Asset Liability Management – Tools, Techniques and Assumptions

Southeastern Actuaries Conference Spring Meeting
Greg Roemelt

June 17, 2010

TOWERS WATSON

Why Asset Liability Analysis is important

- Interest rate risks are embedded into many insurance company products and also investments
  - General account annuities
    - Minimum guarantees
    - Book value surrenders
  - Universal life secondary guarantees
  - Long term care
  - Callable assets
- Important to recognize the costs and risks of the options insurance companies are writing
- We only get one scenario

ALM Tools

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

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)

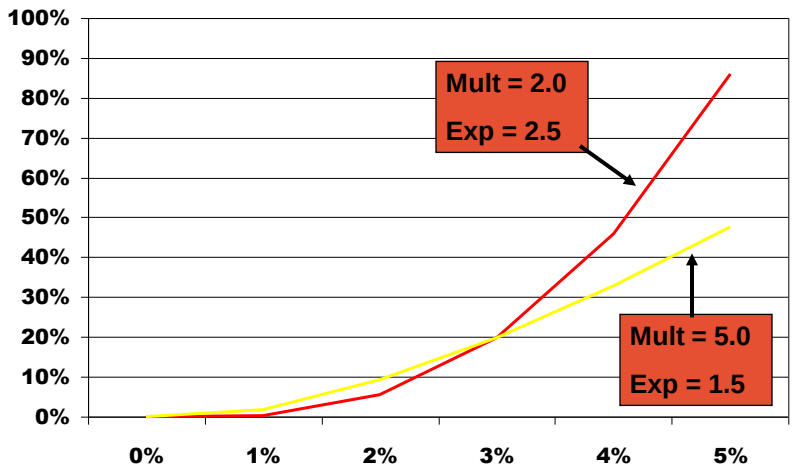
Behavior Assumptions

- 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
    - Mult * (Comp – Cred - Threshold)^{exponent}
      - Surrender charge adjustment
    - Lower exponent, higher multiple
  - Considerations in setting parameters
    - Product
    - Distribution System
    - Market
  - Considerations in setting Competitor Rate

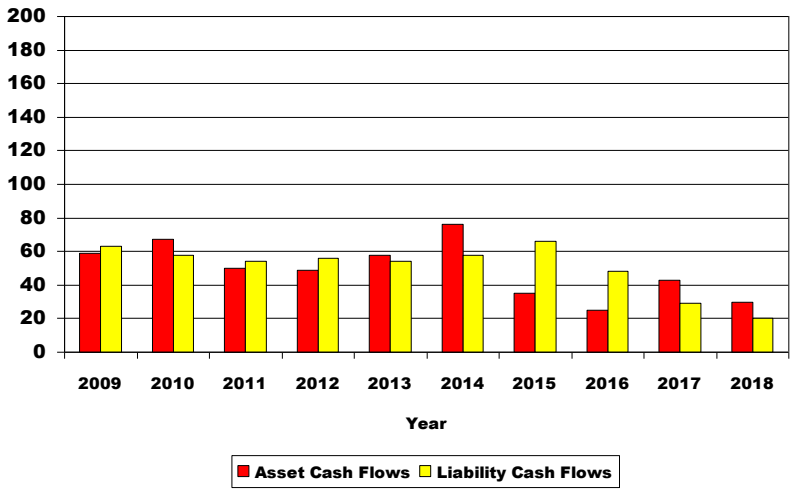
Excess Lapse Function



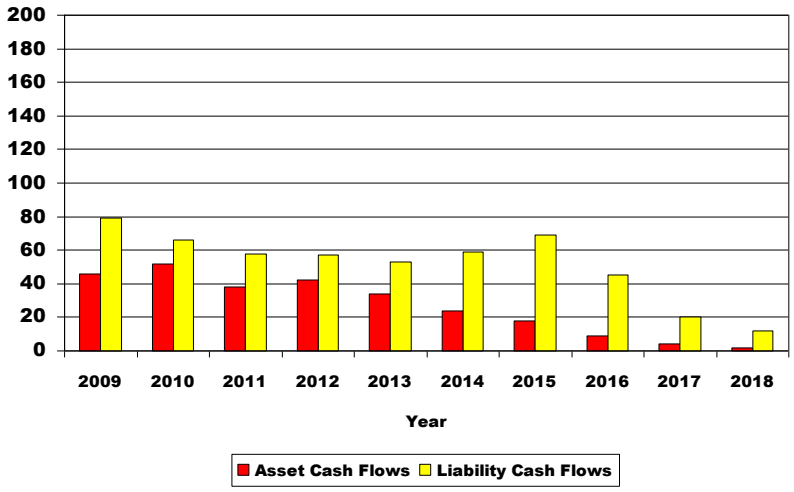
Cash Flow Analysis

- 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
    - Shareholder dividends?

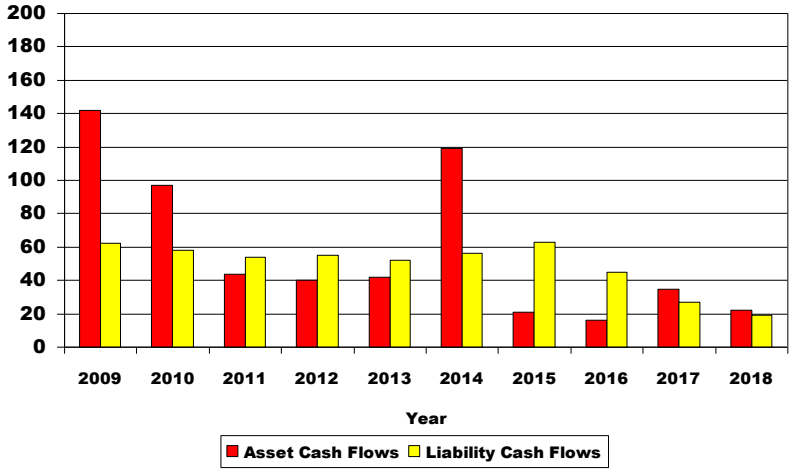
Cash Flow Projections – Level Scenario



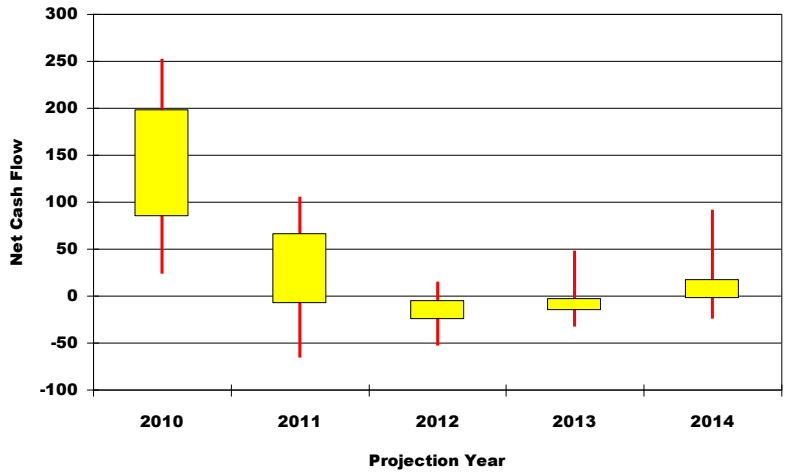
Cash Flow Projections – Pop Up Scenario



Cash Flow Projections – Pop Down Scenario



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



Duration and Convexity

- Duration
  - Negative of the first derivative of the price function with respect to interest rates

Effective 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

Δy = change in interest rate in decimal form

Duration and Convexity

- Convexity
  - Second derivative of the price function with respect to interest

Effective Convexity = $(P_- + P_+ - 2P_0) / 2 * P_0 (\Delta y)^2$

Where

P_0 = Bond price.

P_- = Bond price when interest rate is incremented

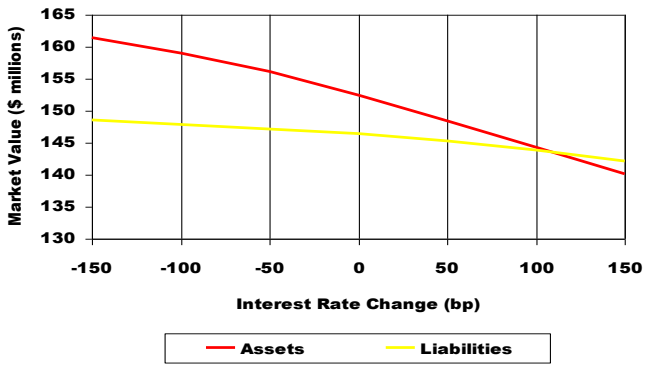
P_+ = Bond price when interest rate is decremented

Δy = change in interest rate in decimal form

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 unusual results

Price Function for Assets and Liabilities



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

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

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

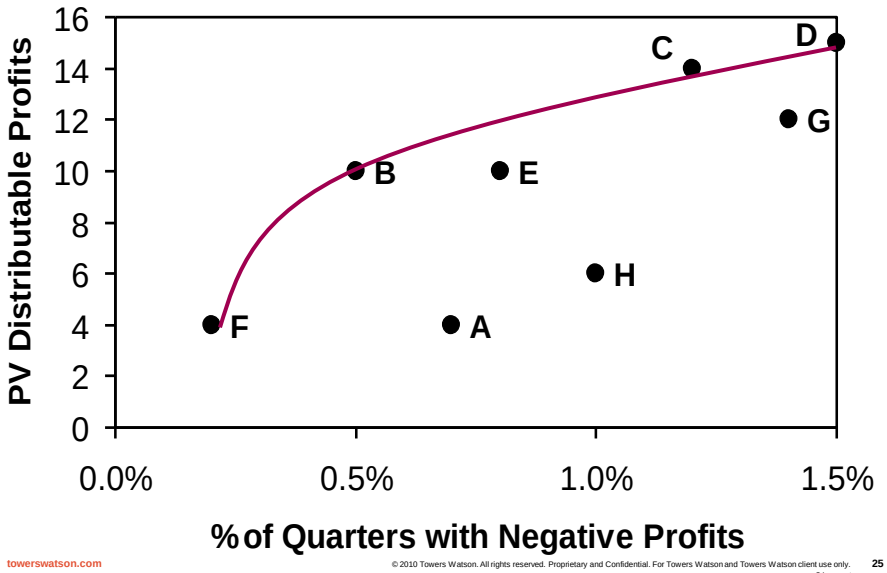
Sample

- 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

Sample

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

Asset Liability Efficient Frontier



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

Benchmark Portfolios

- Used to evaluate investment performance
- Historical have been based on broad, market wide indices
  - Lehman (now Barclays) Aggregate index for bonds
  - S&P 500 index for equities
- More recently, companies have been developing customized benchmarks

Developing Customized Benchmark Portfolios

- Quality target
- Sector allocation
  - Option risk
  - Liquidity
  - Regulatory constraints
  - Duration targets

Sample Indices – Barclays Family of Indices

Index	Duration	Yield
U.S. Treasury	5.32	2.01
Short Treasury	0.41	0.15
U.S. Treasury: U.S. TIPS	4.23	3.02
U.S. Credit	6.32	4.29
1-3 Yr Credit	2.03	2.28
U.S. Intermediate Credit	4.38	3.70
U.S. Long Credit A	12.5	6.01
U.S. Mortgage Backed Securities	2.92	3.49
U.S. Corporate High Yield	4.44	9.48
Municipal Bond	8.24	3.48

Benchmarks by Line of Business

- Linear combination of appropriate benchmarks
- Criteria is desired quality, duration and asset mix
- Can be aggregated across company or used on an LOB basis

Replicating Portfolios

- Definition
  - Portfolio of marketable securities developed to replicate the characteristics of a group of liabilities

Use of Replicating Portfolios

- Performance management
  - Investment strategy benchmarks
- Capital and value calculations
  - Solvency II
  - Economic Capital
- ALM and Risk Management

Process

- Analyze liability characteristics
  - Cash flows
  - Market value sensitivities
- Select securities for replicating portfolio
  - Zero coupon bonds
  - Credit default swaps (to add risk spread)
  - Call and put options (to capture optionally of liabilities)
- Use optimization techniques to select the “best fit” portfolio
  - More art than science

ALM Assumptions

- Asset Options
- Liability Options

Callable Bonds

- Finance theory has shown optimum time to call bond is when it is first in the money
- As usual, reality does not follow theory
  - Firms make irrational decisions
    - Delaying in-the-money calls
    - Calling an out-of-the-money bond
- Implications for asset projection models

Empirical Research

- King and Mauer (2000) examined factors affecting the timing of calls on non-convertible bonds
- Three groups:
  - Called immediately when bond went into the money
  - Called when bond was out of the money
  - Delayed call after bond went into the money
- Significant cost to delaying call

Factors Impacting In The Money Calls

- Opportunity cost of leaving bond outstanding (+)
- Amount of time bond has been in the money (+)
- Slope of the yield curve (+)

Implications For Setting Call Assumptions

- The more calls in are the money, the more likely the bond is to get called
- The longer a bond is in the money, the more likely it is to get called
- Out of the money bonds do get called

Policyholder Behavior Assumptions

- Flip side to call/prepayment assumption
  - Calls and prepayments are the exercise of a call options, usually in a down interest rate environment
  - Interest rate driven surrenders are the exercise of put options, usually in an up interest rate environment
- Usually vary by product type
- Should recognize impact of distribution on policyholder behavior

Types of Policyholder Behavior Assumptions

- Surrenders
- Partial withdrawals
- Flexible premium patterns
  - Higher or lower
- Other

Typical Formulas

- Usually compare credited rates with a defined competitor rate
- Competitor rates should reflect competition for funds in the market
  - Other insurance products
  - Money market accounts
  - CDs
- Include an adjustment for the impact of surrender charges
- Usually of the form:

Dynamic Lapse = Multiplier * .01
* [100 * (Credited Rate – Competitor Rate)]^{Exp}
* (1 – CSV/Fund Value)

Excess Lapse Formulas - Parameters

- Historically, for deferred annuities, multiplier and exponents of 2 and 2
- Recently, trend is towards higher multipliers and lower exponents
  - reducing the exponent reduces the steepness of the lapse curve

Excess Lapse Parameters

- Since the early 80's, interest rates have exhibited a downward or level trend
  - Very few environments for evaluating excess lapse formulas
- Even with more experience, variety of product features and distribution systems will complicate assumption development process

Using mortgage prepayments to estimate deferred annuity excess lapses

- Extensive data on mortgage prepayments is available
- Although not perfectly analogous, prepayments and excess lapses should exhibit similar patterns
  - Surrender charges can be viewed as cost of refinancing
  - Savings on refinanced mortgage rate similar to increased yield on replacement annuity

Mortgage Refinance Decision - Simple

- Years to break even
  - Cost / monthly savings / 12
- Example:
  - 6% mortgage, $300,000 outstanding, 25 years remaining
    - Payment is $1,932
  - Refinance opportunity
    - 5%, 30 year, $1,610 monthly payment
    - Cost: $2,000
  - Breakeven is about 7 months
  - Ignores additional 5 years worth of payments

Mortgage Refinancing Decision - Actuarial Approach

- Calculate present values under both options
- Select option with lower present value

Mortgage Refinancing – Efficiency Ratio

- Apply this analysis to historical data
  - May have to go back to pre housing bubble for meaningful data
- Develop a function that relates likelihood of refinancing to based on "efficiency ratio", i.e.

$$\frac{\text{PV of costs after refinance}}{\text{PV of cost before refinance}}$$

Extension to Excess Lapse Assumption

- Use efficiency ratio function to develop excess lapse formula
- Differences between annuity surrenders and mortgage refinancing
  - Market conditions
  - Tax impacts
  - Surrender charges

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
- The world is always changing – and we only have a rear view mirror

Contact Information

Greg Roemelt
Towers Watson
71 S. Wacker Drive
Chicago, IL 60606
312.201.6317
Greg.Roemelt@TowersWatson.com