The Actuarial Profession
making financial sense of the future

Solvency II Balance Sheets in Simulation-Based Capital Models
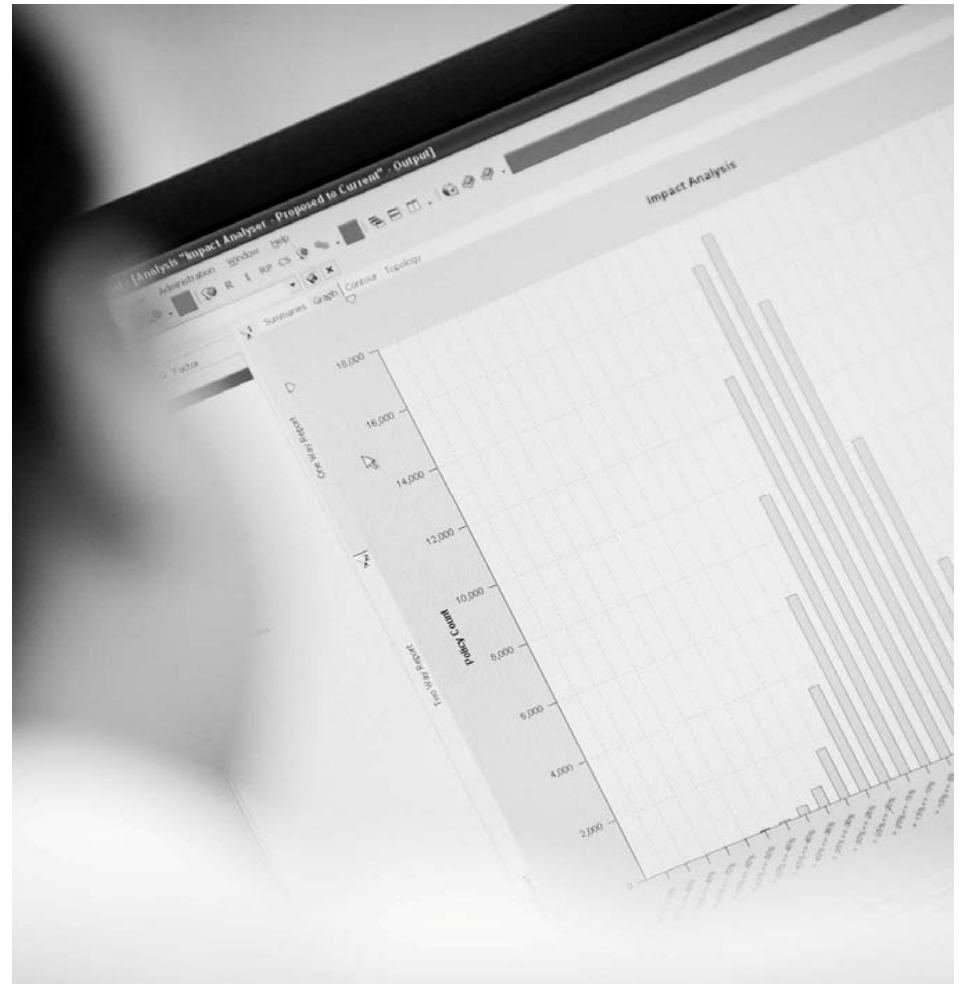## Peter England and Andrew McGuinness

GIRO conference and exhibition

12-15 October 2010

Agenda

- Part 1 – A quick re-cap from last year

- Part 2 – Developments since last year

- Part 3 – An example model

A quick recap from last year…

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, than calculate the VaR @ 99.5%.

"The devil is in the detail…"

Solvency II: Overall SCR
Article 101
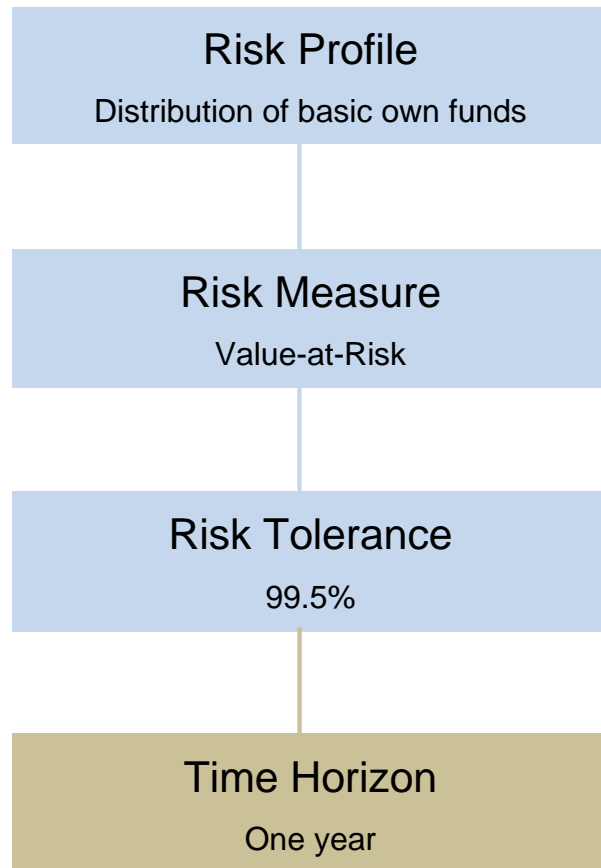
|	
Risk Profile Distribution of basic own funds	← From Article 101 "Capital market consistent" value of liabilities "Economic" balance sheet
Risk Measure Value-at-Risk	*Questions:* *Using a formula based approach (eg QIS 5 SCR), with capital charges by risk type which are then aggregated, what is the risk profile? (What is the risk profile for each component?)*
Risk Tolerance 99.5%	*Can it be shown that it corresponds to a distribution of basic own funds?* *If so, under what assumptions?*
Time Horizon One year	*If not, does it satisfy Article 101?*

A Projected Balance Sheet View

- When projecting Balance Sheets for solvency, we have an opening balance sheet with expected outstanding liabilities

- We then project one year forwards, simulating the payments that emerge in the year

- We then require a closing balance sheet, with (simulated) expected outstanding liabilities conditional on the payments in the year

- In a multi-year model, the closing balance sheet after one year becomes the opening balance sheet in the second year, and so on

Opening Balance Sheet

Year 1 Balance Sheet

Year 2 Balance Sheet

Year *n* Balance Sheet
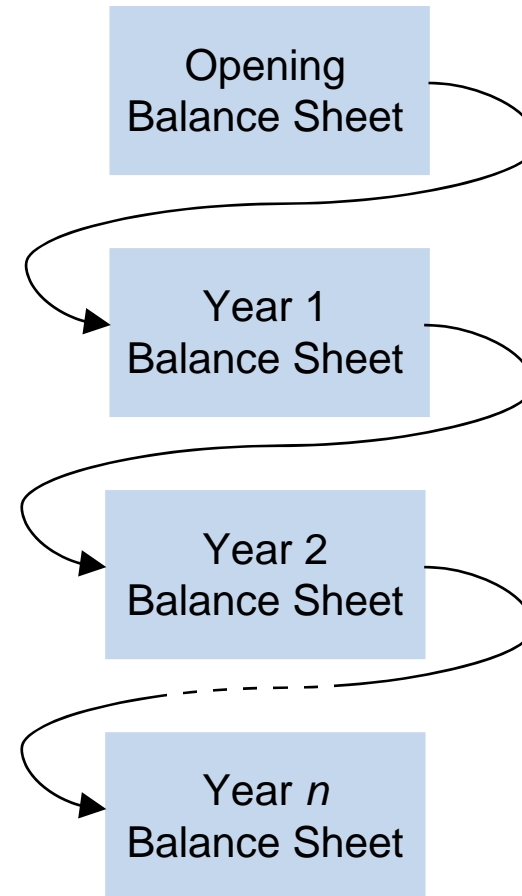
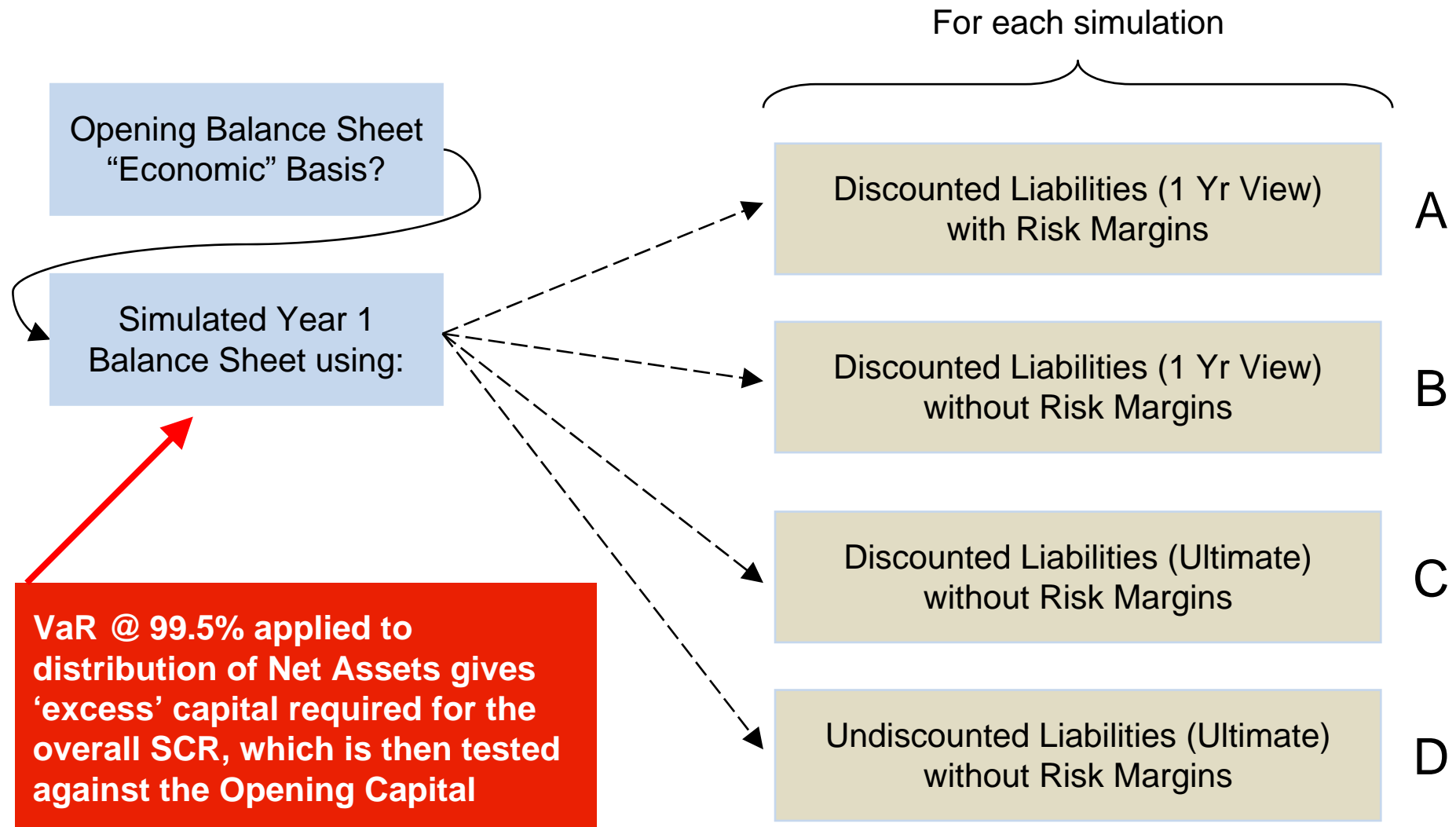# The distribution of the expected liabilities in one year
The actuary-in-the-box

1. Given the opening reserve triangle, simulate all future claim payments to ultimate using a bootstrap or Bayesian MCMC technique.

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.

6. For a one-year model, this will underestimate the true volatility at the end of that year (even if the mean across all simulations is correct).

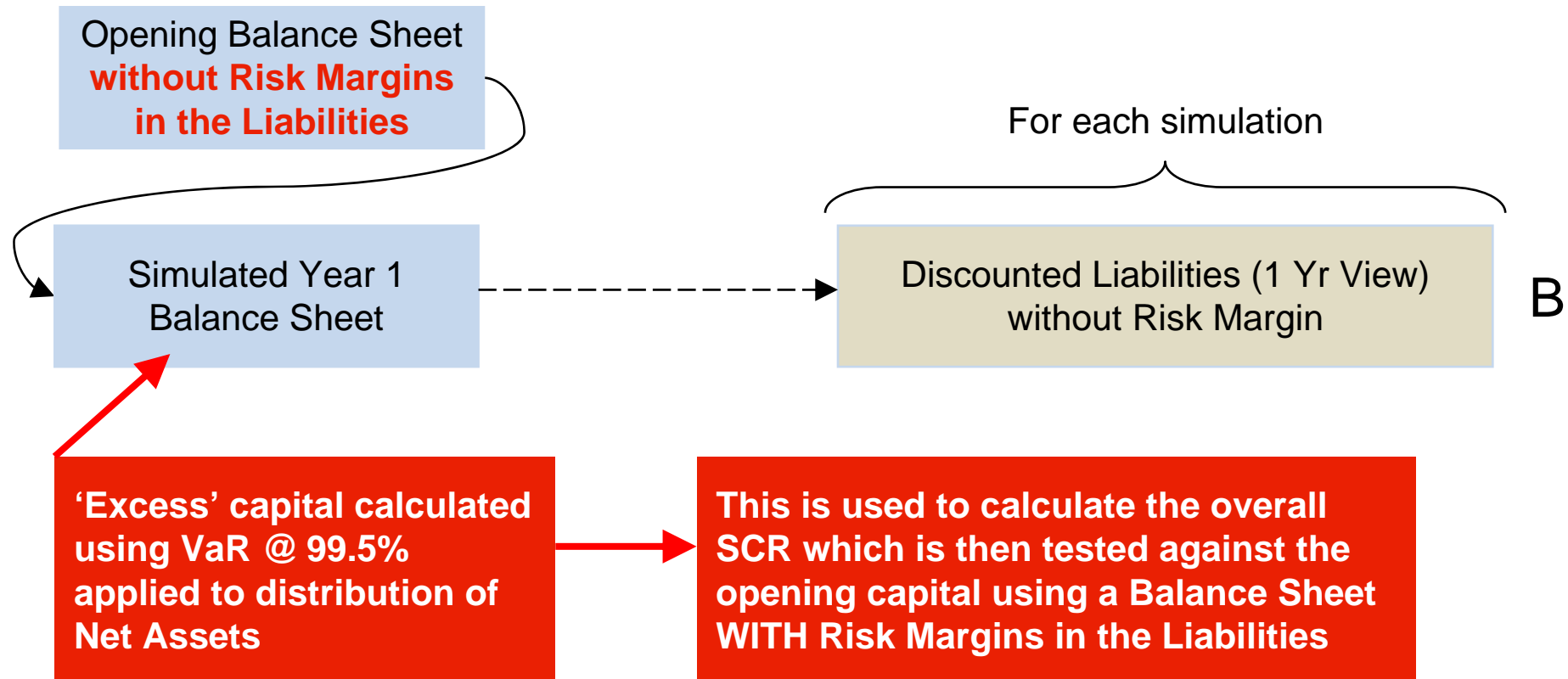** The term "actuary-in-the-box" was coined by Esbjörn Ohlsson*

Overall SCR
GIRO 2009: Simulated Year 1 balance sheet options

For each simulation

Opening Balance Sheet "Economic" Basis?

Simulated Year 1 Balance Sheet using:

Discounted Liabilities (1 Yr View) with Risk Margins — A

Discounted Liabilities (1 Yr View) without Risk Margins — B

Discounted Liabilities (Ultimate) without Risk Margins — C

Undiscounted Liabilities (Ultimate) without Risk Margins — D

VaR @ 99.5% applied to distribution of Net Assets gives 'excess' capital required for the overall SCR, which is then tested against the Opening Capital

Simulated balance sheet definitions after 1 year?
GIRO 2009: A convenient procedure

Opening Balance Sheet
**without Risk Margins
in the Liabilities**

For each simulation

Simulated Year 1
Balance Sheet

Discounted Liabilities (1 Yr View)
without Risk Margin

B

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

This is used to calculate the overall
SCR which is then tested against the
opening capital using a Balance Sheet
WITH Risk Margins in the Liabilities

Under what assumptions can we use a balance sheet definition without risk margins in
simulation based internal capital models for calculating the overall SCR?

What has happened since last year…

- QIS 5 Technical Specification has been issued
- Lloyd's has issued some guidance
- We've changed our minds (but only slightly)

Lloyd's Requirements

- Recognising that the "one-year view" gives a lower measure of risk than looking over the lifetime of the liabilities, Lloyd's requires internal models to provide capital calculations on both bases for the one-year ahead balance sheet:
  - With liabilities calculated using the "ultimo" perspective (perfect foresight)
    - ICA basis in practice
  - With liabilities calculated using the expected outstanding liabilities, conditional on what has emerged over the year (re-reserving)
    - Solvency II basis

Implications of QIS 5

- Technical provisions have changed
  - Legal obligations basis, etc
- Risk margin is now 'diversified'
  - The risk margin can be calculated at an overall level
  - No need for line of business risk margins (and the associated SCRs at LoB level)
  - So we 'just' need a risk margin for aggregate technical provisions on a "legal" obligations basis (and the associated SCRs over time)
  - (We can 'allocate' the risk margin to lines of business if we want to, but risk margins by line of business are irrelevant)
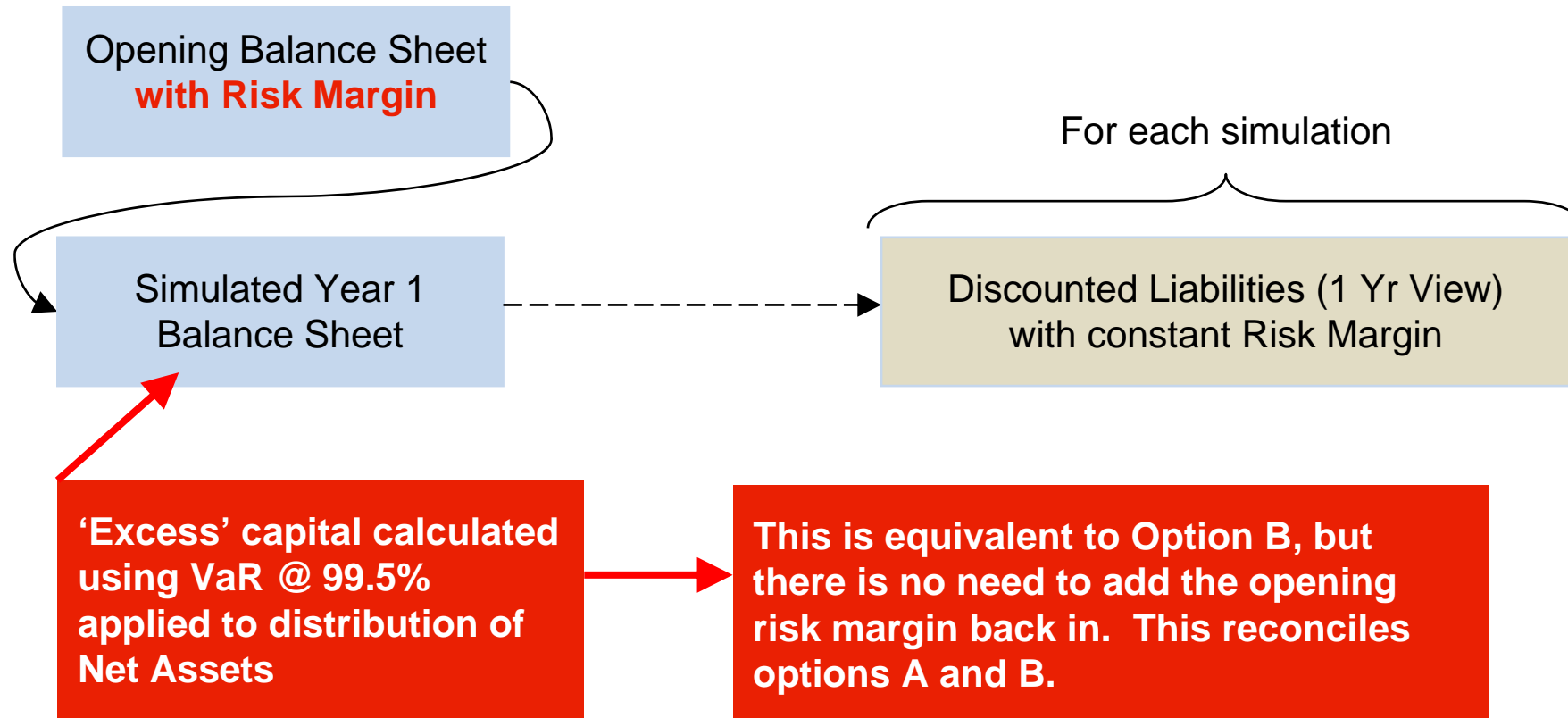
Solvency Capital Requirements
Non-Life Companies
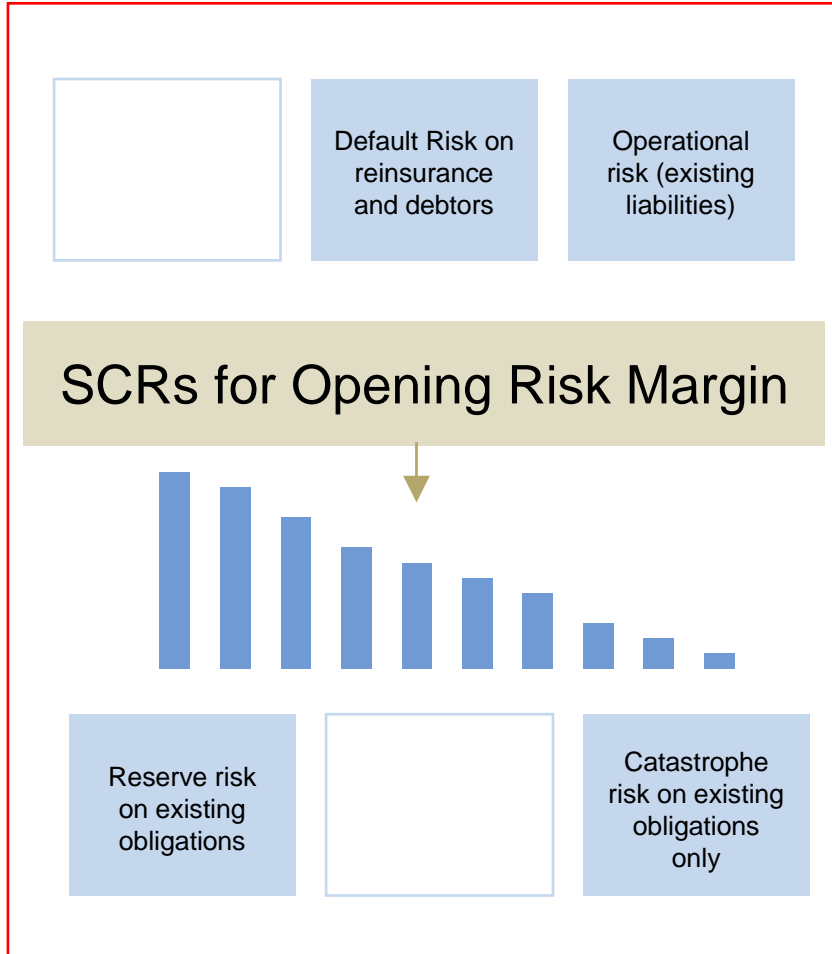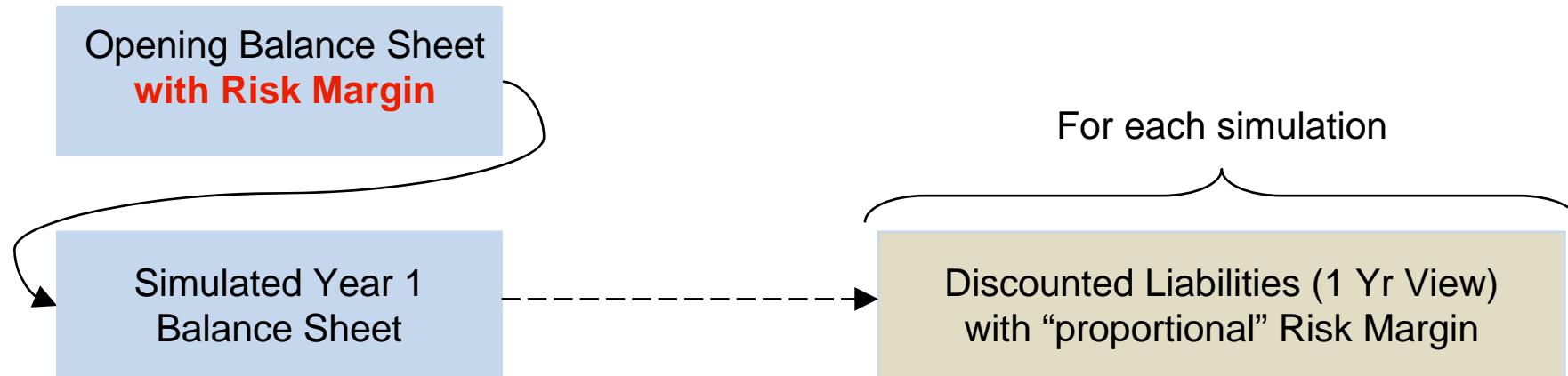
Simulated balance sheet definitions after 1 year?
Simplification 1: Constant Risk Margin

Opening Balance Sheet
with Risk Margin

For each simulation

Simulated Year 1
Balance Sheet

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 Option B, but there is no need to add the opening risk margin back in. This reconciles options A and B.

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

Opening Balance Sheet
with Risk Margin

For each simulation

Simulated Year 1
Balance Sheet

Discounted Liabilities (1 Yr View)
with "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

The Opening Risk Margin

- Whichever method is used, we still need 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?
  - Use the standard formula?
  - Use a modified version of the internal model?

The Opening Risk Margin in Internal Models
Using the Standard Formula

- This has the advantage of appearing to be simple

  - There is no need to justify the assumptions in the standard formula

  - The risk margin method would be standardised across companies

- Calculate the opening SCR by entering reserve and premium volumes in respect of the (expected) technical provisions (legal obligations basis only)

  - Market risk not required (usually)

- Calculate future SCRs:

  - In proportion to the emergence of the (expected) reserves in each future year, or

  - By repeatedly calculating the SCR using the standard formula, but adjusting reserve and premium volumes in each future year

    - The capital requirement percentages can be calculated, relative to the opening SCR

The Opening Risk Margin in Internal Models
Using the Internal Model

- The internal model basis itself could* be used
  - Assume opening assets = 0**
  - For premium volumes, use "legal obligations" basis only (no new business in the forthcoming year)
  - Remember to modify assumptions about cat exposures, reinsurance and expenses
- VaR @ 99.5% will give the TOTAL capital required, for the SCR calculation

- Calculate future SCRs:
  - In proportion to the emergence of the (expected) reserves in each future year, or
  - Using the proportions implied by the recursive standard formula method

* It is possible that the internal model basis *should* be used, but given the concept of proportionality, using the standard formula may be sufficient

** Other assumptions could be used

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

1. Will it be acceptable to have opening and 1 year ahead balance sheets excluding risk margins, and use the change in the balance sheet on that basis to estimate the overall SCR (after adding the opening risk margin back in)? 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?
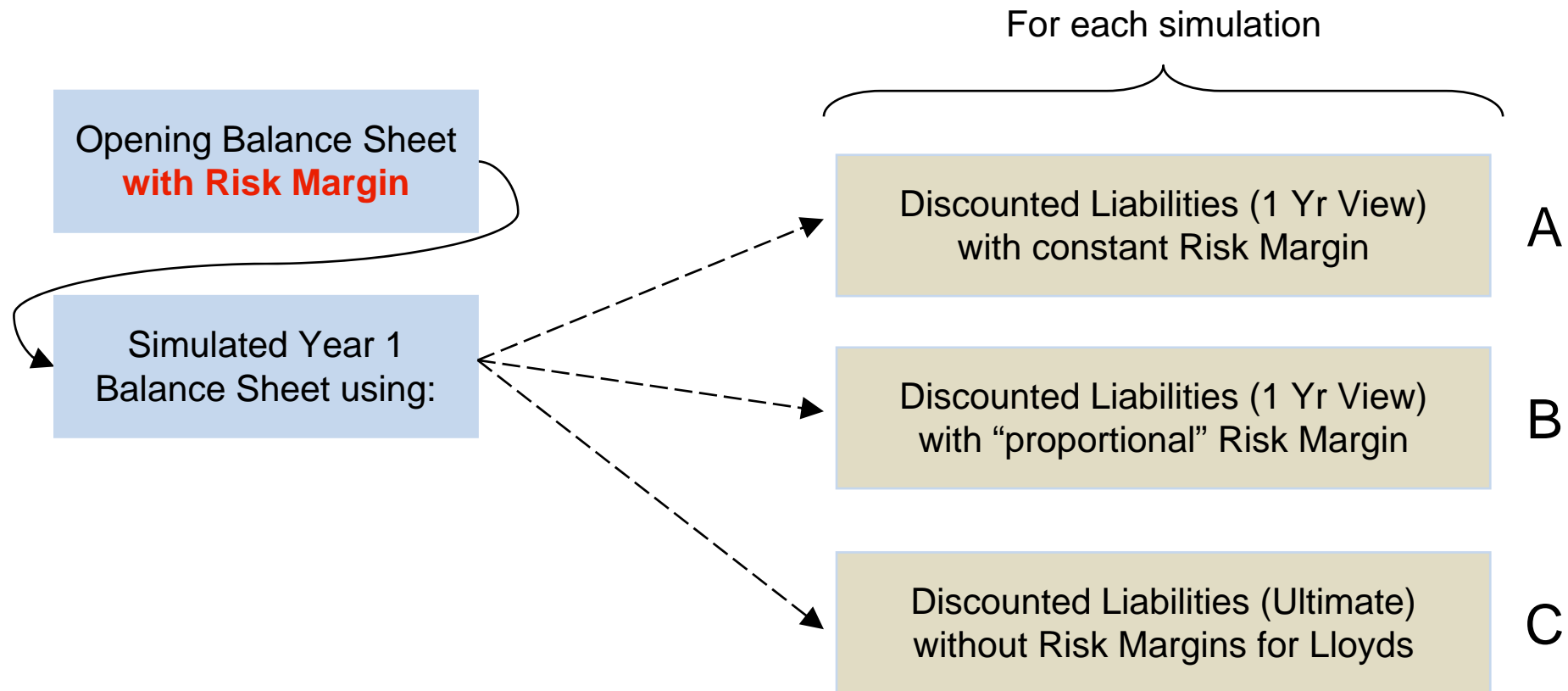
What the FSA has said so far…*

- "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 for clarifying the current position

Overall SCR
GIRO 2010: Simulated Year 1 balance sheet options

For each simulation

Opening Balance Sheet **with Risk Margin**

Simulated Year 1 Balance Sheet using:

Discounted Liabilities (1 Yr View) with constant Risk Margin — A

Discounted Liabilities (1 Yr View) with "proportional" Risk Margin — B

Discounted Liabilities (Ultimate) without Risk Margins for Lloyds — C

The "opening" SCR for the risk margin calculation could be calculated using the standard formula (maybe) or the internal model itself. Use a simple approach for the future SCRs for the risk margin calculation

The distribution of the expected liabilities in one year
A simpler alternative

- The "actuary-in-the-box" approach is not without its difficulties

- Where bootstrap (or equivalent) methods have not been used, an alternative is required anyway

- An alternative is simply to allow the "ultimo" variability to emerge steadily over time

- There is still the problem of calibration

Balance Sheet Definitions in Internal Models
Difficulties

- Companies will want more than one balance sheet definition in their internal model. For example:
  - Current UK/US GAAP
  - Solvency II
  - IFRS

- The inputs and outputs will need to be set up appropriately. Eg:
  - For the opening balance sheet: premium, claims, and expense assumptions will be needed separately for unexpired premiums and 'unincepted obliged' business (gross and RI)
  - The same items will be required for the 1 year ahead balance sheet, for each simulation. (For the legal obligations basis, this may require the business plan 2 years ahead).
  - Etc

EMB Igloo Example

Questions or comments?