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**Market-Consistent Embedded Value Seminar  
December 2008**

**Session 3: Implementing MCEV - Recent  
Experience & Challenges**

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# Implementing MCEV – Recent Experience and Challenges

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## Outline of Presentation

- **ING US Plans for Asset & Liability Modeling**  
Slides 3-7
- **MVBS Approach to MCEV**  
Slides 8-9
- **Cost of Residual Non-Hedgeable Risk**  
Slides 10-13
- **Frictional Costs of Capital**  
Slides 14-17

## Planned ING US Insurance Asset & Liability Modeling for MCEV: Brief Overview

- **ING uses MV based reporting for all risk reporting. With MCEV, ING will move to the MV framework for value reporting.**
- ING will have replications of assets and liabilities available; very useful for movement and sensitivity analysis.
- Replication within the ING ECAPS system advances the causes of robust and timely measurement:
  - Robust measurement in that standardized replication facilitates consistent global risk reporting.
  - Timely measurement in that ECAPS based EC can be reported in the ordinary quarterly financial calendar
- For useful production time-frame, asset portfolios and liabilities likely replicated on at least a one-month lag.
  - Replication relied upon to carry impact of market changes over lag period.
  - Volume driver applied to market insensitive quantity, e.g. Stat Book Value.
- Not asserted that replication value should over-ride true market value data where latter available in time for production calendar
- Idea in Replication is to replace complicated assets and liabilities with bundles of simple instruments which can be valued with closed-form solutions (e.g. Zero Coupon Bonds and European Equity Options)
- Replaces the seeming natural need for a separate stochastic valuation in each considered market state with quick closed form calculations.

## Planned ING US Insurance Asset & Liability Modeling for MCEV: Assets

- The fixed income assets in each of the separately managed portfolios for ING US Insurance (Retail Life, Annual Reset Deferred Annuities, Variable Annuity General Acct., etc.) are subdivided into model categories for replication:
- Example subdivision of asset portfolio
  - MBS pass-throughs and other CMOs.
  - Interest Derivatives
  - Other, Credit Class > BBB (Both callable & non-callable included in final 3 categories)
  - Other, Credit Class BBB
  - Other, BIG
- Cash flows including spreads, gross of default, are generated along prescribed scenarios by ING Investment Management, and replicated by the Business Unit in ECAPS using i) Zero Coupon Bonds, ii) Swaptions and iii) Callable Bonds.
- Zero Coupon Bonds per replication have a pegged credit class, AA, A, BBB, etc. with valuation date Credit Spreads relative to swap rates applied in the mark to market. "No spread" swap ZCBs used for interest derivatives.
- Equity Derivatives are modeled and replicated separately by relevant business units. (Market Index Equity Futures and European Puts/Calls available in replication instruments here.)
- **Challenges**
  - Balancing model tractability with granularity in credit classes. Currently examining the potential need for more credit class bands.
  - Need to monitor appropriateness of volume driving interest and equity derivatives if material purchases or unwinds/sales after the replication date.

Planned ING US Insurance  
Asset & Liability Modeling for MCEV: Liabilities

- The liabilities of each business unit are categorized into one or more classes for replication:
  - Typically at least one liability class is associated with each separately managed asset portfo.
  - For example, US Annuity maintains the following liability classes for EC reporting:
    - Annual Reset Non-Indexed Fixed Annuity
    - MYGA Non-Indexed Fixed Annuity
    - Annual Reset FIA
    - MYGA FIA
    - Variable Annuity (Separate Replications by Major Living Ben. Guarantee Under Analysis)
- The business units maintain liability cash flow models and use them to:
  - Generate liability cash flows to input into the replication
  - Quantify BU model sensitivity of MVL to basic market shocks (e.g. +/- 100 bps. parallel interest shift) to compare to MV sensitivity of replication output.
  - **Divergence between MV sensitivity of replication and that of the BU model is more grounds for further analysis than grounds for rejection of replication.**
  - Replication potentially has more robust treatment of implied volatility surface through use of actual market prices.
- Under discussion is that on a case-by-case basis, individual business unit models could be approved to supply the MVL to MCEV instead of the replicator if BU proves:
  - Adequate documentation and control procedures in place for model
  - Ability to run MVL on current market data with sufficient # of scenarios in production time-line
  - Treatment of market parameters, including implied volatility, of at least equal sophistication as that in the replicator.

Planned ING US Insurance  
Asset & Liability Modeling for MCEV: Liability Crediting Rates

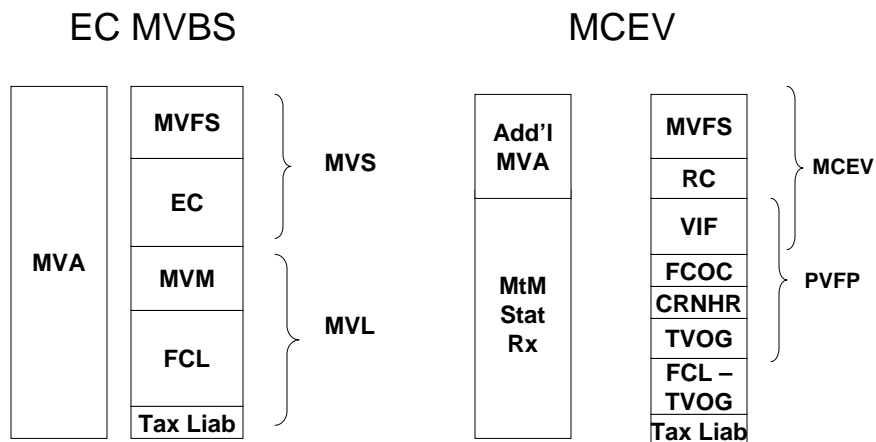
- Widely recognized issue in MCEV is that because Risk-neutral probability gives no reward for taking credit risk, Fixed Crediting products tend to look less valuable
- Also widely recognized problem of what crediting rate to model where reset of crediting rates during liability projections is relevant:
- Current ING thought on this issue:
  - Case I: Where management has ability & intention to recover losses from adverse credit events, the crediting rates in the valuation should be based on assumption of earning risk-free rates.
    - Management utilizes higher anticipated probability of default in setting credited rates.
    - In the extreme case, management anticipates that default will neutralize all credit spread so that the expected earned rates used in rate setting are risk-free
    - This is a limiting form -- chosen to model management response to deterministic defaults far beyond ordinary expectations which eliminate credit spreads.
    - Contractual minimum guaranteed credited rates are still a boundary here.

Planned ING US Insurance  
Asset & Liability Modeling for MCEV: Liability Crediting Rates Cont.

- Current ING thought on this issue (cont.)
  - Case II: Where management lacks ability or does not intend to recover losses, crediting rates should be based on management's expected returns, including the expected credit spread.
    - In this case, target pricing spreads will not be realized in the MCEV valuation.
- Choice between the above two cases in modeling should be backed by documented rate setting procedures and reference to past industry and company practice.
- Plausible acceptable result is a grade-in from crediting based on expected spreads to a crediting based on no spreads, with the grade-in period justified by documentation.
- Useful to keep in mind that this kind of binary choice is motivated by the state of (asset)/ liability models:
  - Deterministic default rates in models are largely the status quo.
  - Risk neutral is really a re-weighting in probability of the same range of default outcomes as in "real world" assumptions.
  - Side analysis with stochastic default may lend insight and support simplifications in official models.

Market Value Balance Sheet vs. MCEV

ING will have to translate the MVBS format into the MCEV Distributable Earnings Format for Public MCEV Reporting



## Comments: MVBS Approach to MCEV

- **The MVBS Approach is suited to Solvency II and is a potential means for reporting MCEV without comprehensive distributable earnings models.**
- Translation of the MVBS into the MCEV Distributable Earnings categories required for public MCEV reporting.
- **Tax Liability makes it difficult to avoid distributable earnings modeling entirely .**
  - If stochastic tax calculations stretch capabilities, MVBS FCL is likely pre-tax.
  - For product lines with material permanent differences or material Regulatory to Tax reserve differences, FIT rate x Balance Sheet Equity is not a reliably good answer.
  - One solution is to require that at least an abbreviated DE calculation on a certainty equivalent basis be performed to produce the Tax Liability.
- **Separate Issue: Margin Confidence: MVM for ING EC balance sheet is at 99.95%, compare with the 99.5% confidence level CRNHR.**

## CRNHR: Principle 9.1 Requirements

- **Cost of Residual Non-Hedgeable Risk: CRNHR: Component of VIF**
- **CFO Forum Principle 9: ... allowance for cost of non-hedgeable risk not already allowed for in the TVOG or the PVFP ...**
  - Allow for Both Non-Hedgeable Financial & Non-Hedgeable Non-Fin. Risks
    - NH Financial (G9.3) : Financial Risks without deep & liquid market  
*Example: Long dated equity optionality*
    - NH Non-Financial : *Examples: Operational Risk, Persistency Risk, Mortality Risk – Cat and Non-Cat*
  - Appropriate Method for Cost of Residual Non-Hedgeable Risks
    - (G9.5): Internal Economic Capital Model: 99.5% Confidence  
*Non-Exhaustive Possibilities:*
      - i) *Joint Distribution of MV G/(L) from Residual NH (ING ECAPS System well-suited for this approach.)*
      - ii) *Marginal Shock to each NH Risk – then superimpose diversification*
  - Disclosures Allow Comparison to Cost of Capital (CoC) Methodology
    - Disclose so that PV of 99.5% EC charges for NH Risk determinable
    - **Equivalent Avg Charge = Implicit CoC =  $CRNHR / PVEC_{NH}$**
    - **Watson Wyatt Survey 2008 Results: Avg. CoC Charge largely between 0.5% & 4.0%, with an average result of 3.0% among those responding. Highest responses were 6.0%.**

## CRNHR: CFO Forum Guidance

- G9.1: Total MCEV should allow for mean impact of NH risk on shareholder value:
  - **CRNHR is excess of this impact over reflection in PVFP and TVOG. PVFP & TVOG must reflect at least mean expectation per relevant NH Risk.**
  - **CRNHR exists because of:**
    - **Risks not addressed by PVFP and TVOG (likely Ops Risk)**
    - **Optionality – asymmetry in impact of factor -- key example is Dynamic Behavior – often treated in PVFP and TVOG**
    - **ING Annuity plans to include explicit margin for dynamic behavior.**
- G9.2: Allow for uncertainty in CFs due to variability in NH risks:
  - **This should be calculated through an EC model (G9.5 below).**
  - **Lapse Uncertainty material CRNHR component for ING US Annuity**
- G9.3: Allowance for impossibility for full market-consistent calibration of financial model due to lack of deep liquid markets:
  - **Basis risk, extrapolation of interest curves in some currencies, etc.**
  - **Variability in approach: Some companies put all in PVFP & TVOG; others have explicit component of CRNHR for these NH financial.**

## CRNHR: CFO Forum Guidance (cont.)

- G9.4: Present CRNHR as Avg. Cost of Capital Charge  
 **$CRNHR = CoC_{CRNHR} \times PV\{\text{Risk Capital for RNHR}\}$**
- G9.5: Risk Capital for NHR should be from internal EC model:
  - **ING ECAPS: (ECAPS built more from focus of replication of hedgeable risk – the following is a discussion of how it accommodates NH risk)**
    - **Monte-Carlo calculate 1 or 2 distrib. points for each risk source:**
    - **e.g. Persistency Uncertainty 99.95 percentile the worst change in MVS due to k% or 100+k% multipliers on whole time horizon base lapse.**
    - **Model MVS change for each risk source as following a parametric distribution with parameters calibrated to calculated distribution points**
    - **Take correlation parameters through combination of data and theory, then generate 20,000 joint risk factor MVS shocks using distributions.**
    - **99.5 CRNHR estimated as 100<sup>th</sup> worst simulated MVS change (where only non-hedgeable risk sources are shocked)**
    - **ING considering increase of the number of MVS shocks > 20k.**

## CRNHR: CFO Forum Guidance (cont.)

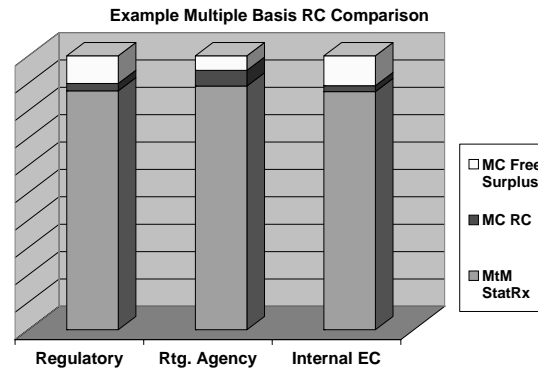
- G9.6: Project Risk Capital for NHR over life of business; approximation through key capital drivers acceptable:
  - **Approximate  $PV\{EC \text{ for RNHR}\} = EC_{0,RNHR}/VolDriver_0 \times PV \text{ Vol Driver}$ .**
  - **PV Vol Driver should be Market Consistent, Stochastic if significant optionality**
  - **Better Approximation if different Vol Drivers for Different Risks**
    - **Example Variable Annuities: Vol Driver = Variable Fund Value for Lapse Risk driven by Variable Fund Value Fees at Risk**
    - **Example Variable Annuities: Vol Driver = Death Benefit NaR for mortality risk on embedded death benefit guarantee put options**
- G9.7: Allow for Diversification in CRNHR, but only between covered non-hedgeable risks
  - **ING ECAPS system has custom report which shocks only non-market risks (together in correlation) in 20,000 realistic shocks**
  - **If Explicit CRNHR for Financial Risks bifurcated from PVFP and TVOG, ECAPS system programmable for sub-run shocking only NH financial component.**
- G9.8: Disclosures for Compliance with Guidance
  - **Avg CoC Charge; Definition, Method for Calc and Amount of EC for RNHR.**

## FCoC: Frictional Costs of Capital (Component of VIF)

- **Guidance 8.2: FCoC represents taxation and investment costs on assets backing Required Capital (RC)**
- **Principle 8.1: FCoC should be independent of the CRNHR.**
  - **Some companies take issue with this principle because a strong contender among calibration approaches for the CoC used in CRNHR is a frictional cost of capital approach. Concerns include the possibility of double-counting.**
- **Guidance 8.1: Use the Definition of RC from Principle 5**
  - **5.2 RC should cover, at minimum, amount at which supervisor empowered to take action, and any amounts that the local regulator can prevent from being distributed away from supporting the regulated entity.**
  - **5.3 RC should cover amounts needed for internal objectives**
    - **Example : Internal Risk Assessment**  
An internal Economic Capital model is arguably an internal risk assessment.
  - **Minimum MVA is the maximum of multiple constraints**
  - **MC RC is MVA minus Mark-to-Market Stat Rx. (Since Guidance 3.5 says that local regulator governs liabilities of covered in-force)**

## Required Capital for FCoC: Hypothetical Multiple Base Comparison

- $RC = \text{Market Consistent Total Asset Req.} - \text{Mark to Market Stat Rx}$
- $\text{Market Consistent TAR} = \text{Max}\{A, B, C\}$
- $A = \text{Mark to Market (Regulator TAR)}$
- $B = \text{Mark to Market (Ratings Agency TAR for Target Rating)}$
- $C = \text{MC TAR from Internal EC Model}$



## Taxation Costs in FCoC

- **Guidance 8.2:** *...allowance for taxation should be based on the taxation rate(s) applicable to investment earnings on assets backing the required capital.*
- Practically, consistency may be the focus. Simple approach may be used: For example, applying the corporate tax rate  $\times$  risk-free earned rates to volume driver estimated PV of Risk Capital Charges.
- Useful to keep in mind theoretical difficulties: cannot directly assume that assets backing required capital earn risk free rates:
  - Even if modelling with deterministic risk free rates per time step, risk neutral probability implies that average change in market value for spready assets plus coupons is the risk free rate, not just coupons minus mean defaults = risk free.
  - Likely that risk neutral measure places more weight on credit migrations into worse credit bands with wider credit spreads. These devaluations would not necessarily result in immediate tax losses.
  - Over life of a spready bond, risk neutral probability of default & distribution of non-recovery will offset credit spread in coupons to give effective risk-free coupons on the whole purchase; but the timing of default could give higher tax costs than tax rate  $\times$  risk free earnings.

## Projection of Principles-Based Risk Capital for FCoC

- **Guidance 8.3: RC should be projected appropriately over the life of the underlying risks. Approximate methods using key capital drivers are allowed.**
- **Companies should periodically re-calibrate a key capital driver approach.**
- **Example: CTE of Minimum PV Stat. Surplus (e.g. Var. Ann. C3p2)**
  - True stochastic capital computationally infeasible (stoch on stoch on stoch).
  - Could periodically take some representative model cells and age them on a grid of maturities x alternative guarantee moniness, then run nested stochastics on this set. This would provide a range of factors to apply to selected risk driver.
- **Example: MVL + EC, with EC = VaR on MV Surplus**
  - ING's ECAPS system is replication based. Assets and liabilities are replicated with instruments that can be valued with closed forms. The closed form replications are valued in many realistic shocks to get a distribution of MV Surplus.
  - For a valuation of a large block, the whole block could be aged and replicated. For full validity, realistic shocks would need to change to reflect expected forward conditions.
  - If granularity across many cells required, might be more feasible to impute approximate equivalent marginal shocks by risk type and use diversification factors based on the whole block's replication based EC.

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## Agenda

- Asset Liability Modeling
- PH Behavior\Mgmt Actions

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## Asset Liability Modeling

- **Projections must be market consistent**
  - Principle 12: "...projected cash flows are valued in line with the prices of similar cash flows that are traded on the capital market. No smoothing of market or account balance values or unrealized gains is permitted."
  - G12.3 Asset values on which to base MCEV calculations must be consistent with values observable in investment markets and not be smoothed. Unrealized gains should be allowed for in the projections used to determine the projected shareholder cash flows.
- **Risk adjust asset cash flows**
  - G14.3 "...make appropriate adjustments to the projected asset cash flows to ensure that the asset cash flows, discounted at the reference rates, equal the market value of the assets."
- **Reference rate is assumed to be the swap rate**
  - Principle 14: The reference rates used should, wherever possible, be the swap yield curve appropriate to the currency of the cash flows.

## Asset Liability Modeling – US

- **Manage business on a book yield basis not market yield**
  - Credited rates for spread based products are set in reference to earned rates based on expected statutory book yields
  - Created detailed BV based AL models to capture impact of interest/market movements on liability cash flows
  
- **How do you model assets on a market consistent basis and accurately reflect the impact of URG/L on credited rates?**
  
- **Complicating Factor: Assets calibrated/projected in reference to Treasury curve not Swap curve**
  - In theory underlying asset cash flows should be based on swap curve
  - RN default rates would be calibrated based on those asset cash flows
  - If sell assets, MVA needs to be projected in reference to swap

## Asset Liability Modeling

- **Look at 3 options to modify current models**
  1. Theoretically Correct Approach
  2. Simplified Approach
  3. In Between
  - Replicating Portfolios will be covered separately

## Asset Liability Modeling – Options

### 1. Theoretically Correct Approach

- No change ALM model methodologies/mechanics (other than default)
- RN defaults calibrated so that PV RACF at swap = initial MV (ideally modeled stochastic)
- Asset CF/MV calibrated/projected based on swap curve

#### Pros

- ✓ Credited rates set consistent with actual practice in relationship to statutory book yields.
- ✓ Any URG/L amortized over life of the assets
- ✓ PV asset cash flows at swap rates = initial MV
- ✓ Maintains level of accuracy of current models

#### Cons

- × Increased model run time with stochastic defaults.
- × Asset CF & MV need to be projected in reference to swap (system mod?)
- × Modify other asset assumptions calibrated to Treasury?

## Asset Liability Modeling – Options

### 2. Simplistic Approach

- Assume at val date assets sold and invested in cash
- Ignore any URG/L impact on MVL
- Assume book = market return = swap rates

#### Pros

- ✓ Easy to understand.
- ✓ No significant model changes
- ✓ Run speed

#### Cons

- × Credited rates set based on market not book yield
- × Invest in cash, company earn new money rate (impact on dynamic lapse)
- × Ignores asset optionality

## Asset Liability Modeling – Options

### 3. In Between

- Various methods
- Approx. impact of market yield and book yield on credited rates

Pros	Cons
<ul style="list-style-type: none"><li>✓ Easier to implement than #1.</li><li>✓ Reflects impact of market/book yield differential on MVL (approx)</li></ul>	<ul style="list-style-type: none"><li>× Accuracy relative to #1 decreased</li><li>× Other – will vary by method</li></ul>

## ALM – Example 1 (AVIVA)

- At val date assume all assets sold and invested in ZCB earning swap rates.
- ZCB based on actual portfolio cash flows projected in BondEdge
- Defaults = 0
- Any URG/L reflected as an upfront adjustment to value and in liabilities as additional spread.
- Credited rate equal earned rate (i.e. swap rate) less target spread less market yield over book yield

#### Example

At valuation date

- BV=100M and MV=80M
- Market Yield = 5%
- Book Yield = 4.5%
- Risk free (swap) = 4%

- Model will reflect assets of BV=MV=100M
- (20M) will be reflected as upfront adjustment to value
- Credited rate = 4% - target spread – (5%-4.5%)

## ALM – Example 2

- Asset cash flows projected in BondEdge in reference to swap curve
- Calibrate a level default assumption based on asset cash flows that will reproduce the initial MV
- The URG/L is amortized over the lifetime of the assets.
- Reinvested Assets are set of swaps of maturities comparable to EEV assumptions
- **ALM model mechanics remain the same**, only model input have been modified
- Methodology allows for breakdown into balance sheet components
  - This is a crucial model check
  - Provides data to check market consistency for existing assets and reinvested assets

## ALM – Example 2 (Cont.)

Income Statement	
	PV
Premium	4,700
Inv. Inc.	70,700
Capital Gain	(7,100)
Revenue	<u>68,300</u>
Benefits	200,300
Expenses	2,400
Reserve Increase	(141,400)
Disbursements	<u>61,300</u>
PVFP	<u>7,000</u>

Balance Sheet			
			PV
Assets	Existing	Coupons	68,300
		Sales/Mat.	136,700
		Subtotal	<u>205,000</u>
	New	Coupons	9,400
		Sales/Mat.	70,700
		Purchases	(80,100)
		Subtotal	<u>-</u>
	MVA		205,000
Liabilities		Net Liab CF	197,100
		Inv. Exp	900
	BEL		<u>198,000</u>
FV Equity			<u>7,000</u>

## ALM – Example 2 (Cont.)

- Compare PV Asset CF to initial MV

	<u>MV</u>
Model (PV CF)	205,000
Actual	205,500
A - M	500
A/M%	100.2%

- Check applied to both PVFP and average of TVOG runs
- Adjust PVFP and TVOG Cost for (A – M) variance

## ALM – Other Considerations

- Non-modeled URG/L – How do you reflect?
  - Include URG/L in allocated BS analysis
  - Ideally separate into components
    - Model variance
    - Assets supporting non-modeled liabilities
    - Assets supporting surplus
- MCEV ANW – Will it be the same as EEV ANW?
  - Depends on how EEV CoC was reflected
- Tax Treatment of Excess Default Losses
  - Treat as capital losses, operating losses, or taxed marginally?

## Agenda

- Asset Liability Modeling
- PH Behavior\Mgmt Actions

## PH Behavior\Mgmt Actions

- **Key Challenge for Valuing US Spread Based Products**
  - Modeling interaction between PH behavior, mgmt actions, and competitor rates.
  - Company & competitor reaction to emerging default experience (at level implied in credit spreads).
  - Moving from EEV to MCEV, results will differ but approach/methodology should be consistent.
- **Mgmt Action - Credit Rate Reset Strategy**
  - Maintain target spreads or reflect grade-in from real world levels?
  - If grade-in, try to recoup impact of reduced spreads in grade-in period?
  - Modeled mgmt action should be consistent with current practice.
- **Possible Competitor Reactions**
  - Consider experience aberration – rates remain at real world
  - Incorporate experience immediately – risk neutral rates
  - Take some time to incorporate – grade into risk neutral

## Credited Rate/Competitor Rate – Ex. 1 (AVIVA)

- **Credited Rate Strategy**
  - Initial rates set at actual credited rates
  - Grade to ultimate target spread (incl. initial credit spread) over 3 years
    - Ultimate target spread larger than actual
    - Try to earn actual spread on average over projection period
    - Initial credit spread = Market Yield – Book Yield
- **Competitor Rate**
  - Initial competitor rate = real world definition
  - Grade to risk neutral basis over 3 years
- **Pros**
  - Grade-in likely most theoretically correct approach
- **Cons**
  - Need to modify model to reflect real world and risk neutral definitions
  - Need to redefine competitor rate in reference to swap and on risk neutral basis
  - Length transition period subjective
  - Modify code to include initial credit spread in target spread

## Credited Rate/Competitor Rate – Example 2

- **Credited Rate Strategy**
  - Initial rates set at actual credited rates
  - No change to credited rate strategy (maintain target spreads)
- **Competitor Rate**
  - Immediately redefine on a risk neutral basis
- **Pros**
  - Consistent with EEV practice
  - No model change required
- **Cons**
  - Need to redefine competitor rate in reference to swap and on RN basis

## Competitor Rate RN Basis – Ex.1 (AVIVA)

- **Initial Competitor Rate**
  - Equal to RW Basis
  - Redefine in term of swap of comparable maturity
  
- **Example**
  - RW competitor rate = 5YR Treasury + 50 bp
  - 5YR Treasury = 3.25%
  - 5YR Swap = 4%
  - Initial Competitor Rate =  $3.25\% + 0.50\% = 3.75\%$   
= 5YR Swap – 25 bp
  
- **Ultimate Competitor Rate on Risk Neutral Basis**
  - Equal to Initial Competitor Rate – Company Target Spread

Example Cont.

- Company Target Spread = 100bp
- RN Competitor Rate = 5YR Swap – 125 bp

## Competitor Rate RN Basis – Example 2

- **Redefine RW Competitor Rate**
  - Go back to basics, credit rates set as portfolio earned rate less target spread
  - Redefine competitor rate in terms of portfolio of A bonds less target spread

Example

- RW competitor rate = 5YR Treasury + 50 bp
- 5YR Treasury = 3.25%
- A bonds = 4.75%
- RW Competitor Rate =  $3.25\% + 0.50\% = 3.75\%$   
= A bond – 100 bp  
= (5Yr Treasury + Credit Spread) – Target Spread

- **Competitor Rate on Risk Neutral Basis**
  - Assume defaults at level implied in credit spread
  - Define credit spread in relationship to swap
  - Swap will be of comparable maturity to Treasury
  - RN world return on A bonds = swap
  - RN Competitor Rate = swap – target spread defined above

Example Cont.

- RN Competitor Rate = 5YR Swap – 100 bp

## Market Consistent Scenarios

- MC scenarios are produced by RN ESGs with volatilities calibrated to volatilities implied by market prices of swaptions
  - Implied volatilities are higher than RW
  - No reversion to long term average
  - MC RN scenarios are more volatile, generally higher, and contain more extreme scenarios than RW
- G15.3 Use most recent market data unless concerns over unusual conditions
- Based 12/07 RN Scenario Set of 1,000 (rates capped at 99%)

# Scn. with Interest Rate(s) Equal or Greater Than			
25%	50%	75%	99%
207	56	18	5

- Are dynamic lapse formulas/competitor rate constraints calibrated in reference to RW rates appropriate for the extreme scenarios?

## Analytics

Analytic Runs			
	<b>PVFP</b>	<b>TVOG Cost</b>	<b>Net</b>
No Constraints	4,100	100	4,200
Guar. Credited Rate Only	3,950	(450)	3,500
Guar. Credited Rate/Dynamic Lapse	3,750	(1,150)	2,600
Baseline	3,700	(1,300)	2,400
Effect of:			
Guar. Credited Rate	(150)	(550)	(700)
Dynamic Lapse	(200)	(700)	(900)
Competitor Rate Constraints	(50)	(150)	(200)
Total	<u>(400)</u>	<u>(1,400)</u>	<u>(1,800)</u>
% Impact:			
Guar. Credited Rate	38%	39%	39%
Dynamic Lapse	50%	50%	50%
Competitor Rate Constraints	13%	11%	11%
Total	<u>100%</u>	<u>100%</u>	<u>100%</u>

## Market Consistent Scenarios (cont)

- Market consistent scenarios are not unique
- Different ESGs and calibration methods can produce different scenario sets that are market consistent

		# Scn. with Interest Rate(s) Equal or Greater Than					
	# Sc in Set	25%	50%	75%	99%	125%	150%
Set #1	1,000	207	56	18	5		
Set #2	5,000	71	12	2	1	1	1

		% Scn. with Interest Rate(s) Equal or Greater Than					
		25%	50%	75%	99%	125%	150%
Set #1		20.7%	5.6%	1.8%	0.5%		
Set #2		1.4%	0.2%	0.0%	0.0%	0.0%	0.0%

### Presenter's Contact Details

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