



18TH EAST ASIAN ACTUARIAL CONFERENCE

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Taipei International Convention Center in Taipei Taiwan

Non-Life Risk Management by Stochastic Loss-Reserving

18th EEAC Conference
Taipei – October 15th, 2014

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Introduction speakers



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Presentation content

- Financial Risk Management – issues we are facing
- Stochastic Loss Reserving through Integral Financial Modelling (IFM): overview & theoretical background
- Solutions provided:
 - Adequate reserving, determination of cash flows and cost-effective management control
 - Improving business profitability and high predictive power
 - Solving regulatory issues (ORSA, Solvency II)
- Stochastic Loss Reserving versus more traditional methods
- Dashboard & Examples

Presentation content

→ Financial Risk Management – issues we are facing

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Financial Risk Management - issues we are facing - I

- Which are the right reserves and cash flows for insurance portfolios?
- Which are the right risk premiums for my portfolio given claims expectations and return requirements? Also for sub-branches, for market segments and/or for homogeneous risk groups?
- What will be the claims levels – both in terms of cash-out and reserving – for the next few years under present company policy? And how can I, based on a solid prediction, manage these better financially and commercially?

Financial Risk Management - issues we are facing - II

- How can I maintain structural insight in claims reserves? And how can I be sure that I have met all requirements including Solvency II & ORSA – both internally and externally?
- How can I better test and determine my reinsurance requirements?
- What is the value of my portfolio? And how do I improve its profitability?

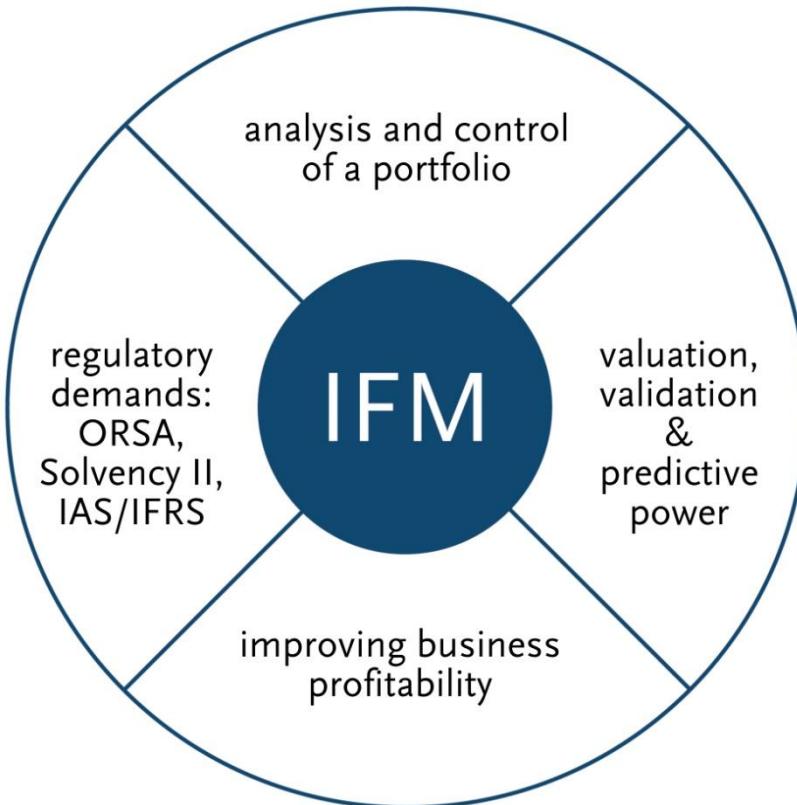
And ‘last but not least’:

- Which is the minimal internal professional staffing and expertise required to address all the above questions?

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IFM overview – management summary



IFM overview – evidence based



- Presented and published at GIRO 2011, CLRS 2012, ASTIN 2012-2013 and Singapore 17th EAAC 2013
- Scientifically validated (by Dutch universities)

Mathematical modelling
Incremental loss triangles,
(paid and incurred) by:
claims ratio time series,
duration functions and
normal distribution



Best Estimate and
SCR calculations
Scenarios, economic value
Back testing
Portfolio analysis



IFM theoretical background - I



IFM is a tool for company actuaries for stochastic loss reserving on the basis of:

1. One or more incremental triangles (paid and/or incurred)
2. Exposure measure (premium income, number of policies) per loss period



IFM theoretical background - II

Normal distribution

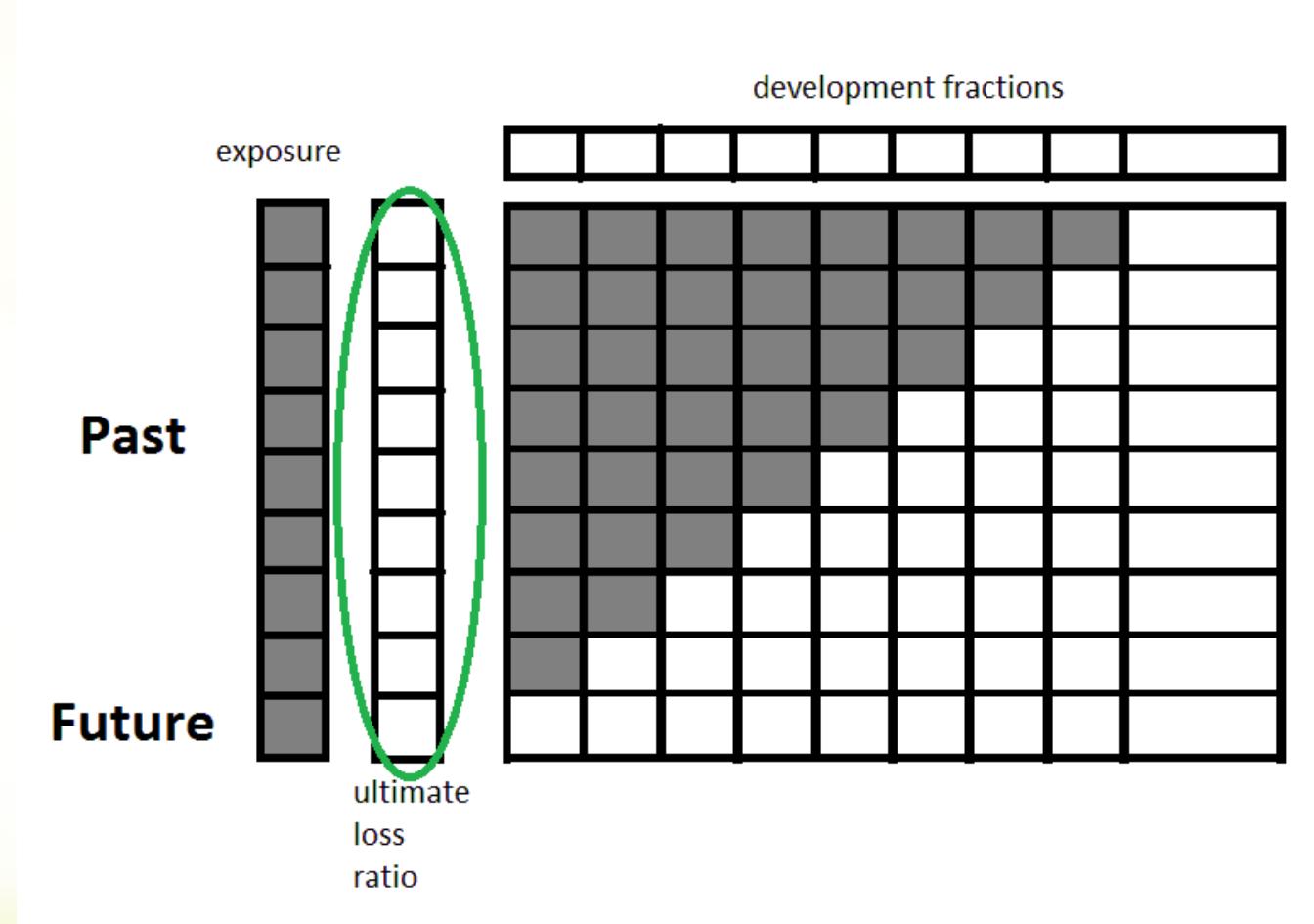


Each increment is a stochastic that is normally distributed. The expected value and variance are depending on:

- Ultimate claim per loss period:
 - exposure per loss period
 - ultimate loss ratio per loss period
- Development fraction per development period

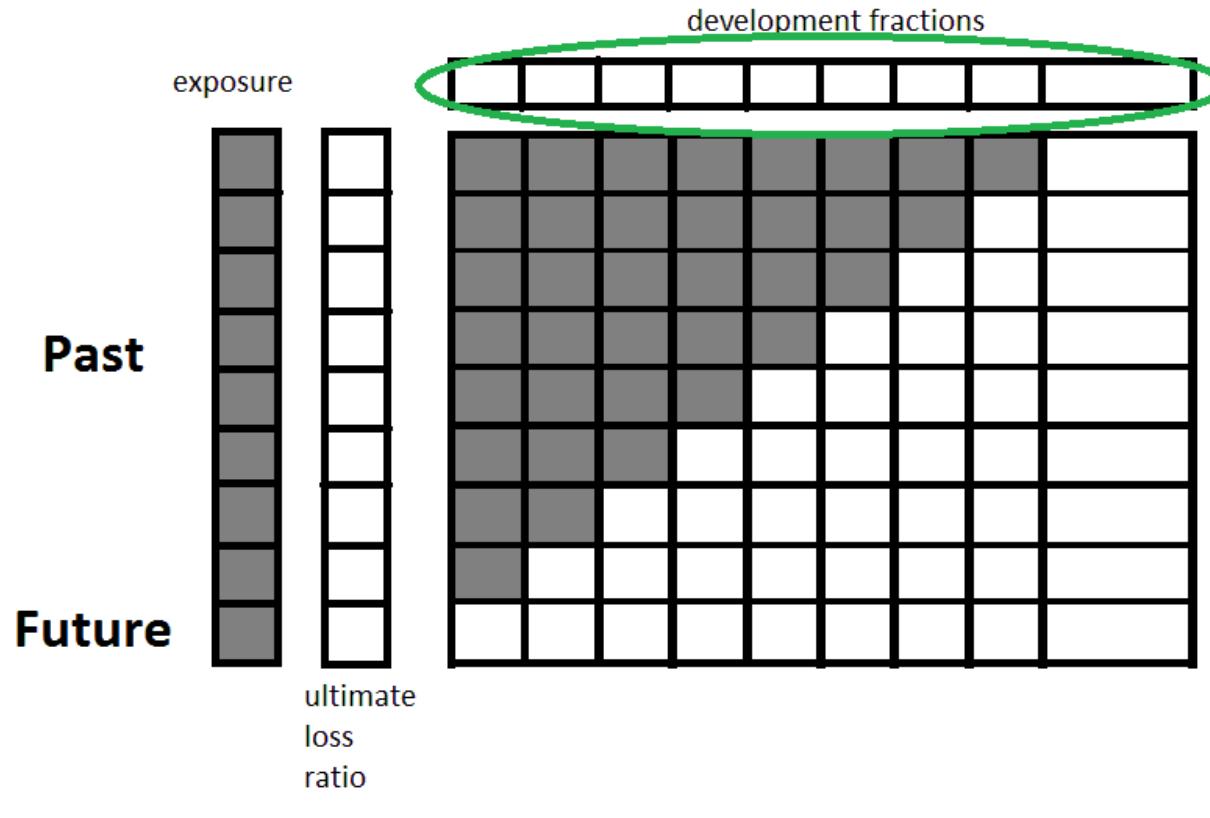
IFM theoretical background - III

Ultimate loss ratio



IFM theoretical background - IV

Development fractions

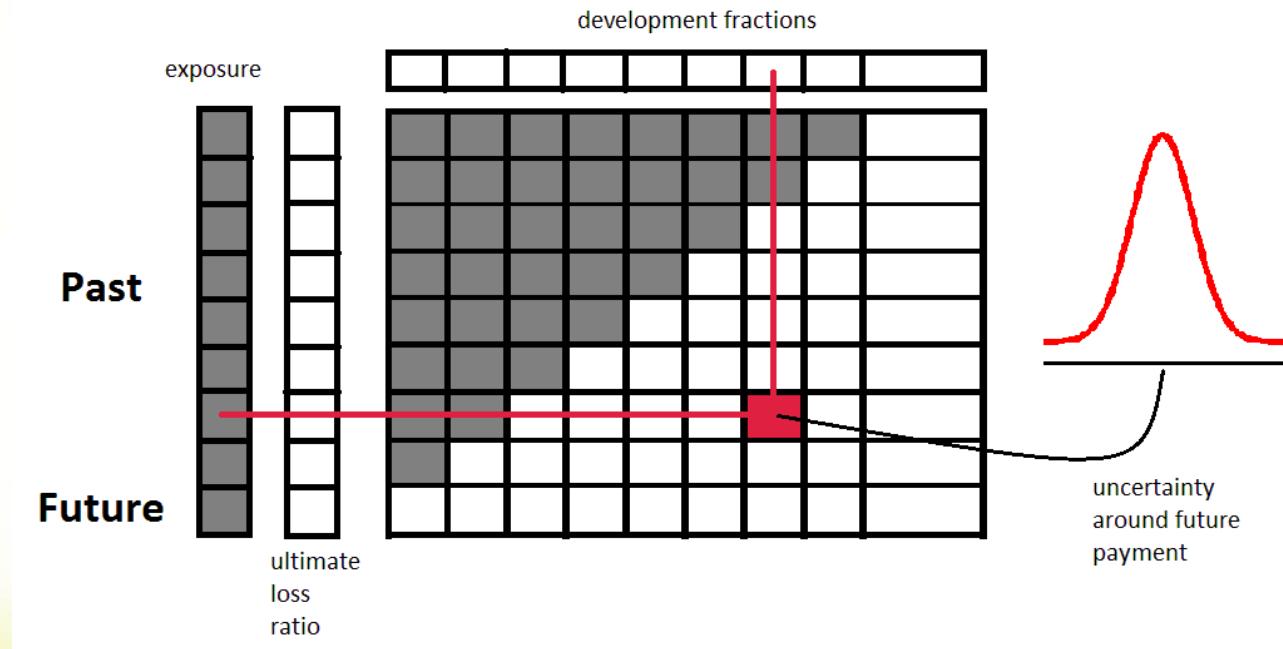


IFM theoretical background - V

Normal distribution of payments



Future cells are uncertain. Therefore we want not only an expected value, but also a probability density function for each cell in the runoff table (paid or incurred).



IFM theoretical background - VI

Multivariate normal distribution



Let Y denote all (known and unknown) cells of a runoff table.

Each Line of Business can be modeled by:

$$Y \sim \mathcal{N}(\mu, \Sigma)$$

The term runoff table can mean:

- incremental paid
- incremental incurred

NOTE: able to handle negative increments

IFM theoretical background - VII

Multivariate normal distribution



If $Y \sim \mathcal{N}(\mu, \Sigma)$ then ...

1. Closed under linear transformations

$$SY \sim \mathcal{N}(S\mu, S\Sigma S^\top) \text{ for a matrix } S \quad *)$$

In practice:

- aggregation of data (incremental cells)
- aggregation of predictions
- discounting future payments with fixed interest rate or yield curve

*) see e.g. papers on www.posthuma-partners.nl

IFM theoretical background - VIII

Multivariate normal distribution



2. Closed under conditioning

$$S_2 Y | \{S_1 Y = s_1 y\} \sim \mathcal{N}(,) \text{ for matrices } S_1 \text{ and } S_2$$

In practice:

- prediction
- to add information
(to be discussed in paid-incurred model)

IFM theoretical background - IX

Multivariate normal distribution

Aggregation of data

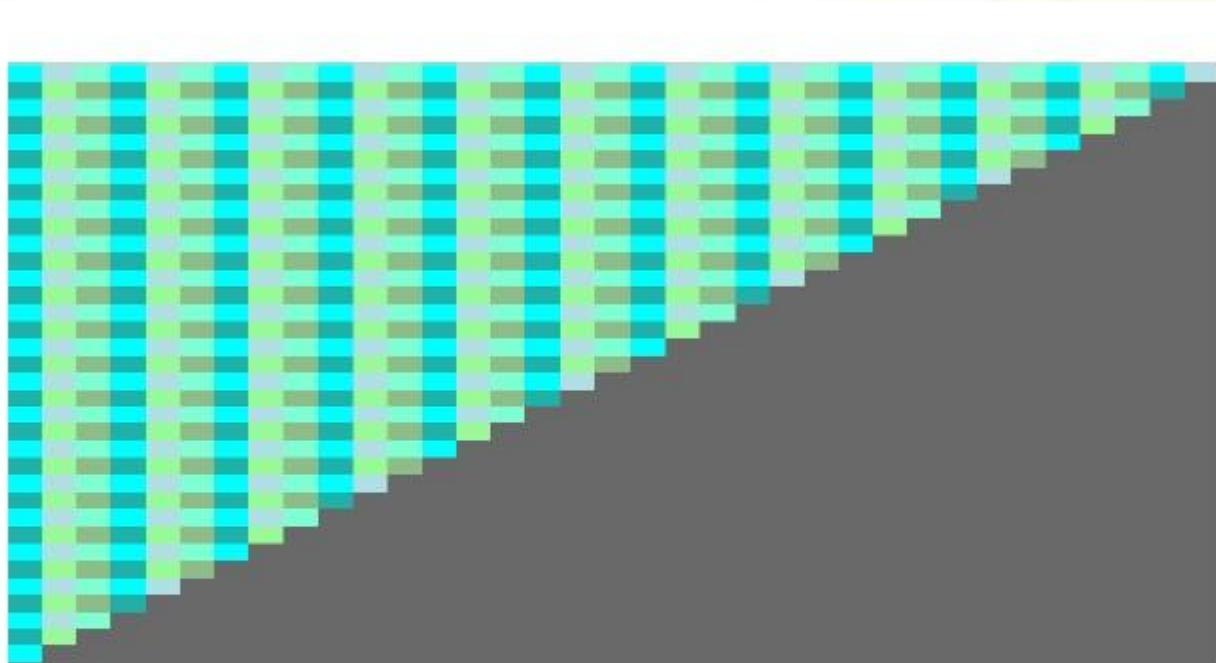


Figure : Suppose you have quarterly data



IFM theoretical background - X

Multivariate normal distribution

Aggregation of data

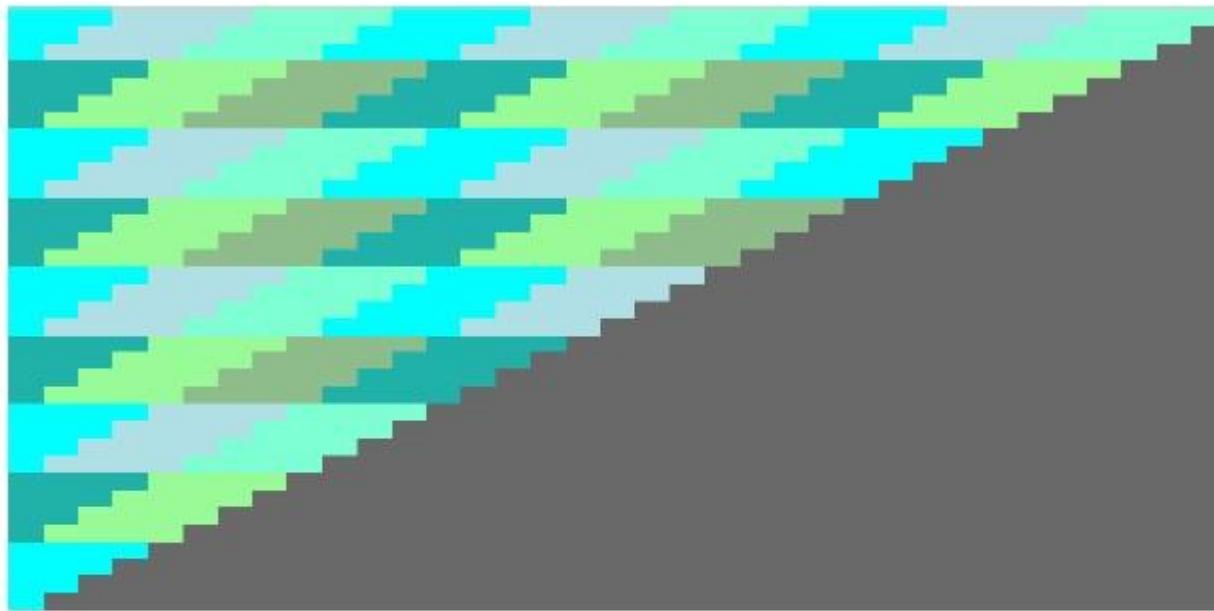


Figure : Aggregate into yearly observations



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Solutions provided - I:

Adequate reserving, determination of cash flows and (cost-effective) management control

Structural and permanent insight, on a monthly/quarterly basis, in the portfolio with regard to risk profile, claims, and required premium setting.

Available in a modular way for various levels (> 200 homogeneous risk groups) based on Economic Value.

Solutions provided - II:

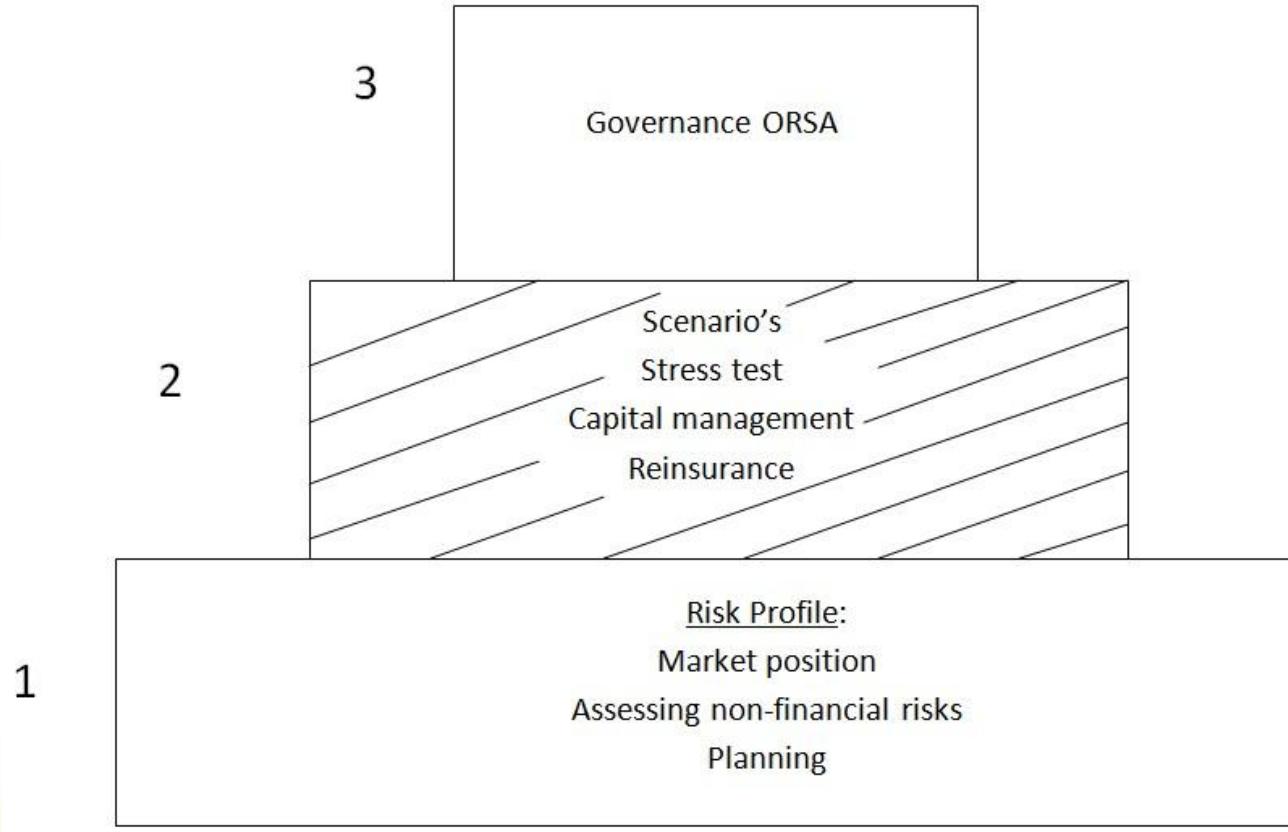
Improving business profitability and high predictive power

- Sound forecasting economic value conform IAS/IFRS
- Segmentation into homogeneous risk groups
- Scenario-analysis through easy variation of parameters (it includes back-testing, Solvency II, one-year stress-testing, etc.)
- IFM outcomes trigger (operational) measures to be taken
- Stochastic Loss Reserving is known for the predictive power of future cash flows

Solutions provided - III: Regulatory issues

- Every month: standardized Solvency II- and ORSA-reporting, linked but not necessary integrated in clients' systems – or any other P/L and Balance sheet input
- Including audit-trail for external report
- Provides necessary validation - new guidelines - of your own internal/standard model or according to the guidelines of your regulatory authority

Solutions provided - IV: ORSA well known 3-stage model



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Stochastic Loss Reserving versus more traditional methods - I

Limitations Chainladder-versions and other methods:

- They perform poorly on longer tailed LOBs
Additional assumptions needed for development factors of later development periods
- They are not able to model trends in any direction
No application of actuarial knowledge of the company is possible
- They are not consistent in their predictions

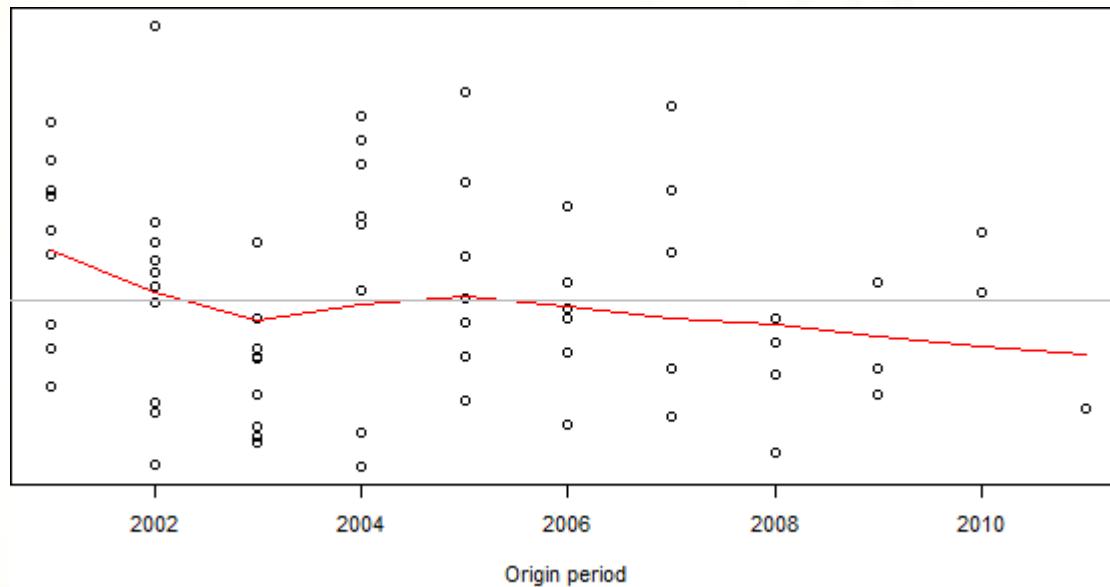
Stochastic Loss Reserving versus more traditional methods - II

Limitations Chainladder-versions and other methods:

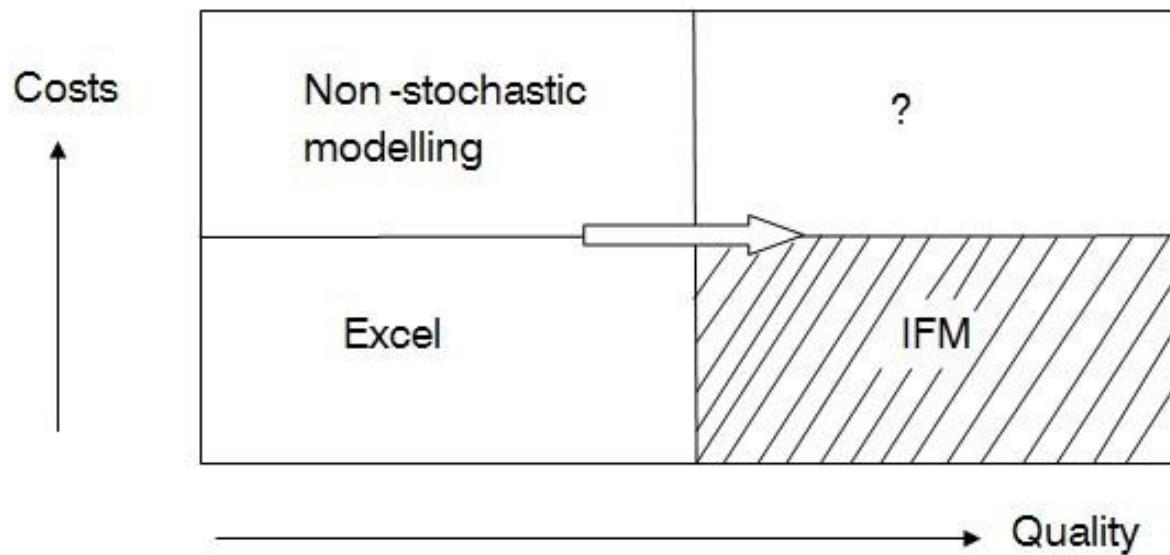
- They are deterministic methods
Bootstrap allows us to generate desired percentiles, but does not beat our model!
- They cannot deal with loss triangles with data for different period length
Triangle data can be available on a monthly or quarterly basis for some years, but only annually or semi-annually for others
- Future loss periods cannot be predicted
- They cannot produce portfolio projections

Stochastic Loss Reserving versus more traditional methods - III

Chain ladder presumes that there is no trend in residues



Stochastic Loss Reserving versus more traditional methods - IV



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→ Dashboard & Examples

Example - I: Dashboard

Integral Financial Modelling 5.1.1.5

1. Model specification

File Import Connection Window Help

Single Beta Inurred Development Duration

180 max possible duration

Single Weibull Paid Development Duration

Constant. 1 regime change

Jan-09 regime change

Development duration: variance as expected value

Bayesian model

12 loss aggregate incurred

12 development aggregate incurred

12 loss aggregate paid

12 development aggregate paid

group rectangular

group incurred accounting >

group payments accounting >

group tail incurred

group tail paid

Jan-13 start aggregation keep last period together

Analyze two triangles

Show Advanced Settings

2. Model saving

Pg Const 12 12 12 - Jan-13
Pg Ctr/W Const 12 12 12 - Jan-13
B-180/W h-Jan-09 12 12 12 - Jan-13
Recon

3. Signal table

number of observations: 32; stochastic, 68% estimation degrees of freedom: 38.0

variance: 32%; stochastic, 68% estimation degrees of freedom: 38.0

minus log likelihood: 1565.66

number of iterations: 50

4. Parameters including interpretation

econometric interpretation checked

current average loss ratio .36

previous average loss ratio .38

standard deviation of current loss ratio .01

50% of incurred/loss occurs within month .15

90% of incurred/loss occurs within month .56

99% of incurred/loss occurs within month .126

5. Standardized errors

Total	Inurred	Paid	1	13	25	37	49	61	73	85	97	109	1	13	25	37	49	61	73	85	97	109		
mean	.14	.16	.11	2003	.09	-.30	-.21	-.84	-.60	.69	-.78	-.108	-.40	-.43	.50	-.84	-.108	-.41	.10	.54	.156	.19	.125	.42
std. dev.	.99	1.00	.98	2004	.54	.61	.15	1.44	.65	.37	-.25	1.35	.41	.33	1.87	-.99	.05	.63	2.11	2.00	1.17	.107	1.46	
skewness	-.26	-.42	-.05	2005	.62	.13	.32	-.14	-.14	-.164	-.109	.83	-.72	1.51	1.44	.13	.06	1.04	1.15	.73				
kurtosis	2.55	2.85	2.26	2006	.93	1.12	1.01	-.89	-.42	.24	.64	.189	-.76	-.30	-.50	.65	.56	.67						
				2007	1.04	1.12	1.01	-.89	-.42	.24	.64	.189	-.76	-.30	-.50	.65	.56	.67						
				2008	1.66	1.23	-.18	.70	.02															
				2009	1.11	1.10	.70	.02																
				2010	.63	-.02	.21																	
				2011	.56	-.77																		
				2012	.09																			

6. Database content

loss period, expected value, 80% quantile, fair allocation of total quantile, IBNR

loss period	expected value	80% quantile	fair allocation of total quantile	IBNR
totals	65,523,636	72,479,444	3,520,763	
2003	1,179,048	2,227,768	1,693,538	282,751
2004	1,592,457	2,000,968	2,126,517	27,211
2005	2,247,780	3,459,039	2,295,292	55,304
2006	4,578,572	6,372,513	5,457,640	(65,304)
2007	4,096,359	5,483,000	4,776,629	(241,401)
2008	5,443,167	6,963,150	6,188,854	(427,791)
2009	5,762,362	7,097,457	6,417,345	(55,921)
2010	8,116,793	9,540,673	8,815,334	(172,828)
2011	11,329,344	12,836,777	12,068,875	317,619
2012	21,150,332	23,042,466	22,078,592	4,206,458

7. Triangle overview

triangle creation date: Jan-13, Certified checked

use other current date: Triangles checked

Inurred/Loss

correlate portefeuille

8. Actuarial screen

12 months aggregate, January start month

Cash Flow, Actual Loss Prediction, Actuarial Loss Provision, IFRS, Completed Table, Loss Reconciliation, Solvency

12 months aggregate, 80 % probability, include future, 0 % interest, Yield file, January start month, 0 % cost of capital, Show C, restrict runoff

9. Specification of actuarial projections

exposure (mln), Inurred/Loss (mln)

exposure	1	13	25	37	49	61	73	85	97	109	1	13	25	37	49	61	73	85	97	109	case res.
2003	100.0	43.9	2.27	(2.41)	(81)	(45)	29	(42)	(50)	(19)	180	17.6	1.39	2.14	1.63	1.40	1.66	66	1.06	53	1.41
2004	100.0	35.9	4.86	07	1.00	.34	.15	.112	.54	.13	172	8.56	3.36	2.40	1.92	2.34	1.87	1.51	1.13		1.91
2005	100.0	35.2	3.07	14	22	(05)	(1.19)	(.92)	(.55)	(.31)	16.0	8.55	2.97	2.05	1.47	1.67	1.39	92			2.79
2006	100.0	35.0	5.32	1.01	1.80	(39)	.56	.22	151	1.85	4.08	2.22	2.42	1.27							6.12
2007	100.0	35.0	5.88	80	(59)	.09	.24	16.1	1.82	2.32	2.06	1.24									5.02
2008	100.0	40.9	5.48	(45)	(54)	(23)			189	11.0	5.21	2.99	2.56								6.62
2009	100.0	37.7	1.05	59	(.08)				17.7	9.84	3.32	1.90									6.47
2010	100.0	34.8	3.38	13					17.0	8.83	3.52										8.99
2011	100.0	35.1	2.03						14.6	10.7											11.75
2012	100.0	32.6																			17.87

11. Graph time series

observations checked

12. Graph development duration

density checked

Example - I.a.

Dashboard Model specification

Single Beta Incurred Development Duration
 max possible duration

Single Weibull Paid Development Duration

Constant, 1 regime change
 regime change
 Development duration: variance as expected value
 Bayesian model

12 loss aggregate incurred
12 development aggregate incurred
12 loss aggregate paid
12 development aggregate paid
 group rectangular
 group incurred accounting >
 group payments accounting >
 group tail incurred
 group tail paid

Jan-13 start aggregation keep last period together
 Analyze two triangles

Example - I.b.

Dashboard Signal table



Example - I.c.

Dashboard Actuarial screen

loss period	expected value	80% quantile	fair allocation of total quantile	IBNR
totals	65,523,636		72,479,444	3,520,763
2003	1,179,048	2,227,768	1,693,538	282,757
2004	1,592,875	2,680,286	2,126,347	212,121
2005	2,276,780	3,458,039	2,856,292	65,053
2006	4,576,572	6,372,513	5,457,640	(665,304)
2007	4,096,359	5,483,000	4,776,629	(241,401)
2008	5,443,167	6,963,150	6,188,854	(427,791)
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Example - II: standard financial outcomes

		INSURANCE RISK LOBs per 31-12-2012 (in € 1,000)					Comments:
		Total	LOB 1	LOB 2	LOB 3		
RESERVE RISK (run of loss reserve)	IFM best estimate (nominal cash flow)	(1)	100,000	40,532	3,189	56,279	Maximum Likelihood and Bayesian tested
	Time value of best estimate	(2)	-11,276	-5,258	-14	-6,004	Discounting by zero risk yield curve
	Margin CoC 6%	(3)	11,920	4,789	1,601	5,529	Based on cash flow 99.5% and surplus interest 6%
	Provision RAL (Risk Adjusted Loss)	(4) = (1) + (2) + (3)	100,644	40,063	4,777	55,804	Economic (fair) value IAS/IFRS
	90% percentile provision	(5)	113,513	45,390	4,051	64,072	Provision at range 90% (an alternative in Solvency II)
	<i>On the balance sheet as best estimate (gross)</i>	(6)	94,475	40,613	5,192	48,670	Balance Company X
	<i>IFM advice for loss provision</i>		too low	OK	OK	too low	Review best estimate
	Provision RAL incl 12-months future premium	(7)	173,804	84,075	16,526	73,203	Loss including 12-months future premium
	Risk premium 12-months on RAL basis	(8) = (7) - (4)	73,160	44,012	11,750	17,399	Loss upon 12-months future premium
	12-months future premium	(9)	113,390	65,876	26,352	21,162	As stated by Company X
PREMIUM RISK (here 12-months future premium)	(8) as percentage of (9)		64.5%	66.8%	44.6%	82.2%	Risk premium as % future premium
	budget for loss 12 months	(10)	79,127	44,332	18,567	16,228	
	<i>IFM advice for 12 months loss budget</i>		OK	OK	OK	too low	Transfer LOB 2 to LOB 3
	loss % (exposure) estimated by IFM		67.3%	43.3%	85.8%		
	50% payments within a month		8.4	8.6	57.0		
IFM statistics	90% payments within a month		40.0	20.5	123.5		
	99% payments within a month		198.9	28.7	171.8		

Example - II.a. standard financial outcomes

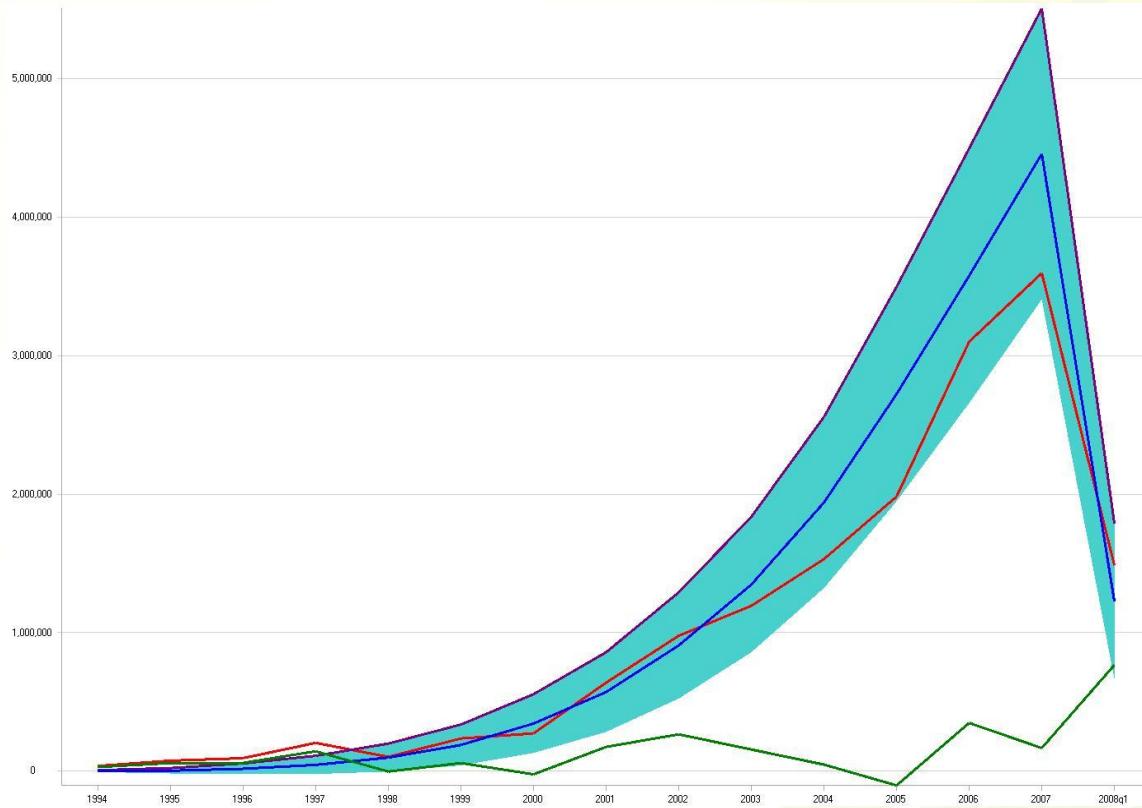
INSURANCE RISK LOBs per 31-12-2012		(in € 1,000)	Total	LOB 1	LOB 2	LOB 3	Comments:
RESERVE RISK (run of loss reserve)	IFM best estimate (nominal cash flow)	(1)	100,000	40,532	3,189	56,279	Maximum Likelihood and Bayesian tested
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	<i>On the balance sheet as best estimate (gross)</i>	(6)	94,475	40,613	5,192	48,670	Balance Company X
	<i>IFM advice for loss provision</i>		too low	OK	OK	too low	Review best estimate

Example - II.b.

standard financial outcomes

INSURANCE RISK LOBs per 31-12-2012						Comments:	
	(in € 1,000)	Total	LOB 1	LOB 2	LOB 3		
PREMIUM RISK (here 12-months future premium)	Provision RAL incl 12-months future premium	(7)	173,804	84,075	16,526	73,203	Loss including 12-months future premium
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	<i>IFM advice for 12 months loss budget</i>		OK	OK	OK	too low	Transfer LOB 2 to LOB 3

Example - III: reliability check



Red line: actual loss

Green line: prudent loss upon accounting period

Blue line: previously predicted expected loss

Purple line: % quantile of previously predicted loss

Light blue area around the blue line: the range of the previously predicted loss

Contact

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