Landscape of Risk Management Approaches and Instruments

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Risks Embedded in Life Insurance Products & Available Tools

Life insurance carriers are concerned about a number of measures affected by market factors, e.g., accounting earnings, capital / surplus and true economic exposures.

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<th>Insurance Risks</th>
<th>Tools Available to Mitigate Embedded Risks</th>
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<td>• Mortality, longevity, morbidity</td>
<td>• Robust product design: limiting certain risks by design</td>
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<tr>
<th>Behavioral Risks</th>
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<tr>
<td>• Premium payment pattern</td>
<td>• Risk pooling by relying on the Law of Large Numbers; it could work for mortality / longevity</td>
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<td>• Persistency / lapse</td>
<td>• Diversifying balance sheet across business lines with offsetting risk exposures; for example, balancing retirement products annuities against protection products</td>
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<td>• Benefit utilization</td>
<td>• Designing / implementing appropriate ALM / hedging programs</td>
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<td>• Fund switching</td>
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<th>Consideration for Developing Hedging Programs</th>
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<td>• Equity market returns</td>
<td>• Hedging objectives and constraints: true economic exposure, US GAAP earnings or capital / surplus? how static / dynamic?</td>
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<td>• Interest rates</td>
<td>• Dynamic hedging vs. macro hedging programs</td>
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<td>• Foreign exchange rates</td>
<td>• Risks hedged vs. risks retained</td>
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<td>• Credit spreads</td>
<td>• First order sensitivities: delta, rho, vega, IR vega</td>
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<td>• Funding rates</td>
<td>• Second order sensitivities: gamma, cross-gamma</td>
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<tr>
<td>• Basis risks</td>
<td>• Available hedging instruments: OTC vs. exchange traded</td>
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Consideration for Developing Hedging Programs

• Hedging objectives and constraints: true economic exposure, US GAAP earnings or capital / surplus? how static / dynamic?
  • Dynamic hedging vs. macro hedging programs
  • Risks hedged vs. risks retained
    • First order sensitivities: delta, rho, vega, IR vega
    • Second order sensitivities: gamma, cross-gamma
    • Available hedging instruments: OTC vs. exchange traded
      • Flexibility vs. liquidity
      • Credit risk considerations
A great variety of derivatives, both exchange traded and OTC, referencing equity, interest rate, FX and credit instruments have been used by life insurance carriers to hedge their capital markets exposures.

**Equity Derivatives**
- Exchange-traded:
  - Equity-index futures: allow carriers to take either a long or short position in the underlying index to hedge equity delta
  - Shorter-dated call / put options on equity indices: give carriers a right (but not an obligation) to buy / sell the underlying index at a specified strike price to hedge equity gamma and shorter-term implied volatility (vega)
- Over-the-counter:
  - Total-return swaps on equity indices: also allow carriers to go long or short the underlying index
  - Longer-term call / put options on equity indices: strikes & expiries are more flexible
  - Variance swaps: allow carriers to hedge vega
  - Dividend swaps

**Interest Rate Derivatives**
- Exchange-traded: interest rate futures
- Over-the-counter:
  - Interest rate swaps: an “exchange” of series of cash flows, e.g. fixed vs. floating interest rate swap in the same currency
  - Interest rate swaptions: an option to enter into a swap at a future date
  - Caps / floors: call / put options on an interest rate index, e.g. 10-yr constant maturity swap
# Comparing Risk Management / Hedging Programs

<table>
<thead>
<tr>
<th>Description</th>
<th>Traditional 3-Greek Hedging</th>
<th>Advanced Dynamic Hedging</th>
<th>Customized Hedging</th>
<th>Partial Reinsurance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Put spread collars • Collars • Puts • TRS • Interest rate swaps • Futures</td>
<td>• Supplement 3-Greek Dynamic Hedging with exotic options</td>
<td>• Customized OTC derivative that fully hedges capital markets exposure</td>
<td>• Reinsurance contracts that leave some risks with the ceding company: actuarial risks (e.g. longevity), and/or market risks</td>
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<td>• E.g. basket options, look-backs, equity-rate hybrids, dividend or variance swaps</td>
<td>• Amortizing notional incorporates VA writer's assumptions for mortality and behavior</td>
<td>• Cash flows can be similar to “Customized Hedging”</td>
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<td></td>
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<td></td>
<td>• Two main approaches: “Cell Based” and “Cash Flows Based”</td>
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<tr>
<td>Benefits</td>
<td>▲ Highly liquid products with numerous counterparties</td>
<td>▲ Most robust hedge via more complex exotic options</td>
<td>▲ Tailored and robust hedge (good to excellent transfer of markets risks)</td>
<td>▲ Tailored to hedge capital intensive blocks of business</td>
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<tr>
<td></td>
<td></td>
<td>▲ Accommodate complexity and liability convexities</td>
<td>▲ Long dated hedging of liabilities</td>
<td>▲ Possibility to achieve efficient accounting</td>
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<td></td>
<td></td>
<td></td>
<td>▲ Blocks of business can be hedged in a single deal</td>
<td>▲ Some transfer of actuarial risks</td>
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<tr>
<td>Considerations</td>
<td>▼ Lowest level of risk transfer</td>
<td>▼ Typically shorter term</td>
<td>▼ Counterparty risk needs to be carefully monitored and mitigants put in place</td>
<td>▼ Residual actuarial and behavioral risk retained</td>
</tr>
<tr>
<td></td>
<td>▼ Limited credit in rating agency and regulatory capital models</td>
<td>▼ Some residual exposure</td>
<td>▼ VA writer retains exposure between observed and modeled behavior and mortality (no transfer of actuarial risks)</td>
<td>▼ Regulatory treatment depends on amount of risk transfer</td>
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<td></td>
<td>▼ Substantial historical rates of hedge breakage across the VA industry</td>
<td>▼ Model / infrastructure complexity (e.g. stochastic hybrid and behavioral modeling)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market Capacity</td>
<td>![High]</td>
<td>![Low]</td>
<td>![Low]</td>
<td>![Low]</td>
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<tr>
<td>Economic Risk Transfer</td>
<td>![Low]</td>
<td>![Low]</td>
<td>![Low]</td>
<td>![Low]</td>
</tr>
<tr>
<td>Fit with Objectives</td>
<td>![Low]</td>
<td>![Low]</td>
<td>![Low]</td>
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Types of Dynamic Hedging Programs

Dynamic hedging programs aim to reduce capital markets exposures embedded in the liabilities by entering into and rebalancing financial contracts with offsetting sensitivities.

One-Greek Hedging Program
- **Advantage:** Lowest expected cost
- **Disadvantages:** No interest rate coverage, most path-dependent results / effectiveness, most residual exposure to long-term market conditions

Two-Greek Hedging Program
- **Advantages:** Moderate expected cost, better at managing short-term accounting results
- **Disadvantages:** No long-term coverage / significant exposure to long-term economics, full exposure to second-order Greeks, including correlation, equity volatility and basis risk

Three-Greek Hedging Program
- **Advantages**
  - Hedging via mostly liquid instruments
  - More complete risk coverage for long-term risks and some market gap risks
- **Disadvantages**
  - Residual exposures from higher-order Greeks, including correlation and residual market gap risk
  - Higher bid / ask spread and difficulty in rebalancing hedges of longer-term equity volatility

- **Equity futures**
- **Total return swaps**

- **Interest rate futures**
- **Interest rate swaps**

- **Interest rate swaptions**
- **Equity puts**

- **Basket options, equity rate hybrids**
- **Dividend swaps, variance swaps**
By using exotic and hybrid instruments advanced dynamic programs produce a more robust hedge with a closer match to the underlying economic exposures.

**Advanced Dynamic Hedging**

- Several larger / more sophisticated hedging programs also hedge some second-order sensitivities (gamma, equity / interest rate cross-gamma) in addition to the first-order Greeks hedged as part of a three-Greek hedging program
- Considerations on long-term equity volatility
  - Expensive as the term structure is upwards sloping due to supply / demand imbalances
  - Alternatives: Asian options (with averaging), timer options (with a volatility budget)
  - Becoming less pressing due to a switch to volatility controlled / targeted funds
- Advantages: more comprehensive coverage of capital markets risks, especially those of a higher order
- Disadvantages: higher expected cost of hedging, more expensive rebalancing costs

<table>
<thead>
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<th>STRATEGY</th>
<th>Advanced Dynamic Hedging</th>
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</table>
| DESCRIPTION | • Supplement 3-Greek Dynamic Hedging with exotic options  
• Basket options, look-backs, equity-rate hybrids, dividend and variance swaps |
| PROS | • More robust hedging via more complex options  
• Accommodate complexity and liability convexities, cross-gamma |
| CONS | • Some residual exposure  
• Sophisticated model / infrastructure (e.g. stochastic hybrid and behavioral modelling) |
Advanced Dynamic Hedging Programs: Hybrid Hedging

Hybrid hedges referencing equity and interest rate instruments provide a better fit for VAs with secondary guarantee risk exposure and are more cost effective.

### Risk Exposures in VAs with GMxBs

- Carriers writing VAs secondary guarantees are exposed to the greatest risk when both equities and rates are lower
  - Consequently, carriers are short equity / rate correlation: as the value of their liabilities increases with a decrease in equities and rates
- Traditionally, carriers hedge their volatility exposure with a combination of vanilla instruments such as equity puts and receiver swaptions
  - This results in a mismatch between the hedge and the true risk profile of the liability.
  - Consequently, the vanilla products usually over-hedge risk at unnecessary expense

### Advantages of Hybrid Hedging

- Carriers can achieve a substantial cost-reduction by taking advantage of the implied correlation between these equity and rate instruments
- A more accurate hedge can be constructed to more closely match the risk-profile by monetizing the equity / rate correlation
- Hybrid hedges can also help reduce rebalancing frequency and result in lower overall frictional costs
- Hybrid hedges can be constructed in such a way that they switch to a vanilla option upon certain conditions

<table>
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<tr>
<th>Equity Down</th>
<th>Rates Down</th>
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<tr>
<td><strong>Moderate Risk: Offsetting Exposures</strong></td>
<td><strong>No Risk</strong></td>
</tr>
<tr>
<td><strong>High Risk</strong></td>
<td><strong>Moderate Risk: Offsetting Exposures</strong></td>
</tr>
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</table>

### Disadvantages of Hybrid Hedging

- It requires more sophisticated modeling, pricing and risk management systems
- At the same time, third party vendors’ tools are becoming increasingly more readily available (e.g., Bloomberg’s DLIB pricing library)
- Hybrid hedges are not meant to be rebalanced frequently as they are substantially less liquid than other instruments; they are better suited to be a static part of the program
Hybrid Hedges Executed by Life Insurance Carriers

Hybrid derivatives have been executed by a number of carriers as part of their both dynamic hedging and macro hedging programs.

Hedging VA Secondary Guarantees

• **Equity Put Option with Rate-Dependent Notional:**
  - **Example:** 5-year European put option on the S&P 500 with the put notional increasing with a decrease in a pre-defined long-term rate (e.g. 10-year or 20-year swap rate)
  - Trades with similar payoffs have been executed as part of a dynamic hedging program, with the S&P 500 put strikes being at-the-money (ATM) to 20% out-of the money (OTM)

• **Equity Put Option Contingent on Lower Rates:**
  - **Example:** 1-3 year European put option on the S&P 500 knocking in if the reference interest rate at maturity is lower than the interest rate strike. The S&P 500 put strike is typically 30% to 60% OTM
  - Similar trades can be useful in the context of both dynamic hedge and macro hedge programs. As part of a macro hedge program, these trades would protect the carrier’s surplus upon a stress scenario of equities dropping 40%. Even though interest rates are typically not hedged in such macro hedging programs, the rate contingency would substantially cheapen the cost of the equity put

Portfolio Protection / Hedging Asset Management Fee Income

• Carriers with substantial asset management fee income dependent on the NAV of mutual funds allocated to both equities and bonds have a different directional exposure to interest rates and equities. The fee income decreases with a decrease in equities and an increase in rates. Hence, their risk increases as the equity / rate implied correlation goes down. This exposure can be hedged with a number of different payoffs
Customized Hedging Strategies: “Top-Down” Approach

The “top-down” approach is based on constructing a customized “asset” with the cash flows statistically fitting the liability cash flows projected over Monte Carlo scenarios.

“Top-Down” (Cash Flow Based) Approach

- Unlike various dynamic hedging strategies, customized hedging approaches do not explicitly focus on reducing various capital markets sensitivities, even though the do reduce them indirectly
- Rationale: the general idea is to create a customized “asset” such that the cash flows produced by the asset would provide a good statistical fit to the cash flows produced by the liabilities, with the fit computed over a set of Monte Carlo scenarios
- Methodology:
  - The mutual funds underlying a defined block of VAs with GMxB are mapped into a basket (“synthetic basket”) of liquid equity and bond indexes (S&P 500, Russell 2000, MSCI EAFE, Citi BIG, money market)
  - Monte Carlo scenarios is generated jointly for these indexes based on assumed volatilities, cross-correlations and returns The scenarios may be risk neutral or real world (to be consistent with AG43 / C3 PII stochastic calculations)
  - GMxB claims also generated on the same scenarios
  - Finally, the projected claims for a given time period are statistically fitted to a non-linear function of the synthetic basket (and other relevant variables)
Customized Hedging Strategies: “Bottom-Up” Approach

The main idea of the “bottom-up” approach is to bifurcate capital markets risks from those that cannot be hedged by splitting a defined block into multiple cells / cohorts and hedging all the capital markets risks within each cell.

“Bottom-Up” (Cell Based) Approach

- A defined block of business is split into multiple cells by grouping the underlying contracts into cells in accordance with gender, age, surrender, benefit utilization and contract vintage, and underlying basket allocation, benefit in-the-money

- The idea is to split the block into a set of cells, with each cell containing multiple contracts with similar characteristics

- Finally, a customized payout needs to be designed for each cell capturing and replicating in the payout all the relevant benefit features, with the primary goal of hedging all (or the majority) of the risks embedded in the cell

- The hedging counterparty assuming all the capital markets risks within each cell and the insurer retaining the non-market risks associated with splitting the block into these cells

- This approach therefore results in a risk coverage closest to a coinsurance cover provided by a 3rd-party reinsurer
Upcoming Accounting Changes Affecting Hedging

The two accounting proposals are likely to result in more hedging reflecting the underlying economic exposures embedded in GMxBs.

FASB Proposal for the Accounting of Long-Duration Insurance Contracts

- The FASB have recently released a proposal for targeted improvements to the accounting for long-duration insurance contracts
- The proposal implementation may take place as early as 2018
- The proposal focuses on several areas (reserving for fixed premium / fixed benefit contracts, DAC amortization, disclosures related to insurance, as well as accounting for GMxBs for separate account products)
- US GAAP accounting for GMxBs for separate account products
  - Currently, life contingent liabilities such as GMIB and GMDB are valued according to SOP 03-1
  - Under the FASB proposal, all GMxBs (including those life contingent) arising from separate accounts (called “market risk benefits” by the FASB) would be required to be measured at fair value
  - The proposal would put “market risk benefits” on the same accounting basis as the assets typically used to hedge the capital markets risks of such benefits

NAIC VA Reserve and Capital Reform

- In 2015 Oliver Wyman proposed to the NAIC several potential improvements to the current AG 43 and C3 Phase II frameworks with several goals, some of which are:
  - Mitigating the accounting mismatch statutory reserves and hedges
  - Removing non-economic volatility in statutory capital
- One of the proposals is to align economically-focused hedge assets with reserves by endorsing hedge accounting for derivatives related to a VA hedging program
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- **Additional Details:**

- **Contact Information:**
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