2020 VIRTUAL ANNUAL MEETING & EXHIBIT

OCTOBER 26–29, 2020
Asset-Liability Modeling and Consulting

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SOCIETY OF ACTUARIES

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Agenda

● Introduction to Asset-Liability Modeling

● Sample Asset-Liability Analysis
  – Corporate Pension Plan
  – LDI Monitoring
  – Public Pension Plan

● Communicating Results and Beyond
Introduction to Asset-Liability Modeling
What Will the Weather Be Like Today?

100%

80% / 20%

Value from the range
Objectives of Asset-Liability Modeling

The objective of an asset-liability study is to quantify risk and reward to determine a long-term strategic asset allocation – this is not meant to be a budgeting exercise.

- 80-90% of funded status volatility is driven by the broad asset allocation decision.

### Public Equity
30% US Equity
10% Int’l Equity

### Alternatives
- 5% Private Equity
- 5% Real Estate
- 5% Hedge Funds

### Liability-Hedging
45% Long Bonds

A full asset-liability study helps the plan sponsor quantify the impact that different strategies might have on relevant metrics:

<table>
<thead>
<tr>
<th>Corporate Pensions</th>
<th>Public Pensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contribution requirements (cash flow impact)</td>
<td>Target returns / Actuarial Discount Rate</td>
</tr>
<tr>
<td>Funded Status (balance sheet impact)</td>
<td>Contributions as % of Payroll</td>
</tr>
<tr>
<td>Pension Expense (income statement impact)</td>
<td>Liquidity profile</td>
</tr>
</tbody>
</table>
Why Stochastic vs. Deterministic?

Deterministic projections can be a misleading risk management tool because volatility has real implications for pension plans. The path matters!

**Deterministic:** In the simple example below the 4-year geometric return is 0% and the asset value remains constant due to a constant 0% annual return. Assuming that the liabilities are fairly stable (i.e. for a public pension plan), the funded status remains at 100%.

<table>
<thead>
<tr>
<th></th>
<th>Yr 1</th>
<th>Yr 2</th>
<th>Yr 3</th>
<th>Yr 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Assets</td>
<td>$100</td>
<td>$100</td>
<td>$100</td>
<td>$100</td>
</tr>
<tr>
<td>Liability</td>
<td>$100</td>
<td>$100</td>
<td>$100</td>
<td>$100</td>
</tr>
<tr>
<td>Funded Ratio</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Stochastic:** In the example below the 4-year geometric return is also 0% but the asset value is volatile and the funded status drops to 50% in some years. In those years, regulatory contributions may be required or operational restrictions may be imposed on the plan.

<table>
<thead>
<tr>
<th></th>
<th>Yr 1</th>
<th>Yr 2</th>
<th>Yr 3</th>
<th>Yr 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>-50%</td>
<td>100%</td>
<td>-50%</td>
<td>100%</td>
</tr>
<tr>
<td>Assets</td>
<td>$50</td>
<td>$100</td>
<td>$50</td>
<td>$100</td>
</tr>
<tr>
<td>Liability</td>
<td>$100</td>
<td>$100</td>
<td>$100</td>
<td>$100</td>
</tr>
<tr>
<td>Funded Ratio</td>
<td>50%</td>
<td>100%</td>
<td>50%</td>
<td>100%</td>
</tr>
</tbody>
</table>
How Do Assets and Liabilities Interact?

We evaluate the interaction of the three key policies that govern a retirement plan with the goal of establishing the best investment policy.

**Investment Policy**
- How will the assets supporting the benefits be invested?
- What risk and return objectives?
- How to manage cash flows?

**Funding Policy**
- How will the benefits/deficits be paid for (funded)?
- What are the actuarial assumptions to use?

**Benefits Policy**
- What type/kind of benefits?
- What level of benefit?
- When and to whom are they payable?
- Are risk transfer actions under consideration?
Which Pension Risks Can be Addressed with Asset-Liability Modeling?

Hybrid benefit designs and lump sum options can shift some pension risks away from the plan sponsor and to the participants. However for a traditional annuity benefit plan, the plan sponsor retains all of the risks listed below.

<table>
<thead>
<tr>
<th>Risk</th>
<th>Can We Hedge?</th>
<th>Can We Model?</th>
<th>Linked to Capital Markets?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest Rate Risk</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Investment Risk</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Inflation Risk</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Longevity Risk</td>
<td>✗*</td>
<td>✓</td>
<td>✗</td>
</tr>
</tbody>
</table>

* Hedging against longevity risk typically would include an insurance contract, which is customized and can be costly.
Asset-Liability Modeling Process

Asset Modeling
- Define Capital Market Assumptions
- Create Asset Mix Alternatives

Liability Modeling
- Define Liability Assumptions
- Build Actuarial Liability Model

Simulate Financial Conditions
- Define Risk Tolerance
- Select Appropriate Target Mix
Sample Asset-Liability Analysis: Corporate Pension Plan
### Annual Baseline Results

**Contributions ($M)**

![Bar Chart]

<table>
<thead>
<tr>
<th>Percentile</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
<th>2027</th>
<th>2028</th>
<th>2029</th>
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</thead>
<tbody>
<tr>
<td>97.5th</td>
<td>$18</td>
<td>$46</td>
<td>$38</td>
<td>$27</td>
<td>$22</td>
<td>$20</td>
<td>$20</td>
<td>$20</td>
<td>$11</td>
<td>$13</td>
</tr>
<tr>
<td>75th</td>
<td>18</td>
<td>32</td>
<td>30</td>
<td>18</td>
<td>17</td>
<td>17</td>
<td>16</td>
<td>15</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>50th</td>
<td>18</td>
<td>25</td>
<td>27</td>
<td>17</td>
<td>16</td>
<td>15</td>
<td>14</td>
<td>6</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>25th</td>
<td>18</td>
<td>19</td>
<td>23</td>
<td>16</td>
<td>15</td>
<td>13</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.5th</td>
<td>17</td>
<td>9</td>
<td>16</td>
<td>14</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

| Prob > 0   | 100%  | 100%  | 100%  | 100%  | 100%  | 96%   | 82%   | 66%   | 55%   | 52%   |

- The floating bars capture 95% of simulated results, from best-case to worse-case
- The width of the bar represents the volatility of results in a given year
- The median is often referred to as the “expected” results and the 97.5th %ile is our “worse-case”
- You can also look at thresholds for metrics; here there is a high likelihood of contributions > $0

*Callan*
### Annual Baseline Results

#### PBO Funded Status (%)

<table>
<thead>
<tr>
<th>Percentile</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
<th>2027</th>
<th>2028</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5th</td>
<td>69%</td>
<td>91%</td>
<td>106%</td>
<td>120%</td>
<td>130%</td>
<td>139%</td>
<td>153%</td>
<td>167%</td>
<td>180%</td>
<td>197%</td>
<td>216%</td>
</tr>
<tr>
<td>25th</td>
<td>69%</td>
<td>78%</td>
<td>86%</td>
<td>93%</td>
<td>101%</td>
<td>108%</td>
<td>113%</td>
<td>121%</td>
<td>127%</td>
<td>134%</td>
<td>142%</td>
</tr>
<tr>
<td>50th</td>
<td>69%</td>
<td>71%</td>
<td>77%</td>
<td>82%</td>
<td>87%</td>
<td>93%</td>
<td>98%</td>
<td>102%</td>
<td>107%</td>
<td>112%</td>
<td>116%</td>
</tr>
<tr>
<td>75th</td>
<td>69%</td>
<td>65%</td>
<td>68%</td>
<td>72%</td>
<td>76%</td>
<td>80%</td>
<td>85%</td>
<td>88%</td>
<td>91%</td>
<td>94%</td>
<td>98%</td>
</tr>
<tr>
<td>97.5th</td>
<td>69%</td>
<td>56%</td>
<td>56%</td>
<td>58%</td>
<td>61%</td>
<td>65%</td>
<td>66%</td>
<td>67%</td>
<td>70%</td>
<td>72%</td>
<td>74%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Probability&gt;115%</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
<th>2027</th>
<th>2028</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>1%</td>
<td>4%</td>
<td>10%</td>
<td>17%</td>
<td>23%</td>
<td>31%</td>
<td>38%</td>
<td>45%</td>
<td>52%</td>
</tr>
</tbody>
</table>

- Worse-case and best-case are flipped for some metrics
- Results are becoming more volatile over the projection period
- Can analyze any threshold: probability fully funded, probably 115% funded as a settlement proxy
Annual Baseline Results

Assets and Liabilities ($M)

Market Value of Assets ($M)

- The asset value varies with investment returns and the liability value varies with simulated corporate yield curves and salary inflation.

- Asset volatility and liability volatility combined will contribute to funded status volatility.

Callan
### Compare Benefit Policies

**Contributions ($M)**

<table>
<thead>
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<td>$25</td>
<td>$17</td>
<td>$12</td>
</tr>
<tr>
<td>75th</td>
<td>18</td>
<td>32</td>
<td>30</td>
<td>18</td>
<td>17</td>
<td>75th</td>
<td>18</td>
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<td>18</td>
<td>17</td>
<td>8</td>
</tr>
<tr>
<td>50th</td>
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<td>25</td>
<td>27</td>
<td>17</td>
<td>16</td>
<td>50th</td>
<td>13</td>
<td>9</td>
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<td>25th</td>
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<td>25th</td>
<td>10</td>
<td>6</td>
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<td>6</td>
<td>6</td>
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<tr>
<td>2.5th</td>
<td>17</td>
<td>9</td>
<td>16</td>
<td>14</td>
<td>12</td>
<td>2.5th</td>
<td>3</td>
<td>0</td>
<td>6</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Prob &gt; 0</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>Prob &gt; 0</td>
<td>100%</td>
<td>98%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

- Stochastic analysis can be useful to show the impact of benefit policy changes
- Freezing this benefit plan noticeably improves the worse-case and median contributions since benefit accruals cease and slower liability growth reduces the deficit more quickly over time
Compare Benefit Policies

Pension Expense/(Income) ($M)

- Annual pension expense is significantly lower and less volatile if the plan is frozen
- Benefit accruals cease (SC = 0) and projected liabilities fall to accrued liabilities (PBO = ABO)
- Gain/loss amortizations decrease as the amortization period lengthens from Average Future Service (AFS) to Average Future Life Expectancy (AFLE)
- Settlement charges and accelerated recognition of prior service cost could increase expense
• **LGC = Long Government/Credit Bonds**

• Increasing fixed income decreases funded status volatility and improves the worst-case result

• Decreasing fixed income improves the median and the probability of achieving 115% funded status

• There is a risk/reward trade-off inherent in the investment policy decision
• Increasing the allocation to long bonds reduces annual contribution volatility

• Risk/reward trade-off: increasing bonds improves the worst-case annual contribution but at the cost of increasing the median
- Increasing the allocation to long bonds reduces annual expense volatility.
- Risk and reward: increasing bonds worsens both the worst-case annual and median result for annual pension expense, due to the lowering of the EROA assumption.
Compare Investment Policies

Ultimate Net Cost over 10 Years

- Ultimate net cost = cumulative contributions over 10 years plus any deficit that remains
  - Represents the true cost of funding this plan over time

- Extending duration of fixed income improves efficiency by significantly improving the worse-case results

- How to make investment policy decision along an efficient frontier?
  - Minimum risk portfolio
  - Risk tolerance threshold
  - Straight risk reduction
  - Risk/reward trade-offs
Sample Asset-Liability Analysis: LDI Monitoring
Risk Monitoring

Pension Risk Reporting

Designed to track the evolution of assets and liabilities over time.

Effective tool to monitor investment strategies and evaluate relevant risk factors.

Output provides:
- Liability Overview
- Change in funded status
- Funded status risk analysis

Helps us track and explain periodic fluctuations and risk estimates.
Surplus Value at Risk Attribution ($M)

- Value at Risk ("VaR") analyzes the one-year funded status loss on a worse-case (95th %ile) basis
- This plan is fairly well-hedged with 84% of the portfolio in fixed income so most of the risk is attributable to equities, even though equities are a smaller portion of the total investments
- Note that the risks are not additive (i.e. there is a diversification benefit)
● Different investment policies will generally have different risk levels but also different attributions of Value at Risk

● The equity risk bars are identical across portfolios since the equity allocation was kept constant at 16% of total assets

● Optimizing the fixed income components reduces surplus VaR to $34.0M (~20% risk reduction) even though it increases credit risk
Sample Asset-Liability Analysis:
Public Pension Plan
Annual Baseline Results
Assets and Liabilities ($M)

*Unlike a corporate pension liability which varies with simulated corporate yield curves, this public pension liability varies slightly with simulated inflation since the actuarial discount rate is fixed.*

*Funded ratio volatility is driven by asset volatility, which highlights the importance of the asset mix decision.*
Asset mixes for public plans are often defined by an expected return target, which translates into a liability discount rate; higher return targets translate into riskier holdings.

Funded Status = Market Value of Assets / Actuarial Accrued Liability (not quite marked-to-market)

Decreasing the return target decreases funded status volatility and marginally improves the worst-case, but at the cost of reducing the median result and the probability of remaining fully funded.
Compare Investment Policies

Probability of Required Contributions

- Increasing the return target lowers the probability of required contributions
- This effect would be amplified if the actuarial discount rate is also increased since the liability and normal cost would decline
Communicating results and beyond
Why do ALMs fail (1/2)?

- ALMs involve a lot of assumptions and calculations

- If not well communicated and understood, the results may not be trusted

- Importance of a clear narrative
  - Tell a story
  - Framed for decision making
  - Address potential communication challenges related to ALM results
Why do ALMs fail (2/2)?

Client’s problem → Your solution
Communication challenge #1

• Mastering the breadth and depth of all of the ALM calculations is a tremendous achievement

• Credible about model limitations requires humility

• Great examples:
  • When there is liability sensitivity not captured explicitly in ALM?
    • Actuarial experience gain/losses on liabilities
    • Challenging actuarial assumptions on future liability development (uncertainty of future benefits/claims)
  • Benefit costs/subsidies within plan design
  • Market risks masked
Communication challenge #2

- Address the issues with the “forest” – not just the ALM calculations of the “trees”

- Public plan finance is a great example where the forest is important
Coordinating financial policies
Difficult because policies are interrelated

All the pension financial decisions create a confusing haze of hard to predict interrelated effects!

Pension plan finance

Underlying principles

1. The benefit promise to employees has value. This value is independent of how assets are invested.

2. Benefit funding comes from contributions to the Plan and investment earnings on plan assets. Pension plans have flexibility in the balance of financing benefits – defining funding policy (How much capital to commit?) and investment policy (How much return to seek?)

3. A key financing decision is to determine how much of expected future investment returns should be used as a source of deferred financing. This is done through choices around setting the funding target (liability measurement policy). The difference between the funding target and the value of the benefit promise is one source of deferred financing and can be described as the value gap.

4. Financial management involves the coordination of all three financial policies: investment, funding/contributions, and liability measurement.

1 See FASB ASC 715 for further clarification on value. Values may vary depending on circumstances such as purposes of calculation, reporting entity, and regulatory oversight bodies.

2 From the assumption of investment risk.
Underlying principle #1
The benefit promise has a value

- Benefit payments for earned benefits can be estimated

  **Projected benefit payments**

  ![](Projected_benefit_payments.png)

  - [Projected benefit payments](#)

  - Value of benefit promise

  ![Value of benefit promise](Value_of_benefit_promise.png)

  - [Value of benefit promise](#)

  - We can determine the value (NPV) of those estimated benefits today

  ![1 lb of feathers](1_lb_of_feathers.png)

  ![1 lb of bricks](1_lb_of_bricks.png)

  This NPV is independent of how the assets are invested.

Charts depicted above are intended for illustrative purposes only.
Underlying principle #2
Benefit funding (B) comes from contributions (C) and investment earnings (I)

Fundamental cost equation

Insurance company / employee perspective

Long term investor perspective

There are different ways to think about how benefits should be financed – more up front cash contribution capital and lower future investment returns, or vice versa.
1. The value of the benefit promise is independent of how assets are invested.

2. Market values are based on market interest rates from pricing observed through insurance company transactions (i.e. corporate bond yields ~4%).

3. Certain plan sponsors may set the funding target\(^1\) based on long-term expected returns (ex: 6%), reducing the NPV of the funding target. This creates a gap between the value of the benefit promise and the funding target and is a source of deferred financing.

4. Added risk to the discount rate (ex: +100 bps risk) further increases the deferred financing and decreases the NPV of the funding target.

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1 The funding target is commonly referred to as the actuarial liability (AL).

Chart depicted above is intended for illustrative purposes only.
Underlying principle #4
Coordinating policies – Investment, funding, liability measurement

- Determine the investment policy and implementation that achieves the plan’s long-term cost and volatility objectives.
- Decide how much cash to contribute each year into the plan’s assets, relative to the funding target as well as value of the benefit promise.
- Determine the liability measure as the funding target, measure the value gap (related to assumptions of long-term EROA for future excess investment returns).
Coordinating policies – understanding market risks
Economic expected returns are anchored to general levels of interest rates

\[
\text{Expected return} = \frac{\text{Market discount rate}}{} + \text{Investment risk premium}
\]

- When interest rates go from 6% to 3%, expected returns on equities go from 10% to 7%*
- The best estimate of economic expected returns does move with the rising and falling tide of interest rates

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1 Illustrative purposes only. This simple illustration assumes the investment risk premium stays at 4% as interest rates fluctuate; in practice, investment risk premium also changes depending on the underlying technical and fundamental causes for changes in the discount rate.
Pension plan finance

Underlying principles

1. The benefit promise to employees has value\(^1\). This value is independent of how assets are invested.

2. Benefit funding comes from contributions to the plan and investment earnings on plan assets. Pension plans have flexibility in the balance of financing benefits – defining funding policy (How much capital to commit?) and investment policy (How much return to seek?)

3. A key financing decision is to determine how much of expected future investment returns\(^2\) should be used as a source of deferred financing. This is done through choices around setting the funding target (liability measurement policy). The difference between the funding target and the value of the benefit promise is one source of deferred financing and can be described as the value gap.

4. Financial management involves the coordination of all three financial policies: investment, funding/contributions, and liability measurement.

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1 See FASB ASC 715 for further clarification on value. Values may vary depending on circumstances such as purposes of calculation, reporting entity, and regulatory oversight bodies.

2 From the assumption of investment risk
Potential implications

• Governance frameworks can keep the three financial policies disconnected (i.e. investment decisions can be made by a different decision-making entity vs. funding policy decisions)

• Actuarial reporting and smoothing can contribute to masking risks and also not provide a holistic framework to coordinate the integration of all three policies

• One purpose of this pension financial framework is to identify and measure un-measured or under-measured risks providing a more transparent assessment of the coordination of overall financial policies

• Potential changes:
  • How will future discount rates / funding targets will be set each year? How much smoothing to keep on a go-forward basis?
  • Should any changes be applied to investment asset allocation to reassess/affirm the level of investment risk and/or hedge uncompensated risks?
  • Revisit funding policy to assess contribution levels to manage funded status outcomes
Limitations of Asset-Liability Modeling

- Asset-liability modeling is imperfect
  - Results are sensitive to assumptions
  - Other data inputs must also be reliable; GIGO
  - Tail risks can be difficult to model
  - Different economic outlooks may lead to different outcomes
  - The “optimal” result might not be suitable for the client circumstance; judgement is required

- However it can still be a powerful risk management tool
  - Project valuations beyond one year and see impact of sensitivity factors
  - Ability to examine a wide distribution of possible results
  - Capital market assumptions should capture a reasonable likelihood of downside scenarios
  - Identify uncompensated risks
Questions?

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“Knowledge is an unending adventure at the edge of uncertainty.” – Jacob Bronowski
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