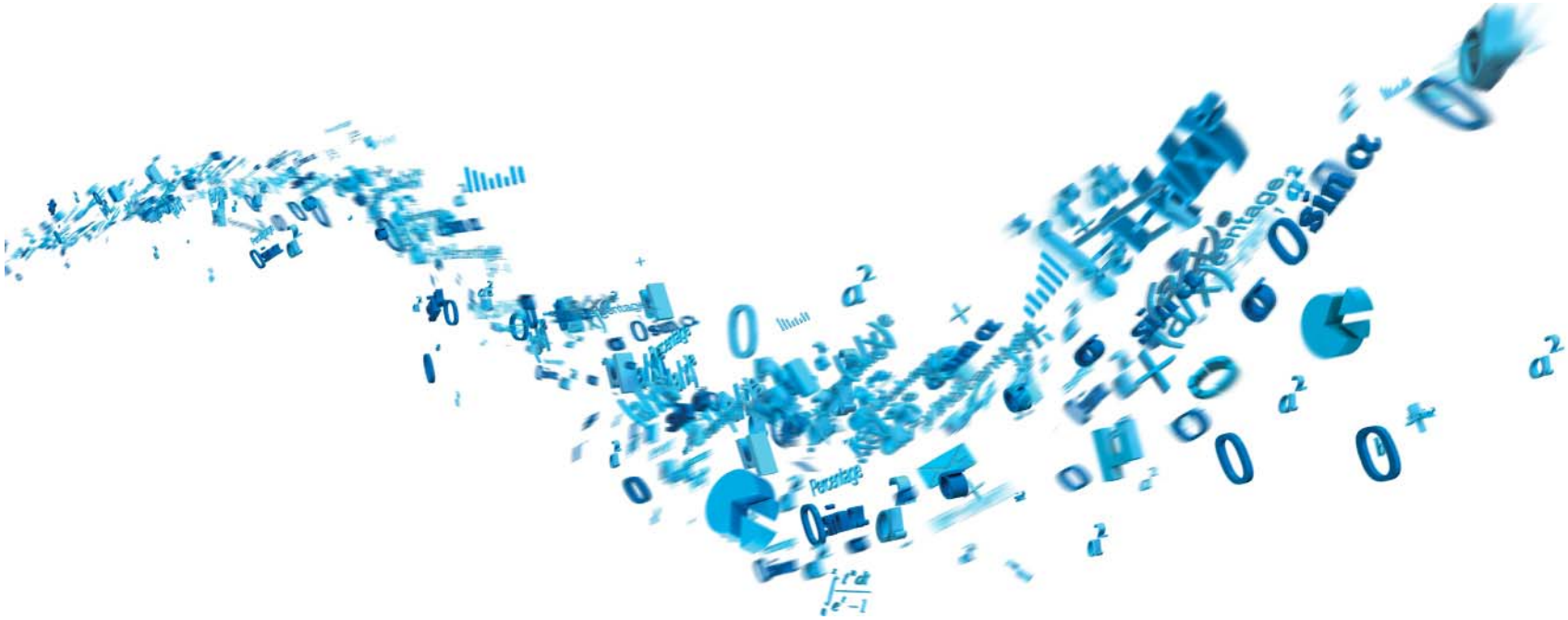

Asset-Liability Study Results

Pennsylvania Public School Employees' Retirement System (PSERS)
July 2018

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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 7.36% over the next 30 years
- PSERS should consider its desired balance between cash funding 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

Liquidity Analysis

- The Current Long-Term Target portfolio has sufficient liquidity in the modeled Base Case, Recession, and Black Skies scenarios
- PSERS would have to pare back on future commitments to illiquid assets at the time of a Black Skies scenario in order to keep the illiquid asset allocation close to target but this would be at the time when they offer the greatest expected returns

Executive Summary
Key Observations

1) PSERS is projected to attain full funding by 2038 (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 two 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 $7.4 billion annually utilizing the Current Long-Term Target allocation

- This is an improvement from last year's analysis where employer contributions reached $8.2 billion annually
- This increase in contributions reflects the amortization of the unfunded liabilities based on the current amortization schedule
- The contributions decline to $1.07 billion annually (the normal cost) at the end of the 30-year projection period as the plan reaches 100% funded
- This portfolio has a 60% probability of reaching full funding at the end of the 30 year projection period
    - A public pension fund which amortizes over 30 years would be expected to have a 50% chance of full funding over 30 years
- The fully liquid ETF portfolio results in the contributions peaking at over $8 billion annually before declining. Since the Plan will not reach full funding using this portfolio mix, the expected contributions at the end of 30 year measurement period are $3.68 billion annually.
- Total nominal employer contributions for the Current Long-Term Target portfolio are expected to be $129.5 billion over 30 years which is $29.3 billion less than the fully liquid ETF portfolio which is expected to total $158.8 billion over the same period

Executive Summary
Key Observations (continued)

3) The Current Long-Term Target portfolio has a higher expected return (by 1.22% and 1.39%, respectively) with better risk adjusted returns as measured by the Sharpe Ratios (by 0.10 and 0.05, respectively) than the Simple 60/40 and ETF Portfolios

- The higher return generated by the use of actively managed alternatives assets and the diversifying benefits of the much broader asset allocation are a benefit even after the consideration of the higher manager fees associated with these strategies

4) The Proposed 1 Year Target portfolio reflects a meaningful reduction in risk versus the Current 1 Year Target (0.95%) with a modest reduction in expected return (0.24%)

- The Proposed 1 Year Target portfolio provides a better risk/reward portfolio than the Current 1 Year Target as measured by the Sharpe Ratio (0.44 versus 0.42)
- This portfolio is designed to perform better in down-markets given its lower leverage and public equity exposure than either the Current 1 Year Target or the Current Long-Term Target
- Stochastic modelling illustrates higher probability for better funding in downside scenarios over the next 5 years versus the Current 1 Year Target portfolio
- This portfolio also does well over the full 30-year projection period and has a 56% probability of reaching full funding at the end of the 30 year projection period
    - A public pension fund which amortizes over 30 years would be expected to have a 50% chance of full funding over 30 years

Executive Summary
Key Observations (continued)

5) Liquidity needs remain noteworthy, but largely manageable and sufficiently met by the Current Long-Term Target and future contributions

- Only the "Black Skies" scenario appears to significantly stress but nevertheless still does not threaten the fund's liquidity over the next ten years; all other scenarios do not represent a liquidity risk to PSERS
- 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

6) 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

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

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	$72.3	$103.0	$75.7	$95.7	117%	44%	$128.3	$216.3
	(B) Proposed 1 Year Target	$74.7	$102.7	$76.6	$95.2	108%	44%	$131.8	$215.3
Long-Term Target	(C) Current Long-Term Target	$72.7	$103.3	$75.9	$96.2	116%	44%	$129.5	$217.5
	(D) Aon Clean Slate	$73.0	$102.8	$76.0	$96.1	116%	44%	$129.2	$215.2
	(E) Simple 60/40	$83.6	$109.6	$81.7	$100.2	89%	37%	$153.0	$234.2
	(F) Simple Same Return as Proposed 1 Year	$74.1	$111.7	$77.8	$103.4	123%	34%	$136.6	$242.3
	(G) Simple Same Risk as Proposed 1 Year	$85.5	$109.4	$82.6	$99.7	84%	37%	$157.4	$233.0
	(H) ETFs of Proposed 1 Year	$86.1	$108.1	$82.5	$98.6	82%	39%	$158.8	$230.4

Key Findings:

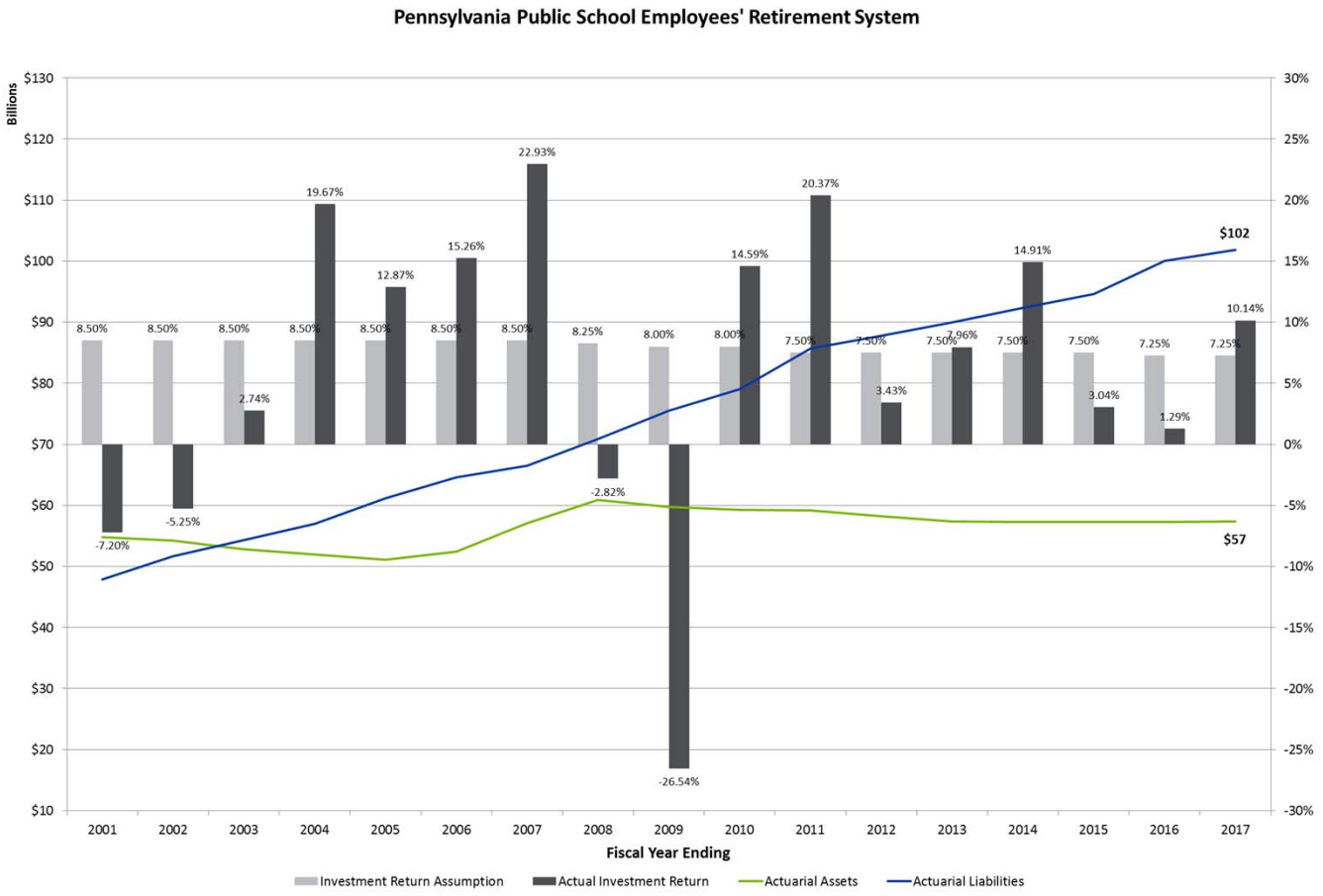
- The Plan is expected to reach full funding in the central expectation (50th percentile) under the Current Long-Term Target policy over the course of the projection period assuming the expected contributions are made
- Adverse market experience and/or not making required contributions will negatively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

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 March 2018; Actuarial valuation report as of June 30, 2017

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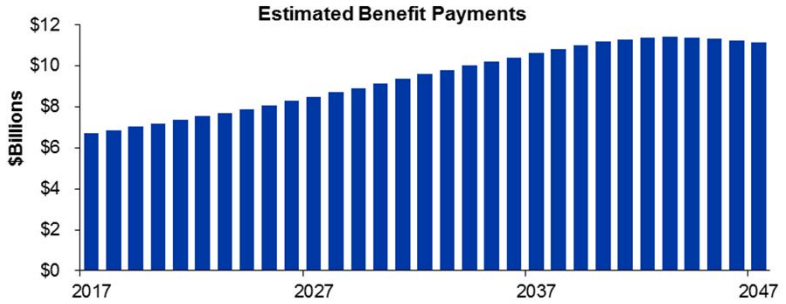
Current State Asset-Liability Profile

As of June 30, 2017

Asset-Liability Snapshot as of 6/30/2017		
Metric ($, Billions)	**Value**	**Fund %**
Market Value of Assets	$53.2	52.2%
Actuarial Value of Assets	$57.3	56.3%
Liability Metrics		
Actuarial Liability (AL) - Funding	$101.8[1]	

Target Asset Allocation as of 6/30/2017		
Metric ($, Billions)	**Value**	**Alloc %**
Return-Seeking		
- Global Equity	$10.6	20%
- Private Equity	$8.0	15%
- Infrastructure	$4.3	8%
- Real Estate	$5.3	10%
- Credit-Related[2]	$5.3	10%
- Commodities	$4.3	8%
- Risk Parity	$5.3	10%
- Total	$43.1	81%
Risk-Reducing / Safety		
- Global TIPS	$8.0	15%
- Hedge Funds[3]	$5.3	10%
- Cash	$1.6	3%
- Core Bonds	$2.7	5%
- Long Duration Gov't Bonds	$2.7	5%
- Developed Int'l Debt	$0.5	1%
- Total	$20.7	39%
Financing		
- Leverage	-$10.6	-20%
Total	$53.2	100%



Asset-Liability Growth Metrics for FYE 6/30/2018			
Metric ($, Billions)	**Value**	**% Liability**	**% Assets**
AL Discount Cost	$7.4	7.25%	13.88%
AL Normal Cost	$2.0	1.94%	3.73%
Total Liability Hurdle Rate	**$9.4**	**9.19%**	**17.61%**
Expected Return on Assets[4]	$3.9	3.80%	7.36%
Total Contributions	$5.1	5.00%	9.60%
Total Exp. Asset Growth	**$9.0**	**8.80%**	**16.96%**
Hurdle Rate Shortfall / (Surplus)	**$0.3**	**0.39%**	**0.65%**
Est. Benefit Payments	$6.7	6.60%	12.60%

[1]Based on a 7.25% discount rate consistent with the June 30, 2017 valuation results
[2]Credit-Related includes Private Credit, High-Yield Bonds, and Emerging Market Debt
[3]Hedge funds have elements of both return-seeking and risk-reducing assets. Hedge funds have been categorized as risk-reducing based on the composition of the hedge funds within the PSERS portfolio.
[4]Using AHIC Q2 2018 30 year capital market assumptions

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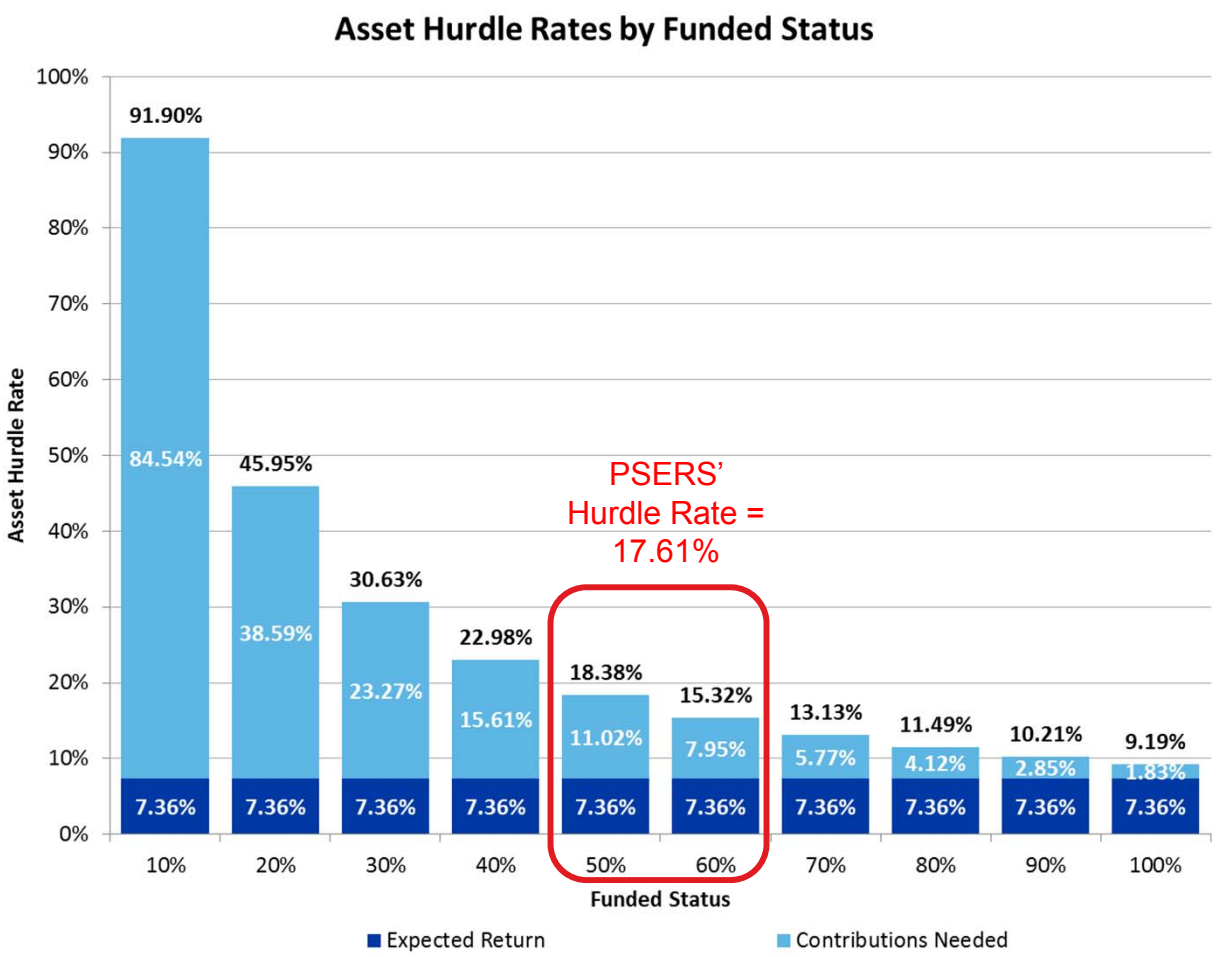
Asset Hurdle Rate

- **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

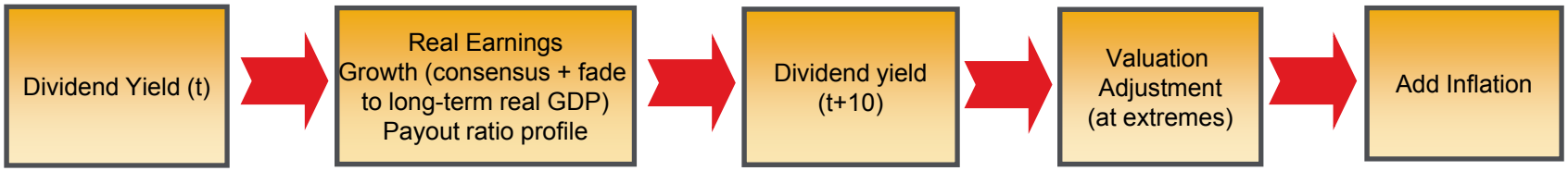


Analysis

- 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 2018 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 Gov Cash	0.3%	2.5%	1.1%	0.0%	0.00
LIBOR (Leverage)	0.8%	3.0%	1.1%	0.5%	0.48
US All Cap	4.2%	6.5%	17.9%	4.0%	0.22
Intl Developed Equity Unhedged	5.2%	7.5%	19.9%	5.0%	0.25
Intl. Developed Equity Hedged	6.5%	8.8%	17.8%	6.3%	0.35
Emerging Mkt. Equity	5.4%	7.7%	27.0%	5.2%	0.19
Private Equity[1]	6.6%	9.0%	26.2%	6.5%	0.25
Core Fixed Income	1.0%	3.2%	4.2%	0.7%	0.17
Long Govt Bonds	1.1%	3.4%	9.0%	0.9%	0.10
High Yield Bonds	1.9%	4.1%	12.0%	1.7%	0.14
Private Credit	6.1%	8.4%	16.4%	5.9%	0.36
Non-US Developed Bonds Hedged	0.5%	2.7%	2.6%	0.2%	0.07
EMD Hard	1.8%	4.0%	13.0%	1.5%	0.12
EMD Local	3.4%	5.7%	14.0%	3.2%	0.23
US TIPS	0.8%	3.0%	4.4%	0.5%	0.12
Global Inflation-Linked[2]	0.6%	2.8%	3.1%	0.4%	0.11
Private Real Estate[3]	4.2%	6.5%	16.9%	4.0%	0.24
REITs	4.4%	6.7%	18.5%	4.2%	0.23
Commodities	3.0%	5.3%	17.1%	2.8%	0.16
Private Infrastructure	4.5%	6.8%	14.5%	4.3%	0.30
Public Infrastructure	4.9%	7.2%	17.0%	4.7%	0.28
Gold	1.1%	3.3%	19.0%	0.8%	0.04
Risk Parity[4]	3.8%	6.1%	10.7%	3.6%	0.34
Hedge Funds[5]	3.2%	5.5%	8.3%	3.0%	0.36

1) 72% Buyout, 13% Venture, 15% Distressed Debt
2) 40% US, 2% Canada, 31% UK, 27% 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

Q2 2018 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 Gov Cash	0.4%	2.6%	1.7%	0.0%	0.00
LIBOR (Leverage)	1.0%	3.2%	1.8%	0.6%	0.31
US All Cap	4.2%	6.5%	18.3%	3.9%	0.21
Intl Developed Equity Unhedged	5.1%	7.4%	20.2%	4.8%	0.24
Intl. Developed Equity Hedged	5.6%	7.9%	18.2%	5.3%	0.29
Emerging Mkt. Equity	5.4%	7.7%	27.7%	5.1%	0.18
Private Equity[1]	6.8%	9.2%	26.6%	6.5%	0.25
Core Fixed Income	1.2%	3.5%	4.9%	0.8%	0.17
Long Govt Bonds	0.9%	3.1%	10.4%	0.5%	0.05
High Yield Bonds	2.8%	5.1%	12.4%	2.4%	0.20
Private Credit	5.5%	7.8%	17.0%	5.1%	0.30
Non-US Developed Bonds Hedged	0.7%	2.9%	3.9%	0.3%	0.07
EMD Hard	2.0%	4.3%	13.8%	1.6%	0.12
EMD Local	3.4%	5.7%	14.5%	3.0%	0.21
US TIPS	1.1%	3.4%	4.5%	0.7%	0.16
Global Inflation-Linked[2]	0.7%	2.9%	3.4%	0.3%	0.09
Private Real Estate[3]	4.3%	6.6%	17.2%	4.0%	0.23
REITs	4.4%	6.7%	19.0%	4.1%	0.21
Commodities	3.5%	5.8%	17.0%	3.2%	0.19
Private Infrastructure	4.6%	6.9%	14.8%	4.3%	0.29
Public Infrastructure	4.9%	7.2%	17.5%	4.6%	0.26
Gold	1.1%	3.4%	19.5%	0.7%	0.04
Risk Parity[4]	3.9%	6.2%	11.0%	3.6%	0.33
Hedge Funds[5]	3.5%	5.8%	8.9%	3.2%	0.36

1) 72% Buyout, 13% Venture, 15% Distressed Debt
2) 40% US, 2% Canada, 31% UK, 27% 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

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 2018**	**Q2 2017**	**Q2 2016**	**Q12015**	**Q1 2014**	***Change***	**Q2 2018**	**Q2 2017**	**Q2 2016**	**Q12015**	**Q1 2014**	***Change***
Liquidity												
Cash	2.5%	2.1%	1.5%	1.8%	2.9%	*-0.4%*	2.6%	2.8%	2.3%	2.4%	4.2%	*-1.5%*
LIBOR	3.0%	2.5%	1.7%	2.0%	3.0%	--	3.2%	3.3%	2.6%	2.7%	4.4%	*-1.2%*
Equity												
Publicly-traded Global Equity[1]	7.7%	7.4%	7.5%	6.9%	7.3%	*0.4%*	7.5%	7.4%	7.5%	7.0%	7.5%	--
Private Markets	9.0%	8.6%	8.8%	8.8%	9.1%	*-0.1%*	9.2%	8.6%	8.8%	8.8%	9.1%	*+0.1%*
Fixed Income												
Investment Grade	3.2%	2.9%	2.4%	2.6%	3.6%	*-0.4%*	3.5%	3.7%	3.3%	3.3%	4.9%	*-1.4%*
Long Treasury Bonds	3.4%	3.1%	2.7%	3.0%	3.6%	*-0.2%*	3.1%	3.4%	3.1%	3.2%	4.4%	*-1.3%*
High Yield Bonds	4.1%	3.9%	6.1%	4.5%	4.5%	*-0.4%*	5.1%	5.4%	6.5%	4.7%	5.4%	*-0.3%*
Non-US Developed Bonds (100% Hedged)	2.7%	2.4%	1.8%	2.1%	3.2%	*-0.5%*	2.9%	3.2%	2.7%	2.9%	4.4%	*-1.5%*
Emerging Market Debt (Hard Currency)	4.0%	4.1%	4.4%	4.8%	5.4%	*-1.4%*	4.3%	5.3%	5.1%	5.4%	6.4%	*-2.1%*
Inflation-Protected[2]	2.8%	2.6%	2.5%	2.7%	3.2%	*-0.4%*	2.9%	3.0%	3.1%	3.2%	4.0%	*-1.1%*
Real Assets												
MLP/Infrastructure[3]	7.4%	7.0%	6.7%	7.4%	7.8%	*-0.4%*	7.5%	7.2%	7.0%	7.4%	7.8%	*-0.3%*
Commodities	5.3%	4.8%	3.8%	4.1%	5.2%	*+0.1%*	5.8%	5.5%	4.7%	4.8%	6.6%	*-0.8%*
Real Estate	6.5%	5.5%	6.2%	6.8%	7.2%	*-0.7%*	6.6%	5.5%	6.2%	6.8%	7.3%	*-0.7%*
Risk Parity [4]	6.1%	5.9%	5.9%	5.8%	6.4%	*-0.3%*	6.2%	6.1%	6.1%	6.0%	6.7%	*-0.5%*
Absolute Return [5]	5.5%	5.0%	5.1%	6.3%	6.9%	*-1.4%*	5.8%	5.6%	5.5%	6.8%	7.8%	*-2.0%*
PSERS Expected Return (Current Long-Term Target)	**7.3%**	**7.0%**	**6.9%**	**6.9%**	**7.5%**	***-0.2%***	**7.4%**	**7.2%**	**7.1%**	**7.1%**	**7.9%**	***-0.5%***

[1] 30-year Global Equity is Hedged to reflect recent PSERS policy changes.
[2] Reflects shift to Global TIPs in 2017 per PSERS policy changes
[3] 33.3% Private Infrastructure, 66.7% Public Infrastructure
[4] 50% Global Equity, 55% TIPS, 75% Intermediate Gov't Bonds, 20% Commodities, -100% LIBOR.
[5] 14% Event Driven, 38% Global Macro, 20% Distressed Debt, 16% Fixed Income Arbitrage, 12% Cat. Bonds.

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Portfolio Analysis
Portfolios Evaluated

	1 Year Target Portfolios		Long-Term Portfolios Tested in Asset-Liability Modeling					
	A	B	C	D	E	F	G	H
	Current 1 Year Target	Proposed 1 Year Target	Current Long-Term Target	Aon Clean Slate[1]	Simple 60/40	Simple Same Return as Proposed 1 Year	Simple Same Risk as Proposed 1 Year	ETFs of Proposed 1 Year[2]
US Equity	7.4%	4.8%	7.8%	13.0%	31.8%	47.2%	29.3%	22.1%
Non-US Dev, Unhedged	2.2%	1.8%	2.4%	0.0%	21.0%	31.2%	19.3%	3.5%
Non-US Dev, USD Hedged	6.5%	5.4%	7.1%	9.8%	0.0%	0.0%	0.0%	5.4%
Emerging Markets	3.0%	3.0%	2.8%	3.3%	7.2%	10.7%	6.6%	3.6%
Private Equity, Unhedged[3]	15.0%	15.0%	15.0%	13.0%	0.0%	0.0%	0.0%	0.0%
Infrastructure: Private, USD Hedged	1.0%	1.0%	4.0%	5.0%	0.0%	0.0%	0.0%	2.0%
Infrastructure: Public, USD Hedged	1.0%	1.0%	4.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Infrastructure: Energy MLPS	4.0%	4.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.0%
Global REITs, USD Hedged	1.0%	1.0%	2.0%	0.0%	0.0%	0.0%	0.0%	3.7%
Private Real Estate, Unhedged	10.0%	9.0%	8.0%	10.0%	0.0%	0.0%	0.0%	0.0%
Credit-Related[4]	11.0%	11.0%	10.0%	12.6%	0.0%	0.0%	0.0%	14.0%
Commodities: Diversified	5.0%	5.0%	5.0%	0.0%	0.0%	0.0%	0.0%	6.6%
Commodities: Gold	3.0%	3.0%	3.0%	0.0%	0.0%	0.0%	0.0%	3.0%
Risk Parity[5]	10.0%	8.0%	10.0%	10.0%	0.0%	0.0%	0.0%	0.0%
Total Return-Seeking	**80.0%**	**73.0%**	**81.0%**	**76.7%**	**60.0%**	**89.1%**	**55.2%**	**67.9%**
Global TIPS, hedged to USD	15.0%	15.0%	15.0%	10.0%	0.0%	0.0%	0.0%	0.0%
US TIPS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	19.4%
Hedge Funds[6]	10.0%	10.0%	10.0%	15.0%	0.0%	0.0%	0.0%	0.0%
Cash	3.0%	6.0%	3.0%	0.0%	0.0%	0.0%	5.0%	5.5%
US Core Fixed Income	5.0%	4.0%	5.0%	13.3%	40.0%	59.4%	39.8%	4.8%
US Long-Term Treasury	3.0%	6.0%	5.0%	5.0%	0.0%	0.0%	0.0%	6.0%
Non-US Dev, USD Hedged	1.0%	0.0%	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total Risk-Reducing/Safety	**37.0%**	**41.0%**	**39.0%**	**43.3%**	**40.0%**	**59.4%**	**44.8%**	**35.7%**
LIBOR (Leverage)	**-17.0%**	**-14.0%**	**-20.0%**	**-20.0%**	**0.0%**	**-48.5%**	**0.0%**	**-3.6%**
Total Plan	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
30-Year Exp. Nom. Return	**7.42%**	**7.18%**	**7.36%**	**7.38%**	**6.14%**	**7.18%**	**5.93%**	**5.97%**
30-Year Exp. Real Return	**5.00%**	**4.77%**	**4.95%**	**4.97%**	**3.75%**	**4.77%**	**3.55%**	**3.59%**
30-Year Expected Risk	**11.45%**	**10.50%**	**11.54%**	**11.59%**	**11.35%**	**16.74%**	**10.49%**	**9.35%**
Sharpe Ratio	**0.421**	**0.436**	**0.413**	**0.412**	**0.312**	**0.274**	**0.317**	**0.360**

[1] See slide 54 for how the Clean Slate portfolio was developed

[2] See slide 55 for how the ETF portfolio was developed

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

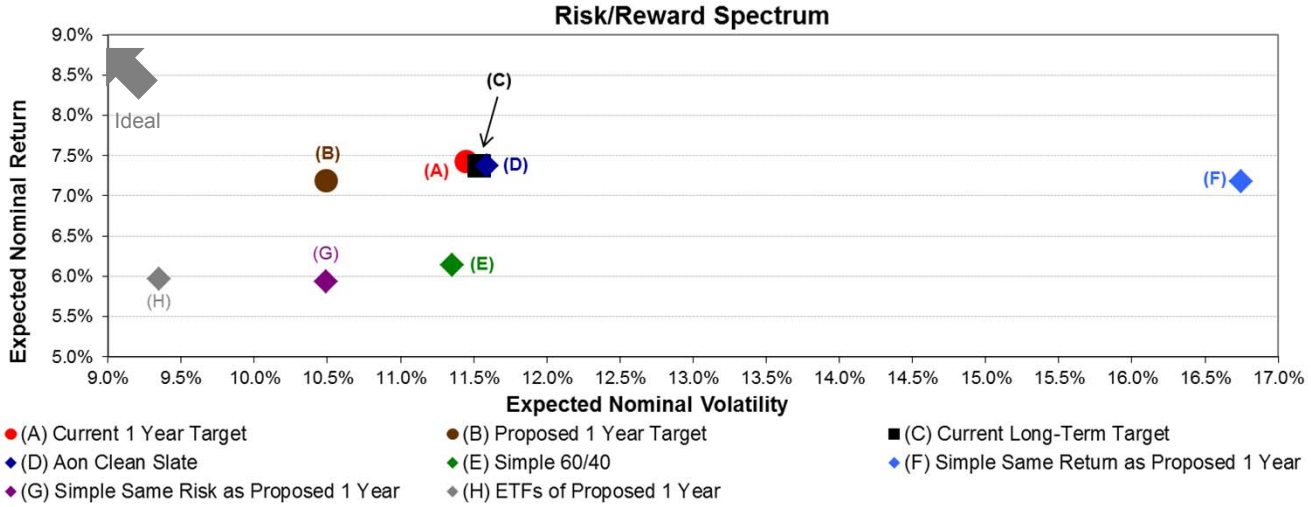
[4] Credit-Related includes allocation to High Yield, Private Credit and EMD. The portfolio allocations are: Current 1 Year Portfolios (10% Private Credit, 1% Local EMD); Current Long-Term (1.6% HY, 6.4% Private Credit,1% Local EMD, 1% Hard EMD); Aon Clean Slate (7% HY, 2.8% Local EMD, 2.8% Hard EMD); ETFs of Proposed 1 Year (13% HY, 1% Local EMD)

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

[6] Hedge Fund assumptions developed as follows: 14% Event Driven, 0% CTA, 38% Global Macro, 20% Distressed Debt, 16% Fixed Income Arbitrage, 12% Insurance Linked; 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-struc-ture	Real Estate	Credit-Related[1]	Comm-odities	Risk Parity	Global TIPS	Hedge Funds[2]	Cash	Core Bonds	Long Dur. Gov't Bonds	Dev. Int'l Debt	Leverage
1 Year Targets	(A) Current 1 Year Target	7.42%	11.45%	0.421	22%	15%	2%	12%	11%	9%	10%	15%	10%	3%	5%	3%	1%	-17%
	(B) Proposed 1 Year Target	7.18%	10.50%	0.436	18%	15%	2%	11%	11%	9%	8%	15%	10%	6%	4%	6%	0%	-14%
Long-Term Targets	(C) Current Long-Term Target	7.36%	11.54%	0.413	20%	15%	8%	10%	10%	8%	10%	15%	10%	3%	5%	5%	1%	-20%
	(D) Aon Clean Slate	7.38%	11.59%	0.412	26%	13%	5%	10%	13%	0%	10%	10%	15%	0%	13%	5%	0%	-20%
	(E) Simple 60/40	6.14%	11.35%	0.312	60%	0%	0%	0%	0%	0%	0%	0%	0%	0%	40%	0%	0%	0%
	(F) Simple Same Return as Proposed 1 Year	7.18%	16.74%	0.274	89%	0%	0%	0%	0%	0%	0%	0%	0%	0%	59%	0%	0%	-49%
	(G) Simple Same Risk as Proposed 1 Year	5.93%	10.49%	0.317	55%	0%	0%	0%	0%	0%	0%	0%	0%	5%	40%	0%	0%	0%
	(H) ETFs of Proposed 1 Year	5.97%	9.35%	0.360	37%	0%	2%	4%	14%	10%	0%	19%	0%	6%	5%	6%	0%	-4%

[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.

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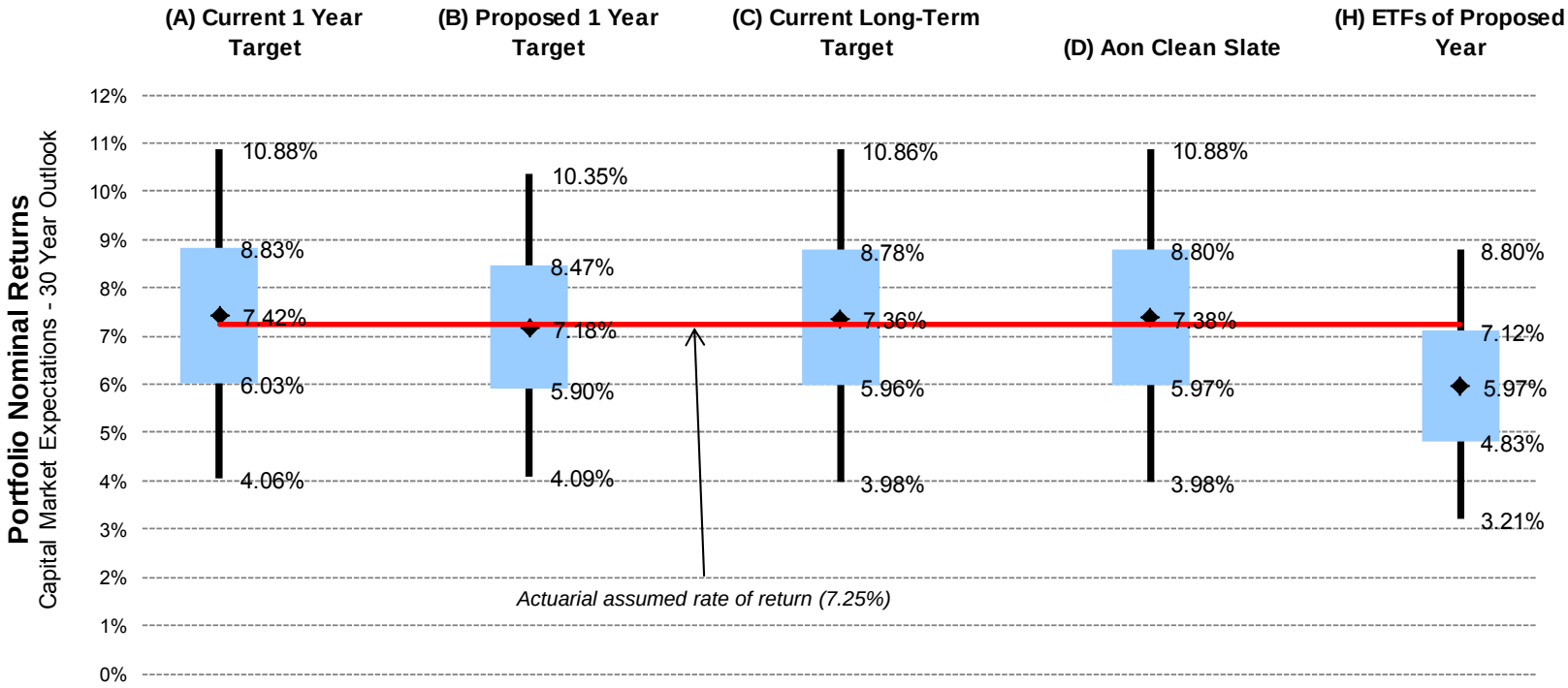
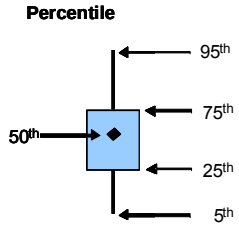
Portfolio Analysis
Range of Nominal Returns



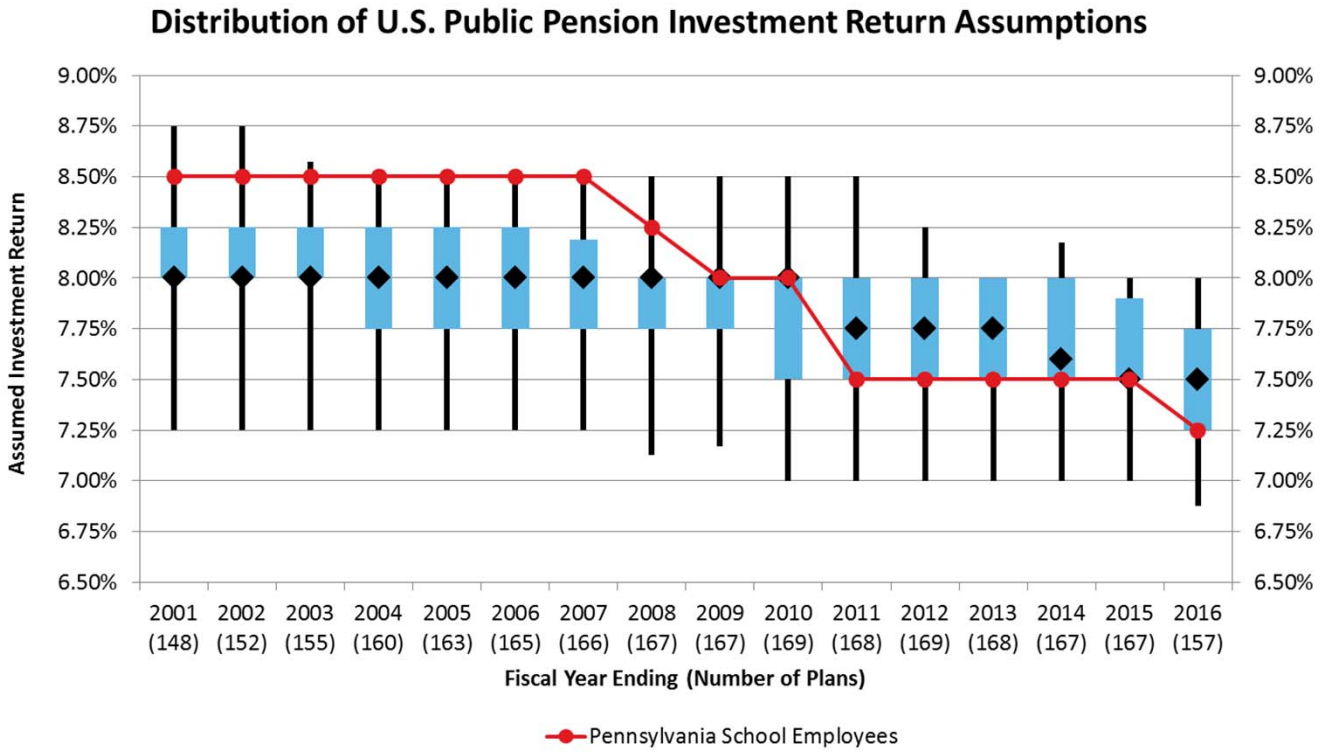


Key Takeaway:

- The Current Long-Term Target (7.36%) is projected to be higher than the actuarial assumed rate of return (7.25%) in the 50th percent outcome

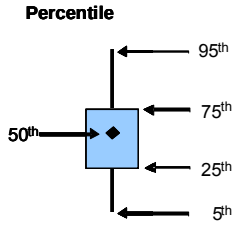
Portfolio Analysis

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 7.50% based on the latest survey data
- PSERS' assumption for FYE 2016 (7.25%) fell below the median relative to its peers
- If PSERS fails to achieve (or exceeds) the actuarial return assumption, higher (or lower) funding will be needed in future years



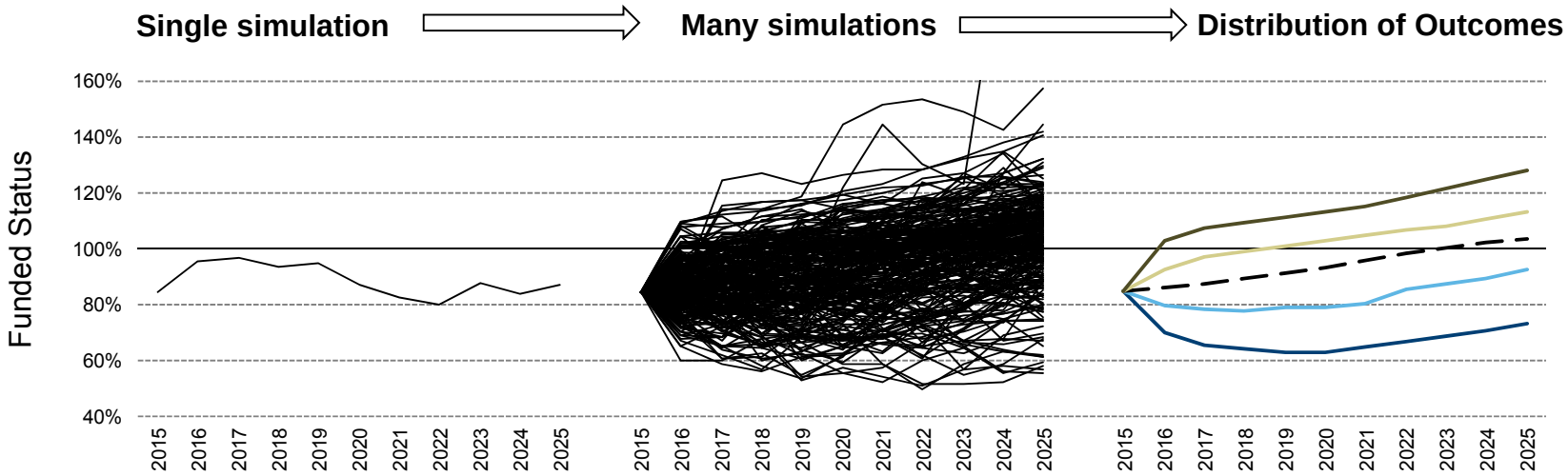
Sources: Public Plans Data (publicplansdata.org) as of March 2018; Expected Returns are the assumptions made by the plans included in the data set.
[1] Peers defined as public funds published within publicplansdata.org as of March 2018; Number of plans per year are shown in parentheses

Analysis

- Asset-Liability Projection Results (Stochastic Results)

Asset-Liability Simulation Overview

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



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

Asset-Liability Simulation vs. Blue Ribbon Panel Stress Testing

- The Blue Ribbon Panel, commissioned by the Society of Actuaries, recommended deterministic stress testing the projected plan performance in a report in 2014
  - Slides 89-93 of the appendix address the specific stress testing scenarios advised by the Blue Ribbon Panel
  - **This section will focus on Aon's stochastic analysis which we believe is a more robust stress testing model**

- Deterministic projections are beneficial in the absence of other stress testing because it aids a plan sponsor to understand the risks inherent in the pension plan should actual experience differ from expectations

- The Blue Ribbon Panel's deterministic scenarios are limited in that they imply a smooth pattern of results over time rather than a choppier progression of highs and lows (i.e., +/-3% of the expected return on assets for 20 years)
  - For this reason, Aon prefers the robustness of our stochastic projection analysis as it looks at 5,000 individual scenarios over a period of 30 years with each individual scenario exhibiting a non-uniform pattern of results

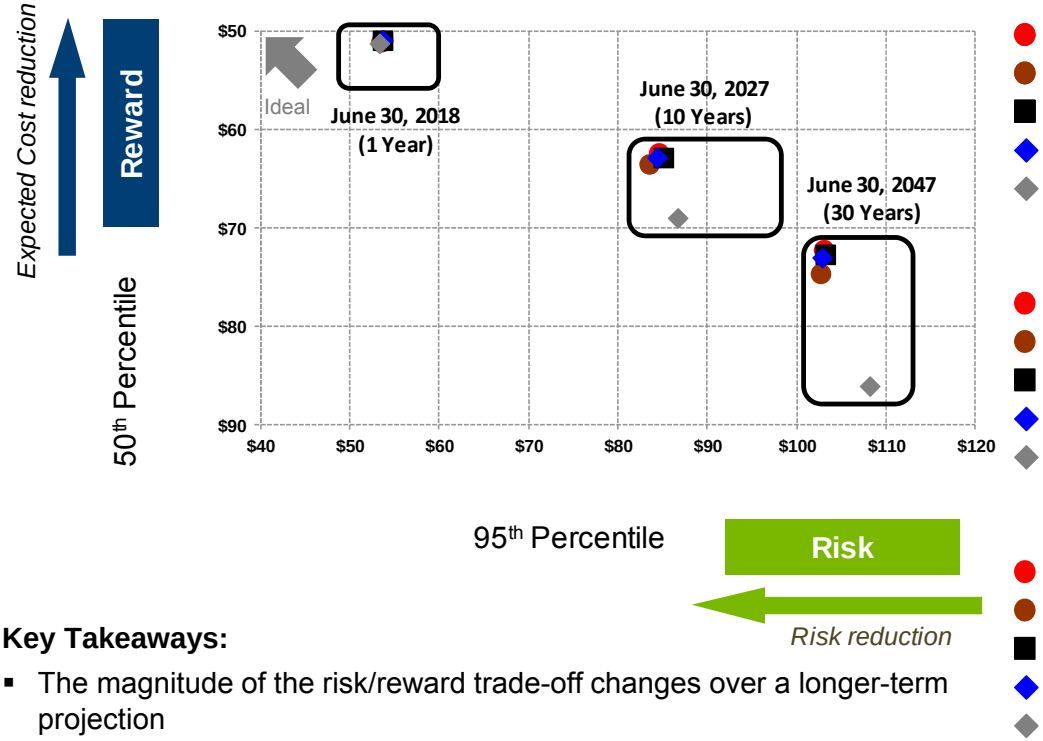
- The overall takeaways from the Blue Ribbon Panel stress testing analysis coincide with Aon's stochastic projection analysis
  - Contributions are expected to increase over the next 15-20 years, decreasing (or increasing) from baseline expectations depending on actual versus expected asset performance
  - Results for the Employer contributions in the Blue Ribbon Panel's Low Return scenario are comparable to the 75th percentile outcome under our stochastic analysis
    - Approximately 25% of Aon's scenarios in its stochastic analysis are worse than the Blue Ribbon Panel's Low Return scenario, making for an even more conservative stress testing approach

Asset-Liability Projection Results (Stochastic Results)

Economic Cost Analysis—1-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, 2018 Cost	Risk
(A) Current 1 Year Target	$51.1	$53.7
(B) Proposed 1 Year Target	$51.1	$53.5
(C) Current Long-Term Target	$51.1	$53.7
(D) Aon Clean Slate	$51.1	$53.8
(H) ETFs of Proposed 1 Year	$51.3	$53.4

Strategy ($Billions)	June 30, 2027 Cost	Risk
(A) Current 1 Year Target	$62.5	$84.6
(B) Proposed 1 Year Target	$63.6	$83.5
(C) Current Long-Term Target	$62.9	$85.1
(D) Aon Clean Slate	$62.9	$84.3
(H) ETFs of Proposed 1 Year	$69.1	$86.8

Strategy ($Billions)	June 30, 2047 Cost	Risk
(A) Current 1 Year Target	$72.3	$103.0
(B) Proposed 1 Year Target	$74.7	$102.7
(C) Current Long-Term Target	$72.7	$103.3
(D) Aon Clean Slate	$73.0	$102.8
(H) ETFs of Proposed 1 Year	$86.1	$108.1

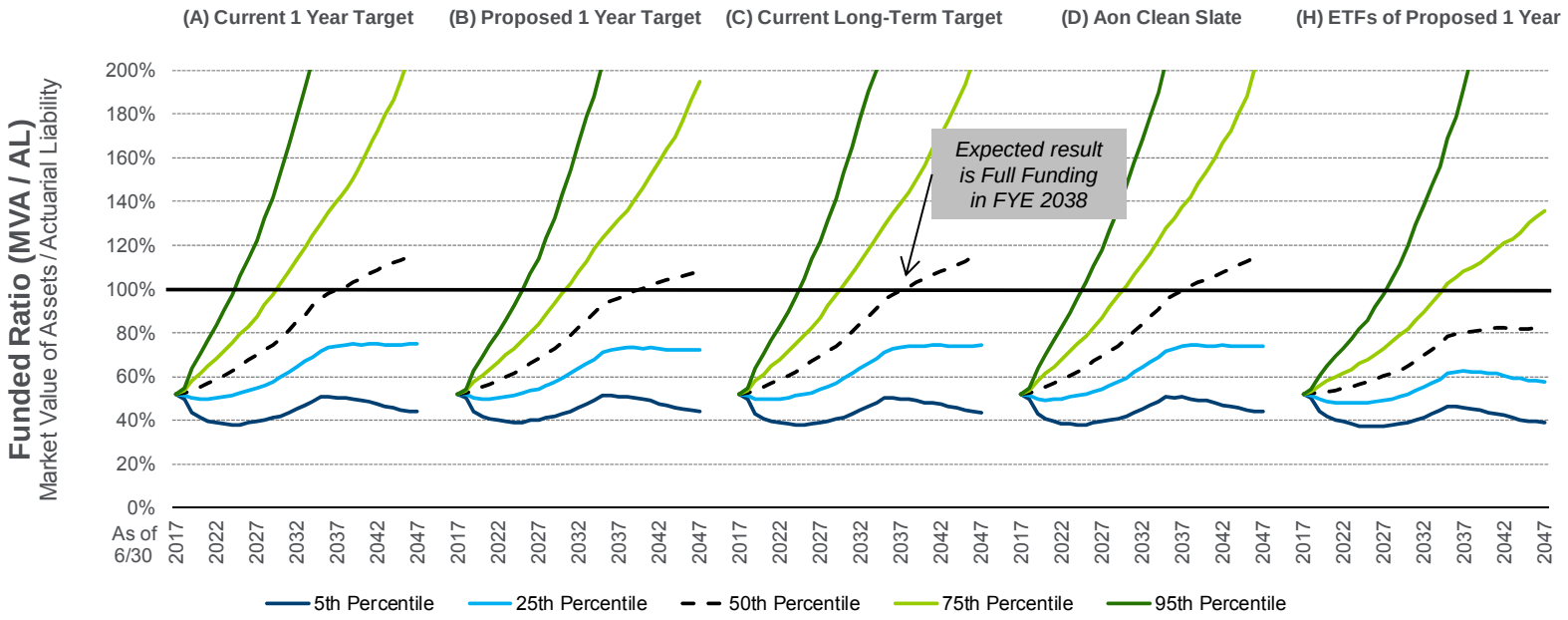
Key Takeaways:

- 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 $72.7B and the potential risk is $103.3B

* 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

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			(C) Current Long-Term Target			(D) Aon Clean Slate			(H) ETFs of Proposed 1 Year		
Year	2027	2037	2047	2027	2037	2047	2027	2037	2047	2027	2037	2047	2027	2037	2047
5th Percentile	39%	50%	44%	40%	51%	44%	39%	50%	44%	39%	51%	44%	38%	46%	39%
25th Percentile	55%	74%	75%	54%	73%	72%	54%	73%	74%	54%	74%	74%	49%	62%	57%
50th Percentile	70%	100%	117%	68%	96%	108%	69%	99%	116%	69%	99%	116%	60%	80%	82%
75th Percentile	87%	140%	214%	84%	132%	195%	87%	139%	214%	87%	137%	207%	73%	108%	136%
95th Percentile	122%	261%	649%	114%	238%	587%	122%	255%	625%	118%	239%	563%	97%	192%	435%
Probability > 100%	18%	50%	60%	14%	47%	56%	17%	49%	60%	17%	49%	60%	5%	32%	42%

Key Takeaways:

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

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

Asset-Liability Projection Results (Stochastic Results)

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

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

Probability of Surpassing Various Funded Ratio Thresholds					
Funded Ratio	**(A) Current 1 Year Target**	**(B) Proposed 1 Year Target**	**(C) Current Long-Term Target**	**(D) Aon Clean Slate**	**(H) ETFs of Proposed 1 Year**
90%	**2.0%**	1.0%	1.9%	1.6%	**0.2%**
80%	**7.3%**	5.0%	7.2%	6.6%	**1.4%**
70%	**21.2%**	17.0%	20.9%	20.1%	**7.7%**
60%	**46.6%**	44.1%	45.9%	46.1%	**30.3%**
50%	75.7%	**75.8%**	74.7%	74.9%	**67.3%**
40%	94.0%	**95.1%**	**93.6%**	**93.6%**	94.0%
30%	99.6%	**99.8%**	**99.4%**	**99.4%**	99.8%
20%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

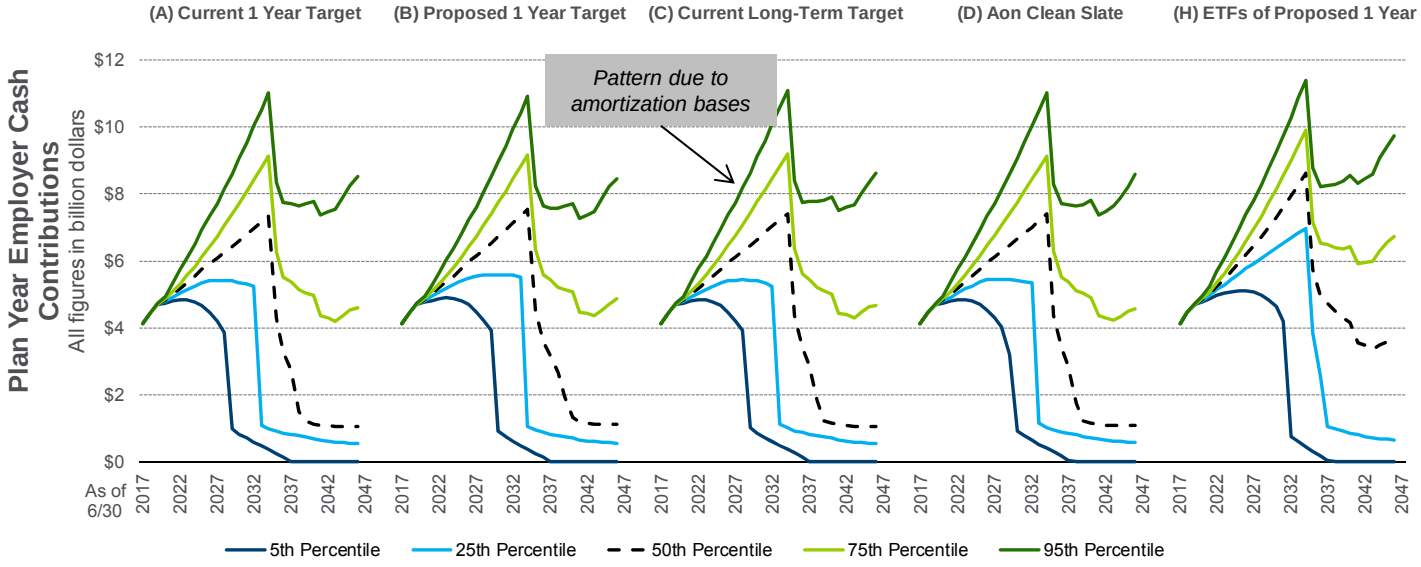
Key Takeaway:

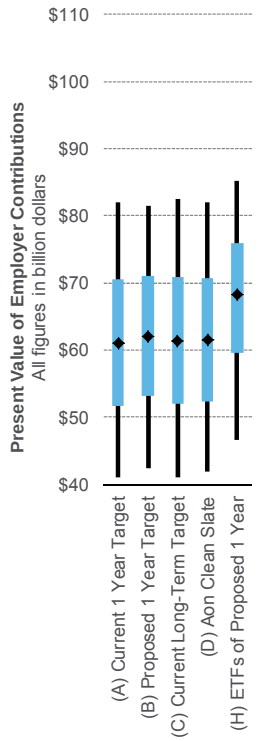
- The Current 1 Year Target portfolio is expected to yield higher funded ratios in optimistic projections while the Proposed 1 Year Target portfolio is expected to yield higher funded ratios in pessimistic projections over five years compared to the Current Long-Term Target portfolio.

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

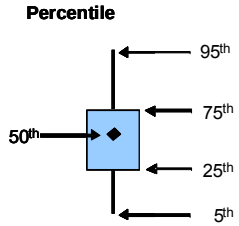
Asset-Liability Projection Results (Stochastic Results)

Employer Contribution Amount





Strategy	(A) Current 1 Year Target			(B) Proposed 1 Year Target			(C) Current Long-Term Target			(D) Aon Clean Slate			(H) ETFs of Proposed 1 Year		
Year	2026	2036	2046	2026	2036	2046	2026	2036	2046	2026	2036	2046	2026	2036	2046
5th Percentile	$4.48	$0.13	$0.00	$4.69	$0.13	$0.00	$4.47	$0.13	$0.00	$4.54	$0.17	$0.00	$5.12	$0.17	$0.00
25th Percentile	$5.39	$0.87	$0.54	$5.49	$0.89	$0.55	$5.40	$0.88	$0.55	$5.43	$0.90	$0.57	$5.79	$2.56	$0.65
50th Percentile	$5.93	$3.30	$1.06	$5.97	$3.58	$1.11	$5.94	$3.42	$1.07	$5.94	$3.41	$1.08	$6.20	$4.94	$3.68
75th Percentile	$6.44	$5.52	$4.60	$6.42	$5.58	$4.86	$6.45	$5.61	$4.67	$6.45	$5.53	$4.58	$6.60	$6.52	$6.74
95th Percentile	$7.33	$7.73	$8.53	$7.23	$7.63	$8.44	$7.36	$7.75	$8.61	$7.32	$7.69	$8.57	$7.39	$8.21	$9.73
Probability > $7B	12%	12%	13%	11%	11%	13%	13%	12%	13%	12%	11%	13%	15%	19%	23%



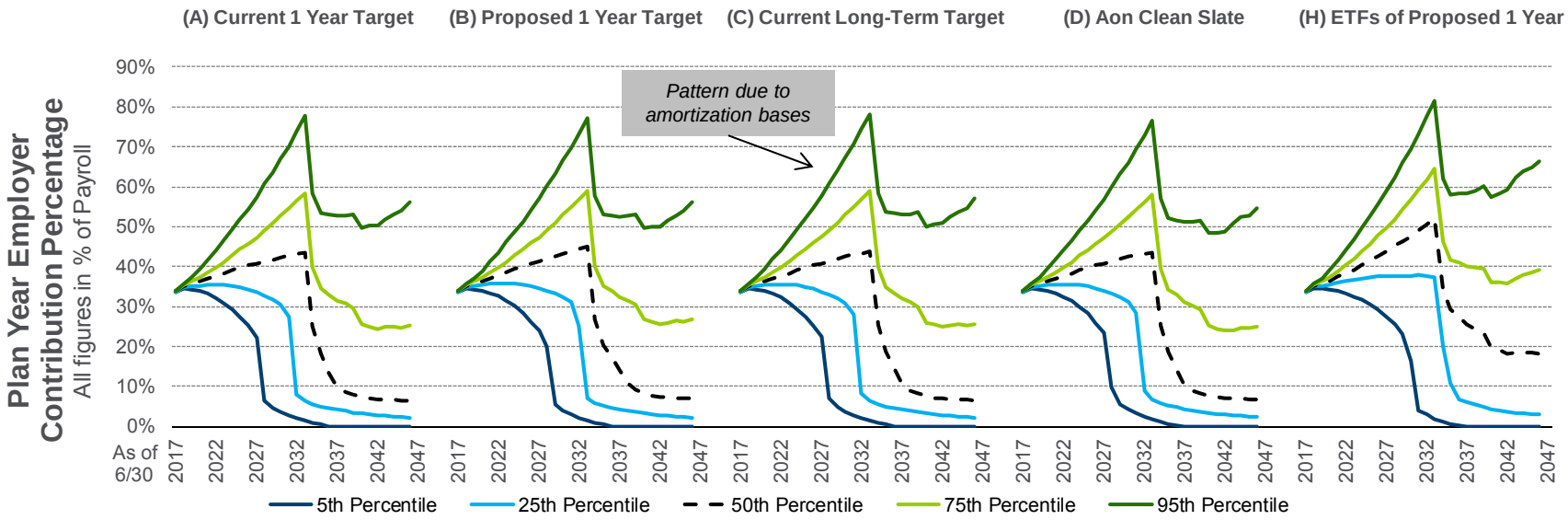
Key Takeaway:

- 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			(C) Current Long-Term Target			(D) Aon Clean Slate			(H) ETFs of Proposed 1 Year		
Year	2026	2036	2046	2026	2036	2046	2026	2036	2046	2026	2036	2046	2026	2036	2046
5th Percentile	25%	0%	0%	26%	0%	0%	25%	0%	0%	26%	0%	0%	29%	0%	0%
25th Percentile	34%	4%	2%	35%	5%	2%	34%	5%	2%	35%	5%	2%	37%	7%	3%
50th Percentile	40%	14%	6%	41%	17%	7%	40%	15%	7%	40%	14%	7%	43%	27%	18%
75th Percentile	46%	33%	25%	46%	34%	27%	46%	33%	25%	46%	33%	25%	48%	41%	39%
95th Percentile	54%	53%	56%	54%	53%	56%	55%	53%	57%	54%	51%	55%	56%	58%	66%
Probability > 50%	15%	8%	9%	15%	8%	9%	16%	8%	9%	15%	6%	8%	19%	15%	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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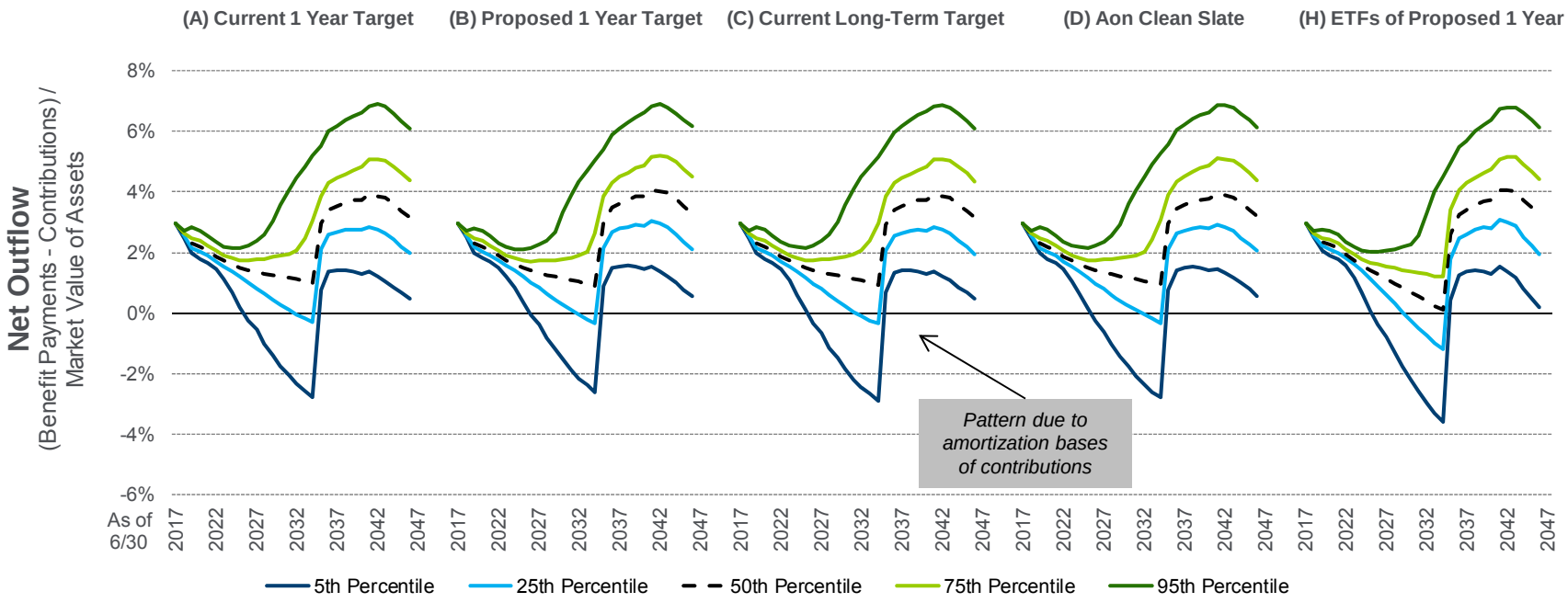
Asset-Liability Projection Results (Stochastic Results)

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



Strategy	(A) Current 1 Year Target			(B) Proposed 1 Year Target			(C) Current Long-Term Target			(D) Aon Clean Slate			(H) ETFs of Proposed 1 Year		
Year	2026	2036	2046	2026	2036	2046	2026	2036	2046	2026	2036	2046	2026	2036	2046
5th Percentile	0%	1%	0%	0%	1%	1%	0%	1%	0%	0%	1%	1%	0%	1%	0%
25th Percentile	1%	3%	2%	1%	3%	2%	1%	3%	2%	1%	3%	2%	1%	2%	2%
50th Percentile	1%	3%	3%	1%	3%	3%	1%	3%	3%	1%	3%	3%	1%	3%	3%
75th Percentile	2%	4%	4%	2%	4%	4%	2%	4%	4%	2%	4%	4%	2%	4%	4%
95th Percentile	2%	6%	6%	2%	6%	6%	2%	6%	6%	2%	6%	6%	2%	5%	6%
Probability > 5%	<1%	17%	18%	<1%	16%	19%	<1%	17%	18%	<1%	17%	18%	<1%	12%	18%

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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Analysis

- Liquidity Analysis

Overview

- PSERS' liquidity analysis is performed under its **Current Long-Term Target** portfolio
  - Intended as a stress-testing model, incorporating the profile of the liabilities as well as expected future contributions
  - Uses different scenarios for economic environments and other relevant events
  - Shows how the portfolio's liquidity profile could evolve with a given investment strategy

- We categorized investments by liquidity into five buckets
  - ***Liquid (Risk-Reducing Assets):*** less than 3 months needed for return of capital (e.g. publicly traded securities)
  - ***Liquid (Return-Seeking Assets):*** less than 3 months needed for return of capital (e.g. publicly traded securities)
  - ***Quasi-Liquid:*** Typical lock-up of 3–12 months. Conservatively, we assumed a 1-year lock-up in most economic environments, 2 years in a Recession scenario, and 3 years in a Black Skies scenario (e.g. many hedge funds, core real estate)
  - ***Illiquid: Potential lock-up of 5–10 years***, depending on economic environment (e.g. closed-ended real estate)
  - ***Illiquid: Potential lock-up of 10+ years*** (e.g. typical private equity)

- This is intended to be a conservative approximation of the actual liquidity properties of the assets

- Not surprisingly, varying economic scenarios would lead PSERS' percentage allocation to alternative assets to differ from its targets due to liquidity differences in asset classes

Background

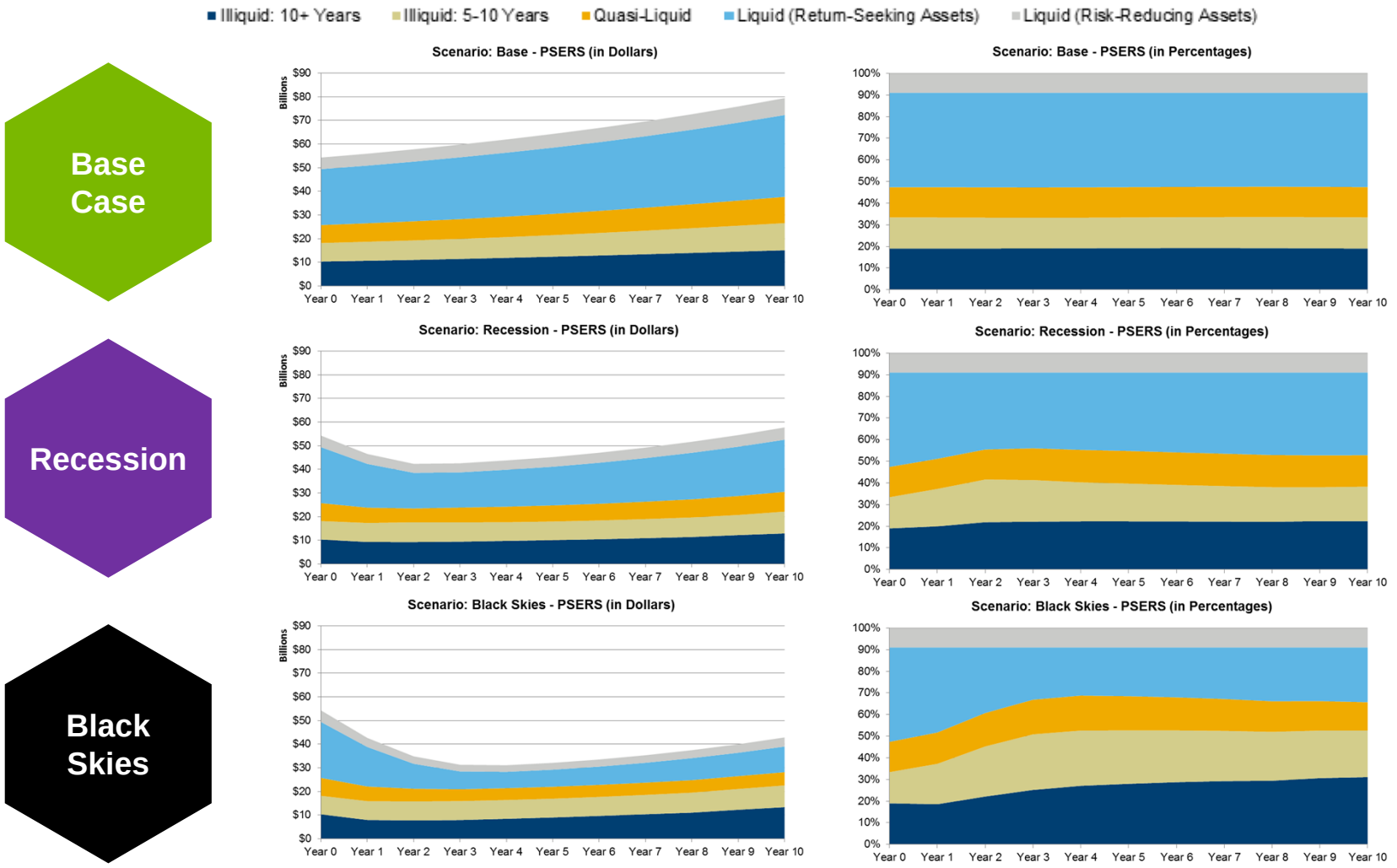
Asset Allocation and Liquidity Category (Current Long-Term Target)

	Asset Class	Target Asset Allocation				
		Liquid	*Quasi-Liquid*	*Illiquid 5-10 Years*	*Illiquid 10+ Years*	*Total*
Return-Seeking	Public Equities	20.0%				20.0%
	Private Equity				15.0%	15.0%
	Infrastructure (Public / Private)		4.0%		4.0%	8.0%
	REITs	2.0%				2.0%
	Private Real Estate			8.0%		8.0%
	Credit-Related[1]	3.6%		6.4%		10.0%
	Commodities	5.0%				5.0%
	Gold	3.0%				3.0%
	Risk Parity	10.0%				10.0%
	Subtotal	43.6%	4.0%	14.4%	19.0%	81.0%
Risk-Reducing / Safety	Global Inflation Linked	15.0%				15.0%
	Hedge Funds[2]		10.0%			10.0%
	Cash	3.0%				3.0%
	U.S. Core Fixed Income	5.0%				5.0%
	U.S. Long-Term Treasury	5.0%				5.0%
	Non-US Dev. Fixed Income	1.0%				1.0%
	LIBOR - Financing	-20.0%				-20.0%
	Subtotal	9.0%	10.0%	0.0%	0.0%	19.0%
	Total	**52.6%**	**14.0%**	**14.4%**	**19.0%**	**100.0%**

[1] Credit-Related includes Private Credit, High-Yield Bonds, and Emerging Market Debt. Private Credit is classified as Illiquid 5-10 Years while High Yield Bonds and Emerging Market Debt are classified as Liquid

[2] Hedge funds have elements of both return-seeking and risk-reducing assets. Aon categorizes hedge funds as diversifiers within a return-seeking portfolio.

Liquidity Analysis
Current Long-Term Target Portfolio



Note: Year 0 represents a starting point of March 31, 2018

Conclusions

- **Base Scenario**
  - The total illiquid and quasi-liquid assets can be maintained near the target with no cash flow problems

- **Recession Scenario**
  - We do not foresee potential cash flow issues occurring in the Recession scenario, but the allocation could drift enough from the targets that PSERS may want to rebalance

- **Black Skies Scenario**
  - The asset allocation could drift far from the target allocation
    - Given the extension of the time horizon for the realization of the illiquid assets, there will not be enough liquidity even with the redemption of quasi-liquid assets to re-balance back to target
    - PSERS may want to pare back future commitments to stay closer to the target allocations
    - Under this scenario, PSERS may be scaling back its alternative asset allocations at a time when the opportunity is greatest

- This analysis is highly sensitive to the assumed contributions
  - If PSERS receives less contributions than assumed, especially in a Black Skies environment, then the potential liquidity issue could be worse than projected here

Analysis

- Summary and Conclusions

Summary and Conclusions
Portfolio Analysis

- **Proposed 1 Year Target**
  - Reduces the volatility versus the Current 1 Year Target by 95 bps
  - Better risk adjusted returns based on the Sharpe Ratio
  - Higher funded status projected versus the Current 1 Year Target in downside events over the next five years
  - Lower leverage and lower equity allocations provides a better risk adjusted return with meaningfully lower risk than the Current 1 Year Target

- **Current Long-Term Target:** Unchanged from the current long-term target for PSERS
  - Expected return exceeds the current 7.25% EROA
  - Provides significantly lower expected Economic Cost than the fully liquid, lower cost ETF portfolio over the 30 year evaluation period ($72.7 billion versus $86.1 billion) with lower worst case risk ($103.3 billion versus $108.1 billion)
  - Has a 60% probability of reaching full funding over the 30 year measurement period
  - Total nominal employer contributions for the Current Long-Term Target portfolio are expected to be $129.5 billion over 30 years

- **ETFs of Proposed 1 Year Portfolio:** A lower cost portfolio representing a 0% allocation to illiquid assets
  - Expected return is lower than the Current Long-Term Target (5.97% versus 7.36%)
  - Has only a 42% probability of reaching full funding at the end of the 30 year measurement period
  - The present value of total contributions over 30 years are $6.6 billion higher than the Current Long-Term Target over the 30 year measurement period
  - Total nominal employer contributions for the fully liquid ETF portfolio are expected to total $158.8 billion over 30 years

Summary and Conclusions
Portfolio Analysis (continued)

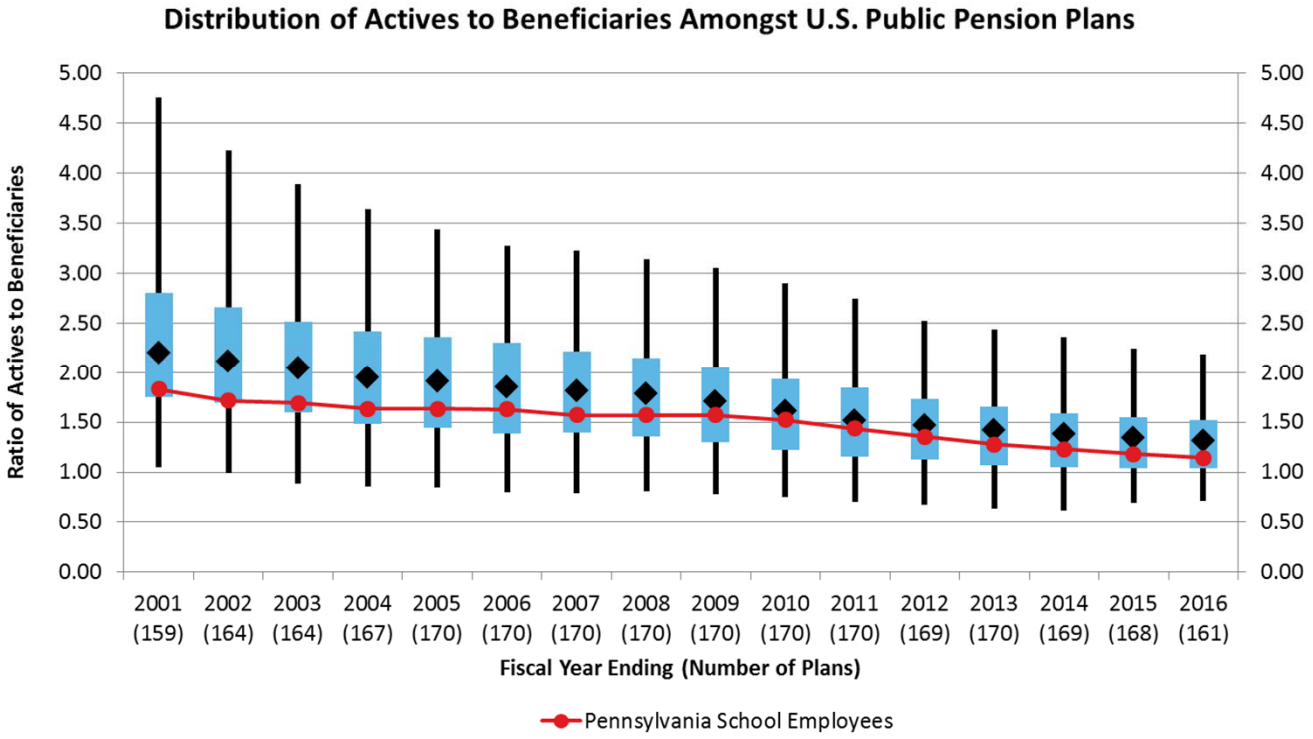
- **Liquidity Analysis**
  - The total illiquid and quasi-liquid assets can be maintained near the target with no cash flow problems in the Base scenario
  - We do not foresee potential cash flow issues occurring in the Recession scenario but the allocation could drift enough from the targets that PSERS may want to rebalance
  - Under a Black Skies scenario, the asset allocation could drift far from the target allocation
  - Given the extension of the time horizon for the realization of the illiquid assets, there will not be enough liquidity even with the redemption of quasi-liquid assets to re-balance back to target
  - In the Black Skies scenario, PSERS may be scaling back its alternative asset allocations at a time when the opportunity is greatest
  - This analysis is highly sensitive to the assumed contributions. If PSERS receives less contributions than the full actuarially assumed amount, especially in a Black Skies environment, then the potential liquidity risk would be higher.

Appendix

- Peer Comparisons

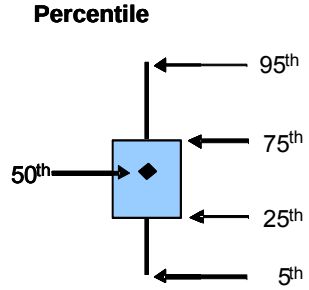
PSERS

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 2016.
- Over that same time frame, PSERS' active to beneficiary ratio has declined from 1.8 to 1.1

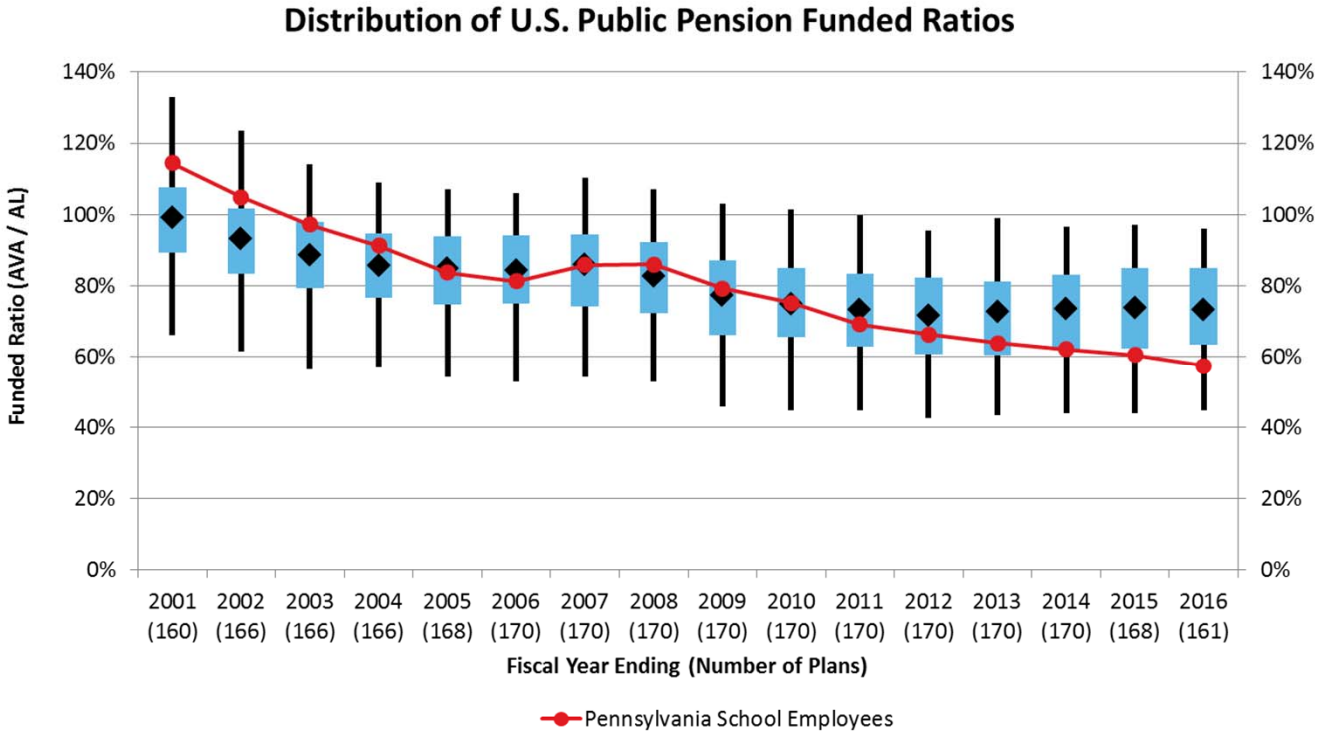


Source: Public Plans Data (publicplansdata.org) as of March 2018;

[1] Peers defined as public funds published within publicplansdata.org as of March 2018; Number of plans per year are shown in parentheses

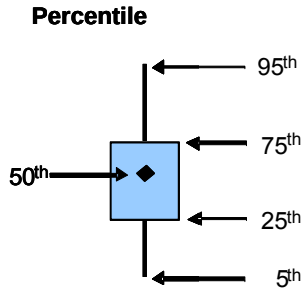
PSERS

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



Key Takeaways:

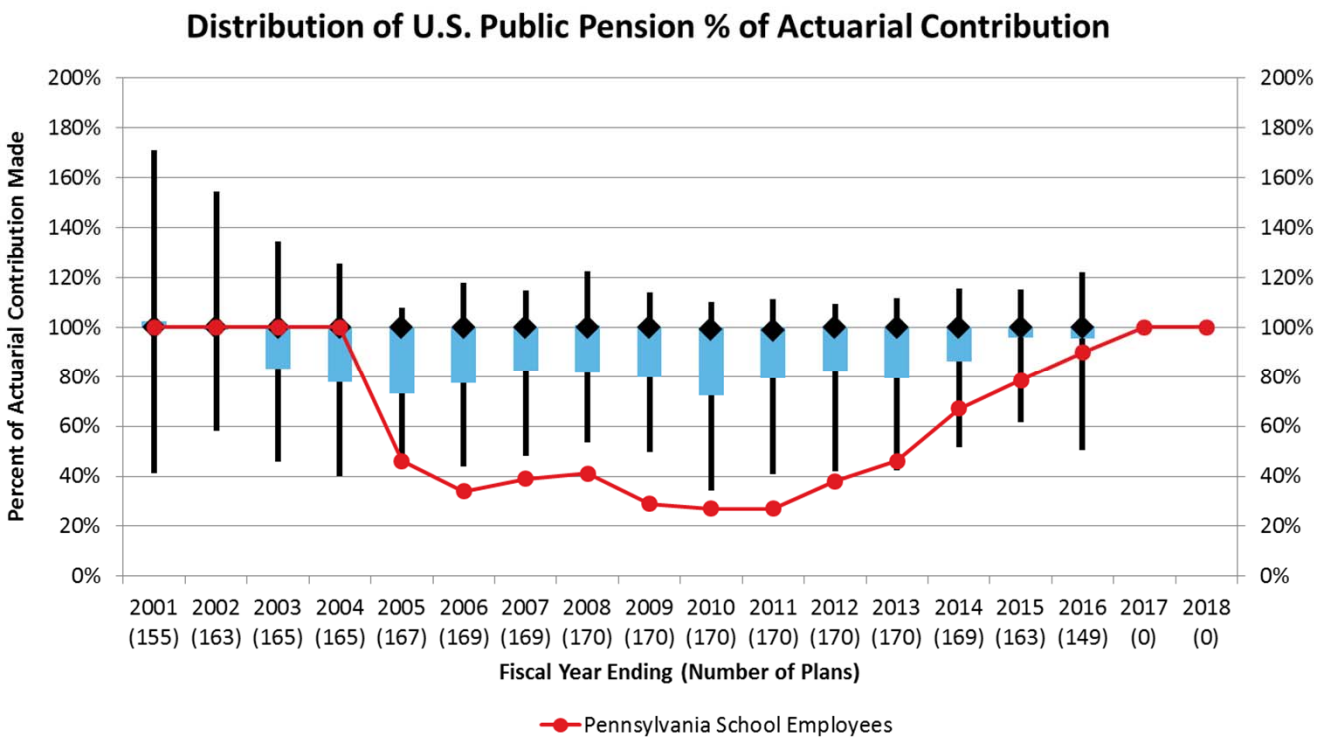
- The median funded ratio as of FYE 2016 was 73% based on the latest survey data
- PSERS' FYE 2016 funded ratio (57%) fell below the 25th percentile relative to its peers



Source: Public Plans Data (publicplansdata.org) as of March 2018;
[1] Peers defined as public funds published within publicplansdata.org as of March 2018; Number of plans per year are shown in parentheses

PSERS

Percentage of Actuarial Contribution Made versus Peers[1]



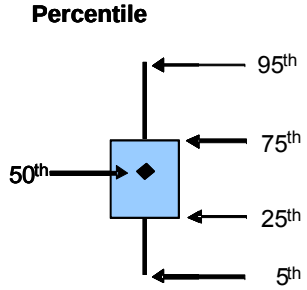
PSERS Annual Underfunding (in $ billions)

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

Accumulated Value of Underfunding as of June 30, 2017 (in $ billions)[2] = **$20.3 billion**

Key Takeaway:

- Contributions for PSERS, as a percentage of the actuarially-determined amount, have been below 100% for a long period, have been trending upward since FYE 2011, and reached 100% in the past two fiscal years



Sources: Public Plans Data (publicplansdata.org) as of March 2018; Actuarial valuation report as of June 30, 2017

[1] Peers defined as public funds published within publicplansdata.org as of March 2018; 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, 2017

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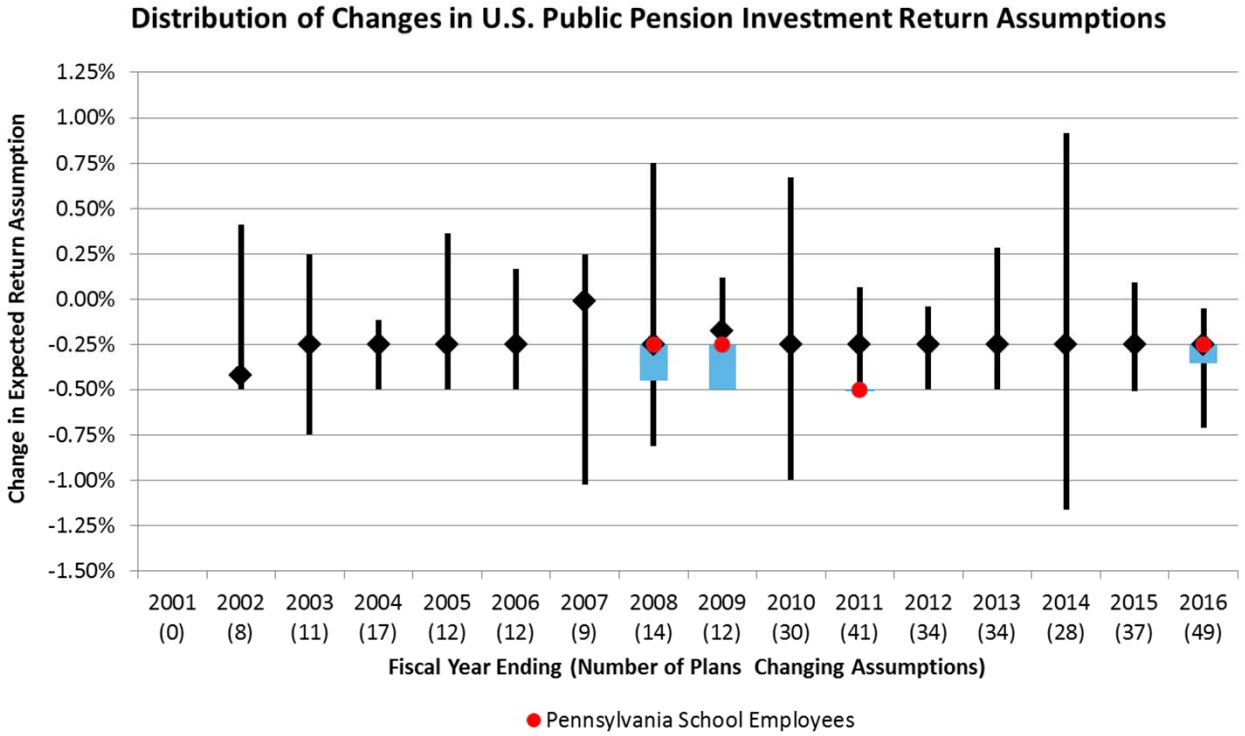
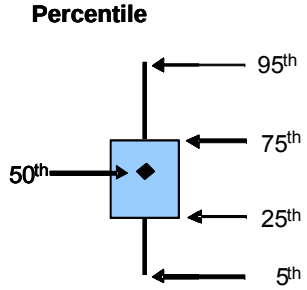
PSERS

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



Key Takeaway:

- The median change in the investment return assumption, for those plans that made a change, has consistently been a reduction in the 25bps range in recent years



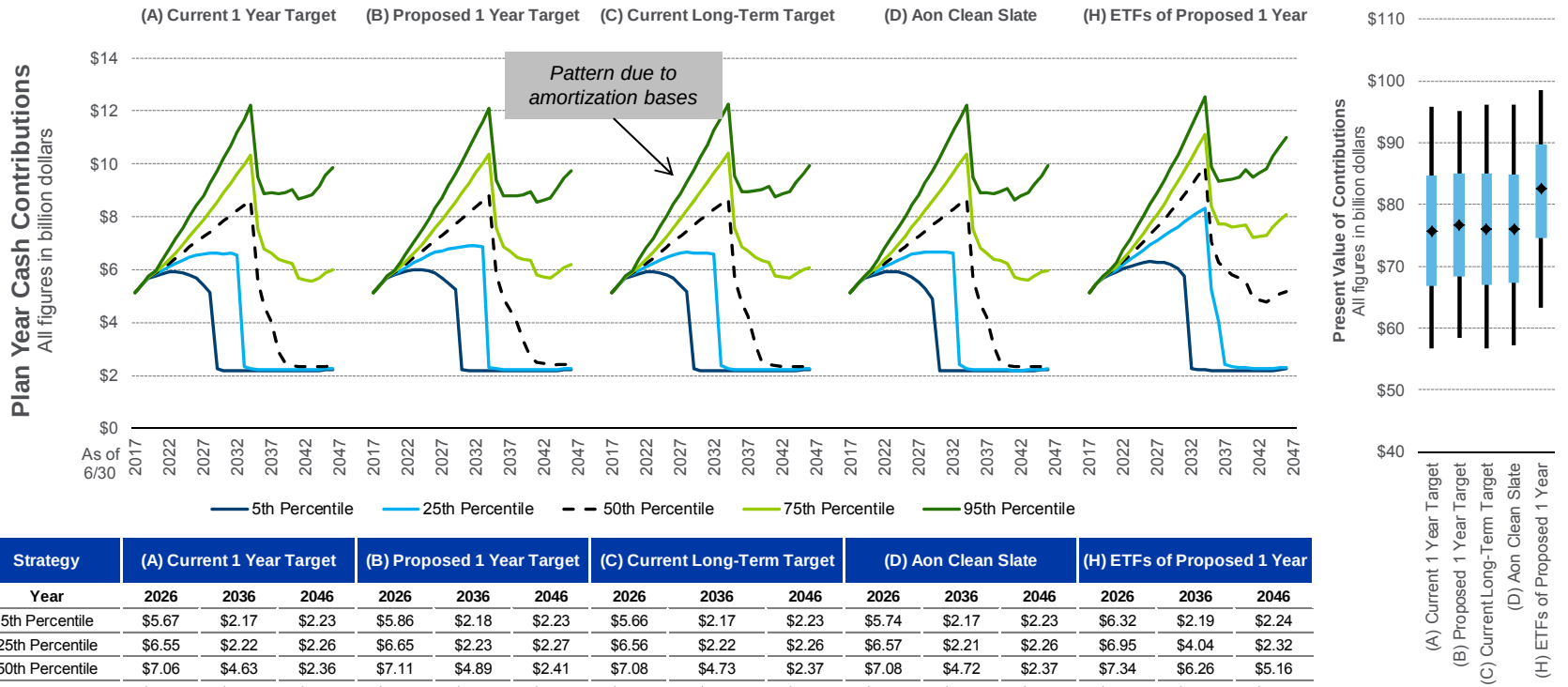
Source: Public Plans Data (publicplansdata.org) as of March 2018;
[1] Peers defined as public funds published within publicplansdata.org as of March 2018; Number of plans per year are shown in parentheses

Appendix

- Asset-Liability Projection Results (Additional Stochastic Results)

Asset-Liability Projection Results (Additional Stochastic Results)

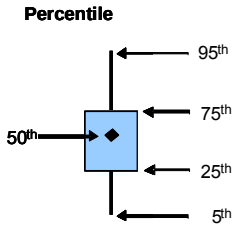
Gross Contribution Amount (Includes Employee and Employer Contributions)



Strategy	(A) Current 1 Year Target			(B) Proposed 1 Year Target			(C) Current Long-Term Target			(D) Aon Clean Slate			(H) ETFs of Proposed 1 Year		
Year	2026	2036	2046	2026	2036	2046	2026	2036	2046	2026	2036	2046	2026	2036	2046
5th Percentile	$5.67	$2.17	$2.23	$5.86	$2.18	$2.23	$5.66	$2.17	$2.23	$5.74	$2.17	$2.23	$6.32	$2.19	$2.24
25th Percentile	$6.55	$2.22	$2.26	$6.65	$2.23	$2.27	$6.56	$2.22	$2.26	$6.57	$2.21	$2.26	$6.95	$4.04	$2.32
50th Percentile	$7.06	$4.63	$2.36	$7.11	$4.89	$2.41	$7.08	$4.73	$2.37	$7.08	$4.72	$2.37	$7.34	$6.26	$5.16
75th Percentile	$7.56	$6.78	$5.99	$7.56	$6.85	$6.20	$7.58	$6.85	$6.06	$7.59	$6.81	$5.97	$7.73	$7.75	$8.09
95th Percentile	$8.42	$8.88	$9.85	$8.32	$8.79	$9.75	$8.46	$8.94	$9.93	$8.44	$8.89	$9.92	$8.48	$9.33	$10.98
Probability > $7B	53%	23%	20%	56%	23%	20%	54%	24%	20%	54%	23%	20%	72%	38%	34%

Key Takeaway:

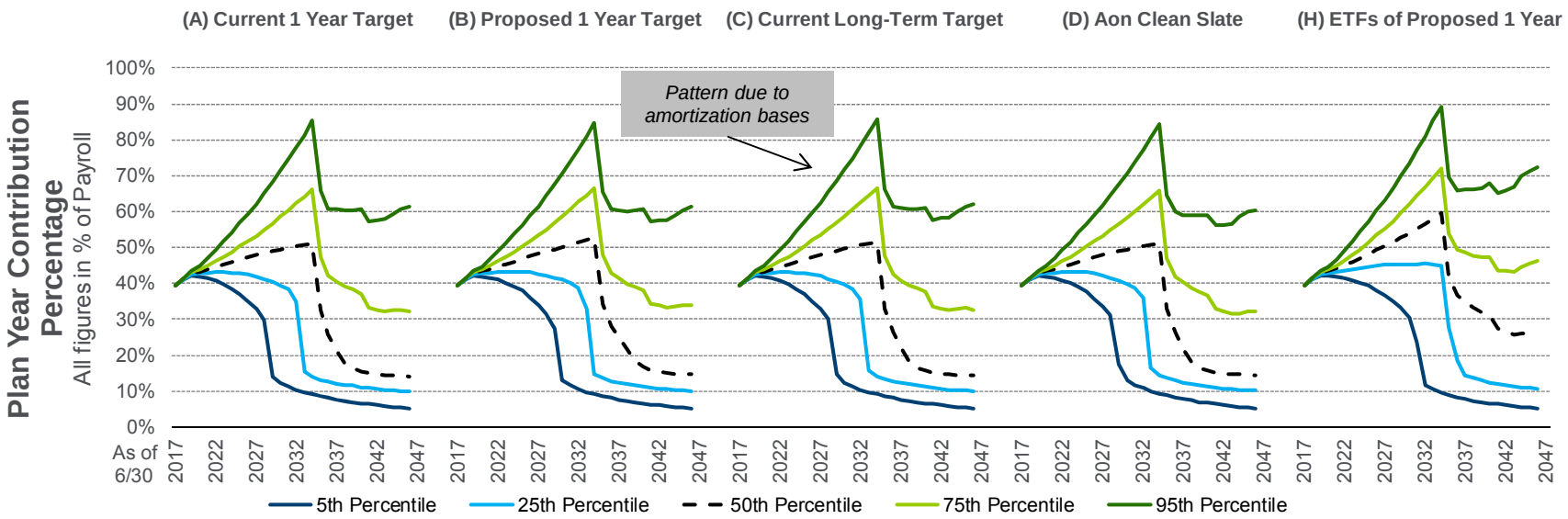
- Contributions in the central expectation (50th percentile outcomes) are projected to increase from their current levels until the expiration of individual amortization bases or when the plan reaches a funded status of at least 100% on an actuarial value of assets basis



* 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			(C) Current Long-Term Target			(D) Aon Clean Slate			(H) ETFs of Proposed 1 Year		
Year	2026	2036	2046	2026	2036	2046	2026	2036	2046	2026	2036	2046	2026	2036	2046
5th Percentile	35%	8%	5%	36%	8%	5%	35%	8%	5%	36%	8%	5%	38%	8%	5%
25th Percentile	43%	13%	10%	43%	13%	10%	43%	13%	10%	43%	13%	10%	45%	18%	11%
50th Percentile	47%	26%	14%	48%	28%	15%	47%	26%	14%	47%	26%	14%	49%	37%	26%
75th Percentile	52%	42%	32%	52%	43%	34%	52%	42%	33%	52%	42%	32%	53%	49%	46%
95th Percentile	59%	61%	61%	59%	61%	62%	60%	61%	62%	59%	60%	60%	60%	66%	72%
Probability > 50%	35%	17%	13%	36%	17%	13%	36%	17%	13%	35%	16%	12%	45%	24%	22%

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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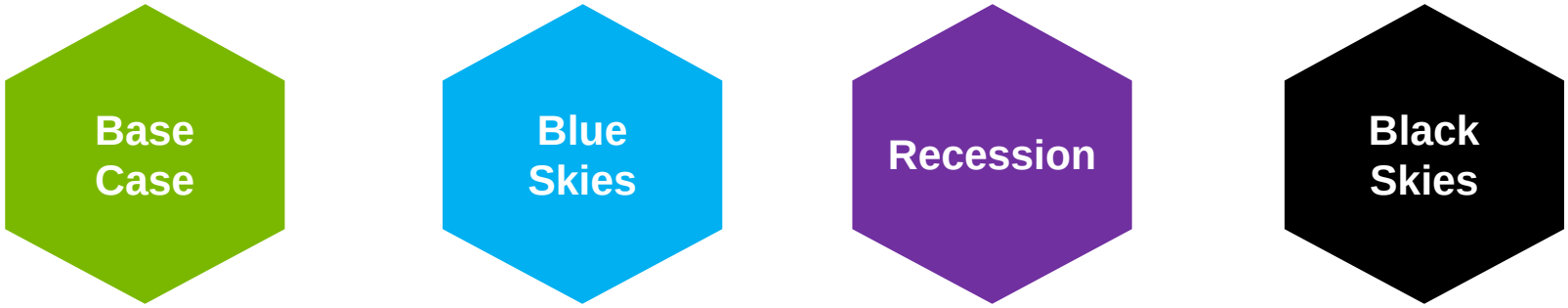
Appendix

- Asset-Liability Projection Results (Deterministic Results)

Deterministic Scenario Analysis
Overview

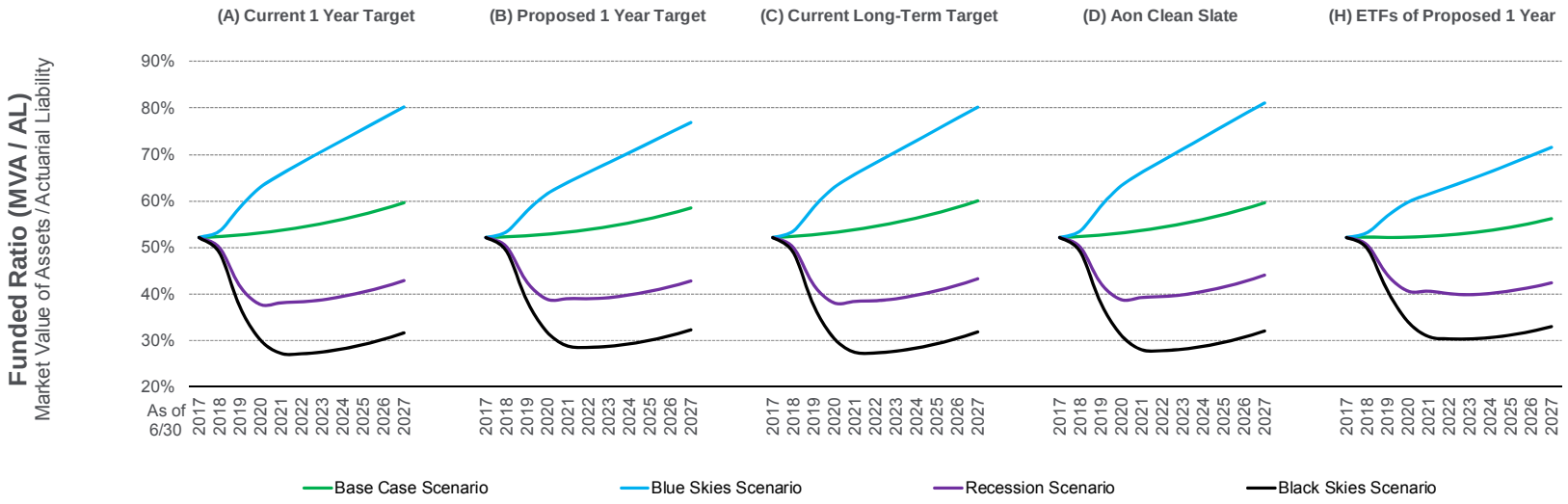


Scenario Description			
▪ Markets perform as expected ▪ ~50th percentile	▪ Optimistic outlook for markets ▪ ~10th percentile	▪ Pessimistic outlook for the markets ▪ ~95th percentile	▪ Very pessimistic outlook for the markets ▪ ~99th percentile
Financial Trend Analysis			
▪ Funded ratio is expected to 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

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			(C) Current Long-Term Target			(D) Aon Clean Slate			(H) ETFs of Proposed 1 Year		
Year	2017	2022	2027	2017	2022	2027	2017	2022	2027	2017	2022	2027	2017	2022	2027
Base Case Scenario	52%	54%	60%	52%	54%	58%	52%	55%	60%	52%	54%	60%	52%	53%	56%
Blue Skies Scenario	52%	68%	80%	52%	66%	77%	52%	68%	80%	52%	69%	81%	52%	63%	72%
Recession Scenario	52%	38%	43%	52%	39%	43%	52%	39%	43%	52%	39%	44%	52%	40%	42%
Black Skies Scenario	52%	27%	32%	52%	29%	32%	52%	27%	32%	52%	28%	32%	52%	30%	33%

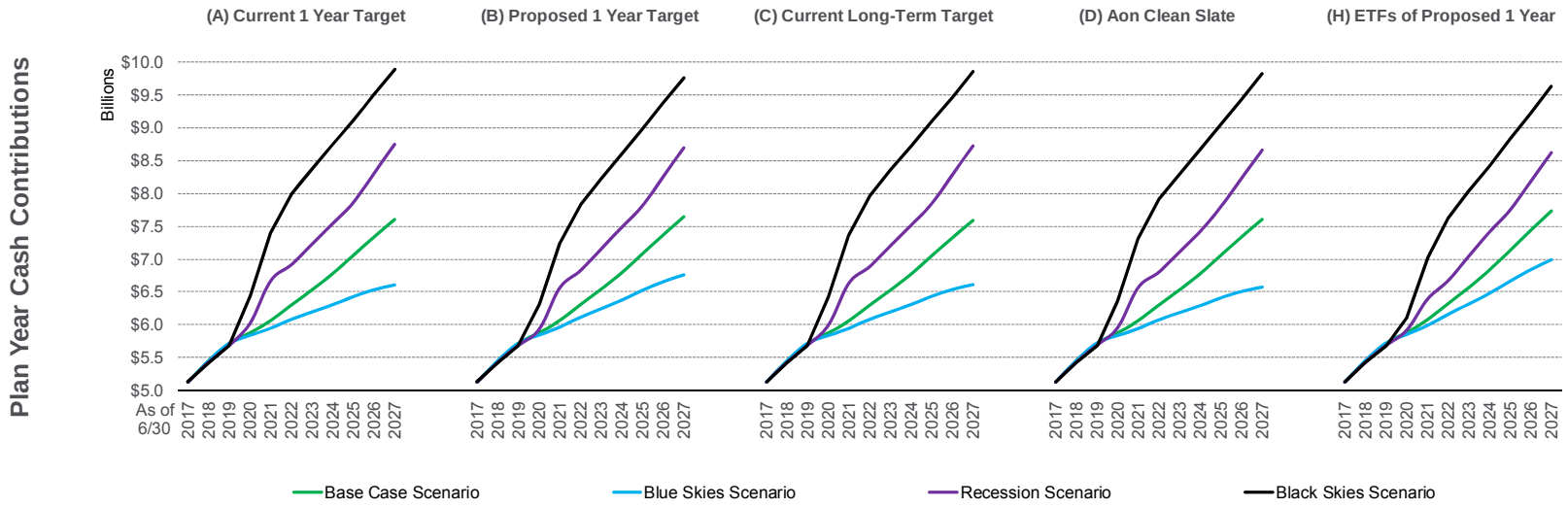
Key Takeaways:

- 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 other portfolios modeled due to its lower return expectation

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

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			(C) Current Long-Term Target			(D) Aon Clean Slate			(H) ETFs of Proposed 1 Year		
Year	2017	2022	2027	2017	2022	2027	2017	2022	2027	2017	2022	2027	2017	2022	2027
Base Case Scenario	$5.1	$6.3	$7.6	$5.1	$6.3	$7.6	$5.1	$6.3	$7.6	$5.1	$6.3	$7.6	$5.1	$6.3	$7.7
Blue Skies Scenario	$5.1	$6.1	$6.6	$5.1	$6.1	$6.8	$5.1	$6.1	$6.6	$5.1	$6.1	$6.6	$5.1	$6.2	$7.0
Recession Scenario	$5.1	$6.9	$8.7	$5.1	$6.8	$8.7	$5.1	$6.9	$8.7	$5.1	$6.8	$8.7	$5.1	$6.7	$8.6
Black Skies Scenario	$5.1	$8.0	$9.9	$5.1	$7.8	$9.8	$5.1	$8.0	$9.9	$5.1	$7.9	$9.8	$5.1	$7.6	$9.6

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 Blue Skies scenario compared to the other portfolios modeled

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

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Appendix

- Actuarial Assumptions and Methods

Actuarial Assumptions and Methods

- Actuarial projections used were the same as those from the 2017 asset-liability study, adjusted so that the starting point syncs to the June 30, 2017 actuarial valuation
- 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
  - All other assumptions as documented in the Actuarial Valuation Report as of June 30, 2017
- 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, 2017 – March 31, 2018 (ending asset value of $54.3 billion)
- Employee contributions are limited to the actuarially-determined contribution
- The health care premium assistance assets and liabilities have been excluded from this analysis
- The system's workforce size is assumed to remain constant over the projection period
- For Act 120 plan projection: Future new employees are assumed to be Class T-E members and have similar characteristics (age/gender/salary) to new employees for the period July 1, 2013 through June 30, 2016.
- For Act 5 plan projection: Future new employees as assumed in Conduent's May 23, 2017 cost note
- 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

Aon Clean Slate Portfolio: Considerations for PSERS

- In developing recommended portfolios for clients, AHIC considers the risk preferences for each client while also utilizing the themes of our model portfolios and Medium Term Views (MTVs 1-3 year) and Market Aware Implementation (MAI 1 year views).
- Aon began with our Opportunity Model Portfolio that consists of 45% Total Equity, 25% Fixed Income, 15% Real Assets and 15% Hedge Funds and expanded the opportunity set to include specific considerations for PSERS including:
  - The ability to use up to 20% leverage
  - The ability to use the following asset classes:

Equities	Return-Seeking FI	Real Assets	Alternatives	Risk Reducing FI
US Equity	High Yield Bonds	Private Real Estate	Hedge Funds	Core Fixed Income
Non-US Equity	Private Credit	REITs	Risk Parity	Long Government
Emerging Markets Equity	Emerging Markets Debt	Commodities		Global Inflation-Linked
Private Equity		Gold		Non-US Fixed Income
		Private Infrastructure		Cash
		Public Infrastructure		

- Aon's MTVs and MAIs illustrate more favorable indicators for hedge funds, private credit and emerging markets (equity and fixed income). Within fixed income, our MTVs prefer shorter duration maturities and TIPS are favored versus nominal long treasuries.
- In building the Clean Slate portfolio, Aon did constrain the efficient frontier to apply the following constraints: Hedge funds limited to 15%, Total illiquid (private equity, private real estate, private infrastructure and private credit) limited to 35%, private credit limited to 7% and long government to 10%.

Exchange-Traded Fund (ETF) Portfolio Construction

- In developing the ETFs of Proposed 1 Year portfolio (Portfolio H 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	1.8%	IXUS	ishares Core MSCI Total International Stock	1.8%
Public Equity: Non-US Developed, hedged to USD	5.4%	HEFA	ishares Currency Hedged MSCI EAFE ETF	5.4%
Public Equity: Emerging Markets	3.0%	IEMG	ishares Core MSCI Emerging Markets ETF	3.0%
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	1.1%
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: US High Yield Bonds	10.0%	HYG	ishares iBoxx $ High Yield Corp Bond	10.0%
Fixed Income: Global TIPS, 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	1.0%	IGF	ishares Global Infrastructure ETF	1.0%
Infrastructure: Energy MLPS	4.0%	AMLP	Alerian MLP ETF	4.0%
Real Estate: Global REITs, hedged to USD	1.0%	REET	ishares Global REIT ETF	1.0%
Real Estate: Private, unhedged	9.0%	USRT	ishares US REIT ETF	2.7%
		IWM	ishares Russell 2000 ETF	0.6%
		HYG	ishares iBoxx $ High Yield Corp Bond ETF	0.4%
		SHV	ishares Short Treasury Bond Index ETF	5.3%
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%

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, 2018 (30 Years)

		Expected Real Return[1]	Expected Nominal Return[1]	Expected Nominal Volatility
	Equity			
1	Large Cap U.S. Equity	4.0%	6.4%	17.5%
2	Small Cap U.S. Equity	4.5%	6.9%	23.5%
3	Global Equity IMI	5.0%	7.4%	19.0%
4	International Equity (Developed) – Hedged	5.5%	7.9%	18.0%
5	International Equity (Developed)	5.0%	7.4%	20.0%
6	Emerging Markets Equity	5.3%	7.7%	27.5%
	Fixed Income			
7	Cash (Gov't)	0.3%	2.6%	1.5%
8	Cash (LIBOR)	0.9%	3.2%	2.0%
9	Global TIPS	0.6%	2.9%	3.5%
10	Core Fixed Income	1.2%	3.5%	5.0%
11	TIPS	1.1%	3.4%	4.5%
12	Long Duration Bonds – Gov't	0.8%	3.1%	10.5%
13	High Yield Bonds	2.7%	5.1%	12.5%
14	Non-US Developed Bond (100% Hedged)	0.6%	2.9%	4.0%
15	Emerging Market Bonds	2.0%	4.3%	14.0%
16	Emerging Market Bonds (Sov. Local)	3.3%	5.7%	14.5%
	Alternatives			
17	Hedge Funds[2]	3.4%	5.8%	9.0%
18	Risk Parity[3]	3.8%	6.2%	11.0%
19	Private Real Estate	4.2%	6.6%	17.0%
20	US REITs	4.3%	6.7%	19.0%
21	Commodities	3.4%	5.8%	17.0%
22	Private Equity[4]	6.7%	9.2%	26.5%
23	Infrastructure	4.5%	6.9%	15.0%
24	Public Infrastructure	4.8%	7.2%	17.5%
25	Gold	1.1%	3.4%	19.5%
26	Private Credit	5.4%	7.8%	17.0%
	Inflation			
	Inflation	0.0%	2.3%	1.5%

[1] All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees.
[2] Hedge Fund assumptions developed as follows: 14% Event Driven, 0% CTA, 38% Global Macro, 20% Distressed Debt, 16% Fixed Income Arbitrage, 12% Insurance Linked
[3] Risk Parity assumptions developed as follows: 50% Global Equity, -100% LIBOR, 55% TIPS, 75% Intermediate Gov't. Bonds, 20% Commodities
[4] Private Equity assumptions developed as follows: 72% Buyouts, 13% Venture Capital, 15% Distressed Debt

AHIC Capital Market Assumptions

As of March 31, 2018 (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
1	Large Cap U.S. Equity	**1.00**	0.92	0.95	0.89	0.79	0.72	0.09	0.09	-0.06	0.03	-0.05	-0.13	0.61	0.00	0.42	0.46	0.56	0.85	0.27	0.66	0.32	0.92	0.38	0.88	0.01	0.32
2	Small Cap U.S. Equity	0.92	**1.00**	0.90	0.82	0.72	0.67	0.07	0.07	-0.06	0.02	-0.05	-0.12	0.56	-0.01	0.38	0.41	0.51	0.80	0.25	0.61	0.27	0.87	0.36	0.82	0.01	0.30
3	Global Equity IMI	0.95	0.90	**1.00**	0.93	0.92	0.84	0.07	0.07	-0.07	0.03	-0.05	-0.13	0.66	-0.01	0.47	0.56	0.55	0.88	0.27	0.64	0.39	0.89	0.37	0.92	0.01	0.34
4	International Equity (Developed) - Hedged	0.89	0.82	0.93	**1.00**	0.88	0.73	0.10	0.10	-0.06	0.04	-0.04	-0.11	0.57	0.00	0.40	0.40	0.51	0.82	0.28	0.61	0.27	0.82	0.35	0.84	0.01	0.31
5	International Equity (Developed)	0.79	0.72	0.92	0.88	**1.00**	0.75	0.04	0.04	-0.07	0.03	-0.04	-0.11	0.59	-0.02	0.43	0.59	0.50	0.79	0.25	0.54	0.44	0.73	0.32	0.85	0.02	0.30
6	Emerging Markets Equity	0.72	0.67	0.84	0.73	0.75	**1.00**	0.06	0.06	-0.06	0.04	-0.04	-0.11	0.66	0.01	0.48	0.52	0.41	0.74	0.23	0.49	0.31	0.68	0.29	0.77	0.01	0.30
7	Cash (Gov't)	0.09	0.07	0.07	0.10	0.04	0.06	**1.00**	0.98	0.60	0.46	0.46	0.24	0.15	0.63	0.17	0.01	0.06	0.22	0.11	0.09	0.23	0.04	0.12	0.11	0.06	0.08
8	Cash (LIBOR)	0.09	0.07	0.07	0.10	0.04	0.06	0.98	**1.00**	0.59	0.46	0.45	0.24	0.15	0.62	0.17	0.01	0.07	0.20	0.11	0.08	0.22	0.04	0.11	0.10	0.05	0.09
9	Global TIPS	-0.06	-0.06	-0.07	-0.06	-0.07	-0.06	0.60	0.59	**1.00**	0.40	0.82	0.22	0.08	0.40	0.10	-0.03	-0.01	0.22	0.03	-0.03	0.23	-0.08	0.02	-0.02	0.05	0.01
10	Core Fixed Income	0.03	0.02	0.03	0.04	0.03	0.04	0.46	0.46	0.40	**1.00**	0.51	0.77	0.32	0.61	0.47	0.13	0.13	0.31	0.05	0.03	0.09	0.02	0.05	0.04	0.02	0.11
11	TIPS	-0.05	-0.05	-0.05	-0.04	-0.04	-0.04	0.46	0.45	0.82	0.51	**1.00**	0.33	0.11	0.23	0.14	-0.02	-0.03	0.31	0.02	-0.02	0.18	-0.06	0.01	-0.01	0.04	-0.05
12	Long Duration Bonds – Gov't	-0.13	-0.12	-0.13	-0.11	-0.11	-0.11	0.24	0.24	0.22	0.77	0.33	**1.00**	-0.12	0.51	0.15	-0.04	-0.12	0.11	-0.02	-0.08	-0.02	-0.13	-0.04	-0.11	-0.01	-0.27
13	High Yield Bonds	0.61	0.56	0.66	0.57	0.59	0.66	0.15	0.15	0.08	0.32	0.11	-0.12	**1.00**	0.13	0.72	0.57	0.59	0.66	0.19	0.41	0.39	0.58	0.26	0.63	0.03	0.64
14	Non-US Developed Bond (100% Hedged)	0.00	-0.01	-0.01	0.00	-0.02	0.01	0.63	0.62	0.40	0.61	0.23	0.51	0.13	**1.00**	0.25	0.08	0.07	0.12	0.05	0.01	0.10	-0.02	0.05	0.02	0.03	0.07
15	Emerging Market Bonds	0.42	0.38	0.47	0.40	0.43	0.48	0.17	0.17	0.10	0.47	0.14	0.15	0.72	0.25	**1.00**	0.62	0.52	0.50	0.13	0.28	0.23	0.40	0.18	0.44	0.02	0.40
16	Emerging Market Bonds (Sov. Local)	0.46	0.41	0.56	0.40	0.59	0.52	0.01	0.01	-0.03	0.13	-0.02	-0.04	0.57	0.08	0.62	**1.00**	0.47	0.49	0.08	0.28	0.44	0.43	0.12	0.54	0.01	0.36
17	Hedge Funds[1]	0.56	0.51	0.55	0.51	0.50	0.41	0.06	0.07	-0.01	0.13	-0.03	-0.12	0.59	0.07	0.52	0.47	**1.00**	0.51	0.15	0.37	0.36	0.52	0.20	0.54	0.01	0.53
18	Risk Parity[2]	0.85	0.80	0.88	0.82	0.79	0.74	0.22	0.20	0.22	0.31	0.31	0.11	0.66	0.12	0.50	0.49	0.51	**1.00**	0.25	0.57	0.59	0.79	0.33	0.86	0.03	0.24
19	Private Real Estate	0.27	0.25	0.27	0.28	0.25	0.23	0.11	0.11	0.03	0.05	0.02	-0.02	0.19	0.05	0.13	0.08	0.15	0.25	**1.00**	0.32	0.06	0.25	0.13	0.27	0.01	0.10
20	US REITs	0.66	0.61	0.64	0.61	0.54	0.49	0.09	0.08	-0.03	0.03	-0.02	-0.08	0.41	0.01	0.28	0.28	0.37	0.57	0.32	**1.00**	0.20	0.61	0.26	0.68	0.01	0.22
21	Commodities	0.32	0.27	0.39	0.27	0.44	0.31	0.23	0.22	0.23	0.09	0.18	-0.02	0.39	0.10	0.23	0.44	0.36	0.59	0.06	0.20	**1.00**	0.29	0.08	0.49	0.05	0.14
22	Private Equity[3]	0.92	0.87	0.89	0.82	0.73	0.68	0.04	0.04	-0.08	0.02	-0.06	-0.13	0.58	-0.02	0.40	0.43	0.52	0.79	0.25	0.61	0.29	**1.00**	0.35	0.82	0.01	0.31
23	Infrastructure	0.38	0.36	0.37	0.35	0.32	0.29	0.12	0.11	0.02	0.05	0.01	-0.04	0.26	0.05	0.18	0.12	0.20	0.33	0.13	0.26	0.08	0.35	**1.00**	0.34	0.01	0.14
24	Public Infrastructure	0.88	0.82	0.92	0.84	0.85	0.77	0.11	0.10	-0.02	0.04	-0.01	-0.11	0.63	0.02	0.44	0.54	0.54	0.86	0.27	0.68	0.49	0.82	0.34	**1.00**	0.02	0.32
25	Gold	0.01	0.01	0.01	0.01	0.02	0.01	0.06	0.05	0.05	0.02	0.04	-0.01	0.03	0.03	0.02	0.01	0.01	0.03	0.01	0.01	0.05	0.01	0.01	0.02	**1.00**	0.01
26	Private Credit	0.32	0.30	0.34	0.31	0.30	0.30	0.08	0.09	0.01	0.11	-0.05	-0.27	0.64	0.07	0.40	0.36	0.53	0.24	0.10	0.22	0.14	0.31	0.14	0.32	0.01	**1.00**

[1] Hedge Fund assumptions developed as follows: 14% Event Driven, 0% CTA, 38% Global Macro, 20% Distressed Debt, 16% Fixed Income Arbitrage, 12% Insurance Linked

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

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

AHIC Capital Market Assumptions

Explanation of Capital Market Assumptions—Q2 2018

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 2018. 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 (2.3%)

Based on Consensus Economics long-term estimates and our near-term economic outlook, we expect U.S. consumer price inflation to be approximately 2.3% 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 (1.1%)** – We expect intermediate duration Treasury Inflation-Protected Securities to produce a real return of about 1.1%.
- **Core Fixed Income (i.e., Market Duration) (1.2%)** – 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 0.7%, 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 2018

- **Long Duration Bonds – Credit (1.8%)** – 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 1.0%, resulting in an expected real return of 1.8%.
- **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 (2.7%)** – 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 2.2%, resulting in an expected real return of 2.7%.
- **Bank Loans (3.5%)** – We expect LIBOR to produce a real return of about 0.9%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults) to be 2.6%, resulting in an expected real return of 3.5%.
- **Non-US Developed Bonds: 50% Hedged (0.6%) –** We forecast real returns for non-US developed market bonds to be 0.6% 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) (2.0%) –** We forecast real returns for emerging market sovereign bonds denominated in USD to be 2.0% over a 30-year period.
- **Emerging Market Bonds (Corporate; USD) (2.4%)** – We forecast real returns for emerging market corporate bonds denominated in USD to be 2.4% over a 30-year period.
- **Emerging Market Bonds (Sovereign; Local) (3.3%)** – We forecast real returns for emerging market sovereign bond denominated in local currency to be 3.3% over a 30-year period.
- **Multi Asset Credit (MAC) (4.1%) –** We assume real returns from beta exposure to high yield, bank loans and emerging market debt to add 3.2% plus 1.0% from alpha (net of fees) over a 30-year period.

AHIC Capital Market Assumptions

Explanation of Capital Market Assumptions—Q2 2018

Equities

- **Large Cap U.S. Equity (4.0%)** – This assumption is based on our 30-year outlook for large cap U.S. company dividends and real earnings growth. Adjustments are made for valuations as needed.
- **Small Cap U.S. Equity (4.5%)** – Adding a 0.5% return premium for small cap U.S. equity over large cap U.S. equity results in an expected real return of 4.5%. 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) (5.0%)** – 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 5.0% for global equity.
- **International (Non-U.S.) Equity, Developed Markets (5.0%)** – We employ a building block process similar to the U.S. equity model using the non-U.S. developed equity markets that comprise the MSCI EAFE Index.
- **Emerging Market Stocks (5.3%)** - 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 (3.8%) –** We expect nominal returns from insurance equity risk premium to average 3.9% plus 2.3% from cash & dividends 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 2018

- **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 (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 (3.2%)** – Our real return assumption for core real estate is based on a gross income of about 4.5%, 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 type and geographic region.
- **U.S. REITs (4.3%)** – Our real return assumption for U.S. REITs is based on income of 4.3% and future capital appreciation near the rate of inflation over the next 30 years. REITs are a sub-set of the U.S. small/mid cap equities.
- **Commodities (3.4%)** – Our commodity assumption is for a diversified portfolio of commodity futures contracts. Commodity futures returns are composed of three parts: spot price appreciation, collateral return, and roll return (positive or negative change implied by the shape of the future curve). We believe that spot prices will converge with CPI over the long run (i.e., 2.3%). Collateral is assumed to be LIBOR cash 0.9%. Also, we believe the roll effect will be approximately 0.2%, resulting in a real return of approximately 3.4% for commodities.

AHIC Capital Market Assumptions

Explanation of Capital Market Assumptions—Q2 2018

- **Private Equity (6.2%)** – Our private equity assumption reflects a diversified fund of funds with exposure to buyouts, venture capital, distressed debt, and mezzanine debt.
- **Infrastructure (4.5%)** – 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 4.5% for infrastructure.
- **Equity Risk Insurance Premium Strategies- Low Beta (3.7%) –** We assume nominal returns from cash of 2.6% + 3.5% from alpha**.**
- **Private Debt – Direct Lending (5.4%) –** We assume spread over bank loans to be approximately 1.9% to reflect illiquidity premium, origination fees and 100% leverage, net of management 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

- 2017 Horizon Survey of Capital Market Assumptions

2017 Horizon Survey Results

AHIC vs. Other Advisors

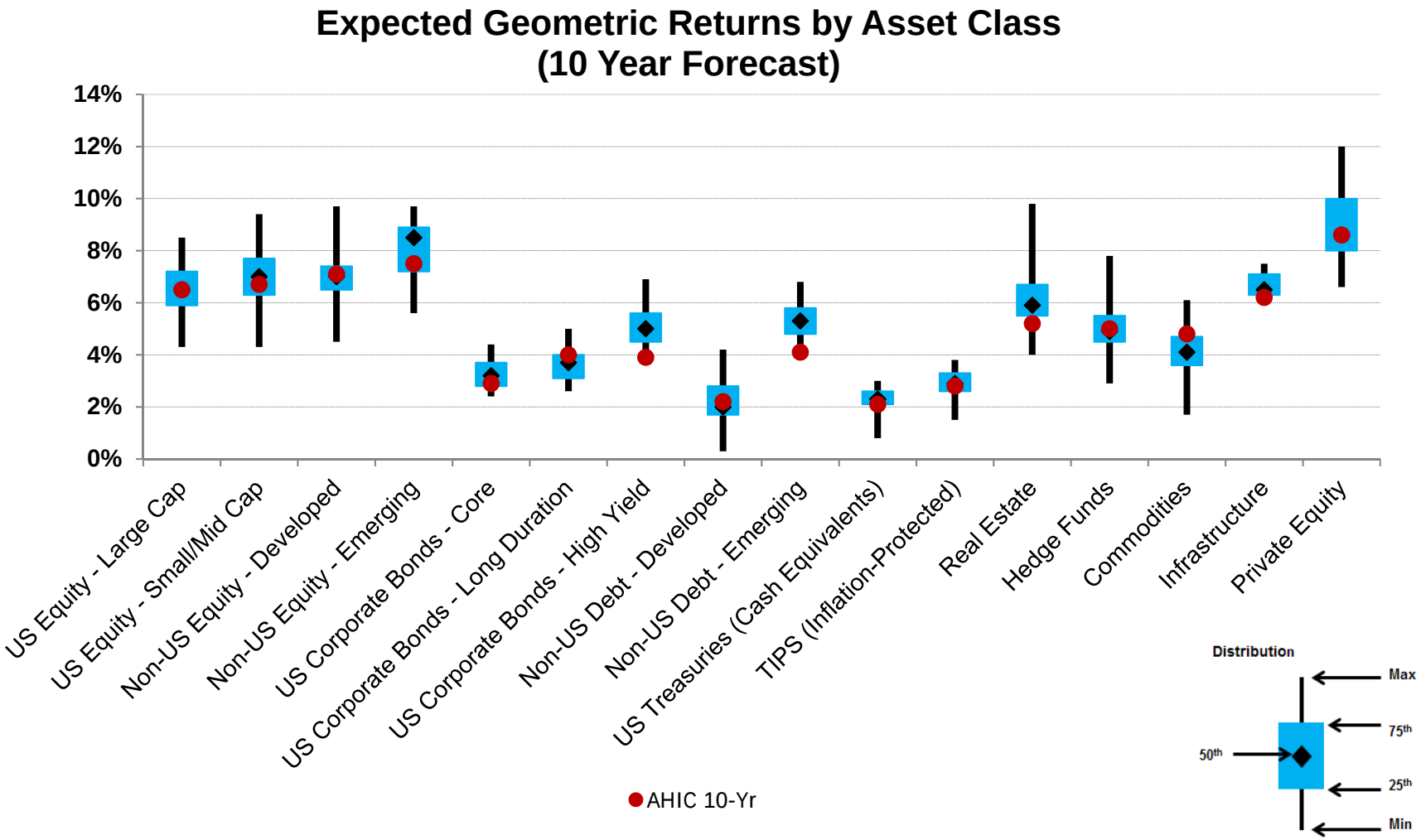
- Since 2010, Horizon Actuarial Services, LLC has conducted a capital market assumption survey of investment firms to aid in determining reasonable assumptions for a pension plan's expected return on assets
  - While we do not seek to change our approach based on how we stack up to peers, it is a helpful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

- Compared to 2016, the 2017 survey results under the 10-year forecast indicate a slight decrease in return assumptions for both risky assets (equity-like) and fixed income asset classes
  - Equity return assumptions are lower by an average of 0.2%
  - Fixed income return assumptions are lower by an average of 0.3%
  - Alternative asset class return assumptions are lower by an average of 0.1%

- 2017 AHIC 10-year forecast assumptions tend to be lower 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, our equity return assumptions have consequently fallen
  - AHIC fixed income assumptions reflect falling yields and flattening of yield curves during the first quarter of 2017
  - AHIC alternative asset class assumptions are generally lower due to methodological and inflation forecast differences compared to survey participant forecasts

- In conclusion, AHIC assumptions appear somewhat more conservative than peers included in the 2017 Horizon Survey of capital market assumptions

Ask 35 Consultants and…



SOURCE: Horizon Actuarial survey of 2017 capital market assumptions from 35 independent investment advisors
Expected returns of the survey are annualized over 10-years (geometric).
AHIC expected returns are annualized over 10-years as of 2Q 2017

AHIC Versus Peers (2017 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	6.5%	16.6%	6.5%	17.0%	0.0%
US Equity - Small/Mid Cap	6.9%	20.2%	6.7%	23.0%	-0.2%
Non-US Equity - Developed	7.0%	18.9%	7.1%	20.0%	0.1%
Non-US Equity - Emerging	8.0%	25.4%	7.5%	30.0%	-0.5%
US Fixed Income - Core	3.2%	5.5%	2.9%	4.0%	-0.3%
US Fixed Income - Long Duration Corp	3.6%	10.4%	4.0%	11.0%	0.4%
US Fixed Income - High Yield	5.1%	10.6%	3.9%	12.0%	-1.2%
Non-US Fixed Income - Developed	2.2%	7.4%	2.2%	5.5%	0.0%
Non-US Fixed Income - Emerging	5.3%	11.8%	4.1%	13.0%	-1.2%
Treasuries (Cash Equivalents)	2.3%	3.0%	2.1%	1.0%	-0.2%
TIPS (Inflation-Protected)	2.9%	6.3%	2.8%	4.5%	-0.1%
Real Estate	6.2%	14.5%	5.2%	11.5%	-1.0%
Hedge Funds	4.9%	8.0%	5.0%	9.0%	0.1%
Commodities	4.1%	17.9%	4.8%	17.0%	0.8%
Infrastructure	6.7%	14.6%	6.2%	14.5%	-0.5%
Private Equity	9.0%	22.0%	8.6%	24.0%	-0.4%
Inflation	2.2%	1.7%	2.2%	1.0%	0.0%

Notes (Horizon Survey):

Source: Horizon Actuarial survey of 2017 capital market assumptions from 35 independent investment advisors

Expected returns are annualized (geometric).

Notes (AHIC Forecasts):

AHIC Forecasts are for Q2 2017

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 Non-US Fixed Income- Emerging Sovereign USD

Real Estate forecasts represents AHIC forecasts for Core Private Real Estate

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

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

- Liquidity Analysis and Deterministic Scenario Details

Background

AHIC Approach to Analyzing Liquidity Risk from Alternatives

- Intended as a stress-testing model
- Develops multi-year projections of assets and spending needs
- Uses different scenarios for economic environments and other relevant events
- Shows how the portfolio's liquidity profile could evolve with a given investment strategy
- Incorporates the profile of the liabilities as well as expected future contributions

Background
Process Inputs and Outputs

Background
Modeling Parameters – Degrees of Illiquidity

- We categorized investments by liquidity into five buckets
  - **Liquid (Risk-Reducing Assets):** less than 3 months needed for return of capital (e.g. publicly traded securities)
  - **Liquid (Return-Seeking Assets):** less than 3 months needed for return of capital (e.g. publicly traded securities)
  - **Quasi-Liquid:** Typical lock-up of 3–12 months. Conservatively, we assumed a 1-year lock-up in most economic environments, 2 years in a Recession scenario, and 3 years in a Black Skies scenario (e.g. many hedge funds, core real estate)
  - **Illiquid: Potential lock-up of 5–10 years**, depending on economic environment (e.g. closed-ended real estate)
  - **Illiquid: Potential lock-up of 10+ years** (e.g. typical private equity)

- This is intended to be a conservative approximation of the actual liquidity properties of the assets

- We started with the Current Long-Term Target allocation, then see how the actual allocations would change in different economic scenarios, continuing new commitments to private assets, as expected.

- Assumptions
  - Starting assets based the June 30, 2017 actuarial valuation report
  - Asset figures reflect actual performance for the period July 1, 2017 – March 31, 2018 (ending asset value of $54.3 billion)
  - The plan's contribution policy is actuarially based, leveraging projections from the plan actuary based on the 2017 asset-liability study
  - Assumes the portfolio starts at the target asset allocation levels for illiquid assets, maintaining close to the Current Long-Term Target portfolio targets over the next 10 years

Background
Economic Scenarios

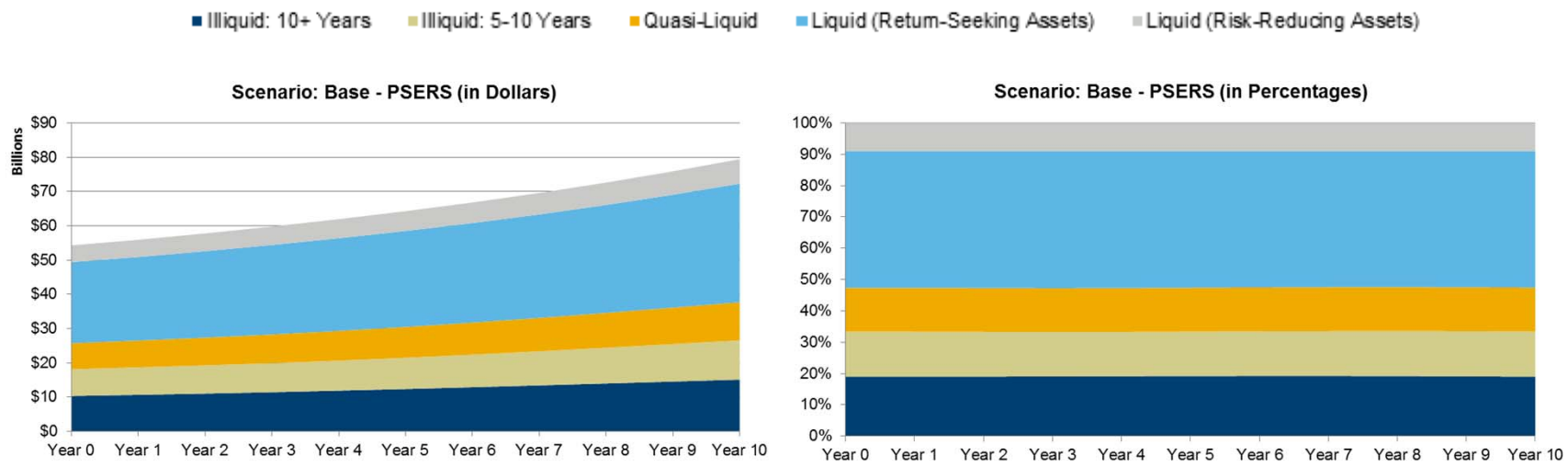
- **Base Scenario**
  - Markets perform consistent with our Capital Market Assumptions (~50th percentile)

- **Recession Scenario**
  - Somewhat pessimistic outlook for the markets (~95th percentile)
  - Return-seeking assets decline in the first two years with a modest rebound in later years

- **Black Skies Scenario**
  - Very pessimistic outlook for markets (~99th percentile)
  - Return-seeking assets decline significantly
  - The value of public equities roughly splits in half over three years, without an immediate rebound

Liquidity Analysis: Base Economic Scenario
Current Long-Term Target

- The exhibit below shows the projected liquidity profile of the current allocation in the Base economic scenario, assuming commitments are continued as expected



- **Key Takeaway:**
  - Total illiquid assets stay near 47% of the plan and can be maintained near the target with no cash flow problems

Note: Year 0 represents a starting point of March 31, 2018

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Liquidity Analysis: Base Economic Scenario (continued)
Current Long-Term Target

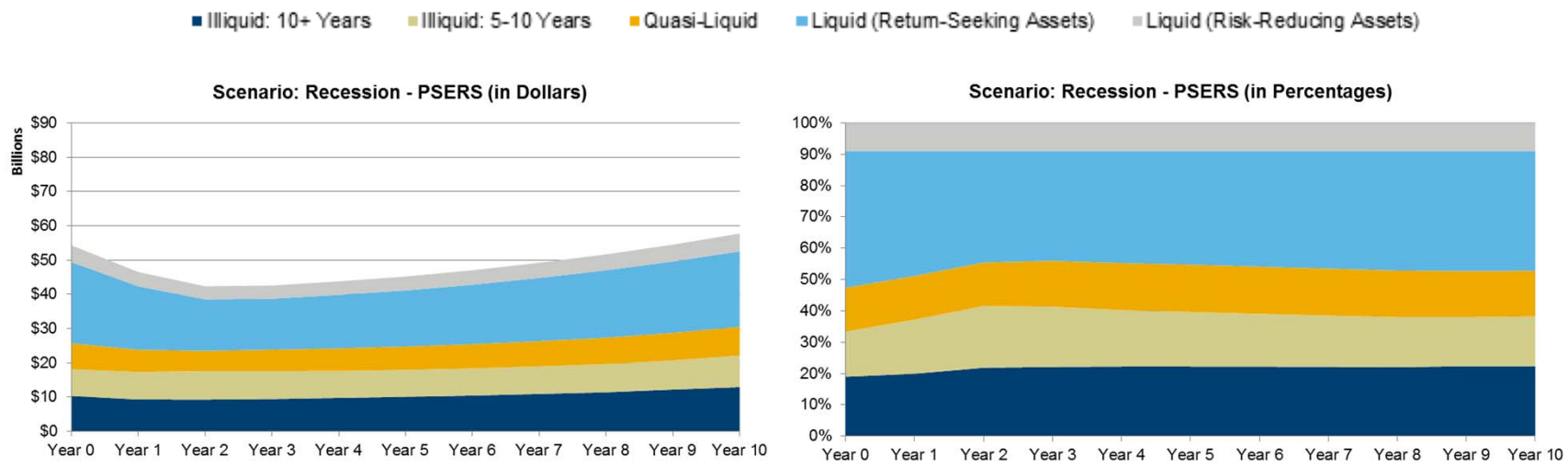
- The exhibit below shows the projected liquidity profile of the current allocation in a Base scenario

Asset Allocation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Liquid Risk-Reducing	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%
Liquid Return-Seeking	44%	44%	44%	44%	44%	44%	44%	43%	43%	43%	44%
Total Liquid	**53%**	**53%**	**53%**	**53%**	**53%**	**53%**	**53%**	**52%**	**52%**	**52%**	**53%**
Quasi-Liquid	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%
Illiquid: 5-10 Year Lock-up	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%
Illiquid: 10+ Year Lock-up	19%	19%	19%	19%	19%	19%	19%	19%	19%	19%	19%
Total Quasi + Illiquid	**47%**	**47%**	**47%**	**47%**	**47%**	**47%**	**48%**	**48%**	**48%**	**48%**	**47%**

Note: Year 0 represents a starting point of March 31, 2018

Liquidity Analysis: Recession Economic Scenario
Current Long-Term Target

- The exhibit below shows the projected liquidity profile of the current allocation in the Recession economic scenario, assuming commitments are continued as expected



- **Key Takeaways:**
  - Commitments to illiquid alternatives are maintained at the steady state level, but recessionary markets cause the total portfolio to shrink
  - Total illiquid and quasi-liquid assets are projected to reach as high as 56% of the plan due to the shrinking market value of the total plan in this scenario
  - There would not be a concern with the ability to pay benefits
  - PSERS may need to redeem some quasi-liquid assets to stay close to its target allocation

Note: Year 0 represents a starting point of March 31, 2018

Liquidity Analysis: Recession Economic Scenario (continued)
Current Long-Term Target

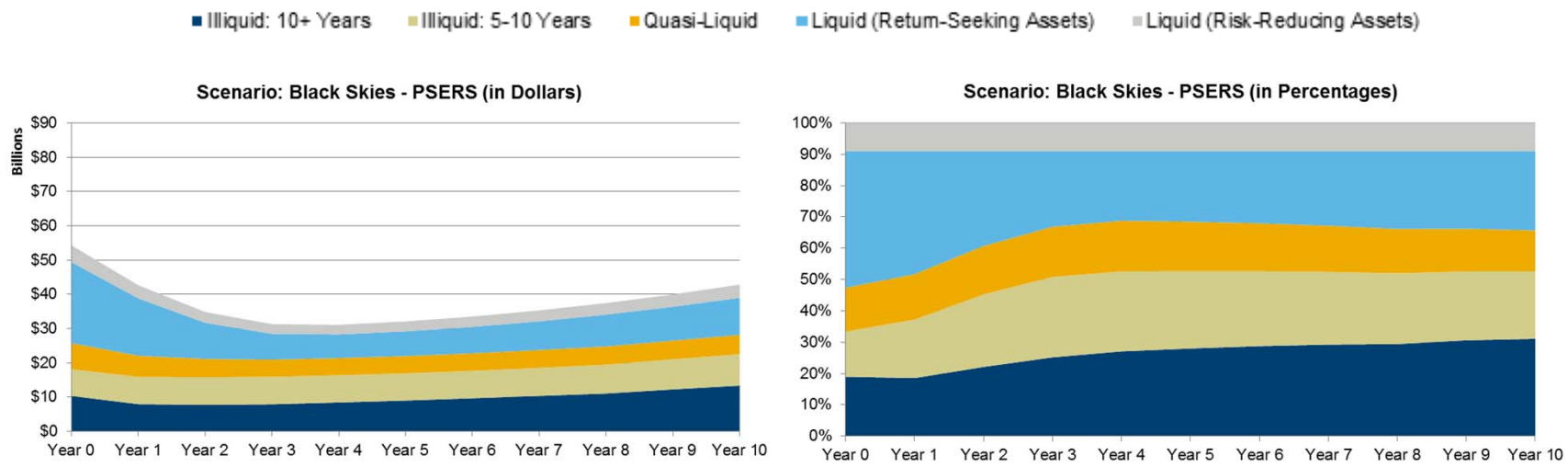
- The exhibit below shows the projected liquidity profile of the current allocation in a Recession scenario

Asset Allocation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Liquid Risk-Reducing	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%
Liquid Return-Seeking	44%	40%	36%	35%	36%	36%	37%	37%	38%	38%	38%
Total Liquid	**53%**	**49%**	**45%**	**44%**	**45%**	**45%**	**46%**	**46%**	**47%**	**47%**	**47%**
Quasi-Liquid	14%	14%	14%	15%	15%	15%	15%	15%	15%	15%	15%
Illiquid: 5-10 Year Lock-up	14%	17%	20%	19%	18%	17%	17%	16%	16%	16%	16%
Illiquid: 10+ Year Lock-up	19%	20%	22%	22%	22%	22%	22%	22%	22%	22%	22%
Total Quasi + Illiquid	**47%**	**51%**	**55%**	**56%**	**55%**	**55%**	**54%**	**54%**	**53%**	**53%**	**53%**

Note: Year 0 represents a starting point of March 31, 2018

Liquidity Analysis: Black Skies Economic Scenario
Current Long-Term Target

- The exhibit below shows the projected liquidity profile of the current allocation in a Black Skies scenario, assuming commitments are continued as expected



- **Key Takeaways:**
  - Commitments to illiquid alternatives are maintained at the steady state level, but subpar markets cause the total portfolio to shrink
  - Total illiquid and quasi-liquid assets are projected to reach as high as 69% of the plan due to the shrinking market value of the total plan in this scenario
  - In this scenario, PSERS may want to redeem some quasi-liquid assets and pare back future commitments to stay closer to the target allocations. However, the allocation would still be significantly different from target.

Note: Year 0 represents a starting point of March 31, 2018

Liquidity Analysis: Black Skies Economic Scenario (continued)
Current Long-Term Target

- The exhibit below shows the projected liquidity profile of the current strategy in a Black Skies scenario

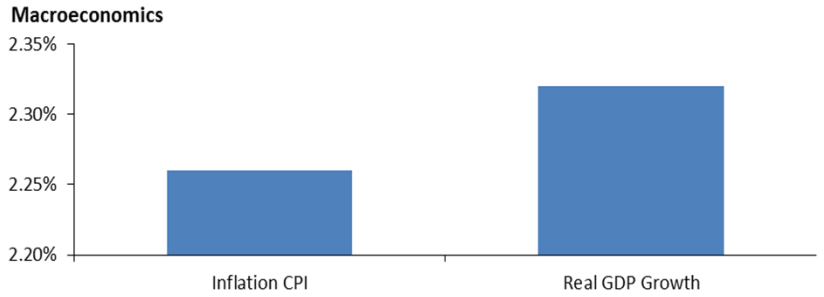
Asset Allocation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Liquid Risk-Reducing	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%
Liquid Return-Seeking	44%	39%	30%	24%	22%	23%	23%	24%	25%	25%	25%
Total Liquid	**53%**	**48%**	**39%**	**33%**	**31%**	**32%**	**32%**	**33%**	**34%**	**34%**	**34%**
Quasi-Liquid	14%	15%	15%	16%	16%	16%	15%	15%	14%	14%	13%
Illiquid: 5-10 Year Lock-up	14%	19%	23%	26%	26%	25%	24%	23%	23%	22%	22%
Illiquid: 10+ Year Lock-up	19%	19%	22%	25%	27%	28%	29%	29%	29%	31%	31%
Total Quasi + Illiquid	**47%**	**52%**	**61%**	**67%**	**69%**	**68%**	**68%**	**67%**	**66%**	**66%**	**66%**

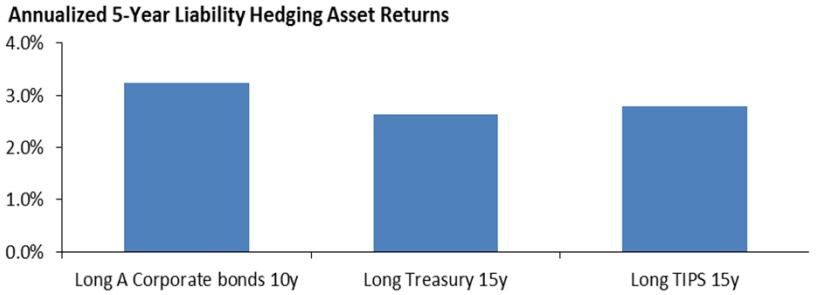
Note: Year 0 represents a starting point of March 31, 2018

Base Case Scenario

World Events Unfold in a Fashion Consistent With our Capital Market Assumptions

- Yield and return series reflect our average estimates. These estimates represent our benchmark view.
- The US economy continues to grow slightly above trend over the next few years, as the US is buoyed by a more optimistic global economic outlook. However, growth gradually moderates as stimulus fades and monetary policy is gradually tightened.
- Consumer price inflation, measured by the Consumer Price Index, remains modestly above 2% over the next five years, supported by global growth prospects.
- Government and corporate bond yields gradually rise. Robust profit margins sustain stable corporate spreads.
- Risk asset returns are in line with our long-term assumptions.





Source: Aon

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Base Case Scenario
Data Table

BASE SCENARIO

	Year 0	1	2	3	4	5	6	7	8	9	10
Yields (BOY)											
Treasury yield 5y	2.6%	2.8%	2.9%	3.0%	3.0%	3.0%	3.1%	3.0%	3.1%	3.2%	3.2%
Long Treasury yield 15y	2.9%	3.0%	3.0%	3.0%	3.1%	3.1%	3.0%	3.0%	3.1%	3.1%	3.1%
TIPS yield 5y	0.5%	0.6%	0.7%	0.8%	0.9%	1.0%	1.1%	1.1%	1.0%	1.0%	0.9%
Long TIPS yield 15y	0.8%	0.8%	0.9%	0.9%	0.9%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Breakeven price inflation 15y	2.1%	2.2%	2.1%	2.1%	2.1%	2.1%	2.0%	2.0%	2.1%	2.1%	2.1%
A Corporate bond yield 5y	3.5%	3.9%	4.1%	4.3%	4.4%	4.5%	4.5%	4.5%	4.4%	4.4%	4.4%
Long A Corporate bond yield 10y	4.0%	4.2%	4.3%	4.3%	4.4%	4.4%	4.5%	4.5%	4.5%	4.6%	4.6%
A Corporate spread 5y	0.9%	1.0%	1.2%	1.3%	1.4%	1.4%	1.4%	1.4%	1.2%	1.1%	1.1%
Long A Corporate spread 10y	1.1%	1.2%	1.3%	1.3%	1.3%	1.3%	1.3%	1.4%	1.4%	1.5%	1.5%
Expected nominal return on assets											
Equity - US		6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%
Equity - Global		7.2%	7.2%	7.2%	7.2%	7.2%	7.2%	7.2%	7.2%	7.2%	7.2%
A Corporate bonds 5y		2.6%	3.0%	3.3%	3.6%	3.8%	4.0%	4.2%	4.2%	4.2%	4.2%
Long A Corporate bonds 10y		2.6%	2.9%	3.3%	3.6%	3.9%	4.1%	4.2%	4.2%	4.2%	4.1%
Treasury 5y		2.1%	2.5%	2.7%	2.8%	3.0%	3.0%	3.1%	3.0%	3.0%	3.1%
Long Treasury 15y		2.1%	2.5%	2.7%	2.8%	3.0%	3.0%	3.1%	3.0%	3.0%	3.1%
TIPS 5y		2.5%	2.6%	2.8%	3.0%	3.0%	3.1%	3.2%	3.4%	3.5%	3.5%
Long TIPS 15y		2.5%	2.6%	2.8%	3.0%	3.0%	3.1%	3.2%	3.4%	3.5%	3.5%
US High Yield		5.2%	4.7%	4.7%	4.9%	5.1%	4.6%	4.8%	5.1%	5.1%	5.3%
Bank Loans		4.3%	4.9%	5.2%	5.2%	5.1%	5.3%	5.2%	5.2%	5.2%	5.3%
USD Emerging Market Debt		3.9%	4.3%	4.8%	4.9%	4.8%	4.8%	5.2%	5.1%	5.2%	5.8%
Local Emerging Market Debt		5.6%	5.6%	5.9%	5.6%	6.0%	5.6%	6.0%	5.9%	6.3%	6.0%
Real Estate		5.6%	5.6%	5.6%	5.6%	5.6%	5.6%	5.6%	5.6%	5.6%	5.6%
Commodities		5.3%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%
Hedge Funds - FoHF - Universe		4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%
Private Equity		8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%
Infrastructure - Europe		6.8%	6.8%	6.8%	6.8%	6.8%	6.8%	6.8%	6.8%	6.8%	6.8%
Cash		2.1%	2.5%	2.7%	2.8%	3.0%	3.1%	3.0%	3.0%	3.1%	3.2%
CPI		2.2%	2.2%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%

Scenario information as of March 31, 2018

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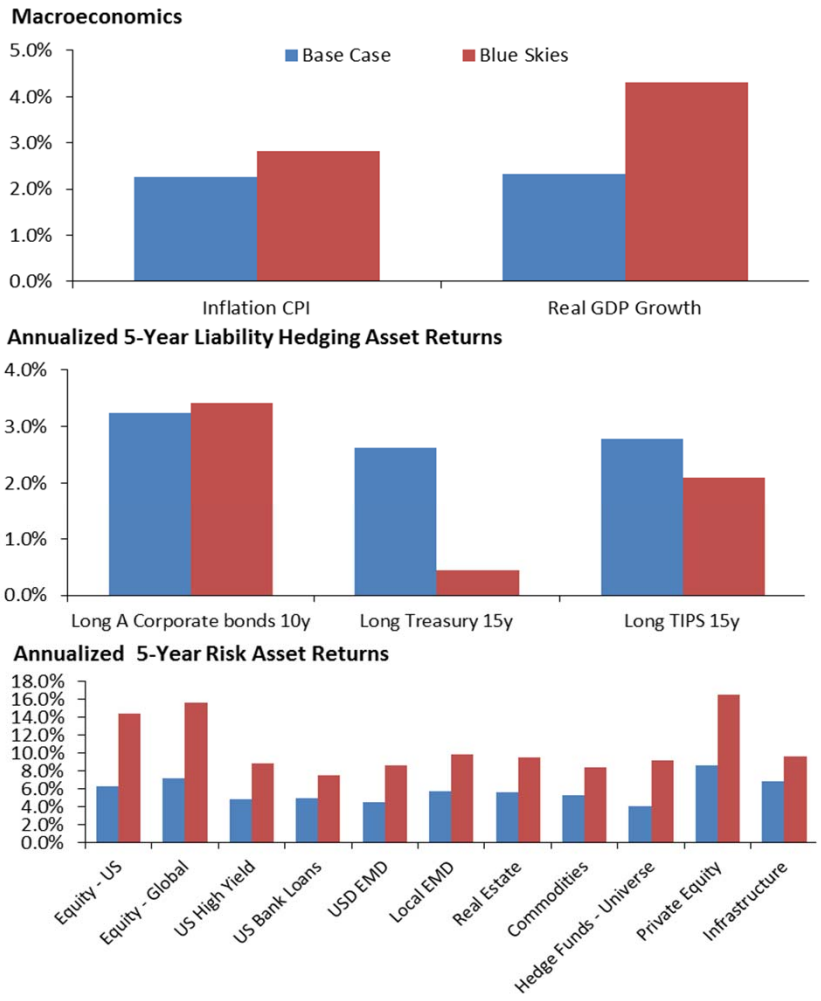
Blue Skies Scenario

The World Economy Grows Ahead of Consensus Expectations, While Inflation Remains Subdued

- A synchronised pick-up in global growth, unimpeded by political risks, provides a strong tailwind to risk assets
- The US experiences a strong recovery as global growth is more robust than expected.
- The Federal Reserve maintains an accommodative monetary policy until confidence in the economic recovery is fully established. Fiscal tightening is limited.
- Stronger economic growth results in moderate rises in bond yields and inflation.
- Credit conditions improve substantially as corporate margins widen further and corporate spreads narrow.
- Risk assets perform well with high returns over the five year period.



Source: Aon

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Blue Skies Scenario
Data Table

BLUE SKIES SCENARIO

	Year 0	1	2	3	4	5	6	7	8	9	10
Yields (BOY)											
Treasury yield 5y	2.6%	3.0%	3.4%	3.7%	3.9%	4.0%	4.1%	4.0%	4.1%	4.2%	4.2%
Long Treasury yield 15y	2.9%	3.5%	3.8%	4.0%	4.0%	4.1%	4.1%	4.1%	4.1%	4.1%	4.2%
TIPS yield 5y	0.5%	0.7%	0.8%	1.0%	1.3%	1.3%	1.4%	1.4%	1.4%	1.3%	1.3%
Long TIPS yield 15y	0.8%	1.0%	1.2%	1.3%	1.4%	1.5%	1.5%	1.5%	1.6%	1.6%	1.6%
Breakeven price inflation 15y	2.1%	2.5%	2.6%	2.6%	2.6%	2.6%	2.5%	2.5%	2.6%	2.6%	2.6%
A Corporate bond yield 5y	3.5%	3.6%	4.0%	4.3%	4.7%	4.8%	4.8%	4.7%	4.7%	4.6%	4.6%
Long A Corporate bond yield 10y	4.0%	4.1%	4.4%	4.5%	4.7%	4.8%	4.8%	4.8%	4.9%	4.9%	5.0%
A Corporate spread 5y	0.9%	0.6%	0.6%	0.6%	0.8%	0.7%	0.7%	0.7%	0.5%	0.4%	0.5%
Long A Corporate spread 10y	1.1%	0.8%	0.8%	0.7%	0.7%	0.7%	0.7%	0.8%	0.8%	0.9%	1.0%
Expected nominal return on assets											
Equity - US		22.2%	19.1%	11.5%	10.5%	9.5%	9.1%	8.8%	8.5%	8.2%	7.9%
Equity - Global		24.3%	20.8%	12.4%	11.3%	10.2%	9.9%	9.6%	9.3%	9.0%	8.7%
A Corporate bonds 5y		3.8%	2.3%	2.8%	2.6%	4.2%	4.4%	4.5%	4.6%	4.6%	4.6%
Long A Corporate bonds 10y		4.0%	2.0%	3.7%	3.1%	4.3%	4.9%	5.0%	5.0%	5.0%	5.0%
Treasury 5y		1.7%	1.8%	2.4%	2.8%	3.6%	3.9%	4.0%	4.0%	4.0%	4.1%
Long Treasury 15y		-4.4%	-0.6%	1.7%	3.3%	2.4%	4.1%	4.2%	4.1%	4.1%	4.2%
TIPS 5y		2.6%	3.6%	3.4%	3.2%	3.7%	3.8%	3.9%	4.1%	4.2%	4.2%
Long TIPS 15y		0.7%	0.7%	3.0%	3.3%	2.9%	4.0%	4.1%	4.2%	4.4%	4.4%
US High Yield		13.3%	10.4%	7.3%	6.8%	6.9%	6.2%	6.2%	6.4%	6.1%	6.2%
Bank Loans		8.9%	8.2%	7.2%	6.7%	6.6%	6.6%	6.4%	6.3%	6.1%	6.1%
USD Emerging Market Debt		12.9%	10.5%	7.1%	6.3%	6.7%	6.5%	6.7%	6.4%	6.3%	6.7%
Local Emerging Market Debt		14.5%	11.8%	8.2%	7.1%	7.9%	7.3%	7.5%	7.2%	7.4%	6.9%
Real Estate		14.6%	11.6%	8.1%	7.1%	6.6%	6.5%	6.4%	6.3%	6.2%	6.1%
Commodities		14.2%	9.2%	6.7%	6.3%	5.9%	5.8%	5.8%	5.7%	5.6%	5.6%
Hedge Funds - FoHF - Universe		13.1%	10.8%	8.0%	7.5%	6.7%	6.4%	6.2%	5.9%	5.7%	5.4%
Private Equity		23.1%	20.1%	14.2%	13.2%	12.2%	11.9%	11.5%	11.1%	10.8%	10.4%
Infrastructure - Europe		14.3%	11.3%	7.8%	7.3%	7.3%	7.3%	7.2%	7.2%	7.1%	7.1%
Cash		2.1%	2.9%	3.4%	4.0%	4.1%	4.2%	4.1%	4.1%	4.2%	4.3%
CPI		2.6%	3.0%	3.1%	2.8%	2.7%	2.7%	2.7%	2.7%	2.7%	2.7%

Scenario information as of March 31, 2018

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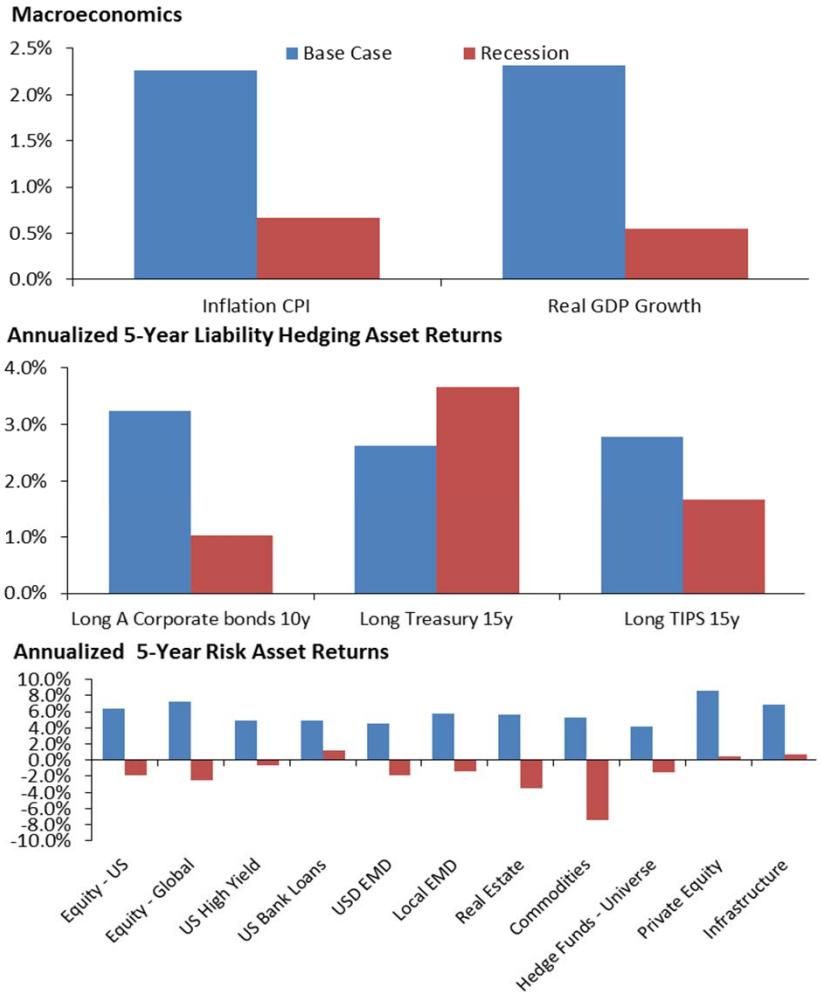
Recession Scenario

The US Economy Slips Back Into Recession in 2018

- Global growth is much slower than under the base case scenario.
- The US experiences a recession in late 2018, due to subdued global growth.
- Inflation turns slightly negative in 2018. However, the period of deflation is short lived and inflation starts to rise in later years as an economic recovery begins to establish itself.
- Treasury yields fall while TIPS yields remain at low levels as the US enters recession. Yields rise in later years as a recovery gets underway.
- Corporate spreads rise significantly due to the poor economic situation and increased risks of downgrades or defaults.
- Most risk assets make losses in the first two years but rebound in later years as the economy recovers.



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Recession Scenario
Data Table

RECESSION SCENARIO

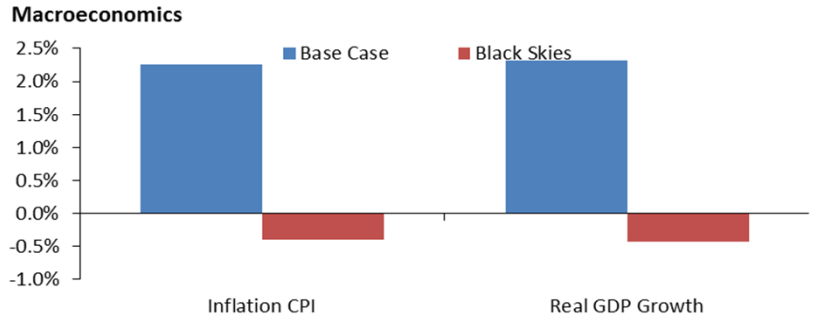
	Year 0	1	2	3	4	5	6	7	8	9	10
Yields (BOY)											
Treasury yield 5y	2.6%	1.5%	1.2%	1.4%	1.8%	2.4%	2.4%	2.4%	2.5%	2.6%	2.5%
Long Treasury yield 15y	2.9%	2.0%	1.7%	1.8%	2.1%	2.6%	2.5%	2.5%	2.6%	2.6%	2.6%
TIPS yield 5y	0.5%	-0.3%	-0.3%	-0.1%	0.4%	0.8%	0.9%	0.9%	0.9%	0.8%	0.8%
Long TIPS yield 15y	0.8%	0.3%	0.2%	0.2%	0.5%	0.7%	0.7%	0.7%	0.8%	0.8%	0.8%
Breakeven price inflation 15y	2.1%	1.8%	1.5%	1.6%	1.6%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%
A Corporate bond yield 5y	3.5%	4.5%	5.0%	5.2%	5.4%	5.5%	5.5%	5.5%	5.4%	5.4%	5.4%
Long A Corporate bond yield 10y	4.0%	4.6%	4.9%	5.0%	5.1%	5.2%	5.2%	5.2%	5.3%	5.3%	5.4%
A Corporate spread 5y	0.9%	3.0%	3.8%	3.8%	3.6%	3.1%	3.1%	3.1%	2.9%	2.8%	2.9%
Long A Corporate spread 10y	1.1%	2.8%	3.5%	3.3%	3.1%	2.7%	2.7%	2.8%	2.8%	2.9%	3.0%
Expected nominal return on assets											
Equity - US		-18.1%	-10.0%	10.7%	5.7%	5.7%	5.8%	5.9%	5.9%	6.0%	6.0%
Equity - Global		-20.9%	-11.5%	11.6%	6.1%	6.1%	6.2%	6.3%	6.4%	6.5%	6.6%
A Corporate bonds 5y		0.0%	1.5%	3.1%	2.7%	3.5%	4.1%	4.2%	4.2%	4.3%	4.3%
Long A Corporate bonds 10y		-1.8%	0.2%	2.7%	2.0%	2.2%	3.4%	3.5%	3.5%	3.5%	3.5%
Treasury 5y		7.8%	2.9%	0.6%	-0.3%	-0.2%	2.3%	2.4%	2.3%	2.3%	2.5%
Long Treasury 15y		16.9%	8.4%	0.0%	-1.8%	-3.8%	2.8%	2.9%	2.8%	2.8%	3.0%
TIPS 5y		4.4%	0.4%	-0.5%	-0.6%	-0.6%	1.5%	1.6%	1.8%	1.9%	1.9%
Long TIPS 15y		8.3%	2.6%	1.3%	-2.0%	-1.5%	1.9%	2.0%	2.2%	2.3%	2.3%
US High Yield		-11.2%	-6.3%	7.3%	4.0%	4.0%	3.6%	4.0%	4.4%	4.4%	4.8%
Bank Loans		-5.6%	-2.2%	5.9%	4.1%	4.1%	4.4%	4.4%	4.6%	4.7%	4.8%
USD Emerging Market Debt		-15.1%	-8.2%	7.8%	3.9%	4.2%	4.2%	4.7%	4.7%	4.8%	5.5%
Local Emerging Market Debt		-15.6%	-8.4%	9.2%	4.6%	5.4%	5.0%	5.5%	5.4%	5.9%	5.6%
Real Estate		-12.6%	-7.5%	-2.3%	1.1%	5.0%	5.1%	5.1%	5.2%	5.3%	5.3%
Commodities		-27.0%	-21.1%	7.9%	4.5%	4.5%	4.6%	4.6%	4.7%	4.8%	4.9%
Hedge Funds - FoHF - Universe		-13.8%	-8.6%	6.9%	5.8%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%
Private Equity		-18.6%	-6.1%	13.4%	8.6%	8.8%	8.8%	8.8%	8.8%	8.7%	8.7%
Infrastructure - Europe		-5.9%	-1.5%	2.0%	2.8%	6.4%	6.4%	6.5%	6.5%	6.5%	6.6%
Cash		2.1%	0.9%	0.7%	1.1%	1.6%	1.7%	1.6%	1.6%	1.7%	1.8%
CPI		-0.3%	0.5%	0.8%	1.1%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%

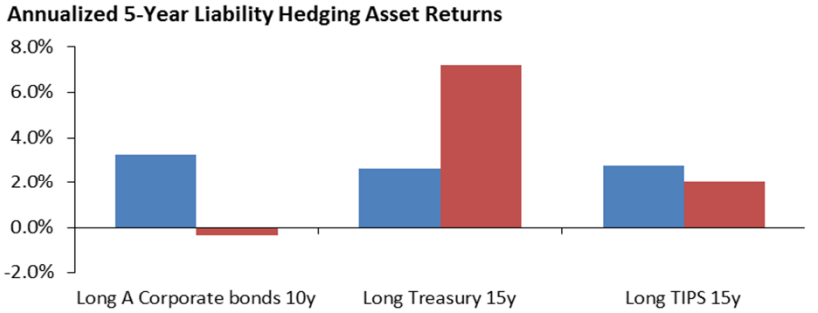
Scenario information as of March 31, 2018

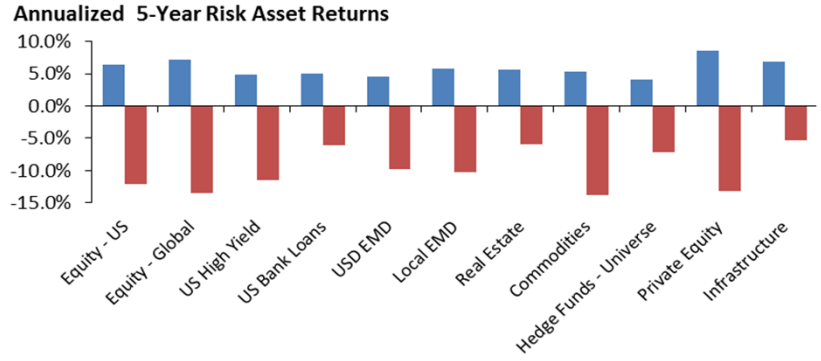
Black Skies Scenario

A Deep Recession Followed by a Longer Period of Stagnant Growth

- There is a sharp deterioration in the global economic outlook, as the Eurozone crisis flares up and there is a sharp slowdown in emerging market economies.
- The US experiences a protracted deep recession.
- Inflation is pushed into negative territory in 2018 and remains there in 2019, while continued sluggish growth over the following years means that inflation stays close to zero.
- Treasury yields fall and remain at low levels as the US enters recession.
- Corporate spreads rise significantly due to the poor economic situation and increased risks of downgrades or defaults.
- Risk assets make losses in the first few years. There is no pronounced bounce in growth and the economic situation remains poor for a long time, which weighs on returns in later years.







Source: Aon

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Black Skies Scenario
Data Table

BLACK SKIES SCENARIO

	Year 0	1	2	3	4	5	6	7	8	9	10
Yields (BOY)											
Treasury yield 5y	2.6%	0.5%	0.4%	0.4%	0.5%	0.7%	0.8%	0.7%	0.8%	0.9%	0.9%
Long Treasury yield 15y	2.9%	1.3%	1.0%	1.0%	1.0%	1.2%	1.2%	1.2%	1.2%	1.2%	1.3%
TIPS yield 5y	0.5%	-0.4%	-0.5%	-0.5%	-0.3%	-0.2%	-0.1%	-0.1%	-0.1%	-0.2%	-0.2%
Long TIPS yield 15y	0.8%	0.0%	-0.1%	-0.1%	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Breakeven price inflation 15y	2.1%	1.3%	1.1%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
A Corporate bond yield 5y	3.5%	4.5%	5.4%	5.6%	5.5%	5.2%	5.2%	5.2%	5.1%	5.1%	5.1%
Long A Corporate bond yield 10y	4.0%	4.6%	5.2%	5.2%	5.1%	4.8%	4.9%	4.9%	4.9%	5.0%	5.0%
A Corporate spread 5y	0.9%	4.0%	5.0%	5.1%	5.0%	4.5%	4.5%	4.5%	4.4%	4.2%	4.3%
Long A Corporate spread 10y	1.1%	3.7%	4.5%	4.5%	4.3%	3.9%	3.9%	4.0%	4.0%	4.1%	4.1%
Expected nominal return on assets											
Equity - US		-28.8%	-20.8%	-11.5%	2.6%	2.6%	3.0%	3.3%	3.7%	4.1%	4.5%
Equity - Global		-31.8%	-23.0%	-12.6%	2.7%	2.7%	3.1%	3.6%	4.0%	4.5%	4.9%
A Corporate bonds 5y		-0.4%	-1.8%	1.1%	1.7%	2.8%	1.5%	1.7%	1.7%	1.8%	1.9%
Long A Corporate bonds 10y		-2.5%	-4.3%	0.9%	1.4%	2.9%	0.8%	0.9%	0.8%	0.8%	0.8%
Treasury 5y		11.9%	1.3%	0.3%	0.1%	0.1%	0.7%	0.8%	0.7%	0.7%	0.9%
Long Treasury 15y		29.0%	7.2%	2.4%	0.4%	-0.4%	1.8%	1.9%	1.8%	1.8%	2.0%
TIPS 5y		3.0%	-0.9%	-0.3%	-0.3%	-0.4%	0.2%	0.3%	0.4%	0.6%	0.6%
Long TIPS 15y		10.5%	0.7%	0.6%	-0.7%	-0.4%	0.7%	0.8%	1.0%	1.2%	1.2%
US High Yield		-26.0%	-19.9%	-11.3%	1.4%	1.7%	1.5%	2.1%	2.8%	3.0%	3.6%
Bank Loans		-16.2%	-11.6%	-5.8%	2.1%	2.1%	2.5%	2.8%	3.1%	3.4%	3.8%
USD Emerging Market Debt		-23.0%	-17.1%	-9.1%	1.5%	1.8%	2.0%	2.7%	2.9%	3.3%	4.2%
Local Emerging Market Debt		-24.5%	-18.3%	-9.6%	1.9%	2.6%	2.5%	3.3%	3.5%	4.2%	4.2%
Real Estate		-15.2%	-10.7%	-4.8%	-0.3%	2.0%	2.4%	2.7%	3.1%	3.4%	3.8%
Commodities		-36.1%	-27.7%	-3.0%	3.0%	3.0%	3.2%	3.4%	3.7%	3.9%	4.1%
Hedge Funds - FoHF - Universe		-17.8%	-12.3%	-6.4%	0.9%	0.9%	1.2%	1.5%	1.9%	2.2%	2.5%
Private Equity		-32.4%	-23.5%	-12.3%	4.4%	4.4%	4.8%	5.2%	5.6%	6.1%	6.5%
Infrastructure - Europe		-13.7%	-9.2%	-5.3%	0.0%	2.7%	3.1%	3.5%	4.0%	4.4%	4.8%
Cash		2.1%	0.6%	0.5%	0.5%	0.6%	0.7%	0.6%	0.6%	0.7%	0.8%
CPI		-1.7%	-1.3%	0.2%	0.3%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%

Scenario information as of March 31, 2018

Appendix

- Blue Ribbon Panel Stress Testing

Blue Ribbon Panel
Background

- Commissioned by the Society of Actuaries in April 2013 to address growing concerns about the financial health of public pension sector and impact of:
  - 2008 financial crisis
  - Changing demographics
  - Risk levels in plan funding

- Focus on improvements in risk measurement and disclosures to improve plan financial management

- Multidisciplinary panel
  - Conducted survey of public plan actuaries/other organizations June 2013
  - Met with actuaries, the Actuarial Standards Board members, economists, investment advisors, plan administrators, trustees, unions and other stakeholders in July 2013
  - Series of meetings from May 2013 to January 2014

- Recommendations published in February 2014

Blue Ribbon Panel
Recommendations

- The Blue Ribbon Panel made a number of recommendations; however, for purposes of this asset-liability analysis, our focus is on their stress testing recommendation

- Stress Testing is recommended over a 30-year period reflecting the following:
  - Baseline actuarial rate of return for 30 years
  - Baseline actuarial rate of return + 3% for 20 years; baseline returns thereafter
  - Baseline actuarial rate of return - 3% for 20 years; baseline returns thereafter
  - Contribution only 80% of recommended actuarial contribution for 20 years; full contributions thereafter
    - This scenario assumes baseline actuarial rate of return for 30 years

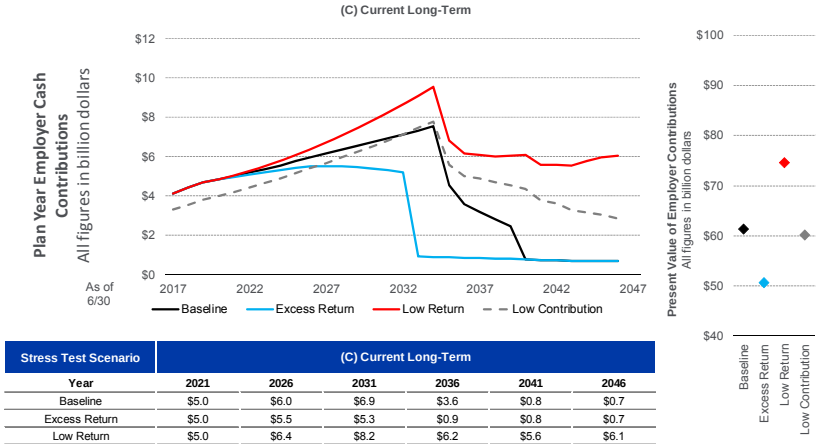
- The following slide illustrates the results of these stress test scenarios for PSERS under the Current Long-Term Target portfolio with the following assumptions:
  - Asset figures reflect actual performance for the period July 1, 2017 – March 31, 2018 (ending asset value of $54.3 billion)
  - **Baseline Scenario** – 7.25% return for 30 years
  - **Excess Return Scenario** – 10.25% return for 20 years; 7.25% thereafter
  - **Low Return Scenario** – 4.25% return for 20 years; 7.25% thereafter
  - **Low Contribution Scenario** – 80% of actuarial contribution for 20 years; full contribution thereafter

Blue Ribbon Panel
Stress Testing Results

Key Takeaways:

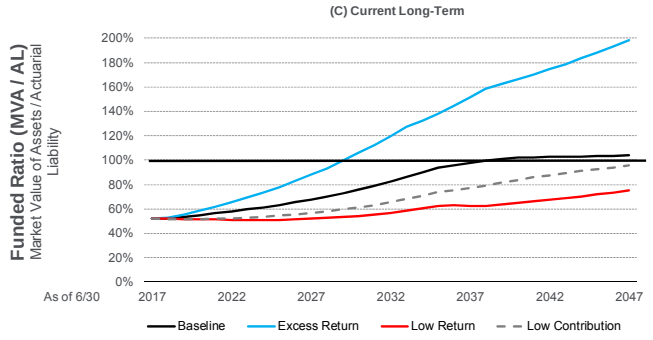
- **Excess Return Scenario:** higher returns lead to higher funded ratio and lower contributions
- **Low Return Scenario:** lower returns lead to lower funded ratio and higher contributions
- **Low Contributions Scenario:** funding less than the full actuarial determination will have a slower growth in funded ratio ultimately leading to higher contributions down the line

Employer Contributions



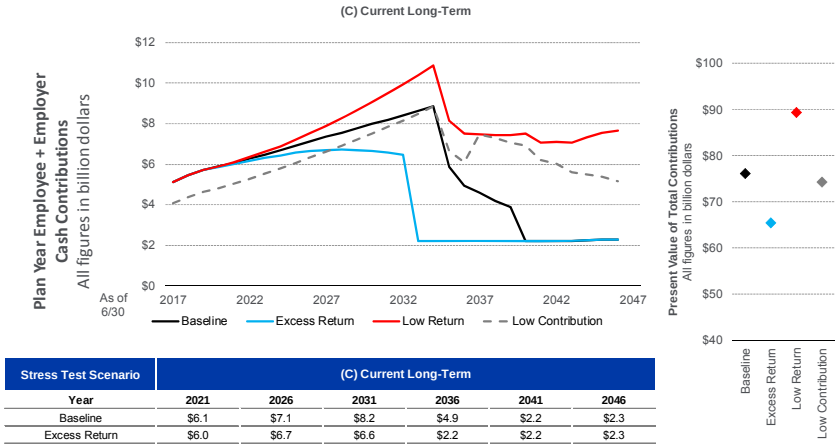
Stress Test Scenario	(C) Current Long-Term					
Year	2021	2026	2031	2036	2041	2046
Baseline	$5.0	$6.0	$6.9	$3.6	$0.8	$0.7
Excess Return	$5.0	$5.5	$5.3	$0.9	$0.8	$0.7
Low Return	$5.0	$6.4	$8.2	$6.2	$5.6	$6.1
Low Contribution	$4.2	$5.4	$6.8	$5.0	$3.8	$2.8

Funded Ratio



Stress Test Scenario	(C) Current Long-Term					
Year	2022	2027	2032	2037	2042	2047
Baseline	58%	68%	82%	98%	103%	104%
Excess Return	65%	88%	120%	151%	174%	198%
Low Return	51%	52%	57%	63%	68%	75%
Low Contribution	52%	57%	66%	77%	88%	96%

Gross Contributions (Employee + Employer)



Stress Test Scenario	(C) Current Long-Term					
Year	2021	2026	2031	2036	2041	2046
Baseline	$6.1	$7.1	$8.2	$4.9	$2.2	$2.3
Excess Return	$6.0	$6.7	$6.6	$2.2	$2.2	$2.3
Low Return	$6.1	$7.6	$9.5	$7.5	$7.1	$7.7
Low Contribution	$5.0	$6.4	$7.8	$6.1	$6.2	$5.2

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Blue Ribbon Panel
Stress Testing Conclusions

- Deterministic projections are beneficial in the absence of other stress testing because it aids a plan sponsor to understand the risks inherent in the pension plan should actual experience differ from expectations

- The Blue Ribbon Panel's deterministic scenarios are limited in that they imply a smooth pattern of results over time rather than a choppier progression of highs and lows (i.e., +/-3% of the expected return on assets for 20 years)
  - For this reason, Aon prefers the robustness of our stochastic projection analysis as it looks at 5,000 individual scenarios over a period of 30 years with each individual scenario exhibiting a non-uniform pattern of results

- The overall takeaways from the Blue Ribbon Panel stress testing analysis coincide with Aon's stochastic projection analysis
  - Contributions are expected to increase over the next 15-20 years, decreasing (or increasing) from baseline expectations depending on actual versus expected asset performance
  - Results for the Employer contributions in the Blue Ribbon Panel's Low Return scenario are comparable to the 75th percentile outcome under our stochastic analysis
    - Approximately 25% of Aon's scenarios in its stochastic analysis are worse than the Blue Ribbon Panel's Low Return scenario, making for an even more conservative stress testing approach

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

Appendix

- Investment Guidance for Public Employee Retirement System Trustees

Investment Guidance for Public Employee Retirement System Trustees[1]

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

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

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

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

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

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

Appendix

- Asset-Liability Management Background

Asset-Liability Management Background

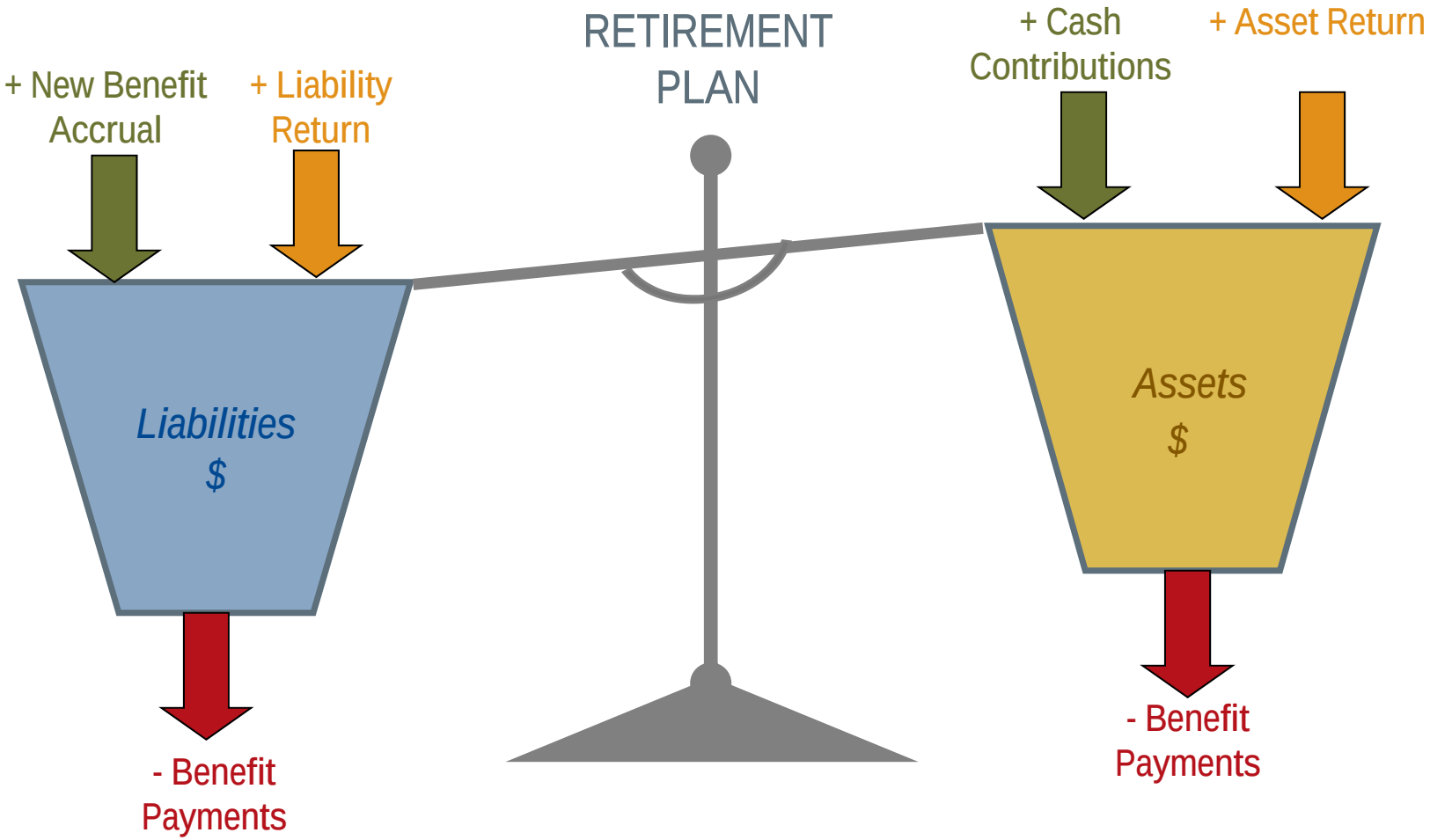
What is an Asset-Liability Study?

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

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

Asset-Liability Management Background

Balance of Liabilities and Assets



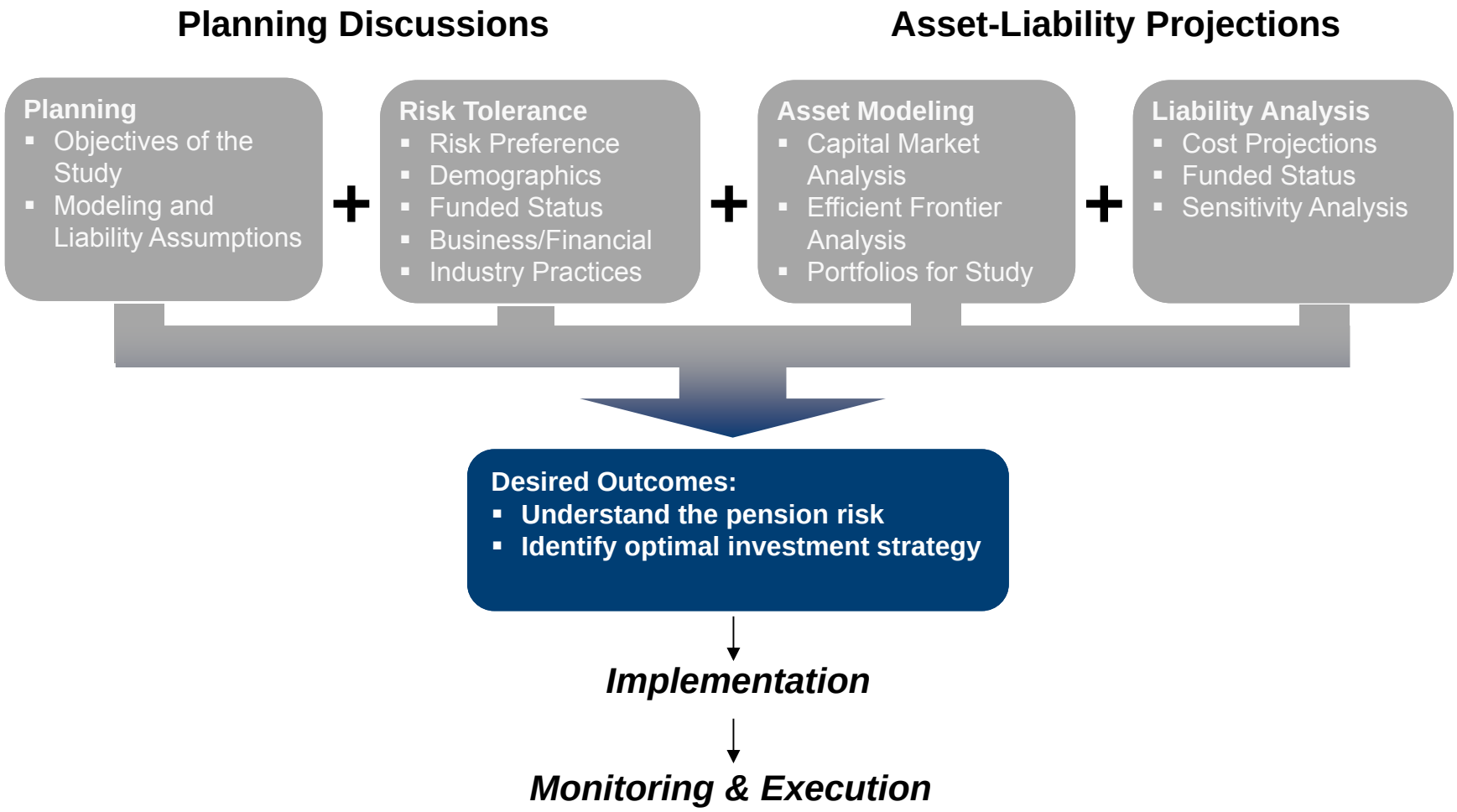
Asset-Liability Management Background

Key Risks for Public Pension Plans

Types of Risk	Time Horizon	Risk Management Tools and Controls
Return Shortfall ▪ Assets do not grow with liabilities ▪ Investment return & contribution less than liability growth	**Long-Term** (10+ years)	▪ Funding policy ▪ Plan design ▪ Investment policy ▪ Assumptions & methods
Liquidity ▪ Cannot liquidate assets efficiently to meet needs ▪ 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

Asset-Liability Management Background

Overview of the Asset-Liability Study Process



Asset-Liability Management Background
Modeling Process

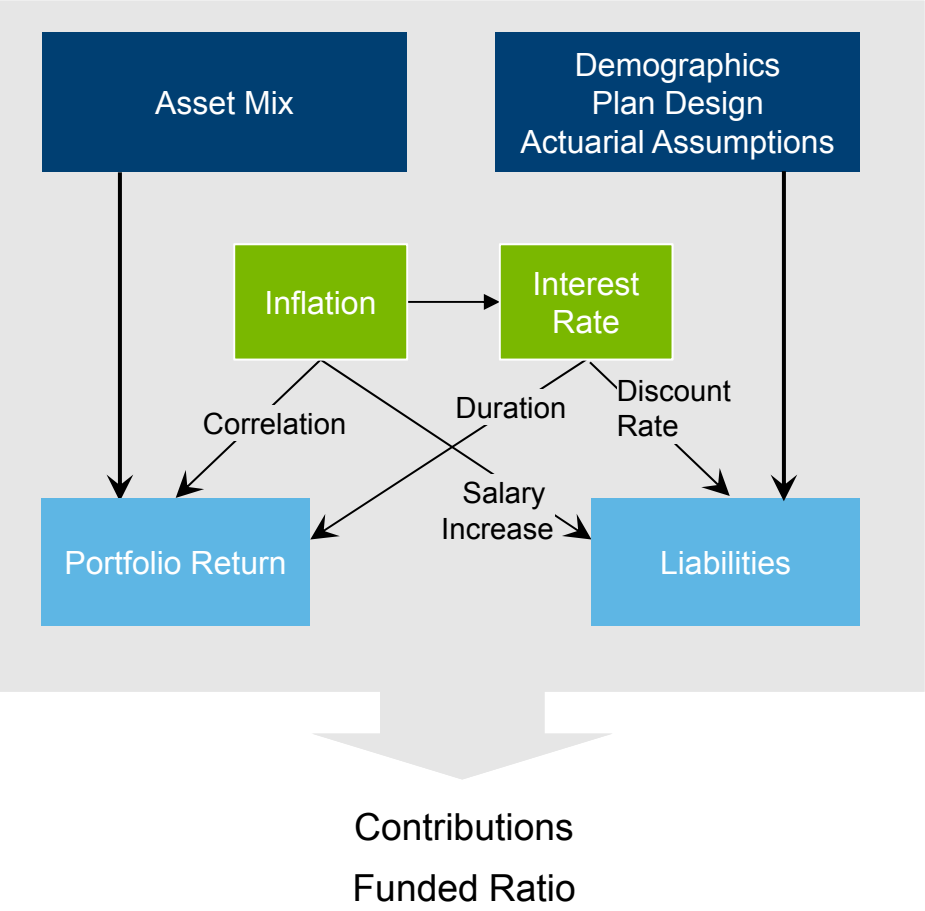
- Goals of an asset-liability study:
  - Understand the pension plan's asset-liability risk, and
  - Identify the optimal investment strategies

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

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

Asset-Liability Management Background

Mechanics of Asset-Liability Modeling Process



Asset and liability modeling integrated in single platform

- Integrates impact of key economic variables

Flexibility in modeling parameters and output to client preferences

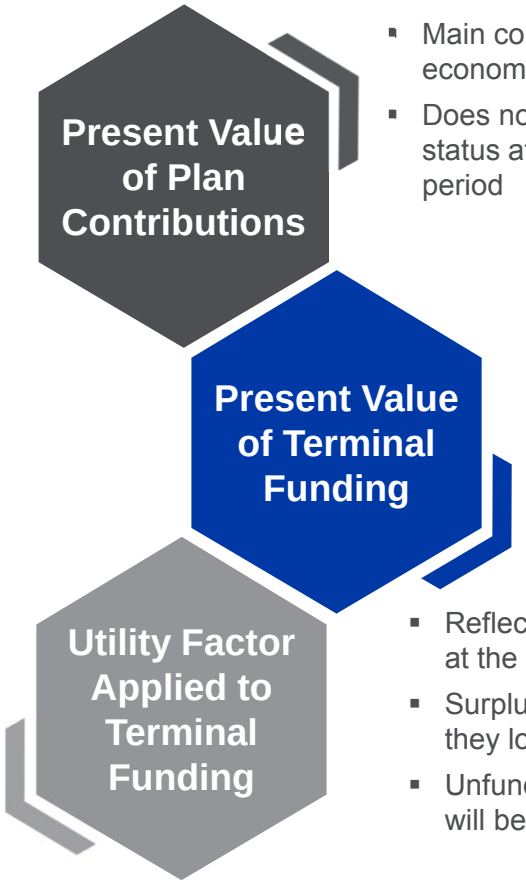
Stochastic and deterministic modeling performed

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

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
- Liquidity
- 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 2017 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, 2017.

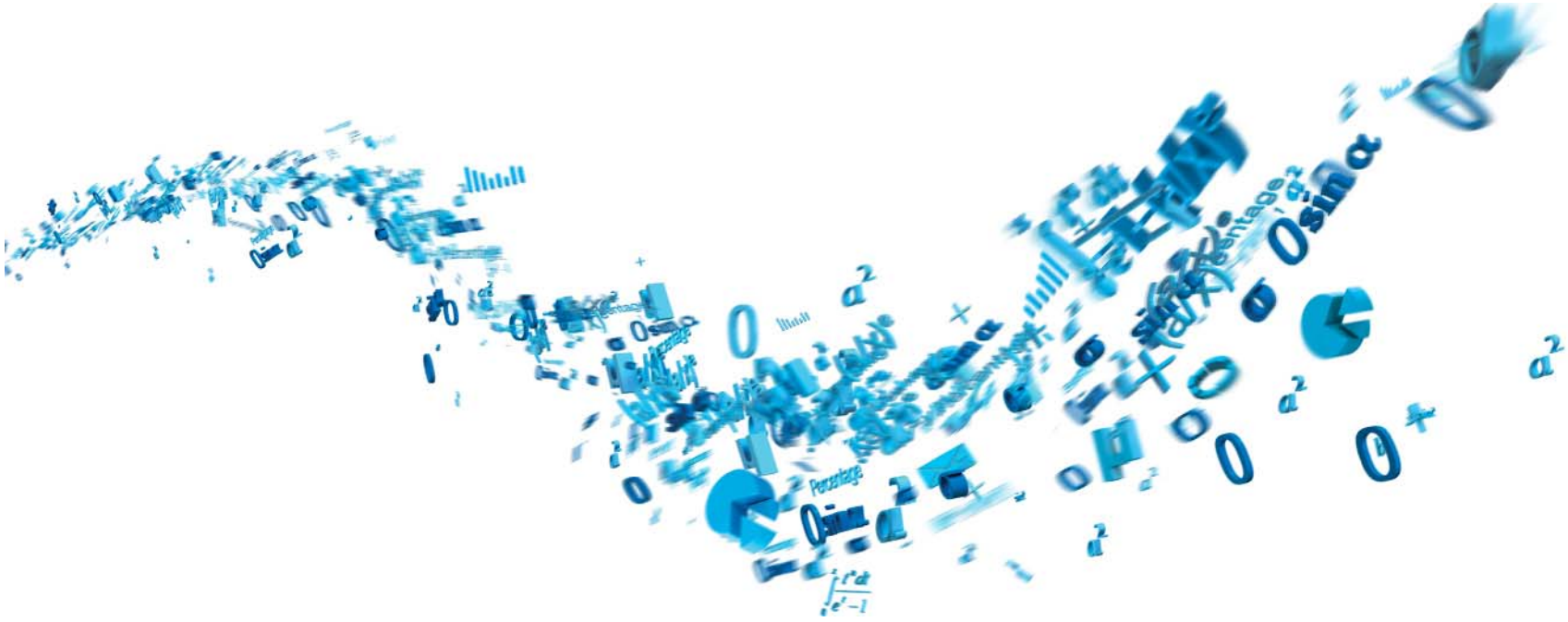
In conducting these projections, we have relied on plan design, demographic and financial information provided by other parties, including the plan's actuary and plan sponsor. While we cannot verify the accuracy of all of the information, the supplied information was reviewed for consistency and reasonableness. 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 associate 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



Asset-Liability Study Results

Pennsylvania Public School Employees' Retirement System (PSERS)
July 2018

NEXT

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