Session 173 PD - Pension Modeling & Scenario Analysis

Moderator:  
Brett Brooks Dutton, FSA, EA, FCA

Presenters:  
Matthew W. McDaniel, FSA, EA, FCA, MAAA  
Thomas William McNab, FSA
2017 SOA Annual Meeting & Exhibit

PRESENTERS: MATT MCDANIEL, FSA, EA, FCA, MAAA, CFA
TOM MCNAB, FSA, EA

MODERATOR: BRETT DUTTON, FSA, EA, FCA, CFA

Session 173, Pension Modeling and Scenario Analysis
October 18, 2017
SOCIETY OF ACTUARIES
Antitrust Compliance Guidelines

Active participation in the Society of Actuaries is an important aspect of membership. While the positive contributions of professional societies and associations are well-recognized and encouraged, association activities are vulnerable to close antitrust scrutiny. By their very nature, associations bring together industry competitors and other market participants.

The United States antitrust laws aim to protect consumers by preserving the free economy and prohibiting anti-competitive business practices; they promote competition. There are both state and federal antitrust laws, although state antitrust laws closely follow federal law. The Sherman Act, is the primary U.S. antitrust law pertaining to association activities. The Sherman Act prohibits every contract, combination or conspiracy that places an unreasonable restraint on trade. There are, however, some activities that are illegal under all circumstances, such as price fixing, market allocation and collusive bidding.

There is no safe harbor under the antitrust law for professional association activities. Therefore, association meeting participants should refrain from discussing any activity that could potentially be construed as having an anti-competitive effect. Discussions relating to product or service pricing, market allocations, membership restrictions, product standardization or other conditions on trade could arguably be perceived as a restraint on trade and may expose the SOA and its members to antitrust enforcement procedures.

While participating in all SOA in person meetings, webinars, teleconferences or side discussions, you should avoid discussing competitively sensitive information with competitors and follow these guidelines:

- **Do not** discuss prices for services or products or anything else that might affect prices
- **Do not** discuss what you or other entities plan to do in a particular geographic or product markets or with particular customers.
- **Do not** speak on behalf of the SOA or any of its committees unless specifically authorized to do so.
- **Do** leave a meeting where any anticompetitive pricing or market allocation discussion occurs.
- **Do** alert SOA staff and/or legal counsel to any concerning discussions
- **Do** consult with legal counsel before raising any matter or making a statement that may involve competitively sensitive information.

Adherence to these guidelines involves not only avoidance of antitrust violations, but avoidance of behavior which might be so construed. These guidelines only provide an overview of prohibited activities. SOA legal counsel reviews meeting agenda and materials as deemed appropriate and any discussion that departs from the formal agenda should be scrutinized carefully. Antitrust compliance is everyone’s responsibility; however, please seek legal counsel if you have any questions or concerns.
Presentation Disclaimer

Presentations are intended for educational purposes only and do not replace independent professional judgment. Statements of fact and opinions expressed are those of the participants individually and, unless expressly stated to the contrary, are not the opinion or position of the Society of Actuaries, its cosponsors or its committees. The Society of Actuaries does not endorse or approve, and assumes no responsibility for, the content, accuracy or completeness of the information presented. Attendees should note that the sessions are audio-recorded and may be published in various media, including print, audio and video formats without further notice.
Today’s agenda

General thoughts on modeling
Types of pension models
Pension modeling considerations

Includes examples (US pension focus)

The focus of this webcast is on *forecasting* models (i.e., projecting future outcomes) rather than *valuation* models (i.e., developing present values)
General thoughts on modeling
“All models are wrong, but some are useful”

- Statistician George E. P. Box
Why are (some) models useful?

Model: a simplified representation of relationships among real world variables, entities, or events using statistical, financial, economic, mathematical, or scientific concepts and equations (from proposed Actuarial Standard of Practice on modeling)

Target system
- Aspect of the real world under study
- Complexity hinders tractable analysis

Model
- Abstract representation of target system
- Contains idealizations (intentional simplifications)
- Less complex than the actual target system
- Needs to be robust enough to facilitate reasonable conclusions

Principal
- Faces a business decision that relates to the target system
- Uses surrogate reasoning – model results form the basis of conclusions about the target system
How should modeling results inform business decisions?

**Dependence on models**

- **Too high**
  - Don’t use model results as “proof”
  - Don’t select a model (or the inputs) based on the desirability of the result
  - Don’t assume that the most complex model is the best

- **Just right**
  - Do model potential future outcomes in multiple ways
  - Do seek a deep understanding of models being used, especially the dependence on assumptions
  - Do retain a healthy and humble skepticism of model results; use professional judgment and empirical evidence to validate a model’s conclusions

- **Too low**
  - Don’t act on judgment and intuition without quantitative validation
  - Don’t rely solely on deterministic forecasts with “expected value” inputs
Why forecast pensions?

- Funded status evolution
- Due diligence for corporate restructuring
- Cash and P&L budgeting
- Risk Management
- Sensitivity to assumptions and benefit design
- Strategic asset allocation
- Plan termination
- Sensitivity to assumptions and benefit design
Types of pension models
Valuation

• Valuation vs. forecasting:
  • Valuation is easy and obvious – it’s just math!
  • Forecasting is confusing, complex, and an art form

Scenario 1: Personal investments
Account A = checking account = $100
Account B = mutual fund = $200
Account C = S&P 500 index fund = $300

Scenario 2: Simple pension plan
• One participant
• Lump sum benefit of $100,000, payable in five years
• Assets in trust of $70,000
Valuation example

Perform a simple valuation for scenarios 1 and 2.

**Scenario 1: Personal investments**
Net worth = market value of investments = sum of accounts = $100 + $200 + $300 = $600

**Scenario 2: Simple pension plan**
Assume 5% interest and no other decrements.

Liability = 100,000 / 1.05^5 = 78,353
Funded status = 70,000 / 78,353 = 89.3%
Risk / Volatility

Volatility (n): a statistical measure of the dispersion of returns

Is volatility the same thing as risk?
How do we measure risk? (example #1)

<table>
<thead>
<tr>
<th>Payoff for a $100 investment</th>
<th>Investment A</th>
<th>Investment B</th>
</tr>
</thead>
<tbody>
<tr>
<td>$200</td>
<td>30%</td>
<td>15%</td>
</tr>
<tr>
<td>$120</td>
<td>20%</td>
<td>40%</td>
</tr>
<tr>
<td>$100</td>
<td>20%</td>
<td>20%</td>
</tr>
<tr>
<td>$50</td>
<td>10%</td>
<td>20%</td>
</tr>
<tr>
<td>$0</td>
<td>20%</td>
<td>5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Expected Value</th>
<th>Volatility (standard deviation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment A</td>
<td>$109</td>
<td>72</td>
</tr>
<tr>
<td>Investment B</td>
<td>$108</td>
<td>51</td>
</tr>
</tbody>
</table>

Volatility seems to be a reasonable measure of risk here
How do we measure risk? (example #2)

Payoff for a $100 investment

<table>
<thead>
<tr>
<th>Percentile (simulated)</th>
<th>Investment C</th>
<th>Investment D</th>
</tr>
</thead>
<tbody>
<tr>
<td>95th</td>
<td>$205</td>
<td>$190</td>
</tr>
<tr>
<td>75th</td>
<td>$165</td>
<td>$160</td>
</tr>
<tr>
<td>50th (median)</td>
<td>$120</td>
<td>$108</td>
</tr>
<tr>
<td>25th</td>
<td>$95</td>
<td>$92</td>
</tr>
<tr>
<td>5th</td>
<td>$42</td>
<td>$41</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Investment C</th>
<th>Investment D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected Value (median)</td>
<td>$120</td>
<td>$108</td>
</tr>
<tr>
<td>Volatility (95th minus 5th)</td>
<td>$163</td>
<td>$149</td>
</tr>
<tr>
<td>Volatility (50th minus 5th)</td>
<td>$78</td>
<td>$67</td>
</tr>
</tbody>
</table>

Investment C has a wider range of outcomes, but each is more favorable than Investment A.

Conclusion: Investment C is more volatile but less risky.
## Forecasting: What do I care about?

<table>
<thead>
<tr>
<th>Questions</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the range of results of my NW/FS over the next five years under thousands of potential outcomes?</td>
<td>Stochastic forecast</td>
</tr>
<tr>
<td>What is the likelihood of having my NW/FS within 80% of my desired outcome in five years?</td>
<td></td>
</tr>
<tr>
<td>What would happen to my NW/FS tomorrow if Trump is impeached?</td>
<td>Future scenario analysis</td>
</tr>
<tr>
<td>What happens to my NW/FS over the next five years under any given set of future assumptions?</td>
<td>(Deterministic forecast)</td>
</tr>
<tr>
<td>What would happen to my NW/FS tomorrow if 2008 happened again?</td>
<td>Historical scenario analysis</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>What is my NW/FS tomorrow if the S&amp;P 500 declines by 10%?</td>
<td>Stress testing</td>
</tr>
</tbody>
</table>
Stress testing

**Strengths**
- Quick and dirty
- Regulatory standard

**Pitfalls**
- Isolated analysis
- Point-in-time only
Historical scenario analysis

**Strengths**
- Accessible and simple
- A more rigorous what-if
- Ubiquitous context

**Pitfalls**
- History doesn’t recur
- Improper application
- Market data shortages
Future scenario analysis / Deterministic forecasting

**Strengths**
- Actuarial standard
- Define own assumptions and tell story “your way”

**Pitfalls**
- No volatility / correlative impacts
- Over-reliance on results as “truth”
Stochastic forecasting

Strengths

- Sophisticated
- Captures volatility/correlations

Pitfalls

- Time-consuming, expensive
- Results are complicated
- No regulatory requirement
- Still relies on underlying assumptions
Communicating stochastic results

- Stochastic models have many strengths, but communicating results to a non-technical audience can be very difficult
  - Raw output is literally thousands of numbers
  - Percentiles can be tough to grasp for “non-math” people
- Focus on a few key results, such as:
  - Median “expected” outcome
  - 5th percentile “very bad case” outcome
- Never use the term “worst case”!
  - There is always a case worse than any given percentile
Communicating stochastic results

• Best practices for communicating stochastic results include:
  • Graphs or charts that display data visually
  • Call out boxes or other commentary that draw the reader’s attention to important information
  • Reducing the volume of results to the minimum amount needed to “tell the story”
  • Presentation in person rather than via conference call or over email
Pension modeling considerations
Objectives of the sponsor / consultant

What does the sponsor care about?

- Cash requirements
- P&L considerations
- Plan hibernation
- Termination or curtailment
- Long-term viability
- Trapped surplus
- Expense management
- Tax efficiencies

What should the sponsor care about?

What does the consultant want to convey?
Example: Stated objectives vs underlying

Imagine a pension plan sponsor embarking on an ALM study. The CFO says he wants an investment policy that gives him the maximum return, but minimizes the chance of assets decreasing.

• “We can’t do anything that will reduce our asset return assumption under US GAAP.”

• “Interest rates are at historic lows and can only go up from here. Lengthening the duration of our fixed income will just lead to asset losses.”
The actuary should take the sponsor’s views into account, but then help them focus on how those views fit with what the sponsor “should” be focused on.

<table>
<thead>
<tr>
<th>Economics</th>
<th>Accounting</th>
<th>Funding</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Plan funded status is generally a better measure of health than asset return in a vacuum</td>
<td>• How does maintaining a high EROA impact plan risks?</td>
<td>• What contributions would be required in different scenarios?</td>
<td>• How does the investment strategy impact plan sustainability?</td>
</tr>
<tr>
<td>• Does this suggest asset liability matching is more important than return?</td>
<td>• How do analysts adjust accounting entries to reflect risk?</td>
<td>• How can contribution policy be used to reduce cost and risk?</td>
<td>• What is the impact on participants?</td>
</tr>
</tbody>
</table>
Liability measurement options

• There are lots of liability standards
  • PBO, ABO, FS, AR-FS, Max Tax, PBGC, PVFB, Economic Termination, Insurer Termination

• Do we need to analyze all of these?
  • Consider the sponsor/consultant objectives
  • Which standards have the most material impact on sponsor decision-making?
Liability measurement options

• Approaches to projecting a liability

  • Roll forward approach
    • Inputs include: Liability value, accrual value, discount rate, duration
    • Future liability values calculated by adjusting current value

  • Cash-flow based approach
    • Inputs include: Liability cash flows, accrual cash flows
    • Future liability values calculated by adjusting current cash flows, then discounting using a projected rate or spot curve

  • Census-based (seriatim) approach
    • Inputs include: Valuation census data
    • Future liabilities calculated by adjusting current census data, then performing a valuation at a future date
Economic assumptions

• Large range of options on the spectrum of sophistication

• Example: Interest rate modeling
  - Flat interest rates
  - Duration adjustment based on sensitivities
  - Full interest rate curve development on plan cash flows

• Example: Asset return for the Aggregate index
  - Flat return and no volatility
  - Modeled with a simple mean-variance structure
  - Addition of correlative effects to other asset classes
  - Model for underlying securities, including mortgages
How are liabilities impacted by economic assumptions?

• Some plans are simple: for example, a frozen, traditional DB plan may only be impacted by discounting

• Many plans are more complex:
  • Active plans with pay based formulas
  • COLAs
  • Plans with medical coverage
  • Cash balance, pension equity or other hybrid designs

• Care is needed to ensure that plans with cashflows sensitive to economic conditions are modeled correctly
  • Are one or more economic rates correlated?
Cash balance plans can be particularly complex

The extent to which crediting rate and conversion rates offset discount rate changes is impacted by:

• Indices used (Corporate vs. Treasury, long vs. short)
• Any floor or caps
• “Stickiness” of actuarial assumptions
Demographic assumptions

• Similarly sophisticated options for growing and aging the plan liability

• Example: New entrants
  - Assume none (zero or declining service cost)
  - Apply simple growth factors (growing service cost)
  - Full new entrant profiles

• Example: Mortality assumption
  - Static valuation assumption
  - Apply “age shifting” factors to rollforward calculations
  - Full future participant valuation (as cohorts)
Investment, funding, accounting policy

• Capture sponsor policies if material
• Example: Asset rebalancing

- Constant allocation
- Point-in-time re-allocation assumptions
- Dynamic allocations (glide paths)

• Example: Funding policies

- No funding
- Minimum required contributions
- Supplemental funding and credit balance elections
Regulatory anticipation

• Consider
  • Materiality to the plan
  • Likelihood of implementation
  • Sophistication of analysis required

• Options for analysis
  • Include implementation in default projection path
  • Stress test a separate deterministic path
  • Show simple stress test calculations
Examples of Complexity

Complexity of the model should be driven by what is needed to capture sponsor policies

Examples:

<table>
<thead>
<tr>
<th>If investment policy includes a glidepath:</th>
<th>If funding policy is based on reaching specific thresholds:</th>
<th>If policies anticipate regulatory change:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Trigger points (e.g. funded status, interest rates) must be adequately modeled</td>
<td>• Extra care should be taken to ensure key liability measures are determined appropriately</td>
<td>• How would regulatory agencies react to extreme downside events?</td>
</tr>
<tr>
<td>• Modeling assumptions following the breach of a trigger point must be adjusted (e.g. EROA)</td>
<td>• Funding policy constraints should be tested with plan sponsor – e.g. would you really put in $500 million to avoid benefit restrictions?</td>
<td>• How should the model reflect these potential outcomes? Is a switch in model regimes feasible?</td>
</tr>
<tr>
<td>• Model should reflect actual path sponsor would take (e.g. re-risk if funded status falls?)</td>
<td></td>
<td>• Be sure to discuss with plan sponsor and appropriately document underlying assumptions</td>
</tr>
</tbody>
</table>
Recap
“Everything should be made as simple as possible, but no simpler.”

- Albert Einstein
Recap

- Modeling is wrong....but useful
- Valuation is a science; Forecasting is an art
- Modeling objectives dictate modeling complexity
Questions