Pension Asset-Liability Study

Pennsylvania Public School Employees' Retirement System (PSERS)
November 2020

Investment advice and consulting services provided by Aon Investments USA Inc.

Empower Results®

Table of Contents

Executive Summary

Executive Summary
Challenges for Public Pension Plan Sponsors

Challenges

Challenging Financial Situation
- Plan is underfunded with a 55.8% funded ratio on a market value of asset basis as of June 30, 2019 (the starting point of our analysis)
- High required contributions at a time when governmental revenues may be strained

Uncertainty Lies Ahead
- Wide range of future outcomes
- Expect a rocky road rather than a smooth line

Portfolio Construction
- Diversify portfolio to counteract future uncertainty
- Use illiquid alternatives to capture additional diversification and return premium, if Plan's liquidity is manageable

Evaluate Financial Impacts
- How do different portfolios impact key financial measures such as funded ratio and contribution rates?
- Sequence of future returns is important when the Plan is underfunded

Executive Summary

Current State Asset-Liability Profile as of June 30, 2019[1]

Funded Ratio	Asset Allocation	Expected Return	Hurdle Rate Analysis
▪ **55.8%** on a Market Value of Asset basis ▪ Consider how to grow the funded ratio over time	▪ **71%** Return-Seeking Assets with a net 29% of Risk-Reducing & Financing assets ▪ Consider a variety of strategies, from across the risk spectrum	▪ Current portfolio has an expected return of **6.73%**[2] over the next 30 years using Aon's latest capital market assumptions ▪ Alternative portfolios have a range of expected returns from 6.47% - 7.20%[2]	▪ **16.55%** Asset Hurdle Rate ▪ Asset growth, contributions plus investment returns, needs to exceed hurdle rate in order for funded ratio to increase

[1] Current State Asset-Liability Profile based on June 30, 2019 actuarial valuation report

[2] Expected returns based on Aon Investments' Q3 2020 30 year Capital Market Assumptions assuming the detailed portfolios found in the Appendix. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See Appendix for the Capital Market Assumptions.

Executive Summary

Summary and Conclusions

Portfolio Analysis

- The current portfolio is well-diversified
- The expected annual return assumption for the Current Target portfolio is 6.73% over the next 30 years
- PSERS should consider its desired balance between cash funding, risk tolerance, and investment returns when determining the ideal investment portfolio

Asset-Liability Projection Analysis

- Longer time horizons are expected to reward higher levels of risk; shorter time horizons are not
- The funded ratio is projected to trend toward full funding over the course of the projection period
- Adverse market experience and/or not making required contributions will negatively impact the funded status over the projection period

Executive Summary

Key Observations

1) PSERS is projected to attain full funding by 2049 (on a market value of assets basis) in our central expectation (50th percentile outcome) under the Current Target Asset Allocation

- This assumes that the actuarially determined contributions are paid in full when they are due
- These projections include the benefit changes from Act 5 of 2017

2) PSERS employer contributions are expected to increase in the central expectation over the next fifteen years to approximately $8.2 billion annually utilizing the Current Target allocation

- This increase in contributions reflects the amortization of the unfunded liabilities based on the current amortization schedule
- The contributions decline to $0.75 billion annually (the employer normal cost) at the end of the 30-year projection period as the plan reaches 100% funded
- This reduction in the contributions for the DB Plan is offset by the expected increasing DC contributions.
- This portfolio has a 51% probability of reaching full funding at the end of the 30 year projection period
- A public pension fund which amortizes over 30 years would be expected to have a 50% chance of full funding over 30 years

3) Given the decline in expected returns for the current portfolio as a result of declining Capital Market Assumptions, the probability of reaching full funding is lower and the expected contributions are slightly higher than last year's analysis

Executive Summary

Key Observations (continued)

4) Based on the feedback from the Board regarding the target portfolios, Aon and PSERS Investment staff have added a new portfolio – Portfolio H to the analysis for the Board's consideration

5)As a result of the analysis, Aon proposes PSERS consider Portfolio H as the new Target Portfolio

- Portfolio H provides a similar risk/reward portfolio as the Current Target Portfolio as measured by the Sharpe Ratio (0.508)
- Stochastic modelling illustrates superior forward-looking projections versus the Current portfolio, with a 55% probability of reaching full funding at the end of the 30-year projection period with a 7% higher expected funded ratio
- Expected contributions over the 30-year period are also lower in both the expected and worst case scenario versus the current portfolio

6) The Proposed Portfolio H improves the liquidity profile of the Plan, reducing the allocation to illiquid assets by 5% from 44% to 39%, reduces net financing from 12% to 10%, and improves the expected return of the Plan by 31 bps to 7.04%

- While the expected volatility does increase to 11.76% from 11.15%, the risk-adjusted return as measured by the Sharpe Ratio is maintained
- The primary allocation changes versus the Current portfolio are:
  - Fixed income -7%
  - Real assets +2%
  - Public equity +8%
  - Private Equity -3%
  - Hedge Funds -2%
  - Net Financing -2%

7) As the expected return for Proposed Portfolio H is 7.04%, a review of PSERS' EROA assumption as part of its planned experience study in early 2021 may be warranted

Asset-Liability Projection Results (Stochastic Results)

Summary and Conclusions

All Scenarios (in $ billions)	30-year Economic Cost		30-year Present Value of Gross Contributions (Employee + Employer)		30-year Ending Funded Ratio (MVA / AL)	
	Expected[1]	Downside[2]	Expected[1]	Downside[2]	Expected[1]	Downside[3]
(A) PSERS Current	$80.0	$107.1	$80.9	$100.8	101%	37%
(B) Highest Return, Liquidity, Fixed Income & Leverage	$76.3	$105.7	$78.9	$100.0	114%	39%
- Delta from Current (A)	*($3.8)*	*($1.4)*	*($1.9)*	*($0.8)*	*13%*	*2%*
(C) Higher Return, Liquidity & Leverage	$77.3	$106.4	$79.5	$100.4	110%	38%
- Delta from Current (A)	*($2.7)*	*($0.7)*	*($1.4)*	*($0.4)*	*10%*	*1%*
(D) Similar Risk & Return / Lower Leverage	$80.0	$107.4	$80.8	$101.1	101%	37%
- Delta from Current (A)	*$0.0*	*$0.3*	*($0.0)*	*$0.3*	*0%*	*0%*
(E) Reduce Left Tail Risk	$83.3	$106.7	$82.5	$100.1	92%	38%
- Delta from Current (A)	*$3.3*	*($0.3)*	*$1.6*	*($0.7)*	*-9%*	*1%*
(F) Similar Risk & Return / No Explicit Leverage	$80.7	$108.0	$81.1	$101.5	100%	36%
- Delta from Current (A)	*$0.7*	*$1.0*	*$0.2*	*$0.7*	*-1%*	*-1%*
(G) Higher Return & Liquidity	$78.3	$108.0	$80.2	$101.9	108%	36%
- Delta from Current (A)	*($1.7)*	*$0.9*	*($0.7)*	*$1.1*	*7%*	*-1%*
(H) *Higher Return & Liquidity / Lower Leverage*	$77.8	$106.8	$79.8	$100.6	108%	37%
- Delta from Current (A)	*($2.3)*	*($0.2)*	*($1.1)*	*($0.2)*	*7%*	*0%*

Green = Savings/Funded Ratio Improvement from Current (A)
Red = Increased Cost/Reduction in Funded Ratio from Current (A)
[1] Expected = 50th percentile outcome or central expectation across all 5,000 simulations
[2] Downside = 95th percentile outcome across all 5,000 simulations
[3] Downside = 5th percentile outcome across all 5,000 simulations
Differences based on unrounded values so may not match the difference of rounded values

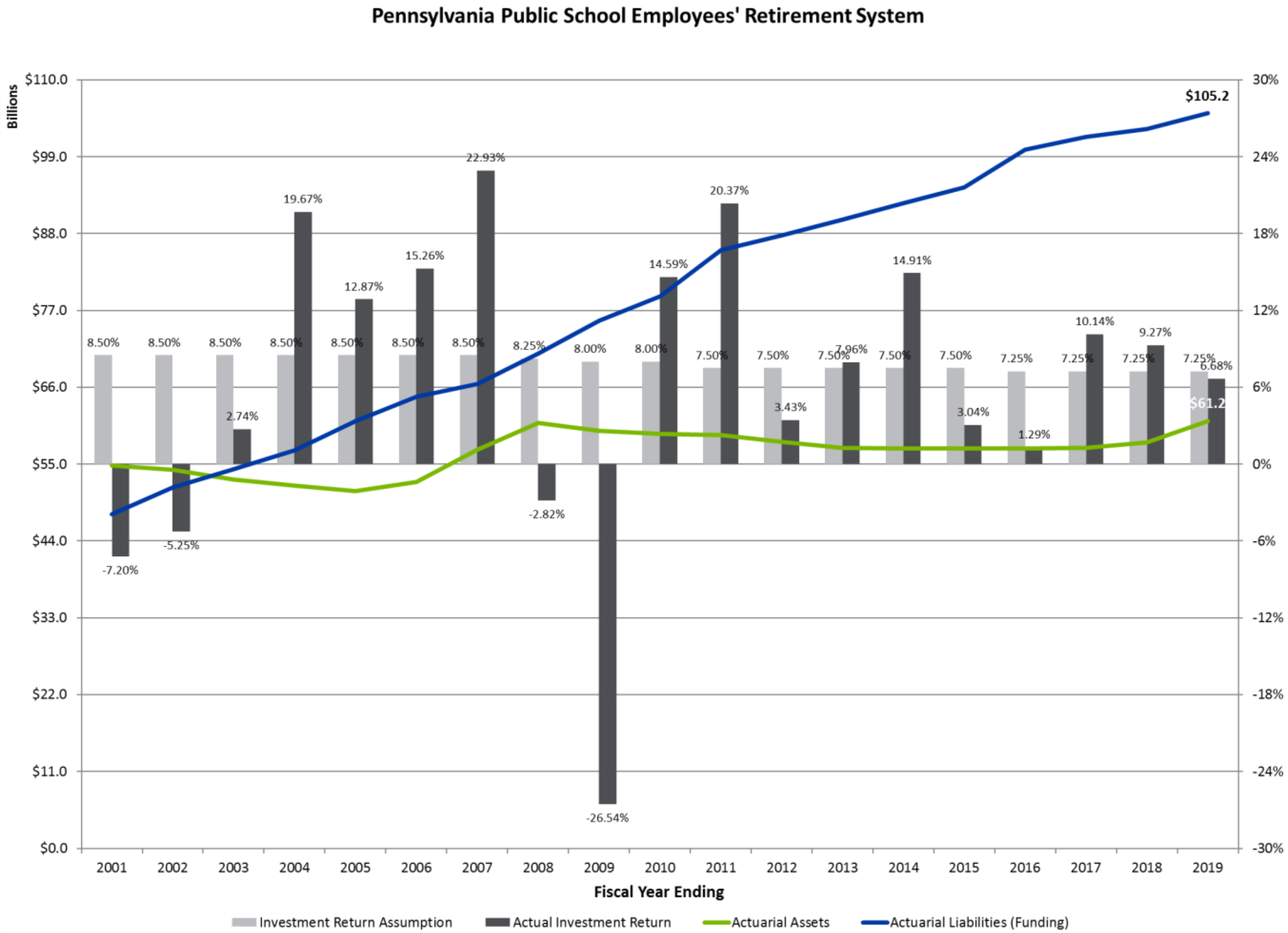
= Recommendation

AON
Empower Results®

Analysis

- Background and Current State

Background and Historical Information
Overview



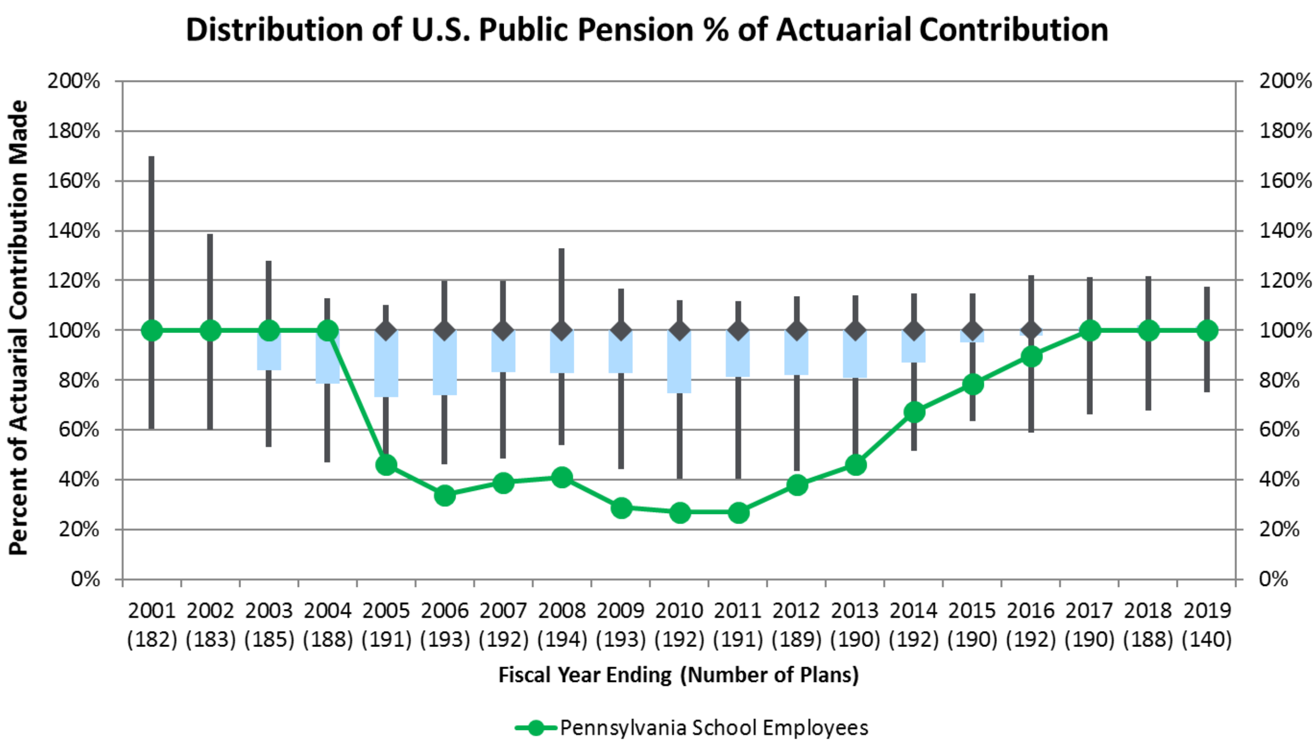
Key Takeaways:

- **Blue line** represents the actuarial liabilities over time
  – Adding to the increase in liability has been the decrease in the assumed investment return (**light gray bar**)
- **Green line** represents the actuarial value of plan assets over time
  – Assets reflect smoothing parameters to the actual return on assets (**dark gray bar**)

Sources: Public Plans Data (publicplansdata.org) as of July 2020; historical actuarial valuation reports

Background and Historical Information

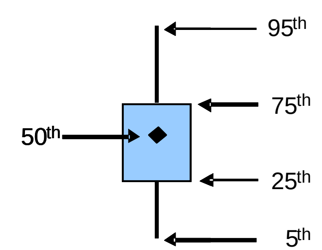
Percentage of Actuarial Contribution Made versus Peers[1]



Key Takeaway:

- Contributions for PSERS, as a percentage of the actuarially-determined amount, had been below 100% for FYE 2005-2016 and have been 100% since that time

Percentile



PSERS Annual Underfunding (in $ billions)

FYE	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Annual Under-funding	$0.0	$0.0	$0.0	$0.0	$0.5	$0.9	$1.0	$1.1	$1.3	$1.4	$1.8	$1.6	$1.7	$1.0	$0.7	$0.4	$0.0	$0.0	$0.0

Accumulated Value of Underfunding as of June 30, 2019 (in $ billions)[2] = **$23.6 billion**

Sources: Public Plans Data (publicplansdata.org) as of July 2020

[1] Peers defined as public funds published within publicplansdata.org as of July 2020; Number of plans per year are shown in parentheses

[2] Calculated as any underfunding from FYE 2001-2019 (determined by historical information found in PSERS' actuarial valuation reports), assuming end-of-year timing of contributions, and PSERS' actual portfolio returns through June 30, 2019

Current State Asset-Liability Profile
As of June 30, 2019

Asset-Liability Snapshot as of 6/30/2019		
Metric ($, Billions)	**Value**	**Fund %**
Market Value of Assets	$58.73	55.8%
Actuarial Value of Assets	$61.07	58.0%
Liability Metrics		
Actuarial Liability (AL) - Funding	$105.20[1]	

Current Target Asset Allocation		
Metric ($, Billions)	**Value**	**Alloc %**
Return-Seeking		
- Public Equity	$11.2	19%
- Private Equity	$8.8	15%
- Real Estate	$5.9	10%
- Commodities	$5.9	10%
- Infrastructure	$2.9	5%
- Energy MLPs	$0.6	1%
- Credit-Related[2]	$6.5	11%
- Total	$41.7	71%
Risk-Reducing + Financing		
- Inflation Linked Bonds[3]	$11.2	19%
- Cash & Financing	-$7.0	-12%
- Core Bonds	$2.3	4%
- Hedge Funds[4]	$5.9	10%
- Long Duration Fixed Income	$4.7	8%
- Total	$17.0	29%
Total	$58.7	100%

Key Takeaways:

- Pension plan is 55.8% funded on a market value of assets basis as of June 30, 2019
- Asset hurdle rate of 16.55%, via cash funding and investment returns, needed to maintain or improve actuarial funded status
- The Total Expected Asset Growth rate (EROA plus Contributions) falls short of the Hurdle Rate by 14 bps; a decrease from last year's study

Asset-Liability Growth Metrics for FYE 6/30/2020			
Metric ($, Billions)	**Value**	**% Liability**	**% Assets**
AL Discount Cost	$7.63	7.25%	12.99%
AL Normal Cost	$2.09	1.99%	3.56%
Total Liability Hurdle Rate	**$9.72**	**9.24%**	**16.55%**
Expected Return on Assets[5]	$3.95	3.75%	6.73%
Total Contributions	$5.68	5.40%	9.68%
Total Exp. Asset Growth	**$9.63**	**9.15%**	**16.41%**
Hurdle Rate Shortfall/(Surplus)	**$0.08**	**0.09%**	**0.14%**
Est. Benefit Payments	$7.34	6.97%	12.49%

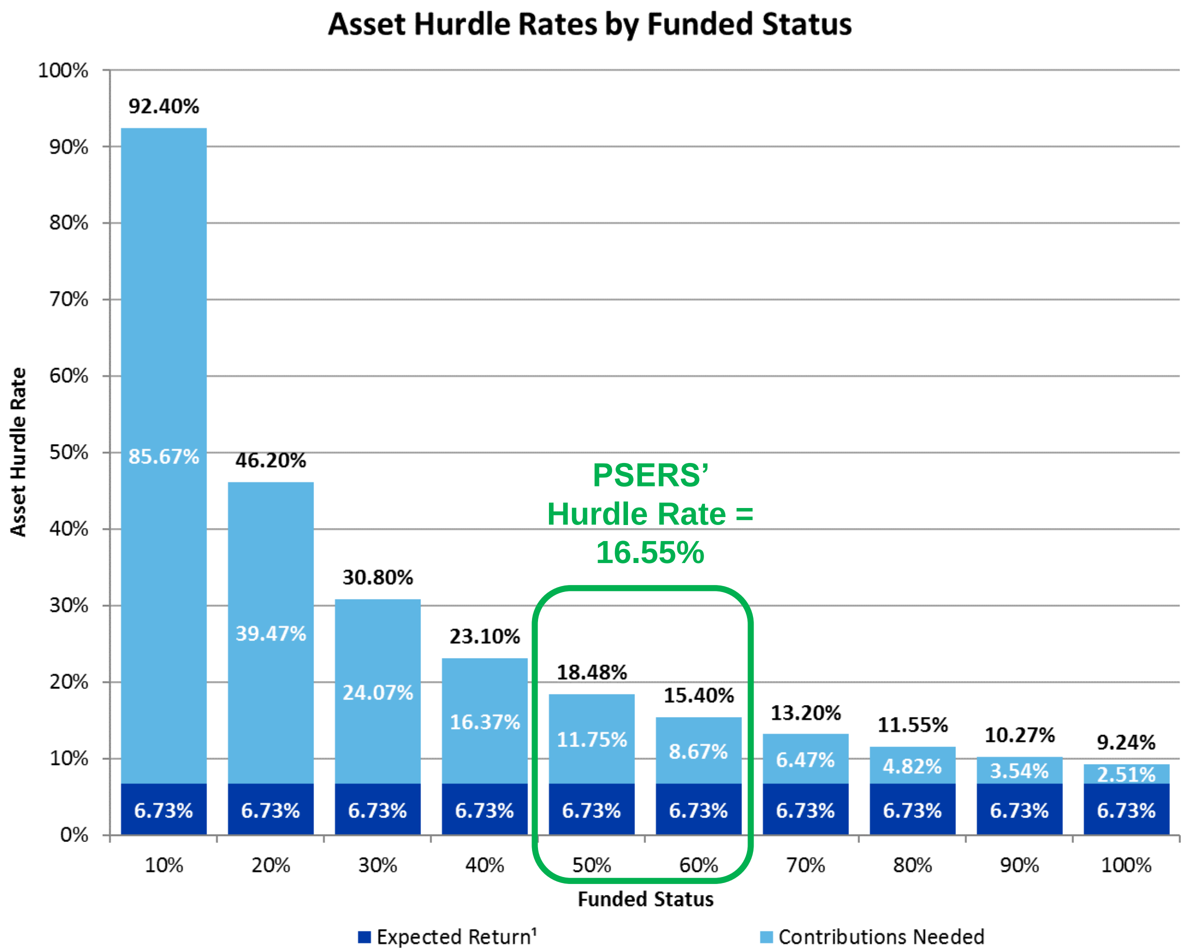
[1] Based on a 7.25% discount rate consistent with the June 30, 2019 valuation results
[2] Credit-Related includes Private Credit, High-Yield Bonds, and Emerging Market Debt
[3] Inflation-Linked has a 50% allocation to US TIPS and 50% allocation to Non-US Inflation-Linked
[4] Hedge funds have elements of both return-seeking and risk-reducing assets. Hedge funds have been categorized as risk-reducing based on the composition of the hedge funds within the PSERS portfolio.
[5] Using Aon Investments' Q3 2020 30 year capital market assumptions

Asset Hurdle Rate

- **Asset Hurdle Rate** is the level of asset growth needed to keep pace with the growth of the Plan liabilities
  - Assets must grow at this rate or more in order to maintain or reduce the existing funding shortfall

- Assets can grow via:
  - Investment performance, and/or
  - Funding contributions

- Asset hurdle rates increase as funded ratio declines, as shown in the chart to the right



[1]Using Aon Investments' Q3 2020 30 year capital market assumptions

Analysis

- Portfolio Analysis

Empower Results®

Portfolio Summary

- In the July 31, 2020 Board discussion and the Board survey, the following goals were identified for the Strategic Asset Allocation:
  - Willingness to review reduction in the EROA from 7.25% reflecting the declining interest rate environment
  - Maintain a return consistent with the current target portfolio return
  - Reduce allocation to illiquid assets
  - Consider lower leverage portfolios
  - Reduce volatility or left tail risk
- Based on the stated objectives and in conversations with Staff, the following allocations were selected to run through our stochastics projection analysis:

	Portfolio	Maintain Consistent Return w/ Current Target	Reduce Illiquid Assets	Reduce Net Leverage	Reduce Left Tail Risk
(A)	**PSERS Current (Target Values)**	**6.73%**	**44%**	**12%**	**-13.25%**
(B)	Highest Return, Liquidity, Fixed Income & Leverage	✓	✓		
(C)	Higher Return, Liquidity & Leverage	✓	✓		
(D)	Similar Risk & Return / Lower Leverage	✓	✓	✓	
(E)	Reduce Left Tail Risk		✓		✓
(F)	Similar Risk & Return / No Explicit Leverage	✓		✓	
(G)	Higher Return & Liquidity	✓	✓		
(H)	Higher Return & Liquidity / Lower Leverage	✓	✓	✓	

Use of Leverage in a Portfolio Context

- Leverage is borrowing assets either explicitly (line of credit) or implicitly through financial instruments with embedded leverage (swaps and futures)

- Leverage is a portfolio tool that investors use to expand the ability to build more efficient portfolio
  - Leverage relaxes the constraint on the amount of assets to be invested
  - Leverage enables the investor to build more efficient portfolios on a risk/reward perspective (Sharpe Ratio)
  - Leverage aids in portfolio construction by:
    - Enabling further risk reduction
    - Balancing the contributions to portfolio risk
    - Improving diversification
    - Improving Total Return for the same level of risk

- The use of leverage will impact the total portfolio's market risk by using uncorrelated asset classes, thereby creating a smoother pattern of performance over time, all else equal
  - Leverage also impacts other portfolio risks which are mitigated by a robust risk management program
  - PSERS' Leverage Policy outlines the policies and procedures used to mitigate these risks; other PSERS' Policies that mitigate risks from leverage include:
    - Liquidity Policy – Liquidity Risk
    - Derivatives Policy – Counterparty Risk

Public Fund Universe Utilizing Leverage at the Policy Level*

Plan Name	AUM ($ Billion)	Policy Level Leverage
Ontario Teachers' Pension Plan	$204	46%
Missouri State Employees' Retirement System (MOSERS)	$9	40%
Nova Scotia Health Employees' Pension Plan	$10	~40%
Missouri Local Government Employees' Retirement System (LAGERS)	$8	35%
Healthcare of Ontario Pension Plan	$94	~30%
California Public Employees' Retirement System (CalPERS)	$413	20%
Canada Pension Plan Investment Board (CPPIB)	$434	20%
Ohio Police and Fire Pension Fund	$16	20%
Ontario Municipal Employees' Pension Plan	$109	~20%
OPTrust – OPSEU Pension Plan	$22	~17%
State of Wisconsin Investment Board (SWIB)	$117	10%
Teacher Retirement System of Texas	$155	6%

* Based on publicly available information

Aon Investments' Capital Market Assumptions

As of June 30, 2020 (30 Years)

		Expected Real Return[1]	Expected Nominal Return[1]	Expected Nominal Volatility
	Equity			
1	Large Cap U.S. Equity	4.3%	6.5%	17.0%
2	Small Cap U.S. Equity	4.8%	7.0%	23.2%
3	International Equity (Developed) - Hedged	4.8%	7.0%	18.0%
4	International Equity (Developed) - Unhedged	5.3%	7.5%	20.0%
5	Emerging Markets Equity	5.9%	8.1%	27.0%
	Fixed Income			
6	Cash (Gov't)	-1.0%	1.1%	1.8%
7	TIPS	0.0%	2.0%	4.6%
8	Non-US Inflation Linked	-0.6%	1.5%	3.9%
9	Core Fixed Income	-0.1%	2.0%	5.1%
10	Long Duration Bonds – Gov't	-0.4%	1.6%	10.7%
11	High Yield Bonds	2.0%	4.1%	12.2%
12	Emerging Market Bonds	1.9%	4.0%	13.9%
13	Emerging Market Bonds (Sov. Local)	1.6%	3.7%	14.4%
	Alternatives			
14	Hedge Funds[2]	2.5%	4.6%	8.7%
15	Non Core Real Estate	5.5%	7.7%	25.3%
16	US REITs	4.1%	6.2%	18.7%
17	Commodities	1.4%	3.5%	16.9%
18	Private Equity[3]	7.2%	9.4%	26.2%
19	Infrastructure - Private	6.1%	8.3%	14.4%
20	Infrastructure - Public	4.7%	6.9%	17.3%
21	Energy MLPs	4.7%	6.9%	17.3%
22	Gold	1.0%	3.1%	19.4%
23	Private Debt	3.7%	5.9%	16.9%
	Inflation			
24	Inflation	0.0%	2.1%	1.5%

[1] All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees.

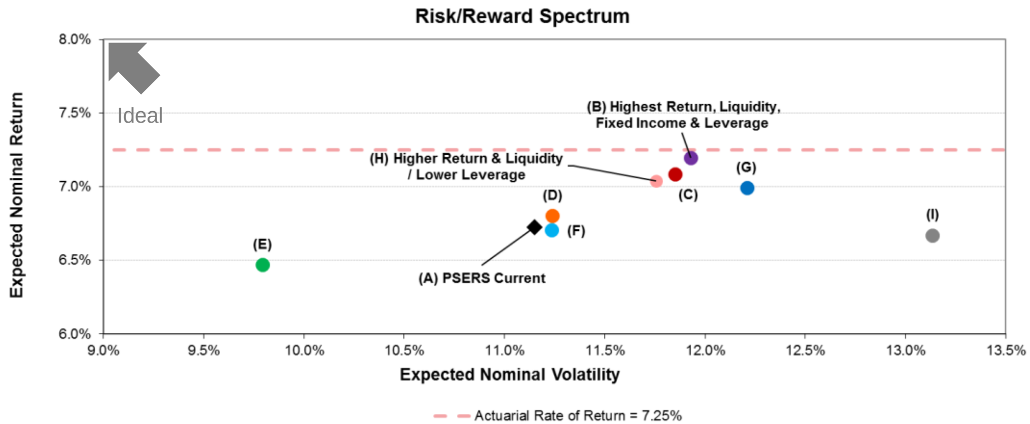
[2] Hedge Fund assumptions developed as follows: 14% Event Driven, 38% Global Macro, 20% Distressed Debt, 16% Fixed Income Arbitrage, 12% Cat. Bonds

[3] Private Equity assumptions developed as follows: 72% Buyouts, 13% Venture Capital, 15% Distressed Debt

Empower Results®

Portfolio Analysis

Risk/Reward Spectrum



Key Takeaways:

- The PSERS Current portfolio (without risk parity) has a high allocation to return-seeking assets
  - Return-seeking assets are broadly diversified
- All portfolios considered have less volatility than the Total Public Plan Universe (Portfolio I)

	Expected Nominal Return	Expected Nominal Volatility	Sharpe Ratio	% Illiquid[1]	Return-Seeking Assets: Public Equity	Private Equity	Credit-Related[2]	Real Estate	Comm-odities	Infra-structure	Energy MLPs	Risk Parity / Multi-Asset	Risk-Reducing / Safety Assets + Financing: Inflation-Linked	Net Cash / Financing	Core Bonds	Hedge Funds[3]	Long Dur. Gov't Bonds
(A) PSERS Current	6.73%	11.15%	0.508	44.0%	19%	15%	11%	10%	10%	5%	1%	0%	19%	-12%	4%	10%	8%
(B) Highest Return, Liquidity, Fixed Income & Leverage	7.20%	11.93%	0.514	38.0%	27%	12%	11%	10%	13%	8%	0%	0%	29%	-26%	1%	8%	7%
(C) Higher Return, Liquidity & Leverage	7.09%	11.85%	0.509	38.0%	27%	12%	12%	10%	10%	8%	0%	0%	23%	-18%	1%	8%	7%
(D) Similar Risk & Return / Lower Leverage	6.80%	11.24%	0.511	40.0%	30%	12%	10%	8%	5%	8%	0%	0%	11%	-8%	9%	8%	7%
(E) Reduce Left Tail Risk	6.47%	9.79%	0.552	43.0%	20%	12%	10%	9%	5%	8%	0%	0%	17%	-13%	10%	10%	12%
(F) Similar Risk & Return / No Explicit Leverage	6.71%	11.24%	0.503	44.0%	25%	15%	10%	9%	3%	8%	0%	0%	10%	0%	7%	8%	5%
(G) Higher Return & Liquidity	6.99%	12.21%	0.486	38.0%	35%	12%	7%	10%	5%	6%	0%	0%	10%	-15%	10%	10%	10%
(H) Higher Return & Liquidity / Lower Leverage	7.04%	11.76%	0.508	39.0%	27%	12%	12%	10%	10%	8%	0%	0%	15%	-10%	1%	8%	7%
(I) Total Public Pension Universe[4]	6.66%	13.15%	0.426	24.8%	48%	10%	8%	7%	1%	1%	0%	3%	0%	2%	16%	5%	0%

[1] Illiquid includes investments considered Quasi-Liquid (typical lock-up of 3-12 months) such as hedge funds and Illiquid with 5+ years such as closed-ended real estate and private equity

[2] Credit-Related includes private credit, high-yield bonds, and emerging market debt

[3] Hedge funds have elements of both return-seeking and risk-reducing assets. Hedge funds have been categorized as risk-reducing based on the composition of the hedge funds within the PSERS portfolio.

[4] Source: "*2019 U.S. Institutional Market Trends*", Greenwich Associates

Portfolio Analysis
Portfolios Evaluated – Group 1

	(A) PSERS Current	Change from (A) to (B)	(B) Highest Return, Liquidity, Fixed Income & Leverage	Change from (A) to (C)	(C) Higher Return, Liquidity & Leverage	Change from (A) to (H)	(H) Higher Return & Liquidity / Lower Leverage
US Equity	7.1%	3.9%	11.0%	3.9%	11.0%	3.9%	11.0%
Non-US Dev, Unhedged	1.9%	5.1%	7.0%	5.1%	7.0%	5.1%	7.0%
Non-US Dev, USD Hedged	5.6%	-3.6%	2.0%	-3.6%	2.0%	-3.6%	2.0%
Emerging Markets	4.4%	2.6%	7.0%	2.6%	7.0%	2.6%	7.0%
Private Equity, Unhedged[1]	15.0%	-3.0%	12.0%	-3.0%	12.0%	-3.0%	12.0%
Total Equity	**34.0%**	**5.0%**	**39.0%**	**5.0%**	**39.0%**	**5.0%**	**39.0%**
US Core Fixed Income	4.0%	-3.0%	1.0%	-3.0%	1.0%	-3.0%	1.0%
US Long-Term Treasury	8.0%	-1.0%	7.0%	-1.0%	7.0%	-1.0%	7.0%
Emerging Market Debt, Local	0.0%	0.0%	0.0%	1.0%	1.0%	0.0%	0.0%
Emerging Markets Debt, Hard	1.0%	0.0%	1.0%	0.0%	1.0%	1.0%	2.0%
High Yield	0.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Private Credit	10.0%	-2.0%	8.0%	-2.0%	8.0%	-2.0%	8.0%
US TIPS	9.5%	10.5%	20.0%	8.5%	18.0%	2.5%	12.0%
Non-US Inflation-Linked[2]	9.5%	-0.5%	9.0%	-4.5%	5.0%	-6.5%	3.0%
Total Fixed Income	**42.0%**	**6.0%**	**48.0%**	**1.0%**	**43.0%**	**-7.0%**	**35.0%**
Infrastructure: Energy MLPS	1.0%	-1.0%	0.0%	-1.0%	0.0%	-1.0%	0.0%
Infrastructure: Private, USD Hedged	1.0%	2.0%	3.0%	2.0%	3.0%	3.0%	4.0%
Infrastructure: Public, USD Hedged	4.0%	1.0%	5.0%	1.0%	5.0%	0.0%	4.0%
Commodities: Diversified	6.0%	-1.0%	5.0%	-3.0%	3.0%	-3.0%	3.0%
Commodities: Gold	4.0%	4.0%	8.0%	3.0%	7.0%	3.0%	7.0%
Private Real Estate, Unhedged	8.0%	-1.0%	7.0%	-1.0%	7.0%	-1.0%	7.0%
Global REITs, USD Hedged	2.0%	1.0%	3.0%	1.0%	3.0%	1.0%	3.0%
Total Real Assets	**26.0%**	**5.0%**	**31.0%**	**2.0%**	**28.0%**	**2.0%**	**28.0%**
Hedge Funds[3]	**10.0%**	**-2.0%**	**8.0%**	**-2.0%**	**8.0%**	**-2.0%**	**8.0%**
Net Cash / Financing	**-12.0%**	**-14.0%**	**-26.0%**	**-6.0%**	**-18.0%**	**2.0%**	**-10.0%**
Total Plan	**100.0%**	**0.0%**	**100.0%**	**0.0%**	**100.0%**	**0.0%**	**100.0%**
30-Year Exp. Nom. Return	**6.73%**	**0.47%**	**7.20%**	**0.36%**	**7.09%**	**0.31%**	**7.04%**
30-Year Expected Risk	**11.15%**	**0.78%**	**11.93%**	**0.70%**	**11.85%**	**0.61%**	**11.76%**
Sharpe Ratio	**0.508**	**0.006**	**0.514**	**0.001**	**0.509**	**0.000**	**0.508**

[1] Private Equity assumptions developed as follows: 72% Buyouts, 13% Venture Capital, 15% Distressed Debt
[2] Non-US Inflation-Linked assumptions developed as follows: 3% Canada, 52% UK, 45% Europe. Hedged to USD.
[3] Hedge Fund assumptions developed as follows: 14% Event Driven, 38% Global Macro, 20% Distressed Debt, 16% Fixed Income Arbitrage, 12% Cat. Bonds; Hedge funds have elements of both return-seeking and risk-reducing assets. Hedge funds have been categorized as risk-reducing based on the composition of the hedge funds within the PSERS portfolio.
Percentages in table may not sum to 100% due to rounding

Portfolio Analysis

Portfolios Evaluated – Group 2

	(A) PSERS Current	Change from (A) to (D)	(D) Similar Risk & Return / Lower Leverage	Change from (A) to (E)	(E) Reduce Left Tail Risk	Change from (A) to (F)	(F) Similar Risk & Return / No Explicit Leverage	Change from (A) to (G)	(G) Higher Return & Liquidity
US Equity	7.1%	10.0%	17.1%	4.3%	11.4%	7.1%	14.2%	12.9%	20.0%
Non-US Dev, Unhedged	1.9%	0.9%	2.8%	-1.9%	0.0%	-1.9%	0.0%	-1.9%	0.0%
Non-US Dev, USD Hedged	5.6%	0.9%	6.5%	0.6%	6.2%	2.2%	7.8%	5.4%	11.0%
Emerging Markets	4.4%	-0.8%	3.6%	-2.0%	2.4%	-1.4%	3.0%	-0.4%	4.0%
Private Equity, Unhedged[1]	15.0%	-3.0%	12.0%	-3.0%	12.0%	0.0%	15.0%	-3.0%	12.0%
Total Equity	**34.0%**	**8.0%**	**42.0%**	**-2.0%**	**32.0%**	**6.0%**	**40.0%**	**13.0%**	**47.0%**
US Core Fixed Income	4.0%	5.0%	9.0%	6.0%	10.0%	3.0%	7.0%	6.0%	10.0%
US Long-Term Treasury	8.0%	-1.0%	7.0%	4.0%	12.0%	-3.0%	5.0%	2.0%	10.0%
Emerging Market Debt, Local	0.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Emerging Markets Debt, Hard	1.0%	-1.0%	0.0%	-1.0%	0.0%	-1.0%	0.0%	-1.0%	0.0%
High Yield	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Private Credit	10.0%	-2.0%	8.0%	-2.0%	8.0%	-2.0%	8.0%	-5.0%	5.0%
US TIPS	9.5%	1.5%	11.0%	7.5%	17.0%	0.5%	10.0%	0.5%	10.0%
Non-US Inflation-Linked[2]	9.5%	-9.5%	0.0%	-9.5%	0.0%	-9.5%	0.0%	-9.5%	0.0%
Total Fixed Income	**42.0%**	**-5.0%**	**37.0%**	**7.0%**	**49.0%**	**-10.0%**	**32.0%**	**-5.0%**	**37.0%**
Infrastructure: Energy MLPS	1.0%	-1.0%	0.0%	-1.0%	0.0%	-1.0%	0.0%	-1.0%	0.0%
Infrastructure: Private, USD Hdgd	1.0%	5.0%	6.0%	5.0%	6.0%	5.0%	6.0%	2.0%	3.0%
Infrastructure: Public, USD Hdgd	4.0%	-2.0%	2.0%	-2.0%	2.0%	-2.0%	2.0%	-1.0%	3.0%
Commodities: Diversified	6.0%	-6.0%	0.0%	-6.0%	0.0%	-6.0%	0.0%	-6.0%	0.0%
Commodities: Gold	4.0%	1.0%	5.0%	1.0%	5.0%	-1.0%	3.0%	1.0%	5.0%
Private Real Estate, Unhedged	8.0%	-2.0%	6.0%	-1.0%	7.0%	-1.0%	7.0%	0.0%	8.0%
Global REITs, USD Hedged	2.0%	0.0%	2.0%	0.0%	2.0%	0.0%	2.0%	0.0%	2.0%
Total Real Assets	**26.0%**	**-5.0%**	**21.0%**	**-4.0%**	**22.0%**	**-6.0%**	**20.0%**	**-5.0%**	**21.0%**
Hedge Funds[3]	**10.0%**	**-2.0%**	**8.0%**	**0.0%**	**10.0%**	**-2.0%**	**8.0%**	**0.0%**	**10.0%**
Net Cash / Financing	**-12.0%**	**4.0%**	**-8.0%**	**-1.0%**	**-13.0%**	**12.0%**	**0.0%**	**-3.0%**	**-15.0%**
Total Plan	**100.0%**	**0.0%**	**100.0%**	**0.0%**	**100.0%**	**0.0%**	**100.0%**	**0.0%**	**100.0%**
30-Year Exp. Nom. Return	**6.73%**	**0.07%**	**6.80%**	**-0.26%**	**6.47%**	**-0.02%**	**6.71%**	**0.26%**	**6.99%**
30-Year Expected Risk	**11.15%**	**0.09%**	**11.24%**	**-1.36%**	**9.79%**	**0.09%**	**11.24%**	**1.06%**	**12.21%**
Sharpe Ratio	**0.508**	**0.003**	**0.511**	**0.044**	**0.552**	**-0.005**	**0.503**	**-0.022**	**0.486**

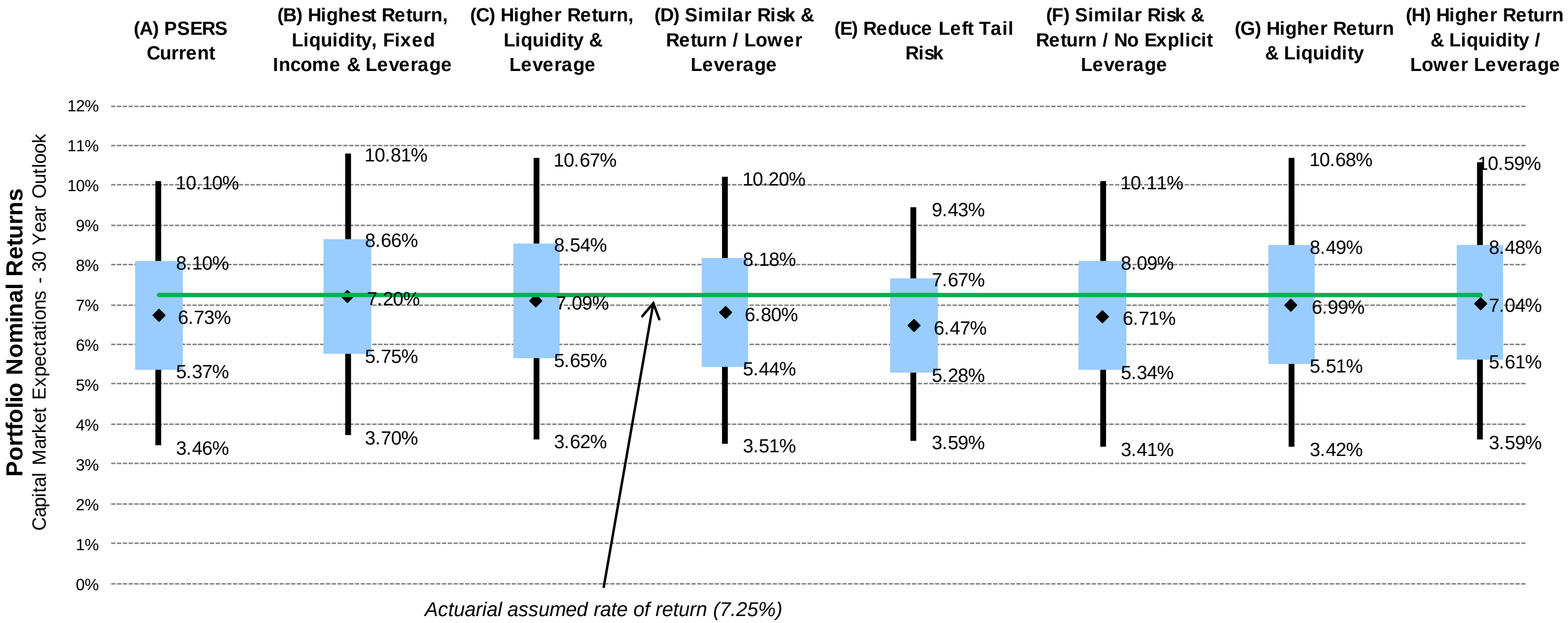
[1] Private Equity assumptions developed as follows: 72% Buyouts, 13% Venture Capital, 15% Distressed Debt

[2] Non-US Inflation-Linked assumptions developed as follows: 3% Canada, 52% UK, 45% Europe. Hedged to USD.

[3] Hedge Fund assumptions developed as follows: 14% Event Driven, 38% Global Macro, 20% Distressed Debt, 16% Fixed Income Arbitrage, 12% Cat. Bonds; Hedge funds have elements of both return-seeking and risk-reducing assets. Hedge funds have been categorized as risk-reducing based on the composition of the hedge funds within the PSERS portfolio.

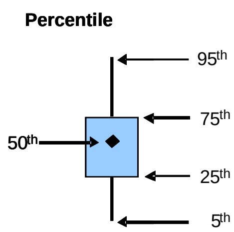
Percentages in table may not sum to 100% due to rounding

Portfolio Analysis
Range of Nominal Returns



Key Takeaways:

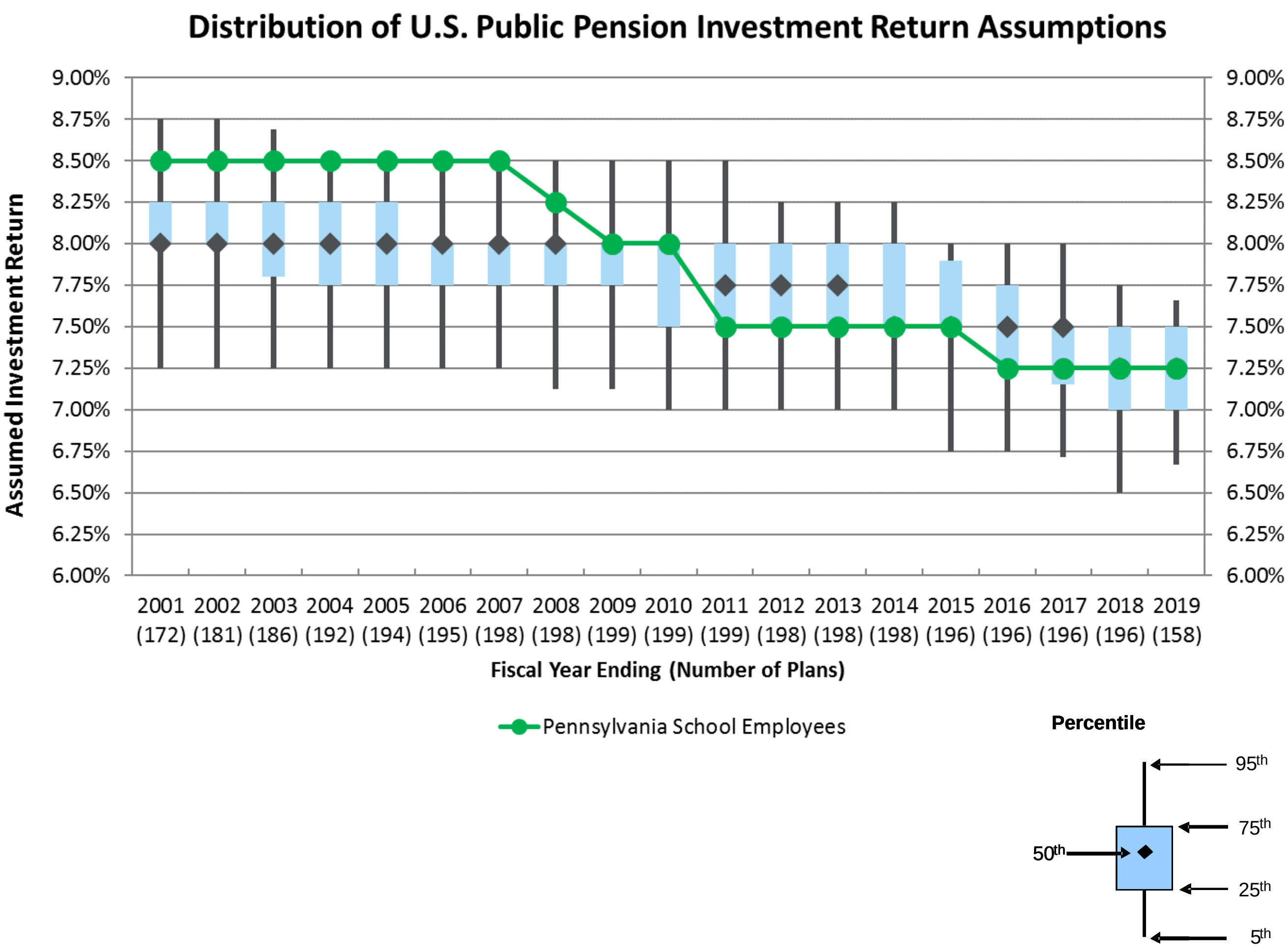
- All portfolios modeled are expected to fall short of the actuarial return assumption (7.25%) in the 50th percentile outcome
- Portfolios B, C, D, G, and H are projected to have higher expected returns than the Current policy in the 50th percentile outcome



Empower Results®

Portfolio Analysis

Expected Return Assumption versus Peers[1]



Key Takeaways:

- The public pension peer median actuarial assumption for investment return has declined from 8.00% in 2001-2010 to 7.25% based on the latest survey data
- PSERS' assumption for FYE 2019 (7.25%) fell at the median relative to its peers
- If PSERS exceeds (or falls short of) the actuarial return assumption, lower (or higher) funding will be needed in future years

Sources: Public Plans Data (publicplansdata.org) as of July 2020; Expected Returns are the assumptions made by the plans included in the data set.

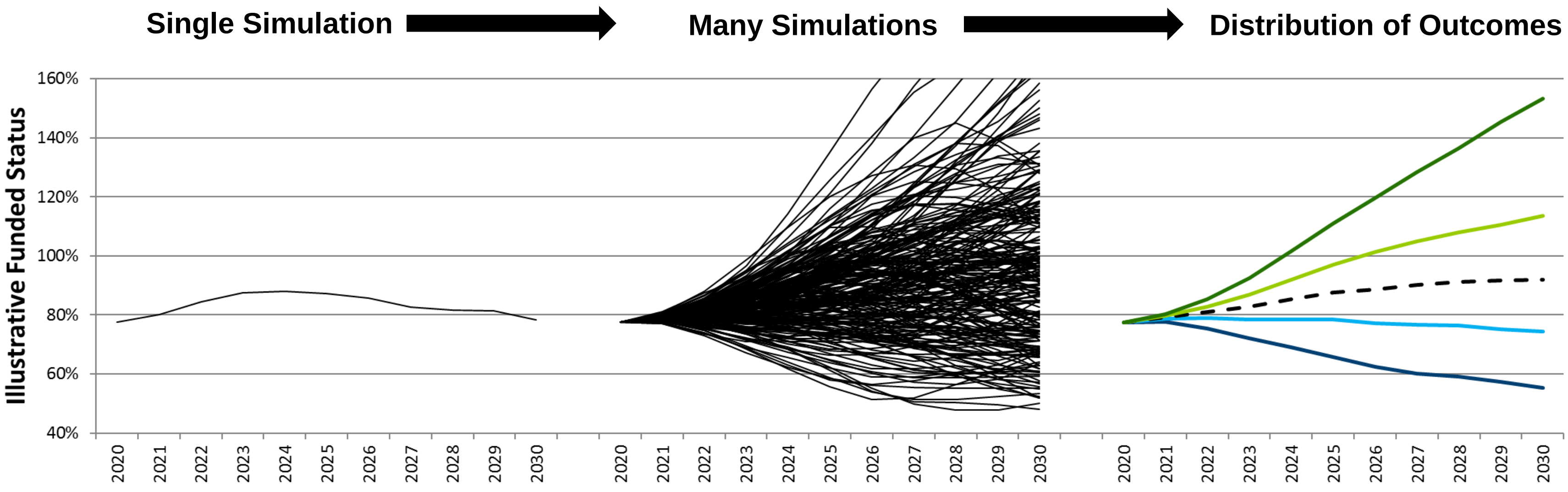
[1] Peers defined as public funds published within publicplansdata.org as of July 2020; Number of plans per year are shown in parentheses

Analysis

- Asset-Liability Projection Results (Stochastic Results)

Asset-Liability Simulation Overview

- Thousands of simulations plotted in one graph would be impossible to interpret
- Instead, we rank the simulations at each point over the future
- This produces a distribution of outcomes illustrating the degree of uncertainty of a plan's financial position over the projection period
- Different investment strategies will produce different distributions of outcomes



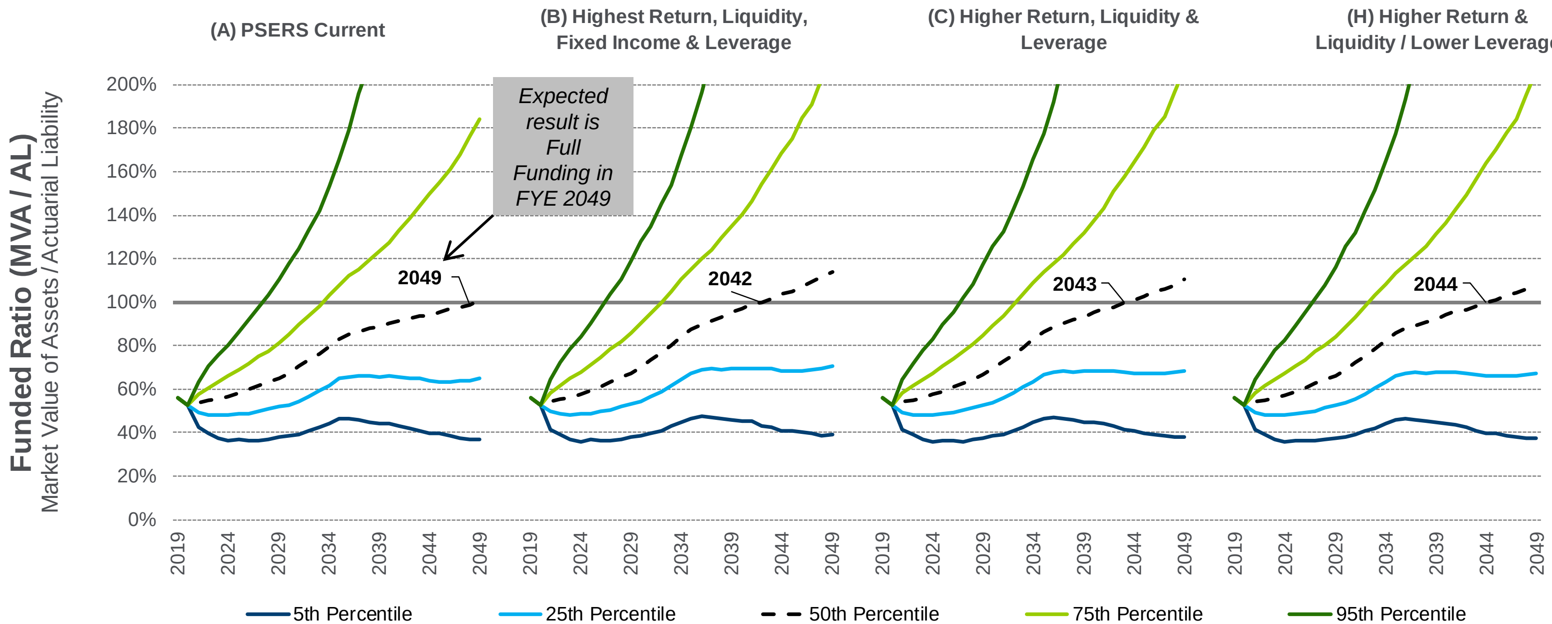
* The path of a given scenario will follow a much less smooth pattern than the distribution suggests, as illustrated above

Asset-Liability Projection Results
Overview

- For ease of viewing, the asset-liability projection results are split into two (2) groups:
  - **Group 1**
    - (A) PSERS Current
    - (B) Highest Return, Liquidity, Fixed Income & Leverage
    - (C) Higher Return, Liquidity & Leverage
    - (H) Higher Return & Liquidity / Lower Leverage
  - **Group 2**
    - (A) PSERS Current
    - (D) Similar Risk & Return / Lower Leverage
    - (E) Reduce Left Tail Risk
    - (F) Similar Risk & Return / No Explicit Leverage
    - (G) Higher Return & Liquidity
- The stochastic analysis to follow assume the full actuarial contribution will be made annually across all future simulations

Asset-Liability Projection Results (Stochastic Results – Group 1)

Market Value of Assets / Actuarial Liability Funded Ratio



Strategy	(A) PSERS Current			(B) Highest Return, Liquidity, Fixed Income & Leverage			(C) Higher Return, Liquidity & Leverage			(H) Higher Return & Liquidity / Lower Leverage		
Year	2029	2039	2049	2029	2039	2049	2029	2039	2049	2029	2039	2049
5th Percentile	38%	44%	37%	38%	46%	39%	38%	45%	38%	38%	45%	37%
25th Percentile	52%	66%	65%	53%	69%	71%	53%	68%	69%	52%	68%	67%
50th Percentile	65%	89%	101%	67%	95%	114%	67%	93%	110%	66%	92%	108%
75th Percentile	81%	123%	184%	86%	134%	>200%	84%	132%	>200%	84%	131%	>200%
95th Percentile	110%	>200%	>200%	119%	>200%	>200%	117%	>200%	>200%	116%	>200%	>200%
Probability > 100%	12%	42%	51%	16%	47%	58%	16%	46%	56%	15%	45%	55%

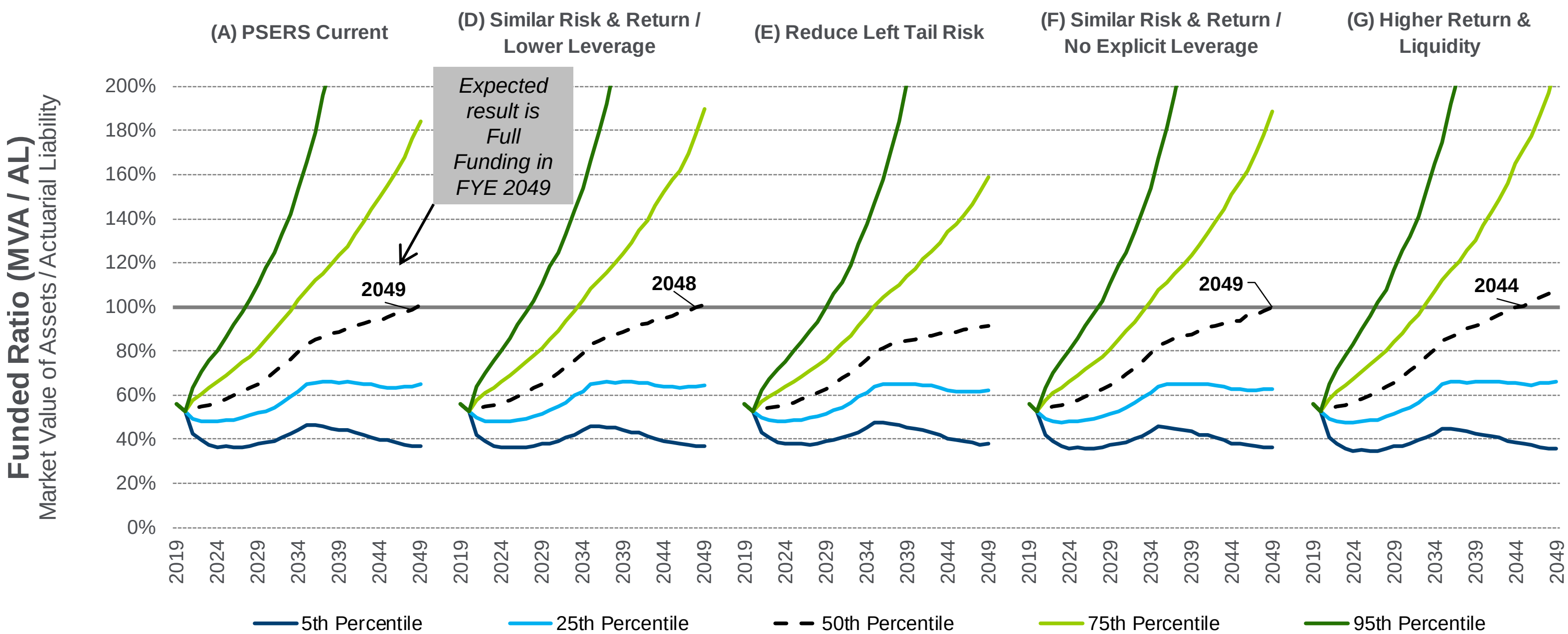
Key Takeaways:

- The funded ratio is projected to trend toward full funding over the course of the projection period
- Adverse market experience could significantly impact the funded status of the Plan

* Liability projections assume discount rates of 7.25% for all investment policies studied

Asset-Liability Projection Results (Stochastic Results – Group 2)

Market Value of Assets / Actuarial Liability Funded Ratio



Strategy	(A) PSERS Current			(D) Similar Risk & Return / Lower Leverage			(E) Reduce Left Tail Risk			(F) Similar Risk & Return / No Explicit Leverage			(G) Higher Return & Liquidity		
Year	**2029**	**2039**	**2049**	**2029**	**2039**	**2049**	**2029**	**2039**	**2049**	**2029**	**2039**	**2049**	**2029**	**2039**	**2049**
5th Percentile	38%	44%	37%	38%	44%	37%	39%	46%	38%	37%	43%	36%	37%	43%	36%
25th Percentile	52%	66%	65%	52%	66%	65%	51%	65%	62%	51%	65%	63%	51%	66%	66%
50th Percentile	65%	89%	101%	65%	89%	101%	63%	84%	92%	64%	88%	100%	66%	91%	108%
75th Percentile	81%	123%	184%	81%	124%	190%	76%	114%	159%	81%	123%	189%	84%	130%	>200%
95th Percentile	110%	>200%	>200%	111%	>200%	>200%	100%	>200%	>200%	110%	>200%	>200%	117%	>200%	>200%
Probability > 100%	12%	42%	51%	12%	42%	51%	5%	37%	47%	12%	41%	50%	15%	44%	55%

Key Takeaways:

- The funded ratio is projected to trend toward full funding over the course of the projection period
- Adverse market experience could significantly impact the funded status of the Plan

* Liability projections assume discount rates of 7.25% for all investment policies studied

Asset-Liability Projection Results (Stochastic Results)

Short-Term Funded Ratio Shortfall Analysis (Based on Market Value of Assets)

- After five (5) years, PSERS is projected to have the following probability of surpassing key funded ratio thresholds:

Funded Status	Probability of Surpassing Various Funded Ratio Thresholds							
	(A) PSERS Current	***(B) Highest Return, Liquidity, Fixed Income & Leverage***	***(C) Higher Return, Liquidity & Leverage***	***(D) Similar Risk & Return / Lower Leverage***	***(E) Reduce Left Tail Risk***	***(F) Similar Risk & Return / No Explicit Leverage***	***(G) Higher Return & Liquidity***	***(H) Higher Return & Liquidity / Lower Leverage***
100%	0.4%	0.7%	0.7%	0.5%	**0.1%**	0.5%	**0.8%**	0.6%
90%	1.3%	**2.2%**	2.0%	1.3%	**0.6%**	1.2%	2.0%	1.9%
80%	5.0%	**7.6%**	7.1%	5.0%	**2.1%**	5.0%	7.2%	6.8%
70%	16.9%	**21.0%**	20.0%	17.2%	**10.8%**	17.1%	20.2%	19.6%
60%	40.5%	**43.7%**	42.6%	40.0%	**35.4%**	39.6%	41.4%	42.1%
50%	69.8%	**71.5%**	70.8%	69.9%	69.9%	69.2%	**69.1%**	70.5%
40%	91.1%	90.7%	90.5%	90.4%	**92.6%**	90.2%	**89.1%**	90.4%
30%	98.9%	98.8%	98.8%	98.9%	**99.5%**	98.8%	**98.3%**	98.8%
20%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
10%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Key Takeaway:

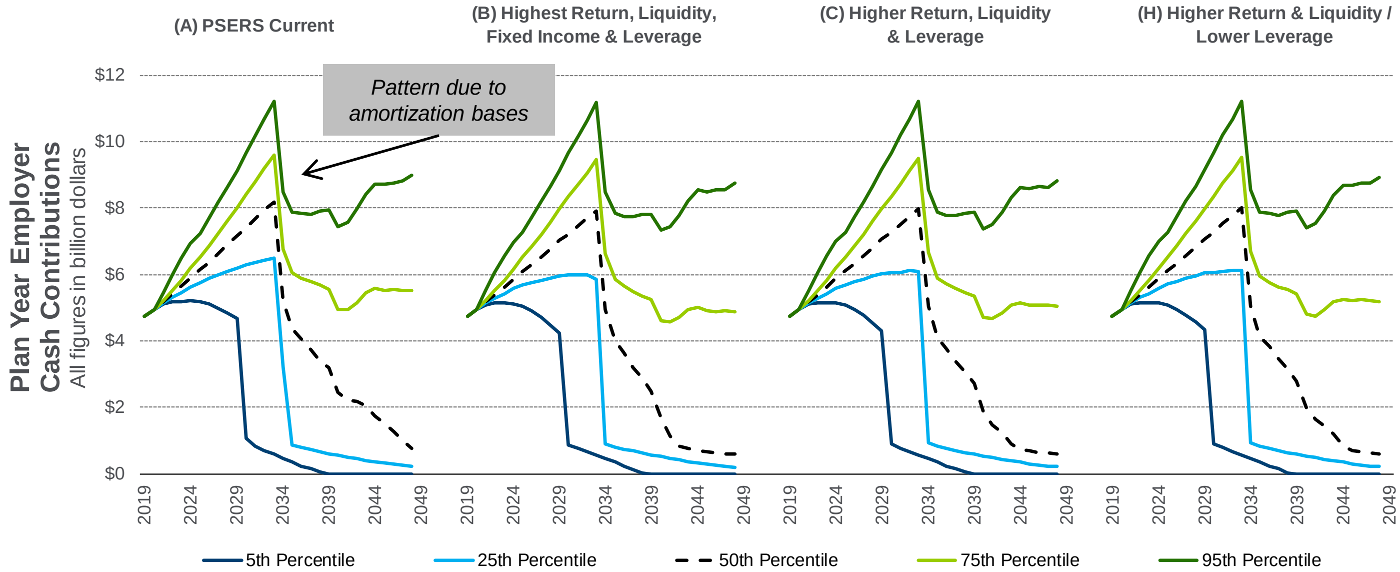
- Portfolio (B) (Highest Return, Liquidity, Fixed Income & Leverage) is expected to yield higher funded ratios in optimistic projections while Portfolio (E) (Reduce Left Tail Risk) is expected to yield higher funded ratios in pessimistic projections over five years.

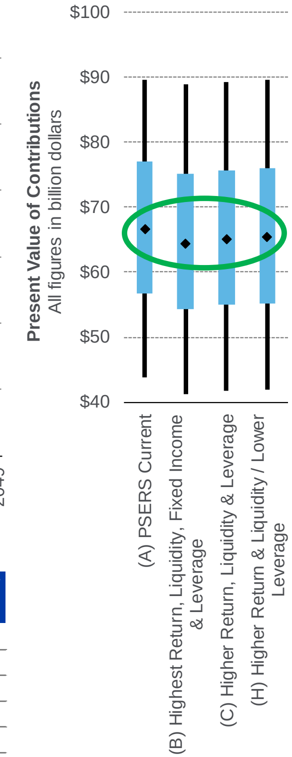
Green = Portfolio with the highest probability of surpassing a given threshold
Red = Portfolio with the lowest probability of surpassing a given threshold

Empower Results®

Asset-Liability Projection Results (Stochastic Results – Group 1)

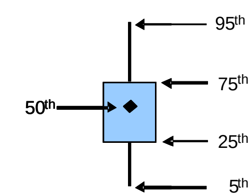
Employer Contribution Amount





Strategy	(A) PSERS Current			(B) Highest Return, Liquidity, Fixed Income & Leverage			(C) Higher Return, Liquidity & Leverage			(H) Higher Return & Liquidity / Lower Leverage		
Year	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**
5th Percentile	$4.83	$0.04	$0.00	$4.49	$0.03	$0.00	$4.55	$0.04	$0.00	$4.57	$0.03	$0.00
25th Percentile	$6.09	$0.67	$0.22	$5.89	$0.63	$0.20	$5.94	$0.64	$0.21	$5.96	$0.64	$0.21
50th Percentile	$6.88	$3.41	$0.75	$6.77	$2.87	$0.58	$6.81	$3.05	$0.60	$6.82	$3.14	$0.60
75th Percentile	$7.62	$5.67	$5.53	$7.58	$5.36	$4.89	$7.60	$5.46	$5.05	$7.60	$5.54	$5.19
95th Percentile	$8.64	$7.90	$9.00	$8.66	$7.80	$8.77	$8.67	$7.85	$8.84	$8.66	$7.88	$8.93

Percentile

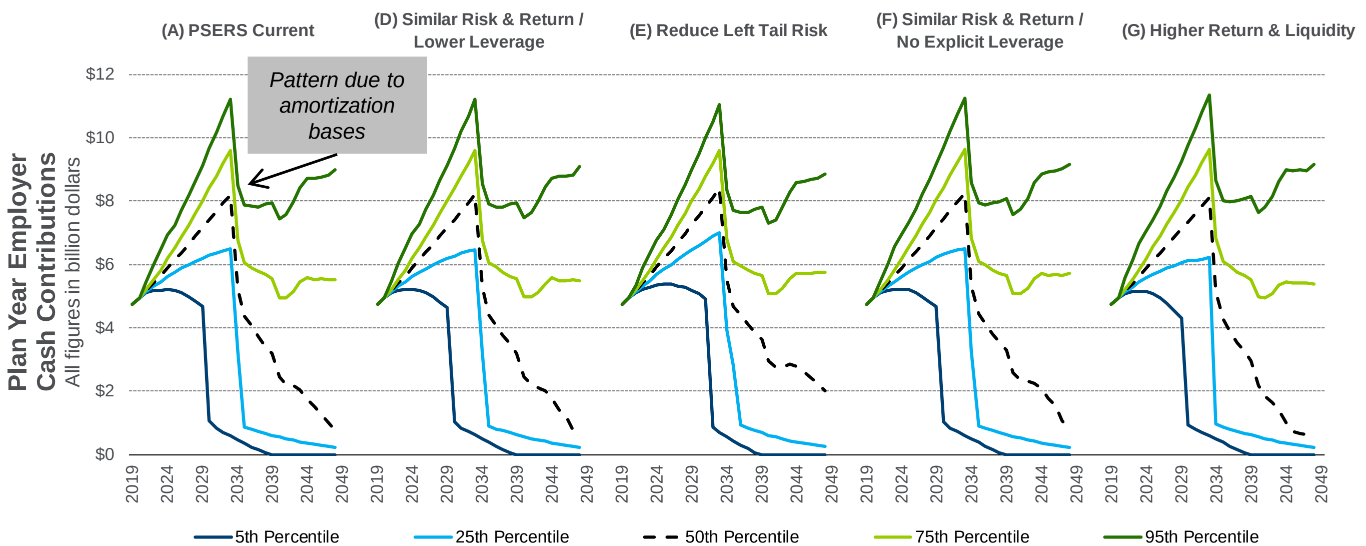


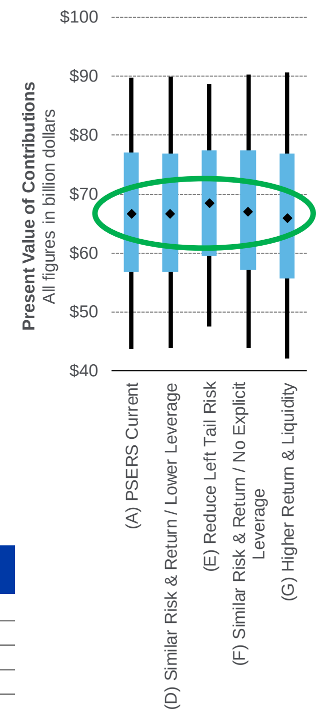
Key Takeaway:

- Contributions in the central expectation (50th percentile outcomes) are projected to increase from their current levels until the expiration of individual amortization bases or when the plan reaches a funded status of at least 100% on an actuarial value of assets basis

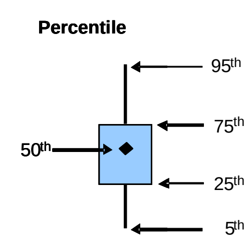
* Liability projections assume discount rates of 7.25% for all investment policies studied

Asset-Liability Projection Results (Stochastic Results – Group 2)
Employer Contribution Amount





Strategy	(A) PSERS Current			(D) Similar Risk & Return / Lower Leverage			(E) Reduce Left Tail Risk			(F) Similar Risk & Return / No Explicit Leverage			(G) Higher Return & Liquidity		
Year	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**
5th Percentile	$4.83	$0.04	$0.00	$4.81	$0.05	$0.00	$5.27	$0.06	$0.00	$4.81	$0.05	$0.00	$4.54	$0.05	$0.00
25th Percentile	$6.09	$0.67	$0.22	$6.09	$0.68	$0.23	$6.31	$0.75	$0.25	$6.11	$0.69	$0.23	$5.97	$0.66	$0.22
50th Percentile	$6.88	$3.41	$0.75	$6.89	$3.48	$0.70	$6.98	$3.86	$2.03	$6.91	$3.55	$0.80	$6.86	$3.27	$0.63
75th Percentile	$7.62	$5.67	$5.53	$7.62	$5.63	$5.50	$7.60	$5.73	$5.77	$7.63	$5.71	$5.73	$7.66	$5.65	$5.40
95th Percentile	$8.64	$7.90	$9.00	$8.66	$7.91	$9.08	$8.51	$7.73	$8.86	$8.68	$8.00	$9.17	$8.77	$8.09	$9.17



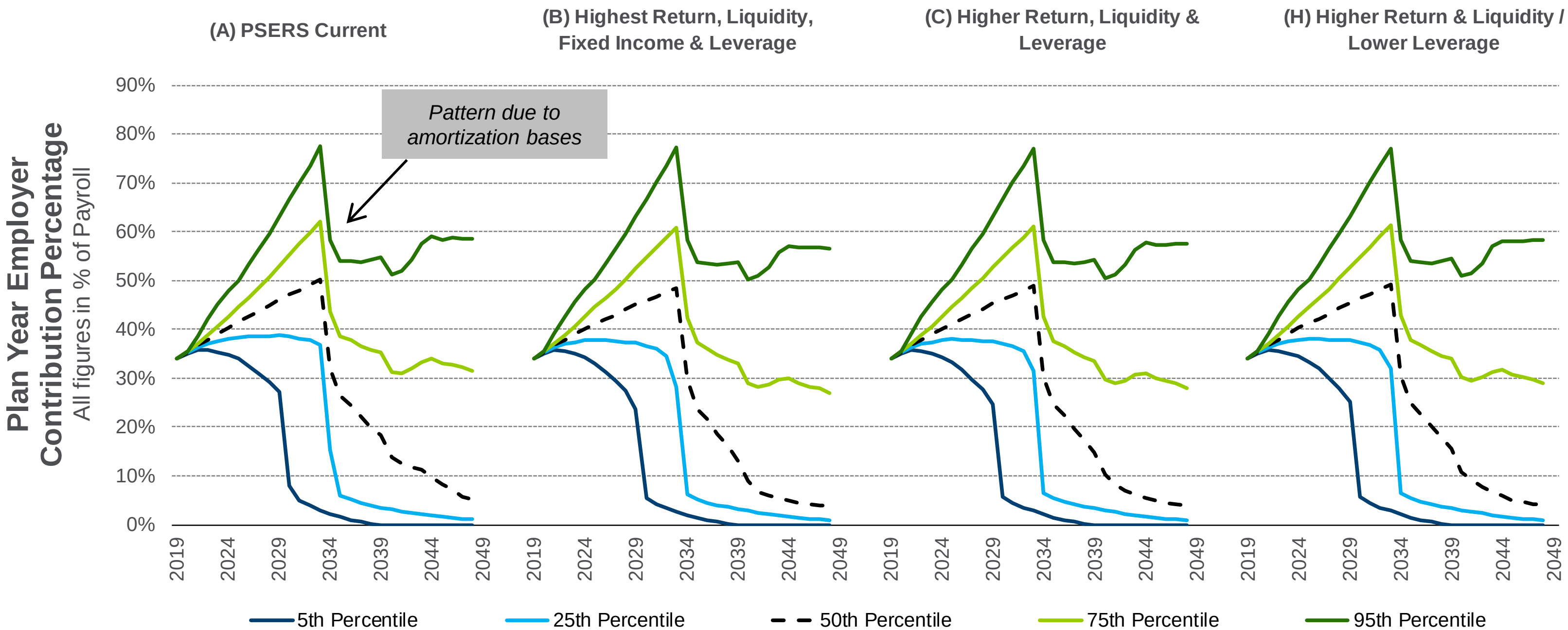
Key Takeaway:

- Contributions in the central expectation (50th percentile outcomes) are projected to increase from their current levels until the expiration of individual amortization bases or when the plan reaches a funded status of at least 100% on an actuarial value of assets basis

* Liability projections assume discount rates of 7.25% for all investment policies studied

Asset-Liability Projection Results (Stochastic Results – Group 1)

Employer Contribution Percentage of Payroll



Strategy	(A) PSERS Current			(B) Highest Return, Liquidity, Fixed Income & Leverage			(C) Higher Return, Liquidity & Leverage			(H) Higher Return & Liquidity / Lower Leverage		
Year	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**
5th Percentile	29%	0%	0%	27%	0%	0%	28%	0%	0%	28%	0%	0%
25th Percentile	39%	4%	1%	37%	4%	1%	38%	4%	1%	38%	4%	1%
50th Percentile	45%	20%	5%	44%	16%	4%	44%	17%	4%	44%	18%	4%
75th Percentile	51%	36%	31%	50%	34%	27%	50%	34%	28%	51%	34%	29%
95th Percentile	59%	54%	59%	60%	54%	56%	60%	54%	58%	60%	54%	58%

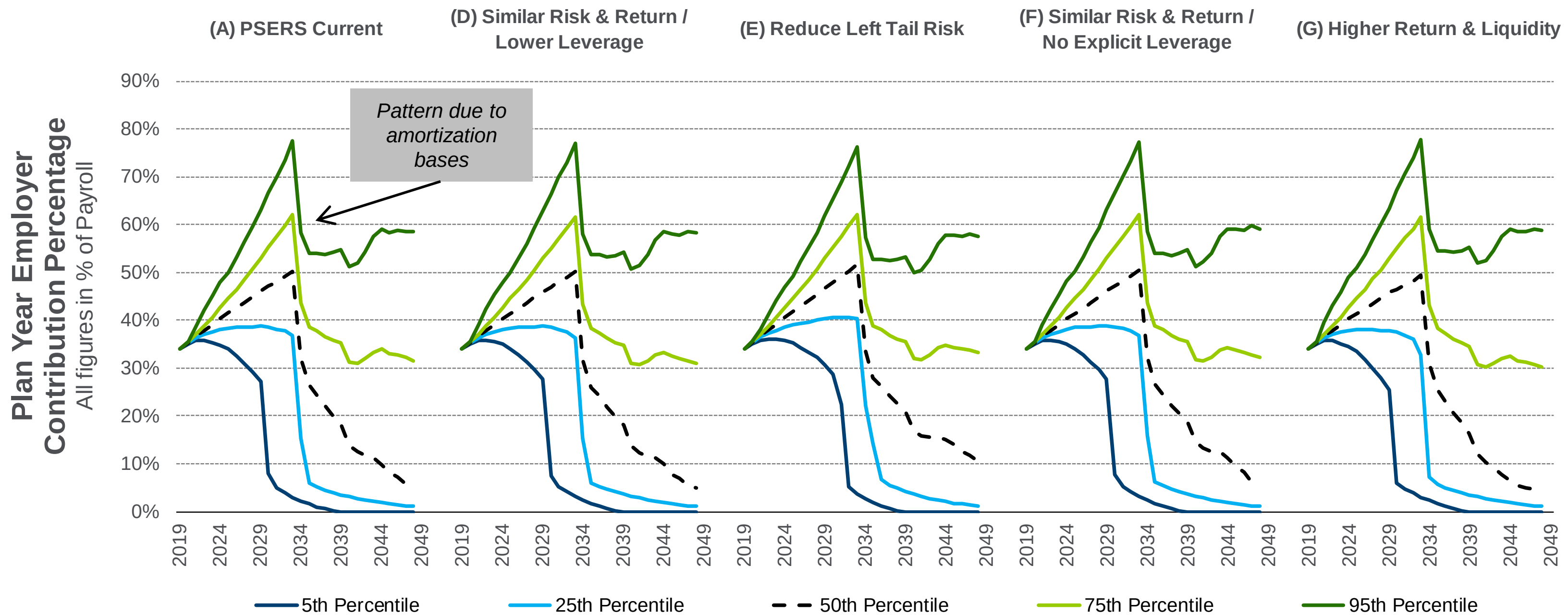
Key Takeaway:

- The trajectories of the central expectations (50th percentile outcomes) are projected to increase until the expiration of individual amortization bases or when the plan reaches a funded status of at least 100% on an actuarial value of assets basis

* Liability projections assume discount rates of 7.25% for all investment policies studied

Asset-Liability Projection Results (Stochastic Results – Group 2)

Employer Contribution Percentage of Payroll



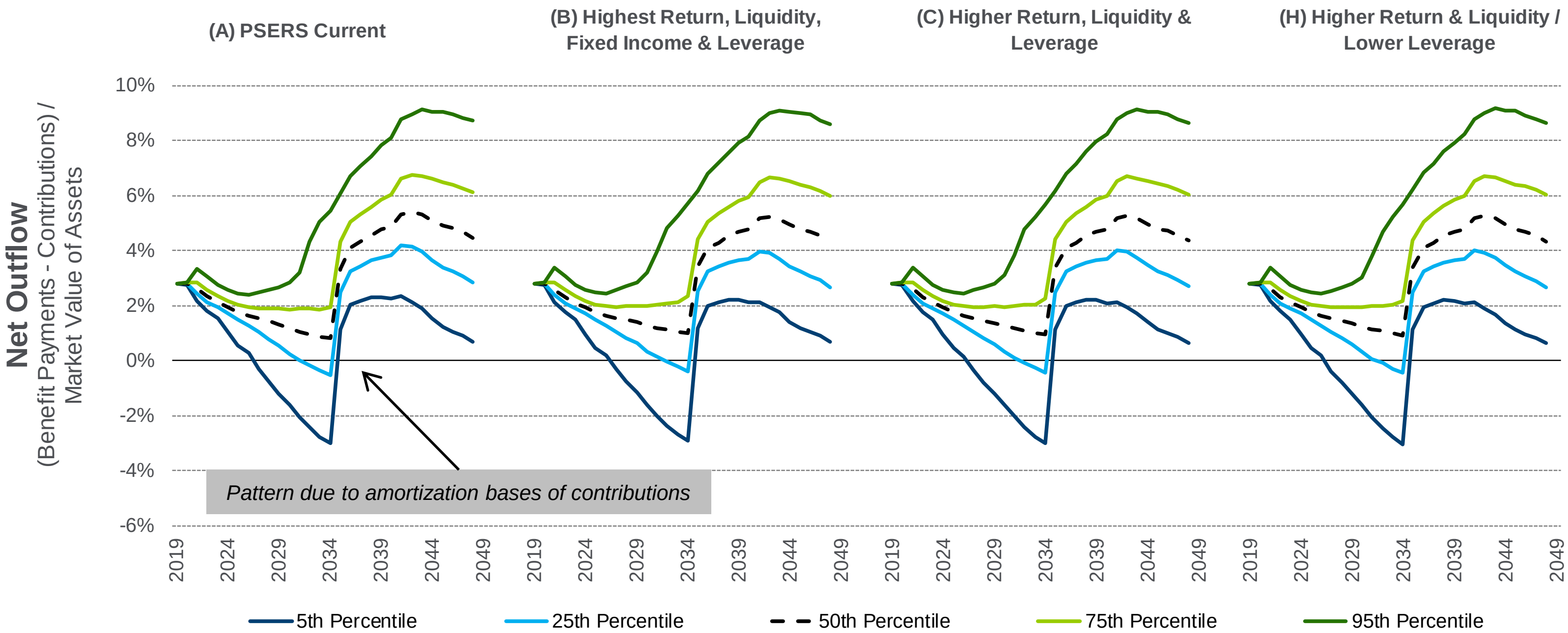
Strategy	(A) PSERS Current			(D) Similar Risk & Return / Lower Leverage			(E) Reduce Left Tail Risk			(F) Similar Risk & Return / No Explicit Leverage			(G) Higher Return & Liquidity		
Year	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**
5th Percentile	29%	0%	0%	30%	0%	0%	32%	0%	0%	30%	0%	0%	28%	0%	0%
25th Percentile	39%	4%	1%	39%	4%	1%	40%	5%	1%	39%	4%	1%	38%	4%	1%
50th Percentile	45%	20%	5%	45%	20%	5%	46%	23%	10%	45%	21%	5%	45%	19%	4%
75th Percentile	51%	36%	31%	51%	35%	31%	51%	36%	33%	51%	36%	32%	51%	35%	30%
95th Percentile	59%	54%	59%	59%	54%	58%	58%	53%	58%	59%	54%	59%	60%	55%	59%

Key Takeaway:

- The trajectories of the central expectations (50th percentile outcomes) are projected to increase until the expiration of individual amortization bases or when the plan reaches a funded status of at least 100% on an actuarial value of assets basis

* Liability projections assume discount rates of 7.25% for all investment policies studied

Asset-Liability Projection Results (Stochastic Results – Group 1)
Net Outflow Analysis: (Benefit Payments less Contributions) / Market Value of Assets



Strategy	(A) PSERS Current			(B) Highest Return, Liquidity, Fixed Income & Leverage			(C) Higher Return, Liquidity & Leverage			(H) Higher Return & Liquidity / Lower Leverage		
Year	2028	2038	2048	2028	2038	2048	2028	2038	2048	2028	2038	2048
5th Percentile	-1%	2%	1%	-1%	2%	1%	-1%	2%	1%	-1%	2%	1%
25th Percentile	1%	4%	3%	1%	4%	3%	1%	4%	3%	1%	4%	3%
50th Percentile	1%	5%	4%	1%	5%	4%	1%	5%	4%	1%	5%	4%
75th Percentile	2%	6%	6%	2%	6%	6%	2%	6%	6%	2%	6%	6%
95th Percentile	3%	7%	9%	3%	8%	9%	3%	8%	9%	3%	8%	9%
Probability > 10%	<1%	<1%	2%	<1%	<1%	1%	<1%	<1%	2%	<1%	<1%	2%

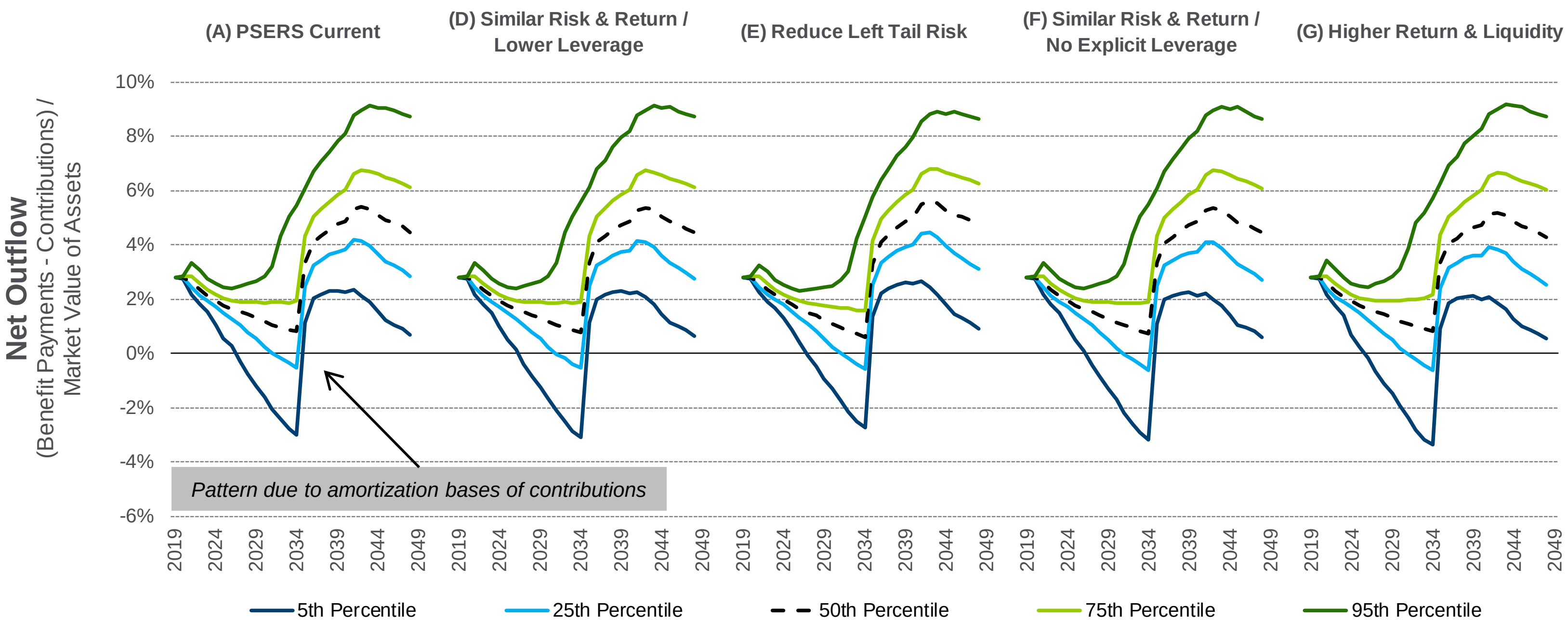
Key Takeaway:

- Net outflow is consistent across the portfolios modeled, sharply increasing once amortization bases fall out of the contribution calculations

* Liability projections assume discount rates of 7.25% for all investment policies studied

Asset-Liability Projection Results (Stochastic Results – Group 2)

Net Outflow Analysis: (Benefit Payments less Contributions) / Market Value of Assets



Strategy	(A) PSERS Current			(D) Similar Risk & Return / Lower Leverage			(E) Reduce Left Tail Risk			(F) Similar Risk & Return / No Explicit Leverage			(G) Higher Return & Liquidity		
Year	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**
5th Percentile	-1%	2%	1%	-1%	2%	1%	0%	3%	1%	-1%	2%	1%	-1%	2%	1%
25th Percentile	1%	4%	3%	1%	4%	3%	1%	4%	3%	1%	4%	3%	1%	3%	3%
50th Percentile	1%	5%	4%	1%	5%	4%	1%	5%	5%	1%	5%	4%	1%	4%	4%
75th Percentile	2%	6%	6%	2%	6%	6%	2%	6%	6%	2%	6%	6%	2%	6%	6%
95th Percentile	3%	7%	9%	3%	8%	9%	2%	7%	9%	3%	8%	9%	3%	8%	9%
Probability > 10%	<1%	<1%	2%	<1%	<1%	2%	<1%	<1%	1%	<1%	<1%	2%	<1%	<1%	2%

Key Takeaway:

- Net outflow is consistent across the portfolios modeled, sharply increasing once amortization bases fall out of the contribution calculations

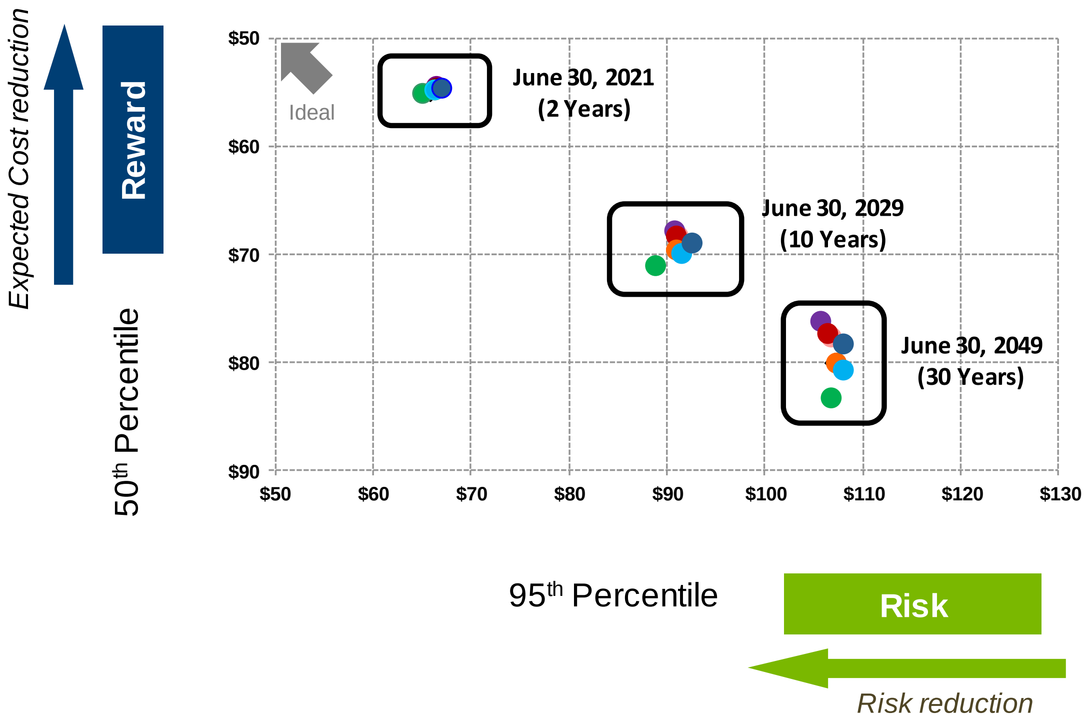
* Liability projections assume discount rates of 7.25% for all investment policies studied

Asset-Liability Projection Results (Stochastic Results)

Economic Cost Analysis—2-Year, 10-Year, and 30-Year Horizons

Economic Cost

Present Value of Contributions plus AL Funding Shortfall/(Surplus)* at 7.25%, $billions



Strategy ($Billions)	June 30, 2021 Cost	June 30, 2021 Risk
(A) PSERS Current	$54.9	$65.9
(B) Highest Return, Liquidity, Fixed Income & Leverage	$54.6	$66.6
(C) Higher Return, Liquidity & Leverage	$54.6	$66.7
(D) Similar Risk & Return / Lower Leverage	$54.9	$66.4
(E) Reduce Left Tail Risk	$55.2	$65.1
(F) Similar Risk & Return / No Explicit Leverage	$54.9	$66.3
(G) Higher Return & Liquidity	$54.8	$67.1
(H) Higher Return & Liquidity / Lower Leverage	$54.7	$66.7
Strategy ($Billions)	**June 30, 2029 Cost**	**June 30, 2029 Risk**
(A) PSERS Current	$69.6	$90.9
(B) Highest Return, Liquidity, Fixed Income & Leverage	$67.8	$90.9
(C) Higher Return, Liquidity & Leverage	$68.3	$91.1
(D) Similar Risk & Return / Lower Leverage	$69.6	$91.0
(E) Reduce Left Tail Risk	$71.1	$88.8
(F) Similar Risk & Return / No Explicit Leverage	$69.9	$91.5
(G) Higher Return & Liquidity	$68.9	$92.6
(H) Higher Return & Liquidity / Lower Leverage	$68.4	$91.3
Strategy ($Billions)	**June 30, 2049 Cost**	**June 30, 2049 Risk**
(A) PSERS Current	$80.0	$107.1
(B) Highest Return, Liquidity, Fixed Income & Leverage	$76.3	$105.7
(C) Higher Return, Liquidity & Leverage	$77.3	$106.4
(D) Similar Risk & Return / Lower Leverage	$80.0	$107.4
(E) Reduce Left Tail Risk	$83.3	$106.7
(F) Similar Risk & Return / No Explicit Leverage	$80.7	$108.0
(G) Higher Return & Liquidity	$78.3	$108.0
(H) Higher Return & Liquidity / Lower Leverage	$77.8	$106.8

Key Takeaways:

- The magnitude of the risk/reward trade-off changes over a longer-term projection
- Under the Current Target (A) over a 30-year time horizon, the expected Economic Cost is $80.0B and the potential risk is $107.1B

* Liability projections assume discount rates of 7.25% for all investment policies studied; Reflects a *utility function:* Excludes 50% of surplus in excess of 120% of Actuarial liability, and includes twice the shortfall below 40% of Actuarial liability, on a market value basis

Analysis

- Summary and Conclusions

Summary and Conclusions

- Given the decline in expected returns for the current portfolio as a result of declining Capital Market Assumptions, the probability of reaching full funding is lower and the expected contributions are slightly higher than last year's analysis

- As a result, Aon proposes PSERS consider Portfolio H as the new Target Portfolio
  - Portfolio H provides a similar risk/reward portfolio as the Current Target Portfolio as measured by the Sharpe Ratio (0.508)
  - Stochastic modelling illustrates superior forward-looking projections versus the Current portfolio, with a 55% probability of reaching full funding at the end of the 30- year projection period with a 7% higher funded ratio
  - Expected contributions over the 30-year period are also lower in both the expected and worst case scenario versus the current portfolio

- The Proposed Portfolio H improves the liquidity profile of the Plan, reducing the allocation to illiquid assets by 5% from 44% to 39% and improves the expected return of the Plan by 31 bps to 7.04%
  - While the expected volatility does increase to 11.76% from 11.15%, the risk-adjusted return as measured by the Sharpe Ratio is maintained

- As the expected return for Proposed Portfolio H is 7.04%, a review of PSERS' EROA assumption as part of its planned experience study in early 2021 may be warranted

Summary and Conclusions

Asset-Liability Projection Results (Stochastic Results)

All Scenarios (in $ billions)	30-year Economic Cost		30-year Present Value of Gross Contributions (Employee + Employer)		30-year Ending Funded Ratio (MVA / AL)	
	Expected[1]	Downside[2]	Expected[1]	Downside[2]	Expected[1]	Downside[3]
(A) PSERS Current	$80.0	$107.1	$80.9	$100.8	101%	37%
(B) Highest Return, Liquidity, Fixed Income & Leverage	$76.3	$105.7	$78.9	$100.0	114%	39%
- Delta from Current (A)	*($3.8)*	*($1.4)*	*($1.9)*	*($0.8)*	*13%*	*2%*
(C) Higher Return, Liquidity & Leverage	$77.3	$106.4	$79.5	$100.4	110%	38%
- Delta from Current (A)	*($2.7)*	*($0.7)*	*($1.4)*	*($0.4)*	*10%*	*1%*
(D) Similar Risk & Return / Lower Leverage	$80.0	$107.4	$80.8	$101.1	101%	37%
- Delta from Current (A)	*$0.0*	*$0.3*	*($0.0)*	*$0.3*	*0%*	*0%*
(E) Reduce Left Tail Risk	$83.3	$106.7	$82.5	$100.1	92%	38%
- Delta from Current (A)	*$3.3*	*($0.3)*	*$1.6*	*($0.7)*	*-9%*	*1%*
(F) Similar Risk & Return / No Explicit Leverage	$80.7	$108.0	$81.1	$101.5	100%	36%
- Delta from Current (A)	*$0.7*	*$1.0*	*$0.2*	*$0.7*	*-1%*	*-1%*
(G) Higher Return & Liquidity	$78.3	$108.0	$80.2	$101.9	108%	36%
- Delta from Current (A)	*($1.7)*	*$0.9*	*($0.7)*	*$1.1*	*7%*	*-1%*
(H) *Higher Return & Liquidity / Lower Leverage*	$77.8	$106.8	$79.8	$100.6	108%	37%
- Delta from Current (A)	*($2.3)*	*($0.2)*	*($1.1)*	*($0.2)*	*7%*	*0%*

Green = Savings/Funded Ratio Improvement from Current (A)
Red = Increased Cost/Reduction in Funded Ratio from Current (A)
[1] Expected = 50th percentile outcome or central expectation across all 5,000 simulations
[2] Downside = 95th percentile outcome across all 5,000 simulations
[3] Downside = 5th percentile outcome across all 5,000 simulations
Differences based on unrounded values so may not match the difference of rounded value

= Recommendation

Summary and Conclusions

Proposed Portfolio versus Current Portfolio

	(A) PSERS Current	Change from (A) to (H)	(H) Higher Return & Liquidity / Lower Leverage
US Equity	7.1%	3.9%	11.0%
Non-US Dev, Unhedged	1.9%	5.1%	7.0%
Non-US Dev, USD Hedged	5.6%	-3.6%	2.0%
Emerging Markets	4.4%	2.6%	7.0%
Private Equity, Unhedged[1]	15.0%	-3.0%	12.0%
Total Equity	**34.0%**	**5.0%**	**39.0%**
US Core Fixed Income	4.0%	-3.0%	1.0%
US Long-Term Treasury	8.0%	-1.0%	7.0%
Emerging Market Debt, Local	0.0%	0.0%	0.0%
Emerging Markets Debt, Hard	1.0%	1.0%	2.0%
High Yield	0.0%	2.0%	2.0%
Private Credit	10.0%	-2.0%	8.0%
US TIPS	9.5%	2.5%	12.0%
Non-US Inflation-Linked[2]	9.5%	-6.5%	3.0%
Total Fixed Income	**42.0%**	**-7.0%**	**35.0%**
Infrastructure: Energy MLPS	1.0%	-1.0%	0.0%
Infrastructure: Private, USD Hedged	1.0%	3.0%	4.0%
Infrastructure: Public, USD Hedged	4.0%	0.0%	4.0%
Commodities: Diversified	6.0%	-3.0%	3.0%
Commodities: Gold	4.0%	3.0%	7.0%
Private Real Estate, Unhedged	8.0%	-1.0%	7.0%
Global REITs, USD Hedged	2.0%	1.0%	3.0%
Total Real Assets	**26.0%**	**2.0%**	**28.0%**
Hedge Funds[3]	**10.0%**	**-2.0%**	**8.0%**
Net Cash / Financing	**-12.0%**	**2.0%**	**-10.0%**
Total Plan	**100.0%**	**0.0%**	**100.0%**
30-Year Exp. Nom. Return	**6.73%**	**0.31%**	**7.04%**
30-Year Expected Risk	**11.15%**	**0.61%**	**11.76%**
Sharpe Ratio	**0.508**	**0.000**	**0.508**

[1] Private Equity assumptions developed as follows: 72% Buyouts, 13% Venture Capital, 15% Distressed Debt

[2] Non-US Inflation-Linked assumptions developed as follows: 3% Canada, 52% UK, 45% Europe. Hedged to USD.

[3] Hedge Fund assumptions developed as follows: 14% Event Driven, 38% Global Macro, 20% Distressed Debt, 16% Fixed Income Arbitrage, 12% Cat. Bonds; Hedge funds have elements of both return-seeking and risk-reducing assets. Hedge funds have been categorized as risk-reducing based on the composition of the hedge funds within the PSERS portfolio.

Percentages in table may not sum to 100% due to rounding

Appendix

- Peer Comparisons

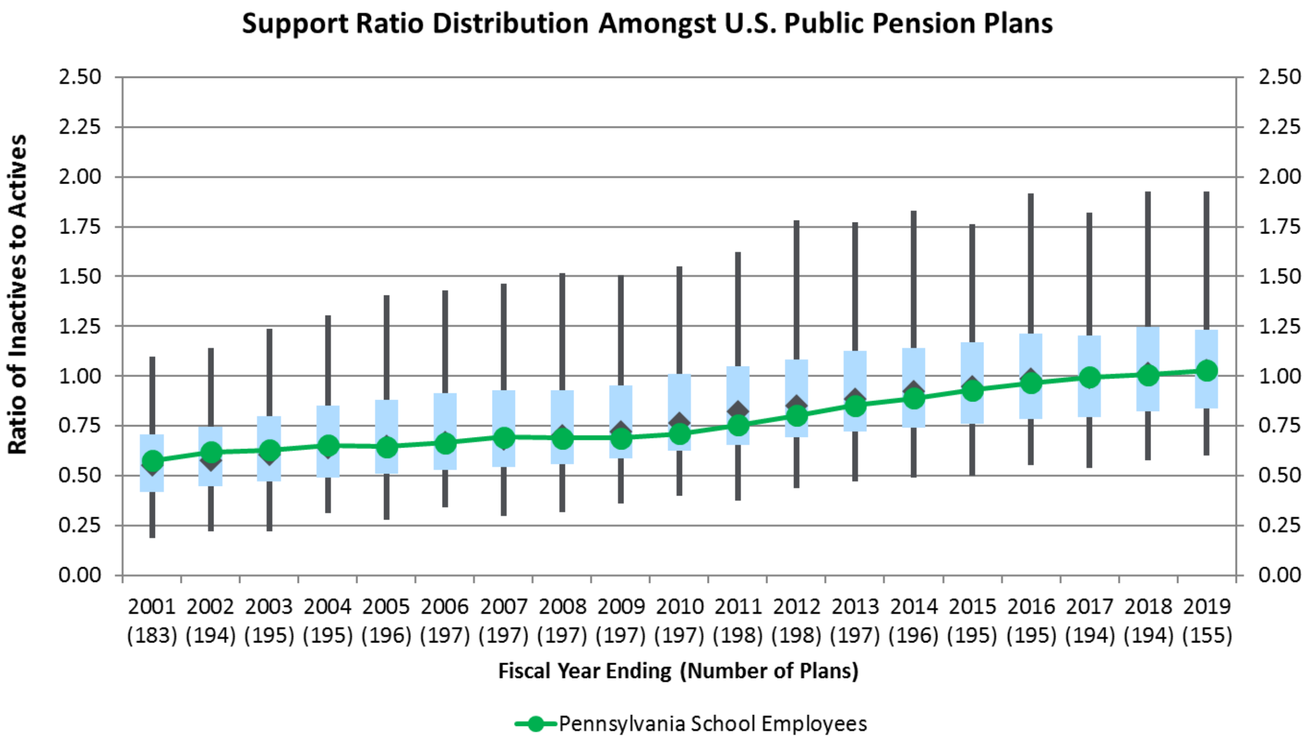
Public Pension Peer Comparison
PSERS' Asset Allocation versus Public Peers

Asset Allocation	PSERS	Public Pension Plans (<$500M)*	Public Pension Plans ($501M-1B)*	Public Pension Plans ($1-5B)*	Public Pension Plans (>$5B)*	Total Public Pension Universe*
Equity Exposure						
Global Equity	0.0%	0.0%	1.0%	5.1%	8.6%	8.0%
Total U.S. Equity	7.1%	33.9%	34.0%	27.1%	20.8%	21.9%
Total Int'l Equity	11.9%	18.4%	20.3%	19.4%	16.5%	16.9%
Private Markets	15.0%	6.4%	2.8%	4.8%	11.1%	10.3%
Total Equity	***34.0%***	***58.7%***	***58.1%***	***56.4%***	***57.0%***	***57.1%***
Fixed Income Exposure						
U.S. Fixed Income	12.0%	21.8%	26.7%	20.8%	14.6%	15.6%
High Yield Bonds / Bank Loans	0.0%					
Private Debt	10.0%	1.7%	0.6%	2.4%	1.6%	1.6%
International / Global Fixed Income	0.0%	0.6%	3.1%	2.3%	4.2%	4.0%
Emerging Market Debt	1.0%	1.2%	0.3%	2.0%	2.0%	2.0%
Inflation Protected	19.0%					
Total Fixed Income	***42.0%***	***25.3%***	***30.7%***	***27.5%***	***22.4%***	***23.2%***
Real Asset Exposure						
Infrastructure	5.0%	0.9%	0.2%	1.0%	1.3%	1.3%
Commodities	10.0%	1.0%	0.4%	0.9%	1.1%	1.1%
Real Estate	10.0%	5.2%	3.6%	1.9%	7.3%	6.6%
Total Real Assets	***25.0%***	***7.1%***	***4.2%***	***3.8%***	***9.7%***	***9.0%***
Hedge Funds / Opportunistic	10.0%	3.8%	2.0%	3.4%	4.7%	4.6%
Multi-Asset / Risk Parity	0.0%	1.0%	1.1%	4.2%	2.9%	3.0%
Money Market / Cash	-12.0%	1.1%	0.4%	1.1%	1.6%	1.5%
Leverage	0.0%					
Other (e.g., MLPs)	1.0%	3.2%	3.5%	3.5%	1.6%	1.8%
Net Other	***-1.0%***	***9.1%***	***7.0%***	***12.2%***	***10.8%***	***10.9%***
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***
Expected Return	***6.73%***	***6.39%***	***6.02%***	***6.21%***	***6.74%***	***6.66%***
Expected Volatility	***11.15%***	***12.75%***	***12.04%***	***12.35%***	***13.30%***	***13.15%***
Sharpe Ratio	***.508***	***.418***	***.412***	***.417***	***.427***	***.426***

* Source: "*2019 U.S. Institutional Market Trends*", Greenwich Associates

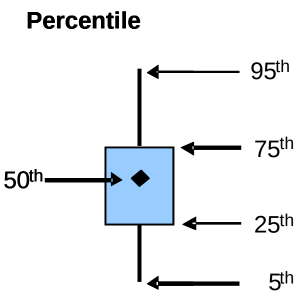
Peer Comparisons

Support Ratio versus Peers[1]



Key Takeaways:

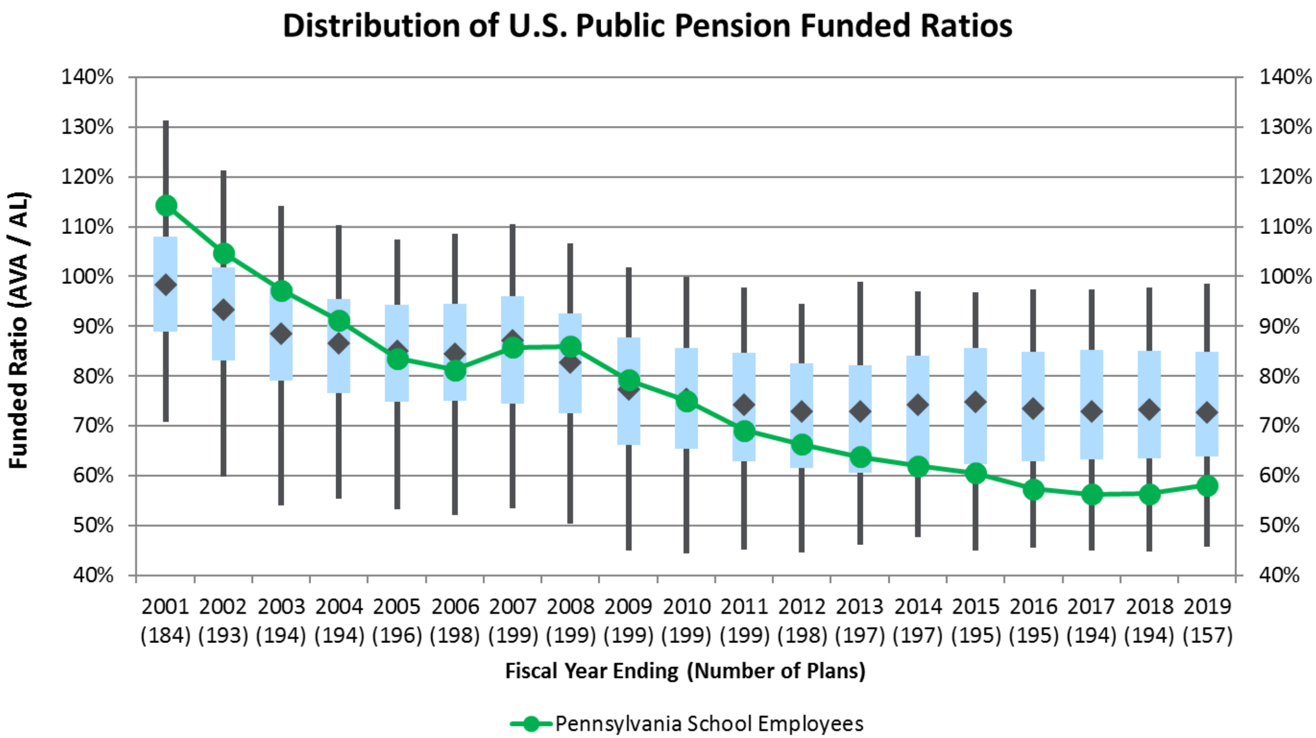
- "Support Ratio" defined as the ratio of inactive participants to active participants
- PSERS' FYE 2019 support ratio (1.03) fell at the median relative to its peers



Source: Public Plans Data (publicplansdata.org) as of July 2020;
[1] Peers defined as public funds published within publicplansdata.org as of July 2020; Number of plans per year are shown in parentheses

Peer Comparisons

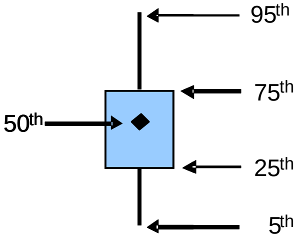
Funded Ratio (Based on Actuarial Value of Assets) versus Peers[1]



Key Takeaways:

- The median funded ratio as of FYE 2019 was 73% based on the latest survey data
- PSERS' FYE 2019 funded ratio (58%) fell below the 25th percentile relative to its peers

Percentile



Source: Public Plans Data (publicplansdata.org) as of July 2020;

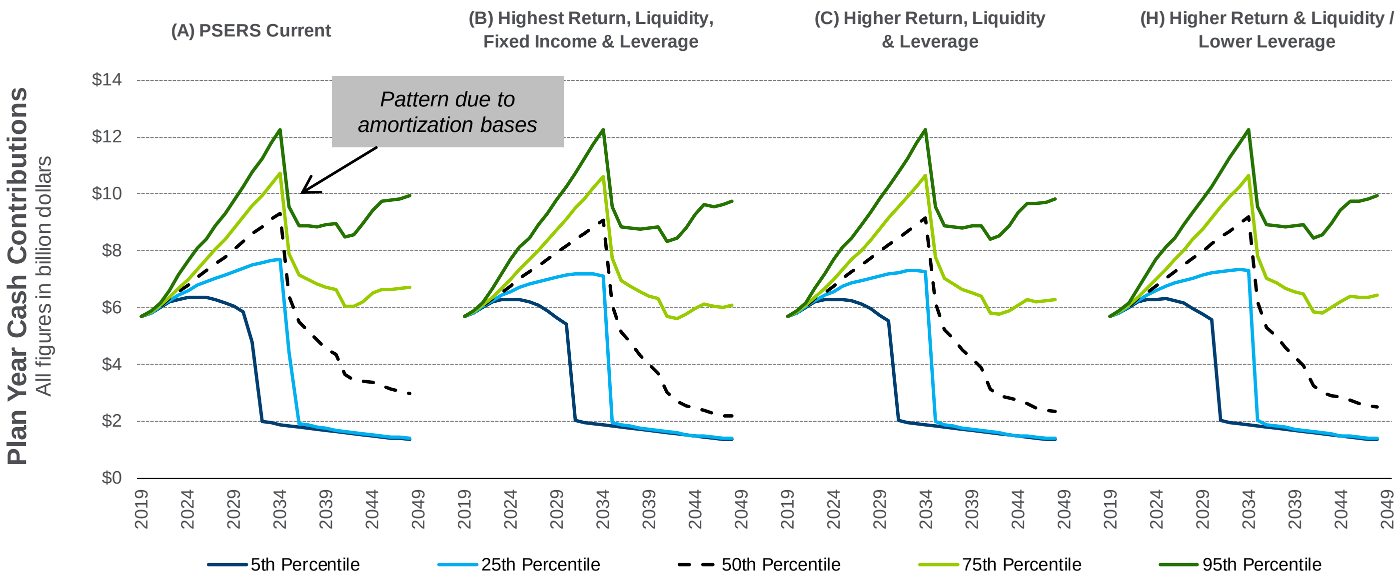
[1] Peers defined as public funds published within publicplansdata.org as of July 2020; Number of plans per year are shown in parentheses

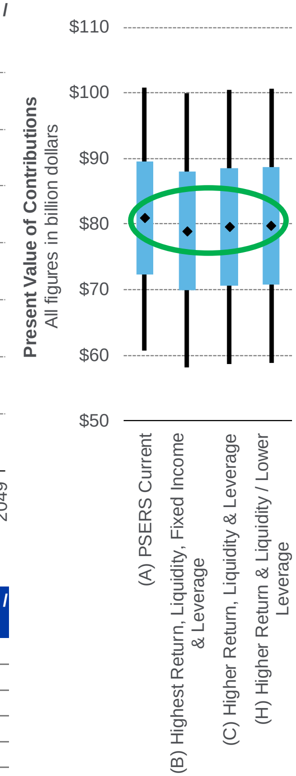
Appendix

- Asset-Liability Projection Results (Additional Stochastic Results)

Asset-Liability Projection Results (Additional Stochastic Results – Group 1)

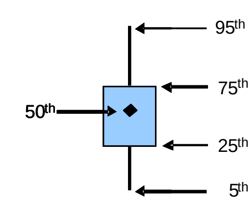
Gross Contribution Amount (Includes Employee and Employer Contributions)





Strategy	(A) PSERS Current			(B) Highest Return, Liquidity, Fixed Income & Leverage			(C) Higher Return, Liquidity & Leverage			(H) Higher Return & Liquidity / Lower Leverage		
Year	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**
5th Percentile	$6.18	$1.72	$1.37	$5.89	$1.72	$1.37	$5.95	$1.72	$1.37	$5.97	$1.72	$1.37
25th Percentile	$7.15	$1.80	$1.41	$7.00	$1.77	$1.40	$7.03	$1.77	$1.40	$7.05	$1.77	$1.40
50th Percentile	$7.79	$4.88	$2.97	$7.70	$4.33	$2.17	$7.73	$4.51	$2.34	$7.74	$4.58	$2.48
75th Percentile	$8.41	$6.82	$6.72	$8.36	$6.54	$6.08	$8.38	$6.63	$6.27	$8.39	$6.67	$6.42
95th Percentile	$9.32	$8.84	$9.94	$9.33	$8.75	$9.73	$9.35	$8.78	$9.84	$9.37	$8.83	$9.94

Percentile



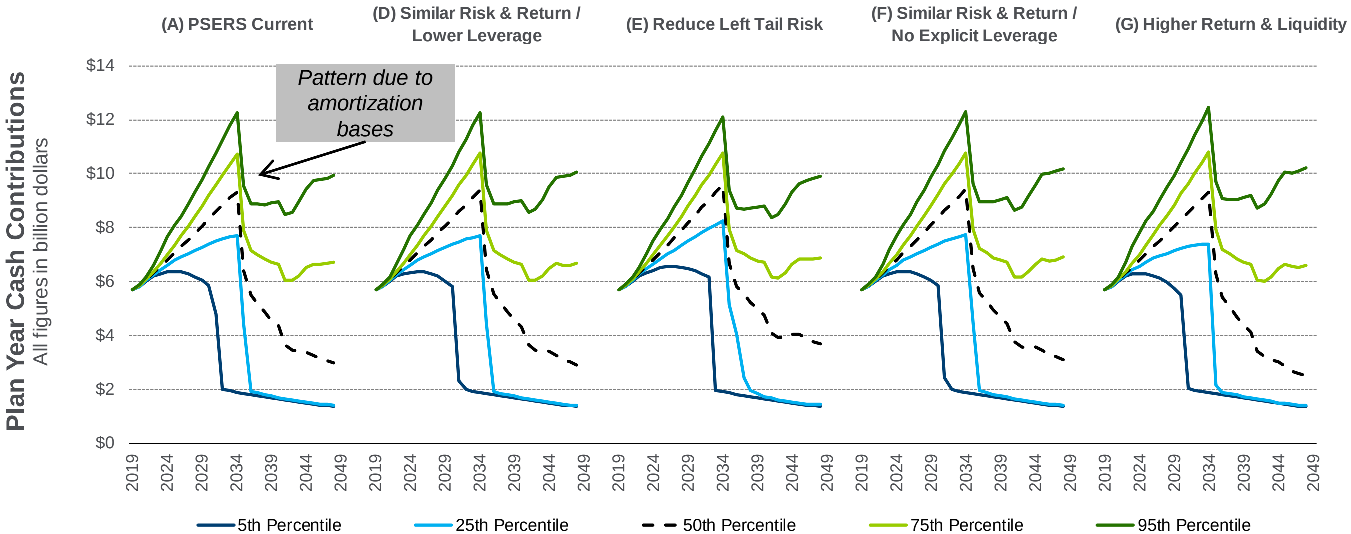
Key Takeaway:

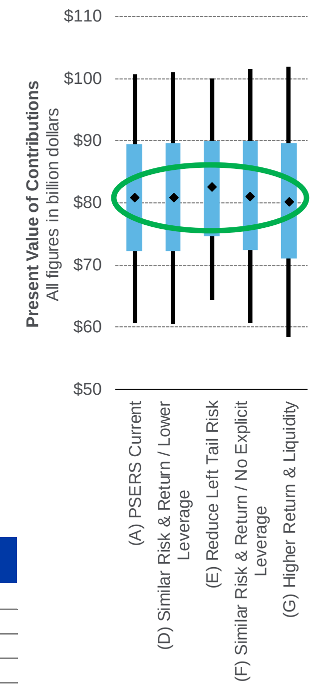
- Contributions in the central expectation (50th percentile outcomes) are projected to increase from their current levels until the expiration of individual amortization bases or when the plan reaches a funded status of at least 100% on an actuarial value of assets basis

* Liability projections assume discount rates of 7.25% for all investment policies studied

Asset-Liability Projection Results (Additional Stochastic Results – Group 2)

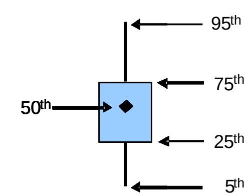
Gross Contribution Amount (Includes Employee and Employer Contributions)





Strategy	(A) PSERS Current			(D) Similar Risk & Return / Lower Leverage			(E) Reduce Left Tail Risk			(F) Similar Risk & Return / No Explicit Leverage			(G) Higher Return & Liquidity		
Year	2028	2038	2048	2028	2038	2048	2028	2038	2048	2028	2038	2048	2028	2038	2048
5th Percentile	$6	$2	$1	$6	$2	$1	$7	$2	$1	$6	$2	$1	$6	$2	$1
25th Percentile	$7	$2	$1	$7	$2	$1	$7	$2	$1	$7	$2	$1	$7	$2	$1
50th Percentile	$8	$5	$3	$8	$5	$3	$8	$5	$4	$8	$5	$3	$8	$5	$3
75th Percentile	$8	$7	$7	$8	$7	$7	$8	$7	$7	$8	$7	$7	$8	$7	$7
95th Percentile	$9	$9	$10	$9	$9	$10	$9	$9	$10	$9	$9	$10	$9	$9	$10

Percentile

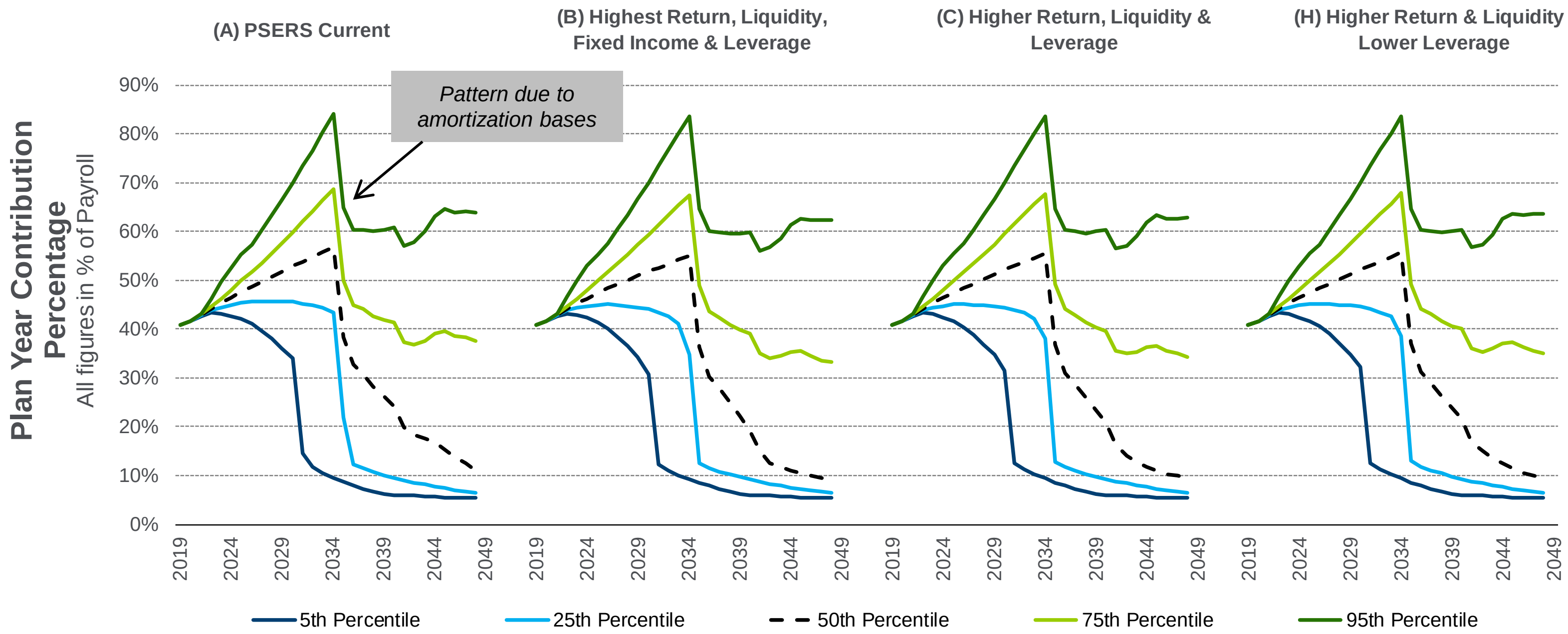


Key Takeaway:

- Contributions in the central expectation (50th percentile outcomes) are projected to increase from their current levels until the expiration of individual amortization bases or when the plan reaches a funded status of at least 100% on an actuarial value of assets basis

* Liability projections assume discount rates of 7.25% for all investment policies studied

Asset-Liability Projection Results (Additional Stochastic Results – Group 1)
Gross Contribution Percentage of Payroll (Includes Employee and Employer Contributions)



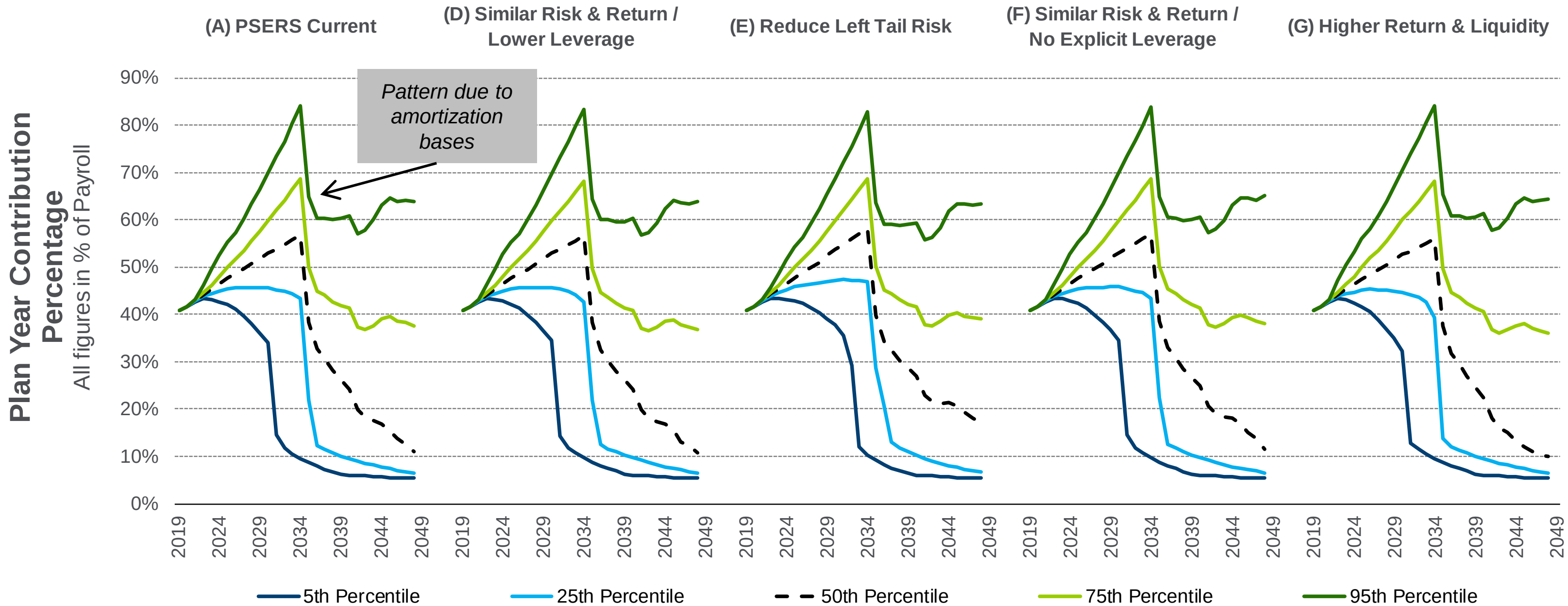
Strategy	(A) PSERS Current			(B) Highest Return, Liquidity, Fixed Income & Leverage			(C) Higher Return, Liquidity & Leverage			(H) Higher Return & Liquidity / Lower Leverage		
Year	2028	2038	2048	2028	2038	2048	2028	2038	2048	2028	2038	2048
5th Percentile	38%	7%	5%	37%	7%	5%	37%	7%	5%	37%	7%	5%
25th Percentile	46%	11%	6%	45%	10%	6%	45%	10%	6%	45%	10%	6%
50th Percentile	51%	28%	11%	50%	25%	9%	50%	26%	10%	50%	26%	10%
75th Percentile	56%	43%	38%	55%	41%	33%	55%	41%	34%	55%	42%	35%
95th Percentile	63%	60%	64%	63%	60%	62%	64%	60%	63%	63%	60%	64%

Key Takeaway:

- The trajectories of the central expectations (50th percentile outcomes) are projected to increase until the expiration of individual amortization bases or when the plan reaches a funded status of at least 100% on an actuarial value of assets basis

* Liability projections assume discount rates of 7.25% for all investment policies studied

Asset-Liability Projection Results (Additional Stochastic Results – Group 2)
Gross Contribution Percentage of Payroll (Includes Employee and Employer Contributions)



Strategy	(A) PSERS Current			(D) Similar Risk & Return / Lower Leverage			(E) Reduce Left Tail Risk			(F) Similar Risk & Return / No Explicit Leverage			(G) Higher Return & Liquidity		
Year	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**
5th Percentile	38%	7%	5%	38%	7%	5%	40%	7%	5%	38%	7%	5%	37%	7%	5%
25th Percentile	46%	11%	6%	46%	11%	7%	47%	12%	7%	46%	11%	7%	45%	11%	6%
50th Percentile	51%	28%	11%	51%	28%	11%	51%	30%	17%	51%	28%	12%	50%	27%	10%
75th Percentile	56%	43%	38%	55%	42%	37%	56%	43%	39%	56%	43%	38%	56%	42%	36%
95th Percentile	63%	60%	64%	63%	59%	64%	62%	59%	63%	63%	60%	65%	64%	60%	64%

Key Takeaway:

- The trajectories of the central expectations (50th percentile outcomes) are projected to increase until the expiration of individual amortization bases or when the plan reaches a funded status of at least 100% on an actuarial value of assets basis

* Liability projections assume discount rates of 7.25% for all investment policies studied

Appendix

- Actuarial Assumptions and Methods

Empower Results®

Actuarial Assumptions and Methods

- Actuarial projections were provided by the plan actuary as of the most recent valuation date (June 30, 2019)
- Actuarial assumptions:
  - Valuation Rate of Interest = 7.25% for all future years
  - Inflation = 2.75%
  - Salary Scale = effective average of 5.00% per year
  - Payroll Growth = 3.50% per year
  - Actuarial Value of Assets: smooth gains/losses relative to expected valuation rate of interest over 10 years and shall be no less than 70% and no greater than 130% of the market value of assets
  - Projection assumptions
    - The active workforce size is assumed to remain constant over the projection period;
    - Future new employees have similar characteristics (age/gender/salary) to new employees for the period July 1, 2016 through June 30, 2019
      - Among new school employees hired on or after July 1, 2019, 65% will become Class T-G members, 30% will elect Class T-H membership, and 5% will elect Class DC participation.
    - Class T-G and T-H members who terminate employment with less than 25 years of service and who commence their benefits prior to age 62 will have their benefits reduced from age 67 to age 62 based on the System's current actuarial-equivalent early retirement factors, which are based on the statutory interest rate of 4%. The benefit will be further reduced from age 62 to the member's age at benefit commencement based on new actuarial-equivalent early retirement factors based on an interest rate of 7.25%.
  - All other assumptions as documented in the Actuarial Valuation Report as of June 30, 2019

Actuarial Assumptions and Methods (continued)

- Actuarially-Determined Contribution Calculation = Normal Cost plus a level percent amortization of the unfunded liability with layered 24 year, closed periods, and a 3.50% salary scale
  - Amortization bases developed are projected to continue until either their individual expiry or the plan reaches 100% funded on an actuarial value of assets basis at which point any remaining balance is fully recognized
- Asset figures reflect preliminary performance for the period July 1, 2019 – June 30, 2020 resulting in a market asset value of $56.646 billion as of June 30, 2020
- Employee contributions are limited to the actuarially-determined contribution
- The health care premium assistance assets and liabilities have been excluded from this analysis
- The rate collar provision of Act 120 was not considered in this analysis as it has been deemed to no longer be effective
- “Shared Risk” provisions of Act 120 have not been considered in this analysis

Appendix

- Capital Market Assumptions

Capital Market Assumption Methodology

- The Aon Asset Model and Economic Scenario Generator (ESG) creates 5,000 simulations of key economic variables and total returns.
- We believe the model is complete and consistent. All the major markets and asset classes are modeled within a consistent framework allowing for the interactions between them to be properly taken into account.
- It is arbitrage free and captures the fact that extreme market events do occur more frequently than would be predicted by simpler statistical models.
- The ESG models the full yield curve as this allows for accurate treatment of liabilities and realistic modeling of the future distribution of interest rates and inflation. This allows us to assess the sensitivities of assets and liabilities to changes in interest and inflation rates.
- The model is calibrated to Aon's globally-consistent Capital Market assumptions every quarter.
- Nominal and real government interest rates are projected using an extended two factor Black-Karasinki model and a 2 factor Vasicek model respectively. The models are mean reverting starting with current yield curves and reverting towards our long-term fair values over the very long-term.
- Credit spreads are modeled stochastically using a Markov based model to determine the probabilities of transition between various credit rating and default, and a stochastic parameter reflecting the level of risk aversion in the market.
- Return seeking assets (including equities) are modeled using an individual asset class model with its own returns and volatilities but no correlations to other asset classes, and exposure to 6 other economic models to gain the correct correlation structures between returns for each asset class.

Empower Results®

Aon Investments' Capital Market Assumptions

As of June 30, 2020 (30 Years)

	Nominal Correlations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	Large Cap U.S. Equity	**1.00**	0.92	0.89	0.78	0.72	0.09	-0.05	0.00	0.04	-0.13	0.59	0.42	0.47	0.55	0.47	0.67	0.34	0.92	0.38	0.89	0.89	0.00	0.37	0.06
2	Small Cap U.S. Equity	0.92	**1.00**	0.81	0.72	0.67	0.07	-0.05	0.00	0.03	-0.12	0.55	0.39	0.42	0.50	0.44	0.61	0.29	0.87	0.35	0.83	0.83	0.00	0.35	0.05
3	International Equity (Developed) - Hedged	0.89	0.81	**1.00**	0.88	0.73	0.10	-0.04	0.00	0.06	-0.12	0.57	0.41	0.42	0.50	0.48	0.61	0.29	0.82	0.35	0.84	0.84	0.01	0.36	0.06
4	International Equity (Developed) - Unhedged	0.78	0.72	0.88	**1.00**	0.75	0.04	-0.04	0.00	0.04	-0.11	0.58	0.44	0.59	0.49	0.44	0.54	0.45	0.73	0.31	0.84	0.84	0.00	0.33	0.07
5	Emerging Markets Equity	0.72	0.67	0.73	0.75	**1.00**	0.07	-0.04	0.00	0.05	-0.12	0.65	0.49	0.54	0.40	0.40	0.49	0.33	0.68	0.29	0.77	0.77	0.00	0.31	0.07
6	Cash (Gov't)	0.09	0.07	0.10	0.04	0.07	**1.00**	0.45	0.02	0.45	0.21	0.14	0.17	0.03	0.06	0.13	0.08	0.22	0.05	0.11	0.11	0.11	0.06	0.04	0.57
7	TIPS	-0.05	-0.05	-0.04	-0.04	-0.04	0.45	**1.00**	0.01	0.48	0.32	0.09	0.13	-0.02	-0.03	0.01	-0.03	0.17	-0.06	0.01	-0.01	-0.01	0.04	-0.10	0.40
8	Non-US Inflation Linked	0.00	0.00	0.00	0.00	0.00	0.02	0.01	**1.00**	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	Core Fixed Income	0.04	0.03	0.06	0.04	0.05	0.45	0.48	0.01	**1.00**	0.73	0.34	0.52	0.16	0.17	0.06	0.04	0.07	0.03	0.06	0.05	0.05	0.01	0.07	0.15
10	Long Duration Bonds – Gov't	-0.13	-0.12	-0.12	-0.11	-0.12	0.21	0.32	0.01	0.73	**1.00**	-0.12	0.16	-0.05	-0.13	-0.05	-0.09	-0.04	-0.13	-0.04	-0.12	-0.12	-0.02	-0.34	-0.11
11	High Yield Bonds	0.59	0.55	0.57	0.58	0.65	0.14	0.09	0.00	0.34	-0.12	**1.00**	0.75	0.60	0.60	0.32	0.40	0.38	0.57	0.25	0.61	0.61	0.02	0.61	0.18
12	Emerging Market Bonds	0.42	0.39	0.41	0.44	0.49	0.17	0.13	0.00	0.52	0.16	0.75	**1.00**	0.65	0.56	0.23	0.28	0.24	0.40	0.18	0.44	0.44	0.01	0.40	0.09
13	Emerging Market Bonds (Sov. Local)	0.47	0.42	0.42	0.59	0.54	0.03	-0.02	0.00	0.16	-0.05	0.60	0.65	**1.00**	0.48	0.19	0.30	0.45	0.44	0.13	0.54	0.54	0.00	0.36	0.02
14	Hedge Funds	0.55	0.50	0.50	0.49	0.40	0.06	-0.03	0.00	0.17	-0.13	0.60	0.56	0.48	**1.00**	0.26	0.36	0.36	0.52	0.21	0.52	0.52	0.01	0.57	0.10
15	Non Core Real Estate	0.47	0.44	0.48	0.44	0.40	0.13	0.01	0.00	0.06	-0.05	0.32	0.23	0.19	0.26	**1.00**	0.49	0.15	0.43	0.21	0.47	0.47	0.00	0.19	0.09
16	US REITs	0.67	0.61	0.61	0.54	0.49	0.08	-0.03	0.00	0.04	-0.09	0.40	0.28	0.30	0.36	0.49	**1.00**	0.21	0.61	0.26	0.68	0.68	0.00	0.25	0.05
17	Commodities	0.34	0.29	0.29	0.45	0.33	0.22	0.17	-0.01	0.07	-0.04	0.38	0.24	0.45	0.36	0.15	0.21	**1.00**	0.31	0.08	0.49	0.49	0.04	0.11	0.39
18	Private Equity	0.92	0.87	0.82	0.73	0.68	0.05	-0.06	0.00	0.03	-0.13	0.57	0.40	0.44	0.52	0.43	0.61	0.31	**1.00**	0.35	0.82	0.82	0.00	0.36	0.05
19	Infrastructure - Private	0.38	0.35	0.35	0.31	0.29	0.11	0.01	0.00	0.06	-0.04	0.25	0.18	0.13	0.21	0.21	0.26	0.08	0.35	**1.00**	0.33	0.33	0.01	0.16	0.07
20	Infrastructure - Public	0.89	0.83	0.84	0.84	0.77	0.11	-0.01	0.00	0.05	-0.12	0.61	0.44	0.54	0.52	0.47	0.68	0.49	0.82	0.33	**1.00**	1.00	0.01	0.34	0.13
21	Energy MLPs	0.89	0.83	0.84	0.84	0.77	0.11	-0.01	0.00	0.05	-0.12	0.61	0.44	0.54	0.52	0.47	0.68	0.49	0.82	0.33	1.00	**1.00**	0.01	0.34	0.13
22	Gold	0.00	0.00	0.01	0.00	0.00	0.06	0.04	0.00	0.01	-0.02	0.02	0.01	0.00	0.01	0.00	0.00	0.04	0.00	0.01	0.01	0.01	**1.00**	0.01	0.10
23	Private Debt	0.37	0.35	0.36	0.33	0.31	0.04	-0.10	0.00	0.07	-0.34	0.61	0.40	0.36	0.57	0.19	0.25	0.11	0.36	0.16	0.34	0.34	0.01	**1.00**	0.08
24	Inflation	0.06	0.05	0.06	0.07	0.07	0.57	0.40	0.00	0.15	-0.11	0.18	0.09	0.02	0.10	0.09	0.05	0.39	0.05	0.07	0.13	0.13	0.10	0.08	**1.00**

Empower Results®

Aon Investments’ Capital Market Assumptions

Explanation of Capital Market Assumptions—Q3 2020

The following capital market assumptions were developed by Aon’s Global Asset Allocation Team and represent the long-term capital market outlook (i.e., 30 years) based on data at the end of the second quarter of 2020. The assumptions were developed using a building block approach, reflecting observable inflation and interest rate information available in the fixed income markets as well as Consensus Economics forecasts. Our long-term assumptions for other asset classes are based on historical results, current market characteristics, and our professional judgment.

Inflation – Expected Level (2.1%)

Based on Consensus Economics long-term estimates and our near-term economic outlook, we expect U.S. consumer price inflation to be approximately 2.1% during the next 30 years.

Real Returns for Asset Classes

Fixed Income

- **Cash (-1.0%)** – Over the long run, we expect the real yield on cash and money market instruments to produce a real return of -1.0% in a moderate to low-inflationary environment.
- **TIPS (-0.1%)** – We expect intermediate duration Treasury Inflation-Protected Securities to produce a real return of about -0.1%.
- **Core Fixed Income (i.e., Market Duration) (-0.1%)** – We expect intermediate duration Treasuries to produce a real return of about -0.8%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 0.7%, resulting in a long-term real return of -0.1%.
- **Long Duration Bonds – Government and Credit (0.1%)** – We expect Treasuries with a duration comparable to the Long Government Credit Index to produce a real return of -0.5%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 0.6%, resulting in an expected real return of 0.1%.

Aon Investments’ Capital Market Assumptions

Explanation of Capital Market Assumptions—Q3 2020

- **Long Duration Bonds – Credit (0.6%)** – We expect Treasuries with a duration comparable to the Long Credit Index to produce a real return of -0.5%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 1.1%, resulting in an expected real return of 0.6%.
- **Long Duration Bonds – Government (-0.5%)** – We expect Treasuries with a duration of ~12 years to produce a real return of -0.5% during the next 30 years.
- **High Yield Bonds (2.0%)** – We expect intermediate duration Treasuries to produce a real return of about -0.8%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 2.8%, resulting in an expected real return of 2.0%.
- **Bank Loans (2.2%)** – We expect LIBOR to produce a real return of about -0.7%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults) to be 2.9%, resulting in an expected real return of 2.2%.
- **Non-US Developed Bonds: 50% Hedged (-0.4%) –** We forecast real returns for non-US developed market bonds to be -0.4% over a 30-year period after adjusting for a 50% currency hedge. We assume a blend of one-third investment grade corporate bonds and two-thirds government bonds. We also produce assumptions for 0% hedged and 100% hedged non-US developed bonds.
- **Emerging Market Bonds (Sovereign; USD) (1.9%) –** We forecast real returns for emerging market sovereign bonds denominated in US dollars to be 1.9% over a 30-year period.
- **Emerging Market Bonds (Corporate; USD) (1.4%) –** We forecast real returns for emerging market corporate bonds denominated in US dollars to be 1.4% over a 30-year period.
- **Emerging Market Bonds (Sovereign; Local) (1.6%)** – We forecast real returns for emerging market sovereign bonds denominated in local currency to be 1.6% over a 30-year period.
- **Multi Asset Credit (MAC) (2.8%) –** We assume real returns from beta exposure to high yield, bank loans and emerging market debt to add 2.1% plus 0.7% from alpha (net of fees) over a 30-year period.
- **Private Debt-Direct Lending (3.7%) –** The base building block is bank loans 2.2% + spread 1.5% (net of management fees and performance incentives). There is 100% leverage included in the assumption with the cost of financing at LIBOR + 1.4%.

Aon Investments’ Capital Market Assumptions
Explanation of Capital Market Assumptions—Q3 2020

Equities

- **Large Cap U.S. Equity (4.3%)** – This assumption is based on our 30-year outlook for large cap U.S. company dividends and real earnings growth. Adjustments are made for valuations as needed.
- **Small Cap U.S. Equity (4.8%)** – Adding a 0.5% return premium for small cap U.S. equity over large cap U.S. equity results in an expected real return of 4.8%. This return premium is theoretically justified by the higher risk inherent in small cap U.S. equity versus large cap U.S. equity, and is also justified by historical data. In recent years, higher small cap valuations relative large cap equity has reduced the small cap premium.
- **Global Equity (Developed & Emerging Markets) (5.2%)** – We employ a building block process similar to the U.S. equity model using the developed and emerging markets that comprise the MSCI All-Country World Index. Our roll-up model produces an expected real return of 5.2% for global equity.
- **International (Non-U.S.) Equity, Developed Markets (5.3%)** – We employ a building block process similar to the U.S. equity model using the non-U.S. developed equity markets that comprise the MSCI EAFE Index.
- **Emerging Market Stocks (5.9%)** - We employ a building block process similar to the U.S. equity model using the non-U.S. emerging equity markets that comprise the MSCI Emerging Markets Index.
- **Equity Risk Insurance Premium Strategies-High Beta (4.1%) –** We expect real returns from 50% equity + 50% cash beta of 2.0% plus 2.1% insurance risk premium over the next 30 years.

Alternative Asset Classes

- **Hedge Fund-of-Funds Universe (1.2%)** – The generic category “hedge funds” encompasses a wide range of strategies accessed through “fund-of-funds” vehicles. We also assume the ***median*** manager is selected and also allow for the additional costs associated with Fund-of-Funds management. A top-tier portfolio of funds (hedge fund-of-funds buy-list) could add an additional 1.2% in return at similar volatility based on alpha, lower fees and better risk management.

Aon Investments' Capital Market Assumptions

Explanation of Capital Market Assumptions—Q3 2020

- **Hedge Fund-of-Funds Buy List (2.4%)** – The generic category of top-tier "hedge funds" encompasses a wide range of strategies accessed through "fund-of-funds" vehicles. We assume additional costs associated with Funds-of-Funds management. To use this category the funds must be buy rated or we advise on manager selection.
- **Broad Hedge Funds Universe (2.5%)** – Represents a diversified portfolio of direct hedge fund investments. This investment will tend to be less diversified than a typical "fund-of-funds" strategy as there will be fewer underlying managers and will not include the extra layer of fees found in a Fund-of-Funds structure.
- **Broad Hedge Funds Buy List (3.8%)** – Represents a diversified portfolio of top-tier direct hedge fund investments. This investment will tend to be less diversified than a typical "fund-of-funds" strategy as there will be fewer underlying managers and will not include the extra layer of fees found in a Fund-of-Funds structure. To use this category the funds must be buy rated or we advise on manager selection.
- **Core Real Estate (3.5%)** -- Our real return assumption for core real estate is based a gross income of about 3.8%, management fees of roughly 1%, and future capital appreciation near the rate of inflation during the next 30 years. We assume a portfolio of equity real estate holdings that is diversified by property and by geographic region.
- **Non-Core Real Estate (5.5%)** -- Core real estate is levered approximately 100% as the base building block for this assumption. We subtract financing costs for the leverage and 2% management costs. We also assume nominal alpha of 3%. We assume a 50/50 mix of value-add and opportunistic investments.
- **U.S. REITs (4.0%)** – Our real return assumption for U.S. REITs is based on income of about 4.0% and future capital appreciation near the rate of inflation during the next 30 years. REITs are a sub-set of U.S. small/mid cap equity universe.
- **Commodities (1.4%)** – Our commodity assumption is for a diversified portfolio of commodity futures contracts. Commodity futures returns are composed of three parts: spot price appreciation, collateral return, and roll return (positive or negative change implied by the shape of the future curve). We believe that spot prices will converge with CPI over the long run (i.e., 2.1%). Collateral is assumed to be LIBOR cash (-0.7%). Also, we believe the roll effect will be near zero, resulting in a real return of about 1.4% for commodities.

Aon Investments' Capital Market Assumptions

Explanation of Capital Market Assumptions—Q3 2020

- **Private Equity (7.2%)** – Our private equity assumption reflects a diversified fund of funds with exposure to buyouts, venture capital, distressed debt, and mezzanine debt.
- **Infrastructure (6.1%)** – Our infrastructure assumption is formulated using a cash flow based approach that projects cash flows (on a diversified portfolio of assets) over a 30-year period. Income and capital growth as well as gearing levels, debt costs and terms, relevant tax and management expenses are all taken into consideration. Our approach produces an expected real return of 6.1% for infrastructure.
- **Equity Risk Insurance Premium Strategies-Low Beta (2.4%) –** We assume real returns from cash of -1.0% + 3.4% from alpha.
- **Alternative Risk Premia (ARP) (3.2%) –** Real return target LIBOR -0.7% plus 3.9% alpha (net of fees)

Volatility / Correlation Assumptions

Assumed volatilities are formulated with reference to implied volatilities priced into option contracts of various terms, as well as with regard to historical volatility levels. For asset classes which are not marked to market (for example real estate), we "de-smooth" historical returns before calculating volatilities. Importantly, we consider expected volatility trends in the future – in recent years we assumed the re-emergence of an economic cycle and a loss of confidence in central bankers would lead to an increase in volatility. Correlation assumptions are generally similar to actual historical results; however, we do make adjustments to reflect our forward-looking views as well as current market fundamentals.

Appendix

- 2020 Horizon Survey of Capital Market Assumptions

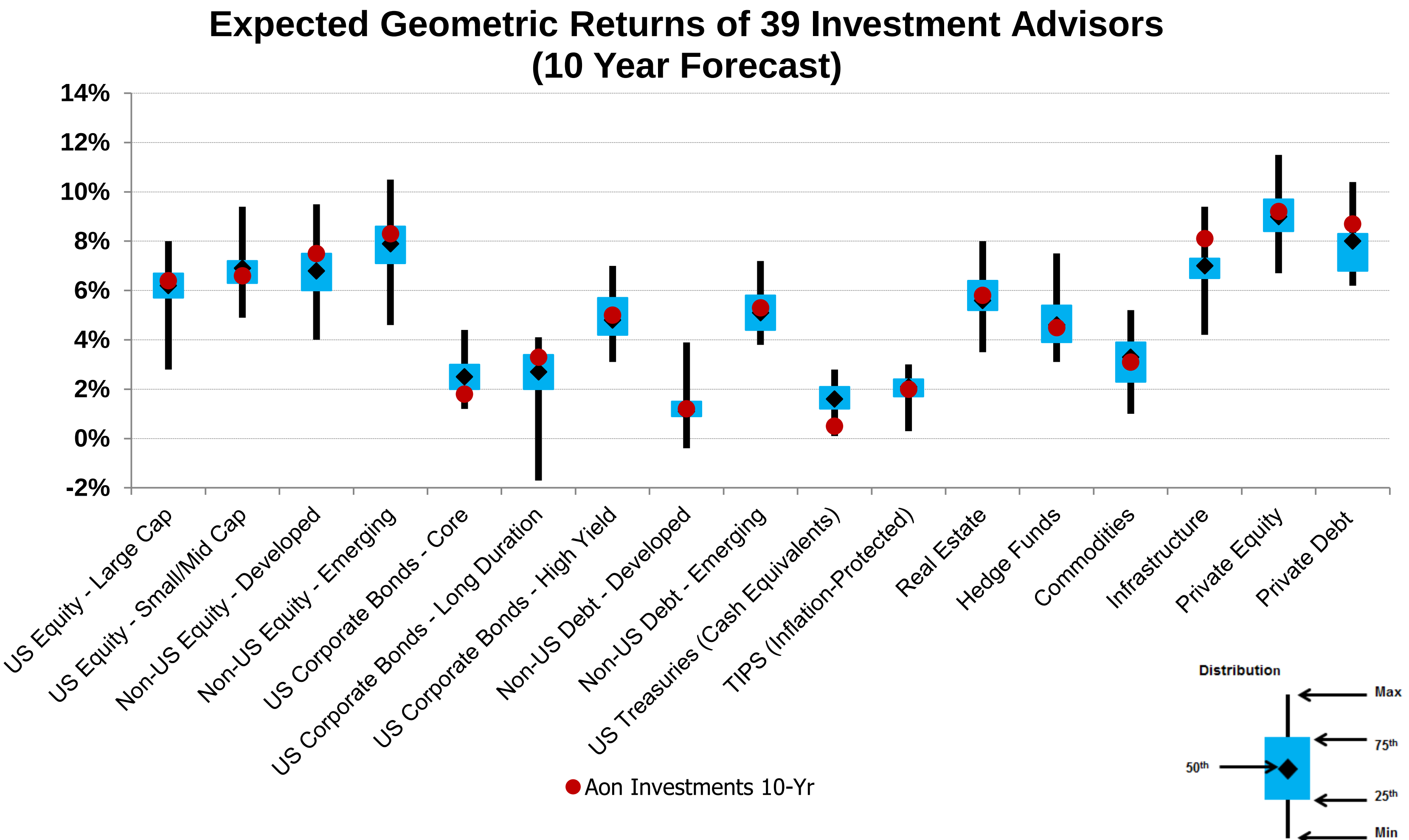
2020 Horizon Survey Results

- **What is the Horizon Survey?**
  - Since 2010, Horizon Actuarial Services, LLC has conducted a capital market assumption survey of investment firms to aid in determining reasonable assumptions for a pension plan's expected return on assets
    - While Aon does not seek to change our approach based on how we stack up to peers, it is a helpful double-check to make sure we are not too far off from others in the industry

- **How does Aon compare to the 2020 survey results?**
  - 2020 Aon Investments' 10-year forecast assumptions (as of March 31, 2020)
    - *Equities:* Non-US equities tend to be **higher** relative to the survey's median level
    - *Fixed Income:* generally **mixed** relative to the survey's median level
    - *Alternatives:* Infrastructure and Private Debt tend to be **higher** relative to the survey's median level

Empower Results®

Aon Investments' Capital Market Assumptions vs. Horizon Survey



SOURCE: Horizon Actuarial Solutions, LLC survey of 2020 capital market assumptions from 39 independent investment advisors
Expected returns of the survey are annualized over 10-years (geometric).
Aon Investments' expected returns are annualized over 10-years as of 2Q 2020 (3/31/2020)

Aon Investments vs. Peers (2020 Horizon Survey)—10-Year Forecast

	Horizon Survey			Aon Investments		
	10 Year Horizon			10 Year Forecasts		Difference
Asset Class	Expected Return	Expected Risk		Expected Return	Expected Risk	Aon Investments- Horizon Survey
US Equity - Large Cap	6.2%	16.2%		6.4%	17.0%	0.2%
US Equity - Small/Mid Cap	6.9%	20.2%		6.6%	23.0%	-0.3%
Non-US Equity - Developed	6.8%	18.1%		7.5%	20.0%	0.7%
Non-US Equity - Emerging	7.9%	24.2%		8.3%	27.0%	0.4%
US Fixed Income - Core	2.5%	5.5%		1.8%	4.0%	-0.7%
US Fixed Income - Long Duration Corp	2.7%	10.2%		3.3%	11.5%	0.6%
US Fixed Income - High Yield	4.8%	9.8%		5.0%	12.0%	0.2%
Non-US Fixed Income - Developed	1.1%	7.0%		1.2%	5.5%	0.1%
Non-US Fixed Income - Emerging	5.1%	11.0%		5.3%	13.0%	0.2%
Treasuries (Cash Equivalents)	1.6%	1.8%		0.5%	1.0%	-1.1%
TIPS (Inflation-Protected)	2.1%	6.1%		2.0%	4.5%	-0.1%
Real Estate	5.6%	16.8%		5.8%	15.0%	0.2%
Hedge Funds	4.6%	8.0%		4.5%	9.0%	-0.1%
Commodities	3.3%	17.6%		3.1%	17.0%	-0.2%
Infrastructure	7.0%	14.6%		8.1%	14.5%	1.1%
Private Equity	9.0%	22.0%		9.2%	25.0%	0.2%
Private Debt	8.0%	12.1%		8.7%	16.0%	0.7%
Inflation	2.0%	1.7%		2.1%	1.0%	0.1%

Notes (Horizon Survey):
Source: Horizon Actuarial survey of 2020 capital market assumptions from 39 independent investment advisors
Expected returns are median annualized (geometric).

Notes (Aon Investments' Forecasts):
Aon Investments' Forecasts are for Q2 2020
- US Equity - Small/Mid Cap forecasts represents Aon Investments' forecasts for US Small Cap
- US Fixed Income - Long Duration forecasts represents Aon Investments' forecasts for Long Duration Credit
- Non-US Fixed Income - Developed forecasts represents Aon Investments' forecasts for Non-US Fixed Income - Developed (50% Hedged)
- Non-US Fixed Income - Emerging forecasts represents Aon Investments' forecasts for Emerging Market Bonds - Sovereign USD
- Real Estate forecasts represents Aon Investments' forecasts for Core Real Estate
- Hedge Funds forecasts represents Aon Investments' forecasts for Direct Hedge Funds (Universe)

Leading Methodologies & Reasons for Differences

Leading Methodologies

- Building Block
- Global Capital Asset Pricing Model (Global CAPM)
- Surveys
- Historical data (as a guide to future)
- Black-Litterman (combination of building block and CAPM)

Reasons for Differences

- Methodology
- Time Horizon
- Arithmetic vs. Geometric forecasts*
- Alpha (active management)*
- Inflation
- Investment Fees*
- Asset class definition

* While some firms in the Horizon survey responded with arithmetic forecasts, the results have been converted to geometric forecasts for comparison purposes. Additionally, the return expectations included in the Horizon survey are generally market returns that do not reflect active management. Returns for asset classes where passive investments are not available (e.g., hedge funds and private equity) are net of fees.

Appendix

- How Do Public Pensions Impact Credit Ratings?

How Do Public Pensions Impact Credit Ratings?
Summary and Conclusions

Pension Impact on Credit Ratings

- Pension plans have a direct impact on the ultimate state or local credit rating
- Rating agencies are not just looking at where public pension plans stand today; they are looking at the expected future trajectory of the plan based on how it is managed

Credit Ratings and Borrowing Costs

- Taxpayers in lower credit rated jurisdictions are paying higher borrowing costs and could save money through healthier pension plan management

Call to Action

- The Big Three (Fitch, Moody's and S&P) value selecting appropriate actuarial assumptions, avoiding excessive risk taking, and developing an adequate funding policy
- While debt priorities and revenue framework to service such debt will vary on a case-by-case basis, every jurisdiction has the ability to thoughtfully develop a funding policy and set appropriate assumptions
- These initial steps will help pension stakeholders better understand the true economic costs, improve the funding outlook for public pensions, and potentially reduce borrowing costs and further taxpayer burden

How Do Public Pensions Impact Credit Ratings?

Call to Action: Plan Sponsors Have Ability to Impact Credit Rating

Below are three specific actions plan sponsors can take today to directly improve the impact a pension plan will have on the credit rating of its locality:

Action	Considerations
1. Conduct an actuarial assumption audit ▪ Review reasonability of key assumptions: – Salary scale, Mortality, Retirement rates, Turnover rates	▪ Assumptions set to plan-specific expectations will lead to lower contribution volatility ▪ Aggressive assumptions may provide short-term relief but may have long-term consequences
2. Consider adjustments to expected return assumption ▪ Adjustments should be in line with forward-looking expectations for asset returns	▪ Contributing an actuarial amount? – **Yes:** Failing to achieve target returns will necessitate increases in future contributions and make what was intended to be a smooth, budget-friendly progression of contribution increases far more volatile – **No:** The funding gap will widen and become highly volatile as contribution policy will not add enough dollars to replenish losses
3. Review the plan's funding policy ▪ Look far enough into the future to identify potential pain points	▪ Conduct "tread water"/hurdle rate analysis to ensure short-term contributions are sufficient to keep pace with growth of plan liabilities ▪ Consider asset-liability study to understand range of potential future outcomes rather than a single deterministic scenario

Appendix

- Investment Guidance for Public Employee Retirement System Trustees

Investment Guidance for Public Employee Retirement System Trustees[1]

1. **PERS trustees should look to the state for statutory direction on behalf of the taxpayers**
   a) Prudent-person rule
   b) Peer analysis

2. **PERS trustees should not be daunted by a liability value that exceeds the value of assets**
   a) Do not feel obliged to incur greater risk in an effort to narrow the gap
   b) Funded status has less to do with investment performance than it does with public policy and politics

3. **PERS trustees should not assume that an equity-oriented investment policy is suitable for their fund**
   a) Discern the risk tolerance of taxpayers
   b) May conclude that a moderate level of risk is warranted

4. **Trustees of individual PERSs should be cognizant of the existence and implications of the unitary state pension fund**
   a) Unitary state pension fund is the only fund of economic consequence to the taxpayers
   b) Multiple actively managed funds may form, in total, a closet index fund

5. **PERS investments should be exposed to rewarded risks, and insulated from unrewarded risks**
   a) Market risk (equity exposure) is rewarded risk, on average
   b) Diversifiable risk is not

[1] Richard M. Ennis, *Is a Statewide Pension Fund a Person or a Cookie Jar? The Answer Has Implications for Investment Policy,* Financial Analysts Journal, November-December 1988

Appendix

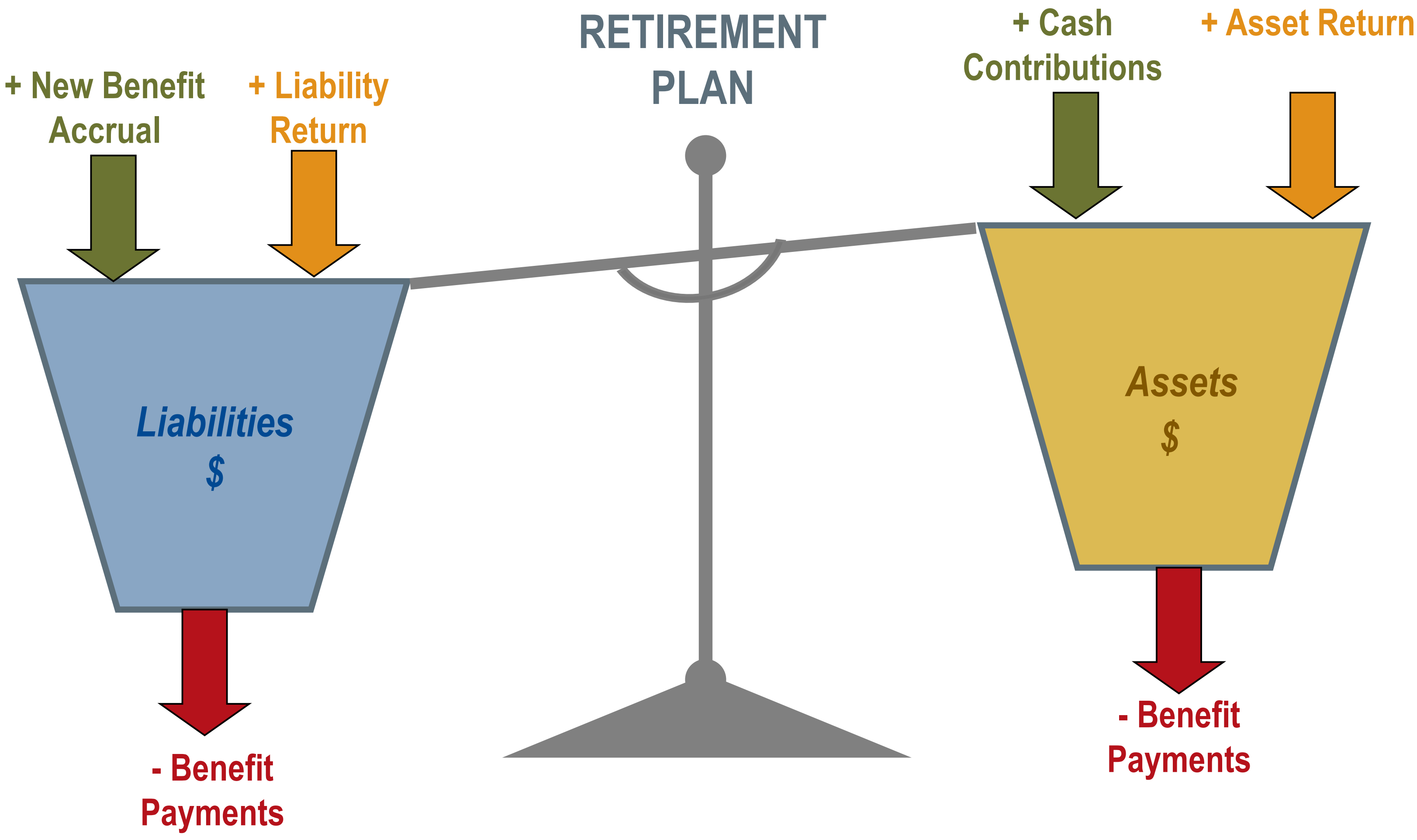
- Asset-Liability Management Background

Asset-Liability Management Background
What is an Asset-Liability Study?

- Provides fiduciaries with an understanding of the dynamic relationship between plan assets and liabilities over time
- Illustrates the impact of various asset allocation targets on required contributions and funded status under a range of different macro-economic scenarios
- Identifies future trends in the financial health of the plan based on economic uncertainties that may not be evident from an actuarial valuation, which provides only a snapshot at a point in time
- Helps determine the level of risk that is appropriate in the context of the Plan’s liabilities

An asset-liability study provides the tools to align a plan’s risk taking with its liabilities

Asset-Liability Management Background
Balance of Liabilities and Assets



Asset-Liability Management Background

Key Risks for Public Pension Plans

Types of Risk	Time Horizon	Risk Management Tools and Controls
Return Shortfall ▪ Assets do not grow with liabilities ▪ Investment Return & Contribution less than Liability Growth	**Long Term** (10+ years)	▪ Funding Policy ▪ Plan Design ▪ Investment Policy ▪ Assumptions & Methods
Liquidity ▪ Cannot liquidate assets efficiently to meet needs ▪ Lost control of asset allocation	**Short to Medium Term** (<5 years)	▪ Funding Policy ▪ Benefit Accruals ▪ Use of Illiquid Investments ▪ Scenario Analysis ▪ Monitoring
Investment ▪ Asset Allocation (Policy) ▪ Investment Structure ▪ Manager Selection ▪ Rebalancing ▪ Scenario (or Path Risk) ▪ Factor	**Short to Medium Term** (<5 years)	▪ Investment Policy Statement – Static/Dynamic – Asset Allocation – Rebalancing – Manager Guidelines – Monitoring/Roles & Responsibilities ▪ Risk Budgeting Tools ▪ Monitoring / Dashboards ▪ Medium Term Views ▪ Regression and Scenario Analysis
Others (e.g., Operational)	Ongoing	▪ Operational and Specialty Due Diligence

Asset-Liability Management Background
Overview of the Asset-Liability Study Process

Planning Discussions

Planning
- Objectives of the Study
- Modeling and Liability Assumptions

+

Risk Tolerance
- Risk Preference
- Demographics
- Funded Status
- Business/Financial
- Industry Practices

+

Asset-Liability Projections

Asset Modeling
- Capital Market Analysis
- Efficient Frontier Analysis
- Portfolios for Study

+

Liability Analysis
- Cost Projections
- Funded Status
- Sensitivity Analysis

Desired Outcomes:
- **Understand the pension risk**
- **Identify optimal investment strategy**

↓

Implementation

↓

Monitoring & Execution

Asset-Liability Management Background
Modeling Process

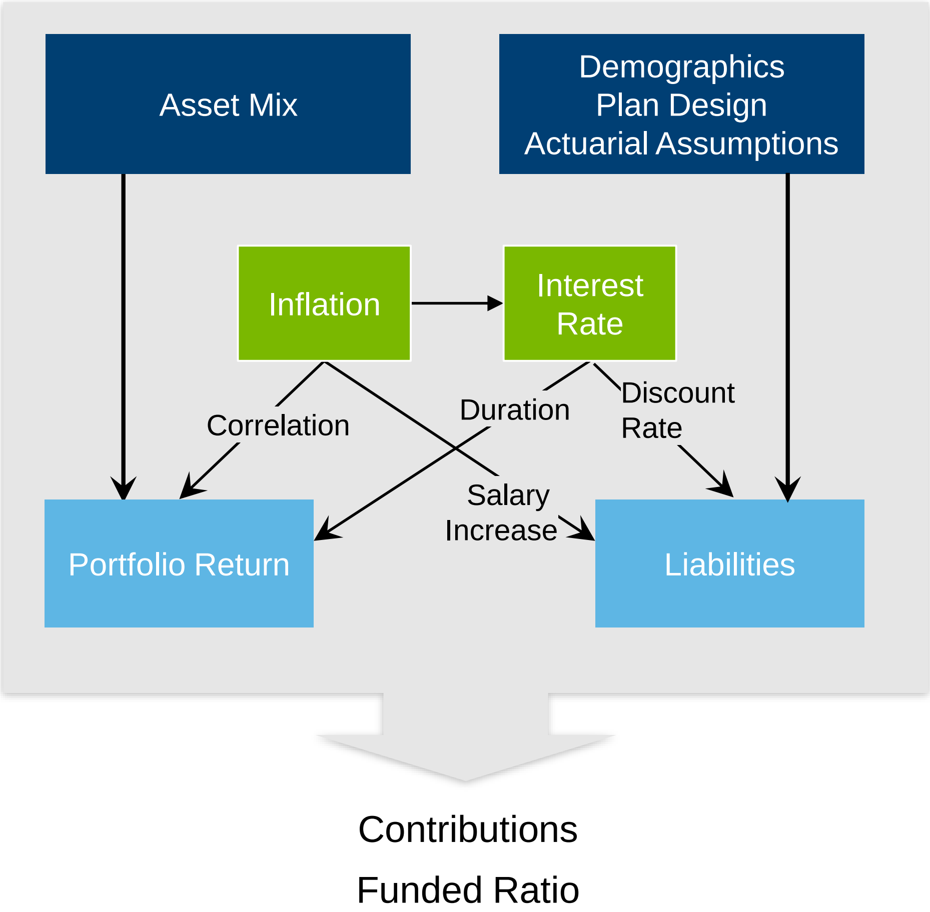
- Goals of an asset-liability study:
  - Understand the pension plan's asset-liability risk, and
  - Identify the optimal investment strategies

- Stochastic, Monte Carlo simulation analysis used
  - 5,000 independent economic trials
  - Building block approach
    - Starts with inflation and interest rates
    - Using a multi-factor regression analysis, other asset classes are then modeled
  - Assets and liabilities are modeled over the projection period
    - Projections include contribution requirements and funded ratios

- Asset-liability studies are best-suited to determine the optimal mix of return-seeking (e.g., equity) and fixed income assets for the pension fund
  - Asset mix is the single most important investment decision for the plan sponsor
    - Is it worthwhile to have a more aggressive allocation in order to reduce long term cost in exchange for risk of higher costs in a bad outcome?
    - Is it worthwhile to have a more conservative allocation in order to have a more predictable cost in exchange for potentially higher average costs?

Asset-Liability Management Background

Mechanics of Asset-Liability Modeling Process



Asset and liability modeling integrated in single platform

- Integrates impact of key economic variables

Flexibility in modeling parameters and output to client preferences

Stochastic and deterministic modeling performed

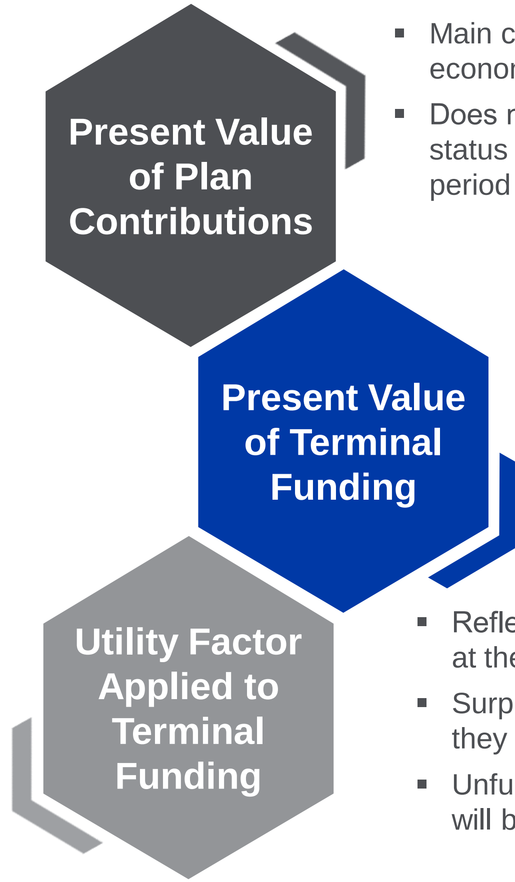
Empower Results®

Asset-Liability Management Background

Long-Term Economic Cost of Plan

Long-Term Economic Cost =

- **Present Value of Plan Contributions +**
- **Present Value of Terminal Funding, adjusted by a utility factor**



- Main component of long-term economic cost
- Does not reflect the plan's funded status at the end of the forecast period

- Reflects the plan's funded status at the end of the forecast period
- Surplus assets are valuable as they lower future contributions
- Unfunded liabilities are costs that will be recognized in future years

Terminal Funding	Surplus	Shortfall
Utility Rationale	Declining value, or utility, from very high funded ratios	Increasing "pain" as unfunded amounts grow to high levels
Threshold	PVB / AL	(5 Yrs. of Benefit Payments) / AL
Utility Factor above/below threshold	50%	200%

Empower Results®

Asset-Liability Management Background

Utility Factor For Terminal Funded Status

- Modest deviations from 100% funding are normal, and no special adjustment is needed for these scenarios – the amount of surplus or unfunded liability can be reflected at its dollar value

- As surplus amounts grow to very high levels, there is a declining value, or utility, to the surplus:
  - Contributions cannot go below zero
  - Long contribution holidays may create a false sense of how much the plan really costs, and lead to confusion when cost levels revert to “normal”
  - Large surplus amounts can become a potential target for non-pension applications

- As unfunded amounts grow to very high levels, there is an increasing amount of “pain” as contributions rise to unacceptable levels:
  - May be viewed as “breaking trust” with future taxpayers
  - Freezing of the pension plan becomes a possibility

Asset-Liability Management Background

Risk and Return in an Asset-Liability Context

- **Traditional:**
  - Return = Investment performance
  - Risk = Annual volatility of investment gains and losses (e.g. weak/negative capital market returns)

- **Asset-Liability:**
  - Return = Potential cost reduction or funded status improvement under average economic conditions
  - Risk = During the worst economic conditions, contributions need to increase or funded status declines (e.g., stocks decline, inflation/deflation shocks and/or interest rates decline)

Asset-Liability Management Background
Key Factors Affecting the Risk/Reward Trade-off

- The key take-away from the A/L study is the allocation between equity (“return-seeking”) vs. fixed income (“risk-reducing”)

- Major factors affecting the ultimate mix are:
  - Time horizon (or amortization period of unfunded liability) to fund the liability: a longer time horizon supports more risk taking
  - Characteristics of plan participants: a growing population of active participants supports more risk taking; a mature population with significant retirees might need a more conservative policy
  - Funded status: a less funded plan can utilize additional returns from equity investments
  - Nature of plan benefits: a pension with sensitivity to wage inflation growth can benefit from equities in the long-term; an increased need in liquidity due to significant benefit payments in the near future can have a more conservative policy

Asset-Liability Management Background
Limitations of Asset-Liability Modeling

- Asset-liability studies are best-suited to determine the optimal mix of return-seeking (e.g., equity) and liability-hedging (e.g., fixed income) assets for the retirement fund
  - Asset mix is the single most important investment decision for the plan sponsor
  - Studies have found that more than 90% of the variability of a portfolio's return is determined by the asset allocation
  - Decisions regarding how to divide allocations among various sub-categories are less important in an asset-liability context and can be addressed in the implementation phase, following the asset-liability study

- Asset-liability modeling can capture the likelihood of a strategy meeting the objectives
  - It does not 'predict' the future, i.e., we cannot say which of the economic scenarios will actually occur
  - The results depend on the assumptions underlying the model and the structure of the model itself

- There are elements that cannot be modeled and must be thought of in addition to the results of any analysis:
  - E.g., idiosyncratic manager risk, liquidity requirements
  - Black swans

Appendix

- About This Material

About This Material

This material includes a summary of calculations and consulting related to the finances of Pennsylvania Public School Employees' Retirement System (PSERS). The following variables have been addressed:

- Contributions
- Economic Cost
- Funded Ratio
- Hurdle Rate
- Net Outflow

This analysis is intended to assist the Investment Committee with a review of the associated issues and options, and its use may not be appropriate for other purposes. This analysis has been prepared solely for the benefit of the Investment Committee. Any further dissemination of this report is not allowed without the written consent of Aon Investments USA Inc.

Our calculations were generally based on the methodologies identified in the actuary's valuation report for PSERS. We believe the methodology used in these calculations conforms to the applicable standards identified in the report.

Models are used to develop alternative scenarios based on the underlying valuation model and project financial results under those scenarios. The models were developed by experts outside and within Aon. Where outside models were used, the models were reviewed by experts within Aon. The models were selected as appropriate for these projections by the undersigned.

Experience different than anticipated could have a material impact on the ultimate costs of the benefits. In addition, changes in plan provisions or applicable laws could have a significant impact on cost. Actual experience may differ from our modeling assumptions.

Our calculations were based on data provided by the plan actuary. The actuarial assumptions and methods and plan provisions reflected in these projections are the same as those used for the 2019 actuarial valuation for PSERS as noted in the actuarial reports, except where noted in this report. Unless specifically noted, our calculations do not reflect any other changes or events after June 30, 2019. Reflecting events after June 30, 2019 would impact the results of the projection.

In conducting these projections, we have relied on plan design, demographic and financial information provided by other parties, including the plan's actuary and plan sponsor. While we cannot verify the accuracy of all of the information, the supplied information was reviewed for consistency and reasonableness. As a result of this review, we have no reason to doubt the substantial accuracy or completeness of the information and believe that it has produced appropriate results.

These projections have been conducted in accordance with generally accepted actuarial principles and practices, including applicable Actuarial Standards of Practice as issued by the Actuarial Standards Board. The undersigned actuary is familiar with the near-term and long-term aspects of pension valuations and meet the Qualification Standards of the American Academy of Actuaries necessary to render the actuarial opinions contained herein. All sections of this report are considered an integral part of the actuarial opinions.

To our knowledge, no colleague of Aon Investments USA Inc. providing services to PSERS has any direct financial interest or indirect material interest in PSERS. Thus, we believe there is no relationship existing that might affect our capacity to prepare and certify this report for PSERS.

Aon Investments USA Inc.

Phil Kivarkis FSA, CFA

Legal Disclosures and Disclaimers

Investment advice and consulting services provided by Aon Investments USA Inc. (“Aon Investments”). The information contained herein is given as of the date hereof and does not purport to give information as of any other date. The delivery at any time shall not, under any circumstances, create any implication that there has been a change in the information set forth herein since the date hereof or any obligation to update or provide amendments hereto.

This document is not intended to provide, and shall not be relied upon for, accounting, legal or tax advice. Any accounting, legal, or taxation position described in this presentation is a general statement and shall only be used as a guide. It does not constitute accounting, legal, and tax advice and is based on Aon Investments’ understanding of current laws and interpretation.

Aon Investments disclaims any legal liability to any person or organization for loss or damage caused by or resulting from any reliance placed on that content. Aon Investments reserves all rights to the content of this document. No part of this document may be reproduced, stored, or transmitted by any means without the express written consent of Aon Investments.

Aon Investments USA Inc. is a federally registered investment advisor with the U.S. Securities and Exchange Commission. Aon Investments is also registered with the Commodity Futures Trading Commission as a commodity pool operator and a commodity trading advisor, and is a member of the National Futures Association. The Aon Investments ADV Form Part 2A disclosure statement is available upon written request to:

Aon Investments USA Inc.
200 E. Randolph Street
Suite 700
Chicago, IL 60601
ATTN: Aon Investments Compliance Officer