November 2000
Course 8V
Society of Actuaries
Questions 1 – 3 pertain to the Case Study.
Each question should be answered independently.

1. (10 points) The Board of Directors of LifeCo was recently given a presentation on the paper by Robert van der Meer and Meye Smink, *Strategies and Techniques for Asset-Liability Management: An Overview*. As the newly appointed Chief Risk Officer for LifeCo, the Board has asked you to give a presentation.

(a) Categorize and describe the ALM strategies and techniques employed by LifeCo within the framework provided by van der Meer and Smink.

(b) Assess the relative merits or return-driven versus value-driven strategies for LifeCo.

(c) Formulate an ALM strategy for LifeCo (from the framework provided by van der Meer and Smink) that reduces the total company exposure to interest rate risk and provides an opportunity to increase company surplus.

(d) Evaluate your proposed strategy using the criteria set out in the paper by van der Meer and Smink.
2. (9 points) LifeCo management wants to segment the Group line of business for asset/liability management purposes into:

(i) Long Term Disability (LTD), and  
(ii) Other A&H.

The newly allocated balance sheet for LTD is shown below:

<table>
<thead>
<tr>
<th></th>
<th>Present Value</th>
<th>Modified Duration</th>
<th>Adjusted Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assets</td>
<td>550.9</td>
<td>13.5</td>
<td>11.00</td>
</tr>
<tr>
<td>Liabilities</td>
<td>532.0</td>
<td>8.1</td>
<td>5.37</td>
</tr>
<tr>
<td>Economic Value</td>
<td>18.9</td>
<td></td>
<td>169.47</td>
</tr>
</tbody>
</table>

The Relative Volatility of assets for Other A&H is the same as for LTD. The Relative Volatility of liabilities for Other A&H is 1.

(a) Construct the new Other A&H allocated balance sheet.

(b) Assess the limitations of only using the above measures in managing interest rate risk.

(c) Contrast the use of Adjusted Duration with the measures used by LifeCo to manage its exposure to interest rate risk.

(d) The portfolio manager for the Group line of business argues that Franchise Value should be considered in the liability target duration calculation. Define Franchise Value.

(e) Explain the implications of using Franchise Value for determining target durations.
3. (22 points) LifeCo wants to establish a delta/gamma/vega/rho hedge on the equity exposure of their variable annuity business, using positions in some or all of the following assets.

<table>
<thead>
<tr>
<th>Asset</th>
<th>Price</th>
<th>Delta</th>
<th>Gamma</th>
<th>Vega</th>
<th>Rho</th>
</tr>
</thead>
<tbody>
<tr>
<td>S&amp;P 500 Future</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>30-year Treasury bond future</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-12,598</td>
</tr>
<tr>
<td>1-year Put</td>
<td>51.98</td>
<td>-0.34608</td>
<td>0.00184</td>
<td>3.688</td>
<td>-3.98</td>
</tr>
<tr>
<td>1-year Call</td>
<td>109.45</td>
<td>0.65392</td>
<td>0.00184</td>
<td>3.688</td>
<td>5.45</td>
</tr>
<tr>
<td>10-year Put</td>
<td>42.88</td>
<td>-0.10529</td>
<td>0.00029</td>
<td>5.761</td>
<td>-14.82</td>
</tr>
<tr>
<td>10-year Call</td>
<td>489.57</td>
<td>0.89472</td>
<td>0.00029</td>
<td>5.761</td>
<td>40.51</td>
</tr>
</tbody>
</table>

LifeCo’s liabilities have the following sensitivities:

- Delta: -2,659.90
- Gamma: 1.036
- Vega: 1952
- Rho: -101,910,000

All deltas and gammas are per unit change in the S&P 500 index.
Vegas are per 1% change in volatility
Rhos are per 1% change in interest rates
Current value of the S&P 500 is 1300

(a) (6 points) Construct a hedge position using the above assets that minimizes the cost of the hedge without regard to the operational guidelines.

(b) (1 point)

(i) Assess whether the hedge determined in part (a) would be in violation of the operational guidelines for use of derivatives.

(ii) Recommend any necessary changes to the guidelines.
3. (Continued)

(c)  (6 points)

(i) Calculate the 1-day, 99%VAR on the portfolio, before and after the hedge is applied using delta and gamma to approximate it.

(ii) Assess the validity of these numbers.

(d)  (4 points) LifeCo is worried about the liquidity of the 30-year Treasury bond future.

(i) Analyse the effectiveness of the proposed hedges with respect to rho.

(ii) Propose alternative methods and alternative assets to improve rho exposure coverage.

(e)  (5 points) The newly appointed Chief Risk Officer is concerned about the use of derivatives in the hedging strategy. Verify that the operational and credit risks of managing derivatives have been adequately covered by LifeCo’s operational guidelines for use of derivatives.
4. *(6 points)* You have the following market information:

- Price of a 2-year zero coupon bond: 89
- 1-year short rate \(i_0\): 7%

A new actuarial student in your company has implemented an interest rate model to price interest rate derivatives. His model gives the following results:

<table>
<thead>
<tr>
<th>Sample space</th>
<th>(i_1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\omega_1)</td>
<td>6.0%</td>
</tr>
<tr>
<td>(\omega_2)</td>
<td>8.0%</td>
</tr>
</tbody>
</table>

(a) Describe the different types of model risk that must be considered when building or using a model.

(b) Explain the concept of arbitrage-free in the context of an interest rate model for pricing derivatives.

(c) Assess the validity of the proposed model given the information above.

5. *(4 points)*

(a) Describe how the following factors will generally impact the Option-Adjusted Spread (OAS) of a Planned Amortization Class (PAC) for a typical PAC bond.

(i) Average life of the PAC
(ii) Premium versus discount collateral
(iii) Lockout versus no lockout
(iv) Window length
(v) Whether or not a Z-bond funds the PAC

(b) Describe the shortcomings associated with OAS in evaluating mortgage-backed securities.

(c) Describe how you would use OAS, considering the shortcomings.
6.  *(5 points)  You are given the following information on a European put option on a bond:

- **Put option**
  - Maturity of option: 1 year
  - Strike price level: 1000

- **Underlying bond**
  - Cash price: 1000
  - Present value of bond coupon payments: 100
  - 1 year forward yield volatility: 10%
  - Modified duration: 10 years
  - Forward yield: 7%

- Risk-free rates are flat at 5.13%

  (a) Calculate the price of this option using Black’s model. Show your work.

  (b) Contrast alternatives for calculating delta and gamma for this option with a stock option.

7.  *(4 points)*

  (a) Describe the psychological factors that prevent rational investment decision-making.

  (b) List five major anomalies which the standard paradigm of rationality fails to explain. Give an example for each case and specify the key behavioral factors that explain such anomalies.

**END OF EXAMINATION**

MORNING SESSION
8.  (4 points) As a product development actuary you have been asked to research and develop an Equity Indexed Annuity (EIA) product.

(a) Describe the basic product features of an EIA.

(b) Recommend and justify an investment strategy for the EIA product.

(c) Describe the potential risks associated with an EIA and the investment strategy you have recommended in (b).
9. (7 points) Consider a simple sequential Commercial Mortgage-Backed Securities (CMBS) deal with the following senior/subordinated structure:

<table>
<thead>
<tr>
<th>Class</th>
<th>Rating</th>
<th>Average Life</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>AAA</td>
<td>9.3</td>
<td>73.50</td>
</tr>
<tr>
<td>A-2</td>
<td>AA</td>
<td>10.0</td>
<td>5.50</td>
</tr>
<tr>
<td>A-3</td>
<td>A</td>
<td>10.0</td>
<td>6.00</td>
</tr>
<tr>
<td>B-1</td>
<td>BBB</td>
<td>10.0</td>
<td>4.75</td>
</tr>
<tr>
<td>B-2</td>
<td>BB</td>
<td>10.0</td>
<td>4.00</td>
</tr>
<tr>
<td>B-3</td>
<td>B</td>
<td>10.0</td>
<td>4.00</td>
</tr>
<tr>
<td>C</td>
<td>Not Rated</td>
<td>10.0</td>
<td>2.25</td>
</tr>
<tr>
<td>Loan</td>
<td>N/A</td>
<td>9.5</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Collateral information:

<table>
<thead>
<tr>
<th></th>
<th>Debt Service Coverage Ratio (DSCR)</th>
<th>Loan-to-value (LTV)</th>
<th>Net Operating Income (NOI) Volatility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original</td>
<td>2.5</td>
<td>65%</td>
<td>6%</td>
</tr>
<tr>
<td>Stressed</td>
<td>1.2</td>
<td>90%</td>
<td>10%</td>
</tr>
</tbody>
</table>

- Collateral consists of 9% coupon, non-callable, 10-year balloon, commercial mortgage loans with a 30-year amortization schedule.

(a) Describe how your Option Adjusted Spread (OAS) valuations would change by rated class if the collateral weighted average DSCR and LTV ratios were to change over the short term from original to stressed levels.

(b) Describe the relative impact of using the stressed NOI volatility assumption versus the original assumption on your OAS valuations for the B classes.
9. (Continued)

(c) Assume the following:

- The collateral is made up of lower quality commercial mortgage loans that have prepayment penalties and are fully callable at par after five years without penalty.

- The most senior class is priced at a discount.

Describe the impact of these assumptions on your OAS valuations for the most senior class.

(d) (i) Explain the rationale for an issuer to use interest-only (IO) classes in a class structure.

(ii) Describe the sensitivity of the OAS valuation of an IO class to default losses and involuntary principal payments in a senior-subordinated CMBS deal.
10. (7 points) You are the portfolio manager for a United Kingdom domiciled insurance company. The portfolio currently has a U.S. asset of $300,000 with a volatility (σ) of 0.02 per day.

You have been asked to evaluate an investment in a Planned Amortization Class (PAC) tranche of a collateralized mortgage obligation, where the mortgage collateral is residential mortgages originated in the U.S. The PAC security you are considering is $200,000 and has an asset volatility (σ) of 0.015 per day.

The two assets have a correlation factor of 30%. The change in portfolio value is normally distributed and asset returns have a bivariate normal distribution.

(a) Describe the factors affecting mortgage prepayment modeling.

(b) Describe, in general, the risks associated with political climate risk.

(c) Describe the three distinct categories of currency hedging techniques available for hedging this asset.

(d) Assess the benefit of diversification when adding this PAC security to the portfolio, using a 5-day, 95% VAR. Show your work.
11. (6 points) Your company has a portfolio of investment-grade bonds and mortgage-backed securities (MBS) with an option-adjusted duration of 4 years. The portfolio supports a closed block of single premium deferred annuities (SPDAs) with minimum rate guarantees of 5%.

The company, using the portfolio yield method, declares the crediting interest rates monthly. However, the V.P. of marketing strongly recommends that the credited rate be based on current market rates.

The company's economist has forecast the following interest rates under two economic scenarios:

<table>
<thead>
<tr>
<th></th>
<th>Current Environment</th>
<th>Recession Scenario</th>
<th>Inflation Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Year T-Note Yield</td>
<td>6%</td>
<td>4%</td>
<td>8%</td>
</tr>
<tr>
<td>90 Day T-Bill Yield</td>
<td>5%</td>
<td>3%</td>
<td>11%</td>
</tr>
</tbody>
</table>

(a) Predict the effects on your company's asset portfolio and the SPDA block using each interest rate crediting methodologies under the following:
(i) recession scenario
(ii) inflation scenario

(b) Explain why it may be disadvantageous to reposition the portfolio using outright sales and purchases.

(c) Describe option strategies to hedge against a movement from the current environment to:
(i) recession scenario
(ii) inflation scenario

(d) Describe the risks related to the options strategies used in (c).
12. *(6 points)* XYZ Life Insurance Company originates home equity loans to elderly homeowners. The loan is not due for repayment until the borrower dies or moves out of the property. The amount of the initial loan is based on the age of the borrower and the property value. Interest and fees are accumulated until repayment. The only source of repayment is the property.

A government institution provides insurance against the risk that the eventual repayment amount is less than the loan balance at that time. The premium, which is added to the loan balance, is an initial fee of 2% of the loan value and 0.5% of the outstanding loan balance annually. The homeowner can repay in full at anytime without penalty.

The loan interest rate is reset every six months. The net rate of interest, after insurance premium and expenses, is the rate on 6 month CD's plus 3%. Based on projected cash flow, the company issues GICs of 1, 3 and 5-year maturities.

The following three strategies have been proposed:

(i) Issue fixed rate instead of variable rate loans.

(ii) Swap the variable interest rates for fixed interest rates.

(iii) Purchase insurance against the risk of homeowners dying earlier or later than expected.

(a) Analyze the risks associated with the current strategy.

(b) Describe the risks associated with the three proposed strategies.
13. (7 points) You are given the following information about a European put option on a non-dividend paying stock:

- Stock price 40
- Risk-free interest rate 7% (continuously compounded)
- Strike price 35
- Time to maturity 8 months

You are also given the following volatilities derived from actively-traded European call options on the stock:

<table>
<thead>
<tr>
<th>Time to maturity</th>
<th>Strike Price</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30</td>
</tr>
<tr>
<td>3 months</td>
<td>0.290</td>
</tr>
<tr>
<td>6 months</td>
<td>0.280</td>
</tr>
<tr>
<td>1 year</td>
<td>0.275</td>
</tr>
</tbody>
</table>

(a) Calculate the price of this option using the Black-Scholes formula. Show your work.

(b) Contrast the stock price distribution implied by the volatility matrix with the log-normal distribution.

(c) Describe models of stock price behavior that are consistent with the implied distribution.

14. (5 points) The asset portfolio of a U.S. life insurance company includes real estate properties. The portfolio manager is currently considering adding to the portfolio an equity investment in an office building in Atlanta. The building is fully leased at fixed rates with 10 years remaining on its leases and subject to a mortgage equal to 50% of its current market value. The mortgage is for 10 years, interest-only, and interest is paid monthly at 1 month LIBOR plus a fixed spread.

(a) Evaluate the risks of this specific investment.

(b) Propose approaches to reduce the risks identified in (a).
15. (7 points) The debt of Company X consists of one zero coupon bond with the following payment probabilities at maturity:

<table>
<thead>
<tr>
<th>Default Risk Probabilities</th>
<th>Real World</th>
<th>Risk-Neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td>No default</td>
<td>85%</td>
<td>75%</td>
</tr>
<tr>
<td>Default with 70% recovery</td>
<td>10%</td>
<td>15%</td>
</tr>
<tr>
<td>Default with 35% recovery</td>
<td>5%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Additional information is as follows:

- Debt maturity: 5 Years
- Payment due at maturity: 1000
- Risk-free rate: 5% (continuously compounded)

Company Z has written a European option which will pay 1000 in 5 years in exchange for Company X’s debt.

Assume Company X and Z have equal but independent default risk.

(a) Calculate the market's expected spread for the bond over the risk-free rate. Show your work.

(b) Determine the possible payoffs at maturity of a European option written by Company Z which will pay 1000 in 5 years in exchange for Company X's debt.

(c) Calculate the value of this option. Show your work and state your assumptions.
16. (6 points) You are given the following information about two estimations of the Market Value (MV) of the total policy liabilities of a life insurance company:

<table>
<thead>
<tr>
<th>Method used</th>
<th>Estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>MV (Liability)</td>
<td>$2.0 billion</td>
</tr>
<tr>
<td>MV (Asset) – MV (Equity)</td>
<td>$1.8 billion</td>
</tr>
</tbody>
</table>

(a) Contrast the two methods.

(b) Explain how the uncertainty of cash flows can be reflected in the estimation of the market value under the MV (Liability) method.

17. (5 points)

(a) Describe the following fixed income risk measures:

(i) prepayment uncertainty,

(ii) volatility risk (vega),

(iii) zero volatility spread (ZVO),

(iv) spread duration.

(b) Your company’s fixed income portfolio contains MBS, CMBS, CMO, ARM, callable and putable corporate bonds, and ABS. Explain the impact of each of the risk measures above on the different fixed income asset classes.

** END OF EXAMINATION **

AFTERNOON SESSION
1. Solutions

a) Static Techniques
1. Cash flow calendar equals maturity overview of cash inflows/outflows
   - looks at balance sheet differences in A/L values by maturity and looks for possible shortfalls
   - Does this in a general overall sense by examining A&L difference at end of period

2. Cash Flow Matching (dedication)
   - matches A&L cash flows
   - not done for LifeCo

3. Gap Analysis
   - looks at balance sheet differences between fixed rate A's & L's and floating rate A's & L's
   - gap of approximately zero means you are doing a good job
   - they do more of a duration gap analysis (similar to immunization)

4. Segmentation
   - creates specialized P's (portfolios) designed especially to reflect and support a particular L product group
   - separate A P's for each L product line
   - LifeCo uses segmentation

Dynamic Strategies – Value Driven Strategies

Passive
1. Traditional Immunization
   - matches dollar duration of A's & L's subject to present value and, perhaps, dollar convexity constraints
   - may maximize dollar duration weighted return
   - LifeCo does this

2. Single Factor Immunization/Multiple Factor Immunization
   - not specifically performed by LifeCo

3. Key Rate Immunization
   - matches key rate durations (and convexities, if desired)
   - key rates are segmentation of the YC and measurement of price sensitivity to particular maturity segments
   - this is done and called “partial duration”
Multiscenario Analysis
- link between static techniques and dynamic strategies
- uses multiple economic/assumptions scenarios to study A/L CF’s under changing conditions
- focus on problem detection
- adds multi-dimensional concept to risk analysis
- can use stochastic or deterministic scenarios
- used by LifeCo

Dynamic Strategies – Value Driven
Active
1. Contingent Immunization - not done
2. Portfolio Insurance (PI)
   - use of synthetic or actual puts to protect floor P value
   - LifeCo uses derivatives to hedge risks, if approved
3. Constant Properties – PI
   - not used

Dynamic Strategies – Return Driven
1. Required return on assets approach
   - calculate a return necessary to support L’s
   - similar to total return or excess spread approach
   - not specifically used
2. Spread Approach
   - manage spread between rate earned on A’s and cost of funds
   - not specifically used

Risk and Return Analysis
- choose P’s on efficient frontier given client’s risk/return profile
- not used

b) Return Driven Strategies
- provides an easy and consistent way to measure relative value of lines of business
- readily available measure if spread based from accounting statements
- spread may be important as expenses may be amortized according to spread
- rating agencies are interested in spread measure
- used by actuaries to analyze distributable earnings
- encourages passive management of asset where more active management may be more appropriate
- does not take account of short-term interest rate risk
- may not identify risk acceptances i.e. add expected return to increase spread by adding more credit risk or increasing duration.
Value Driven Strategies
- protects against small changes in yield curve
- standard immunization protects against parallel shifts
- key rate duration against non parallel shifts
- requires continuous rebalancing as duration drift over time in both assets and liabilities
- insulates Co surplus from general market moves
- does not take into account credit risk of portfolio and other non interest rate risks
- unless merge convexity and place appropriate limits on allocations can end up with two asset portfolio i.e. barbell
- re-investment risk due to rebalancing

c) Strategy: Contingent Immunization
- category involves setting a lower bound for asset value or conversely surplus value
- actively manage portfolio until reach lower bound (if reach lower bound)
- revert to immunized strategy if lower bound- reached
- provides opportunity to increase surplus through active management of portfolio while still aware of a lower bound on surplus values.
- needs to be monitored or large changes in market can breach lower bound before chance to immunize
- treat portfolio as a whole to take account of any correlations among liabilities that offset some market risk

d) Criteria
- return completeness
- risk completeness
- data requirements
- observability
- model independence

1. Provide means of seeking out all possible sources of return
   - can seek out extra return through active management
   - sector bets
   - duration bets
   - bond selection

2. Account for all risks
   - strategy takes interest rate risk into account if revert to key rate immunization then can protect against non parallel shifts

Course 8 Investments Exam
Fall 2000
Illustrative Solutions
3. Not dependent on particular assumptions or model
   - strategy is independent of model and any particular assumptions
   - if used factor immunization or multi factor interest rate model then exposed to risk
     that factor model incorrect
2. Solutions

a) 

<table>
<thead>
<tr>
<th></th>
<th>PV</th>
<th>Duration</th>
<th>Rel Vol</th>
<th>Adj Dur</th>
<th>$ Dur</th>
<th>Adj $ Dur</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTD Asset</td>
<td>550.90</td>
<td>13.50</td>
<td>0.815</td>
<td>11.00</td>
<td>7437.20</td>
<td>6059.90</td>
</tr>
<tr>
<td>Liab</td>
<td>532.00</td>
<td>8.10</td>
<td>0.663</td>
<td>5.37</td>
<td>4309.20</td>
<td>2856.80</td>
</tr>
<tr>
<td>Econ Val</td>
<td>18.90</td>
<td></td>
<td></td>
<td>169.47</td>
<td>3128.00</td>
<td>3203.10</td>
</tr>
<tr>
<td>Total Grp Asset</td>
<td>660.00</td>
<td>12.30</td>
<td>0.815</td>
<td>10.02</td>
<td>8129.10</td>
<td>6623.70</td>
</tr>
<tr>
<td>Liab</td>
<td>624.00</td>
<td>7.00</td>
<td>0.668</td>
<td>4.67</td>
<td>4368.00</td>
<td>2915.60</td>
</tr>
<tr>
<td>Econ Val</td>
<td>36.90</td>
<td></td>
<td></td>
<td>100.49</td>
<td>3761.10</td>
<td>3708.00</td>
</tr>
<tr>
<td>Other A&amp;H Asset</td>
<td>110.00</td>
<td>6.29</td>
<td>0.815</td>
<td>5.13</td>
<td>691.90</td>
<td>563.80</td>
</tr>
<tr>
<td>Liab</td>
<td>92.00</td>
<td>0.64</td>
<td>1.000</td>
<td>0.64</td>
<td>58.80</td>
<td>58.80</td>
</tr>
<tr>
<td>Econ Val</td>
<td>18.00</td>
<td></td>
<td></td>
<td>28.08</td>
<td>633.10</td>
<td>505.00</td>
</tr>
</tbody>
</table>

- PV Assets (A&H) = PV Assets (Group) – PV Assets (LTD) = 660.9 – 550.9 = 110
- PV Liab (A&H) = PV Liab (Group) – PV Liab (LTD) = 624 – 532 = 92
- EV (A&H) = PV Assets (A&H) – PV Liab (A&H) = 110 – 92 = 18
- Mod Dur Assets (A&H) = (12.3 x 660.9 – 13.5 x 550.9) / 110 = 6.29
- Adj. Dur Assets (A&H) = (11.00 / 13.5) x 6.29 = 5.13
- Mod Dur Liab (A&H) = (7.0 x 624 – 8.1 x 532) / 92 = 0.64
- Adj. Dur Liab (A&H) = 1.0 x 0.64 = 0.64
- Adj. Dur EV (A&H) = (110 x 5.13 – 92 x 0.64) / 18 = 28.08

b) A focus on adjusted duration ignores convexity, or the curvature of the Assets or Liabilities to changes in interest rates. Adjusted duration is preferable to modified duration alone as it does account for volatility but effective duration is preferable, as effective duration will account for changes in interest sensitive cash flows. Preferable still might be key rate duration. Modified and effective duration only considers parallel shifts in the yield curve; key rates will allow for shape changes.

Adjusted duration alone will not account for the risk that your claims may have positive correlation with interest rate changes and claim inflation. In addition, interest risk is affected by many assumptions and by exposure to future and renewal business. Without an assessment that includes these factors, the measures used will not capture all interest rate influences.

c) LifeCo uses:
- Dollar Duration – gives a dollar value for the impact of rate changes; similar to adjusted duration but different scale of reference. Limited by only considering parallel shifts that seldom happen.

Course 8 Investments Exam
Fall 2000
• Modified Duration – rate sensitivity in percentage terms of MV of assets and liabilities, suffers from the same problem as adjusted duration in that it assumes parallel shifts.

• Convexity – rate of change in duration; much more useful in conjunction with adjusted duration; gives the second order sensitivity to rate changes.

• Key Rate Sensitivities – address the parallel problem; much more useful than adjusted duration.

• Cash Flow Analysis – careful interpretation is necessary; no reinvestment assumption. Can help with other risks than interest rate (e.g. liquidity); useful in conjunction with adjusted duration.

• Scenario Testing – test results under various scenarios; can see what effect scenario changes have on the adjusted duration. Let us know whether adjusted duration is stable, how much it could change in the future. Some value when used together.

• Asset Quality – defaults can significantly affect adjusted duration values; high credit quality is necessary.

d) Franchise Value is the PV of cash flows from new and renewal business in the future. It is usually discounted at risk adjusted rates. More generally, shareholder value consists of the sum of Economic Value and Franchise Value where Economic Value is PV of Assets less the PV of Liabilities of cash flows from the existing Balance Sheet.

e) Where premiums do not vary with interest rates, the duration of franchise value is negative and the target asset duration must be increased. Where premiums do vary with interest rates, the duration of franchise value is positive and the target asset duration must be reduced.

Competitor pricing also impacts the relationship along with the elasticity of consumer demand to price differences.
3. Solutions

a) The first step is to determine the number of put and call contracts to make the portfolio gamma and vega neutral. Must determine cheapest hedge.

Use 1 year put and 10 year put
or 1 year call or 10 year call

Gamma hedge equation:
\[ x \cdot 0.00184 + y \cdot 0.00029 = 1.036 \]

Vega hedge equation:
\[ x \cdot 3.688 + y \cdot 5.761 = 1952 \]

This solves to:
\[ y = -24.04 \]
\[ x = 566.83 \]

Use \( x = 1 \)-year put
\( y = 10 \)-year call
because this combination minimizes the cost

Now use the S&P future to hedge delta.

\[-2659 = -0.34608 \times 566 + 0.89472 \times -24 + 100 \cdot y \]
(Delta of Liabilities) (Delta of 1-year puts) (Delta of 10-year calls) (Delta of futures)

\[ y = -24.42 \]

Use the 30-year treasury future to hedge rho:

\[-101,910,000 = -3.98 \cdot 566 + 40.51 \cdot -24 + -12,598 \cdot z \]
(RHO of Liab.) (RHO of 1-year put) (RHO of 1-year call)

\[ z = 8089.1 \]

b) To hedge, one would need to short an option, which is in violation of the guidelines. The guidelines make no reference to put options, which is also needed to create the minimum cost hedge.
I recommend that the guidelines allow the purchase of put options. I don’t recommend changing the guidelines to allow for shorting options. Shorting options lever downside potential. Synthetic short options can be set up without violating the guidelines.

c)

\[ VAR = \Delta S \times \Delta S + 0.5 \times \Delta S^2 \times \text{GAMMA} \]

\( \Delta S \) is the drop in the S&P 500.

The 99th percentile drop in S&P is 2% VOL x \(-2.33\) (99th percentile of N (0,1)) = -0.04652

\[ 1300 \times -0.04652 = -59.09 \]

\[ VAR = -2659 \times -59.09 + 0.5 \times (59.09)^2 \times 1.036 \]

\[ = 158982.15 \]

Hedged
Same formula but Delta = Gamma = 0
so VAR = 0

Limitations
- results depend on model, data, parameters
- many risks ignored

d)

\[ \text{RHO} = \frac{\partial \text{P}}{\partial \text{R}} \text{ which is analogous to duration} \]

Therefore, RHO hedging is similar to duration matching, which is good only for small, level shifts in the yield curve.

Could use other methods:
- key rate duration matching
- duration and convexity matching
- cash flow matching → probably not feasible since cash flows very volatile

Could use anything sensitive to interest rates:
bonds, swaps, swaptions, floors, etc.

e)

Operational Risks Include
1. Inadequate systems and controls
2. Human error
3. Management failure

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• management is informed and involved
• policies, procedures and approved activities documented
• independent checks, balances for purchases, payments and accounting exist – e.g. two quotes required.
• back office exists – systems

Credit Risk – Risk of Counterparty Default

Manage by:
• diversification – by number and exposure
• minimum rating – BBB, should be higher
• analysis of current and potential exposure
  - current = replacement cost
  - potential = VAR or simulation

• Netting with respect to counterparty
• Monitoring of ratings
• Settlement Risk Control

Deficiencies:
• Exposure limits too high relative to surplus
• No downgrade triggers
• No requirement for netting everywhere
• No exposure limit triggers
4. Solutions

a) Model Risks

Inapplicability of Modeling – problem does not require a model
Incorrect Model
  e.g. missing a key factor or making incorrect assumptions
Correct Model but Incorrect Solution
Inappropriate use of a model – using it in a way that its builder never intended it to be used
Badly approximated solution
Software/Hardware Bugs
Unstable data used in model

b) Arbitrage-Free

- Model is calibrated to the current market price of zero coupon bonds
- Model respects the law-of-one-price (i.e. no arbitrage opportunities are present within the model)
- A probability measure Q (representing probabilities of the various sample spaces \( w_i \)) exists such that:

\[
\frac{S_i}{B_i} = E^Q \left( \frac{S_i}{B_i} / P_i \right)
\]

If such Q exists, Q is said to be a risk-neutral (or martingale) probability measure

c) Market price = 89 = \frac{1}{1.07} \left[ q \left( \frac{100}{1.06} \right) + (1 - q) \left( \frac{100}{1.08} \right) \right]

Solve for q to determine if q is valid probability measure

\[ q = 151 \]
\[ 1 - q = 0.51 :. q \text{ is not a valid martingale probability measure} \]
5. Solutions
a) As average life increases, option cost increases, assuming fixed price, OAS goes down
i) Premium securities generally have higher option costs and therefore a lower OAS. This
   is because they are more susceptible to prepayments than discount securities in low
   interest rate scenarios.
ii) Lockouts increase stability of earlier classes, lower options cost, increase OAS
iv) Minimal impact on OAS
v) Z bonds increase stability of other classes, implies lower option costs and higher OAS
b) - Average number over space and time
   - unlikely to earn OAS
   - Model dependent
     - extremely sensitive to methodology, assumptions and data
   - summary #
     - no PASS price distribution provided
     - others could give indication of problem scenarios and asymmetry
   - Portfolio OAS usually just a simple market value weighted average of OAS of each
     asset. Better to aggregate portfolio cash flows at each node and then calculate
     portfolio OAS
   - Abuses in practice
   - Constant spread added to interest rates subtly changes their distribution
   - Non-interest-related events not easily modeled
   - MBS’s prepayment models usually assume preps are deterministic and not path
     dependent
c) - disclose sensitivity of OAS to varying volatility and prepay assumptions
   - provide PASS price distribution
     - path and spread specific PASS
     - outline problem scenarios, asymmetry
   - calculate true portfolio OAS by aggregating P cash flows at each node
   - Use double stochastic approach to calculating preps
   - Look at other measures
6. Solutions

a) 
\[ P = P(O, T^*)[X \cdot N(-d2) - FxN(-d_1)] \]

\( P = \) Put Value

\( P(O, T^*) = \) price of a zero coupon bond that matures at time \( T^* \) for $1

\( T^* = \) time to maturity

\( x = \) strike price

\[ d_1 = \frac{1}{\sigma \sqrt{T}} \left( \frac{F_o}{x} + \frac{\sigma^2T}{2} \right), \quad d_2 = d_1 - \sigma \sqrt{T} \]

\( F_o = \) forward price = \( \frac{B_o - I}{P(O, T)} \)

\( B_o = \) bond price \quad \( D = \) modified duration

\( I = \) present value of dividends

\( \sigma = \) volatility of forward bond

\[ D = \left( \frac{-1}{B} \right) \left( \frac{\Delta B}{\Delta y} \right) \Rightarrow \frac{\Delta B}{B} = -D \cdot \Delta y \]

\[ = -Dy \left( \frac{\Delta y}{y} \right) \]

\[ \Rightarrow \sigma = D \cdot \sigma_y \cdot y_o \]

where

\( \sigma_y = \) forward yield volatility

\( y_o = \) forward yield

\[ \Rightarrow \sigma = 10(10)(.07) = .07 \]

\[ F_o = \frac{1000 - 100}{e^{-0.0513y(1)}} = 947.37 \]
\[ d_1 = \frac{\ln\left(\frac{947.37}{1000}\right) + 0.07^2}{0.07\sqrt{1}} = -0.74 \]

\[ N(-d_1) = 1 - N(d_1) = 1 - N(-0.74) = 1 - 0.2296 = 0.7704 \]

\[ d_2 = d_1 - \sigma\sqrt{T} = -0.74 - 0.07 = -0.81 \]

\[ N(-d_2) = 1 - N(d_2) = 1 - N(-0.81) = 1 - 0.2090 = 0.791 \]

\[ p = e^{-0.0513(1)} [1000(0.791) - 947.37(0.7704)] = 58.09 \]

b)
For a put option on a stock, \( \Delta = N(-d_1) - 1 \)

\[ \frac{1}{\sigma\sqrt{T}} \frac{\ln \frac{S_0}{x} + \left( r + \frac{\sigma^2}{2}\right) T}{d_1} \]

where \( d_1 = \frac{\ln \frac{S_0}{x} + \left( r + \frac{\sigma^2}{2}\right) T}{\sigma\sqrt{T}} \)

on the same put option \( \Gamma = \frac{1}{2\sigma\sqrt{T}} \times N'(d_1) \)

However for a bond option there are many ways of calculating delta and gamma because there is not a single underlying variable (as in the case of a stock price) but multiple variables in the form of various interest rates from various points of the yield curve.

Ways of calculating delta for bond option:
1. assume a parallel shift in all interest rates
2. divide the yield curve into segments and calculate a \( \Delta \) for each segment based on a parallel shift in the rate of that segment
3. Calculate a \( \Delta \) for each rate by shifting only that rate
4. Use the first three factors from principal component analysis
   a. almost parallel shift
   b. twist
   c. butterfly

Ways of calculating \( \Gamma \):
1. Calculate \( \Gamma \) for each \( \Delta \) ignoring cross-partialials
2. Assume parallel shift in all rates
3. Use first three factors of principal components analysis

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7. Solutions

a) Over Confidence
Over confidence in information one has, especially if in one’s area of expertise.

Biased Forecasters (non-bayesian)
Too much weight is given to most recent information; leads to under- and over-reactions.

Loss Aversion
More pain is felt with $5 loss than pleasure with $5 gain.

Mental Accounting
Willingness to sell a loser if with a winner, but wouldn’t sell loser by itself.

Framing
Decision made often depends on how framed, i.e. would get more upset as a customer if asked to pay surcharge for credit card use versus discount to cash paying customers.

Fads and Fashion
Fads come and go. Investors feel pressure to conform.

Regret, Responsibility and Prudence
When investors take actions to avoid regret – pain felt by decision which led to a bad outcome regardless if decision was bad.
Actions taken: hire an agent
Also describes tendency to follow prudent and responsible decision-making, i.e. buy well recognized stock even if overvalued.

b) 1. Volume of trading and active management
Behavior explanation: everyone thinks can pick a winner

2. Contrarian Strategies
- investing in low P/E
- shouldn’t be able to profit on publicly available information
Behavior explanation: overconfidence, which leads to over reaction; biased forecasts and misperception of risk.

3. Asset values and Investor Sentiment
- asset values should represent intrinsic value
- NAV often @ discount
Behavior explanation: non-rational trader sentiment varies over time.
4. Equity Risk Premium
   - Much larger than can be explained by risk alone
   Behavior explanation: Myopic loss aversion – riskiness of investment depends on how frequently it is valued.

5. Payment of Dividends
   - not rational
   Mental accounting: think of dividend as separate return. Avoid dipping into capital to finance spending.
8. Solutions

a) EIA Product
- offers participation in the growth of a market index (such as S&P 500) with min interest rate guarantee
- crediting is based on a participation rate times an index increase, with possible cap on increase
- index increase may be calculated in different ways such as point-to-point, annual ratchet etc.
- may have surrender charges, free partial withdrawals
- may receive full account value on death
- may have vesting schedule on increases

b) it is necessary to hedge the index increase, minimum guarantee and any decrements
- use OTC or exchange options, such as calls
- type of option depends on design, e.g. point-to-point use European call
- may purchase put option to hedge free lock
- recommend to purchase call options to hedge index exposure
- minimum guarantee = use bond to hedge
  recommend to purchase corporate bonds with good spread above min guarantee

c) OTC options have low liquidity, high lapses can create problems if need to liquidate options
- free withdrawals when market value is lower than min guarantees
- exposures to the credit risk when OTC used
- less than full hedging creates concern if no decrements and high index increases
- excess lapses may create significant losses when interest rate up and market down
9. Solutions

a) OAS is considered compensation for shorting options thus $OAS \downarrow$ for a MBS as price payment risk $\uparrow$ or default risk $\uparrow$

Stressed Level
Debt service coverage ratio (DSCR) = annual NOI/annual cost of debt

As $DSCR \downarrow \Rightarrow Probability(Defaults) \uparrow \Rightarrow OAS \downarrow$

b) More volatile income stream $\Rightarrow$ greater prob of default.

Thus since $NOI\ volatility \uparrow \Rightarrow prob(Defaults) \uparrow \Rightarrow OAS \downarrow$

Largest decline in OAS takes place in junior classes since they are first to absorb losses caused by default.

For Senior class, price at prem – OAS will also decrease since recoveries are used to pay this class first, but receipt of principal means lower yield since class priced at prem

B classes are most protected since they are not first to absorb losses or recoveries (OAS does not change)

c) Since senior class is priced at discount, the OAS will benefit from call feature and thus $OAS \uparrow$

d) Many investors do not want to buy premium bonds. Thus issuer strips away interest and the interest only class is created.

The issuer will create the stripped classed only if the proceeds from stripped class plus the par bond is greater than the proceeds from the prem bond only.

e) - Interest is paid when principal is outstanding
- When principal is reduced, interest paid to IO declines
- Principal reduced through defaults and involuntary principal payment
- For default, loss is allocated to junior classes thus senior class insulated
- Involuntary payment arising from recoveries go first to the most senior class and thus erode the principal.
- Senior – Subordinate structure requires most senior class receive principal payments first
10. **Solutions**

a) **Factors Affecting Prepayment**
- human behavior
- relocation
  - economic conditions to relocate
  - higher equity values
  - lower mortgage rates
  - non-economic conditions
  - seasonality
- curtailment
  - less 1% of all mortgage payments are partial payments
  - considered as unscheduled principal payments
  - cumulative effect can be quite large

- assumptions
  - FHA/VHA mortgage can be assumed
  - can reduce prepayment if mortgaged at a low rate
  - conventional mortgages are no longer assumable
  - hence big difference in prepayment volatility between assumable and unassumable

- Refinancing
  - biggest part of the prepayment uncertainty
  - burnout could reduce this to an extent
  - willing to refinance
    - is it cost effective after penalties are taken into consideration?
  - able to refinance
    - do you have credit available
    - most people move between willing and unwilling
  - ready to refinance
  - remember lower rates usually increase refinancing
  - sometimes refinancing increases just after an increase in rates as people believe rates are continuing to increase and they were trying to catch the bottom

- Burnout
  - generally occurs when people refinance as soon as it is economically feasible
  - low or no point refinancing has reduced this to an extent
  - seasonality
    - higher prepayment in summer than winter as people prefer to move during those periods
    - seasoning
- older mortgages are more prone to refinancing
- new mortgages generally haven’t had enough time to react to change in rates
- family considerations have not changed enough
- usually unable to pay origination fees

b)  

- Competitiveness
  - imports plus exports as a % of GDP is used as a measure
  - the more competitive the less chance of political instability

- Quality of Life
  - proxied by life expectancy

- Predictability
  - is inflation stable
  - stable inflation is a sign of political stability

- Agriculture
  - if agriculture is the dominant thing in the county there is a greater chance of political instability

- Trauma
  - need to create an infrastructure for future stability

- Human Capital

- GDP
  - largest part
  - the greater the per capita GDP the greater the stability

- Rental Income
  - if there is federal aid or resource based income then political instability might be present

- Dispersion in Income
  - a greater dispersion from high and low income is a sign of political instability
  - proxied by infant mortality

c)  

Full Hedging

- attempts to strip away all the currency risk to attain a risk return profile identical to local currency investor
- requires a forward in an amount equal to the foreign currency exposure

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As the foreign currency exposure fluctuates with investment returns, the investor in foreign will become over or under hedged investors accept a certain amount of deviation from the ideal hedge to offset rebalancing and associated costs.

Minimum Variance
- combines the effects of asset risk and currency risk to develop a hedge to minimize variance given an expected return
- goal is to minimize the overall risk of a foreign assets, while full hedging attempts to neutralize only the currency component
- requires accurate estimates of currency volatilities and correlations

Downside – option based
- minimize the probability of excessive currency losses
- can be done in many ways:
  - purchase a put on the individual currencies
  - purchase a put on a basket of currencies
  - purchase a put on the total base currency value for the asset

d) Diversification Benefits:

- **US asset**
  \[ w = 300,000 \quad \tau_{DAV} = .02 \quad P = 0.30 \]
  \[ \tau_{US \ ASSET} = 6,000 = (300,000)(.02) \]

- **PAC**
  \[ w = 200,000 \quad \tau_{DAV} = .015 \]
  \[ \tau_{PAC} = (200,000)(.015) = 3.000 \]

Individually: \[ \tau_{US \ ASSET} + \tau_{PAC} = 6000 + 3000 = 9000 = \tau_p \]

Diversify

\[ \sigma^2 = \Sigma W_i^2 \tau_i^2 + 2\Sigma W_i W_j \tau_i \tau_j \subset \]

\[ \sigma^2 = (300,000)^2(.02)^2 + (200,000)^2(.015)^2 + 2(300,000)(200,000)(.02)(.015)(.30) \]

\[ \sigma_p^2 = 55,800,000 \]

\[ \tau_p = 7,469.94 \]
By diversifying the $\tau_p$ is brought down from $9000$ to $7,469.94$.

\[ VAR_{US\ ASSET} = 1.645(6000)\sqrt{5} = 22,070 \]

\[ VAR_{PAC} = 1.645(3000)\sqrt{5} = 11,035 \]

$VAR$ for the portfolio with both: \( 1.645 \times 7470 \sqrt{5} = 27,477 \)

Before diversification: \( VAR = 22,070 + 11035 = 33,105 \)

After: \( VAR = 27,477 \)

Benefit of Diversification = $5,628$
11. Solutions

a) Portfolio Yield Strategy

(i) Recession Scenario
- the assets are indexed at higher yield than the yield under recession scenario, therefore, the portfolio yield will improve due to the lowering in interest rates
- the lower in yield will impact on the reinvestment income; however, it will not have instant negative impact on the portfolio yield now.
- the portfolio yield will not go down that much
- However, as the recession scenario persists, the portfolio yield will go down, the guaranteed minimum interest rate of 5% may kick in
- because crediting rates remain above current, and therefore are competitive, lower lapses should be experienced
  - the profit margin will be narrowed

(ii) Inflation Scenario
- the portfolio yield will lag the market yield, therefore, there may be some interest sensitive surrenders
- to avoid surrender, the company can either:
  1. increase the crediting rate, which erodes the profit margin or
  2. continue crediting yield lower than the market rate. If the surrenders accelerate
     the assets need to be sold at a loss to pay for cash outflow
     - the additional surrenders may create the need to sell assets at deflated values

Current Market Rates Strategy

(i) Recession Strategy
- the lower in interest rates will result in gains in the asset portfolio
- since the crediting rate is switched to the new money rate, the company can credit the lower rate to policyholders without sharing the benefits of gains (however, 5% minimum interest rate is guaranteed)
  ⇒ the end result is that the profit condition is improved over the portfolio yield crediting approach, but pricing spreads are compressed due to the guarantee kicking in

(ii) Inflation Scenarios
- higher interest rates depress the company asset portfolio
- new money crediting strategy further erodes the company’s profit margin
- the end result is that the company has smaller profit margins, or may even result in negative profit

b) - it incurs transaction costs
- it may have tax consequence
- it will generate earnings and cause earnings volatility which accounting department may not like
- the sales/purchases of assets should be based on the ALM, not just interest rate movement
- when an asset is purchased time and effort is spent on research, therefore, the effort will be wasted if an asset is sold
- there are other (better) methods to hedge interest rate risk

e)

(i) Recession Scenario
- to protect against declining interest rates, can do the following:

(1) buy interest rate floors on constant maturity treasury (CMT) or Constant Maturity Swap (CMS), with strike of 5%.
  - payoff on interest rate floors will offset losses of buying at high prices
  - good because CMT approximates rate credited on SPDA
  - this will also provide a gain to offset interest rate guaranteed

(2) prepayment Options
  - pays if prepayment exceeds a certain level
  - works against increasing in prepayments when rates fall
  - payment received would offset losses on reinvestment

(3) buy receiver swaption – option to enter into received fixed swap – protects against falling rates

(4) buy Bond Warrant – long dated calls on bonds
  Go up in value as rates fall

(ii) Inflation Scenario
  - strategies here are opposite of those to hedge recession scenario namely:
  1. buy interest rate caps that pay difference between index rate and strike rate when rates go above the strike rate.
  2. buy payor swaption – right to enter into pays fixed swap – protects against rising rates
  3. buy a bull spread – long a call, short a different call with a lower strike
Risks Include

1. **Operational Risk**
   - risks due to mismanagement or technical mistakes
   - must have good internal control

2. **Credit Risk**
   - risk due to counterparty default
   - must consider both current and potential exposure

3. **Market Risks**
   - basis or correlation risk in that instrument used to hedge is not correlated with hedged instrument
   - other risks include delta, gamma, vega (volatility),
   - 8ho risk that market moves away from you

4. **Legal Risk** – contract may not be enforceable
   - ultra vires – counterparty may be incompetent to enter contract

Use netting and exposure limits to control some of these risks.
12. Solutions

a)  
   • Cash flow uncertainty – As loans are not repaid until death of borrower or relocation, the cash flow stream is highly uncertain. Yet, GICs have stated maturity dates, fixed returns and in general are considered “preservation of principal” products.
   • GICs rates are fixed in advance. So if interest rates drop, the company may not be able to provide the required fixed return.
   • GICs allow for book value withdrawals and as the liquidity of these loans is minimal, it would be difficult to sell these assets should there be significant withdrawal activity.
   • Spread Risk – The company return is based on the spread between its GIC rate and the rate earned from approximately 6 months CD’s + 3%. If interest rates drop, the company’s margin will decrease as well.

(b)  
   (i) Fixed rate loans will have the advantage to better match the rate of the liabilities, namely GICs that are stable value products. However, if the company wishes to continue issuing such loans, its GIC rates may become uncompetitive as the fixed rate loans will not be able to match current market yields. In addition, fixed rate loans may not be able to match current market yields. In addition, fixed rate loans may not be a solid market. Shaky if it is determined that these homeowners prefer variable rate loans.

   (ii) Swapping variable for fixed has the advantage of (b)(i) but still allow the market of the product with fixed loan rates. There is counterparty risk with swaps. However, again, if yields rise, new GIC rates may be uncompetitive given a fixed rate asset base. In addition, there is cash flow uncertainty i.e. whether the company can make floating payment given uncertainly of its cash flows.

   (iii) Insurance will protect against cash flow uncertainty but it will be another cost that will reduce the spread between the loan rate and the GIC rate. In addition, this insurance will not protect the company from interest rate risk as the liability is floating but the asset is fixed.
13. **Solutions**

a) Use the volatility matrix to determine the volatility at 8 months with a strike of $X=35$.

Interpolate:

$$\sigma(12 \text{ mths}) = 0.236$$
$$\sigma(6 \text{ mths}) = 0.230$$
$$\sigma(8 \text{ mths}) = \sigma(6) + 2/6*(\sigma(12) - \sigma(6))$$
$$= 0.230 + 2/6*(0.236 - 0.230)$$
$$= 0.232$$

$S_0 = 40$
$X = 35$
$r = 0.07$
$T = 2/3$

Value of put option (European) $P = X \ e^{-rT} N(-d_2) - S_0 N(-d_1)$

$$d_1 = \frac{\ln(S_0/X) + (r + \sigma^2/2)T}{(\sigma \sqrt{T})}$$
$$= \frac{\ln(40/35) + (0.07 + 0.232^2/2) \times 2/3}{0.232 \sqrt{2/3}} = 1.04599$$

$$d_2 = d_1 - \sigma \sqrt{T}$$
$$= 1.04599 - 0.232 \sqrt{2/3} = 0.85657$$

b) The implied volatilities decrease as strike price increases.

This matrix is consistent with the equity smile used by traders to price options. It implies a fatter left tail and thinner right tail stock price distribution versus the lognormal distribution.

c) (i)

**Compound option model**

Equity is a call option on value of firm with strike price equal to debt of firm.
Stock option is an option on the option of the value of the firm.
When value of firm increases from rise in stock price, proportion of debt decreases making stock less risky.
Therefore volatility of stock decreases (consistent with implied distribution).

(ii)

**Displaced Diffusion Model**

Assumes assets are risky or riskless
Assumes fixed amount of default free debt

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\( a = \alpha(1 + \beta) \) where \( \alpha = \% \) risky assets, \( \beta = \text{debt/equity ratio} \)
If \( a > 1 \) – debt is greater than riskless assets.
Volatility falls as stock prices rise.
Model behaves like compound option model.
The difference with the compound option model is that if debt > Value of firm, equity may become negative.

(iii)
Constant elasticity of variance (\( \sigma \))
Stock price volatility is \( \sigma S - \alpha \) where \( 1 \geq \alpha \geq 0 \)
When stock price increases, volatility decreases
Assumes a company has fixed expenses. If firm performs poorly, earnings become more volatile because it still has to meet the fixed expenses. Stock price decreases and volatility increases.

(iv)
Any stochastic model for volatility
Once volatility negatively correlated to stock price.
14. Solutions

a)  
- mortgage at floating rates, leases at fixed — will lose if rates rise
- leases may not be renewed after they expire
- market value may fall
- lessees may go belly-up
- overall economic conditions could worsen, reducing the property value, increasing insolvency among lessees, and making it difficult to replace leases
- as a single property, not diversified either by industry or geographically

b)  
- enter into an interest rate swap-fixed rate for floating. Pay fixed.
- buy an interest rate cap that will pay when interest rates rise above a certain level
- diversify by buying other property types (e.g., commercial, residential) and in other geographic regions
15. Solutions

a) Using real world probabilities, expected payoff is
(1,000) (0.85) + (700) (0.1) + (350)(0.05) = 937.5

Using risk-neutral probability

<table>
<thead>
<tr>
<th>Probability</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.75</td>
<td>1000</td>
</tr>
<tr>
<td>0.15</td>
<td>700</td>
</tr>
<tr>
<td>0.10</td>
<td>350</td>
</tr>
</tbody>
</table>

Expected value = 890 \( PV = 8\% e^{-0.25} = 693 \)
\[ e^{5x} = \frac{937.50}{693}, x = 6.04\% \]
\[ \text{spread} = 6.04\% - 5\% = 1.04\% \]

b) No default: Max (0,1000-1000) = 0
Default with 70% Rec: Max (0, 1000-700) = 300
Default with 35% Rec: Max(0, 1000-350) = 650
\[ \text{Possible payoff of 0, 300, 650} \]

If further assume that \( \delta \) may default, total 9 payoff, see section C

c) Using risk-neutral probabilities:

Assumption Z may default with recovery % applied to payoff

<table>
<thead>
<tr>
<th>Situation</th>
<th>Payoff</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>( X_1 - X ) doesn't default</td>
<td>0</td>
<td>0.75 x 0.75</td>
</tr>
<tr>
<td>( X_2 - X ) default 70% rec</td>
<td>300</td>
<td>0.75 x 0.1</td>
</tr>
<tr>
<td>( X_3 - X ) default 35% rec</td>
<td>650</td>
<td>0.15 x 0.75</td>
</tr>
<tr>
<td>( X_1, Z_1 )</td>
<td>0</td>
<td>0.75 x 0.15</td>
</tr>
<tr>
<td>( X_1, Z_2 )</td>
<td>0</td>
<td>0.15 x 0.75</td>
</tr>
<tr>
<td>( X_1, Z_3 )</td>
<td>0</td>
<td>0.15 x 0.1</td>
</tr>
<tr>
<td>( X_2, Z_1 )</td>
<td>210</td>
<td>0.1 x 0.75</td>
</tr>
<tr>
<td>( X_2, Z_2 )</td>
<td>455</td>
<td>0.1 x 0.15</td>
</tr>
<tr>
<td>( X_2, Z_3 )</td>
<td>105</td>
<td>0.1 x 0.1</td>
</tr>
<tr>
<td>( X_3, Z_1 )</td>
<td>650</td>
<td>0.1 x 0.75</td>
</tr>
<tr>
<td>( X_3, Z_2 )</td>
<td>227.5</td>
<td>0.1 x 0.15</td>
</tr>
</tbody>
</table>

\[ \text{expected payoff = 97.9} \]
\[ \text{option value = 97.9 x } e^{-0.25} \]
\[ = 76.24 \]
16. Solutions

a)

<table>
<thead>
<tr>
<th>MV (Liability)</th>
<th>MV(A) – MV (Equity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct</td>
<td>Indirect</td>
</tr>
<tr>
<td>Independent of assets and how they are</td>
<td>dependent on assets and how they are</td>
</tr>
<tr>
<td>calculated</td>
<td>calculated</td>
</tr>
<tr>
<td>Independent of accounting rules (statement)</td>
<td>relies on accounting statement</td>
</tr>
<tr>
<td>Independent of with credit quality of company</td>
<td>relies on credit quality of company</td>
</tr>
<tr>
<td>no adjustments need to be made to it</td>
<td>relies on equity (dist. earnings) which can be difficult to model</td>
</tr>
<tr>
<td></td>
<td>Requires adjustments</td>
</tr>
</tbody>
</table>

Adjustments
(i) must subtract out franchise value from MV equity) no adjustment in direct approach
(ii) must subtract out corporate debt from estimate of MV(L) in indirect method
(iii) indirect method produces higher liability value after accounting for put option in state guarantee funds

- indirect: some issues on how assets from takeover/merger should be handled no related issue for direct method

b)

Two Approaches
First: Spread Adjustment
⇒ add required spread to interest rates in model to account for risk
⇒ problems with spreads though
  a. not necessarily additive
  b. small change in optionality leads to large change in spread
  c. no market comparables from which spread can be determined

⇒ too subjective – is spread correct?

⇒ Okay to use spread method if market comparables available
e.g. default risk can be easily modeled using spread approach

2nd Approach
⇒ explicitly model the CF
⇒ required if options embedded in CF’s
⇒ each CF than has a new risk-adjusted discount rate
\[ r^* = r_r + \text{risk aversion for risks modeled} + \text{risk spread for those not} \]

use of IR lattice limited to those cases when CF's not path dependent on previous results
MC simulation needed for path dependent flows e.g. MBS, rate crediting based on average rate, however MC cannot value an American Option
17. Solutions

a) Prepayment Uncertainty
Sensitivity of security price to changes in level of prepay speed projected by a prepayment model can measure overall prepayment risk or that due only to refinancing or relocation.

Volatility Risk (Vega)
Sensitivity of a security’s price to a change in the underlying volatility of treasury rates. Hold OAS constant and recalculate price for a 1% increase and decrease in interest rate volatility.

Zero Volatility Spread (ZV0)
Spread investor expects to earn if there was no uncertainty about future path of interest rates. The constant spread over the treasury curve which equates the discounted cash flows from today’s implied forward curve to the current price of the security.

Spread Duration
Sensitivity of bond price to change in its OAS

Prepayment Uncertainty
Prepayment uncertainty increases the value of an option. Since OAS is compensation for shorting options, the greater prepayment risk => ↑ option cost => ↓ OAS. Thus mortgage-backed securities (MBS, CMBS, CMO) value ↓. CMO value affected less depending on seniority at the tranche. ARM’s move with the i-rate-no charge.

Volatility Risk
Debt instrument with embedded options depend on level of interest rates ↑ volatility => ↑ value of option. Investor in mortgage-backed securities (MBS, GMBS, CMO) or callable bond has granted this option at issue so price must fall since value has fallen.
- putable bond value will rise ↑ since investor has option => price ↑
- ARM will not be affected – rate resets

ZV0
related to volatility => with no volatility in interest rates time value of prepayment option drops to zero
true of callable & putable bonds as well

ZV0 is like OAS with assumptions of no uncertainty concern future term structure
Difference in ZV0 and OAS represents time value of option
- small when timing of cash flows and interest rate △’s insensitive
- difference in ARM’s and CMO’s due to any cap
Spread Duration
Duration for MBS and ARM, reflect fact that a change in OAS affects the PV of (future cash flows)
But cash flows themselves unaffected by $\Delta's$ in OAS.
- $\Delta's$ in OAS for callable and putable bond does affect the cash flows an investor receives
- For MBS, measure analogous to MacCarley duration as refinancing motivated by $\Delta's$ in level of interest rates.
- For CMO, though, it could be very different.
- For corporate bonds, spread donation = effective duration
  $\Delta's$ in OAS could mean difference between refinancing or not
The Education and Examination Committee provides study notes to persons preparing for the examinations of the Society of Actuaries. They are intended to acquaint candidates with some of the theoretical and practical considerations involved in the various subjects. While varying opinions are presented where appropriate, limits on the length of the material and other considerations sometimes prevent the inclusion of all possible opinions. These study notes do not, however, represent any official opinion, interpretations or endorsement of the Society of Actuaries or its Education and Examination Committee. The Society is grateful to the authors for their contributions in preparing the study notes.
COURSE 8 - INVESTMENTS
CASE STUDY

LifeCo
BACKGROUND AND HISTORY

LifeCo is a multinational stock life insurance company and has general account assets totaling $5 billion supporting three main lines of business: Individual Life and Annuity, Institutional Pensions and Group Benefits. Its assets are internally segmented in eleven major portfolios defined below. Each portfolio is fully integrated in the accounting databases with full income statements and balance sheets produced monthly. LifeCo has recently implemented guidelines for Asset Liability Management and is in the process of identifying strategies for mitigating its exposure to interest rate and other risks.

LINES OF BUSINESS

_Individual Life and Annuity_
- Traditional Life
- Non Traditional Life
- Accumulation Annuity
- Equity-Linked GIC
- Separate Account for Variable Annuity and Variable UL

_Institutional Pensions_
- Payout Annuity
- GIC
- Separate Account for Institutional GICs

_Group Benefits_
- Long Term Disability
- Medical, Dental, Group Term

_Surplus Account_
- Surplus Capital

DESCRIPTION OF LIABILITIES

_Individual Life and Annuity_

_Traditional Life_ includes all non-interest-sensitive individual life products and is predominantly comprised of non-par term and whole life. Guaranteed interest on whole life policies ranges from 3% to 6%. Policyholders can take out policy loans against any cash surrender value. A maximum loan rate of 7% exists on older policies. The duration of the traditional life liability cash flows tends to be fairly long. It has been difficult to find assets with suitable characteristics to effectively match these liabilities. The liabilities in the traditional life segment are supported by $300 million of assets.

_Non Traditional Life_ consists entirely of universal life. Universal life policyholders can direct their investments into a number of interest bearing or equity-linked accounts.
Interest accounts generally credit a portfolio average rate and have a minimum credited interest guarantee of 4% across the board. Because LifeCo incurs significant costs associated with the acquisition of this business, even though the present value of future fund profits exceeds the present value of all future benefits and expenses, it will not have the hard assets to invest at issue in order to match the interest rate exposure of the liabilities. This situation creates significant reinvestment rate risk. To further complicate matters, the embedded options present in universal life mean that the liability cash flows will not be fixed and will vary with interest rates. The liabilities in the non-traditional life segment are supported by $400 million of assets.

**Accumulation Annuity** contains all individual flexible and single premium deferred annuities. Assets total $1.5 billion. Most funds are available for withdrawal at a book value basis. Surrender charges decline to 0% over a 5-7 year period. Minimum guarantees are generally in the 3-4% range but there is a $500 million block of annuities that have a 5% minimum guarantee. This latter block was sold with a 6% cliff surrender charge and will be reaching the end of the surrender charge period in the next year (i.e. the surrender charge will go from 6% to 0). There is also a $250 million block of MVA (market value adjusted) annuities included in this segment. The Accumulation Annuity portfolio has been the subject of much modeling scrutiny over the years to better understand the product profitability and risk profile. Actuaries at LifeCo have internally flagged each asset purchase in the portfolio to a particular product in order to support a more detailed level of analysis.

**Equity Linked GICs** offer the return of principal after five years, plus 75% of the percentage increase of the S&P 500 total return index over that five year period (if positive) As at December 31st, 1999:

- assets total $55 million
- remaining term to maturity of GICs is 4.5 years
- current percentage increase of the S&P 500 total return index since issue is 6%
- volatility of the S&P 500 index equals 18%
- interest rate is 5.5% continuously compounded
- S&P 500 total return index is expected to grow at 15%/year

**Variable Annuities** include a guaranteed minimum death benefit, which, upon death of the policyholder, will pay the maximum of the current account value and the deposits accumulated at 5%. Upon surrender, the market value less surrender charges is paid.

**Separate Accounts for Variable Annuity and Variable UL** are invested in various, externally managed, mutual funds. Policyholders may transfer between the funds offered, make new deposits, and withdraw money, subject to a surrender charge.

**Institutional Pensions**

**Payout Annuity** contains pension buyout annuities in both immediate and deferred status, supplementary contracts arising from life or annuity contracts and structured settlement annuities. This segment was established to hold intermediate to long term income.
payment streams that may or may not include life contingencies. Structured settlement
annuities contain standard and substandard annuities, non life contingent streams and
some COLA (cost of living adjustment) escalators. Assets total $700 million.

**Guaranteed Investment Contract (GIC)** include both single deposit and window GICs
This segment holds $1.5 billion of assets. $200 million of the portfolio consists of
funding agreements that are puttable with 60 days notice. The remainder are benefit-
sensitive contracts with institutional pension plans, which mature over the next 5 years

**Separate Account Institutional GIC** offers single deposit and window GICs to larger
institutional clients. For accounts larger than $150 million, the company will offer to set
up a separate portfolio for one client, with its own asset allocation targets.
Administrative fees are reduced for the commingled accounts, which are available to
clients with at least $25 million. While the institutional client owns the market value of
its share in the separate account, the individual participants receive interest credited to the
book value of their individual accounts. LifeCo annually resets the crediting rates, so that
the market value gains and losses in the commingled account are shared with participants.
The general formula used to set the credited rate is as follows.

\[
\text{Credited rate} = \text{Market yield of separate account} - \text{Administration fees} + \frac{\text{MV separate account} - \text{BV individual accounts}}{\text{Duration of separate account}}
\]

In addition, LifeCo guarantees that the market value of each separate account will never
be less than 80% of the book value of the individual accounts associated with it. LifeCo
does not offer synthetic GICs.

**Group Benefits**

**Group Long-Term Disability** pays up to 70% of an employee's salary prior to the
disability claim. Premiums are paid through payroll deduction. Premium rates are
guaranteed for 2 years. Claims incurred stay with LifeCo even if the employer changes
insurance carrier for new business. The current product provides “own occupation”
benefits generally for two years from the date of incurrence, after which payments continue
only if the claimant is unable to work at all. LifeCo offers rehabilitative services and
counseling where it may be effective, usually through the first four years of a claim.
Claim runoff is such that reserves at claim duration 10 are expected to be about 10% of
the reserve at date of incurrence. There is no cash surrender benefit to either individual
claimants or group policyholders. The claim liabilities and unearned premium in respect
of the group LTD segment are backed by $500 million of assets.

**Other A&H** includes short term group medical, dental, and term life products. These
products are sold through the same group benefits general agents who distribute the
company’s LTD product. The company competes on strong underwriting and customer
service. The products are repriced at least annually to meet profitability targets. While
investment margins are material, they are seen as independent of underwriting margins.
Earned premium to surplus leverage is low, at about 4/1. The claim reserves and unearned premium in respect of the other A&H segment are backed by $100 million of assets.

*Surplus Account* contains the excess surplus capital. The Surplus Account is managed to maximize total rate of return growth over time subject to a series of constraints related to liquidity, bond ratings and operating income versus surplus income concerns. Company guidelines require an asset mix of 10-70% in equities, 0-50% in real estate, and 5-90% in bonds. The target asset mix is 50% equities, 35% real estate, and 15% public and private bonds.

**RATINGS OF COMPANY**

Mud & Poor’s (M&P) Rating Agency uses the following rating categories:

AAA, AA, A, BBB, BB, B, etc

LifeCo is currently rated “AA-”. One year ago, M&P raised concerns about LifeCo and placed the company under ratings review. LifeCo was not downgraded at that time.

M&P’s report at that time included the following rationale for the review:

**Capital:** LifeCo’s capital position of 3.6% of assets is weak relative to the other insurers rated “AA-”.

**Liquidity:** LifeCo’s liquidity position appears weak. Given that the GIC’s will mature over the next few years and that a significant portion of the new sales are directed to separate account products, the company would appear to have a higher than usual liquidity risk.

**Credit Risk:** LifeCo is exposed to C1 risk because of its investments in: below investment grade bonds, commercial mortgages, equity, and real estate. LifeCo also has a high percentage of total assets invested in CMO’s which exhibit cashflow volatility.

**Growth/Profitability:** LifeCo’s business mix is shifting to less capital intensive lower margin products.

**PERFORMANCE HISTORY**

LifeCo was established in 1945; however most of LifeCo’s growth has taken place in the last ten years.

Although LifeCo has been profitable on both a Statutory and GAAP basis for the past 6 years, profits have fluctuated. Return on Equity (ROE) has averaged 8% over the past 5
years compared to an ROE of 12% for the industry. LifeCo’s Stock, on a total return basis, has returned 10%, on average, over the past 3 years.

ENVIRONMENT

In surveys, the company has generally received positive reviews from its customers for service and for value. One weakness of the company has been its public relations department. Early in 1999, LifeCo took steps to deal with this weakness by hiring the one of the top public relations specialists in the country.

The insurance industry in general has received some bad press of late due to perceived market conduct problems. As a result, financial service companies that are not perceived as insurers have taken business away from companies perceived as insurers. LifeCo is definitely viewed as an insurer.

Because of the rapid changes in product design, LifeCo has 16 products running on 6 different administrative systems. With the strong stock market and declining interest rates, money has been moving from the fixed account to the variable accounts for both the variable annuity and the variable life products. The variable life market has been growing in recent years. The variable annuity market has also been growing, but it has been adversely affected by recent tax law changes. Additionally, recent changes in regulation have allowed banks to underwrite variable annuities, and several large banks are offering low load versions of this product. These changes have resulted in a dramatic slowing of variable annuity sales for LifeCo. At the same time, many reinsurers have taken a second look at offering reinsurance for the risk associated with the investment guarantees offered on these products and are now either not willing to provide reinsurance on this business at all or, if they do, at a much higher cost than was previously assumed in pricing.

DESCRIPTION OF ASSETS

General Fund Assets Backing Individual Life & Annuity and Institutional Pensions
LifeCo invests in private placement bonds, public bonds (including CMO’s), commercial mortgages, equities and real estate. For private placement bonds, LifeCo tries to maintain a 75% investment grade, 25% below investment grade mix. The current mix is worse than these percentages because of downgrades in the portfolio. 30% of the private placement bonds are callable.

For public bonds LifeCo tries to maintain an 80% investment grade, 20% below investment grade mix. Currently, LifeCo maintains a higher credit quality for the public bonds to offset the current mix for the private placement bonds. 75% of the public bonds are callable.

General account assets are segmented into portfolios supporting the liability lines. LifeCo’s asset mix backing its pension business is: 83% bonds, 13% commercial
mortgages, 2% equities and 2% cash & short term. LifeCo’s asset mix backing its individual life and annuity business, including the liability arising from the guaranteed minimum death benefit, is: 74% bonds, 10% commercial mortgages, 5% equities, 7% real estate, 2% policy loans and 2% cash & short term. LifeCo’s asset mix backing its Group Life and Health business is: 85% bonds, 8% commercial mortgages, 5% equities and real estate, and 2% cash and other.

Separate Accounts Variable Annuities and Variable UL Policies
The overall distribution is 70% US equity, 15% US bonds, 5% money market, and 10% international bonds/equity for the variable annuity block. Assets total $2.4 billion of variable annuities, and $1.2 billion for variable annuities.

<table>
<thead>
<tr>
<th>Fund Type</th>
<th>Volatility</th>
<th>Equity</th>
<th>Bond</th>
<th>Mortgage</th>
<th>Asian</th>
<th>Global</th>
<th>Money Market</th>
<th>Balanced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equity</td>
<td>18%</td>
<td>1</td>
<td>0.00%</td>
<td>0.00%</td>
<td>25.00%</td>
<td>70.00%</td>
<td>0.00%</td>
<td>95.00%</td>
</tr>
<tr>
<td>Bond</td>
<td>4%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>1</td>
<td>80.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Mortgage</td>
<td>3%</td>
<td>0.00%</td>
<td>60.00%</td>
<td>1</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Asian</td>
<td>21%</td>
<td>25.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>1</td>
<td>45.00%</td>
<td>0.00%</td>
<td>25.00%</td>
</tr>
<tr>
<td>Global</td>
<td>19%</td>
<td>70.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>1</td>
<td>0.00%</td>
<td>70.00%</td>
<td></td>
</tr>
<tr>
<td>Money Market</td>
<td>0%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>1</td>
<td>0.00%</td>
</tr>
<tr>
<td>Balanced</td>
<td>9%</td>
<td>95.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>25.00%</td>
<td>70.00%</td>
<td>0.00%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit Value</th>
<th>Variable Annuities</th>
<th>Variable UL ($ millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equity</td>
<td>18.2</td>
<td>2,452</td>
</tr>
<tr>
<td>Bond</td>
<td>13.1</td>
<td>2,452</td>
</tr>
<tr>
<td>Mortgage</td>
<td>11.1</td>
<td>2,452</td>
</tr>
<tr>
<td>Asian</td>
<td>9.5</td>
<td>2,452</td>
</tr>
<tr>
<td>Global Equity</td>
<td>14.8</td>
<td>2,452</td>
</tr>
<tr>
<td>Money Market</td>
<td>10.5</td>
<td>2,452</td>
</tr>
<tr>
<td>Balanced</td>
<td>15.2</td>
<td>2,452</td>
</tr>
<tr>
<td>Total</td>
<td>2,452</td>
<td></td>
</tr>
</tbody>
</table>

Note: The Delta and Gamma applies to the minimum guaranteed death benefit included in the variable annuity product.

<table>
<thead>
<tr>
<th>Variable Annuities</th>
<th>DAC</th>
<th>Net Book Value</th>
<th>PV of Cash-Flows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported Book Value</td>
<td>2459</td>
<td>2,385</td>
<td>2,360</td>
</tr>
<tr>
<td>Variable UL</td>
<td>1122</td>
<td>1,094</td>
<td>1,085</td>
</tr>
</tbody>
</table>

Separate Account Institutional GIC
In total this line of business holds $1.2 billion in market value of assets. Each commingled account offers a different target asset allocation.
### Account 1

<table>
<thead>
<tr>
<th>Category</th>
<th>Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treasuries</td>
<td>5%</td>
</tr>
<tr>
<td>AA/AAA public corporates</td>
<td>35%</td>
</tr>
<tr>
<td>A public corporates</td>
<td>15%</td>
</tr>
<tr>
<td>BBB public corporates</td>
<td>10%</td>
</tr>
<tr>
<td>Federal/Agency MBS passthroughs</td>
<td>25%</td>
</tr>
<tr>
<td>High grade private corporate debt</td>
<td>10%</td>
</tr>
</tbody>
</table>

### Account 2

<table>
<thead>
<tr>
<th>Category</th>
<th>Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treasuries</td>
<td>5%</td>
</tr>
<tr>
<td>AA/AAA public corporates</td>
<td>10%</td>
</tr>
<tr>
<td>A public corporates</td>
<td>15%</td>
</tr>
<tr>
<td>BBB public corporates</td>
<td>15%</td>
</tr>
<tr>
<td>High yield public corporates</td>
<td>15%</td>
</tr>
<tr>
<td>Convertible securities</td>
<td>10%</td>
</tr>
<tr>
<td>Federal/Agency MBS passthroughs</td>
<td>15%</td>
</tr>
<tr>
<td>High grade private corporate debt</td>
<td>10%</td>
</tr>
<tr>
<td>Other private debt</td>
<td>5%</td>
</tr>
</tbody>
</table>

**Group Long-Term Disability**

The asset portfolio is designed to have relatively low liquidity and high total return, with a duration target of 7 years. The target asset allocation is as follows:

<table>
<thead>
<tr>
<th>Category</th>
<th>Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treasuries</td>
<td>5%</td>
</tr>
<tr>
<td>Inv Grade public corporates</td>
<td>35%</td>
</tr>
<tr>
<td>Federal/Agency MBS passthroughs</td>
<td>20%</td>
</tr>
<tr>
<td>High yield public corporates</td>
<td>10%</td>
</tr>
<tr>
<td>Commercial mortgages</td>
<td>10%</td>
</tr>
<tr>
<td>High grade private corporate debt</td>
<td>10%</td>
</tr>
<tr>
<td>Other private debt</td>
<td>5%</td>
</tr>
<tr>
<td>Real estate partnerships</td>
<td>5%</td>
</tr>
</tbody>
</table>

**Other A&H**

Invested assets are managed for high liquidity and high total return.

<table>
<thead>
<tr>
<th>Category</th>
<th>Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treasuries</td>
<td>10%</td>
</tr>
<tr>
<td>Inv Grade public corporates</td>
<td>50%</td>
</tr>
<tr>
<td>Federal/Agency MBS passthroughs</td>
<td>25%</td>
</tr>
<tr>
<td>High yield public corporates</td>
<td>10%</td>
</tr>
<tr>
<td>Public equities</td>
<td>5%</td>
</tr>
</tbody>
</table>
### Total Company (excluding Separate Accounts)

<table>
<thead>
<tr>
<th>Assets</th>
<th>Reported Book Value</th>
<th>Book Yield</th>
<th>PV Cash Flows</th>
<th>Modified Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonds (total)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1a Gov’t</td>
<td>202.4</td>
<td>5.97%</td>
<td>202.8</td>
<td>6.1</td>
<td>1.0</td>
</tr>
<tr>
<td>A1b Public Corporate (Inv. Grade)</td>
<td>1573.7</td>
<td>6.76%</td>
<td>1621.0</td>
<td>9.2</td>
<td>23.6</td>
</tr>
<tr>
<td>A1c Public Corporate (below Inv Grade)</td>
<td>399.8</td>
<td>7.21%</td>
<td>419.0</td>
<td>5.8</td>
<td>20.0</td>
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<tr>
<td>A1d Private Corporate (Inv Grade)</td>
<td>790.3</td>
<td>6.99%</td>
<td>829.1</td>
<td>7.0</td>
<td>15.8</td>
</tr>
<tr>
<td>A1e Private Corporate (below Inv Grade)</td>
<td>437.7</td>
<td>7.54%</td>
<td>470.1</td>
<td>5.4</td>
<td>30.6</td>
</tr>
<tr>
<td>A1f Pass-throughs</td>
<td>274.2</td>
<td>6.88%</td>
<td>288.0</td>
<td>4.7</td>
<td>8.2</td>
</tr>
<tr>
<td>A1g CMO’s</td>
<td>219.2</td>
<td>6.60%</td>
<td>227.5</td>
<td>4.3</td>
<td>6.6</td>
</tr>
<tr>
<td>A1 Bonds Subtotal</td>
<td>3897.2</td>
<td>6.90%</td>
<td>4057.5</td>
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<td>105.8</td>
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<tr>
<td>A2 Cash &amp; short term</td>
<td>103.0</td>
<td>4.75%</td>
<td>103.0</td>
<td>0.1</td>
<td>0.3</td>
</tr>
<tr>
<td>A3 Commercial Mortgages</td>
<td>554.0</td>
<td>8.39%</td>
<td>595.0</td>
<td>5.4</td>
<td>27.7</td>
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<td>A4 Derivative securities</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.0</td>
<td>-</td>
<td>0.0</td>
</tr>
<tr>
<td>A5 Equities</td>
<td>249.3</td>
<td>1.66%</td>
<td>249.3</td>
<td>19.9</td>
<td>49.9</td>
</tr>
<tr>
<td>A6 Real Estate (unleveraged)</td>
<td>237.0</td>
<td>9.70%</td>
<td>274.1</td>
<td>10.0</td>
<td>35.6</td>
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<tr>
<td>A7 Invested Assets Subtotal</td>
<td>5040.5</td>
<td>6.89%</td>
<td>5278.8</td>
<td>8.0</td>
<td>219.3</td>
</tr>
<tr>
<td>A8 Accrued investment income</td>
<td>50.3</td>
<td>0.00%</td>
<td>50.3</td>
<td>-</td>
<td>0.0</td>
</tr>
<tr>
<td>A9 Policyholder Loans</td>
<td>52.5</td>
<td>7.17%</td>
<td>52.5</td>
<td>0.1</td>
<td>0.0</td>
</tr>
<tr>
<td>A10 Provision for asset default</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.0</td>
<td>-</td>
<td>0.0</td>
</tr>
<tr>
<td>A10 Other</td>
<td>75.5</td>
<td>0.00%</td>
<td>75.5</td>
<td>-</td>
<td>0.0</td>
</tr>
<tr>
<td>A11 Total Assets</td>
<td>5218.8</td>
<td>6.73%</td>
<td>5457.1</td>
<td>7.7</td>
<td>219.3</td>
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<table>
<thead>
<tr>
<th>Liabilities</th>
<th>Reported Book Value</th>
<th>Req Interest</th>
<th>PV Cash Flows</th>
<th>Modified Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1 Benefit liabilities</td>
<td>5030.8</td>
<td>6.27%</td>
<td>5220.0</td>
<td>9.8</td>
<td>155.5</td>
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<tr>
<td>B Total Liabilities</td>
<td>5030.8</td>
<td>6.27%</td>
<td>5220.0</td>
<td>9.8</td>
<td>155.5</td>
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<tr>
<td>C PreTax Equity</td>
<td>188.0</td>
<td></td>
<td>237.1</td>
<td>(38.62)</td>
<td></td>
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</table>

### Tax and Other Adjustments

| D Subtotal, tax and other adjustments | 65.8 | 83.0 |

| Net Value (C-D) | 122.2 | 154.1 |
### Surplus Account

<table>
<thead>
<tr>
<th>Assets</th>
<th>Reported Book Value</th>
<th>Book Yield</th>
<th>PV Cash Flows</th>
<th>Modified Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonds (total)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1a Gov't</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>A1b Public Corporate (Inv Grade)</td>
<td>9.2</td>
<td>7.53%</td>
<td>4.3</td>
<td>2.20</td>
<td>0.14</td>
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<td>A1c Public Corporate (below Inv Grade)</td>
<td>4.9</td>
<td>9.17%</td>
<td>8.8</td>
<td>3.90</td>
<td>0.25</td>
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<tr>
<td>A1d Private Corporate (Inv Grade)</td>
<td>3.5</td>
<td>8.01%</td>
<td>5.9</td>
<td>3.80</td>
<td>0.07</td>
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<td>A1e Private Corporate (below Inv Grade)</td>
<td>10.8</td>
<td>9.82%</td>
<td>18.4</td>
<td>5.30</td>
<td>0.76</td>
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<tr>
<td>A1f Pass-throughs</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>A1g CMO's</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td><strong>A1 Bonds Subtotal</strong></td>
<td><strong>26.4</strong></td>
<td><strong>8.74%</strong></td>
<td><strong>37.4</strong></td>
<td><strong>3.87</strong></td>
<td><strong>1.21</strong></td>
</tr>
<tr>
<td>A2 Cash &amp; short term</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>A3 Commercial Mortgages</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>A4 Derivative securities</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>A5 Equities</td>
<td>101.5</td>
<td>2.61%</td>
<td>101.5</td>
<td>9.50</td>
<td>20.30</td>
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<tr>
<td>A6 Real Estate (unleveraged)</td>
<td>58.0</td>
<td>7.23%</td>
<td>95.1</td>
<td>12.10</td>
<td>8.71</td>
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<tr>
<td><strong>A6 Invested Assets Subtotal</strong></td>
<td><strong>188.0</strong></td>
<td><strong>4.96%</strong></td>
<td><strong>196.6</strong></td>
<td><strong>9.45</strong></td>
<td><strong>38.9</strong></td>
</tr>
<tr>
<td>A7 Accrued investment income</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>A8 Policyholder Loans</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>A9 Provision for asset default</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>A10 Other</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td><strong>A11 Total Assets</strong></td>
<td><strong>188.0</strong></td>
<td><strong>4.96%</strong></td>
<td><strong>234.0</strong></td>
<td><strong>9.45</strong></td>
<td><strong>38.9</strong></td>
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</table>

<table>
<thead>
<tr>
<th>Liabilities</th>
<th>Reported Book Value</th>
<th>Req Interest</th>
<th>PV Cash Flows</th>
<th>Modified Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1 Benefit liabilities</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B Total Liabilities</strong></td>
<td><strong>0.0</strong></td>
<td><strong>0.0</strong></td>
<td><strong>0.0</strong></td>
<td><strong>0.0</strong></td>
<td><strong>0.0</strong></td>
</tr>
<tr>
<td>C PreTax Equity</td>
<td>188.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Tax and Other Adjustments

| D1 Future tax payments       | 0.0                 |              |               |                   |             |
| D2 Other adjustments         | 0.0                 |              |               |                   |             |
| **D Subtotal, tax and other adjustments** | **0.0** | | | |

**Net Value (C-D)** 188.0
### Individual Life & Annuity - Traditional Life

#### Assets

<table>
<thead>
<tr>
<th>Bonds (total)</th>
<th>Reported Book Value</th>
<th>Book Yield</th>
<th>PV Cash Flows</th>
<th>Modified Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gov't</td>
<td>6.5</td>
<td>6.10%</td>
<td>6.45</td>
<td>13.9</td>
<td>0.03</td>
</tr>
<tr>
<td>Public Corporate (Inv. Grade)</td>
<td>51.6</td>
<td>6.90%</td>
<td>54.44</td>
<td>26.8</td>
<td>0.77</td>
</tr>
<tr>
<td>Public Corporate (below Inv Grade)</td>
<td>12.9</td>
<td>7.30%</td>
<td>13.61</td>
<td>12.0</td>
<td>0.65</td>
</tr>
<tr>
<td>Private Corporate (Inv Grade)</td>
<td>28.4</td>
<td>7.00%</td>
<td>29.94</td>
<td>17.2</td>
<td>0.57</td>
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<tr>
<td>Private Corporate (below Inv Grade)</td>
<td>15.5</td>
<td>7.50%</td>
<td>16.33</td>
<td>8.5</td>
<td>1.08</td>
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<tr>
<td>Pass-throughs</td>
<td>7.1</td>
<td>7.00%</td>
<td>7.45</td>
<td>5.5</td>
<td>0.21</td>
</tr>
<tr>
<td>CMO's</td>
<td>7.1</td>
<td>7.10%</td>
<td>7.52</td>
<td>6.5</td>
<td>0.21</td>
</tr>
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<td>Bonds Subtotal</td>
<td>129.0</td>
<td>7.01%</td>
<td>135.74</td>
<td>19.0</td>
<td>3.53</td>
</tr>
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</table>

| Cash & short term      | 6.0                | 4.75%      | 6.00          | 0.1               | 0.02        |
| Commercial Mortgages   | 39.0               | 8.00%      | 41.93         | 5.0               | 1.95        |
| Derivative securities  | 0.0                | 0.00%      | 0.00          | 0.0               | 0.00        |
| Equities               | 75.0               | 1.00%      | 75.00         | 28.0              | 15.00       |
| Real Estate (unleveraged) | 21.0            | 10.50%     | 21.00         | 10.0              | 3.15        |
| Invested Assets Subtotal | 270.0          | 5.71%      | 279.7         | 18.4              | 23.6        |

| Accrued investment income | 3.0 | 0.00% | 3.00 | 0.0 | 0.00 |
| Policyholder Loans       | 22.5 | 7.00% | 22.50 | 0.1 | 0.00 |
| Provision for asset default | 0.0  | 0.00% | 0.00 | 0.0 | 0.00 |
| Other                    | 4.5 | 0.00% | 4.50 | 0.0 | 0.00 |
| **Total Assets**         | 300.0 | 5.66% | 309.7 | 16.6 | 26.8 |

#### Liabilities

<table>
<thead>
<tr>
<th>Benefit liabilities</th>
<th>Reported Book Value</th>
<th>Req Interest</th>
<th>PV Cash Flows</th>
<th>Modified Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>300.0</td>
<td>6.10%</td>
<td>318.00</td>
<td>31.9</td>
<td>2.0</td>
<td></td>
</tr>
</tbody>
</table>

**Total Liabilities** | 300.0 | 6.10% | 318.0 | 31.9 | 2.0 |

#### C PreTax Equity

| 0.0 | -8.3 | 600.59 |

#### Tax and Other Adjustments

| Future tax payments | 0.0 | -2.9 |
| Other adjustments   |     |     |

**Subtotal, tax and other adjustments** | 0.0 | -2.9 |

#### Net Value (C-D)

| 0.0 | -5.4 |
### Individual Life & Annuity - Non Traditional Life

<table>
<thead>
<tr>
<th>Assets</th>
<th>Reported Book Value</th>
<th>Book Yield</th>
<th>PV Cash Flows</th>
<th>Modified Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bonds (total)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1a</td>
<td>Gov't</td>
<td>13.8</td>
<td>6.20%</td>
<td>13.75</td>
<td>12.8</td>
</tr>
<tr>
<td>A1b</td>
<td>Public Corporate (Inv. Grade)</td>
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<td>7.00%</td>
<td>114.95</td>
<td>27.9</td>
</tr>
<tr>
<td>A1c</td>
<td>Public Corporate (below Inv Grade)</td>
<td>27.5</td>
<td>7.50%</td>
<td>29.01</td>
<td>13.1</td>
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<td>Private Corporate (Inv Grade)</td>
<td>60.5</td>
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<td>63.83</td>
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</tr>
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<td>Private Corporate (below Inv Grade)</td>
<td>33.0</td>
<td>7.60%</td>
<td>34.82</td>
<td>9.1</td>
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<tr>
<td>A1f</td>
<td>Pass-throughs</td>
<td>15.1</td>
<td>7.00%</td>
<td>15.88</td>
<td>5.6</td>
</tr>
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<td>A1g</td>
<td>CMO's</td>
<td>15.1</td>
<td>7.30%</td>
<td>16.03</td>
<td>6.5</td>
</tr>
<tr>
<td>A1</td>
<td>Bonds Subtotal</td>
<td>275.0</td>
<td>7.12%</td>
<td>288.27</td>
<td>19.8</td>
</tr>
<tr>
<td>A2</td>
<td>Cash &amp; short term</td>
<td>8.0</td>
<td>4.75%</td>
<td>8.00</td>
<td>0.1</td>
</tr>
<tr>
<td>A3</td>
<td>Commercial Mortgages</td>
<td>44.0</td>
<td>8.00%</td>
<td>47.30</td>
<td>5.0</td>
</tr>
<tr>
<td>A4</td>
<td>Derivative securities</td>
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<td>0.00%</td>
<td>0.00</td>
<td>0.0</td>
</tr>
<tr>
<td>A5</td>
<td>Equities</td>
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<td>1.00%</td>
<td>5.00</td>
<td>28.0</td>
</tr>
<tr>
<td>A6</td>
<td>Real Estate (unleveraged)</td>
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<td>10.50%</td>
<td>28.00</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>Invested Assets Subtotal</td>
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<td>7.35%</td>
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<td>A7</td>
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<td>4.00</td>
<td>0.0</td>
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<tr>
<td>A8</td>
<td>Policyholder Loans</td>
<td>30.0</td>
<td>7.30%</td>
<td>30.00</td>
<td>0.1</td>
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<tr>
<td>A9</td>
<td>Provision for asset default</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.0</td>
</tr>
<tr>
<td>A10</td>
<td>Other</td>
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<td>Total Assets</td>
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<td>416.6</td>
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<table>
<thead>
<tr>
<th>Liabilities</th>
<th>Reported Book Value</th>
<th>Req Interest</th>
<th>PV Cash Flows</th>
<th>Modified Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>Benefit liabilities</td>
<td>400.0</td>
<td>6.30%</td>
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<td>40.2</td>
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<tr>
<td>B</td>
<td>Total Liabilities</td>
<td>400.0</td>
<td>6.30%</td>
<td>406.0</td>
<td>40.2</td>
</tr>
<tr>
<td>C</td>
<td>PreTax Equity</td>
<td>0.0</td>
<td></td>
<td>10.6</td>
<td>(943.69)</td>
</tr>
<tr>
<td>D</td>
<td>Subtotal, tax and other adjustments</td>
<td>0.0</td>
<td></td>
<td>3.7</td>
<td></td>
</tr>
</tbody>
</table>

### Net Value (C-D)

| Net Value (C-D) | 0.0 | 6.9 |
### Individual Life & Annuity - Accumulation Annuity

#### Assets

<table>
<thead>
<tr>
<th></th>
<th>Reported Book Value</th>
<th>Book Yield</th>
<th>PV Cash Flows</th>
<th>Modified Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonds (total)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1a Gov't</td>
<td>58.7</td>
<td>6.20%</td>
<td>58.69</td>
<td>5.0</td>
<td>0.29</td>
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<tr>
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<td>469.5</td>
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<td>7.04</td>
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<td>5.87</td>
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<td>5.16</td>
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<td>148.60</td>
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<td>A1f Pass-throughs</td>
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<td>7.00%</td>
<td>67.14</td>
<td>4.6</td>
<td>1.94</td>
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<tr>
<td>A1g CMO's</td>
<td>64.6</td>
<td>7.10%</td>
<td>67.46</td>
<td>5.2</td>
<td>1.94</td>
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<tr>
<td><strong>A1 Bonds Subtotal</strong></td>
<td><strong>1173.8</strong></td>
<td><strong>7.11%</strong></td>
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<tr>
<td>A2 Cash &amp; short term</td>
<td>30.0</td>
<td>4.75%</td>
<td>30.00</td>
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<td>A3 Commercial Mortgages</td>
<td>135.0</td>
<td>8.00%</td>
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<td>6.75</td>
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<tr>
<td>A4 Derivative securities</td>
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<td>0.00%</td>
<td>0.00</td>
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<tr>
<td>A5 Equities</td>
<td>18.8</td>
<td>1.00%</td>
<td>18.75</td>
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<td>A6 Real Estate (unleveraged)</td>
<td>105.0</td>
<td>10.50%</td>
<td>105.00</td>
<td>8.0</td>
<td>15.75</td>
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<td><strong>A6 Invested Assets Subtotal</strong></td>
<td><strong>1462.5</strong></td>
<td><strong>7.31%</strong></td>
<td><strong>1508.1</strong></td>
<td><strong>5.5</strong></td>
<td><strong>58.4</strong></td>
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<tr>
<td>A7 Accrued investment income</td>
<td>15.0</td>
<td>0.00%</td>
<td>15.00</td>
<td>0.0</td>
<td>0.00</td>
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<tr>
<td>A8 Policyholder Loans</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.0</td>
<td>0.00</td>
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<tr>
<td>A9 Provision for asset default</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.00</td>
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<td>0.00</td>
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<td>A10 Other</td>
<td>22.5</td>
<td>0.00%</td>
<td>22.50</td>
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<td><strong>A11 Total Assets</strong></td>
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<td><strong>7.13%</strong></td>
<td><strong>1545.6</strong></td>
<td><strong>5.3</strong></td>
<td><strong>74.2</strong></td>
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#### Liabilities

<table>
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<tr>
<th></th>
<th>Reported Book Value</th>
<th>Req Interest</th>
<th>PV Cash Flows</th>
<th>Modified Duration</th>
<th>Req Capital</th>
</tr>
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<tr>
<td>B1 Benefit liabilities</td>
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<td>5.90%</td>
<td>1575.00</td>
<td>5.3</td>
<td>15.0</td>
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<td><strong>B Total Liabilities</strong></td>
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<td><strong>5.90%</strong></td>
<td><strong>1575.0</strong></td>
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<td><strong>15.0</strong></td>
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<td>-29.4</td>
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#### Tax and Other Adjustments

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<td>D1 Future tax payments</td>
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<tr>
<td>D2 Other adjustments</td>
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<td><strong>D Subtotal, tax and other adjustments</strong></td>
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<td><strong>-10.3</strong></td>
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#### Net Value (C-D)

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<td><strong>Net Value (C-D)</strong></td>
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### Institutional Pensions - Payout Annuity

#### Assets

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<th>Modified Duration</th>
<th>Req Capital</th>
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<td><strong>Bonds (total)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>A1a Gov't</td>
<td>16.9</td>
<td>6.40%</td>
<td>17.26</td>
<td>10.4</td>
<td>0.08</td>
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<tr>
<td>A1b Public Corporate (Inv Grade)</td>
<td>135.4</td>
<td>7.20%</td>
<td>144.20</td>
<td>9.2</td>
<td>2.03</td>
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<tr>
<td>A1c Public Corporate (below Inv Grade)</td>
<td>33.9</td>
<td>7.60%</td>
<td>36.56</td>
<td>8.3</td>
<td>1.69</td>
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<tr>
<td>A1d Private Corporate (Inv Grade)</td>
<td>74.5</td>
<td>7.40%</td>
<td>80.06</td>
<td>8.0</td>
<td>1.49</td>
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<td>A1e Private Corporate (below Inv Grade)</td>
<td>40.6</td>
<td>7.90%</td>
<td>44.28</td>
<td>7.2</td>
<td>2.84</td>
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<tr>
<td>A1f Pass-throughs</td>
<td>18.6</td>
<td>7.10%</td>
<td>19.55</td>
<td>6.5</td>
<td>0.56</td>
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<tr>
<td>A1g CMO's</td>
<td>18.6</td>
<td>7.30%</td>
<td>19.83</td>
<td>7.5</td>
<td>0.56</td>
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<tr>
<td><strong>A1 Bonds Subtotal</strong></td>
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<td>361.73</td>
<td>9.0</td>
<td>9.26</td>
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<td>A2 Cash &amp; short term</td>
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<td>4.75%</td>
<td>14.00</td>
<td>0.1</td>
<td>0.04</td>
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<td>A3 Commercial Mortgages</td>
<td>286.0</td>
<td>8.75%</td>
<td>308.88</td>
<td>6.0</td>
<td>14.30</td>
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<tr>
<td>A4 Derivative securities</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.0</td>
<td>0.00</td>
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<tr>
<td>A5 Equities</td>
<td>44.0</td>
<td>1.00%</td>
<td>44.00</td>
<td>28.0</td>
<td>8.80</td>
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<td>A6 Real Estate (unleveraged)</td>
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<td>10.50%</td>
<td>0.00</td>
<td>10.0</td>
<td>0.00</td>
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<tr>
<td><strong>A6 Invested Assets Subtotal</strong></td>
<td>682.5</td>
<td>7.46%</td>
<td>728.6</td>
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<td>32.4</td>
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<td>A7 Accrued investment income</td>
<td>7.0</td>
<td>0.00%</td>
<td>7.00</td>
<td>0.0</td>
<td>0.00</td>
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<tr>
<td>A8 Policyholder Loans</td>
<td>0.0</td>
<td>7.00%</td>
<td>0.00</td>
<td>0.1</td>
<td>0.00</td>
</tr>
<tr>
<td>A9 Provision for asset default</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.0</td>
<td>0.00</td>
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<tr>
<td>A10 Other</td>
<td>10.5</td>
<td>0.00%</td>
<td>10.50</td>
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<td>0.00</td>
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<td><strong>A11 Total Assets</strong></td>
<td><strong>700.0</strong></td>
<td><strong>7.28%</strong></td>
<td><strong>746.1</strong></td>
<td><strong>8.8</strong></td>
<td><strong>32.4</strong></td>
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#### Liabilities

<table>
<thead>
<tr>
<th></th>
<th>Reported Book Value</th>
<th>Req Interest</th>
<th>PV Cash Flows</th>
<th>Modified Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>B1 Benefit liabilities</strong></td>
<td>700.0</td>
<td>6.75%</td>
<td>759.50</td>
<td>9.5</td>
<td>2.00</td>
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<tr>
<td><strong>B Total Liabilities</strong></td>
<td><strong>700.0</strong></td>
<td>6.75%</td>
<td><strong>759.5</strong></td>
<td><strong>9.5</strong></td>
<td><strong>2.0</strong></td>
</tr>
</tbody>
</table>

#### C PreTax Equity

|                | 0.0 | -13.4 |

#### Tax and Other Adjustments

|                | 0.0 | -4.7  |

#### D Subtotal, tax and other adjustments

|                | 0.0 | -4.7  |

#### Net Value (C-D)

|                | 0.0 | -8.7  |
## Institutional Pensions - GIC

### Assets

<table>
<thead>
<tr>
<th></th>
<th>Reported Book Value</th>
<th>Book Yield</th>
<th>PV Cash Flows</th>
<th>Modified Duration</th>
<th>Req Capital</th>
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<tbody>
<tr>
<td><strong>Bonds (total)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1a Gov't</td>
<td>71.6</td>
<td>5.60%</td>
<td>71.63</td>
<td>2.5</td>
<td>0.36</td>
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<tr>
<td>A1b Public Corporate (Inv. Grade)</td>
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<td>6.40%</td>
<td>584.46</td>
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<td>8.60</td>
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<tr>
<td>A1c Public Corporate (below Inv Grade)</td>
<td>143.3</td>
<td>6.75%</td>
<td>146.83</td>
<td>3.0</td>
<td>7.16</td>
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<td>A1d Private Corporate (Inv Grade)</td>
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<td>329.33</td>
<td>4.3</td>
<td>6.30</td>
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<td>7.30%</td>
<td>181.35</td>
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<td>12.03</td>
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<td>A1f Pass-throughs</td>
<td>78.8</td>
<td>6.80%</td>
<td>83.51</td>
<td>5.0</td>
<td>2.36</td>
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<td>A1g CMO's</td>
<td>78.8</td>
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<td>79.58</td>
<td>1.3</td>
<td>2.36</td>
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<td><strong>A1 Bonds Subtotal</strong></td>
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<td>6.58%</td>
<td>1476.69</td>
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<td>39.18</td>
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<td>A2 Cash &amp; short term</td>
<td>30.0</td>
<td>4.75%</td>
<td>30.00</td>
<td>0.1</td>
<td>0.09</td>
</tr>
<tr>
<td>A3 Commercial Mortgages</td>
<td>0.0</td>
<td>8.00%</td>
<td>0.00</td>
<td>5.0</td>
<td>0.00</td>
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<tr>
<td>A4 Derivative securities</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.0</td>
<td>0.00</td>
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<tr>
<td>A5 Equities</td>
<td>0.0</td>
<td>1.00%</td>
<td>0.00</td>
<td>28.0</td>
<td>0.00</td>
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<tr>
<td>A6 Real Estate (unleveraged)</td>
<td>0.0</td>
<td>10.50%</td>
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<td>0.00</td>
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<tr>
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<td>6.54%</td>
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<td>A7 Accrued investment income</td>
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<td>0.00%</td>
<td>15.00</td>
<td>0.0</td>
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<tr>
<td>A8 Policyholder Loans</td>
<td>0.0</td>
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<td>0.00</td>
<td>0.1</td>
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<tr>
<td>A9 Provision for asset default</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.0</td>
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<tr>
<td>A10 Other</td>
<td>22.5</td>
<td>0.00%</td>
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<td><strong>A11 Total Assets</strong></td>
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<td><strong>1544.2</strong></td>
<td><strong>3.3</strong></td>
<td><strong>39.3</strong></td>
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### Liabilities

<table>
<thead>
<tr>
<th></th>
<th>Reported Book Value</th>
<th>Req Interest</th>
<th>PV Cash Flows</th>
<th>Modified Duration</th>
<th>Req Capital</th>
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<tbody>
<tr>
<td>B1 Benefit liabilities</td>
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<td>6.60%</td>
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<td><strong>B Total Liabilities</strong></td>
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<td><strong>6.60%</strong></td>
<td><strong>1537.5</strong></td>
<td><strong>3.1</strong></td>
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### PreTax Equity

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### Tax and Other Adjustments

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**D Subtotal, tax and other adjustments**

|                | 0.0                  |

**Net Value (C-D)**

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## Group Business

### Assets

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<th>Book Yield</th>
<th>PV Cash Flows</th>
<th>Modified Duration</th>
<th>Req Capital</th>
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<tbody>
<tr>
<td>A1a Gov't</td>
<td>35.0</td>
<td>6.00%</td>
<td>35.00</td>
<td>8.9</td>
<td>0.18</td>
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<td>A1b Public Corporate (Inv. Grade)</td>
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<td>237.38</td>
<td>20.9</td>
<td>3.38</td>
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<td>63.30</td>
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<td>11.9</td>
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<td>1.75</td>
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<td>5.8</td>
<td>1.05</td>
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<td>0.05</td>
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<td>A3 Commercial Mortgages</td>
<td>50.0</td>
<td>8.00%</td>
<td>53.75</td>
<td>5.0</td>
<td>2.50</td>
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<td>A4 Derivative securities</td>
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<td>0.00%</td>
<td>0.00</td>
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<td>0.00</td>
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<tr>
<td>A5 Equities</td>
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<td>0.00%</td>
<td>5.00</td>
<td>28.0</td>
<td>1.00</td>
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<td>A6 Real Estate (unleveraged)</td>
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<td>10.50%</td>
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<td>20.3</td>
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<tr>
<td>A8 Policyholder Loans</td>
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<td>0.00%</td>
<td>0.00</td>
<td>0.1</td>
<td>0.00</td>
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<tr>
<td>A9 Provision for asset default</td>
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<td>0.00%</td>
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<td>0.00</td>
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<tr>
<td>A10 Other</td>
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<td>0.00</td>
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<td>24.1</td>
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### Liabilities

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<thead>
<tr>
<th>Reported Book Value</th>
<th>Req Interest</th>
<th>PV Cash Flows</th>
<th>Modified Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1 Benefit liabilities</td>
<td>630.8</td>
<td>5.90%</td>
<td>624.00</td>
<td>7.0</td>
</tr>
<tr>
<td>B Total Liabilities</td>
<td>630.8</td>
<td>5.90%</td>
<td>624.0</td>
<td>7.0</td>
</tr>
</tbody>
</table>

### C PreTax Equity

<table>
<thead>
<tr>
<th>Reported Book Value</th>
<th>Req Interest</th>
<th>PV Cash Flows</th>
<th>Modified Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>30.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Tax and Other Adjustments

<table>
<thead>
<tr>
<th>Reported Book Value</th>
<th>Req Interest</th>
<th>PV Cash Flows</th>
<th>Modified Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1 Future tax payments</td>
<td>10.8</td>
<td></td>
<td>12.9</td>
<td></td>
</tr>
<tr>
<td>D2 Other adjustments</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D Subtotal, tax and other adjustments</td>
<td>10.8</td>
<td></td>
<td>12.9</td>
<td></td>
</tr>
</tbody>
</table>

### Net Value (C-D)

<table>
<thead>
<tr>
<th>Reported Book Value</th>
<th>Req Interest</th>
<th>PV Cash Flows</th>
<th>Modified Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.0</td>
<td></td>
<td></td>
<td>24.0</td>
<td></td>
</tr>
</tbody>
</table>
I. Overall Objective for the ALM Function

ALM is the ongoing process of formulating, implementing and monitoring strategies in respect of assets and liabilities to attain our financial objectives for a given set of risk tolerances and constraints.

As with all financial services companies, risk is an inherent part of doing business. Over the normal course of business LifeCo is exposed to credit risk, interest rate risk, foreign exchange rate risk, off-balance sheet risk, pricing risk, liquidity risk, as well as other various market risks. ALM is a vital ongoing process that requires the management of all these risks.

The principal risk management objectives are to eliminate excessive and unacceptable risk and optimize the risk/return profile of the total company. A key focus of the ALM function at LifeCo is interest rate risk.

As a result of timing differences in the repricing of assets and liabilities, fluctuations in market interest rates can affect both accounting earnings and the market value of assets, liabilities and off-balance sheet items and hence the economic value and net worth of LifeCo. The objectives in managing interest rate risk are to:

- Maximize the economic value of LifeCo subject to stated risk tolerances and constraints (see ALM Guidelines).
- Support the achievement of business strategies while protecting earnings and liquidity.
- Minimize the potential for significant loss as a result of changes in interest rates.
- Manage interest rate risk of current and future earnings to a level that is consistent with the mix of businesses and that limits such exposure to a percentage of the book value of assets.

Another key focus of the ALM function at LifeCo is market risk. Market risk arises whenever financial results can be adversely affected by changes in the equity markets. The most extreme exposure to market risk occurs when investment guarantees are offered. The risk exposure associated with these guarantees is managed by using dynamic hedging.

Liquidity risk is the risk that LifeCo will be unable to maintain cash flows that are adequate to fund its operations and meet all present and future financial obligations on a timely and cost effective basis. A separate Liquidity Policy details the management of LifeCo’s liquidity risk.

Foreign exchange rate risk arises whenever future payments in a foreign currency are made or received. A loss occurs if there is an appreciation (in the case of foreign dollars owed) or depreciation (in the case of foreign dollars due) of the local currency relative to
the foreign currency. The objective is to eliminate any foreign exchange rate risk. This is accomplished through the use of currency swaps.

**Credit risk** includes the risk of default on scheduled payments of either interest or principal. Credit quality guidelines are determined by the Investment Department of LifeCo, approved by the Board of Directors and are specified in the Investment Policy. The credit quality of the assets is monitored the Investment Department of LifeCo and reported to the Board of Directors.

**Off-balance sheet risk** refers to the risk associated with derivative instruments. The Operational Guidelines for Use of Derivatives provides control procedures and details the management of LifeCo’s exposure to derivatives risk.

## II. ALM Process

The ALM process consists of four fundamental steps:

**Identify the level of risk exposure**
It is a requirement that at all times the exposure to all risks be known. This is accomplished by regular measurement and monitoring of the exposure to various risks.

**Decide whether the risk exposure is appropriate**
The purpose of ALM is not necessarily to eliminate or even minimize risk. The level of risk will vary with the return requirement and financial objectives. Return objectives and risk tolerances are determined by LifeCo and reviewed from time to time.

**Modify the existing risk**
This is accomplished by rebalancing the portfolio or through the use of interest rate swaps, currency swaps or other hedging techniques to assume offsetting risk.

**Optimize the risk/return profile of the business**
For a given level of risk financial objectives are maximized. Optimization ensures that portfolios lie on the risk/return efficient frontier for LifeCo’s stated return objectives, risk tolerances and constraints.

## III. ALM Committee Purpose

Risk tolerances are determined by the ALM Committee and approved by the Board of Directors. Asset-Liability strategies as well as the policies and guidelines for the management of the aforementioned risks are established by the ALM committee. The ALM committee sets limits on potential earnings fluctuations that could arise from interest rate risk as well as on- and off-balance sheet accrual positions. The ALM committee monitors exposures in view of market developments and LifeCo’s financial condition, sets guidance for interest rate risk management decisions and monitors liquidity and capital adequacy. ALM policy is established by the ALM Committee, reviewed by the Board of Directors at least annually and is implemented by Corporate
Actuarial in conjunction with the Investment Department of LifeCo and the Finance division of LifeCo.

IV. ALM Committee Composition/Frequency of Meetings
The ALM committee meets monthly and consists of the CEO, CFO, Chief Actuary, CIO, VP Risk Management and includes representation from functional areas as appropriate. Committee proceedings are chaired and recorded by the VP Risk Management.

V. ALM Guidelines
LifeCo’s exposure to interest rate risk is quantified by calculating price sensitivity statistics such as modified duration, dollar duration, convexity, and partial durations and by performing scenario testing and cash-flow analysis. A pure dedication strategy of matching asset and liability cash-flows is widely recognized as costly, unnecessary and would not be appropriate for LifeCo. Negative net cash flows are identified and assessed from a liquidity perspective only. Exposure to interest rate risk is monitored for each product line and for all major products. Although ALM is performed at both the product and product line level, specific guidelines are set for Accumulation Annuities in total, Traditional Life Products in total, Non-Traditional Life Products in total and total company surplus.

(a) Accumulation Annuities

<table>
<thead>
<tr>
<th>Metric</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dollar Duration of Assets less</td>
<td>&lt; 30% x book value of assets</td>
</tr>
<tr>
<td>Dollar Duration of Liabilities</td>
<td></td>
</tr>
<tr>
<td>Key Rate Sensitivity</td>
<td>&lt; 0.02% x book value of assets for any and all key rates</td>
</tr>
<tr>
<td>Worst Case Scenario at 95%</td>
<td>&lt; 0.50% x book value of assets</td>
</tr>
<tr>
<td>Confidence Level</td>
<td></td>
</tr>
</tbody>
</table>

(b) Variable Annuities

<table>
<thead>
<tr>
<th>Metric</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delta of liability less delta of assets</td>
<td>&lt;10% of delta of liability</td>
</tr>
<tr>
<td>Gamma</td>
<td>Unheded</td>
</tr>
<tr>
<td>Vega</td>
<td>Unheded</td>
</tr>
<tr>
<td>Rho</td>
<td>&lt;5% of rho of liability</td>
</tr>
<tr>
<td>(Rho of liability less rho of assets)</td>
<td></td>
</tr>
</tbody>
</table>

(c) Traditional Life Products
(c) Non-Traditional Life Products

Dollar Duration of Assets less Dollar Duration of Liabilities < 100% x book value of assets

Key Rate Sensitivity < 0.10% x book value of assets for any and all key rates

Worst Case Scenario at 95% Confidence Level < 5.00% x book value of assets

(d) Institutional Pension - Payout

Dollar Duration of Assets less Dollar Duration of Liabilities < 100% x book value of assets

Key Rate Sensitivity < 0.10% x book value of assets for any and all key rates

Worst Case Scenario at 95% Confidence Level < 5.00% x book value of assets

(e) Institutional Pension - GIC

Dollar Duration of Assets less Dollar Duration of Liabilities < 30% x book value of assets

Key Rate Sensitivity < 0.02% x book value of assets for any and all key rates

Worst Case Scenario at 95% Confidence Level < 2.00% x book value of assets
(f) Group Business

Dollar Duration of Assets less Dollar Duration of Liabilities < 100% x book value of assets

Key Rate Sensitivity < 0.1% x book value of assets for any and all key rates

Worst Case Scenario at 95% Confidence Level < 5.00% x book value of assets

(g) Total Company

Dollar Duration of Assets less Dollar Duration of Liabilities < 100% x book value of assets

Key Rate Sensitivity < 0.05% x book value of assets for any and all key rates

Worst Case Scenario at 95% Confidence Level < 2.00% x book value of assets

(h) Surplus

Dollar Duration of Actual Assets less Dollar Duration of Benchmark < 100% x book value of assets

Where the modified duration of benchmark is assumed to be 10 years and the present value of the benchmark is assumed equal to the present value of the assets.

In order to ensure that the above guidelines are met for each product line, it may be necessary to rebalance the portfolio by trading assets or through the use of financial engineering. Rebalancing is performed monthly for Accumulation Annuities and quarterly for Life Products. In addition to meeting the above guidelines, for rebalancing purposes, each asset segment shall have assets that do not exceed the liabilities by more than +/- $2,000,000.

The Investment Department has the discretion to position the exposure of the company to the worst case scenario that it deems least likely to occur within the above guidelines for mismatch provision.
ASSET LIABILITY MANAGEMENT
PROCEDURE MANUAL

I. Reporting
Corporate Actuarial reports on LifeCo’s ALM position to the Investment Department and the ALM Committee on a quarterly basis. For Accumulation Annuities the ALM position is monitored on a weekly basis and reflects all asset commitments from the time at which they are priced. Corporate Actuarial reports on LifeCo’s ALM position to the Board of Directors at each of its meetings.
The quarterly reports include a discussion of our exposure to interest rate risk, changes in market interest rates during the period, the results of scenario testing and various technical notes. Attached to the report are the following:
- price sensitivity statistics including dollar duration, modified duration, convexity, and key rate sensitivity analysis
- cash flow analysis
- a comparison of the mismatch provision for the past 12 months
- book values and market values of assets and liabilities
- a comparison of the term structure of interest rates for the current and prior periods

Appendix A contains a sample ALM report

II. Allocation of Asset Commitments

Status of Commitments
Corporate Actuarial receives a weekly report on the status of asset commitments from the Investment Department which contains information on the following stages of commitment:
1. Under Review/Negotiation
2. Under Application/Recommended for Investment
3. Internal Approval - Not Yet Committed
4. Committed - Not Yet Priced
5. Priced
6. Funded

Allocation of Commitment to Product Lines
Once an asset reaches the committed stage, Corporate Actuarial reviews each of the product line portfolios in terms of the liability characteristics and ALM guidelines and recommends allocation of the commitment to the most suitable product line. Once an asset reaches the committed stage the Investment Department and Corporate Actuarial will determine whether a hedge transaction will be needed between the time the commitment is priced and the time it is funded.

Determination of Method of Funding
The committed asset is added to the portfolio for purposes of measuring exposure to interest rate risk. Corporate Actuarial examines the impact of various funding
alternatives and recommends the sale of asset(s) that optimizes the portfolio with respect to LifeCo’s financial objectives within the approved ALM guidelines.

Priced Commitments
Committed assets are not reflected for ALM purposes until they become priced. Until this point there is no exposure to interest rate risk. If a hedge transaction was previously deemed necessary, it will be effected once the asset becomes priced.

III. Hedging

Measurement
A hedge is the assumption of an additional risk exposure that offsets an existing risk. The intended effect of a hedge is to reduce the overall portfolio risk (e.g., currency or interest rate risk). Thus, the impact on the overall risk exposure of the portfolio is examined for all hedges. Although hedges are examined at the portfolio level, care must be taken to ensure that any derivatives transactions are appropriately arranged to qualify for hedge accounting treatment where intended.

IV. Priced Commitments
A new priced commitment will add exposure to interest rate risk to a portfolio. Before a hedge is effected for this transaction the overall impact on the portfolio must be examined.

V. Portfolio Rebalancing
From time to time, portfolio rebalancing will be required to keep the assets in balance with the liabilities and in order to ensure that all ALM guidelines specified in the ALM Policy Statement are adhered to. Formally, all portfolios are reviewed quarterly with the exception of the Accumulation Annuities portfolio which is reviewed monthly. Optimization is also performed in order to maximize LifeCo’s financial objectives subject to its risk tolerances and constraints. Portfolio rebalancing and optimization may involve asset trades and/or the use of financial engineering. Any asset trades between asset segments must be done at market value and requires the physical sale and purchase of assets. Transfers at book value are strictly prohibited.

VI. Interest Rate Sensitivity
A number of tools are used to measure the interest rate sensitivity of the assets and liabilities.
Dollar duration provides a measure of the interest rate sensitivity in dollar terms of the market value of the assets and liabilities for a parallel change in interest rates. For example, if the dollar duration of assets is $100,000,000 greater than the dollar duration of liabilities, then for a 100 basis point increase in interest rates for all terms to maturity across the yield curve, the market value of assets will decrease by approximately $1,000,000 more than the market value of liabilities.
Modified duration provides a measure of the interest rate sensitivity in percentage terms of the market value of the assets and liabilities for a parallel change in interest rates. For
example, if the modified duration of an asset is 4, then for a 100 basis point increase in interest rates the market value of the asset will decline by approximately 4%.

**Convexity** measures the rate of change of duration. Duration only provides an approximation of the price sensitivity to changes in interest rates. The precision of the approximation deteriorates as the change in interest rates increases. Including convexity improves the approximation. In general, assets with greater convexity are more desirable than assets with less convexity. This is because as interest rates decrease the increase in the market value of the assets increases at a faster rate. Conversely, as interest rates increase the decrease in the market value of the assets decreases. It is therefore desirable to have assets which have higher convexity than the liabilities.

**Key rate sensitivity analysis** measures the impact on market value of changes in interest rates at each term to maturity along the yield curve. This is a valuable tool as interest rates seldom move in a parallel fashion.

**Cash flow analysis** assumes no renewal or reinvestment of cash flows and must be interpreted with care. It is not necessary or advisable to be perfectly cash flow matched; however, large net cash outflows must be considered in the context of liquidity available in the portfolio.

**Scenario testing** is performed on a deterministic basis and involves measuring the sensitivity of economic value to both parallel and non-parallel yield curve shifts.

**Asset Quality**
Credit quality guidelines are contained in the Investment Policy and specify maximum holdings of individual credits which decline as credit quality declines, as well as an average quality constraint on the total portfolio. It is the philosophy of LifeCo that the credit risk exposure of the Company's assets should be highly diversified, actively managed, and under continuous review by the Investment Department. The ALM committee will be informed by the Investment Department of the credit risk exposure of the Company’s assets to ensure compliance with the credit quality guidelines.

**VII. Liquidity**
Cash flow analysis is performed which provides an indication of the potential liquidity requirements of the portfolio. In addition, asset mix is monitored with respect to renewal and surrender experience to ensure that sufficient liquid assets exist to meet anticipated cash outflow requirements.

**VIII. Capital Adequacy**
Target capital is 150% of regulatory capital required.

**IX. Profitability**
Profitability is measured in terms of return on total company surplus. Economic value is the central focus of ALM.
X. Specific Responsibilities

**ALM Committee**
The ALM Committee is responsible for overall policy formulation as detailed in the Policy Statement. The ALM Committee is also responsible for monitoring the ALM position of LifeCo and ensuring that all ALM guidelines are adhered to.

**ALM Sub-Committees**

**Portfolio Rebalance Subcommittee**
All asset trades affect the statutory reserve and mismatch provision under GAAP, the measurement of profitability, the economic value of surplus, key rate sensitivity, capital requirements and the return on capital. In addition to determining whether a trade increases the yield to maturity - or even the total rate of return - of a portfolio, the aforementioned considerations need to be taken into account whenever asset trades are contemplated. The function of this subcommittee is to examine portfolio changes, quantify the impact of derivatives and asset trades, monitor and measure the exposure to interest rate and other risks and perform optimization and rebalancing of all portfolios. This subcommittee meets a minimum of once per quarter and consists of a representative from the Investment Department of LifeCo, Corporate Actuarial and Finance.

**Rate Setting Subcommittee**
The function of this subcommittee is to determine crediting rates for both Life and Accumulation Annuities. This subcommittee meets weekly and consists of a representative from the Investment Department of LifeCo, Corporate Actuarial, Finance, Marketing Actuarial and Accumulation Annuities Marketing.

**Product managers**
The Life and Investment Product vice-presidents are responsible for the execution of business strategies decided at ALM Committee.

**Corporate Actuarial**
Corporate Actuarial is responsible for implementing ALM policy and ensuring that ALM guidelines are adhered to. Corporate Actuarial projects asset and liability cash flows, calculates all price sensitivity statistics, performs key rate sensitivity analysis and scenario testing, determines reserves and mismatch provision. Corporate Actuarial, together with the Investment Department of LifeCo, suggests assets trades or the use of financial engineering for the purposes of rebalancing the portfolio in order to ensure that LifeCo’s financial objectives are maximized and that all ALM guidelines are met.

**Investment Department**
The Investment Department is responsible, with input from Corporate Actuarial, for the determination and execution of all trades, financial engineering and hedging strategies in accordance with the guidelines specified in the ALM Policy Statement. the Investment Department communicates all transactions including forward
commitments to Finance and Corporate Actuarial and distributes a weekly report on the status of mortgage and private placement commitments and related hedging arrangements.

**Finance**
Finance is responsible for recording all transactions and keeping the asset accounting system up to date. Finance provides electronic files of bond and private placements on a quarterly basis.
OPERATIONAL GUIDELINES FOR USE OF DERIVATIVES

I. Overview
LifeCo, by the nature of its business activities and products, is routinely exposed to risks such as those described in sections V through VIII.

LifeCo purchases derivatives to manage these risks that are identified by the liability product managers and/or Corporate Actuarial. Derivatives may not be purchased for speculative purposes.

The guiding principle in the use of derivatives is that LifeCo is a limited end-user acting primarily to reduce risk. Strategies that involve the writing of options by LifeCo are specifically excluded, with the exception of options embedded in LifeCo's products.

II. Definition of Derivatives
For purposes of these guidelines, derivatives are defined as contracts that the company enters into with a counterparty, where the contract value derives from the value of an underlying asset or underlying reference rate or index. Such indices include, but are not limited to, LIBOR, U.S. Treasury instruments, and the S&P 500 index. This definition of derivatives includes instruments as described in section IX. This definition does not include asset classes such as mortgage-backed securities, collateralized mortgage obligations, asset-backed securities, and other structured assets that are treated as bonds for accounting and regulatory purposes.

III. Responsibilities
The ALM Committee is responsible for recommending the type and amount of each derivative purchase. The Investment Department is responsible for the purchase of derivatives. The Finance Department is responsible for derivatives accounting and reporting. The ALM Committee is responsible for all board reports relating to derivatives activity.

IV. Objectives
The objective of derivatives use at LifeCo is to reduce potential volatility in the future operating earnings of the lines of business. Depending on the source of the volatility and the type of derivative purchased, the derivative may reduce both upside and downside earnings volatility, or may reduce only downside earnings volatility.
V. Business Exposures Managed
LifeCo’s life insurance and accumulation annuity products have minimum interest guarantees. In an extended period of low interest rates, profit margins would be reduced, and possibly even be negative.

The life insurance and accumulation products allow surrenders at book value, possibly with a book value surrender charge. In periods of rapidly rising interest rates, the assets backing these products would not support a credited rate that is competitive with new money rates. If the company chose to maintain competitive credited rates, then profit margins would be reduced or even be negative. If the company chose to maintain profit margins with an uncompetitive credited rate, then policy surrenders could increase, leading to a loss of future profit margins and market value losses on asset sales to pay the surrender benefits.

LifeCo’s equity-linked GIC credits an interest rate that is linked to the performance of the S&P 500 equity index. This product also guarantees the return of principal. LifeCo’s investments must meet both of these guarantees.

VI. Mismatch risk
The company’s assets and liabilities are not cash flow matched.

In time periods where the company’s asset cash flows exceed the liability cash flows, there is reinvestment risk. For example, the assets allocated to the payout annuity business are shorter than the liability cash flows. Since the payout annuity benefits cannot be changed, reinvestment risk would be realized if interest rates were low at the time of the asset reinvestment.

In time periods where the company’s liability cash flows exceed the asset cash flows, there is funding risk. For example, if assets have to be sold to pay excess benefits at a time when interest rates are high, market value losses will be realized on the asset sales. There is also potential mismatch risk in LifeCo’s equity-linked GIC. If the assets allocated to this business do not match the performance guaranteed relative to the S&P 500 index, then the profits may vary substantially from the product’s pricing assumption.

VII. Mortgage commitment risk
LifeCo’s Investment Department commits to funding commercial mortgage loans weeks in advance of disbursing funds for the loan. These commitments require a loan rate to be locked in at that time for the mortgage. If interest rates rise between this commitment date and the disbursement date, then the earned rate on these assets acquired on the disbursement date will be lower than the earned rates that the liability pricing areas would expect the Investment Department to be able to achieve in the current interest rate environment.

VIII. Foreign exchange risk
The Investment Department may invest in assets denominated in foreign currencies. In addition, the multinational nature of the operations of LifeCo produces operating earnings denominated in more than one currency. As currency exchange rates fluctuate, the value
of LifeCo’s investment income and operating earnings will also fluctuate unless the
currency risk is hedged.

IX. Approved Derivative Classes
The Board of Directors has currently approved the purchase, subject to the guidelines
detailed below, of interest rate swaps, currency swaps, interest rate caps, interest rate
floors, and equity options indexed to the S&P 500. Derivatives not in these categories
may be purchased only with the prior approval of both the Chief Investment Officer and
Chief Executive Officer of LifeCo.

Interest rate swaps: interest rate swaps are bilateral agreements between LifeCo and the
counterparty to exchange a series of cash flows at specified intervals. The cash flows may
be fixed or floating. Floating cash flows would be calculated based on a set formula and
reference index. Swap terms and conditions such as a reference index, frequency of
payments, expiry date of the contract, and notional amount of the contract are set at the
time of the swap purchase.

Government bond futures: a futures contract obligates its owner to buy a specified
amount of a specified government bond at a specified price on a specified date. These
contracts are used by LifeCo in either “long” positions (an agreement to buy a
government bond) or “short” positions (an agreement to sell a government bond). Futures
contracts are entered into directly with an exchange clearinghouse.

Purchased options on government bond futures: these options give LifeCo the right,
but not the obligation, to buy (or sell, depending on the type of option) government bond
futures at a set price on a set future date. These options allow LifeCo to benefit from
favorable price movements in government bond futures. LifeCo’s loss on unfavorable
price movements is limited to the premium paid to purchase the option.

Forward rate agreements: these agreements are similar to the futures described above,
but they are negotiated with other financial institutions rather than an exchange
clearinghouse. They are agreements that a certain interest rate will apply to a certain
principal amount for a certain time period in the future.

Foreign currency swaps: these are bilateral agreements between LifeCo and the
counterparty whereby interest and principal in one currency are exchanged for interest
and principal in another currency.

Foreign currency forward rate agreements: forwards are transacted over-the-counter,
typically with a domestic Schedule 1 bank. LifeCo agrees to buy or sell a specific amount
of foreign currency at a specified rate of exchange on a specified date.

Foreign currency futures: LifeCo agrees to buy or sell a specific amount of foreign
currency at a specified rate of exchange on a specified date. The actual currency
transaction being hedged seldom coincides with the maturity of the futures contract. The
futures are usually sold prior to maturity and the gain or loss on the contract is used to
offset the increase or decrease in the value of the currency transaction being hedged.

Purchased interest rate caps and floors: interest rate caps protect LifeCo in rising
interest rate environments by paying the excess, if any, of a prevailing reference rate at a
future date over the strike rate in the contract. The contract has a set notional amount,
maturity date, payment dates, and reference rate. Since only positive differences are paid
to LifeCo, LifeCo’s only outlay is the premium paid for the cap. Interest rate floors are
similar to caps, but protect LifeCo in falling rate environments by paying the excess, if any, of the contract's strike rate over the prevailing reference rate at a future date.

**Equity index options:** European call options on the S&P 500 index give LifeCo a payment at maturity equal to the excess, if any, of the value of the index over the option's strike price. Each call option contract is for $100 times the value of the index. LifeCo's only outlay is the premium paid for the call option.

**X. Acquisition of Derivatives**
Interest rate swaps may be purchased in combination with a floating rate asset to achieve a fixed rate of return. The procedures and policies are then the same as the procedures and policies for acquiring fixed rate assets. If an interest rate swap is purchased for other ALM purposes, the ALM Committee must submit a written request for the purchase to the Investment Department. Interest rate caps and floors purchases and equity option purchases must be in the form of a written request from the ALM Committee to the Investment Department. The Investment Department must obtain at least two quotes from approved counterparties.

**XI. Transaction Approval**
Each derivative purchase will result in a written sheet with the terms and conditions (the "confirmation sheet") of that derivative. This sheet must be signed by the Investment Department employee responsible for that purchase.

**XII. Exposure Limits**
The net market value exposure of all interest rate and currency swaps with any one counterparty will not exceed $250 million. The market value of all equity call options with any one counterparty will not exceed $100 million. The market value of all interest rate caps and floors with any one counterparty will not exceed $100 million.

**XIII. Transaction Documentation and Control Procedures**
Each derivative purchase results in a confirmation sheet (see section XI). A copy of this sheet is sent by the Investment Department to the Finance Department. The Finance Department maintains a file for all derivatives. The Finance Department documents all payments made and received under swap contracts and verifies the calculation of these payments. The Finance Department also verifies the amounts of payments, if any, due from the counterparty on all caps and floors each time a payment, if any, is due. The Vice President of Finance reviews and initials all of these payment calculations.

**XIV. Accounting and Disclosure**
LifeCo will follow all required accounting practices for derivatives and disclose the balance sheet effect of derivatives in all shareholder reports and other required reports for securities regulators.

**XV. Communication of Purchases**
The Board of Directors will be notified of each derivative purchase at the next scheduled board meeting following such purchase.
XVI. Approved Counterparties
Counterparties must have a credit rating of at least BBB from Mood & Poll’s Agency. LifeCo must have a master ISDA agreement signed with the counterparty prior to the derivative purchase. Each agreement is subject to the approval of LifeCo’s Secretary and General Counsel.

XVII. Market Valuation
Each December 31st, the Investment Department will obtain market valuations for each derivative from the counterparty for that derivative. A report showing the market values and market values from the prior December 31st will be provided to the ALM Committee.

XVIII. Administration
All derivatives will be maintained where possible on LifeCo’s Investment Administration System. If a derivative cannot be administered on this system, it will be identified in an exception report, which will be submitted by the Finance Department to the ALM Committee each December 31st. This report will show, for each derivative not administered on the Investment Administration System, the type of derivative, the counterparty, the purchase date, the notional amount, and the current market value as provided by the Investment Department.
Asset Liability Management Report for

December 31, 1999

This report details the ALM position for all of LifeCo's products and focuses on the company's exposure to interest rate risk. The ALM guidelines specified in the company's ALM Policy Statement and Procedure Manual reflect the company's tolerance to interest rate risk.

Interest Rates

Summary of ALM Position
At December 31, 1999, significant mismatches existed in the Life and Group Benefit portfolios, all other portfolios were within the guidelines specified in the ALM Policy Statement and Procedure Manual. Various ways are being investigated to reduce asset liability mismatches. It is anticipated that extensive rebalancing of the affected asset portfolios will be required. A summary of the ALM position for LifeCo follows.
<table>
<thead>
<tr>
<th></th>
<th>Book Value ('000)</th>
<th>Present Value ('000)</th>
<th>Modified Duration</th>
<th>Dollar Duration ('000)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TRADITIONAL LIFE PRODUCTS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>Assets</td>
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<td><strong>NON-TRADITIONAL LIFE PRODUCTS</strong></td>
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<td><strong>GROUP BENEFITS</strong></td>
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ACCUMULATION ANNUITIES

Dollar Duration (Price Sensitivity to Parallel Shifts in the Yield Curve)
The modified duration of assets is longer than the duration of liabilities by less than 0.01. The difference between the dollar duration of assets and liabilities is (124,000,000). This is within the approved guideline of +/- 450,000,000.

Key Rate Sensitivity Analysis (Price Sensitivity to Specific Rate Changes)
For all points along the curve key rate sensitivities are within the approved guideline.

Scenario Testing
Worst Case Scenario
The worst case scenario that was tested was an increase followed by a decrease in interest rates. If this scenario were realized, it would result in a loss of $76 million in economic surplus.

Cash Flow Analysis
The accompanying graph does not represent actual cash outflows but rather interest rate reset dates for the assets and liabilities. No renewals or new sales are projected and asset maturities are not reinvested. Thus the usefulness of this analysis is limited to studying interest rate risk exposure. This would represent an extreme adverse scenario for measuring liquidity risk exposure.
Portfolio Rebalance
Rebalancing is performed on a monthly basis for Accumulation Annuities. At the end of December, except for cash reallocation there was no rebalancing required for Accumulation Annuities.

Asset Mix
The target mix calls for more bonds and private placements and less mortgages. The C1 capital requirement for the Accumulation Annuities portfolio excluding additional requirements for troubled assets is approximately $11.7 million at the end of December. In comparison, the C1 requirement based on the target asset mix would be $11.2 million.
TRADITIONAL LIFE PRODUCTS

Dollar Duration (Price Sensitivity to Parallel Shifts in the Yield Curve)
The modified duration of assets is shorter than the duration of liabilities by 15.3 years. This reflects the difficulty in finding assets that match the extremely long duration of liabilities. The difference between the dollar duration of assets and liabilities is (5,006,000,000) which exceeds our approved guideline of +/- 300,000,000.

Key Rate Sensitivity Analysis (Price Sensitivity to Specific Rate Changes)
We are exposed to rates falling at the 25 and 30 year terms and to rates increasing at the 10, 15 and 20 year terms. Exposure is large and exceeds guidelines.

Scenario Testing
The maximum decline in economic surplus at the 95% confidence was $89.7 million at the end of December. The scenario that gives rise to this exposure is a decrease in long term interest rates.

Cash Flow Analysis
The large positive spikes represent the maturity of the long zero coupon bonds that were purchased to extend the duration of the assets.
Portfolio Rebalance
At the end of December, rebalancing was necessary as a result of the lengthening of the liabilities due to assumption changes.

Asset Mix
The target mix does not reflect policy loans, calls for more government bonds, and less private placements. The C1 capital requirement for the Traditional Life Products portfolio excluding additional requirements for troubled assets is approximately $0.5 million. In comparison, the C1 requirement based on the target asset mix would be $0.5 million. The asset mix does not reflect the assumed equity position.
NON-TRADITIONAL LIFE PRODUCTS

Projection of Cash Flows
Based on December 31, 1999 assets and liabilities, net cash flows are projected to be an average of $13 million per month going forward.

Margin Squeeze
Interest sensitive cash flows have been modeled to vary for given changes in interest rates (i.e. the margin squeeze will be reflected in the price sensitivity statistics). The impact of the margin squeeze for a 1% decrease in interest rates is a $103 million loss in economic value.

Dollar Duration (Price Sensitivity to Parallel Shifts in the Yield Curve)
The modified duration of assets is shorter than the duration of liabilities by 250 years. The difference between the dollar duration of assets and liabilities is $9,974,000,000. This significantly exceeds the guideline of 400,000,000.

Key Rate Sensitivity Analysis (Price Sensitivity to Specific Rate Changes)
Significant exposure exists to a decrease in interest rates at the long end of the curve, a result of the duration mismatch between the assets and liabilities. The company is exposed to increases in interest rates for the other points on the curve.

Scenario Testing
The maximum decline in economic surplus at the 95% confidence level decreased from $129.3 million to $122.1 million at the end of December. The scenario that gives rise to this exposure is a graduated decrease in long-term interest rates.
Cash Flow Analysis
Note that both fixed and variable cash flows are shown together.

Portfolio Rebalancing
At the end of December rebalancing was necessary to counteract the lengthening of the liabilities due to assumption changes. It was assumed that the majority of Surplus assets were sold to fund the purchase of long bonds in this portfolio.
INSTITUTIONAL PENSION - PAYOUT

Dollar Duration (Price Sensitivity to Parallel Shifts in the Yield Curve)
The modified duration of assets is shorter than the duration of liabilities by 0.70 years.
The difference between the dollar duration of assets and liabilities is (680,000,000) and is
within the approved guideline of 700,000,000.

Key Rate Sensitivity Analysis (Price Sensitivity to Specific Rate Changes)
Due to the efficiency of the immunization strategy, no significant interest rate exposure
exists on that line of business.

Scenario Testing
The maximum decline in economic surplus at the 95% confidence level decreased stands
at $5.96 million, and is the result of a increasing interest rate for the first 20 years
followed by a sharp increase

Cash Flow Analysis
INSTITUTIONAL PENSION - GIC
Dollar Duration (Price Sensitivity to Parallel Shifts in the Yield Curve)
The modified duration of assets are longer than the duration of liabilities by 0.20 years.
The difference between the dollar duration of assets and liabilities is 300,000,000.

Key Rate Sensitivity Analysis (Price Sensitivity to Specific Rate Changes)
Due to the efficiency of the immunization strategy and the short duration of the liabilities,
no significant interest rate exposure exists on that line of business.

Scenario Testing
The maximum decline in economic surplus at the 95% confidence level decreased stands
at $5.2 million, and is the result of an immediate, large increase in interest rates.

Cash Flow Analysis
GROUP BENEFITS

Dollar Duration (Price Sensitivity to Parallel Shifts in the Yield Curve)
The modified duration of liabilities exceeds the duration of assets by 0.10 years. The
difference between the dollar duration of assets and liabilities is 3,789,000,000. This
greatly exceeds the guideline of 630,000,000

Key Rate Sensitivity Analysis (Price Sensitivity to Specific Rate Changes)
The exposure tends to be at the longer durations, where a decrease in interest rates will
create a loss.

Scenario Testing
The maximum decline in economic surplus at the 95% confidence level decreased stands
at $1.1 million, and is the result of a slow decrease in interest rates.

Cash Flow Analysis