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Residual and Ancillary Risks in VA Guarantees

James Maher
Catherine Henshall & Tamsin Abbey
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- Behavioural Risk
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The VA Guarantee

- Rider accompanying unit linked policy
- Variants GMAB/GMDB/GMIB/GMWB …….
- Insurance company sells long term exotic options
- With considerable policyholder optionality
- Putting risk back into the industry
- Profession well placed to analyse and understand the risk, but….

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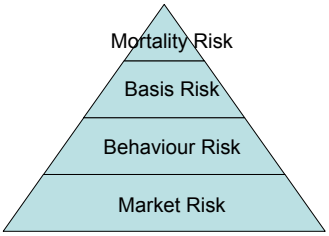
Decomposing the Risk



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Dynamic Lapse Modelling

Catherine Henshall and Tamsin Abbey

Dynamic lapse modelling

- It is common for companies to model lapses dynamically in stochastic models used for variable annuities.
- However in practice these models are loosely calibrated.
- The factors that influence the calibration are typically as follows:
  - Historic experience
  - Different economic events
  - The level of policyholder rationality
- Historic experience is sparse for variable annuities, and companies usually have a very high level estimate regarding the level of rationality of their policyholders.

A 'worst case' level of rational behaviour can be used to check the calibration of dynamic models.

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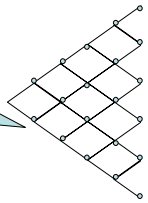
Lapse behaviour modelled

- GMAB lapse rule: If the guarantee is out of the money then the policy lapses, otherwise it continues in force.
- Moneyness is determined by comparing the fund value to the present value of the option.
- For a GMWB the same would apply, except that the guarantee would be calculated by taking the present value of a series of cashflows (the present value of the future withdrawals).
- Depending on the timing of the lapse and its position in the node tree, a lapse may increase or decrease profitability due to the relative loss of future charges and claims.



Lapse decision occurs at each point in the node, if fund > guarantee then lapse

The fund is always projected to the end, which differs from stochastic modelling where the policy lapses as soon as the guarantee bites

Policyholder behaviour Binomial tree model

Mathematical model of rational and irrational policyholder behaviour for GMABs.

Rational policyholder behaviour is modelled using a recombining binomial distribution tree. Economic conditions under various stresses may be inputs to this.	• We can calculate the present value of guarantee outgo and charges under many stressed scenarios.
These dynamic present values may be reworked to solve for an equivalent deterministic lapse rate for both charges and outgo.	• In an extreme event we can see what the equivalent lapse rates would be if deterministic lapse rates had been used in the pricing.
We can make assumptions about what the proportion of rational policyholders is.	• We can use the model to examine what would happen in extreme events under different 'rationality' assumptions.
Policyholder behaviour is combined with other risks using worse combined stress techniques to calculate combined extreme events.	• We can calculate the percentage of rational policyholders (vs irrational) in the combined likely scenario that will hurt the most.

Base case and worse combined stress

	Base	100% rational	Worse combined stress
Fund value	100	100	68
Index	100	100	68
Present value strike	67.03	67.03	67.03
Rational:			
Present value gtee	6.2	6.2	26.1
Present value charges	5.0	5.0	10.1
Irrational:			
Present value gtee	4.4	4.4	16.2
Present value charges	11.6	11.6	11.0
% Rational policyholders	**30%**	**100%**	**42.3%**
Excess charges over cost of guarantee	4.7	-1.2	-9.8

Base case is profitable, but relies on 70% irrational lapses

Combines increased rationality with worsening market conditions

Assumptions

	Base	Worse combined stress
Equity	100%	79.86%
Interest rate	4%	3.31%
Volatility	20%	27.98%
Tracking error	0%	-2.15%
Credit spread	0%	0.46%
Lapse	10%	5.26%
% rational	30%	42.36%

*Special thanks to Andrew D Smith for the above results.

Advantages of Model

•We have more accurate picture of total dynamic lapses, including the implicit assumptions about rational and irrational policyholder behaviour that exist.
•We have solved for equivalent static lapse rates for reference and overall reasonableness testing.

It provides an independent check on the stochastic lapse rule in the model.

It can be used to check individual lapse stress levels.

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Tracking Error & Basis Risk

Colin Murray

Basis Risk

- "Basis risk" often the appendix to many studies…
- "….need to remember to allow for basis risk"
- What is it?
- How do we quantify for it?
- How do we manage it?

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Basis Risk

- Benchmark deviates from the underlying of hedging instruments
- Fund manager deviates from benchmark (tracking error)
- Fund expenses (TER)
- Underperformance
- Particularly a problem for “external funds” which are wrapped

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Tracking error – an Example

- Insurance Company sells 5 year put, strike at 100 on an account value with Vol of 15%
- Regression identifies proxy indices with differing correlation coefficients ranging from 100% down to 90%
- Insurance company can rebalance monthly
- What happens to hedge effectiveness (reduction in monthly earning volatility) for different proxies ?

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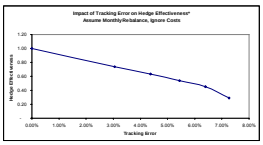
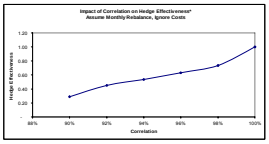
Example - Outcomes

- Tracking Error/Correlation
- Significant Deterioration in effectiveness
- Question hedging below X%
- In practice observe mapping worse than 90% correlation !





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Putting a price on it

- Option Volatility Approach
  - Index A = Index B + Tracking Error
  - Vol of Index A = $\sqrt{\sigma^2_b + \sigma^2_{te}}$
  - Eg for σ_{te} = 5% => $\sigma^2_a = \sigma^2_b$ + 80bps
- Utility Approach
  - Assymetric values on Profits and Losses
  - Mean Value of TE shifts to create a cost
- Cost of Capital Approach
  - Set aside capital for TE
  - Cost of carrying Capital

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Regression

- Revealing the truth
  - If can map to Indices what are we paying the fund manager for ?
- Compromise
  - Recent experience V credibility
  - Longer cycles – "behind the curve"
- Noise & Drift
  - As above, R-squared fit doesn't always catch drift

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Solutions & Responses

- Include funds where there are opportunities to short
  - Need for two way markets
  - Expensive stock borrowing costs
- Direct Access to fund composition
  - Practical Issues
- Index funds only
  - Client gets optimal access to market Beta
- Hand it back
  - Redress for non performance to benchmarks ?

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Market Risk – Residual Risks

James Maher

Market Risk – Profit Sources

- Rider seen as a source of profit
  - A "spread business" => Comprehensive hedging/reinsurance
  - Retain Risk and related margins
- Realising Profit from Risk
  - Un-hedged ?
  - Capital Implications - Reserves & Capital
  - Assume - Delta/Delta Rho Hedging
- Delta Hedging – Residual Risks
  - Isolate and Retain Variance related risks
  - Isolate and Retain Correlation related risks

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Variance Related Risks & Opportunity

- $\sum$ Dollar Gamma * $(\sigma_r^2 - \sigma_i^2) + \Delta \sigma_i$
- Options Approach
  - Sensitivity to current volatility – reduce Gamma
  - Sensitivity to future volatility – reduce Vega
- Variance Swaps $- \sum (\sigma_r^2 - \sigma_i^2)$
  - Sensitivity to current volatility – requires constant dollar gamma
  - Sensitivity to future volatility – pure play
  - Strike >ATM Implied Volatility
- Hybrid
  - Options with a target/agreed volatility budget
  - Either Expire or Reprice for realised volatility > budget

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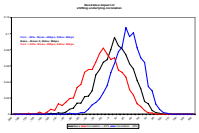
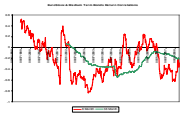
Correlation Risk & Opportunity

- Impacts Account Value volatility
- Experienced in P&L via realised variance V implied variance
- Pricing
  - Constant/Historic + Margin
  - Translate into + 100/200 bps of vol ?



- More Complex Modelling
  - Not Stable over time
  - Conditionality
- Hedging
  - Correlation/Dispersion trades



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Retail Margins & Residual Risks

- Focus on Distribution and Asset Management
  - Guarantee = Means to an end
- Replicating Derivatives
  - Retain Freedom & Non market risks
- Mortality and Market Risk Reinsurance
  - Retain Freedom & Non Market Risks Ex Mortality
  - Transfer Reserves & Capital
- White Label / Full Risk Reinsurance
  - Retain – Nothing ?
  - Transfer – Control/Freedom ?

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Knitting it together

Been there, done that !

Remind me why we are taking this ?

Take a leap with your eyes open

Hedge a Little or Hedge a lot

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