Public Safety Retirement Funds

- Risks and Opportunities
- Market Environment
- Actuarial Risks
- Institutional Asset Allocation
- Risk Management Tools
- Takeaways
Evolving Risks and Opportunities
**Retirement System Challenges and Opportunities**

- **Funding Levels**
  - Strong returns since ‘09; pressure on funded levels

- **Capital Markets**
  - Return assumptions; Fed policy; asset valuations

- **Actuarial Assumptions**
  - Evolving economic and demographic inputs

- **Asset Allocation**
  - Improved diversification; market complexity

- **Capital Stewardship**
  - Best governance; risk oversight; ESG investing

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“Public pension funds contributed a net $1373 billion to state and local government coffers during 2016, underscoring their power to strengthen the U.S. economy.”

—NCPERS, May 16, 2018

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**State & Local Pension Fund Assets (Billions)**

- 2009: 2,466
- 2017: 3,785

Source: U.S. Census Bureau, Top 100 Funds.
Capital Market Assumptions

- Equity market valuations
- Interest rate normalization
- Modestly improved global economic outlook
- Low yields; elevated interest rate risk
- Potential risk related to currency and inflation
- Global trade conflict; geopolitical risk
- Fiscal policy: near and long-term impacts.

“The Fed is in the midst of trying the hardest trick in its book, which is to raise interest rates without causing a recession.”
—Aaron Klein, Brookings Institution, February 6, 2018

“Despite the encouraging headline growth figures, the global economy is facing the highest level of risk in years.”
—The Economist Intelligence Unit, January 2018

Capital Market Assumptions: 10 Year*

<table>
<thead>
<tr>
<th>Asset Class</th>
<th>Expected Return</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Large Cap</td>
<td>7.6%</td>
<td>16.0%</td>
</tr>
<tr>
<td>U.S. Small Cap</td>
<td>9.4%</td>
<td>24.0%</td>
</tr>
<tr>
<td>Int’l Equity (unhedged)</td>
<td>8.9%</td>
<td>20.0%</td>
</tr>
<tr>
<td>Int’l Emerging Market</td>
<td>11.3%</td>
<td>24.0%</td>
</tr>
<tr>
<td>FI – Core</td>
<td>3.2%</td>
<td>5.5%</td>
</tr>
<tr>
<td>FI – High Yield</td>
<td>5.8%</td>
<td>11.0%</td>
</tr>
<tr>
<td>FI – Global</td>
<td>3.2%</td>
<td>7.6%</td>
</tr>
<tr>
<td>FI – Emerging Market</td>
<td>6.1%</td>
<td>10.5%</td>
</tr>
<tr>
<td>Real Estate – Core</td>
<td>6.6%</td>
<td>11.5%</td>
</tr>
</tbody>
</table>

* For illustrative purposes only. Not all inclusive. Expected return is arithmetic.
Public Retirement System Risk Exposures

- Actuarial
  - Demographic
  - Asset Performance
  - Actuarial Standards
  - Return Assumption

- Market
  - Stock Market
  - Interest Rates
  - Inflation
  - Currency Rates

- Operational
  - Compliance / Legal
  - Disclosure
  - Valuations
  - Cybersecurity

- Liquidity
  - Contributions
  - Benefit Payments
  - Alternative Investments
  - Redemption Terms

Public Funds Average Funded Percentage:

- 2017: 71.2%
- 2016: 74.7%

Projected Cash Flow (Sample):

Source: NCPerS 2017 Public Retirement Systems Study; January 2018
Public retirement systems have reduced public equity and interest rate risk by reducing public markets allocations since 2001 and adding new sources of return from alternatives.

While increased allocations to alternatives may improve expected risk-adjusted returns, they introduce new operational and liquidity risks that require a management framework.
Public and private pension funds collectively own 17% of the U.S. equity market.

This does not include equities held indirectly by public and private defined contribution plans in mutual funds and other commingled vehicles.

“The big pools of equity owners in the world today are the pension funds. They’re the policemen, they’re the firemen, they’re the teachers, they’re the civil servants of America….”

—Gary Cohn, White House Economic Advisor, September 1, 2017
Market Environment
Global Economic Environment

Global Outlook for Growth of Domestic Product

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.</td>
<td>3.0%</td>
<td>2.1%</td>
<td>1.9%</td>
</tr>
<tr>
<td>Europe</td>
<td>2.0%</td>
<td>1.5%</td>
<td>1.2%</td>
</tr>
<tr>
<td>All Mature Economies*</td>
<td>2.4%</td>
<td>1.9%</td>
<td>1.6%</td>
</tr>
<tr>
<td>Emerging &amp; Developing</td>
<td>3.9%</td>
<td>3.9%</td>
<td>3.9%</td>
</tr>
</tbody>
</table>


U.S. Inflation

<table>
<thead>
<tr>
<th>Inflation Measure</th>
<th>50 Year Average</th>
<th>September 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headline CPI</td>
<td>4.2%</td>
<td>2.2%</td>
</tr>
<tr>
<td>Core CPI</td>
<td>4.1%</td>
<td>2.2%</td>
</tr>
</tbody>
</table>

“The long dark shadow cast by the global financial crisis has receded...”
— J.P. Morgan Chase, 2018

“Growth has proven to be less balanced than we hoped.”
— Maurice Obstfeld, IMF, October 8, 2018

Source: J.P. Morgan Asset Management.
Macroeconomic and Market Risk Factors

Global Economy
- U.S. strength; trade conflicts
- Fiscal stimulus; debt service
- Slowing emerging market growth

Monetary & Fiscal Policy
- Fed interest rate normalization
- Divergent global central bank policies
- Deficit spending; government debt

Asset Valuations
- Impact of equity bull market
- U.S. vs. non-U.S. equities
- Real estate; illiquid investments

Interest Rate Risk
- U.S. rates rising
- Impact of inflation
- Yield curve shape

Note: Sample risk factors. Not all inclusive.
Fed rate normalization through rate hikes and balance sheet contraction is well underway.

- Current Fed funds rate is 2.0% - 2.25%
- Futures market is pricing in an end rate of 2.9%
- FOMC model plots rate at 3.4%
- Neutral rate of 2.9% is low by historical standards.
### Global Economic Environment

#### Equity Valuations: Price to Earnings Ratios

**Forward Price to Earnings (x)**

<table>
<thead>
<tr>
<th>Index</th>
<th>Median</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>S&amp;P 500</td>
<td>24.1</td>
<td>16.1</td>
</tr>
<tr>
<td>S&amp;P 400</td>
<td>20.6</td>
<td>16.3</td>
</tr>
<tr>
<td>S&amp;P 600</td>
<td>19.9</td>
<td>17.3</td>
</tr>
<tr>
<td>MSCI EAFE</td>
<td>27.2</td>
<td>13.6</td>
</tr>
<tr>
<td>MSCI EM</td>
<td>14.4</td>
<td>11.3</td>
</tr>
<tr>
<td>MSCI World</td>
<td>25.9</td>
<td>15.2</td>
</tr>
<tr>
<td>MSCI UK</td>
<td>21.8</td>
<td>15.2</td>
</tr>
<tr>
<td>MSCI Japan</td>
<td>44.5</td>
<td>13.2</td>
</tr>
<tr>
<td>MSCI Canada</td>
<td>25.1</td>
<td>12.8</td>
</tr>
</tbody>
</table>

### Global Interest Rates

<table>
<thead>
<tr>
<th>Country</th>
<th>10 Year June 2018</th>
<th>10 Year June 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>0.03%</td>
<td>0.05%</td>
</tr>
<tr>
<td>Germany</td>
<td>0.30%</td>
<td>0.45%</td>
</tr>
<tr>
<td>U.K.</td>
<td>1.27%</td>
<td>1.25%</td>
</tr>
<tr>
<td>U.S.</td>
<td>2.85%</td>
<td>2.27%</td>
</tr>
<tr>
<td>China</td>
<td>3.57%</td>
<td>3.53%</td>
</tr>
<tr>
<td>Brazil</td>
<td>11.42%</td>
<td>10.25%</td>
</tr>
</tbody>
</table>

Source: FactSet as of 6/30/18
Actuarial Risks
Risks Facing Public Sector Pension Plans

Risks related to economic variables
- Investment return
- Inflation
  - Price inflation
  - Wage inflation
- Contributions

Risks related to demographic events
- Mortality
- Payroll growth
- Population decline
- Retirement, disability, termination
- Plan maturity

Risks related to external forces
- Budgets
- Regulatory risk
- Litigation risk
- Political risk

These risks are challenging to manage effectively
## Risk is Very Much in the Eye of the Beholder

<table>
<thead>
<tr>
<th>Investment Returns and Volatility</th>
<th>Mortality/Longevity</th>
<th>Changing Workforce Demographics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plan Sponsor:</strong> Costs will fluctuate and may increase to unsustainable levels</td>
<td><strong>Plan Sponsor:</strong> Longer life expectancies translate to higher contributions</td>
<td><strong>Plan Sponsor:</strong> Aging population may result in cost increases</td>
</tr>
<tr>
<td><strong>Member:</strong> Benefits levels may change or contributions may increase</td>
<td><strong>Member:</strong> Benefits may not retain purchasing power</td>
<td><strong>Member:</strong> Benefit levels may change or contributions may increase</td>
</tr>
</tbody>
</table>

Risk is Very Much in the Eye of the Beholder
Demographic Risks

Public Sector pension plans have aging populations...

Source: Center for Retirement Research at Boston College Public Plan Database
Workforce Demographic Risk

- Baby boomers aging
- Older participants are closer to payment and generally more expensive than those that are younger
- Higher ratios of actuarial accrued liability to payroll and market value of assets to payroll exacerbates the impact of investment losses on contributions
- Ratio of non-actives to actives
  - Sign of Plan maturity
  - More pressure on investments
  - Difficult to restore financial health after losses
    - Less contributions to increase
Plan Maturity

➢ How much will Plan mature over time?
  • Consider different scenarios for future active population, etc.

➢ As Plan matures, it will become more sensitive to investment volatility
  • In other words, it will be harder to recover from investment losses with increases in contributions, reductions in benefit accruals, or both

➢ Examples of Maturity Measures:
  • Inactive Liability/Total Liability
  • Ratio of Benefit Payments to Contributions
Mortality/Longevity Risk

Continued improvements in mortality = longer periods of payment and higher costs

<table>
<thead>
<tr>
<th></th>
<th>Age at July 1, 2018</th>
<th>65</th>
<th>45</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>83.3</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life expectancy of a male retiree at age 65</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RP-2000 Healthy Annuitant w/Scale BB from 2009</td>
<td>85.0</td>
<td>82.8</td>
<td>82.1</td>
<td></td>
</tr>
<tr>
<td>RP-2014 Blue Collar Healthy Annuitant w/Scale MP-2017</td>
<td>85.3</td>
<td>82.5</td>
<td>82.5</td>
<td></td>
</tr>
<tr>
<td>RP-2014 Healthy Annuitant w/Scale MP-2017</td>
<td>86.3</td>
<td>83.7</td>
<td>83.7</td>
<td></td>
</tr>
</tbody>
</table>

- New tables can increase liability by 3% to 5%.
- Has your mortality assumption been updated and does it include a sufficient margin for mortality improvement?
  - If not, losses will be created.
Governance and Risk Management Tools
Asset Allocation:
Changing Risk Exposures

10 Yr. Expected Return

- Public Equity: 60%
- Fixed Income: 40%

Annualized Risk: 10.4%
Sharpe Ratio: 0.33
20 Yr. Expected Return: 6.0%

10 Yr. Expected Return

- Public Equity: 55%
- Fixed Income: 35%
- Alternatives*: 10%

Annualized Risk: 10.4%
Sharpe Ratio: 0.37
20 Yr. Expected Return: 6.4%

10 Yr. Expected Return

- Public Equity: 47%
- Fixed Income: 33%
- Alternatives*: 20%

Annualized Risk: 11.5%
Sharpe Ratio: 0.43
20 Yr. Expected Return: 7.5%

*Note: Sample for illustrative purposes.

“...alternative investments generally have a low correlation with traditional asset classes...Alternative investments may require additional staff expertise, increased due diligence and careful attention to controls.”

— Government Finance Officers Association
Asset and Liability Management Integration

Governance Framework

- Laws & Regulations
- Board Policies
- Rulings & Agreements
- Plan Document
- Required Reporting

- Provide Guidance & Strategic Oversight
- Review and Approve Policy
- Oversee Performance & Risk
- Oversee Internal Controls & Compliance

- Develop and Recommend Policy
- Monitor Performance & Risk
- Supervise Service Providers
- Report on Internal Controls & Service Delivery

* Fund Staff/Counsel
- Administration
- Benefits
- Finance/Compliance
- Counsel*

* Advisors/Service Providers*
- Investment* Consultant
- Investment Managers
- Custodian
- Actuary*
- Auditor

- Advisors to the Board may include Counsel, Investment Consultant and Actuary
- Depending on structure, “Administration” may be performed by an executive director & staff, trustees, internal administrator or third party administrator
Environmental, Social, Governance

**ESG Defined:** Factors outside the scope of traditional financial measures that may impact company performance.

**Environmental**
- water scarcity
- climate change
- energy efficiency
- pollution

**Social**
- labor relations
- human capital management
- health and safety
- supply chain
- human rights
- corruption
- ethical business practices

**Governance**
- board composition
- board structure
- board accountability
- executive compensation
- shareholder rights
- transparency
- ethical conduct

*Note: See Appendix for additional terms.*
Environmental, Social, Governance: Implementation

**Investment Policy**
- Objectives
- Risk Management
- Selection Criteria
- Required Reporting

**Manager Selection**
- Philosophy
- Process
- Security Selection
- Risk Management

**Proxy Voting**
- Proxy Policy
- Annual Meetings
- Proposals
- Reporting

**Corporate Governance**
- Board of Directors
- Engagement
- Advocacy
- Alliances

---

**ESG Factors Considered in Investment Analysis or Decisions**

- Governance: 64% (2015) - 67% (2017)
- Environmental: 50% (2015) - 54% (2017)
- Social: 49% (2015) - 54% (2017)

Source: CFA Institute Enterprising Investor; September 1, 2016

**Asset Managers Considering ESG Criteria (Trillions)**

- 2016: $8.10
- 2014: $4.80

ESG Implementation: Investment Policy Statement

Approximately six in ten global public pension funds surveyed in 2017 changed their investment policies to apply ESG criteria*

* Source: BlackRock / Economist Intelligence Unit; March 2018. Sample data. Does not include full survey responses.
By breaking risk into distinct categories an investor can more effectively measure and manage risk toward the end of reducing the probability and severity of losses.

### Risk Management Framework: Categories and Definitions

#### Broad Risk Categories
- **Operational Risk**
- **Market Risk**
- **Reputation Risk**
- **Asset/Liability Risk**
- **Credit Risk**

#### Risk Definitions

<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational</td>
<td>Risk of loss resulting from inadequate or failed processes, people and systems of from external events.</td>
</tr>
<tr>
<td>Market</td>
<td>Risk related to adverse movement in market factors such as asset prices, currency rates or interest rates.</td>
</tr>
<tr>
<td>Asset / Liability</td>
<td>Risk that liquidity will not be adequate to meet operational requirements or financial obligations.</td>
</tr>
<tr>
<td>Credit</td>
<td>Risk of loss due to failure of obligors (e.g. bond issuers) to honor their payments.</td>
</tr>
</tbody>
</table>

“ERM (Enterprise Risk Management) provides a centralized framework for identifying, analyzing, responding to and monitoring both investment and non-investment risks.”

—Rotman International Journal of Pension Management; Spring 2013

**Note:** Risk categories are not all inclusive. Asset/Liability Risk is distinct from, but related to Actuarial Risk (encompasses Liquidity Risk).
Risk Management Framework

Governance Structure

Board of Trustees/Executive Staff

Consultant

Counsel

Custodian Bank
Equity Managers
Fixed Income Managers
Real Estate Managers
Hedge Fund Managers
Private Equity Managers
Cash Manager

Risk Management Framework

Governance
- Governance Structure
- Regulatory Framework
- Investment Policy
- Contracts

Assessments
- Asset/Liability Studies
- Due Diligence Reviews
- Liquidity Tier Analysis
- Cost and Fee Analysis

Measures
- Asset Class Exposures
- Standard Deviation
- Credit Rating
- Failed Transactions

Reporting
- Financial Audit
- Required Reports
- Actuarial Valuation
- Advisors / Managers
Risk Management Framework:  
*Historical Stress Testing—Assessment*

**Financial Market Shock (ROR%)**

<table>
<thead>
<tr>
<th>Event</th>
<th>Current Allocation</th>
<th>Sample Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology Meltdown (2Q00 - 1Q01)</td>
<td>-9.4%</td>
<td>-7.1%</td>
</tr>
<tr>
<td>9/11 Terrorist Attacks (3Q01)</td>
<td>-8.7%</td>
<td>-7.3%</td>
</tr>
<tr>
<td>Bear Stearns Collapse (4Q07 - 1Q08)</td>
<td>-6.1%</td>
<td>-5.2%</td>
</tr>
<tr>
<td>China Concerns, Oil Downturn (3Q15)</td>
<td>-4.7%</td>
<td>-4.7%</td>
</tr>
</tbody>
</table>

**Historical Asset Mix Performance (Based on Common Time Frame Across Each Mix)**

*From 4/1/1997 To 12/31/2016 (79 Quarters; 19.75 Years)*

<table>
<thead>
<tr>
<th>Metric</th>
<th>Current Allocation</th>
<th>Sample Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annualized Return</td>
<td>7.4%</td>
<td>7.3%</td>
</tr>
<tr>
<td>Annualized Risk</td>
<td>11.9%</td>
<td>10.8%</td>
</tr>
<tr>
<td>Sharpe Ratio</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Maximum Drawdown</td>
<td>-34.0%</td>
<td>-31.1%</td>
</tr>
<tr>
<td>Quarterly VaR (95%)</td>
<td>-7.2%</td>
<td>-6.5%</td>
</tr>
<tr>
<td>Quarterly MVaR (95%)</td>
<td>-7.8%</td>
<td>-7.2%</td>
</tr>
<tr>
<td>Quarterly CVaR (95%)</td>
<td>-9.5%</td>
<td>-8.6%</td>
</tr>
</tbody>
</table>

Historically, the Sample has had better risk adjusted returns and protected better during drawdown periods.
The asset classes have been separated into tiers based on their respective liquidity, or how easily they can be redeemed for cash.

Tier 1 is the most liquid (daily liquidity) while Tier 6 is the least liquid (dollars tied up for 7 or more years).

Additional inputs into the liquidity assessment include the Fund’s projected cash flows; funded ratio.

### Risk Management Framework:
**Liquidity Tiering—Assessment**

- The asset classes have been separated into tiers based on their respective liquidity, or how easily they can be redeemed for cash.
- Tier 1 is the most liquid (daily liquidity) while Tier 6 is the least liquid (dollars tied up for 7 or more years).
- Additional inputs into the liquidity assessment include the Fund’s projected cash flows; funded ratio.

### Tier Analysis – Includes Current Committed Capital

<table>
<thead>
<tr>
<th>Terms</th>
<th>Tier 1</th>
<th>Tier 2</th>
<th>Tier 3</th>
<th>Tier 4</th>
<th>Tier 5</th>
<th>Tier 6*</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Liquidity</td>
<td>$318,800,000</td>
<td>$30,000,000</td>
<td>$70,000,000</td>
<td>$10,000,000</td>
<td>$10,000,000</td>
<td>$61,200,000</td>
<td>$500,000,000</td>
</tr>
<tr>
<td>Allocated %</td>
<td>63.8%</td>
<td>6.0%</td>
<td>14.0%</td>
<td>2.0%</td>
<td>2.0%</td>
<td>12.2%</td>
<td></td>
</tr>
<tr>
<td>Aggregate Available %</td>
<td>63.8%</td>
<td>69.8%</td>
<td>83.8%</td>
<td>85.8%</td>
<td>87.8%</td>
<td>100.0%</td>
<td></td>
</tr>
</tbody>
</table>

### When Will Assets be Available by Tier?

<table>
<thead>
<tr>
<th></th>
<th>Tier 1 (Daily)</th>
<th>+Tier 2 (Monthly)</th>
<th>+Tier 3 (1 Year)</th>
<th>+Tier 4 (3 years)</th>
<th>+Tier 5 (7 Years)</th>
<th>+Tier 6 (10 Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>64%</td>
<td>64%</td>
<td>64%</td>
<td>64%</td>
<td>64%</td>
<td>64%</td>
</tr>
</tbody>
</table>

Note: Sample for illustrative purposes. Tiers are adjusted for future capital calls. Tier 6 assets are funded from Tier 1.

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Segal Marco Advisors
Risk Assessment: Deterministic Projections

- Projections provide a meaningful way to assess the long-term health of a pension plan
  - Not only provides information on what future funding measures might look like, but also their value relative to the current valuation date

- Deterministic projections are based on a defined set of inputs
  - “If this happens, then this is the result”
  - Often inputs are based on all assumptions being met, with perhaps one or two deviations to demonstrate sensitivity

![Graph showing Funded Ratio and Employer Contribution Rate over years 2015 to 2015]
Risk Assessment:
Case Study

- Scenario tests
  - Determine impact of varying investment returns
  - Baseline: actuarial assumption is met in each future year
  - Other scenarios evaluate short-term lower returns and possible volatility
  - Develop a stress/sensitivity analysis of the client’s asset allocation at the 25th or 10th percentile return for 1, 5 or 10 years

- Stress tests
  - Measure impact of large, one-time loss in 2018
    - Loss could also be measured over a number of years
Deterministic Scenario Tests

- **Scenario 1: baseline returns**
  - Investment returns = 7.5% in all future years

---

**Projected Funded Percentage**

<table>
<thead>
<tr>
<th>Year</th>
<th>Assumed Return</th>
<th>Funded Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>7.5%</td>
<td>82%</td>
</tr>
<tr>
<td>2019</td>
<td>7.5%</td>
<td>82%</td>
</tr>
<tr>
<td>2020</td>
<td>7.5%</td>
<td>82%</td>
</tr>
<tr>
<td>2021</td>
<td>7.5%</td>
<td>84%</td>
</tr>
<tr>
<td>2022</td>
<td>7.5%</td>
<td>86%</td>
</tr>
<tr>
<td>2023</td>
<td>7.5%</td>
<td>90%</td>
</tr>
<tr>
<td>2024</td>
<td>7.5%</td>
<td>93%</td>
</tr>
<tr>
<td>2025</td>
<td>7.5%</td>
<td>95%</td>
</tr>
<tr>
<td>2026</td>
<td>7.5%</td>
<td>98%</td>
</tr>
<tr>
<td>2027</td>
<td>7.5%</td>
<td>101%</td>
</tr>
<tr>
<td>2028</td>
<td>7.5%</td>
<td>105%</td>
</tr>
<tr>
<td>2029</td>
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</tr>
<tr>
<td>2038</td>
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</tr>
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</table>
Deterministic Stress Test

- **Scenario 4: one-time loss**
  - Investment returns = 0% return in 2018, 7.5% per year thereafter

**Projected Funded Percentage**

<table>
<thead>
<tr>
<th>Year</th>
<th>Assumed Return</th>
<th>Funded Percentage</th>
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<tbody>
<tr>
<td>2018</td>
<td>-6.0%</td>
<td>82%</td>
</tr>
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<td>2019</td>
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<td>80%</td>
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<tr>
<td>2020</td>
<td>7.5%</td>
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</tr>
<tr>
<td>2022</td>
<td>7.5%</td>
<td>73%</td>
</tr>
<tr>
<td>2023</td>
<td>7.5%</td>
<td>73%</td>
</tr>
<tr>
<td>2024</td>
<td>7.5%</td>
<td>74%</td>
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<td>7.5%</td>
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<td>2026</td>
<td>7.5%</td>
<td>76%</td>
</tr>
<tr>
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<td>7.5%</td>
<td>77%</td>
</tr>
<tr>
<td>2028</td>
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<td>76%</td>
</tr>
<tr>
<td>2029</td>
<td>7.5%</td>
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</tr>
<tr>
<td>2030</td>
<td>7.5%</td>
<td>80%</td>
</tr>
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<td>2031</td>
<td>7.5%</td>
<td>81%</td>
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<tr>
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<td>7.5%</td>
<td>95%</td>
</tr>
<tr>
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<td>98%</td>
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</table>
Risk Assessment: Comparisons
Risk Assessment: 
*Stochastic Modeling*

- Given a certain set of assumptions:
  - What is the range of possible results?
  - What is the probability of reaching certain metrics (e.g. funded percentage)?
  - What is the likelihood of long-term “success?”

- What are metrics for success?
  - Probability of achieving full funding by stated target date?
  - Probability of remaining fully funded?
  - Probability of contributions remaining below a stated level?

- Monitor risk
  - Evaluate range of possible funded ratios in future years, assuming no changes to contributions
  - Evaluate range of possible contributions in future years to meet funding targets
Stochastic projections provide a view of expected outcomes with an element of probability attached.

For example, the sample tables above illustrate that there is a 25% probability of being less than 63% funded by 2025 and the contribution rate exceeding 41.6%.

Stochastic modeling can be used to establish and assess parameters for monitoring the health and direction of a System.
Portfolio investment returns are simulated using capital market assumptions and the results of thousands of “projections” are tabulated into percentiles:

- **95th percentile**: 5% chance of exceeding this value, 95% chance of falling below
- **75th percentile**: 25% chance of exceeding this value, 75% chance of falling below
- **50th percentile**: (i.e., median value): 50/50 chance of exceeding or falling below this value
- **25th percentile**: 75% chance of exceeding this value, 25% chance of falling below
- **5th percentile**: 95% chance of exceeding this value, 5% chance of falling below

Most deterministic projections show 50/50 results.

Items that can be modeled using stochastic projections:
- Expected investment return
- Employer contributions
- Funded percentage
Limitations of Stochastic Projections

- Current tools allow only one variable to be modeled stochastically: year-by-year actual return on market value of assets
- Simulated investment returns will include improbable scenarios
  - 5th and 95th percentile results may be substantially unreliable

<table>
<thead>
<tr>
<th>Trial</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
<th>Year 6</th>
<th>Year 7</th>
<th>Year 8</th>
<th>Year 9</th>
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<td>-9%</td>
<td>-3%</td>
<td>15%</td>
<td>4%</td>
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</tr>
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</table>
Takeaways
Public retirement systems’ evolving actuarial, market, operational and liquidity risk exposures require new governance frameworks and management approaches.

In the wake of the financial crisis, funds are further diversifying their portfolios and managing new risks related to alternative investments.

Best practices include adoption of Enterprise Risk Management (ERM), asset liability modeling (ALM), ESG investing and expanded use of measures and metrics.

Tools under an integrated risk framework include deterministic modeling, stochastic modeling liquidity tiering and portfolio stress testing.

Funds that implement frameworks to manage risk across retirement system functions will be positioned to achieve risk-adjusted returns through market cycles.
Appendix
Presenters

Julian Regan  
Senior Vice President and Public Sector Market Leader  
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Tammy Dixon  
FSA, FCA, MAAA, EA  
Vice President & Actuary  
tdixon@segalco.com

Expertise

Mr. Regan joined Segal Marco Advisors in 2009 as part of the firm’s continued commitment to public and multi employer benefit plans. Prior to joining the firm, Mr. Regan served in leadership, investment and risk oversight roles in the private and public sectors. Between 2001 and 2006, Mr. Regan served as Executive Director for the New York State Deferred Compensation Board, where he ran the state’s then $8 billion supplemental retirement plan and administered regulations that governed 250 local government plans. Mr. Regan also served as Vice President, Risk Governance and Strategy for Fidelity Investments, and as Assistant General Manager and Budget Director for the Massachusetts Bay Transportation Authority.

Professional Background

From 2005 to 2008, Mr. Regan was a member of the U.S. Internal Revenue Service (IRS) Advisory Committee on Tax Exempt and Government Entities. He is co-author of the National Conference on Public Employee Retirement Systems (NCPERS) Best Governance Practices for Public Retirement Systems, and contributing author to the IFEPP Trustee Handbook, among other publications.

Education/Professional Designations

Mr. Regan received his M.B.A. and B.S.B.A. from Suffolk University and studied at Georgetown University. Mr. Regan is a 2008 recipient of the IRS TE / GE “Commissioner’s Award” and a 2004 “Plan Sponsor of the Year” award recipient.

Expertise

Ms. Dixon joined Segal Consulting in 1998. She has over 30 years of consulting experience working with pension plans for all types of employers, and of varying sizes, with participants ranging from highly compensated, professional or creative personnel to lower-paid seasonal workers, and extensive experience with compliance issues and legislative processes.

Professional Background

Ms. Dixon is a member of the Pension Committee for the Actuarial Standards Board, developing standards for actuaries working in the pension area. She has previously served on the SOA Pension Section Council, the SOA Education and Examination Committee for pension exams and the joint SOA/Casualty Actuarial Society (CAS) Minority Recruiting Committee. Ms. Dixon speaks and presents frequently at professional organizations and has testified before state legislative bodies. She recently co-authored a paper for the Society of Actuaries, “Public Pension Plan Design: A Two-Component Approach to Addressing Challenges”.

Education/Professional Designations

Ms. Dixon has a B.A. in Mathematics, with a minor in Economics, from Southern Illinois University. She is a Fellow of the Society of Actuaries, a Fellow of the Conference of Consulting Actuaries, a Member of the American Academy of Actuaries and an Enrolled Actuary.