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**Valuation Actuary Symposium  
September 24-25, 2009**

**Session 5 PD: Using Asset Liability Management  
to Improve General Account Results**

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**Moderator**

**Gregory J. Roemelt, FSA, MAAA**




**Using ALM to Improve General Account Performance**

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**Valuation Actuary Symposium**

Greg Roemelt

September, 2009



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**ALM Tools**

- Cash flow analysis
- Financial statistics
  - Duration
  - Convexity
- Valuing embedded liability options
- Asset liability efficient frontier analysis

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## Sample ALM Model

- Liabilities
  - Single premium deferred annuities
    - \$454 million reserve
    - \$415 cash surrender value
    - \$454 fund value
  - Issued over last 8 years
  - Guaranteed credited rates either 3% or 4%
  - 7% initial surrender charge grading to zero over 7 years
- Assets
  - \$216 million corporate bonds
  - \$64 million mortgage passthroughs
  - \$174 million CMOs (Sequentials and PACs)

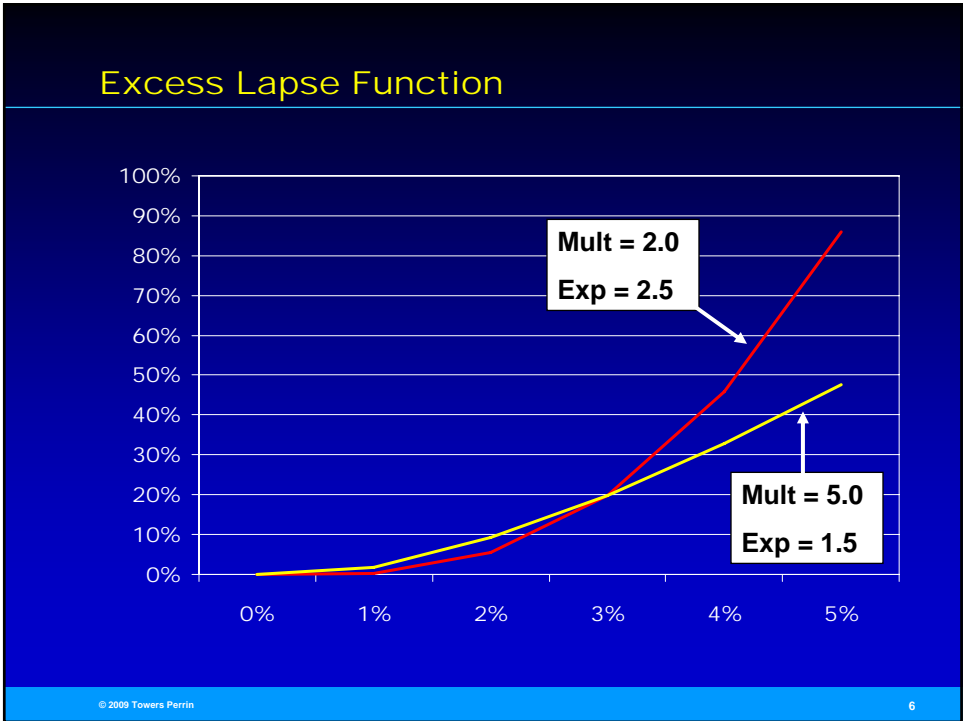
## Behavior Assumptions

- Assets – bonds calls and mortgage prepayments
  - Callable Bonds
    - Firms make irrational decisions
      - Delay calling in-the-money bonds
      - Call out-of-the-money bonds
  - Residential mortgage pre-payments
    - Outside models (ADCO, BondEdge)
    - Single factor assumptions
    - Impact of economic environment
  - Commercial mortgages
    - Yield maintenance or make-whole provisions

## Behavior Assumptions

- Liability - "Excess Lapse" formulas
  - Typically Exponential Formulas
    - $\text{Mult} * (\text{Comp} - \text{Cred} - \text{Threshold})^{\text{exponent}}$ 
      - Surrender charge adjustment
      - Lower exponent, higher multiple
  - Considerations in setting parameters
    - Product
    - Distribution System
    - Market
  - Considerations in setting Competitor Rate

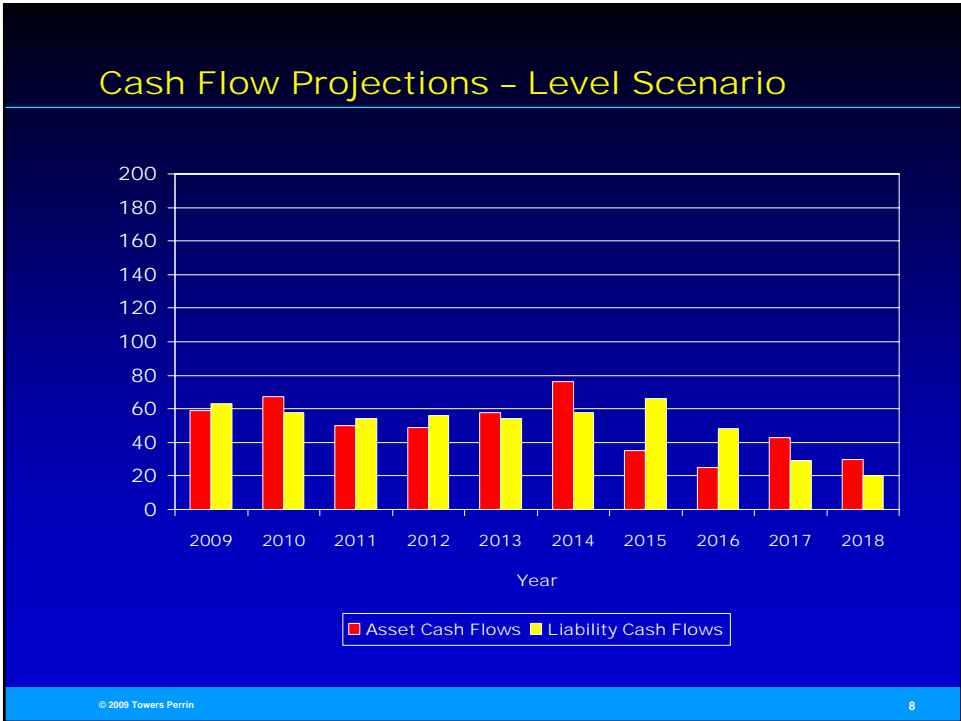
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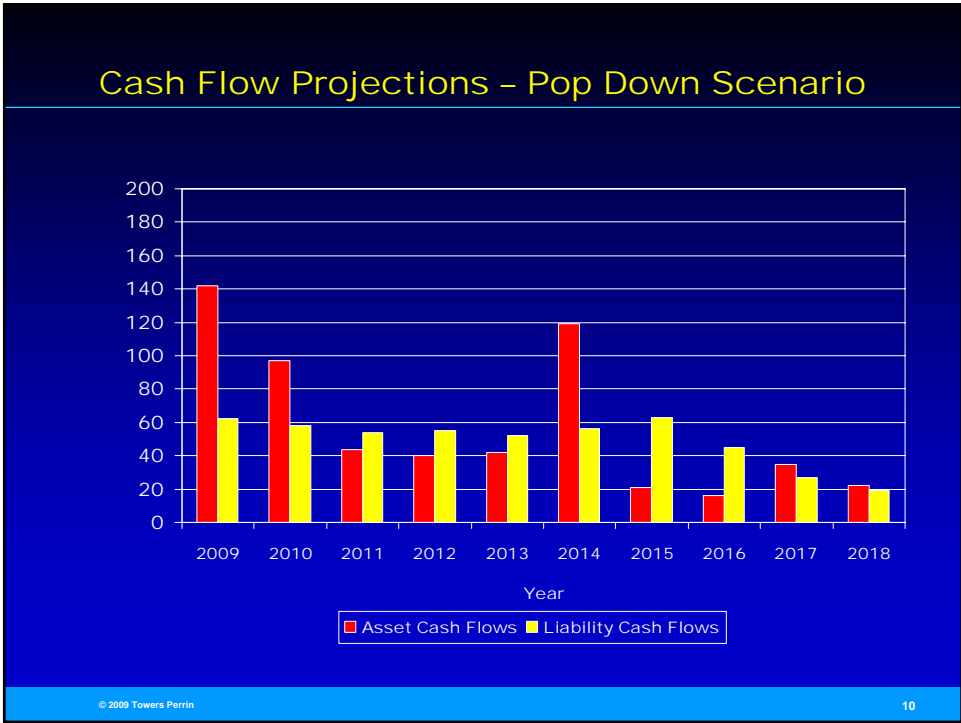
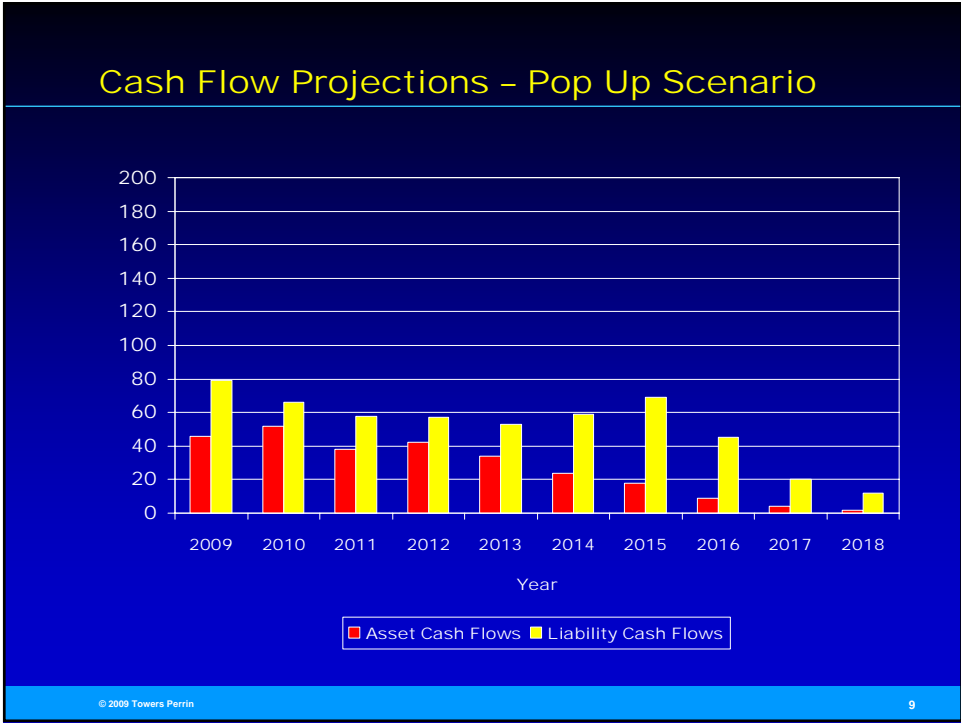


## Cash Flow Analysis

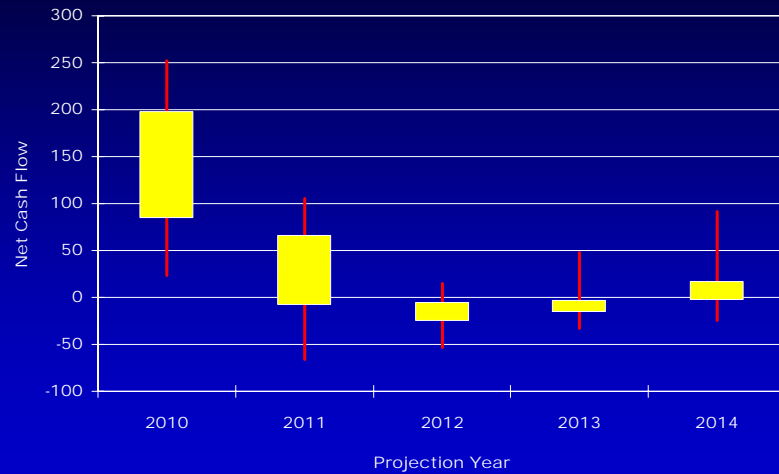
- Comparing expected cash flows from assets and liabilities
- Should include all cash flows
  - Assets
    - Coupon
    - Calls/Prepayments
    - Adjusted for defaults
  - Liabilities
    - Premium
    - Benefits
    - Expenses
    - Taxes

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## Net Cash Flows – Stochastic Scenarios Maximum, Minimum, 25 and 75 Percentiles



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## Duration and Convexity

### ■ Effective Duration

- First derivative of the price function with respect to interest rates

$$\text{Duration} = -(P_- - P_+) / 2P_0 \Delta y$$

Where

$P_0$  = Bond price.

$P_-$  = Bond price when interest rate is incremented

$P_+$  = Bond price when interest rate is decremented

$\Delta y$  = change in interest rate in decimal form

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## Duration and Convexity

### ■ Effective Convexity

- Second derivative of the price function with respect to interest

$$\text{Convexity} = (P_- + P_+ - 2P_0) / P_0 (\Delta y)^2$$

Where

$P_0$  = Bond price.

$P_-$  = Bond price when interest rate is incremented

$P_+$  = Bond price when interest rate is decremented

$\Delta y$  = change in interest rate in decimal form

## Calculating Duration and Convexity

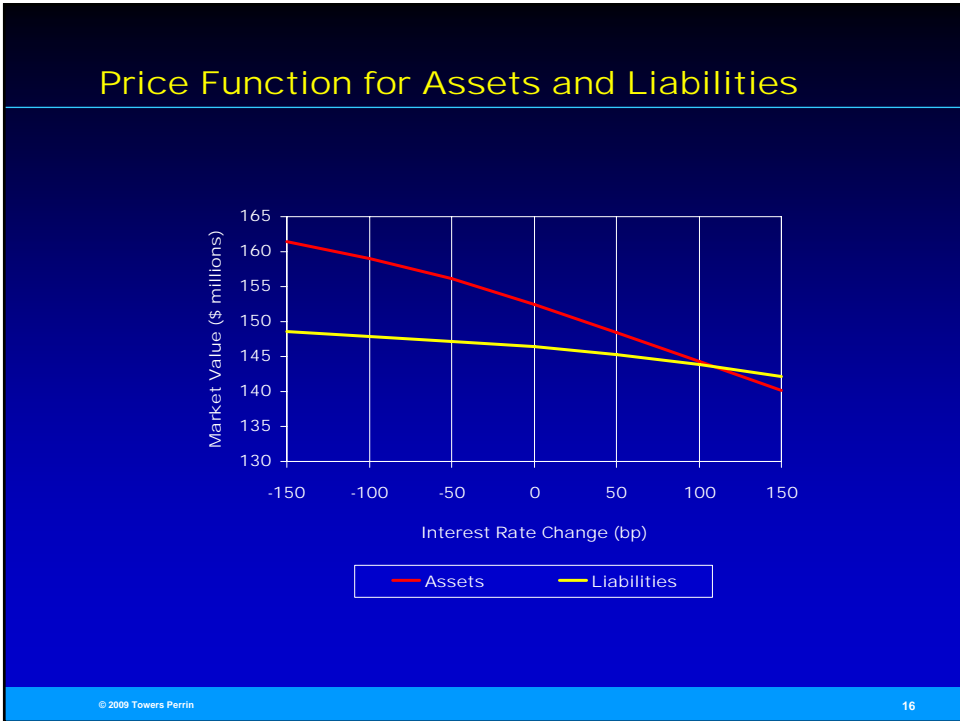
### ■ Assets

- Start with market value of assets
- Project asset cash flows over arbitrage free stochastic scenarios
- Determine option adjusted spread
  - Additional spread over treasury rates such that the discounted value of cash flows, discounted at the spot rates plus the spread, averaged over all scenarios, equals market value of assets
- Calculated  $P_-$  and  $P_+$  by increasing and decreasing starting yield curve and holding OAS constant

## Calculating Duration and Convexity

- Liabilities
  - Project liability cash flows over arbitrage free stochastic scenarios
  - Use either spot rates or spot rates plus asset OAS to discount cash flows
  - Calculated  $P_-$  and  $P_+$  by increasing and decreasing starting yield curve
  - Issues:
    - Future premiums (especially on flexible premium products) can lead to usual results

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### Asset Duration and Convexity

Scenario	Market Value (\$ millions)	Duration	Convexity
Plus 100 bp	144.3	5.7	3.9
Plus 50 bp	148.5	5.4	-58.2
Base Line	152.4	5.0	-65.9
Minus 50 bp	156.1	4.2	-198.9
Minus 100 bp	159.0	3.4	-95.4

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### Liability Duration and Convexity

Scenario	Market Value (\$ millions)	Duration	Convexity
Plus 100 bp	143.8	2.2	-66.9
Plus 50 bp	145.3	1.8	-93.7
Base Line	146.5	1.3	-117.8
Minus 50 bp	147.2	0.9	-12.7
Minus 100 bp	147.8	1.0	33.0

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## Valuing Embedded Liability Options

- Example – Partial Free Withdrawals
  - Project average distributable profits with partial free withdrawals over stochastic scenarios (base line)
  - Remove partial withdrawals and adjust credited rate until average distributable profits equal base line
  - Difference in credited rate is the “value” of partial withdrawal benefit
  - Analysis can be extended to any embedded liability option

## Asset Liability Efficient Frontier Analysis

- Extension of the efficient frontier from the capital asset pricing model (CAPM)
- CAPM uses the rates of return on assets and the volatility of those returns to determine “optimal” portfolios
- Asset liability efficient frontier analysis extends this concept to test various ALM strategies

## Methodology

- Define Risk and Return
  - Anything that can be calculated from the projection output
    - Risk
      - Volatility
      - Number of scenarios with negative present values
      - Number of periods where surplus is negative
    - Return
      - Average present value of distributable profits
      - Number of scenarios where assets under management exceed x dollars

## Methodology

- Develop a robust set of strategies
  - Investment
  - Crediting
  - Product design
- Run stochastic projections for each strategy
- Plot risk and return statistics
- Determine efficient strategies
- Decide on acceptable levels of risk and return

## Sample

- Define 9 different reinvestment strategies
  - 50/50 5 year A and 5 year BBB corporate bonds
  - High quality (AAA) corporate short
  - High quality (AAA) corporate long
  - BBB corporate short
  - BBB corporate long
  - 100% PAC CMOs
  - 100% Passthroughs
  - 50% PAC CMOs, 50% A corporate long
  - 50% AAA corporate short, 50% BBB corporate long

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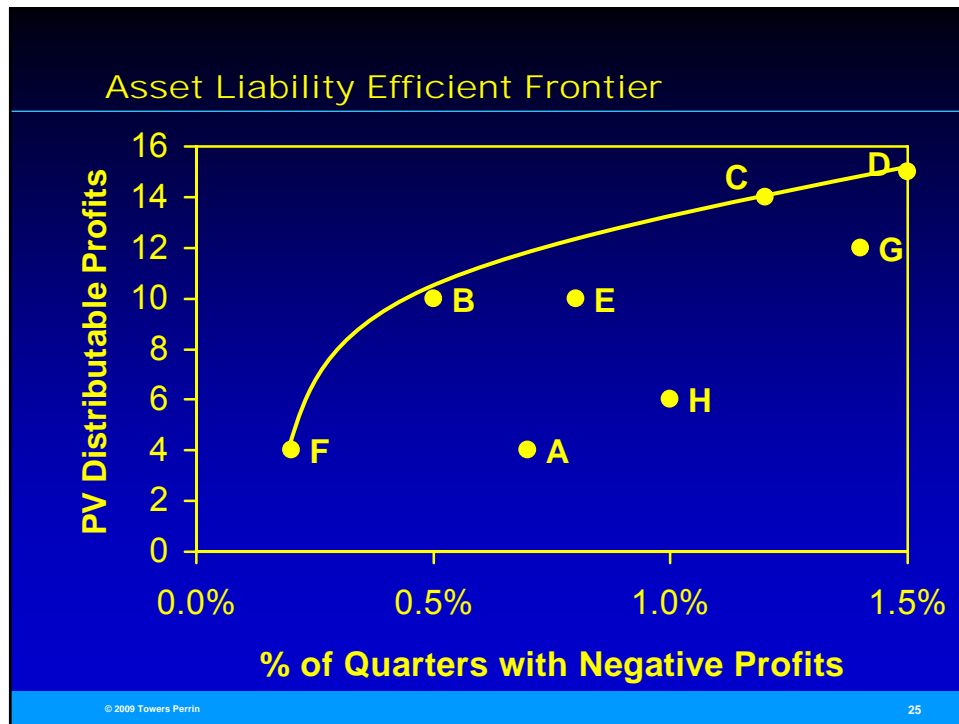
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## Sample

- Risk and return statistics
  - Return
    - Average present value of distributable profits at 12%
  - Risk
    - Percentage of quarters with negative statutory profits

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- ### Advantages of ALEF Methodology
- Measure the impact of different strategies on key financial metrics
  - Definition of risk and return consistent with company objectives
    - Not limited to standard definitions
  - Allows for stochastic processes for any assumption
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## Final Thoughts

- ALM analysis performed over multiple scenarios – actual results occur in one scenario
  - Averages are important, but so are distribution of results
  - Results in the tails can provide useful insights
- ALM is heavily dependent on assumptions
  - Policyholder behavior
  - Asset calls and prepayments
  - Good data not always available
    - Use best estimate, but useful to sensitivity test

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▶ Using ALM to Improve General Account Results

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▶ Agenda

- ▶ Structure
- ▶ Why worry about matching assets and liabilities
- ▶ Illustrative example to establish Asset / Liability matching framework

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## ▶ Structure



- > Treasury / Finance
- > Independent of Product Development and Investment Management
- > Involved with the management of inforce and new business
  - Manage exposure within product development phase
  - Manage exposure post product issue

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## ▶ Hypothetical Example: A Perfectly Matched Portfolio



- > Clients commit \$1,000,000 to purchase a 5-year deferred annuity on 5/14/2009. The annuity is to credit the client 2.40%.
- > On 5/15/09, the Investment Department received notice of funds available for investment.
- > Assumptions:
  - The investment strategy is to perfectly match the client cash flows (ignoring expenses, taxes, etc.)
  - No tolerance for default risk
  - No specific yield is required
  - Client will withdraw funds at the end of 5 years

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# Hypothetical Example: A Perfectly Matched Portfolio



- There is an investment to achieve the previously defined requirements.

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### SECURITY DISPLAY

STRIPS \$ 05/15/14 88-15+ / 88-18+ (2.46 /44) BGN @11:00

<b>SECURITY INFORMATION</b> CPN TYPE NONE MTY/REFUND TYP NORMAL CALC TYP ( 1) STREET CONVENTION DAY COUNT ( 1) ACT/ACT MARKET ISS <b>US GOVT</b> COUNTRY/CURR USA/ DOL SECURITY TYPE USW AMT UNSTRIPPED 1(MM) AMT STRIPPED 1(MM) MIN PIECE .01	<b>ISSUER INFO</b> NAME STRIPS TYPE US GOVT NATIONAL  <b>IDENTIFICATION #'s</b> CUSIP 912833KC3 MLNUM H2BPO SEDOL 2 2915016 WERTPAP 175108 ISIN US912833KC37 FRENCH 827139 EURO COM 004650590	<b>REDEMPTION INFO</b> MATURITY DT <b>5/15/14</b> NEXT CALL DT WORKOUT DT 5/15/14 RISK FACTOR 4.38  <b>ISSUANCE INFO</b> ISSUE DATE 11/15/85 PRC @ ISSUE
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Interest Rate  
Maturity Date

Source: Bloomberg

# Hypothetical Example: A Perfectly Matched Portfolio



- Bloomberg lists the cash streams for every \$1,000,000 of face value as:

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Enter all values and hit <GO>.

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PRICE 88.558 SETTLEMENT DATE 5/11/09 ISSUE 11/15/85 MATURITY 5/15/14

YIELD 2.440000 to Maturity on 5/15/14 € 100.000000

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Display  C=Cashflow or P=Present Value @ % compounded 2/YR

DATE	INTEREST	PRINCIPAL	DATE	INTEREST	PRINCIPAL
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11/15/09	0.00	0.00			
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5/15/11	0.00	0.00			
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Source: Bloomberg

## Hypothetical Example: A Perfectly Matched Portfolio



- > The bond matures on 5/15/2014 with the company to receive approximately \$1,130,000 to fund client outflows.
- > Company pays out approximately \$1,126,000 to the client to match the commitment of paying a rate of 2.40%.

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## Risks Assumed



- > Why the simplified example doesn't work
  - A 2.40% annual rate is likely not competitive for a 5-year product.
  - Cash flows other than just the client flows need to be funded.
    - Commissions, taxes, other expenses, etc.
  - Shareholder returns would not be satisfied with a 6bp spread.
- > How do we resolve?
  - Assume more risk in order to provide a competitive client rate, fund all cash flows, and provide shareholders an adequate return.
  - Additional risk can take many forms
    - Credit, prepayment, duration, liquidity, etc.
  - Risk must be taken in a prudent and thoughtful manner. The question now becomes how to size the risk and determine which exposures are appropriate.

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## What is ALM?



- > “The ongoing process of formulating, implementing, monitoring and revising strategies related to assets and liabilities to achieve an organization’s financial objectives, given the organization’s risk tolerances and other constraints.” \*

\* SOA ALM Specialty Guide 2003

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## Why do ALM?



- > The prior example demonstrated that it’s relatively easy to match predictable cash flow using a risk free asset. Unfortunately, there are several other items to consider:
  - Disintermediation Risk: With the exception of period certain immediate annuities, policyholders are not bound to keep their deposits for a set period of time.
  - Future Interest Rates: Policyholders expect to be paid a rate which is competitive. Additionally, the yield earned on fixed income investments, as well as the expected cash flows, will change.
  - Expenses: All expenses must be funded.
  - Shareholder Return: Shareholders expect to earn a return that is commensurate with the risk assumed when in investing in a company.

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## Illustrative Steps in ALM Portfolio Analysis



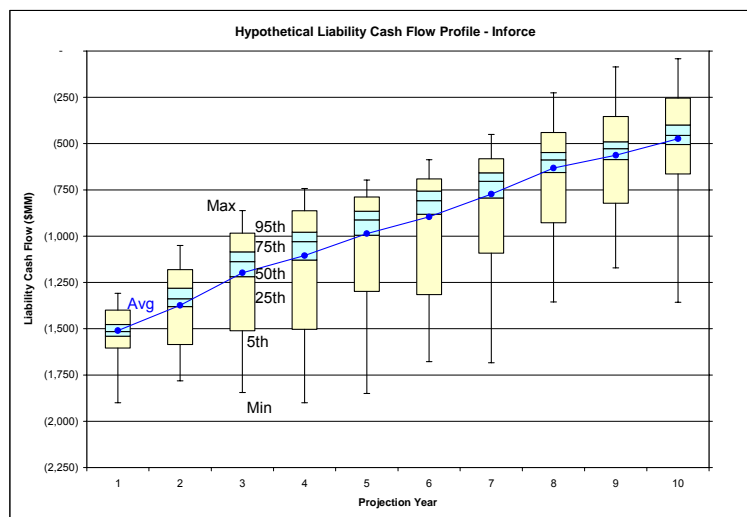
- > Identify Liability Characteristics
  - Cash Flow Profile
  - Duration and Convexity
  - General Risk Characteristics (mix of business, minimum guarantees, surrender charge, etc)
- > Identify Constraints and General Objectives
- > **Development of Alternative Investment Strategies**
- > Identify Asset Management Tolerances
- > Ongoing Monitoring and Analysis

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## Identify Liability Characteristics



- Hypothetical example of a liability cash flow profile for a block of fixed annuity business.
- These cash flows would be generated over a stochastic set of interest rate scenarios.

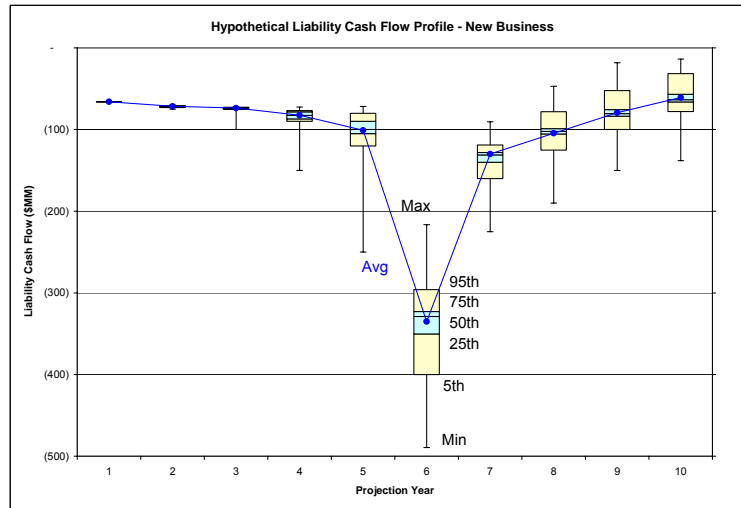


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## Identify Liability Characteristics



- Hypothetical example of a liability cash flow profile for a newly issued block of 5 year SC fixed annuity business.



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## Identify Liability Characteristics



- > The table below is a hypothetical example of duration and convexity for a block of fixed annuity business and an asset portfolio decked against this line of business.
- > A stochastic set of risk neutral scenarios would be used for these calculations.

Shift	Effective Duration								Effective Convexity			
	(100)	(50)	0	50	100	150	200	250	(50)	0	50	200
Assets	2.6	2.9	3.4	3.4	3.4	3.4	3.4	3.4	(0.5)	(0.1)	0.0	0.1
Liabilities	3.6	3.4	3.2	2.9	2.5	2.4	2.2	2.0	0.6	0.5	0.3	0.1
Mismatch	(1.0)	(0.5)	0.2	0.5	0.9	1.0	1.2	1.4	(1.1)	(0.6)	(0.3)	0.0

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## Identify Constraints and General Objectives



- > A critical component that must be addressed prior to exploring alternate investment strategies.
- > Investment strategies will impact key business metrics. Defining tolerances around the metrics will facilitate narrowing the set of possible strategies and to then rank those strategies that fit within the defined tolerances.
- > Tolerances would likely be provided by senior management.
- > Metrics analyzed should be company specific. Examples:
  - Income – level and volatility
  - Return on Equity
  - Capital Requirements (RBC, Economic)

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## Development of Alternative Investment Strategies



- > A decision framework must be used to filter potential investment strategies. The decision framework will involve balancing multiple objectives; as such, strict adherence to hard and fast criteria is not likely.
- > Iterative process, balancing the impact on defined metrics.
- > Selecting an investment strategy for a product line will involve trade-offs between key criteria. Examples could include:
  - Long Term Risk / Reward Profile (PVDE)
  - Income (level and volatility) and ROE
  - Earned Spread
  - Capital Requirements (RBC, Economic)
  - Cash Flow
  - Time Zero Realized Gain / Loss Implications

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## Development of Alternative Investment Strategies & Identify Asset Management Tolerances



• End Result:  
A strategy that balances the previously defined objectives.

- > Level of detail should balance the need for achieving defined objectives yet leave enough room for the investment managers to manage the portfolio.
- > Additional elements that could be added to the framework:
  - Credit, Maturity, Duration, etc.

Asset Class	Target	Target Ranges
Intermediate IG Corp Bonds	30%	20-40%
Long IG Corporate Bonds	9%	5-15%
High Yield Bonds	5%	0-10%
Commercial Mortgage Loans	10%	5-15%
CMBS	10%	5-15%
ABS	15%	5-25%
CMO	10%	5-15%
MBS	10%	5-15%
Cash / Short Terms	1%	0-5%

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## Ongoing Monitoring and Analysis



- > A position report should be established and used to monitor:
  - The portfolio relative to the defined targets;
  - The key metrics used in establishing the target strategy.
- > Periodic discussions with senior management to notify them of the current position and to recommend any potential changes to the strategy.
- > Finally, it is important to continually monitor the strategy for the same reasons it was important to construct the strategy. Process must reflect changes in:
  - Policyholder Behavior – lapses and death claims
  - Interest Rates – rising or falling rates impact both assets and liabilities
  - Business Mix – future sales, run-off of inforce
  - Asset Performance – mortgage prepayments, defaults, etc.
  - Shareholder Expectations – ensure adequate return

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## Summary



- > Manage Assets and Liabilities in a cohesive framework to ensure achievement of financial objectives while staying within defined tolerances.
- > Establish strategy.
- > Monitor portfolio relative to defined strategy.
- > Refresh the analysis to account for changes in assets, liabilities, and the economic environment.