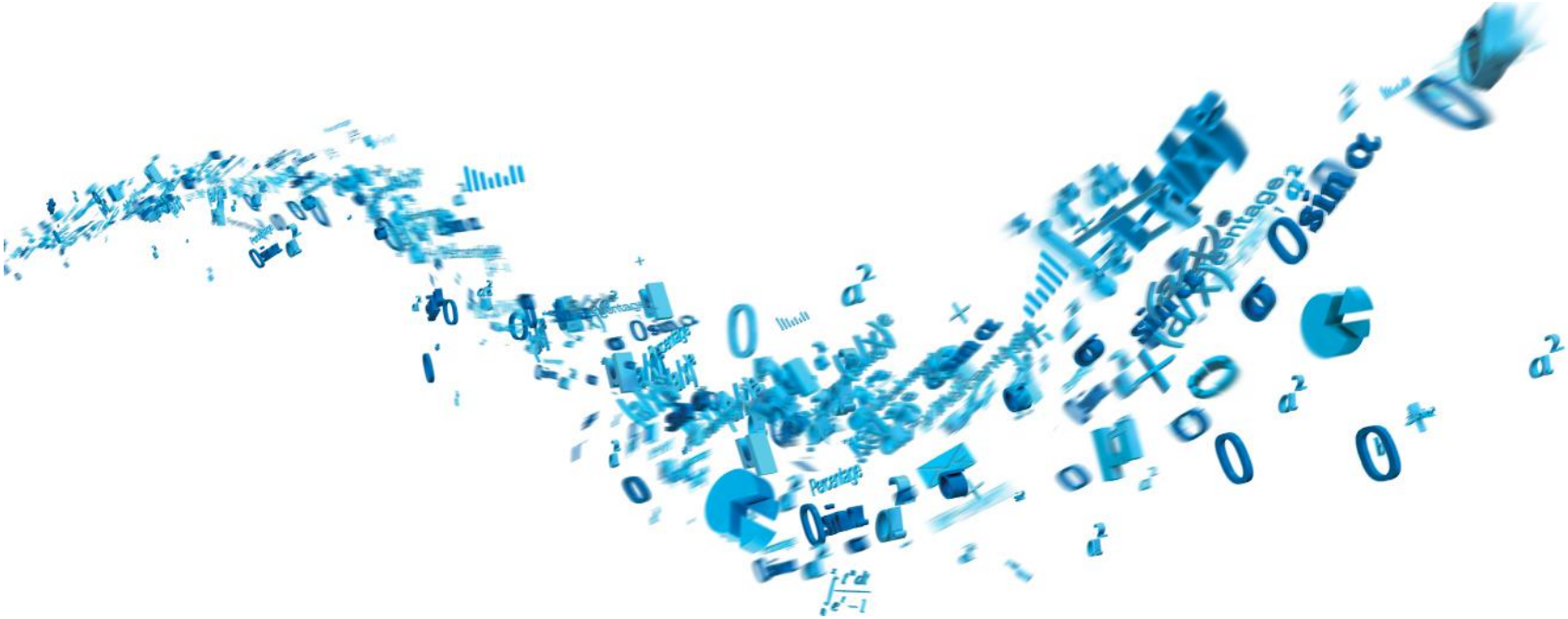

Asset-Liability Study Results

Pennsylvania Public School Employees' Retirement System (PSERS)
July 24, 2019

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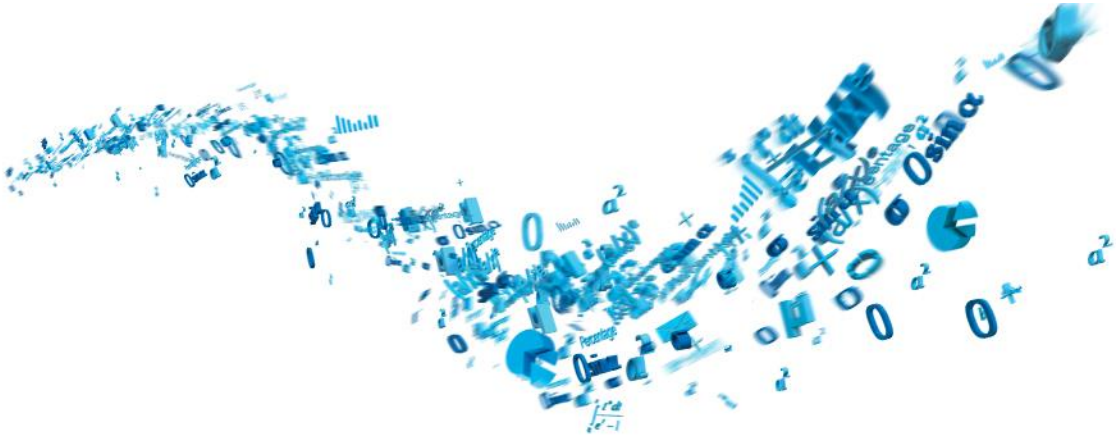

Executive Summary

Executive Summary
Summary and Conclusions

Portfolio Analysis

- The current portfolio is well-diversified
- The expected annual return assumption for the Current Long-Term Target portfolio is 7.55% over the next 30 years while the Proposed Long-Term portfolio is 7.66% over the same period
- 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

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Executive Summary
Key Observations

1) PSERS is projected to attain full funding by 2037 (on a market value of assets basis) in our central expectation (50th percentile outcome) under the Current Long-Term Target Asset Allocation

- This is a one year improvement versus the projections from last year's analysis
- 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 sixteen years to approximately $7.2 billion annually utilizing the Current Long-Term Target allocation

- This is an improvement from last year's analysis where employer contributions reached $7.4 billion annually
- This increase in contributions reflects the amortization of the unfunded liabilities based on the current amortization schedule
- The contributions decline to $0.5 billion annually (the normal cost) at the end of the 30-year projection period as the plan reaches 100% funded (an $0.57 billion improvement from last year's analysis)
- This reduction in the contributions for the DB Plan is offset by the expected increasing DC contributions.
- This portfolio has a 63% probability of reaching full funding at the end of the 30 year projection period; a 3% improvement versus last year's study
    - A public pension fund which amortizes over 30 years would be expected to have a 50% chance of full funding over 30 years

3) The Proposed Long-Term Target portfolio has a higher expected return (by 0.11%) with better risk adjusted returns as measured by the Sharpe Ratios (by 0.010) than the Current Long-Term Target portfolio

- The higher return is achieved through a re-allocation of the credit-related fixed income, with a higher allocation to private credit, along with a 1% increase in leverage

Executive Summary
Key Observations (continued)

4) The Proposed 1 Year Target portfolio reflects a modest increase in expected return (0.01%) and expected risk (0.09%) relative to the Current 1 Year Target

- The Proposed 1 Year Target portfolio provides a lower risk/reward portfolio than the Current 1 Year Target as measured by the Sharpe Ratio (0.448 versus 0.451)
- Stochastic modelling illustrates similar forward-looking projections, each with a 58% probability of reaching full funding at the end of the 30 year projection period

5) The ETF Portfolio is an illustrative all liquid, diversified portfolio

- Liquidity concerns for certain asset class ETFs would require PSERS to implement certain asset class allocations with separate accounts rather than investments in modeled ETFs

6) The analysis supports continuing to use 7.25% as the assumption for the expected return on assets for the given level of risk

7) The proposed 1-year and Long-Term targets are consistent with the Risk Objectives outlined in the IPS

- The portfolios are well diversified by asset class, investment type, industry, sector, geographic and maturity
- The probability of investment losses in excess of 15% in any one year is no greater than 2.5% (or two standard deviations below the expected return).

Asset-Liability Projection Results (Stochastic Results)

Summary and Conclusions

	All Scenarios	30-year Economic Cost		30-year Present Value of Gross Contributions (Employee + Employer)		30-year Ending Funded Ratio (MVA / AL)		30-Year Total Nominal Employer Contributions	
	$ billions	Expected[1]	Downside[2]	Expected[1]	Downside[2]	Expected[1]	Downside[3]	Expected[1]	Downside[2]
1 Year Target	(A) Current 1 Year Target	$73.6	$100.5	$75.6	$94.4	116%	34%	$121.4	$211.0
1 Year Target	(B) Proposed 1 Year Target	$73.5	$100.6	$75.5	$94.5	117%	33%	$121.5	$211.8
1 Year Target	(C) 60/40 Levered Same Return as Proposed 1 Year	$73.5	$107.2	$77.1	$101.4	130%	25%	$126.5	$232.9
1 Year Target	(D) 60/40 Levered Same Risk as Proposed 1 Year	$83.2	$106.8	$81.4	$99.2	84%	25%	$146.6	$229.6
1 Year Target	(E) ETFs of Proposed 1 Year	$84.0	$105.3	$81.4	$97.6	79%	27%	$149.1	$226.5
Long-Term Target	(F) Current Long-Term Target	$71.0	$101.0	$74.5	$95.1	130%	33%	$117.0	$212.9
Long-Term Target	(G) Proposed Long-Term Target	$70.0	$100.3	$74.1	$94.5	134%	35%	$115.0	$210.2
Long-Term Target	(H) Simple 60/40	$81.4	$106.9	$80.6	$99.5	91%	26%	$142.7	$230.2

Key Findings:

- The Plan is expected to reach full funding in the central expectation (50th percentile) under both the Current and Proposed 1-year and the Current and Proposed Long-Term Target policy over the course of the projection period assuming the expected contributions are made
- Adverse market experience and/or not making required contributions will negatively impact the funded status over the projection period

[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

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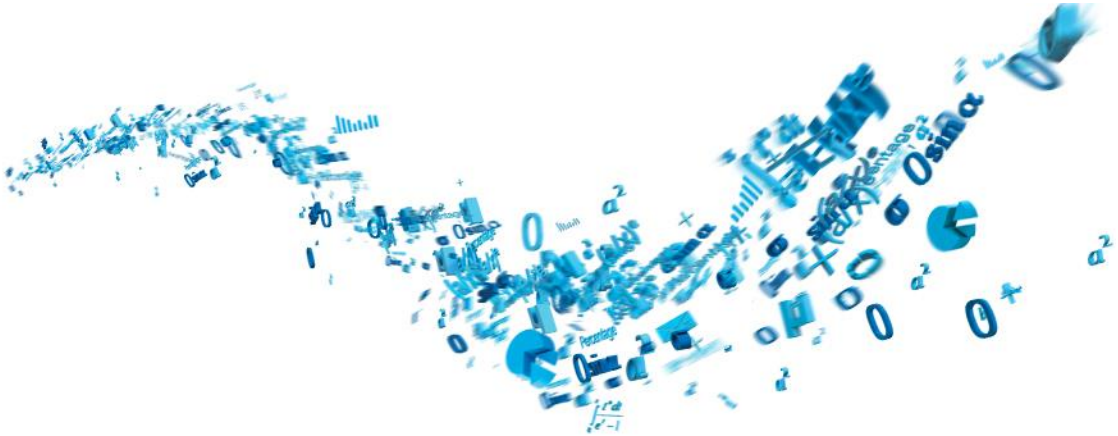
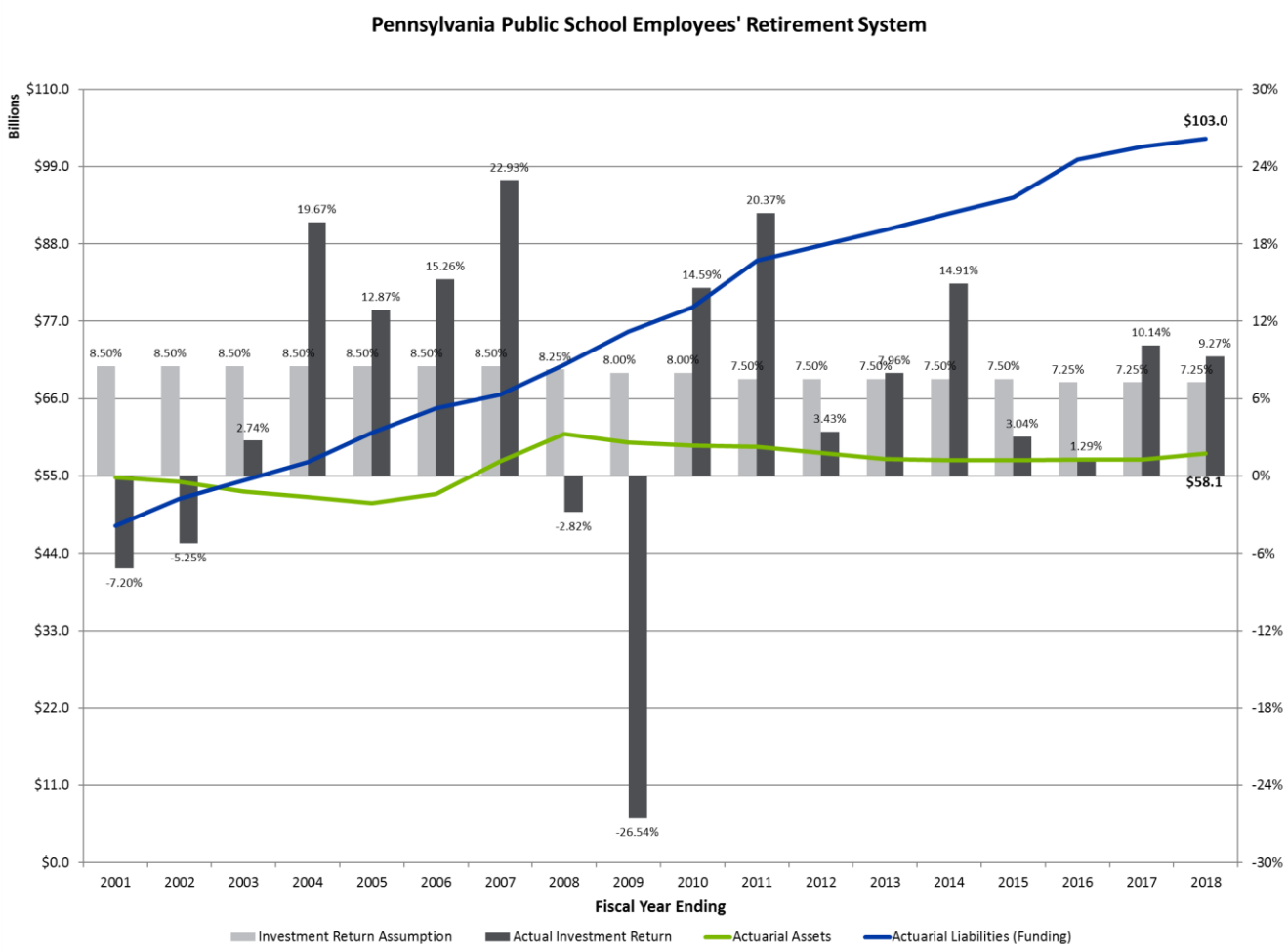


Analysis

- Background and Current State

Background and Historical Information



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 April 2019; Actuarial valuation report as of June 30, 2018

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Current State Asset-Liability Profile

As of June 30, 2018

Asset-Liability Snapshot as of 6/30/2018		
Metric ($, Billions)	**Value**	**Fund %**
Market Value of Assets	$56.4	54.7%
Actuarial Value of Assets	$58.1	56.4%
Liability Metrics		
Actuarial Liability (AL) – Funding	$103.0[1]	

Target Asset Allocation as of 6/30/2018		
Metric ($, Billions)	**Value**	**Alloc %**
Return-Seeking		
- Global Equity	$11.3	20%
- Private Equity	$8.5	15%
- Infrastructure	$4.5	8%
- Real Estate	$5.6	10%
- Credit-Related[2]	$5.6	10%
- Commodities	$4.5	8%
- Risk Parity	$5.6	10%
- Total	$45.7	81%
Risk-Reducing / Safety		
- Inflation-Linked[3]	$8.5	15%
- Hedge Funds[4]	$5.6	10%
- Cash	$1.7	3%
- Core Bonds	$2.8	5%
- Long Duration Gov't Bonds	$2.8	5%
- Developed International Debt	$0.6	1%
- Total	$22.0	39%
Financing		
- Leverage	-$11.3	-20%
Total	$56.4	100%

Key Takeaways:

- Pension plan is 54.7% funded on a market value of assets basis as of June 30, 2018
- Asset hurdle rate of 16.96%, via cash funding and investment returns, needed to maintain or improve actuarial funded status
- The Total Expected Asset Growth rate (EROA plus Contributions) exceeds the Hurdle Rate by 41 bps; an improvement versus last year's shortfall

Asset-Liability Growth Metrics for FYE 6/30/2018			
Metric ($, Billions)	**Value**	**% Liability**	**% Assets**
AL Discount Cost	$7.5	7.25%	13.25%
AL Normal Cost	$2.1	2.03%	3.71%
Total Liability Hurdle Rate	**$9.6**	**9.28%**	**16.96%**
Expected Return on Assets[5]	$4.3	4.13%	7.55%
Total Contributions	$5.5	5.37%	9.82%
Total Exp. Asset Growth	**$9.8**	**9.50%**	**17.37%**
Hurdle Rate (Shortfall)/Surplus	**$0.2**	**0.22%**	**0.41%**
Est. Benefit Payments	$7.2	6.97%	12.73%

[1] Based on a 7.25% discount rate consistent with the June 30, 2018 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 AHIC Q2 2019 30 year capital market assumptions

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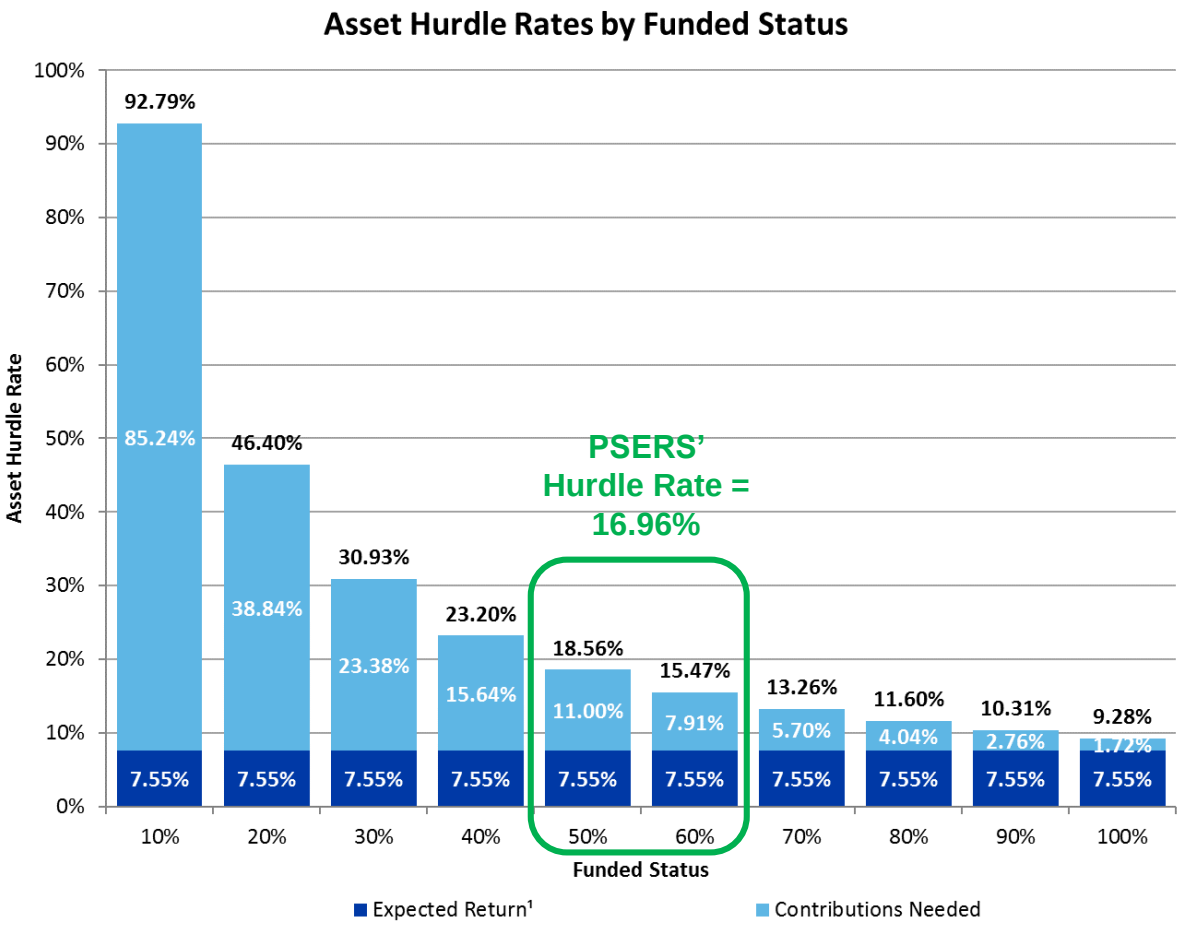
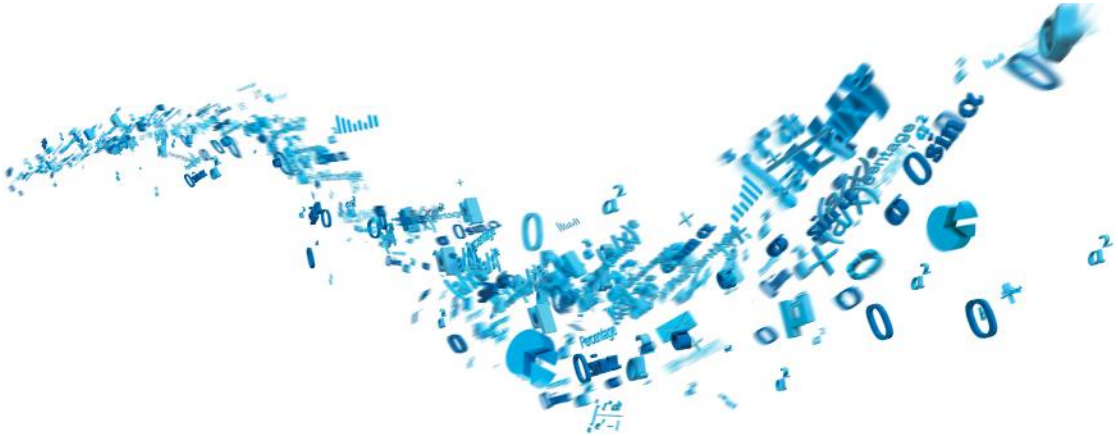
Asset Hurdle Rate

- **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 AHIC Q2 2019 30 year capital market assumptions

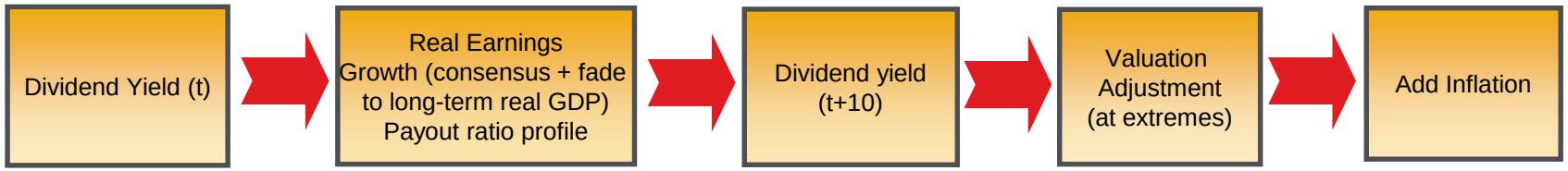


Analysis

- Portfolio Analysis

Portfolio Analysis
How Do We Set Assumptions?

- Our global assumptions are Aon's asset class return, volatility and correlation assumptions. "Best estimate" asset class returns, i.e., 50/50 chance actual returns will be below our assumptions.
- Updated quarterly
- Details of our assumptions are shown in the appendices to this material
- Assumptions are set passively except for private equity and hedge funds. We add manager alpha separately for asset classes.
- Time Horizon – Up to 30 years.
- Return assumptions modelled differently according to asset class attributes.
  - E.g., Equities based on discounted dividend ('cash flow') approach:



Portfolio Analysis

Capital Market Assumption Overview

- We have what we consider a consistent and conservative approach to modeling asset class returns, risk, and correlations

- AHIC regularly reviews these critical inputs relative to peer consultants as well as the investment management community

Q2 2019 AHIC 10-year Capital Market Assumptions

- Asset class exposures are represented within the PSERS portfolio

	Real Return	Nominal Return	Risk	Premium Over Cash	Sharpe
US Equity	4.0%	6.4%	17.9%	4.2%	0.24
Intl Developed Equity Unhedged	5.1%	7.4%	19.9%	5.2%	0.26
Intl. Developed Equity Hedged	6.4%	8.7%	17.8%	6.5%	0.37
Emerging Mkt. Equity	5.8%	8.1%	27.0%	5.9%	0.22
Private Equity[1]	6.7%	9.0%	26.0%	6.8%	0.26
Core Fixed Income	0.7%	2.9%	4.0%	0.7%	0.18
Non-US Developed Bonds Hedged	0.2%	2.4%	2.5%	0.2%	0.07
Long Govt Bonds	0.9%	3.1%	8.9%	0.9%	0.10
EMD Local	3.1%	5.4%	14.0%	3.2%	0.23
EMD Hard	2.4%	4.6%	13.0%	2.4%	0.19
High Yield Bonds	2.0%	4.3%	12.0%	2.1%	0.17
Private Credit	5.2%	7.5%	16.4%	5.3%	0.32
US TIPS	0.7%	2.9%	4.4%	0.7%	0.15
Non-US Inflation-Linked Hedged[2]	0.4%	2.6%	3.3%	0.4%	0.11
Public Infrastructure	4.7%	7.0%	17.0%	4.8%	0.28
Private Infrastructure	5.4%	7.7%	14.5%	5.5%	0.38
Master Limited Partnerships	4.8%	7.1%	15.9%	4.9%	0.31
Commodities	2.5%	4.7%	16.8%	2.5%	0.15
Gold	1.0%	3.3%	18.9%	1.1%	0.06
Private Real Estate[3]	3.9%	6.2%	17.1%	4.0%	0.23
REITs	3.9%	6.2%	18.5%	4.0%	0.21
Risk Parity[4]	4.0%	6.2%	10.6%	4.0%	0.38
Hedge Funds[5]	2.9%	5.2%	8.2%	3.0%	0.36
US Gov Cash	0.0%	2.2%	1.0%	0.0%	0.00
LIBOR (Leverage)	0.3%	2.5%	1.0%	0.3%	0.28

1) 72% Buyout, 13% Venture, 15% Distressed Debt
2) 3% Canada, 52% UK, 45% Europe. Hedged to USD.
3) 20% Core Real Estate and 80% Non-Core Real Estate
4) 50% Global Equity, -100% LIBOR, 55% TIPS, 75% Intermediate US Govt. Bonds, 20% Commodities
5) 14% Event Driven, 38% Global Macro, 20% Distressed Debt, 16% Fixed Income Arbitrage, 12% Cat. Bonds

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Q2 2019 AHIC 30-year Capital Market Assumptions

- Asset class exposures are represented within the PSERS portfolio

	Real Return	Nominal Return	Risk	Premium Over Cash	Sharpe
US Equity	4.6%	7.0%	18.2%	4.5%	0.24
Intl Developed Equity Unhedged	5.3%	7.6%	20.0%	5.1%	0.26
Intl. Developed Equity Hedged	5.9%	8.2%	18.0%	5.7%	0.32
Emerging Mkt. Equity	6.3%	8.6%	27.6%	6.1%	0.22
Private Equity[1]	7.4%	9.7%	26.6%	7.2%	0.27
Core Fixed Income	1.2%	3.4%	4.9%	0.9%	0.17
Non-US Developed Bonds Hedged	0.6%	2.8%	4.1%	0.2%	0.06
Long Govt Bonds	0.8%	3.0%	10.6%	0.5%	0.05
EMD Local	3.1%	5.4%	14.4%	2.8%	0.20
EMD Hard	2.7%	5.0%	13.7%	2.5%	0.18
High Yield Bonds	2.9%	5.1%	12.2%	2.6%	0.21
Private Credit	5.0%	7.4%	16.8%	4.8%	0.29
US TIPS	1.0%	3.2%	4.5%	0.7%	0.16
Non-US Inflation-Linked Hedged[2]	0.3%	2.5%	3.6%	0.0%	0.00
Public Infrastructure	5.0%	7.3%	17.4%	4.8%	0.27
Private Infrastructure	5.5%	7.8%	14.8%	5.3%	0.36
Master Limited Partnerships	5.2%	7.5%	16.4%	5.0%	0.30
Commodities	2.8%	5.1%	16.8%	2.6%	0.15
Gold	1.0%	3.2%	19.5%	0.7%	0.03
Private Real Estate[3]	3.9%	6.2%	17.3%	3.7%	0.21
REITs	3.9%	6.2%	18.9%	3.6%	0.19
Risk Parity[4]	4.1%	6.4%	10.9%	3.9%	0.36
Hedge Funds[5]	3.4%	5.6%	8.8%	3.1%	0.35
US Gov Cash	0.3%	2.5%	1.7%	0.0%	0.00
LIBOR (Leverage)	0.7%	2.9%	1.8%	0.4%	0.20

1) 72% Buyout, 13% Venture, 15% Distressed Debt
2) 3% Canada, 52% UK, 45% Europe. Hedged to USD.
3) 20% Core Real Estate and 80% Non-Core Real Estate
4) 50% Global Equity, -100% LIBOR, 55% TIPS, 75% Intermediate US Govt. Bonds, 20% Commodities
5) 14% Event Driven, 38% Global Macro, 20% Distressed Debt, 16% Fixed Income Arbitrage, 12% Cat. Bonds

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Portfolio Analysis

AHIC Capital Market Assumption Changes

- Below illustrates the changes in AHIC's capital market assumptions over the past 5 years

	10-Year						30-Year					
Asset Allocation	**Q2 2019**	**Q2 2018**	**Q2 2017**	**Q2 2016**	**Q12015**	***Change***	**Q2 2019**	**Q2 2018**	**Q2 2017**	**Q2 2016**	**Q12015**	***Change***
Equity												
Publicly-traded Global Equity Hedged	7.2%	7.7%	7.4%	7.5%	6.9%	*+0.3%*	7.8%	7.5%	7.4%	7.5%	7.0%	*+0.8%*
Private Markets	9.0%	9.0%	8.6%	8.8%	8.8%	*+0.2%*	9.7%	9.2%	8.6%	8.8%	8.8%	*+0.9%*
Fixed Income												
Investment Grade	2.9%	3.2%	2.9%	2.4%	2.6%	*+0.3%*	3.4%	3.5%	3.7%	3.3%	3.3%	*+0.1%*
Non-US Developed Bonds (100% Hedged)	2.4%	2.7%	2.4%	1.8%	2.1%	*+0.3%*	2.8%	2.9%	3.2%	2.7%	2.9%	*-0.1%*
Long Treasury Bonds	3.1%	3.4%	3.1%	2.7%	3.0%	*+0.1%*	3.0%	3.1%	3.4%	3.1%	3.2%	*-0.2%*
Emerging Markets Debt (Local Currency)	5.4%	5.7%	6.1%	6.1%	6.3%	*-0.9%*	5.4%	5.7%	6.1%	6.1%	6.3%	*-0.9%*
Emerging Market Debt (Hard Currency)	4.6%	4.0%	4.1%	4.4%	4.8%	*-0.2%*	5.0%	4.3%	5.3%	5.1%	5.4%	*-0.4%*
High Yield Bonds	4.3%	4.1%	3.9%	6.1%	4.5%	*-0.2%*	5.1%	5.1%	5.4%	6.5%	4.7%	*+0.4%*
Private Credit	7.5%	8.4%	9.0%	NA	NA	*-1.5%**	7.4%	7.8%	9.2%	NA	NA	*-1.8%**
Inflation-Protected[1]	2.7%	2.8%	2.6%	2.5%	2.7%	---	2.8%	2.9%	3.0%	3.1%	3.2%	*-0.4%*
Real Assets												
MLP/Infrastructure	7.0%	7.2%	7.0%	6.7%	7.4%	*-0.4%*	7.3%	7.2%	7.1%	7.0%	7.4%	*-0.1%*
Private Infrastructure	7.7%	6.8%	6.2%	NA	NA	*+1.5%**	7.8%	6.9%	6.3%	NA	NA	*+1.5%**
Commodities	4.7%	5.3%	4.8%	3.8%	4.1%	*+0.6%*	5.1%	5.8%	5.5%	4.7%	4.8%	*+0.3%*
Gold	3.3%	3.3%	3.2%	NA	NA	*+0.1%**	3.2%	3.4%	3.2%	NA	NA	---
Real Estate	6.2%	6.5%	5.5%	6.2%	6.8%	*-0.6%*	6.2%	6.6%	5.5%	6.2%	6.8%	*-0.6%*
Global REITs	6.2%	6.7%	6.2%	6.4%	6.1%	*+0.1%*	6.2%	6.7%	6.2%	6.4%	6.2%	---
Risk Parity [2]	6.2%	6.1%	5.9%	5.9%	5.8%	*+0.4%*	6.4%	6.2%	6.1%	6.1%	6.0%	*+0.4%*
Absolute Return [3]	5.2%	5.5%	5.0%	5.1%	6.3%	*-1.1%*	5.6%	5.8%	5.6%	5.5%	6.8%	*-1.2%*
Liquidity												
Cash	2.2%	2.5%	2.1%	1.5%	1.8%	*+0.4%*	2.5%	2.6%	2.8%	2.3%	2.4%	*+0.1%*
LIBOR	2.5%	3.0%	2.5%	1.7%	2.0%	*+0.5%*	2.9%	3.2%	3.3%	2.6%	2.7%	*+0.2%*
PSERS Expected Return (Current Long-Term Target)	**7.3%**	**7.3%**	**7.0%**	**6.9%**	**6.9%**	***+0.4%***	**7.6%**	**7.4%**	**7.2%**	**7.1%**	**7.1%**	***+0.4%***

[1] Reflects shift to Global TIPs in 2017 per PSERS policy changes
[2] 50% Global Equity, 55% TIPS, 75% Intermediate Gov't Bonds, 20% Commodities, -100% LIBOR.
[3] 14% Event Driven, 38% Global Macro, 20% Distressed Debt, 16% Fixed Income Arbitrage, 12% Cat. Bonds
* Change reflects 3-year change

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Portfolio Analysis

Portfolios Evaluated

	1 Year Target Portfolios					Long-Term Portfolios		
	A	B	C	D	E	F	G	H
	Current 1 Year Target	Proposed 1 Year Target	60/40 Levered Same Return as Proposed 1 Year	60/40 Levered Same Risk as Proposed 1 Year	ETFs of Proposed 1 Year[1]	Current Long-Term Target	Proposed Long-Term Target	Simple 60/40
US Equity	4.8%	4.8%	42.7%	29.6%	21.9%	7.8%	7.8%	0.0%
Global Equity	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	60.0%
Non-US Dev, Unhedged	1.8%	1.6%	28.1%	19.8%	3.9%	2.2%	2.0%	0.0%
Non-US Dev, USD Hedged	5.5%	4.9%	0.0%	0.0%	4.9%	6.6%	6.0%	0.0%
Emerging Markets	2.9%	3.7%	9.6%	6.8%	3.7%	3.4%	4.2%	0.0%
Private Equity, Unhedged[2]	15.0%	15.0%	0.0%	0.0%	0.0%	15.0%	15.0%	0.0%
Total Equity	**30.0%**	**30.0%**	**80.4%**	**56.2%**	**34.4%**	**35.0%**	**35.0%**	**60.0%**
US Core Fixed Income	4.0%	4.0%	53.2%	37.8%	4.8%	5.0%	5.0%	40.0%
Non-US Dev, USD Hedged	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	1.0%	0.0%
US Long-Term Treasury	6.0%	6.0%	0.0%	0.0%	6.0%	5.0%	6.0%	0.0%
Emerging Markets Debt[3]	1.0%	1.0%	0.0%	0.0%	1.0%	2.0%	2.0%	0.0%
High Yield	0.0%	0.0%	0.0%	0.0%	13.0%	1.6%	0.0%	0.0%
Private Credit	10.0%	10.0%	0.0%	0.0%	0.0%	6.4%	10.0%	0.0%
US TIPS	7.5%	7.5%	0.0%	0.0%	19.4%	7.5%	7.5%	0.0%
Non-US Inflation-Linked	7.5%	7.5%	0.0%	0.0%	0.0%	7.5%	7.5%	0.0%
Total Fixed Income	**36.0%**	**36.0%**	**53.2%**	**37.8%**	**44.2%**	**36.0%**	**39.0%**	**40.0%**
Infrastructure: Energy MLPS	4.0%	3.0%	0.0%	0.0%	3.0%	0.0%	0.0%	0.0%
Infrastructure: Private, USD Hedged	1.0%	1.0%	0.0%	0.0%	3.0%	4.0%	4.0%	0.0%
Infrastructure: Public, USD Hedged	1.0%	2.0%	0.0%	0.0%	0.0%	4.0%	4.0%	0.0%
Commodities: Diversified	5.0%	5.0%	0.0%	0.0%	6.6%	5.0%	5.0%	0.0%
Commodities: Gold	3.0%	3.0%	0.0%	0.0%	3.0%	3.0%	3.0%	0.0%
Private Real Estate, Unhedged	9.0%	8.0%	0.0%	0.0%	0.0%	8.0%	8.0%	0.0%
Global REITs, USD Hedged	1.0%	2.0%	0.0%	0.0%	4.4%	2.0%	2.0%	0.0%
Total Real Assets	**24.0%**	**24.0%**	**0.0%**	**0.0%**	**20.0%**	**26.0%**	**26.0%**	**0.0%**
Risk Parity[4]	**8.0%**	**8.0%**	**0.0%**	**0.0%**	**0.0%**	**10.0%**	**8.0%**	**0.0%**
Hedge Funds[5]	**10.0%**	**10.0%**	**0.0%**	**0.0%**	**0.0%**	**10.0%**	**10.0%**	**0.0%**
Cash	**6.0%**	**6.0%**	**0.0%**	**6.0%**	**5.5%**	**3.0%**	**3.0%**	**0.0%**
LIBOR (Leverage)	**-14.0%**	**-14.0%**	**-33.6%**	**0.0%**	**-4.1%**	**-20.0%**	**-21.0%**	**0.0%**
Total Plan	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
30-Year Exp. Nom. Return	**7.27%**	**7.28%**	**7.28%**	**6.12%**	**6.05%**	**7.55%**	**7.66%**	**6.38%**
30-Year Exp. Real Return	**4.95%**	**4.96%**	**4.97%**	**3.83%**	**3.76%**	**5.23%**	**5.34%**	**4.09%**
30-Year Expected Risk	**10.53%**	**10.62%**	**15.18%**	**10.62%**	**9.23%**	**11.58%**	**11.56%**	**11.52%**
Sharpe Ratio	**0.451**	**0.448**	**0.314**	**0.339**	**0.383**	**0.435**	**0.445**	**0.335**

[1] See slide 48 for how the ETF portfolio was developed

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

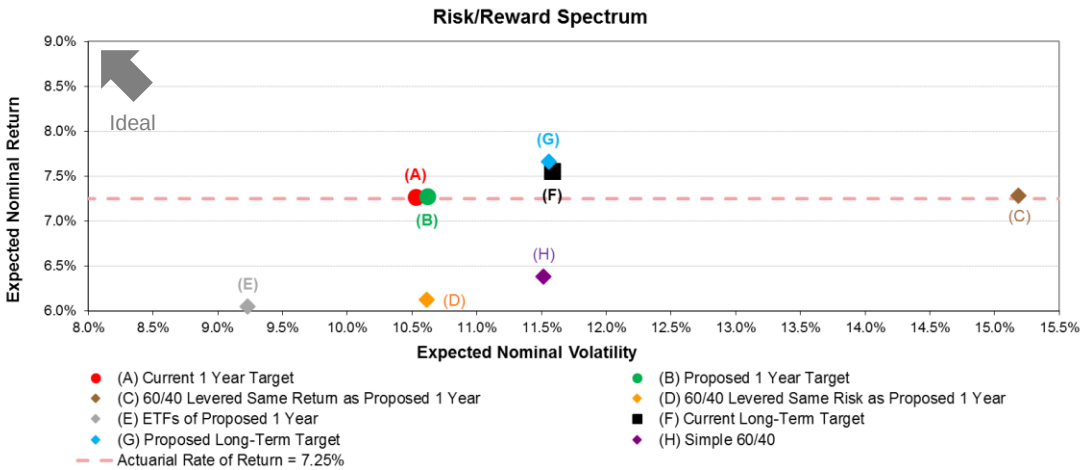
[3] The Emerging Markets Debt allocation is comprised as follows: Current 1 Year Target, Proposed 1 Year Target and ETF Portfolio:1% Local EMD; Current and Proposed Long-Term: 1% Local EMD, 1% Hard EMD

[4] Risk Parity assumptions developed as follows: 50% Global Equity, -100% LIBOR, 55% TIPS, 75% Intermediate Gov't. Bonds, 20% Commodities

[5] 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
Risk/Reward Spectrum



Key Takeaways:

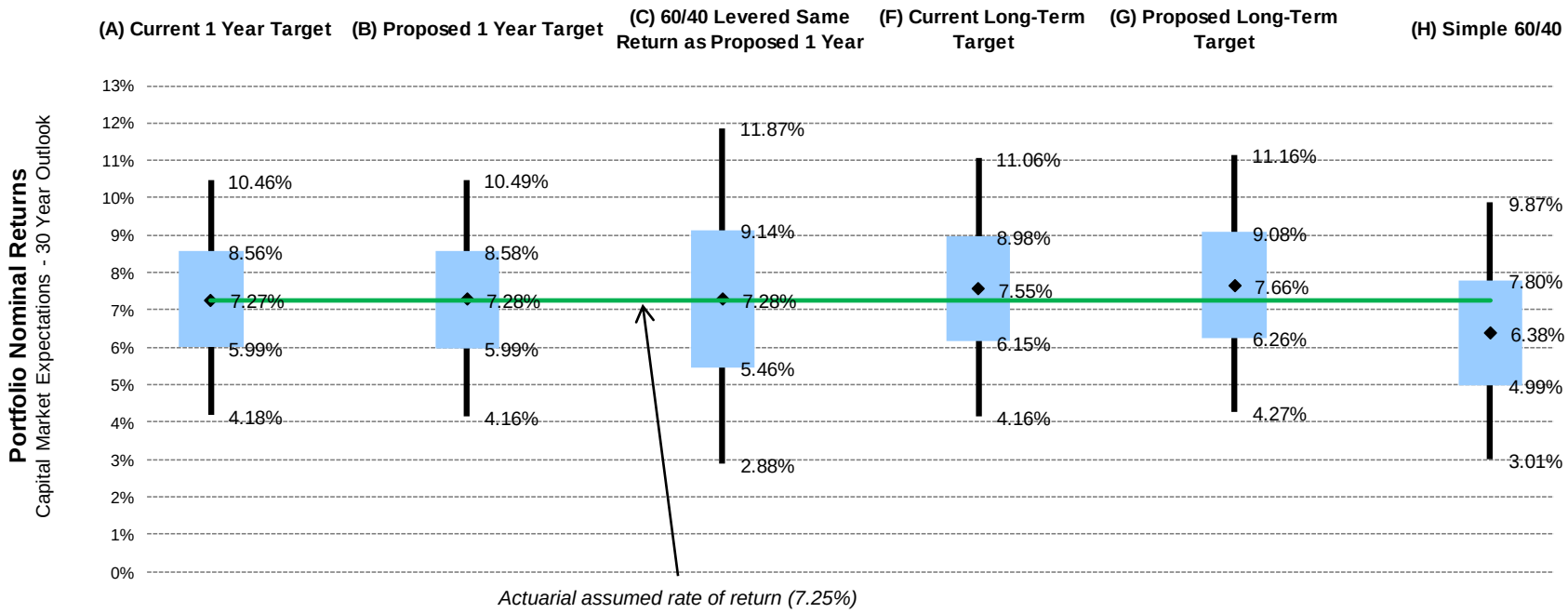
- The Current Long-Term Target portfolio has a high allocation to return-seeking assets
  - Return-seeking assets are broadly diversified
- The Current Long-Term Target portfolio includes a leveraged position of 20%

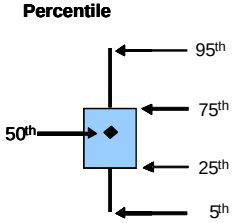
Portfolio Weights

					Return-Seeking								Risk-Reducing / Safety								Financing
		Exp. Nom. Return	Exp. Nom. Vol.	Sharpe Ratio	Global Equity	Private Equity	Infra-structure	Real Estate	Credit-Related[1]	Comm-odities	Risk Parity	Master Limited Partner-ships	Non-US Inflation-Linked	Hedge Funds[2]	Cash	Core Bonds	Inter-mediate Bonds	US TIPS	Long Dur. Gov't Bonds	Dev. Int'l Debt	Leverage
1 Year Targets	(A) Current 1 Year Target	7.27%	10.53%	0.451	15%	15%	2%	10%	11%	8%	8%	4%	8%	10%	6%	4%	0%	8%	6%	0%	-14%
1 Year Targets	(B) Proposed 1 Year Target	7.28%	10.62%	0.448	15%	15%	3%	10%	11%	8%	8%	3%	8%	10%	6%	4%	0%	8%	6%	0%	-14%
1 Year Targets	(C) 60/40 Levered Same Return as Proposed 1 Year	7.28%	15.18%	0.314	81%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	54%	0%	0%	0%	0%	-35%
1 Year Targets	(D) 60/40 Levered Same Risk as Proposed 1 Year	6.12%	10.62%	0.339	56%	0%	0%	0%	0%	0%	0%	0%	0%	0%	6%	38%	0%	0%	0%	0%	0%
1 Year Targets	(E) ETFs of Proposed 1 Year	6.05%	9.23%	0.383	34%	0%	3%	4%	14%	10%	0%	3%	0%	0%	0%	4%	6%	19%	6%	0%	-4%
Long-Term Targets	(F) Current Long-Term Target	7.55%	11.58%	0.435	20%	15%	8%	10%	10%	8%	10%	0%	8%	10%	3%	5%	0%	8%	5%	1%	-20%
Long-Term Targets	(G) Proposed Long-Term Target	7.66%	11.56%	0.445	20%	15%	8%	10%	12%	8%	8%	0%	8%	10%	3%	5%	0%	8%	6%	1%	-21%
Long-Term Targets	(H) Simple 60/40	6.38%	11.52%	0.335	60%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	40%	0%	0%	0%	0%	0%

[1] Credit-Related includes Private Credit, High-Yield Bonds, and Emerging Market Debt
[2] 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.

Portfolio Analysis
Range of Nominal Returns



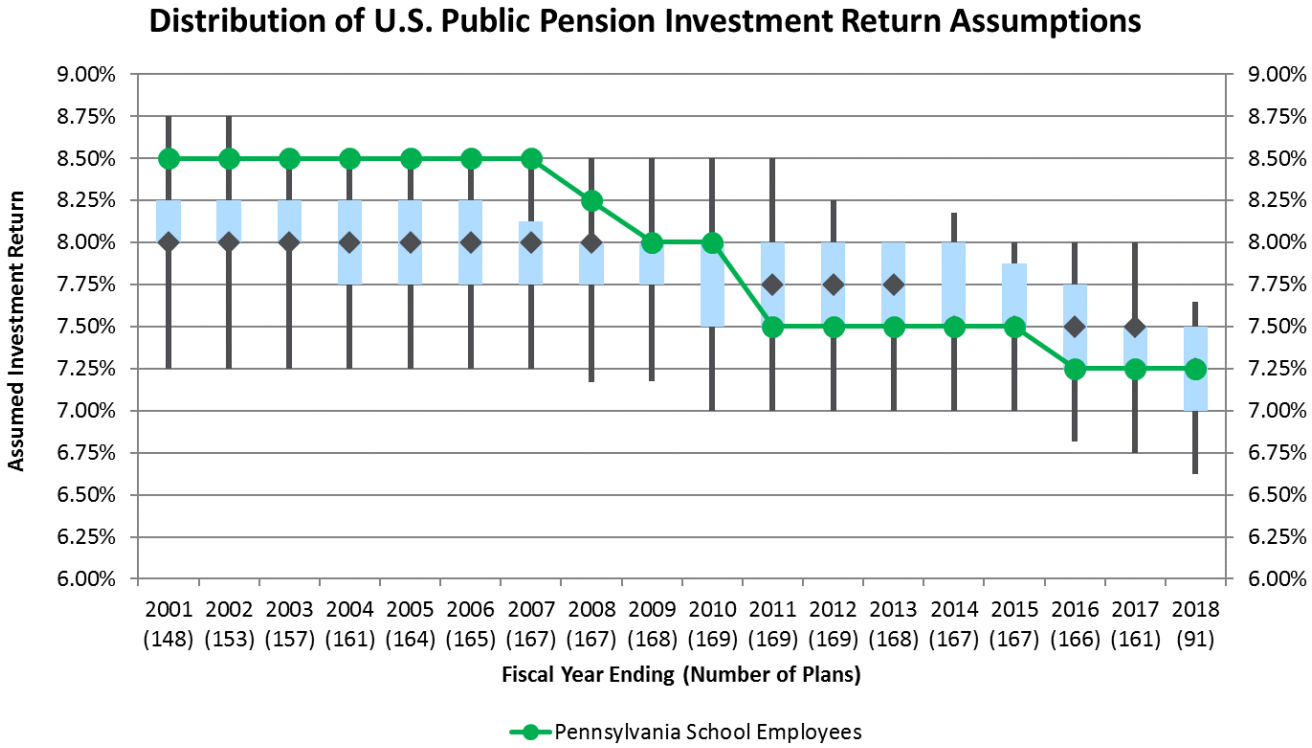


Key Takeaway:

- The Current & Proposed 1 Year Targets as well as the Current & Proposed Long-Term Targets are projected to have a higher expected return than the actuarial assumed rate of return (7.25%) in the 50th percent outcome

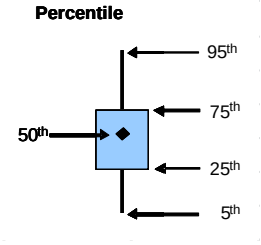
Portfolio Analysis

Expected Return Assumption versus Peers[1]

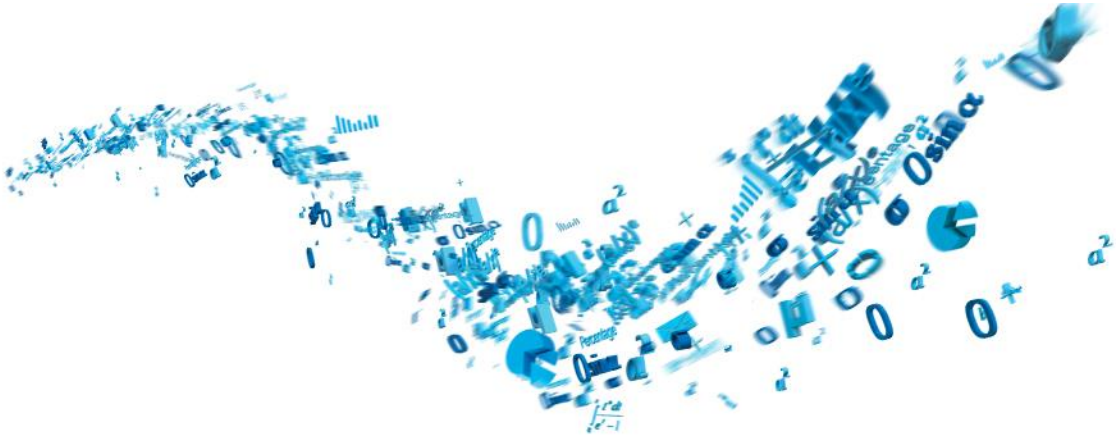


Key Takeaways:

- 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 2018 (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 April 2019; 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 April 2019; Number of plans per year are shown in parentheses



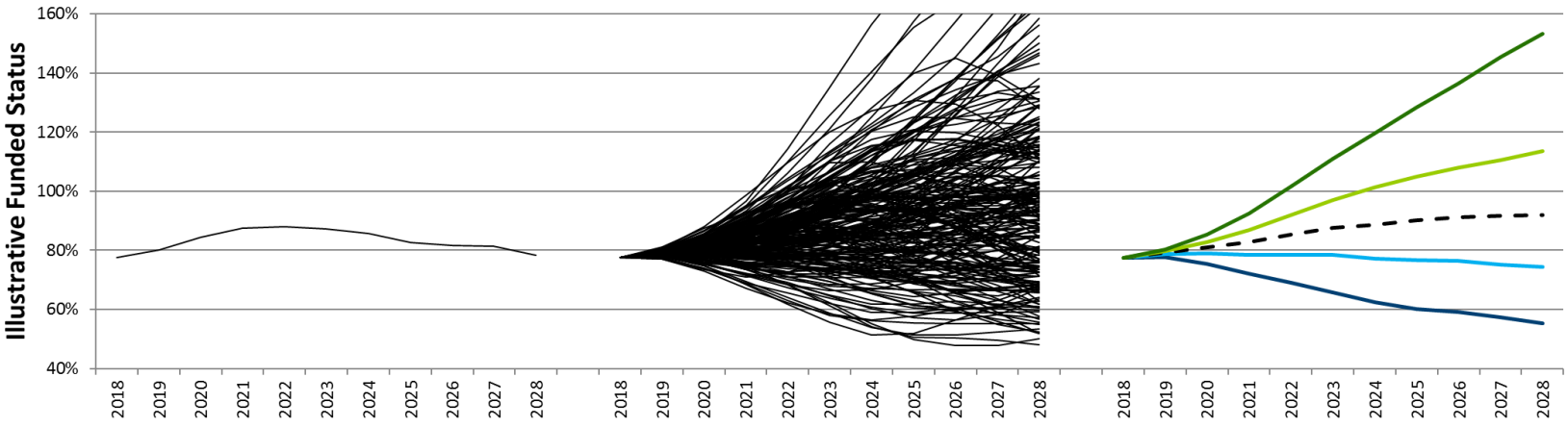
Analysis

- 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

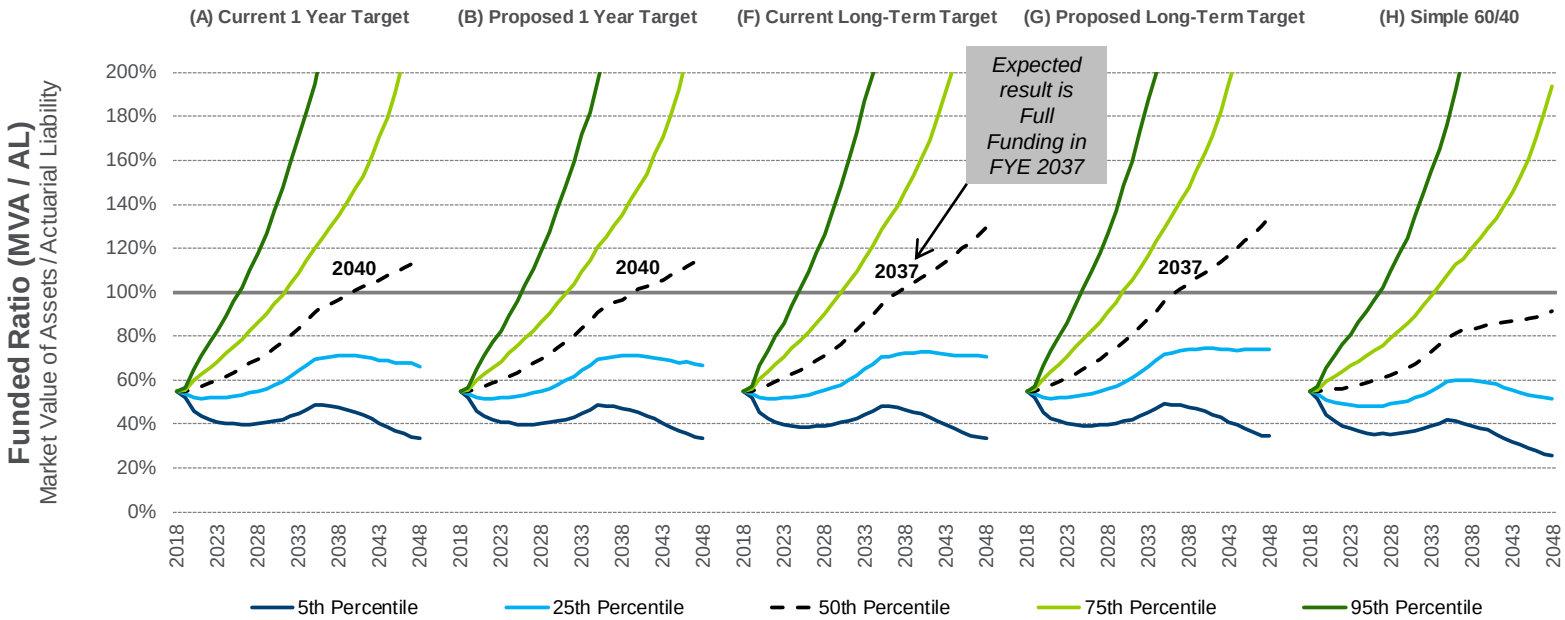
Single simulation → **Many simulations** → **Distribution of Outcomes**



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

Asset-Liability Projection Results (Stochastic Results)

Market Value of Assets / Actuarial Liability Funded Ratio



Strategy	(A) Current 1 Year Target			(B) Proposed 1 Year Target			(F) Current Long-Term Target			(G) Proposed Long-Term Target			(H) Simple 60/40		
Year	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**
5th Percentile	40%	47%	34%	40%	47%	33%	39%	46%	33%	40%	47%	35%	35%	39%	26%
25th Percentile	55%	71%	66%	55%	71%	66%	55%	72%	71%	56%	74%	74%	49%	60%	51%
50th Percentile	69%	96%	116%	70%	97%	117%	71%	102%	130%	72%	104%	134%	62%	83%	91%
75th Percentile	86%	135%	>200%	87%	136%	>200%	90%	146%	>200%	91%	148%	>200%	79%	120%	194%
95th Percentile	118%	>200%	>200%	118%	>200%	>200%	126%	>200%	>200%	126%	>200%	>200%	109%	>200%	>200%
Probability > 100%	16%	48%	58%	17%	48%	58%	20%	52%	63%	20%	53%	64%	11%	39%	48%

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

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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:

Probability of Surpassing Various Funded Ratio Thresholds					
Funded Status	**(A) Current 1 Year Target**	**(B) Proposed 1 Year Target**	**(F) Current Long-Term Target**	**(G) Proposed Long-Term Target**	**(H) Simple 60/40**
100%	**0.3%**	**0.3%**	**0.9%**	0.8%	**0.3%**
90%	1.8%	1.9%	**3.3%**	**3.3%**	**1.4%**
80%	6.6%	6.7%	9.9%	**10.0%**	**5.3%**
70%	21.5%	21.9%	26.0%	**26.4%**	**17.0%**
60%	50.3%	50.3%	52.5%	**53.3%**	**41.0%**
50%	79.9%	79.8%	79.3%	**80.0%**	**71.1%**
40%	**95.7%**	**95.7%**	94.8%	95.0%	**92.4%**
30%	**99.8%**	**99.8%**	99.6%	99.7%	**99.4%**
20%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
10%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Key Takeaway:

- The Proposed Long Term Target portfolio is expected to yield higher funded ratios in optimistic projections while the Current 1 Year Target portfolio 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

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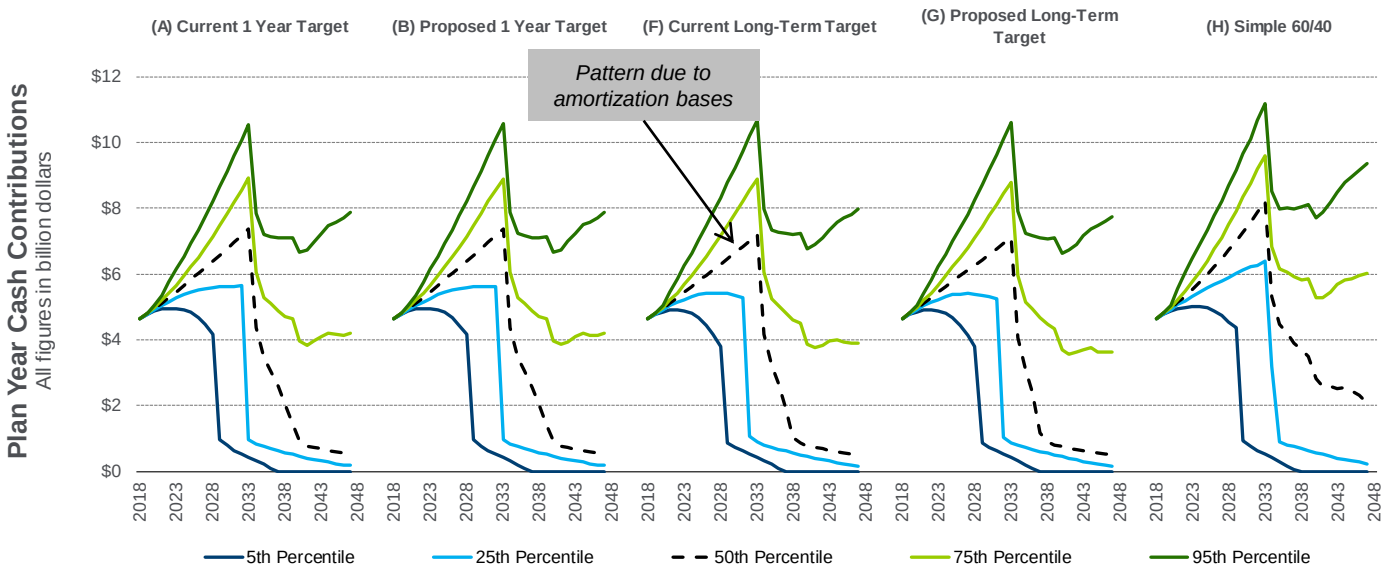
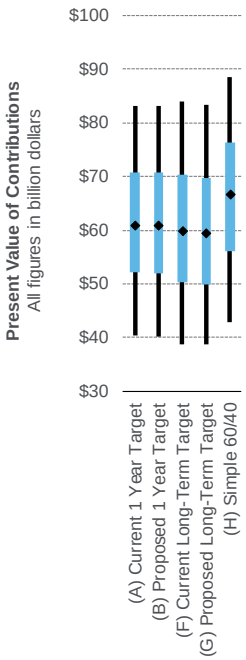
Asset-Liability Projection Results (Stochastic Results)

Employer Contribution Amount

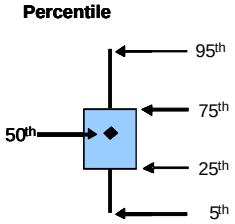




Strategy	(A) Current 1 Year Target			(B) Proposed 1 Year Target			(F) Current Long-Term Target			(G) Proposed Long-Term Target			(H) Simple 60/40		
Year	2027	2037	2047	2027	2037	2047	2027	2037	2047	2027	2037	2047	2027	2037	2047
5th Percentile	$4.46	$0.00	$0.00	$4.44	$0.00	$0.00	$4.16	$0.00	$0.00	$4.14	$0.00	$0.00	$4.75	$0.05	$0.00
25th Percentile	$5.56	$0.63	$0.17	$5.55	$0.63	$0.17	$5.42	$0.61	$0.16	$5.40	$0.61	$0.16	$5.79	$0.75	$0.24
50th Percentile	$6.20	$2.57	$0.56	$6.20	$2.55	$0.56	$6.13	$1.89	$0.52	$6.11	$1.17	$0.51	$6.46	$3.90	$2.07
75th Percentile	$6.81	$4.89	$4.19	$6.82	$4.88	$4.20	$6.82	$4.80	$3.91	$6.79	$4.67	$3.62	$7.12	$5.92	$6.03
95th Percentile	$7.76	$7.09	$7.87	$7.76	$7.10	$7.87	$7.87	$7.24	$7.97	$7.81	$7.10	$7.75	$8.21	$7.98	$9.35
Probability > $7B	21%	6%	10%	21%	6%	10%	22%	7%	10%	21%	6%	9%	29%	15%	19%

Key Takeaway:

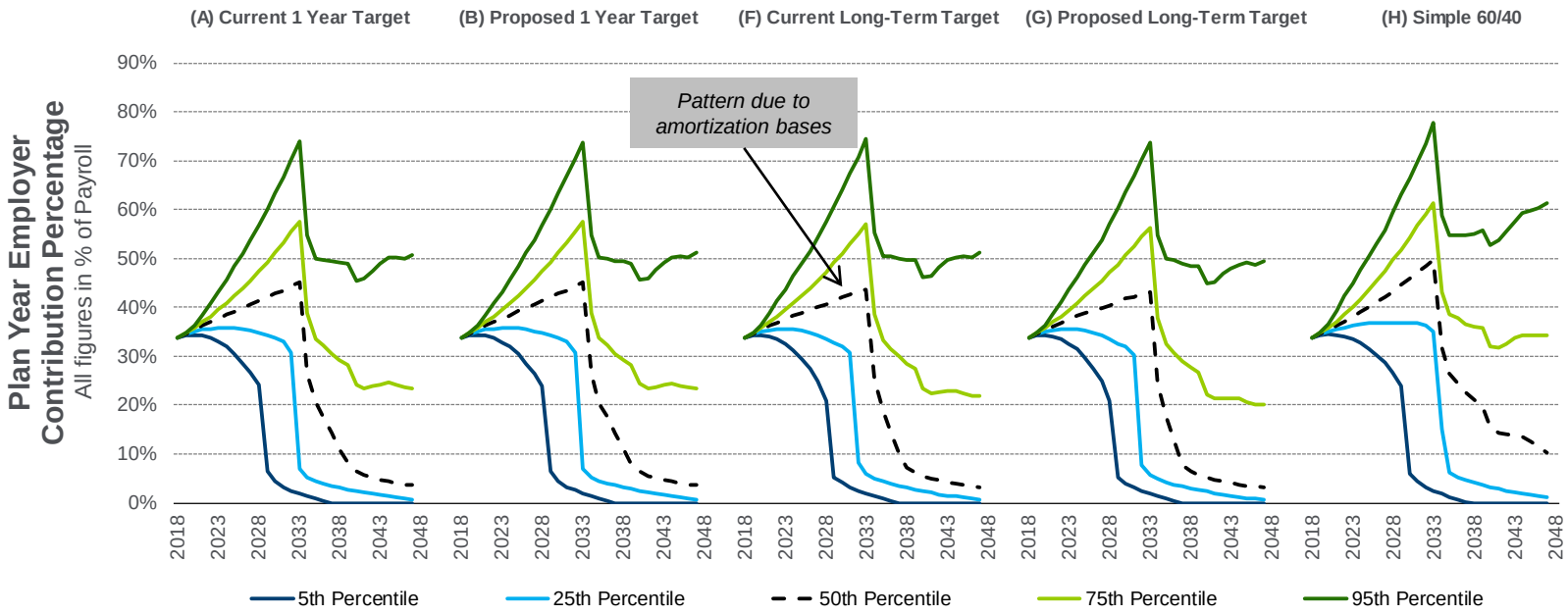
- Contributions in the central expectation (50th percentile outcomes) are projected to increase from their current levels until the expiration of individual amortization bases or when the plan reaches a funded status of at least 100% on an actuarial value of assets basis



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

Asset-Liability Projection Results (Stochastic Results)

Employer Contribution Percentage of Payroll



Strategy	(A) Current 1 Year Target			(B) Proposed 1 Year Target			(F) Current Long-Term Target			(G) Proposed Long-Term Target			(H) Simple 60/40		
Year	**2027**	**2037**	**2047**	**2027**	**2037**	**2047**	**2027**	**2037**	**2047**	**2027**	**2037**	**2047**	**2027**	**2037**	**2047**
5th Percentile	27%	0%	0%	27%	0%	0%	25%	0%	0%	25%	0%	0%	29%	0%	0%
25th Percentile	35%	4%	1%	35%	4%	1%	34%	3%	1%	34%	3%	1%	37%	5%	1%
50th Percentile	41%	14%	4%	41%	14%	4%	40%	10%	3%	40%	8%	3%	42%	23%	10%
75th Percentile	46%	30%	23%	46%	31%	23%	46%	30%	22%	45%	29%	20%	48%	37%	34%
95th Percentile	54%	49%	51%	54%	49%	51%	54%	50%	51%	54%	49%	49%	56%	55%	61%
Probability > 45%	28%	10%	9%	28%	10%	9%	27%	10%	9%	27%	9%	8%	37%	16%	17%

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

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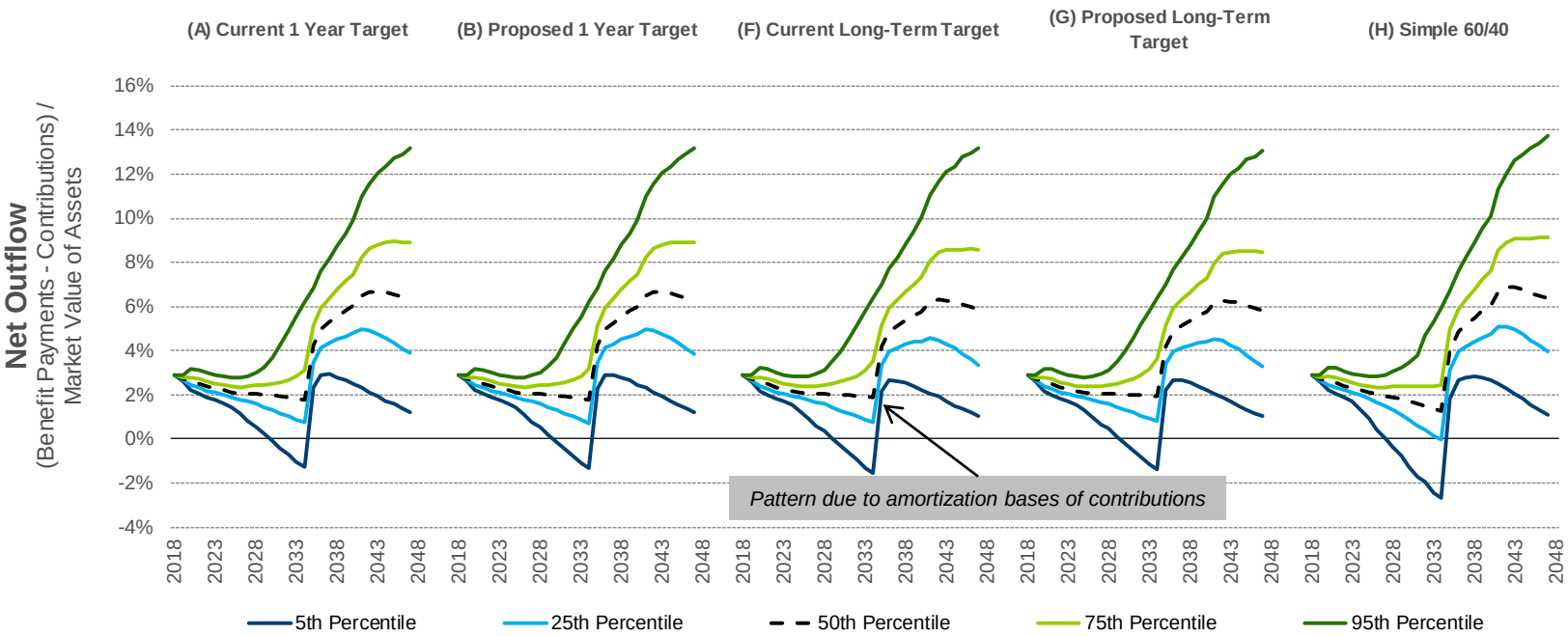
Asset-Liability Projection Results (Stochastic Results)

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



Strategy	(A) Current 1 Year Target			(B) Proposed 1 Year Target			(F) Current Long-Term Target			(G) Proposed Long-Term Target			(H) Simple 60/40		
Year	**2027**	**2037**	**2047**	**2027**	**2037**	**2047**	**2027**	**2037**	**2047**	**2027**	**2037**	**2047**	**2027**	**2037**	**2047**
5th Percentile	1%	3%	1%	1%	3%	1%	1%	3%	1%	1%	3%	1%	0%	3%	1%
25th Percentile	2%	4%	4%	2%	4%	4%	2%	4%	3%	2%	4%	3%	2%	4%	4%
50th Percentile	2%	5%	6%	2%	5%	6%	2%	5%	6%	2%	5%	6%	2%	5%	6%
75th Percentile	2%	6%	9%	2%	6%	9%	2%	6%	9%	2%	6%	8%	2%	6%	9%
95th Percentile	3%	8%	13%	3%	8%	13%	3%	8%	13%	3%	8%	13%	3%	8%	14%
Probability > 10%	<1%	<1%	20%	<1%	<1%	20%	<1%	<1%	19%	<1%	<1%	18%	<1%	<1%	21%

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

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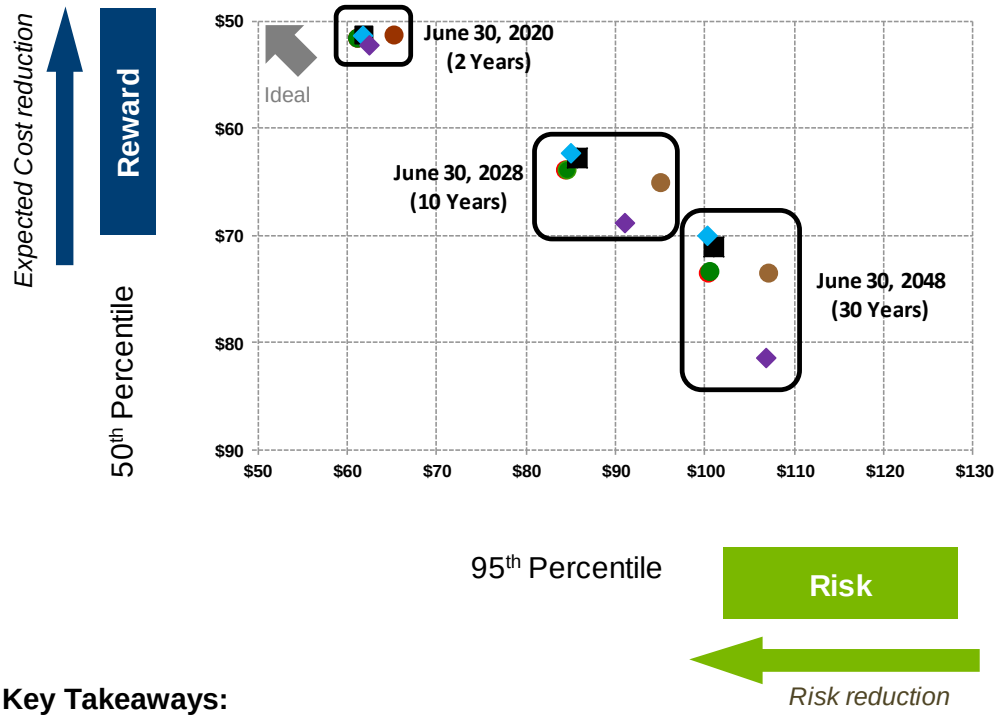
Asset-Liability Projection Results (Stochastic Results)

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

Economic Cost

PV of Gross Contributions (Employee + Employer) plus AL Funding Shortfall/(Surplus)* at 7.25%, $billions



Strategy ($Billions)	Economic Cost June 30, 2020 Cost	Risk
(A) Current 1 Year Target	$51.7	$61.2
(B) Proposed 1 Year Target	$51.7	$61.3
(C) 60/40 Levered Same Return as Proposed 1 Year	$51.4	$65.3
(F) Current Long-Term Target	$51.4	$61.9
(G) Proposed Long-Term Target	$51.4	$61.8
(H) Simple 60/40	$52.3	$62.5

Strategy ($Billions)	June 30, 2028 Cost	Risk
(A) Current 1 Year Target	$64.0	$84.4
(B) Proposed 1 Year Target	$63.9	$84.7
(C) 60/40 Levered Same Return as Proposed 1 Year	$65.1	$95.2
(F) Current Long-Term Target	$62.8	$85.8
(G) Proposed Long-Term Target	$62.2	$85.0
(H) Simple 60/40	$68.8	$91.0

Strategy ($Billions)	June 30, 2048 Cost	Risk
(A) Current 1 Year Target	$73.6	$100.5
(B) Proposed 1 Year Target	$73.5	$100.6
(C) 60/40 Levered Same Return as Proposed 1 Year	$73.5	$107.2
(F) Current Long-Term Target	$71.0	$101.0
(G) Proposed Long-Term Target	$70.0	$100.3
(H) Simple 60/40	$81.4	$106.9

Key Takeaways:

- The magnitude of the risk/reward trade-off changes over a longer-term projection
- Under the Current Long-Term Target policy asset allocation over a 30-year time horizon, the expected Economic Cost is $71.0B and the potential risk is $101.0B

* 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

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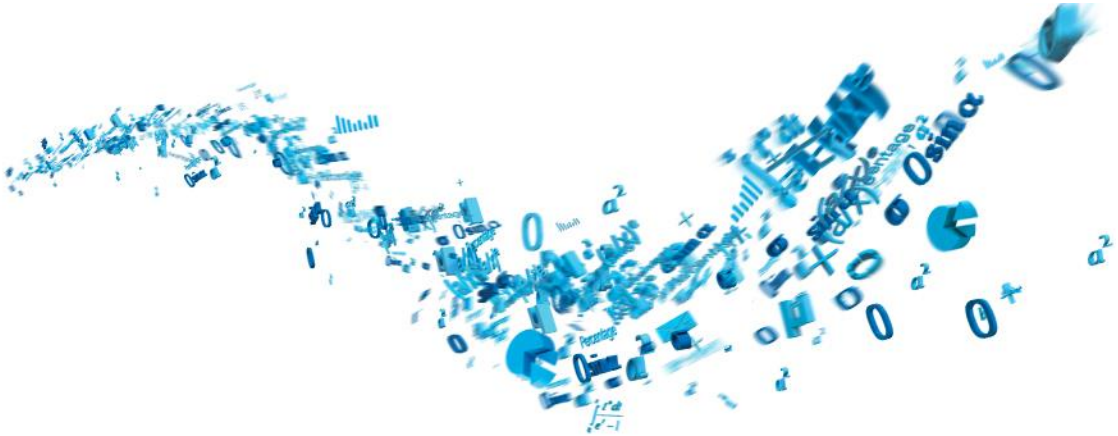


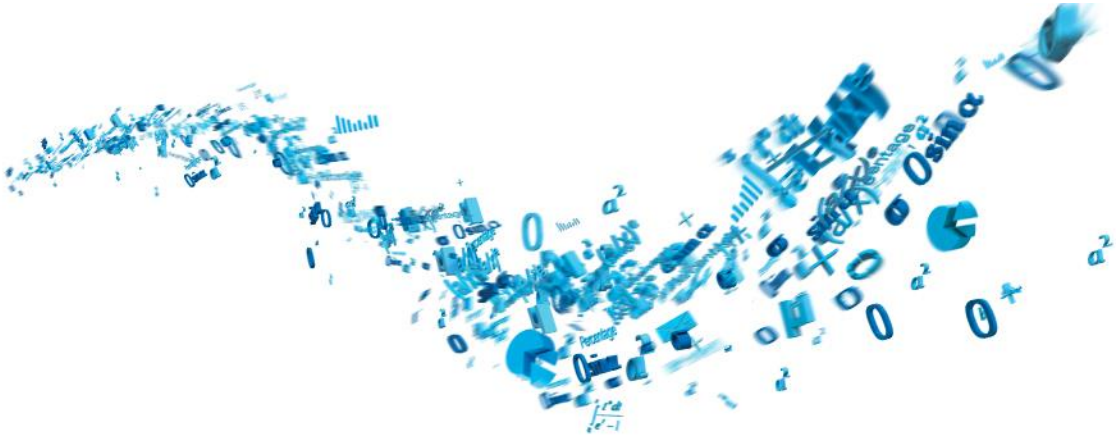
Analysis

- Summary and Conclusions

Summary and Conclusions
Portfolio Analysis

- **Proposed Long-Term Target**
  - Expected return exceeds the current 7.25% EROA
  - Increases the expected return (by 0.11%) with better risk adjusted returns as measured by the Sharpe Ratios (by 0.010) than the Current Long-Term Target portfolio
    - The higher return is achieved through a re-allocation of the credit-related fixed income, with a higher allocation to private credit, along with a 1% increase in leverage
  - Has a 64% probability of reaching full funding over the 30 year measurement period compared to the Current Long-Term Target's 63% likelihood

- **Proposed 1 Year Target**
  - Increases the expected return (0.01%) and expected risk (0.09%) relative to the Current 1 Year Target which lowers the risk/reward trade-off measured by the Sharpe Ratio (0.448 vs. 0.451)
  - Has similar projected funded status results versus the Current 1 Year Target in downside events over the next five years



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%	1.9%	0.7%	4.8%	11.6%	10.6%
Total U.S. Equity	7.8%	37.0%	35.9%	28.2%	18.3%	19.9%
Total Int'l Equity	12.2%	19.3%	21.6%	20.2%	19.1%	19.2%
Private Markets	15.0%	4.1%	4.2%	5.0%	8.3%	7.9%
Total Equity	***35.0%***	***62.3%***	***62.4%***	***58.2%***	***57.3%***	***57.6%***
Fixed Income Exposure						
U.S. Fixed Income	10.0%	23.3%	22.5%	21.4%	25.5%	25.0%
High Yield Bonds / Bank Loans	1.6%					
Non-US Developed Bonds	1.0%	1.6%	1.9%	3.0%	1.5%	1.6%
Emerging Market Debt	2.0%	0.7%	0.3%	1.6%	1.6%	1.6%
Inflation Protected	15.0%					
Private Debt	6.4%					
Total Fixed Income	***36.0%***	***25.6%***	***24.7%***	***26.0%***	***28.6%***	***28.2%***
Real Asset Exposure						
Infrastructure (Public + Private)	8.0%	0.0%	0.0%	0.0%	0.3%	0.2%
Commodities	8.0%	0.6%	0.8%	0.8%	1.5%	1.4%
Real Estate	10.0%	4.3%	3.4%	3.6%	2.4%	2.6%
Total Real Assets	***26.0%***	***4.9%***	***4.2%***	***4.4%***	***4.2%***	***4.2%***
Hedge Funds / Opportunistic	10.0%	3.5%	2.1%	3.7%	3.0%	3.0%
Multi-Asset / Risk Parity	10.0%	0.7%	0.5%	2.6%	0.2%	0.4%
Money Market / Cash	3.0%	0.7%	0.8%	0.6%	3.0%	2.7%
Leverage	-20.0%					
Other**	0.0%	2.2%	5.2%	4.4%	3.9%	4.0%
Net Other	***3.0%***	***7.1%***	***8.6%***	***11.3%***	***10.1%***	***10.1%***
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***
Expected Return	***7.55%***	***6.77%***	***6.81%***	***6.81%***	***6.80%***	***6.81%***
Expected Volatility	***11.58%***	***12.57%***	***12.85%***	***12.48%***	***12.22%***	***12.28%***
Sharpe Ratio	***0.435***	***0.338***	***0.334***	***0.343***	***0.351***	***0.349***

* Source: "*2018 U.S. Institutional Market Trends*", Greenwich Associates

** Assets labeled as "Other" were assumed to be re-allocated pro-rata to the asset allocation listed for purposes of determining expected return / volatility / Sharpe Ratio

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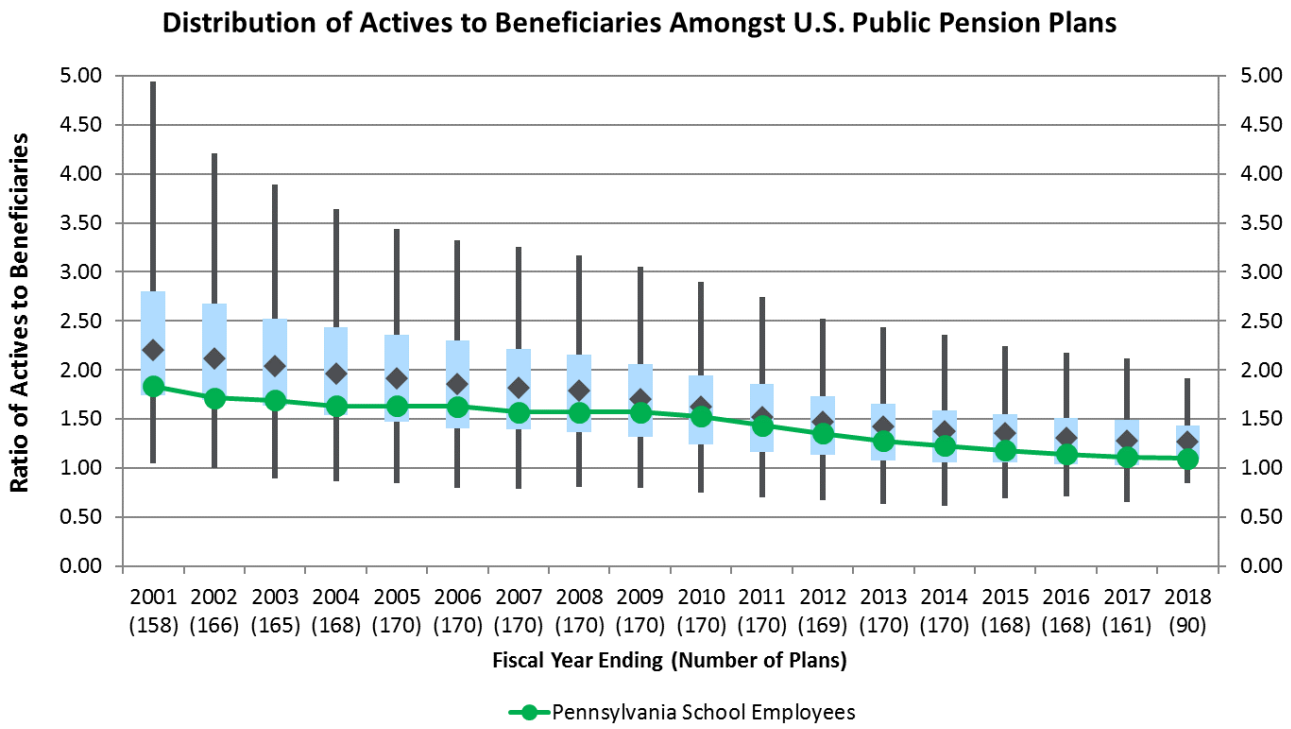
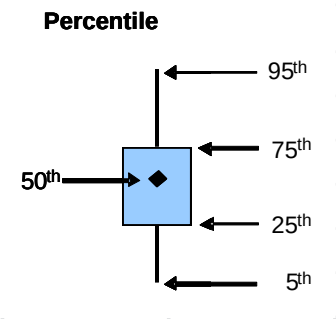
Demographic Data versus Peers[1]



Key Takeaways:

- The median ratio of actives to beneficiaries has declined from 2.2 at FYE 2001 to 1.3 at FYE 2018.
- Over that same time frame, PSERS' active to beneficiary ratio has declined from 1.8 to 1.1



Source: Public Plans Data (publicplansdata.org) as of April 2019;
[1] Peers defined as public funds published within publicplansdata.org as of April 2019; Number of plans per year are shown in parentheses

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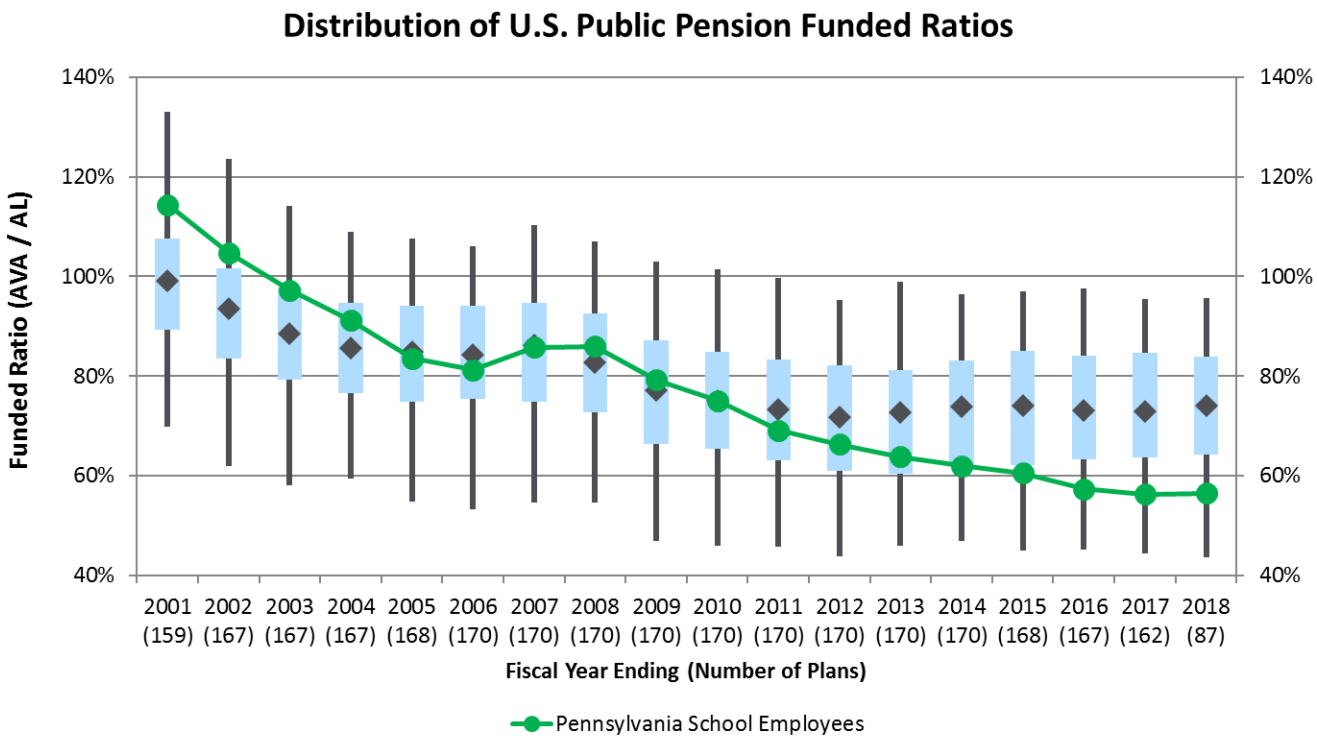
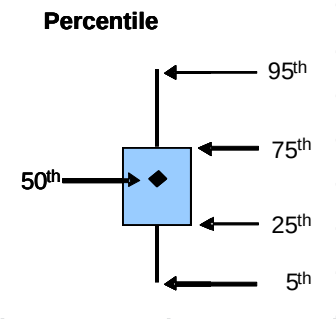
Funded Ratio (Based on Actuarial Value of Assets) versus Peers[1]



Key Takeaways:

- The median funded ratio as of FYE 2018 was 74% based on the latest survey data
- PSERS' FYE 2018 funded ratio (55.5%) fell below the 25th percentile relative to its peers



Source: Public Plans Data (publicplansdata.org) as of April 2019;
[1] Peers defined as public funds published within publicplansdata.org as of April 2019; Number of plans per year are shown in parentheses

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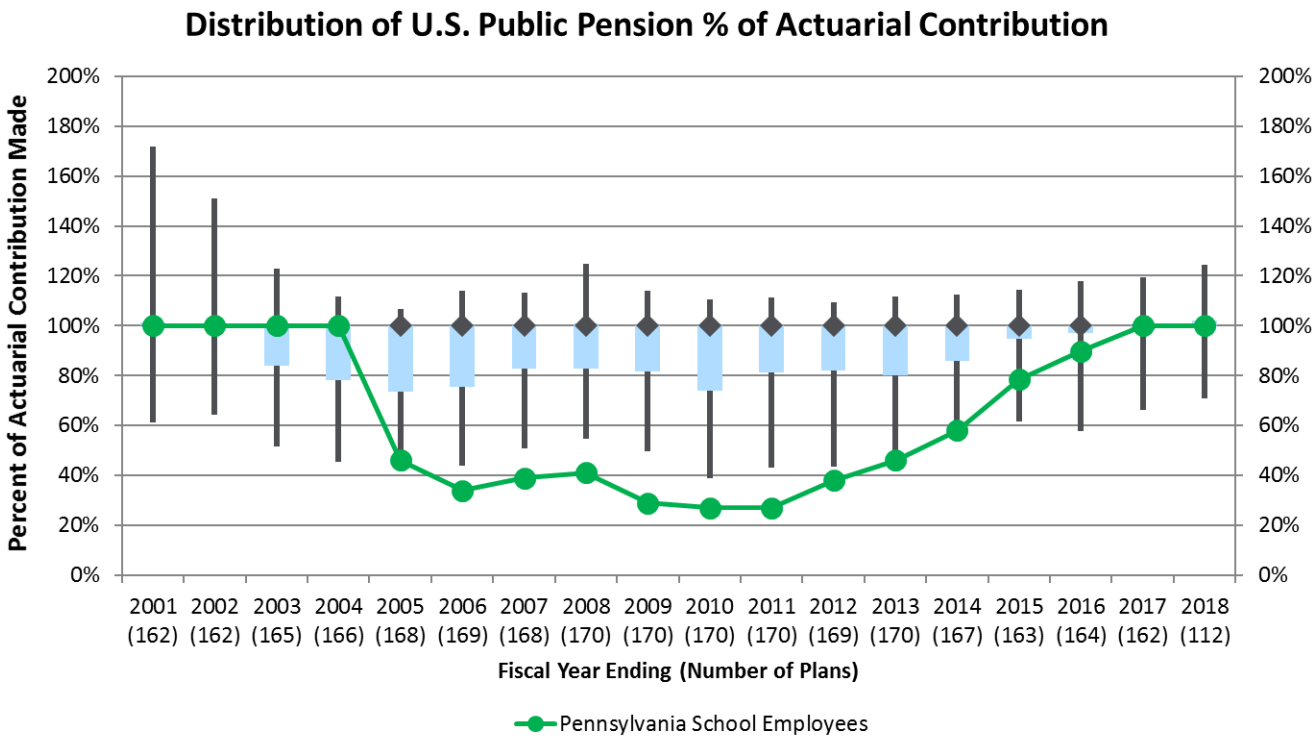
Percentage of Actuarial Contribution Made versus Peers[1]



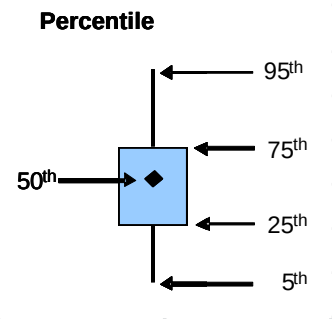
Key Takeaway:

- Contributions for PSERS, as a percentage of the actuarially-determined amount, had been below 100% for FYE 2005-2016 and have been 100% in the past two fiscal years

PSERS Annual Underfunding (in $ billions)

FYE	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
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

Accumulated Value of Underfunding as of June 30, 2018 (in $ billions)[2] = **$22.2 billion**



Sources: Public Plans Data (publicplansdata.org) as of April 2019; Actuarial valuation report as of June 30, 2018

[1] Peers defined as public funds published within publicplansdata.org as of April 2019; Number of plans per year are shown in parentheses

[2] Calculated as any underfunding from FYE 2001-2017 (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, 2018

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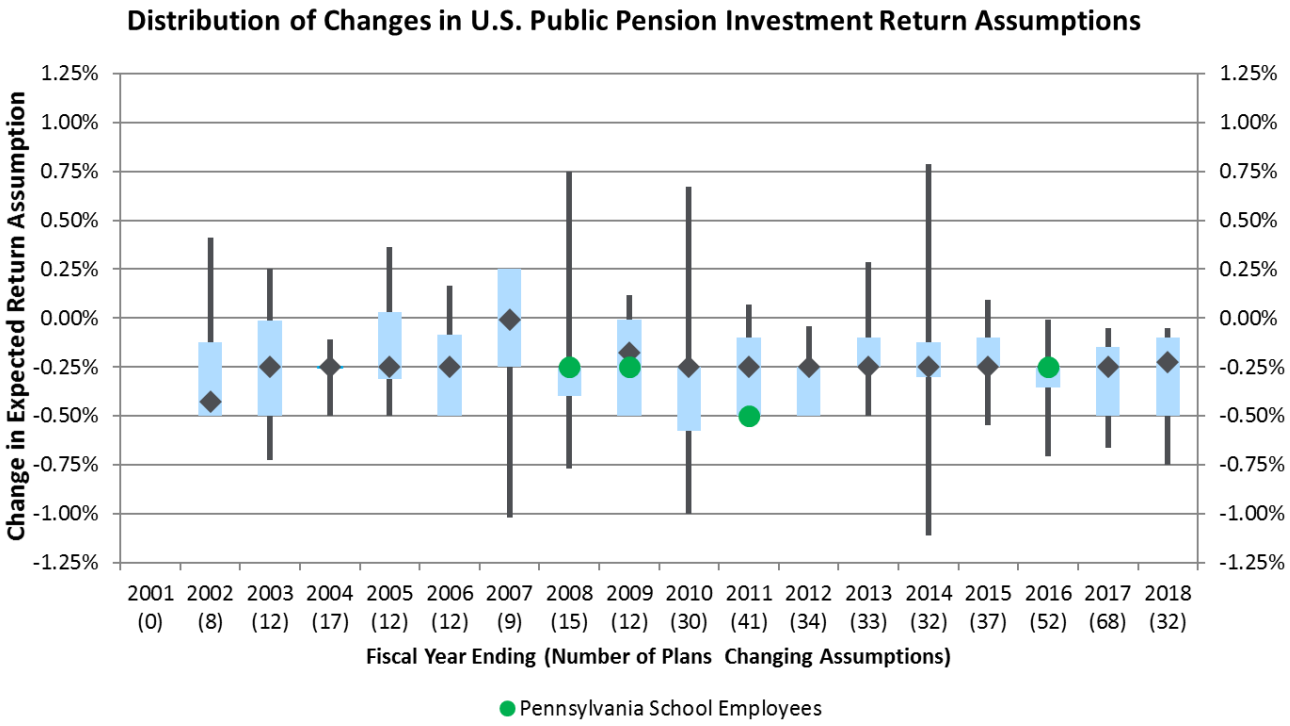
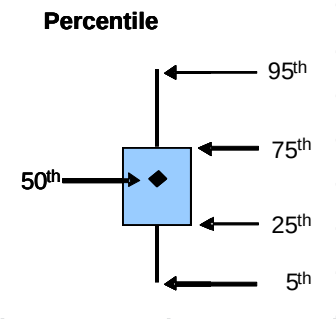
Magnitude of Expected Return on Assets Assumption Changes versus Peers[1]



Key Takeaways:

- More plans have been changing their expected return assumptions in recent years
- The median change in the investment return assumption has consistently been a reduction in the 25bps range in recent years



Source: Public Plans Data (publicplansdata.org) as of April 2019;
[1] Peers defined as public funds published within publicplansdata.org as of April 2019; Number of plans per year are shown in parentheses

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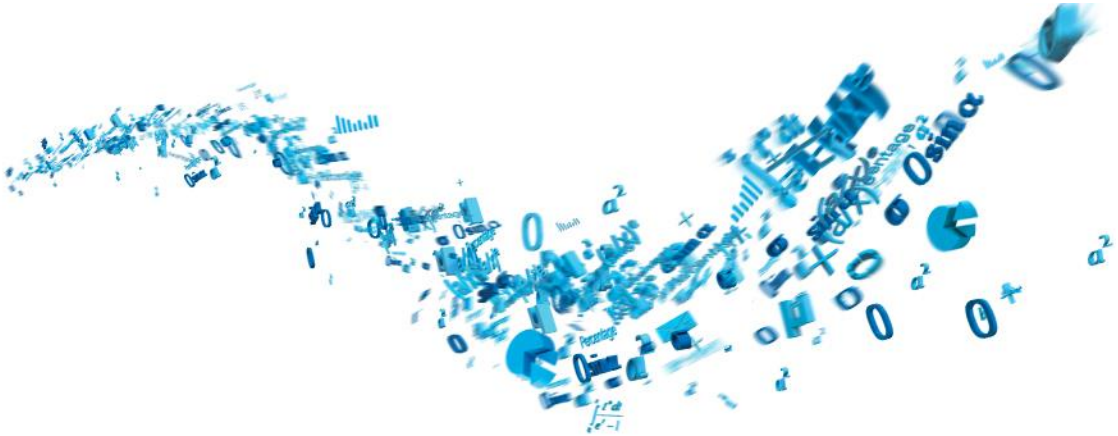
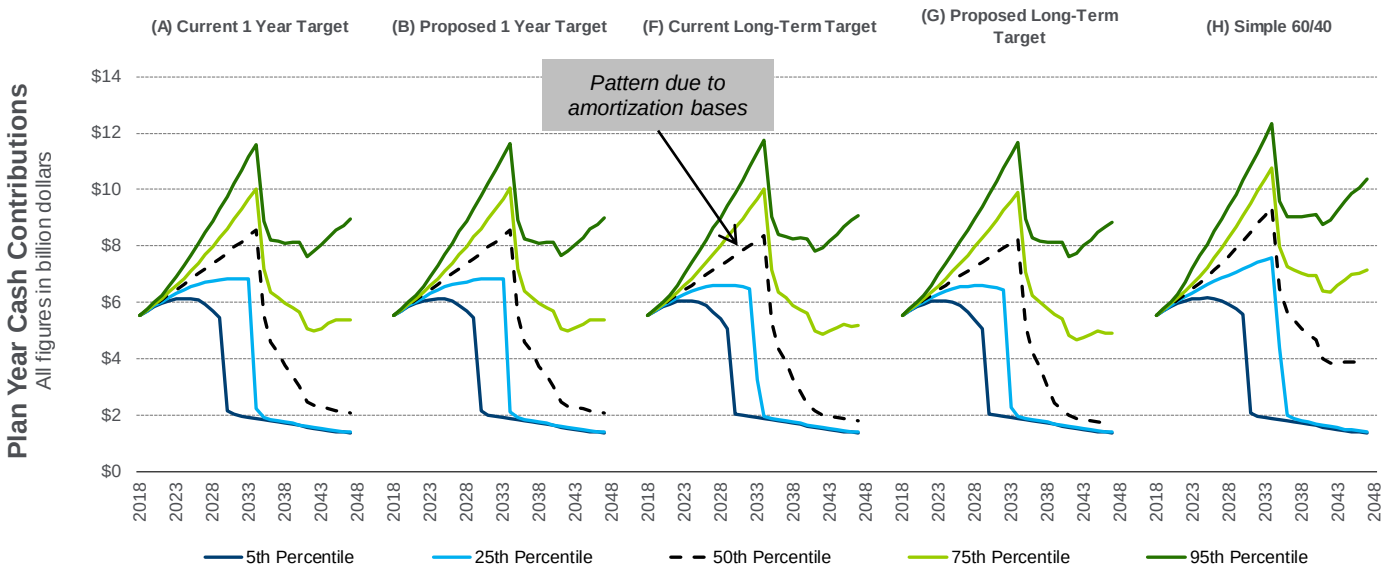


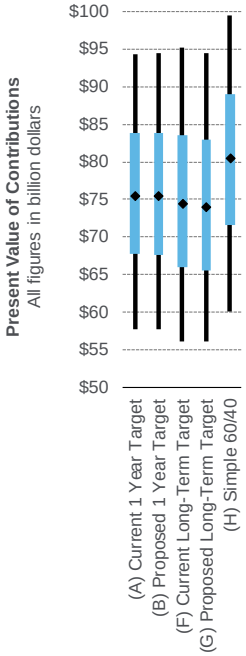
Appendix

- Asset-Liability Projection Results (Additional Stochastic Results)

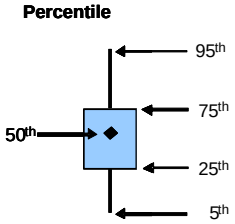
Asset-Liability Projection Results (Additional Stochastic Results)

Gross Contribution Amount (Includes Employee and Employer Contributions)





Strategy	(A) Current 1 Year Target			(B) Proposed 1 Year Target			(F) Current Long-Term Target			(G) Proposed Long-Term Target			(H) Simple 60/40		
Year	2027	2037	2047	2027	2037	2047	2027	2037	2047	2027	2037	2047	2027	2037	2047
5th Percentile	$5.92	$1.75	$1.36	$5.89	$1.75	$1.36	$5.66	$1.74	$1.36	$5.65	$1.74	$1.36	$6.05	$1.75	$1.37
25th Percentile	$6.70	$1.79	$1.39	$6.69	$1.80	$1.39	$6.58	$1.79	$1.39	$6.57	$1.78	$1.39	$6.86	$1.87	$1.42
50th Percentile	$7.18	$4.21	$2.07	$7.18	$4.22	$2.05	$7.13	$3.86	$1.80	$7.11	$3.68	$1.69	$7.40	$5.36	$3.86
75th Percentile	$7.68	$6.17	$5.38	$7.69	$6.18	$5.37	$7.70	$6.15	$5.17	$7.67	$6.01	$4.91	$7.94	$7.15	$7.13
95th Percentile	$8.50	$8.17	$8.95	$8.52	$8.18	$8.98	$8.62	$8.32	$9.06	$8.58	$8.18	$8.85	$8.94	$9.04	$10.35
Probability > $7B	59%	17%	16%	59%	17%	16%	56%	17%	16%	55%	16%	14%	68%	27%	26%



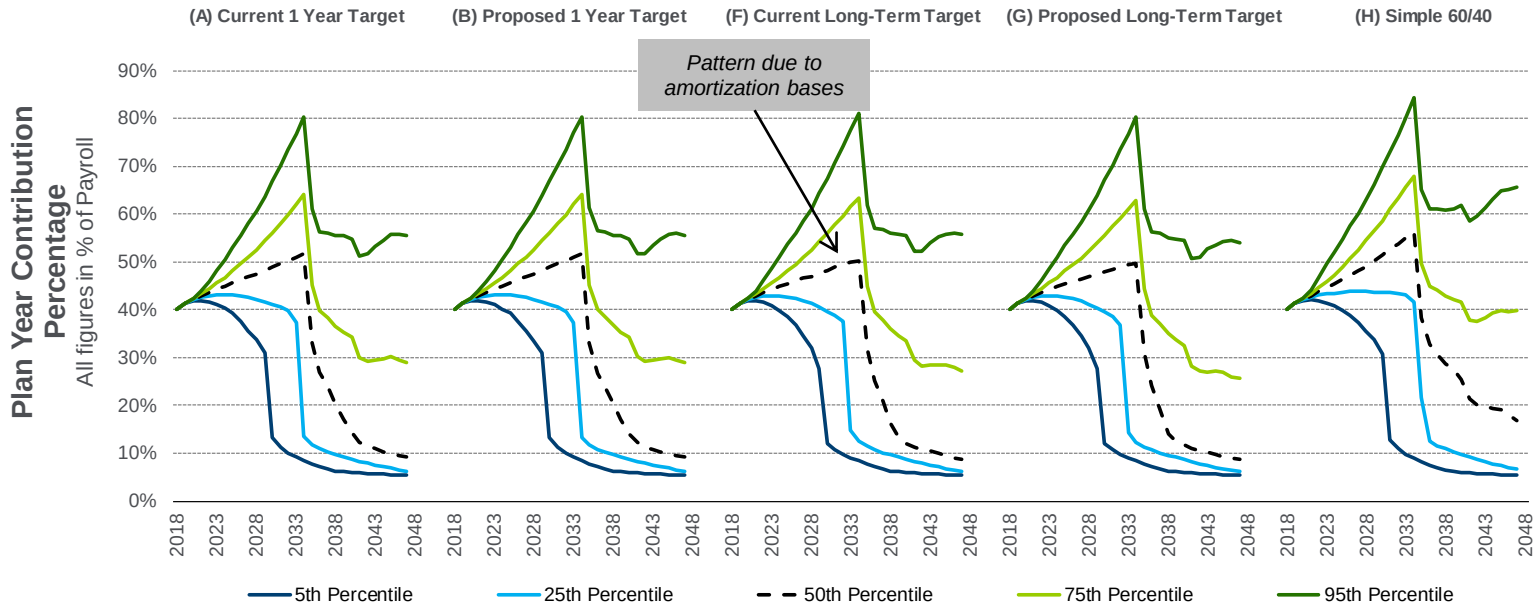
Key Takeaway:

- 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)

Gross Contribution Percentage of Payroll (Includes Employee and Employer Contributions)



Strategy	(A) Current 1 Year Target			(B) Proposed 1 Year Target			(F) Current Long-Term Target			(G) Proposed Long-Term Target			(H) Simple 60/40		
Year	2027	2037	2047	2027	2037	2047	2027	2037	2047	2027	2037	2047	2027	2037	2047
5th Percentile	36%	7%	5%	36%	7%	5%	35%	7%	5%	34%	7%	5%	37%	7%	5%
25th Percentile	43%	10%	6%	43%	10%	6%	42%	10%	6%	42%	10%	6%	44%	12%	7%
50th Percentile	47%	24%	9%	47%	24%	9%	47%	21%	9%	46%	19%	9%	48%	31%	17%
75th Percentile	51%	38%	29%	51%	39%	29%	51%	38%	27%	51%	37%	26%	53%	44%	40%
95th Percentile	58%	56%	55%	58%	56%	56%	59%	57%	56%	58%	56%	54%	60%	61%	66%
Probability > 50%	31%	12%	9%	31%	12%	9%	31%	12%	9%	30%	11%	8%	39%	18%	17%

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

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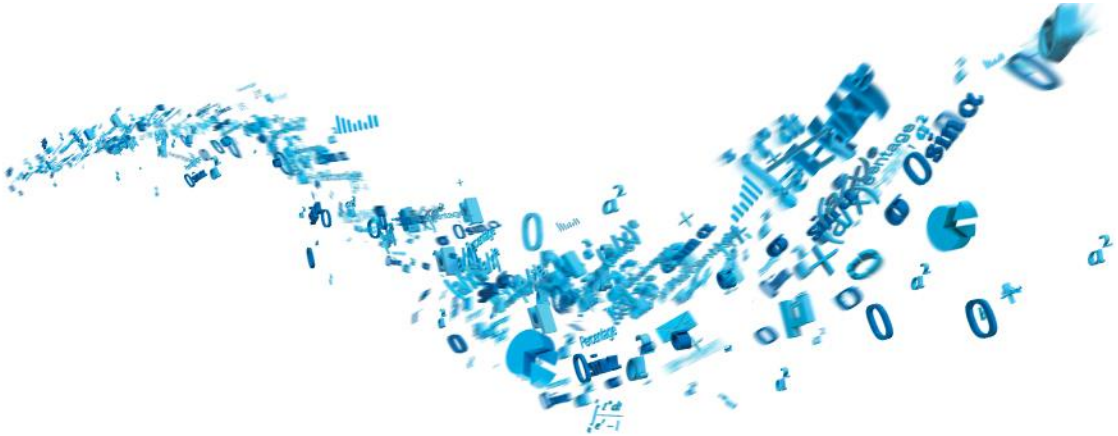

Appendix

- Asset-Liability Projection Results (Deterministic Results)

Deterministic Scenario Analysis

Overview

Base Case	Blue Skies	Recession	Black Skies
Scenario Description			
▪ Markets perform as expected ▪ ~50th percentile	▪ Optimistic outlook for markets ▪ ~10th percentile	▪ Pessimistic outlook for the markets ▪ ~95th percentile	▪ Very pessimistic outlook for the markets ▪ ~99th percentile
Financial Trend Analysis			
▪ Funded ratio is expected to gradually increase over the coming 10 years ▪ Contribution amounts are expected to increase over the period	▪ Funded ratio is expected to improve over the coming 10 years ▪ Contribution amounts are expected to grow at a more gradual pace over the period as asset returns fund the shortfall	▪ Funded ratio is expected to decline to below 40% funded on a market value of asset basis during the coming 10 years ▪ Contribution amounts are expected to rise by extension to better fund the shortfall	▪ Funded ratio is expected to decline to below 30% funded on a market value of asset basis during the coming 10 years ▪ Contribution amounts are expected to rise by extension to better fund the shortfall

Note: Results for deterministic scenarios are sensitive to contributions and would be worse if the contributions made are lower than the modeled actuarially-determined contributions

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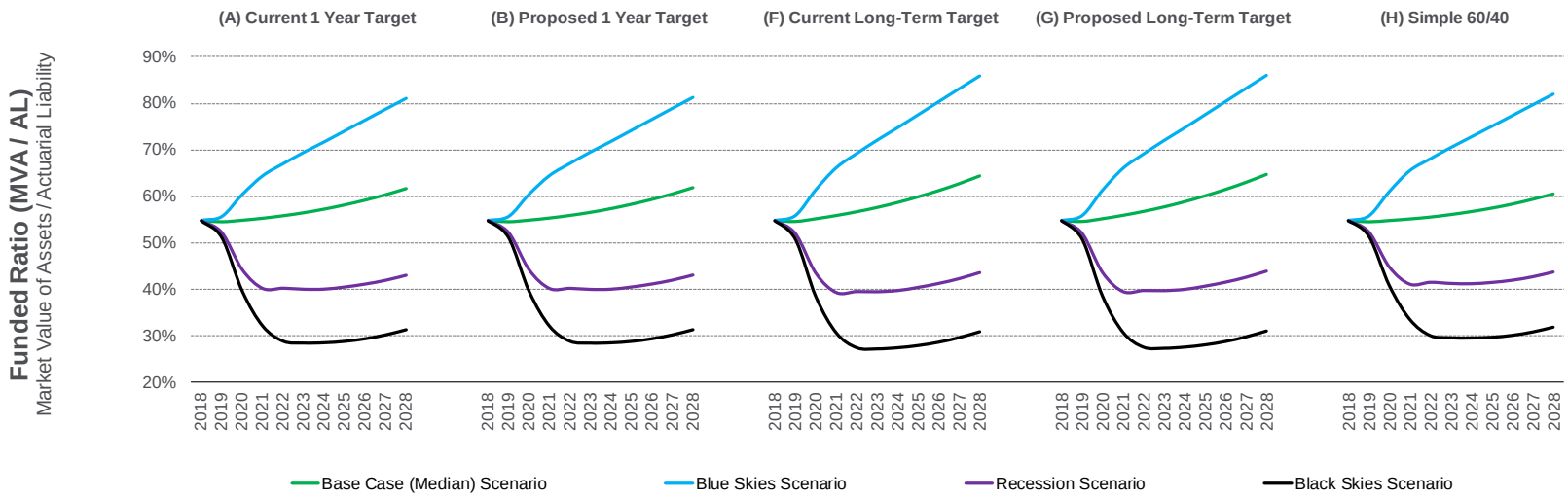
Asset-Liability Projection Results (Deterministic Results)

Market Value of Assets / Actuarial Liability Funded Ratio



Strategy	(A) Current 1 Year Target			(B) Proposed 1 Year Target			(F) Current Long-Term Target			(G) Proposed Long-Term Target			(H) Simple 60/40		
Year	2018	2023	2028	2018	2023	2028	2018	2023	2028	2018	2023	2028	2018	2023	2028
Base Case (Median) Scenario	55%	56%	62%	55%	57%	62%	55%	58%	64%	55%	58%	65%	55%	56%	60%
Blue Skies Scenario	55%	69%	81%	55%	69%	81%	55%	72%	86%	55%	72%	86%	55%	70%	82%
Recession Scenario	55%	40%	43%	55%	40%	43%	55%	39%	44%	55%	40%	44%	55%	41%	44%
Black Skies Scenario	55%	28%	31%	55%	28%	31%	55%	27%	31%	55%	27%	31%	55%	30%	32%

Key Takeaways:

- Funded ratio is projected to increase over the projection period in the Base Case scenario
- Portfolio H has slower growth, more downside protection (in a Black Skies scenario), and less upside benefit (in a Blue Skies scenario) than the Long-Term Target portfolios modeled due to its lower return expectation

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

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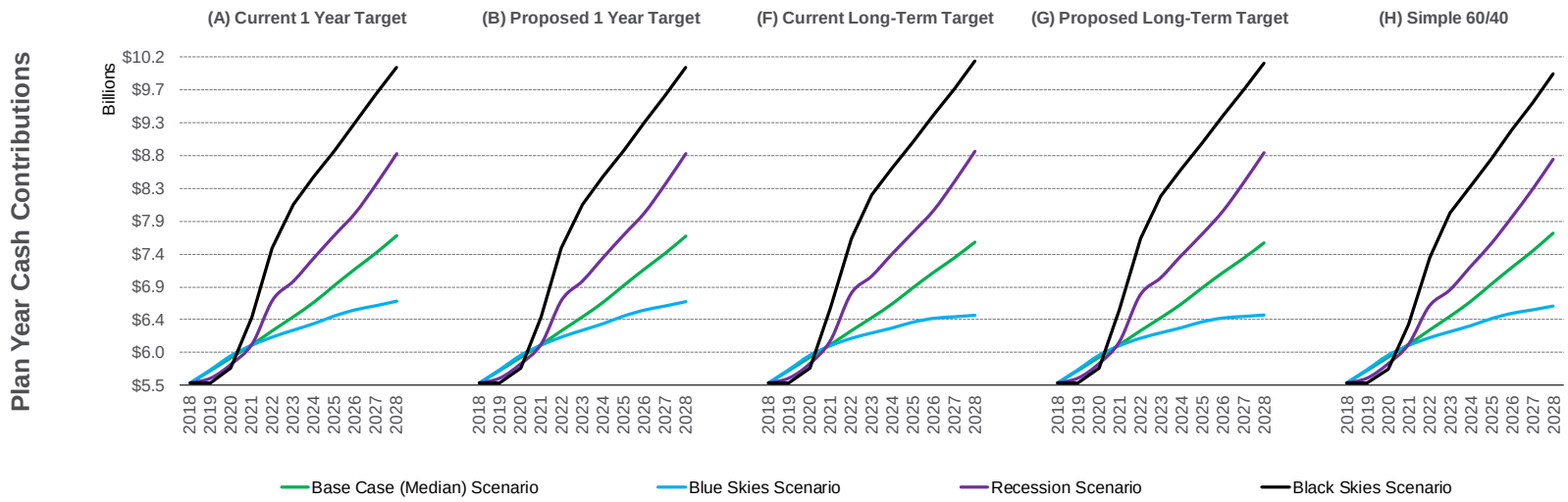
Asset-Liability Projection Results (Deterministic Results)

Gross Contribution Amount (Includes Employee and Employer Contributions)

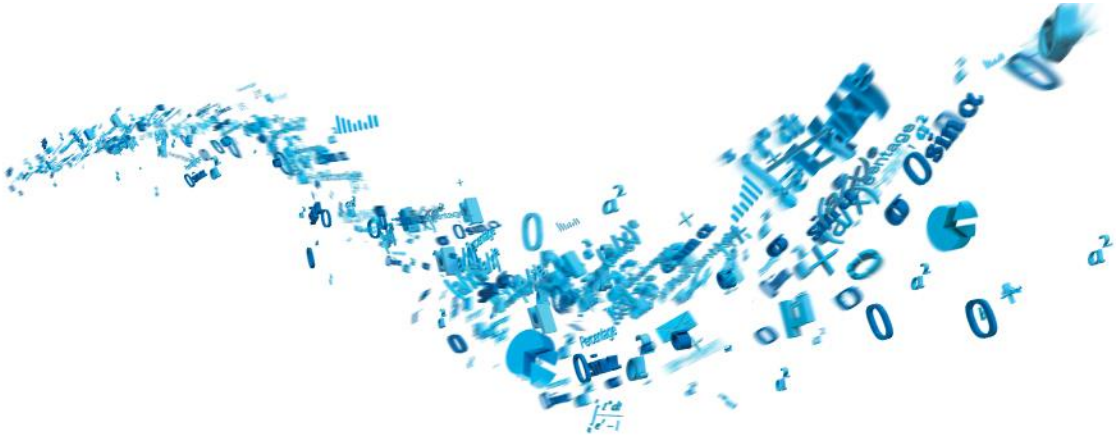


Strategy	(A) Current 1 Year Target			(B) Proposed 1 Year Target			(F) Current Long-Term Target			(G) Proposed Long-Term Target			(H) Simple 60/40		
Year	2018	2023	2028	2018	2023	2028	2018	2023	2028	2018	2023	2028	2018	2023	2028
Base Case (Median) Scenario	$5.5	$6.5	$7.6	$5.5	$6.5	$7.6	$5.5	$6.5	$7.6	$5.5	$6.5	$7.5	$5.5	$6.5	$7.7
Blue Skies Scenario	$5.5	$6.3	$6.7	$5.5	$6.3	$6.7	$5.5	$6.3	$6.5	$5.5	$6.3	$6.5	$5.5	$6.3	$6.6
Recession Scenario	$5.5	$7.0	$8.8	$5.5	$7.0	$8.8	$5.5	$7.1	$8.9	$5.5	$7.0	$8.8	$5.5	$6.9	$8.7
Black Skies Scenario	$5.5	$8.1	$10.1	$5.5	$8.1	$10.1	$5.5	$8.2	$10.1	$5.5	$8.2	$10.1	$5.5	$8.0	$10.0

Key Takeaways:

- Contributions are expected to rise over the projection period
- Portfolio H is projected to have lower contributions under a Black Skies scenario with higher contributions under a Base scenario compared to the other portfolios modeled

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



Appendix

- Actuarial Assumptions and Methods

Actuarial Assumptions and Methods

- Actuarial projections were provided by the plan actuary as of the most recent valuation date (June 30, 2018)
- 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, 2015 through June 30, 2018 and:
      - New school employees hired on or after July 1, 2017 through June 30, 2019 are assumed to be Class T-E members
      - 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, 2018

Actuarial Assumptions and Methods (continued)

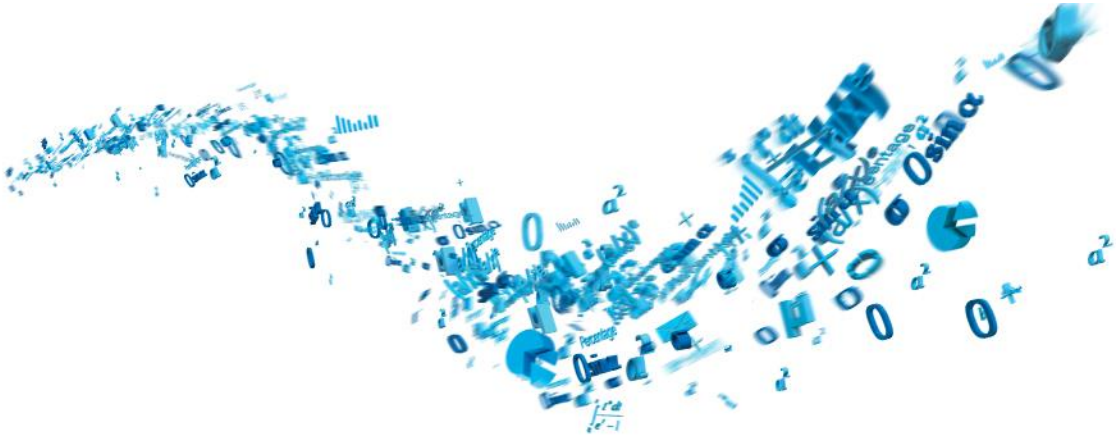
- Actuarially-Determined Contribution Calculation = Normal Cost plus a level percent amortization of the unfunded liability with layered 24 year, closed periods, and a 3.50% salary scale
  - Amortization bases developed are projected to continue until either their individual expiry or the plan reaches 100% funded on an actuarial value of assets basis at which point any remaining balance is fully recognized
- Asset figures reflect actual performance for the period July 1, 2018 – March 31, 2019 (3.39% return)
- 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

Exchange-Traded Fund (ETF) Portfolio Construction

- In developing the ETFs of Proposed 1 Year portfolio (Portfolio E in the analysis), the Proposed 1 Year Target allocation was mapped as follows to available ETFs:

Asset Class Weights	Proposed 1 Yr Target	ETF Ticker	ETF Name	ETF Weight
Public Equity: US	4.8%	ITOT	ishares Core S&P Total US Stock Market	4.8%
Public Equity: Non-US Developed, unhedged	1.6%	IXUS	ishares Core MSCI Total International Stock	1.6%
Public Equity: Non-US Developed, hedged to USD	4.9%	HEFA	ishares Currency Hedged MSCI EAFE ETF	4.9%
Public Equity: Emerging Markets	3.7%	IEMG	ishares Core MSCI Emerging Markets ETF	3.7%
Private Equity, unhedged	15.0%	IVV	ishares Core S&P 500 ETF	11.9%
		IWM	ishares Russell 2000 ETF	2.0%
		HYG	ishares iBoxx $ High Yield Corp Bond	1.2%
Fixed Income: US Core	4.0%	AGG	ishares Core U.S. Aggregate Bond ETF	4.0%
Fixed Income: US Long-term Treasury	6.0%	SPTL	SPDR Portfolio Long Term Treasury Index	6.0%
Fixed Income: Emerging Market Debt, local curr	1.0%	LEMB	ishares JPMorgan EM Local Currency ETF	1.0%
Fixed Income: Private Credit	10.0%	HYG	ishares iBoxx $ High Yield Corp Bond	10.0%
Fixed Income: Non-US Inflation-Linked, hedged to USD	15.0%	TIP	ishares TIPS Bond ETF	15.0%
Infrastructure: Private, hedged to USD	1.0%	IGF	ishares Global Infrastructure ETF	1.0%
Infrastructure: Public, hedged to USD	2.0%	IGF	ishares Global Infrastructure ETF	2.0%
Infrastructure: Energy MLPS	3.0%	AMLP	Alerian MLP ETF	3.0%
Real Estate: Global REITs, hedged to USD	2.0%	REET	ishares Global REIT ETF	2.0%
Real Estate: Private, unhedged	8.0%	USRT	ishares US REIT ETF	2.4%
		IWM	ishares Russell 2000 ETF	0.5%
		HYG	ishares iBoxx $ High Yield Corp Bond ETF	0.4%
		SHV	ishares Short Treasury Bond Index ETF	4.7%
Commodities: Diversified	5.0%	COMT	ishares Bloomberg Roll Select Commodity ETF	5.0%
Commodities: Gold	3.0%	IAU	ishares Gold Trust	3.0%
Risk Parity	8.0%	ITOT	ishares Core S&P Total US Stock Market	2.2%
		IXUS	ishares Core MSCI Total International Stock	1.8%
		TIP	ishares TIPS Bond ETF	4.4%
		GOVT	ishares US Treasury Bond	6.0%
		COMT	ishares Bloomberg Roll Select Commodity ETF	1.6%
		SHV	ishares Short Treasury Bond Index ETF	-8.0%
Hedge Funds	10.0%	SHV	ishares Short Treasury Bond Index ETF	7.2%
		GOVT	ishares US Treasury Bond	-0.5%
		CIU	ishares Intermediate Credit Bond ETF	0.8%
		HYG	ishares iBoxx $ High Yield Corp Bond	1.5%
		ITOT	ishares Core S&P Total US Stock Market	0.6%
		IXUS	ishares Core MSCI Total International Stock	0.5%
Cash	6.0%	SHV	ishares Short Treasury Bond Index ETF	6.0%
Financing - LIBOR	-14.0%	SHV	ishares Short Treasury Bond Index ETF	-14.0%
Total	100.0%			100.0%

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



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.

AHIC Capital Market Assumptions

As of March 31, 2019 (30 Years)

		Expected Real Return[1]	Expected Nominal Return[1]	Expected Nominal Volatility
	Equity			
1	Large Cap U.S. Equity	4.5%	6.8%	17.3%
2	Small Cap U.S. Equity	5.0%	7.3%	23.6%
3	Global Equity IMI	5.4%	7.8%	18.8%
4	International Equity (Developed) - Hedged	5.9%	8.2%	18.0%
5	International Equity (Developed)	5.3%	7.6%	20.0%
6	Emerging Markets Equity	6.3%	8.6%	27.6%
	Fixed Income			
7	Cash (Gov't)	0.3%	2.5%	1.7%
8	Cash (LIBOR)	0.7%	2.9%	1.8%
9	Non-US Inflation-Linked	0.3%	2.5%	3.6%
10	Core Fixed Income	1.1%	3.4%	4.9%
11	TIPS	1.0%	3.2%	4.5%
12	Long Duration Bonds – Gov't	0.8%	3.0%	10.6%
13	High Yield Bonds	2.9%	5.1%	12.2%
14	Non-US Developed Bond (100% Hedged)	0.5%	2.8%	4.1%
15	Emerging Market Bonds	2.7%	5.0%	13.7%
16	Emerging Market Bonds (Sov. Local)	3.1%	5.4%	14.4%
	Alternatives			
17	Hedge Funds[2]	3.4%	5.6%	8.8%
18	Non Core Real Estate	3.9%	6.2%	19.8%
19	Real Estate[3]	3.9%	6.2%	17.3%
20	US REITs	3.9%	6.2%	18.9%
21	Commodities	2.8%	5.1%	16.8%
22	Private Equity[4]	7.4%	9.7%	26.6%
23	Private Infrastructure	5.5%	7.8%	14.8%
24	Public Infrastructure	5.0%	7.3%	17.4%
25	Risk Parity[5]	4.1%	6.4%	10.9%
26	Master Limited Partnerships	5.2%	7.5%	16.4%
27	Gold	1.0%	3.2%	19.5%
28	Private Debt	5.0%	7.4%	16.8%
	Inflation			
	Inflation	0.0%	2.2%	1.6%

[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] Real Estate assumption developed as follows: 80% Non-Core Rel Estate, 20% Core Real Estate
[4] Private Equity assumptions developed as follows: 72% Buyouts, 13% Venture Capital, 15% Distressed Debt
[5] Risk Parity assumptions developed as follows: 50% Global Equity, -100% LIBOR, 55% TIPS, 75% Intermediate Gov't. Bonds, 20% Commodities

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AHIC Capital Market Assumptions

As of March 31, 2019 (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	25	26	27	28
1	Large Cap U.S. Equity	**1.00**	0.92	0.96	0.89	0.78	0.72	0.08	0.08	-0.06	0.04	-0.06	-0.13	0.60	0.01	0.42	0.47	0.56	0.24	0.27	0.66	0.32	0.92	0.38	0.88	0.86	0.94	0.01	0.34
2	Small Cap U.S. Equity	0.92	**1.00**	0.90	0.82	0.72	0.67	0.07	0.07	-0.06	0.03	-0.06	-0.12	0.56	0.00	0.39	0.42	0.51	0.22	0.25	0.61	0.27	0.87	0.36	0.82	0.80	0.88	0.00	0.32
3	Global Equity IMI	0.96	0.90	**1.00**	0.92	0.91	0.84	0.07	0.07	-0.07	0.04	-0.06	-0.13	0.66	0.00	0.47	0.56	0.55	0.24	0.27	0.64	0.38	0.89	0.38	0.92	0.89	0.98	0.01	0.36
4	International Equity (Developed) - Hedged	0.89	0.82	0.92	**1.00**	0.88	0.73	0.10	0.10	-0.06	0.05	-0.04	-0.11	0.57	0.01	0.40	0.41	0.51	0.25	0.28	0.61	0.27	0.82	0.35	0.84	0.82	0.89	0.01	0.33
5	International Equity (Developed)	0.78	0.72	0.91	0.88	**1.00**	0.75	0.04	0.04	-0.08	0.03	-0.04	-0.11	0.58	-0.02	0.43	0.60	0.50	0.22	0.25	0.53	0.44	0.73	0.32	0.84	0.79	0.90	0.01	0.32
6	Emerging Markets Equity	0.72	0.67	0.84	0.73	0.75	**1.00**	0.06	0.06	-0.06	0.04	-0.05	-0.11	0.66	0.01	0.48	0.53	0.41	0.20	0.22	0.49	0.31	0.68	0.30	0.77	0.74	0.82	0.01	0.32
7	Cash (Gov't)	0.08	0.07	0.07	0.10	0.04	0.06	**1.00**	0.99	0.54	0.46	0.44	0.23	0.15	0.59	0.17	0.00	0.07	0.09	0.11	0.08	0.22	0.04	0.11	0.10	0.21	0.11	0.06	0.02
8	Cash (LIBOR)	0.08	0.07	0.07	0.10	0.04	0.06	0.99	**1.00**	0.53	0.46	0.44	0.23	0.15	0.58	0.18	0.01	0.07	0.09	0.10	0.08	0.22	0.04	0.11	0.10	0.20	0.11	0.06	0.03
9	Non-US Inflation-Linked	-0.06	-0.06	-0.07	-0.06	-0.08	-0.06	0.54	0.53	**1.00**	0.21	0.45	0.07	0.03	0.40	0.04	-0.04	0.03	0.02	0.02	-0.03	0.20	-0.07	0.02	-0.03	0.09	-0.03	0.04	0.01
10	Core Fixed Income	0.04	0.03	0.04	0.05	0.03	0.04	0.46	0.46	0.21	**1.00**	0.49	0.76	0.34	0.61	0.50	0.14	0.16	0.04	0.04	0.04	0.08	0.03	0.05	0.05	0.31	0.05	0.02	0.06
11	TIPS	-0.06	-0.06	-0.06	-0.04	-0.04	-0.05	0.44	0.44	0.45	0.49	**1.00**	0.31	0.11	0.20	0.15	-0.02	-0.02	0.01	0.02	-0.03	0.18	-0.06	0.00	-0.02	0.30	-0.02	0.05	-0.08
12	Long Duration Bonds – Gov't	-0.13	-0.12	-0.13	-0.11	-0.11	-0.11	0.23	0.23	0.07	0.76	0.31	**1.00**	-0.10	0.51	0.18	-0.04	-0.11	-0.02	-0.03	-0.08	-0.03	-0.12	-0.04	-0.11	0.10	-0.12	-0.01	-0.33
13	High Yield Bonds	0.60	0.56	0.66	0.57	0.58	0.66	0.15	0.15	0.03	0.34	0.11	-0.10	**1.00**	0.14	0.73	0.58	0.59	0.16	0.18	0.41	0.38	0.58	0.27	0.62	0.66	0.66	0.02	0.64
14	Non-US Developed Bond (100% Hedged)	0.01	0.00	0.00	0.01	-0.02	0.01	0.59	0.58	0.40	0.61	0.20	0.51	0.14	**1.00**	0.28	0.08	0.09	0.04	0.05	0.01	0.09	-0.01	0.05	0.01	0.12	0.02	0.02	0.01
15	Emerging Market Bonds	0.42	0.39	0.47	0.40	0.43	0.48	0.17	0.18	0.04	0.50	0.15	0.18	0.73	0.28	**1.00**	0.63	0.53	0.11	0.13	0.28	0.24	0.40	0.18	0.44	0.51	0.47	0.02	0.37
16	Emerging Market Bonds (Sov. Local)	0.47	0.42	0.56	0.41	0.60	0.53	0.00	0.01	-0.04	0.14	-0.02	-0.04	0.58	0.08	0.63	**1.00**	0.47	0.06	0.07	0.29	0.44	0.45	0.13	0.54	0.50	0.58	0.00	0.37
17	Hedge Funds[1]	0.56	0.51	0.55	0.51	0.50	0.41	0.07	0.07	0.03	0.16	-0.02	-0.11	0.59	0.09	0.53	0.47	**1.00**	0.13	0.15	0.37	0.36	0.52	0.22	0.54	0.52	0.57	0.01	0.53
18	Non Core Real Estate	0.24	0.22	0.24	0.25	0.22	0.20	0.09	0.09	0.02	0.04	0.01	-0.02	0.16	0.04	0.11	0.06	0.13	**1.00**	0.99	0.29	0.05	0.21	0.12	0.24	0.22	0.25	0.01	0.09
19	Real Estate[2]	0.27	0.25	0.27	0.28	0.25	0.22	0.11	0.10	0.02	0.04	0.02	-0.03	0.18	0.05	0.13	0.07	0.15	0.99	**1.00**	0.33	0.06	0.24	0.14	0.27	0.25	0.29	0.01	0.10
20	US REITs	0.66	0.61	0.64	0.61	0.53	0.49	0.08	0.08	-0.03	0.04	-0.03	-0.08	0.41	0.01	0.28	0.29	0.37	0.29	0.33	**1.00**	0.20	0.61	0.26	0.68	0.57	0.72	0.00	0.22
21	Commodities	0.32	0.27	0.38	0.27	0.44	0.31	0.22	0.22	0.20	0.08	0.18	-0.03	0.38	0.09	0.24	0.44	0.36	0.05	0.06	0.20	**1.00**	0.29	0.08	0.48	0.59	0.51	0.04	0.13
22	Private Equity[3]	0.92	0.87	0.89	0.82	0.73	0.68	0.04	0.04	-0.07	0.03	-0.06	-0.12	0.58	-0.01	0.40	0.45	0.52	0.21	0.24	0.61	0.29	**1.00**	0.35	0.82	0.79	0.87	0.01	0.33
23	Private Infrastructure	0.38	0.36	0.38	0.35	0.32	0.30	0.11	0.11	0.02	0.05	0.00	-0.04	0.27	0.05	0.18	0.13	0.22	0.12	0.14	0.26	0.08	0.35	**1.00**	0.34	0.33	0.36	0.01	0.15
24	Public Infrastructure	0.88	0.82	0.92	0.84	0.84	0.77	0.10	0.10	-0.03	0.05	-0.02	-0.11	0.62	0.01	0.44	0.54	0.54	0.24	0.27	0.68	0.48	0.82	0.34	**1.00**	0.86	0.94	0.01	0.33
25	Risk Parity[4]	0.86	0.80	0.89	0.82	0.79	0.74	0.21	0.20	0.09	0.31	0.30	0.10	0.66	0.12	0.51	0.50	0.52	0.22	0.25	0.57	0.59	0.79	0.33	0.86	**1.00**	0.91	0.03	0.24
26	Master Limited Partnerships	0.94	0.88	0.98	0.89	0.90	0.82	0.11	0.11	-0.03	0.05	-0.02	-0.12	0.66	0.02	0.47	0.58	0.57	0.25	0.29	0.72	0.51	0.87	0.36	0.94	0.91	**1.00**	0.02	0.35
27	Gold	0.01	0.00	0.01	0.01	0.01	0.01	0.06	0.06	0.04	0.02	0.05	-0.01	0.02	0.02	0.02	0.00	0.01	0.01	0.01	0.00	0.04	0.01	0.01	0.01	0.03	0.02	**1.00**	0.01
28	Private Debt	0.34	0.32	0.36	0.33	0.32	0.32	0.02	0.03	0.01	0.06	-0.08	-0.33	0.64	0.01	0.37	0.37	0.53	0.09	0.10	0.22	0.13	0.33	0.15	0.33	0.24	0.35	0.01	**1.00**

[1] Hedge Fund assumptions developed as follows: 14% Event Driven, 38% Global Macro, 20% Distressed Debt, 16% Fixed Income Arbitrage, 12% Cat. Bonds
[2] Real Estate assumption developed as follows: 80% Non-Core Rel Estate, 20% Core Real Estate
[3] Private Equity assumptions developed as follows: 72% Buyouts, 13% Venture Capital, 15% Distressed Debt
[4] Risk Parity assumptions developed as follows: 50% Global Equity, -100% LIBOR, 55% TIPS, 75% Intermediate Gov't. Bonds, 20% Commodities

AHIC Capital Market Assumptions

Explanation of Capital Market Assumptions—Q2 2019

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 first quarter of 2019. 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 (2.2%)

Based on Consensus Economics long-term estimates and our near-term economic outlook, we expect U.S. consumer price inflation to be approximately 2.2% during the next 30 years.

Real Returns for Asset Classes

Fixed Income

- **Cash (0.3%)** – Over the long run, we expect the real yield on cash and money market instruments to produce a real return of 0.3% in a moderate to low-inflationary environment.
- **TIPS (1.0%)** – We expect intermediate duration Treasury Inflation-Protected Securities to produce a real return of about 1.0%.
- **Core Fixed Income (i.e., Market Duration) (1.2%)** – We expect intermediate duration Treasuries to produce a real return of about 0.7%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 0.5%, resulting in a long-term real return of 1.2%.
- **Long Duration Bonds – Government and Credit (1.4%)** – We expect Treasuries with a duration comparable to the Long Government Credit Index to produce a real return of 0.8%. 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 1.4%.

AHIC Capital Market Assumptions

Explanation of Capital Market Assumptions—Q2 2019

- **Long Duration Bonds – Credit (1.9%)** – We expect Treasuries with a duration comparable to the Long Credit Index to produce a real return of 0.8%. 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 1.9%.
- **Long Duration Bonds – Government (0.8%)** – We expect Treasuries with a duration of ~12 years to produce a real return of 0.8% during the next 30 years.
- **High Yield Bonds (2.8%)** – We expect intermediate duration Treasuries to produce a real return of about 0.5%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 2.3%, resulting in an expected real return of 2.8%.
- **Bank Loans (3.5%)** – 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 2.8%, resulting in an expected real return of 3.5%.
- **Non-US Developed Bonds: 50% Hedged (0.5%) –** We forecast real returns for non-US developed market bonds to be 0.5% 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) (2.7%) –** We forecast real returns for emerging market sovereign bonds denominated in US dollars to be 2.7% over a 30-year period.
- **Emerging Market Bonds (Corporate; USD) (2.5%) –** We forecast real returns for emerging market corporate bonds denominated in US dollars to be 2.5% over a 30 year period.
- **Emerging Market Bonds (Sovereign; Local) (3.1%)** – We forecast real returns for emerging market sovereign bonds denominated in local currency to be 3.1% over a 30 year-period.
- **Multi Asset Credit (MAC) (4.2%) –** We assume real returns from beta exposure to high yield, bank loans and emerging market debt to add 3.3% plus 0.9% from alpha (net of fees) over a 30-year period.
- **Private Debt-Direct Lending (5.1%) –** The base building block is bank loans 3.5% + spread 1.6% (net of management fees and performance incentives). There is 100% leverage included in the assumption with the cost of financing at LIBOR + 2.5%.

AHIC Capital Market Assumptions

Explanation of Capital Market Assumptions—Q2 2019

Equities

- **Large Cap U.S. Equity (4.5%)** – 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 (5.0%)** – Adding a 0.2% 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) (5.5%)** – 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 5.5% 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 (6.3%)** - 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 (4.3%) –** We expect nominal returns from 50% equity + 50% cash beta of 5.0% plus 1.6% insurance risk premium over the next 30 years.

Alternative Asset Classes

- **Hedge Fund-of-Funds Universe (2.0%)** – 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 1.1% in return at similar volatility based on alpha, lower fees and better risk management.

AHIC Capital Market Assumptions

Explanation of Capital Market Assumptions—Q2 2019

- **Hedge Fund-of-Funds Buy List (3.1%)** – 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 (3.3%)** – 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 (4.7%)** – 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 (2.9%)** -- Our real return assumption for core real estate is based a gross income of about 4.4%, 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.
- **U.S. REITs (3.9%)** – Our real return assumption for U.S. REITs is based on income of about 3.9% 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 (2.8%)** – 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., 2.2%). 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 2.8% for commodities.
- **Private Equity (7.1%)** – Our private equity assumption reflects a diversified fund of funds with exposure to buyouts, venture capital, distressed debt, and mezzanine debt.

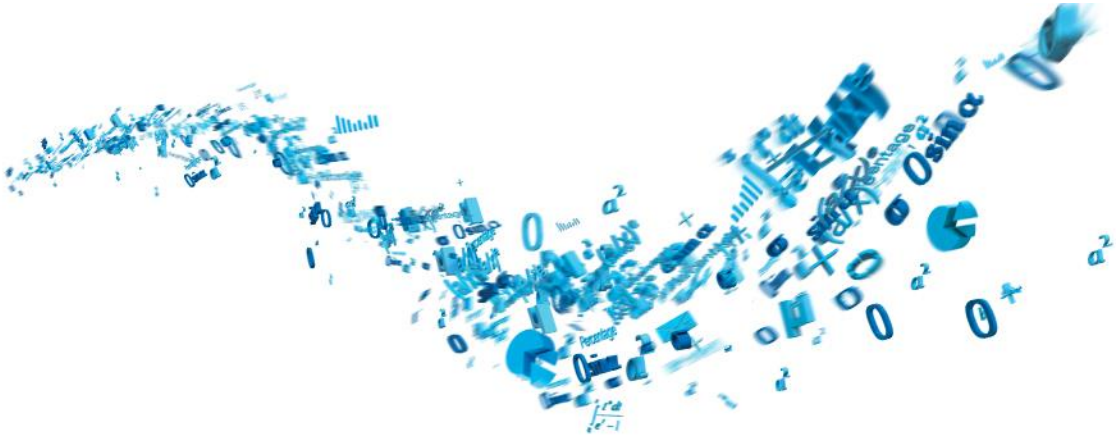
AHIC Capital Market Assumptions

Explanation of Capital Market Assumptions—Q2 2019

- **Infrastructure (5.5%)** – 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 5.5% for infrastructure.
- **Equity Risk Insurance Premium Strategies-Low Beta (3.7%) –** We assume real returns from cash of 0.3% + 3.4% from alpha.
- **Alternative Risk Premia (ARP) (4.6%) –** Nominal return target LIBOR 2.9% plus 4.0% 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

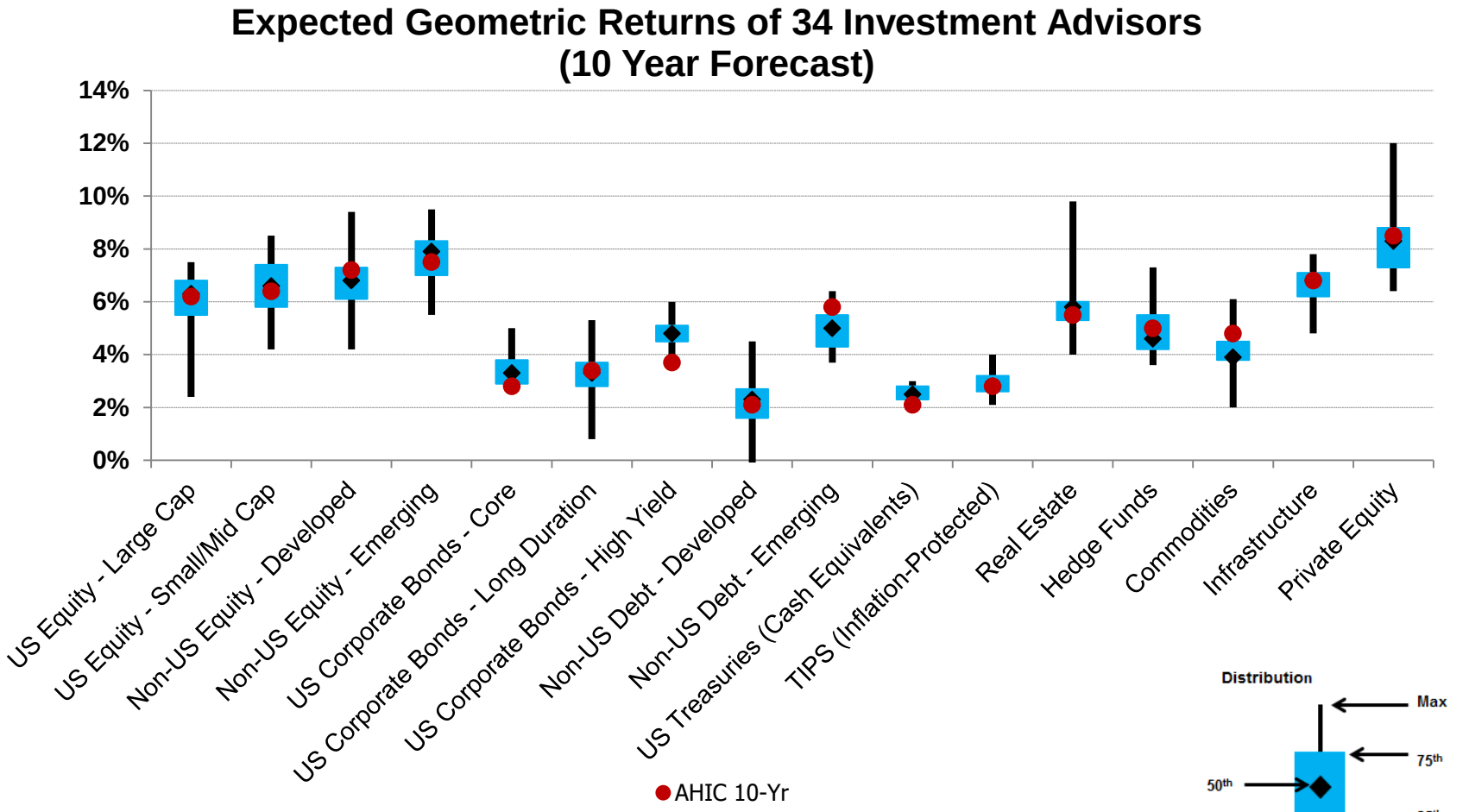
- 2018 Horizon Survey of Capital Market Assumptions

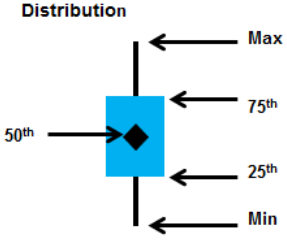
2018 Horizon Survey Results

AHIC Capital Market Assumptions

- Long-term (10 and 30 year forecasts) forward-looking assumptions (asset class geometric return, volatility and correlations)
- Building Block approach. Primarily based on consensus expectations and market based inputs
- Best estimates of annualized returns (50/50 better or worse)
- Market returns: no active management value added (other than hedge funds and private equity)
- Net of investment fees

AHIC Capital Market Assumptions vs. Horizon Survey





SOURCE: Horizon Actuarial survey of 2018 capital market assumptions from 34 independent investment advisors
Expected returns of the survey are annualized over 10-years (geometric).
AHIC expected returns are annualized over 10-years as of 1Q 2018

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AHIC Versus Peers (2018 Horizon Survey)—10-Year Forecast

	Horizon Survey			AHIC		
	10 Year Horizon			10 Year Forecasts		
Asset Class	**Expected Return**	**Expected Risk**		**Expected Return**	**Expected Risk**	**Difference**
US Equity - Large Cap	6.1%	16.4%		6.2%	17.0%	0.1%
US Equity - Small/Mid Cap	6.6%	20.2%		6.4%	23.0%	-0.2%
Non-US Equity - Developed	6.7%	18.7%		7.2%	20.0%	0.5%
Non-US Equity - Emerging	7.6%	24.9%		7.5%	30.0%	-0.1%
US Fixed Income - Core	3.4%	5.7%		2.8%	4.0%	-0.6%
US Fixed Income - Long Duration Corp	3.3%	10.8%		3.4%	11.0%	0.1%
US Fixed Income - High Yield	4.8%	10.2%		3.7%	12.0%	-1.1%
Non-US Fixed Income - Developed	2.2%	6.9%		2.1%	5.5%	-0.1%
Non-US Fixed Income - Emerging	5.0%	11.4%		5.8%	11.8%	0.8%
Treasuries (Cash Equivalents)	2.5%	2.7%		2.1%	1.0%	-0.4%
TIPS (Inflation-Protected)	2.9%	6.2%		2.8%	4.5%	-0.1%
Real Estate	5.9%	13.9%		5.5%	11.5%	-0.4%
Hedge Funds	5.0%	7.9%		5.0%	9.0%	0.0%
Commodities	4.0%	17.6%		4.8%	17.0%	0.8%
Infrastructure	6.6%	14.7%		6.8%	14.5%	0.2%
Private Equity	8.3%	22.2%		8.5%	24.0%	0.2%
Inflation	2.2%	1.8%		2.3%	1.0%	0.1%

Notes (Horizon Survey):

Source: Horizon Actuarial survey of 2018 capital market assumptions from 34 independent investment advisors

Expected returns are annualized (geometric).

Notes (AHIC Forecasts):

AHIC Forecasts are for Q1 2018

US Equity - Small/Mid Cap forecasts represents AHIC forecasts for US Small Cap

US Fixed Income - Long Duration forecasts represents AHIC forecasts for Long Duration Credit

Non-US Fixed Income - Developed forecasts represents AHIC forecasts for Non-US Fixed Income - Developed (50% Hedged)

Non-US Fixed Income- Emerging forecasts represents AHIC forecasts for Sovereign Local Currency

Real Estate forecasts represents AHIC forecasts for Core Private Real Estate

Hedge Funds forecasts represents AHIC forecasts for Hedge Fund-of-Funds (Buy List)

AHIC Versus Peers: Observations

- Compared to 2017, 2018 survey results under the 10-year forecast indicate a slight **decrease** in return assumptions of both risky assets (equity-like) and fixed income asset classes
  - Equity return assumptions are lower by an average of 0.3%
  - Fixed income return assumptions are lower by an average of 0.1%
  - Alternative asset class return assumptions are lower by an average of 0.2%

- 2018 AHIC 10-year forecast assumptions of Equities tend to be **mixed** compared to the survey average, Fixed Income assets slightly **lower** and Alternative Assets **higher** than the survey average
  - AHIC equity assumptions are driven by market valuations, earnings growth expectations and assumed payouts to investors. Recent experience suggests strong equity market performance has been driven more by increasing valuations than increasing profits. As markets have become more expensive in the US and Emerging Markets, our equity return assumptions have consequently fallen. In other developed markets, a combination of slightly higher GDP growth expectations, small increase in inflation expectations and some of the market depreciation drive our return assumptions higher.
  - AHIC fixed income assumptions reflect rising yields, narrower credit spreads and flattening of yield curves during the first quarter of 2018
  - AHIC alternative asset class assumptions are generally higher due to methodological and inflation forecast differences compared to survey participant forecasts

- In conclusion, AHIC assumptions of public equity and fixed income asset classes appear somewhat more conservative than peers included in the 2018 Horizon Survey of capital market assumptions

Leading Methodologies & Reasons for Differences

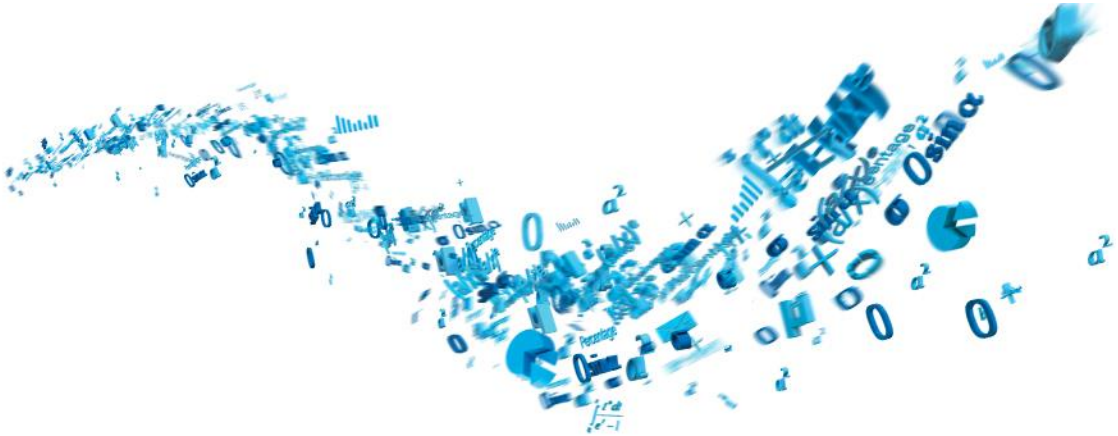
Leading Methodologies

- 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 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 based on indexed returns (no “alpha”). However, AHIC return assumptions for certain asset classes include “alpha” or active management premium (e.g., Hedge Funds)



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

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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

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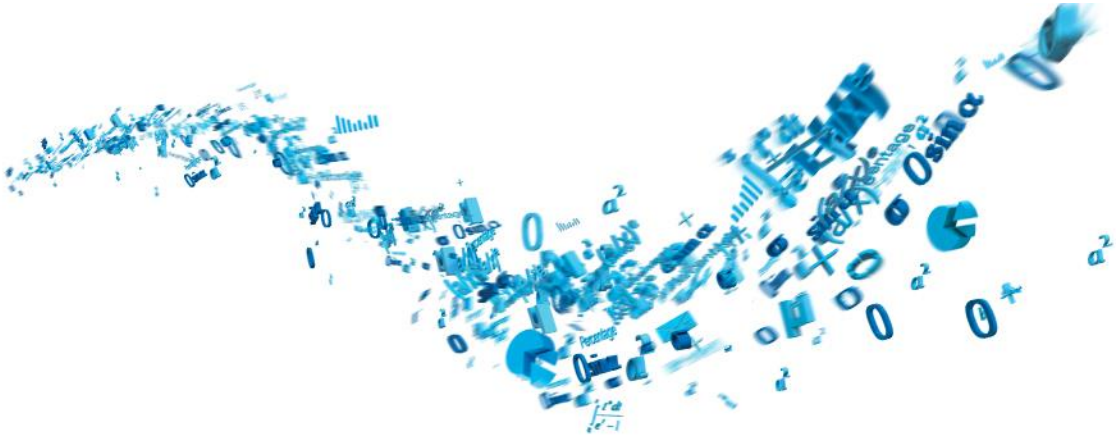


Appendix

- 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

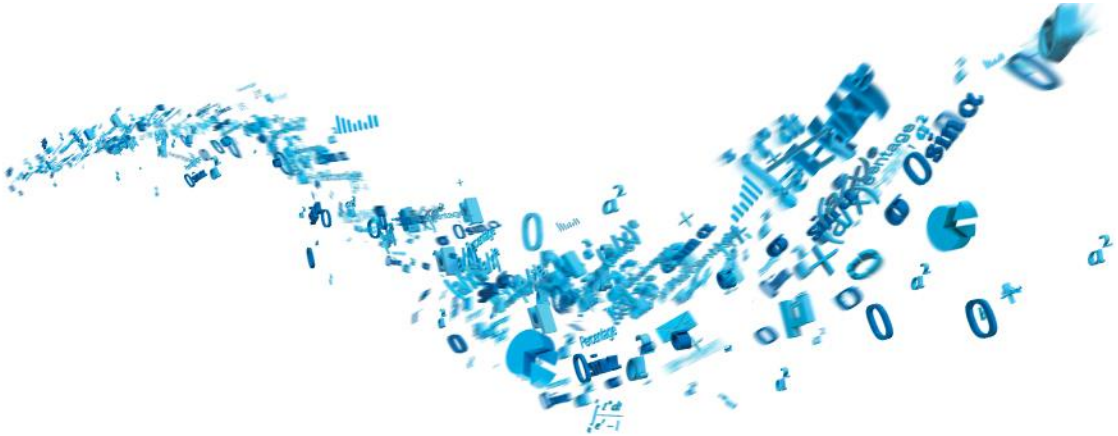
2. **PERS trustees should not be daunted by a liability value that exceeds the value of assets**
   a) Do not feel obliged to incur greater risk in an effort to narrow the gap
   b) Funded status has less to do with investment performance than it does with public policy and politics

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

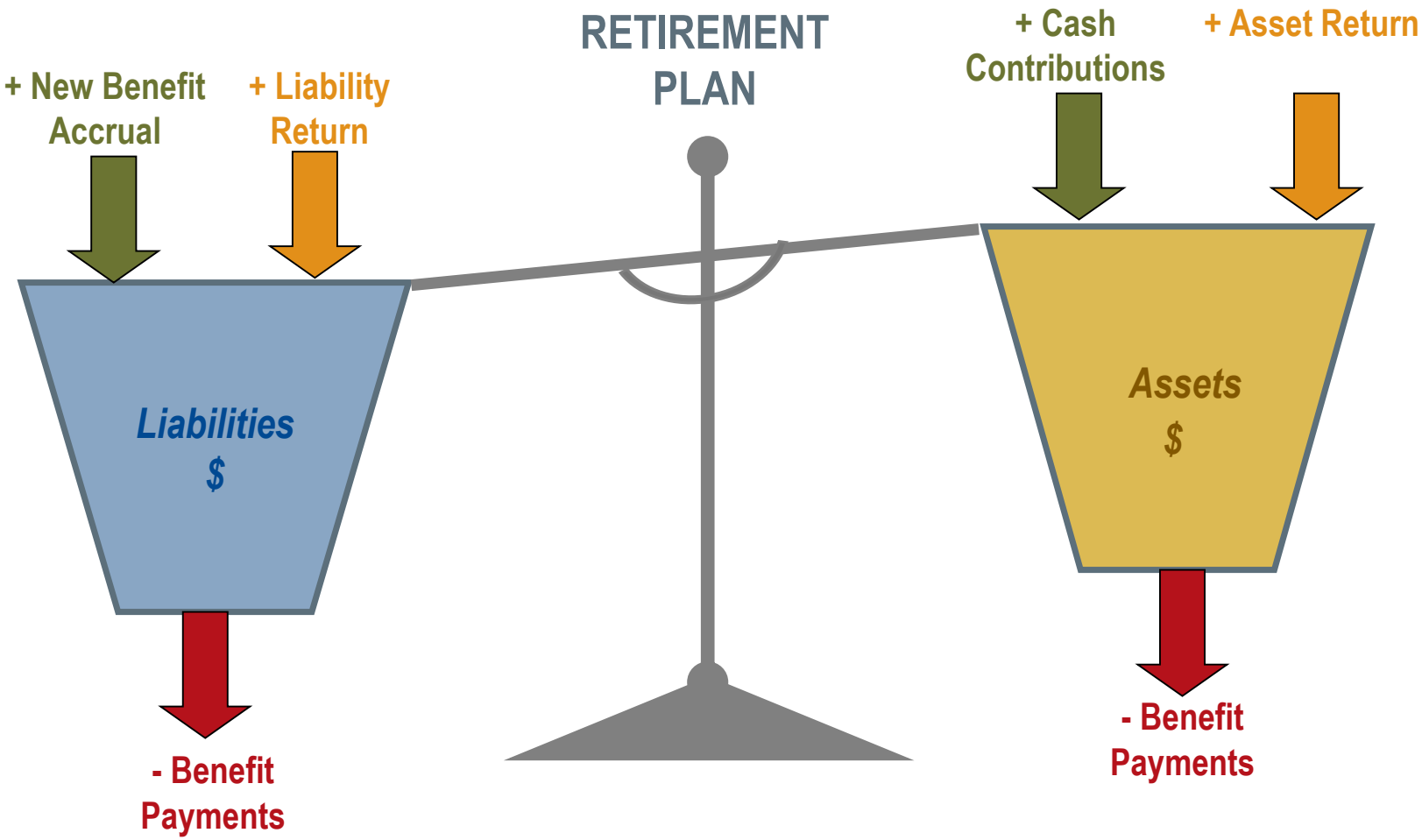
What is an Asset-Liability Study?

- 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



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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 ▪ Lose 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 ▪ Monitoring / dashboards ▪ Medium term views ▪ Regression and scenario analysis

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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?

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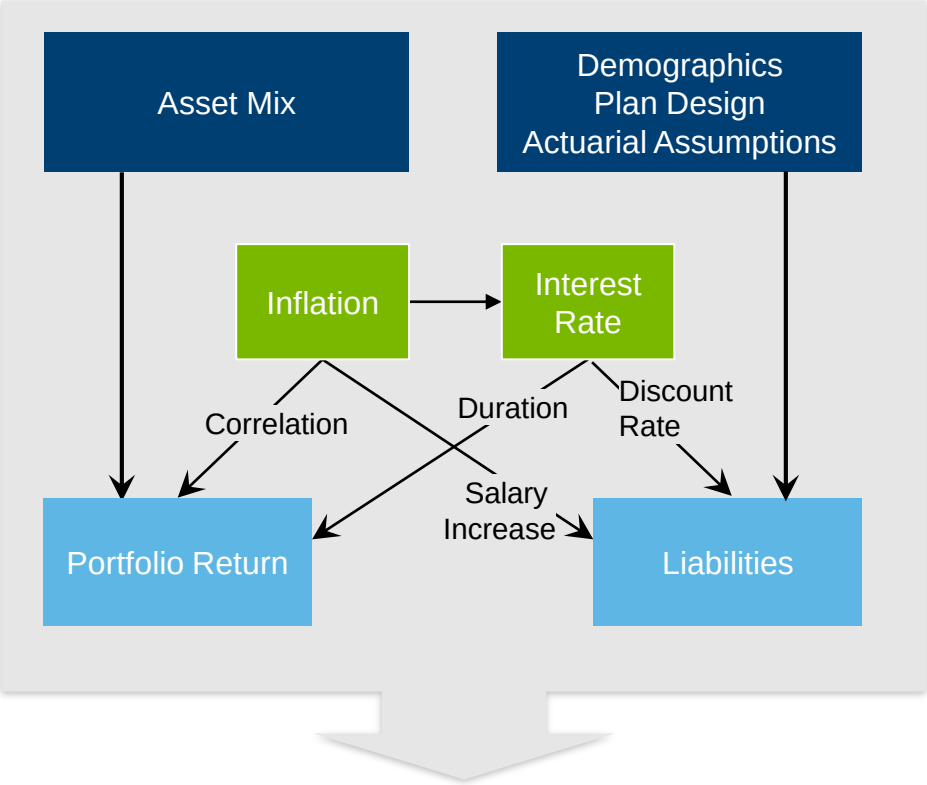
Asset-Liability Management Background

Mechanics of Asset-Liability Modeling Process



Contributions

Funded Ratio

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

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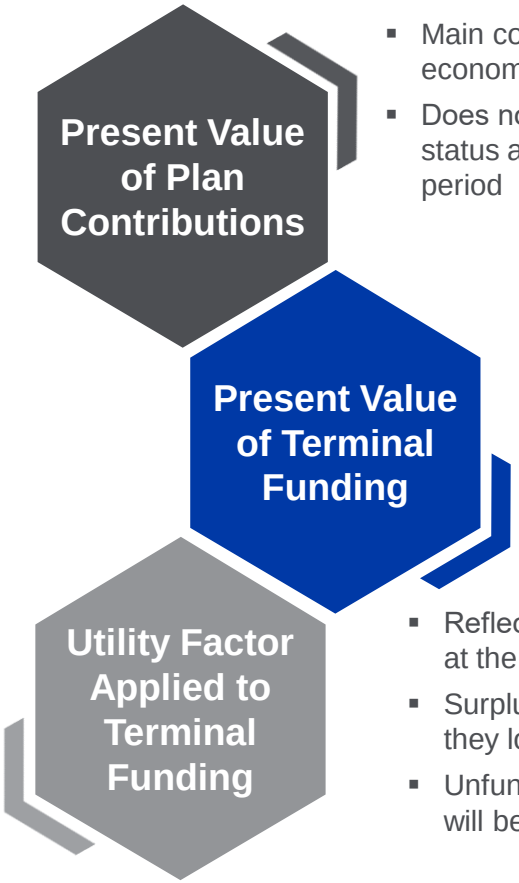
Asset-Liability Management Background

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**

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%



- 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

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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)

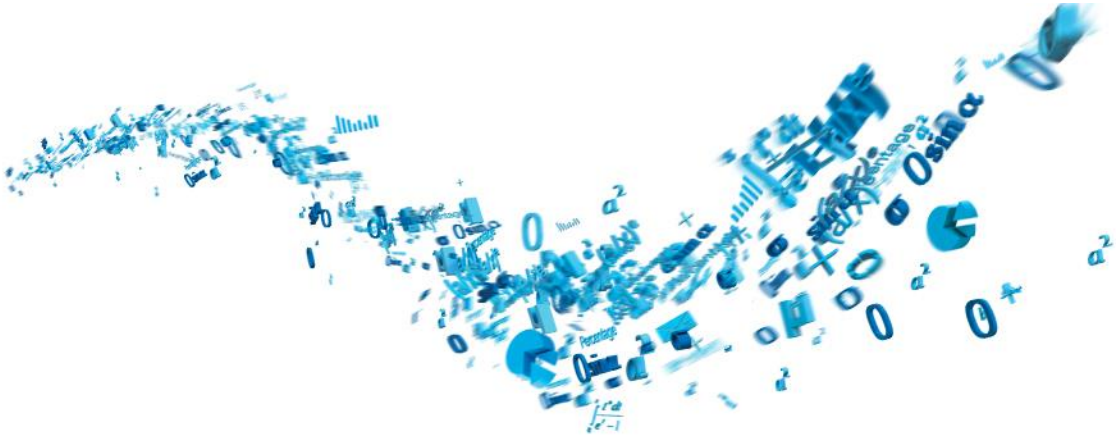
- **Asset-Liability:**
  - Return = Potential cost reduction or funded status improvement under average economic conditions
  - Risk = During the worst economic conditions, contributions need to increase or funded status declines (e.g., stocks decline, inflation/deflation shocks and/or interest rates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



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 Hewitt Investment Consulting, 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.

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 2018 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, 2018.

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 Hewitt Investment Consulting, 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 Hewitt Investment Consulting, Inc.

Phil Kivarkis FSA, CFA

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