3.18	**Risk Margin = 3.05**

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Slide 57

Risk-Margin
Granularity

- The risk margin assumes transfer of all business, hence it can allow for diversification between all reserve elements, including lines of business
- However, "technical provisions" need to be estimated at "class" level (own segmentation, or at least no higher than Solvency II LoB level)
  - Hence need to produce risk margin at this level
  - Sum of class risk margins should equal the total risk margin
- So need a way of allocating the overall risk margin to class

Calculating the Risk Margin by Line of Business
Possible Simplification TP 5.28

$$COCM_{lob} = \frac{SCR_{RU,lob}(0)}{\sum_{lob} SCR_{RU,lob}(0)}.COCM$$

where

$COCM_{lob}$ = *risk margin allocated to line of business*
$SCR_{RU,lob}(0)$ = *SCR of the reference undertaking for line of business at t=0*
$COCM$ = *risk margin for the whole business*

Notes:
1) The concept of an SCR by *lob* is a strange one, and appears to be a relic of QIS 4
2) Although it is not clear from the documentation, the SCRs should be in respect prior year reserves and legally incepted business only (but include an allowance for operational risk and reinsurance default risk).
3) There is no requirement for the sum of capital requirements across *lob*s to equal the total capital requirement

Requirements

- An overall SCR
  - Requires a distribution of the basic own funds after 1 year
- A risk margin on the opening balance sheet
  - Requires future SCRs in respect of the opening technical provisions only
- An allocation of the opening risk margin to LoB
  - Requires opening SCRs by LoB (in respect of the opening technical provisions only), at the very least
  - More robust methods require opening and future SCRs by LoB
- Simulated risk margins for the 1 year ahead balance sheet (for the overall SCR calculation
  - Just use a constant? (analogous to the standard formula approach)
  - Proportional to the simulated expected technical provisions at *T=1*?
  - Based on a cost-of-capital approach using future SCRs by LoB?

The Opening Risk Margin

The Opening Risk Margin

- We require a risk margin for the opening balance sheet
  - This requires “SCRs” in respect of the opening technical provisions, for all future years
- How should those be calculated?
  - Using the standard formula?
  - Using a modified version of the internal model?
- The FSA (UK) and CEIOPS (now EIOPA) view is that if an internal model is used for the overall SCR then the same should also be used for calculating the risk margin

The Opening Risk Margin in Internal Models

- Using the internal model
  - Assume opening assets = 0*
  - For future premium volumes, use “legal obligations” basis only
  - Remember to modify assumptions about cat exposures, reinsurance and expenses
  - Calculate the net result on a 1 year view, allowing for:
    - Prior year reserves and expenses
    - Unexpired risk and expenses
    - Legally obliged but unincepted
    - Operational risk, RI default, and unavoidable market risk (not usually material)
- VaR @ 99.5% will give the TOTAL capital required, for the SCR calculation
- Then calculate future SCRs:
  - In proportion to the emergence of the (expected) reserves in each future year in aggregate? By Lob?

** Other assumptions could be used*

Risk Margin – Future SCRs

QIS 5 Options

1. Make a full calculation of all future SCRs without using simplifications.
2. Approximate the individual risks or sub-risks within some or all modules and sub-modules to be used for the calculation of future SCRs.
3. Approximate the whole SCR for each future year, e.g. by using a proportional approach.
4. Estimate all future SCRs “at once”, e.g. by using an approximation based on the duration approach.
5. Approximate the risk margin by calculating it as a percentage of the best estimate.

Future SCR Calculation – An Approach

1. Take the one-year profit/(loss) distribution by class for the opening net technical provision (claims plus premium provision) as described earlier
2. Calculate the expected run-off of the total net technical provision by class
3. Approximate the distribution of the technical provision profit/loss by class in future years in proportion to the ratio of the expected technical provisions by class in future years divided by the opening technical provisions by class*
4. Calculate the 99.5% VaR of the loss distributions implied by 3, to give the SCR run-off by class before diversification. Call this $SCR(pre\text{-}div)^{RM}$ (0,class,t)
5. Aggregate the loss distributions at each run-off time and calculate the 99.5% VaR to give the total SCR run-off by time. Call this SCR^{RM} (0,t)
6. Due to diversification, the sum of $SCR(pre\text{-}div)^{RM}$ (class,t) across classes will be greater than $SCR^{RM}{}_{(t)}$. Hence scale these amounts proportionally to give SCR^{RM} (0,class,t), such that: Sum_{class} (SCR^{RM} (0,class,t)) = SCR^{RM} (0,t)
7. Calculate the risk margin using the cost-of-capital approach at the class and total level (it will be additive).

Assumptions

- The coefficient of variation of the one-year distribution around the expected technical provision (or function thereof) is the same at each year in the run-off within a class of business (proportional proxy)
- The dependency between classes is the same at each point in the run-off

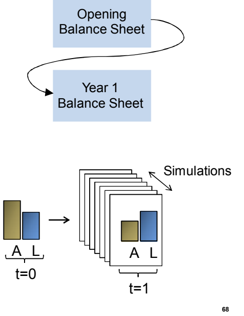
* *In step 3 we could instead assume that the loss distribution scales in proportion to a function of the reserves rather than simply the reserves themselves e.g. the square root of the reserves.*

Example

Risk Margins in the 1-Year Ahead Balance Sheets

A Projected Balance Sheet View

- Remember, from Article 101, the SCR is calculated from a distribution of net assets over a 1 year time horizon
- So when we project one-year forwards, in addition to the (simulated) expected outstanding liabilities conditional on the payments in the year, we also need a risk margin for each simulation, in respect of the outstanding liabilities at that time.



Simulated balance sheet definitions after 1 year?
Simplification 1: Constant Risk Margin

Opening Balance Sheet **with Risk Margin**

Simulated Year 1 Balance Sheet

For each simulation

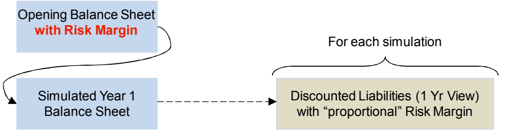
Discounted Liabilities (1 Yr View) with constant Risk Margin

'Excess' capital calculated using VaR @ 99.5% applied to distribution of Net Assets

This is equivalent to excluding the risk margin in the capital model, then adding the opening risk margin back in.

Using a constant risk margin appears to be analogous to the assumptions underlying the QIS 5 standard formula (that is, the change in the risk margin is not considered)

Simulated balance sheet definitions after 1 year?
Simplification 2: "Proportional" Risk Margin



We could devise more complicated alternatives based on "proportions" where the risk margin is different for each simulation, giving the appearance of a better solution

Projection of the Risk Margin

Options

1. Fixed risk margin (i.e. set closing risk margin equal to the opening value)
2. Risk margin based on expected best-estimate closing reserves
3. Risk margin based on the simulated best-estimate closing reserves

For example, if the risk margin was set as a constant proportion of the reserve then we would have:

	BE t = 0	RM t = 0	BE t = 1	RM t = 1		
				Opt 1	Opt 2	Opt 3
High	100	10	130	10	11	13
Average	100	10	110	10	11	11
Low	100	10	90	10	11	9

Projection of the Risk Margin

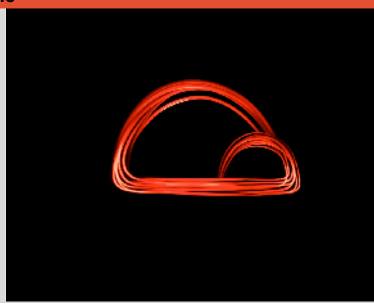
Project the risk margin to t=1,2,3 etc. by using some results from the t=0 calculation and making some further assumptions:

1. Calculate SCR^{RM} (1,class,t) by multiplying the expected reserve run-off (based on the stochastic or deterministic reserves at t=1) by the ratio SCR^{RM} (0,class,t) / Expected Reserve(0,t) *
2. Sum across classes to give the overall SCR^{RM} (1,t)

** Again, in step 1 we could instead assume that the reserve distribution scales in proportion to a function of the reserve rather than simply the reserve itself e.g. the square root of the reserve.*

Assumptions
- The same assumptions as for the t=0 calculations, plus the following:
- The coefficient of variation of the one-year distribution around the technical provision (in each simulation) within a class at t=1 is the same as at t=0
- The diversification between classes at each point in the run-off is the same at t=0 and t=1

Example



What Methods will be Approved?

The Important Question

- When calculating risk margins, it is impossible to satisfy the Solvency II requirements without simulation on simulation, which is impracticable
- Simplifications must be made
  - When calculating the opening SCR for the risk margin calculations
  - When calculating future SCRs
- Simplifications must be made for risk margins for each simulation on the 1 year ahead balance sheet
  - Assume a constant risk margin?
  - Use a simple ratio method?
- What we don't know is: "What methods will be approved?"
- The question can only be answered by the regulators

What We Asked the FSA (UK)

1. Will it be acceptable to have opening and 1 year ahead balance sheets using a constant risk margin to estimate the overall SCR? If that is not acceptable, what simplifications will be approved for calculating risk margins for each simulation in the 1 year ahead balance sheet?
2. If the proposal in (1) is acceptable, will it also be acceptable to use the standard formula for estimating the opening risk margin, even with an internal model?
3. If the standard formula basis is not acceptable for estimating the opening risk margin when using an internal model, what methods will be approved for estimating the initial "SCR" for the risk margin calculation from the internal model, and what simplifications will be approved for estimating the future "SCRs" for the risk margin calculation?

What the FSA (UK) has said so far…*

- "At present there is no definitive answer"
- "We don't want to give an answer that turns out to be wrong"
  - QIS 5 is not final: it is only a test
- "Do something sensible and explain why it's sensible"
- "Worry more about the technical provisions; the risk margin will usually be a lot smaller"
  - "Proportionality" should be borne in mind

** Thanks to the FSA (UK) for clarifying the current position*

Summary

- There are many complications associated with risk margins under Solvency II:
  - Risk margins are required for the opening balance sheet, and for each simulation at the 1 year ahead position
  - Although a "diversified" risk margin can now be calculated under QIS 5, there is still a requirement to allocate the risk margin to line of business (TP5.26-5.28)
  - This requires an opening SCR, as well as future SCRs for the cost of capital method
- This presentation proposes a new approach to calculating the opening risk margin using outputs from an internal model, and also considers how the risk margins might then be calculated for each simulation at the 1 year ahead position.

Article 101 to Room 101

- We've seen Estimating Capital Requirements "101", and "Article 101", and Reserving Risk "101", so now Room 101…

  *Room 101 is a place introduced in the novel "Nineteen Eighty-Four" by George Orwell. It is a torture chamber in which the Party attempts to subject a prisoner to his or her own worst nightmare, fear or phobia. It is a place designed to break your spirit.**

  *Orwell named Room 101 after a conference room at BBC Broadcasting House where he used to sit through tedious meetings.**

- Working on Solvency II can be hugely rewarding, but at times it is like sitting in Room 101. There is a lot to learn, a lot to read, and a lot to implement in the time available, but the end result should benefit companies and policyholders alike.

THE END!

** Source: Wikipedia*

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Questions or comments?

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