



SOCIETY OF ACTUARIES

**Equity-based Insurance Guarantees Conference  
October 27-28, 2008**

**Pricing GMWB Riders**

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**Moderator**

Dr. K. (Ravi) Ravindran

# GMWB PRICING CONSIDERATIONS

1:30 – 3:00 P.M., October 27, 2008

*Radha Lakshminarayanan*  
*Penn Mutual Life Insurance Company*

## CASE STUDY

- **XYZ Company wants to introduce a GMWB Rider which satisfies the following constraints:**
  - *Design must be attractive and comparable to riders in the marketplace*
  - *Must be competitively priced*
  - *Must be able to manage embedded risks*
  - *Must meet Company's profitability standards*
- **Pricing Challenges:**
  - *Price coming out to be 25 bps higher than what the market can bear*
  - *Management of risks under current market conditions*

## CASE STUDY

- **Adding a new GMWB rider to an existing VA**
- **GMWB Rider Design**
  - *Minimum Issue Age: 40 & Maximum Issue Age: 80*
  - *Max (6% Roll-Up, Maximum Anniversary Value)*
    - *Roll-Up & MAV end upon the earlier of 10 years or 1<sup>st</sup> withdrawal*
  - *Automatic & Annual Step-Ups before & after 1<sup>st</sup> withdrawal*
  - *Guaranteed Lifetime Withdrawal Percentage: 5.0%*
  - *Minimum Withdrawal Age: 40*
  - *Currently, no investment income allocation restrictions but can reinforce in the future*

## CASE STUDY

- **GMWB Rider Design**
  - *Death Benefit: Max (6% Roll-Up, MAV) up to earlier of 10 years or 1<sup>st</sup> withdrawal*
  - *Death Benefit: Annual Step-Ups before and after 1<sup>st</sup> withdrawal*
  - *Treatment of Withdrawals:*
    - *If Withdrawal <= Guaranteed Lifetime Withdrawal Amount:*
      - *GMWB not reduced but GMDB reduced \$-for-\$*
    - *Upon an Excess Withdrawal:*
      - *GMWB & GMDB Bases reduce proportionally*
  - *Investment allocation restrictions (80% Maximum Equity Allocation)*
  - *Single Life rider fee: 0.95% of Contract Value (target 70 b.p.)*

## CASE STUDY

- **GMWB Rider Design:**
  - *10 yr GMAB with annual step-ups*
  - *Can extend the 10-yr period upon a step-up*
- **Base VA**
  - *M&E + Contract Administration Fee: 1.40%*
  - **Agent Commissions:**
    - *FY : 5.25% of Premium*
    - *Yrs 2+ : 50 b.p. of Contract Value*
  - **Profit Objectives:**
    - *ROI : 18%*
    - *ROA : 40 b.p.*

## PRICING TRADE-OFFS

| Option                                | Trade-off  |
|---------------------------------------|--|
| <i>Charge 25 bp over market price</i> | <i>Competitiveness</i>   |
| <i>Charge market price</i>            | <i>Profitability</i>   |
| <i>Product Design</i>                 | <i>Competitiveness</i>   |
| <i>Limit # of Greeks hedged</i>       | <i>Exposure</i>  |
| <i>Increase M &amp; E charges</i>     | <i>Competitiveness, possible re-filing, more feasible on a new Chassis</i> |
| <i>Reduce field compensation</i>      | <i>Lowers incentive to sell, more feasible on a new Chassis</i>            |

## VARIABLE ANNUITY CONTRACT



Work best as a couple

## TOTAL CONTRACT FEES

|                             |  |
|-----------------------------|--|
| Mortality & Expense (M&E)   | ≈ 1.25% of Contract Value  |
| Contract Administration Fee | ≈ 0.15% of Contract Value  |
| Investment Management Fee   | ≈ 1.00% of Contract Value  |
| Policy Fee                  | ≈ \$50 if Contract Value < \$50K   |
| Surrender Charges           | ≈ 8.00% of Premium in 1 <sup>st</sup> year<br>grading down to 0.00% at the end<br>of 8 years |
| GMWB Rider Fee              | Single Life: ≈ 0.65% - 0.95%<br>Joint life: ≈ 0.85% - 1.15%<br>Maximum Fee: 1.25%            |

## GMWB PRICING CONSIDERATIONS

$$\begin{aligned} &\text{GMWB Rider fee} \\ &= \\ &\text{Hedge Cost} \\ &+ \\ &\text{Risk Margin} \\ &+ \\ &\text{Rider Capital Costs} \\ &+ \\ &\text{Rider Administrative Expenses} \\ &\textit{(The above ignores any Base VA subsidies)} \end{aligned}$$

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## GMWB PRICING CONSIDERATIONS

- Product Design
- Risk Management
- Base VA features
- Key modeling considerations
- Summary

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## GMWB PRICING CONSIDERATIONS

Trade- Off :  
Product Design

## GMWB PRICING CONSIDERATIONS

- **Death Benefit Design Trade-off alternatives**
  - Is a stand-alone GMDB rider offered? If so:
    - Can it be elected with the GMWB?
    - Is a Death Benefit component needed?
  - Does the Base VA death benefit include a guarantee?
  - Roll-Up guarantees are expensive:
    - Not offer a roll-up guarantee or
    - Lower the 6% roll-up guarantee to 5% but it will not coordinate with the GMWB Roll-Up guarantee of 6%
  - Proportional reduction of withdrawals before & after 1<sup>st</sup> withdrawal
  - Not offer annual step-ups or make them dependent upon GMWB step-ups

## GMWB PRICING CONSIDERATIONS

- **GMWB Design Trade-Off alternatives**
  - Re-Visit Market Positioning – Income now or Income later
  - Withdrawal Delay incentives
    - Effective risk lever
    - Increase the minimum withdrawal age from 40 to 59½ or age 60
      - Lowers tail risk
    - Roll-Ups are expensive
      - Current interest rate environment
      - Drag on Contract Value due to aggregate Contract Value-based charges
      - Reduce duration cap
      - Institute an age cap

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## GMWB PRICING CONSIDERATIONS

- **GMWB Design Trade-Off alternatives**
  - Withdrawal Delay incentives
    - Roll-Ups are expensive
      - Can reduce roll-up percent but it will significantly lowers competitiveness
      - Simple Interest instead of Compound Interest
    - Step-Ups
      - Making it optional and less frequent than annual lowers hedge cost
      - Changing automatic annual step-ups to optional / 3-year step-ups significantly impacts competitiveness
      - Can institute Age and/or duration caps
      - Option to increase fee upon a step-up

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## GMWB PRICING CONSIDERATIONS

- **GMWB Design Trade-Off alternatives**
  - **Withdrawal Phase**
    - Remove the step-up provision after 1<sup>st</sup> withdrawal
    - Restrict additional premium dump-ins
    - Re-visit RMD-Friendliness
  - **Maturity Age considerations**
    - Treatment of GMWB past maturity age
    - Should projections in the model go beyond the maturity age?
  - **Spousal continuation**
    - Allow spousal continuation or not?
    - Need to price for that, if allowed

## GMWB PRICING CONSIDERATIONS

- **Other Design Trade-Off alternatives**
  - Not offer a GMAB component
  - **Institute Stricter Investment Allocation Restrictions**
    - Control of equity exposure by controlling volatility
  - **Fee structure**
    - Charge as a % of GMWB Base
      - Better alignment with the risk
    - % of greater of (Contract Value, GMWB Base)
  - **Packaging of rider features**
    - Consider unbundling features
      - Can get a bit unwieldy for the end consumer
    - Administrative system capabilities

## GMWB PRICING CONSIDERATIONS Implemented Product Design Trade-offs

| Feature                | Trade-off                                 | Hedge Cost Impact                     |
|------------------------|---|---------------------------------------|
| Minimum Withdrawal Age | Age 59 ½ (vs. Age 40)                     | ≈ 3 to 5 b.p.                         |
| GMDB Roll-Up           | Not Offer                                 | ≈ 15 to 18 b.p.                       |
| Fees                   | % of Guarantee Base<br>Do not lock-in fee | ■ Risk levers                         |
| Step-Ups               | Limit to Age 80                           | ■ More of an impact for Death Benefit |
| GMAB                   | Not offer                                 | ≈ 5 to 6 b.p.                         |

- Altering product design can have a significant impact on hedge costs

## GMWB PRICING CONSIDERATIONS

### Embedded Risks

## GMWB PRICING CONSIDERATIONS

### ■ GMWB RISK PROFILE

- Non-diversifiable risk
- Claim distribution does not follow the law of large numbers
  - Claims do not converge to the mean / median
  - Risk quantified in terms of standard deviation
- Optionality with policyholder behavior
  - Claim pay-offs similar to put option payoffs

## GMWB PRICING CONSIDERATION

### ■ Capital Market Risks

- Equity Risks
  - Exposure due to absolute market levels
  - Exposure due to volatility in market levels
- Interest Rate Risks
  - Actual interest rates could be lower than rates used to project fund values and discount claim / premium cashflows
  - Exposure to convexity

## GMWB PRICING CONSIDERATIONS

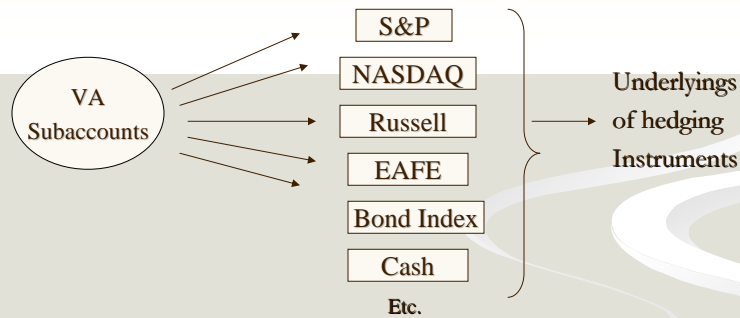
- **Policyholder Behavior Risk**
  - A key differentiator of risk profile
  - A major driver of rider cost
  - Unhedgeable risk
  - Manifests itself in the following ways:
    - **Unexpected fund allocation changes**
      - Hedge cost very sensitive to Equity/Fixed Income fund allocation
    - **Unexpected lapses**
      - Higher lapses bad for Base contract
        - lose out on M&E fees & DAC write-downs
      - Good for GMWB rider as lower expectation of benefits

## GMWB PRICING CONSIDERATIONS

- **Policyholder Behavior Risk**
  - Manifests itself in the following ways:
    - **Timing of first withdrawal**
      - Major driver of hedge cost
      - Withdrawal delay incentives and waiting period to exercise the benefit built into the design as a result.
    - **Dynamic withdrawal utilization**
      - Withdrawal behavior a function of ITM-ness of liabilities, attained age, duration etc.

# GMWB PRICING CONSIDERATIONS

## ■ Basis Risk



- Sub-accounts deviating from proxy indices & proxy indices deviating from underlying hedging instruments

# GMWB PRICING CONSIDERATIONS

## Risk Management

## GMWB PRICING CONSIDERATIONS

- **Product Design**
  - Starting point for risk management
- **Reinsurance**
  - ***Traditional***
    - Transfer of capital market and actuarial risks
    - Watch out for Counterparty Risk!
    - 1 or 2 reinsurers
    - Very expensive – Need to give up M&E in addition to rider fees

## GMWB PRICING CONSIDERATIONS

- **Reinsurance**
  - ***Capital Markets reinsurance***
    - Transfer of market risks only
    - Retain Policyholder Behavior, Basis and Longevity risks
    - Counterparty risk – Recent market events a good evidence!
    - Availability likely to be limited

## GMWB PRICING CONSIDERATIONS

### ■ Hedging

- Align rider pricing with derivative market pricing
- Economic or Accounting objective?
- ?-Greek hedging
- Full or partial hedge?
- Dynamic hedging
  - Likely to become costly due to increased expectancy of volatility
  - Buying long-term put options
    - Cost cost-effective

## GMWB PRICING CONSIDERATIONS

### ■ Hedging

- Dynamic hedging
  - Buying a combination of short-term (up to 2 years) put options:
    - Higher transaction costs
    - Renewal cost would rise with subsequent replications
    - Possibly, higher basis risk

## GMWB PRICING CONSIDERATIONS

### ■ Hedging

#### ■ Natural hedging

- Diversify insurance (Life + Annuity) liabilities
  - Equity & mortality risk
  - VA Guarantees + Indexed Life
  - VA Guarantees + Indexed Annuity
  - Offering Estate Enhancement Benefit
- With the right sales mix, the above benefits can partially hedge each other

## GMWB PRICING CONSIDERATIONS

### Real-World vs. Risk Neutral Valuation

## GMWB PRICING CONSIDERATIONS

- **Base Contract pricing (typically) on a real-world basis**
  - Priced using mean returns based on historic equity performance (average historical equity returns)
  - Based on the law of large numbers
  - Recognizes the risk premium in the future fund returns
  - Relevant for Statutory & GAAP (except FAS 133 reserves) reporting

## GMWB PRICING CONSIDERATIONS

- **Rider pricing (hedge cost) on a risk-neutral basis**
  - GMWB claim pay-offs similar to a put option pay-off (market-consistent)
  - Assumes all funds earn the risk-free rate i.e risk-free rates as a growth rate
  - Risk-neutral price assumes all market risks are hedged
  - Not reflected in the risk-neutral valuation are:
    - Policyholder behavior
    - Cost of capital and reserves &
    - Return on capital

## GMWB PRICING CONSIDERATIONS

### Base VA Considerations & Trade-Offs

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## GMWB PRICING CONSIDERATIONS

### Distribution Allowance

- Allowance for field expenses
  - E.g. Agent Commissions, Field Management Compensation & other Distribution-Related Expenses
  - Can reduce Distribution Allowance
- Typical distribution allowances
  - Upfront: FY Commission (Producer + field allowance) % of Premium
  - Trails: % of assets (Producer + field allowance)
  - Longer the CDSC period, higher the upfront commission & lower trail commissions
  - Can reduce agent commissions
  - Commission charge-backs
- Could vary by channel

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## **GMWB PRICING CONSIDERATIONS**

### **Expense Allowances**

- Fully allocated or marginal expenses
  - Use marginal expenses instead of fully allocated expenses?
- Acquisition & maintenance expense allowances
  - Per Policy
  - % of Premium
  - Asset-Based expenses
- Reflect Revenue Sharing from mutual funds (a positive offset to expenses)

## **GMWB PRICING CONSIDERATIONS**

### **Regulation & Accounting Considerations**

- Reflect VA CARVM reserving methodology effective 12/31/09
- Reflect C3P2 capital requirements
- Pricing margins will be squeezed
- Credit for hedging
  - Reflect credit for hedging in pricing only if intend to actually take credit in practice
  - Nested Stochastic simulation of the hedging strategy
- Understand Accounting implications
- Reflect any tax-law changes

## GMWB PRICING CONSIDERATIONS

### Profitability Measures

- ROI ( $\approx 15\% - 20\%$ ) – Internal Rate of Return; widely used
- ROA ( $\approx 0.40\%$ ) – Present value of profits as a % of present value of account value
- Profit Margin – Present value of profits as a % of present value of premium
- ROE ( $\approx 10\% - 18\%$ ) – Return on Equity
- CTE to measure tail risk
- Embedded Value
- Modify the product design until the profitability targets are met & the risk exposures fit within Company's risk appetite

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## GMWB PRICING CONSIDERATIONS

### Base VA Trade-Off Options

| Feature                                     | Trade-Offs   |
|---|--|
| Agent Commissions                           | <ul style="list-style-type: none"> <li>■ Reduce Agent Commissions</li> <li>■ Feasible if pricing a new Base VA or re-pricing an existing chassis</li> <li>■ Not likely to go over well with the Field</li> </ul> |
| Expenses                                    | <ul style="list-style-type: none"> <li>■ Use marginal expense allowances</li> </ul>  |
| Increase M&E                                | <ul style="list-style-type: none"> <li>■ Competitiveness</li> <li>■ Easier to do when pricing a new Base VA or re-pricing existing VA</li> </ul>   |
| Charge the xx b.p. higher than market price | <ul style="list-style-type: none"> <li>■ Competitiveness</li> </ul>  |
| Charge the market price                     | <ul style="list-style-type: none"> <li>■ Profitability</li> </ul>  |

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# GMWB PRICING CONSIDERATIONS

## Key Modeling Considerations

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# GMWB PRICING CONSIDERATIONS

- **Lot more uncertainty in pricing**
  - **Need to get more sophisticated in our pricing**
  - **Need to look at modeling techniques and assumptions**
- **Scenario generator**
  - **Lognormal or Regime-Switching**
- **A holistic pricing model for Base VA & GMWB rider**
- **A stochastic model needed to model market risks**
  - **Transparent**
  - **Balance simplicity, accuracy & run-time**
  - **Understand model limitations**

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## GMWB PRICING CONSIDERATIONS

| Market Risks  | Challenges / Considerations  |
|---------------|--|
| Volatility    | <ul style="list-style-type: none"> <li>■ Implied or historical volatility?</li> <li>■ Single point volatility or volatility term structure or a volatility surface?</li> <li>■ Projection of fund values from one time-step to another if using a Volatility Surface</li> </ul>              |
| Interest Rate | <ul style="list-style-type: none"> <li>■ Level interest rate or a swap curve?</li> <li>■ Model stochastic interest rates to address convexity                             <ul style="list-style-type: none"> <li>■ What industry standard interest rate model to use?</li> </ul> </li> </ul> |
| Correlation   | <ul style="list-style-type: none"> <li>■ Model correlations between the hedged indices</li> </ul>  |

## GMWB PRICING CONSIDERATIONS

| Policyholder Behavior Risks | Challenges / Considerations  |
|-----------------------------|--|
| Fund Allocations            | <ul style="list-style-type: none"> <li>■ Vary by issue age, living benefit election</li> <li>■ Fund modeling</li> <li>■ Wild card assumption</li> </ul>  |
| Withdrawal Deferral Period  | <ul style="list-style-type: none"> <li>■ Hedge cost varies significantly between various deferral periods</li> <li>■ Positioning of the rider should be taken into account while pegging distribution probabilities</li> </ul> |
| Dynamic Lapses              | <ul style="list-style-type: none"> <li>■ Wild card assumption</li> <li>■ One or two-sided formula?</li> <li>■ Takes into account ITM-ness, attained age, duration etc.</li> </ul>  |

## GMWB PRICING CONSIDERATIONS

| Other                  | Challenges / Considerations  |
|------------------------|--|
| Drag on Contract Value | <ul style="list-style-type: none"> <li>■ Ensure that ALL asset-based fees are taken into account</li> </ul>                                |
| Longevity              | <ul style="list-style-type: none"> <li>■ Mortality improvements</li> <li>■ Joint Life mortality</li> <li>■ Spousal Continuation</li> </ul> |
| Demographics           | <ul style="list-style-type: none"> <li>■ Issue Age distribution</li> <li>■ Gender mix</li> <li>■ Average initial deposit</li> </ul>        |

*Sensitivity testing all assumptions is a must*  
*Analyze tail risk or adverse scenarios*  
*Perform analysis of the Entire Contract*

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## GMWB PRICING CONSIDERATIONS

### Summary

- Design a sound product design that the rider fee can support and is marketable
- Tweaking product design can have a significant impact on hedge costs
- Total Contract must meet profitability objectives
- Undercharging on the rider fee and increasing M&E or reducing commissions works as long as the Total Contract meets profitability objectives
- Build flexibility in the Contract to not lock-in the rider fee
- Profitability may need to be sacrificed a bit if building scale is a priority

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## Pricing GMWB Riders Solutions to avoid mispricing



Equity-Based Insurance Guarantees  
October 27, 2008 (1330 – 1500 hours)  
Boston, MA



1. Overview of price drivers
2. Price and hedge cost
3. Volatility risk : Solution to cut price
4. Dealing with Basis Risk
5. Lapses: best estimate or market price ?
6. Conclusion



## A wide range of possible features for GMWB

- **Accumulation period**
  - Fixed maturity
  - Maturity chosen upfront by the policyholder
  - Depends on policyholder
- **Guaranteed withdrawals**
  - Fixed percentage of AV
  - Depending on policyholder age
  - Ratchet
  - Bonus depending of previous withdrawals done by the policyholder
- **Withdrawals during drawdown phase**
  - Fixed amount paid on periodic basis
  - Chosen by the policyholder at each period
- **Underlying Funds offer**
  - From unique funds to wide range of funds choice
  - From Fixed allocation to switching options with or without constraints
- **Maturity**
  - Fixed maturity
  - Lifetime guarantee



## Main pricing assumptions

- **Financial risks**
  - Swap yields
  - Equity option implied volatility
  - Swaptions implied volatility
  - Tracking error
- **Non financial risks**
  - Funds choice
  - Withdrawals
  - Lapses
  - Mortality rates
- ➔ **Interactions between financial and non financial risks**
  - The implied volatility of the underlying asset depends on the funds mix chosen by the policyholder
  - The basis risk depends on the tracking error related to the funds mix chosen by the policyholder
  - No lapse assumptions are needed if the rider is priced as an American option



1. Overview of price drivers
2. **Price and hedge cost**
3. Volatility risk : Solution to cut price
4. Dealing with Basis Risk
5. Lapses: best estimate or market price ?
6. Conclusion



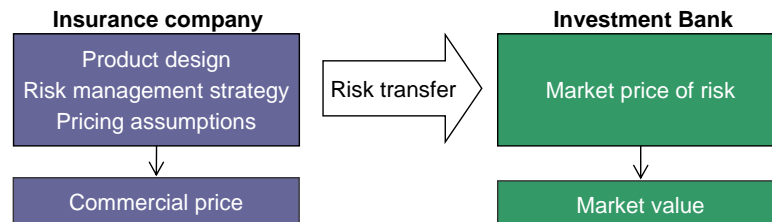
## “Price = Hedge Cost” : Is that true ?

### ■ Insurance companies

- Actuarial anticipations (lapses, mortality, funds choice, business mix and other policyholder behaviours)
- Financial anticipations for the unhedged financial components like volatility

### ■ Investment Bank

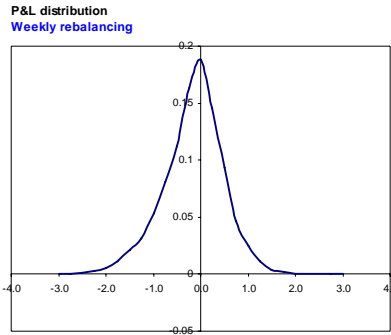
- Market prices in order to get the hedge cost for financial risks
- Lapse risks and other embedded options can be priced as American options
- Mortality can be valued using reinsurance market prices





## Common way of anticipating delta hedging risks

- Delta hedging is seen as a way to save the volatility risk premium
  - It is expected that the future realized volatility will be below the current implied volatility
  - It is expected having losses if the realized volatility is higher than the pricing level and having profits if it is lower.
- According to this view, if the realized volatility is equal to the pricing volatility, then the P&L volatility only depends on the hedging portfolio rebalancing frequency.

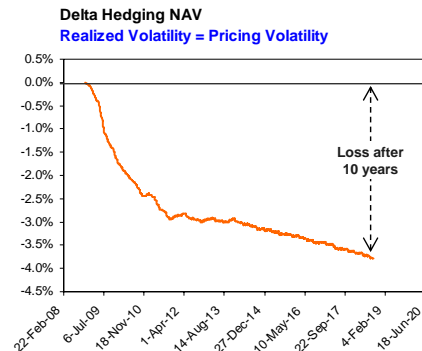
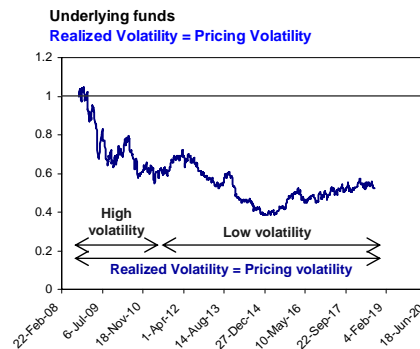


→ This is true only if the volatility is constant along the time...



## Concrete way of getting unexpected delta hedge losses

- With a delta hedging, it is possible to lose money even if the realized volatility is lower than the pricing level
  - This occurs if the high volatility periods match with high product gamma periods
  - Upfront GMWB price with implied volatility of 27% : 5.05%

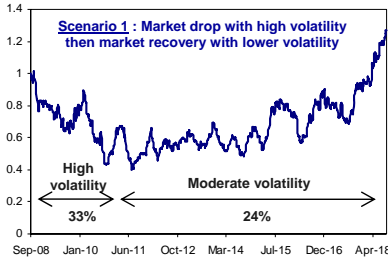


- It exists some solutions in order to reduce volatility risks
  - Standard Variance swaps
  - Variance swap corridor optimized for GMWB riders

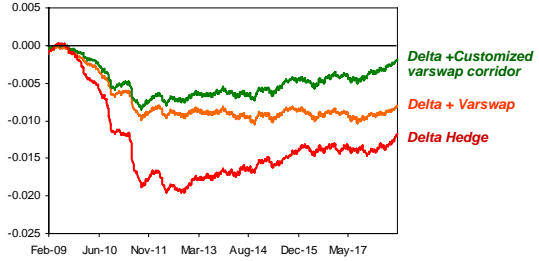


## Hedging volatility : Solutions for GMWB riders

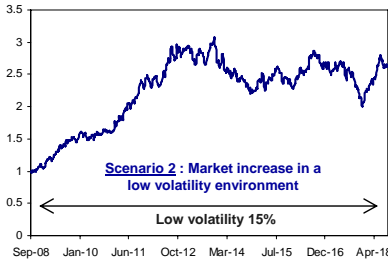
Underlying Funds



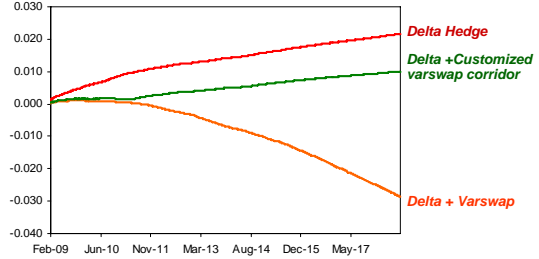
GMWB hedging NAV



Underlying Funds



GMWB hedging NAV



Corporate & Investment Banking

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1. Overview of price drivers
2. Price and hedge cost
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5. Lapses: best estimate or market price ?
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## Optimizing product design with capped volatility funds

- To get the market value, guarantees must be priced using a model calibrated on equity implied volatility
  - No liquidity for long dated options
  - No implied volatility for all stocks or funds
- Implied volatility may vary along the time
  - Possible losses even if the volatility realizes in average below the implied (with delta hedge)
  - The economic value of the riders may become negative
- Using capped volatility funds allows to
  - Reduce the fees
  - Reduce the product re pricing frequency
  - Pay only for realized volatility and saves the volatility risk premium
  - Having a guarantee value insensitive to guarantee price
  - No need for volatility hedging anymore
- Principles
  - Reducing equity exposure during high realized volatility periods while increasing the exposure during low volatility period (it exists various mechanisms)
  - No impact on funds performance (see next slide)
  - Can be used as an add-on to avoid impact on funds management



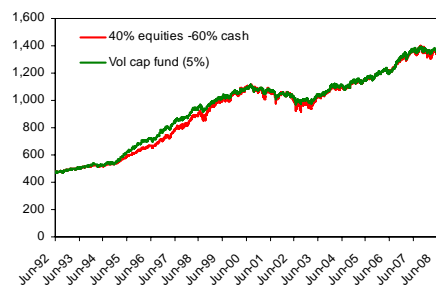
## Principle of capped volatility funds

- Based on historical returns, each equity allocation can be linked to a cap level

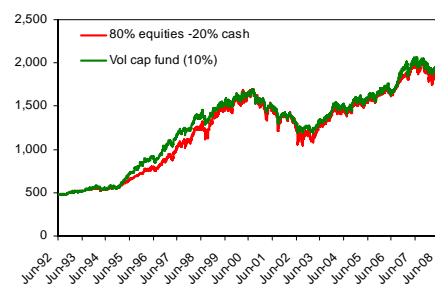
| Equity Average Exposure | Volatility Cap |
|-------------------------|----------------|
| 40%                     | 5.0%           |
| 50%                     | 6.2%           |
| 60%                     | 7.5%           |
| 70%                     | 8.9%           |
| 80%                     | 10.1%          |

- The capped volatility funds have even better performance than the constant allocation corresponding to the same volatility

Example : Capped volatility S&P500 index (5%)



Example : Capped volatility S&P500 index (10%)





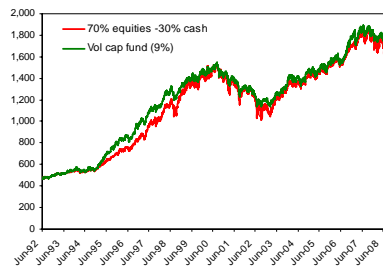
## Volatility cap Impact on GMWB price

### ■ Product features (case study)

- 20 guaranteed withdrawals of 5%
- Equity target exposure: 70% S&P 500
- 3% of insurance & management fees

### ■ Impact of using a volatility cap

- The volatility cap corresponding to 70% equity exposure is 8.9%
- The back test shows that the volatility cap does not impact the funds returns



- Using a volatility cap reduces the guarantee fees by 53%

→ Using volatility cap allows very significant price cutting while keeping the same equity exposure target



1. Overview of price drivers
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## Solutions for basis risk

- There is basis risk when the hedge is done through a tracker and not by trading the riders underlying funds shares
  - GMWB → negative delta → Short position
  - However, the funds shares can not be sold by the insurance company
  - Use of futures on equity indices
  - The weight of each equity index is determined to match the rider underlying funds performance
  - The tracking error creates some basis risk
- The basis risk creates some P&L volatility. This should lead the insurer to add a risk margin to the price.
- To avoid the tracking error risk, the entity responsible for the hedge should be able to sell the funds shares
- Solutions
  - Share lending
  - Certificate
  - Funds of funds



1. Overview of price drivers
2. Price and hedge cost
3. Volatility risk : Solution to cut price
4. Dealing with Basis Risk
5. **Lapses: best estimate or market price ?**
6. Conclusion



## What is the price of the lapse option ?

### ■ Statistical approach (insurance)

- The expected lapse rates are computed using a best estimate based on historical data
- Price = Expected value of the claims (under the best estimate probability) + risk margin (depending on lapse volatility)

### ■ Impact on P&L

- The impact of having realized lapse rates different from the pricing assumptions depends on market performance

|                                 | BULL MARKET                      | BEAR MARKET                      |
|---------------------------------|----------------------------------|----------------------------------|
| HIGHER REDEMPTION THAN EXPECTED | Losses for the insurance company | Gains for the insurance company  |
| LOWER REDEMPTION THAN EXPECTED  | Gains for the insurance company  | Losses for the insurance company |



## What is the price of the lapse option ?

### ■ Financial approach

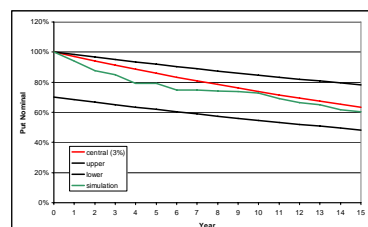
- It is considered that the policyholder optimizes his guarantee value at any time (the guarantee is priced as an American option) :
  - ➔ The policyholder lapses when the market value of the future fees exceeds the market value of the future claims (assuming that he will have the same behaviour going forward)

### ■ Impact on P&L

- If the lapses are priced and hedged according to the financial approach then, whatever are the policyholder behaviour, the P&L will be positive.
- ➔ Using this approach provides a real lapse hedging

### ■ Solution combining statistical and financial approach

- The financial pricing of lapse option is only performed on a proportion of the initial nominal
- The lapse rate are fully priced and hedged while the notional stays inside a corridor, no matter how it moves inside the corridor (even if there is some gap).
- The corridor is determined according to a best estimate approach



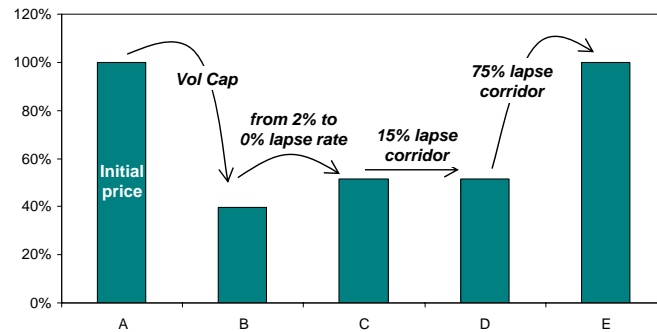


## Solution for lapse risk management

### ■ Case study : GMWB rider

- 20 guaranteed withdrawals of 5%
- Equity target exposure: 70% S&P 500
- 3% of insurance & management fees

### ■ Impacts on Price



- The lapse corridor allows to remove the main part of the lapse risk with a limited impact on the guarantee cost



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## Conclusion

### ■ Pricing issues

- Interaction between non-financial and financial risks
- Combination between market value and expected value

### → Product design optimisation

- Robust and stable prices
- Lower fees and more attractive rider features

### → Hedging optimisation

- Lower P&L volatility
- Capture more risk premium with less risk