Risk-based profit and loss attribution

Oliver Lockwood
Motivation

• Annuity business backed by a mixture of government and corporate bond assets
• Largest movements in valuation result usually investment variances
• Isolated credit spread variance by generating new asset data on old spreads
• Procedure not entirely adequate
• Only balancing item for impact of interest rate movements
• Better approach?
Key observation

• Spread variance assumed that all spread movements occurred at end of period
• Other items quantified as at start of period
• Why this inconsistency?
• Consistency requires all risks to occur simultaneously, otherwise there is an arbitrary choice of order
Categorisation of analysis items

• Established process in place
• Better to make consistent with risk management?
• Already hold capital against these risks under Individual Capital Assessment (ICA) regime
• Verify consistency of sensitivities with ICA stresses
• Verify that no material risk impacts omitted from ICA
• Greater integration between financial reporting and risk management
Solvency II

Tests to be satisfied for internal model approval:

- Use test
- Model governance
- Statistical quality
- Calibration
- Profit and loss attribution
- Validation
- Documentation
- External models and data
Profit and loss attribution (1)

• Article 123 of Solvency II Directive (my bold):

“Insurance and reinsurance undertakings shall review, at least annually, the causes and sources of profits and losses for each major business unit. They shall demonstrate how the categorisation of risk chosen in the internal model explains the causes and sources of profits and losses. The categorisation of risk and attribution of profits and losses shall reflect the risk profile of the insurance and reinsurance undertakings.”

• Likely to be difficult to achieve by adapting a traditional AoS
Profit and loss attribution (2)

- Paragraph 7.19 of EIOPA former CP56 (my bold):

  “The Profit and loss attribution for each major business unit shall be as transparent as possible. The attribution shall enable the insurance or reinsurance undertaking to explain a large part of its annual profit and loss. Furthermore the Profit and loss attribution has to be a tool for validating the internal model (Article 124) and for managing the business (Article 120).”
Validation

• Attribution should not produce a large unexplained movement
• Unexplained might be due to risks not allowed for in internal model
• Traditional AoS may not be robust enough to establish whether or not ‘unexplained’ is due to risks not allowed for in internal model
Managing the business – use test

• Each item of attribution is:
  % of risk factor that has occurred
  * Sensitivity to risk factor

• Sensitivities should be verified for consistency with risk appetite

• Breakdown into ‘% of risk factor’ and ‘Sensitivity to risk factor’ typically not transparent from a traditional AoS
Further advantages

• Second-order impacts fall out in a transparent way
• Maximise work that can be performed in advance of closing valuation date
Methodology – Step 1

• Determine value metric, period and risk factors
• Determination of risk factors would typically be led by risk management function
• Attribution provides independent validation of risk management function’s categorisation
Methodology – Step 2

• Isolate impact of unexpected data changes
• Example: inconsistencies in age, gender or annuity amount between old and new data files
• Suggest reporting separately at end of attribution
Methodology – Step 3

• Perform Taylor series expansion of movement in terms of risk factors
• Process automatically derives an equivalent level % of each risk factor that has occurred, *e.g.* equivalent level interest rate shift
• Therefore introduce ‘error terms’ and equate their sum to zero
• Can derive equivalent level % by solving a linear equation (Section 2 of paper)
• More refined method: quadratic equation (Section 3 of paper)
Different terms in the series expansion

• Coefficients of risk factors give sensitivities to risks
• Constant term gives expected movement assuming no risk factors occur
• Second-order terms – see paper for interpretation
• Don’t necessarily need to set up calculations for all second-order terms, only significant ones
Methodology – Step 4

• ‘Unexplained’ in principle represents interactions between risk factors not quantified explicitly
• Need to test that what is reported here in practice is indeed due to interactions not quantified explicitly
• Otherwise attribution has been coded incorrectly
Communication

• Generate table showing, for each risk factor:
  – % of risk factor that has occurred
  – Sensitivity to risk factor
  – Impact = % of risk factor * Sensitivity

• Likely to raise new questions

• Example: Why is calculated % of a risk factor different from that expected?

• Plot graph of error terms

• Break down into:
  – Differences between ‘local’ and ‘global’ percentages of risk factor
  – Sensitivities to those differences
Suggestions for further research - 1

• Don’t have to define, for example, 50% of a 1% rise in interest rates as a 0.5% rise
• In financial impact:
  50% of 1% rise < 0.5% rise
• Avoids second-order terms that are not amenable to interpretation
• Would still communicate to users that there had been a 0.5% rise
• Separate paper called for to articulate how to define risk factors
Suggestions for further research - 2

• Single interest rate risk factor not fully representative of range of yield curve movements
• Derive possible shapes of yield curve movement, e.g. using principal component analysis
• Impose condition that interest rate error terms should have no component in direction of each of these shapes
• Separate paper called for to specify methodology formally
Suggestions for further research - 3

• Apply methodology to value metrics that don’t vary smoothly with underlying risks
• Example - capital requirement equal to the greater of:
  – Formula prescribed by supervisor, and
  – Calculation taking account of specific risk profile
• Aim is to be aware in advance of types of scenarios that would cause biting regime to switch
• Natural extension of methodology, using step functions and Dirac delta functions
• Separate paper called for to specify fully
Questions?