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# Non-Life Risk Management by Stochastic Loss-Reserving

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Taipei – October 15th, 2014

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EAAC

# 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

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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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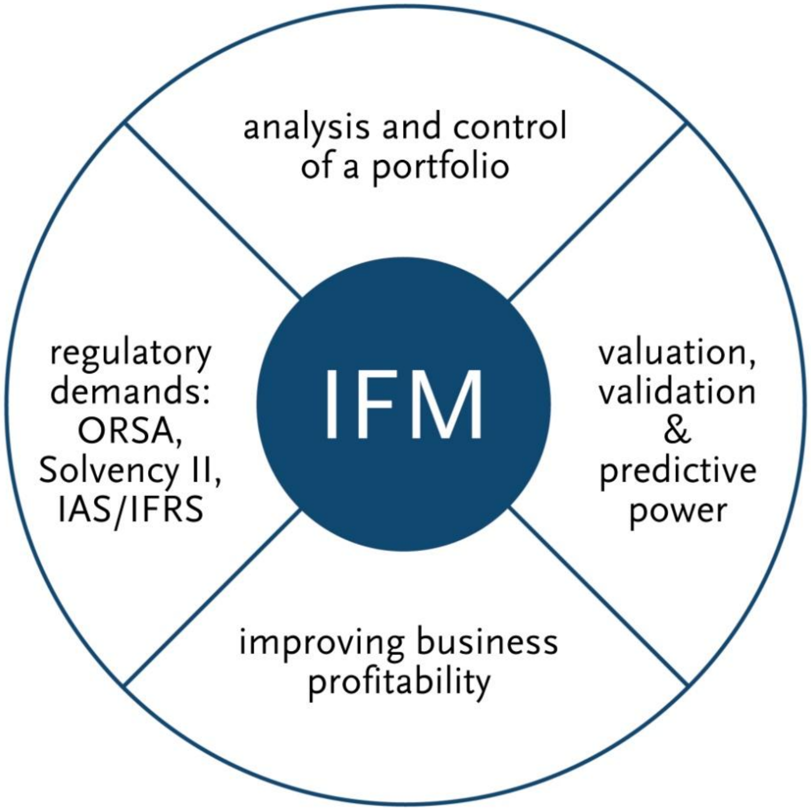
# IFM overview – management summary



# 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)

<u>Mathematical modelling</u>
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:

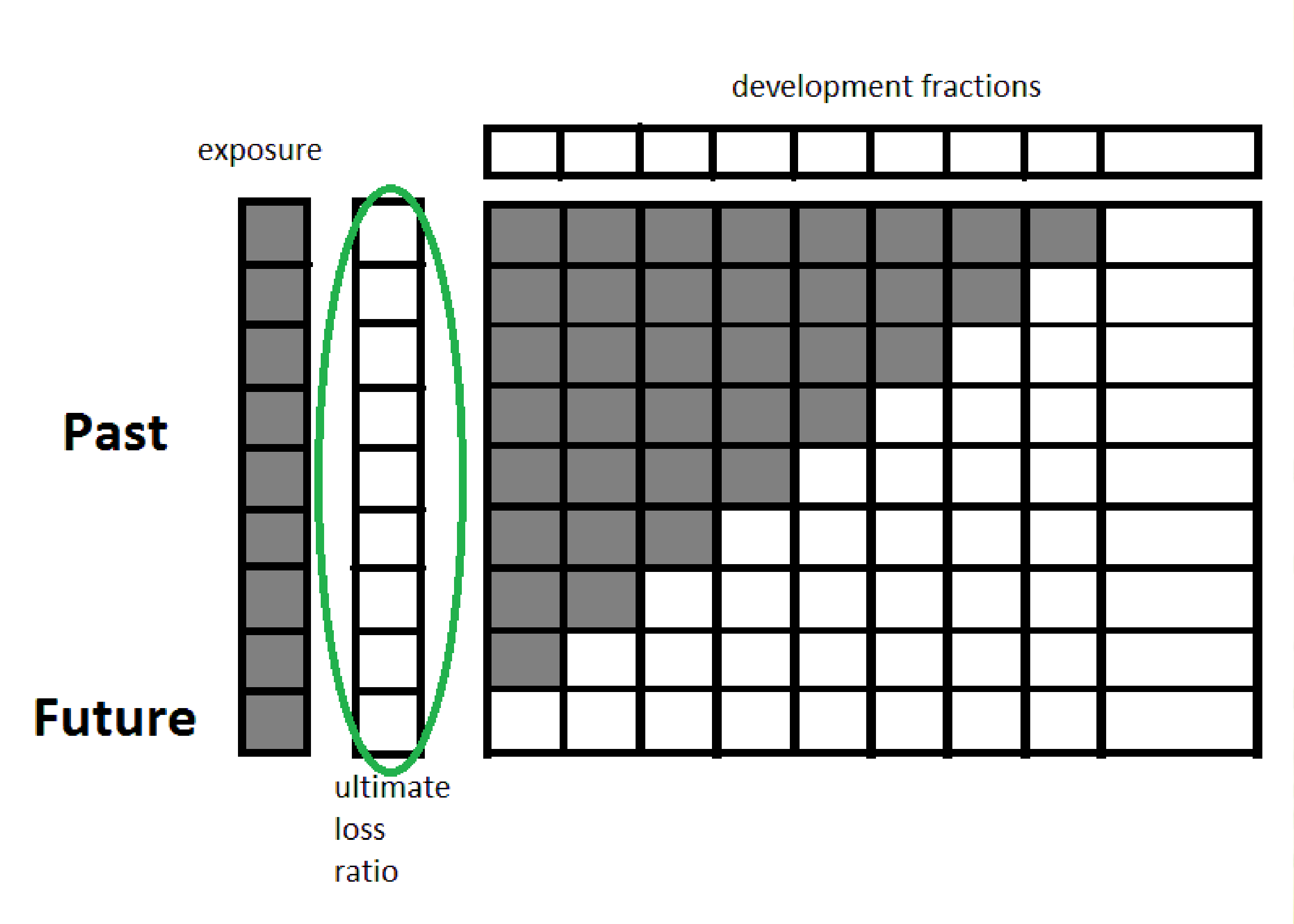
1. One or more incremental triangles (paid and/or incurred)
2. Exposure measure (premium income, number of policies) per loss period

# IFM theoretical background - II
# Normal distribution

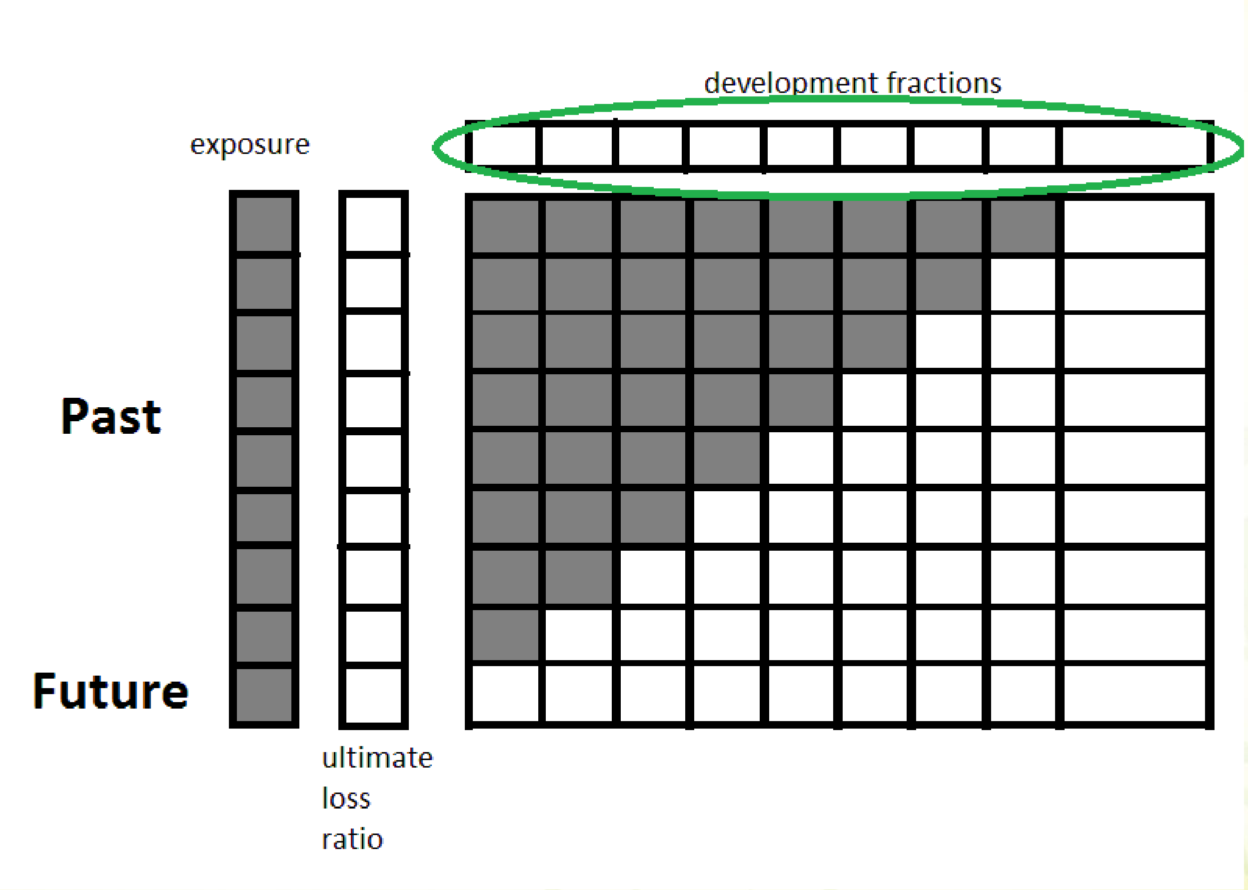
Each increment is a stochast that is normally distributed. The expected value and variance are depending on:

- 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

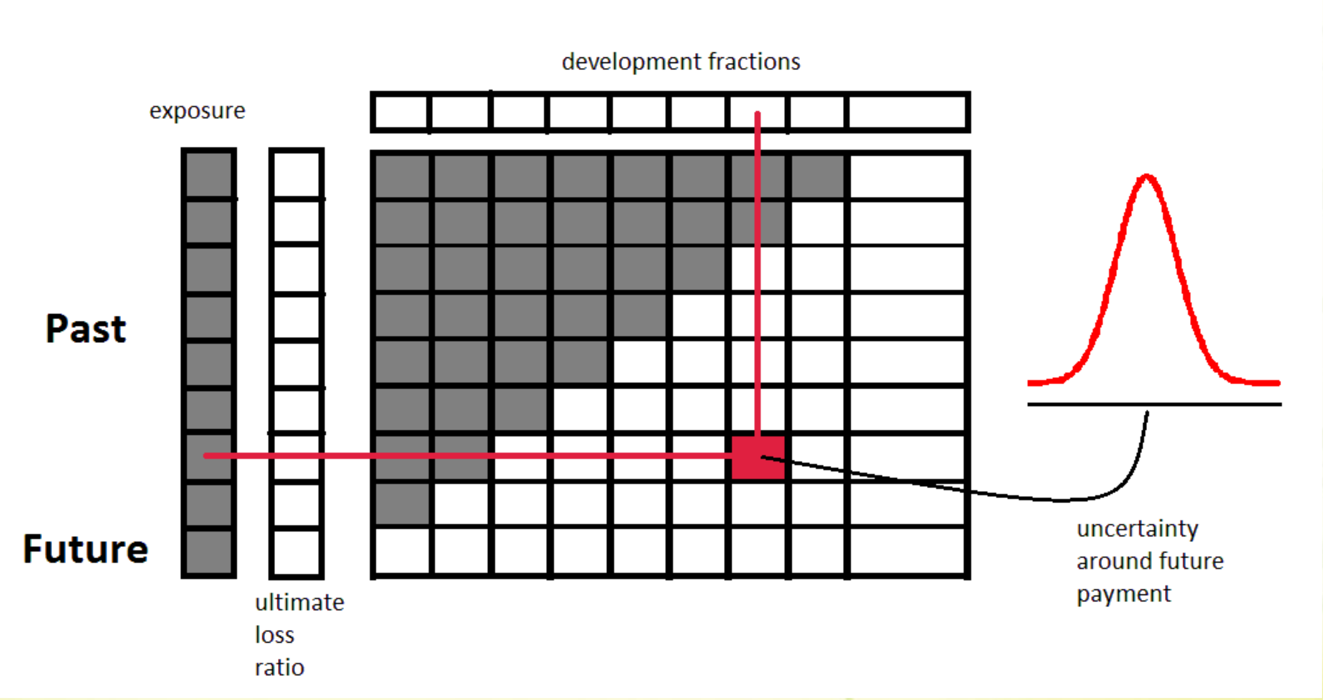


# IFM theoretical background - IV
# Development fractions



# 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 <u>negative</u> 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

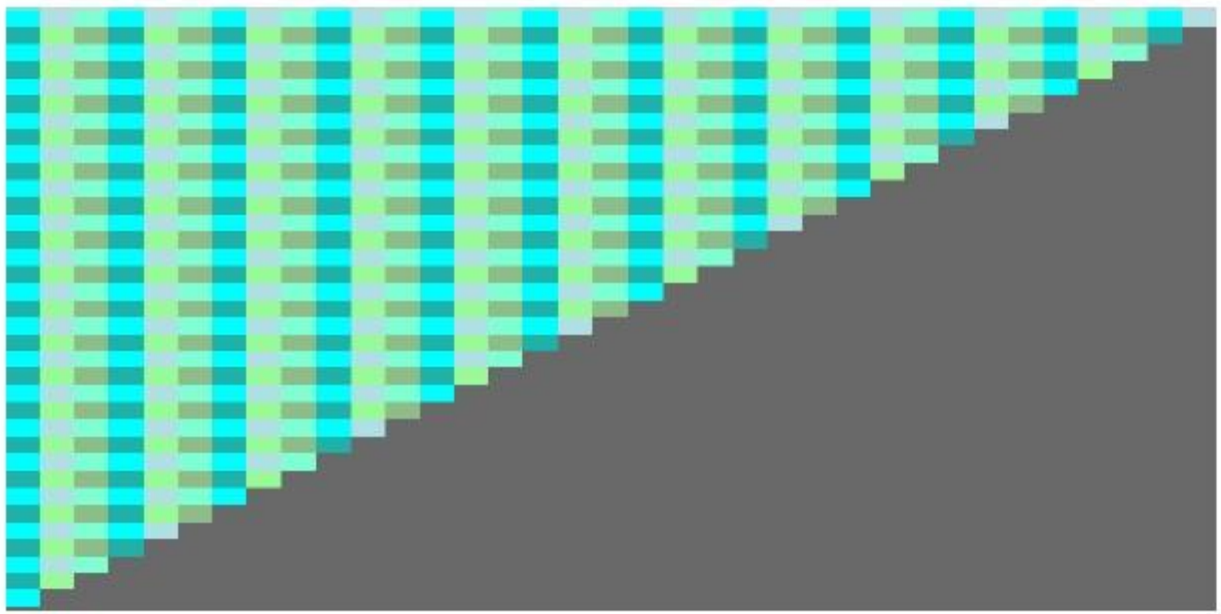


Figure : Suppose you have quarterly data

# IFM theoretical background - X
# Multivariate normal distribution

Aggregation of data

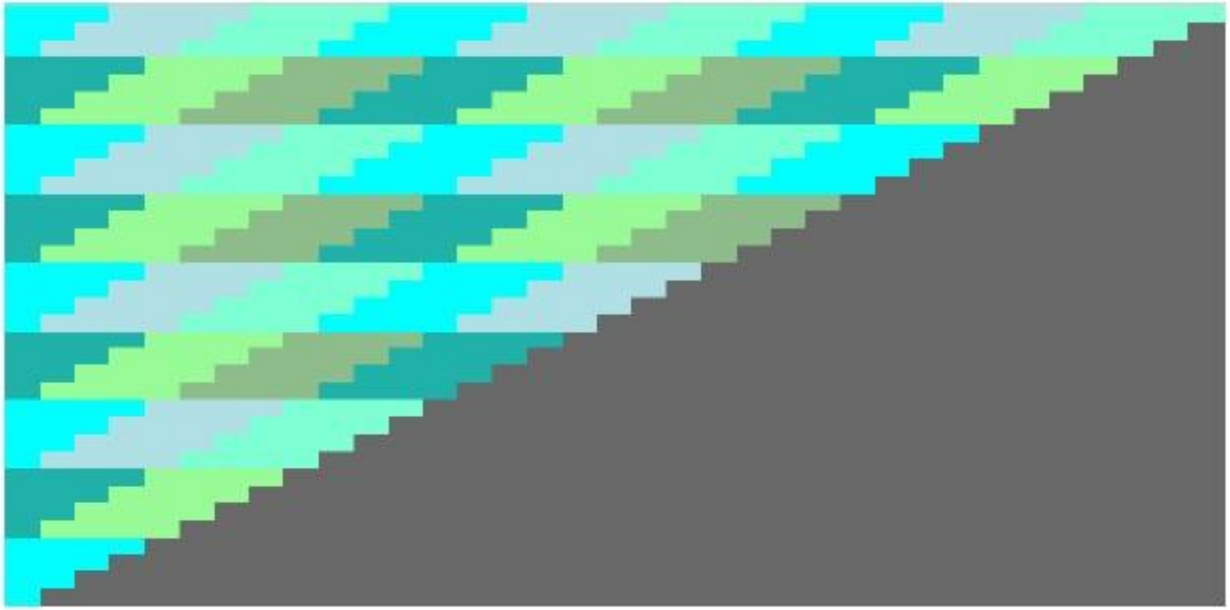


Figure : Aggregate into yearly observations

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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 (> <u>200</u> homogeneous risk groups) based on Economic Value.

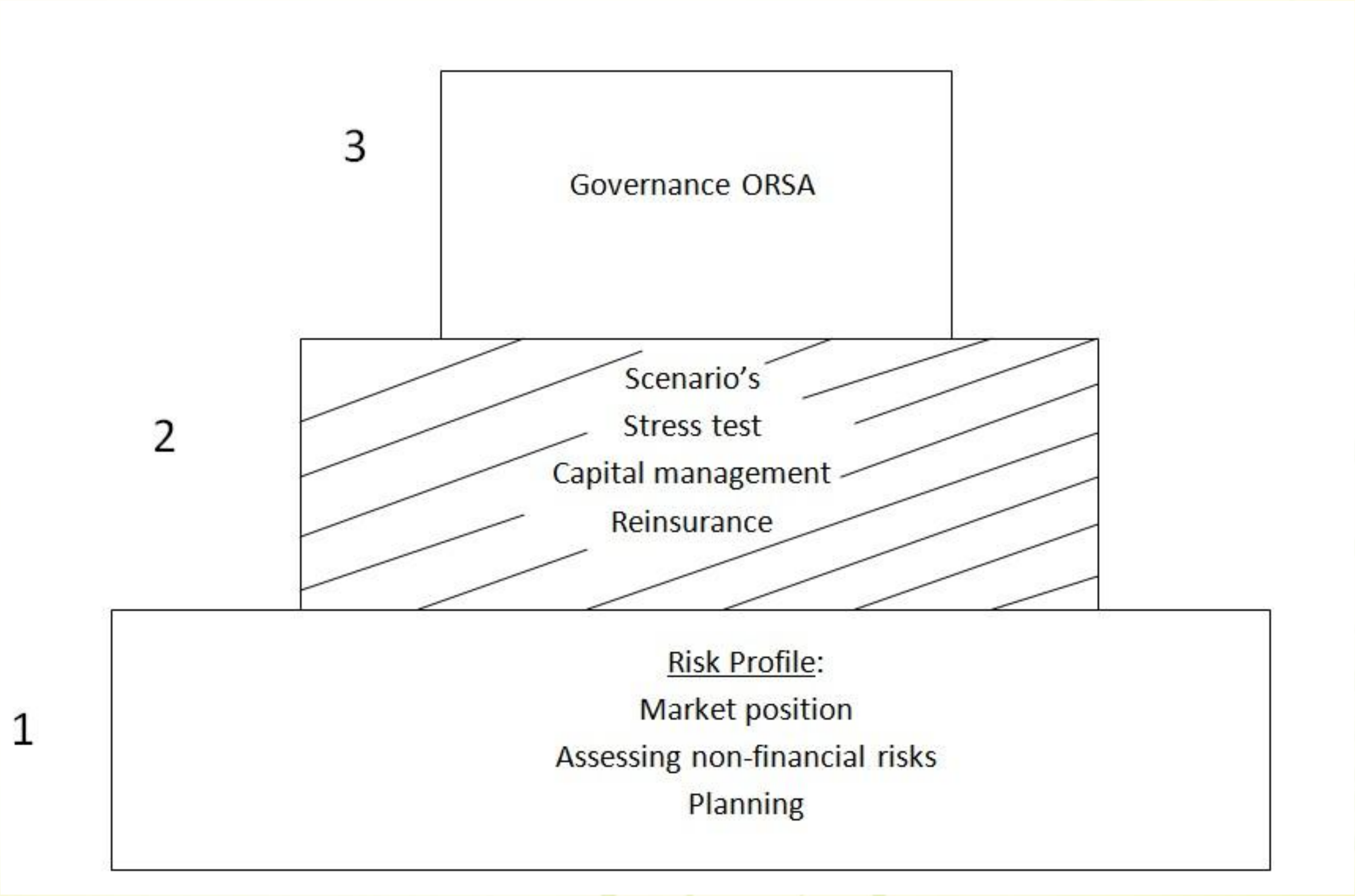
# Solutions provided - II:
# Improving business profitability and high predictive power

- 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

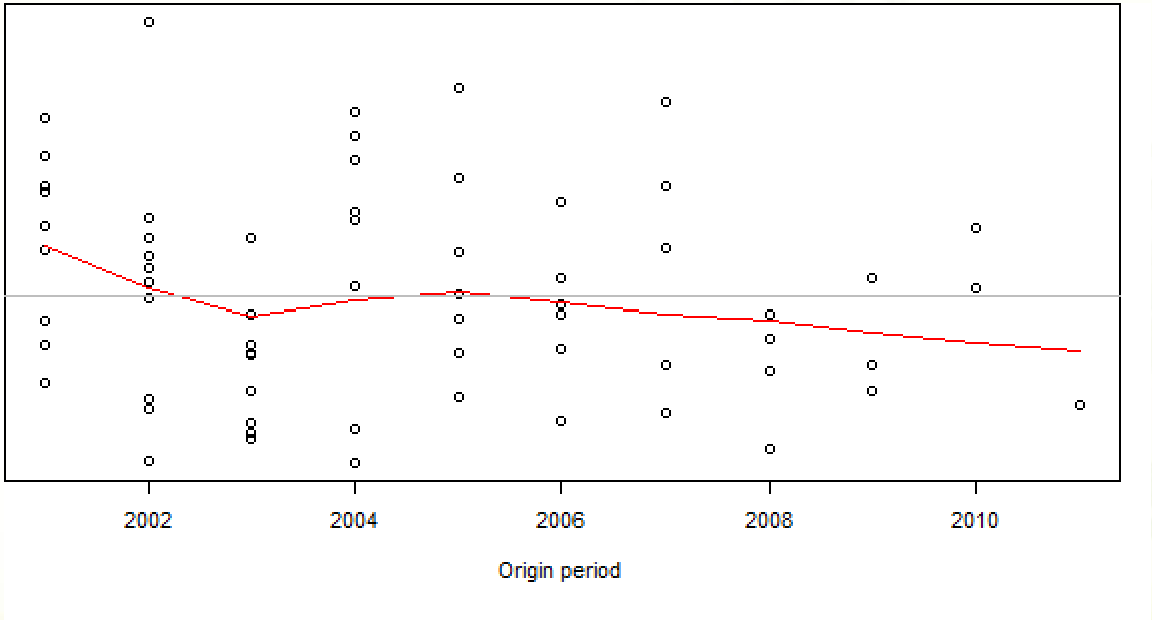
# Stochastic Loss Reserving versus more traditional methods - II

Limitations Chainladder-versions and other methods:

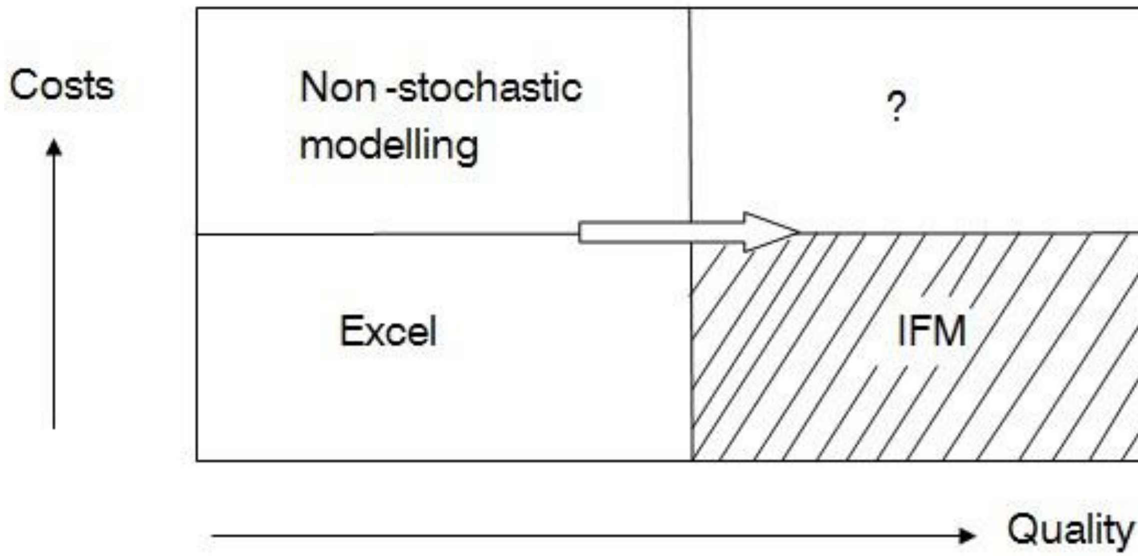
- They are deterministic methods
  Bootstrap allows us to generate desired percentiles, but does not beat our model!
- They cannot deal with loss triangles with data for different period length
  Triangle data can be available on a monthly or quarterly basis for some years, but only annually or semi-annually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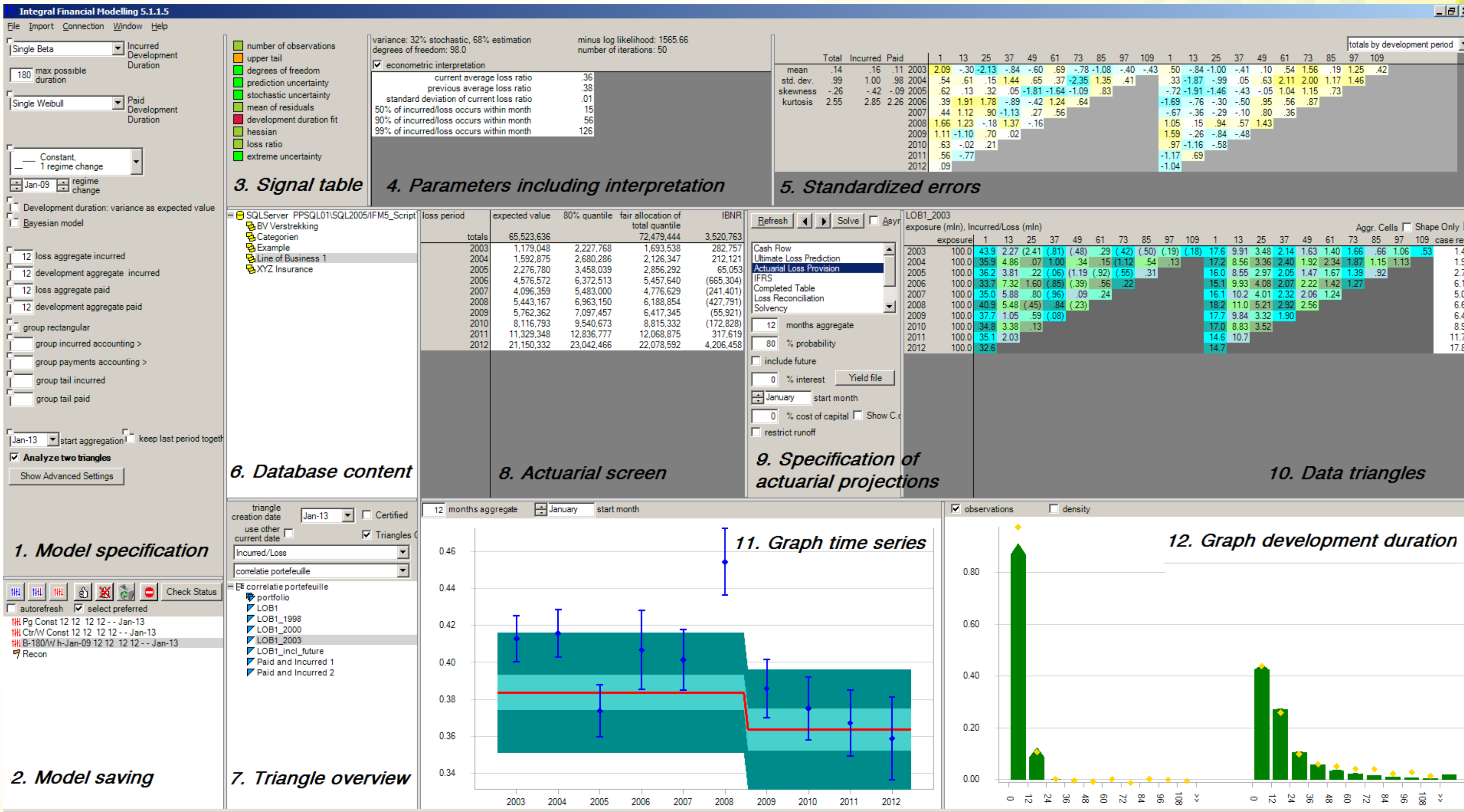
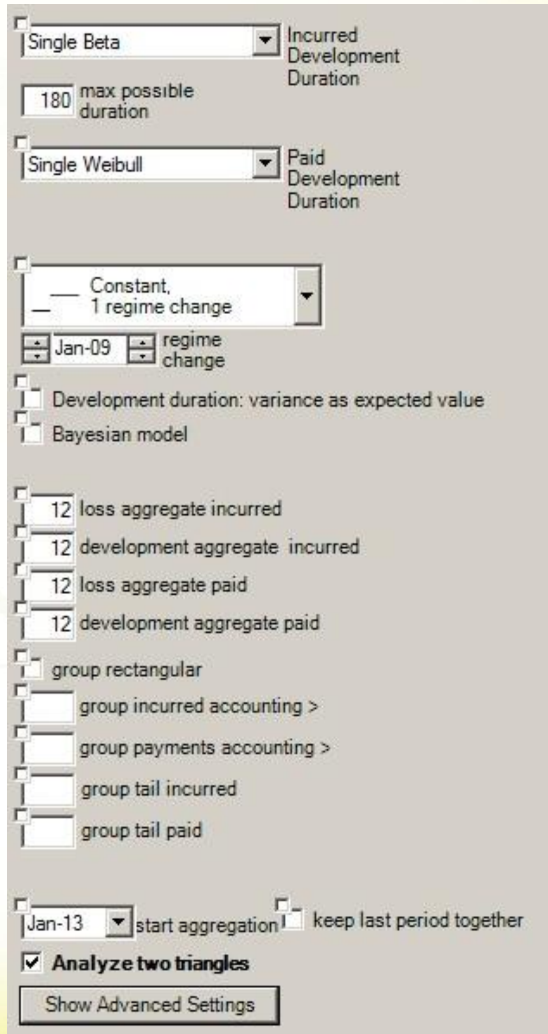
➡ Dashboard & Examples

# Example - I: Dashboard



# Example - I.a.
# Dashboard Model specification



# 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) |
| 2009 | 5,762,362 | 7,097,457 | 6,417,345 | (55,921) |
| 2010 | 8,116,793 | 9,540,673 | 8,815,332 | (172,828) |
| 2011 | 11,329,348 | 12,836,777 | 12,068,875 | 317,619 |
| 2012 | 21,150,332 | 23,042,466 | 22,078,592 | 4,206,458 |

# Example - II: 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 (nominale 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) |
| | *On the balance sheet as best estimate (gross)* | *(6)* | 94,475 | 40,613 | 5,192 | 48,670 | Balance Company X |
| | *IFM advice for loss provision* | | **too low** | **OK** | **OK** | **too low** | Review **best estimate** |
| **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 |
| | **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 |
| | (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 | |
| | *IFM advice for 12 months loss budget* | | **OK** | **OK** | **OK** | **too low** | **Transfer LOB 2 to LOB 3** |
| **IFM statistics** | loss % (exposure) estimated by IFM | | | 67.3% | 43.3% | 85.8% | |
| | 50% payments within a month | | | 8.4 | 8.6 | 57.0 | |
| | 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 (nominale cash flow) | (1) | 100,000 | 40,532 | 3,189 | 56,279 | Maximum Likelihood and Bayesian tested |
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| | *On the balance sheet as best estimate (gross)* | *(6)* | 94,475 | 40,613 | 5,192 | 48,670 | Balance Company X |
| | *IFM advice for loss provision* | | too low | **OK** | **OK** | too low | Review **best estimate** |

# Example - II.b.
# standard financial outcomes

| PREMIUM RISK (here 12-months future premium) | INSURANCE RISK LOBs per 31-12-2012 (in € 1,000) | | Total | LOB 1 | LOB 2 | LOB 3 | Comments: |
|---|---|---|---|---|---|---|---|
| | 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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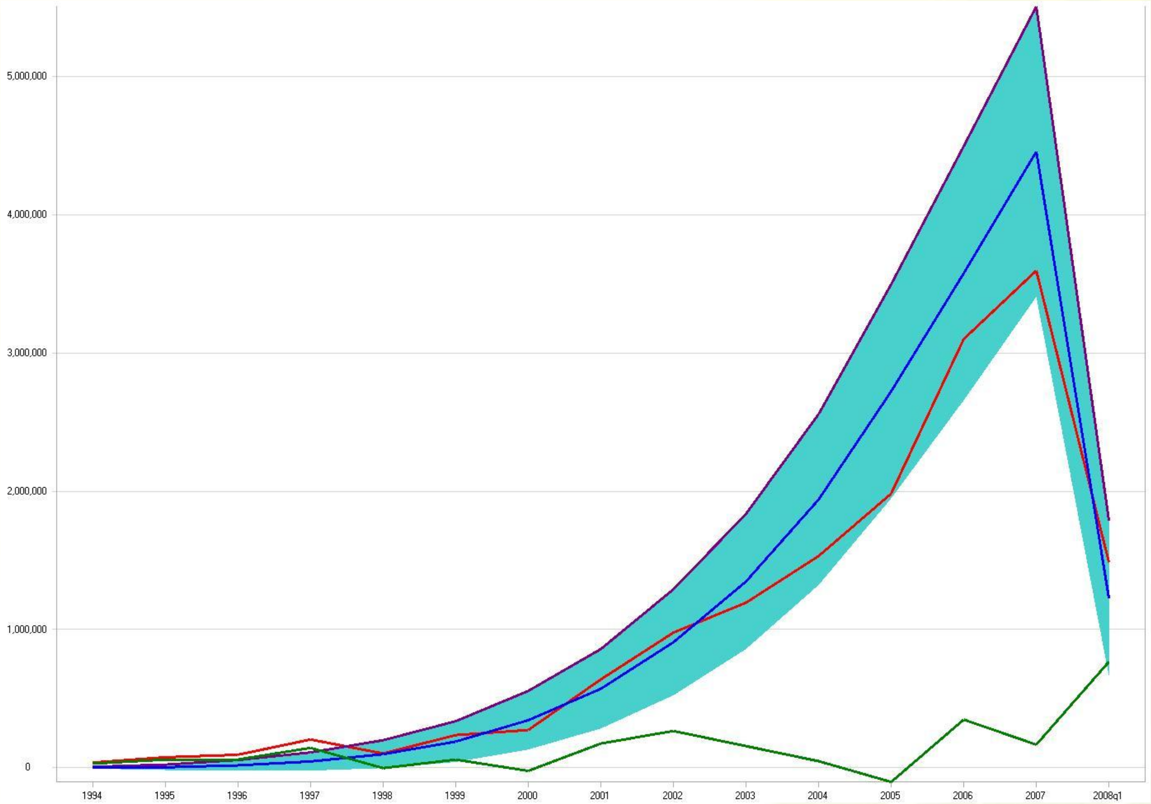
| | *IFM advice for 12 months loss budget* | | **OK** | **OK** | **OK** | **too low** | **Transfer LOB 2 to LOB 3** |

# 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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