Institute and Faculty of Actuaries

Risk-Based Performance Attribution

Oliver Lockwood

27 April 2015

Original motivation (1)

- Existing AoS process for annuity business inadequate to provide required understanding within timescales
- Fundamental redesign of process called for
- Needed to validate performance-based investment management fees

Institute and Faculty of Actuaries

Original motivation (2)

- Existing process had fixed order in which risks were assumed to occur
- Time-consuming
- Practical difficulties verifying that ordering being applied consistently throughout → reliability issues
- Paper to 2012 IAA Life Section Colloquium: http://www.actuaries.org/mexico2012/papers/Lockwood.pdf
- Working Party established to articulate methodology in a way more accessible to practitioners

Institute and Faculty of Actuaries

Further advantages of RBPLA over traditional AoS

- Integration between financial reporting and risk management
- Second-order impacts can be incorporated in a systematic way
- Items are % of risk factor occurred * Sensitivity to risk factor → validation
- **Identifies risks not allowed for in internal model**

Institute and Faculty of Actuaries

Reasons for focus on annuity business

- Simple type of business to use to illustrate concepts
- Liability cash flows do not depend on asset performance
- Historic compulsory annuitisation → financially significant

Institute and Faculty of Actuaries

Risk factors

- Start from risk factors in internal model

	GBP	EUR	USD
Interest rates	3	3	3
Inflation	3	3	3
Government bond spreads	3	3	3
Supranational bond spreads	1	1	1
Corporate bond spreads	7	7	7
Currency movements relative to sterling	N/A	1	1

Institute and Faculty of Actuaries

Further detail on risk factors

- Base yield curve = swap yield curve – default risk deduction. This is starting point for spreads
- Interest rate, inflation and government bond spread stresses derived by principal component analysis, but with adjustments for smoothing and tapering down to fixed UFR
- Government bond spread and inflation stresses are to forward rates. Interest rate stresses are to log forward rates, to avoid negative forward rates
- Level spread movements only
- Corporate bond spread stresses relative to next higher rating rather than risk-free yield curve, to avoid correlations close to 1
- Risk factors are movements in market indices, rather than in specific assets held

Credit migration risk

1. Impact of rating changes over reporting period on assets held
   - Derive a base and stressed transition matrix by reference to historic rating agency data
   - Asset values move according to spread curves for different ratings
   - Partial offset via MA (for funds with MA)
   - Rating changes might or might not be in line with market as a whole
2. Impact of changes in future fundamental spread assumptions (for funds with MA)
   - Does not come through if fundamental spreads are equal to floor of 35% of long-term spreads

Longevity and expense risks

- Can be brought into same P&L attribution framework as asset risks
- Requires look-through to how liability cash flows are derived
- Area for further research

Z-spread risk factors

- For measuring performance of assets held relative to market as a whole
- Level uplift to yield curve for asset class in question required to replicate market price of each asset
- Yield curves defined for:
  - Government bonds of each currency
  - Supranational bonds of each currency
  - Corporate bonds of each currency and rating
  - Swaps of each currency

Granularity of reporting

- Reflect how business is managed where not constrained by existing internal model structure
- e.g. for monitoring investment managers, use one Z-spread risk factor for each investment mandate
- In this example, Z-spread risk factors defined for:
  - Corporate bonds of each currency
  - Supranational bonds of each currency
  - Government bonds of each currency
  - Swaps: probably not of interest for performance measurement

Value metric in which to perform P&L attribution

- Theoretical framework completely general
- Bottom line value metrics, e.g. own funds, most relevant in a reporting exercise
- Useful for illustrating concepts to consider assets and liabilities separately
- In this example:
  - Assets
  - Own funds without MA = Assets – BEL without MA
  - Own funds with MA = Assets – BEL with MA
  - NB: no risk margin as all risks hedgeable (except credit migration risk, for which a bespoke allowance is made)

Taylor series expansion

Change in value metric
= Expected closing value – Opening value
+ Actual closing value – Expected closing value

= Expected change
+ f(Expected value of variable 1 + Risk factor 1,
Expected value of variable 2 + Risk factor 2, …)
- f(Expected value of variable 1, Expected value of variable 2, …)

= Expected change
+ Sensitivity to risk factor 1 * Risk factor 1
+ Sensitivity to risk factor 2 * Risk factor 2 + …

Institute and Faculty of Actuaries

Expected position

- Does not fall out automatically, so needs to be defined
- Needs to be commercially acceptable as a forecast, **but** rigour of P&L attribution process imposes realism
- Definition open to debate subject to meeting these criteria

Institute and Faculty of Actuaries

Expected position example

- Forward rates or spreads:

Year 1	Year 2	Year 3
0.5%	1.0%	1.5%

- Risk-free yield curve after one year:

Year 1	Year 2
1.0%	1.5%

due to no-arbitrage arguments

- A-rated corporate spreads after one year:

Year 1	Year 2
0.5%	1.0%

possibly more appropriate due to rating transitions

Institute and Faculty of Actuaries

Deviations

- Shape of yield curve movements will not in general be in line with risk factors
- Define: Deviation = Actual ZCB price – Expected ZCB price – Sensitivity of ZCB price to risk factor 1 * Risk factor 1 – Sensitivity of ZCB price to risk factor 2 * Risk factor 2 – …
- Add deviation terms into Taylor series expansion
- Similarly for corporate and supranational bond spreads, where movements will in general vary by term
- Credit migration experience: Need deviation term for each asset and each rating

Institute and Faculty of Actuaries

Solving for the amounts of the risk factors that have occurred

- Corporate bond spreads, supranational bond spreads, credit migration experience:
  Σ (deviation terms) = 0 gives a linear equation to be solved
- Inflation:
  - Vector of deviation terms should have zero component in direction of each risk factor
  - Gives 3 simultaneous linear equations
- Interest rates and government bond spreads:
  - Need to solve for both at once
  - Gives 6 simultaneous linear equations

Institute and Faculty of Actuaries

Specimen results – Sterling interest rate risk

	Assets	Own funds without MA	Own funds with MA
Risk factor 1	**(58.6)**	**(1.4)**	**(1.6)**
% of risk factor occurred	47%	44%	45%
Sensitivity to risk factor	(124.7)	(3.2)	(3.6)
Risk factor 2	**59.1**	**(1.2)**	**(1.2)**
% of risk factor occurred	(73)%	(75)%	(76)%
Sensitivity to risk factor	(80.9)	1.6	1.5
…			

- Small own funds sensitivities due to close matching
- Takes account of more assets needing to be held to back BEL when there is no MA
- Risk factor %'s slightly different in each column due to weighting differences

Institute and Faculty of Actuaries

Specimen results – Sterling inflation risk

	Assets	Own funds without MA	Own funds with MA
Risk factor 1	**28.3**	**0.8**	**0.8**
% of risk factor occurred	65%	62%	64%
Sensitivity to risk factor	43.6	1.3	1.2
Risk factor 2	**13.2**	**(0.4)**	**(0.4)**
% of risk factor occurred	48%	46%	46%
Sensitivity to risk factor	27.4	(0.9)	(0.8)
…			

- Similar sensitivities to sterling interest rate risk, but smaller magnitude of asset stresses because:
  - Inflation stresses only apply to inflation-linked assets and liabilities
  - Lower volatility of risk factors

Institute and Faculty of Actuaries

Specimen results – Currency risk

	Assets	Own funds without MA	Own funds with MA
EUR currency risk	**1.8**	**1.8**	**1.8**
% appreciation of EUR	9%	9%	9%
Sensitivity to a 1% appreciation	0.2	0.2	0.2
USD currency risk	**1.1**	**1.1**	**1.1**
% appreciation of USD	(11)%	(11)%	(11)%
Sensitivity to a 1% appreciation	(0.1)	(0.1)	(0.1)
…			

- Zero liability sensitivities, as liabilities denominated in sterling in this example
- Small asset sensitivities, in view of hedging
- Similar comments apply to overseas interest rate and inflation risks

Institute and Faculty of Actuaries

Specimen results – Spread risks

	Assets	Own funds without MA	Own funds with MA
GBP supranational bond spreads	**(1.4)**	**(1.4)**	**0.1**
Spread widening occurred	0.21%	0.21%	0.21%
Sensitivity to a 1% widening	(6.8)	(6.8)	0.4
GBP A-rated corporate bond spreads	**9.5**	**9.5**	**0.2**
Spread widening occurred	(0.32)%	(0.32)%	(0.32)%
Sensitivity to a 1% widening	(29.7)	(29.7)	(0.7)
…			

- P&L attribution for assets in isolation may be important here
  - Partly because some annuity funds will not have an MA
  - Also because some asset features, e.g. callability, may have been set up to give financial impacts outside matching adjustment portfolio

Specimen results – Credit migration risk

	Assets	Own funds without MA	Own funds with MA
Credit migration risk	**(14.4)**	**(14.4)**	**(3.6)**
% of risk factor occurred	36%	36%	36%
Sensitivity to risk factor	(40.0)	(40.0)	(10.0)

- Results will depend on assumed asset management strategy in expected position
  - Higher sensitivity if assets sold on downgrade than if asset holdings unchanged
- Deviations between actual asset management strategy and that assumed will appear as unexplained

Specimen results – Z-spread risk

	Assets	Own funds without MA	Own funds with MA
GBP supranational bond Z-spreads	**0.3**	**0.3**	**(0.0)**
Z-spread widening occurred	(0.05)%	(0.05)%	(0.05)%
Sensitivity to a 1% widening	(6.8)	(6.8)	0.4
GBP corporate bond Z-spreads	**(5.3)**	**(5.3)**	**(0.1)**
Z-spread widening occurred	0.14%	0.14%	0.14%
Sensitivity to a 1% widening	(38.1)	(38.1)	(0.9)
…			

- P&L attribution for assets in isolation may again be important here
  - Some annuity funds will not have an MA
  - No MA offset when assets are purchased or sold
  - Asset performance fees likely to be defined in market value terms

Unexplained

- Only two possible causes:
  1. Data changes not mapped to a risk factor
  2. Second-order interactions between risk factors
- If unexplained too large, then attempt to rule out 1. before quantifying second-order impacts
- Natural extension of methodology if second-order impacts do need to be quantified (see IAA paper)

Extension to new business risks

- Suggest bringing these into P&L attribution in same way as any other type of risk
- Expected position would use:
  - Sales volumes in line with business planning forecasts
  - Levels of profitability targeted by pricing process
- Independent verification that level of profitability targeted by pricing process is being achieved in practice
- Risk factors for:
  - Variance in sales volumes against those expected
  - Variance in profitability against that expected

Institute and Faculty of Actuaries

Extension to value metrics that do not vary smoothly

- Examples:
  - Fundamental spreads only vary with credit transition matrix when they need to rise above floor
  - Limited price indexation
- Similar problem in Economic Capital modelling – cannot sensibly fit smooth formulae to quantities that do not vary smoothly
- Can be dealt with by adding indicator variables as additional risk factors

Institute and Faculty of Actuaries

Developing an Excel-based tool

- Import asset data and liability cash flows to provide a P&L attribution for any annuity fund
- Making P&L attribution more granular, reflecting the way business is managed, likely to be of interest to all insurance companies
- Increased granularity unlikely to be progressed separately by each company, for resourcing reasons

Institute and Faculty of Actuaries

Balance sheet metrics

- Need robust understanding of a balance sheet metric to perform P&L attribution
- Balance sheet calculations in Excel tool likely to be appropriate as industry standards
- Opportunity for improved consistency and transparency of financial reporting practices

Institute and Faculty of Actuaries

Relationship with instantaneous stresses

- Only difference is that instantaneous sensitivities are calculated on an actual balance sheet, P&L attribution coefficients on an expected rolled-forward balance sheet
- Gives means of quantifying instantaneous stresses without a separate model run on each set of stressed assumptions
- Opportunity to improve efficiency of Solvency II and Economic Capital reporting processes, including risk margin

Institute and Faculty of Actuaries

Future of Excel tool

- Not released outside Working Party yet, as limited testing on actual data carried out
- Need further volunteers to get to a position where tool can be circulated to all UK life insurance companies with annuity business
- Also looking for volunteers interested in applying techniques to other classes of business/practice areas
- New call for volunteers to be published on IFoA website

Institute and Faculty of Actuaries

Renaming of Working Party

- To be renamed ‘Commoditising Financial Reporting’ WP to reflect broadened remit
- Easy trap to fall into to cut expenditure on reporting aggressively, resulting in poor quality information being provided to key decision makers
- Developing common platform will allow consistent standard of reporting across industry

Institute and Faculty of Actuaries

Questions Comments

Expressions of individual views by members of the Institute and Faculty of Actuaries and its staff are encouraged.

The views expressed in this presentation are those of the presenter.

E-mail: olockwood1980@gmail.com

Institute and Faculty of Actuaries