Ninth Annual Bruins Actuarial Society Case Competition

Christopher Nie, Jiayu Wang,
Alycia Liem, Agustin Wong
Agenda

- Enterprise Perspective
- Product Line Risks
- Data Quality
- Sensitivity Expectations
- Sensitivity Results
- Methodology for Bond Summary
- 0% Shock on SPIA Asset Portfolio
- Factors to Consider
- Appropriateness of Portfolio
- Appendix
Enterprise Perspective

● Liability and Asset Sensitivity Analysis

● Impact of Different Interest Rates on
  ○ Asset-liability mismatch
  ○ Obligation to policies
  ○ Product
Product Line Risks

**Term Life**
- **Least Risk**
  - Risk of policyholders not paying premium
  - Few assets backing liability reserves

**IUL**
- **Less Risk**
  - Long term growth of index
  - Equity liability

**SPIA**
- **Less Risk**
  - Dynamic hedging
  - Adverse selection

**Variable Annuity**
- **More Risk**
  - Unreliable hedging
  - Exotics availability
  - Greeks accuracy
  - RBC requirement changes
Data Quality

ASOP No 23 3.1

- “...Identify data values that are questionable or relationships that are significantly inconsistent.”

Minor Issues

- Data Entry Errors in “Issue Year” = 17
  - Changed to 2017
- “Pol_Sts” = NA
  - Changed to AC
- “Birth_Yr” = 2055
  - Changed to 1955
- “Iss_Age” = 0
  - Calculated new Issue Age from birthdate

Normal Data

- No issues identified with month/day of issue & sex

Relationships in Data

- Modal Benefit $\alpha \frac{1}{\text{Mode}}$
- Modal Benefit $\alpha \text{Single Premium}$
Data Quality

Inconsistent yearly payment

- Yearly payment = Modal • Modal Benefit
- Yearly payment amounts far outpacing single premium
- SPIA00323:
  
  Single Premium = $122,400
  Mode = 12 • Modal Benefit = $8,604 = $103,248

Outliers affect SPIA PV of Benefits

- Revised numbers where possible to infer
## Sensitivity Expectations

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Expectation on PV Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Best Estimate</td>
<td><em>N/A (Base line)</em></td>
</tr>
<tr>
<td>Base Mortality Shock</td>
<td>Present Value</td>
</tr>
<tr>
<td>Mortality Improvement Shock</td>
<td>Present Value</td>
</tr>
<tr>
<td>1% Interest Rate Increase</td>
<td>Present Value</td>
</tr>
<tr>
<td>1% Interest Rate Decrease</td>
<td>Present Value</td>
</tr>
<tr>
<td>Discount Rate: 0%</td>
<td>Present Value</td>
</tr>
</tbody>
</table>

---

1/10/2021

Annual Review

7
Sensitivity Results

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Best Est</th>
<th>Mort Shock</th>
<th>MI Shock</th>
<th>Rates Up</th>
<th>Rates Down</th>
<th>Rates 0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/31/2020</td>
<td>$333,748,917</td>
<td>$344,104,431</td>
<td>$335,459,402</td>
<td>$300,541,726</td>
<td>$373,365,795</td>
<td>$400,874,084</td>
</tr>
</tbody>
</table>
Methodology & Implications

Accounting for Convexity

- Duration assumes interest rates and bonds have linear relationship
- Convexity allows for other factors and accounts for non-linearity changes
- Assuming yield is equal to coupon rate

\[ Convexity = \frac{P_i + P_d - P_0}{2 \cdot P_0 \cdot (\Delta Y)^2} \]

\[ Change \ in \ Bond \ Price = -D \cdot \Delta Y \cdot \frac{(\Delta Y)^2}{2} \cdot Convexity \]

\[ \begin{align*}
P_0 & = \text{bond price} \\
P_i & = \text{bond price after increase in interest rate} \\
P_d & = \text{bond price after decrease in interest rate} \\
\Delta Y & = \text{change in interest rate} \\
D & = \text{duration} \]

Implications for a decreasing interest rate environment

- Bond prices increase as yield decrease, thus portfolio value increases
- Gains not realized unless portfolio was sold. Benefits of selling would be offset by lower yields
- Proceeds reinvested at potential lower interest rate results in reinvestment risk
0% Shock on Bond Portfolios

Yield Rate vs Portfolio Prices

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>Current</th>
<th>Alt 1</th>
<th>Alt 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Interest</td>
<td>2.10%</td>
<td>2.25%</td>
<td>1.80%</td>
</tr>
<tr>
<td>Up 1%</td>
<td>$309M</td>
<td>$313M</td>
<td>$318M</td>
</tr>
<tr>
<td>Down 1%</td>
<td>$379M</td>
<td>$374M</td>
<td>$369M</td>
</tr>
<tr>
<td>0% shock</td>
<td>$417M</td>
<td>$412M</td>
<td>$390M</td>
</tr>
</tbody>
</table>

The diagram shows the relationship between yield rates and portfolio prices for different scenarios. The table provides the value of the portfolio under various interest rate changes.
Sensitivity Factors affecting Portfolio PV

- Exact Cash Flows & Individual Yields
- Default risk
- Embedded Options
  - Callable
  - Convertible
- Inflation Risk
- Market Interest Rates
Appropriateness of Portfolios

Current Portfolio
21% 5-year AA, 38% 10-year A, and 41% 20-year A
Pro: Hedging potential risks; Value increases when interest rate decreases
Con: Most sensitive; Inability to cover liabilities when rate increases

Alternative 1
30% 5-year A, 50% 10-year BBB, and 20% 20-year BBB
Pro: Less sensitive; A balance between current and Alt 2
Con: Inability to cover liabilities when rate increases.

Alternative 2
50% 5-year AA, 40% 10-year A, and 10% 20-year A
Pro: Least sensitive; Covers more liability when interest rates go up (relative to other portfolios)
Con: Adverse to low interest rate environment
Data Appendix

Single Prem vs Modal Benefit

Discount Rates

- 2.40%
- Base
- 4.00%
Conclusion

Thank you judges and organizers for this great opportunity!