1. (12 points) LifeCo is concerned that it may not reach its profit target from international activities due to adverse currency movements. Less than 50% of the currency exposure is currently hedged using currency swaps and forwards for selected countries based on net cash flow projections for each country.

A group has been established to manage the overall currency risk of LifeCo. Its mandate is to measure the worst case scenario exposure at a 95% confidence level, review the currency hedging strategy and propose a method to allocate the return from international activities to the appropriate business units. It is expected that the allocation formula will allow the company to evaluate the performance of its foreign operations converted into local currency and the impact of managing the currency risk.

The results for the worst case scenario exposure are:

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VAR based on historical simulation</td>
<td>500,000</td>
</tr>
<tr>
<td>VAR based on the delta-normal method</td>
<td>800,000</td>
</tr>
</tbody>
</table>

(a) (4 points) Contrast the considerations in the selection of a target level of currency hedging in general versus LifeCo.

(b) (3 points) Describe alternative techniques to manage the currency risk that would be suitable given LifeCo’s objectives.

(c) (3 points) Compare the two methodologies used by LifeCo to calculate VAR.

(d) (1 point) Define the concept of transfer pricing and explain how it can be used for LifeCo’s performance assessment.

(e) (1 point) Describe the application of a transfer pricing methodology to attribute the return from international activities to appropriate sources for LifeCo.
Question 1

a) Optimal hedge rates (% of currency hedges) in general depends on:
- % of asset portfolio that’s invested in foreign assets
- Potential hedging costs which include:
  - contract trading cost
  - bid ask spreads on forwards
  - transaction costs
  - custody costs
  - custody fees
In total these costs range in 20-50 bp range. These costs reduce expected return directly on hedges portfolio.
- Risk reduction benefits must be higher than hedging costs
- General level of risk aversion for LifeCo.

This is the utility function $S(R) - \frac{\sigma^2}{RT}$

Where RT is risk tolerance level.
- The correlations and volatilities of different currency exposure, for LifeCo. For example, if source currency exposures have negative correlations, they don’t need to be hedged, because they offset each other.
- Based on net foreign CR and volatility/correlation projection
- Depends on type of investors
- Depends on consumption mix of foreign products
- Foreign exchange exposure can be inflation hedge for imported goods
- Consider impact on strategic plan
Depends on forecast of foreign exchange rates

b) The objective of LifeCo is to eliminate currency risk. This is consistent with LifeCo objective of delivering stable earnings. Currently they use currency swaps and forwards to hedge currency risk. This is consistent with Full Hedging Approach, where certain exposure is hedged using forwards, swaps. The problems with this approach are that:
- Because under/over hedged when foreign assets appreciate/depreciate, need frequent hedge adjustments.
- Only hedges currency movement. Ignores foreign asset impairment in context of total portfolio

Alternatives are:
- Minimum Variance Hedging
  where asset class volatilities and correlations are integrated with currency volatilities and correlations to derive a minimum risk portfolio per a given level of expected return. This would be consistent with minimizing total earnings volatility.
- **Downside-Option Based Hedging**
  useful to truncate downside exposure but still retain upside potential, 3 alternatives:
  - Buy puts on individual currencies
  - Buy puts on basket of currencies
  - Buy puts on base $ currency value of foreign exposure.
  Second approach is probably cheaper because it accounts for offsetting correlations of currencies.
- Can also create synthetic put positions, via Delta hedging, where forward contracts are traded.
- No hedging
- Set up foreign subsidiaries to improve foreign currency revenue/expense mismatch
- Downside/Option based approach retains upside potential but at cost = option premium
Could use semi-variance to reflect downside risk aversion

c) **Historical Simulation**
- Simulation based on historical currency movements applied to current portfolio.
  - How long is historical period (60 days, 360 days) or more?
  - What did the market do during historical period, where there any crisis events?
- Can use bootstrapping to alleviate this to an extent.

Estimation error for historical greater than for Delta normal

d) - Transfer pricing involves the determination of a price or cost for funds transferred internally from one business unit to another
- Can be used to allocate performance into meaningful components e.g. credit risk, interest rate mismatch, etc.
- Need (n-1) benchmarks for n components

e) - Actual Foreign Income = (Actual Foreign Income – Benchmark) + Benchmark
  Benchmark = Income from foreign operations of a fully hedged portfolio, reflecting all hedging costs
Questions 1 – 4 pertain to the Case Study
This question should be answered independently.

2. (8 points) LifeCo currently uses income statement based measurement in its ALM decision making process. You are the ALM actuary for LifeCo and have been asked to research the subject of fair value accounting and its potential applications to performance measurement.

(a) Compare and contrast a fair value based total return accounting approach to a book value based current accounting approach such as GAAP.

(b) Assess the expected impact of using fair value based performance measurement in the ALM decision making process on a long term basis in terms of:

(i) asset portfolio return
(ii) economic profits (value)
(iii) future accounting earnings
2. Continued

(c) Institutional Pensions-Payout Annuity of LifeCo conducted the pilot test in the first quarter of 2000 to validate the new performance measurement system based on fair value accounting. To isolate the performance of the product from the performance of investments, the Product Division and the Investment Division decided to use the benchmark portfolio that consists of non-callable investment grade corporate bonds to approximately match the liability cashflows. The selected financial data are given below:

<table>
<thead>
<tr>
<th></th>
<th>December 31, 1999</th>
<th>March 31, 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Book Value (Asset, Liability, Benchmark)</td>
<td>700.0</td>
<td></td>
</tr>
<tr>
<td>Market or Fair Value vs. Book Value Ratio</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asset</td>
<td>1.066</td>
<td>1.090</td>
</tr>
<tr>
<td>Liability</td>
<td>1.085</td>
<td>1.100</td>
</tr>
<tr>
<td>Benchmark</td>
<td>1.065</td>
<td>1.080</td>
</tr>
<tr>
<td>Book Yield or Book Valuation Rate (i^{(1)})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asset</td>
<td>7.28%</td>
<td>7.28%</td>
</tr>
<tr>
<td>Liability</td>
<td>6.75%</td>
<td>6.75%</td>
</tr>
<tr>
<td>Benchmark</td>
<td>7.20%</td>
<td>7.20%</td>
</tr>
<tr>
<td>Actual Cashflow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asset</td>
<td>20.0</td>
<td></td>
</tr>
<tr>
<td>Liability</td>
<td>19.9</td>
<td></td>
</tr>
<tr>
<td>Benchmark</td>
<td>20.8</td>
<td></td>
</tr>
<tr>
<td>Realized Book Gain (Loss)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asset</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Liability</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Benchmark</td>
<td>0.0</td>
<td></td>
</tr>
</tbody>
</table>

Calculate the Investment Division’s performance and the Product Division’s performance (in absolute amount) for the first quarter of 2000 in terms of:

(i) book value  
(ii) fair value
Question 2

(a)
Fair value based:
- asset & liability market value-based
- total return included realized and unrealized gain/loss
- good for long term view
- more realistically captures firm value

Book value based:
- asset & liability book value
- asset may partially mark-to-market under FAS 115
- ignore unrealized gain/loss
- false feeling of security

(b)
(i)
- long term portfolio return should be better
- company would not invest a lot in high yield bonds to pursue higher income, because fair value based would capture the risk
- fair value would mark asset to market
- future impact would be captured
- equity offers high long term return but with long current income

(ii & iii)
- fair value based measurement would mark both A & L to market
- it captures both current and future income
- by maximizing total return, future accounting income likely to be better
- more likely to invest in projects with future potential, thus future economic profit will be better

(c)
Investment division: compare asset return to benchmark return
Product division: compare benchmark return to liability

Asset book income = 700 * (1 + 0.0728)^0.25 - 1 + g/L = 12.4
Similarly, liability book income = 12.0 and benchmark book income = 12.3

Investment performance = 12.4 – 12.3 = 0.1
Product performance = 12.3 – 12.0 = 0.2

Book value @ end of quarter = beg book + book income – CF
Market value = book value * market/book ratio
Market return = change of market value + CF
3. (8 points) You are an actuary at LifeCo responsible for the management of the guaranteed minimum accumulation benefit (GMAB) included in the variable annuities.

(a) Describe the alternatives for option pricing stochastic models that can be used to determine the theoretical value of the guarantee.

(b) Evaluate the following risk management techniques:

(i) running the risk naked
(ii) static hedging
(iii) dynamic hedging

(c) Describe the key considerations for developing an integrated risk management approach for GMAB risk.

(d) Recommend changes to LifeCo’s ALM policy statement in light of the considerations identified in (c).

(e) Formulate the modeling considerations under a simulation approach if LifeCo chooses the following risk management technique:

(i) holding sufficient funds to cover expected losses within a specified tolerance level
(ii) dynamic hedging
Question 3

(a) **Option Pricing Stochastic Models**

1) **Monte Carlo Simulation**

- Simulate paths for interest rate movements that are arbitrage free
- Project cash flows along each path and discount at short rates to derive expected cost
- Can handle path dependent cash flows, complete payoffs
- Good for derivatives dependent on several variables
- Cannot handle American option
- Not a problem for GMAB since most guarantees are at specified times

2) **Binomial Trees**

- Each period stock can move up by a proportional amount ‘u’ or decrease by ‘d’
- Expected payoff is discounted at risk neutral rate to derive price
- Can handle American option but not path dependency
- If GMAB has more than one guarantee at different times, can use backwardization to see if GMAB sill be exercised early

3) **Finite Differences**

- Solve Black-Scholes Merton differential equation by difference formula
- Not very good for GMAB

4) **Black’s Model**

- GMAB is essentially a put on the accumulated account value (bond) as if interest rate rise, annuitant would exercise (sell the bond) to the insurer
- \[ P = p(O,T^*)[XN(-d_2) - F_oN(-d)] \]
- Requires bond price to lognormal at time T*, payoff of option
- Fo is expected forward bond price =

\[
= \frac{B_0 - I}{P(O,T)}
\]

I = present value of coupon payments

(b) (i) **Running the risk naked**

1) Take the view that accumulated guarantee payoffs will be less than accumulated guarantee fees
2) Problems are:

- The view may be wrong
- Potentially volatile earnings
- Potentially severe capital requirement
- Have marketing risk of having to increase premium
- Exposure is high downside risk with limit to upside (receiving premium)
- Put exposure
- Insurance risk remains
- Limitation of model misspecification

(ii) Static hedging
1) Hedge guarantee risk by purchasing customized options from a third party over the counter market
2) Considerations are:

- Exposure to counterparty credit risk
- Restrictions on volume
- Unwillingness of investment bank to transact in certain market and strike prices
- High expense and profit margins built on the options
- Bid ask spread
- Insurers must generate enough premium income
- Provide only partial protection against guarantee risk

(iii) Dynamic Hedging
1) Hedge the guarantee risk by creating synthetic option using traded underlying securities, interest rate futures and short dated options
2) Requires dynamic rebalancing
3) Increase holdings in underly securities when security price increase – buy high and sell low
4) Require expertise and supporting system
5) Internal management cost may be higher than that in price in option purchased
6) Volatility is uncertain and may change – hedging cost may be higher than expected
7) Liquidity risk and transaction costs extreme events may cause trading difficulties
8) Revenue risk – option cost and risk charge move opposite direction
9) There is basis risk and model risk

(c)
Key Considerations

1) Management and stakeholders risk attitude toward specific risk classes
2) Willingness to manage or sell risks and specific risk classes
3) Presence and absence of expertise and supporting system to manage specific risks
4) Market price dynamics (price taker or setter) and marketing strategy (penetration, skimming, price leader or differential)
5) Risk size and its correlation with other company risk
LifeCo must be able to identify the many risks that exist in the GMAB. Should take an active approach to the modeling of the guarantee. Should change its ACM process into 5 steps:

- Identify risk exposure
- Determine how much exposure is acceptable
- Determine appropriate hedging instruments
- Create the hedging portfolio
- Evaluate effectiveness

Reserving | Dynamic Hedging
---|---
**Process:** Brownian motion. The drift is adjusted to reflect fund mana. Fees and guarantee fees | Same
Process parameters should reflect real world expectations, risk aversion and market imperfections. | Process parameters: capital market. Risk free rate of return reflecting the no arbitrage assumption
For an elective reset, option election process should be included | Same
Modification to the scenario generator needed to reflect American nature of the reset | Same
Mortality and policyholder behavior | Same
| Bid ask spread and transaction cost upon rebalancing
4. (12 points) You are a consulting actuary hired by LifeCo to review their operational guidelines for managing the credit risk of derivatives. You have been asked to recommend and describe a methodology for integrated modeling of market and credit risk.

You decide that the Mark-to-Future (MtF) methodology is the appropriate framework for this assignment.

(a) (2 points) Critique LifeCo’s operational guidelines for managing credit risk of derivatives.

(b) (3 points) Describe risk and reward measures that can be used in the MtF framework for the measurement of:

(i) market risk
(ii) credit risk

Define all terms.

(c) (2 points) Describe each of the following approaches to credit risk measurement and compare them to the approach used by LifeCo.

(i) counterparty exposure models

(ii) portfolio credit risk models

(d) (5 points) Describe the steps involved in implementing an integrated market and credit risk framework for measuring the risks in LifeCo’s derivatives portfolio.
Question 4

Integrated Risk Management

No integration with market risk, i.e. Default rates are not a function of market level or behavior

Risk Reduction

Derivative type restrictions reduce volatility
Policies set by senior management
Master agreement netting across counterparties

Exposure Limits

Limit by class only, not counterparty
No limits for some classes (futures)
Current exposure (vs. potential) only monitored
Limits not function of credit rating or defaults

Monitoring

Frequency unspecified
Accountability not specified
No downgrade procedure
No marking to market

b)
Risk
Variance
VAR
Expected shortfall
Regret
Put value
Expected counterparty credit exposure
Expected counterparty credit loss
Expected cross-counterparty credit loss

Reward
Expected profit and loss
Expected return
Expected upside
Call value
c)  Counterparty exposure models
   Economic loss on immediate default of all transactions for a given counterparty
   Credit migration can be included
   No future changes in exposure accounted for
   Doesn’t highlight “wrong-way” exposures
   Almost exactly LifeCo’s model

ii) Portfolio Credit Risk Models
    Measure portfolio effects, specifically obligor correlations
    Include default and migration correlation
    Deterministic interest rates
    Bigger impact on derivatives
    LifeCo has none of these elements

d)  Risk factors and Scenarios
    Over analysis period project scenarios of systemic risk factors
    Include joint evolution of both credit and market factors

    Obligor exposures, recoveries and losses
    Compute in each scenario
    Based on market level
    Account for netting, mitigation and collateral

    Joint default/migration model
    Develop scenario dependent default/migration probabilities
    Relationship to scenario done through “Creditworthiness index”
    Correlations are driven by joint variation of conditional probabilities

    Conditional portfolio loss distribution in a scenario
    Computers using Monte Carlo or statistical tools

    Unconditional loss aggregation across scenarios
    Average conditional losses across all scenarios
    Must assign probabilities to each scenario
5. (6 points) Company X is a seller of very large fixed rate long-term GICs to institutional investors. The company is considering approaches for hedging interest rate risk.

(a) Describe the considerations associated with warehousing assets in anticipation of issuing a GIC.

(b) Describe the considerations associated with hedging the interest rate risk between the time the GIC rate commitment is made and the time the proceeds are invested when assets have not been warehoused.

(c) Describe the advantages and disadvantages of using each of the hedging instruments identified below to hedge the risks identified in (a) and (b).

(i) government bonds
(ii) government bond futures
(iii) interest rate swaps
Question 5

a)

Warehousing assets sometimes is beneficial if the assets could be acquired at favorable price since GIC is usually sold at discrete time interval and opportunities for GIC sale may not coincide with opportunity to acquire assets. However, there is a risk that asset value may go down between the time acquired and time of a GIC sale due to for example an interest rate increase. Normally futures are sold against the acquired assets to minimize risk, and then unwound as GICs are issued.

b)

If assets have not been warehoused when GIC rate is committed, there is a risk that interest may go down and suitable assets may not be available to fund the GIC since there is usually a lag between commitment and the deposits are made.

To hedge can enter a pay floating/receive fixed swap as soon as GIC is committed and then unwind swap when the assets are finally acquired. There is still a risk that spread between the asset acquired and the futures will change (basis risk) resulting in loss. Basis risk can be hedged with spread locks or CMT/CMS swaps.

Need to estimate the price volatility
- need to know the acceptable level of volatility
- need to choose hedge instrument
- need to calculate the hedge ratio
- need to look at the price (cost) of available instruments

COURSE 8: Investment - 16 -
November 2001
Morning Session
Favorite hedge accounting treatment by FASB  
No upfront cash deposit required

Disadvantage

Cheapest to delivery (CTD) ⇒ Negative convexity  
CTD difficult to evaluate/monitor interest ratio risk  
Does not hedge basis (spread) risk

Interest Rate Swap

Advantage

Off-balance sheet transaction  
No “on special” issue as training  
Flexible maturity  
Better interest rate risk protection. Swap rate closely related to corporate spread  
Priced off Treasuries, so give same interest rate protection

Disadvantage

OTC mostly  
Credit risk involved  
Bid/Ask spread (less liquid)
6.  

(6 points) You are the pricing actuary for a life company that sells EIAs with the following product features:

<table>
<thead>
<tr>
<th>Product Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term to maturity</td>
</tr>
<tr>
<td>Design</td>
</tr>
<tr>
<td>Underlying index</td>
</tr>
<tr>
<td>Minimum guarantee</td>
</tr>
<tr>
<td>Payout to the contract holder</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Your company has just sold 10 million in premium. Market conditions are as follows:

<table>
<thead>
<tr>
<th>Market Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current index value</td>
</tr>
<tr>
<td>Expected annual index return</td>
</tr>
<tr>
<td>10-year implied volatility on OTC call options</td>
</tr>
<tr>
<td>Risk-free rate</td>
</tr>
<tr>
<td>Term of available futures contracts</td>
</tr>
<tr>
<td>Contract size of available futures contracts</td>
</tr>
</tbody>
</table>

Two investment strategies are being considered for this product:

- buy fixed income bonds and 10-year OTC call options
- buy fixed income bonds and replicate the embedded option through delta hedging with index futures

(a) Compare and contrast the two strategies with respect to:

(i) costs
(ii) risks
(iii) effectiveness in matching the liability

(b) Calculate the futures transaction necessary to hedge your company’s position at issue using the delta hedging strategy.
Question 6

A

i) Costs

<table>
<thead>
<tr>
<th>OTC Call Option</th>
<th>Delta Hedging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usually more expensive</td>
<td>In theory cheaper, as implied volatility of synthetic option less than what investment bankers use</td>
</tr>
<tr>
<td></td>
<td>But significant risks that could increase costs</td>
</tr>
<tr>
<td></td>
<td>Significant systems/expertise required, which if you don’t have already is expensive</td>
</tr>
</tbody>
</table>

ii) Risks

<table>
<thead>
<tr>
<th>Liquidity Risk</th>
<th>Model Risk – is S&amp;P going to move like the model predicts?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit Risk</td>
<td>Basis Risk – minimal, with futures</td>
</tr>
<tr>
<td>- counterparty default</td>
<td></td>
</tr>
<tr>
<td>- long term option riskier</td>
<td></td>
</tr>
<tr>
<td>Operational Risk</td>
<td>Market Risk – major index moves might not get hedged</td>
</tr>
<tr>
<td>- will OTC transaction be executed properly?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Volatility Risk – impacts rebalancing frequency, also transaction costs</td>
</tr>
<tr>
<td></td>
<td>Consider hedging Gamma &amp; Rho as well</td>
</tr>
<tr>
<td></td>
<td>Huge operational risk</td>
</tr>
<tr>
<td></td>
<td>- many complicated transactions take place with great frequency</td>
</tr>
</tbody>
</table>

iii) Effectiveness in Matching Liability

<table>
<thead>
<tr>
<th>Perfect match if no decrement</th>
</tr>
</thead>
<tbody>
<tr>
<td>But, how to handle withdrawals?</td>
</tr>
<tr>
<td>hedge less than 100%</td>
</tr>
<tr>
<td>hedge fully, but sell off excess as necessary?</td>
</tr>
<tr>
<td>(liquidity issues, and selling when out of the money)</td>
</tr>
<tr>
<td>Hold excess for speculative purposes?</td>
</tr>
<tr>
<td>(legal?)</td>
</tr>
</tbody>
</table>
b) 

\[ \text{strike price} = 10M \times 90\% \times (1.03)^{10} \]

\[ x = 12.0952 \text{ M} \]

\[ S_o = 100M \]

\[ T = 10 \]

\[ \sigma = .15 \]

\[ r = .05 \]

Dividend is assumed to be zero.

Delta of option \( \Delta = N(d_1) \)

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

\[
d_1 = \frac{\ln\left(\frac{10}{12.0952}\right) + \left(0.05 + \frac{.15^2}{2}\right)10}{.15 \sqrt{10}} = .8902
\]

\[ N(d_1) = .8133 = \text{amount of index required} \]

\[ .8133 \times e^{-rT} \times 10M \]

\[ \frac{100,000}{.05} \]

\[ = \frac{.8133 \times e^{-0.05(1)} \times 10M}{100,000} = 77.4 \text{ contracts} \]
7. *(4 points)* Describe the differences between modern finance theory and empirical studies of corporate management.
Question 7

Modern Finance Theory indicates that investors are risk averse, utility maximizes and Bayesian forecaster

Empirical Studies of corporate management

1. **Dividend Policy**

   According to modern finance theory (PMT) that dividends don’t matter since dividends are taxed at income ratio

   Companies do manage a smoothing dividend policies due to:

   - Investors don’t like to dip in capital gains
   - Dividends can be additional income in a rising market or a silver lining when markets are down
   - Client issue and some investors like dividends

2. **Earnings Management**

   According to PMT, the PV of earnings matters more than quarter-to-quarter to quote earnings but corporate spends a lot effort to manipulate earnings. Reasons.
   
   a. Management reveals internal information through earnings
   
   b. There is a cost associated with earnings volatility
      
      Higher funding costs since external funding is higher than internal funding ⇒ earnings volatility may influence companies ability to execute business plan or loss of investment opportunity
      
      Cost of insolvency costs - extreme earnings may cause the company to go insolvent
   
   c. Target for takeover if earnings are bad
   
   d. Manager’s ability is judged by producing stable earnings
3. Expansion; reorganization

PMT suggests the goal is to create value for shareholders; however, the companies tend to expand the company more than PMT suggest. Reasons:

a. Managers benefit from managing large companies and more assets
b. Managers believe they can do a better job than the company being acquired
c. Increase opportunities for current employees
d. Personal gain = some managers will overpay upon acquisition or merger for personal benefits
8. (4 points) A mid-size publicly traded company’s recent decision to increase dividend payments to their shareholders was not well received by the market.

(a) Describe the arguments for and against dividend payments.

(b) Describe the market myths of "market myopia" and "supply and demand" and offer some evidence or arguments that are contrary to these myths.
Question 8

a) For Dividends

Some shareholders prefer continuous stream of payments as income

Higher dividend means company will be viewed as doing well

Companies should pay dividend based on its investment needs and financing opportunities

Pay dividends if there are not any attractive investment opportunities

Against Dividends

It is considered that the company failed to find appropriate investment opportunities to invest all the available cash

If the shareholders needed income they should diversify to fixed income a percentage of their portfolio or sell their shares

Historically there is no relation between company’s dividend policy and stock performance

Share price decline equal to the amount of the dividend paid, never to be recovered

Dividend income is taxed at a higher rate from capital gain

Remaining capital gains are riskier

b) Market Myopia

The company has to perform to provide good accounting results on a short-term basis (quarterly)

The myth is not true because:

companies with long term pr aspects and profitability command high P/E ratios
Insurance companies and pension funds invest more in R&D intensive companies than blue chip

Historically it has been proven that the markets:

Realistically factor in the effects of long term management actions on the stock price

Does not care if the accounts expense or capitalize value building out-lay

Can distinguish between value neutral and value adding opportunities

If the myth were true:

All the companies will sell for same P/E ratio

Share value should depend on CF expected to be generated over firm’s life time

Simple strategy to buy depressed shares and short sell overpriced stocks should always out perform

Supply and Demand

Myth that the supply and demand of the stock effects the stock price

\[ \therefore \] company should promote their stock to increase demand

It is based on the simple assumption that the supply of shares is fixed and the demand affects the price. Supply can be created by traders with derivatives and short selling. Institution investors buys stocks to perform in a certain way, they can use any proxy stock.

Trading is not an indicator of demand, it is the change in outlook that changes stock price

Stock price determined by intrinsic value

Stock price determined by lead steers

Volume will increase but price will not change

Supply is not fixed due to short selling and synthetic securities
You are given:

- \( f \) is a derivative security with payoff \( f_T \) at \( T \) and 0 elsewhere
- interest rate, \( r \), is stochastic
- money market account is the numeraire

(a) Define a martingale process and state the equivalent martingale measure result. Define all terms.

(b) Prove that \( f = \hat{E}(e^{-rT} f_T) \) using the equivalent martingale measure.
Question 9

**Answer to question 9 – 2001 – 8V**

a) Martingale is a process of the form $d\theta = \sigma dz$ where $dz$ is a Weiner process

Let $f$ and $g$ be the prices of two derivative securities that depend on a single source of uncertainty

Then $\theta = \frac{f}{g}$ is a martingale for all securities $f$ if the market price of risk is the volatility of numeraire $g$

Hence $\frac{f_0}{g_0} = E_g (\frac{f_T}{g_T})$

b) Set $g$ equal to the money market account, where $g_0 = 1$ and $g$ grows at instantaneous interest rate $r$, at any given time.

And follows the process $dg = rg dt$ and

$$\int_0^T gdtdg = e^{\int_r^T dt}$$

The volatility of $g$ is 0, and therefore this is risk-free world

And $f_0 = g_0 \hat{E} (\frac{f_T}{g_T})$ under risk-neutral expectation

Hence $f_0 = g_0 \hat{E} (\frac{f_T}{g_T}) = 1 \cdot \hat{E} \left[ \frac{\int_r^T f_T}{\int_r^T e^{\int_r^T dt} e^o} \right] = \hat{E}(e^{-rt} f_T)$
10. (7 points) Policyholder lapse behavior has often been compared to the prepayment behavior observed in mortgage-backed security (MBS) collateral.

You are given the following policyholder lapse assumption for a single premium deferred annuity (SPDA).

SPDA lapse rate = Max (Base lapse + Excess lapse, 0)

where

\[
\text{base lapse} = \begin{cases} 
1\% \times \left( \frac{y}{2} \right) + 2\% & \text{for } y < 5 \\
30\% & \text{for } y = 5 \\
5\% & \text{for } y > 5 
\end{cases}
\]

\[
\text{excess lapse} = \begin{cases} 
\left( CR - CP - SC / 3 \right)^2 & \text{for } CR > CP + SC / 3 \\
0.5 \times \left( CR - CP - SC / 2 \right) & \text{otherwise}
\end{cases}
\]

\( y = \) years from issue
\( CR = \) credited rate, reset annually, minimum guarantee of 4%
\( CP = \) competitor rate = max (90-day Treasury rate + 70bp, 5-year Treasury rate)
\( SC = \) surrender charge, 5-year declining schedule

(a) Identify and describe the four basic determinants of MBS collateral prepayment behavior.

(b) Explain, for each of the four determinants, whether they are present or absent in this lapse assumption.

(c) Describe the lapse rate variance for each item in (b) that would occur over time if the item is ignored.

(d) Describe the steps needed to calculate the required spread on assets (RSA) using the approach as described by Griffin for an SPDA at the time it is issued.

(e) Describe how the lapse assumption error in (c) would affect the RSA at the time of the policy’s issue in the situation where the initial yield curve is relatively steep.
Question 10

a)

**Seasoning** – prepayment rates increase as mortgage ages and then level off or decrease slightly with age

**Interest Rates** – low rates produce higher preps due to refinancings and relocations

**Seasonality** – preps are higher in summer and lower in winter

**Burnout**
- as rates reach a certain low a second or third time, prepayments decrease
- path dependence of prepay rates versus interest rates
- after lots of preps, these left in pool are less likely to prepay

b)

**Seasoning (aging)** –
- yes, base assumption has seasoning
- five years from issue, house rate is flat
- takes time to reach fully seasoned state

Interest rates – yes
- competitor rates are included in excess lapse function

Seasonality – not present

Burnout – not present
- high credited rates continue to affect lapses

c)

Interest Rates – if ignored, lapse cannot reflect interest sensitive lapses at a lower interest rate level environment

Seasoning – if this term is ignored, the lapse for early years will be overstated, which does not reflect the underlying situation of newly issued policy

Seasonality – if ignored, the total lapses will be the same but the timing is different

Burnout – if ignored, the lapses for a prolonged period of lower interest rates will be overstated while the lapse rate at that moment will be quite stable.
d) generate a set of arbitrage-free interest rate paths
project cash flows along each path and calculate present values
add a spread to all the paths and repeat the process and fin the average of $PV(CF_s)$

e) Interest rates – if ignored will understate the lapse, as in a steep YC environment the future credited rate for competitors is high. This would lead to earlier lapse and the acquisition expense unamortized. The RSA is underestimated.

Seasoning – if ignores should not have effect on RSA

Burnout – if ignored will lead to overstated lapses. The RSA is bigger than actual.
11. *(7 points)* You have been asked to evaluate the use of exotic options to hedge the impact of a market downturn on management fees from equity-linked products. These management fees are earned continuously.

(a) Describe the payoff at maturity associated with the following:

(i) straddle  
(ii) down-and-in put with barrier \( H < X \), where \( X \) is the strike price  
(iii) average price put  
(iv) forward start at-the-money put option starting at time \( T_1 \)  
(v) lookback put

(b) Assess the potential usage of each of the options listed in (a) to:

(i) Guarantee a minimum level of fees on equity-linked products for the current portfolio.  
(ii) Guarantee a minimum level of fees on equity-linked products for deposits made during the next time period.

(c) Describe the trinomial valuation method and compare its application in valuing barrier options and American options.
Question 11

a)

i) Straddle payoff max \((S_T - X, X - S_T)\)

ii) Pays off \((X - S)\) if \(S < H\) at some point before \(T\)

iii) At end of term pays \((X - S)\), where \(S_{\text{ave}}\) is average strike price over period

iv) Payoff if \((S_1 - S_2)\) where \(S_1\) is price at time \(T_1\) (strike price) and \(S_2\) stock price at time \(T_2\)

v) Pays \((S_{\text{max}} - X)\), where \(S_{\text{max}}\) is the maximum value of \(S\) over term of option

b)

i) Will lose money if stocks go down so we want put options

Straddle also pays if stock goes up so unnecessary option

Management fees are earned continuously so in retrospect are a function of the average level of stocks of the period. Average price put would be the best fit.

Forward start at-the-money average price put would be great for guaranteeing fees for next period

Forward start put not a good fit to hedge management fees earned on average stock price during the period

Look back put provides downside protection but would be too expensive

ii) Above arguments remain the same. We need a forward start at-the-money put option.
c) Trinomial valuation method: we have a trinomial tree with branches for each node that can go up, down or remain the same. See graph.

Moving along an up branch multiplies current stock price by \( u = e^{\sigma \sqrt{T \Delta t}} \), the middle branch remain at same level, and the down branch multiplies by \( l/u \). The probabilities are

\[
p_m = \frac{2}{3}, \quad p_d = \frac{\Delta t}{2 \sigma^2} \left( r - \frac{\sigma^2}{2} \right) + \frac{1}{6}, \quad p_u = \frac{\Delta t}{2 \sigma^2} \left( r - \frac{\sigma^2}{2} \right) + \frac{1}{6}
\]

For barrier options, there are 3 ways one can value if the barrier does not lie on nodes of the tree.

1. Adaptive Mesh method decrease step size closer to the barrier (see example)

2. Calculate value of option assuming barrier is on inner and outer nodes around barrier and average.

3. Adjust tree or so that barrier is on nodes (see example)
For American options and trinomial method: use backwardisation like on binomial tree. The value at each node is 

\[ f_{ij} = \max \left( \text{intrinsic value, } e^{-r\Delta t} \left[ p_u f_{i+1,j+1} + p_m f_{i+1,j} + p_d f_{i+1,j-1} \right] + \Delta \right) \]
12. (7 points) Consider the following portfolio of variable deferred annuities:

<table>
<thead>
<tr>
<th>Separate account assets (MV)</th>
<th>700,000 in S&amp;P 500 index fund</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed account assets (BV)</td>
<td>100,000 yielding 6%, duration 4</td>
</tr>
<tr>
<td>Fixed account liabilities (BV)</td>
<td>100,000 crediting 5%</td>
</tr>
<tr>
<td>Guarantees on variable accounts</td>
<td>none</td>
</tr>
<tr>
<td>Minimum guarantee on fixed account</td>
<td>3% annual credited rate</td>
</tr>
<tr>
<td>Management fees</td>
<td>150 basis points per year charged on MV of separate accounts</td>
</tr>
<tr>
<td>Fixed expenses</td>
<td>3,000 per year</td>
</tr>
</tbody>
</table>

You are given the following annual rates:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk-free rate</td>
<td>4.50%</td>
</tr>
<tr>
<td>S&amp;P 500 index expected return</td>
<td>15%</td>
</tr>
<tr>
<td>Dividend yield</td>
<td>0%</td>
</tr>
<tr>
<td>Volatility on S&amp;P 500</td>
<td>20%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Strike</th>
<th>d1</th>
<th>d2</th>
<th>N(d1)</th>
<th>N(-d1)</th>
<th>N(d2)</th>
<th>N(-d2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>0.1625</td>
<td>0.0625</td>
<td>0.5645</td>
<td>0.4355</td>
<td>0.5249</td>
<td>0.4751</td>
</tr>
<tr>
<td>95</td>
<td>0.6754</td>
<td>0.5754</td>
<td>0.7503</td>
<td>0.2497</td>
<td>0.7175</td>
<td>0.2825</td>
</tr>
<tr>
<td>90</td>
<td>1.2161</td>
<td>1.1161</td>
<td>0.8880</td>
<td>0.1120</td>
<td>0.8678</td>
<td>0.1322</td>
</tr>
</tbody>
</table>

Ignore capitalized expenses, target surplus, taxes, lapse, transfers, and CARVM expense allowances. The assets in the separate account have minimal basis risk with the traded equity index.

(a) Calculate the mean and standard deviation of the rate of return (continuously compounded, before management fees) on the separate account assets for a 3 month period using the normal model.

(b) Assuming that the average separate account assets during the next 3 months are half of beginning and ending values from (a):

   (i) State the equation for expected pretax income over the next 3 months.
   (ii) Calculate the expected pretax income over the next 3 months.
12. (Continued)

(c) Calculate a 95% confidence interval for gross rate of return on separate account funds over the next 3 months.

(d) Estimate a 95% confidence interval for pretax income over the next 3 months. Assume that average separate account assets are half of beginning and ending amounts calculated in (c).

(e) Calculate the percentage change in pretax income versus expected, for each bound in (c).

(f) Calculate the expected ratio of pretax income to the range of a 95% confidence interval.

(g) Calculate the prices for 90-day European put options on the S&P 500 index with strike prices at 100, 95 and 90.

(h) Fixed assets are liquidated to partially hedge income volatility by purchasing a put option contract with a strike price of 95. The notional amount of each put option contract is equal to the expected pretax income from (b) above.

(i) Calculate the price for the hedge.

(ii) Recalculate the expected return and the 95% confidence interval calculated in (d) for the hedged portfolio.

(iii) Recalculate the ratio in (f) for the hedged portfolio.
Question 12

a) normally distributed return, $\mu = 0.15$, $\sigma = 0.20$, $T = 0.25$

$$\text{mean} = \left(\mu - \frac{\sigma^2}{2}T\right) = \left(0.15 - \frac{(0.20)^2}{2} \times 0.25\right) = 0.0325$$

std. deviation = $\sigma \sqrt{T} = 0.20\sqrt{0.25} = 0.10$

expected end of period assets = $700,000 - e^{0.0325} = 723,124$

b) average assets = $\frac{700,000 + 723,124}{2} = 711,562$

i) pre tax income – mgmt. fees + earnings on fixed assets – credited i on fixed - fixed expenses

ii) $(711,562)(0.015)(0.25) + (100,000)(0.06)(0.25) - (100,000)(0.05)(0.25) - (3,000)(0.25)$

= 2168

c) 95% < CI is $\pm 1.96$ std. Deviations

$0.0325 \pm 1.96\pm 0.16(0.10) = [−16.35\%, 22.85\%]$  

d) for both scenarios, only change is in management fees, constant pretax baseline of −500

high estimate: $-500 + (0.015)(0.25)(700,000)\left(\frac{l + e^{0.2285}}{2}\right) = 2,462$

low estimate: $-500 + (0.015)(0.25)(700,000)\left(\frac{l + e^{-0.1635}}{2}\right) = 1,927$
95% CI = [1,927, 2,462]

e)  
high: 2,462 – 2,168 = 294  
low: 1,927 – 2,168 = (241)  
  
high: \(\frac{294}{2,168} = 13.6\%\)  
low: \(\frac{241}{2,168} = (11.1\%)\)  

f)  
\[
\frac{\text{pre-tax income}}{\text{range}} = \frac{2,168}{294 - (241)} = 4.05
\]

g)  
\[P = Xe^{-rT}N(-d_2) - SN(-d_1)\]

Assume \(S_o = 100\)  
\[P = Xe^{-0.045(0.25)}(0.4751) - (100)(0.4355)\]

for \(x = 100, P = 3.431\)  
\(x = 95, P = 1.567\)  
\(x = 90, P = 0.567\)

h)  
i)  
\[
\frac{2,168}{100} (1.567) = 33.97
\]

ii)  
Index = 84.92  
Option Payoff = (10.08)(21.68) = 218.53

Lower income limit: 1,927 – 33.97 + 218.53 = 2,134  
Upper income limit: 2,462 – 33.97 = 2,428
iii)
\[
\frac{2,168}{2,428 - 2,134} = 7.37
\]
13. (6 points) You are the chief risk officer for a life insurance company. A Wall Street vendor of model analytics has approached you with their latest interest rate modeling product. The vendor claims that it is a realistic, arbitrage-free term structure model which should be appropriate for most of your ALM and reserve adequacy testing projects.

(a) Evaluate the appropriateness of the term structure model proposed by the vendor.

(b) Describe the categorization of approaches to term structure modeling and the resulting four classes of interest rate models.

(c) Outline the specific uses and limitations of the four classes of interest rate models.
Question 13

Primary Source: The Four Faces of an Interest Rate Model, Chap. 11, Investment Management for Insurers, Babbel and Fabozzi

1(a): The realistic, arbitrage-free term structure model proposed by the vendor is NOT appropriate for ALM and reserve adequacy work.

Such models are affected by confounding, where it is impossible to discriminate between model misspecification error and the term premia. As a result, such models are generally not of practical use.

1(b): Arbitrage-free models take certain market prices as given or input, and adjust model parameters in order to fit the prices exactly.

Equilibrium term structure models are truly models of the term structure process. Rather than interpolating among prices at one particular point in time, they attempt to capture the behaviors of the term structure over time.

Risk Neutral: The principle of risk neutral valuation asserts that, regardless of how risk averse investors are, we can identify a set of spot rates that values discount bonds correctly relative to the rest of the market by changing the probability distribution of the short term rates so that the expected rate of return on any security over the next instant is the same.

The important aspect of a risk neutral model is that the expected return on all securities is the risk-free rate, i.e., there is no extra expected return to compensate investors for the extra price risk in bonds of longer maturity.

Realistic: Realistic simulation generates scenarios that bear resemblance to observed changes in interest rates and risk premia in the real world.

Describe the four classes of interest rate modeling approaches:

1) Risk Neutral and Arbitrage-Free: This type of model is risk adjusted to use for pricing derivatives.

2) Risk Neutral and Equilibrium: Equilibrium models capture the global behavior of the term structure over time, so security-specific effects are treated in the appropriate way, as noise.

3) Realistic and Arbitrage-Free: Such a model starts by exactly matching the term structure of interest rates implied by a set of market prices on an initial date, then evolves that curve into the future according to the realistic probability measure.

4) Realistic and Equilibrium: In contrast, this type of model does not take observed market prices at a particular point in time as given, rather it uses a statistical approach to capture the behavior of the term structure over time.

Uses and limitations of the four classes of interest rate models:

1) Risk Neutral and Arbitrage-Free: It is appropriately used for current pricing when the set of market prices is complete and reliable. Useless for horizon pricing whereby future prices are unknown.
2) Risk Neutral and Equilibrium: For current pricing, such models can be estimated from historical data when current market prices are sparse. Can also be used for horizon pricing, since the horizon prices obtained under the different values of the state variables are available in an equilibrium model.

3) Realistic and Arbitrage-Free: However, such models are affected by confounding, where it is impossible to discriminate between model misspecification error and the term premia. As a result, such models are not of practical use.

4) Realistic and Equilibrium: Since the arbitrage-free form of a realistic model is not available, the equilibrium form must be used for stress testing, VAR calculations, reserve and asset adequacy testing, and other uses of realistic scenarios.
14.  (6 points) The current price of a stock, $S$, is 5 and the price follows a generalized Wiener process with a mean of 10% of its price and a volatility of 20% of its price. Another security, $G$, is derived from $S$ by the formula: $G = S^2 + S + 1$. Two students have been asked to use Ito’s lemma to determine the dynamics of a position of 1 unit of $G$ hedged with a position $H(S)$. The students used the following formulas:

- Student A: $H(S) = 1 - S^2$
- Student B: $H(S) = S^2 - 10S + 1$

(a) Determine the position in $S$ that is needed to hedge a long position of 1 unit of $G$.
(b) Using Ito’s lemma:

(i) Determine the process that the hedge position would follow under each student’s formula.

(ii) State which formula should be used to understand and manage the dynamics of the hedge position. Justify your choice and explain why the other formula is not appropriate.
Question 14

a) Determine the position in S needed to hedge a long position in G.

\[ dS = 0.1 S \, dt + 0.2 S \, dz \]

\[ G = S^2 + S + 1 \]

By Ito’s lemma

\[ dG = \left( \frac{dG}{dS} \mu S + \frac{dG}{dt} + \frac{1}{2} \frac{d^2 G}{dS^2} r^2 S^2 \right) dt + \frac{dGrSdz}{dS} \]

\[ \mu = 0.1 \quad \tau = 0.2 \]

\[ \frac{dG}{dS} = 2S + 1 \quad \frac{dG}{dt} = 0 \quad \frac{d^2 G}{dS^2} = 2 \]

\[ dG = \left( (2S + 1)(0.1)S + \frac{1}{2} 2(0.21^2 S^2) dt + (2S + 1)2Sdz \right) \]

Need a position in S, X, so the coefficient of dz is zero

\[ (2S + 1)2Sdz + x(2)Sdz = 0 \]

\[ x = -(2S + 1) \]

S=5

X=-11

Short 11 shares of S

a) Use of Ito’s Lemma

Determine the process that the hedge position would follow under each student’s formula.

\[ H(S) = 1 - S^2 \]
\[ dH_A = \left( \frac{dH}{dS} US + \frac{dH}{dt} + \frac{1}{2} \frac{d^2H}{dS^2} r^2 S^2 \right) dt + rSdz \]

\[ u = .1 \quad \frac{dt}{ds} = -2S \quad \frac{d^2H}{dS^2} = -2 \quad r = .2 \]

\[ dH_A = \left( -2S^2 + \frac{1}{2} (-2)(.21^2)S^2 \right) dt + (-2S)(.2)Sdz \]

\[ = (-.24S^2)dt - .4S^2dz \]

b)

\[ H(S) = S^2 - 105 + 1 \]

\[ \frac{dH}{dS} = 2S - 10 \quad \frac{d^2H}{dS^2} = 2 \quad \frac{dH}{dt} = 0 \]

\[ dH_B = ((2S - 10)(.1)S + \frac{1}{2} (.2)(.2)S^2 \frac{dt}{dt} + (2S - 10)(.2)Sdz \]

\[ = (.24S^2 - S)dt + .4S^2 - 2S \]

ii)

Use Student As.

At S=5, the coefficient of dz is zero for student B and cannot offset the risk in G.
15. (5 points) XYZ Life has proposed changing its management compensation plan to separately reflect performance of asset and liability components. You have been asked to use the Total Return Approach to Performance Measurement to execute the new compensation plan.

Describe the total return attribution analysis for the following:

(a) portfolio of tradeable securities
(b) liabilities
(c) net profits

Define all terms.
Question 15

Performance Measurement

A. Asset:

\[ R_a = R_f + OAS - DOAS \ \Delta OAS - \Delta D(i) + \frac{r}{c} + pa + E_a \]

\( R_f = \) risk free rate  
\( OAS = \) option-adjusted spread, at the beginning of the period  
\( \Delta OAS = \) change in the OAS during the period  
\( DOAS = \) price sensitivity of the security (or asset) to the change in the OAS  
\( D(i) = \) ith key-rate duration  
\( r(i) = \) shift of the ith key-rate  
\( \frac{r}{c} = \) rich/cheap rate one period change the rich/cheap value  
\( pa = \) portfolio adjustment = change in total return due to trading  
\( E_a = \) investment expenses

B. Liability:

\[ R_l = R_f + ROAS - \Delta D(l) \Delta r(i) + E_i \]

\( R_f = \) risk free rate  
\( ROAS = \) option-adjusted spread required by the liability’s pricing  
\( D(l) = \) ith key-rate duration MVL (or LV) price sensitivity, to the ith key-rate  
\( r(i) = \) shift of the ith key-rate  
\( E_i = \) insurance (or admin) expenses

C. Attribution:

Net profits = \( R_a - R_l \)

\( C1 \) Risk = credit risk = \( OAS - DOAS \ \Delta OAS = \) skill in sector rotation

\( C2 \) risk = pricing risk = \(-ROAS\)

\( C3 \) risk = duration management = interest rate risk = ALM risk  
\[ = \sum(Da(i) - DI(i)) \Delta r(i) = \) skill in interest-rate anticipation
Intraweek changes = \( \frac{r}{c} + pa = \) skill in bond/security selection

Expense management = expense underrun = \(- (E_a - E_i)\)
16. (8 points) You are given the following information for BBB-rated zero coupon corporate bonds:

<table>
<thead>
<tr>
<th>Term (years)</th>
<th>Current Price</th>
<th>Average Cumulative Default Probabilities</th>
<th>Recovery Rate Upon Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>70.470</td>
<td>3.00%</td>
<td>40%</td>
</tr>
<tr>
<td>10</td>
<td>48.675</td>
<td>13.00%</td>
<td>40%</td>
</tr>
</tbody>
</table>

You are also given:

- The principal payment due at maturity is 100.00.
- The corporate zero coupon yields are continuously compounded.
- The risk-free rate is 5.50% per year (continuously compounded).

(a) Calculate the value, at time zero, of expected losses from default on BBB-rated zero coupon corporate bonds based on the current bond prices for the following future time periods:

(i) during the first 5 years
(ii) during the first 10 years
(iii) between years 5 and 10

(b) Compare the estimates of future default, based on the current bond prices, with the historical default experience on BBB-rated zero coupon corporate bonds for the same time periods stated in (a).

(c) Describe the possible reasons for the discrepancy between actual default experience and the default probabilities implied in bond prices. Explain how each of these can be used in the analysis of credit risk.

(d) Calculate the annual returns that an investor can expect to earn, on average, in excess of those in a risk-free world for both the 5-year and 10-year BBB-rated zero coupon corporate bonds, given the extent of the discrepancy between actual default experience and the default probabilities implied in bond prices.
Question 16

a)

i) expected portion of no-default value lost through defaults

\[ h(0, T) = \frac{e^{-\gamma(T)T} - e^{-\gamma(T)T}}{E^{-\gamma(T)T}} \]

\[ h(0.5) = \frac{e^{-\gamma(5)5} - e^{-\gamma(5)5}}{e^{-\gamma(5)5}} \]

\[ y \times (5) = 0.055 \quad 100 e^{-\gamma(5)5} = 70.47 \Rightarrow e^{-\gamma(5)5} = 0.7047 \]

\[ h(0.5) = \frac{e^{-0.055x5} - 0.7047}{e^{-0.055x5}} = \frac{0.7586 - 0.7047}{0.7596} \]

= 0.07226 or 7.226%

ii)  

\[ h(0, 10) = \frac{e^{-\gamma(10)10} - e^{-\gamma(10)10}}{e^{-\gamma(10)10}} \]

\[ y \times (10) = 0.055 \quad 100 e^{\gamma(10)10} = 48.675 \Rightarrow e^{\gamma(10)10} = 0.48675 \]

\[ h(0, 10) = \frac{e^{-0.055x10} - 0.48675}{e^{-0.055x10}} \]

\[ = \frac{0.57695 - 0.48675}{0.57695} \]

=0.1563 or 15.634%

iii)  

\[ h(T_1, T_2) = h(O, T_2) - h(O, T_1) \]

\[ = h(0, 10) - h(0, 5) \]

\[ = 15.634\% - 7.226\% \]

\[ = 8.408\% \]
b

i)

default probability during first five years

\[ h(0.5) \]

\[ = \frac{1}{1 - \text{recovery rate}} \]

\[ = \frac{0.07226}{1 - 0.4} = 0.12043 \text{ or } 12.043\% \]

= 4 times historical default rate

Historical default rate for 1st 5 years = 3%

ii)

default probability 1st 10 years = \[ \frac{0.1563}{1 - 0.4} \]

= 0.14013 or 14.013%

= 1.4 times historical default rate

historical default rate \(-1.5 \& 10 = 13\% - 3\% = 10\%\)

iii)

default prob. Between 5 & 10 years = \[ \frac{0.08408}{1 - 0.4} \]

0.14013 or 14.013%

= 1.4 times historical default rate

historical default rate \(-5 \& 10 = 13\% - 3\% = 10\%\)
c) Reasons for discrepancies
- traders may be pricing in possibility of recession or depression
- part of higher return may be compensation for lower liquidity

Specific Uses
- risk-neutral (based on bond prices)
- used to value credit derivatives
- estimate impact of default risk on the pricing of derivatives
- real-world (historical)
- used when carry out scenario analysis to calculate future losses from defaults

d) i) 5 year
Total Excess Return = (0.12043-0.03)x (1-0.4)
= 0.05426
Annual Excess Return = \[ \frac{5.426\%}{5} = 1.085\% \]

ii) 10 year
Total Excess Return = (26.057\% - 13\%)x(1–0.4)
= 7.8342%
Annual Excess Return = \[ \frac{7.8342\%}{10} = 0.7834\% \]
17. *(3 points)* Describe each of the following:

(a) Option Pricing Method (OPM)

(b) Actuarial Appraisal Method (AAM)

(c) The circumstances under which AAM is equivalent to OPM.
Question 17

Fair Value Accounting

OPM : direct method

\[ MVL = \sum (L_i + E_i) / (1 + r + s)^t \]

Discount liability and expense cash flows at the risk free rate plus a spread

AAM : indirect method

\[ DDE = \sum DE_i / (1 + k)^t \]

Discount distributable earnings at the cost of capital

\[ MVL = MVA^* - DDE \] where MVA* means all assets, not just product assets

Market value of liabilities is the market value of assets less DDE

\[ DEt = I_t - \Delta RS_{t-1} \]

Distributable earnings equal statutory earnings less the change in required surplus

Equivalence of AAM and OPM: when a consistent discount rate is used

When \( \theta^L_t = \theta^4_t - (RP_t / MVL_{t-1}) \) is the required profit margin and \( \theta^L_t \) is the real spread above the risk free rate for discounting liability cash flows

Necessary assumptions include:

Statutory accounting
Taxes
Risk based capital
Investment strategy
18. (6 points) You are the pricing actuary and are considering the following design for a new 5-year EIA:

- point-to-point with a 2-year Asian end and a participation rate of 80%
- annual discrete lookback with a participation rate of 50%
- annual discrete lookforward with a participation rate of 60%
- annual simple ratchet with a participation rate of 100% and an annual cap of 12%
- point-to-point ladder design with a 125 "rung" at year 3 and a participation rate of 90%

You have been given the following projected equity index scenario:

<table>
<thead>
<tr>
<th>Time in Years</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anniversary Index Level</td>
<td>100</td>
<td>130</td>
<td>110</td>
<td>120</td>
<td>150</td>
<td>140</td>
</tr>
</tbody>
</table>

(a) Calculate the value of a 100,000 premium deposit at the end of five years under each 5-year design assuming no withdrawals.

(b) Compare the advantages and disadvantages of stochastic versus deterministic scenario testing in EIA pricing.
Question 18

a) 
ii) 

point-to point with a 2-year Asian end

\[ AV_5 = 100,000 x \left\{ 1 + \left[ \frac{150 + 140}{100} - 1 \right] x 80\% \right\} \]

= $136,000 

ii) 
Annual discrete lookback

\[ AV_5 = 100,000 x \left\{ 1 + \left[ \frac{150}{100} - 1 \right] x 50\% \right\} \]

= 125,000 

iii) 
annual discrete lookforward

\[ AV_s = 100,000 x \left\{ 1 + \left[ \frac{140}{100} - 1 \right] x 60\% \right\} \]

=124,000 

iv) 
annual simple ratchet (assume minimum = 0 )

\[ AV_s = 100,000 x \left\{ 1 + \max \left( \frac{130}{100} - 1 \right) .12 \right\} + \left[ \min \left( \frac{110}{130} - 1 \right) .0 \right] \]

\[ + \left[ \max \left( \frac{120}{110} - 1 \right) .12 \right] + \left[ \max \left( \frac{150}{120} - 1 \right) .12 \right] \]
\[ + \left[ \min \left( \frac{140}{150} - 1, 0 \right) \right] \]

\[ = 100,000 \left[ 1 + 1.12 + 0.0909 + 1.12 + 0 \right] = 133.090 \]

a)

Point-to-Point Ladder Design

Since 125 level was not reached at year 3,

\[ AV_3 = 100,000 \times \left\{ 1 + \left[ \frac{140}{100} - 1 \right] \times 90\% \right\} \]

= 136,000

b)

Advantages of deterministic scenario testing:
Ease of interpretation of results
Can incorporate subjective opinion
Extreme case can be included
Similar to the method used in cashflow testing

Disadvantages of deterministic scenario testing:
Difficult to create a large number of scenarios
Difficult to allocate probability to each scenario
Difficult to reflect the full range of variability
Difficult to create scenarios where the economic variables are consistent
Question 1

a) Optimal hedge rates (% of currency hedges) in general depends on:
- % of asset portfolio that’s invested in foreign assets
- Potential hedging costs which include:
  - contract trading cost
    - bid ask spreads on forwards
    - transaction costs
  - custody costs
  - custody fees
In total these costs range in 20-50 bp range. These costs reduce expected return directly on hedges portfolio.
- Risk reduction benefits must be higher than hedging costs
- General level of risk aversion for LifeCo.

This is the utility function \( U(R) = S(R) - \frac{\sigma^2}{RT} \)

Where RT is risk tolerance level.
- The correlations and volatilities of different currency exposure, for LifeCo. For example, if source currency exposures have negative correlations, they don’t need to be hedged, because they offset each other.
- Based on net foreign CR and volatility/correlation projection
- Depends on type of investors
- Depends on consumption mix of foreign products
- Foreign exchange exposure can be inflation hedge for imported goods
- Consider impact on strategic plan
Depends on forecast of foreign exchange rates

b) The objective of LifeCo is to eliminate currency risk. This is consistent with LifeCo objective of delivering stable earnings. Currently they use currency swaps and forwards to hedge currency risk. This is consistent with Full Hedging Approach, where certain exposure is hedged using forwards, swaps. The problems with this approach are that:
- Because under/over hedged when foreign assets appreciate/depreciate, need frequent hedge adjustments.
- Only hedges currency movement. Ignores foreign asset impairment in context of total portfolio

Alternatives are:
- Minimum Variance Hedging
  where asset class volatilities and correlations are integrated with currency volatilities and correlations to derive a minimum risk portfolio per a given level of expected return. This would be consistent with minimizing total earnings volatility.
- **Downside-Option Based Hedging**
  useful to truncate downside exposure but still retain upside potential, 3 alternatives:
  - Buy puts on individual currencies
  - Buy puts on basket of currencies
  - Buy puts on base currency value of foreign exposure.
  Second approach is probably cheaper because it accounts for offsetting correlations of currencies.
- Can also create synthetic put positions, via Delta hedging, where forward contracts are traded.
- No hedging
- Set up foreign subsidiaries to improve foreign currency revenue/expense mismatch
- Downside/Option based approach retains upside potential but at cost = option premium
Could use semi-variance to reflect downside risk aversion

c) **Historical Simulation**
- Simulation based on historical currency movements applied to current portfolio.
  - How long is historical period (60 days, 360 days) or more?
  - What did the market do during historical period, where there any crisis events?
- Can use bootstrapping to alleviate this to an extent.

Estimation error for historical greater than for Delta normal

d) - Transfer pricing involves the determination of a price or cost for funds transferred internally from one business unit to another
- Can be used to allocate performance into meaningful components e.g. credit risk, interest rate mismatch, etc.
- Need (n-1) benchmarks for n components

(e) - Actual Foreign Income = (Actual Foreign Income – Benchmark) + Benchmark
Benchmark = Income from foreign operations of a fully hedged portfolio, reflecting all hedging costs
Question 2

(a)  
Fair value based:
   - asset & liability market value-based
   - total return included realized and unrealized gain/loss
   - good for long term view
   - more realistically captures firm value

Book value based:
   - asset & liability book value
   - asset may partially mark-to-market under FAS 115
   - ignore unrealized gain/loss
   - false feeling of security

(b)  
   (i)  
   - long term portfolio return should be better
   - company would not invest a lot in high yield bonds to pursue higher income, because fair
     value based would capture the risk
   - fair value would mark asset to market
   - future impact would be captured
   - equity offers high long term return but with long current income

   (ii & iii)
   - fair value based measurement would mark both A & L to market
   - it captures both current and future income
   - by maximizing total return, future accounting income likely to be better
   - more likely to invest in projects with future potential, thus future economic profit will be
     better

(c)  
Investment division: compare asset return to benchmark return
Product division: compare benchmark return to liability

Asset book income = 700 * ((1 + 0.0728)^0.25-1) +g/L = 12.4
Similarly, liability book income = 12.0 and benchmark book income = 12.3

Investment performance = 12.4 – 12.3 = 0.1
Product performance = 12.3 – 12.0 = 0.2

Book value @ end of quarter = beg book + book income – CF
Market value = book value * market/book ratio
Market return = change of market value + CF
Question 3

(a) Option Pricing Stochastic Models

1) Monte Carlo Simulation

- Simulate paths for interest rate movements that are arbitrage free
- Project cash flows along each path and discount at short rates to derive expected cost
- Can handle path dependent cash flows, complete payoffs
- Good for derivatives dependent on several variables
- Cannot handle American option
- Not a problem for GMAB since most guarantees are at specified times

2) Binomial Trees

- Each period stock can move up by a proportional amount ‘u’ or decrease by ‘d’
- Expected payoff is discounted at risk neutral rate to derive price
- Can handle American option but not path dependency
- If GMAB has more than one guarantee at different times, can use backwardization to see if GMAB still be exercised early

3) Finite Differences

- Solve Black-Scholes Merton differential equation by difference formula
- Not very good for GMAB

4) Black’s Model

- GMAB is essentially a put on the accumulated account value (bond) as if interest rate rise, annuitant would exercise (sell the bond) to the insurer
- \[ P = p(O,T^*)[XN(-d_1) - F_0N(-d)] \]
- Requires bond price to lognormal at time T*, payoff of option
- \( F_0 \) is expected forward bond price =

\[
\frac{B_o - I}{P(O,T)}
\]

I = present value of coupon payments

(b) Running the risk naked

1) Take the view that accumulated guarantee payoffs will be less than accumulated guarantee fees
2) Problems are:

- The view may be wrong
- Potentially volatile earnings
- Potentially severe capital requirement
- Have marketing risk of having to increase premium
- Exposure is high downside risk with limit to upside (receiving premium)
- Put exposure
- Insurance risk remains
- Limitation of model misspecification

(ii) Static Hedging
1) Hedge guarantee risk by purchasing customized options from a third party over the counter market
2) Considerations are:

- Exposure to counterparty credit risk
- Restrictions on volume
- Unwillingness of investment bank to transact in certain market and strike prices
- High expense and profit margins built on the options
- Bid ask spread
- Insurers must generate enough premium income
- Provide only partial protection against guarantee risk

(iii) Dynamic Hedging
1) Hedge the guarantee risk by creating synthetic option using traded underlying securities, interest rate futures and short dated options
2) Requires dynamic rebalancing
3) Increase holdings in underly securities when security price increase – buy high and sell low
4) Require expertise and supporting system
5) Internal management cost may be higher than that in price in option purchased
6) Volatility is uncertain and may change – hedging cost may be higher than expected
7) Liquidity risk and transaction costs extreme events may cause trading difficulties
8) Revenue risk – option cost and risk charge move opposite direction
9) There is basis risk and model risk

(c)
Key Considerations

1) Management and stakeholders risk attitude toward specific risk classes
2) Willingness to manage or sell risks and specific risk classes
3) Presence and absence of expertise and supporting system to manage specific risks
4) Market price dynamics (price taker or setter) and marketing strategy (penetration, skimming, price leader or differential)
5) Risk size and its correlation with other company risk
LifeCo must be able to identify the many risks that exist in the GMAB. Should take an active approach to the modeling of the guarantee. Should change its ACM process into 5 steps:

- Identify risk exposure
- Determine how much exposure is acceptable
- Determine appropriate hedging instruments
- Create the hedging portfolio
- Evaluate effectiveness

<table>
<thead>
<tr>
<th>Reserving</th>
<th>Dynamic Hedging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process: Brownian motion. The drift is adjusted to reflect fund mana. Fees and guarantee fees</td>
<td>Same</td>
</tr>
<tr>
<td>Process parameters should reflect real world expectations, risk aversion and market imperfections.</td>
<td>Process parameters: capital market. Risk free rate of return reflecting the no arbitrage assumption</td>
</tr>
<tr>
<td>For an elective reset, option election process should be included</td>
<td>Same</td>
</tr>
<tr>
<td>Modification to the scenario generator needed to reflect American nature of the reset</td>
<td>Same</td>
</tr>
<tr>
<td>Mortality and policyholder behavior</td>
<td>Same</td>
</tr>
<tr>
<td></td>
<td>Bid ask spread and transaction cost upon rebalancing</td>
</tr>
</tbody>
</table>
Question 4

Integrated Risk Management

No integration with market risk, i.e. Default rates are not a function of market level or behavior

Risk Reduction

Derivative type restrictions reduce volatility
Policies set by senior management
Master agreement netting across counterparties

Exposure Limits

Limit by class only, not counterparty
No limits for some classes (futures)
Current exposure (vs. potential) only monitored
Limits not function of credit rating or defaults

Monitoring

Frequency unspecified
Accountability not specified
No downgrade procedure
No marking to market

b)
Risk
Variance
VAR
Expected shortfall
Regret
Put value
Expected counterparty credit exposure
Expected counterparty credit loss
Expected cross-counterparty credit loss

Reward
Expected profit and loss
Expected return
Expected upside
Call value
c) Counterparty exposure models
   Economic loss on immediate default of all transactions for a given counterparty
   Credit migration can be included
   No future changes in exposure accounted for
   Doesn’t highlight “wrong-way” exposures
   Almost exactly LifeCo’s model

ii) Portfolio Credit Risk Models
    Measure portfolio effects, specifically obligor correlations
    Include default and migration correlation
    Deterministic interest rates
    Bigger impact on derivatives
    LifeCo has none of these elements

d) Risk factors and Scenarios
   Over analysis period project scenarios of systemic risk factors
   Include joint evolution of both credit and market factors

   Obligor exposures, recoveries and losses
   Compute in each scenario
   Based on market level
   Account for netting, mitigation and collateral

   Joint default/migration model
   Develop scenario dependent default/migration probabilities
   Relationship to scenario done through “Creditworthiness index”
   Correlations are driven by joint variation of conditional probabilities

   Conditional portfolio loss distribution in a scenario
   Computers using Monte Carlo or statistical tools

   Unconditional loss aggregation across scenarios
   Average conditional losses across all scenarios
   Must assign probabilities to each scenario
Question 5

a)

Warehousing assets sometimes is beneficial if the assets could be acquired at favorable price since GIC is usually sold at discrete time interval and opportunities for GIC sale may not coincide with opportunity to acquire assets. However, there is a risk that asset value may go down between the time acquired and time of a GIC sale due to for example an interest rate increase. Normally futures are sold against the acquired assets to minimize risk, and then unwound as GICs are issued.

b)

If assets have not been warehoused when GIC rate is committed, there is a risk that interest may go down and suitable assets may not be available to fund the GIC since there is usually a lag between commitment and the deposits are made.

To hedge can enter a pay floating/receive fixed swap as soon as GIC is committed and then unwind swap when the assets are finally acquired. There is still a risk that spread between the asset acquired and the futures will change (basis risk) resulting in loss. Basis risk can be hedged with spread locks or CMT/CMS swaps.

Need to estimate the price volatility
- need to know the acceptable level of volatility
- need to choose hedge instrument
- need to calculate the hedge ratio
- need to look at the price (cost) of available instruments

c)

i) Government Bond
   Advantage
   - No default risk
   - Good protection against interest rate
   - Liquid

   Disadvantage
   - On-balance sheet transaction
   - “On-the-run” or “on special” issue more expensive to borrow
   - Basis risk not hedged

ii) Bond Future
    Advantage
    - Off-balance sheet transaction
    - Liquid
    - No “on special” / “on the run” issue as Treasury
Favorite hedge accounting treatment by FASB
No upfront cash deposit required

Disadvantage
Cheapest to delivery (CTD) $\Rightarrow$ Negative convexity
CTD difficult to evaluate/monitor interest ratio risk
Does not hedge basis (spread) risk

Interest Rate Swap
Advantage
Off-balance sheet transaction
No “on special” issue as training
Flexible maturity
Better interest rate risk protection. Swap rate closely related to corporate spread
Priced off Treasuries, so give same interest rate protection

Disadvantage
OTC mostly
Credit risk involved
Bid/Ask spread (less liquid)
Question 6

A
i) Costs

<table>
<thead>
<tr>
<th>OTC Call Option</th>
<th>Delta Hedging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usually more expensive</td>
<td>In theory cheaper, as implied volatility of synthetic option less than what investment bankers use</td>
</tr>
<tr>
<td></td>
<td>But significant risks that could increase costs</td>
</tr>
<tr>
<td></td>
<td>Significant systems/expertise required, which if you don’t have already is expensive</td>
</tr>
</tbody>
</table>

ii) Risks

<table>
<thead>
<tr>
<th>Liquidity Risk</th>
<th>Model Risk – is S&amp;P going to move like the model predicts?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit Risk</td>
<td>Basis Risk – minimal, with futures</td>
</tr>
<tr>
<td>- counterparty default</td>
<td></td>
</tr>
<tr>
<td>- long term option riskier</td>
<td></td>
</tr>
<tr>
<td>Operational Risk</td>
<td>Market Risk – major index moves might not get hedged</td>
</tr>
<tr>
<td>- will OTC transaction be executed properly?</td>
<td>Volatility Risk – impacts rebalancing frequency, also transaction costs</td>
</tr>
<tr>
<td></td>
<td>Consider hedging Gamma &amp; Rho as well</td>
</tr>
<tr>
<td></td>
<td>Huge operational risk</td>
</tr>
<tr>
<td></td>
<td>- many complicated transactions take place with great frequency</td>
</tr>
</tbody>
</table>

iii) Effectiveness in Matching Liability

| Perfect match if no decrement | - won’t know until end of term                                               |
| But, how to handle withdrawals? |                                                                              |
| hedge less than 100%           |                                                                              |
| hedge fully, but sell off excess as necessary? | May fail to replicate the option                                             |
| (liquidity issues, and selling when out of the money) |                                     |
| Hold excess for speculative purposes? (legal?) |                                     |
b) strike price = $10M \times 90\% \times (1.03)^{10}

x = $12.0952 \ M

S_o = $10M

T = 10

\sigma = .15

r = .05

Dividend is assumed to be zero.

Delta of option \( \Delta = N(d_1) \)

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

\[
d_1 = \frac{\ln\left(\frac{10}{12.0952}\right) + \left(0.05 + \frac{0.15^2}{2}\right)10}{0.15 \sqrt{10}} = 0.902
\]

\( N(d_1) = 0.8133 = \text{amount of index required} \)

\[
\frac{.8133 \times e^{-rt} \times 10M}{100,000}
\]

\[
= \frac{.8133 \times e^{-0.05(1)} \times 10M}{100,000} = 77.4 \ \text{contracts}
\]
Modern Finance Theory indicates that investors are risk averse, utility maximizes and Bayesian forecaster

Empirical Studies of corporate management

1. **Dividend Policy**

   According to modern finance theory (PMT) that dividends don’t matter since dividends are taxed at income ratio

   Companies do manage a smoothing dividend policies due to:

   - Investors don’t like to dip in capital gains
   - Dividends can be additional income in a rising market or a silver lining when markets are down
   - Client issue and some investors like dividends

2. **Earnings Management**

   According to PMT, the PV of earnings matters more than quarter-to-quarter to quote earnings but corporate spends a lot effort to manipulate earnings. Reasons:

   a. Management reveals internal information through earnings

   b. There is a cost associated with earnings volatility

      Higher funding costs since external funding is higher than internal funding =⇒ earnings volatility may influence companies ability to execute business plan or loss of investment opportunity

      Cost of insolvency costs - extreme earnings may cause the company to go insolvent

   c. Target for takeover if earnings are bad

   d. Manager’s ability is judged by producing stable earnings
3. Expansion; reorganization

PMT suggests the goal is to create value for shareholders; however, the companies tend to expand the company more than PMT suggest. Reasons:

a. Managers benefit from managing large companies and more assets
b. Managers believe they can do a better job than the company being acquired
c. Increase opportunities for current employees
d. Personal gain = some managers will overpay upon acquisition or merger for personal benefits
Question 8

a) For Dividends

Some shareholders prefer continuous stream of payments as income

Higher dividend means company will be viewed as doing well

Companies should pay dividend based on its investment needs and financing opportunities

Pay dividends if there are not any attractive investment opportunities

Against Dividends

It is considered that the company failed to find appropriate investment opportunities to invest all the available cash

If the shareholders needed income they should diversify to fixed income a percentage of their portfolio or sell their shares

Historically there is no relation between company’s dividend policy and stock performance

Share price decline equal to the amount of the dividend paid, never to be recovered

Dividend income is taxed at a higher rate from capital gain

Remaining capital gains are riskier

b) Market Myopia

The company has to perform to provide good accounting results on a short-term basis (quarterly)

The myth is not true because:

companies with long term pr aspects and profitability command high P/E ratios
Insurance companies and pension funds invest more in R&D intensive companies than blue chip

Historically it has been proven that the markets:
Realistically factor in the effects of long term management actions on the stock price
Does not care if the accounts expense or capitalize value building out-lay
Can distinguish between value neutral and value adding opportunities

If the myth were true:

All the companies will sell for same P/E ratio
Share value should depend on CF expected to be generated over firm’s life time
Simple strategy to buy depressed shares and short sell overpriced stocks should always out perform

Supply and Demand

Myth that the supply and demand of the stock effects the stock price

\[ \therefore \text{company should promote their stock to increase demand} \]

It is based on the simple assumption that the supply of shares is fixed and the demand affects the price. Supply can be created by traders with derivatives and short selling. Institution investors buys stocks to perform in a certain way, they can use any proxy stock.

Trading is not an indicator of demand, it is the change in outlook that changes stock price

Stock price determined by intrinsic value

Stock price determined by lead steers

Volume will increase but price will not change

Supply is not fixed due to short selling and synthetic securities
Question 9

**Answer to question 9 – 2001 – 8V**

a) Martingale is a process of the form $d\theta = \sigma dz$ where $dz$ is a Weiner process

Let $f$ and $g$ be the prices of two derivative securities

that depend on a single source of uncertainty

Then $\theta = \frac{f}{g}$ is a martingale

for all securities $f$

if the market price of risk is the volatility of numeraire $g$

Hence $\frac{f_0}{g_0} = E_g\left(\frac{f_T}{g_T}\right)$

b) Set $g$ equal to the money market account, where $g_0 = 1$ and $g$ grows at instantaneous interest rate $r$, at any given time.

And follows the process $dg = rg dt$ and

$$g_T = e^{rt}$$

The volatility of $g$ is 0,

and therefore this is risk-free world

And $f_0 = g_0 \hat{E}\left(\frac{f_T}{g_T}\right)$ under risk-neutral expectation

Hence $f_0 = g_0 \hat{E}\left(\frac{f_T}{g_T}\right) = 1 \hat{E}\left[\frac{f_T}{e^{\int_{r_0}^{t} r ds}}\right] = \hat{E}(e^{-r_1} f_1)$
Question 10

a)  
**Seasoning** – prepayment rates increase as mortgage ages and then level off or decrease slightly with age

**Interest Rates** – low rates produce higher preps due to refinancings and relocations

**Seasonality** – preps are higher in summer and lower in winter

**Burnout**
- as rates reach a certain low a second or third time, prepayments decrease
- path dependence of prepay rates versus interest rates
- after lots of preps, those left in pool are less likely to prepay

b)  
**Seasoning (aging)** –
- yes, base assumption has seasoning
- five years from issue, house rate is flat
- takes time to reach fully seasoned state

**Interest rates** – yes
- competitor rates are included in excess lapse function

**Seasonality** – not present

**Burnout** – not present
- high credited rates continue to affect lapses

c)  
**Interest Rates** – if ignored, lapse cannot reflect interest sensitive lapses at a lower interest rate level environment

**Seasoning** – if this term is ignored, the lapse for early years will be overstated, which does not reflect the underlying situation of newly issued policy

**Seasonality** – if ignored, the total lapses will be the same but the timing is different

**Burnout** – if ignored, the lapses for a prolonged period of lower interest rates will be overstated while the lapse rate at that moment will be quite stable.
d) generate a set of arbitrage-free interest rate paths
   project cash flows along each path and calculate present values
   add a spread to all the paths and repeat the process and find the average of $PV(CF)$

e) Interest rates – if ignored will understate the lapse, as in a steep YC environment the future
   credited rate for competitors is high. This would lead to earlier lapse and the acquisition expense
   unamortized. The RSA is underestimated.

Seasoning – if ignores should not have effect on RSA

Burnout – if ignored will lead to overstated lapses. The RSA is bigger than actual.
Question 11

a) 
  i)  
  Straddle payoff \( \max(S_T - X, X - S_T) \)

  ii)  
  Pays off \( (X - S_T) \) if \( S < H \) at some point before \( T \)

  iii)  
  At end of term pays \( (X - S_T) \), where \( S_{ave} \) is average strike price over period

iv)  
Payoff if \( (S_t - S_T) \), where \( S_t \) is price at time \( T_1 \) (strike price) and \( S_T \) stock price at time \( T_2 \)

v)  
Pays \( (S_{max} - X) \), where \( S_{max} \) is the maximum value of \( S \) over term of option

b)  
  i)  
  Will lose money if stocks go down so we want put options

  Straddle also pays if stock goes up so unnecessary option

Management fees are earned continuously so in retrospect are a function of the average level of stocks of the period. Average price put would be the best fit.

Forward start at-the-money average price put would be great for guaranteeing fees for next period

Forward start put not a good fit to hedge management fees earned on average stock price during the period

Look back put provides downside protection but would be too expensive

ii)  
  Above arguments remain the same. We need a forward start at-the-money put option.
c) Trinomial valuation method: we have a trinomial tree with branches for each node that can go up, down or remain the same. See graph.

Moving along an up branch multiplies current stock price by \( u = e^{\sqrt{3}M} \), the middle branch remain at same level, and the down branch multiplies by \( l/u \). The probabilities are

\[
P_u = \frac{2}{3}
\]

\[
P_d = \frac{\Delta t}{12\sigma^2} \left( r - \frac{\sigma^2}{2} \right) + \frac{1}{6}, P_m = \frac{\Delta t}{12\sigma^2} \left( r - \frac{\sigma^2}{2} \right) + \frac{1}{6}
\]

For barrier options, there are 3 ways one can value if the barrier does not lie on nodes of the tree.

1. Adaptive Mesh method decrease step size closer to the barrier (see example)

2. Calculate value of option assuming barrier is on inner and outer nodes around barrier and average.

3. Adjust tree or so that barrier is on nodes (see example)
For American options and trinomial method: use backwardisation like on binomial tree. The value at each node is $f_y = \max$ (intrinsic value, $e^{-r\Delta t}\left[p_u f_{i+1,j+1} + p_m f_{i+1,j} + p_d f_{i+1,j-1}\right]$)
Question 12

a) normally distributed return, \( \mu = 0.15, \sigma = 0.20, T = 0.25 \)

\[
\text{mean} = \left( \mu - \left( \frac{\sigma^2}{2} \right)(T) \right) = \left( 0.15 - \frac{(0.20)^2}{2} \right)(0.25)
\]

\[
= 0.0325
\]

std. deviation = \( \sigma \sqrt{T} = 0.20 \sqrt{0.25} = 0.10 \)

expected end of period assets = \( 700,000 \cdot e^{0.0325} = 723,124 \)

b) average assets = \( \frac{700,000 + 723,124}{2} = 711,562 \)

i) pre tax income – mgmt. fees + earnings on fixed assets – credited i on fixed

- fixed expenses

ii) \( (711,562)(0.015)(0.25) + (100,000)(0.06)(0.25) - (100,000)(0.05)(0.25) - (3,000)(0.25) \)

\[
= 2168
\]

c) 95% < CI is \( \pm 1.96 \) std. Deviations

\[
0.0325 \pm 1.96 \pm 1.96(0.10) = [-16.35\%, 22.85\%]
\]

d) for both scenarios, only change is in management fees, constant pretax baseline of -500

high estimate: \(-500 + (0.015)(0.25)(700,000) \left( \frac{1 + e^{0.2285}}{2} \right) = 2,462 \)

low estimate: \(-500 + (0.015)(0.25)(700,000) \left( \frac{1 + e^{-0.1635}}{2} \right) = 1,927 \)
95% CI = [1,927, 2,462]

e)
high: \( 2,462 - 2,168 = 294 \)
low: \( 1,927 - 2,168 = 241 \)

high: \( \frac{294}{2,168} = 13.6\% \)
low: \( \frac{241}{2,168} = (111\%) \)

f)
\[
\frac{\text{pre-tax income}}{\text{range}} = \frac{2,168}{294 - (241)} = 4.05
\]

g)
\[ P = Xe^{-\alpha} N(-d_2) - SN(-d_1) \]
Assume \( S_o = 100 \)
\[ P = Xe^{-(0.045)(0.25)}(0.4751) - (100)(0.4355) \]
for \( x = 100, P = 3.431 \)
\( x = 95, P = 1.567 \)
\( x = 90, P = 0.567 \)

h)
i)
\[ \frac{2,168}{100} (1567) = 33.97 \]

ii)
Index = 84.92
Option Payoff = \( (10.08)(2168) = 218.53 \)
Lower income limit: \( 1,927 - 33.97 + 218.53 = 2,134 \)
Upper income limit: \( 2,462 - 33.97 = 2,428 \)
iii)

\[
\frac{2,168}{2,428 - 2,134} = 7.37
\]
Question 13

Primary Source: The Four Faces of an Interest Rate Model, Chap. 11, Investment Management for Insurers, Babbel and Fabozzi

1(a): The realistic, arbitrage-free term structure model proposed by the vendor is NOT appropriate for ALM and reserve adequacy work.

Such models are affected by confounding, where it is impossible to discriminate between model misspecification error and the term premia. As a result, such models are generally not of practical use.

1(b): Arbitrage-free models take certain market prices as given or input, and adjust model parameters in order to fit the prices exactly.

Equilibrium term structure models are truly models of the term structure process. Rather than interpolating among prices at one particular point in time, they attempt to capture the behaviors of the term structure over time.

Risk Neutral: The principle of risk neutral valuation asserts that, regardless of how risk averse investors are, we can identify a set of spot rates that values discount bonds correctly relative to the rest of the market by changing the probability distribution of the short term rates so that the expected rate of return on any security over the next instant is the same.

The important aspect of a risk neutral model is that the expected return on all securities is the risk-free rate, i.e., there is no extra expected return to compensate investors for the extra price risk in bonds of longer maturity.

Realistic: Realistic simulation generates scenarios that bear resemblance to observed changes in interest rates and risk premia in the real world.

Describe the four classes of interest rate modeling approaches:

1) Risk Neutral and Arbitrage-Free: This type of model is risk adjusted to use for pricing derivatives.

2) Risk Neutral and Equilibrium: Equilibrium models capture the global behavior of the term structure over time, so security-specific effects are treated in the appropriate way, as noise.

3) Realistic and Arbitrage-Free: Such a model starts by exactly matching the term structure of interest rates implied by a set of market prices on an initial date, then evolves that curve into the future according to the realistic probability measure.

4) Realistic and Equilibrium: In contrast, this type of model does not take observed market prices at a particular point in time as given, rather it uses a statistical approach to capture the behavior of the term structure over time.

Uses and limitations of the four classes of interest rate models:
1) Risk Neutral and Arbitrage-Free: It is appropriately used for current pricing when the set of market prices is complete and reliable. Useless for horizon pricing whereby future prices are unknown.
2) Risk Neutral and Equilibrium: For current pricing, such models can be estimated from historical data when current market prices are sparse. Can also be used for horizon pricing, since the horizon prices obtained under the different values of the state variables are available in an equilibrium model.

3) Realistic and Arbitrage-Free: However, such models are affected by confounding, where it is impossible to discriminate between model misspecification error and the term premia. As a result, such models are not of practical use.

4) Realistic and Equilibrium: Since the arbitrage-free form of a realistic model is not available, the equilibrium form must be used for stress testing, VAR calculations, reserve and asset adequacy testing, and other uses of realistic scenarios.
Question 14

a) Determine the position in S needed to hedge a long position in G.

\[ dS = 1S \ dt + 2S \ dz \]

\[ G = S^2 + S + 1 \]

By Ito’s lemma

\[
\frac{dG}{dS} \mu S + \frac{dG}{dt} + \frac{1}{2} \frac{d^2G}{dS^2} \sigma_S^2 \] \[ dt + \frac{dG \sigma_S dz}{dS} \]

\[ \mu = .1 \quad \tau = .2 \]

\[ \frac{dG}{dS} = 2S + 1 \quad \frac{dG}{dt} = 0 \quad \frac{d^2G}{dS^2} = 2 \]

\[ dG = \left( (2S+1)(1)S + \frac{1}{2} 2(21^2 S^2) dt + (2S+1)2Sdz \right) \]

Need a position in S, X, so the coefficient of dz is zero

\[ (2S + 1)2Sdz + x(2)Sdz = 0 \]

\[ x = -(2S + 1) \]

S=5

X=-11

Short 11 shares of S

a) Use of Ito’s Lemma

Determine the process that the hedge position would follow under each student’s formula.

\[ H(S) = 1 - S^2 \]
\[ dH_A = \left( \frac{dH}{dS} uS + \frac{dH}{dt} + \frac{1}{2} \frac{d^2 H}{dS^2} r^2 S^d \right) dt + rSdz \]

\[ u = .1 \quad \frac{dt}{ds} = -2S \quad \frac{d^2 H}{dS^2} = -2 \quad r = 2 \]

\[ dH_A = \left( -2S^2 + \frac{1}{2} (-2)(21^2)S^2 \right) dt + (-2S)(2)Sdz \]

\[ = (-24S^2)dt - 4S^2dz \]

b) \[ H(S) = S^2 - 105 + 1 \]

\[ \frac{dH}{dS} = 2S - 10 \quad \frac{d^2 H}{dS^2} = 2 \quad \frac{dH}{dt} = 0 \]

\[ dH_B = ((2S - 10)(1)S + \frac{1}{2} (2)(2) S^2 \frac{dt}{dS} + (2S - 10)(2)Sdz \]

\[ = (24 S^2 - S)dt + [4S^2 - 2S]dz \]

ii) Use Student As.

At S=5, the coefficient of dz is zero for student B and cannot offset the risk in G.
Question 15

Performance Measurement

A. Asset:

\[ R_a = R_f + OAS - DOAS \Delta OAS - \Delta D(i) + \frac{r}{c} + pa + E_a \]

- \( R_f \) = risk free rate
- OAS = option-adjusted spread, at the beginning of the period
- \( \Delta OAS \) = change in the OAS during the period
- DOAS = price sensitivity of the security (or asset) to the change in the OAS
- \( D(i) \) = ith key-rate duration
- \( r(i) \) = shift of the ith key-rate
- \( \frac{r}{c} \) = rich/cheap rate one period change the rich/cheap value
- \( p_a \) = portfolio adjustment = change in total return due to trading
- \( E_a \) = investment expenses

B. Liability:

\[ R_l = R_f + ROAS - \Delta D1(i) \Delta r(i) + E_l \]

- \( R_f \) = risk free rate
- ROAS = option-adjusted spread required by the liability's pricing
- \( D1(i) \) = ith key-rate duration MVL (or LV) price sensitivity, to the ith key-rate
- \( r(i) \) = shift of the ith key-rate
- \( E_l \) = insurance (or admin) expenses

C. Attribution:

Net profits = \( R_a - R_l \)

C1 Risk = credit risk = OAS - DOAS \( \Delta OAS \) = skill in sector rotation

C2 risk = pricing risk = -ROAS

C3 risk = duration management = interest rate risk = ALM risk

\[ = \sum (Da(i) - D1(i)) \Delta r(i) = \text{skill in interest-rate anticipation} \]
Intraweek changes = \frac{r}{c} + pa = skill in bond/security selection

Expense management = expense underrun = -(E_o - E_1)
Question 16

a)

i)

expected portion of no-default value lost through defaults

\[ h(0, T) = \frac{e^{-\gamma(T)^T} - e^{-\gamma(T)^T}}{E^{-\gamma(T)^T}} \]

\[ h(0.5) = \frac{e^{-\gamma(0.5)^5} - e^{-\gamma(0.5)^5}}{e^{-\gamma(0.5)^5}} \]

\[ y \times (5) = 0.055 \quad 100 e^{-\gamma(5)^5} = 70.47 \Rightarrow e^{-\gamma(5)^5} = 0.7047 \]

\[ h(0.5) = \frac{e^{-0.055 \times 5} - 0.7047}{e^{-0.055 \times 5}} = \frac{0.7586 - 0.7047}{0.7596} \]

= 0.07226 or 7.226%

ii)

\[ h(0, 10) = \frac{e^{-\gamma(10)^{10}} - e^{-\gamma(10)^{10}}}{e^{-\gamma(10)^{10}}} \]

\[ y \times (10) = 0.055 \quad 100 e^{\gamma(10)^{10}} = 48.675 \Rightarrow e^{\gamma(10)^{10}} = 0.48675 \]

\[ h(0, 10) = \frac{e^{-0.055 \times 10} - 0.48675}{e^{-0.055 \times 10}} \]

= \frac{0.57695 - 0.48675}{0.57695} \]

= 0.1563 or 15.634%

iii)

\[ h(T_1, T_2) = h(O, T_2) - h(O, T_1) \]

= \[ h(0, 10) - h(0, 5) \]

= 15.634% - 7.226%

= 8.408%

COURSE 8: Investment
November 2001
Morning Session
b)
i) default probability during first five years

\[
\frac{h(0.5)}{1 - \text{recovery rate}} = \frac{0.07226}{1 - 0.4} = 0.12043 \text{ or } 12.043\%
\]

= 4 times historical default rate

Historical default rate for 1st 5 years = 3%

ii) default probability 1st 10 years = \( \frac{0.1563}{1 - 0.4} \)

= 0.14013 or 14.013%

= 1.4 times historical default rate

historical default rate \(-1.5 \& 10 = 13\% - 3\% = 10\%

iii)

default prob. Between 5 \& 10 years = \( \frac{0.08408}{1 - 0.4} \)

= 0.14013 or 14.013%

= 1.4 times historical default rate

historical default rate \(-5 \& 10 = 13\% - 3\% = 10\%

COURSE 8: Investment
November 2001
Morning Session
c) Reasons for discrepancies
- traders may be pricing in possibility of recession or depression
- part of higher return may be compensation for lower liquidity

Specific Uses
- risk-neutral (based on bond prices)
- used to value credit derivatives
- estimate impact of default risk on the pricing of derivatives
- real-world (historical)
- used when carry out scenario analysis to calculate future losses from defaults

d) i)

5 year
Total Excess Return = (0.12043-0.03)x (1-0.4)

= 0.05426

Annual Excess Return = \frac{5.426\%}{5} = 1.085\%

ii) 10 year
Total Excess Return = (26.057\%-13\%)x(1-0.4)

= 7.8342\%

Annual Excess Return = \frac{7.8342\%}{10} = 0.7834\%
Question 17

Fair Value Accounting

OPM: direct method

\[ MVL = \Sigma (L_t + E_t) / (1 + r + s)^t \]

Discount liability and expense cash flows at the risk free rate plus a spread

AAM: indirect method

\[ DDE = \Sigma DE_t / (1 + k)^t \]

Discount distributable earnings at the cost of capital

\[ MVL = MVA^* - DDE \] where MVA* means all assets, not just product assets

Market value of liabilities is the market value of assets less DDE

\[ DE_t = I_t - \Delta RS_{t-1} \]

Distributable earnings equal statutory earnings less the change in required surplus

Equivalence of AAM and OPM: when a consistent discount rate is used

When \( \theta^f_t = \theta^A_t - (RP_t / MVL_{t-1}) \) is the required profit margin and \( \theta^f_t \) is the real spread above the risk free rate for discounting liability cash flows

Necessary assumptions include:

Statutory accounting
Taxes
Risk based capital
Investment strategy
Question 18

a)
i) point-to point with a 2-year Asian end

\[ AV_2 = 100,000 \times \left( 1 + \frac{(150 + 140)}{2} \times \frac{2}{100} \times 80\% \right) \]

= $136,000

ii) Annual discrete lookback

\[ AV_5 = 100,000 \times \left( 1 + \frac{150}{100} - 1 \times 50\% \right) \]

= 125,000

iii) Annual discrete lookforward

\[ AV_6 = 100,000 \times \left( 1 + \frac{140}{100} \times 60\% \right) \]

= 124,000

iv) Annual simple ratchet (assume minimum = 0)

\[ AV_7 = 100,000 \times \left( 1 + \max \left( \frac{130}{100} - 1, 12 \right) \right) + \min \left( \frac{110}{130} - 1, 0 \right) \]

\[ + \left[ \max \left( \frac{120}{110} - 1, 12 \right) + \left[ \max \left( \frac{150}{120} - 1, 12 \right) \right] \right] \]
\[ + \left[ \min \left( \frac{140}{150} - 1 \right), 0 \right] \]

\[ = 100,000 \left[ 1 + 0.12 + 0.0909 + 0.12 + 0 \right] = 133,090 \]

a) Point-to-Point Ladder Design

Since 125 level was not reached at year 3,

\[ AV_3 = 100,000 \times \left\{ 1 + \left[ \frac{140}{100} - 1 \right] \times 90\% \right\} \]

\[ = 136,000 \]

b) Advantages of deterministic scenario testing
   Ease of interpretation of results
   Can incorporate subjective opinion
   Extreme case can be included
   Similar to the method used in cashflow testing

Disadvantages of deterministic scenario testing:
   Difficult to create a large number of scenarios
   Difficult to allocate probability to each scenario
   Difficult to reflect the full range of variability
   Difficult to create scenarios where the economic variables are consistent
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COURSE 8 - INVESTMENTS
CASE STUDY

LifeCo

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Keith Drzal
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, 2000:

- 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%
- 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** 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 putable 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.

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

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 incurring, 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 incurring. 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 million of assets.

**Surplus Account** contains the 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 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 $1 billion of variable annuities, and $ billion for variable.

<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>1</td>
<td>80.00%</td>
<td>0.00%</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>80.00%</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>45.00%</td>
<td>1</td>
<td>0.00%</td>
<td>70.00%</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>1</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></td>
<td>Fund Value</td>
<td>Delta</td>
</tr>
<tr>
<td>Equity</td>
<td>18.2</td>
<td>1,042</td>
</tr>
<tr>
<td>Bond</td>
<td>13.1</td>
<td>294</td>
</tr>
<tr>
<td>Mortgage</td>
<td>11.1</td>
<td>37</td>
</tr>
<tr>
<td>Asian</td>
<td>9.5</td>
<td>49</td>
</tr>
<tr>
<td>Global Equity</td>
<td>14.8</td>
<td>343</td>
</tr>
<tr>
<td>Money Market</td>
<td>10</td>
<td>123</td>
</tr>
<tr>
<td>Balanced</td>
<td>15.2</td>
<td>564</td>
</tr>
</tbody>
</table>

Total 2,452 1,122

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

<table>
<thead>
<tr>
<th>Reported Book Value</th>
<th>DAC</th>
<th>Net Book PV of Cash-Value Flows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable Annuities</td>
<td>2459</td>
<td>(74) 2,385 2,360</td>
</tr>
<tr>
<td>Variable UL</td>
<td>1122</td>
<td>(28) 1,094 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>Asset Type</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>Asset Type</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>Asset Type</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>Asset Type</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>
</tr>
<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>
<td>7.5</td>
<td>105.8</td>
</tr>
<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>
</tr>
<tr>
<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>
</tr>
<tr>
<td>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>A7   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>A8   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>A9   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>
</tr>
</tbody>
</table>

### Liabilities

<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>
</tr>
<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>
</tr>
<tr>
<td>C    PreTax Equity</td>
<td>188.0</td>
<td></td>
<td>237.1</td>
<td>(38.62)</td>
<td></td>
</tr>
<tr>
<td>D    Tax and Other Adjustments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1   Future tax payments</td>
<td>65.8</td>
<td></td>
<td>83.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2   Other adjustments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D    Subtotal, tax and other adjustments</td>
<td>65.8</td>
<td>83.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

#### 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>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>
</tr>
<tr>
<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>
</tr>
<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>
</tr>
<tr>
<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>
</tr>
<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>A1</td>
<td>Bonds Subtotal</td>
<td>28.4</td>
<td>8.74%</td>
<td>37.4</td>
<td>3.87</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>
</tr>
<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>
</tr>
<tr>
<td></td>
<td>Invested Assets Subtotal</td>
<td>188.0</td>
<td>4.96%</td>
<td>196.6</td>
<td>9.45</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>A11 Total Assets</td>
<td>188.0</td>
<td>4.96%</td>
<td>234.0</td>
<td>9.45</td>
<td>38.9</td>
</tr>
</tbody>
</table>

#### 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>B1 Benefit liabilities</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>B Total Liabilities</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.00</td>
</tr>
</tbody>
</table>

#### C PreTax Equity

- 188.0

#### Tax and Other Adjustments

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>D1 Future tax payments</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>D2 Other adjustments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>D Total, tax and other adjustments</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td>0.00</td>
</tr>
</tbody>
</table>

**Net Value (C-D)**

- 188.0
### Individual Life & Annuity - 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>Bonds (total)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1a 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>A1b 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>A1c 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>A1d 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>
</tr>
<tr>
<td>A1e 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>
</tr>
<tr>
<td>A1f 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>A1g CMO's</td>
<td>7.1</td>
<td>7.10%</td>
<td>7.52</td>
<td>6.5</td>
<td>0.21</td>
</tr>
<tr>
<td>A1 Total</td>
<td>129.0</td>
<td>7.01%</td>
<td>135.74</td>
<td>19.0</td>
<td>3.53</td>
</tr>
<tr>
<td>Bonds Subtotal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2 Cash &amp; short term</td>
<td>6.0</td>
<td>4.75%</td>
<td>6.0</td>
<td>0.1</td>
<td>0.02</td>
</tr>
<tr>
<td>A3 Commercial Mortgages</td>
<td>39.0</td>
<td>8.00%</td>
<td>41.93</td>
<td>5.0</td>
<td>1.95</td>
</tr>
<tr>
<td>A4 Derivative securities</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.0</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>A5 Equities</td>
<td>75.0</td>
<td>1.00%</td>
<td>75.0</td>
<td>28.0</td>
<td>15.0</td>
</tr>
<tr>
<td>A6 Real Estate (unleveraged)</td>
<td>21.0</td>
<td>10.50%</td>
<td>21.0</td>
<td>10.0</td>
<td>3.15</td>
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<tr>
<td>Invested Assets Subtotal</td>
<td>270.0</td>
<td>5.71%</td>
<td>279.7</td>
<td>18.4</td>
<td>23.6</td>
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<tr>
<td>A7 Accrued investment income</td>
<td>3.0</td>
<td>0.00%</td>
<td>3.0</td>
<td>0.0</td>
<td>0.00</td>
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<tr>
<td>A8 Policyholder Loans</td>
<td>22.5</td>
<td>7.00%</td>
<td>22.5</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>0.0</td>
<td>0.0</td>
<td>0.00</td>
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<tr>
<td>A10 Other</td>
<td>4.5</td>
<td>0.00%</td>
<td>4.5</td>
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<td>0.00</td>
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<tr>
<td>A11 Total Assets</td>
<td>300.0</td>
<td>5.66%</td>
<td>309.7</td>
<td>16.6</td>
<td>26.8</td>
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### Liabilities

<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>
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<tbody>
<tr>
<td>B1 Benefit liabilities</td>
<td>300.0</td>
<td>6.10%</td>
<td>318.0</td>
<td>31.9</td>
<td>2.00</td>
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<tr>
<td>B Total Liabilities</td>
<td>300.0</td>
<td>6.10%</td>
<td>318.0</td>
<td>31.9</td>
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<tr>
<td>C PreTax Equity</td>
<td>0.0</td>
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<td>-8.3</td>
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### Tax and Other Adjustments

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<tr>
<td>D1 Future tax payments</td>
<td>0.0</td>
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<td>-2.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2 Other adjustments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D Subtotal, tax and other adjustments</td>
<td>0.0</td>
<td></td>
<td>-2.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Net Value (C-D)

| Net Value (C-D)                              | 0.0            |              | -5.4          |                   |             |
### Individual Life & Annuity - Non Traditional Life

#### 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>13.8</td>
<td>6.20%</td>
<td>13.75</td>
<td>12.8</td>
<td>0.07</td>
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<tr>
<td>A1b Public Corporate (Inv. Grade)</td>
<td>110.0</td>
<td>7.00%</td>
<td>114.95</td>
<td>27.9</td>
<td>1.65</td>
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<tr>
<td>A1c Public Corporate (below Inv Grade)</td>
<td>27.5</td>
<td>7.50%</td>
<td>29.01</td>
<td>13.1</td>
<td>1.38</td>
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<tr>
<td>A1d Private Corporate (Inv Grade)</td>
<td>60.5</td>
<td>7.10%</td>
<td>63.83</td>
<td>18.2</td>
<td>1.21</td>
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<tr>
<td>A1e Private Corporate (below Inv Grade)</td>
<td>33.0</td>
<td>7.60%</td>
<td>34.82</td>
<td>9.1</td>
<td>2.31</td>
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<tr>
<td>A1f Pass-throughs</td>
<td>15.1</td>
<td>7.00%</td>
<td>15.88</td>
<td>5.6</td>
<td>0.45</td>
</tr>
<tr>
<td>A1g CMO's</td>
<td>15.1</td>
<td>7.30%</td>
<td>16.03</td>
<td>6.5</td>
<td>0.45</td>
</tr>
<tr>
<td>A1 Bonds Subtotal</td>
<td>275.0</td>
<td>7.12%</td>
<td>288.27</td>
<td>19.8</td>
<td>7.52</td>
</tr>
<tr>
<td>A2 Cash &amp; short term</td>
<td>8.0</td>
<td>4.75%</td>
<td>8.00</td>
<td>0.1</td>
<td>0.02</td>
</tr>
<tr>
<td>A3 Commercial Mortgages</td>
<td>44.0</td>
<td>8.00%</td>
<td>47.30</td>
<td>5.0</td>
<td>2.20</td>
</tr>
<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>
</tr>
<tr>
<td>A5 Equities</td>
<td>5.0</td>
<td>1.00%</td>
<td>5.00</td>
<td>28.0</td>
<td>1.00</td>
</tr>
<tr>
<td>A6 Real Estate (unleveraged)</td>
<td>28.0</td>
<td>10.50%</td>
<td>28.00</td>
<td>10.0</td>
<td>4.20</td>
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<tr>
<td>Invested Assets Subtotal</td>
<td>360.0</td>
<td>7.35%</td>
<td>376.6</td>
<td>16.9</td>
<td>14.9</td>
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<tr>
<td>A7 Accrued investment income</td>
<td>4.0</td>
<td>0.00%</td>
<td>4.00</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>A8 Policyholder Loans</td>
<td>30.0</td>
<td>7.30%</td>
<td>30.00</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>
</tr>
<tr>
<td>A10 Other</td>
<td>6.0</td>
<td>0.00%</td>
<td>6.00</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>A11 Total Assets</td>
<td>400.0</td>
<td>7.17%</td>
<td>416.6</td>
<td>15.2</td>
<td>19.1</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>B1 Benefit liabilities</td>
<td>400.0</td>
<td>6.30%</td>
<td>406.00</td>
<td>40.2</td>
<td>4.00</td>
</tr>
<tr>
<td>B Total Liabilities</td>
<td>400.0</td>
<td>6.30%</td>
<td>406.0</td>
<td>40.2</td>
<td>4.0</td>
</tr>
</tbody>
</table>

|                |                  |              |              |                   |             |
| C PreTax Equity | 0.0              |              | 10.6         | (943.69)           |             |

#### Tax and Other Adjustments

|                |                  |              |              |                   |             |
| D1 Future tax payments | 0.0              |              | 3.7          |                   |             |
| D2 Other adjustments  |                  |              |              |                   |             |
| D Subtotal, tax and other adjustments | 0.0              |              | 3.7          |                   |             |

**Net Value (C-D)**

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.0</td>
<td></td>
<td>6.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## 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>
</tr>
<tr>
<td>A1b Public Corporate (Inv. Grade)</td>
<td>469.5</td>
<td>7.00%</td>
<td>481.24</td>
<td>4.9</td>
<td>7.04</td>
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<td>A1c Public Corporate (below Inv Grade)</td>
<td>117.4</td>
<td>7.50%</td>
<td>120.90</td>
<td>5.6</td>
<td>5.87</td>
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<tr>
<td>A1d Private Corporate (Inv Grade)</td>
<td>256.2</td>
<td>7.10%</td>
<td>267.26</td>
<td>5.3</td>
<td>5.16</td>
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<tr>
<td>A1e Private Corporate (below Inv Grade)</td>
<td>140.9</td>
<td>7.60%</td>
<td>148.60</td>
<td>5.0</td>
<td>9.86</td>
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<tr>
<td>A1f Pass-throughs</td>
<td>64.6</td>
<td>7.00%</td>
<td>67.14</td>
<td>4.6</td>
<td>1.94</td>
</tr>
<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>
</tr>
<tr>
<td><strong>A1 Bonds Subtotal</strong></td>
<td><strong>1173.8</strong></td>
<td><strong>7.11%</strong></td>
<td><strong>1211.28</strong></td>
<td><strong>5.2</strong></td>
<td><strong>32.10</strong></td>
</tr>
<tr>
<td><strong>A2 Cash &amp; short term</strong></td>
<td><strong>30.0</strong></td>
<td><strong>4.75%</strong></td>
<td><strong>30.00</strong></td>
<td><strong>0.1</strong></td>
<td><strong>0.09</strong></td>
</tr>
<tr>
<td><strong>A3 Commercial Mortgages</strong></td>
<td><strong>135.0</strong></td>
<td><strong>8.00%</strong></td>
<td><strong>143.10</strong></td>
<td><strong>4.3</strong></td>
<td><strong>6.75</strong></td>
</tr>
<tr>
<td><strong>A4 Derivative securities</strong></td>
<td><strong>0.0</strong></td>
<td><strong>0.00%</strong></td>
<td><strong>0.00</strong></td>
<td><strong>0.0</strong></td>
<td><strong>0.00</strong></td>
</tr>
<tr>
<td><strong>A5 Equities</strong></td>
<td><strong>18.8</strong></td>
<td><strong>1.00%</strong></td>
<td><strong>18.75</strong></td>
<td><strong>20.0</strong></td>
<td><strong>3.75</strong></td>
</tr>
<tr>
<td><strong>A6 Real Estate (unleveraged)</strong></td>
<td><strong>105.0</strong></td>
<td><strong>10.50%</strong></td>
<td><strong>105.00</strong></td>
<td><strong>8.0</strong></td>
<td><strong>15.75</strong></td>
</tr>
<tr>
<td><strong>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><strong>A7 Accrued investment income</strong></td>
<td><strong>15.0</strong></td>
<td><strong>0.00%</strong></td>
<td><strong>15.00</strong></td>
<td><strong>0.0</strong></td>
<td><strong>0.00</strong></td>
</tr>
<tr>
<td><strong>A8 Policyholder Loans</strong></td>
<td><strong>0.0</strong></td>
<td><strong>0.00%</strong></td>
<td><strong>0.00</strong></td>
<td><strong>0.0</strong></td>
<td><strong>0.00</strong></td>
</tr>
<tr>
<td><strong>A9 Provision for asset default</strong></td>
<td><strong>0.0</strong></td>
<td><strong>0.00%</strong></td>
<td><strong>0.00</strong></td>
<td><strong>0.0</strong></td>
<td><strong>0.00</strong></td>
</tr>
<tr>
<td><strong>A10 Other</strong></td>
<td><strong>22.5</strong></td>
<td><strong>0.00%</strong></td>
<td><strong>22.50</strong></td>
<td><strong>0.0</strong></td>
<td><strong>0.00</strong></td>
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<tr>
<td><strong>A11 Total Assets</strong></td>
<td><strong>1500.0</strong></td>
<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>
<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>B1 Benefit liabilities</td>
<td>1500.0</td>
<td>5.90%</td>
<td>1575.00</td>
<td>5.3</td>
<td>15.00</td>
</tr>
<tr>
<td><strong>B Total Liabilities</strong></td>
<td><strong>1500.0</strong></td>
<td><strong>5.90%</strong></td>
<td><strong>1575.0</strong></td>
<td><strong>5.3</strong></td>
<td><strong>15.0</strong></td>
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### C PreTax Equity

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<tbody>
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<td></td>
<td><strong>-29.4</strong></td>
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### Tax and Other Adjustments

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</thead>
<tbody>
<tr>
<td>D1 Future tax payments</td>
<td><strong>0.0</strong></td>
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<td><strong>-10.3</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2 Other adjustments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>D Subtotal, tax and other adjustments</strong></td>
<td><strong>0.0</strong></td>
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<td><strong>-10.3</strong></td>
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### Net Value (C-D)

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

#### Assets

<table>
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<tr>
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<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>A1a</td>
<td>Gov't</td>
<td>16.9</td>
<td>6.40%</td>
<td>17.26</td>
<td>10.4</td>
</tr>
<tr>
<td>A1b</td>
<td>Public Corporate (Inv. Grade)</td>
<td>135.4</td>
<td>7.20%</td>
<td>144.20</td>
<td>9.2</td>
</tr>
<tr>
<td>A1c</td>
<td>Public Corporate (below Inv Grade)</td>
<td>33.9</td>
<td>7.60%</td>
<td>36.56</td>
<td>8.3</td>
</tr>
<tr>
<td>A1d</td>
<td>Private Corporate (Inv Grade)</td>
<td>74.5</td>
<td>7.40%</td>
<td>80.06</td>
<td>8.0</td>
</tr>
<tr>
<td>A1e</td>
<td>Private Corporate (below Inv Grade)</td>
<td>40.6</td>
<td>7.90%</td>
<td>44.28</td>
<td>7.2</td>
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<tr>
<td>A1f</td>
<td>Pass-throughs</td>
<td>18.6</td>
<td>7.10%</td>
<td>19.55</td>
<td>6.5</td>
</tr>
<tr>
<td>A1g</td>
<td>CMO's</td>
<td>18.6</td>
<td>7.30%</td>
<td>19.83</td>
<td>7.5</td>
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<tr>
<td>A1</td>
<td>Bonds Subtotal</td>
<td>338.5</td>
<td>7.33%</td>
<td>361.73</td>
<td>9.0</td>
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<tr>
<td>A2</td>
<td>Cash &amp; short term</td>
<td>14.0</td>
<td>4.75%</td>
<td>14.00</td>
<td>0.1</td>
</tr>
<tr>
<td>A3</td>
<td>Commercial Mortgages</td>
<td>286.0</td>
<td>8.75%</td>
<td>308.88</td>
<td>6.0</td>
</tr>
<tr>
<td>A4</td>
<td>Derivative securities</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.0</td>
</tr>
<tr>
<td>A5</td>
<td>Equities</td>
<td>44.0</td>
<td>1.00%</td>
<td>44.00</td>
<td>28.0</td>
</tr>
<tr>
<td>A6</td>
<td>Real Estate (unleveraged)</td>
<td>0.0</td>
<td>10.50%</td>
<td>0.00</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>Invested Assets Subtotal</td>
<td>682.5</td>
<td>7.46%</td>
<td>728.60</td>
<td>9.0</td>
</tr>
<tr>
<td>A7</td>
<td>Accrued investment income</td>
<td>7.0</td>
<td>0.00%</td>
<td>7.00</td>
<td>0.0</td>
</tr>
<tr>
<td>A8</td>
<td>Policyholder Loans</td>
<td>0.0</td>
<td>7.00%</td>
<td>0.00</td>
<td>0.1</td>
</tr>
<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>
<td>10.5</td>
<td>0.00%</td>
<td>10.50</td>
<td>0.0</td>
</tr>
<tr>
<td>A11</td>
<td>Total Assets</td>
<td>700.0</td>
<td>7.28%</td>
<td>746.10</td>
<td>8.8</td>
</tr>
</tbody>
</table>

#### 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>B1</td>
<td>Benefit liabilities</td>
<td>700.0</td>
<td>6.75%</td>
<td>759.50</td>
<td>9.5</td>
</tr>
<tr>
<td>B</td>
<td>Total Liabilities</td>
<td>700.0</td>
<td>6.75%</td>
<td>759.50</td>
<td>9.5</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 |
### 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>71.6</td>
<td>5.60%</td>
<td>71.63</td>
<td>2.5</td>
<td>0.36</td>
</tr>
<tr>
<td>A1b Public Corporate (Inv. Grade)</td>
<td>573.0</td>
<td>6.40%</td>
<td>584.46</td>
<td>2.8</td>
<td>8.60</td>
</tr>
<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>
</tr>
<tr>
<td>A1d Private Corporate (Inv Grade)</td>
<td>315.2</td>
<td>6.80%</td>
<td>329.33</td>
<td>4.3</td>
<td>6.30</td>
</tr>
<tr>
<td>A1e Private Corporate (below Inv Grade)</td>
<td>171.9</td>
<td>7.30%</td>
<td>181.35</td>
<td>4.0</td>
<td>12.03</td>
</tr>
<tr>
<td>A1f Pass-throughs</td>
<td>78.8</td>
<td>6.80%</td>
<td>83.51</td>
<td>5</td>
<td>2.36</td>
</tr>
<tr>
<td>A1g CMO's</td>
<td>78.8</td>
<td>5.80%</td>
<td>79.58</td>
<td>1.3</td>
<td>2.36</td>
</tr>
<tr>
<td>A1 Bonds Subtotal</td>
<td>1432.5</td>
<td>6.58%</td>
<td>1476.69</td>
<td>3.4</td>
<td>39.18</td>
</tr>
<tr>
<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>
</tr>
<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>
</tr>
<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>
</tr>
<tr>
<td>A6 Real Estate (unleveraged)</td>
<td>0.0</td>
<td>10.50%</td>
<td>0.00</td>
<td>10.0</td>
<td>0.00</td>
</tr>
<tr>
<td>Invested Assets Subtotal</td>
<td>1462.5</td>
<td>6.54%</td>
<td>1506.7</td>
<td>3.4</td>
<td>39.3</td>
</tr>
<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>
</tr>
<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>
</tr>
<tr>
<td>A10 Other</td>
<td>22.5</td>
<td>0.00%</td>
<td>22.50</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>A11 Total Assets</td>
<td>1500.0</td>
<td>6.38%</td>
<td>1544.2</td>
<td>3.3</td>
<td>39.3</td>
</tr>
</tbody>
</table>

### 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>B1 Benefit liabilities</td>
<td>1500.0</td>
<td>6.60%</td>
<td>1537.50</td>
<td>3.1</td>
<td>7.50</td>
</tr>
<tr>
<td>B Total Liabilities</td>
<td>1500.0</td>
<td>6.60%</td>
<td>1537.5</td>
<td>3.1</td>
<td>7.5</td>
</tr>
<tr>
<td>C PreTax Equity</td>
<td>0.0</td>
<td></td>
<td>6.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Tax and Other Adjustments

<table>
<thead>
<tr>
<th></th>
<th>Reported Book Value</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>0.0</td>
<td>2.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2 Other adjustments</td>
<td>0.0</td>
<td>2.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D Subtotal, tax and other adjustments</td>
<td>0.0</td>
<td>2.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Net Value (C-D)

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Value (C-D)</td>
<td>0.0</td>
<td>4.4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Group Business

<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><strong>Bonds (total)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<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>
</tr>
<tr>
<td>A1b  Public Corporate (Inv. Grade)</td>
<td>225.0</td>
<td>6.70%</td>
<td>237.38</td>
<td>20.9</td>
<td>3.38</td>
</tr>
<tr>
<td>A1c  Public Corporate (below Inv Grade)</td>
<td>60.0</td>
<td>7.20%</td>
<td>63.30</td>
<td>7.0</td>
<td>3.00</td>
</tr>
<tr>
<td>A1d  Private Corporate (Inv Grade)</td>
<td>50.0</td>
<td>6.80%</td>
<td>52.75</td>
<td>11.9</td>
<td>1.00</td>
</tr>
<tr>
<td>A1e  Private Corporate (below Inv Grade)</td>
<td>25.0</td>
<td>7.30%</td>
<td>26.38</td>
<td>7.5</td>
<td>1.75</td>
</tr>
<tr>
<td>A1f  Pass-throughs</td>
<td>90.0</td>
<td>6.80%</td>
<td>94.50</td>
<td>3.9</td>
<td>2.70</td>
</tr>
<tr>
<td>A1g  CMO's</td>
<td>35.0</td>
<td>6.70%</td>
<td>37.10</td>
<td>5.8</td>
<td>1.05</td>
</tr>
<tr>
<td><strong>A1 Bonds Subtotal</strong></td>
<td>520.0</td>
<td>6.77%</td>
<td>546.40</td>
<td>13.7</td>
<td>13.05</td>
</tr>
<tr>
<td><strong>A2 Cash &amp; short term</strong></td>
<td>15.0</td>
<td>4.75%</td>
<td>15.00</td>
<td>0.1</td>
<td>0.05</td>
</tr>
<tr>
<td><strong>A3 Commercial Mortgages</strong></td>
<td>50.0</td>
<td>8.00%</td>
<td>53.75</td>
<td>5.0</td>
<td>2.50</td>
</tr>
<tr>
<td><strong>A4 Derivative securities</strong></td>
<td>0.0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>A5 Equities</strong></td>
<td>5.0</td>
<td>1.00%</td>
<td>5.00</td>
<td>28.0</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>A6 Real Estate (unleveraged)</strong></td>
<td>25.0</td>
<td>10.50%</td>
<td>25.00</td>
<td>10.0</td>
<td>3.75</td>
</tr>
<tr>
<td><strong>Invested Assets Subtotal</strong></td>
<td>615.0</td>
<td>6.92%</td>
<td>645.2</td>
<td>12.7</td>
<td>20.3</td>
</tr>
<tr>
<td><strong>A7 Accrued investment income</strong></td>
<td>6.3</td>
<td>0.00%</td>
<td>6.31</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>A8 Policyholder Loans</strong></td>
<td>0.0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.1</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>A9 Provision for asset default</strong></td>
<td>0.0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>A10 Other</strong></td>
<td>9.5</td>
<td>0.00%</td>
<td>9.46</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>A11 Total Assets</strong></td>
<td>630.8</td>
<td>6.75%</td>
<td>660.9</td>
<td>12.3</td>
<td>24.1</td>
</tr>
</tbody>
</table>

## Liabilities

<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><strong>B1 Benefit liabilities</strong></td>
<td>630.8</td>
<td>5.90%</td>
<td>624.00</td>
<td>7.0</td>
<td>125.00</td>
</tr>
<tr>
<td><strong>B Total Liabilities</strong></td>
<td>630.8</td>
<td>5.90%</td>
<td>624.0</td>
<td>7.0</td>
<td>125.0</td>
</tr>
</tbody>
</table>

## PreTax Equity

| C   PreTax Equity                         | 30.8                | 36.9         |

## Tax and Other Adjustments

| D1  Future tax payments                   | 10.8                | 12.9         |
| D2  Other adjustments                     |                     |              |
| **D Subtotal, tax and other adjustments** | 10.8                | 12.9         |

## Net Value (C-D)

| Net Value (C-D)                           | 20.0                | 24.0         |

15
APPENDIX B

ASSET LIABILITY MANAGEMENT
POLICY STATEMENT

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

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
< 0.50% x book value of assets

(b) Variable Annuities

Delta of liability less delta of assets
<10% of delta of liability

Gamma
Unhedged

Vega
Unhedged

Rho
<5% of rho of liability
(Rho of less rho of assets)

(c) 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

(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 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 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
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
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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 I 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 a minimum of 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 & Poor’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,

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

![Risk Free (Government) Spot Rate Curve]

**Summary of ALM Position**

At December 31, 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>
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<tr>
<td><strong>TRADITIONAL LIFE PRODUCTS</strong></td>
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<tr>
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<td><strong>ACCUMULATION ANNUITIES</strong></td>
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<tr>
<td>Assets</td>
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<tr>
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<tr>
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<td><strong>GROUP BENEFITS</strong></td>
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<td></td>
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<tr>
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<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
**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.

![Graph showing key rate sensitivity](image)

**Scenario Testing**

**Worst Case Scenario**
The worst case scenario that was tested was a increase followed by a decrease in interest rates. If this scenario were realized, it would result in a loss of $7.6 million in economic surplus.

![Graph showing maximum decline in economic surplus](image)

**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 matches 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, assets and liabilities, net cash flows are projected to be an average of $1.3 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 $10.3 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 25.0 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.

<table>
<thead>
<tr>
<th>Term -Years</th>
<th>Changes in Net Position ('000) per .01% Increase in Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
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<tr>
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<tr>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>

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.

Maximum Decline in Economic Surplus ('000)

| Mar-00       | 3,964          |
| Jun-00       | 4,320          |
| Sep-00       | 4,505          |
| Dec-00       | 5,247          |

Cash Flow Analysis

Cumulative Net Cash Flow
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.

<table>
<thead>
<tr>
<th>Key Rate Sensitivity</th>
<th>Changes in Net Position ('000) per .01% Increase in Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term - Years</td>
<td>5 0.1 0.9 0.3 0.7 0.9 1.1 1.6 2.6 1.9 2.6</td>
</tr>
<tr>
<td>1 2 3 4 5 7 10 15 20 25</td>
<td></td>
</tr>
</tbody>
</table>

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

Asset/Liability Cash Flows by Month ('000)