PSERS

DATE: July 22, 2019

SUBJECT: Proposed Revisions to Investment Policy Statement, Objectives, and Guidelines

TO: Members of the Board

FROM: Joseph W. Sheva, CPA, FRM JWS
Senior Risk Manager

At the August Investment Committee meeting, the Investment Office will recommend that the Board adopt the Investment Policy Statement, Objectives and Guidelines (IPS) revisions described below to sections IV. Strategic Asset Allocation, V. Performance Objectives, VI. Risk Management and Controls and VIII. Definitions with an effective date of October 1, 2019.

IV. Strategic Asset Allocation – Long-Term Target Allocation:

The Investment Office and Aon recommend the following summarized changes to the Long-Term Target Allocation:

Asset Class:	Current Target	Proposed Target	Change
Investment Grade	11%	12%	1%
Credit-Related	10%	12%	2%
Risk Parity	10%	8%	-2%
Market Exposure Increase:	**31%**	**32%**	**1%**

Explicit Leverage:	Current Target	Proposed Target	Change
Cash	3%	3%	0%
Leverage (gross)*	-20%	-21%	-1%
Net Leverage	**-17%**	**-18%**	**-1%**

* Depicted as "Financing Cost of Leverage" in IPS

Aon's Asset Liability Study and presentation at the August meeting will cover the above changes in detail, with a summary as follows:

- The 1% increase in the Investment Grade asset class is to US Long Treasuries. This is intended to provide greater fund-level resiliency during stress periods.
- The 2% increase in the Credit-Related asset class is to Private Credit. Private Credit is an asset class that is expected to perform well over the long-term on a risk-adjusted basis and also provides strong diversification benefits for the fund as a whole.
- The 2% decrease in the Risk Parity asset class and the 1% increase in Leverage are funding the increases to US Long Treasuries and Private Credit. This is consistent with the ongoing goal for the fund as a whole to be more risk balanced and diversified.

- The 1% increase in Leverage which is explicit leverage is offset by the reduction in embedded leverage coming from the 2% reduction to the Risk Parity asset class, as the Risk Parity asset class has embedded leverage.

IV. Strategic Asset Allocation – Current Target Allocation:

The Investment Office and Aon recommend no changes to the Current Target Allocation.

V. Performance Objectives:

A. While there are no changes to the Current Target Allocation, the Policy Index has more granularity than the Current Target Allocation. At this more granular level, the Investment Office and Aon recommend the following summarized changes, as determined by Aon's Asset Liability Study:

Asset Class:	Current Target	Proposed Target	Change
Equity Exposure			
Global Ex-US Equity	9.70%	8.70%	-1.00%
Emerging Markets Equity	0.50%	1.50%	1.00%
Real Asset Exposure - Infrastructure			
Master Limited Partnerships	4.00%	3.00%	-1.00%
Private Infrastructure*	0.00%	1.00%	1.00%
Real Asset Exposure - Real Estate			
Public Real Estate	1.00%	2.00%	1.00%
Private Real Estate	9.00%	8.00%	-1.00%

* The Policy Index identifies performance benchmarks. Private Infrastructure in the current Policy Index is presented as part of the Public Infrastructure benchmark percentage. In Aon's benchmark review, it is being proposed to show the Private Infrastructure independently.

The table shows that the weights for Equity Exposure, Real Asset Exposure – Infrastructure and Real Asset Exposure – Real Estate exposure remain unchanged. At the more granular level, however, there are changes. Aon's Asset Liability Study and presentation at the August meeting will cover these changes in detail, with a summary as follows:

- **<u>Equity Exposure:</u>** The small shift from Global Ex-US Equity to Emerging Markets Equity is reflective of the world evolving toward a greater share of the global economy and global capital markets being represented by emerging markets.
- **<u>Real Asset Exposure – Infrastructure:</u>** The small shift from Master Limited Partnerships to Private Infrastructure improves diversification of the Infrastructure allocation, as MLPs represent a meaningful but still narrow segment of infrastructure, namely, energy midstream infrastructure.

- **Real Asset Exposure – Real Estate:** The small shift from Private Real Estate to Public Real Estate improves diversification of the Real Estate allocation, while also serving to keep the allocation to illiquid assets consistent by offsetting the increase to Private Infrastructure.

B. The Investment Office and Aon recommend changes to the Policy Index benchmarks as presented on the "PSERS Policy Index Review Summary" page of the Aon Benchmark Review presentation. Hamilton Lane, the Board's Non-Traditional Investments investment consultant, deemed the recommended performance benchmarks for Private Equity, Private Credit, Private Infrastructure and Private Real Estate, to be reasonable and appropriate, considering the characteristics of the underlying holdings within each respective portfolio, as noted in their attached memo. Aksia, the Board's Absolute Return investment consultant, deemed the recommended performance benchmark for the Absolute Return program to be reasonable and appropriate, as noted in their attached memo.

VI. Risk Management and Controls:

The Investment Office and Aon recommend adding risk benchmarks as presented on the "PSERS Policy Index Review Summary" page of the Aon Benchmark Review presentation. The inclusion of risk benchmarks within the IPS will provide a framework for improved ex-ante risk and reporting discussions.

Hamilton Lane, the Board's Non-Traditional Investments investment consultant, deemed the recommended risk benchmarks for Private Equity, Private Credit, Private Infrastructure and Private Real Estate, to be reasonable and appropriate, considering the characteristics of the underlying holdings within each respective portfolio, as noted in their attached memo. Aksia, the Board's Absolute Return investment consultant, deemed the recommended risk benchmark for the Absolute Return program to be reasonable and appropriate, as noted in their attached memo.

VIII. Definitions:

The Investment Office recommends updating the Index section within the Definitions section to be consistent with the Board's adopted performance and risk benchmarks. This will be completed after Board approval of the above.

A blacklined excerpt and a clean copy of the above recommendations have been included in the package for your review. The Investment Office will also update section VIII. Definitions after Board approval of the performance benchmark and risk benchmark recommendations. Also, Aon professionals will be present at the Board meeting to present the Asset Liability Study, Liquidity Analysis, Stress Testing Analysis and Benchmark review and answer any questions regarding the above recommendations.

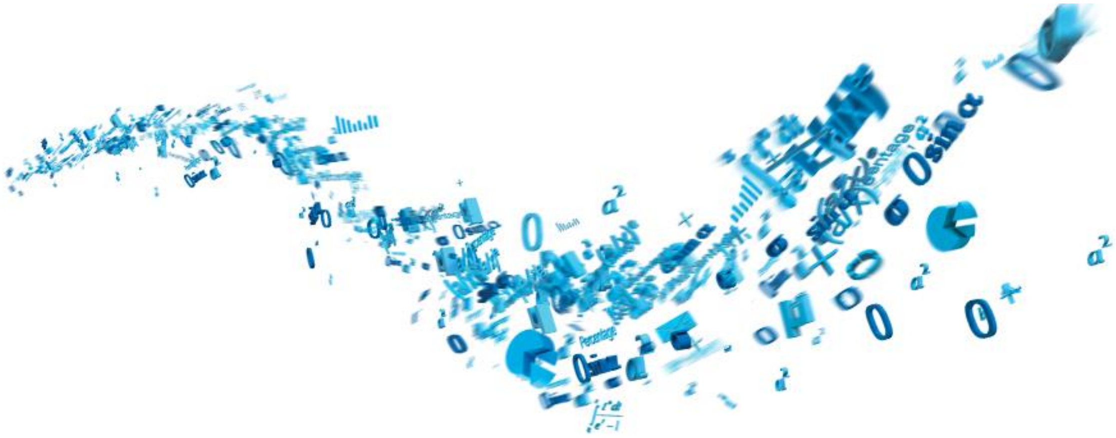
Please contact me at 717-720-4632 with any questions.

Benchmark Review – Full Report

Pennsylvania Public School Employees’ Retirement System (PSERS)
July 2019

Empower Results®

Contents



Introduction

Introduction

- The purpose of these materials is to review existing policy performance benchmarks for broad level asset classes
  - *US Equity*
  - *Non-US Equity Developed*
  - *Emerging Market Equity*
  - *Core Fixed Income*
  - *Long Treasuries*
  - *High Yield Bonds*
  - *Emerging Market Debt*
  - *Inflation-Linked Bonds*
  - *Alternative Investments (Infrastructure, MLPs, Commodities, Gold, Private/Public Real Estate, Private Equity, Risk Parity & Absolute Return)*
  - *Financing*

- Establish risk benchmarks different from performance benchmarks where needed

- Provide holdings-based analysis for equity asset classes

Our Philosophy on Benchmarks

<u>We recommend benchmarks that have the following characteristics:</u>

- **Broad coverage**
  - *Market capitalization*
  - *Countries*
  - *Sectors*
  - *Number of securities*
- **Investable**
  - *Easily replicated through passive management*
  - *Liquidity considerations*
  - *Bond indexes are typically not investable*
- **Transparent**
  - *Rules-based methodology*
  - *Holdings available for review*
- **Appropriate**
  - Representative of asset class characteristics for desired asset class
  - Portfolio's assets are similar to the benchmark
  - Minimizes tracking error (active risk) of portfolio against the benchmark
- **Risk Benchmarks**
  - Be consistent with the performance benchmark in most cases
  - For private markets, consider public market proxies which are better representatives of the underlying characteristics of the holdings (geographic, market cap and volatility)

PSERS Policy Index Review Summary

Asset Class	Current Policy Performance Index	Proposed Policy Performance Index (if different)	Proposed Risk Benchmark (if different from Performance Index)
U.S. Equity	MSCI USA IMI Index	75% S&P 500 Index 12.5% S&P MidCap 400 Index 12.5% S&P SmallCap 600 Index	
Non-U.S. Equity	MSCI AC World ex USA IMI Index (75% Hedged)		
Emerging Markets Equity	MSCI Emerging Markets IMI Index		
Private Equity	Burgiss All Private Markets ex Real Estate (1Q Lag)		65% MSCI USA Small Cap/35% MSCI ACWI ex-US Small Cap
U.S. Fixed Income	Bloomberg Barclays U.S. Aggregate Index		
Non-U.S. Fixed Income	Bloomberg Barclays Global Agg GDP-Wtd Dev Mkts ex-US (Hedged)		
U.S. Long Treasuries	Bloomberg Barclays U.S. Long Treasury Index		
Emerging Markets Debt	Bloomberg Barclays EM Local Currency Gov't 10% Capped	33% JPM EMBI Global Div/ 33% JPM GBI-EM Broad Div/ 33% ICE BofAML EM Corp Plus (Hdg)	
Public High Yield	Bloomberg Barclays U.S. Corporate High Yield Index		
Private Credit	N/A	S&P/LSTA Leveraged Loan Index +200bps	S&P/LSTA Leveraged Loan Index
U.S. TIPS	N/A (Global)	Bloomberg Barclays US Gov't Inflation-Linked All Maturities Total Return Index (B Series)	
Non-U.S. Inflation-Linked	N/A (Global)	Bloomberg Barclays World Gov't ex-US Inflation-Linked Bonds All Maturity Total Return Index (Hedged) (B Series)	
MLP	S&P MLP Index Total Return	Alerian Midstream Energy Total Return	
Public Infrastructure	FTSE Developed Core Infrastructure 50/50 Index (Hedged)		
Private Infrastructure	N/A	FTSE Developed Core Infrastructure 50/50 Index (Hedged) (1Q Lag)	FTSE Developed Core Infrastructure 50/50 Index (Hedged)
Commodities	Bloomberg Commodity Index		
Gold	Bloomberg Commodity Gold Subindex		
Private Real Estate	Hybrid Burgiss Value-Added/Opportunistic Medians/NCREIF ODCE (1Q Lag)		90% FTSE NAREIT Composite/10% FTSE/EPRA NAREIT Developed ex US
Public Real Estate	FTSE EPRA/NAREIT Developed Index Hedged		
Risk Parity	Static Weight Hybrid		
Absolute Return	3-Month LIBOR + 350 bps	HFRI FOF: Conservative Index +100bps	HFRI FOF: Conservative Index
Financing	3-Month LIBOR		

See the Appendix for a listing of the benchmark tickers

PSERS Policy Index Review Summary

Benchmarks Reviewed	Recommendation
U.S. Equity	
MSCI USA IMI Index (current) S&P Composite 1500 Index Dow Jones U.S. Total Stock Market Index 75% S&P 500 Index / 12.5% S&P MidCap 400 Index / 12.5% S&P SmallCap 600 Index	**Consider replacing** the current policy index with a blended benchmark composed of 75% S&P 500 Index, 12.5% S&P MidCap 400 Index, and 12.5% S&P SmallCap 600 Index, which is representative of the broad U.S. equity market, as well as the PSERS portfolio exposures.
Non-U.S. Equity	
MSCI AC World ex USA IMI Index (current)* FTSE Global ex US All Cap Index S&P Global ex US BMI * Hedged to the current policy hedge ratio of 75%	**Maintain** current policy index, the MSCI AC World ex USA IMI Index, which captures large, mid and small cap exposure across 22 developed markets countries and 24 emerging markets countries. Index covers approximately 99% of the global equity opportunity set outside the U.S. The index will be hedged to the current hedge ratio of 75%.
Emerging Markets Equity	
MSCI Emerging Markets IMI Index (current) MSCI Emerging Markets Index FTSE Emerging Index S&P Emerging BMI	**Maintain** current policy index, the MSCI Emerging Markets IMI Index, which captures large, mid and small cap representation across 24 emerging markets countries. With 2,687 constituents, the index covers approximately 99% of the free float-adjusted market capitalization in each country.
Private Equity	
Burgiss All Private Markets ex Real Estate 1Q lagged (current) Public Equity+ (65% US Small/35% Non-US Small) + 200bps 1Q lagged Cambridge Associates U.S. PE 1Q lagged	**Maintain** current policy index, Burgiss All Private Markets ex Real Estate (1Q lagged), which captures total market returns, and reflects all exposures utilized. **Add** public equity+ blend of 65% MSCI USA Small Cap/35% MSCI ACWI ex. U.S. Small Cap + 200bps (1Q Lag) as a long-term secondary performance benchmark.
U.S. Fixed Income	
Bloomberg Barclays U.S. Aggregate Index (current) Bloomberg Barclays U.S. Universal Index	**Maintain** current policy index, the Bloomberg Barclays U.S. Aggregate Index, which remains the industry standard for U.S. fixed income.
Non-U.S. Fixed Income	
Bloomberg Barc. Global Aggregate GDP-Weighted Dev Mkt ex-US Hedged (current) FTSE Non-US World Government Bond Index Hedged	**Maintain** current policy index, the Bloomberg Barclays Global Aggregate GDP-Weighted Developed Markets ex-US Hedged Index, which offers broader market exposure including non-government issues vs. the strictly government FTSE alternative. The Bloomberg index is also GDP-weighted, which reduces the index weight to Japan.
U.S. Long Treasuries	
Bloomberg Barclays U.S. Long Treasury Index (current) ICE BofAML US Treasuries 15+ Index	**Maintain** current policy index, the Bloomberg Barclays U.S. Long Treasury Index, which provides broader market exposure vs. the BofA alternative by allowing securities with a minimum maturity of 10 years vs. 15 years.

PSERS Policy Index Review Summary

Benchmarks Reviewed	Recommendation
Emerging Markets Debt	
Bloomberg Barclays EM Local Currency Gov't 10% Capped (current) JPM EMBI Global Diversified JPM GBI-EM Global Diversified ICE BofAML Emerging Market Corporate Plus Index (USD Hedged) 33% JPM EMBI Global Diversified/33% JPM GBI-EM Broad Diversified, 33% ICE BofAML Emerging Market Corporate Plus Index (USD Hedged)	**Consider replacing** the current policy index with an equal-weighted blend of JPM EMBI Global Diversified, JPM GBI-EM Broad Diversified, and ICE BofAML Emerging Market Corporate Plus Index (USD Hedged). The JPM indices are the industry standard for EMD, and the 1/3-each blend captures a mix government and corporate bonds, representing both hard and local currency exposure.
Public High Yield	
Bloomberg Barclays US Corporate High Yield Index (current) BofA Merrill Lynch High Yield Master II FTSE High-Yield Market	**Maintain** current policy index, the Bloomberg Barclays US Corporate High Yield Index, which represents the market exposure of the High Yield market.
Private Credit	
HFRI Distressed/Restructuring Index 50% Bloomberg Barclays US Corporate High Yield/50% S&P LSTA Levered Loan Index S&P/LSTA Leveraged Loan Index S&P LSTA Leveraged Loan Index + 200bps 2X Levered S&P/LSTA Leveraged Loan Index (3M LIBOR Adjusted)	**Consider adopting** the S&P/LSTA Leveraged Loan Index +200bps as the policy index for Private Credit.
U.S. TIPS	
Bloomberg Barclays US Gov't Inflation-Linked All Maturities Total Return Index ICE BofAML All Maturity US Inflation-Linked Treasury Index	**Consider adopting** the Bloomberg Barclays US Gov't Inflation-Linked All Maturities Total Return Index as the policy index for U.S. TIPS.
Non-U.S. Inflation-Linked	
Bloomberg Barclays World Gov't ex-US Inflation-Linked Bonds All Maturity Total Return Index (Hedged) ICE BofAML Global ex-US Diversified Inflation-Linked Index (Hedged)	**Consider adopting** the Bloomberg Barclays World Gov't ex-US Inflation-Linked Bonds All Maturity Total Return Index (Hedged) as the policy index for Non-U.S. TIPS.
MLP	
S&P MLP Total Return Index (current) Alerian MLP Total Return Index Alerian Midstream Energy Total Return Index	**Consider replacing** the current policy index, with the Alerian Midstream Energy Total Return index. The Alerian index is more broadly diversified by name and geography.
Public Infrastructure	
FTSE Developed Core Infrastructure 50/50 (current)* S&P Global Infrastructure FTSE Global Infrastructure Dow Jones Brookfield Infrastructure Composite Index	**Maintain** current policy index, the FTSE Developed Core Infrastructure 50/50 Index (Hedged), which includes 50% Utilities, 30% Transportation including capping of 7.5% for railroads/railways and a 20% mix of other sectors including pipelines, satellites and telecommunication towers.
Private Infrastructure	
FTSE Developed Core Infrastructure 50/50 (1Q Lag)*	**Consider adopting** the FTSE Developed Core Infrastructure 50/50 Index (1Q Lag) (Hedged) as the policy index for Private Infrastructure.

* Policy Benchmark is 100% Hedged

Empower Results®

PSERS Policy Index Review Summary

Benchmarks Reviewed	Recommendation
Commodities	
Bloomberg Commodity Index (current) Bloomberg Roll Select Commodity Index S&P GSCI Total Return Index	**Maintain** current policy index, the Bloomberg Commodity Index, as the S&P alternative is less diversified, including more than 50% in energy.
Gold	
Bloomberg Commodity Gold Subindex (current) S&P GSCI Gold Index Total Return	**Maintain** current policy index, the Bloomberg Commodity Gold Subindex in order to be consistent with the Commodity policy index. The respective Gold indices are not differentiated enough to merit changing the policy index.
Private Real Estate	
Hybrid Burgiss Value-Added/Opportunistic Medians/NCREIF ODCE 1Q lagged (current) NCREIF ODCE + 200bps 1Q lagged 90% FTSE NAREIT Composite/10% FTSE EPRA/NAREIT Developed ex US	**Maintain** current policy index, the Hybrid Burgiss Value-Added/Opportunistic Medians/NCREIF ODCE 1Q Lagged, which captures actual benchmark returns of each real estate style in PSERS portfolio (Core, Value-Add and Opportunistic). **Add** the NCREIF ODCE + 200bps (1Q lagged) as a long-term secondary performance benchmark.
Publicly-Traded Real Estate	
FTSE EPRA/NAREIT Developed Index* (current) Dow Jones Global Select REIT Index * 100% Hedged	**Maintain** current policy index, the FTSE EPRA/NAREIT Developed Index (Hedged), which provides broader coverage of the REIT market vs. the Dow Jones alternative, including more securities across more countries, with a smaller relative allocation to the U.S. market.
Risk Parity	
Static Weight Hybrid (current) 60% MSCI World/40% Barclays Agg 90-Day U.S. Treasury Bills 90-Day U.S. Treasury Bills + 600 bps HFR Risk Parity Vol 12 Institutional S&P Risk Parity Index – 12% Target Volatility Wilshire Risk Parity Index – 15% Garget Volatility	**Maintain** current policy index, a Static Weight Hybrid Index which is most representative of the market exposures of the strategy.
Absolute Return	
3-Month LIBOR + 350 bps (current) 90-Day U.S. Treasury Bills HFRI Fund Weighted Composite Index HFRX Absolute Return Index HFRI FOF: Conservative Index +100 bps HFRI FOF: Diversified Index +100 bps Custom Blend	**Consider replacing** current policy index with the HFRI FOF: Conservative Index +100 bps. The HFRI FOF: Conservative Index consists of hedge fund-of-funds which primarily have investment strategies that are equity market neutral, fixed income arbitrage, and convertible arbitrage. The strategies are broadly representative of the PSERS portfolio and exhibit similar return, equity beta and risk characteristics of the PSERS portfolio.
Financing	
3-Month LIBOR (current) 3-Month Treasury Bills Sterling Overnight Index Average (SONIA) Secured Overnight Financing Rate (SOFR)	**Maintain** current policy index, 3-Month LIBOR, which remains the industry standard for swap contracts and other derivative instruments. Consider reassessing alternatives in 2020 given the expected elimination of published LIBOR by year-end 2021.

U.S. Equity

U.S. Equity Index Definitions

- **MSCI USA IMI (Current Benchmark)** – Designed to measure the performance of the large, mid and small cap segments of the US market. The index covers approximately 99% of the free float-adjusted market capitalization in the US.
- **S&P Composite 1500** – Combines three leading indices, the S&P 500, the S&P MidCap 400, and the S&P SmallCap 600 to cover approximately 90% of the U.S. market capitalization.
- **Dow Jones U.S. Total Stock Market Index** – Designed to measure all U.S. equity issues with readily available prices.
- **S&P Hybrid –** Custom blended benchmark composed of 75% S&P 500 Index, 12.5% S&P 400 Index, and 12.5% S&P 600 Index.

Index	MSCI USA IMI	S&P Composite 1500	DJ U.S. Total Stock Market Index
Weighting Methodology	Float-adjusted Market Cap	Float-adjusted Market Cap	Float-adjusted Market Cap
Rebalancing Frequency	Quarterly	Quarterly	Quarterly

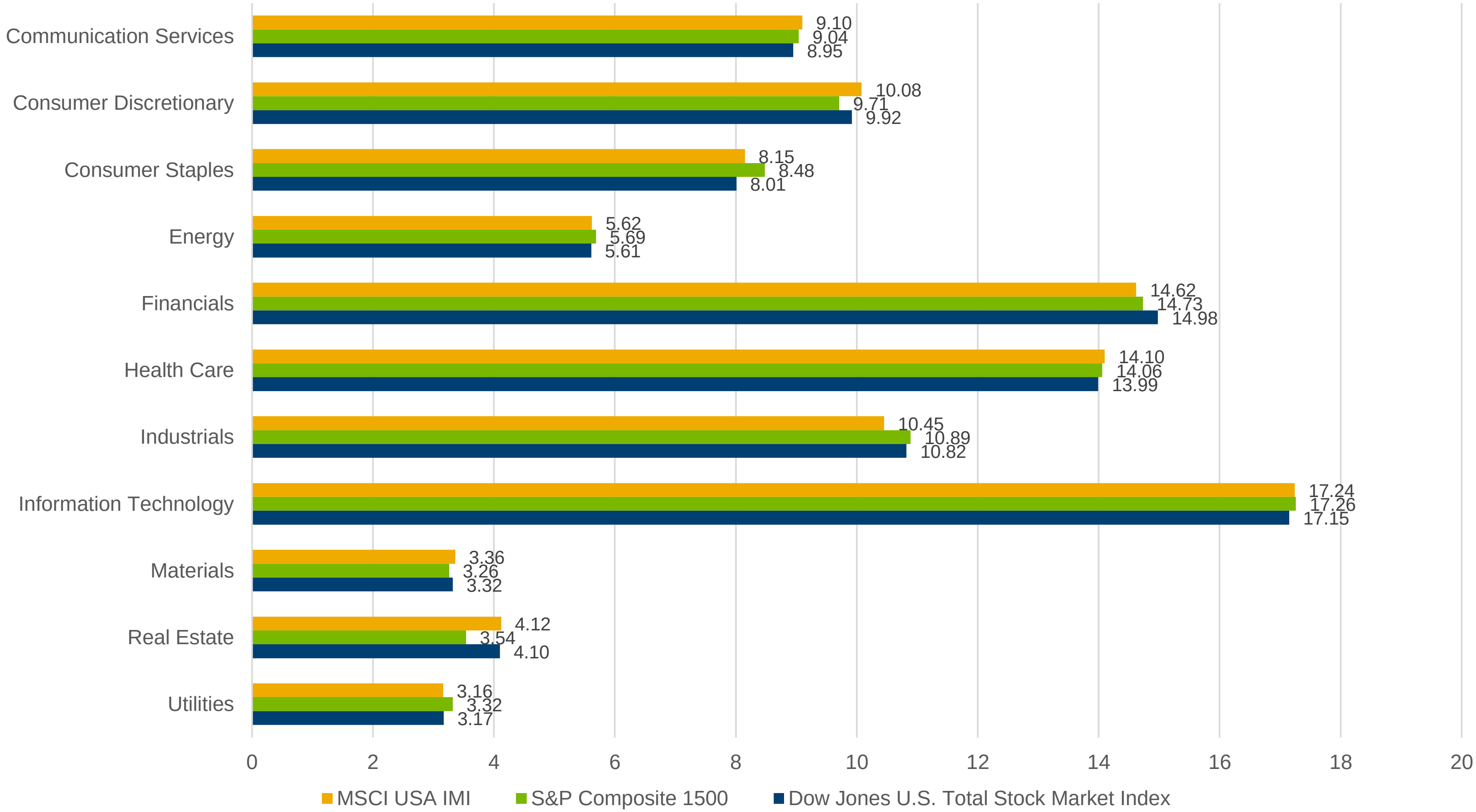
AHIC recommends that PSERS consider replacing the current U.S. Equity policy index, the MSCI USA IMI, with a custom blend of 75% S&P 500, 12.5% S&P MidCap 400, and 12.5% S&P SmallCap 600 Index. While the MSCI USA IMI represents broader market coverage, the S&P hybrid is reflective of the portfolio's exposures.

U.S. Equity Index Characteristics
As of March 31, 2019

	MSCI USA IMI	S&P Composite 1500	Dow Jones U.S. Total Stock Market Index
# of Holdings	2,473	1,506	3,800
% Top 15 Holdings	19.95	22.04	20.19
% Top 25 Holdings	27.36	30	27.48
Wtd. Avg. Mkt. Cap ($K)	137,863,142.59	150,003,284.63	138,092,515.85
Median Mkt. Cap ($K)	2,258,197.95	3,513,075.26	885,871.00
Price/Earnings ratio	21.67	21.70	21.55
Price/Book ratio	3.21	3.23	3.18
5 Yr. EPS Growth Rate	11.28	11.3	11.42
Current Yield	1.92	1.96	1.91
Number of Stocks	2,473	1,506	3,800
Debt to Equity	1.50	1.51	1.47
Forecast P/E	18.78	18.61	18.71

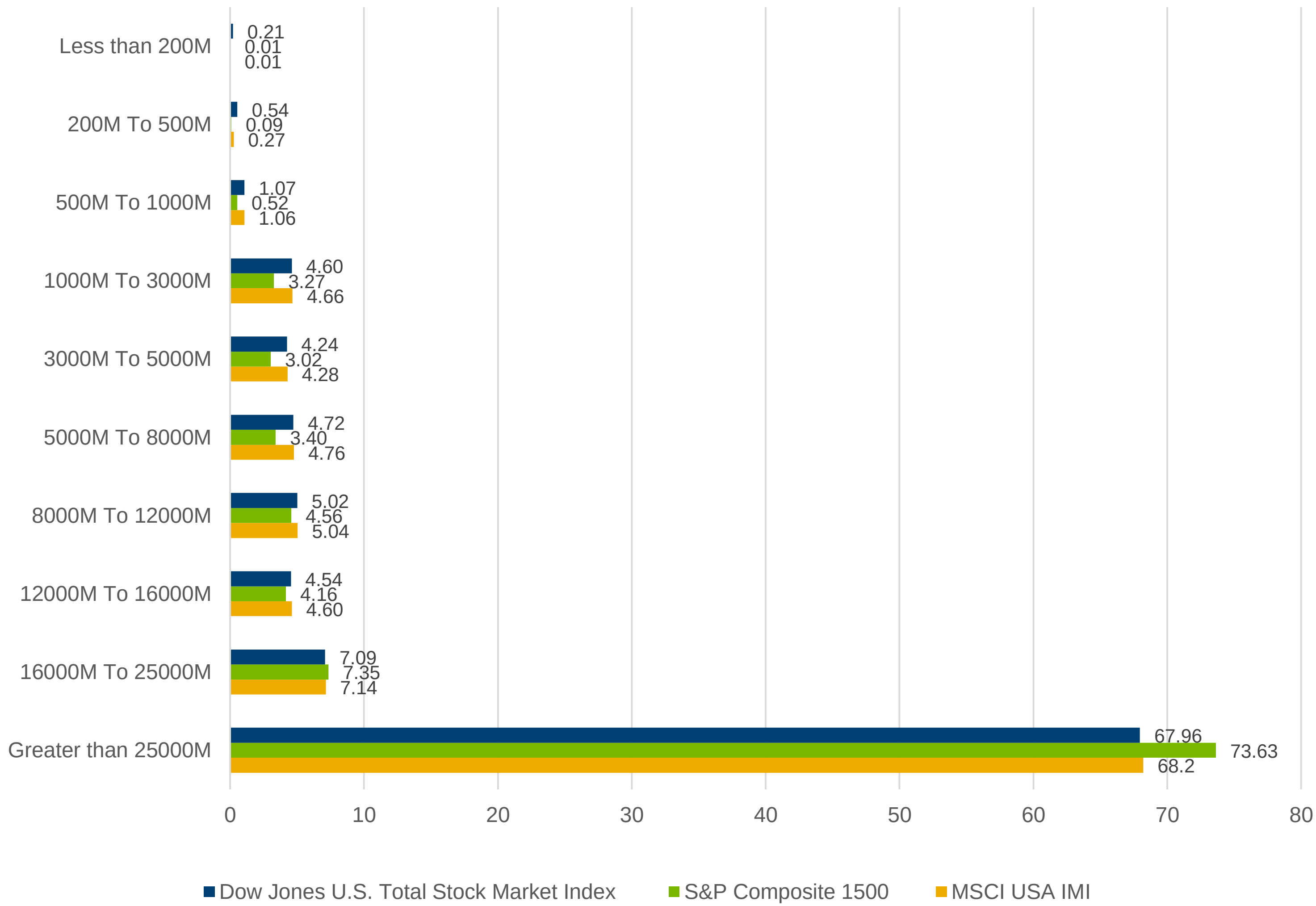
U.S. Equity Index Sector Allocations

As of March 31, 2019



U.S. Equity Index Market Capitalizations

As of March 31, 2019



U.S. Equity Index Performance & Correlation
As of March 31, 2019

Trailing Period Performance:

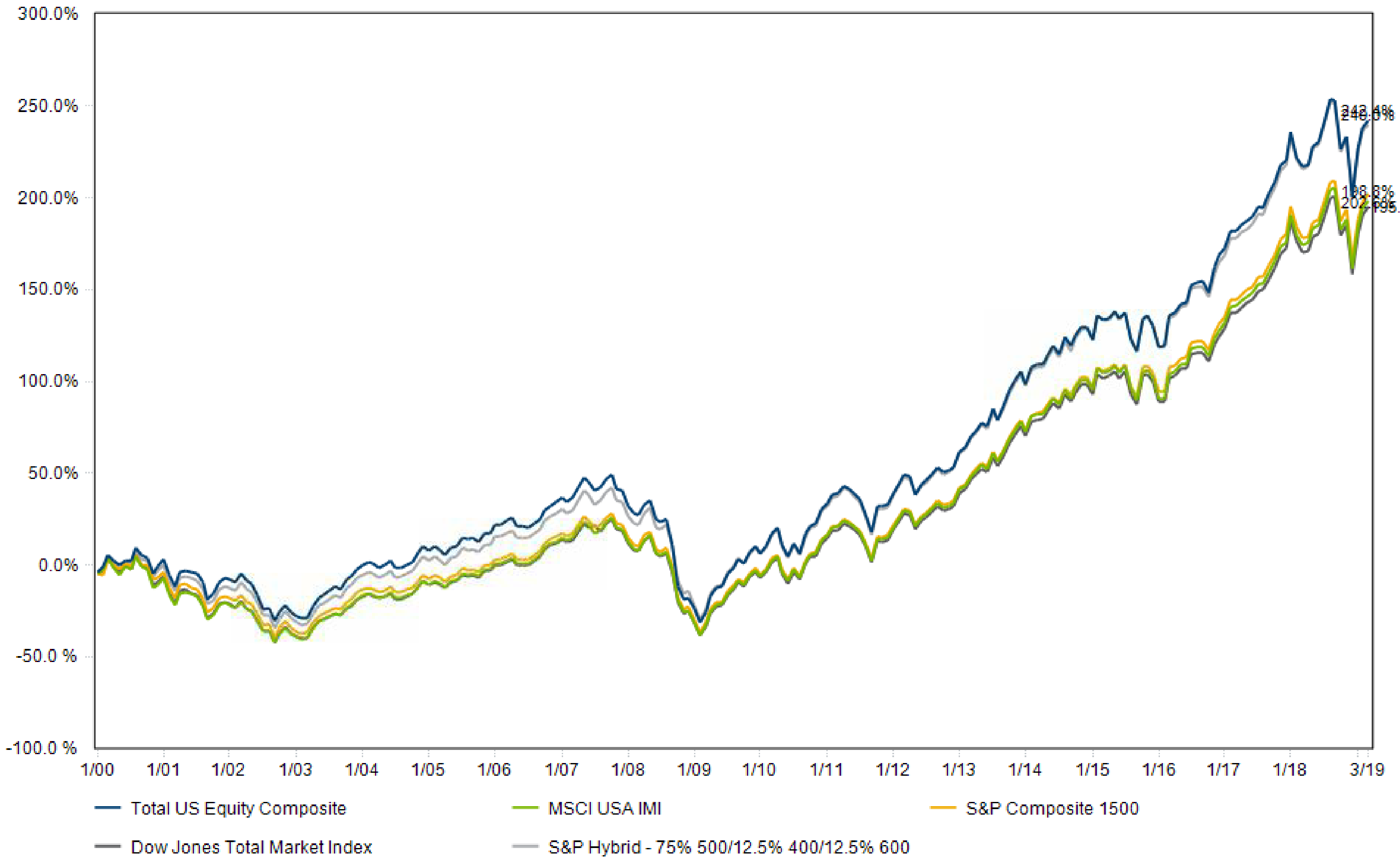
	1 Year	3 Years	5 Years	10 Years
Total US Equity Composite	**8.01**	**13.19**	**10.31**	**16.57**
MSCI USA IMI	8.89	13.57	10.44	16.08
S&P Composite 1500	8.79	13.34	10.64	16.01
Dow Jones Total Market Index	9.03	13.48	10.48	16.02
S&P Hybrid - 75% 500/12.5% 400/12.5% 600	7.66	13.17	10.33	16.16

5-Year Actual Correlation Matrix:

	Total US Equity Composite	MSCI USA IMI	S&P Composite 1500	Dow Jones Total Market Index	S&P Hybrid - 75% 500/12.5% 400/12.5% 600
Total US Equity Composite	**1.00**				
MSCI USA IMI	1.00	1.00			
S&P Composite 1500	0.99	1.00	1.00		
Dow Jones Total Market Index	0.99	1.00	1.00	1.00	
S&P Hybrid - 75% 500/12.5% 400/12.5% 600	1.00	1.00	1.00	0.99	1.00

U.S. Equity Cumulative Performance
As of March 31, 2019

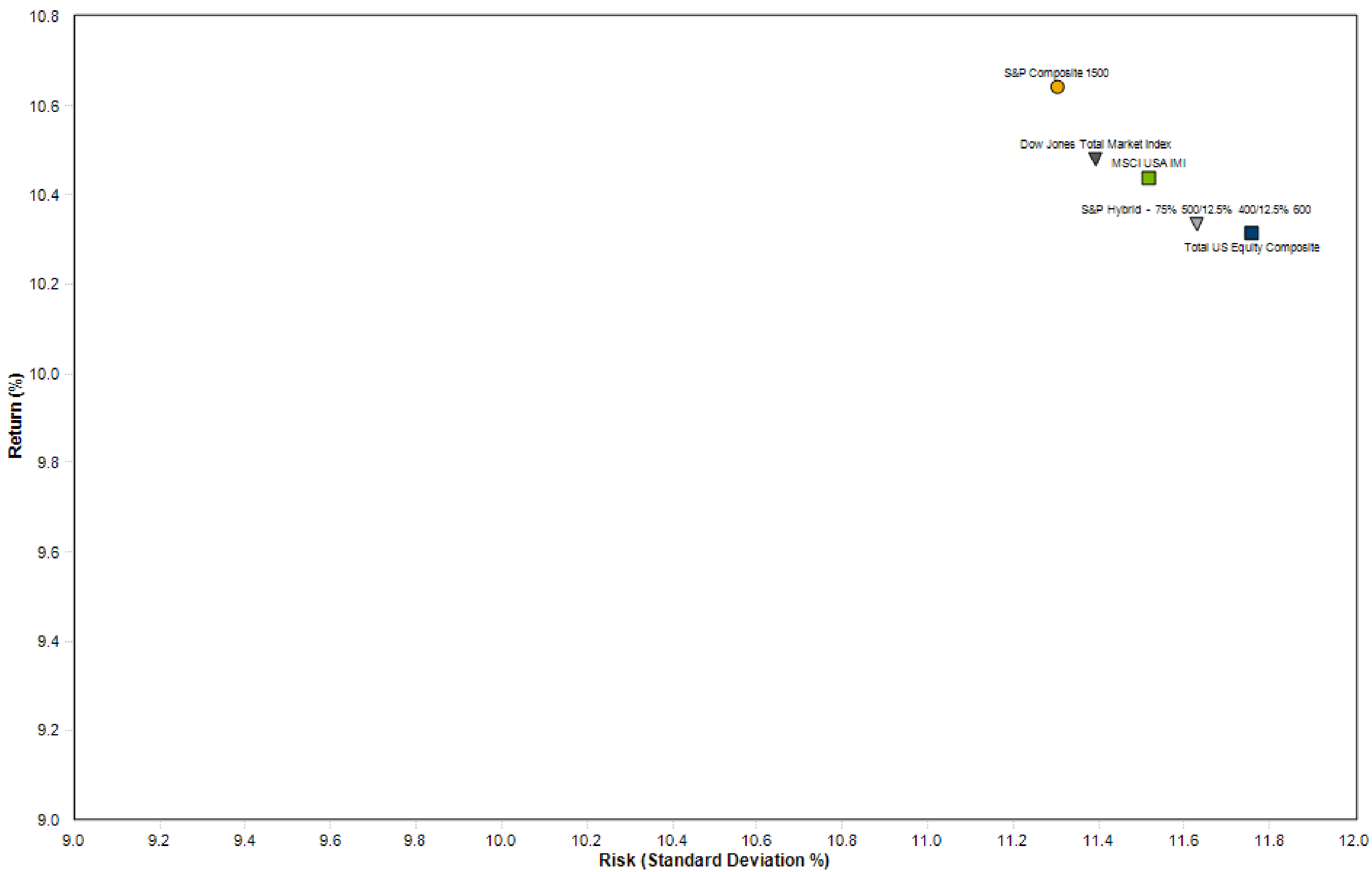
January 1, 2000 to March 31, 2019



Empower Results®

U.S. Equity Risk & Return

5-Years as of March 31, 2019



Non-U.S. Equity

Non-U.S. Equity Index Definitions

- **MSCI AC World ex USA IMI (Current Benchmark)** – captures large, mid and small cap representation across 22 of 23 developed markets countries (excluding the United States) and 24 emerging markets countries. With over 6,000 constituents, the index covers approximately 99% of the global equity opportunity set outside the US.
- **FTSE Global ex US All Cap Index** – comprises large, mid and small cap stocks globally excluding the US. The index is derived from the FTSE Global Equity Index Series (GEIS), which covers 98% of the world's investable market capitalization.
- **S&P Global ex US BMI –** comprises the S&P Developed BMI and S&P Emerging BMI, and is a comprehensive, rules-based index measuring stock market performance globally, excluding the US.

Index	MSCI AC World ex USA IMI	FTSE Global ex US All Cap Index	S&P Global ex US BMI
Weighting Methodology	Float-adjusted Market Cap	Float-adjusted Market Cap	Float-adjusted Market Cap
Rebalancing Frequency	Quarterly	Semi-Annual (March and September)	Annually in September with share changes and IPO updates in March, June and December

AHIC continues to recommend that PSERS maintain the MSCI AC World ex USA IMI as the Non-U.S. Equity policy index. All three benchmarks provide similar broad market coverage of Non-U.S. equities. One notable difference is that while MSCI classifies South Korea as an Emerging Markets country, both FTSE and S&P classify it as a Developed Markets country.

Note: The non-U.S. equity policy benchmark will be hedged at the current hedge ratio of 75%.

Non-U.S. Equity Index Characteristics
As of March 31, 2019

	MSCI AC World ex USA IMI (Net)	FTSE Global ex USA All Cap Index (USD)	S&P Global Ex-U.S. BMI
# of Holdings	6,126	5,832	8,557
% Top 15 Holdings	10.08	10.2	9.53
% Top 25 Holdings	14.54	14.6	13.72
Median Mkt. Cap ($K)	1,335,612.96	1,565,516.98	914,384.80
Price/Earnings ratio	16.92	16.68	16.76
Price/Book ratio	2.16	2.13	2.15
5 Yr. EPS Growth Rate	5.52	5.56	5.83
Current Yield	2.89	2.95	2.86
Number of Stocks	6,126	5,832	8,557
Debt to Equity	1.06	1.07	1.11
Forecast P/E	14.08	14.02	14.11

Non-U.S. Equity Index Country Allocations

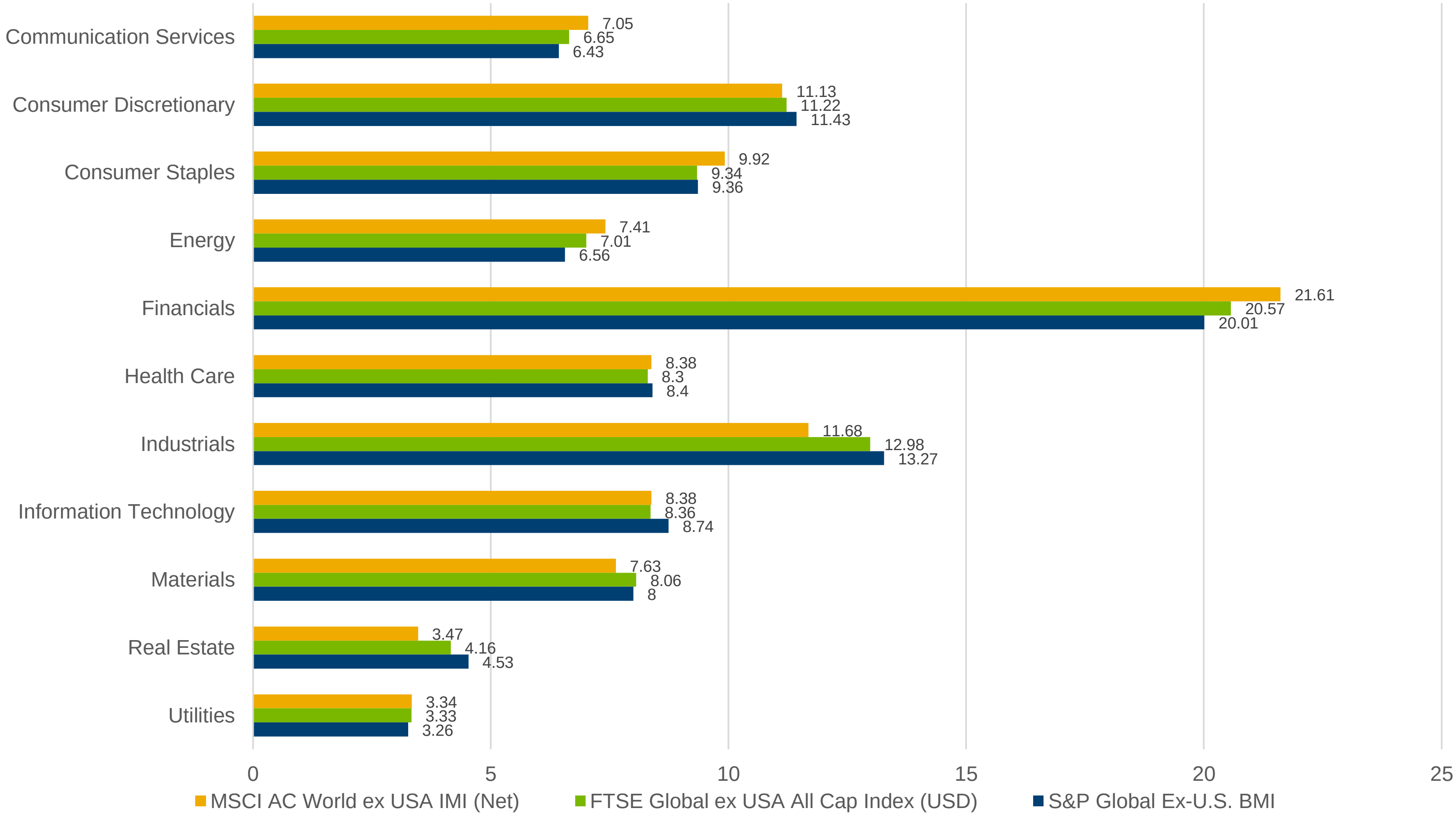
As of March 31, 2019

	MSCI AC World ex USA IMI Index	FTSE Global ex USA All Cap Index	S&P Global Ex-U.S. BMI
Australia	4.83	4.87	4.65
Hong Kong	2.78	2.75	2.94
Japan	16.88	16.94	17.87
New Zealand	0.24	0.28	0.25
Singapore	0.96	0.96	0.98
Korea[1]	0.00	3.36	3.66
Pacific + Asia	**25.69**	**29.15**	**30.36**
Austria	0.23	0.23	0.22
Belgium	0.77	0.77	0.84
Finland	0.72	0.85	0.71
France	6.84	6.65	6.46
Germany	5.50	5.49	5.31
Ireland	0.43	0.41	0.48
Italy	1.73	1.76	1.64
Luxembourg	0.11	0.11	0.15
Netherlands	2.34	2.12	2.32
Portugal	0.13	0.13	0.13
Spain	1.98	1.96	1.86
EMU	**20.79**	**20.49**	**20.13**
Denmark	1.21	1.17	1.13
Norway	0.63	0.60	0.59
Sweden	2.04	1.93	1.97
Switzerland	5.62	5.62	5.51
United Kingdom	11.58	11.43	11.03
Europe ex EMU	**21.07**	**20.74**	**20.24**
Israel	0.48	0.35	0.48
Middle East	**0.48**	**0.35**	**0.48**
Canada	6.79	6.82	6.58
United States	0.12	0.00	0.17
Developed Markets	**74.93**	**77.55**	**77.95**
Brazil	1.81	1.89	1.89
Cayman Islands	0.01	0.00	0.00
Chile	0.28	0.27	0.27
Colombia	0.11	0.11	0.11
Mexico	0.68	0.70	0.70
Peru	0.10	0.08	0.08
Virgin Islands	0.00	0.00	0.00
EM Latin America	**3.00**	**3.05**	**3.05**
China	7.52	7.27	7.27
India	2.52	2.69	2.69
Indonesia	0.56	0.54	0.54
Korea[1]	3.42	0.00	0.00
Malaysia	0.59	0.70	0.70
Philippines	0.28	0.31	0.31
Taiwan	3.10	3.21	3.21
Thailand	0.64	0.88	0.88
EM Asia	**18.62**	**15.60**	**15.60**
Czech Republic	0.04	0.04	0.04
Egypt	0.05	0.05	0.05
Greece	0.08	0.08	0.08
Hungary	0.08	0.08	0.08
Poland	0.28	0.28	0.28
Qatar	0.24	0.26	0.26
Russia	0.84	0.86	0.86
South Africa	1.42	1.44	1.44
Turkey	0.16	0.17	0.17
United Arab Emirates	0.19	0.20	0.20
EM Europe + Middle East + Africa	**3.37**	**3.46**	**3.46**
Emerging Markets	**24.99**	**22.10**	**22.10**
Frontier Markets	**0.00**	**0.06**	**0.00**
Cash	0.00	0.00	0.00
Other	0.00	0.13	0.13
Total	**100.00**	**100.00**	**100.00**

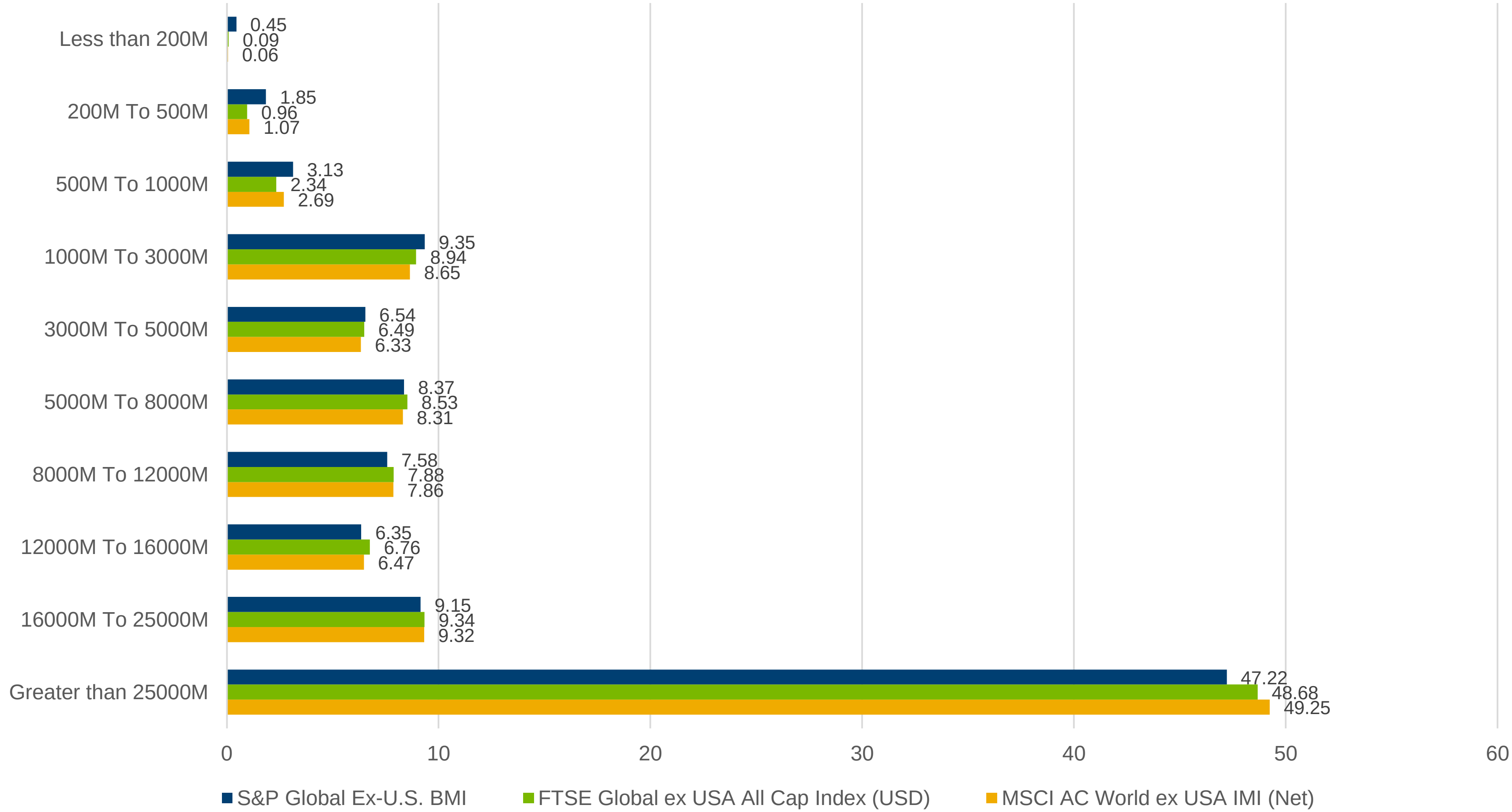
[1]FTSE and S&P classify South Korea under Developed Markets, while MSCI classifies under Emerging Markets

Non-U.S. Equity Index Sector Allocations

As of March 31, 2019



Non-U.S. Equity Index Market Capitalizations
As of March 31, 2019



Non-U.S. Equity Index Performance & Correlation
As of March 31, 2019

Trailing Period Performance:

	1 Year	3 Years	5 Years	10 Years
Total Non-U.S. Equity x Emerging Markets Composite (unhedged)	**-4.09**	**9.08**	**4.05**	**10.74**
MSCI AC World ex USA IMI (Net)	-4.96	7.94	2.66	9.20
FTSE Global ex USA All Cap Index (Net)	-4.81	7.99	2.84	9.42
S&P Global Ex-U.S. BMI	-4.44	8.60	3.39	9.91

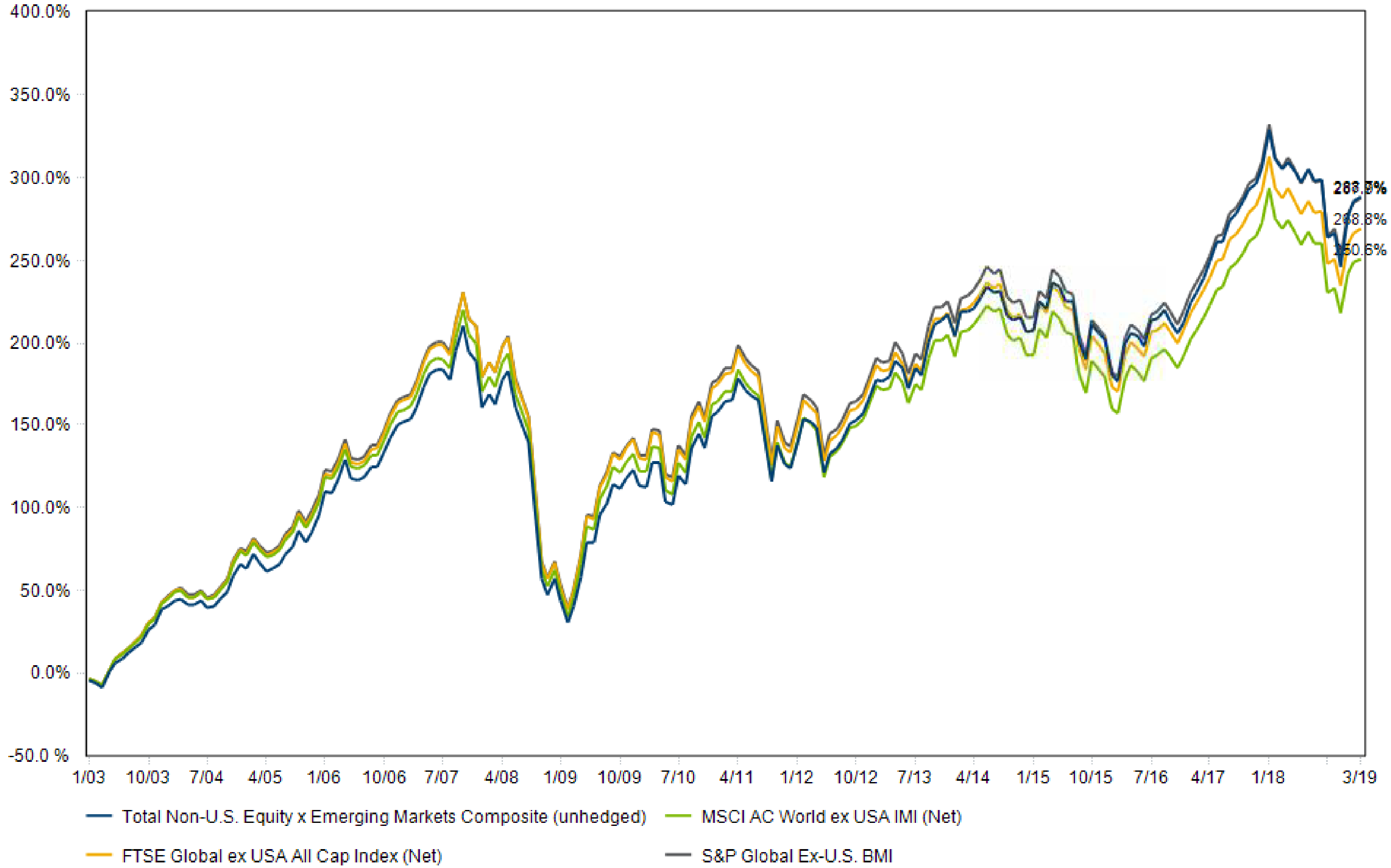
5-Years Actual Correlation Matrix:	Total Non-U.S. Equity x Emerging Markets Composite (unhedged)	MSCI AC World ex USA IMI (Net)	FTSE Global ex USA All Cap Index (Net)	S&P Global Ex-U.S. BMI
Total Non-U.S. Equity x Emerging Markets Composite (unhedged)	**1.00**			
MSCI AC World ex USA IMI (Net)	0.99	1.00		
FTSE Global ex USA All Cap Index (Net)	0.99	1.00	1.00	
S&P Global Ex-U.S. BMI	0.99	1.00	1.00	1.00

Note: The non-U.S. equity policy benchmark will be hedged at the current hedge ratio of 75%.

Non-U.S. Equity Cumulative Performance

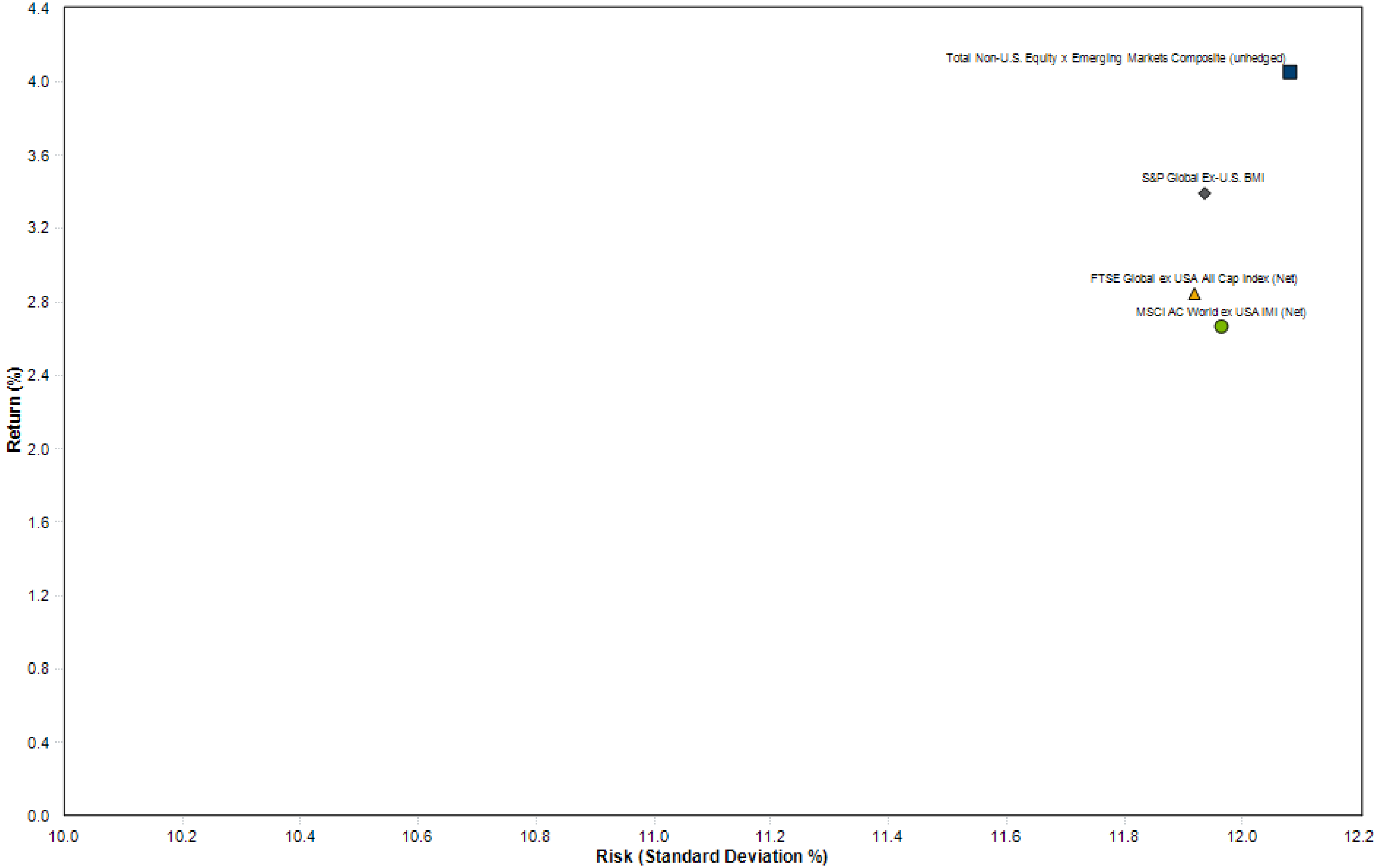
As of March 31, 2019

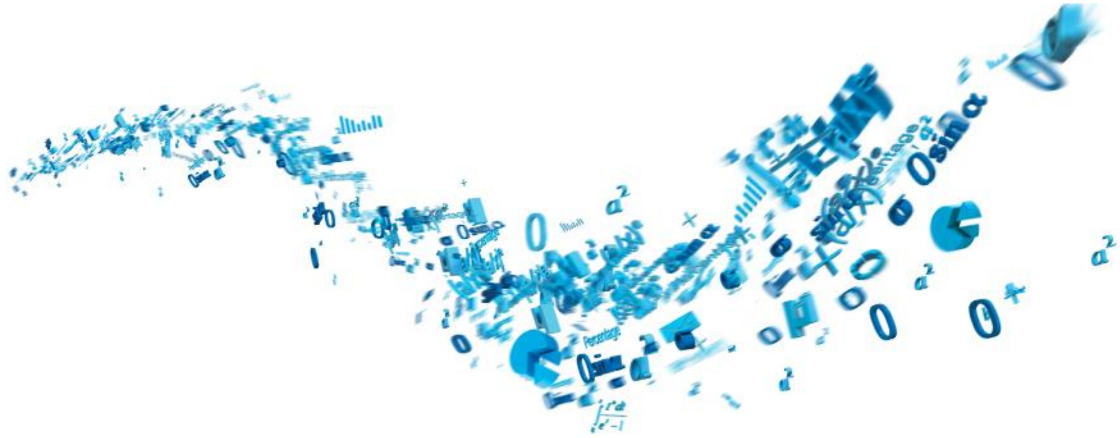
January 1, 2003 to March 31, 2019



Non-U.S. Equity Risk & Return

5-Years as of March 31, 2019





Emerging Markets Equity

Emerging Markets Equity Index Definitions

- **MSCI Emerging Markets IMI Index (Current Benchmark) –** captures large, mid and small cap representation across 24 emerging markets countries. With 2,687 constituents, the index covers approximately 99% of the free float-adjusted market capitalization in each country.
- **MSCI Emerging Markets Index –** captures large and mid cap representation across 24 emerging markets countries. With 845 constituents, the index covers approximately 85% of the free float-adjusted market capitalization in each country.
- **FTSE Emerging Index –** includes large and mid cap securities from advanced and secondary emerging markets. The Index provides investors with a comprehensive means of measuring the performance of the most liquid companies in the emerging markets.
- **S&P Emerging BMI –** captures all companies domiciled in the emerging markets within the S&P Global BMI with a float-adjusted market capitalization of at least $100 million and a minimum annual trading liquidity of $50 million.

Index	MSCI Emerging Markets IMI Index	MSCI Emerging Markets Index	FTSE Emerging Index	S&P Emerging BMI
Weighting Methodology	Float-adjusted Market Cap	Float-adjusted Market Cap	Float-adjusted Market Cap	Float-adjusted Market Cap
Rebalancing Frequency	Quarterly	Quarterly	Semi-Annual (March and September)	Annually in September with share changes and IPO updates in March, June and December

AHIC continues to recommend that PSERS maintain the MSCI Emerging Markets IMI Index as the Emerging Markets Equity policy index. Note that MSCI includes a 13.5% weight to South Korea, while FTSE and S&P classify SK as a developed country and exclude it from their EM benchmarks.

Emerging Markets Equity Index Characteristics
As of March 31, 2019

	MSCI Emerging Markets IMI	MSCI Emerging Markets Index	FTSE Emerging Index	S&P Emerging BMI
Composition				
# of Holdings	2,711	1,136	1,068	3,213
% Top 15 Holdings	25.44	28.58	28.52	23.86
% Top 25 Holdings	30.98	34.79	34.67	29.35
Characteristics				
Wtd. Avg. Mkt. Cap ($K)	76,177,504.62	85,403,055.64	83,165,220.85	71,260,218.65
Median Mkt. Cap ($K)	1,229,179.62	5,466,905.57	4,210,442.07	886,299.08
Price/Earnings ratio	12.81	12.82	13.21	13.24
Price/Book ratio	2.23	2.23	2.38	2.39
5 Yr. EPS Growth Rate	13.97	14.2	14.51	13.56
Current Yield	2.83	2.86	2.89	2.81
Number of Stocks	2,711	1,136	1,068	3,213
Debt to Equity	0.85	0.85	0.9	0.9
Forecast P/E	11.58	11.53	11.8	11.85

Empower Results®

Emerging Markets Equity Index Country Allocations

As of March 31, 2019

	MSCI Emerging Markets IMI	MSCI Emerging Markets Index	FTSE Emerging Index	S&P Emerging BMI
Australia	0.00	0.00	0.00	0.00
Hong Kong	0.93	0.70	0.72	2.16
Japan	0.00	0.00	0.00	0.00
New Zealand	0.00	0.00	0.00	0.00
Singapore	0.03	0.03	0.06	0.09
Pacific	**0.96**	**0.73**	**0.79**	**2.25**
Austria	0.00	0.00	0.00	0.00
Belgium	0.00	0.00	0.00	0.00
Finland	0.00	0.00	0.00	0.00
France	0.00	0.00	0.00	0.00
Germany	0.00	0.00	0.00	0.00
Ireland	0.00	0.00	0.00	0.00
Italy	0.00	0.00	0.00	0.00
Luxembourg	0.05	0.05	0.00	0.05
Netherlands	0.05	0.06	0.00	0.23
Portugal	0.00	0.00	0.00	0.00
Spain	0.00	0.00	0.00	0.00
EMU	**0.11**	**0.11**	**0.00**	**0.28**
Denmark	0.00	0.00	0.00	0.00
Norway	0.00	0.00	0.00	0.00
Sweden	0.00	0.00	0.00	0.00
Switzerland	0.00	0.00	0.00	0.02
United Kingdom	0.21	0.24	0.22	0.33
Europe ex EMU	**0.21**	**0.24**	**0.22**	**0.35**
Israel	0.00	0.00	0.00	0.00
Middle East	**0.00**	**0.00**	**0.00**	**0.00**
Canada	0.00	0.00	0.00	0.00
United States	0.27	0.31	0.00	0.31
Developed Markets	**1.55**	**1.38**	**1.00**	**3.19**

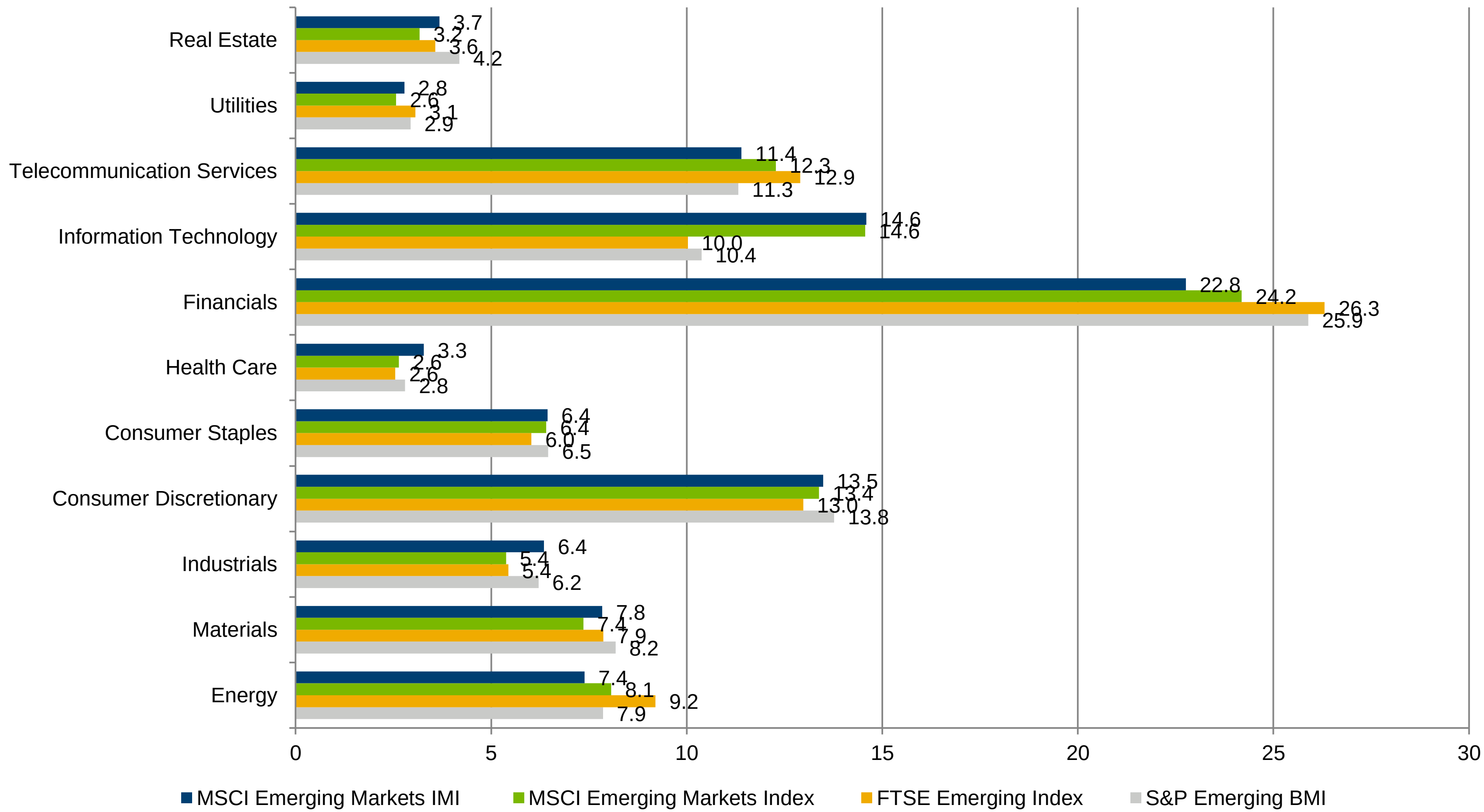
	MSCI Emerging Markets IMI	MSCI Emerging Markets Index	FTSE Emerging Index	S&P Emerging BMI
Brazil	7.15	7.23	8.76	8.13
Cayman Islands	0.03	0.03	0.00	0.09
Chile	1.10	1.03	1.20	1.17
Colombia	0.44	0.46	0.50	0.58
Mexico	2.69	2.66	3.21	2.79
Peru	0.39	0.43	0.42	0.46
Virgin Islands	0.00	0.00	0.00	0.05
EM Latin America	**11.80**	**11.84**	**14.08**	**13.26**
China	29.50	31.95	33.77	30.83
India	9.92	9.16	11.81	13.71
Indonesia	2.20	2.18	2.36	2.48
Korea[1]	13.49	13.00	0.00	0.00
Malaysia	2.31	2.20	3.02	2.62
Philippines	1.09	1.10	1.37	1.35
Taiwan	12.22	11.33	12.60	13.23
Thailand	2.51	2.34	3.60	3.00
EM Asia	**73.24**	**73.26**	**68.53**	**67.22**
Czech Republic	0.15	0.16	0.20	0.16
Egypt	0.18	0.13	0.20	0.24
Greece	0.32	0.22	0.32	0.37
Hungary	0.30	0.32	0.39	0.32
Poland	1.12	1.13	0.00	1.22
Qatar	0.94	0.93	1.27	0.97
Russia	3.33	3.64	4.20	3.63
South Africa	5.60	5.65	6.89	6.16
Turkey	0.61	0.55	0.72	0.76
United Arab Emirates	0.70	0.72	0.90	0.73
EM Europe + Middle East + Africa	**13.24**	**13.44**	**15.09**	**14.56**
Emerging Markets	**98.29**	**98.54**	**97.71**	**95.04**
Frontier Markets	**0.11**	**0.03**	**0.91**	**0.16**
Cash	0.00	0.00	0.00	0.00
Other	0.05	0.04	0.37	1.60
Total	**100.00**	**100.00**	**100.00**	**100.00**

[1]FTSE and S&P classify South Korea under Developed Markets, while MSCI classifies under Emerging Markets

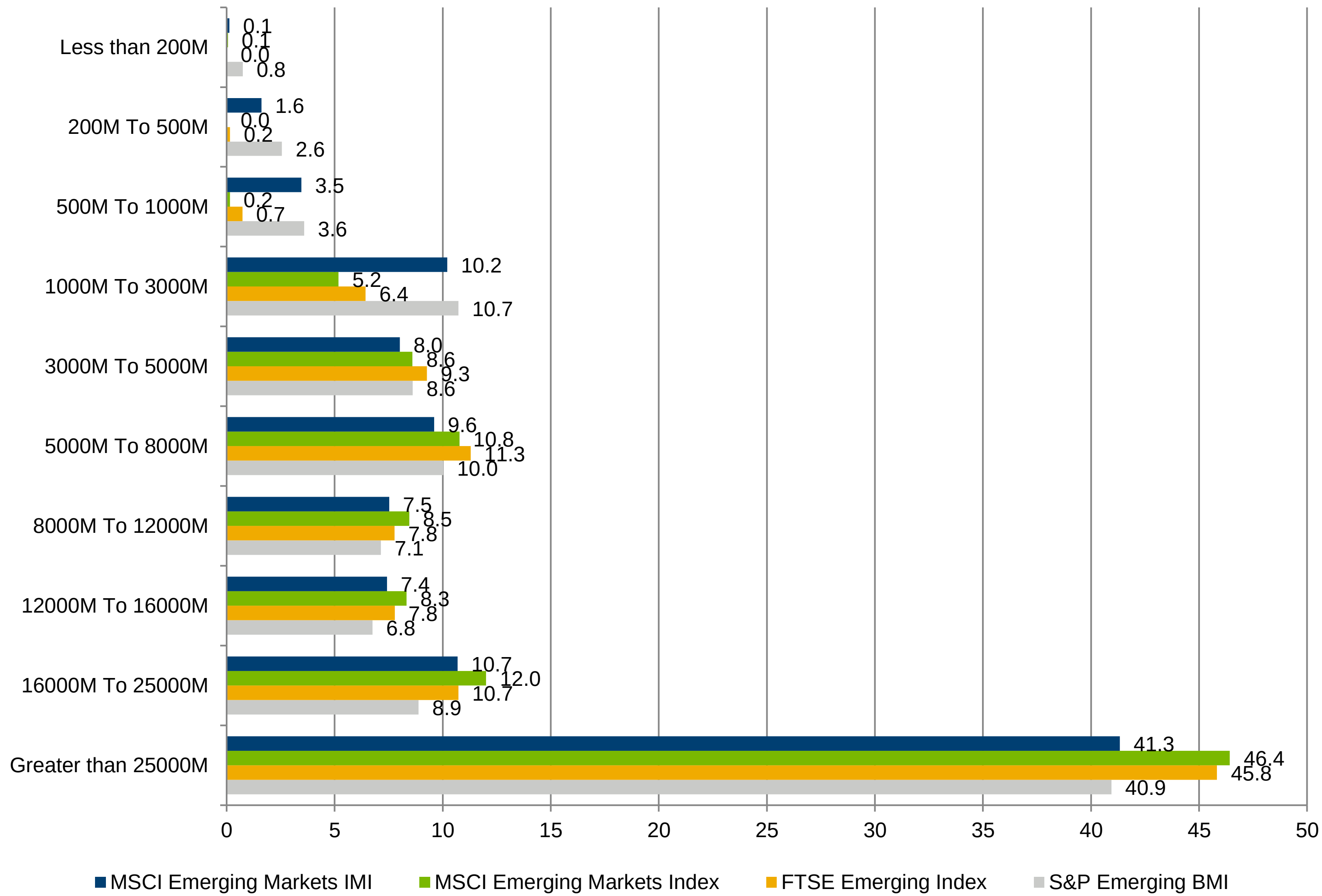
Empower Results®

Emerging Markets Equity Index Sector Allocations

As of March 31, 2019



Emerging Markets Equity Index Market Capitalizations –
As of March 31, 2019



Emerging Markets Equity Index Performance & Correlation
As of March 31, 2019

Trailing Period Performance:

	1 Year	3 Years	5 Years	10 Years
Emerging Markets Equity Composite	**-9.60**	**5.58**	**2.20**	**8.38**
MSCI Emerging Markets IMI (Net)	-7.97	10.08	3.45	9.12
MSCI Emerging Markets Index (Net)	-7.41	10.68	3.68	8.95
FTSE Emerging Index (Net)	-5.68	10.46	4.13	9.18
S&P Emerging BMI	-5.90	11.35	4.67	9.77

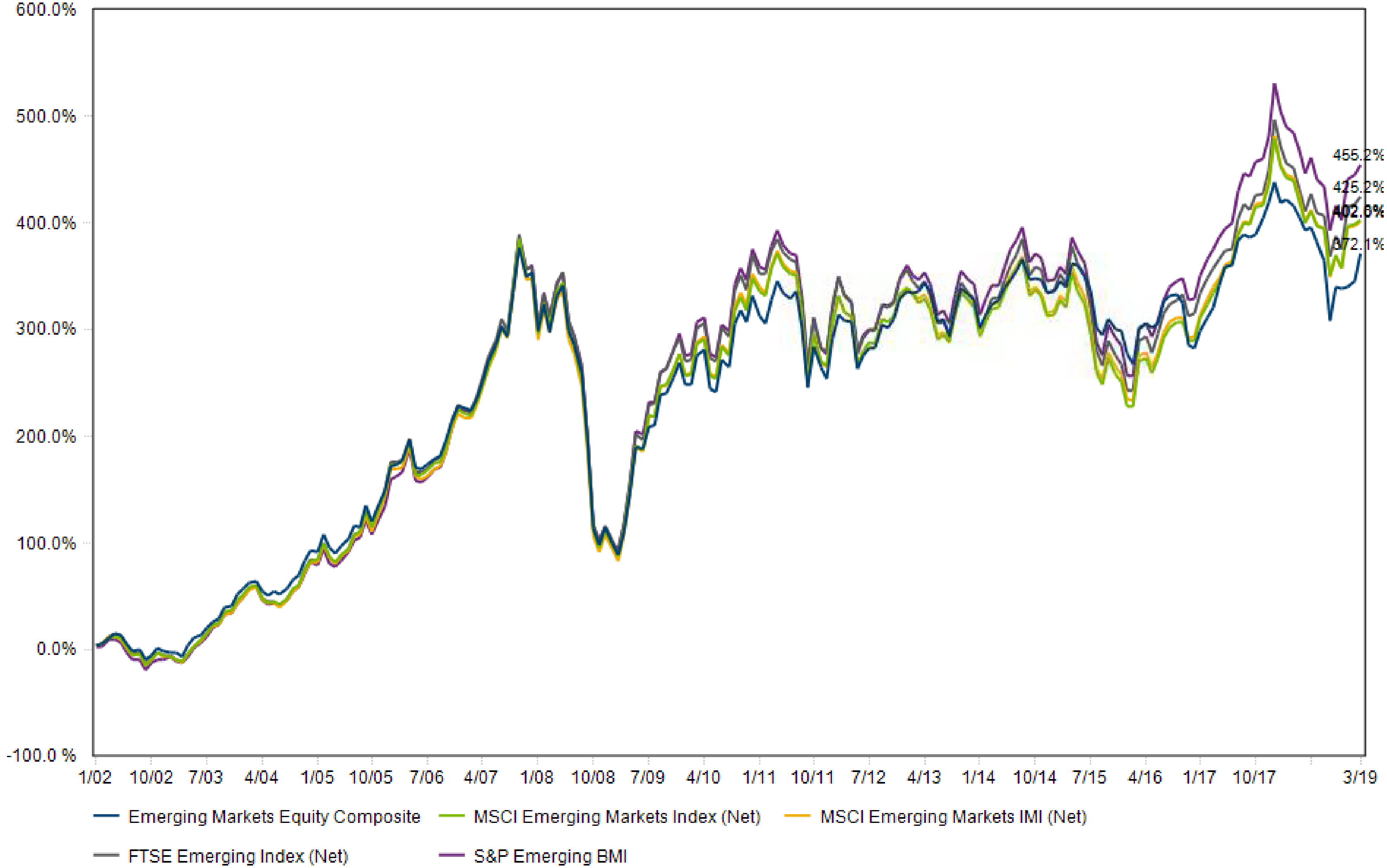
5-Years Actual Correlation Matrix:

	Emerging Markets Equity Composite	MSCI Emerging Markets IMI (Net)	MSCI Emerging Markets Index (Net)	FTSE Emerging Index (Net)	S&P Emerging BMI
Emerging Markets Equity Composite	**1.00**				
MSCI Emerging Markets IMI (Net)	0.85	1.00			
MSCI Emerging Markets Index (Net)	0.84	1.00	1.00		
FTSE Emerging Index (Net)	0.83	0.99	0.99	1.00	
S&P Emerging BMI	0.84	0.99	0.99	1.00	1.00

Emerging Markets Equity Cumulative Performance

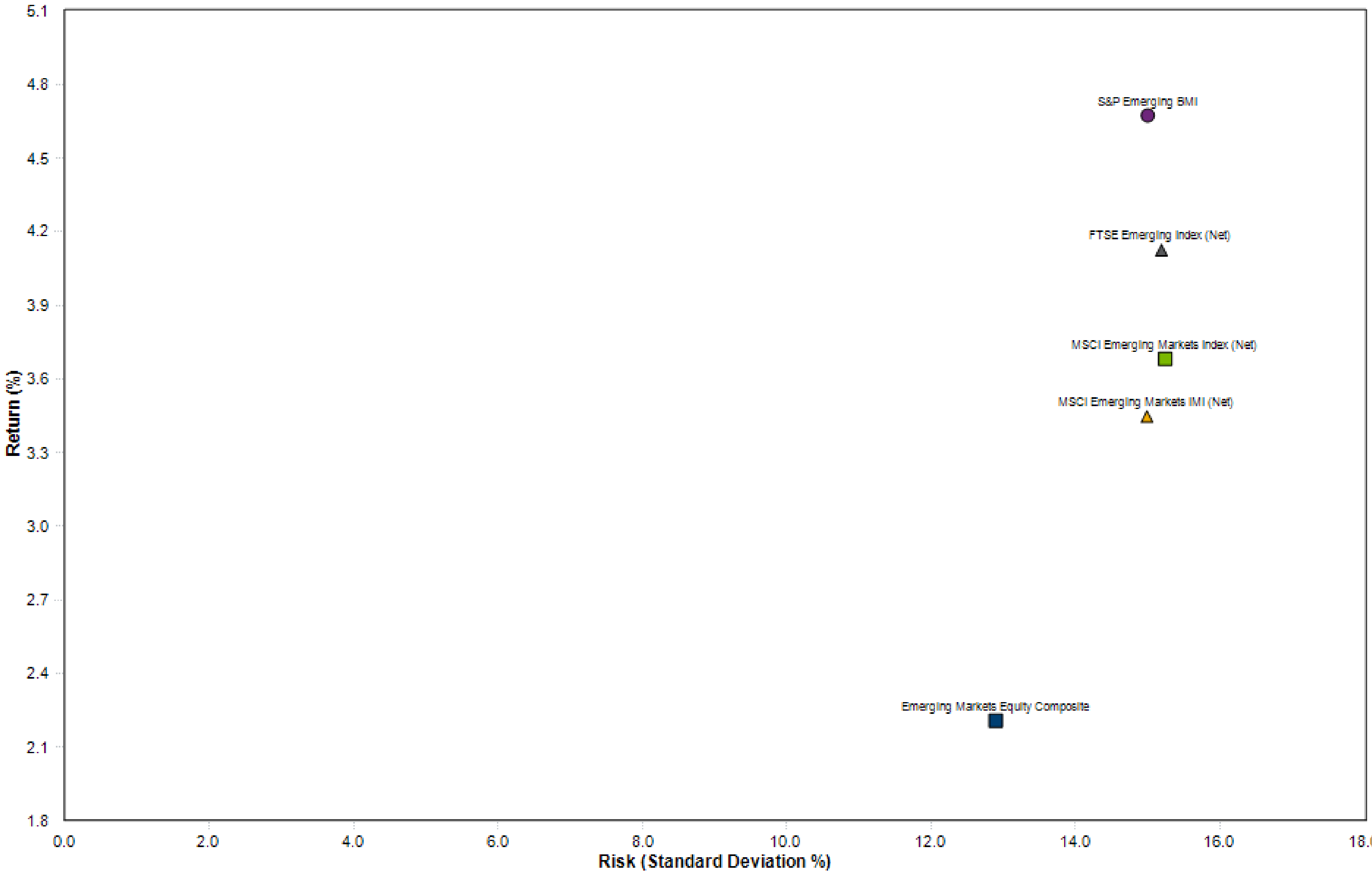
As of March 31, 2019

January 1, 2002 to March 31, 2019



Emerging Markets Equity Risk & Return

5-Years as of March 31, 2019



Private Equity

Private Equity Benchmark Options

- **Burgiss All Private Markets ex Real Estate (1-Quarter Lagged) (Current Benchmark)**
- Public Equity Plus: (65% MSCI USA Small Cap/35% MSCI ACWI ex USA Small Cap) + 200bps, 1-Quarter Lagged
- Cambridge Associates U.S. Private Equity Index (1-Quarter Lagged)

Performance Benchmark:
AHIC continues to recommend that PSERS maintain Burgiss All Private Markets ex Real Estate as the Private Equity policy index, which captures total market returns, and reflects all exposures utilized. Additionally, we suggest that PSERS consider adding the public equity plus benchmark as a long-term secondary performance benchmark.

Risk Benchmark:
We recommend using the 65% MSCI USA Small Cap/35% MSCI ACWI ex US Small Cap as this benchmark is the best proxy for the underlying risk and geographic exposures of the Private Equity portfolio.

Private Equity Benchmark Options
Pros & Cons

	Burgiss All Private Markets ex Real Estate	Public Equity Plus	Cambridge Associates U.S. PE
Pros	▪ Attempts to capture all exposures utilized ▪ Uses actual vintage years of underlying funds in calculation ▪ Captures total market returns ▪ High correlation to PSERS portfolio	▪ Most common approach among other AHIC public fund clients ▪ Represents broad equity market exposure ▪ Simple to calculate ▪ Best representation of long-term expectations	▪ Represents exposure to PE ▪ High return correlation to PSERS actual investments
Cons	▪ Difficult to calculate and replicate	▪ Does not capture characteristics of private equity (i.e. liquidity, volatility) ▪ Lacks coverage utilized in PSERS' strategies (i.e. Private Debt, Venture Capital, Private Equity) ▪ Not a good benchmark for short-term quarterly performance	▪ Lacks coverage utilized in PSERS' strategies (i.e. Private Debt, Venture Capital) ▪ U.S. only

Private Equity Index Performance & Correlation
As of March 31, 2019

Trailing Period Performance:	1 Year	3 Years	5 Years	10 Years
Private Equity/Private Debt/Venture Capital/Co-Invest (Hedged)	**9.21**	**13.05**	**9.33**	**11.02**
Burgiss All Private Markets ex Real Estate (1Q Lag)	9.17	12.40	10.86	12.56
CA US Private Equity Index (1Q Lag)	10.40	13.57	11.45	13.74
65% MSCI USA Small Cap/35% MSCI ACWI ex USA Small Cap (1Q Lag) +200bps	-11.07	8.89	6.51	15.02

5-Years Actual Correlation Matrix:	Private Equity/Private Debt/Venture Capital/Co-Invest (Hedged)	Burgiss All Private Markets ex Real Estate (1Q Lag)	CA US Private Equity Index (1Q Lag)	65% MSCI USA Small Cap/35% MSCI ACWI ex USA Small Cap (1Q Lag)
Private Equity/Private Debt/Venture Capital/Co-Invest (Hedged)	**1.00**			
Burgiss All Private Markets ex Real Estate (1Q Lag)	0.88	1.00		
CA US Private Equity Index (1Q Lag)	0.82	0.88	1.00	
65% MSCI USA Small Cap/35% MSCI ACWI ex USA Small Cap (1Q Lag)	0.69	0.76	0.76	1.00

5-Years:	Standard Deviation
Private Equity/Private Debt/Venture Capital/Co-Invest (Hedged)	**4.15**
Burgiss All Private Markets ex Real Estate (1Q Lag)	3.59
CA US Private Equity Index (1Q Lag)	4.37
65% MSCI USA Small Cap/35% MSCI ACWI ex USA Small Cap (1Q Lag)	11.92

U.S. Fixed Income

U.S. Fixed Income Index Definitions

- **Bloomberg Barclays U.S. Aggregate Index (Current Benchmark)** – represents securities that are SEC-registered, taxable, and dollar denominated. The index covers the U.S. investment grade fixed rate bond market, with index components for government and corporate securities, mortgage pass-through securities, and asset-backed securities.
- **Bloomberg Barclays U.S. Universal Index** – represents the union of the U.S. Aggregate Index, the U.S. High-Yield Corporate Index, the 144A Index, the Eurodollar Index, the Emerging Markets Index, and the non-ERISA portion of the CMBS Index. Municipal debt, private placements, and non-dollar-denominated issues are excluded from the Universal Index. The only constituent of the index that includes floating-rate debt is the Emerging Markets Index.

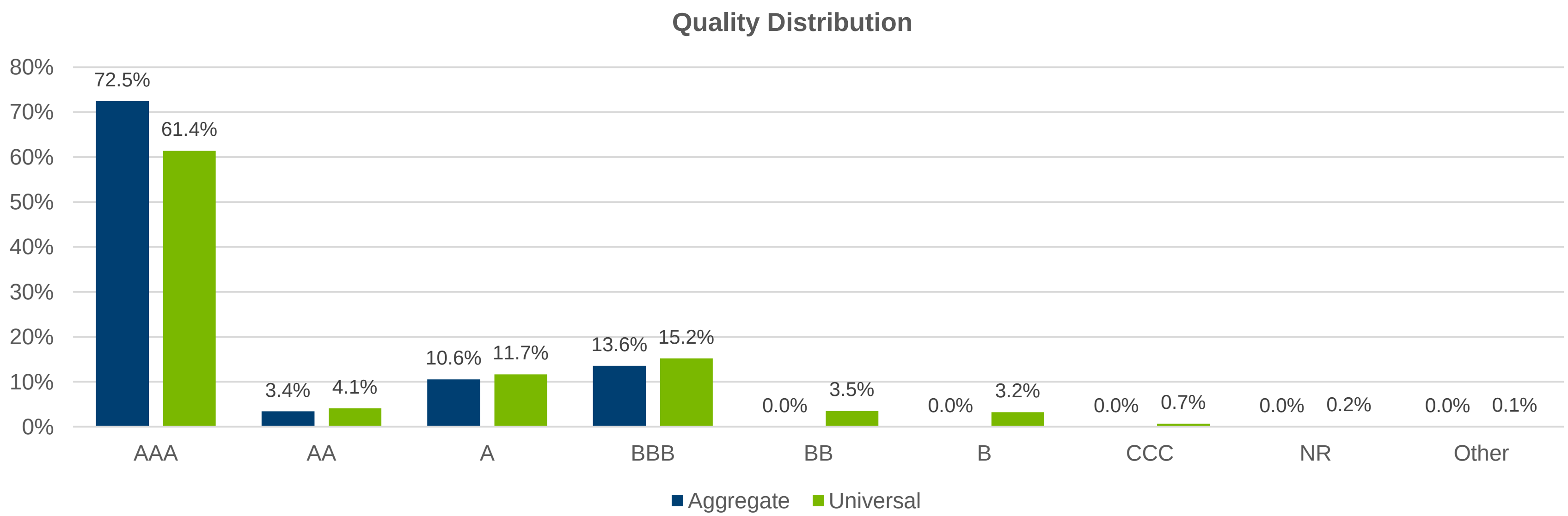
Index	Bloomberg Barclays U.S. Aggregate Index	Bloomberg Barclays U.S. Universal Index
Weighting Methodology	Market cap weighted	Market cap weighted
Rebalancing Frequency	Monthly	Monthly

AHIC continues to recommend that PSERS maintain the Bloomberg Barclays U.S. Aggregate Index as the U.S. Fixed Income policy index. The Bloomberg Barclays U.S. Universal Index includes additional “plus” sectors not included in the traditional Bloomberg Barclays U.S. Aggregate, such as High Yield, 144As, Eurodollar, Emerging Markets, and CMBS. However the Aggregate remains the industry standard.

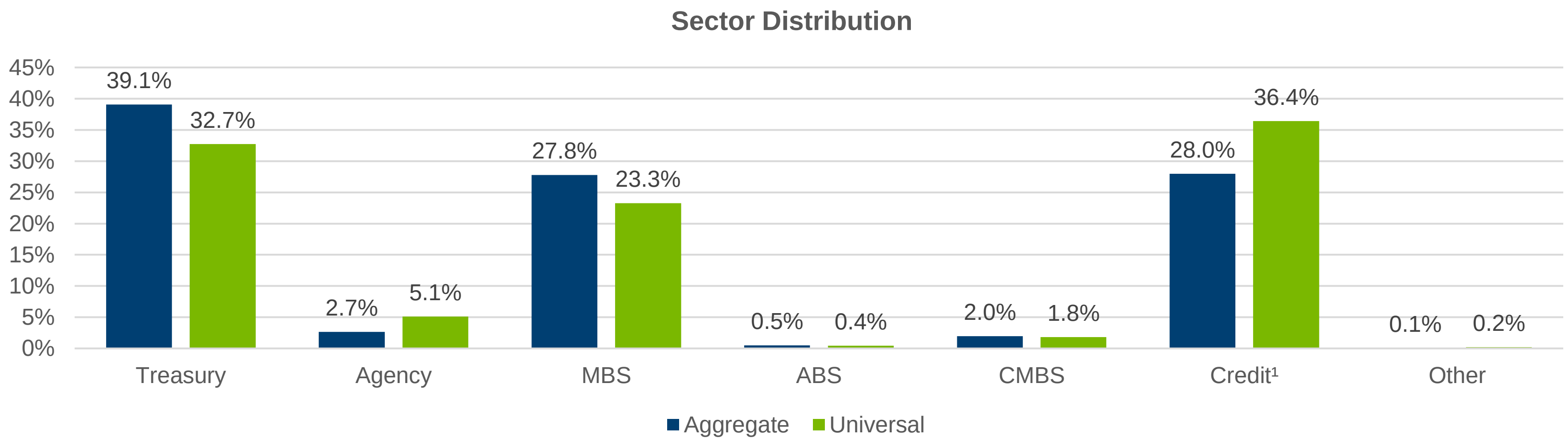
U.S. Fixed Income Index Characteristics

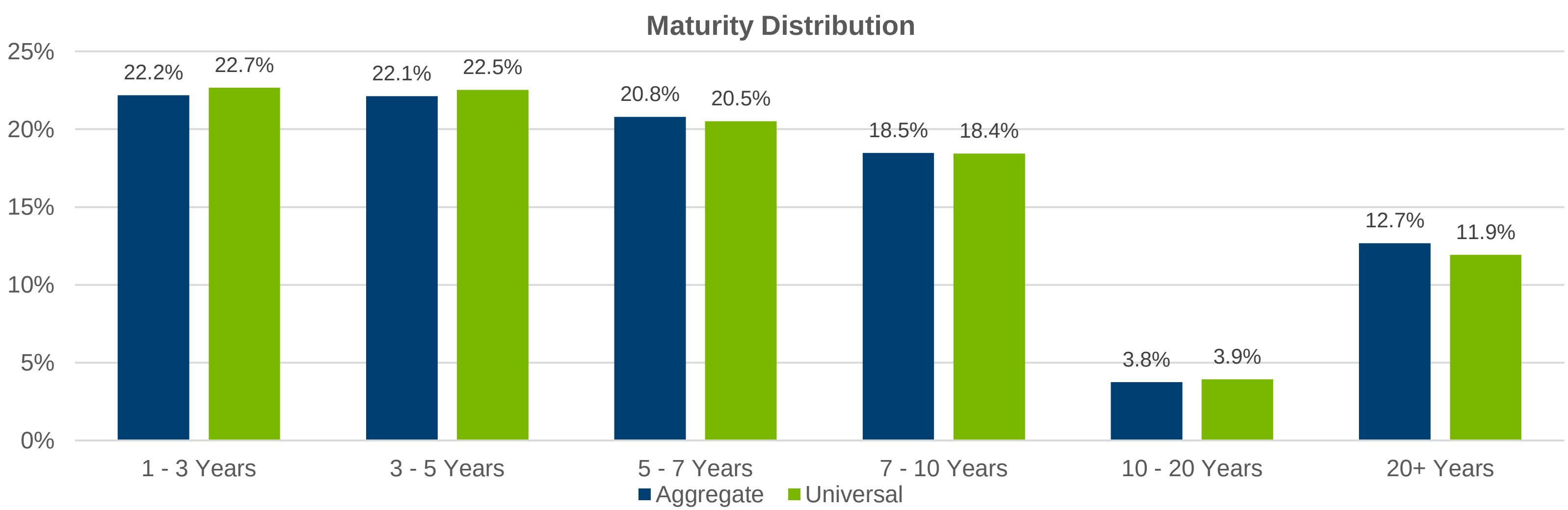
As of March 31, 2019

	Bloomberg Barclays U.S. Aggregate Index	Bloomberg Barclays U.S. Universal Index
# of Issues	10,343	16,382
Average Maturity	8.07	7.91
Coupon	3.23	3.55
Yield to Maturity	2.94	2.32
Average Quality	AA+/AA	A
Modified Duration	5.75	5.54
Effective Duration	5.82	5.63



U.S. Fixed Income Characteristics
As of March 31, 2019





[1]Credit includes local authority, sovereign, and supranational bonds including securities from EMD countries.

US Core Plus Fixed Income Performance & Correlation
As of March 31, 2019

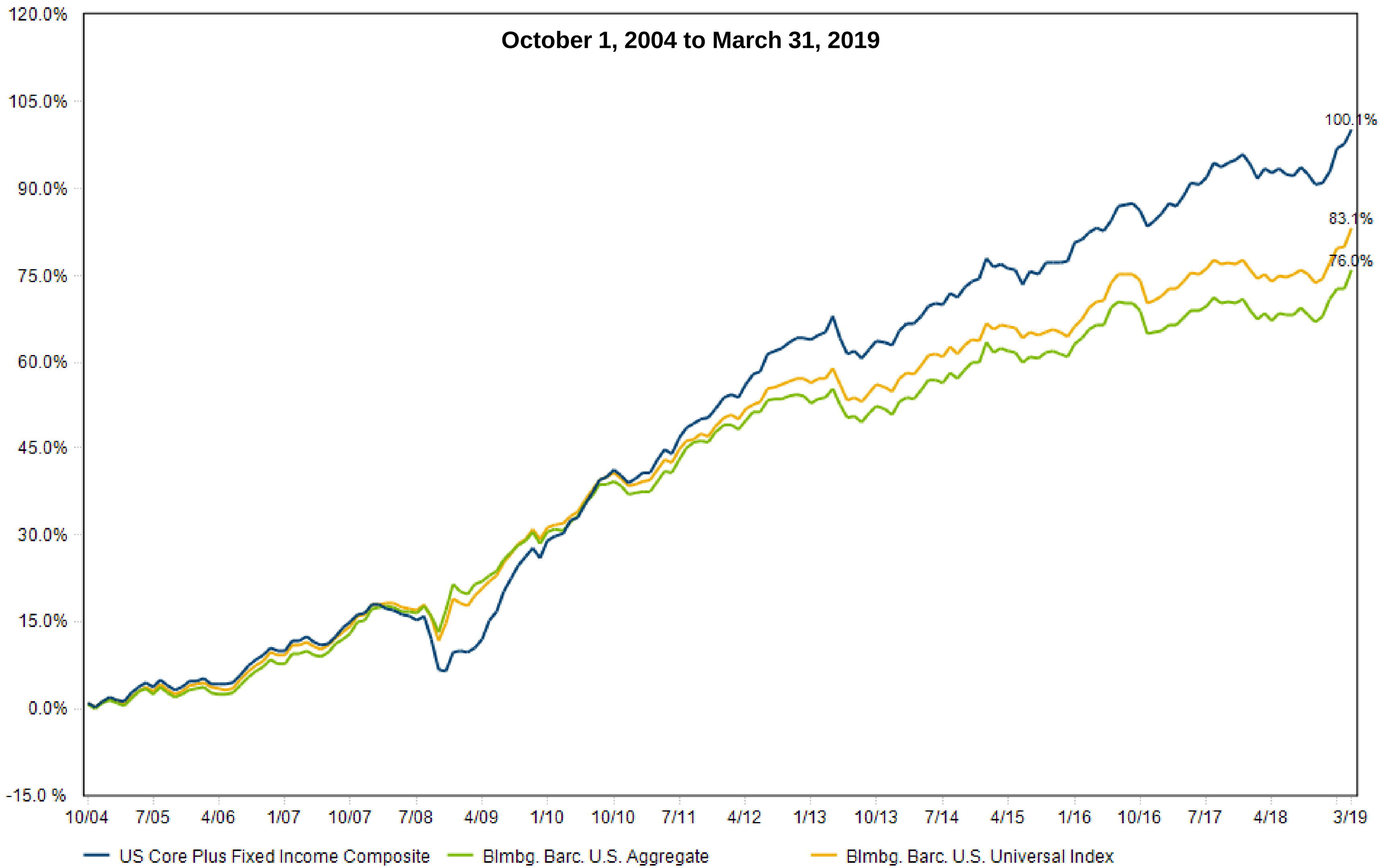
Trailing Period Performance:

	1 Year	3 Years	5 Years	10 Years
US Core Plus Fixed Income Composite	3.42	3.14	3.71	6.10
Blmbg. Barc. U.S. Aggregate	4.48	2.03	2.74	3.77
Blmbg. Barc. U.S. Universal Index	4.53	2.65	3.00	4.36

5-Years Actual Correlation Matrix:

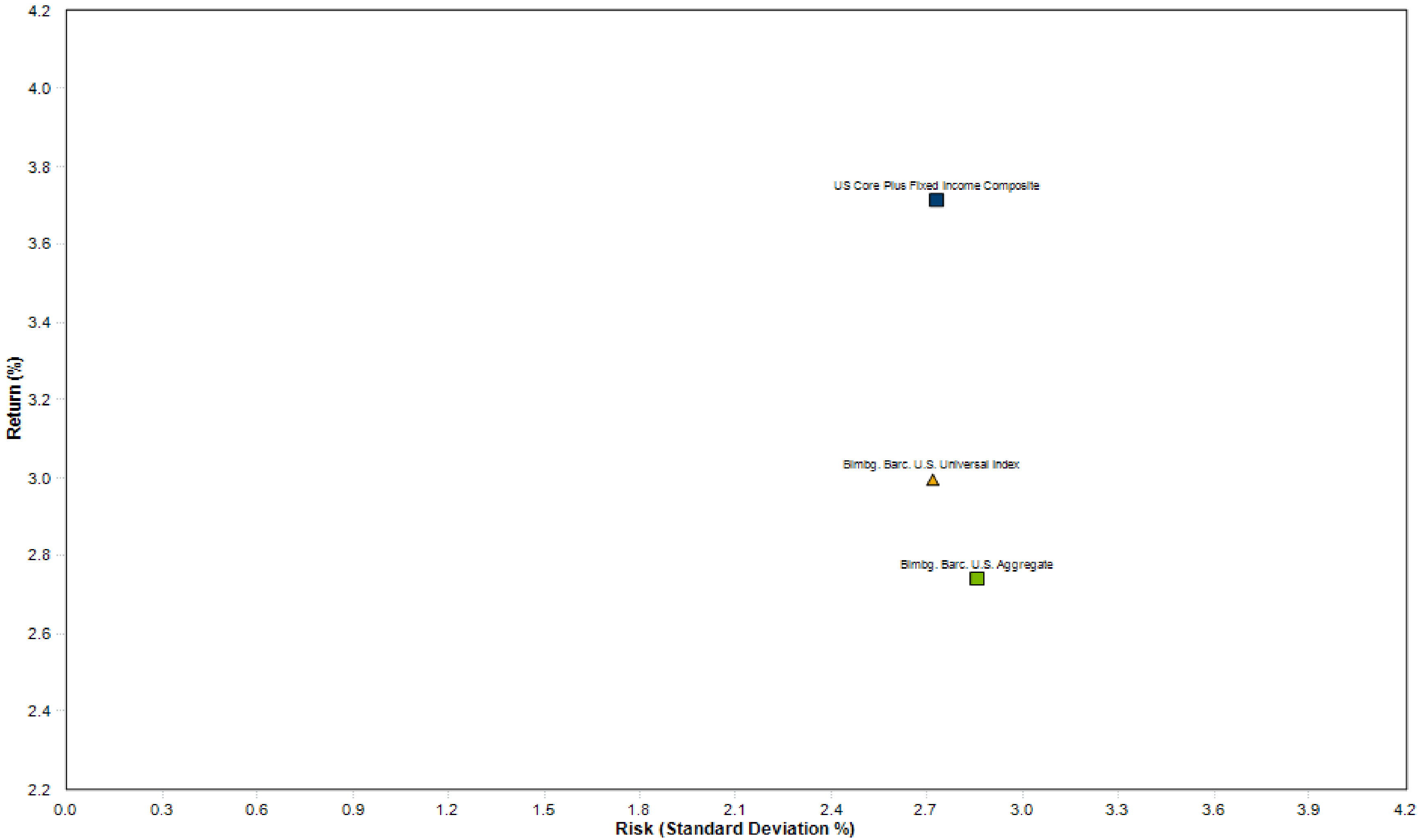
	US Core Plus Fixed Income Composite	Blmbg. Barc. U.S. Aggregate	Blmbg. Barc. U.S. Universal Index
US Core Plus Fixed Income Composite	1.00		
Blmbg. Barc. U.S. Aggregate	0.87	1.00	
Blmbg. Barc. U.S. Universal Index	0.90	0.99	1.00

US Core Plus Fixed Income Cumulative Performance
As of March 31, 2019



US Core Plus Fixed Income Risk & Return

5-Years as of March 31, 2019



Non-U.S. Fixed Income

Non-U.S. Fixed Income Index Definitions

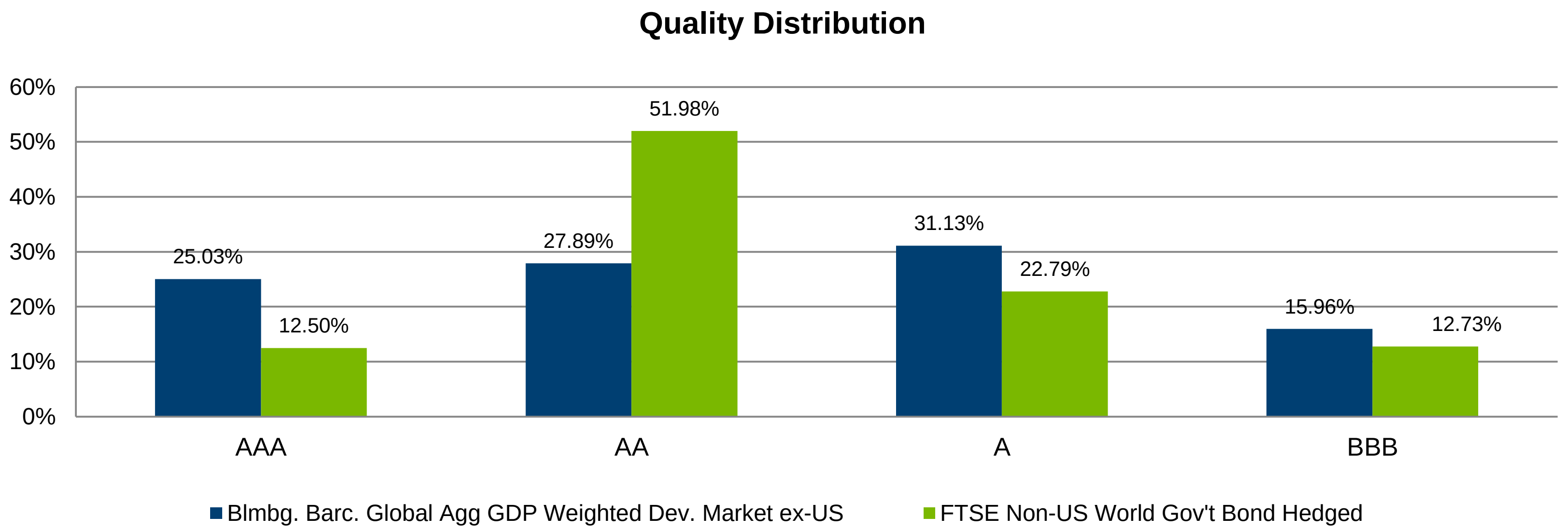
- **Bloomberg Barclays Global Agg. GDP Weighted Developed Market ex-US Hedged (Current Benchmark)** – Provides a broad-based measure of the non-U.S. investment-grade fixed income markets. The two major components of this index are the Pan-European Aggregate, and the Asian-Pacific Aggregate Indices. The index also includes Eurodollar and Euro-Yen corporate bonds, Canadian government, agency and corporate securities.
- **FTSE Non-US World Government Bond Hedged** – Measures the performance of fixed-rate, investment grade sovereign bonds, hedged to USD. The Non-U.S. WGBI is a widely used benchmark that currently comprises sovereign debt from many countries and has more than 25 years of history available.

Index	Bloomberg Barclays Global Agg. GDP-Weighted Developed Market ex US Hedged	FTSE Non-US Government Bond Hedged
Weighting Methodology	GDP Weighted	Market Cap Weighted
Rebalancing Frequency	Monthly	Monthly

AHIC continues to recommend that PSERS maintain the Bloomberg Barclays Global Aggregate GDP-Weighted Developed Market ex-US Hedged as the Non-U.S. Fixed Income policy index. The current policy benchmark offers broader exposure than FTSE including non-Government issued securities. It is also GDP-weighted, which reduces the index weight to Japan.

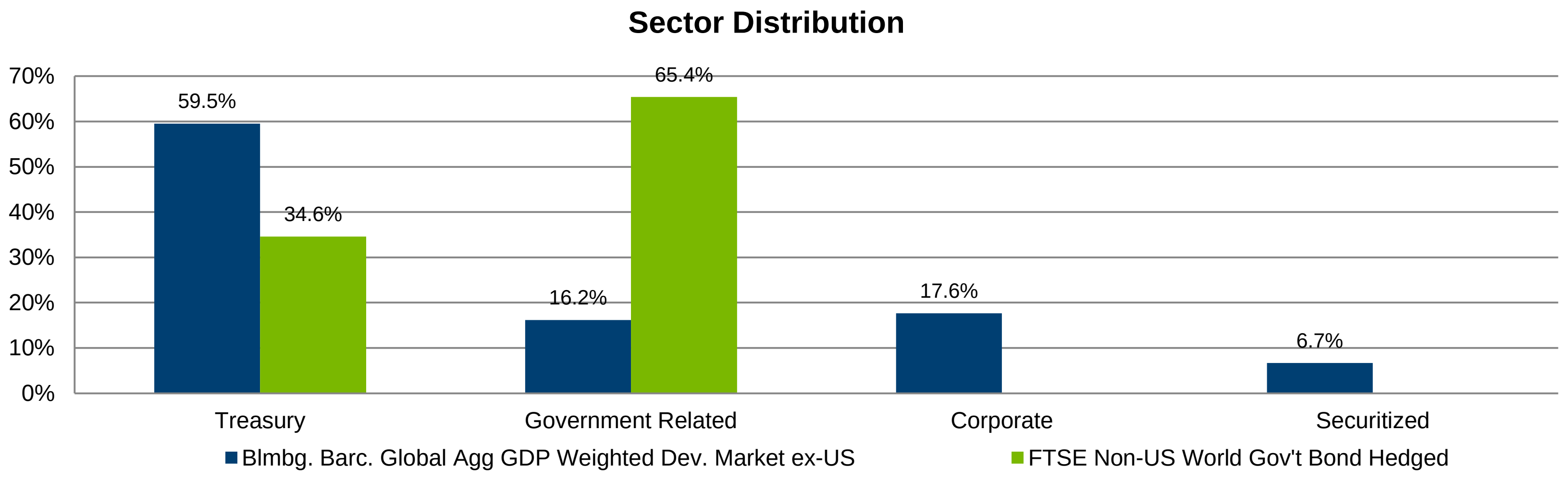
Non-U.S. Fixed Income Index Characteristics
As of March 31, 2019

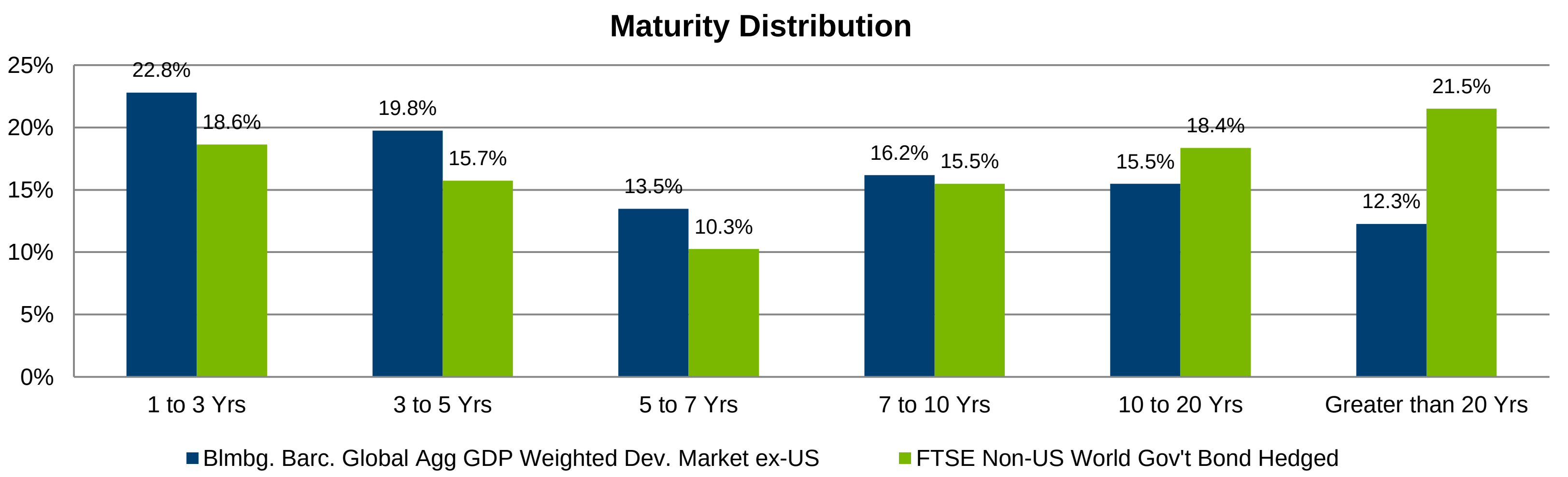
	Bloomberg Barclays Global Agg. GDP Weighted Developed Market ex-US	FTSE Non-US World Government Bond Hedged
Market Value (USD in Millions)	27,795,566	14,256,520
Yield to Maturity	0.89	0.48
Average Maturity	9.13	10.40
Coupon	2.31	2.30
Modified Duration	7.65	9.35



Following London Stock Exchange Group's ("LSEG") acquisition of The Yield Book and Citi Fixed Income Indices businesses from Citigroup, the names of the indexes have changed from "Citi" to "FTSE."

Non-U.S. Fixed Income Index Characteristics
As of March 31, 2019





Non-U.S. Fixed Income Country Allocation
As of March 31, 2019

Country	Blmbg. Barc. GDP-Weighted Global Agg Dev Mkts ex-US	FTSE Non-US World Government Bond Hedged
Australia	5.16	2.65
Austria	1.43	1.95
Belgium	2.24	3.33
Canada	6.31	2.51
Cyprus	0.03	0.00
Denmark	1.17	0.70
Finland	0.85	0.78
France	12.23	13.17
Germany	10.57	8.72
Hong Kong	0.82	0.00
Ireland	0.72	0.97
Italy	7.17	11.54
Japan	19.12	30.37
Latvia	0.03	0.00
Lithuania	0.04	0.00
Luxembourg	0.12	0.00
Malaysia	0.00	0.61
Malta	0.01	0.00
Mexico	0.00	0.99
Netherlands	3.32	2.63
New Zealand	0.52	0.00
Norway	1.09	0.32
Poland	0.00	0.82
Portugal	0.76	0.00
South Africa	0.00	0.78
Singapore	1.71	0.55
Slovakia	0.19	0.00
Slovenia	0.12	0.00
Spain	5.35	7.75
Supranational	3.25	0.00
Sweden	2.47	0.46
Switzerland	2.69	0.00
Taiwan	0.04	0.00
United Kingdom	10.43	8.37
Total	**100.00**	**100.00**

Non-U.S. Fixed Income Index Performance & Correlation
As of March 31, 2019

Trailing Period Performance:

	1 Year	3 Years	5 Years	10 Years
Non-U.S. Developed Markets Fixed Income Composite	**-0.20**	**2.32**	**0.08**	**4.21**
Blmbg. Barc. Global Agg GDP Wght'd Dev x U.S. ($H)	5.30	3.47	4.27	4.46
FTSE Non-U.S. World Government Bond Hedged	5.12	3.20	4.50	4.07

5-Years Actual Correlation Matrix:

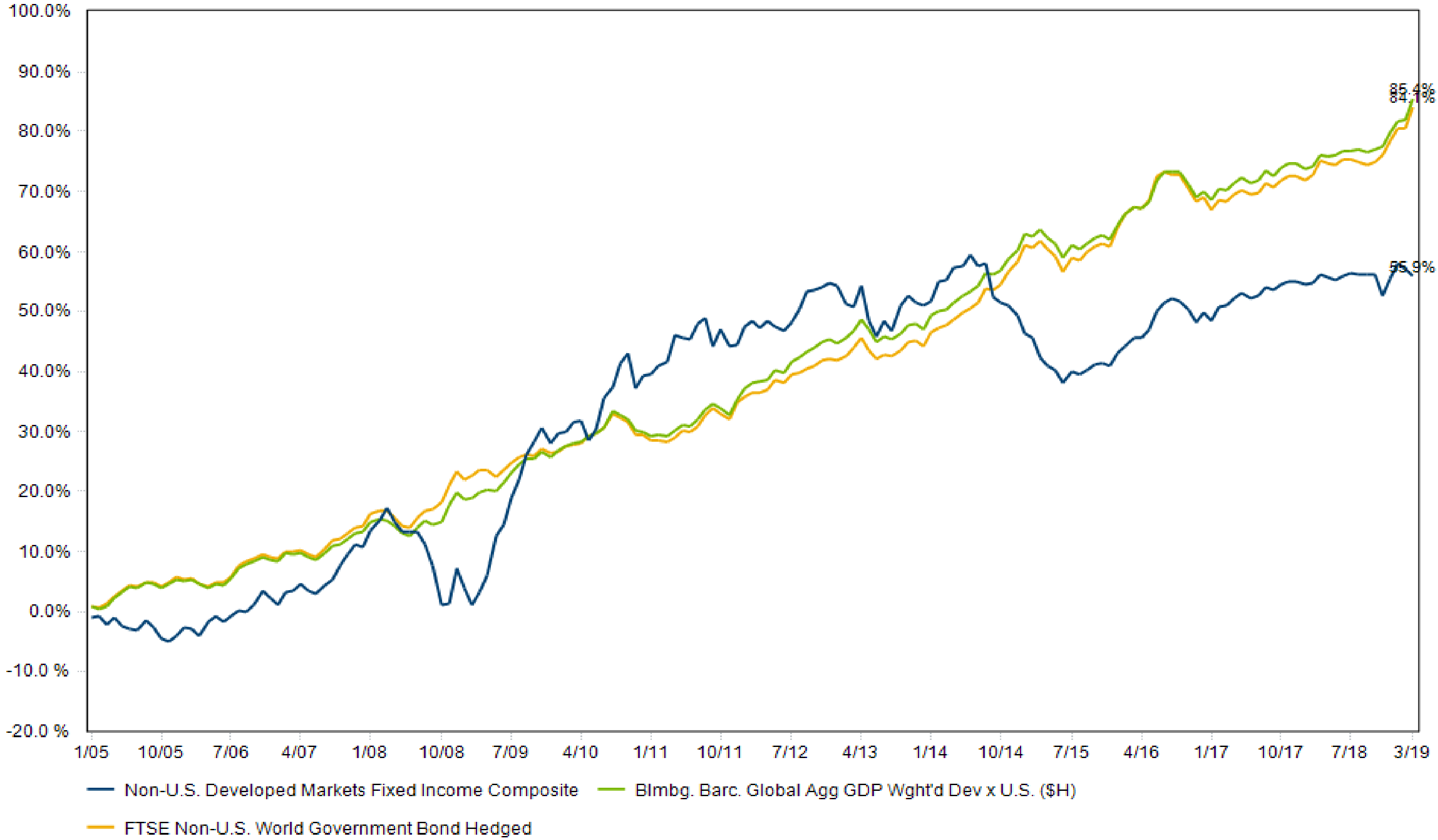
	Non-U.S. Developed Markets Fixed Income Composite	Blmbg. Barc. Global Agg GDP Wght'd Dev x U.S. ($H)	FTSE Non-U.S. World Government Bond Hedged
Non-U.S. Developed Markets Fixed Income Composite	**1.00**		
Blmbg. Barc. Global Agg GDP Wght'd Dev x U.S. ($H)	0.47	1.00	
FTSE Non-U.S. World Government Bond Hedged	0.44	0.98	1.00

- Underperformance due to termination of external manager in October 2018, with only a small position of approximately $7m remaining.

Non-U.S. Fixed Income Index Cumulative Performance

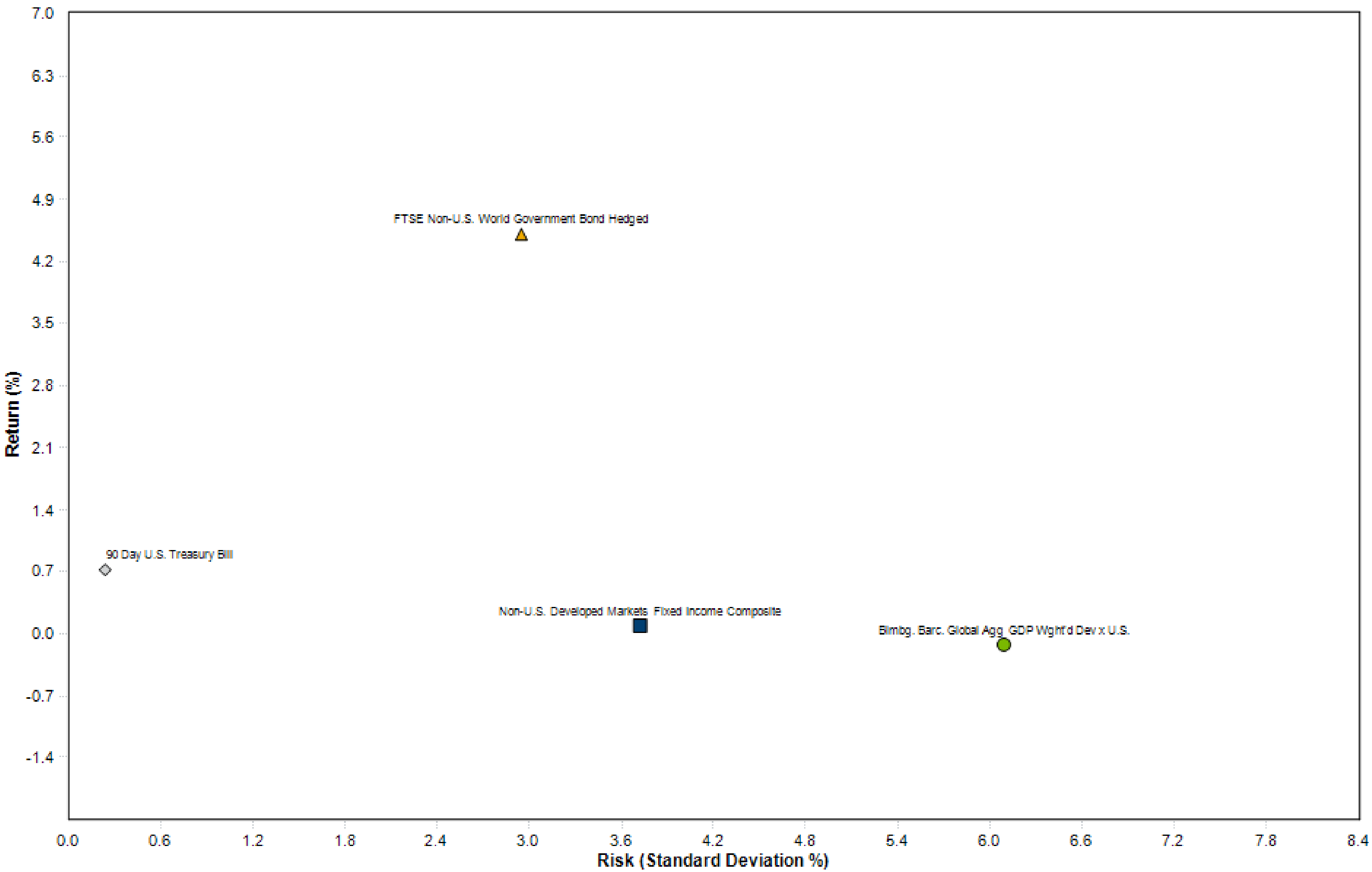
As of March 31, 2019

January 1, 2005 to March 31, 2019



Non-U.S. Fixed Income Index Risk & Return

5-Years as of March 31, 2019



U.S. Long Treasuries

U.S. Long Treasuries Index Definitions

- **Bloomberg Barclays U.S. Long Treasury Index (Current Benchmark)** – Securities in the long maturity (greater than 10 years) range of the U.S. Treasury Index.
- **ICE BofAML U.S. Treasuries 15+ Index** – Securities in the long maturity (greater than 15 years) range of the U.S. Treasury Index.

Index	Bloomberg Barclays U.S. Long Treasury Index	ICE BofAML U.S. Treasuries 15+ Index
Weighting Methodology	Market cap weighted	Market cap weighted
Rebalancing Frequency	Monthly	Monthly

AHIC continues to recommend that PSERS maintain the Bloomberg Barclays U.S. Long Treasury Index as the Long Treasury policy index. The Bloomberg index provides broader market exposure vs. the ICE BofAML alternative by including securities with a minimum maturity of 10 years vs. 15 years.

U.S. Long Treasuries Index Characteristics
As of March 31, 2019

	Bloomberg Barclays U.S. Long Treasury Index	ICE BofAML U.S. Treasuries 15+ Index
# of Issues	49	46
Maturity	25.10	24.29
Coupon	3.26	3.78
Avg. Quality	AAA	AAA
Yield to Worst	2.77	2.75
Modified Duration	17.62	N/A
Effective Duration	17.65	17.12

Distribution by Maturity	**Bloomberg Barclays U.S. Long Treasury Index**	**ICE BofAML U.S. Treasuries 15+ Index**
10 – 20 years	6.94	8.48
20+ years	93.06	91.52

U.S. Long Treasuries Performance & Correlation
As of March 31, 2019

Trailing Period Performance:

	1 Year	3 Years	5 Years	10 Years
U.S. Long Treasuries Composite (unlevered)	**2.39**	**-0.88**	**3.33**	**N/A**
Blmbg. Barc. U.S. Treasury: Long	6.24	1.47	5.44	5.13
ICE BofAML U.S. Treasuries 15+ Index	6.25	1.48	5.60	5.08

5-Years Actual Correlation Matrix:	U.S. Long Treasuries Composite (unlevered)	Blmbg. Barc. U.S. Treasury: Long	ICE BofAML U.S. Treasuries 15+ Index
U.S. Long Treasuries Composite (unlevered)	**1.00**		
Blmbg. Barc. U.S. Treasury: Long	0.99	1.00	
ICE BofAML U.S. Treasuries 15+ Index	0.99	1.00	1.00

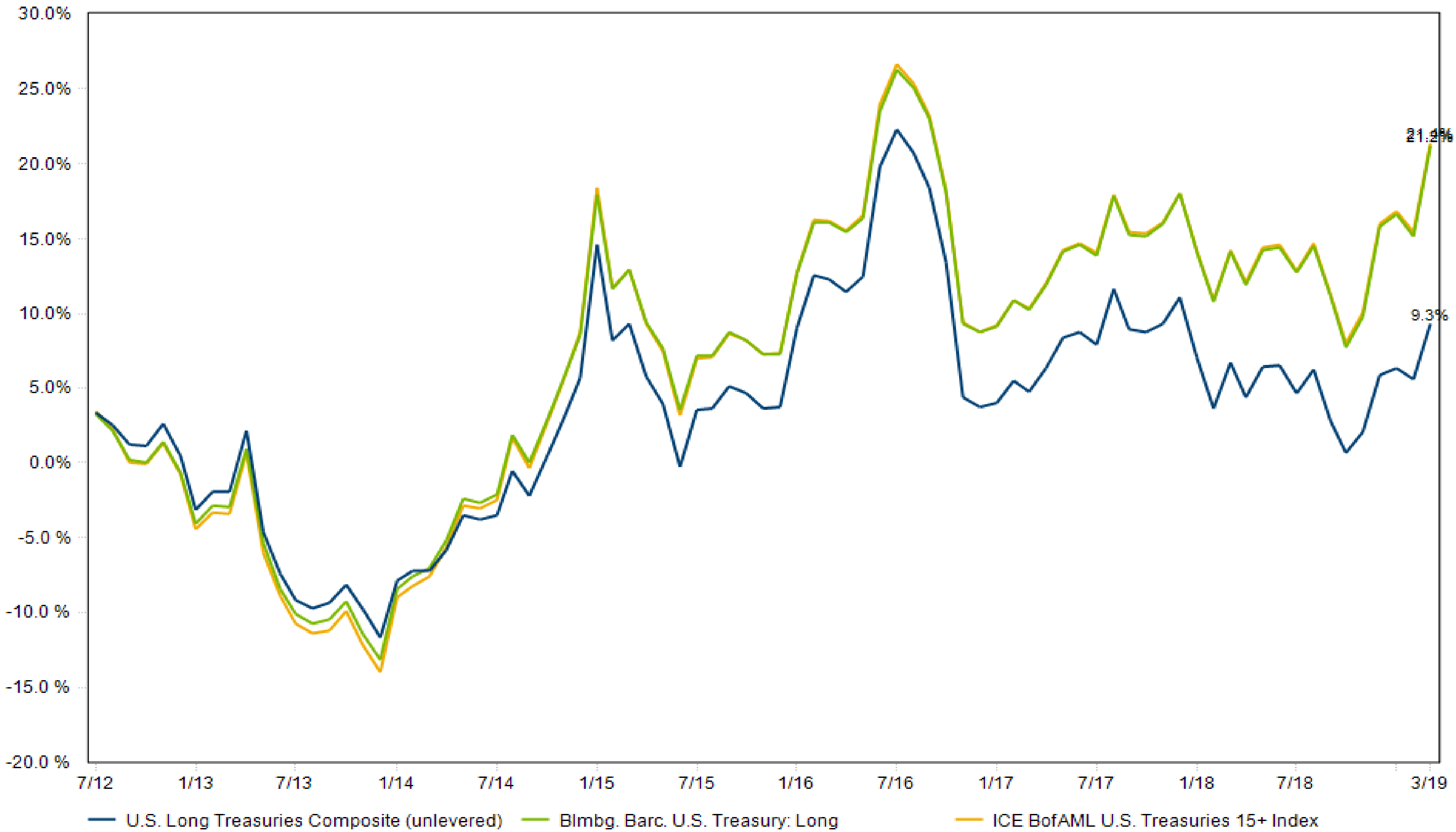
- Recent underperformance relative to policy index primarily the result of shorter duration treasuries exposure held in the portfolio from September 2018 through March 2019

Returns for periods greater than one year are annualized.
Returns are expressed as percentages.

U.S. Long Treasuries Cumulative Performance

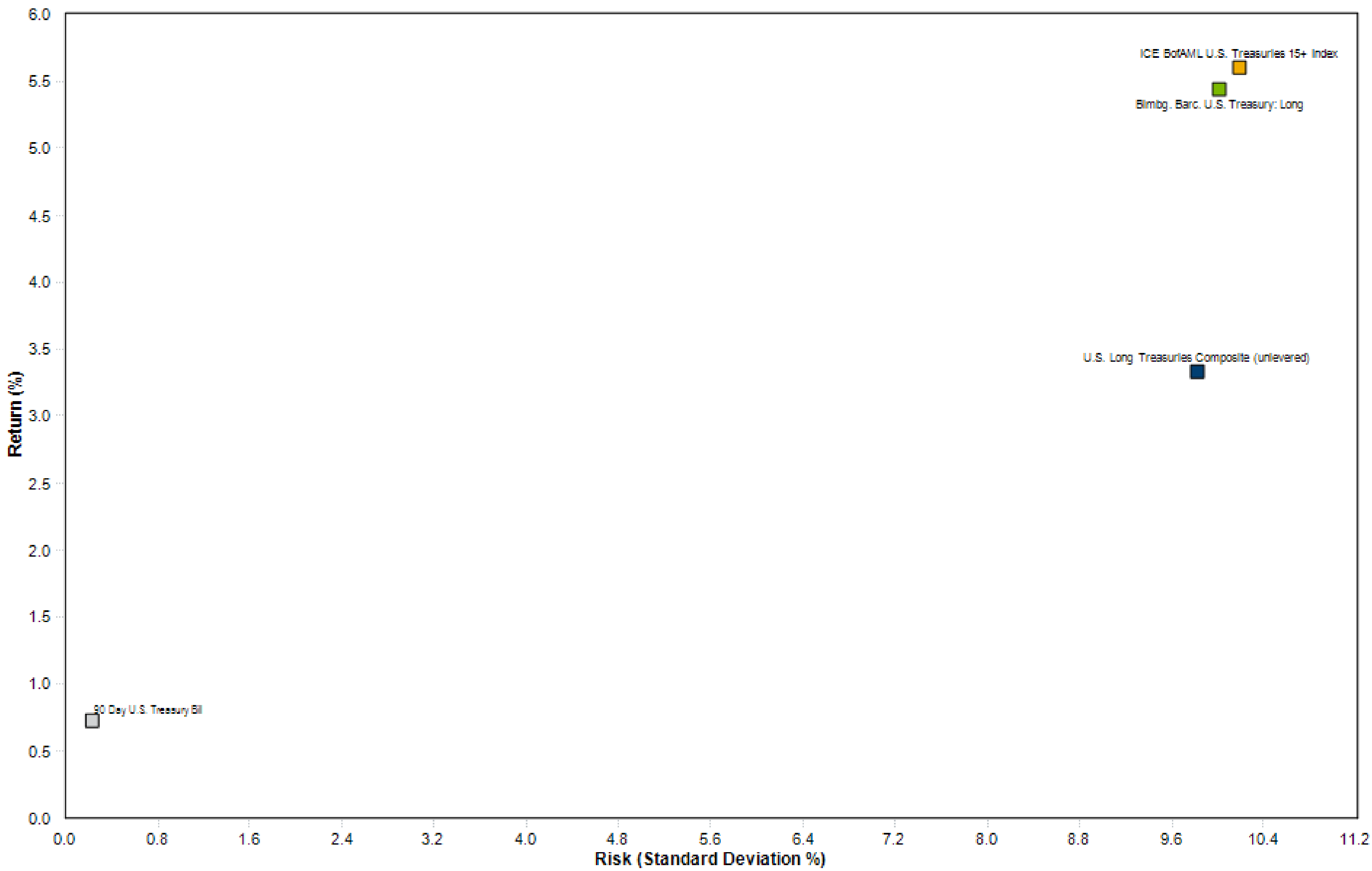
As of March 31, 2019

July 1, 2012 to March 31, 2019



U.S. Long Treasuries Risk & Return

5-Years as of March 31, 2019



Emerging Markets Debt

Emerging Markets Debt Index Definitions

- **Bloomberg Barclays EM Local Currency Government 10% Capped (Current Benchmark) –** Designed to provide a broad measure of the performance of local currency emerging markets debt. Classification as an Emerging Market is rules-based and reviewed on an annual basis using World Bank income group and International Monetary Fund (IMF) country classifications.
- **JPM EMBI Global Diversified –** U.S. dollar denominated benchmark for emerging market government-issued debt. The index defines emerging markets countries with a combination of World Bank-defined per capita income brackets and each country's debt-restructuring history. The Index limits the weights of countries with larger debt stocks by only including a specified portion of these countries' eligible current face amounts of debt outstanding.
- **JPM GBI-EM Global Diversified –** Local currency denominated benchmark for emerging market government-issued debt. The index defines emerging markets countries with a combination of World Bank-defined per capita income brackets and each country's debt-restructuring history. The Index limits the weights of countries with larger debt stocks by only including a specified portion of these countries' eligible current face amounts of debt outstanding.
- **ICE BofAML Emerging Market Corporate Plus Index (USD hedged) –** tracks the performance of US dollar (USD) and Euro denominated emerging markets non-sovereign debt publicly issued within the major domestic and Eurobond markets. The index includes corporate and quasi-government debt of qualifying countries, but excludes sovereign and supranational debt.
- **Blended Benchmark –** 33.33% JPM EMBI Global Diversified, 33.33% JPM GBI-EM Global Diversified, 33.33% ICE BofAML Emerging Market Corporate Plus Index (USD Hedged)

Index	Bloomberg Barclays EM Local Currency Gov't	JPM EMBI Global Diversified	JPM GBI-EM Global Diversified	ICE BofAML Emerging Market Corporate Plus Index (USD hedged)
Weighting Methodology	Market Cap Weighted; 10% Country Capped	Market Cap Weighted	Market Cap Weighted	Market Cap Weighted
Rebalancing Frequency	Monthly	Monthly	Monthly	Monthly

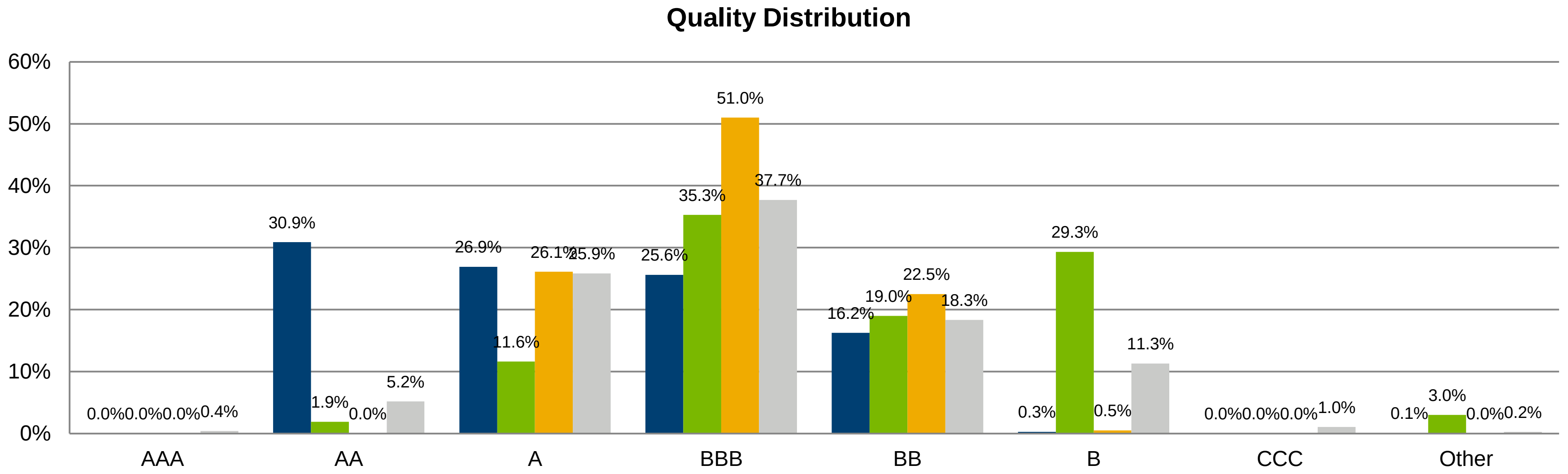
AHIC recommends that PSERS replace the current policy index with an equal-weighted blend of JPM EMBI Global Diversified, JPM GBI-EM Broad Diversified, and ICE BofAML Emerging Market Corporate Plus Index (USD Hedged). The JPM indices are the industry standard for EMD, and the 1/3 each blend captures a mix of hard and local currency exposure.

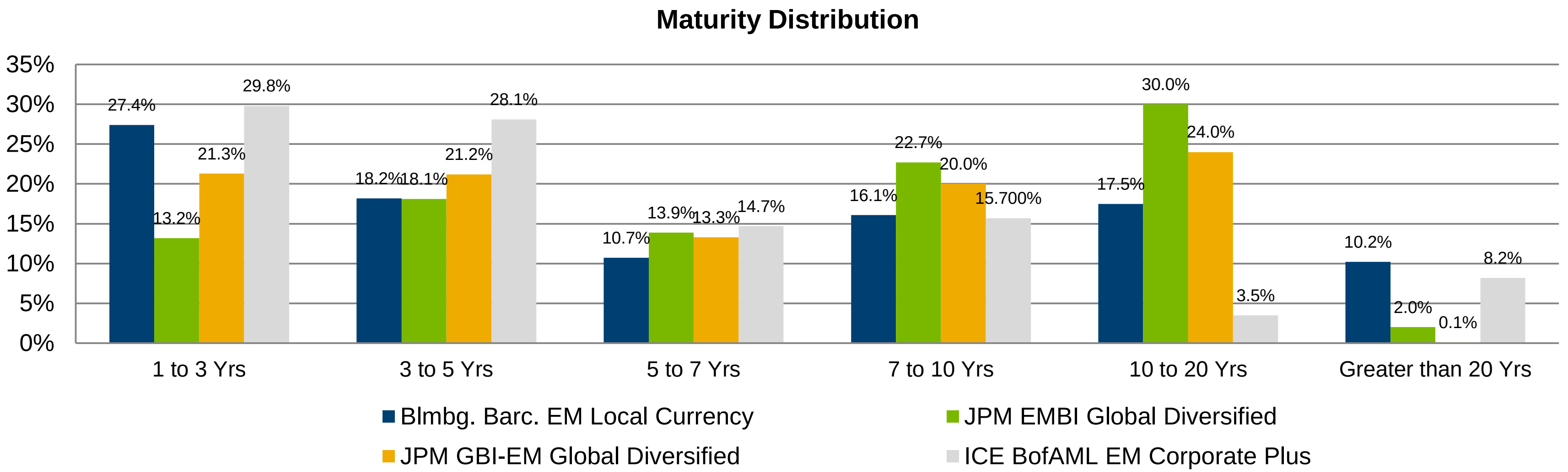
Emerging Markets Debt Index Characteristics

As of March 31, 2019

	Bloomberg Barclays EM Local Currency Gov't 10% Country Capped	JPM EMBI Global Diversified	JPM GBI-EM Global Diversified	ICE BofAML Emerging Market Corporate Plus Index (USD hedged)
Holdings Count	658	736	217	2,160
Average Maturity	8.53	11.13	7.59	6.66
Average Quality	BBB+	BB+	BBB	BBB
Coupon Rate (%)	4.81	5.94	6.20	N/A
Modified Duration	6.15	6.64	5.21	4.70
Yield To Maturity (%)	4.66	5.99	6.16	4.77

Emerging Markets Debt Index Characteristics
As of March 31, 2019





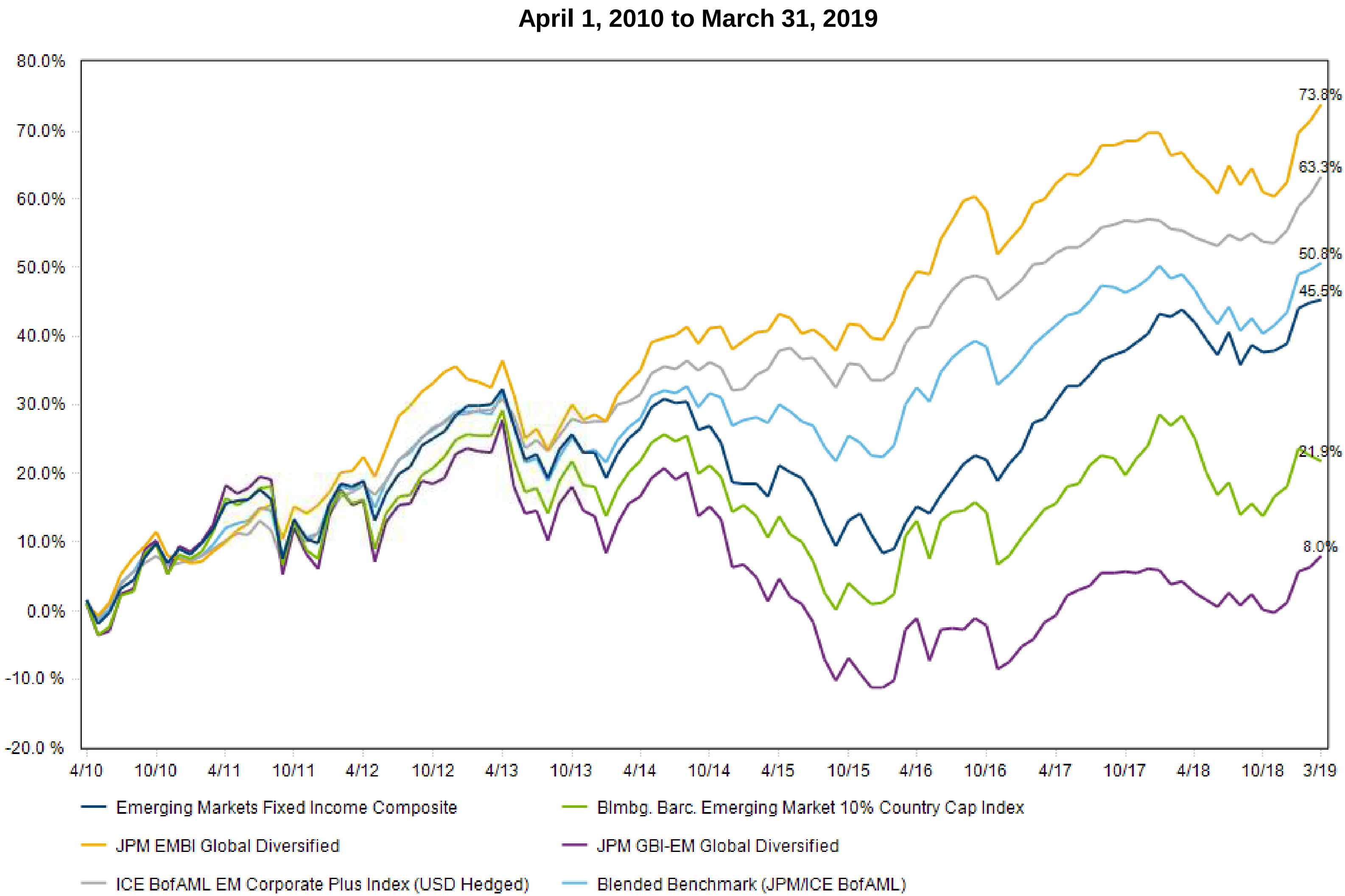
Emerging Markets Debt Index Comparative Performance & Correlation

As of March 31, 2019

Trailing Period Performance:	1 Year	3 Years	5 Years	7 Years
Emerging Markets Fixed Income Composite	**1.01**	**8.82**	**3.05**	**3.03**
Blmbg. Barc. Emerging Market 10% Country Cap Index	-5.00	3.18	0.27	0.76
JPM EMBI Global Diversified	4.21	5.79	5.44	5.38
JPM GBI-EM Global Diversified	3.54	3.54	-1.36	-0.96
ICE BofAML EM Corporate Plus Index (USD Hedged)	5.00	5.54	4.57	4.83
Blended Benchmark (JPM/ICE BofAML)	1.13	5.05	3.53	3.60

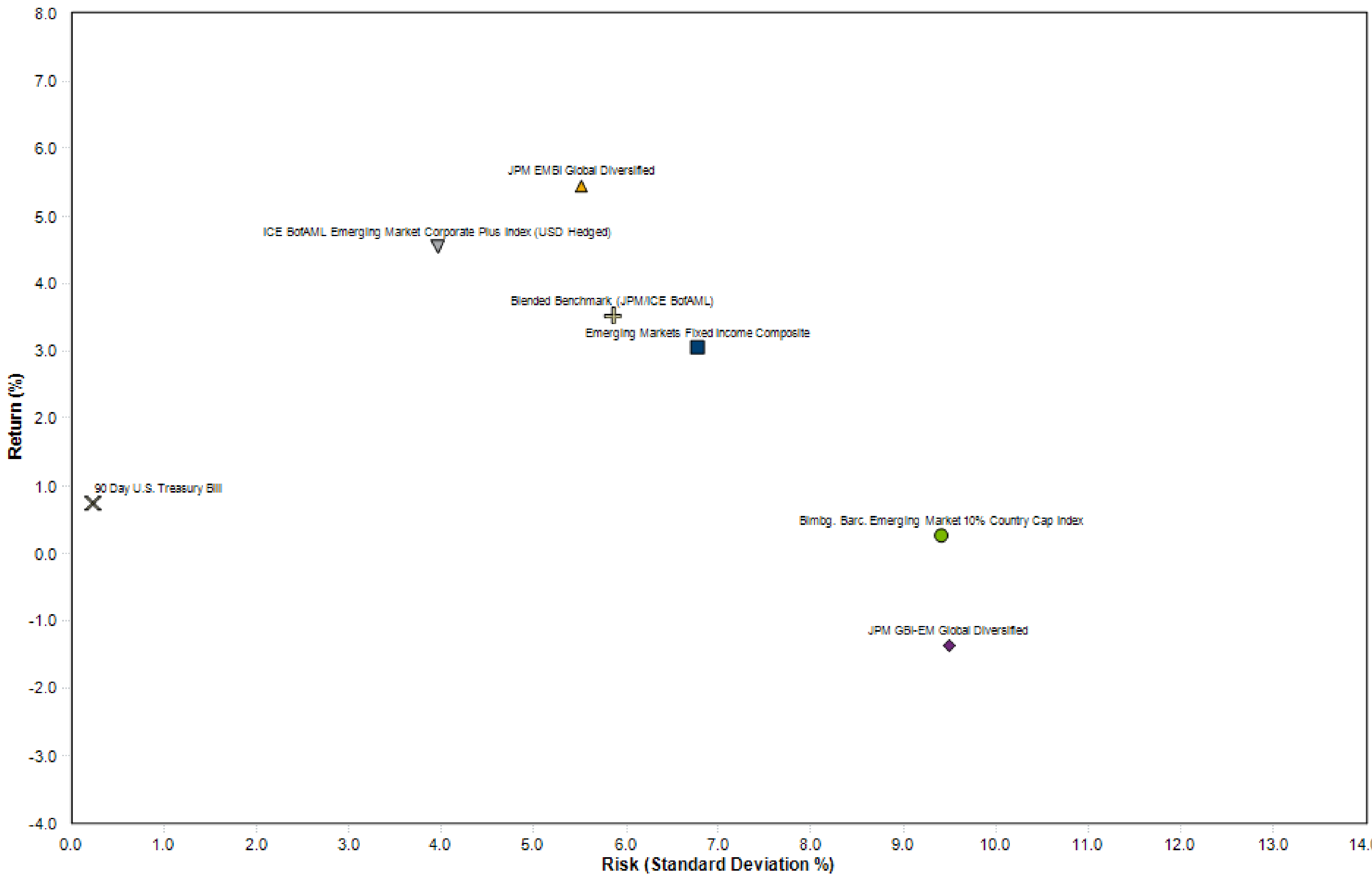
5-Years Actual Correlation Matrix:	Emerging Markets Fixed Income Composite	Blmbg. Barc. Emerging Market 10% Country Cap Index	JPM EMBI Global Diversified	JPM GBI-EM Global Diversified	ICE BofAML EM Corporate Plus Index (USD Hedged)	Blended Benchmark (JPM/ICE BofAML)
Emerging Markets Fixed Income Composite	1.00					
Blmbg. Barc. Emerging Market 10% Country Cap Index	0.84	1.00				
JPM EMBI Global Diversified	0.81	0.79	1.00			
JPM GBI-EM Global Diversified	0.82	0.91	0.80	1.00		
ICE BofAML EM Corporate Plus Index (USD Hedged)	0.85	0.75	0.92	0.81	1.00	
Blended Benchmark (JPM/ICE BofAML)	0.89	0.94	0.93	0.91	0.91	1.00

Emerging Markets Debt Index Cumulative Performance
As of March 31, 2019



Emerging Markets Debt Index Risk & Return

5-Years As of March 31, 2019



Public High Yield

Public High Yield Index Definitions

- **Bloomberg Barclays US Corporate High Yield Index (Current Benchmark) –** covers the universe of fixed rate, non-investment grade debt. Eurobonds and debt issues from countries designated as emerging markets (sovereign rating of BBB+ and below using the middle of Moody's, S&P and Fitch) are excluded, but Canadian and global bonds (SEC registered) of issuers in non-EMG countries are included. Original issue zeroes, step-up coupon structures, 144-As and pay-in-kind bonds (PIKs, as of October 1, 2009) are also included.
- **ICE BofAML High Yield Master II –** tracks the performance of US dollar denominated below investment grade corporate debt publicly issued in the US domestic market. Qualifying securities must have a below investment grade rating (based on an average of Moody's, S&P and Fitch), at least 18 months to final maturity at the time of issuance, at least one year remaining term to final maturity as of the rebalancing date, a fixed coupon schedule and a minimum amount outstanding of $250 million.
- **FTSE US High-Yield Market –** a US Dollar-denominated index which measures the performance of high-yield debt issued by corporations domiciled in the US or Canada. Recognized as a broad measure of the North American high-yield market, the index includes cash-pay, deferred-interest securities, and debt issued under Rule 144A in unregistered form.

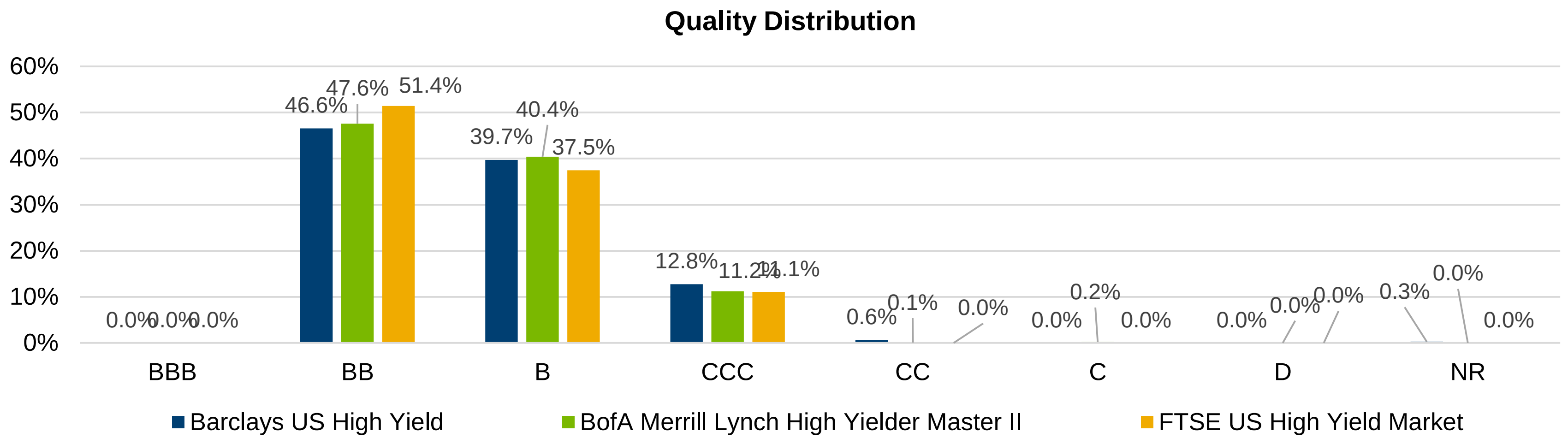
Index	Bloomberg Barclays US Corporate High Yield Index	ICE BofAML High Yield Master II	FTSE High-Yield Market
Weighting Methodology	Market cap	Market cap	Market cap
Rebalancing Frequency	Monthly	Monthly	Monthly

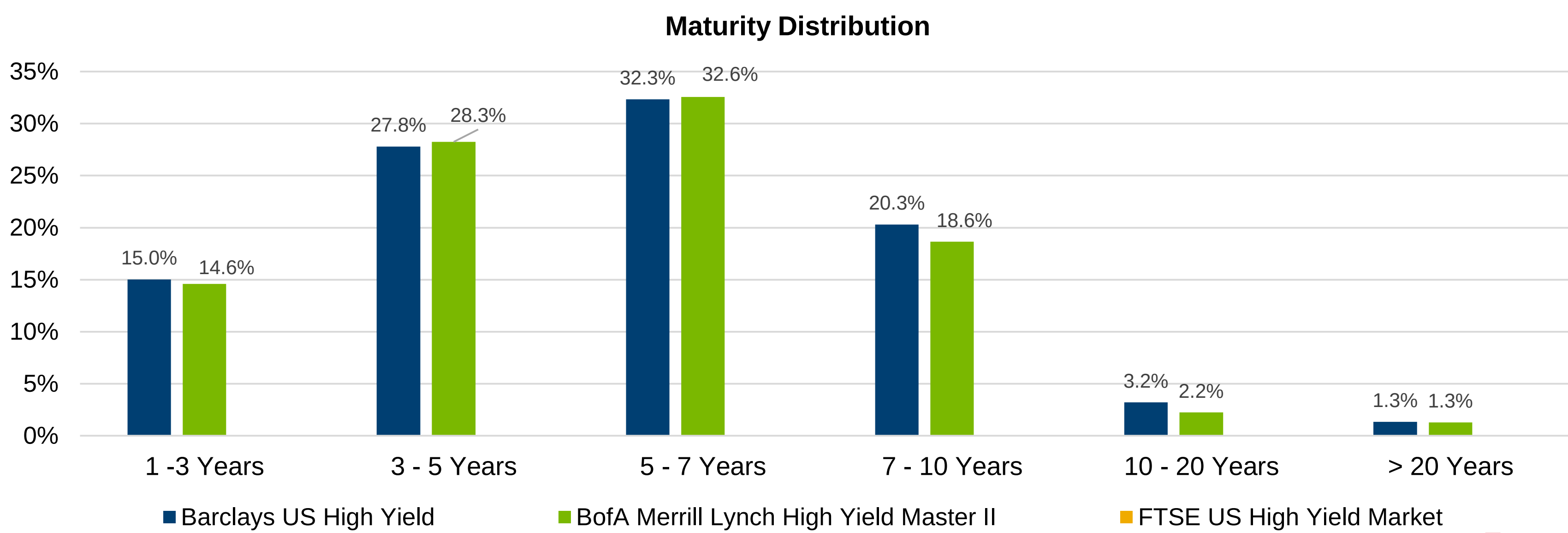
AHIC continues to recommend that PSERS maintain the Bloomberg Barclays US Corporate High Yield Index as the policy benchmark for public high yield. The Bloomberg index provides broad market exposure of the public high yield market.

Public High Yield Index Characteristics
As of March 31, 2019

	Bloomberg Barclays US Corporate High Yield Index	ICE BofAML High Yield Master II	FTSE US High Yield Market Index
# of Issues	1,931	1,800	1,550
Maturity	5.77	5.27	5.68
Coupon	6.37	6.11	6.39
Avg. Quality	B+	BB-	B+
Yield to Maturity	6.43	5.78	6.84
Modified Duration	3.33	N/A	N/A
Effective Duration	3.42	3.69	3.56

Public High Yield Index Characteristics
As of March 31, 2019





Note: FTSE does not publicly provide maturity distribution.

Public High Yield Index Performance & Correlation

As of March 31, 2019

Trailing Period Performance:

	1 Year	3 Years	5 Years	10 Years
High Yield Fixed Income Composite (hedged)	**6.56**	**10.25**	**6.89**	**11.27**
Blmbg. Barc. U.S. Corp: High Yield	5.93	8.56	4.68	11.26
ICE BofAML High Yield Master II	5.93	8.69	4.70	11.24
FTSE High Yield Market Index	5.86	8.63	4.36	10.87

5-Years Actual Correlation Matrix:

	High Yield Fixed Income Composite (hedged)	Blmbg. Barc. U.S. Corp: High Yield	ICE BofAML High Yield Master II	FTSE High Yield Market Index
High Yield Fixed Income Composite (hedged)	**1.00**			
Blmbg. Barc. U.S. Corp: High Yield	0.41	1.00		
ICE BofAML High Yield Master II	0.42	1.00	1.00	
FTSE High Yield Market Index	0.42	1.00	1.00	1.00

5-Years:	Standard Deviation
High Yield Fixed Income Composite (hedged)	**2.97**
Blmbg. Barc. U.S. Corp: High Yield	5.42
ICE BofAML High Yield Master II	5.47
FTSE High Yield Market Index	5.71

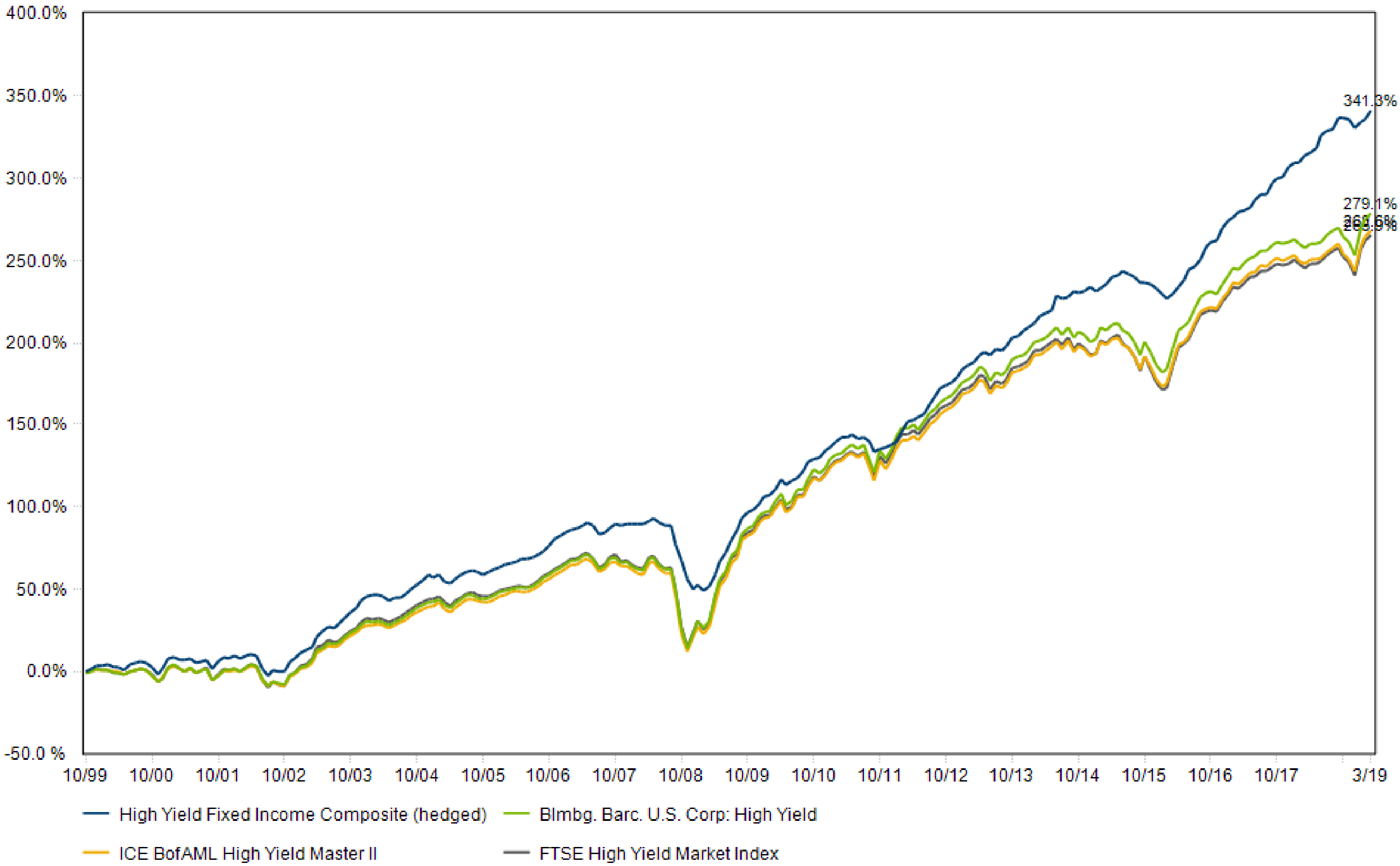
Note: The high yield portfolio transitioned from public to private credit, effective October 2007.

Returns for periods greater than one year are annualized.
Returns are expressed as percentages.

Public High Yield Index Cumulative Performance

As of March 31, 2019

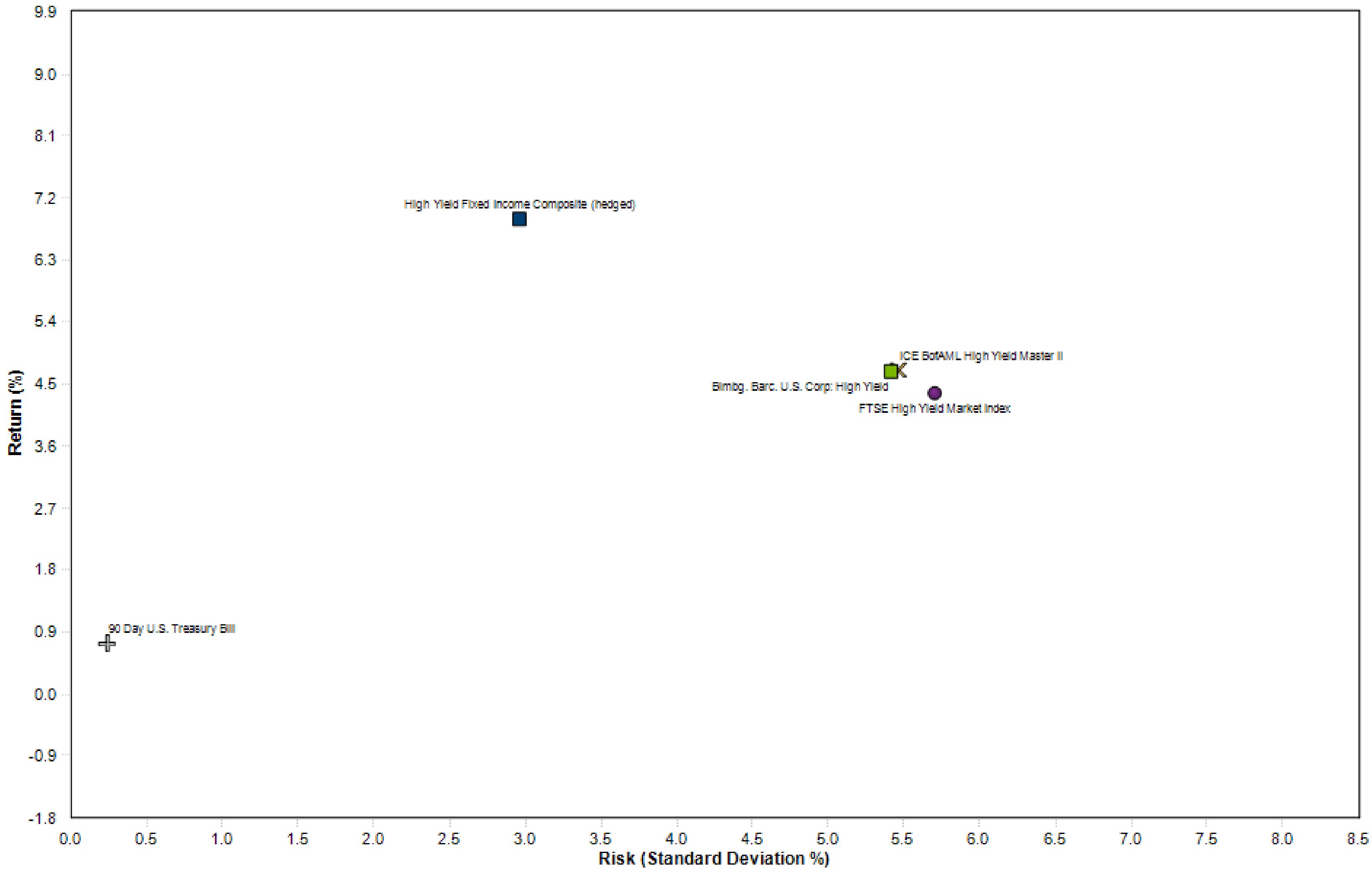
October 1, 1999 to March 31, 2019



Note: The high yield portfolio transitioned from public to private credit, effective October 2007.

Public High Yield Index Risk & Return

5-Years as of March 31, 2019



Note: The high yield portfolio transitioned from public to private credit, effective October 2007.

Private Credit

Private Credit Index Definitions

- **HFRI Distressed/Restructuring Index –** the index represents a peer group of strategies focused on corporate fixed income instruments, primarily trading at significant discounts to their value at issuance or obliged (par value) at maturity as a result of either formal bankruptcy proceeding or financial market perception of near term proceedings. In most cases portfolio exposures are concentrated in instruments which are publicly traded, in some cases actively and in others under reduced liquidity but in general for which a reasonable public market exists.
- **S&P/LSTA Leveraged Loan Index –** reflects the market-weighted performance of institutional leveraged loans in the U.S. based upon real-time market weightings, spreads and interest payments. The index components are the institutional tranches (Term Loan A, Term Loan B and higher and Second Lien) of loans syndicated to U.S. loan investors.
- **50/50 Blend Bloomberg Barclays US Corporate High Yield and S&P/LSTA Leveraged Loan Index**
- **S&P/LSTA Leveraged Loan Index + 200bps**
- **2X Levered S&P/LSTA Leveraged Loan Index (3M LIBOR Adjusted)**

Index	Bloomberg Barclays US Corporate High Yield Index	HFRI Distressed/Restructuring Index	S&P/LSTA Leveraged Loan Index
Weighting Methodology	Market cap	Equal weighted	Market cap
Rebalancing Frequency	Monthly	Monthly	Monthly

<u>Performance Benchmark</u>:
AHIC recommends that PSERS adopt the S&P/LSTA Leveraged Loan Index + 200 bps as the Private Credit policy benchmark. The benchmark is a broad benchmark of the direct lending universe (a primary component of the PSERS portfolio).

<u>Risk Benchmark:</u>
AHIC recommends that PSERS adopt the S&P/LSTA Leveraged Loan Index as the risk benchmark for Private Credit.

Private Credit Index Characteristics
As of March 31, 2019

	S&P/LSTA Leveraged Loan Index	Bloomberg Barclays US Corporate High Yield Index
# of Issues	1,180	1,906
Maturity	6.18	6.32
Coupon	N/A*	6.37
Avg. Quality	B	B+
Yield to Maturity	6.85	6.32
Duration Modified to Maturity	N/A*	3.21

Note: Holdings-level data not available for HFRI Distressed/Restructuring Index.

*Coupon and duration are not applicable metrics due to the floating rate interest structure of the S&P/LSTA Levered Loan Index.

Private Credit Index Performance & Correlation

As of March 31, 2019

Trailing Period Performance:

	1 Year	3 Years	5 Years	10 Years
High Yield Fixed Income Composite (hedged)	**6.56**	**10.25**	**6.89**	**11.27**
HFRI ED: Distressed/Restructuring Index	1.19	8.05	1.81	7.22
50% Barclays Corporate HY/50% S&P/LSTA Leveraged Loans	4.45	7.12	4.16	9.63
S&P/LSTA Leveraged Loan Index	2.97	5.67	3.62	7.98
S&P/LSTA Leveraged Loan Index + 200 bps	5.02	7.78	5.69	10.14
2X Levered S&P/LSTA Leveraged Loan Index (Adjusted)	3.23	9.77	6.11	15.44

5-Years Actual Correlation Matrix:

	High Yield Fixed Income Composite (hedged)	HFRI ED: Distressed/Restructuring Index	50% Barclays Corporate HY/50% S&P/LSTA Leveraged Loans	S&P/LSTA Leveraged Loan Index	S&P/LSTA Leveraged Loan Index + 200 bps	2X Levered S&P/LSTA Leveraged Loan Index (Adjusted)
High Yield Fixed Income Composite (hedged)	**1.00**					
HFRI ED: Distressed/Restructuring Index	0.63	1.00				
50% Barclays Corporate HY/50% S&P/LSTA Leveraged Loans	0.44	0.83	1.00			
S&P/LSTA Leveraged Loan Index	0.45	0.82	0.93	1.00		
S&P/LSTA Leveraged Loan Index + 200 bps	0.45	0.82	0.93	1.00	1.00	
2X Levered S&P/LSTA Leveraged Loan Index (Adjusted)	0.44	0.81	0.92	1.00	1.00	1.00

5-Years:

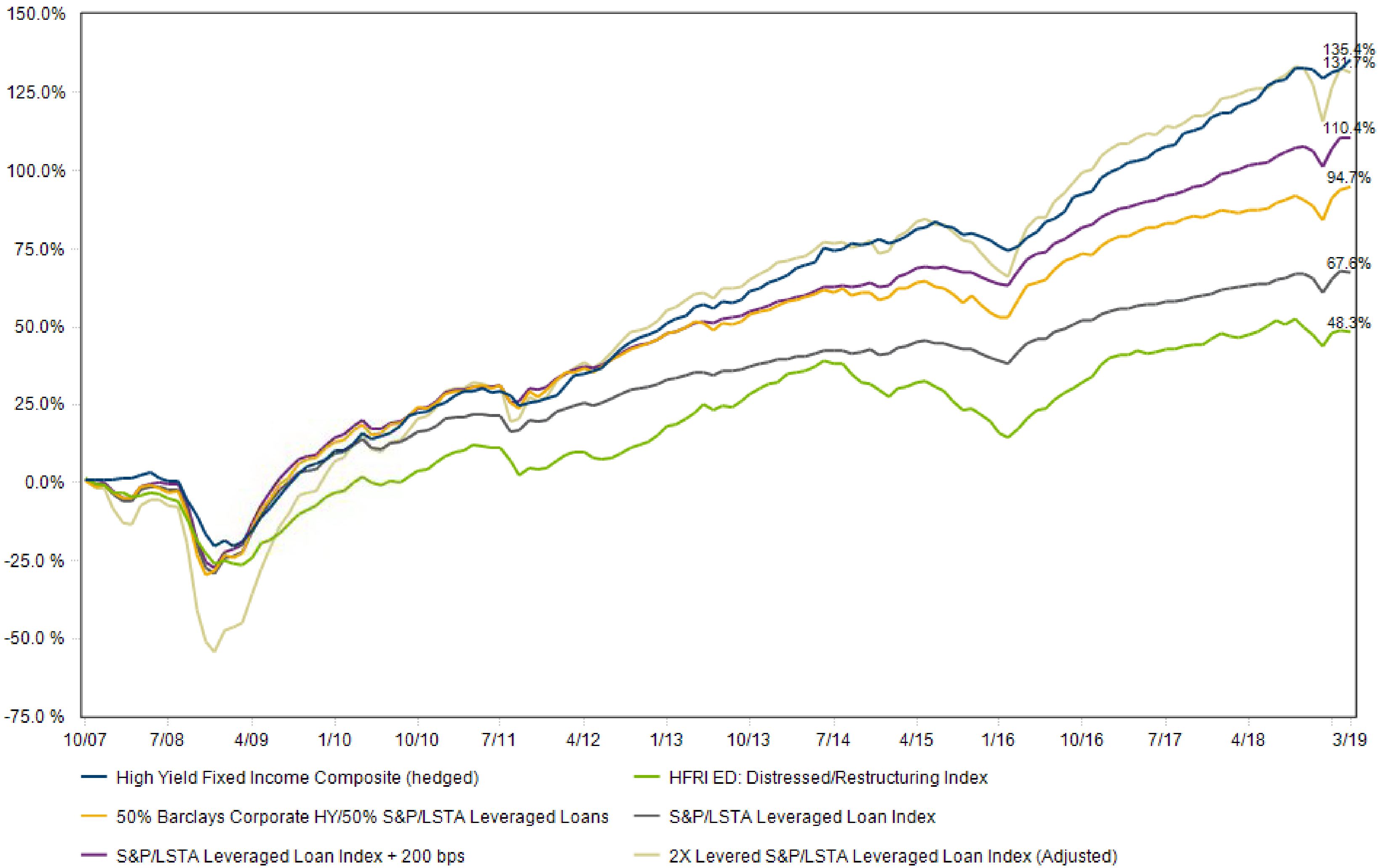
	Standard Deviation
High Yield Fixed Income Composite (hedged)	**2.97**
HFRI ED: Distressed/Restructuring Index	5.11
50% Barclays Corporate HY/50% S&P/LSTA Leveraged Loans	4.02
S&P/LSTA Leveraged Loan Index	2.96
S&P/LSTA Leveraged Loan Index + 200 bps	2.97
2X Levered S&P/LSTA Leveraged Loan Index (Adjusted)	5.92

Returns for periods greater than one year are annualized.
Returns are expressed as percentages.

Private Credit Index Cumulative Performance

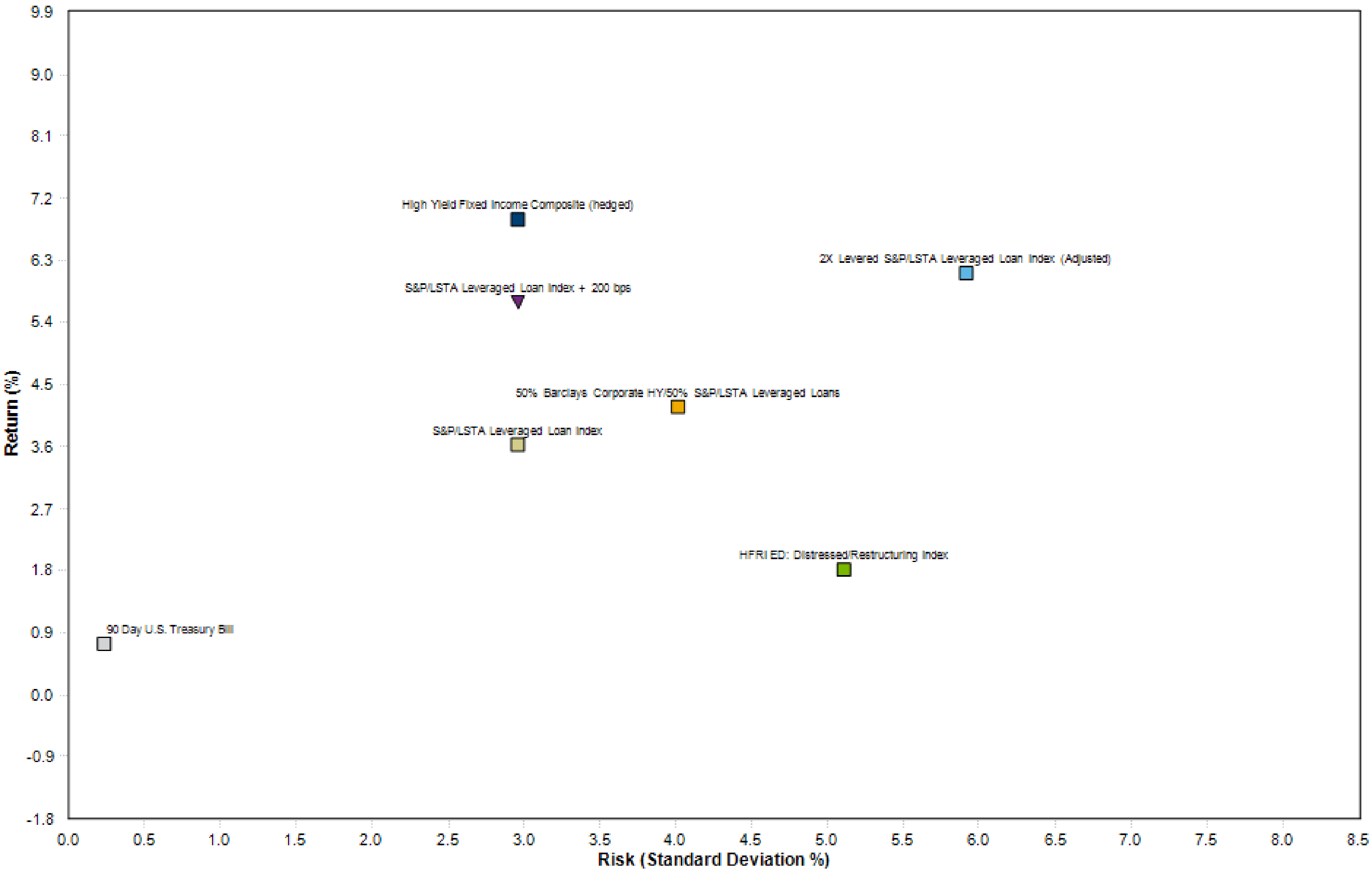
As of March 31, 2019

October 1, 2007 to March 31, 2019



Private Credit Index Risk & Return

5-Years as of March 31, 2019



Empower Results®

U.S. TIPS

U.S. TIPS Index Definitions

- **Bloomberg Barclays US Government Inflation-Linked All Maturities Total Return Index (B Series)** – consists of Inflation-Protection securities issued by the U.S. Treasury.
- **ICE BofAML All Maturity US Inflation-Linked Treasury Index** – tracks the performance of US dollar denominated inflation-linked sovereign debt publicly issued by the US Government in its domestic market.

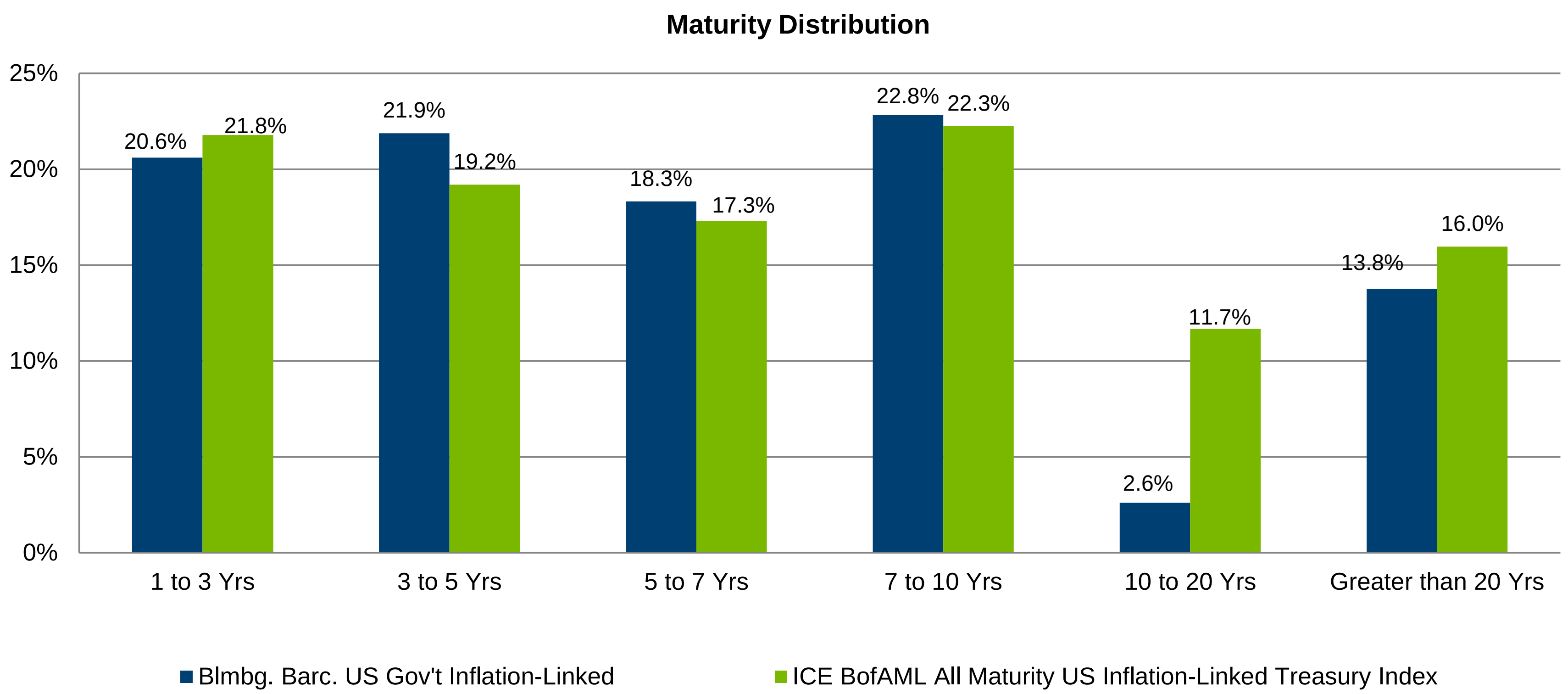
Index	Bloomberg Barclays US Government Inflation-Linked All Maturities Total Return Index (B Series)	ICE BofAML All Maturity US Inflation-Linked Treasury Index
Weighting Methodology	Market cap	Market cap
Rebalancing Frequency	Monthly	Monthly

AHIC recommends that PSERS adopt the US Government Inflation-Linked All Maturities Total Return Index as the policy index for U.S. TIPS.

U.S. TIPS Index Characteristics
As of March 31, 2019

	Bloomberg Barclays US Government Inflation-Linked All Maturities Total Return Index (B Series)	ICE BofAML All Maturity US Inflation-Linked Treasury Index
# of Issues	40	42
Average Maturity	8.07	8.41
Coupon Rate (%)	0.76	0.51
Effective Duration	5.15	5.13
Yield To Worst (%)	2.60	N/A
Effective Yield (%)	N/A	0.51

U.S. TIPS Index Characteristics
As of March 31, 2019



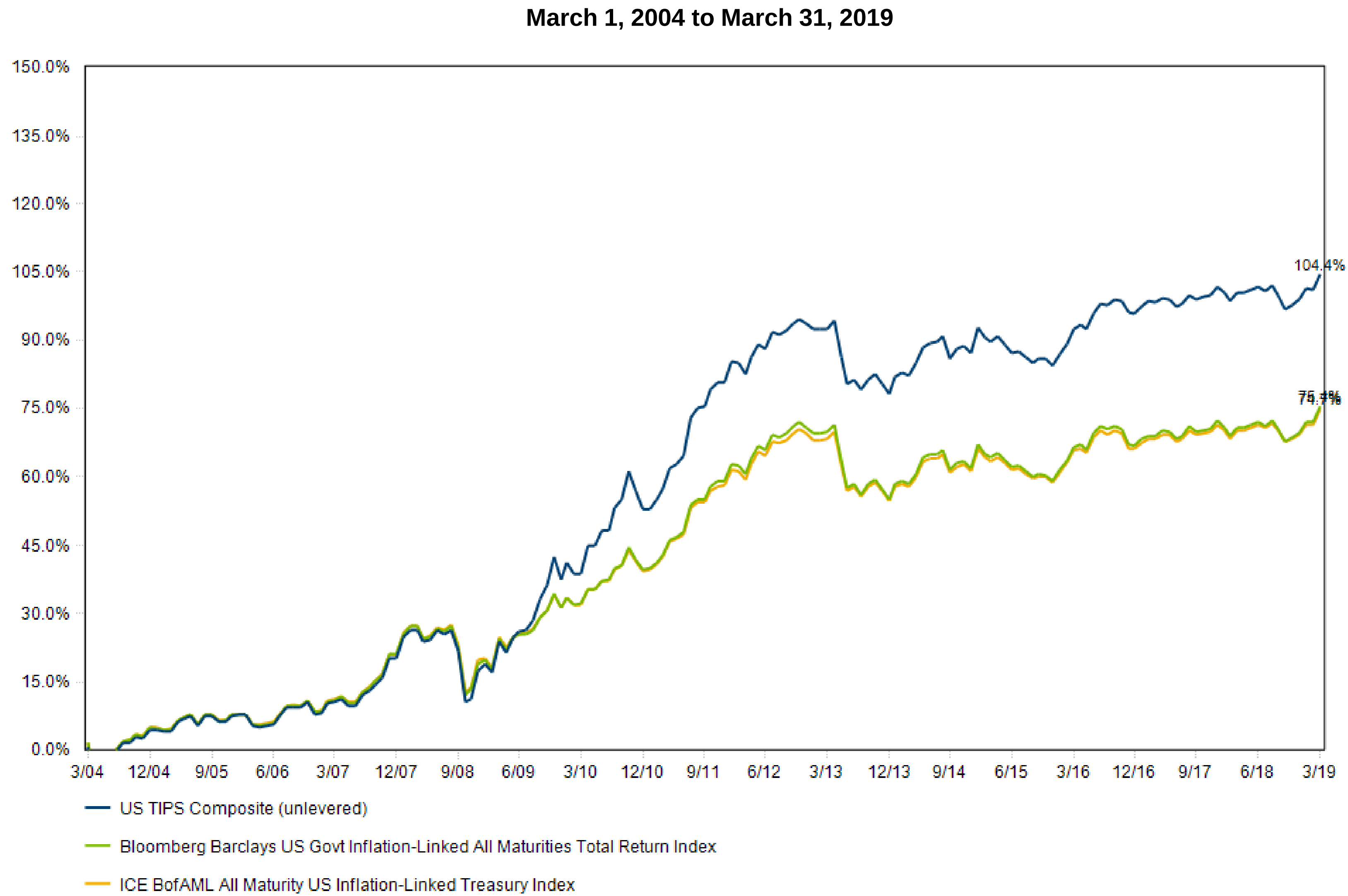
U.S. TIPS Index Performance & Correlation

As of March 31, 2019

Trailing Period Performance:	1 Year	3 Years	5 Years	10 Years
US TIPS Composite (unlevered)	**1.93**	**2.01**	**2.31**	**5.13**
Bloomberg Barclays US Govt Inflation-Linked All Maturities Total Return Index	2.69	1.75	2.06	3.49
ICE BofAML All Maturity US Inflation-Linked Treasury Index	2.66	1.77	2.05	3.42

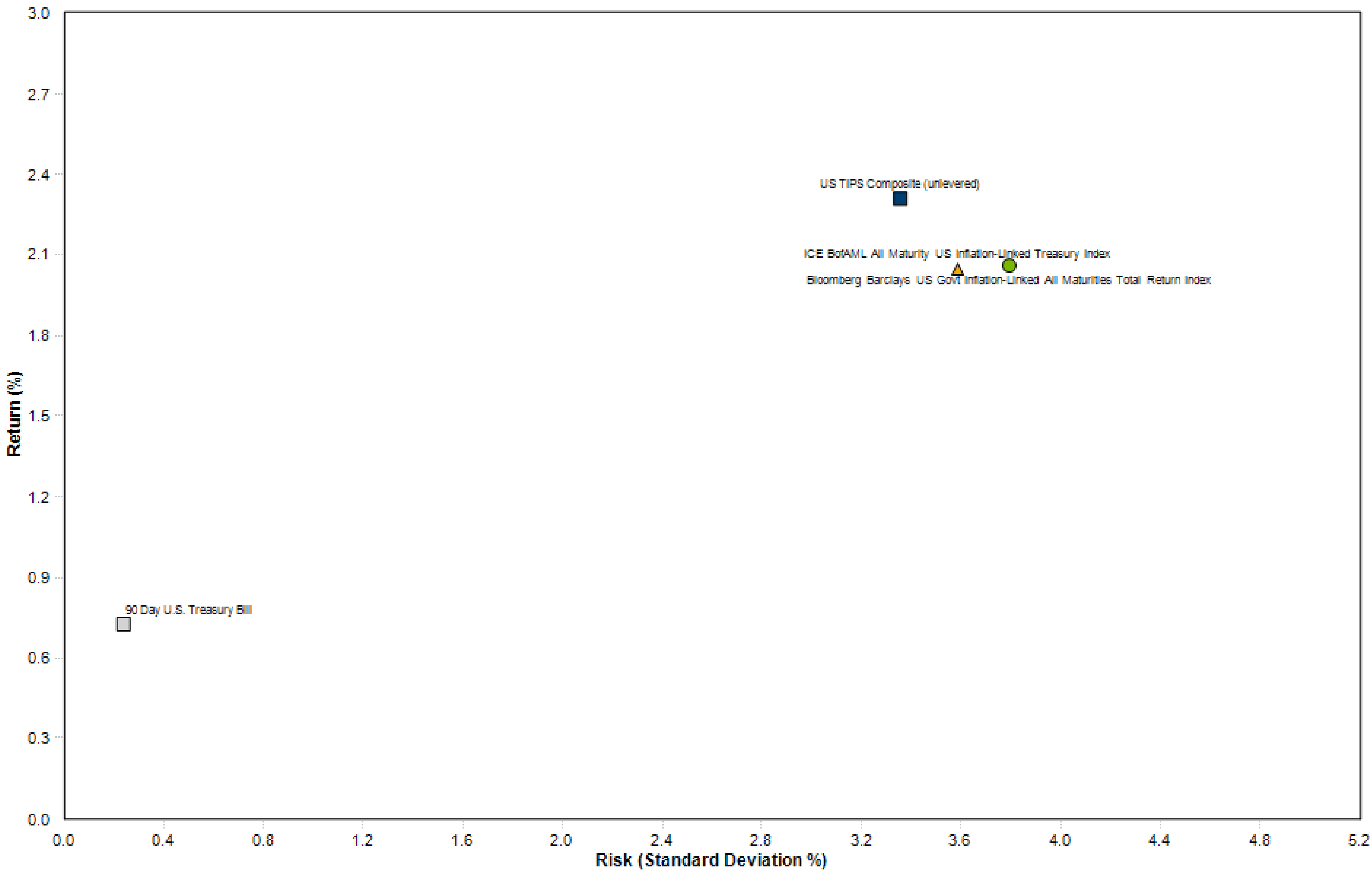
5-Years Actual Correlation Matrix:	US TIPS Composite (unlevered)	Bloomberg Barclays US Govt Inflation-Linked All Maturities Total Return Index	ICE BofAML All Maturity US Inflation-Linked Treasury Index
US TIPS Composite (unlevered)	**1.00**		
Bloomberg Barclays US Govt Inflation-Linked All Maturities Total Return Index	0.99	1.00	
ICE BofAML All Maturity US Inflation-Linked Treasury Index	0.99	1.00	1.00

U.S. TIPS Index Cumulative Performance
As of March 31, 2019



U.S. TIPS Index Risk & Return

5-Years as of March 31, 2019



Non-U.S. Inflation-Linked

Non-U.S. Inflation-Linked Index Definitions

- **Bloomberg Barclays World Gov't ex-U.S. Inflation-Linked Bonds All Maturities Total Return Index (Hedged) (B Series)**– measures the performance of the major government inflation-linked bond markets.
- **ICE BofAML Global ex-US Diversified Inflation-Linked Index (Hedged)** – tracks the performance of inflation-linked sovereign debt publicly issued in the issuer's own domestic currency.

Index	Bloomberg Barclays World Gov't ex-U.S. Inflation-Linked Bonds All Maturities Total Return Index (Hedged) (B Series)	ICE BofAML Global ex-US Diversified Inflation-Linked Index (Hedged)
Weighting Methodology	Market cap	Market cap
Rebalancing Frequency	Monthly	Monthly

AHIC recommends that PSERS adopt the Bloomberg Barclays Global Inflation-Linked ex-U.S. Index (Hedged) as the policy benchmark for Non-U.S. Inflation-Linked. The Bloomberg index is highly correlated with the Bridgewater TIPS portfolio.

Non-U.S. Inflation-Linked Index Characteristics
As of March 31, 2019

	Bloomberg Barclays World Gov't ex-U.S. Inflation-Linked Bonds All Maturities Total Return Index (Hedged) (B Series)	ICE BofAML Global ex-US Diversified Inflation-Linked Index (Hedged)
# of Issues	101	186
Average Maturity	16.57	11.72
Coupon Rate (%)	N/A	0.37
Effective Duration	N/A	6.25
Effective Yield (%)	N/A	0.37

Non-U.S. Inflation-Linked Index Performance & Correlation
As of March 31, 2019

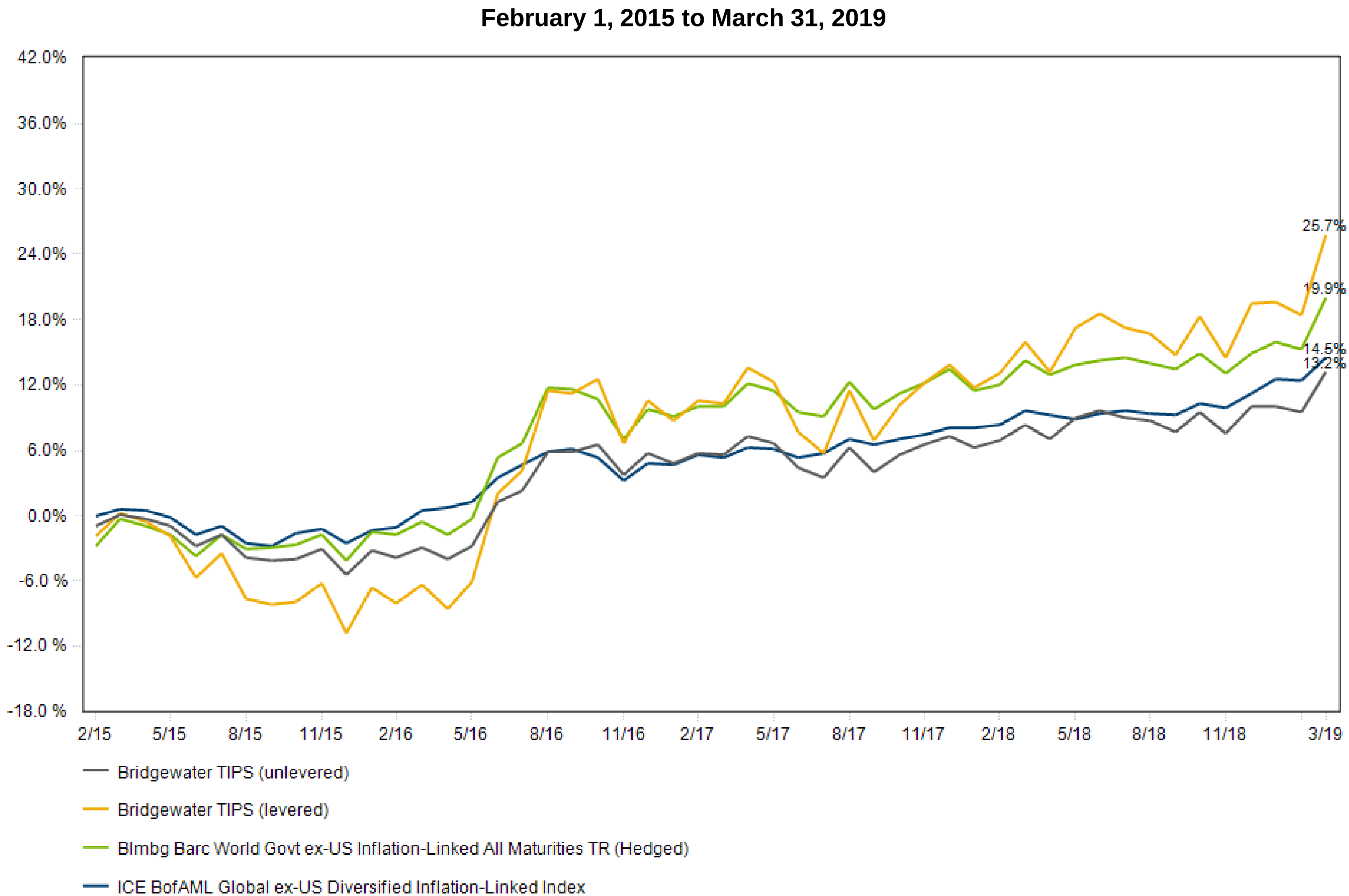
Trailing Period Performance:

	1 Year	3 Years	5 Years	10 Years
Bridgewater TIPS (unlevered)	4.46	5.24	N/A	N/A
Bridgewater TIPS (levered)	8.44	10.31	9.08	11.50
Blmbg Barc World Govt ex-US Inflation-Linked All Maturities TR (Hedged)	4.95	6.45	6.48	5.89
ICE BofAML Global ex-US Diversified Inflation-Linked Index (Hedged)	4.45	4.46	4.47	N/A

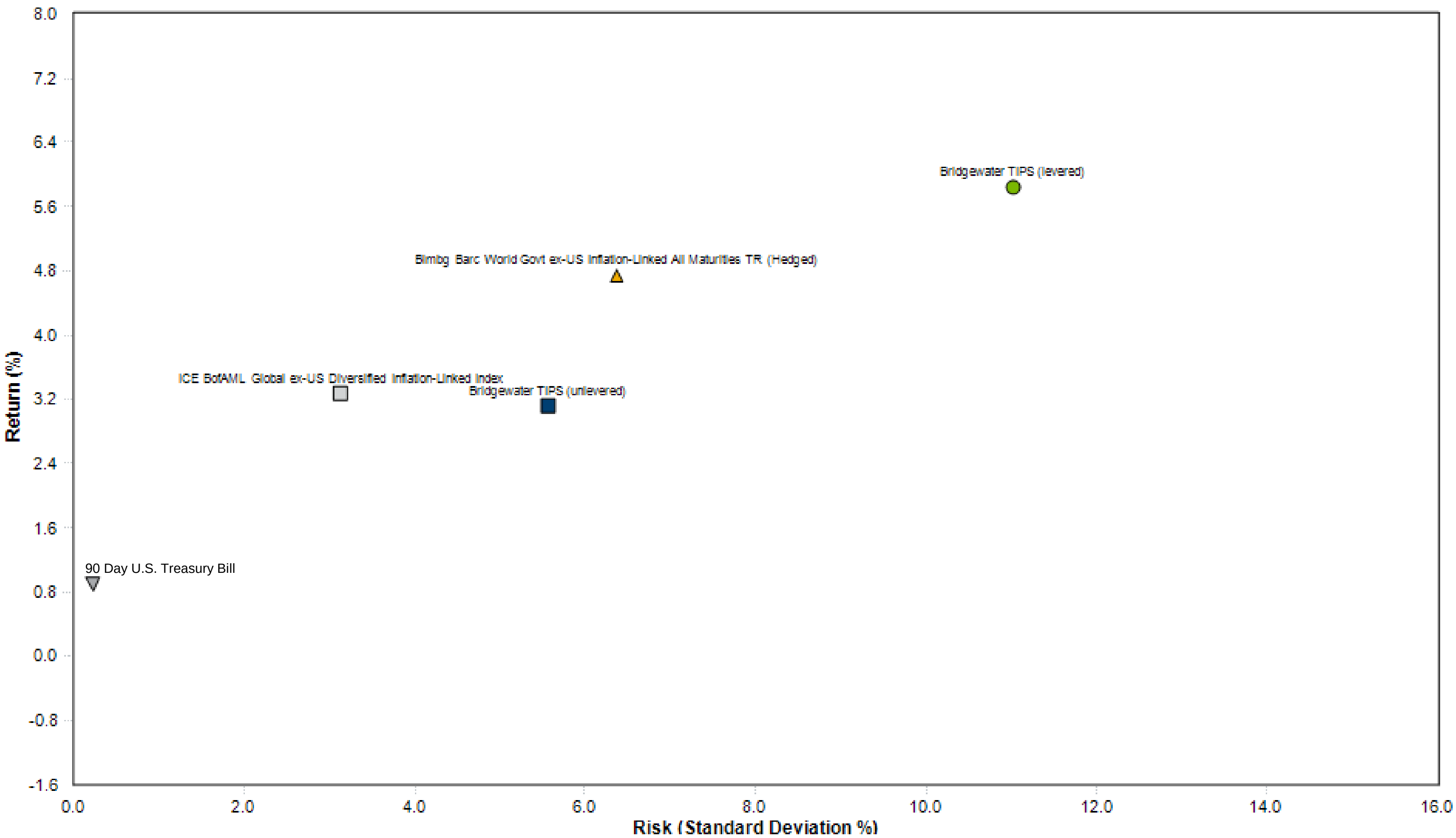
4-Years Actual Correlation Matrix:

	Bridgewater TIPS (unlevered)	Bridgewater TIPS (levered)	Blmbg Barc World Govt ex-US Inflation-Linked All Maturities TR (Hedged)	ICE BofAML Global ex-US Diversified Inflation-Linked Index (Hedged)
Bridgewater TIPS (unlevered)	1.00			
Bridgewater TIPS (levered)	1.00	1.00		
Blmbg Barc World Govt ex-US Inflation-Linked All Maturities TR (Hedged)	0.96	0.96	1.00	
ICE BofAML Global ex-US Diversified Inflation-Linked Index (Hedged)	0.83	0.83	0.87	1.00

Non-U.S. Inflation-Linked Index Cumulative Performance
As of March 31, 2019



Non-U.S. Inflation-Linked Index Risk & Return
4-Years as of March 31, 2019



MLPs

MLP Index Definitions

- **S&P MLP Index (Current Benchmark)** – includes both master limited partnerships (MLPs) and publicly traded limited liability companies (LLCs), which have a similar legal structure to MLPs and share the same tax benefits.
- **Alerian MLP Index** – capped, float-adjusted, capitalization-weighted index, whose constituents represent approximately 85% of total float-adjusted market capitalization.
- **Alerian Midstream Energy Index** – capped, float-adjusted, capitalization-weighted index, whose constituents earn the majority of their cash flow from midstream activities involving energy commodities.

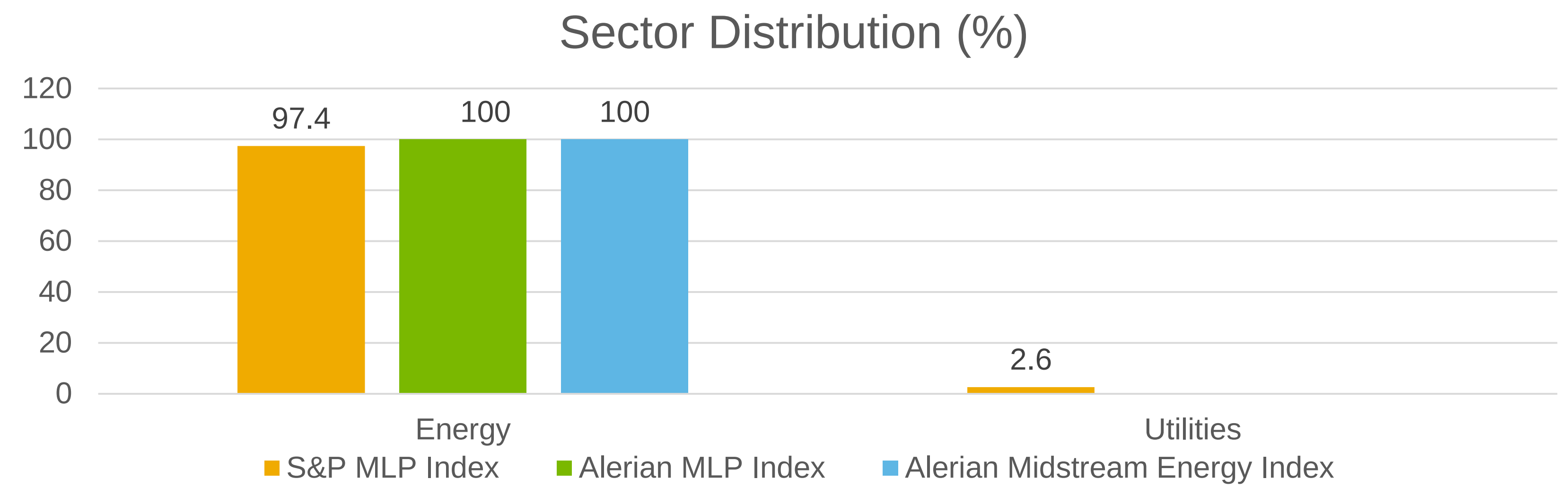
Index	S&P MLP Index	Alerian MLP Index	Alerian Midstream Energy Index
Weighting Methodology	Modified Market Cap	Float-adjusted Market Cap	Float-adjusted Market Cap
Rebalancing Frequency	Annually (October)	Quarterly	Quarterly

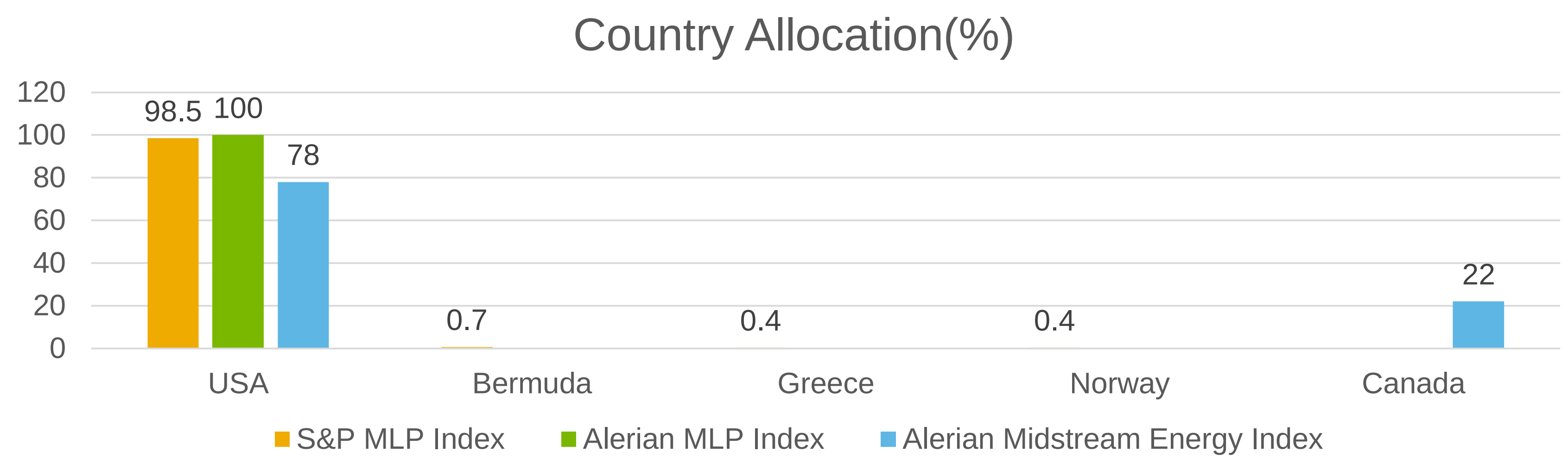
AHIC recommends replacing the S&P MLP Index with the Alerian Midstream Energy Index as the policy benchmark for MLPs. The Alerian Midstream Energy Index is the broadest index by number of securities, includes both MLPs and C corps and is diversified by geography with 22% invested in Canada.

MLP Index Characteristics
As of March 31, 2019

	S&P MLP Index	Alerian MLP Index	Alerian Midstream Energy Index
No. of Securities	41	35	60
Weighted Average Market Capitalization ($M)	6,571	8,175	9,978
Median Market Capitalization ($M)	2,675	3,426	3,522
Largest Company	Enterprise Product Partners LP (17.7%)	Enterprise Product Partners LP (10.1%)	Enterprise Products Partners LP (10.0%)
% Top 10 Holdings	69.9	70.3	73.0

MLP Index Characteristics
As of March 31, 2019





MLP Index Performance & Correlation
As of March 31, 2019

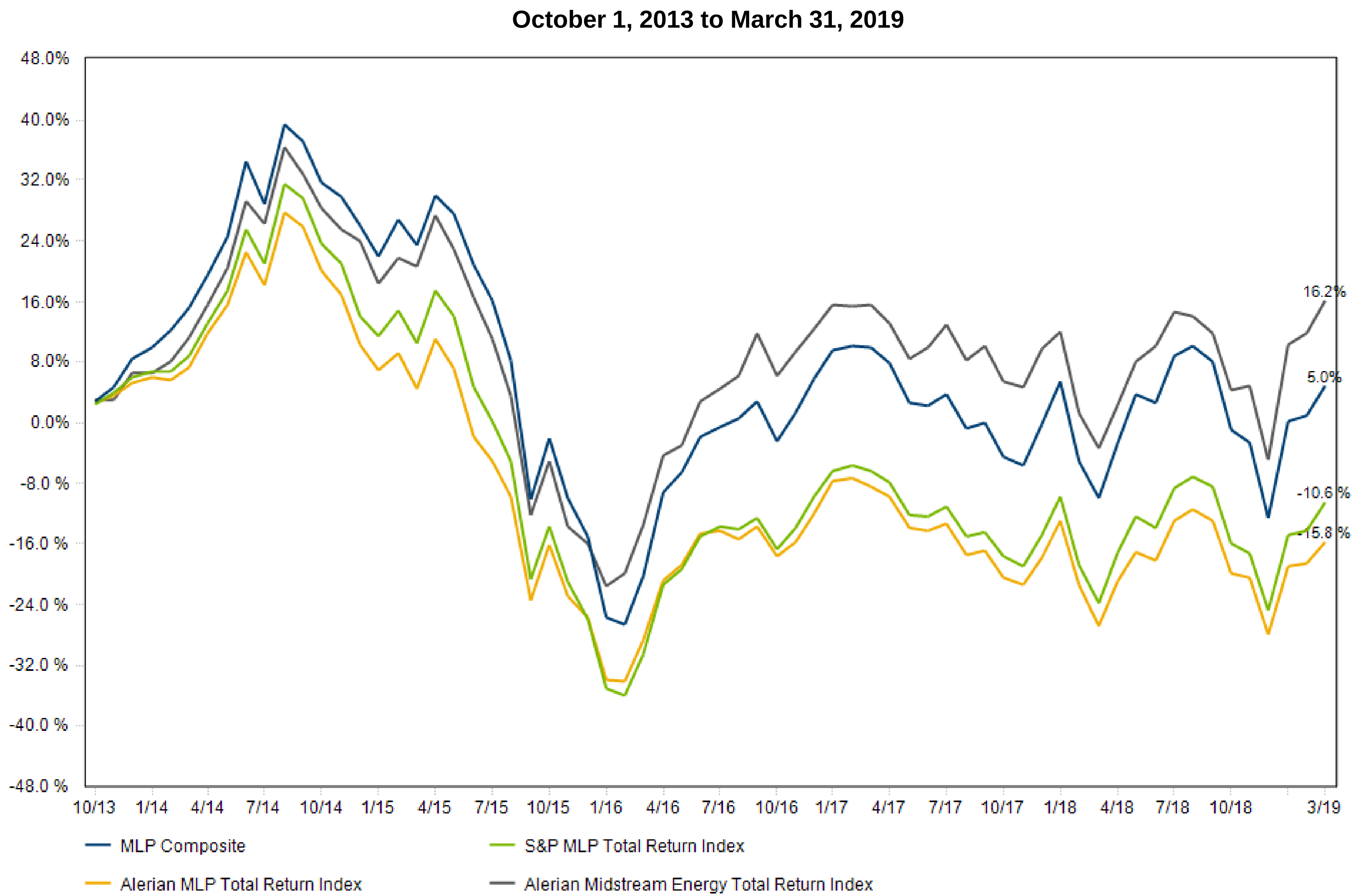
Trailing Period Performance:	1 Year	3 Years	5 Years	7 Years	10 Years
MLP Composite	**16.57**	**9.55**	**-1.84**	**5.40**	**14.40**
S&P MLP Total Return Index	17.50	8.84	-3.86	1.74	11.01
Alerian MLP Total Return Index	15.11	5.69	-4.73	0.67	10.12
Alerian Midstream Energy Total Return Index	20.30	10.30	0.89	N/A	N/A

5-Years Actual Correlation Matrix:

	MLP Composite	S&P MLP Total Return Index	Alerian MLP Total Return Index	Alerian Midstream Energy Total Return Index
MLP Composite	**1.00**			
S&P MLP Total Return Index	0.99	1.00		
Alerian MLP Total Return Index	0.98	0.99	1.00	
Alerian Midstream Energy Total Return Index	0.97	0.95	0.95	1.00

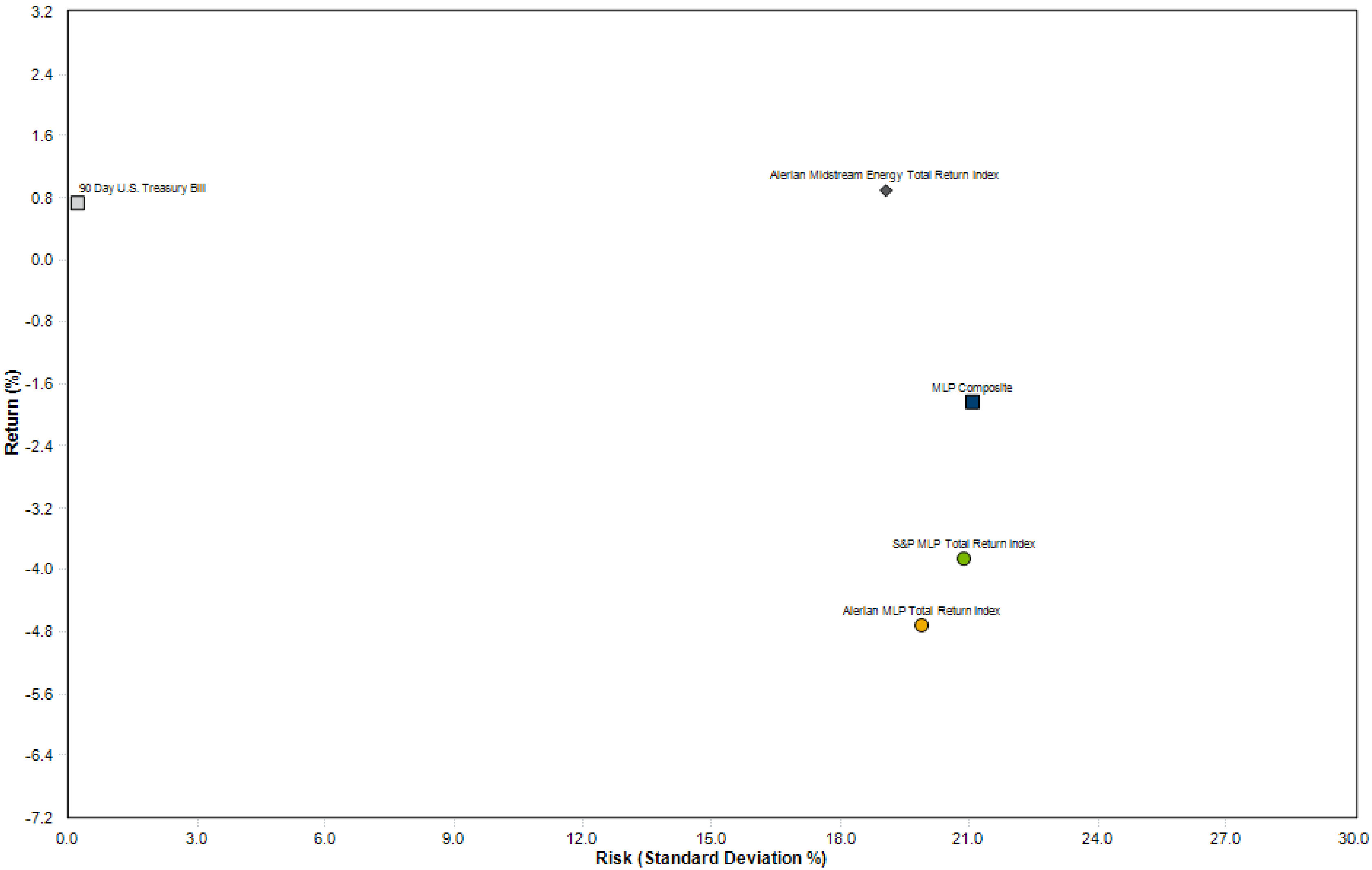
Returns for periods greater than one year are annualized.
Returns are expressed as percentages.

MLP Index Cumulative Performance
As of March 31, 2019



MLP Index Risk & Return

5-Years as of March 31, 2019



Infrastructure (Public and Private)

Infrastructure Index Definitions

- **FTSE Developed Core 50/50 (Current Benchmark) –** 50% Utilities, 30% Transportation including capping of 7.5% for railroads/railways and a 20% mix of other sectors including pipelines, satellites and telecommunication towers. Company weights within each group are adjusted in proportion to their investable market capitalization.
- **S&P Global Infrastructure –** designed to track 75 companies from around the world chosen to represent the listed infrastructure industry while maintaining liquidity and tradability. To create diversified exposure, the index includes three distinct infrastructure clusters: energy, transportation, and utilities.
- **FTSE Global Infrastructure –** a comprehensive set of nine cap-weighted indices, diversified across six FTSE-defined infrastructure sub-sectors, to reflect the performance of infrastructure and infrastructure-related listed securities worldwide.
- **Dow Jones Brookfield Infrastructure Composite Index –** designed to measure the performance of pure-play infrastructure companies domiciled globally. The index covers all sectors of the infrastructure market and includes Master Limited Partnerships (MLPs) in addition to other equity securities. To be included in the index, a company must derive at least 70% of cash flows from infrastructure lines of business.

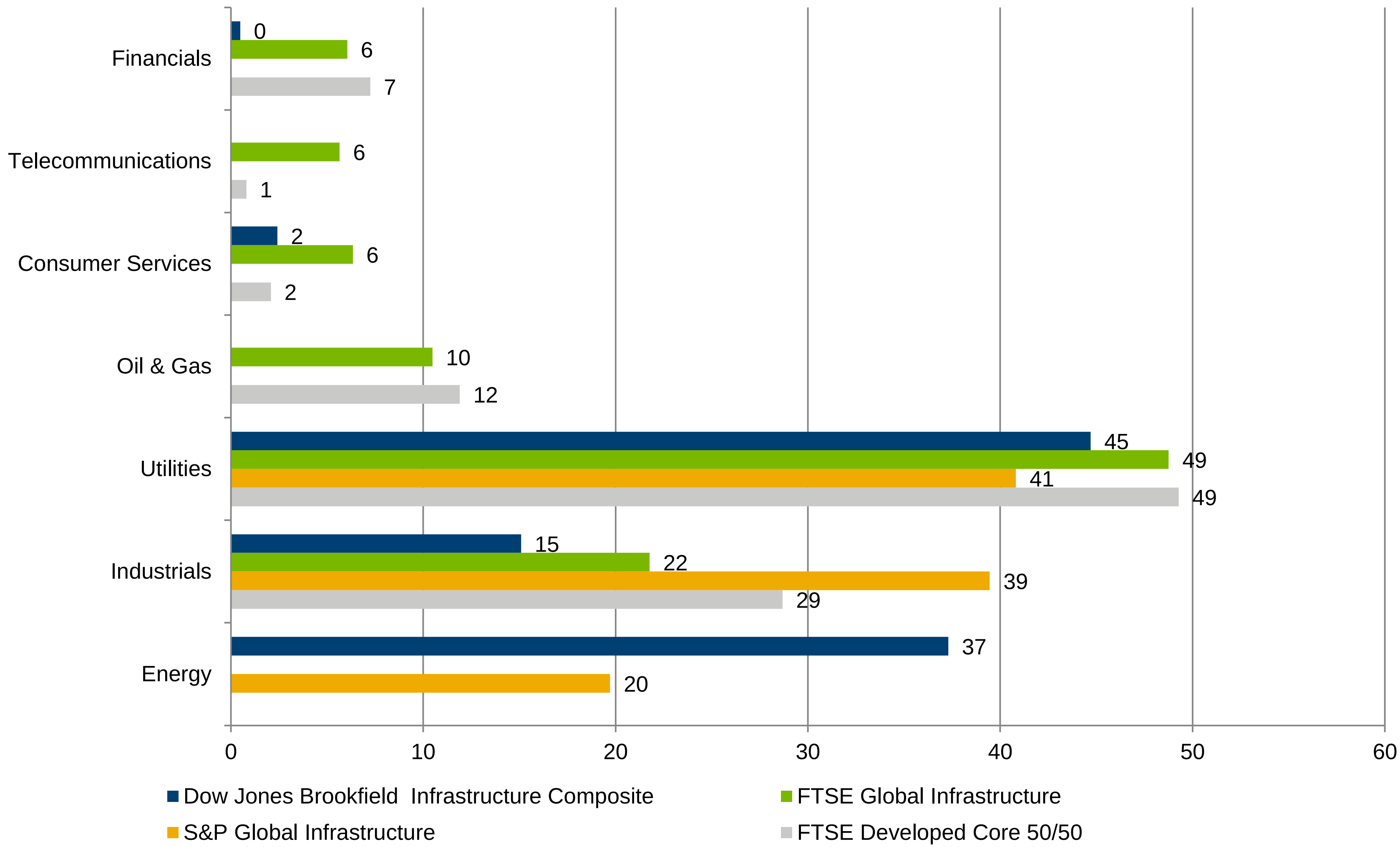
Index	FTSE Developed Core 50/50	S&P Global Infrastructure	FTSE Global Infrastructure	DJ Brookfield Infrastructure
Weighting Methodology	Float-adjusted market cap	Modified market cap	Float-adjusted market cap	Modified market cap
Rebalancing Frequency	Semi-annual (March & September)	Semi-annual (March & September)	Semi-annual (March & September)	Quarterly

Public: AHIC continues to recommend that PSERS maintain the FTSE Developed Core Infrastructure 50/50 as the Public Infrastructure policy index. While the current policy index focuses on developed markets, the three alternate indices include small allocations to emerging markets.
Private: AHIC recommends that PSERS adopt the FTSE Developed Core Infrastructure 50/50 (1Q Lag) as the policy benchmark for Private Infrastructure, as there is currently no market standard index for private infrastructure and this represents the public market proxy.

Infrastructure Index Characteristics
As of March 31, 2019

	FTSE Developed Core 50/50	**S&P Global Infrastructure**	**FTSE Global Infrastructure**	**Dow Jones Brookfield Infrastructure Composite Index**
Market Coverage	50% utilities, 30% transportation, 20% other	Energy, transportation and utilities	65% Core Infrastructure / 20% Infrastructure Opportunities	Pure-play infrastructure companies domiciled globally
No. of Securities	145	75	862	124
Weighted Average Market Capitalization ($M)	14,004.97	32,434.06	5,804.07	33,563.21
Median Market Capitalization ($M)	6,146.25	11,905.64	1,422.62	6,194.82
Largest Country Allocation	U.S. (53.44%)	U.S. (37.72%)	U.S. (54.27%)	U.S. (50.30%)
Largest Company	Transurban Group	Transurban Group	Union Pacific Corp	Enbridge Inc
% Top 10 Holdings	34.83	48.70	26.63	51.82
% Top 25 Holdings	58.72	66.62	47.68	65.98

Infrastructure Index Sector Allocations
As of March 31, 2019



Infrastructure Index Country Allocations

As of March 31, 2019

	FTSE Developed Core 50/50	S&P Global Infrastructure	FTSE Global Infrastructure	Dow Jones Brookfield Global Infrastructure
Australia	8.65	9.71	2.21	4.12
Austria	8.65	0.00	0.06	0.00
Belgium / Luxembourg	0.10	0.00	0.10	0.19
Brazil	0.00	0.53	1.15	0.32
Canada	8.79	9.31	9.61	14.59
Chile	0.00	0.24	0.42	0.00
China	0.00	5.52	1.83	4.21
Colombia	0.00	0.00	0.08	0.00
Denmark	0.54	0.00	0.53	0.00
Egypt	0.00	0.00	0.01	0.00
Finland	0.00	0.00	0.04	0.00
France	2.14	6.07	2.68	6.34
Germany	0.98	2.36	0.76	0.29
Greece	0.00	0.00	0.03	0.00
Hong Kong China	2.79	2.05	2.41	1.87
India	0.00	0.00	0.74	0.00
Indonesia	0.00	0.00	0.17	0.00
Israel	0.00	0.00	0.01	0.00
Italy	5.96	8.78	1.82	3.57
Japan	5.14	0.00	9.10	1.60
Korea	0.38	0.00	0.48	0.00
Kuwait	0.00	0.00	0.01	0.00
Malaysia	0.00	0.00	0.18	0.00
Mexico	0.00	3.02	0.61	0.75
Netherlands	0.00	0.22	0.13	0.28
New Zealand	1.58	1.86	0.26	0.46
Norway	0.00	0.00	0.08	0.00
Pakistan	0.00	0.00	0.02	0.00
Philippines	0.00	0.00	0.25	0.00
Poland	0.01	0.00	0.05	0.00
Portugal	0.05	0.00	0.04	0.00
Qatar	0.00	0.00	0.02	0.00
Russia	0.00	0.00	0.31	0.00
Singapore	0.39	0.61	0.26	0.11
South Africa	0.00	0.00	0.07	0.00
Spain	4.88	7.74	3.78	4.07
Sweden	0.00	0.00	0.13	0.00
Switzerland	1.03	1.24	0.42	0.31
Taiwan	0.00	0.00	0.28	0.00
Thailand	0.00	0.00	0.74	0.00
Turkey	0.00	0.00	0.07	0.00
United Arab Emirates	0.00	0.00	0.13	0.00
United Kingdom	3.00	3.01	3.66	5.60
USA	53.44	37.72	54.27	50.82

Infrastructure Index Performance & Correlation
As of March 31, 2019

Trailing Period Performance:	1 Year	3 Years	5 Years	10 Years
Publicly-Traded Infrastructure Composite (unlevered)	**13.16**	**8.73**	**N/A**	**N/A**
Private Infrastructure Composite	**14.71**	**N/A**	**N/A**	**N/A**
FTSE Developed Core Infrast 50/50 Index (Net)	14.07	9.23	7.69	N/A
S&P Global Infrastructure	9.24	8.66	5.44	10.92
FTSE Global Infrastructure	14.89	8.87	5.56	N/A
Dow Jones Brookfield Global Infrastructure Composite Index	14.69	8.43	4.20	13.16
FTSE Developed Core Infrast 50/50 Index (Net) (1Q Lag)	-4.63	7.63	5.98	N/A

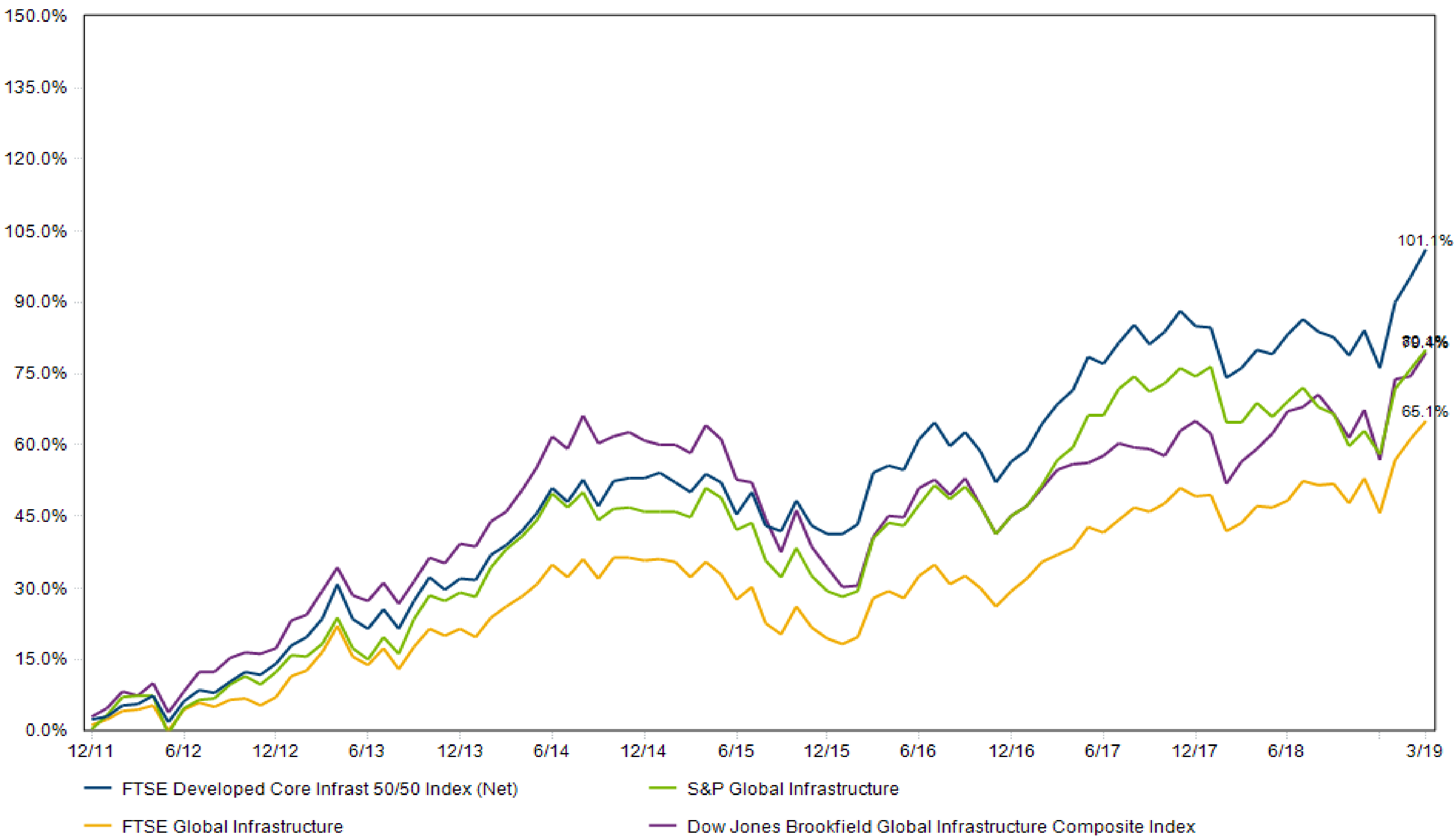
3-Year Actual Correlation Matrix:	Publicly-Traded Infrastructure Composite (unlevered)	FTSE Developed Core Infrast 50/50 Index (Net)	S&P Global Infrastructure	FTSE Global Infrastructure	Dow Jones Brookfield Global Infrastructure Composite Index	FTSE Developed Core Infrast 50/50 Index (Net) (1Q Lag)
Publicly-Traded Infrastructure Composite (unlevered)	**1.00**					
FTSE Developed Core Infrast 50/50 Index (Net)	1.00	1.00				
S&P Global Infrastructure	0.96	0.96	1.00			
FTSE Global Infrastructure	0.97	0.97	0.93	1.00		
Dow Jones Brookfield Global Infrastructure Composite Index	0.84	0.84	0.82	0.86	1.00	
FTSE Developed Core Infrast 50/50 Index (Net) (1Q Lag)	0.13	0.13	0.12	0.08	-0.13	1.00

5-Years:	Standard Deviation
FTSE Developed Core Infrast 50/50 Index (Net)	9.94
S&P Global Infrastructure	10.62
FTSE Global Infrastructure	9.53
Dow Jones Brookfield Global Infrastructure Composite Index	11.76
FTSE Developed Core Infrast 50/50 Index (Net) (1Q Lag)	9.43

- Underperformance relative to policy index primarily the result of the cost of financing.

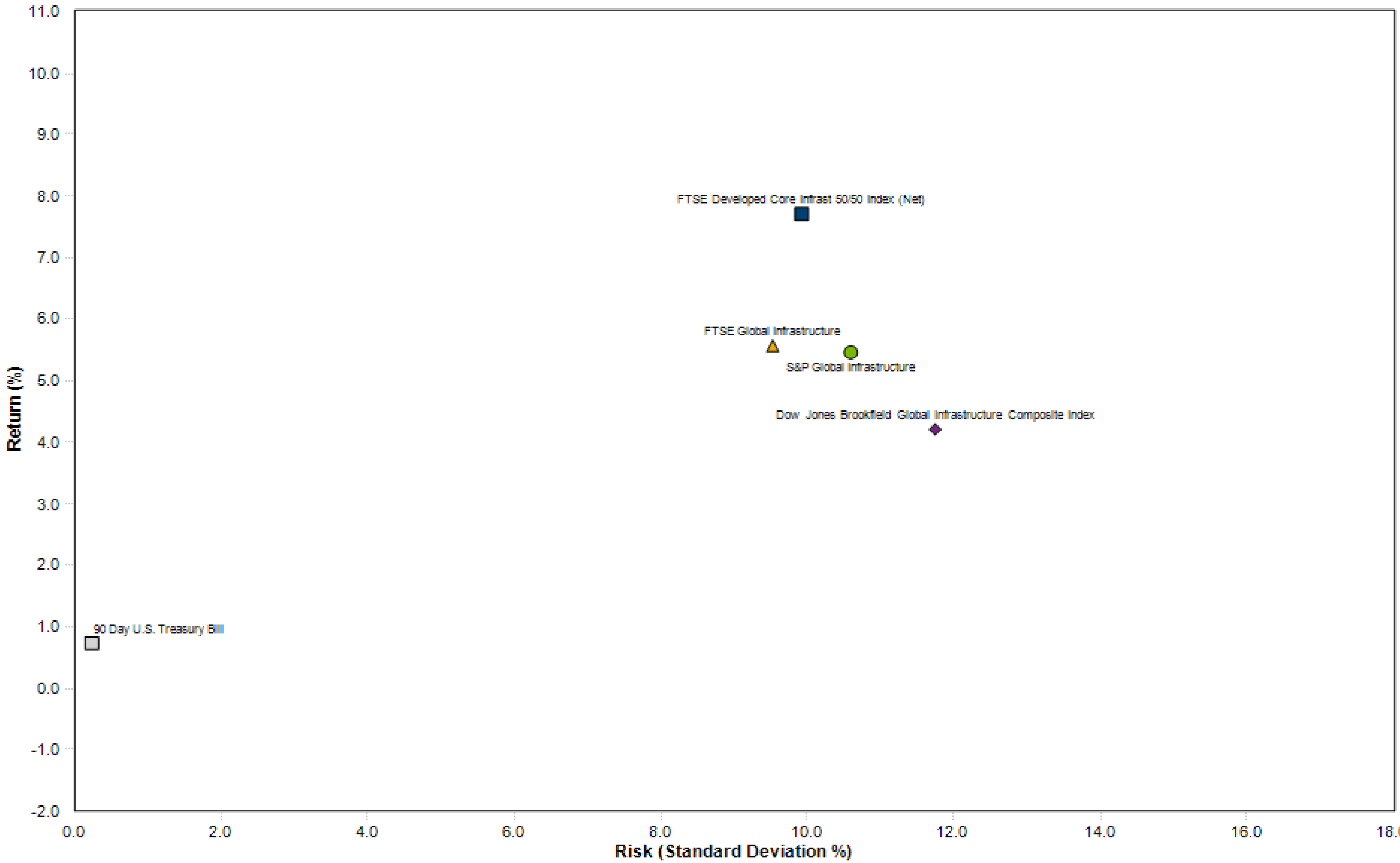
Infrastructure Index Cumulative Performance
As of March 31, 2019

December 1, 2011 to March 31, 2019



Infrastructure Risk & Return

5-Years as of March 31, 2019



Commodities

Commodity Index Definitions

- **Bloomberg Commodity Index (Current Benchmark) –** The index is made up of 22 exchange-traded futures on physical commodities. The index currently represents 20 commodities, which are weighted to account for economic significance and market liquidity.
- **Bloomberg Roll Select Commodity Index –** A dynamic version of the Bloomberg Commodity Index that aims to mitigate the effects of contango market structure on index performance.
- **S&P GSCI Total Return Index –** The index – representing market beta – is world-production weighted. It is designed to be investable by including the most liquid commodity futures, and provides diversification with low correlations to other asset classes.

Index	Bloomberg Commodity Index	Bloomberg Roll Select Commodity Index	S&P GSCI Total Return Index
Weighting Methodology	Based on production and liquidity	Based on production and liquidity	World production weighted
Rebalancing Frequency	Annually	Annually	Annually

AHIC continues to recommend that PSERS maintain the Bloomberg Commodity Index as the Commodity policy index. Bloomberg Commodity Index and Roll Select Commodity Index have nearly identical exposures, but different roll methodology, which results in a different return pattern. The S&P GSCI has over twice the weight to the Energy sector (57%) compared to Bloomberg.

Empower Results®

Commodities Index Characteristics
As of March 31, 2019

	Bloomberg Commodity Index	Bloomberg Roll Select Commodity Index	S&P GSCI Total Return Index
No. of Securities	22 exchange-traded futures on 20 commodities	22 exchange-traded futures on 20 commodities	24
Largest Holding	Gold (12.2%)	Gold (11.9%)	Oil (57.6%)
Energy Allocation	30.34%	31.19%	60.49%
Agriculture Allocation	29.95%	30.70%	17.10%
Industrial Metals Allocation	17.65%	16.65%	10.42%
Precious Metals Allocation	16.13%	16.18%	4.60%
Livestock Allocation	5.94%	5.27%	7.39%

Commodities Performance & Correlation

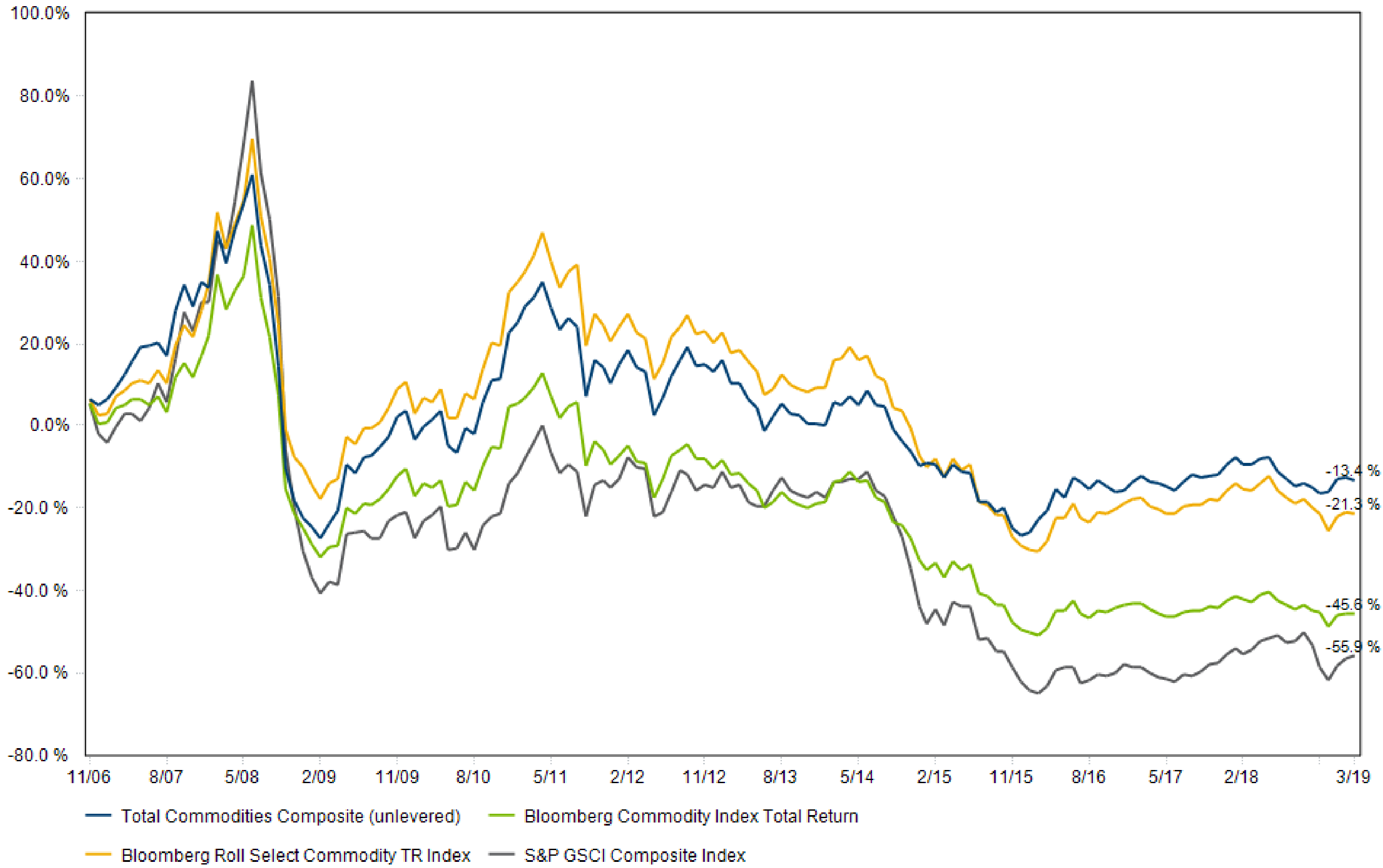
As of March 31, 2019

Trailing Period Performance:	1 Year	3 Years	5 Years	10 Years
Total Commodities Composite (unlevered)	**-4.53**	**2.95**	**-3.79**	**1.29**
Bloomberg Commodity Index Total Return	-5.25	2.22	-8.92	-2.56
Bloomberg Roll Select Commodity TR Index	-6.55	2.93	-7.51	-0.90
S&P GSCI Composite Index	-3.04	6.18	-12.61	-3.37

5-Years Actual Correlation Matrix:	Total Commodities Composite (unlevered)	Bloomberg Commodity Index Total Return	Bloomberg Roll Select Commodity TR Index	S&P GSCI Composite Index
Total Commodities Composite (unlevered)	**1.00**			
Bloomberg Commodity Index Total Return	0.82	1.00		
Bloomberg Roll Select Commodity TR Index	0.85	0.99	1.00	
S&P GSCI Composite Index	0.66	0.87	0.86	1.00

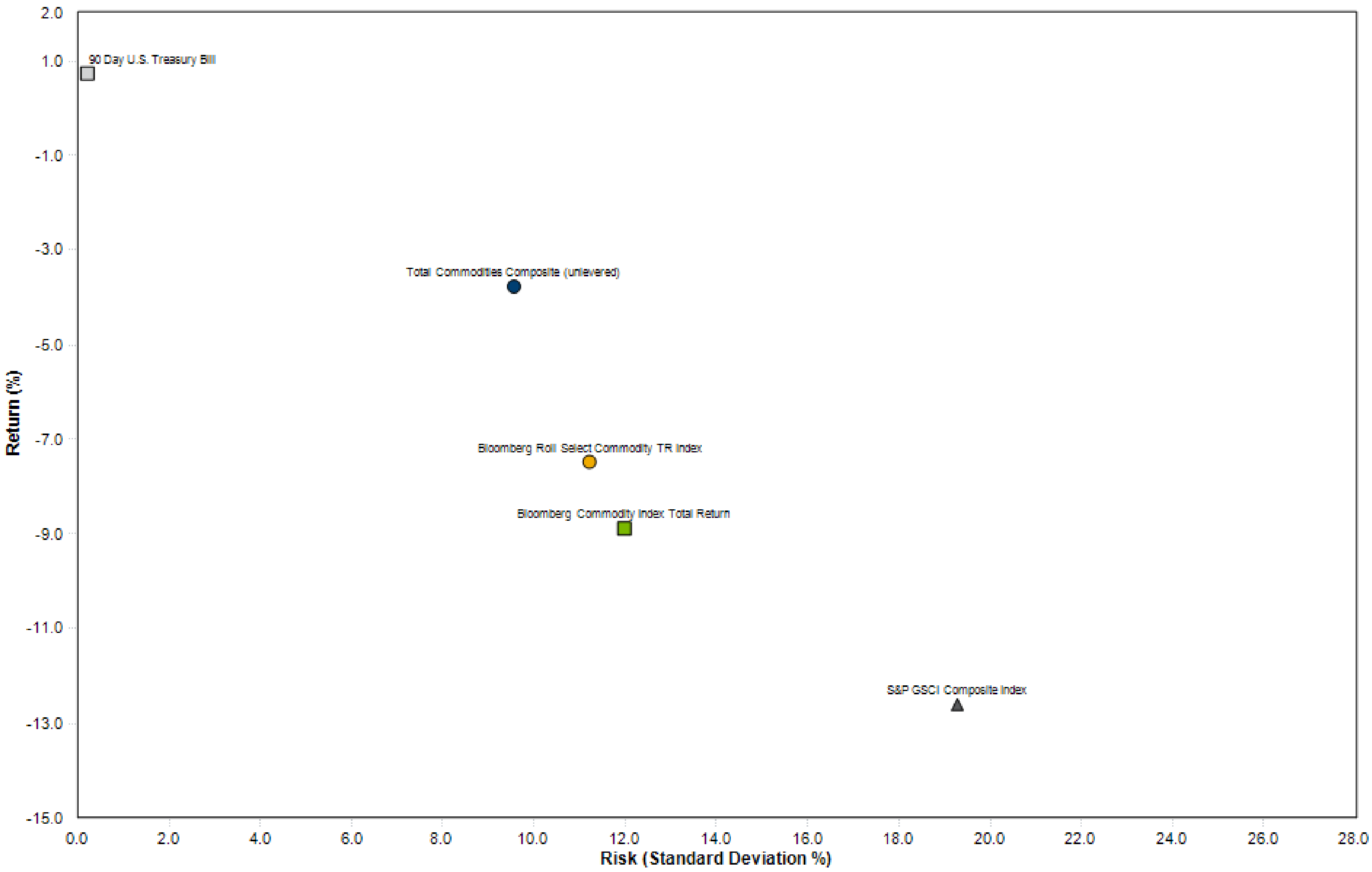
Commodities Cumulative Performance
As of March 31, 2019

November 1, 2006 to March 31, 2019



Commodities Risk & Return

5-Years as of March 31, 2019



Gold

Gold Index Characteristics

	Bloomberg Commodity Gold Subindex	S&P GSCI Gold Index Total Return
Market Coverage	Exchange-traded gold futures	World production weighted; a sub-index of the S&P GSCI Index
Rebalancing Frequency	Annually on a price-percentage basis	Annual reconstitution
Roll Frequency	6th to 10th business day each month	Monthly
Calculation Frequency	Every 15 Seconds	Real time
Calculation Currencies	USD	USD

AHIC continues to recommend that PSERS maintain the Bloomberg Commodity Gold Subindex as the Gold policy index. Bloomberg Commodity Gold Subindex (current policy index) and S&P GSCI Gold Index Total Return are nearly identical in composition and historical results.

Gold Index Performance & Correlation
As of March 31, 2019

Trailing Period Performance:

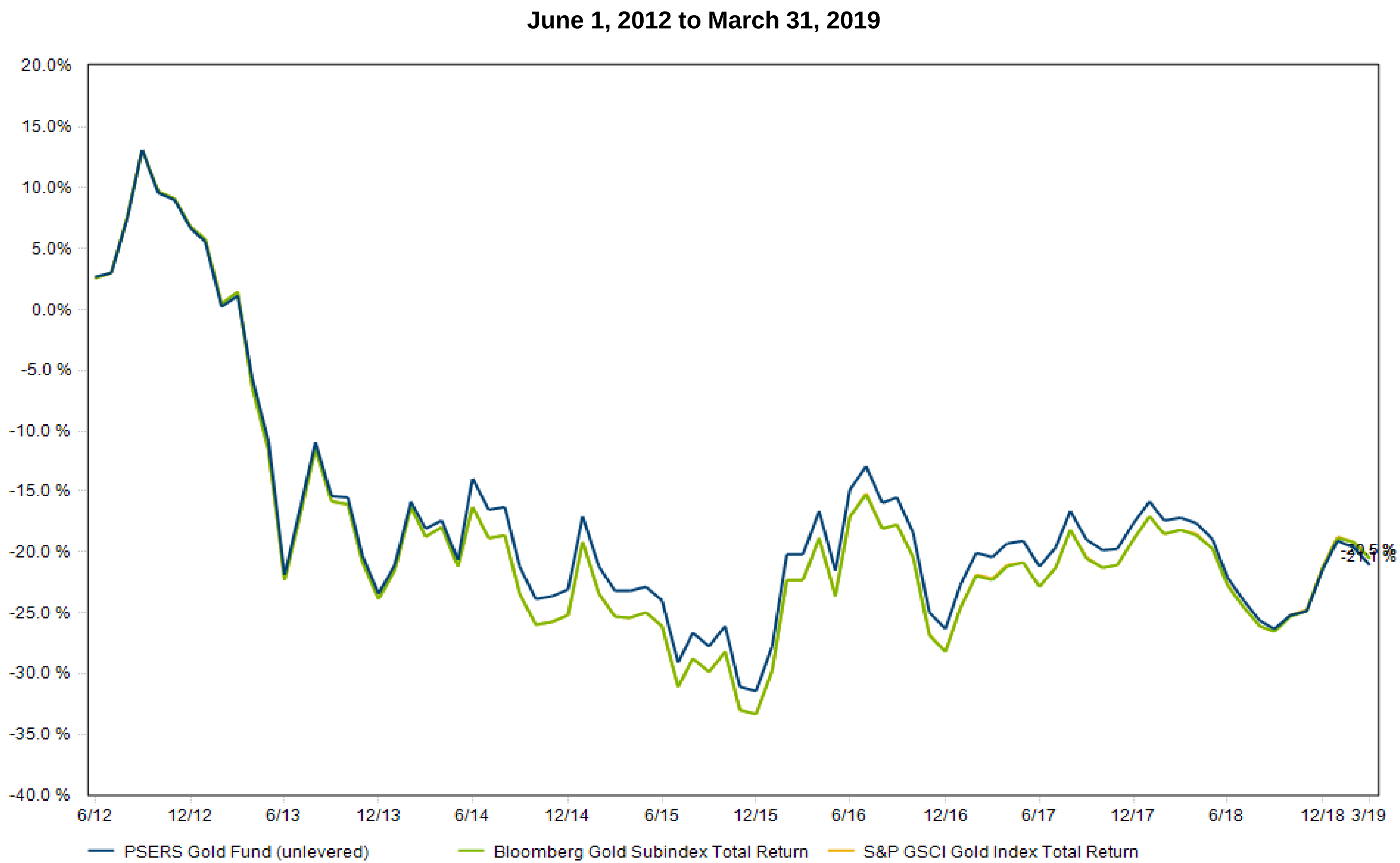
	1 Year	3 Years	5 Years	10 Years
PSERS Gold Fund (unlevered)	**-4.72**	**-0.38**	**-0.73**	**N/A**
Bloomberg Gold Subindex Total Return	-2.84	0.76	-0.45	2.77
S&P GSCI Gold Index Total Return	-2.84	0.77	-0.44	4.74

5-Years Actual Correlation Matrix:

	PSERS Gold Fund (unlevered)	Bloomberg Gold Subindex Total Return	S&P GSCI Gold Index Total Return
PSERS Gold Fund (unlevered)	**1.00**		
Bloomberg Gold Subindex Total Return	1.00	1.00	
S&P GSCI Gold Index Total Return	1.00	1.00	1.00

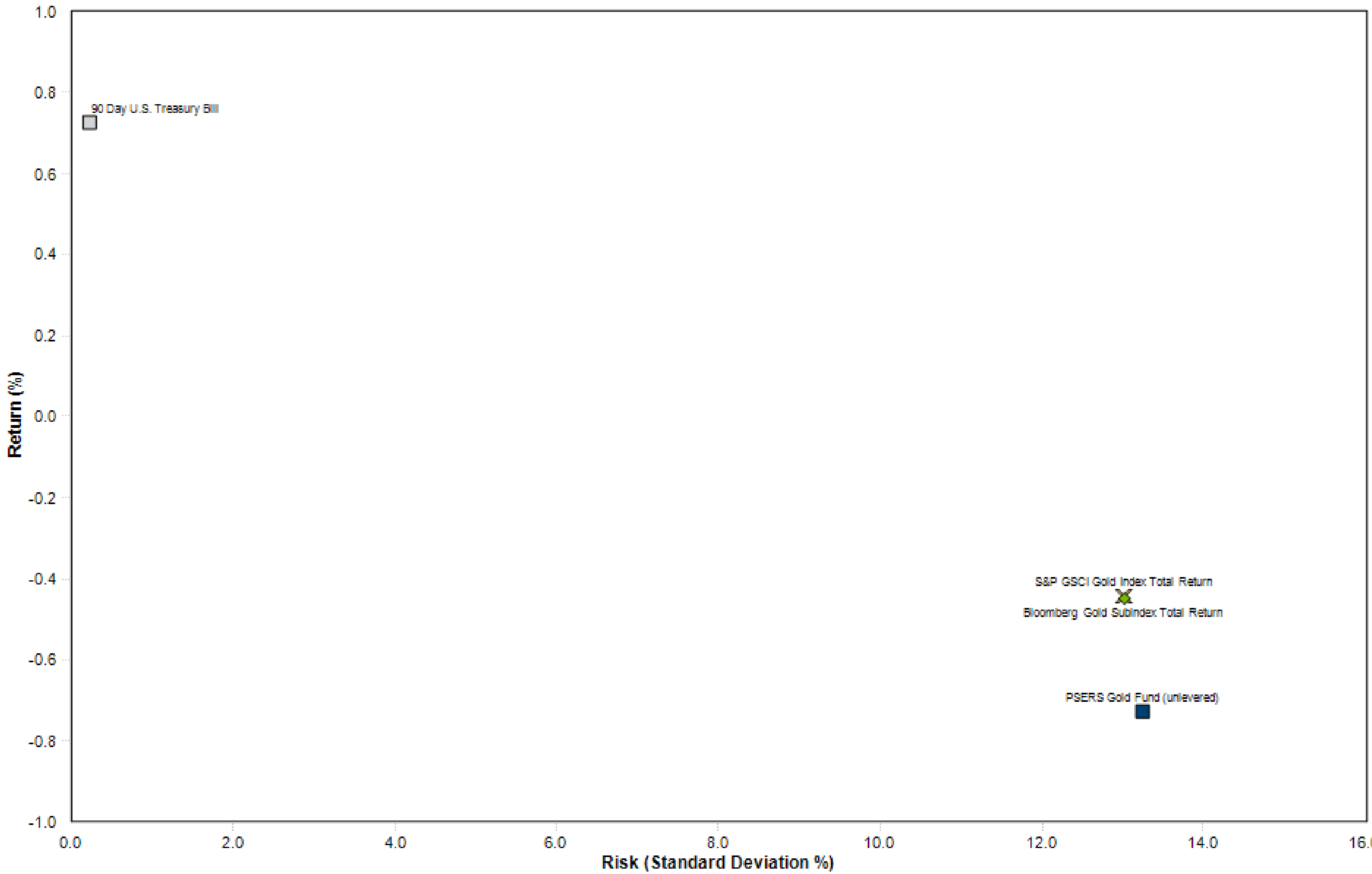
- Underperformance relative to policy index primarily the result of the cost of financing.

Gold Index Cumulative Performance
As of March 31, 2019



Gold Index Risk & Return

5-Years as of March 31, 2019



Private Real Estate

Private Real Estate Benchmark Options

1. Hybrid Burgiss Value-Added and Opportunistic Medians/NCREIF ODCE (1-Quarter Lagged) - Current Benchmark

2. NCREIF ODCE + 200bps (1-Quarter Lagged)

Performance Benchmark:
AHIC continues to recommend that PSERS maintain the Hybrid Burgiss Value-Added/Opportunistic Medians/NCREIF ODCE 1Q Lagged as the Private Real Estate policy index, which captures actual benchmark returns of each real estate style in PSERS portfolio (Core, Value-Add and Opportunistic). Additionally, we suggest that PSERS consider adding the NCREIF ODCE + 200bps (1Q Lagged) as a long-term secondary performance benchmark.

Risk Benchmark:
We recommend using a blend of 90% FTSE NAREIT Composite REIT/10% FTSE EPRA/NAREIT Developed ex US Index, representing U.S. and non-U.S. public market REIT markets as the risk benchmark, as this blend best reflects the volatility characteristics of the underlying investments.

Private Real Estate Benchmark Options

Characteristics

	Burgiss Value-Added	Burgiss Opportunistic	NCREIF ODCE
Long-Term Expected Net Returns	11-14%	15+%	7-9%
Risk	Moderate	High	Conservative
Property Types	Core + Specialty	Core + Specialty	Core (Office, Apartment, Retail, Industrial)
Return Type/Focus	Income + Appreciation	Appreciation	Income

Private Real Estate Benchmark Options

Pros & Cons

	Burgiss Median Hybrid (Current)	NCREIF ODCE Plus
Pros	▪ Captures actual benchmark returns of each real estate style in PSERS portfolio (Core, Value-Add, Opportunistic) ▪ Weights determined on PSERS' actual investment weights	▪ Simple to calculate
Cons	▪ Complex calculation with quarterly adjustments	▪ Uses 200bps alpha to estimate impact of "Value-Added" and "Opportunistic" buckets ▪ Low correlation to PSERS portfolio returns

Private Real Estate Index Performance & Correlation

As of March 31, 2019

Trailing Period Performance:

	1 Year	3 Years	5 Years	10 Years
Private Real Estate Composite	**8.22**	**10.27**	**10.90**	**6.48**
Blended Policy (Private Real Estate)	7.15	9.33	10.62	7.86
NCREIF ODCE +200bps (Lagged)	9.51	9.42	11.60	8.12
90% FTSE NAREIT Composite REIT/10% FTSE EPRA/NAREIT Dev. ex US Index	18.71	8.24	9.51	17.69

5-Years Actual Correlation Matrix:

	Private Real Estate Composite	Blended Policy (Private Real Estate)	NCREIF ODCE NOF 1 Quarter Lag	90% FTSE NAREIT Composite REIT/10% FTSE EPRA/NAREIT Dev. ex US Index
Private Real Estate Composite	**1.00**			
Blended Policy (Private Real Estate)	0.81	1.00		
NCREIF ODCE NOF 1 Quarter Lag	0.00	0.17	1.00	
90% FTSE NAREIT Composite REIT/10% FTSE EPRA/NAREIT Dev. ex US Index	-0.07	-0.18	-0.02	1.00

5-Years:

	Standard Deviation
Private Real Estate Composite	**2.19**
Blended Policy (Private Real Estate)	2.32
NCREIF ODCE NOF 1 Quarter Lag	1.39
90% FTSE NAREIT Composite REIT/10% FTSE EPRA/NAREIT Dev. ex US Index	12.18

Note: Blended Policy (Private Real Estate) represents the Hybrid Burgiss Value-Added and Opportunistic Medians/NCREIF ODCE (1-Quarter Lagged).

Publicly-Traded Real Estate

Publicly-Traded Real Estate Index Definitions

- **FTSE EPRA/NAREIT Developed Index Hedged (Current Benchmark) –** designed to represent general trends in eligible real estate equities worldwide. Relevant activities are defined as the ownership, disposal and development of income-producing real estate.
- **Dow Jones Global Select REIT Index –** designed to measure the performance of publicly traded REITs and REIT-like securities and is a sub-index of the Dow Jones Global Select Real Estate Securities Index, which seeks to measure equity real estate investment trusts (REITs) and real estate operating companies traded globally. The index is designed to serve as a proxy for direct real estate investment, in part by excluding companies whose performance may be driven by factors other than the value of real estate.

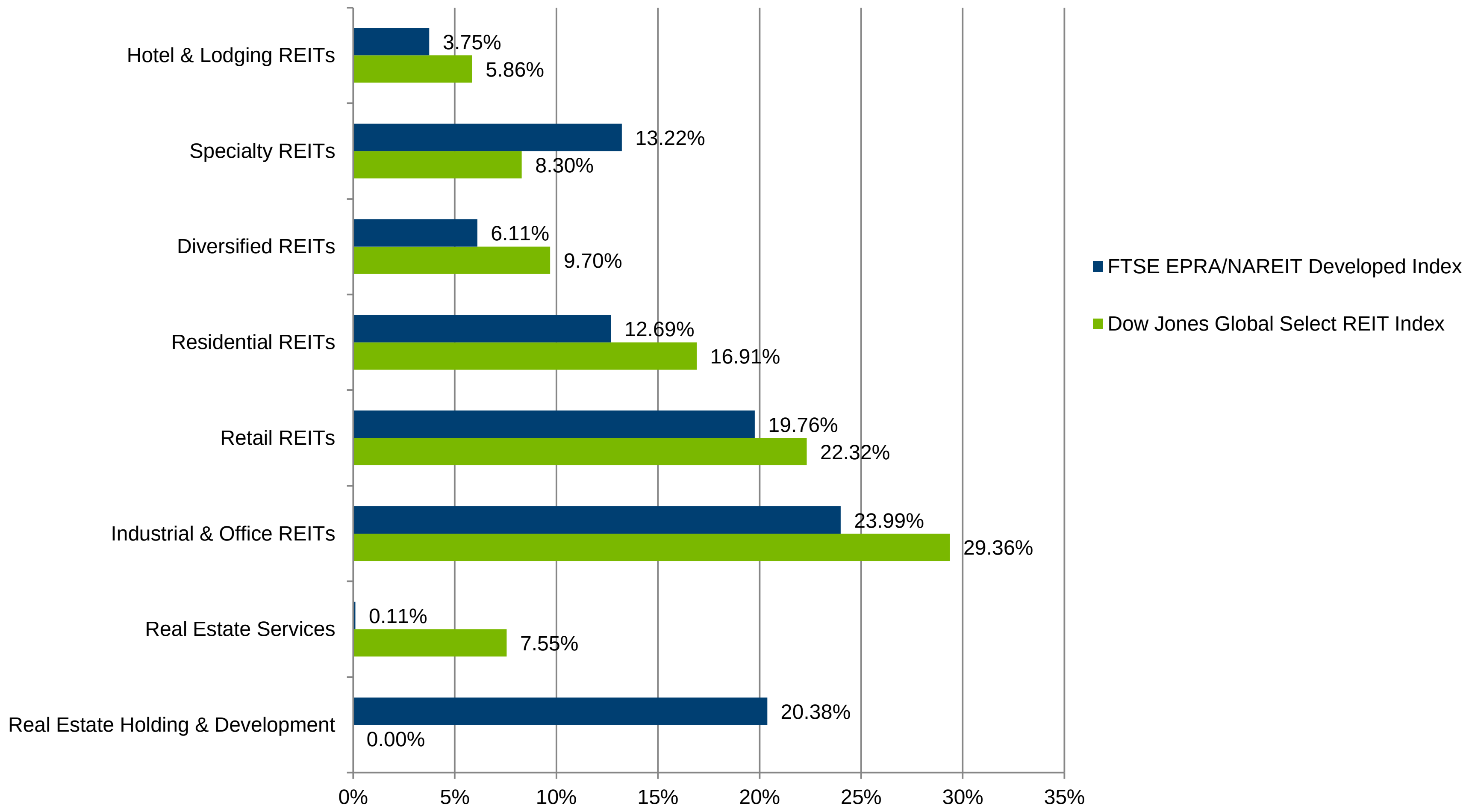
Index	FTSE EPRA/NAREIT Developed Index	Dow Jones Global Select REIT Index
Weighting Methodology	Float-adjusted market cap	Float-adjusted market cap
Rebalancing Frequency	Quarterly	Quarterly

AHIC continues to recommend that PSERS maintain the FTSE EPRA/NAREIT Developed Index as the Publicly-Traded Real Estate policy Index. While both indices focus on the developed markets, FTSE provides broader coverage of the REIT market vs. the Dow Jones alternative, including more securities across more countries, with a smaller relative allocation to the U.S. market.

Publicly-Traded Real Estate Index Characteristics
As of March 31, 2019

	FTSE EPRA/NAREIT Developed Index Hedged	Dow Jones Global Select REIT Index
Market Coverage	Float-adjusted market cap weighted	Float-adjusted market cap weighted
No. of Securities	336	182
Weighted Avg. Mkt. Capitalization	$4,155.4 MM	$16,801.2 MM
Median Market Capitalization	$2,225.1 MM	$3,683.4 MM

Publicly-Traded Real Estate Index Sector Allocations
As of March 31, 2019



Publicly-Traded Real Estate Index Country Allocations
As of March 31, 2019

	FTSE EPRA/NAREIT Developed Index	DJ Global Select REIT Index
Australia	4.71%	5.64%
Austria	0.16%	-
Belgium	0.84%	0.28%
Canada	2.86%	1.46%
Finland	0.12%	-
France	1.49%	4.35%
Germany	4.67%	0.25%
Hong Kong	8.50%	2.41%
Ireland	0.18%	-
Israel	0.14%	-
Italy	0.02%	-
Japan	11.07%	10.65%
Mexico	-	0.41%
Netherlands	1.66%	0.22%
New Zealand	0.09%	-
Norway	0.11%	-
Singapore	2.53%	2.79%
South Africa	-	0.97%
Spain	0.52%	0.74%
Sweden	1.65%	-
Switzerland	0.97%	-
UK	4.62%	2.37%
USA	53.09%	67.46%

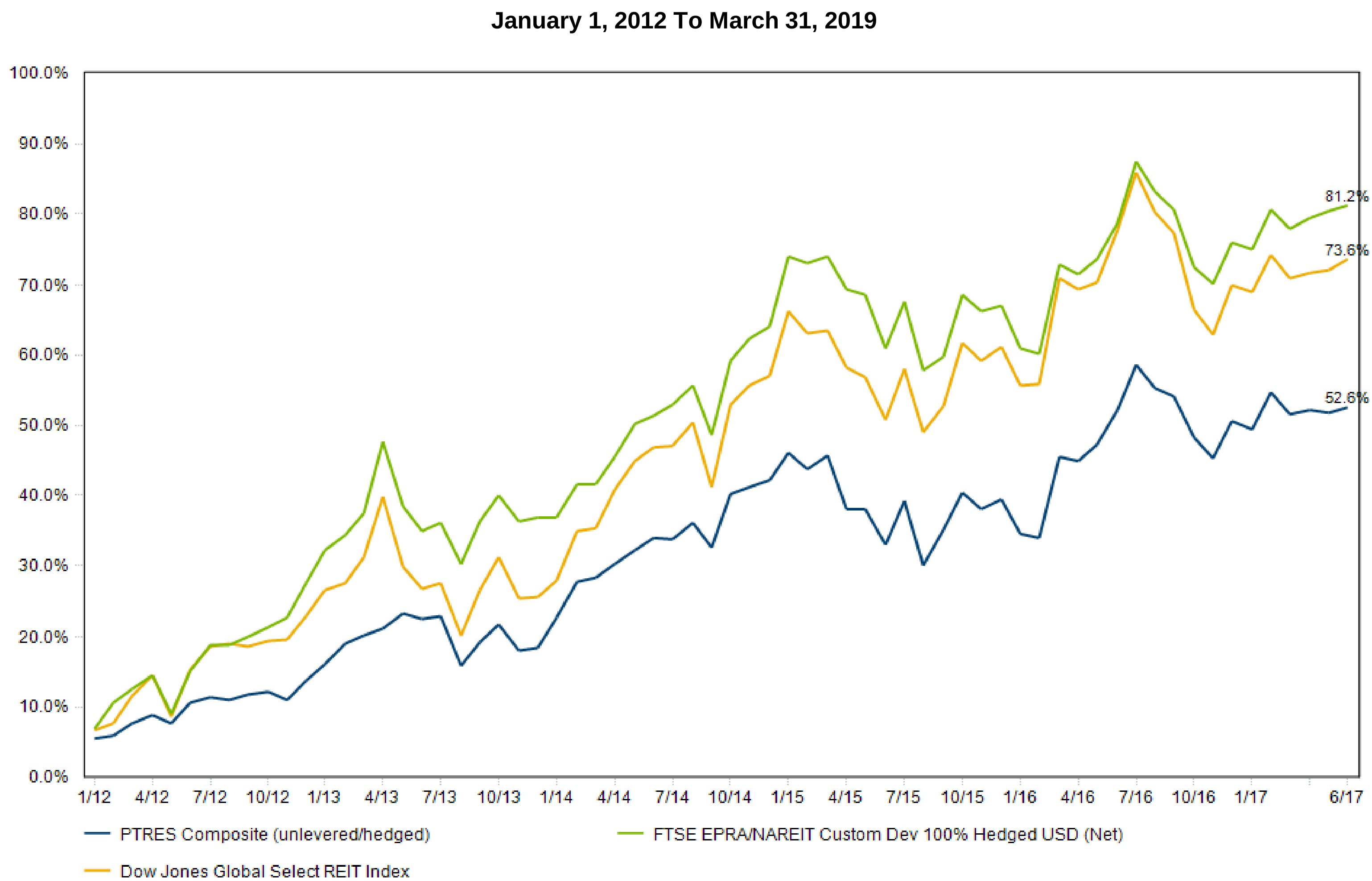
Publicly-Traded Real Estate Index Performance & Correlation
As of March 31, 2019

Trailing Period Performance:	1 Year	3 Years	5 Years	10 Years
PTRES Composite (unlevered/hedged)	**17.87**	**6.73**	**6.62**	**15.04**
FTSE EPRA/NAREIT Custom Dev 100% Hedged USD (Net)	17.23	6.80	8.28	N/A
Dow Jones Global Select REIT Index	14.68	4.93	7.84	16.28

5-Years Actual Correlation Matrix:	PTRES Composite (unlevered/hedged)	FTSE EPRA/NAREIT Custom Dev 100% Hedged USD (Net)	Dow Jones Global Select REIT Index
PTRES Composite (unlevered/hedged)	**1.00**		
FTSE EPRA/NAREIT Custom Dev 100% Hedged USD (Net)	0.96	1.00	
Dow Jones Global Select REIT Index	0.96	0.98	1.00

- The portfolio is managed very closely to the current benchmark the FTSE EPRA/NAREIT Custom Dev 100% Hedged index since 2015 and the performance during this period is in line. Prior to 2015, the portfolio was managed versus the FTSE EPRA/NAREIT Global Index resulting in some underperformance over the trailing five year period.

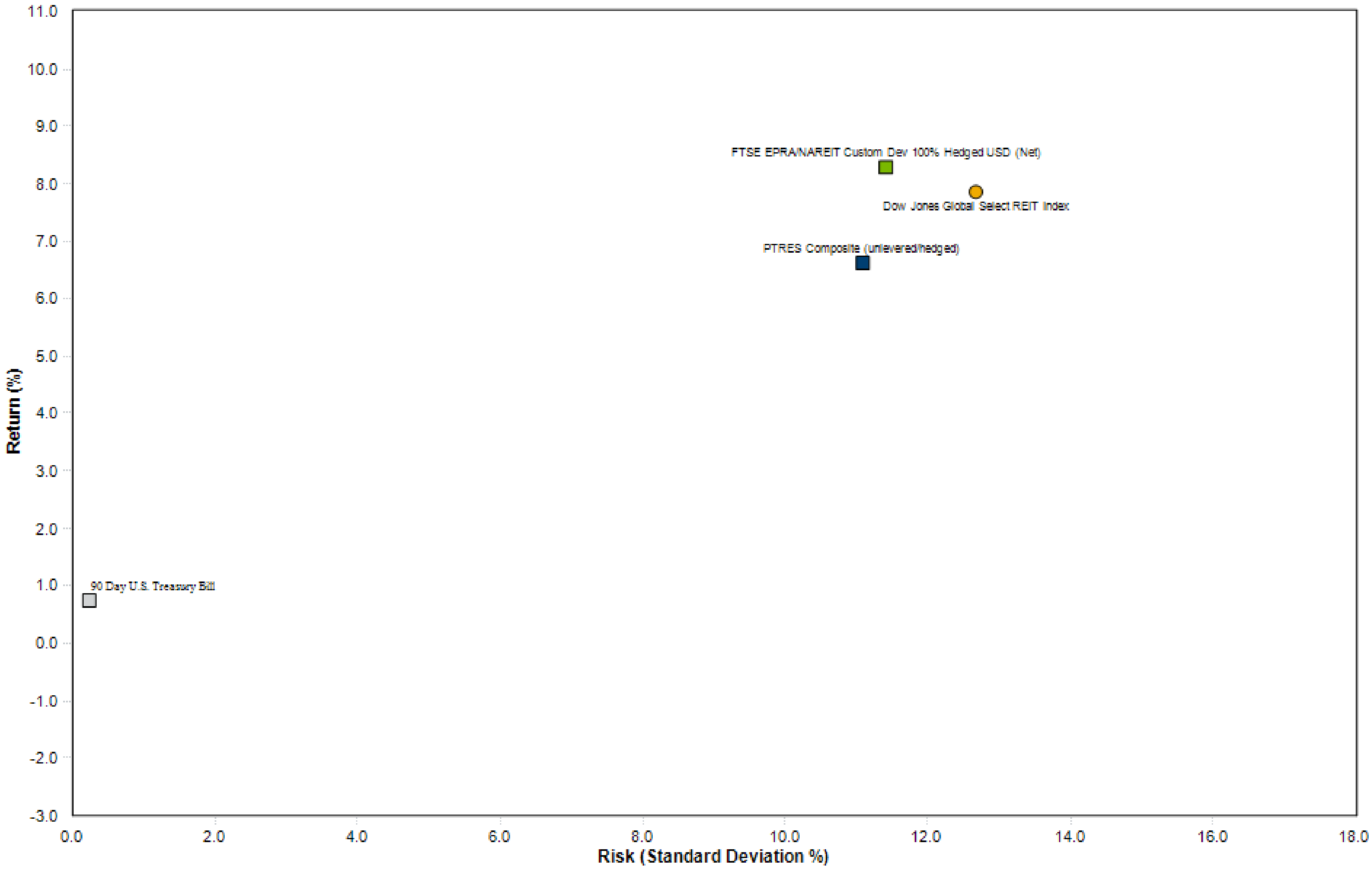
Publicly-Traded Real Estate Index Cumulative Performance
As of March 31, 2019



Empower Results®

Publicly-Traded Real Estate Index Risk & Return

5-Years As of March 31, 2019



Risk Parity

Risk Parity Benchmark Options

1. Weighted average of public benchmarks (current benchmark)

   Current weights:

   - 50% MSCI All Country World Index (Net)
   - 75% Bloomberg Barclays U.S. Treasury Index
   - 55% Bloomberg Barclays World Inflation-Linked Bonds ($-Hedged)
   - 15% Bloomberg Commodity Index Total Return
   - 5% Bloomberg Gold Sub-Index Total Return
   - -100% 3-month LIBOR

2. 60/40 split of MSCI World Index (Net) and Bloomberg Barclays Aggregate Bond Index
3. Cash (90-day U.S. T-bills)
4. Cash Plus (90-day U.S. T-bills + 600bps) – 600bps hurdle is based on 12% vol target
5. HFR Risk Parity Vol 12 Institutional Index
6. S&P Risk Parity Index – 12% Target Volatility
7. Wilshire Risk Parity Index – 15% Target Volatility

Risk Parity Benchmark Options

Pros & Cons

	Static Weight Hybrid (Current)	60/40 MSCI World & Barclays Agg	Cash	Cash Plus	HFR Risk Parity Vol 12 Institutional Index	S&P Risk Parity Index 12% Vol	Wilshire Risk Parity Index 15% Vol
Pros	▪ Attempts to capture all market exposures utilized ▪ Includes leverage	▪ Most common risk parity manager benchmark ▪ Has similar volatility to PSERS' target of 12% ▪ Represents broad market exposure	▪ Best benchmark for absolute returns strategies, which risk parity is a subset of ▪ Simple to calculate	▪ Second most common risk parity manager benchmark ▪ Premium chosen to reflect targeted volatility ▪ Simple to calculate	▪ Reflects similar vol to PSERS target ▪ Index includes funds with a volatility target of greater than 10% and less than 15% ▪ Includes only funds with > $500m in assets	▪ 12% Vol Target, aligns with PSERS program target	▪ Represents equal risk exposure to equities, rates, and inflation, including commodities, and TIPS
Cons	▪ Not all managers use all asset classes represented by benchmark ▪ Does not capture manager risk management and volatility adjustments	▪ Does not capture manager risk management and volatility adjustments ▪ Lacks coverage utilized in PSERS' strategies	▪ Low performance hurdle ▪ Can lead to high tracking error ▪ Does not reflect targeted volatility ▪ Does not include leverage utilized by strategies	▪ Can be challenging benchmark in down markets since always positive ▪ Does not reflect shifts in risk management and volatility of strategies	▪ Limited transparency into constituents ▪ Trailing two months of performance are subject to revision	▪ Represents equal risk exposure to equities, fixed income, and commodities. Does not capture TIPS	▪ 15% target volatility does not align with PSERS program target of 12%

AHIC continues to recommend that PSERS maintain the current Static Weight Hybrid which is most representative of the market exposures of the strategy.

Risk Parity Benchmark Performance & Correlation

As of March 31, 2019

Trailing Period Performance:

	Performance (%)			
	1 Year	3 Years	5 Years	10 Years
Risk Parity Composite	**4.89**	**8.57**	**5.28**	**N/A**
Risk Parity Composite (vol adjusted)	**4.60**	**7.66**	**4.66**	**N/A**
Blended Policy (Risk Parity)	3.42	7.43	5.25	10.24
60% MSCI World / 40% Barclays Aggregate	4.46	7.28	5.31	9.12
90 Day U.S. Treasury Bill	2.12	1.17	0.73	0.41
90 Day TBill + 600bps	8.25	7.24	6.77	6.44
HFR Risk Parity Vol 12 Institutional Index	2.50	8.49	4.81	9.81
S&P Risk Parity Index - 12% Target Volatility (TR)	6.74	6.80	3.64	8.05
Wilshire Risk Parity Index 15% Vol	10.92	13.48	12.66	19.69

5-Years Actual Correlation:

	Risk Parity Composite	Risk Parity Composite (vol adjusted)	Blended Policy (Risk Parity)	60% MSCI World / 40% Barclays Aggregate	90 Day U.S. Treasury Bill	90 Day TBill + 600bps	HFR Risk Parity Vol 12 Institutional Index	S&P Risk Parity Index - 12% Target Volatility (TR)	Wilshire Risk Parity Index 15% Vol
Risk Parity Composite	**1.00**								
Risk Parity Composite (vol adjusted)	**1.00**	**1.00**							
Blended Policy (Risk Parity)	0.95	0.96	1.00						
60% MSCI World / 40% Barclays Aggregate	0.80	0.80	0.80	1.00					
90 Day U.S. Treasury Bill	0.05	0.06	0.07	0.05	1.00				
90 Day TBill + 600bps	0.05	0.06	0.07	0.05	1.00	1.00			
HFR Risk Parity Vol 12 Institutional Index	0.97	0.98	0.96	0.79	0.06	0.06	1.00		
S&P Risk Parity Index - 12% Target Volatility (TR)	0.89	0.90	0.88	0.78	0.13	0.13	0.92	1.00	
Wilshire Risk Parity Index 15% Vol	0.85	0.85	0.87	0.54	0.03	0.03	0.90	0.84	1.00

Empower Results®

Absolute Return

Absolute Return Benchmark Options

1. **LIBOR Plus (3-Month LIBOR + 350 bps) (Current benchmark)**
2. Cash – 90-Day U.S. Treasury Bills
3. HFRI Fund Weighted Composite Index – Global, equal-weighted index of over 2,000 single-manager funds that report to HFR Database. Constituent funds report monthly net of all fees performance in US Dollar and have a minimum of $50 Million under management or a twelve (12) month track record of active performance. The HFRI Fund Weighted Composite Index does not include Funds of Hedge Funds.
4. HFRX Absolute Return Index – Designed to be representative of the overall composition of the hedge fund universe. It is comprised of all eligible hedge fund strategies; including but not limited to convertible arbitrage, distressed securities, equity hedge, equity market neutral, event driven, macro, merger arbitrage, and relative value arbitrage.
5. HFRI FOF: Conservative Index - FOFs which seek consistent returns by primarily investing in funds that generally engage in more 'conservative' strategies such as Equity Market Neutral, Fixed Income Arbitrage, and Convertible Arbitrage; exhibits a lower historical annual standard deviation than the HFRI Fund of Funds Composite Index.
6. HFRI FOF: Diversified Index - FOFs which invests in a variety of strategies among multiple managers across a wide array of strategies including equity long/short.
7. Custom Blend of underlying Hedge Fund benchmarks based on underlying portfolio construction:
   - 14% HFRI Event Driven (Total)
   - 38% HFRI Macro: Systemic Diversified
   - 20% HFRI ED: Credit Arbitrage
   - 16% HFRI Relative Value (Total)
   - 12% Eurekahedge ILS Advisors Index

AHIC recommends that PSERS consider replacing the existing policy index the HFRI FOF: Conservative Index +100bps. The HFRI FOF: Conservative Index representing a broadly diversified low equity beta hedge fund universe. The HFRI FOF: Conservative Index has the highest correlations to the PSERS portfolio and has a similar equity beta. This benchmark is more representative of the return/risk characteristics than the current benchmark. An additional +100bps are added to adjust for the additional layer of fees typical of Fund-of-Fund structures.

Absolute Return Benchmark Options

Pros & Cons

	LIBOR Plus (Current)	Cash	HFRI Fund Weighted Composite Index	HFRX Absolute Return Index	HFRI FOF: Conservative	HFRI FOF: Diversified	Custom Blend
Pros	▪ Simple to calculate ▪ Represents targeted return	▪ Simple to calculate	▪ Represents broad hedge fund universe ▪ Higher correlations to existing portfolio ▪ Risk characteristics more consistent with PSERS portfolio ▪ Most commonly utilized benchmark	▪ Represents broad hedge fund universe ▪ Higher correlations to existing portfolio ▪ Risk characteristics more consistent with PSERS portfolio ▪ Daily valued	▪ Represent broad universe of diversified hedge FOF which exhibit low equity beta consistent with the PSERS portfolio ▪ Captures broad array of underlying hedge fund strategies	▪ Represent broadest universe of diversified hedge FOFs ▪ Captures broad array of underlying hedge fund strategies	▪ Represents broad hedge fund universe ▪ Underlying hedge fund strategy allocations consistent with PSERS portfolio ▪ Higher correlations to existing portfolio ▪ Risk characteristics more consistent with PSERS portfolio
Cons	▪ Can be challenging benchmark in down markets since always positive ▪ Does not reflect shifts in risk management and volatility of strategies	▪ Low performance hurdle ▪ Can lead to high tracking error ▪ Does not include leverage utilized by strategies	▪ Only includes hedge funds that report to HFR which may lead to bias ▪ Trailing four months of performance are subject to revision ▪ Underlying mix of hedge funds represent different strategy allocations versus PSERS portfolio	▪ Only includes hedge funds that report to HFR which may lead to bias ▪ Underlying mix of hedge funds represent different strategy allocations versus PSERS portfolio	▪ Consists of Fund-of-Funds which have an additional layer of fees ▪ Underlying mix of hedge funds represent different strategy allocations versus PSERS portfolio	▪ Consists of Fund-of-Funds which have an additional layer of fees ▪ Includes strategies such as Equity L/S not included in PSERS portfolio ▪ Underlying mix of hedge funds represent different strategy allocations versus PSERS portfolio	▪ More complex to calculate ▪ Weightings need to be determined by PSERS

Absolute Return Benchmarks Performance & Correlation
As of March 31, 2019

Trailing Period Performance:

	1 Year	3 Years	5 Years	10 Years
Total Absolute Return	**1.77**	**4.72**	**3.48**	**6.34**
3-Month Libor + 3.50%	6.11	5.18	4.64	4.26
90 Day U.S. Treasury Bill	2.12	1.17	0.73	0.41
HFRI Fund Weighted Composite Index	0.49	4.98	2.98	5.44
HFRX Absolute Return Index	-0.23	1.44	1.21	0.47
HFRI FOF: Conservative Index + 100 bps	2.74	4.52	3.11	4.39
HFRI FOF: Divserified Index + 100 bps	1.82	4.72	3.18	4.56
Custom Blend	0.68	2.39	2.36	4.43

5-Years Actual Correlation:

	Total Absolute Return	3-Month Libor + 3.50%	90 Day U.S. Treasury Bill	HFRI Fund Weighted Composite Index	HFRX Absolute Return Index	HFRI FOF: Conservative Index + 100 bps	HFRI FOF: Divserified Index + 100 bps	Custom Blend
Total Absolute Return	**1.00**							
3-Month Libor + 3.50%	-0.02	1.00						
90 Day U.S. Treasury Bill	-0.08	0.97	1.00					
HFRI Fund Weighted Composite Index	0.23	-0.01	0.01	1.00				
HFRX Absolute Return Index	0.31	-0.08	-0.08	0.57	1.00			
HFRI FOF: Conservative Index + 100 bps	0.42	0.04	0.03	0.85	0.54	1.00		
HFRI FOF: Divserified Index + 100 bps	0.36	0.00	0.02	0.90	0.58	0.95	1.00	
Custom Blend	0.30	-0.09	-0.04	0.67	0.34	0.61	0.72	1.00

5-Years:

	Standard Deviation	Beta
Total Absolute Return	**2.90**	**0.04**
3-Month Libor + 3.50%	0.25	0.00
90 Day U.S. Treasury Bill	0.24	0.00
HFRI Fund Weighted Composite Index	4.23	0.36
HFRX Absolute Return Index	1.58	0.07
HFRI FOF: Conservative Index + 100 bps	2.29	0.15
HFRI FOF: Divserified Index + 100 bps	3.47	0.25
Custom Blend	3.21	0.16
MSCI AC World Index (Net)	11.06	1.00

Financing

Empower Results®

Financing

- PSERS currently utilizes 3-Month LIBOR as a proxy for the cost of financing in the Total Fund and Total Public Markets policy benchmarks.

- Aon currently uses 3-month LIBOR for performance reporting:
  - The monthly benchmark returns are calculated using daily LIBOR rates, averaging the rates for the month, and multiplying by (# of days in the month/365).
  - Continues to be reported and calculated.

- Additionally, 3-Month LIBOR is used as the policy benchmark for Absolute Return (+350bps), as well as the benchmark for PSERS LIBOR Plus (not part of Total Fund).
  - PSERS LIBOR Plus portfolio was previously benchmarked against the US Cash Indices LIBOR Total Return 3 month, which captures the income return net of duration impacts.
    - Bloomberg has discontinued this index.

So Long, LIBOR: Next Steps

- Over the past year few years, industry leaders and regulators have articulated tangible steps to implement alternatives to LIBOR, laying the foundation for markets to reference and build liquidity around them.

- Public-private working groups in each regional jurisdiction nominated alternative reference rates: overnight funding rates that reflect the majority of funding activity

	Jurisdiction	Inception	Governing Body	Source	Secured
London Interbank Offered Rate **(LIBOR)**	UK	1980's	Intercontinental Exchange	Survey-based rate	No
Sterling Overnight Index Average **(SONIA)**	UK	March 1997[1]	Bank of England	Weighted average of the interest rates charged in the unsecured London overnight market	No
Secured Overnight Financing Rate **(SOFR)**	US	April 2018	Federal Reserve Bank of New York	Triparty repo, Fixed Income Clearing Corp General Collateral financing and bilateral	Yes

[1]The Bank of England became the administrator of the Sonia benchmark in April of 2016. The Bank of England backed a reformed Sonia rate as an alternative to sterling Libor and began publishing the new rate in April 2018.

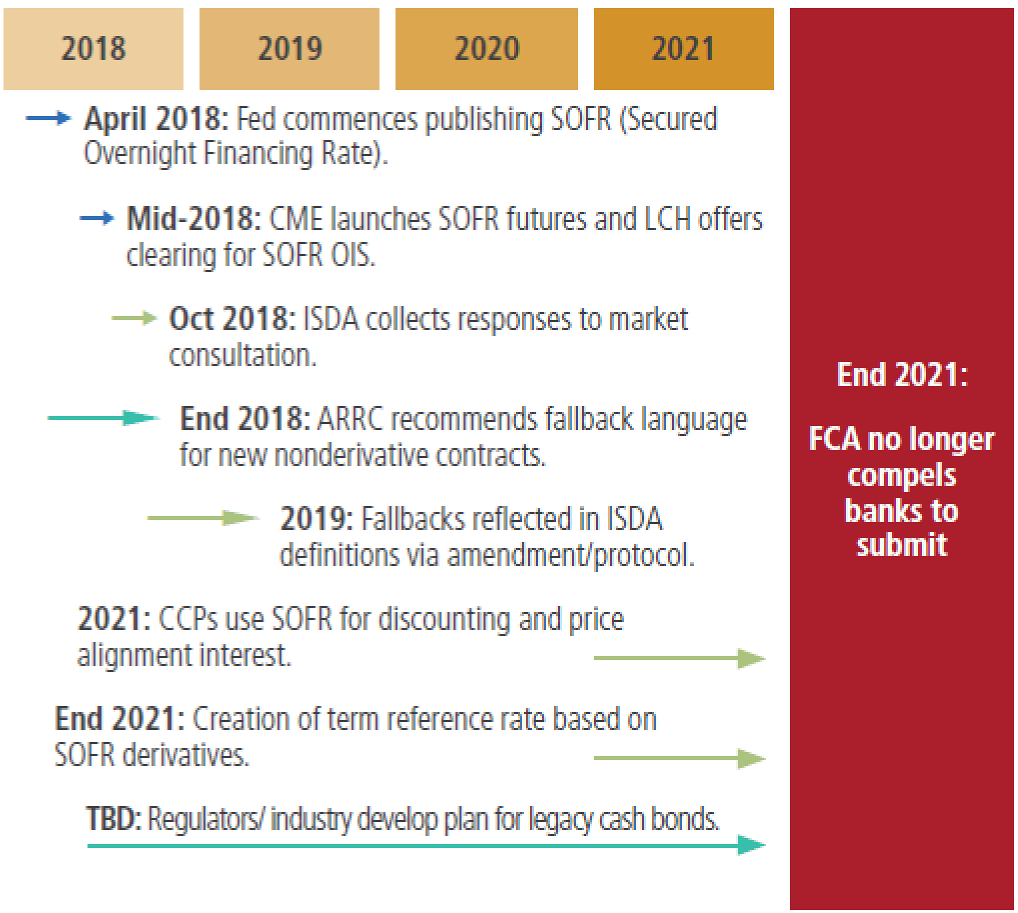
So Long, LIBOR: Alternative Rates

- **Sterling Overnight Index Average (SONIA)** – A widely used interest rate benchmark and the reference rate for Sterling Overnight Indexed Swaps (OIS).
  - SONIA is based entirely on transactions reported to the Bank of England, providing representative coverage of the market which the benchmark seeks to measure, and a statutory footing for the data reporting. The daily production of SONIA involves data validation and plausibility checking. Short-term contingency arrangements are robust and made clear to users.
  - SONIA for the previous London business day is published by authorized distributors at 9:00 a.m. (London Time).

- **Secured Overnight Financing Rate (SOFR) –** A broad measure of the cost of borrowing cash overnight collateralized by Treasury securities.
  - SOFR includes all trades in the Broad General Collateral Rate plus bilateral Treasury repurchase agreement (repo) transactions cleared through the Delivery-versus-Payment (DVP) service offered by the Fixed Income Clearing Corporation (FICC), which is filtered to remove a portion of transactions considered “specials.”
  - Each business day, the New York Fed publishes the SOFR on the New York Fed website at approximately 8:00 a.m. (New York Time).

So Long, LIBOR: Timeline of Events

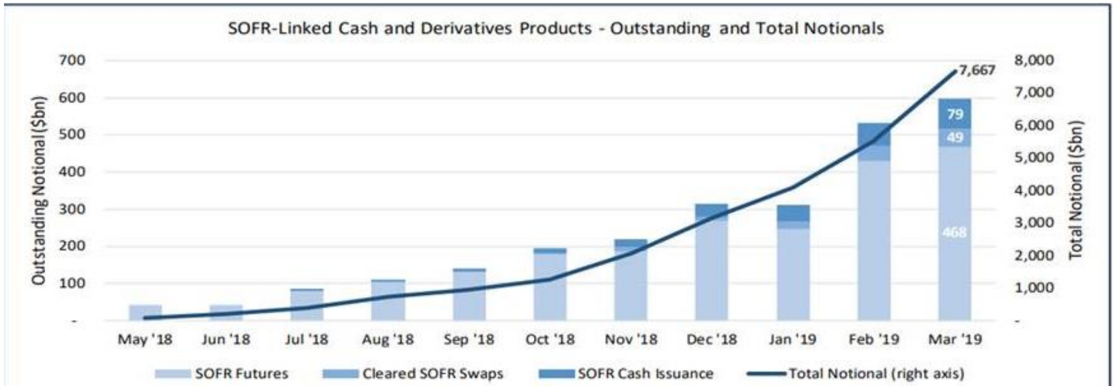
Figure 1: Libor transition – industry efforts



Source: PIMCO as of 31 July 2018.

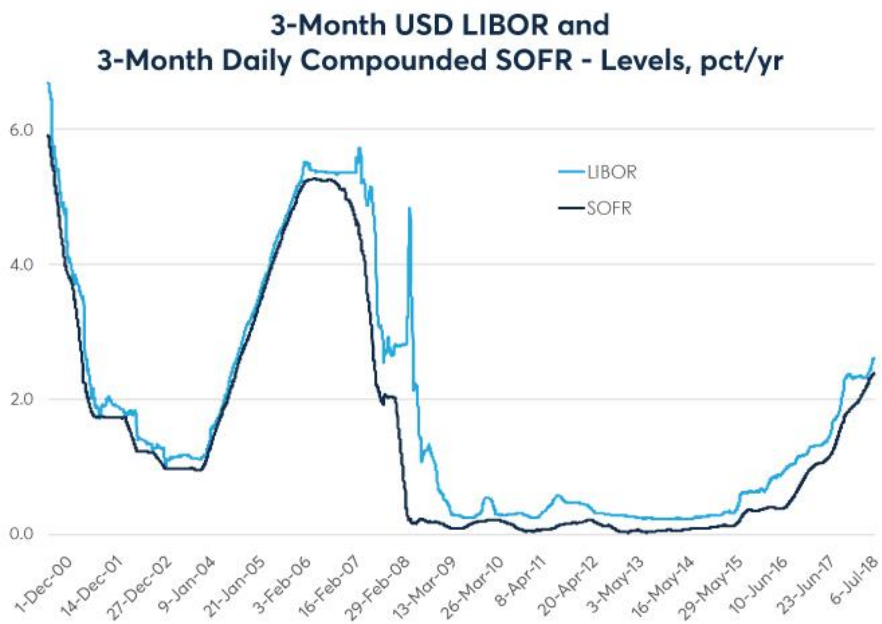
- The Chicago Mercantile Exchange (CME) launched futures based on the SOFR rate in May 2018, and central counterparties (CCPs) recently began accepting overnight index and basis swaps for clearing.
- In June 2018, the European Investment Bank (EIB) issued a sterling-denominated floating-rate bond linked to SONIA.
- In July 2018, Fannie Mae issued a $6 billion SOFR-linked floating-rate note debt transaction.
- Middle 2020, the discount rate used for clearing contracts by clearing houses will move from LIBOR to SOFR while reference rate will continue to be LIBOR

SOFR



[1] **Sources**: CME Group (cash issuances, futures and cleared swaps), ICE (futures) and LCH (cleared swaps). Historical data provided as of March month-end.

[2] SOFR cleared swaps are based on consolidated outstanding notionals provided by LCH and CME



Data Source: Bloomberg LLC, CME Group, Federal Reserve Bank of NY

- Outstanding SOFR-linked notional steadily grew throughout 2018 and early 2019, indicating steady interest and involvement of market participants
- Total notional has reached more than $7 trillion in the market

LIBOR Today

- LIBOR is still readily available and remains the most utilized and liquid derivative option
  - Libor is still being used as the primary rate in most derivatives and other financial instrument contracts

- Market participants are supportive of market initiatives to establish alternative rates (SONIA and SOFR) that are robust and representative of actual transactions.

- As the market develops, new issuance and derivative market participants may transition to an alternative rate.
  - The expectation is SOFR will be the new reference benchmark for derivative instruments cleared via ISDA.
  - In the middle of 2020, the discount rate for clearing derivatives will be SOFR instead of LIBOR (even if the reference rate for floating interest is LIBOR). The use of two reference rates instead of one will introduce some basis risk for these instruments and their dealers. The mechanics of how this will be calculated and the net collateral calculated is still being discussed.
  - SOFR currently trades at a 25 bps discount versus LIBOR. One reason for the difference is that SOFR is a secured rate (by Treasury collateral) while LIBOR is unsecured. The security on the collateral ensures less risk, which translates to a lower rate.

PSERS Benchmark Considerations

1. Continue to utilize LIBOR as the benchmark for PSERS' composites. The LIBOR benchmark Aon calculates in its reports is still available and is expected to continue to be available as long as LIBOR is published (expected through 2021).
   - LIBOR continues to be the reference benchmark for the vast majority of swap contracts and other derivative instruments, and is expected to remain the market standard through at least 2020.
   - Continue to monitor the markets for the use of alternative reference rates and consider migrating to a benchmark based on LIBOR alternatives (SOFR and/or SONIA) when the market liquidity of these instruments becomes more robust.

2. Switch the PSERS policy benchmarks now to one of the proposed alternative cash rates now:
   a. 3-Month T-Bill
   b. SOFR

AHIC recommends PSERS continue to use LIBOR until there is a greater consensus in the market regarding the preferred alternative rate and greater issuance of financial instruments utilizing this rate. We recommend reassessing in 2020.

Appendix

Proposed Policy Benchmarks & Bloomberg Tickers

Asset Class	Benchmark	Bloomberg Ticker
U.S. Equity	75% S&P 500 Total Return Index 12.5% S&P MidCap 400 Total Return Index 12.5% S&P SmallCap 600 Total Return Index	SPTR SPTRMDCP SPTRSMCP
Non-U.S. Equity	MSCI ACWI ex USA IMI Net Total Return USD Index (75% Hedged)	M1CXPPSB
Emerging Markets Equity	MSCI Emerging Markets IMI Net Total Return USD Index	MIMUEMRN
Private Equity	**Performance:** Burgiss All Private Markets ex Real Estate (1Q Lag) **Risk:** 65% MSCI USA Small Cap Gross Total Return USD Index 35% MSCI ACWI ex USA Small Cap Net Total Return USD Index	N/A M2USSC M1WDUSC
U.S. Core Fixed Income	Bloomberg Barclays US Agg Total Return Value Unhedged USD	LBUSTRUU
Non-U.S. Fixed Income	Bloomberg Barclays GDP Global Agg Developed Market ex US Index TR Hedged USD	H27752US
U.S. Long Treasuries	Bloomberg Barclays US Long Treasury Total Return Index Value Unhedged	LUTLTRUU
Emerging Markets Debt	33.33% JPM EMBI Global Diversified 33.33% JPM GBI-EM Broad Diversified 33.33% ICE BofAML Emerging Market Corporate Plus Index (Hedged)	JPEIDIVR JGENBDUL EMCB
Public High Yield	Bloomberg Barclays US Corporate High Yield Total Return Index Value Unhedged	LF98TRUU
Private Credit	**Performance:** S&P/LSTA Leveraged Loan Total Return Index + 200bps **Risk:** S&P/LSTA Leveraged Loan Total Return Index	SPBDAL SPBDAL
U.S. TIPS	Bloomberg Barclays US Govt Inflation-Linked All Maturities Total Return Index (B Series)	BCIT1T
Non-U.S. Inflation-Linked	Bloomberg Barclays World Govt ex US Inf Lkd Bonds All Mtry TR Hedged USD (B Series)	BCIO1U
MLP	Alerian Midstream Energy Total Return Index	AMNAX
Public Infrastructure	FTSE Developed Core Infrastructure 50/50 100% Hedged to USD Net Tax Index	FDCICUHN
Private Infrastructure	**Performance:** FTSE Developed Core Infrastructure 50/50 100% Hedged to USD Net Tax Index (1Q Lag) **Risk:** FTSE Developed Core Infrastructure 50/50 100% Hedged to USD Net Tax Index	FDCICUHN FDCICUHN
Commodities	Bloomberg Commodity Index Total Return	BCOMTR
Gold	Bloomberg Gold Subindex Total Return	BCOMGCTR
Private Real Estate	**Performance:** Hybrid Burgiss Value-Added/Opportunistic Medians/NCREIF ODCE (1Q Lag) **Risk:** 90% FTSE NAREIT Composite Total Return Index 10% FTSE/EPRA NAREIT Developed ex US Total Return Index	N/A FNCOTR REGXU
Public Real Estate	FTSE/EPRA NAREIT Custom Developed 100% Hedged to USD Net Tax Index	GPPPSH1
Risk Parity	50% MSCI ACWI Net Total Return USD Index 75% Bloomberg Barclays US Treasury Total Return Unhedged USD 55% Bloomberg Barclays World Govt Inflation-Linked All Maturities TR Hedged USD 15% Bloomberg Commodity Index Total Return 5% Bloomberg Gold Subindex Total Return -100% ICE LIBOR USD 3 Month	M1WD LUATTRUU BCIW1U BCOMTR BCOMGCTR US0003M
Absolute Return	Hedge Fund Research HFRI FOF Conservative Index + 100bps	HFRIFOFC
Financing	ICE LIBOR USD 3 Month	LUS5
Cash	ICE BOFAML 0-3 Month US Treasury Bill Index	G0B1

Legal Disclosures and Disclaimers

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

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

This document is intended for general information purposes only and should not be construed as advice or opinions on any specific facts or circumstances. The comments in this summary are based upon AHIC's preliminary analysis of publicly available information. The content of this document is made available on an "as is" basis, without warranty of any kind. AHIC disclaims any legal liability to any person or organization for loss or damage caused by or resulting from any reliance placed on that content. AHIC reserves all rights to the content of this document. No part of this document may be reproduced, stored, or transmitted by any means without the express written consent of AHIC.

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

Aon Hewitt Investment Consulting, Inc.

200 E. Randolph Street

Suite 1500

Chicago, IL 60601

ATTN: AHIC Compliance Officer

Empower Results®

Aksia

July 22, 2019

Board of Trustees
Commonwealth of Pennsylvania, Public School Employees' Retirement System ("PSERS")
5 North Fifth Street
Harrisburg, PA 17101

Re: Non-Traditional Assets Benchmark Review

Dear Trustees:

Aksia LLC, having been duly authorized by the Board of PSERS, has reviewed the Proposed Policy Performance Index and Proposed Risk Benchmark for the Absolute Return asset class as prepared by Aon Hewitt Investment Consulting ("Aon"). The Proposed Policy Performance Index and Proposed Risk Benchmark, as prepared by Aon, are HFRI FOF: Conservative Index +100bps and HFRI FOF: Conservative Index, respectively. We believe these benchmarks are reasonable and appropriate given the characteristics, return objectives and management methodologies of the PSERS Absolute Return program.

We believe the use of an HFR index to benchmark portfolios of non-traditional assets is consistent with industry standards. While the use of any index in this space has drawbacks to consider, including the potential to reflect various data biases or strategy mis-matches between the referenced index and portfolio it is meant to benchmark, we believe the HFRI FOF series is preferable to peers given its large sample size and broader adoption by the institutional investors.

With regard to the HFRI FOF: Conservative Index, we have reviewed the description and methodology provided by HFR in constructing the index and believe it to be appropriate for the PSERS Absolute Return program. The index consists of hedge fund-of-funds which primarily invest in lower-beta strategies, such as equity market neutral, fixed income arbitrage and convertible arbitrage. We believe this index's volatility, beta and downside protection-oriented return profile are consistent with those of the Absolute Return program. We support the addition of an annual premium to the index returns to adjust for the additional layer of fees typically charged in hedge fund-of-fund structures, and believe +100 basis points per annum is a reasonable estimation of those fees.

Please feel free to contact us should you have any questions about this recommendation.

Respectfully,

Matt Mullarkey
Head of Advisory, Americas

Hamilton Lane

July 22, 2019

Board of Trustees
Commonwealth of Pennsylvania
Public School Employees' Retirement System
5 North 5th Street
Harrisburg, PA 17101

Re: Non-Traditional Assets Benchmark Review

Dear Trustees:

In its role as Consultant for the Commonwealth of Pennsylvania, Public School Employees' Retirement System's Private Markets, High Yield & Private Credit, and Private Real Assets Portfolios, Hamilton Lane has reviewed the Proposed Policy Performance Index and Proposed Risk Benchmarks for Private Equity, Private Credit, Private Infrastructure and Private Real Estate as prepared by Aon Hewitt Investment Consulting. Private Markets continue to be a tough asset class to benchmark for many reasons included but not limited to: (1) the infrequent appraisal valuations inherent in private markets indices arguably understate the "true" volatility of the underlying assets, (2) there is no constant stream of exposure; exposure is built over time and (3) an average spread at some prior point in time may not be representative of what you are capable of earning "today." In consideration of these factors, this letter is to inform the Board that the benchmarks stated below are reasonable and consistent with industry standards. Philosophically, Hamilton Lane agrees that for private markets, public market proxies may represent better risk benchmarks given the underlying holdings characteristics and the assumed volatility. While appropriate, and despite public and private indices investing in similar assets, it's important to note that the public and private real estate and infrastructure markets may deviate meaningfully from one another at times in reflection of their differing investor bases, which can result in tracking error. The benchmarks recommended below are all reasonable and appropriate, considering the characteristics of the underlying holdings within each respective portfolio.

Asset Class	**Current/Proposed Performance Benchmark**	**Proposed Risk Benchmark**	**Hamilton Lane Commentary**
Private Equity	Burgiss All Private markets ex Real Estate (1Q lag)	65% MSCI USA Small Cap/35% MSCI ACWI ex-US Small Cap	• Burgiss benchmarks are appropriate performance benchmarks as the data set represents a robust sample for the set of private market strategies targeted by PSERS • The public indices selected for the risk benchmark are appropriate given the private equity portfolio's overweight to middle market equity investments • Geographic weightings are in line with underlying asset diversification
Private Credit	S&P LSTA Leveraged Loan + 200bps	S&P LSTA Leveraged Loan	• S&P LSTA Leveraged Loan is a common index to benchmark private credit portfolios with a focus on credit origination strategies • The +200 bps per annum premium is a constant added to the return stream

Hamilton Lane

			and therefore does not impact the volatility / risk benchmark • The credit risk in this index approximates the credit risk taken by private credit managers pursuing an origination strategy
Private Real Estate	Hybrid Burgiss Value-Added/ Opportunistic Medians/ NCREIF ODCE (1Q lag)	90% FTSE NAREIT Composite/ 10% FTSE EPRA/ NAREIT Developed ex US	• The NCREIF ODCE and private market peer group based indices like the Burgiss are reasonable choices for benchmarking the performance of a private real estate portfolio • Public REIT market indices are the practical and default choice for measuring the public market risk of the real estate market • The selection of the 90% FTSE NAREIT Composite / 10% FTSE EPRA NAREIT Developed ex US Hybrid Index is an appropriate choice for a public market indices and reflects the geographical composition of the real estate portfolio
Private Infrastructure	FTSE Developed Core Infrastructure 50/50 Index (Hedged) (1Q Lag)	FTSE Developed Core Infrastructure 50/50 Index (Hedged)	• As of today, there is not an industry accepted private infrastructure index • Therefore, public market indices are the most appropriate proxy for benchmarking a private infrastructure portfolio for both performance and risk • Of the public market indexes available, the FTSE Developed Core Infrastructure 50/50 Index (Hedged) is an appropriate choice, as it has measures in place to ensure its constituency consists of companies that have a focus on pure-play infrastructure assets

Sincerely,

Michael Koenig,
Chief Client Officer

Corina English,
Principal

Asset-Liability Study Results

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

Table of Contents

Executive Summary

Empower Results®

Executive Summary
Summary and Conclusions

Portfolio Analysis

- The current portfolio is well-diversified
- The expected annual return assumption for the Current Long-Term Target portfolio is 7.55% over the next 30 years while the Proposed Long-Term portfolio is 7.66% over the same period
- PSERS should consider its desired balance between cash funding, risk tolerance, and investment returns when determining the ideal investment portfolio

Asset-Liability Projection Analysis

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

Executive Summary

Key Observations

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

- This is a one year improvement versus the projections from last year's analysis
- This assumes that the actuarially determined contributions are paid in full when they are due
- These projections include the benefit changes from Act 5 of 2017

2) PSERS employer contributions are expected to increase in the central expectation over the next sixteen years to approximately $7.2 billion annually utilizing the Current Long-Term Target allocation

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

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

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

Empower Results®

Executive Summary
Key Observations (continued)

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

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

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

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

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

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

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

Asset-Liability Projection Results (Stochastic Results)

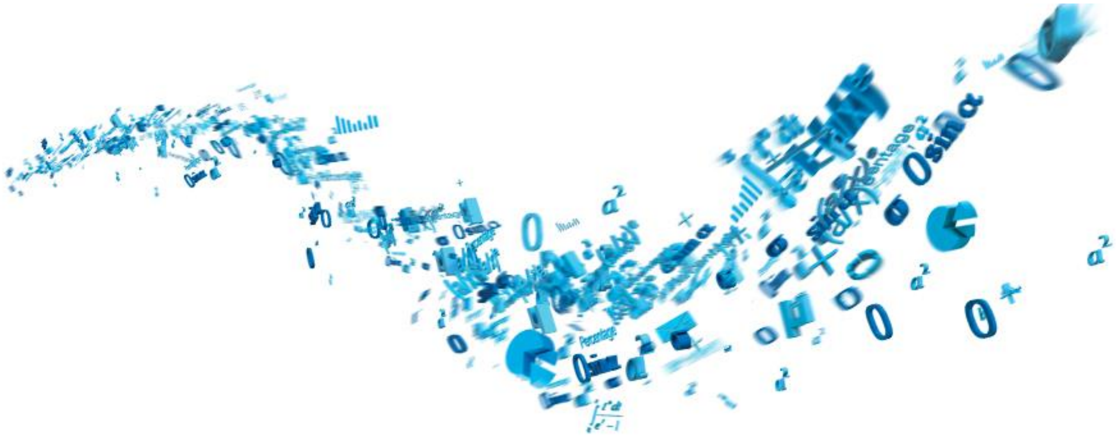
Summary and Conclusions

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

Key Findings:

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

[1] Expected = 50th percentile outcome or central expectation across all 5,000 simulations
[2] Downside = 95th percentile outcome across all 5,000 simulations
[3] Downside = 5th percentile outcome across all 5,000 simulations

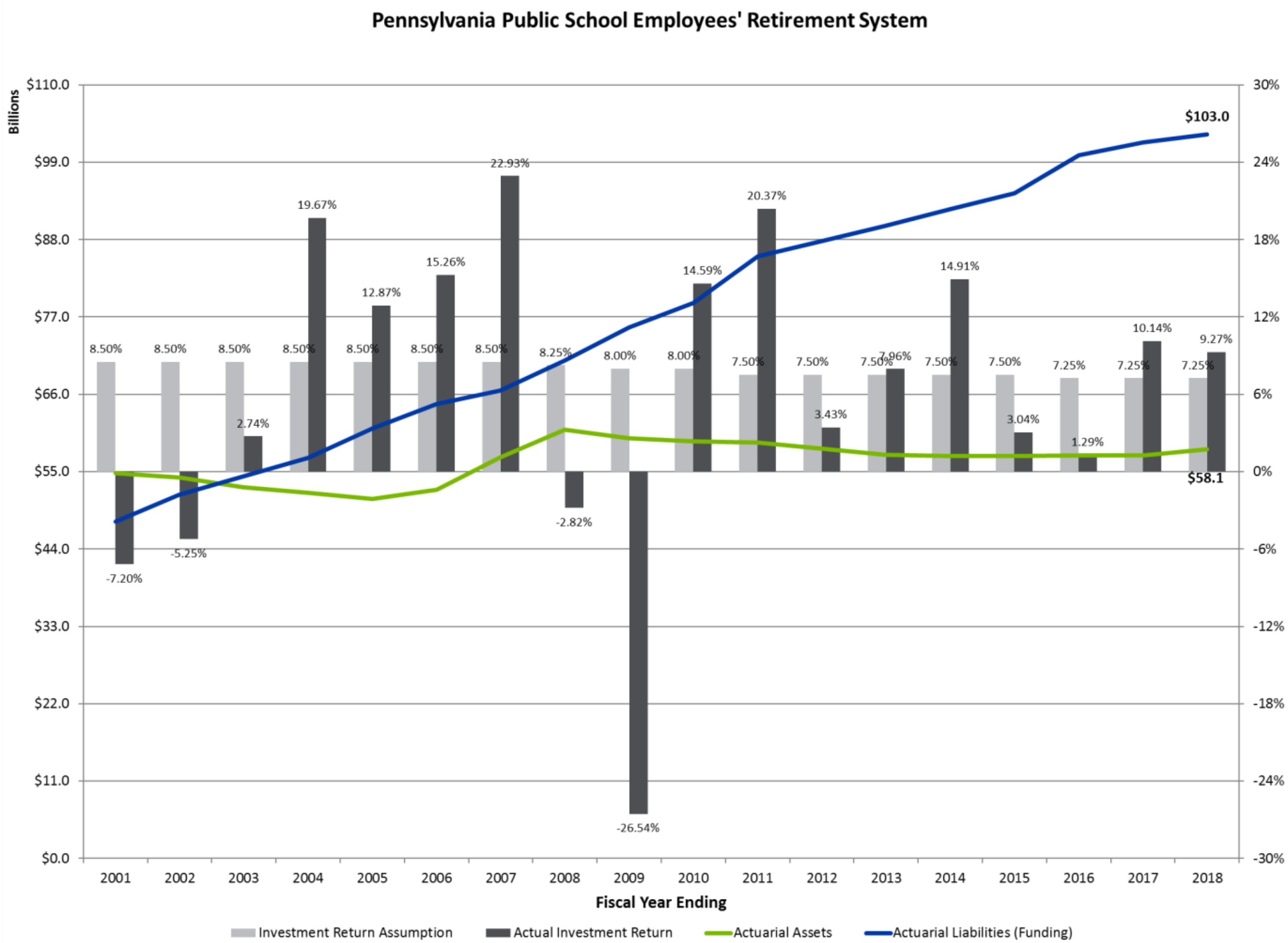


Analysis

- Background and Current State

Empower Results®

Background and Historical Information



Key Takeaways:

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

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

Current State Asset-Liability Profile

As of June 30, 2018

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

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

Key Takeaways:

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

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

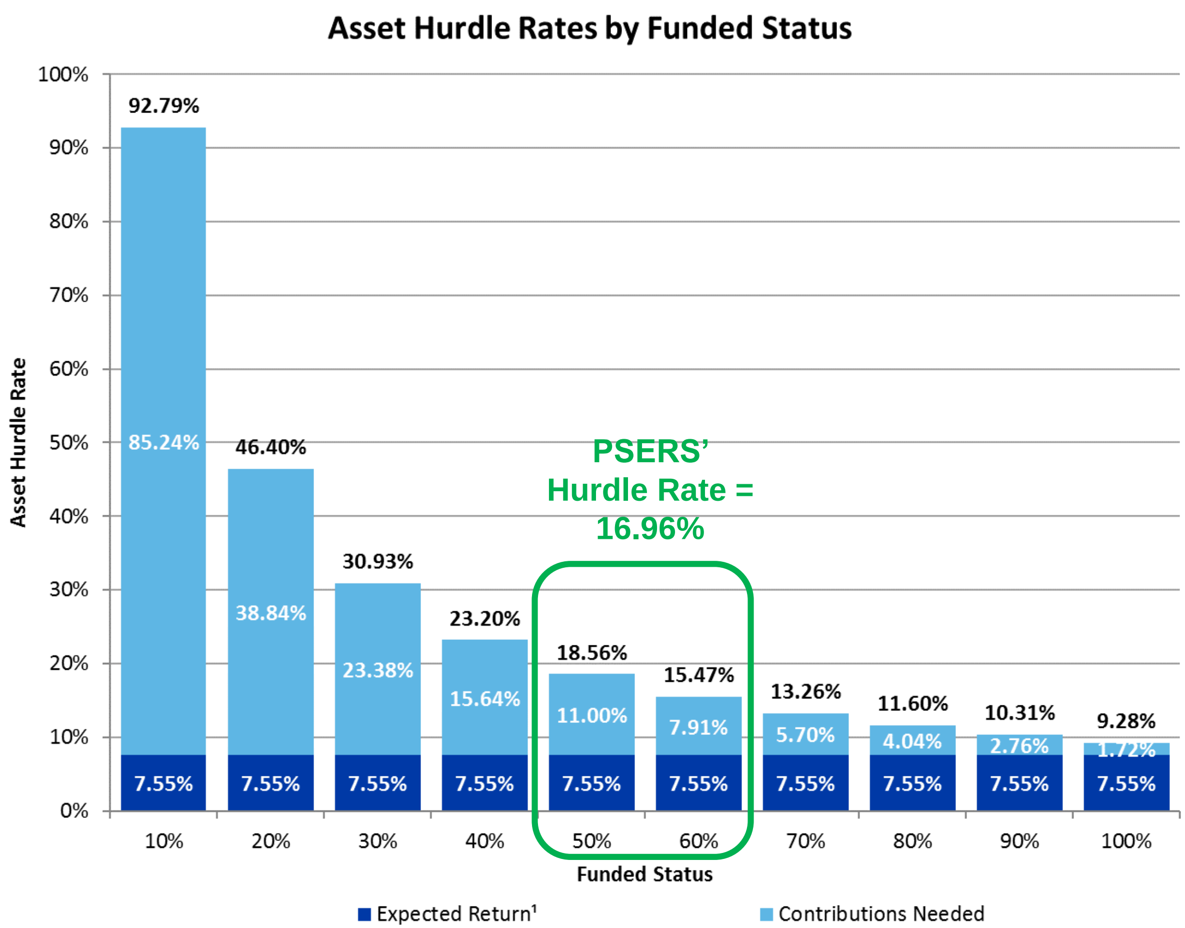
[1] Based on a 7.25% discount rate consistent with the June 30, 2018 valuation results
[2] Credit-Related includes Private Credit, High-Yield Bonds, and Emerging Market Debt
[3] Inflation-Linked has a 50% allocation to US TIPS and 50% allocation to Non-US Inflation-Linked
[4] Hedge funds have elements of both return-seeking and risk-reducing assets. Hedge funds have been categorized as risk-reducing based on the composition of the hedge funds within the PSERS portfolio.
[5] Using AHIC Q2 2019 30 year capital market assumptions

Asset Hurdle Rate

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

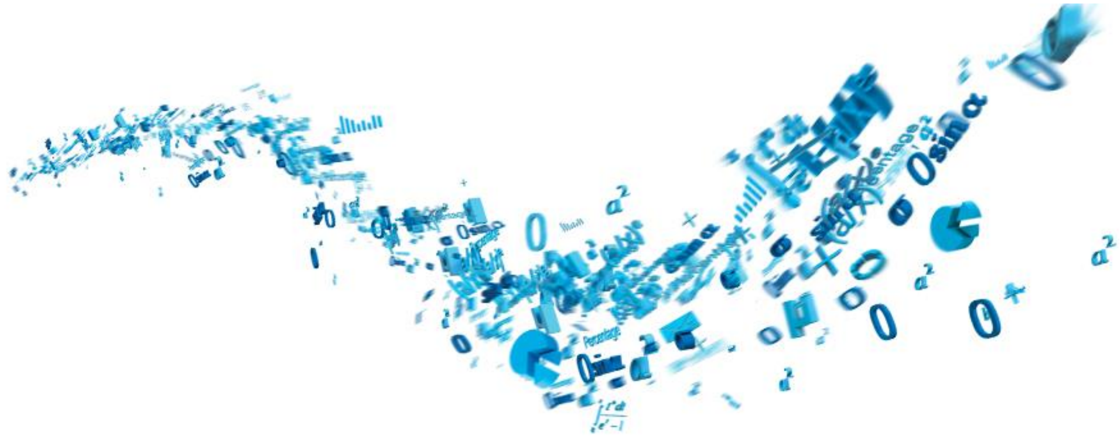
- Assets can grow via:
  - Investment performance, and/or
  - Funding contributions

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



[1]Using AHIC Q2 2019 30 year capital market assumptions

Empower Results®

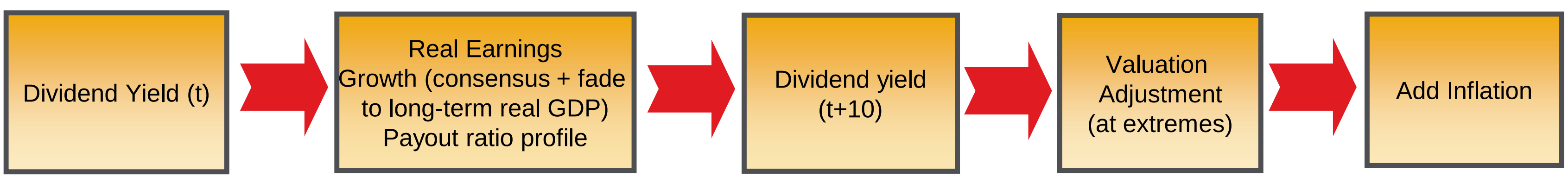


Analysis

- 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:



Empower Results®

Portfolio Analysis
Capital Market Assumption Overview

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

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

Q2 2019 AHIC 10-year Capital Market Assumptions

- Asset class exposures are represented within the PSERS portfolio

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

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

Empower Results®

Q2 2019 AHIC 30-year Capital Market Assumptions

- Asset class exposures are represented within the PSERS portfolio

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

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

Portfolio Analysis

AHIC Capital Market Assumption Changes

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

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

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

Portfolio Analysis
Portfolios Evaluated

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

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

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

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

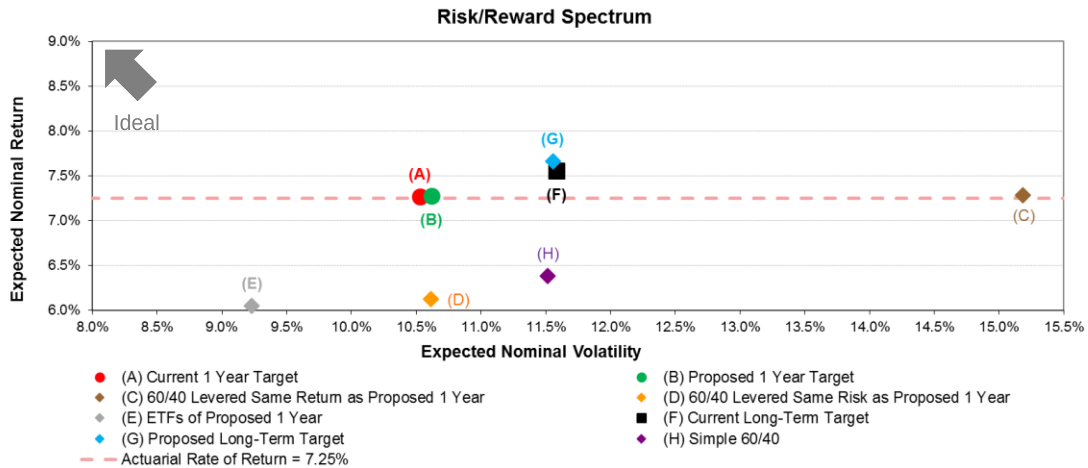
[4] Risk Parity assumptions developed as follows: 50% Global Equity, -100% LIBOR, 55% TIPS, 75% Intermediate Gov't. Bonds, 20% Commodities

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

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

Portfolio Analysis

Risk/Reward Spectrum



Key Takeaways:

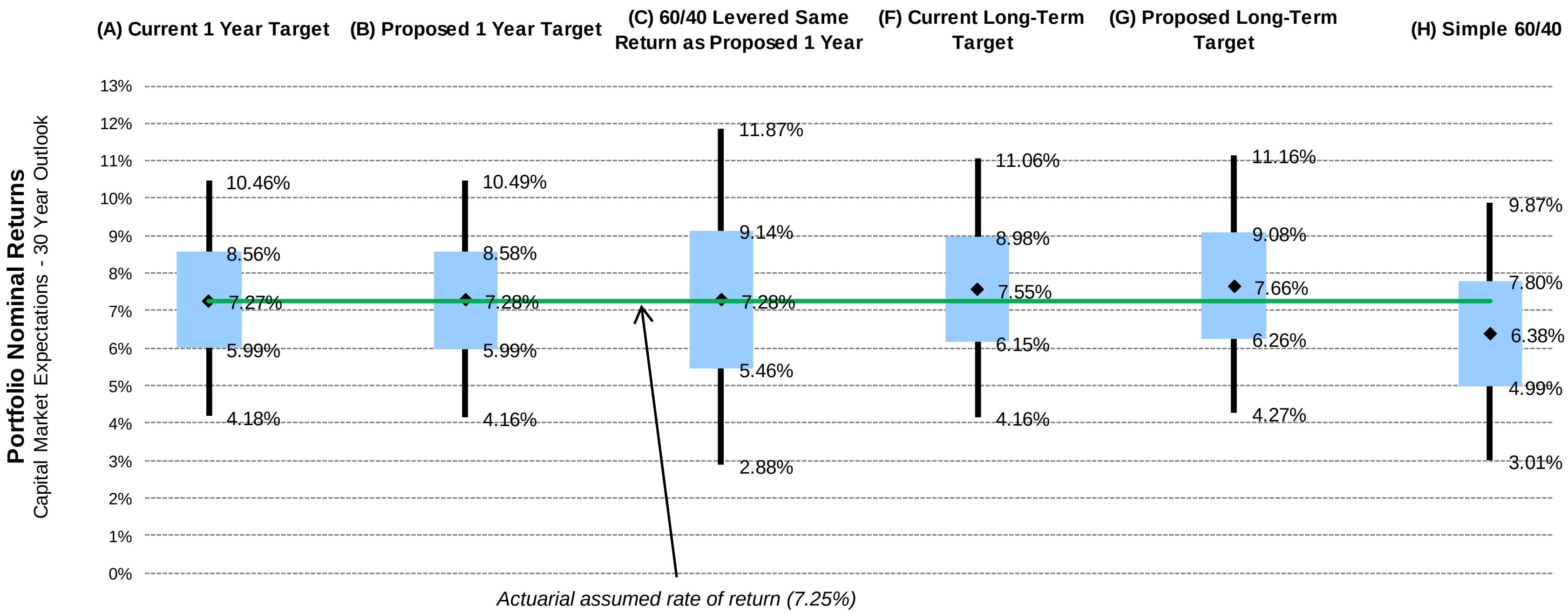
- The Current Long-Term Target portfolio has a high allocation to return-seeking assets
  - Return-seeking assets are broadly diversified
- The Current Long-Term Target portfolio includes a leveraged position of 20%

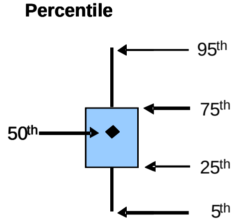
Portfolio Weights

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

[1] Credit-Related includes Private Credit, High-Yield Bonds, and Emerging Market Debt
[2] Hedge funds have elements of both return-seeking and risk-reducing assets. Hedge funds have been categorized as risk-reducing based on the composition of the hedge funds within the PSERS portfolio.

Portfolio Analysis
Range of Nominal Returns



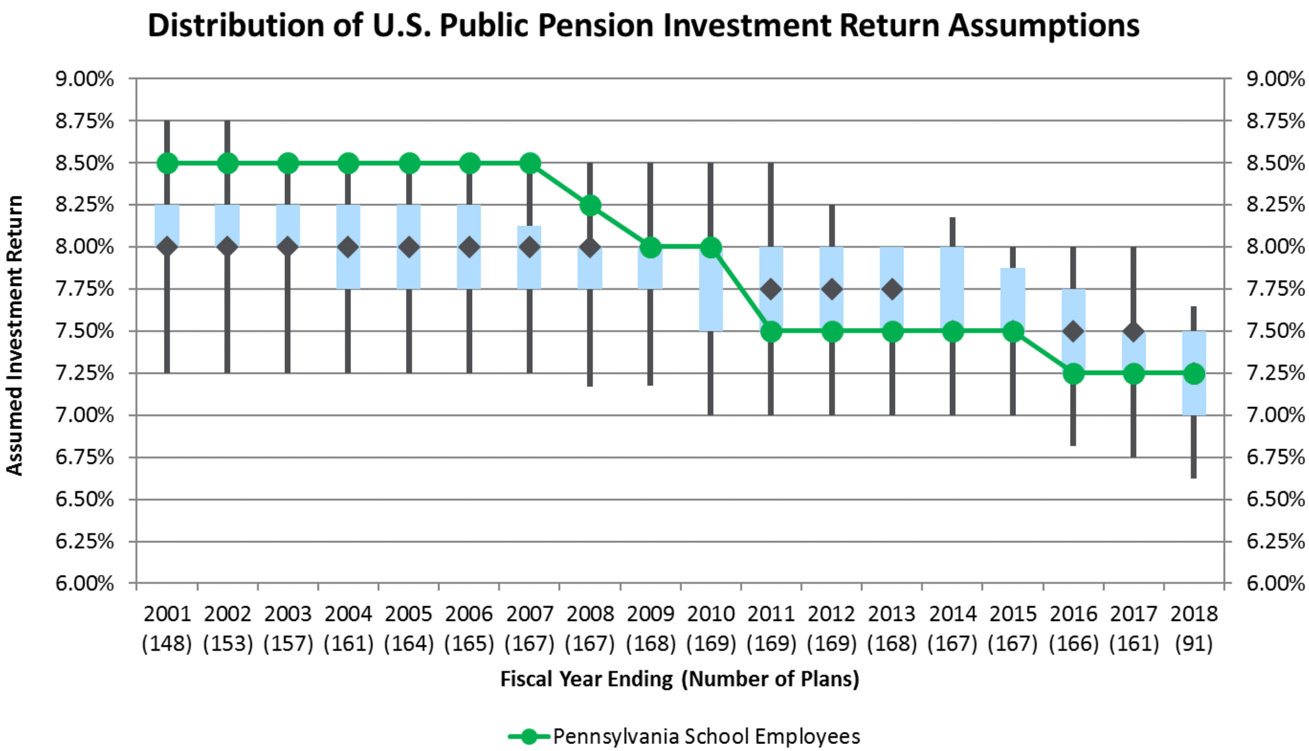


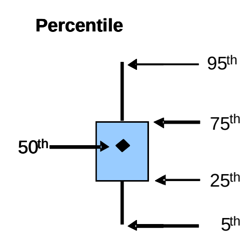
Key Takeaway:

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

Portfolio Analysis

Expected Return Assumption versus Peers[1]





Key Takeaways:

- The public pension peer median actuarial assumption for investment return has declined from 8.00% in 2001-2010 to 7.25% based on the latest survey data
- PSERS' assumption for FYE 2018 (7.25%) fell at the median relative to its peers
- If PSERS exceeds (or falls short of) the actuarial return assumption, lower (or higher) funding will be needed in future years

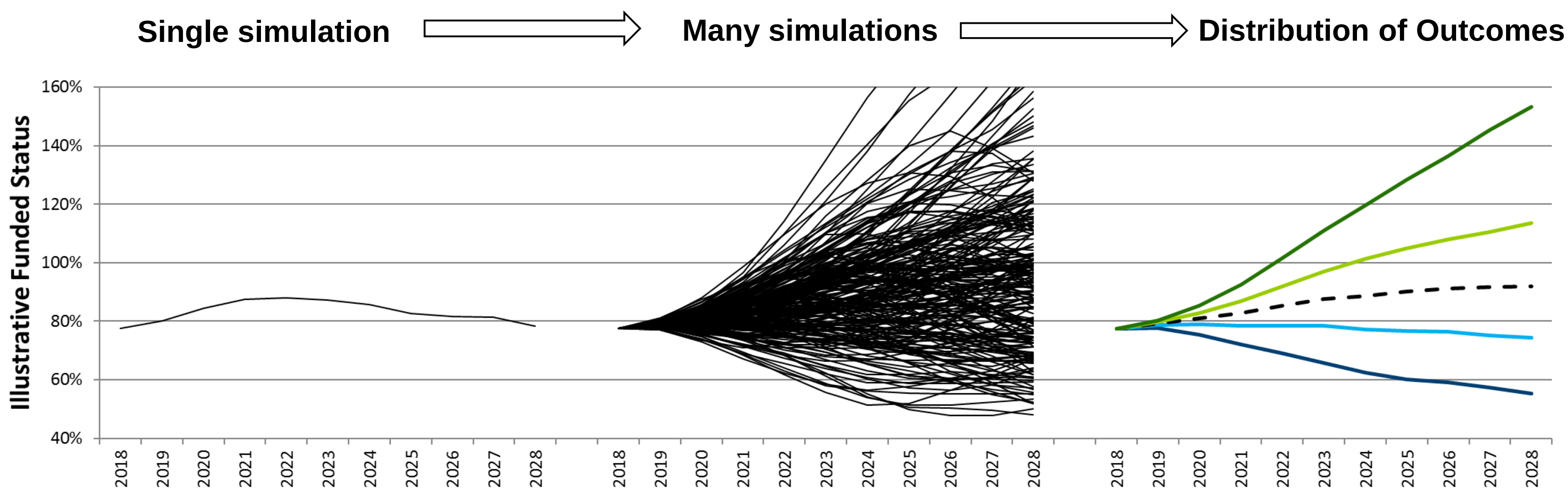
Sources: Public Plans Data (publicplansdata.org) as of April 2019; Expected Returns are the assumptions made by the plans included in the data set.
[1] Peers defined as public funds published within publicplansdata.org as of April 2019; Number of plans per year are shown in parentheses

Analysis

- Asset-Liability Projection Results (Stochastic Results)

Asset-Liability Simulation Overview

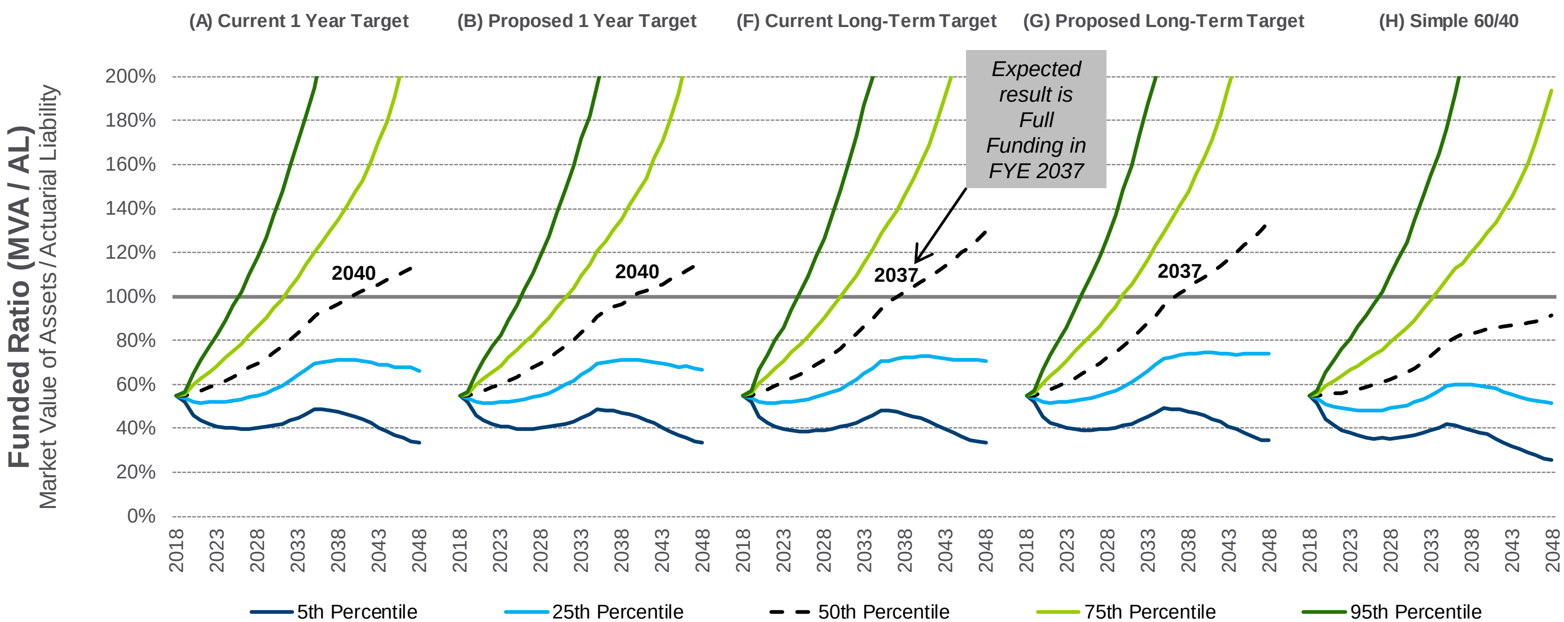
- Thousands of simulations plotted in one graph would be impossible to interpret
- Instead, we rank the simulations at each point over the future
- This produces a distribution of outcomes illustrating the degree of uncertainty of a plan's financial position over the projection period
- Different investment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



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

Asset-Liability Projection Results (Stochastic Results)

Market Value of Assets / Actuarial Liability Funded Ratio



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

Key Takeaways:

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

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

Empower Results®

Asset-Liability Projection Results (Stochastic Results)
Short-Term Funded Ratio Shortfall Analysis (Based on Market Value of Assets)

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

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

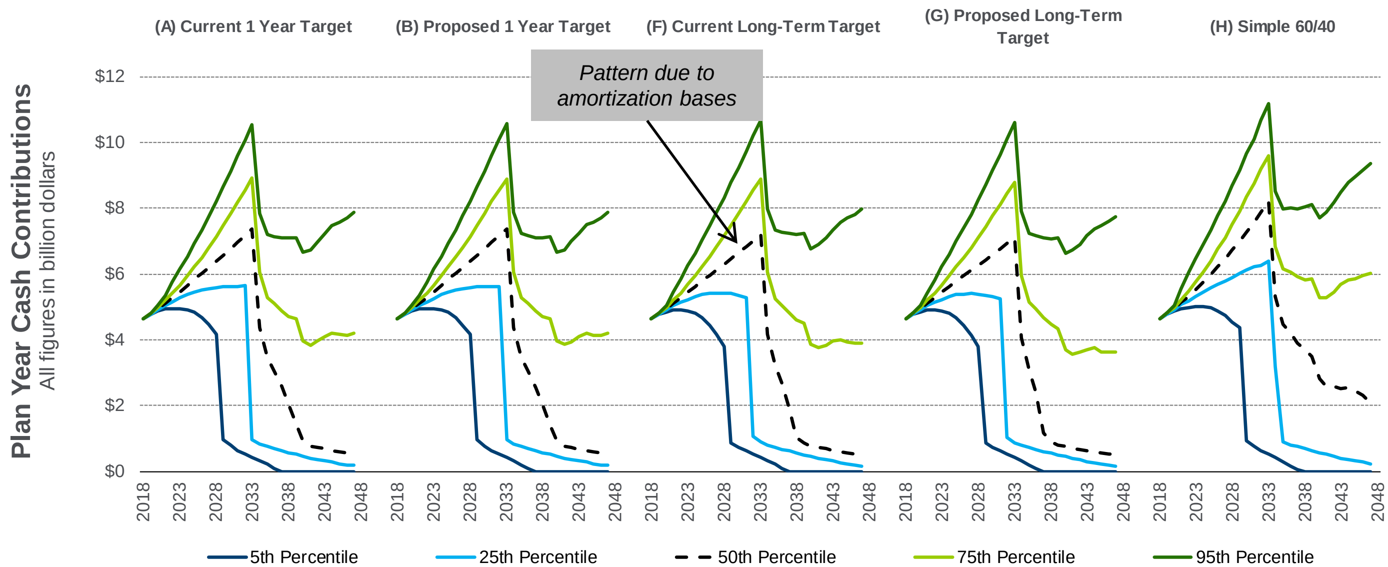
Key Takeaway:

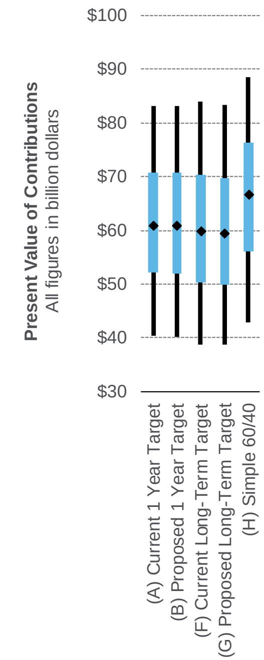
- The Proposed Long Term Target portfolio is expected to yield higher funded ratios in optimistic projections while the Current 1 Year Target portfolio is expected to yield higher funded ratios in pessimistic projections over five years.

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

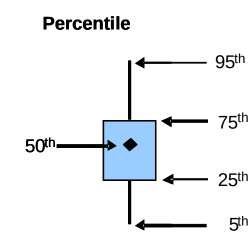
Asset-Liability Projection Results (Stochastic Results)

Employer Contribution Amount





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



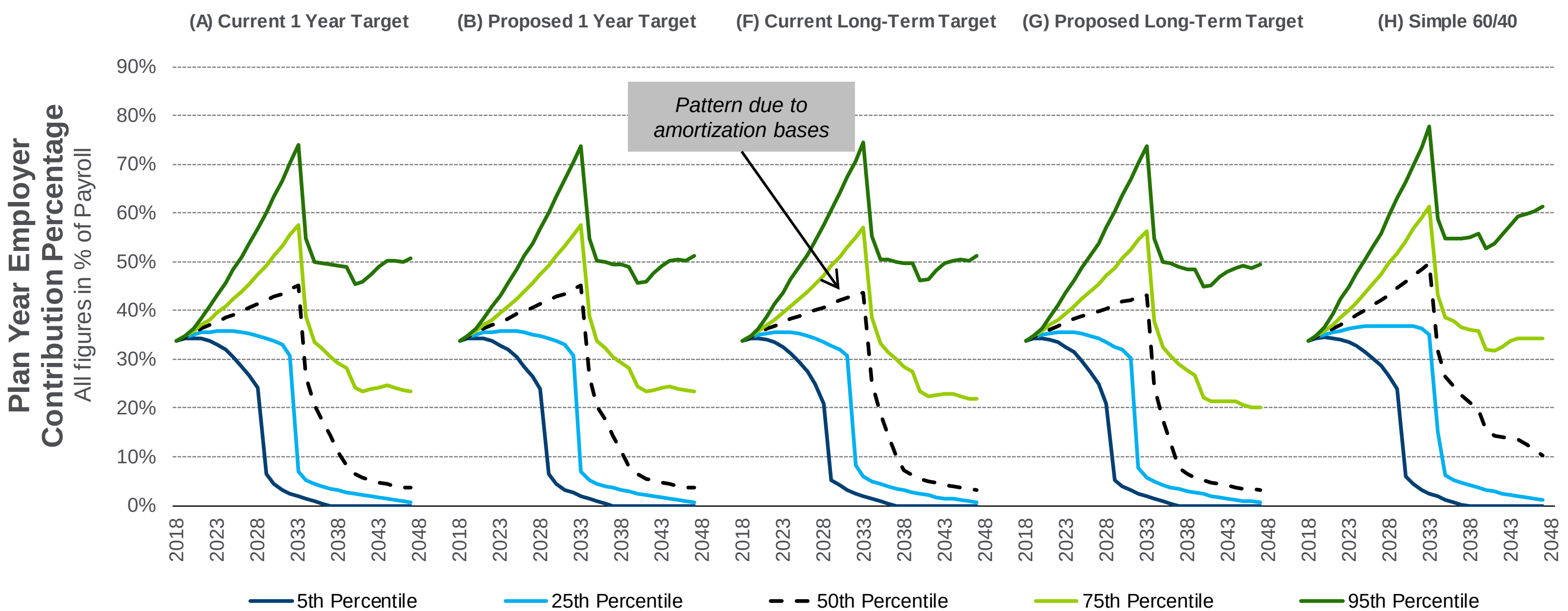
Key Takeaway:

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

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

Asset-Liability Projection Results (Stochastic Results)

Employer Contribution Percentage of Payroll



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

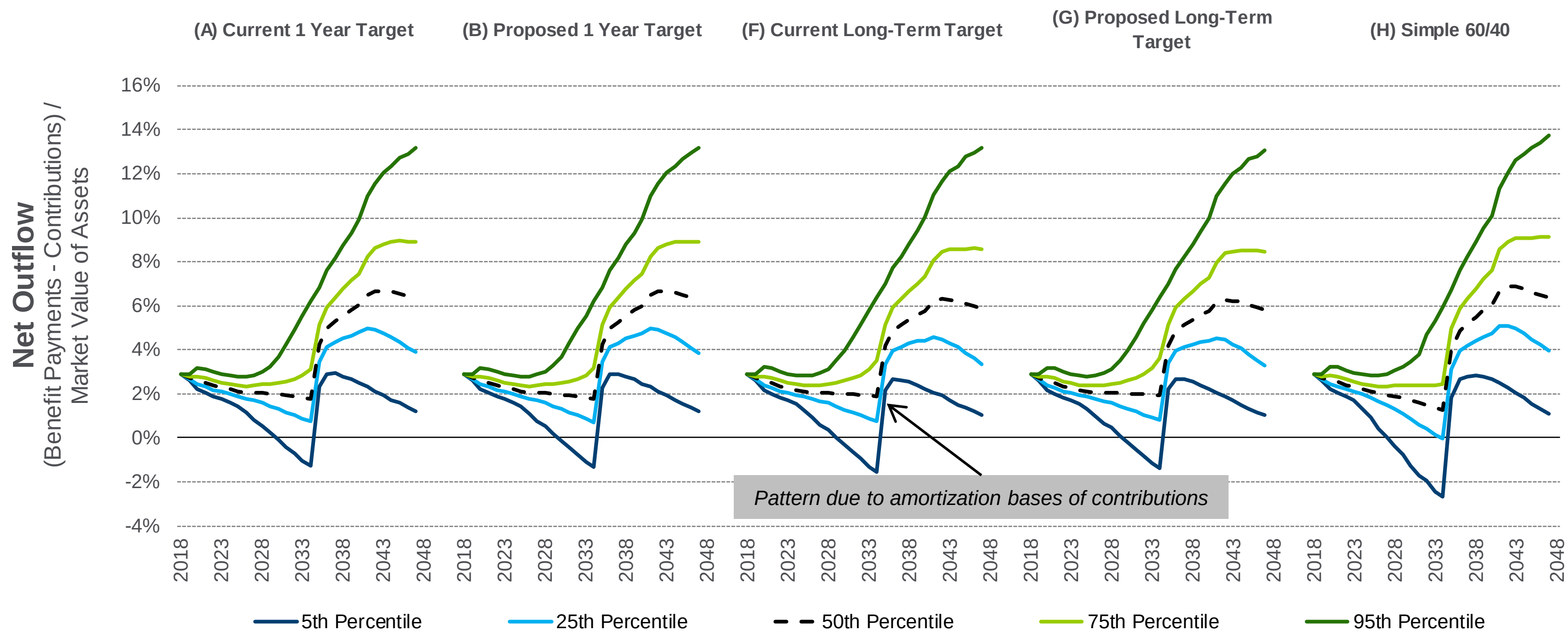
Key Takeaway:

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

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

Asset-Liability Projection Results (Stochastic Results)

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



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

Key Takeaway:

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

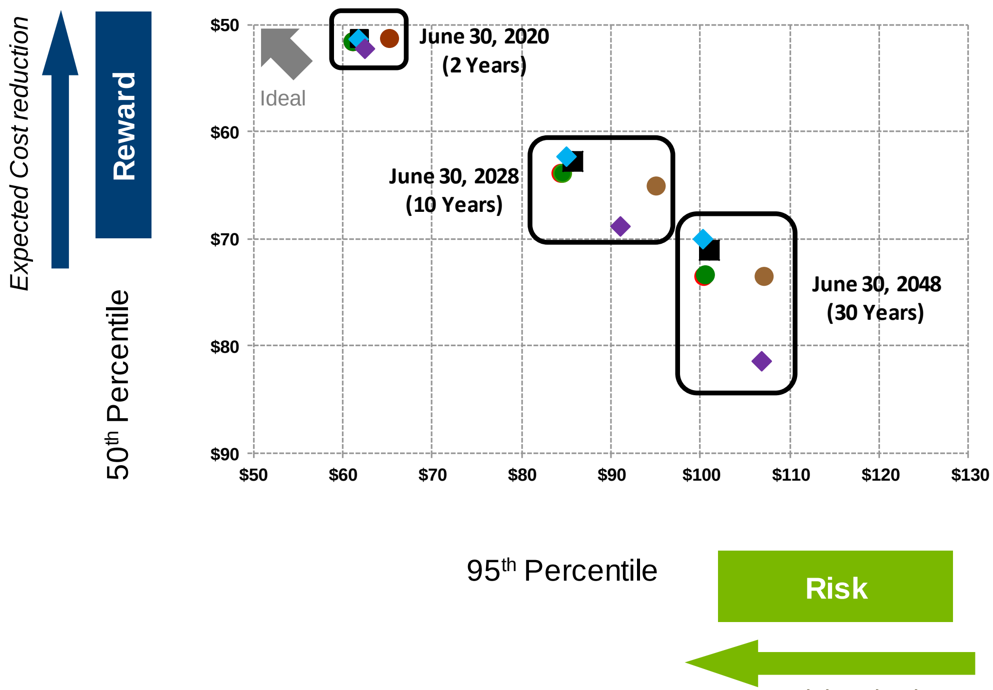
* Liability projections assume discount rates of 7.25% for all investment policies studied

Asset-Liability Projection Results (Stochastic Results)

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

Economic Cost

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



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

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

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

Key Takeaways:

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

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

Analysis

- Summary and Conclusions

Summary and Conclusions
Portfolio Analysis

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

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

Appendix

- Peer Comparisons

Public Pension Peer Comparison

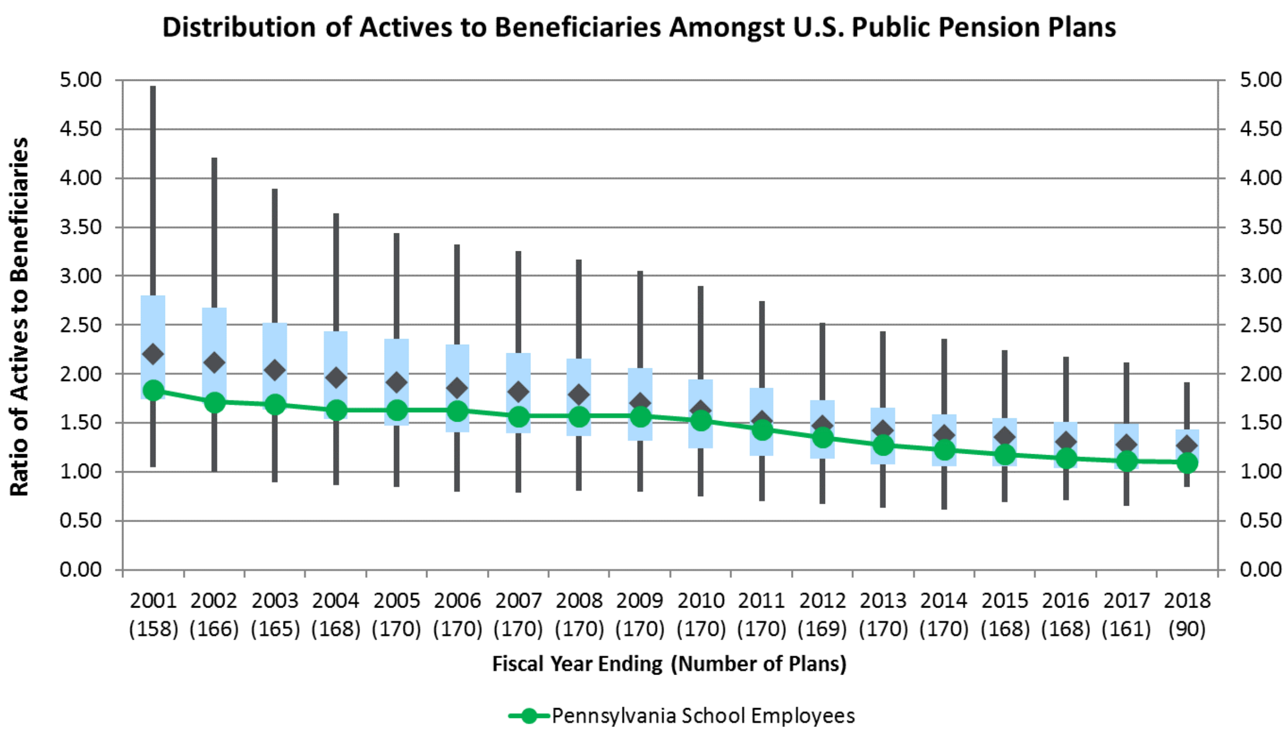
PSERS' Asset Allocation versus Public Peers

Asset Allocation	PSERS	Public Pension Plans (<$500M)*	Public Pension Plans ($501M-1B)*	Public Pension Plans ($1-5B)*	Public Pension Plans (>$5B)*	Total Public Pension Universe*
Equity Exposure						
Global Equity	0.0%	1.9%	0.7%	4.8%	11.6%	10.6%
Total U.S. Equity	7.8%	37.0%	35.9%	28.2%	18.3%	19.9%
Total Int'l Equity	12.2%	19.3%	21.6%	20.2%	19.1%	19.2%
Private Markets	15.0%	4.1%	4.2%	5.0%	8.3%	7.9%
Total Equity	***35.0%***	***62.3%***	***62.4%***	***58.2%***	***57.3%***	***57.6%***
Fixed Income Exposure						
U.S. Fixed Income	10.0%	23.3%	22.5%	21.4%	25.5%	25.0%
High Yield Bonds / Bank Loans	1.6%					
Non-US Developed Bonds	1.0%	1.6%	1.9%	3.0%	1.5%	1.6%
Emerging Market Debt	2.0%	0.7%	0.3%	1.6%	1.6%	1.6%
Inflation Protected	15.0%					
Private Debt	6.4%					
Total Fixed Income	***36.0%***	***25.6%***	***24.7%***	***26.0%***	***28.6%***	***28.2%***
Real Asset Exposure						
Infrastructure (Public + Private)	8.0%	0.0%	0.0%	0.0%	0.3%	0.2%
Commodities	8.0%	0.6%	0.8%	0.8%	1.5%	1.4%
Real Estate	10.0%	4.3%	3.4%	3.6%	2.4%	2.6%
Total Real Assets	***26.0%***	***4.9%***	***4.2%***	***4.4%***	***4.2%***	***4.2%***
Hedge Funds / Opportunistic	10.0%	3.5%	2.1%	3.7%	3.0%	3.0%
Multi-Asset / Risk Parity	10.0%	0.7%	0.5%	2.6%	0.2%	0.4%
Money Market / Cash	3.0%	0.7%	0.8%	0.6%	3.0%	2.7%
Leverage	-20.0%					
Other**	0.0%	2.2%	5.2%	4.4%	3.9%	4.0%
Net Other	***3.0%***	***7.1%***	***8.6%***	***11.3%***	***10.1%***	***10.1%***
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***
Expected Return	***7.55%***	***6.77%***	***6.81%***	***6.81%***	***6.80%***	***6.81%***
Expected Volatility	***11.58%***	***12.57%***	***12.85%***	***12.48%***	***12.22%***	***12.28%***
Sharpe Ratio	***0.435***	***0.338***	***0.334***	***0.343***	***0.351***	***0.349***

* Source: "*2018 U.S. Institutional Market Trends*", Greenwich Associates
** Assets labeled as "Other" were assumed to be re-allocated pro-rata to the asset allocation listed for purposes of determining expected return / volatility / Sharpe Ratio

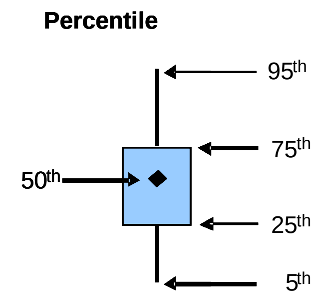
PSERS

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 2018.
- Over that same time frame, PSERS' active to beneficiary ratio has declined from 1.8 to 1.1

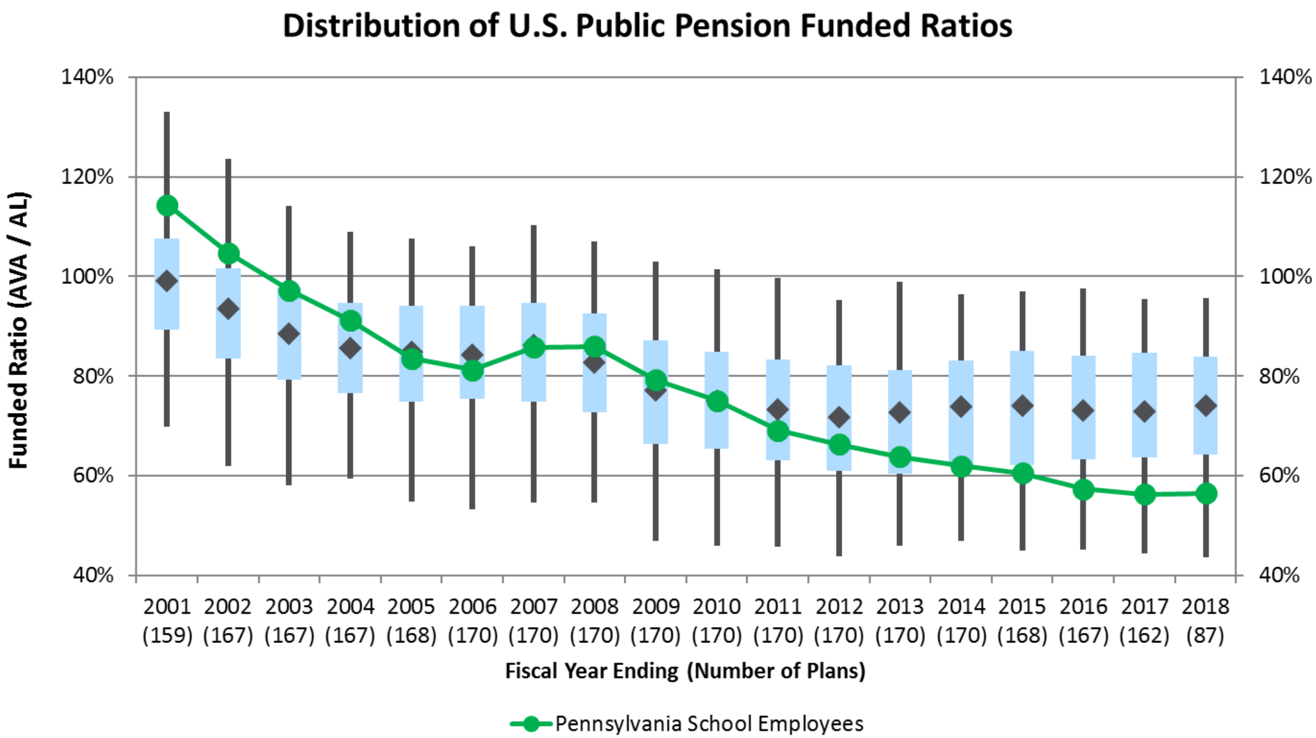


Source: Public Plans Data (publicplansdata.org) as of April 2019;

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

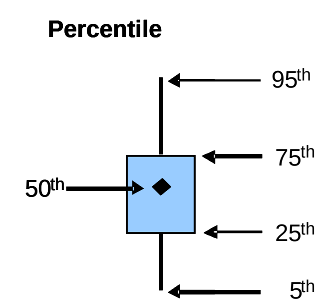
PSERS

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



Key Takeaways:

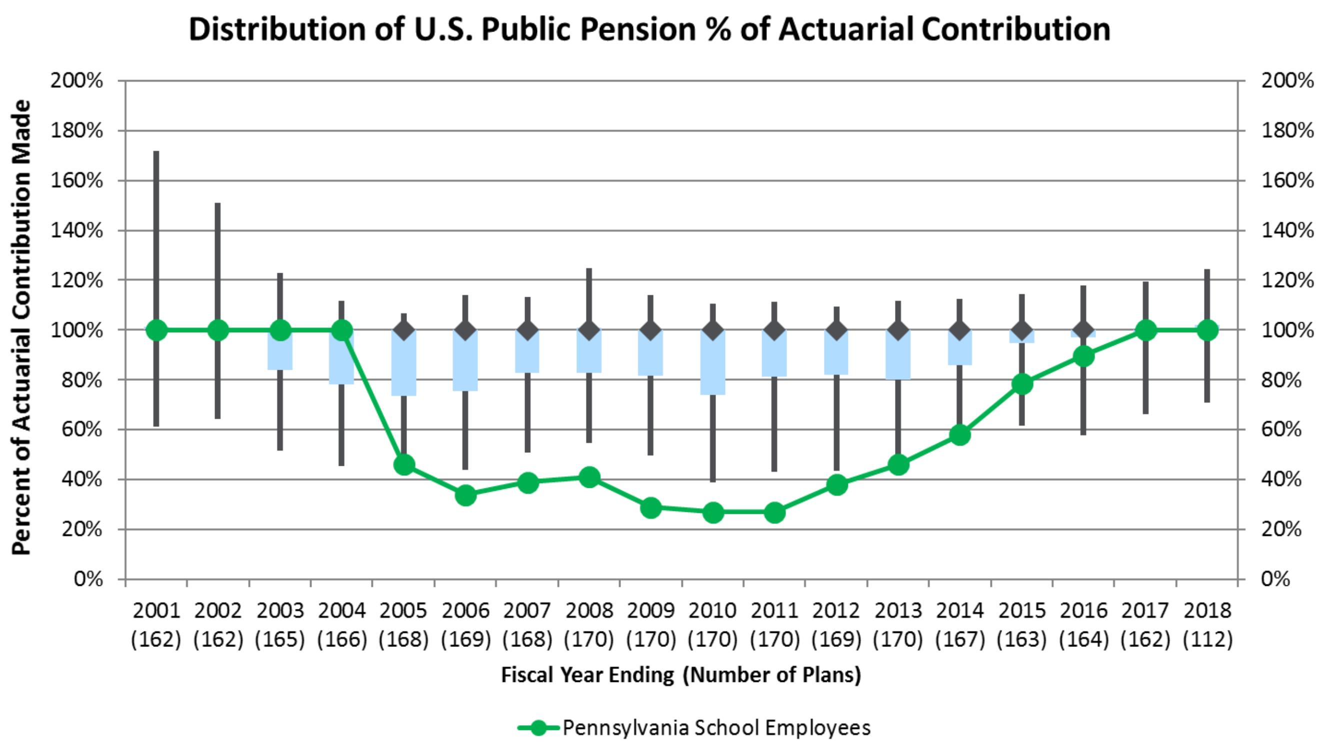
- The median funded ratio as of FYE 2018 was 74% based on the latest survey data
- PSERS' FYE 2018 funded ratio (55.5%) fell below the 25th percentile relative to its peers



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

PSERS

Percentage of Actuarial Contribution Made versus Peers[1]



PSERS Annual Underfunding (in $ billions)

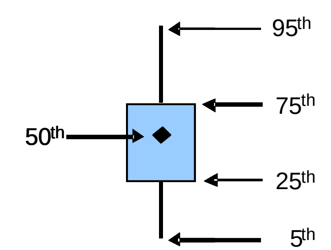
FYE	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Annual Under-funding	$0.0	$0.0	$0.0	$0.0	$0.5	$0.9	$1.0	$1.1	$1.3	$1.4	$1.8	$1.6	$1.7	$1.0	$0.7	$0.4	$0.0	$0.0

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

Key Takeaway:

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

Percentile



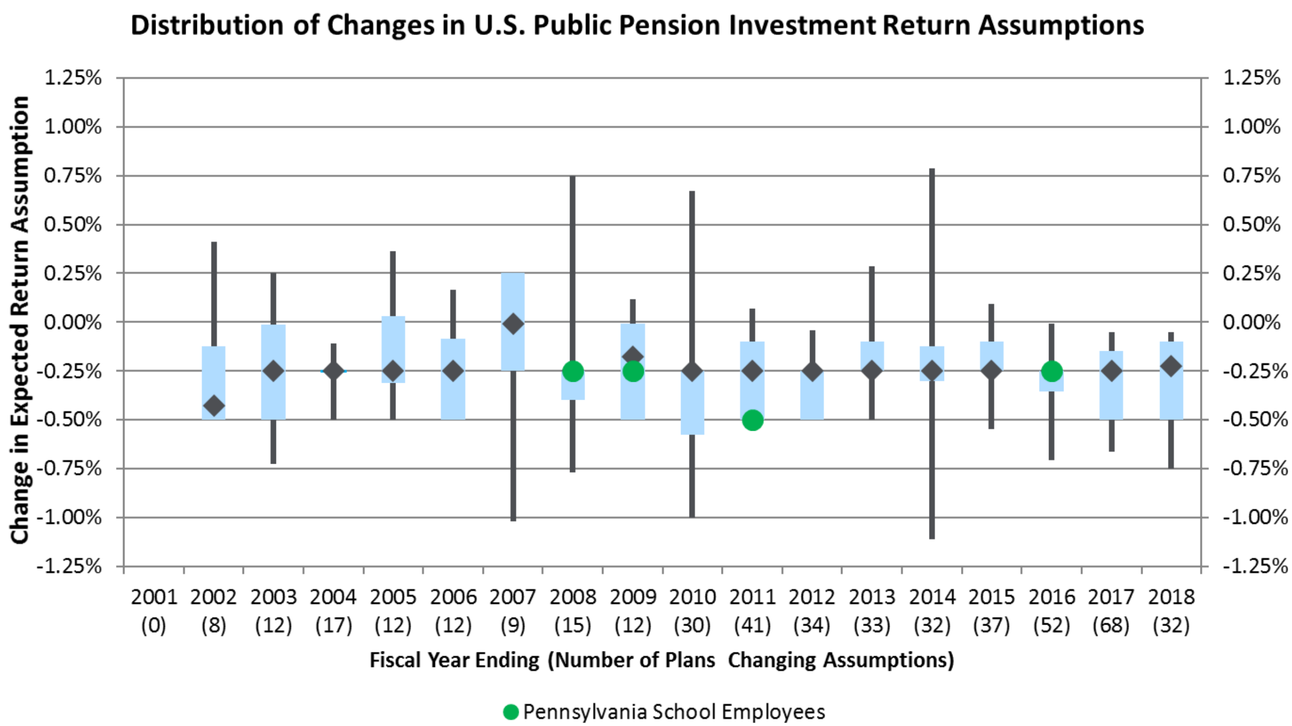
Sources: Public Plans Data (publicplansdata.org) as of April 2019; Actuarial valuation report as of June 30, 2018

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

[2] Calculated as any underfunding from FYE 2001-2017 (determined by historical information found in PSERS' actuarial valuation reports), assuming end-of-year timing of contributions, and PSERS' actual portfolio returns through June 30, 2018

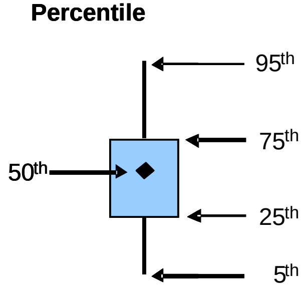
PSERS

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



Key Takeaways:

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



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

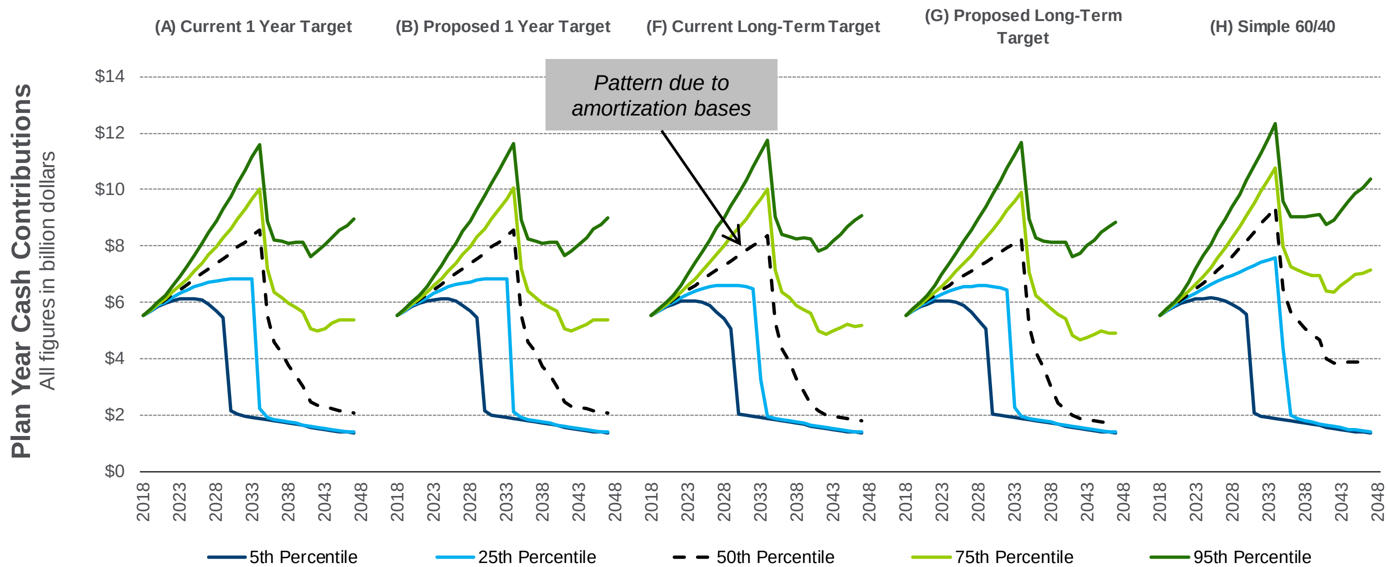
Appendix

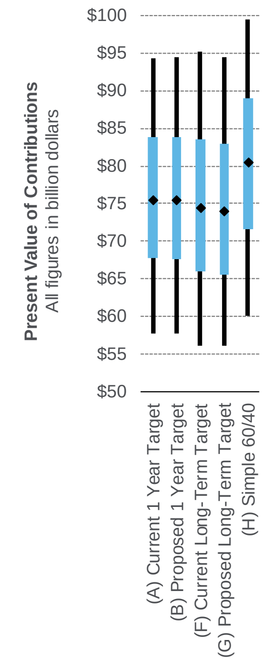
- Asset-Liability Projection Results (Additional Stochastic Results)

Empower Results®

Asset-Liability Projection Results (Additional Stochastic Results)

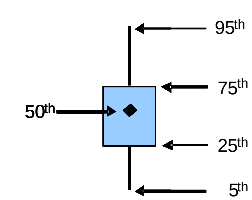
Gross Contribution Amount (Includes Employee and Employer Contributions)





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

Percentile



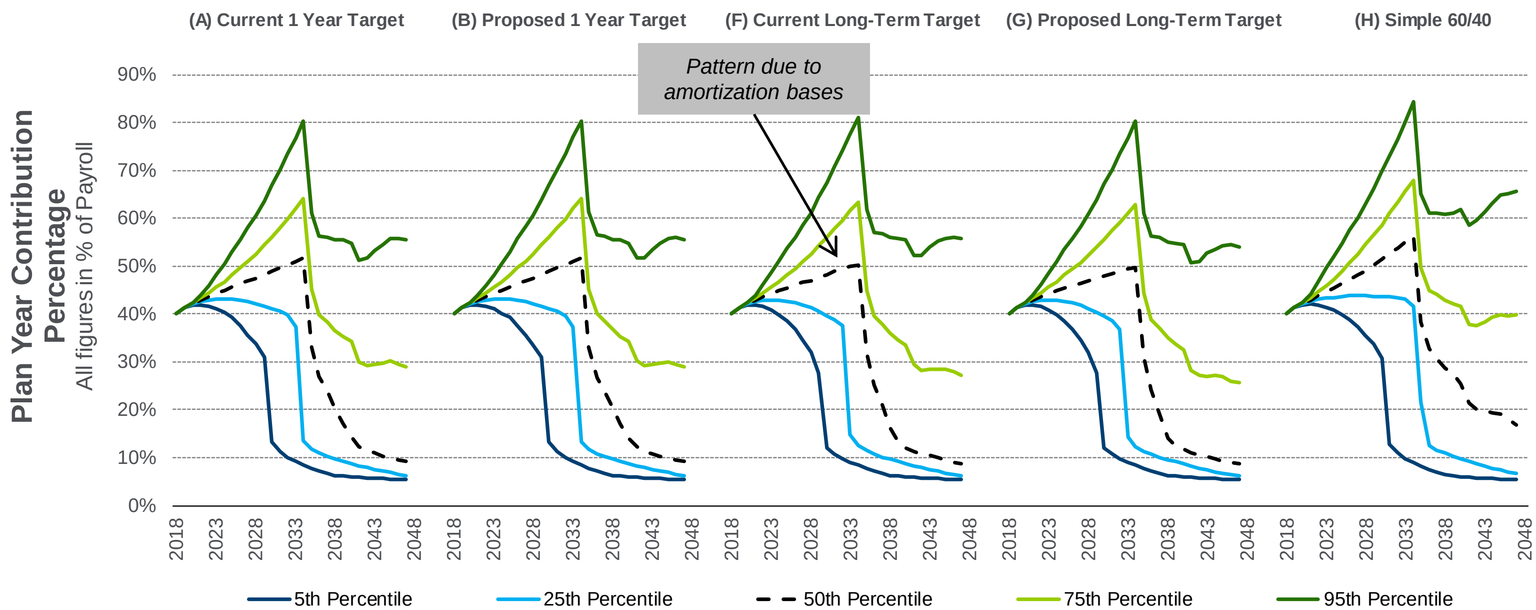
Key Takeaway:

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

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

Asset-Liability Projection Results (Additional Stochastic Results)

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



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

Key Takeaway:

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

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

Appendix

- Asset-Liability Projection Results (Deterministic Results)

Deterministic Scenario Analysis

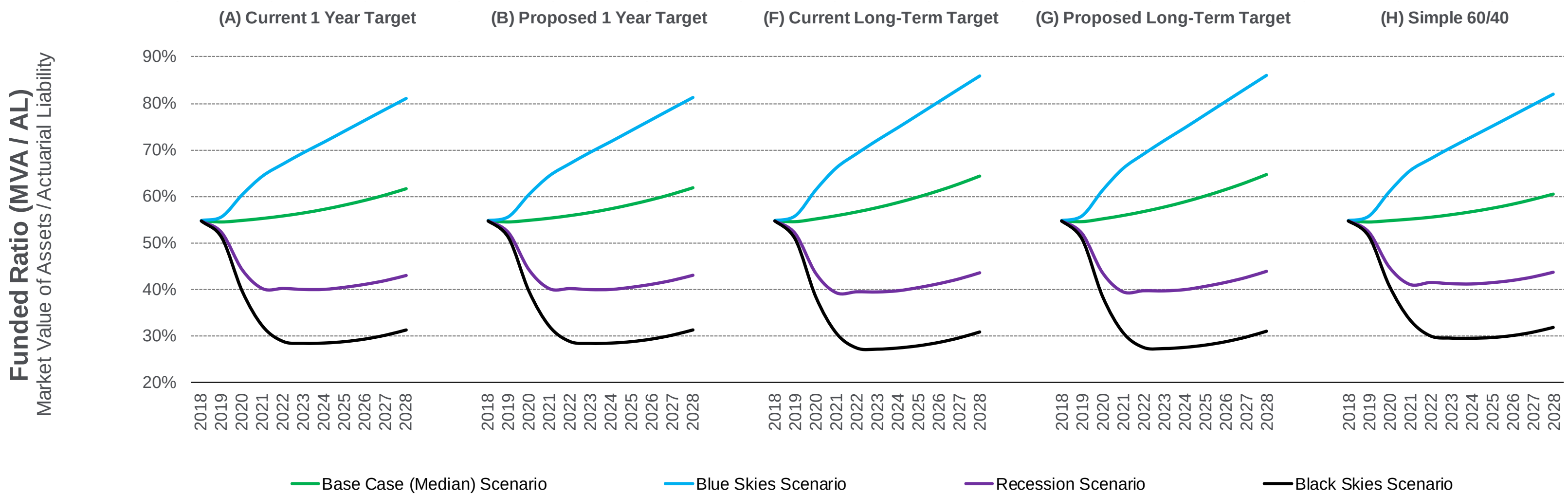
Overview

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

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

Asset-Liability Projection Results (Deterministic Results)

Market Value of Assets / Actuarial Liability Funded Ratio



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

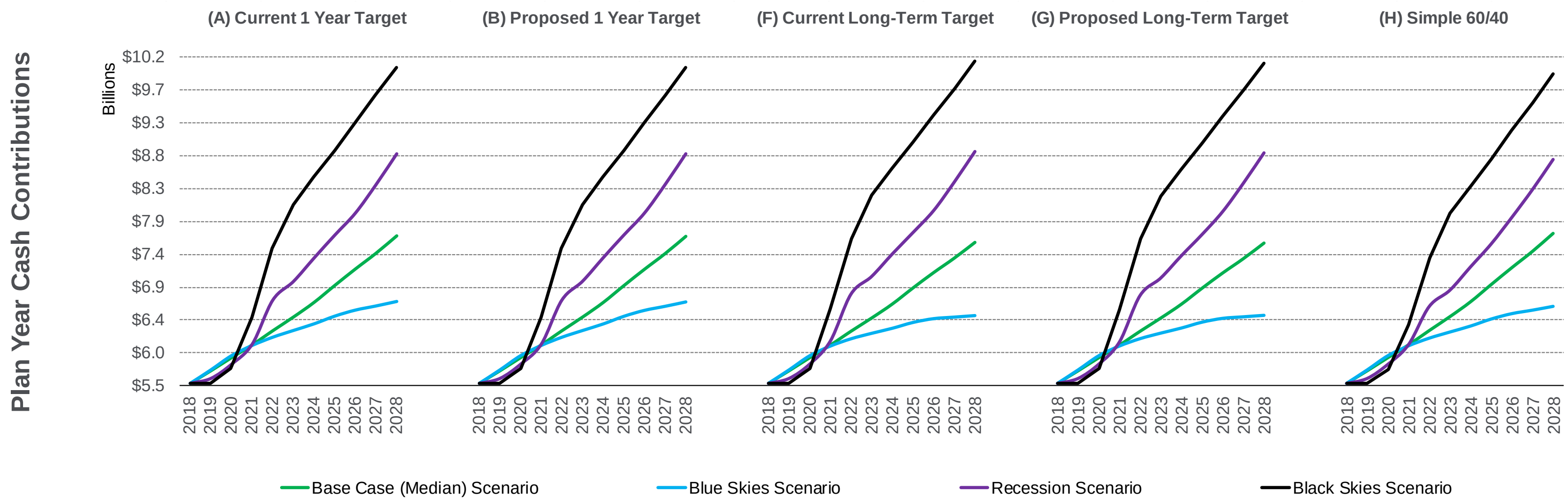
Key Takeaways:

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

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

Asset-Liability Projection Results (Deterministic Results)

Gross Contribution Amount (Includes Employee and Employer Contributions)



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

Key Takeaways:

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

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

Appendix

- Actuarial Assumptions and Methods

Actuarial Assumptions and Methods

- Actuarial projections were provided by the plan actuary as of the most recent valuation date (June 30, 2018)
- Actuarial assumptions:
  - Valuation Rate of Interest = 7.25% for all future years
  - Inflation = 2.75%
  - Salary Scale = effective average of 5.00% per year
  - Payroll Growth = 3.50% per year
  - Actuarial Value of Assets: smooth gains/losses relative to expected valuation rate of interest over 10 years and shall be no less than 70% and no greater than 130% of the market value of assets
  - Projection assumptions
    - The active workforce size is assumed to remain constant over the projection period;
    - Future new employees have similar characteristics (age/gender/salary) to new employees for the period July 1, 2015 through June 30, 2018 and:
      - New school employees hired on or after July 1, 2017 through June 30, 2019 are assumed to be Class T-E members
      - Among new school employees hired on or after July 1, 2019, 65% will become Class T-G members, 30% will elect Class T-H membership, and 5% will elect Class DC participation.
    - Class T-G and T-H members who terminate employment with less than 25 years of service and who commence their benefits prior to age 62 will have their benefits reduced from age 67 to age 62 based on the System's current actuarial-equivalent early retirement factors, which are based on the statutory interest rate of 4%. The benefit will be further reduced from age 62 to the member's age at benefit commencement based on new actuarial-equivalent early retirement factors based on an interest rate of 7.25%.
  - All other assumptions as documented in the Actuarial Valuation Report as of June 30, 2018

Actuarial Assumptions and Methods (continued)

- Actuarially-Determined Contribution Calculation = Normal Cost plus a level percent amortization of the unfunded liability with layered 24 year, closed periods, and a 3.50% salary scale
  - Amortization bases developed are projected to continue until either their individual expiry or the plan reaches 100% funded on an actuarial value of assets basis at which point any remaining balance is fully recognized
- Asset figures reflect actual performance for the period July 1, 2018 – March 31, 2019 (3.39% return)
- Employee contributions are limited to the actuarially-determined contribution
- The health care premium assistance assets and liabilities have been excluded from this analysis
- The rate collar provision of Act 120 was not considered in this analysis as it has been deemed to no longer be effective
- “Shared Risk” provisions of Act 120 have not been considered in this analysis

Exchange-Traded Fund (ETF) Portfolio Construction

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

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

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

Appendix

- Capital Market Assumptions

Empower Results®

Capital Market Assumption Methodology

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

AHIC Capital Market Assumptions
As of March 31, 2019 (30 Years)

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

[1] All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees.
[2] Hedge Fund assumptions developed as follows: 14% Event Driven, 38% Global Macro, 20% Distressed Debt, 16% Fixed Income Arbitrage, 12% Cat. Bonds
[3] Real Estate assumption developed as follows: 80% Non-Core Rel Estate, 20% Core Real Estate
[4] Private Equity assumptions developed as follows: 72% Buyouts, 13% Venture Capital, 15% Distressed Debt
[5] Risk Parity assumptions developed as follows: 50% Global Equity, -100% LIBOR, 55% TIPS, 75% Intermediate Gov't. Bonds, 20% Commodities

AHIC Capital Market Assumptions
As of March 31, 2019 (30 Years)

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

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

AHIC Capital Market Assumptions

Explanation of Capital Market Assumptions—Q2 2019

The following capital market assumptions were developed by Aon's Global Asset Allocation Team and represent the long-term capital market outlook (i.e., 30 years) based on data at the end of the first quarter of 2019. The assumptions were developed using a building block approach, reflecting observable inflation and interest rate information available in the fixed income markets as well as Consensus Economics forecasts. Our long-term assumptions for other asset classes are based on historical results, current market characteristics, and our professional judgment.

Inflation – Expected Level (2.2%)

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

Real Returns for Asset Classes

Fixed Income

- **Cash (0.3%)** – Over the long run, we expect the real yield on cash and money market instruments to produce a real return of 0.3% in a moderate to low-inflationary environment.
- **TIPS (1.0%)** – We expect intermediate duration Treasury Inflation-Protected Securities to produce a real return of about 1.0%.
- **Core Fixed Income (i.e., Market Duration) (1.2%)** – We expect intermediate duration Treasuries to produce a real return of about 0.7%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 0.5%, resulting in a long-term real return of 1.2%.
- **Long Duration Bonds – Government and Credit (1.4%)** – We expect Treasuries with a duration comparable to the Long Government Credit Index to produce a real return of 0.8%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 0.6%, resulting in an expected real return of 1.4%.

AHIC Capital Market Assumptions

Explanation of Capital Market Assumptions—Q2 2019

- **Long Duration Bonds – Credit (1.9%)** – We expect Treasuries with a duration comparable to the Long Credit Index to produce a real return of 0.8%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 1.1%, resulting in an expected real return of 1.9%.
- **Long Duration Bonds – Government (0.8%)** – We expect Treasuries with a duration of ~12 years to produce a real return of 0.8% during the next 30 years.
- **High Yield Bonds (2.8%)** – We expect intermediate duration Treasuries to produce a real return of about 0.5%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 2.3%, resulting in an expected real return of 2.8%.
- **Bank Loans (3.5%)** – We expect LIBOR to produce a real return of about 0.7%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults) to be 2.8%, resulting in an expected real return of 3.5%.
- **Non-US Developed Bonds: 50% Hedged (0.5%) –** We forecast real returns for non-US developed market bonds to be 0.5% over a 30-year period after adjusting for a 50% currency hedge. We assume a blend of one-third investment grade corporate bonds and two-thirds government bonds. We also produce assumptions for 0% hedged and 100% hedged non-US developed bonds.
- **Emerging Market Bonds (Sovereign; USD) (2.7%) –** We forecast real returns for emerging market sovereign bonds denominated in US dollars to be 2.7% over a 30-year period.
- **Emerging Market Bonds (Corporate; USD) (2.5%) –** We forecast real returns for emerging market corporate bonds denominated in US dollars to be 2.5% over a 30 year period.
- **Emerging Market Bonds (Sovereign; Local) (3.1%)** – We forecast real returns for emerging market sovereign bonds denominated in local currency to be 3.1% over a 30 year-period.
- **Multi Asset Credit (MAC) (4.2%) –** We assume real returns from beta exposure to high yield, bank loans and emerging market debt to add 3.3% plus 0.9% from alpha (net of fees) over a 30-year period.
- **Private Debt-Direct Lending (5.1%) –** The base building block is bank loans 3.5% + spread 1.6% (net of management fees and performance incentives). There is 100% leverage included in the assumption with the cost of financing at LIBOR + 2.5%.

AHIC Capital Market Assumptions

Explanation of Capital Market Assumptions—Q2 2019

Equities

- **Large Cap U.S. Equity (4.5%)** – This assumption is based on our 30-year outlook for large cap U.S. company dividends and real earnings growth. Adjustments are made for valuations as needed.
- **Small Cap U.S. Equity (5.0%)** – Adding a 0.2% return premium for small cap U.S. equity over large cap U.S. equity results in an expected real return of 4.8%. This return premium is theoretically justified by the higher risk inherent in small cap U.S. equity versus large cap U.S. equity, and is also justified by historical data. In recent years, higher small cap valuations relative large cap equity has reduced the small cap premium.
- **Global Equity (Developed & Emerging Markets) (5.5%)** – We employ a building block process similar to the U.S. equity model using the developed and emerging markets that comprise the MSCI All-Country World Index. Our roll-up model produces an expected real return of 5.5% for global equity.
- **International (Non-U.S.) Equity, Developed Markets (5.3%)** – We employ a building block process similar to the U.S. equity model using the non-U.S. developed equity markets that comprise the MSCI EAFE Index.
- **Emerging Market Stocks (6.3%)** - We employ a building block process similar to the U.S. equity model using the non-U.S. emerging equity markets that comprise the MSCI Emerging Markets Index.
- **Equity Risk Insurance Premium Strategies-High Beta (4.3%) –** We expect nominal returns from 50% equity + 50% cash beta of 5.0% plus 1.6% insurance risk premium over the next 30 years.

Alternative Asset Classes

- **Hedge Fund-of-Funds Universe (2.0%)** – The generic category "hedge funds" encompasses a wide range of strategies accessed through "fund-of-funds" vehicles. We also assume the ***median*** manager is selected and also allow for the additional costs associated with Fund-of-Funds management. A top-tier portfolio of funds (hedge fund-of-funds buy-list) could add an additional 1.1% in return at similar volatility based on alpha, lower fees and better risk management.

AHIC Capital Market Assumptions

Explanation of Capital Market Assumptions—Q2 2019

- **Hedge Fund-of-Funds Buy List (3.1%)** – The generic category of top-tier "hedge funds" encompasses a wide range of strategies accessed through "fund-of-funds" vehicles. We assume additional costs associated with Funds-of-Funds management. To use this category the funds must be buy rated or we advise on manager selection.
- **Broad Hedge Funds Universe (3.3%)** – Represents a diversified portfolio of direct hedge fund investments. This investment will tend to be less diversified than a typical "fund-of-funds" strategy as there will be fewer underlying managers and will not include the extra layer of fees found in a Fund-of-Funds structure.
- **Broad Hedge Funds Buy List (4.7%)** – Represents a diversified portfolio of top-tier direct hedge fund investments. This investment will tend to be less diversified than a typical "fund-of-funds" strategy as there will be fewer underlying managers and will not include the extra layer of fees found in a Fund-of-Funds structure. To use this category the funds must be buy rated or we advise on manager selection.
- **Core Real Estate (2.9%)** -- Our real return assumption for core real estate is based a gross income of about 4.4%, management fees of roughly 1%, and future capital appreciation near the rate of inflation during the next 30 years. We assume a portfolio of equity real estate holdings that is diversified by property and by geographic region.
- **U.S. REITs (3.9%)** – Our real return assumption for U.S. REITs is based on income of about 3.9% and future capital appreciation near the rate of inflation during the next 30 years. REITs are a sub-set of U.S. small/mid cap equity universe.
- **Commodities (2.8%)** – Our commodity assumption is for a diversified portfolio of commodity futures contracts. Commodity futures returns are composed of three parts: spot price appreciation, collateral return, and roll return (positive or negative change implied by the shape of the future curve). We believe that spot prices will converge with CPI over the long run (i.e., 2.2%). Collateral is assumed to be LIBOR cash (0.7%). Also, we believe the roll effect will be near zero, resulting in a real return of about 2.8% for commodities.
- **Private Equity (7.1%)** – Our private equity assumption reflects a diversified fund of funds with exposure to buyouts, venture capital, distressed debt, and mezzanine debt.

AHIC Capital Market Assumptions

Explanation of Capital Market Assumptions—Q2 2019

- **Infrastructure (5.5%)** – Our infrastructure assumption is formulated using a cash flow based approach that projects cash flows (on a diversified portfolio of assets) over a 30 year period. Income and capital growth as well as gearing levels, debt costs and terms, relevant tax and management expenses are all taken into consideration. Our approach produces an expected real return of 5.5% for infrastructure.
- **Equity Risk Insurance Premium Strategies-Low Beta (3.7%) –** We assume real returns from cash of 0.3% + 3.4% from alpha.
- **Alternative Risk Premia (ARP) (4.6%) –** Nominal return target LIBOR 2.9% plus 4.0% alpha (net of fees)

Volatility / Correlation Assumptions

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

Appendix

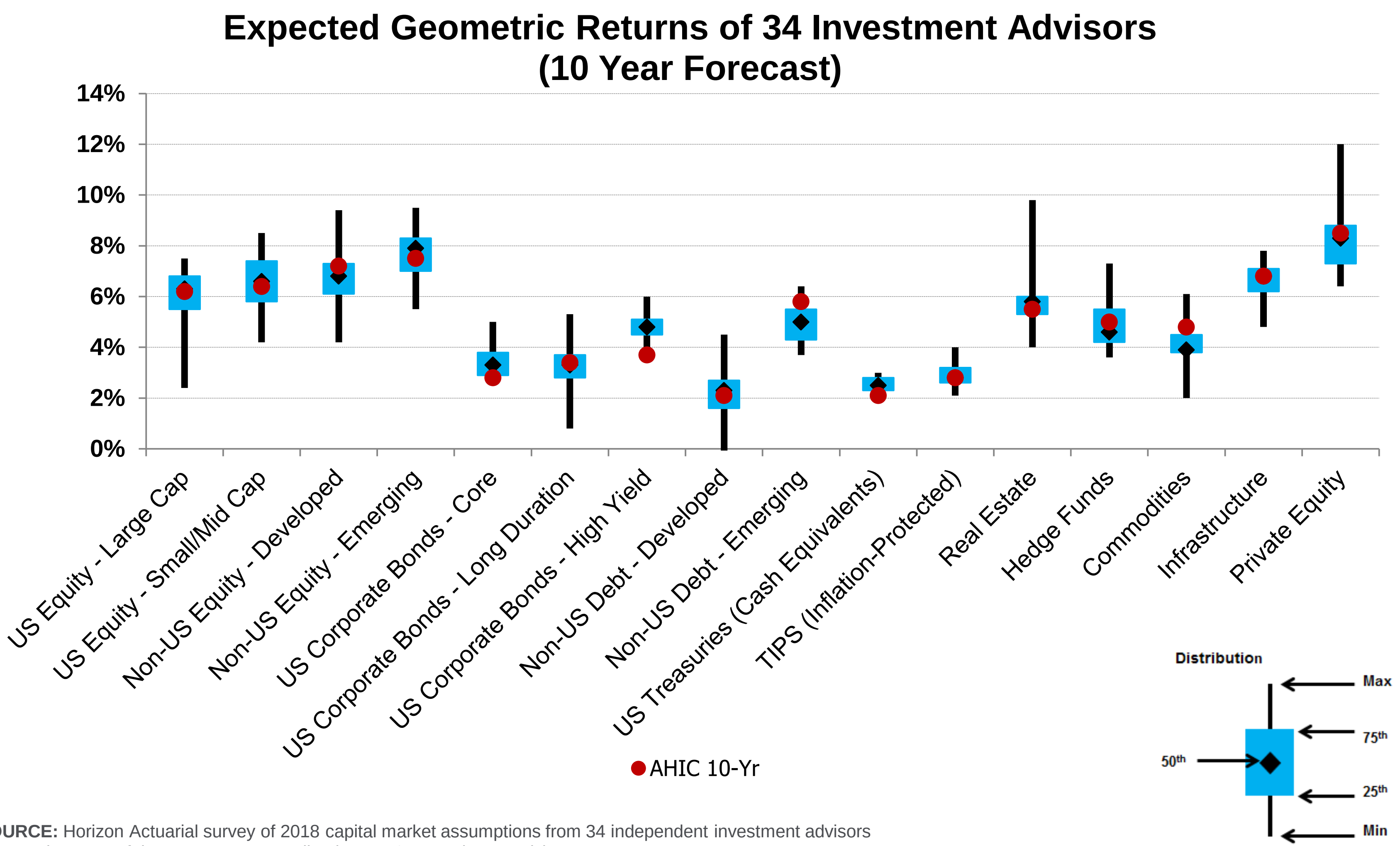
- 2018 Horizon Survey of Capital Market Assumptions

2018 Horizon Survey Results

AHIC Capital Market Assumptions

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

AHIC Capital Market Assumptions vs. Horizon Survey



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

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

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

Notes (Horizon Survey):

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

Expected returns are annualized (geometric).

Notes (AHIC Forecasts):

AHIC Forecasts are for Q1 2018

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

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

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

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

Real Estate forecasts represents AHIC forecasts for Core Private Real Estate

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

AHIC Versus Peers: Observations

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

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

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

Leading Methodologies & Reasons for Differences

Leading Methodologies

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

Reasons for Differences

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

* While some firms in Horizon survey responded with Arithmetic forecasts, the results have been converted to Geometric forecasts for comparison purposes. Additionally, the return expectations included in the Horizon survey are based on indexed returns (no “alpha”). However, AHIC return assumptions for certain asset classes include “alpha” or active management premium (e.g., Hedge Funds)

Appendix

- How Do Public Pensions Impact Credit Ratings?

How Do Public Pensions Impact Credit Ratings?

Summary and Conclusions

Pension Impact on Credit Ratings

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

Credit Ratings and Borrowing Costs

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

Call to Action

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

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

Empower Results®

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

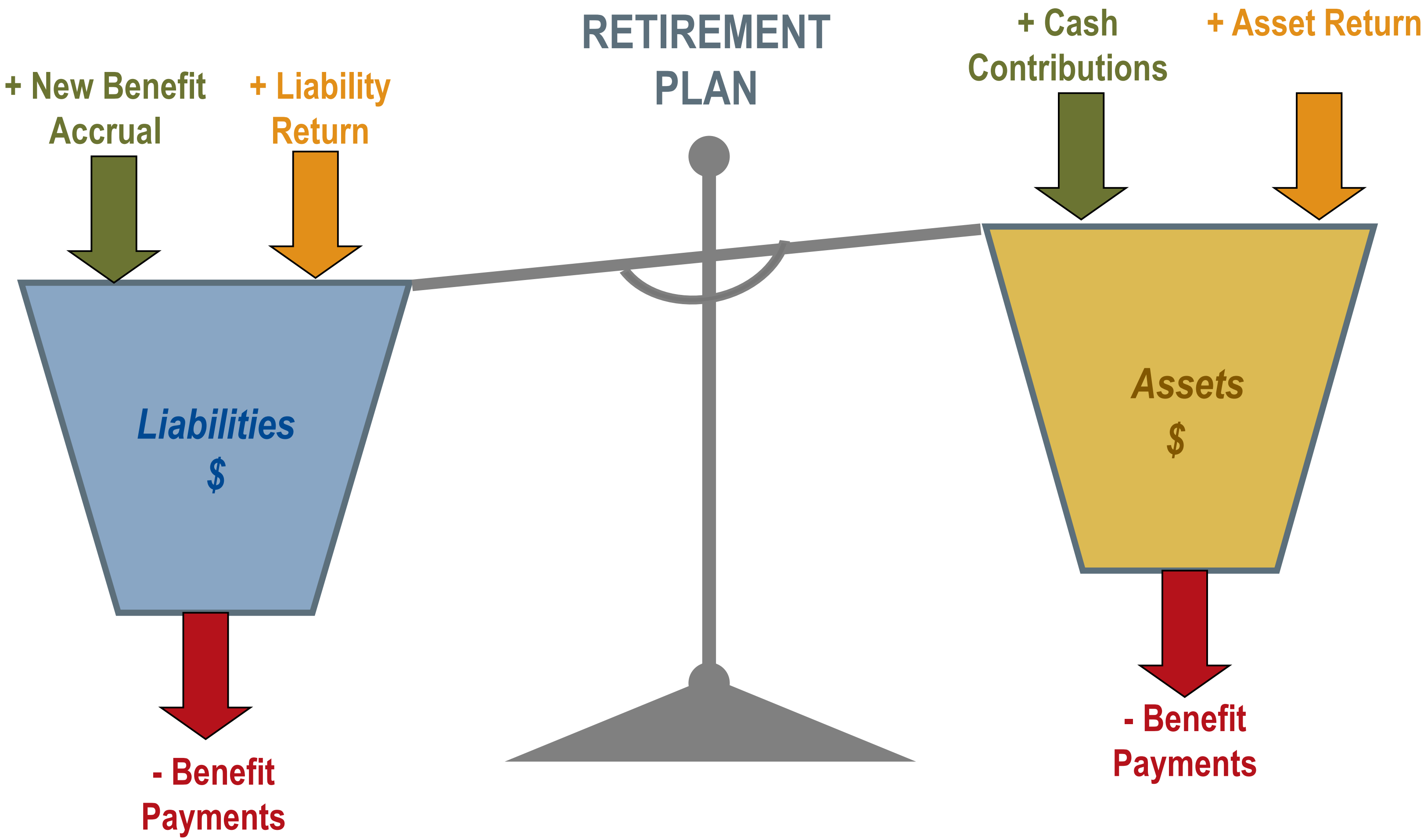
- Illustrates the impact of various asset allocation targets on required contributions and funded status under a range of different macro-economic scenarios

- 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

Planning Discussions

Planning
- Objectives of the Study
- Modeling and Liability Assumptions

+

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

+

Asset-Liability Projections

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

+

Liability Analysis
- Cost Projections
- Funded Status
- Sensitivity Analysis

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

↓

Implementation

↓

Monitoring & Execution

Asset-Liability Management Background
Modeling Process

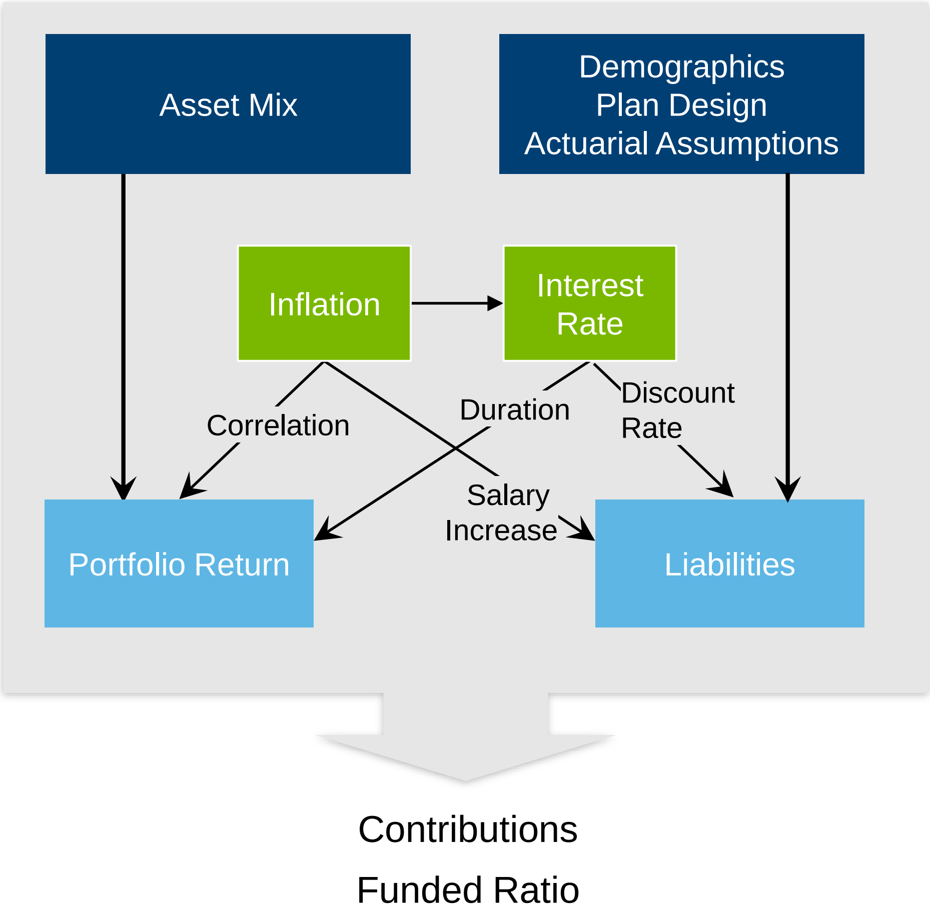
- Goals of an asset-liability study:
  - Understand the pension plan's asset-liability risk, and
  - Identify the optimal investment strategies

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

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

Asset-Liability Management Background

Mechanics of Asset-Liability Modeling Process



Asset and liability modeling integrated in single platform

- Integrates impact of key economic variables

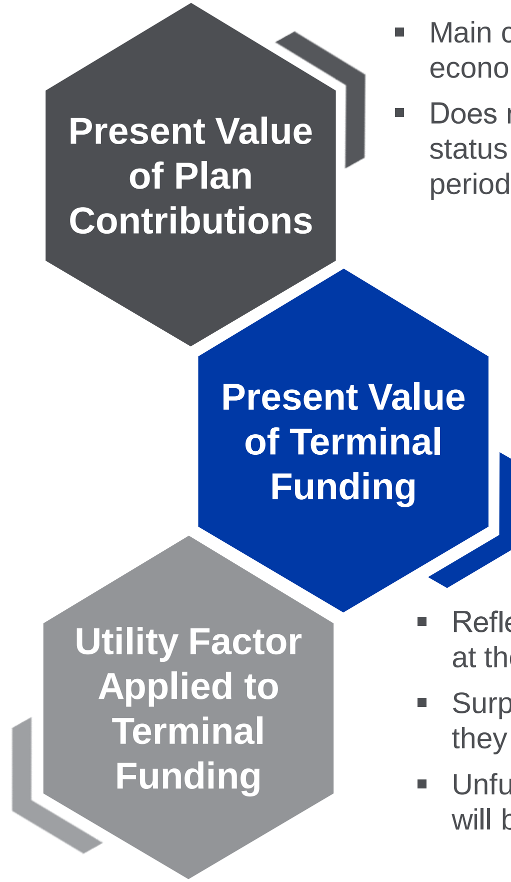
Flexibility in modeling parameters and output to client preferences

Stochastic and deterministic modeling performed

Asset-Liability Management Background
Long-Term Economic Cost of Plan

Long-Term Economic Cost =

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



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

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

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

Asset-Liability Management Background
Utility Factor For Terminal Funded Status

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

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

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

Asset-Liability Management Background
Risk and Return in an Asset-Liability Context

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

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

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

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

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

Appendix

- About This Material

About This Material

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

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

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

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

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

Our calculations were based on data provided by the plan actuary. The actuarial assumptions and methods and plan provisions reflected in these projections are the same as those used for the 2018 actuarial valuation for PSERS as noted in the actuarial reports, except where noted in this report. Unless specifically noted, our calculations do not reflect any other changes or events after June 30, 2018.

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

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

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

Aon Hewitt Investment Consulting, Inc.

Phil Kivarkis FSA, CFA

Legal Disclosures and Disclaimers

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

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

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

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

Aon Hewitt Investment Consulting, Inc.
200 E. Randolph Street
Suite 1500
Chicago, IL 60601
ATTN: AHIC Compliance Officer

Liquidity Analysis

Pennsylvania Public School Employees' Retirement System (PSERS)
August 7, 2019

AON
Empower Results®

Table of Contents

Overview
Background

- PSERS' liquidity analysis is performed under its **Proposed 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 <u>conservative</u> 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

Empower Results®

Overview

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

	Asset Class	Target Asset Allocation				
		Liquid	*Quasi-Liquid*	*Illiquid 5-10 Years*	*Illiquid 10+ Years*	*Total*
Return-Seeking	Public Equities	18.0%	2.0%			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%
	Private Credit		1.0%	9.0%		10.0%
	Commodities	4.5%		0.5%		5.0%
	Gold	3.0%				3.0%
	Emerging Market Debt	2.0%				2.0%
	Risk Parity	7.0%	1.0%			8.0%
	Subtotal	40.5%	4.0%	17.5%	19.0%	**81.0%**
Risk-Reducing / Safety	Hedge Funds	0.5%	9.5%			10.0%
	U.S. / Non-U.S. Inflation Protection	15.0%				15.0%
	Cash	3.0%				3.0%
	U.S. Core Fixed Income	4.5%	0.5%			5.0%
	U.S. Long-Term Treasury	6.0%				6.0%
	Non-US Dev. Fixed Income	1.0%				1.0%
	LIBOR - Financing	-21.0%				-21.0%
	Subtotal	9.0%	10.0%	0.0%	0.0%	**19.0%**
	Total	**49.5%**	**14.0%**	**17.5%**	**19.0%**	**100.0%**

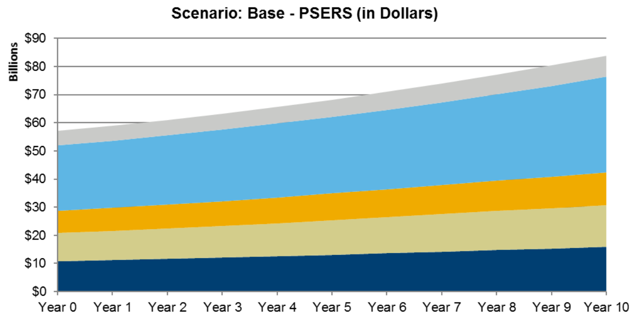
Empower Results®

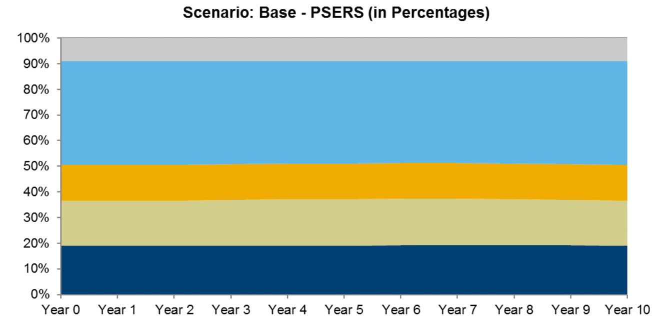
Liquidity Analysis

Summary of Results | Proposed Long-Term Target (Full Actuarial Contributions)

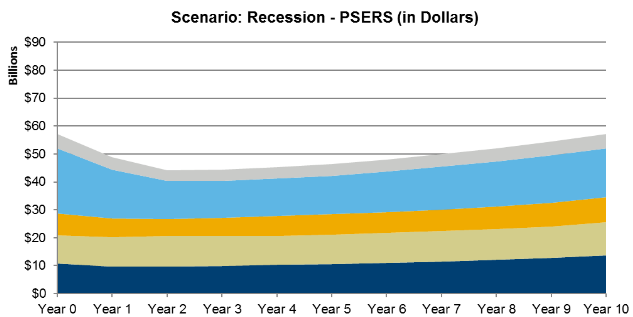
■ Illiquid: 10+ Years ■ Illiquid: 5-10 Years ■ Quasi-Liquid ■ Liquid (Return-Seeking Assets) ■ Liquid (Risk-Reducing Assets)

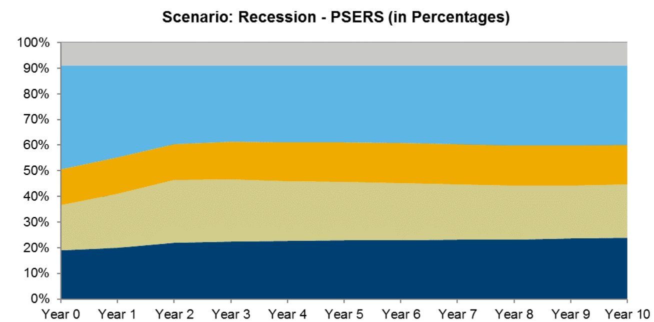
Base Case



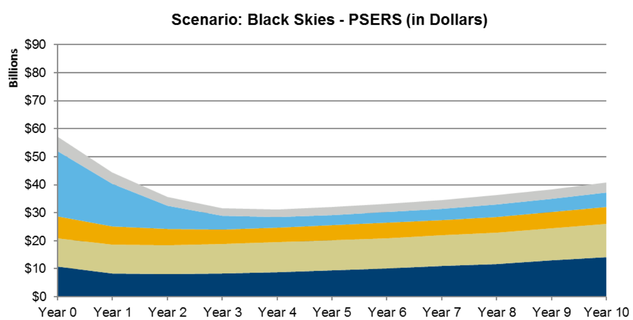


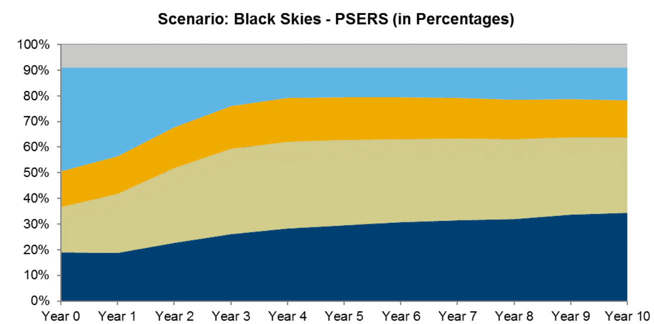
Recession





Black Skies





Note: Year 0 represents a starting point of March 31, 2019

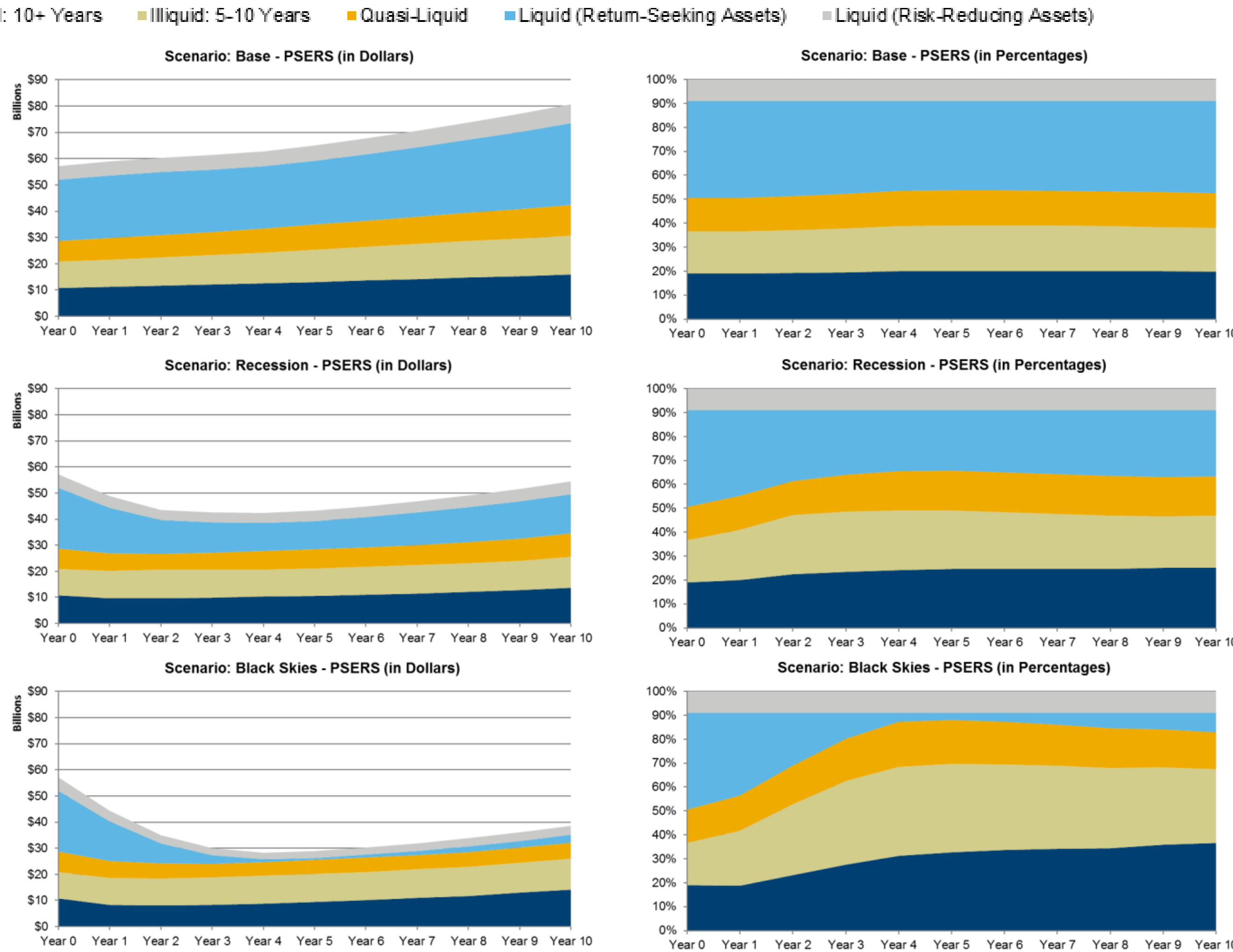
Liquidity Analysis

Summary of Results | Proposed Long-Term Target (3 Years of 80% Actuarial Contributions)

Base Case

Recession

Black Skies



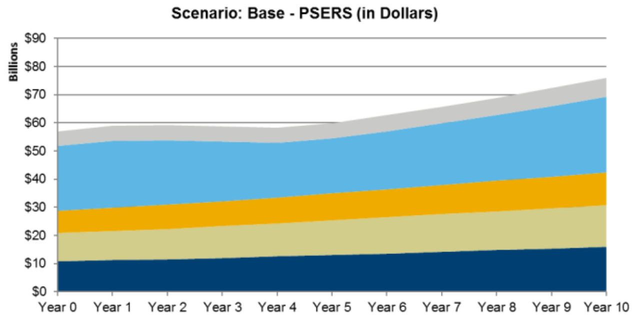
Note: Year 0 represents a starting point of March 31, 2019

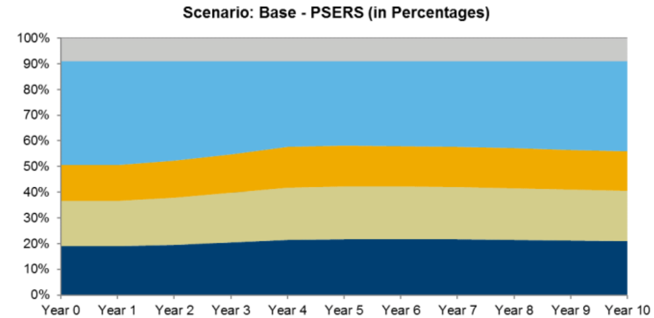
Liquidity Analysis

Summary of Results | Proposed Long-Term Target (3 Years of 50% Actuarial Contributions)

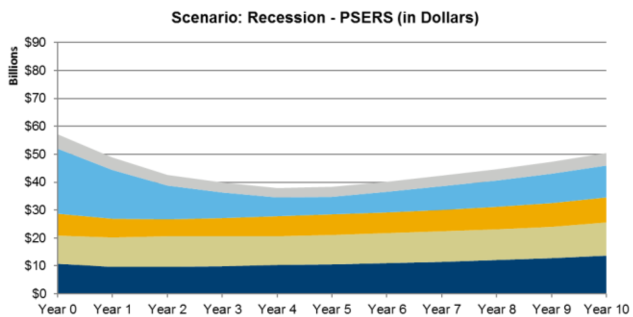
Illiquid: 10+ Years | Illiquid: 5-10 Years | Quasi-Liquid | Liquid (Return-Seeking Assets) | Liquid (Risk-Reducing Assets)

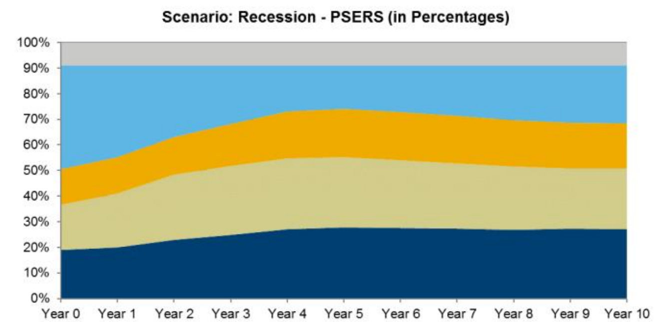
Base Case



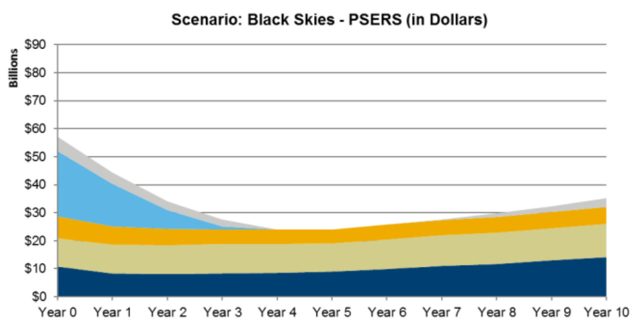


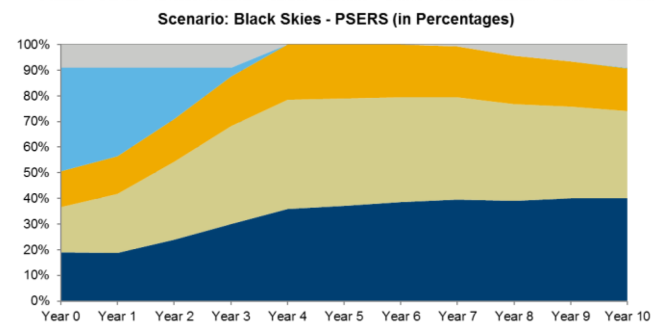
Recession





Black Skies





Note: Year 0 represents a starting point of March 31, 2019

Conclusions

- **Base Scenario**
  - The total illiquid and quasi-liquid assets can be maintained near the target (50.5% illiquid assets) 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 (50.5% illiquid assets) that PSERS may want to rebalance
- **Black Skies Scenario**
  - The asset allocation could drift far from the target allocation (50.5% illiquid assets)
    - 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
    - Under this scenario, PSERS may want to pare back future commitments to stay closer to the target allocations
      - PSERS may be scaling back its alternative asset allocations at a time when the opportunity is greatest
- **Reduced Actuarial Contribution Scenarios**
  - Lower contributions put more pressure on liquidity
    - In such scenarios, PSERS can look to manage the pace of commitments
- 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

Appendix

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 <u>conservative</u> approximation of the actual liquidity properties of the assets

- We started with the Proposed 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, 2018 actuarial valuation report
  - Asset figures reflect actual performance for the period July 1, 2018 – March 31, 2019 (3.39% return)
  - The plan's contribution policy is actuarially based, leveraging projections from the plan actuary based on the 2019 asset-liability study
  - Assumes the portfolio starts at the target asset allocation levels for illiquid assets, maintaining close to the Proposed Long-Term Target portfolio targets over the next 10 years

Background
Economic Scenarios

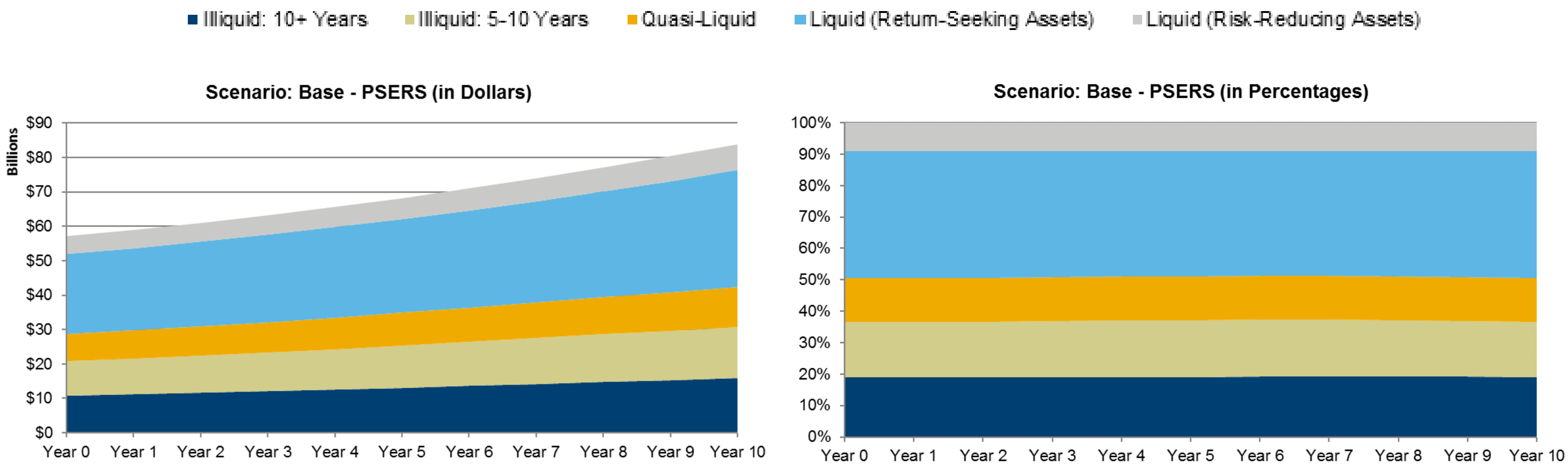
- **Base Scenario**
  – Markets perform consistent with Aon’s Capital Market Assumptions (~50th percentile)

- **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 is cut in half over three years, without an immediate rebound

Liquidity Analysis: Base Economic Scenario
Proposed Long-Term Target (Full Actuarial Contributions)

- The exhibit below shows the projected liquidity lock-up of the Proposed Long-Term Target allocation in the Base economic scenario, assuming commitments are continued as expected



- **Key Takeaway:**
  - Total illiquid and quasi-liquid assets are projected to stay near 50.5% 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, 2019

Liquidity Analysis: Base Economic Scenario (continued)

Proposed Long-Term Target (Full Actuarial Contributions)

- The exhibit below shows the projected liquidity lock-up of the Proposed Long-Term Target allocation in a Base scenario

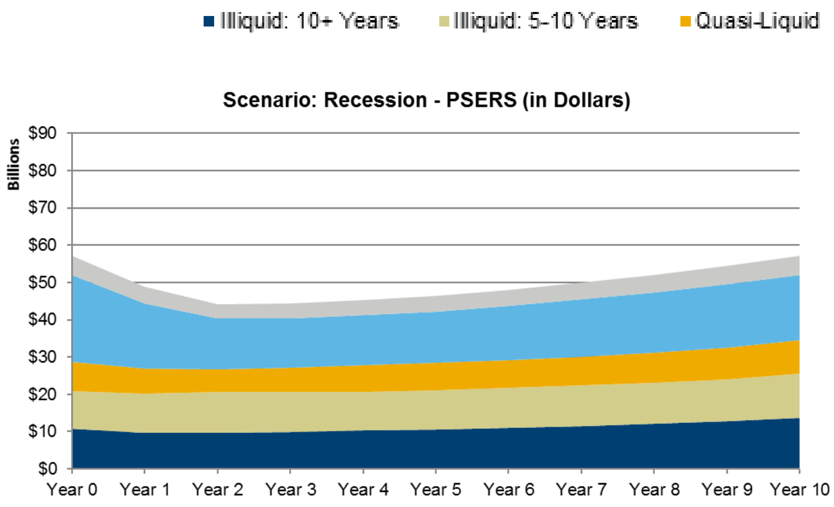
Asset Allocation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Risk-Reducing Assets	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%
Liquid Return-Seeking	41	41	40	40	40	40	40	40	40	40	40
Total Liquid	**50%**	**50%**	**49%**	**49%**	**49%**	**49%**	**49%**	**49%**	**49%**	**49%**	**49%**
Quasi-Liquid	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%
Illiquid: 5-10 Year Lock-up	18	18	18	18	18	18	18	18	18	18	18
Illiquid: 10+ Year Lock-up	19	19	19	19	19	19	19	19	19	19	19
Total Quasi + Illiquid	**51%**	**51%**	**51%**	**51%**	**51%**	**51%**	**51%**	**51%**	**51%**	**51%**	**51%**

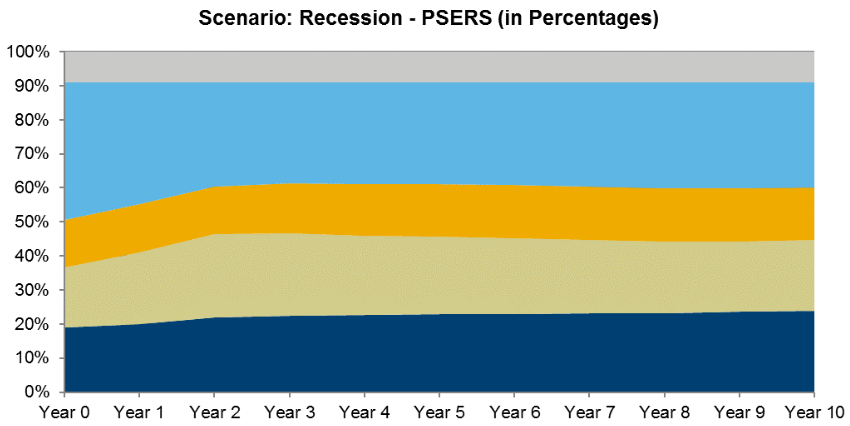
Note: Year 0 represents a starting point of March 31, 2019; Percentages may not sum to 100% due to rounding

Liquidity Analysis: Recession Economic Scenario

Proposed Long-Term Target (Full Actuarial Contributions)

- The exhibit below shows the projected liquidity lock-up of the Proposed Long-Term Target 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 61% 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 (50.5% illiquid assets)

Note: Year 0 represents a starting point of March 31, 2019

Liquidity Analysis: Recession Economic Scenario (continued)

Proposed Long-Term Target (Full Actuarial Contributions)

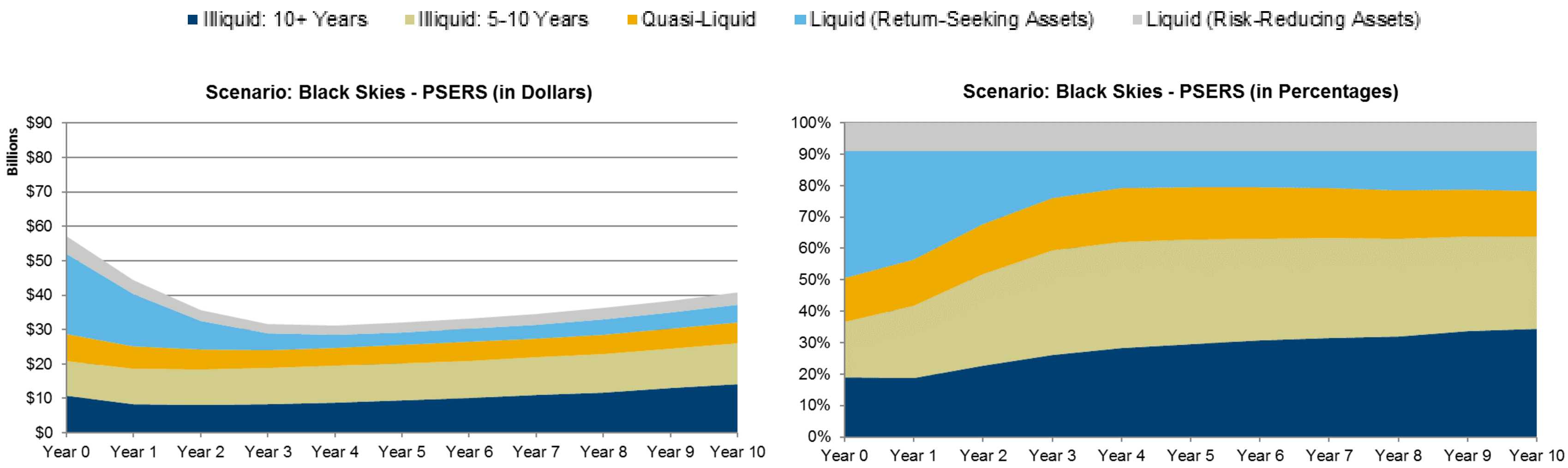
- The exhibit below shows the projected liquidity lock-up of the Proposed Long-Term Target allocation in a Recession scenario

Asset Allocation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Risk-Reducing Assets	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%
Liquid Return-Seeking	41	36	31	30	30	30	30	31	31	31	31
Total Liquid	**50%**	**45%**	**40%**	**39%**	**39%**	**39%**	**39%**	**40%**	**40%**	**40%**	**40%**
Quasi-Liquid	14%	14%	14%	15%	15%	16%	16%	16%	16%	16%	15%
Illiquid: 5-10 Year Lock-up	18	21	24	24	23	23	22	22	21	21	21
Illiquid: 10+ Year Lock-up	19	20	22	22	23	23	23	23	23	24	24
Total Quasi + Illiquid	**51%**	**55%**	**60%**	**61%**	**61%**	**61%**	**61%**	**60%**	**60%**	**60%**	**60%**

Note: Year 0 represents a starting point of March 31, 2019; Percentages may not sum to 100% due to rounding

Liquidity Analysis: Black Skies Economic Scenario
Proposed Long-Term Target (Full Actuarial Contributions)

- The exhibit below shows the projected liquidity lock-up of the Proposed Long-Term Target 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 80% of the Plan due to the shrinking market value of the total Plan in this scenario
  - In this Black Skies scenario, PSERS may want to redeem some quasi-liquid assets and pare back future commitments to stay closer to the target allocations (50.5% illiquid assets). However, the allocation would still be significantly different from target.

Note: Year 0 represents a starting point of March 31, 2019

Empower Results®

Liquidity Analysis: Black Skies Economic Scenario (continued)

Proposed Long-Term Target (Full Actuarial Contributions)

- The exhibit below shows the projected liquidity lock-up of the Proposed Long-Term Target allocation 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
Risk-Reducing Assets	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%
Liquid Return-Seeking	41	35	23	15	12	12	11	12	13	12	13
Total Liquid	**50%**	**44%**	**32%**	**24%**	**21%**	**21%**	**20%**	**21%**	**22%**	**21%**	**22%**
Quasi-Liquid	14%	15%	16%	17%	17%	17%	16%	16%	15%	15%	14%
Illiquid: 5-10 Year Lock-up	18	23	29	33	34	33	33	32	31	30	29
Illiquid: 10+ Year Lock-up	19	19	23	26	28	30	31	32	32	34	35
Total Quasi + Illiquid	**51%**	**56%**	**68%**	**76%**	**79%**	**79%**	**80%**	**79%**	**78%**	**79%**	**78%**

Note: Year 0 represents a starting point of March 31, 2019; Percentages may not sum to 100% due to rounding

Liquidity Analysis: Black Skies Economic Scenario (continued)

Proposed Long-Term Target (3 Years of 80% Actuarial Contributions)

- The exhibit below shows the projected liquidity lock-up of the Proposed Long-Term Target allocation 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
Risk-Reducing Assets	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%
Liquid Return-Seeking	41	35	22	11	4	3	4	5	6	7	8
Total Liquid	**50%**	**44%**	**31%**	**20%**	**13%**	**12%**	**13%**	**14%**	**15%**	**16%**	**17%**
Quasi-Liquid	14%	15%	16%	18%	19%	19%	18%	17%	17%	16%	15%
Illiquid: 5-10 Year Lock-up	18	23	30	35	37	37	36	35	33	32	31
Illiquid: 10+ Year Lock-up	19	19	23	28	31	33	34	34	35	36	37
Total Quasi + Illiquid	**51%**	**56%**	**69%**	**80%**	**87%**	**88%**	**87%**	**86%**	**85%**	**84%**	**83%**

Note: Year 0 represents a starting point of March 31, 2019; Percentages may not sum to 100% due to rounding

Liquidity Analysis: Black Skies Economic Scenario (continued)

Proposed Long-Term Target (3 Years of 50% Actuarial Contributions)

- The exhibit below shows the projected liquidity lock-up of the Proposed Long-Term Target allocation in a Black Skies scenario

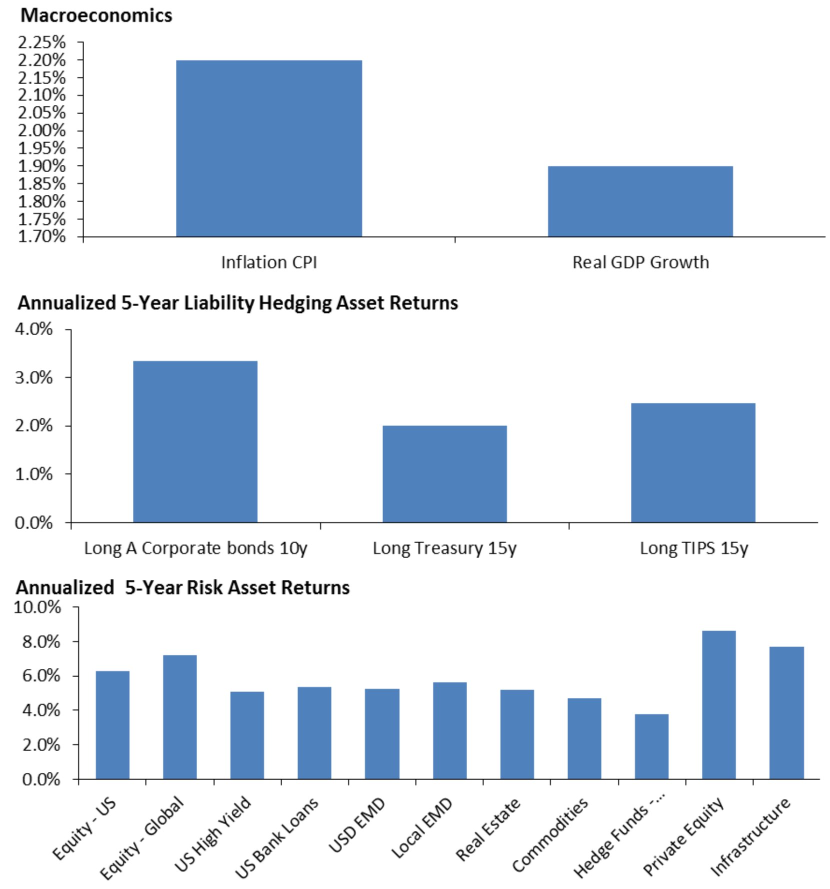
Asset Allocation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Risk-Reducing Assets	9%	9%	9%	9%	0%	0%	0%	1%	4%	6%	9%
Liquid Return-Seeking	41	35	20	4	0	0	0	0	0	0	0
Total Liquid	**50%**	**44%**	**29%**	**13%**	**0%**	**0%**	**0%**	**1%**	**4%**	**6%**	**9%**
Quasi-Liquid	14%	15%	17%	19%	22%	21%	21%	20%	19%	18%	17%
Illiquid: 5-10 Year Lock-up	18	23	31	38	43	42	41	40	38	36	34
Illiquid: 10+ Year Lock-up	19	19	24	30	36	37	39	40	39	40	40
Total Quasi + Illiquid	**51%**	**56%**	**71%**	**87%**	**100%**	**100%**	**100%**	**99%**	**96%**	**94%**	**91%**

Note: Year 0 represents a starting point of March 31, 2019; Percentages may not sum to 100% due to rounding

Base Case Scenario

World Events Unfold In A Fashion Consistent With Our Capital Market Assumptions

- Yield and bond return series reflect our average estimates. These estimates represent our benchmark view.
- The US economy continues to grow slightly above trend over the next 12 months, as the US is buoyed by previous fiscal stimulus and a good global economic outlook. However, US growth moderates to trend growth in later years as stimulus fades and global growth slows.
- 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.



Returns from 31 March 2019
Source: Aon

The opinions referenced are as of the date of publication and are subject to change due to changes in the market or economic conditions and may not necessarily come to pass. Information contained herein is for informational purposes only and should not be considered investment advice.

Base Case Scenario
Data Table

BASE SCENARIO

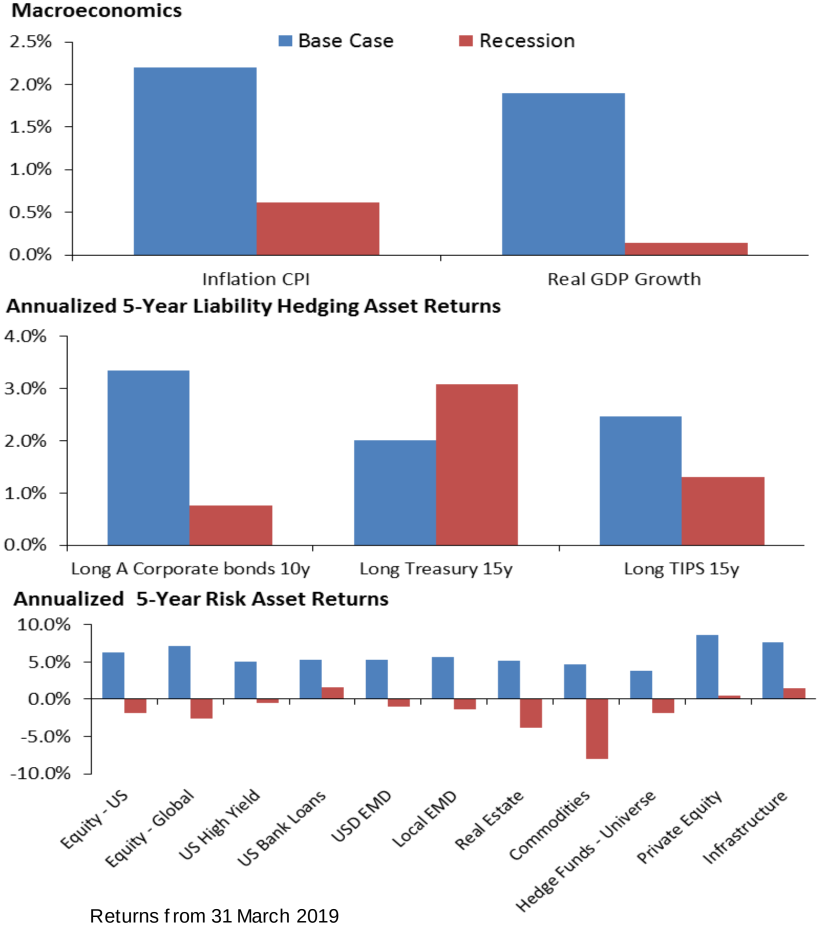
	Year 0	1	2	3	4	5	6	7	8	9	10
Yields (BOY)											
Treasury yield 5y	2.3%	2.3%	2.4%	2.5%	2.6%	2.7%	2.9%	3.0%	3.1%	3.1%	3.2%
Long Treasury yield 15y	2.7%	2.7%	2.8%	2.9%	3.0%	3.1%	3.2%	3.3%	3.4%	3.4%	3.5%
TIPS yield 5y	0.4%	0.5%	0.6%	0.6%	0.7%	0.8%	0.9%	0.9%	1.0%	1.0%	1.1%
Long TIPS yield 15y	0.7%	0.8%	0.8%	0.9%	1.0%	1.0%	1.1%	1.1%	1.2%	1.2%	1.3%
Breakeven price inflation 15y	1.9%	1.9%	2.0%	2.0%	2.0%	2.1%	2.1%	2.2%	2.2%	2.2%	2.2%
A Corporate bond yield 5y	3.2%	3.4%	3.6%	3.7%	3.9%	4.1%	4.3%	4.4%	4.5%	4.6%	4.7%
Long A Corporate bond yield 10y	3.8%	3.9%	4.1%	4.2%	4.4%	4.5%	4.7%	4.8%	4.9%	5.0%	5.1%
A Corporate spread 5y	0.9%	1.0%	1.1%	1.2%	1.3%	1.3%	1.4%	1.4%	1.4%	1.4%	1.4%
Long A Corporate spread 10y	1.2%	1.3%	1.4%	1.4%	1.5%	1.5%	1.6%	1.6%	1.6%	1.6%	1.6%
Expected nominal return on assets											
Equity - US		6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%
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		3.0%	3.0%	3.1%	3.2%	3.4%	3.6%	3.7%	4.0%	4.1%	4.3%
Long A Corporate bonds 10y		3.3%	3.2%	3.3%	3.4%	3.6%	3.9%	4.1%	4.3%	4.5%	4.8%
Treasury 5y		2.4%	2.2%	2.3%	2.3%	2.4%	2.5%	2.6%	2.7%	2.9%	3.1%
Long Treasury 15y		2.2%	2.0%	1.9%	1.9%	2.0%	2.0%	2.1%	2.2%	2.7%	2.7%
TIPS 5y		2.5%	2.6%	2.7%	2.7%	2.8%	2.9%	2.9%	3.1%	3.1%	3.2%
Long TIPS 15y		2.4%	2.4%	2.5%	2.4%	2.6%	2.8%	2.6%	2.9%	3.0%	3.0%
US High Yield		5.8%	5.1%	4.7%	4.9%	4.8%	4.5%	4.6%	5.0%	4.8%	5.2%
Bank Loans		5.1%	5.2%	5.5%	5.4%	5.6%	5.7%	5.7%	5.6%	5.5%	5.7%
USD Emerging Market Debt		5.8%	5.1%	5.0%	5.1%	5.2%	5.1%	5.3%	5.5%	5.4%	5.4%
Local Emerging Market Debt		5.7%	5.8%	5.6%	5.4%	5.7%	5.2%	5.0%	5.3%	6.3%	5.4%
Real Estate		5.2%	5.2%	5.2%	5.2%	5.2%	5.2%	5.2%	5.2%	5.2%	5.2%
Commodities		4.7%	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%
Hedge Funds - FoHF - Universe		3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%
Private Equity		8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%
Infrastructure - Europe		7.7%	7.7%	7.7%	7.7%	7.7%	7.7%	7.7%	7.7%	7.7%	7.7%
Cash		2.4%	2.2%	2.2%	2.3%	2.4%	2.5%	2.6%	2.8%	2.9%	3.0%
CPI		2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%

Scenario information as of March 31, 2019

Recession Scenario

The US Economy Slips Back Into Recession In 2020

- Global growth is much slower than under the base case scenario.
- The US experiences a recession in 2020, due to subdued global growth.
- Inflation turns slightly negative in 2020. 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.



Returns from 31 March 2019
Source: Aon

The opinions referenced are as of the date of publication and are subject to change due to changes in the market or economic conditions and may not necessarily come to pass. Information contained herein is for informational purposes only and should not be considered investment advice.

Recession Scenario
Data Table

RECESSION SCENARIO

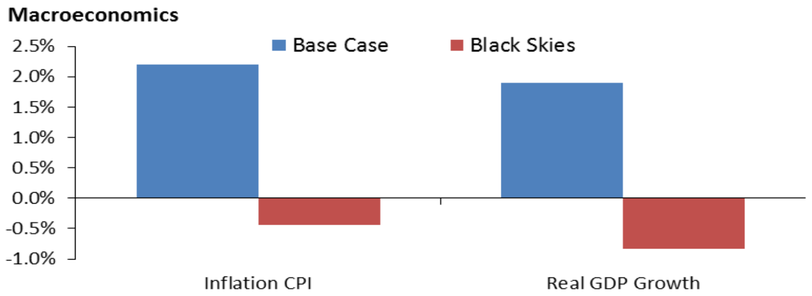
	Year 0	1	2	3	4	5	6	7	8	9	10
Yields (BOY)											
Treasury yield 5y	2.3%	1.0%	0.7%	0.9%	1.4%	2.0%	2.2%	2.3%	2.5%	2.7%	2.8%
Long Treasury yield 15y	2.7%	1.8%	1.5%	1.6%	1.9%	2.5%	2.6%	2.8%	2.9%	3.0%	3.2%
TIPS yield 5y	0.4%	-0.5%	-0.5%	-0.2%	0.2%	0.7%	0.7%	0.8%	0.9%	1.0%	1.0%
Long TIPS yield 15y	0.7%	0.3%	0.2%	0.2%	0.5%	0.8%	0.8%	0.9%	1.0%	1.1%	1.1%
Breakeven price inflation 15y	1.9%	1.5%	1.3%	1.4%	1.5%	1.7%	1.8%	1.8%	1.9%	2.0%	2.0%
A Corporate bond yield 5y	3.2%	4.1%	4.6%	4.6%	4.9%	5.0%	5.0%	5.1%	5.1%	5.1%	5.1%
Long A Corporate bond yield 10y	3.8%	4.4%	4.7%	4.8%	5.0%	5.2%	5.2%	5.3%	5.3%	5.4%	5.4%
A Corporate spread 5y	0.9%	3.1%	3.9%	3.7%	3.5%	3.0%	2.9%	2.7%	2.6%	2.4%	2.3%
Long A Corporate spread 10y	1.2%	3.0%	3.7%	3.5%	3.3%	2.9%	2.8%	2.7%	2.6%	2.4%	2.3%
Expected nominal return on assets											
Equity - US		-18.1%	-10.1%	10.6%	5.7%	5.7%	5.7%	5.8%	5.9%	5.9%	6.0%
Equity - Global		-20.8%	-11.5%	11.5%	6.0%	6.0%	6.1%	6.2%	6.4%	6.5%	6.6%
A Corporate bonds 5y		0.3%	1.6%	3.5%	2.9%	3.7%	4.1%	4.2%	4.4%	4.5%	4.7%
Long A Corporate bonds 10y		-2.2%	0.1%	2.5%	1.4%	2.1%	3.3%	3.5%	3.9%	4.2%	4.5%
Treasury 5y		8.5%	2.6%	0.4%	-0.5%	-0.4%	1.5%	1.7%	1.9%	2.2%	2.4%
Long Treasury 15y		16.3%	7.4%	-0.3%	-2.1%	-4.5%	0.4%	0.6%	0.8%	1.3%	1.4%
TIPS 5y		4.6%	0.3%	-0.4%	-0.6%	-0.5%	1.7%	1.8%	2.1%	2.3%	2.5%
Long TIPS 15y		7.8%	2.2%	1.0%	-2.4%	-1.8%	1.3%	1.3%	1.7%	1.9%	2.0%
US High Yield		-10.7%	-6.0%	7.4%	4.0%	3.9%	3.7%	3.9%	4.4%	4.3%	4.7%
Bank Loans		-5.1%	-1.8%	6.3%	4.3%	4.7%	4.9%	5.0%	5.0%	5.0%	5.2%
USD Emerging Market Debt		-13.3%	-7.4%	8.3%	4.5%	5.0%	4.8%	5.1%	5.3%	5.2%	5.3%
Local Emerging Market Debt		-15.5%	-8.2%	9.3%	4.7%	5.4%	4.9%	4.8%	5.1%	6.1%	5.2%
Real Estate		-13.0%	-7.9%	-2.7%	0.7%	4.6%	4.7%	4.7%	4.8%	4.8%	4.9%
Commodities		-27.6%	-21.7%	7.3%	3.9%	3.9%	4.0%	4.1%	4.1%	4.2%	4.3%
Hedge Funds - FoHF - Universe		-14.1%	-8.9%	6.6%	5.5%	3.7%	3.7%	3.7%	3.7%	3.7%	3.7%
Private Equity		-18.6%	-6.1%	13.4%	8.6%	8.8%	8.8%	8.7%	8.7%	8.7%	8.7%
Infrastructure - Europe		-5.0%	-0.7%	2.8%	3.6%	7.2%	7.3%	7.3%	7.4%	7.4%	7.5%
Cash		2.4%	0.3%	0.3%	0.7%	1.1%	1.3%	1.6%	1.9%	2.1%	2.3%
CPI		-0.3%	0.4%	0.7%	1.0%	1.3%	1.4%	1.5%	1.6%	1.7%	1.8%

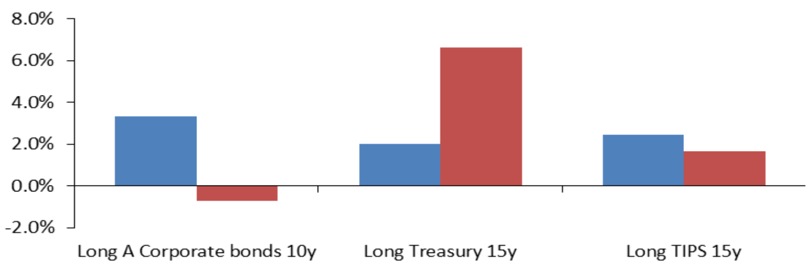
Scenario information as of March 31, 2019

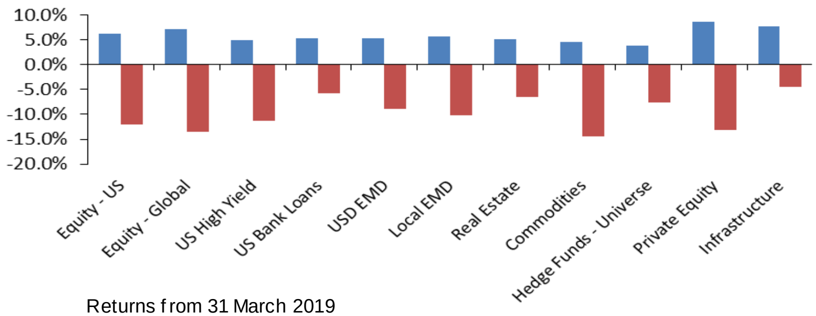
Black Skies Scenario

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 2020 and remains there in 2021, 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.







Returns from 31 March 2019
Source: Aon

The opinions referenced are as of the date of publication and are subject to change due to changes in the market or economic conditions and may not necessarily come to pass. Information contained herein is for informational purposes only and should not be considered investment advice.

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	2.3%	0.1%	-0.1%	0.0%	0.1%	0.3%	0.6%	1.0%	1.3%	1.6%	2.0%
Long Treasury yield 15y	2.7%	1.1%	0.8%	0.8%	0.9%	1.1%	1.4%	1.7%	2.0%	2.2%	2.5%
TIPS yield 5y	0.4%	-0.6%	-0.7%	-0.6%	-0.5%	-0.3%	-0.2%	0.0%	0.2%	0.4%	0.5%
Long TIPS yield 15y	0.7%	0.0%	-0.1%	0.0%	0.1%	0.2%	0.3%	0.5%	0.6%	0.7%	0.9%
Breakeven price inflation 15y	1.9%	1.1%	0.9%	0.8%	0.8%	0.9%	1.1%	1.2%	1.4%	1.5%	1.6%
A Corporate bond yield 5y	3.2%	4.2%	5.0%	5.0%	5.0%	4.7%	4.8%	4.9%	4.9%	5.0%	5.0%
Long A Corporate bond yield 10y	3.8%	4.5%	5.0%	5.0%	5.0%	4.8%	4.9%	5.0%	5.1%	5.2%	5.2%
A Corporate spread 5y	0.9%	4.1%	5.1%	5.0%	4.9%	4.4%	4.1%	3.9%	3.6%	3.3%	3.0%
Long A Corporate spread 10y	1.2%	3.9%	4.7%	4.6%	4.5%	4.1%	3.9%	3.6%	3.4%	3.1%	2.9%
Expected nominal return on assets											
Equity - US		-28.8%	-20.9%	-11.6%	2.5%	2.5%	2.9%	3.3%	3.7%	4.0%	4.4%
Equity - Global		-31.7%	-22.9%	-12.6%	2.6%	2.6%	3.1%	3.5%	4.0%	4.5%	4.9%
A Corporate bonds 5y		-0.3%	-1.5%	1.5%	1.9%	3.0%	1.5%	1.7%	2.2%	2.5%	2.8%
Long A Corporate bonds 10y		-3.1%	-4.2%	0.6%	0.8%	2.6%	0.3%	0.7%	1.3%	1.8%	2.4%
Treasury 5y		12.4%	1.2%	0.1%	-0.1%	-0.1%	-0.7%	-0.4%	0.0%	0.4%	0.7%
Long Treasury 15y		28.4%	6.2%	2.1%	0.1%	-1.1%	-2.4%	-2.1%	-1.8%	-1.3%	-1.0%
TIPS 5y		3.2%	-1.0%	-0.3%	-0.3%	-0.4%	0.0%	0.3%	0.7%	1.0%	1.3%
Long TIPS 15y		10.0%	0.3%	0.2%	-1.2%	-0.7%	-0.5%	-0.4%	0.1%	0.4%	0.6%
US High Yield		-25.4%	-19.5%	-11.2%	1.4%	1.5%	1.5%	1.9%	2.7%	2.8%	3.5%
Bank Loans		-15.5%	-11.2%	-5.5%	2.3%	2.6%	3.0%	3.3%	3.5%	3.7%	4.2%
USD Emerging Market Debt		-21.2%	-16.3%	-8.7%	1.9%	2.3%	2.4%	3.0%	3.4%	3.6%	4.0%
Local Emerging Market Debt		-24.4%	-18.1%	-9.7%	1.9%	2.5%	2.3%	2.4%	3.1%	4.3%	3.7%
Real Estate		-15.6%	-11.1%	-5.2%	-0.7%	1.6%	1.9%	2.3%	2.7%	3.0%	3.4%
Commodities		-36.7%	-28.3%	-3.6%	2.4%	2.4%	2.6%	2.9%	3.1%	3.3%	3.5%
Hedge Funds - FoHF - Universe		-18.1%	-12.6%	-6.7%	0.6%	0.6%	0.9%	1.2%	1.6%	1.9%	2.2%
Private Equity		-32.5%	-23.5%	-12.3%	4.3%	4.3%	4.8%	5.2%	5.6%	6.0%	6.5%
Infrastructure - Europe		-12.8%	-8.4%	-4.4%	0.9%	3.6%	4.0%	4.4%	4.8%	5.2%	5.7%
Cash		2.4%	0.1%	0.1%	0.1%	0.1%	0.4%	0.8%	1.2%	1.5%	1.8%
CPI		-1.8%	-1.3%	0.1%	0.3%	0.5%	0.7%	0.8%	1.0%	1.2%	1.4%

Scenario information as of March 31, 2019

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
- Funded Ratio
- Net Outflow

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

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

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

Our calculations were based on data provided by the plan actuary. The actuarial assumptions and methods and plan provisions reflected in these projections are the same as those used for the 2018 actuarial valuation for PSERS as noted in the actuarial reports, except where noted in this report. Unless specifically noted, our calculations do not reflect any other changes or events after June 30, 2018.

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

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

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

Aon Hewitt Investment Consulting, Inc.

Phil Kivarkis, FSA, CFA

Legal Disclosures and Disclaimers

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

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

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

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

Aon Hewitt Investment Consulting, Inc.
200 E. Randolph Street
Suite 1500
Chicago, IL 60601
ATTN: AHIC Compliance Officer

Stress Testing Analysis

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

Empower Results®

Table of Contents

Executive Summary

Purpose

- In December 2018, the Public Pension Management and Asset Investment Review Commission (PPMAIRC) issued their final report and recommendations
  - The recommendations called for annual stress testing, aligning to the Society of Actuaries' Blue Ribbon Panel, and covering the following scenarios:
    - **Baseline** – assumes the pension plan earns its expected return assumption for the next 30 years
    - **Excess Return** – assumes the pension plan annually earns 2% higher than its expected return assumption for 20 years and then the baseline assumption for the next 10 years
    - **Low Return** – assumes the pension plan annually earns 2% lower than its expected return assumption for 20 years and then the baseline assumption for the next 10 years
    - **Contribution Risk** – assumes the pension plan is funded with 80% of the actuarially-determined contributions for 20 years followed by the full amounts for the next 10 years
  - The variables analyzed include the following:
    - Contributions (in dollars)
    - Contributions (as a percent of payroll)
    - Funded Ratio

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 PPMAIRC'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., +/-2% 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 PPMAIRC 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
  - The 30 year ending funded ratio in the PPMAIRC's Low Return scenario (76%) is comparable to the 75th percentile outcomes under our stochastic analysis (74%)
    - Approximately 25% of Aon's scenarios in its stochastic analysis are worse than the PPMAIRC's Low Return scenario, making for an even more conservative stress testing approach

Analysis

- Asset-Liability Projection Results (Deterministic Results)

Empower Results®

Asset-Liability Projection Results (Deterministic Results)
Summary of Results

Scenario	5 Years				10 Years				30 Years			
	Cumulative Contributions		Funded Ratio		Cumulative Contributions		Funded Ratio		Cumulative Contributions		Funded Ratio	
	$	Δ (from Baseline)	%	Δ (from Baseline)	$	Δ (from Baseline)	%	Δ (from Baseline)	$	Δ (from Baseline)	%	Δ (from Baseline)
1. Baseline	$29.6	N/A	61.4%	N/A	$63.4	N/A	71.6%	N/A	$150.2	N/A	104.7%	N/A
2. Excess Return	$29.5	-$0.1	67.6%	6.2%	$62.2	-$1.2	86.7%	15.1%	$125.5	-$24.6	186.4%	81.7%
3. Low Return	$29.6	$0.1	55.6%	-5.8%	$64.6	$1.2	58.9%	-12.7%	$196.1	$46.0	76.2%	-28.5%
4. Low Contributions	$24.1	-$5.5	55.6%	-5.7%	$53.5	-$9.9	59.9%	-11.7%	$173.5	$23.3	92.8%	-11.9%

Key Takeaways:

- Greater return on plan assets will lead to lower future contributions and higher funded ratio; and vice versa
- Funding less than the full actuarially-determined amount will lead to lower funded ratios and higher contribution amounts

Detailed Stress Test Scenario

1. Baseline Scenario

June 30th	Return	Total Contribution ($ Billions)	Total Contribution (% of Payroll)	Funded Ratio (Market Value of Assets / Accrued Liability)
2018	7.25%	$5.5	40.2%	54.7%
2019	7.25%	$5.7	41.3%	55.7%
2020	7.25%	$5.9	42.1%	56.9%
2021	7.25%	$6.1	42.6%	58.3%
2022	7.25%	$6.3	43.1%	59.8%
2023	7.25%	$6.4	43.5%	61.4%
2024	7.25%	$6.6	43.9%	63.1%
2025	7.25%	$6.8	44.4%	65.0%
2026	7.25%	$7.0	44.8%	67.0%
2027	7.25%	$7.1	45.0%	69.2%
2028	7.25%	$7.3	45.4%	71.6%
2029	7.25%	$7.4	45.8%	74.1%
2030	7.25%	$7.6	46.2%	76.8%
2031	7.25%	$7.8	46.6%	79.7%
2032	7.25%	$8.0	47.1%	82.9%
2033	7.25%	$8.2	47.6%	86.4%
2034	7.25%	$8.3	48.1%	90.2%
2035	7.25%	$5.3	30.1%	94.4%
2036	7.25%	$4.3	24.2%	96.6%
2037	7.25%	$3.9	21.8%	98.2%
2038	7.25%	$3.5	19.1%	99.7%
2039	7.25%	$3.1	16.9%	101.0%
2040	7.25%	$1.7	8.8%	102.2%
2041	7.25%	$1.6	8.5%	102.4%
2042	7.25%	$1.6	8.1%	102.6%
2043	7.25%	$1.5	7.8%	102.9%
2044	7.25%	$1.5	7.5%	103.2%
2045	7.25%	$1.4	7.1%	103.5%
2046	7.25%	$1.4	6.9%	103.9%
2047	7.25%	$1.4	6.6%	104.2%
2048				104.7%

Key Takeaways:

- Contributions are expected to peak in 2034 and decrease thereafter
- Plan reaches 100% funded ratio by 2039

$150.2B
Cumulative 30 Year Contributions

104.7%
Expected Funded Ratio After 30 Years

Empower Results®

Detailed Stress Test Scenario

2. Excess Return Scenario (Asset Returns Increase by 2% for 20 Years)

June 30th	Return	Total Contribution ($ Billions)	Total Contribution (% of Payroll)	Funded Ratio (Market Value of Assets / Accrued Liability)
2018	9.25%	$5.5	40.2%	54.7%
2019	9.25%	$5.7	41.3%	56.8%
2020	9.25%	$5.9	42.0%	59.1%
2021	9.25%	$6.1	42.4%	61.7%
2022	9.25%	$6.2	42.8%	64.6%
2023	9.25%	$6.3	42.9%	67.6%
2024	9.25%	$6.4	42.9%	70.9%
2025	9.25%	$6.6	43.0%	74.4%
2026	9.25%	$6.7	42.8%	78.2%
2027	9.25%	$6.7	42.5%	82.3%
2028	9.25%	$6.7	42.1%	86.7%
2029	9.25%	$6.8	41.6%	91.3%
2030	9.25%	$6.8	41.1%	96.3%
2031	9.25%	$6.8	40.5%	101.6%
2032	9.25%	$6.7	39.8%	107.3%
2033	9.25%	$6.7	39.1%	113.4%
2034	9.25%	$1.9	10.9%	120.1%
2035	9.25%	$1.9	10.6%	123.6%
2036	9.25%	$1.8	10.3%	127.6%
2037	9.25%	$1.8	9.9%	132.1%
2038	7.25%	$1.7	9.6%	137.0%
2039	7.25%	$1.7	9.2%	139.9%
2040	7.25%	$1.7	8.8%	143.1%
2041	7.25%	$1.6	8.5%	146.6%
2042	7.25%	$1.6	8.1%	150.6%
2043	7.25%	$1.5	7.8%	155.1%
2044	7.25%	$1.5	7.5%	160.2%
2045	7.25%	$1.4	7.1%	165.7%
2046	7.25%	$1.4	6.9%	171.9%
2047	7.25%	$1.4	6.6%	178.8%
2048				186.4%

Key Takeaways:

- Contributions are expected to peak in 2029-2031 and decrease thereafter
- Plan reaches 100% funded ratio by 2031

$125.5B
Cumulative 30 Year Contributions

186.4%
Expected Funded Ratio After 30 Years

Detailed Stress Test Scenario

3. Low Return Scenario (Asset Returns Decrease by 2% for 20 Years)

June 30th	Return	Total Contribution ($ Billions)	Total Contribution (% of Payroll)	Funded Ratio (Market Value of Assets / Accrued Liability)
2018	5.25%	$5.5	40.2%	54.7%
2019	5.25%	$5.7	41.3%	54.7%
2020	5.25%	$5.9	42.1%	54.8%
2021	5.25%	$6.1	42.8%	55.0%
2022	5.25%	$6.3	43.5%	55.2%
2023	5.25%	$6.5	44.1%	55.6%
2024	5.25%	$6.7	44.8%	56.0%
2025	5.25%	$7.0	45.7%	56.6%
2026	5.25%	$7.2	46.5%	57.2%
2027	5.25%	$7.5	47.4%	58.0%
2028	5.25%	$7.7	48.3%	58.9%
2029	5.25%	$8.0	49.5%	59.9%
2030	5.25%	$8.3	50.6%	61.1%
2031	5.25%	$8.7	51.9%	62.5%
2032	5.25%	$9.0	53.2%	64.1%
2033	5.25%	$9.4	54.6%	66.0%
2034	5.25%	$9.7	56.1%	68.1%
2035	5.25%	$6.9	39.1%	70.5%
2036	5.25%	$6.1	34.3%	70.9%
2037	5.25%	$5.9	32.9%	70.6%
2038	7.25%	$5.7	31.4%	70.2%
2039	7.25%	$5.6	30.3%	71.0%
2040	7.25%	$5.5	29.5%	71.7%
2041	7.25%	$4.9	25.8%	72.4%
2042	7.25%	$4.8	25.0%	72.7%
2043	7.25%	$4.9	25.1%	72.9%
2044	7.25%	$5.0	25.3%	73.2%
2045	7.25%	$5.1	25.3%	73.7%
2046	7.25%	$5.1	24.9%	74.4%
2047	7.25%	$5.1	24.5%	75.2%
2048				76.2%

Key Takeaways:

- Contributions are expected to peak in 2034
- Plan does not reach 100% funded ratio over the projection period

$196.1B
Cumulative 30 Year Contributions

76.2%
Expected Funded Ratio After 30 Years

Empower Results®

Detailed Stress Test Scenario

4. Low Contribution Scenario (Contribute 80% of ADC for 20 Years)

June 30th	Return	Total Contribution ($ Billions)	Total Contribution (% of Payroll)	Funded Ratio (Market Value of Assets / Accrued Liability)
2018	7.25%	$4.4	32.1%	54.7%
2019	7.25%	$4.6	33.1%	54.6%
2020	7.25%	$4.8	34.1%	54.7%
2021	7.25%	$5.0	35.0%	54.9%
2022	7.25%	$5.2	36.0%	55.2%
2023	7.25%	$5.4	36.8%	55.6%
2024	7.25%	$5.7	37.6%	56.2%
2025	7.25%	$5.9	38.5%	56.9%
2026	7.25%	$6.1	39.5%	57.7%
2027	7.25%	$6.4	40.3%	58.7%
2028	7.25%	$6.6	41.2%	59.9%
2029	7.25%	$6.9	42.2%	61.2%
2030	7.25%	$7.1	43.2%	62.7%
2031	7.25%	$7.4	44.3%	64.4%
2032	7.25%	$7.7	45.4%	66.3%
2033	7.25%	$8.0	46.6%	68.5%
2034	7.25%	$8.3	47.8%	71.0%
2035	7.25%	$6.0	34.3%	73.9%
2036	7.25%	$5.4	30.5%	75.2%
2037	7.25%	$5.3	29.2%	76.2%
2038	7.25%	$6.3	34.8%	77.1%
2039	7.25%	$6.2	33.4%	78.8%
2040	7.25%	$5.9	31.7%	80.6%
2041	7.25%	$5.2	27.3%	82.4%
2042	7.25%	$5.0	25.8%	83.7%
2043	7.25%	$4.9	25.2%	85.0%
2044	7.25%	$4.8	24.0%	86.5%
2045	7.25%	$4.6	22.8%	88.0%
2046	7.25%	$4.3	21.1%	89.6%
2047	7.25%	$4.1	19.7%	91.2%
2048				92.8%

Key Takeaways:

- Contributions are expected to peak in 2034
- Plan does not reach 100% funded ratio over the projection period

$173.5B
Cumulative 30 Year Contributions

92.8%
Expected Funded Ratio After 30 Years

Empower Results®

Analysis

- Asset-Liability Projection Results (Stochastic Results)

Asset-Liability Projection Results (Stochastic Results)

Summary of Results

All Scenarios	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[3]	Expected[1]	Downside[2]
(B) Proposed 1 Year Target	$75.5	$94.5	117%	33%	$121.5	$211.8
(G) Proposed Long-Term Target	$74.1	$94.5	134%	35%	$115.0	$210.2

Key Findings:

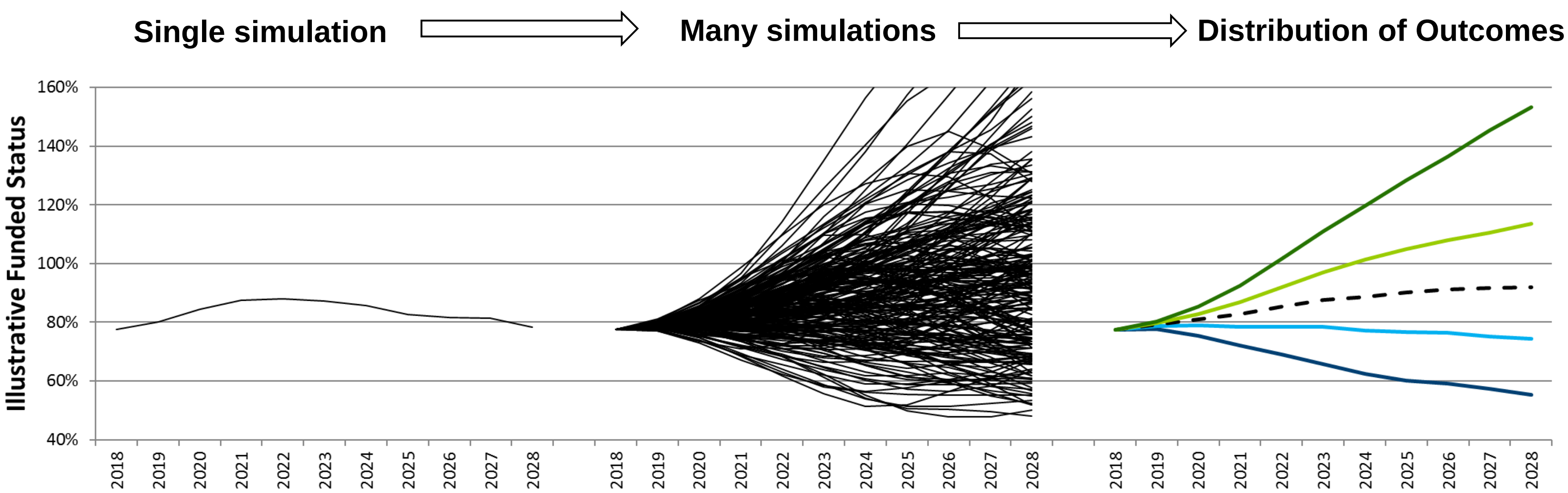
- The Plan is expected to reach full funding in the central expectation (50th percentile) under both the Proposed 1 Year and the Proposed Long-Term Target policy over the course of the projection period assuming the expected contributions are made
- Adverse market experience and/or not making required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

[1] Expected = 50th percentile outcome or central expectation across all 5,000 simulations
[2] Downside = 95th percentile outcome across all 5,000 simulations
[3] Downside = 5th percentile outcome across all 5,000 simulations

Empower Results®

Asset-Liability Simulation Overview

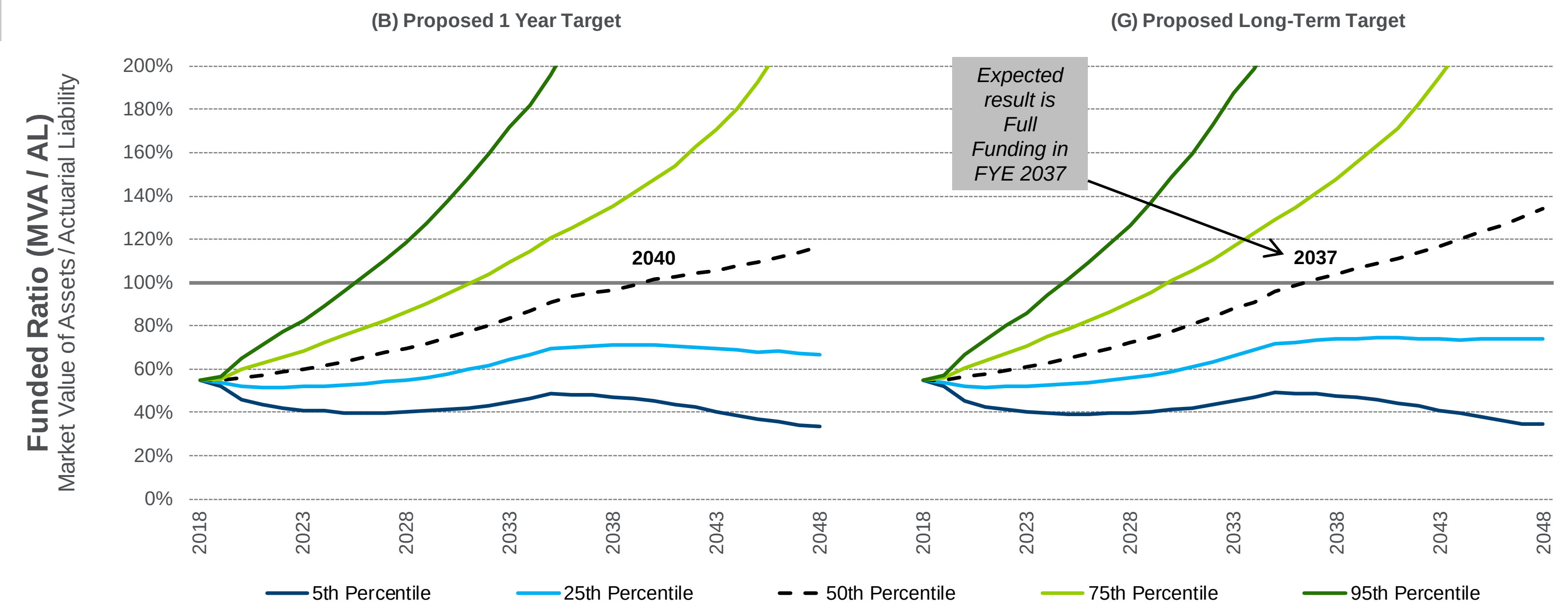
- Thousands of simulations plotted in one graph would be impossible to interpret
- Instead, we rank the simulations at each point over the future
- This produces a distribution of outcomes illustrating the degree of uncertainty of a plan's financial position over the projection period
- Different investment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



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

Asset-Liability Projection Results (Stochastic Results)

Market Value of Assets / Actuarial Liability Funded Ratio



Strategy	(B) Proposed 1 Year Target			(G) Proposed Long-Term Target		
Year	**2028**	**2038**	**2048**	**2028**	**2038**	**2048**
5th Percentile	40%	47%	33%	40%	47%	35%
25th Percentile	55%	71%	66%	56%	74%	74%
50th Percentile	70%	97%	117%	72%	104%	134%
75th Percentile	87%	136%	>200%	91%	148%	>200%
95th Percentile	118%	>200%	>200%	126%	>200%	>200%
Probability > 100%	17%	48%	58%	20%	53%	64%

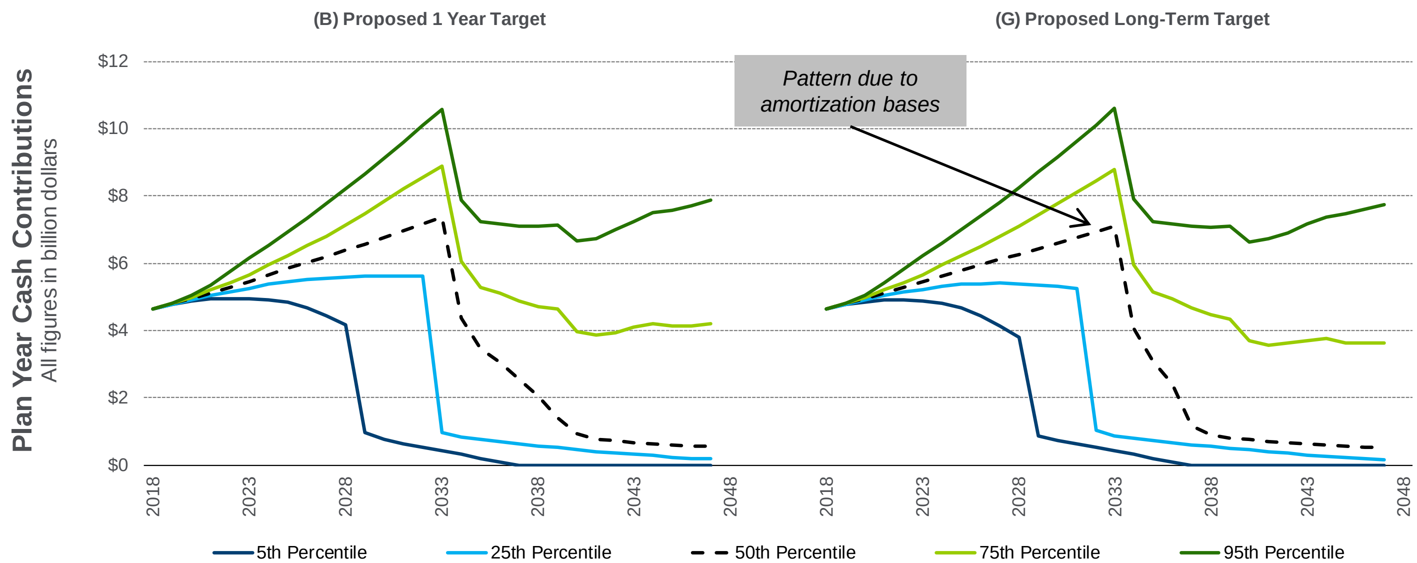
Key Takeaways:

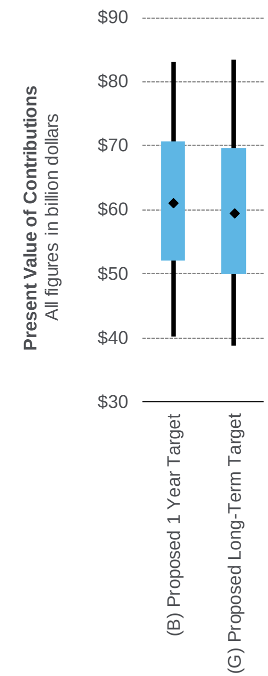
- The funded ratio is projected to trend toward full funding over the course of the projection period
- Adverse market experience could significantly impact the funded status of the Plan

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

Asset-Liability Projection Results (Stochastic Results)

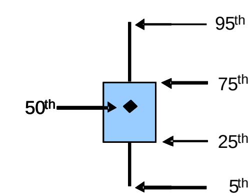
Employer Contribution Amount





Strategy	(B) Proposed 1 Year Target			(G) Proposed Long-Term Target		
Year	**2027**	**2037**	**2047**	**2027**	**2037**	**2047**
5th Percentile	$4.44	$0.00	$0.00	$4.14	$0.00	$0.00
25th Percentile	$5.55	$0.63	$0.17	$5.40	$0.61	$0.16
50th Percentile	$6.20	$2.55	$0.56	$6.11	$1.17	$0.51
75th Percentile	$6.82	$4.88	$4.20	$6.79	$4.67	$3.62
95th Percentile	$7.76	$7.10	$7.87	$7.81	$7.10	$7.75
Probability > $7B	21%	6%	10%	21%	6%	9%

Percentile



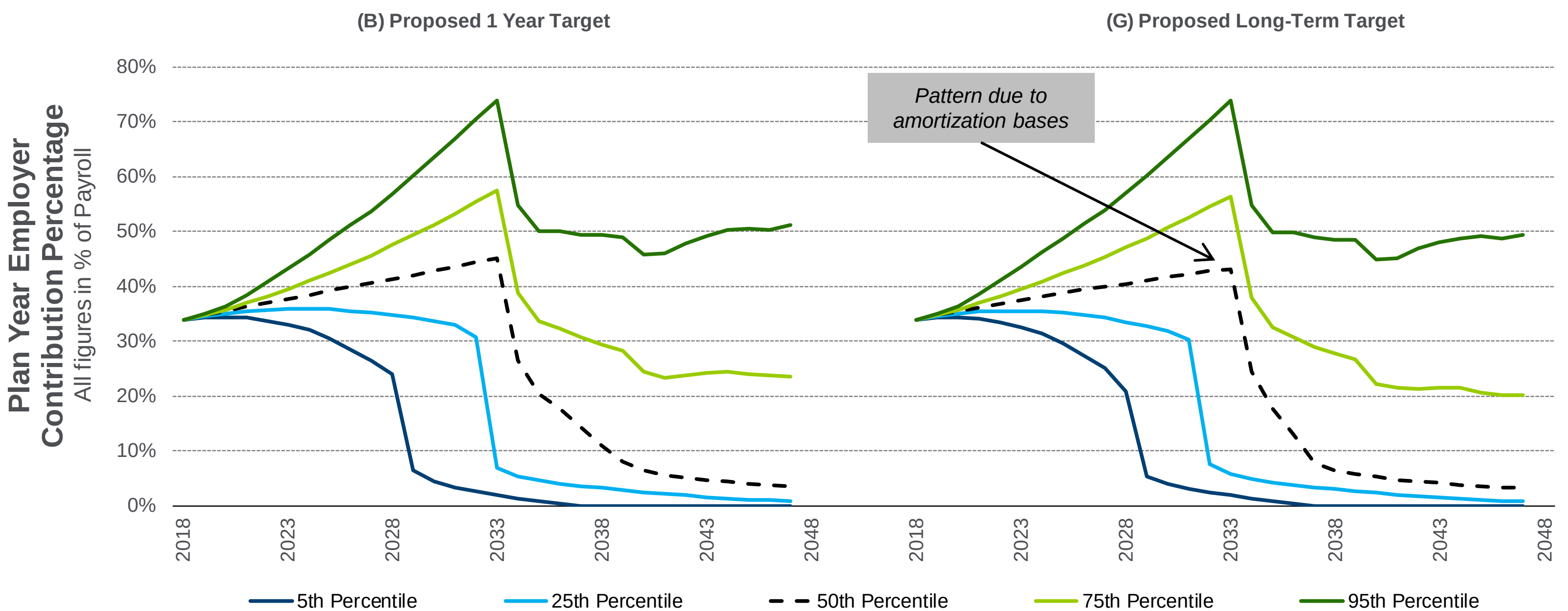
Key Takeaway:

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

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

Asset-Liability Projection Results (Stochastic Results)

Employer Contribution Percentage of Payroll



Strategy	(B) Proposed 1 Year Target			(G) Proposed Long-Term Target		
Year	**2027**	**2037**	**2047**	**2027**	**2037**	**2047**
5th Percentile	27%	0%	0%	25%	0%	0%
25th Percentile	35%	4%	1%	34%	3%	1%
50th Percentile	41%	14%	4%	40%	8%	3%
75th Percentile	46%	31%	23%	45%	29%	20%
95th Percentile	54%	49%	51%	54%	49%	49%
Probability > 45%	28%	10%	9%	27%	9%	8%

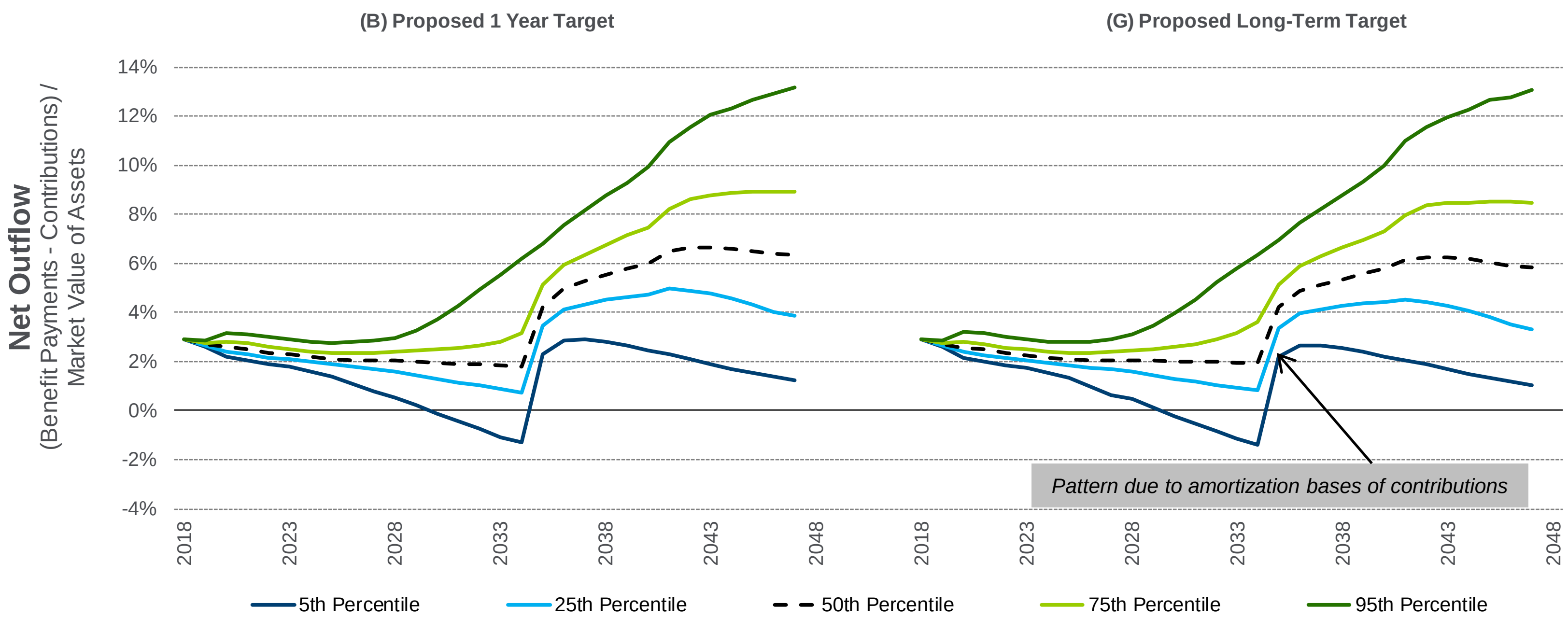
Key Takeaway:

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

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

Asset-Liability Projection Results (Stochastic Results)

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



Strategy	(B) Proposed 1 Year Target			(G) Proposed Long-Term Target		
Year	**2027**	**2037**	**2047**	**2027**	**2037**	**2047**
5th Percentile	1%	3%	1%	1%	3%	1%
25th Percentile	2%	4%	4%	2%	4%	3%
50th Percentile	2%	5%	6%	2%	5%	6%
75th Percentile	2%	6%	9%	2%	6%	8%
95th Percentile	3%	8%	13%	3%	8%	13%
Probability > 10%	<1%	<1%	20%	<1%	<1%	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

Appendix

Portfolio Analysis
Portfolios Evaluated

	B	G
	Proposed 1 Year Target	Proposed Long-Term Target
US Equity	4.8%	7.8%
Global Equity	0.0%	0.0%
Non-US Dev, Unhedged	1.6%	2.0%
Non-US Dev, USD Hedged	4.9%	6.0%
Emerging Markets	3.7%	4.2%
Private Equity, Unhedged[1]	15.0%	15.0%
Total Equity	**30.0%**	**35.0%**
US Core Fixed Income	4.0%	5.0%
Non-US Dev, USD Hedged	0.0%	1.0%
US Long-Term Treasury	6.0%	6.0%
Emerging Markets Debt[2]	1.0%	2.0%
High Yield	0.0%	0.0%
Private Credit	10.0%	10.0%
US TIPS	7.5%	7.5%
Non-US Inflation-Linked	7.5%	7.5%
Total Fixed Income	**36.0%**	**39.0%**
Infrastructure: Energy MLPS	3.0%	0.0%
Infrastructure: Private, USD Hedged	1.0%	4.0%
Infrastructure: Public, USD Hedged	2.0%	4.0%
Commodities: Diversified	5.0%	5.0%
Commodities: Gold	3.0%	3.0%
Private Real Estate, Unhedged	8.0%	8.0%
Global REITs, USD Hedged	2.0%	2.0%
Total Real Assets	**24.0%**	**26.0%**
Risk Parity[4]	**8.0%**	**8.0%**
Hedge Funds[5]	**10.0%**	**10.0%**
Cash	**6.0%**	**3.0%**
LIBOR (Leverage)	**-14.0%**	**-21.0%**
Total Plan	**100.0%**	**100.0%**
30-Year Exp. Nom. Return	**7.28%**	**7.66%**
30-Year Exp. Real Return	**4.96%**	**5.34%**
30-Year Expected Risk	**10.62%**	**11.56%**
Sharpe Ratio	**0.448**	**0.445**

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

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

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

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

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

Empower Results®

AHIC Capital Market Assumptions

As of March 31, 2019 (30 Years)

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

[1] All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees.
[2] Hedge Fund assumptions developed as follows: 14% Event Driven, 38% Global Macro, 20% Distressed Debt, 16% Fixed Income Arbitrage, 12% Cat. Bonds
[3] Real Estate assumption developed as follows: 80% Non-Core Rel Estate, 20% Core Real Estate
[4] Private Equity assumptions developed as follows: 72% Buyouts, 13% Venture Capital, 15% Distressed Debt
[5] Risk Parity assumptions developed as follows: 50% Global Equity, -100% LIBOR, 55% TIPS, 75% Intermediate Gov't. Bonds, 20% Commodities

AHIC Capital Market Assumptions

As of March 31, 2019 (30 Years)

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

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

Actuarial Assumptions and Methods

- Actuarial projections were provided by the plan actuary as of the most recent valuation date (June 30, 2018)
- Actuarial assumptions:
  - Valuation Rate of Interest = 7.25% for all future years
  - Inflation = 2.75%
  - Salary Scale = effective average of 5.00% per year
  - Payroll Growth = 3.50% per year
  - Actuarial Value of Assets: smooth gains/losses relative to expected valuation rate of interest over 10 years and shall be no less than 70% and no greater than 130% of the market value of assets
  - Projection assumptions
    - The active workforce size is assumed to remain constant over the projection period;
    - Future new employees have similar characteristics (age/gender/salary) to new employees for the period July 1, 2015 through June 30, 2018 and:
      - New school employees hired on or after July 1, 2017 through June 30, 2019 are assumed to be Class T-E members
      - Among new school employees hired on or after July 1, 2019, 65% will become Class T-G members, 30% will elect Class T-H membership, and 5% will elect Class DC participation.
    - Class T-G and T-H members who terminate employment with less than 25 years of service and who commence their benefits prior to age 62 will have their benefits reduced from age 67 to age 62 based on the System's current actuarial-equivalent early retirement factors, which are based on the statutory interest rate of 4%. The benefit will be further reduced from age 62 to the member's age at benefit commencement based on new actuarial-equivalent early retirement factors based on an interest rate of 7.25%.
  - All other assumptions as documented in the Actuarial Valuation Report as of June 30, 2018

Actuarial Assumptions and Methods (continued)

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

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
- Funded Ratio
- Net Outflow

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

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

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

Our calculations were based on data provided by the plan actuary. The actuarial assumptions and methods and plan provisions reflected in these projections are the same as those used for the 2018 actuarial valuation for PSERS as noted in the actuarial reports, except where noted in this report. Unless specifically noted, our calculations do not reflect any other changes or events after June 30, 2018.

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

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

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

Aon Hewitt Investment Consulting, Inc.

Phil Kivarkis FSA, CFA

Legal Disclosures and Disclaimers

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

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

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

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

Aon Hewitt Investment Consulting, Inc.
200 E. Randolph Street
Suite 1500
Chicago, IL 60601
ATTN: AHIC Compliance Officer

V. Performance Objectives

The overall return objective is to realize a return sufficient to achieve funding adequacy on an inflation-adjusted basis. Funding adequacy is achieved when the actuarial market value of assets is at least equal to the System's projected benefit obligations. The System has a return objective of meeting or exceeding the actuarial rate (currently 7.25%) over the long-term. In addition, the Board has the following broad objectives:

- The assets of the System shall be invested to maximize the returns for the level of Risk taken; and,
- The System shall strive to achieve a return that exceeds the Policy Index.

Policy Index

The Board adopts the following weighted policy benchmarks for the Current Target Allocation to measure the performance of the System beginning October 1, 201~~8~~9, subject to footnotes 1 & 4:

	Policy Weight	
Equity Exposure		
~~Publicly-traded Global Equity~~Public:		
~~MSCI USA IMI Gross Index~~S&P 500 TR Index (75%), S&P MidCap 400 TR Index (12.5%), S&P Small Cap 600 TR Index (12.5%)	4.80% [1]	
MSCI ACWI ex~~Ex~~ USA IMI with Developed Market Currencies (75% Hedged to USD) ~~Index~~ Net TR Index	~~9.70~~8.70%	
MSCI Emerging Markets ~~Index~~ IMI Net TR Index	~~0.50~~1.50%	
Private:~~ Markets~~		
Burgiss ~~Total Return~~TR, one-quarter lagged[2]	15.00% [1]	
Total Equity Exposure		**30.00%**
Fixed Income Exposure		
Investment Grade		
Bloomberg Barclays ~~Capital~~ U~~.~~S~~.~~ Aggregate Bond TR Index	4.00%	
Bloomberg Barclays GDP ~~Capital~~ Global Aggregate~~d GDP-~~ ~~weighted~~ Bond Developed Market ex ~~-~~U~~.~~S~~.~~ TR Index (Hedged to USD)~~ Index~~	0.00%	
Bloomberg Barclays ~~Capital~~ U.S. ~~Aggregate~~ Long Treasury TR Index	6.00%	
Credit-Related		
~~Barclays Capital EM Local Currency –~~	1.00%	

~~Government - MV Weighted (Unhedged) - 10%~~		
~~Country Cap Index~~**Public:**		
J.P. Morgan GBI-EM Broad Diversified Index (34%), J.P. Morgan EMBI Global Diversified Index (33%), ICE BofAML EM Corporate Plus Index (Hedged to USD) (33%)		
Bloomberg Barclays ~~Capital~~ U~~.~~S~~.~~ Corporate High Yield Bond Index	~~10.00~~0%	
Private:		
S&P LSTA Leveraged Loan TR Index + 200bps	10.00%	
Inflation Protected		
Bloomberg Barclays US Government Inflation-Linked Bond All Maturities TR Index~~Capital World Government Inflation-Linked Bond Index (Hedged to USD)~~	~~15.00~~7.50%	
Bloomberg Barclays World Government ex US Inflation-Linked Bond All Maturities TR Index (Hedged to USD)	7.50%	
Total Fixed Income Exposure		**36.00%**
Real Asset Exposure		
Infrastructure		
Public:		
~~S&P MLP Index~~ Alerian Midstream Energy TR Index	~~4.00~~3.00%	
FTSE Developed Core Infrastructure 50/50 ~~(Hedged to USD) Index~~ Net TR Index (Hedged to USD)	2.00%	
Private:		
FTSE Developed Core Infrastructure 50/50 Net TR Index (Hedged to USD), one-quarter lagged	1.00%	
Commodities		
Bloomberg Commodity TR Index	5.00%	
Bloomberg ~~Commodity~~ Gold TR Subindex	3.00%	
Real Estate		
~~**Publicly-traded**~~**Public:**		
FTSE EPRA/NAREIT Developed, Net TR Index (Hedged to USD) ~~Net~~	~~1.00~~2.00%[4]	
Private		
NFI and Burgiss ~~Total Return~~TR, one-~~-~~quarter lagged[3]	~~9.00%~~8.00%[4]	
Total Real Asset Exposure		**24.00%**
Risk Parity		

Custom Benchmark[5]		**8.00%**
Absolute Return		
~~3-Month LIBOR + 3.50%~~HFRI Fund of Funds Conservative Index + 100bps		**10.00%**
Net Leverage		
Cash		
ICE BofAML ~~Merrill Lynch~~ 0-3 Month U~~.~~S~~.~~ Treasury Bill ~~0 - 3 Months~~Index	6.00%	
Financing Cost of Leverage[6]		
~~3-Month LIBOR~~ICE LIBOR 3 Month Index	(14.00%)	
Net Leverage		**(8.00%)**
TOTAL		**100.00%**

Footnotes to Policy Index:

[1] As the Private Markets allocation is funded (or distributions received) and/or the allocation increases/decreases due to the total market value of the Fund changing, the Publicly-traded Global Equity policy weight (specifically, the combination of ~~MSCI USA IMI Gross Index~~US Equity Indices and MSCI ACWI ~~E~~ex USA IMI with Developed Market Currencies hedged to USD Index policy weights) will be proportionately and conversely revised to reflect these changes using a 60-40 split between the ex. USA (60%) and USA (40%) indices. For example, if the allocation to Private Markets increases by 100 basis points due to a change in the market value of the total Fund in the fourth quarter, then starting with the first quarter the policy weight will include this 100 basis points increase in the Private Markets benchmark and the Publicly-traded Global Equity policy weights will also be proportionately reduced by 100 basis points. Adjustments to the Private Markets policy weight will be completed in 50 basis point increments (adjustment will be made to the nearest 0.50%) on a quarterly basis.

Footnotes to Policy Index (continued):

[2] The benchmark returns are calculated using the rolling 5-year (20 quarters) total returns obtained from Burgiss Private IQ relevant universe (i.e. Generalist, Expansion Capital, Buyout, Debt, Infrastructure, Natural Resources, Secondary Fund of Funds, and North America-focused Venture Capital).

[3] PSERS weights each of the real estate investment strategies actual net asset values of the System's private real estate investments quarterly to produce a customized, blended benchmark return. The NFI-ODCE (NCREIF Open-end Diversified Core Equity) is used for the core strategy whereas returns for value-added and opportunistic

strategies are calculated using the total returns obtained from Burgiss Private IQ. This provides a single blended Real Estate policy benchmark return for the System.

[4] As the Private Real Estate allocation is funded (or distributions received) and/or the allocation increases/decreases due to the total market value of the Fund changing, the Publicly-traded Real Estate policy weight will be proportionately and conversely revised to reflect these changes. For example, if the allocation to Private Real Estate increases by 100 basis points due to a change in the market value of the total Fund in the fourth quarter, then starting with the first quarter the policy weight will include this 100 basis points increase in the Private Real Estate benchmark and the Publicly-traded Real Estate policy weight will also be proportionately reduced by 100 basis points. Adjustments to the Private Real Estate policy weight will be completed in 50 basis point increments (adjustment will be made to the nearest 0.50%) on a quarterly basis.

[5] Custom benchmark is structure as follows: MSCI ACWI ~~($Net)~~ TR Index (50%); Bloomberg Barclays ~~Capital~~ U~~.~~S~~.~~ Treasury TR Index (75%); Bloomberg Barclays ~~Capital~~ World Inflation-~~-~~Linked Bond All Maturities TR Index (Hedged to USD) (55%); Bloomberg Commodity TR Index ~~(Total Return)~~ (15%); Bloomberg Gold TR Subindex (5%); and ~~3-Month LIBOR~~ICE LIBOR 3 Month Index (-100%).

[6] Financing Cost of Leverage represents the amount of leverage embedded in the asset allocation. Financing may be deployed across any asset class in the portfolio where it is prudent to do so, based on efficient use of leverage within the constraints of the policy range and maximum net leverage permissible under this Policy.

VI. Risk Management and Controls

Risk Objectives

1. The assets of the System shall be diversified to minimize the Risk of losses within any one asset class, investment type, industry or sector exposure, maturity date, or geographic location. Failure to do so could seriously impair the System's ability to achieve its funding and long-term investment goals and objectives; and,

2. The System's assets shall be invested so that the probability of investment losses (as measured by the Policy Index) in excess of 15% in any one year is no greater than 2.5% (or two standard deviations below the expected return).

Constraints

1. The System shall maintain adequate liquidity to meet required benefit payments to the System's beneficiaries.

2. The System's assets shall be invested in a manner that is consistent with the System's long-term investment horizon.

3. As a tax-exempt investor, the System's assets may be invested without distinction between returns generated from income and returns generated from capital gains.

Risk Benchmarks

The Board adopts the following benchmarks, weighted for the Current Target Allocation, as a framework for risk measurement.

	Policy Weight
Equity Exposure	
Public:	
S&P 500 TR Index (75%), S&P MidCap 400 TR Index (12.5%), S&P Small Cap 600 TR Index (12.5%)	4.80%
MSCI ACWI ex USA IMI with Developed Market Currencies (75% Hedged to USD) Net TR Index	8.70%
MSCI Emerging Markets IMI Net TR Index	1.50%
Private:	
MSCI USA Small Cap TR Index (65%), MSCI ACWI ex USA Small Cap Net TR Index (35%)	15.00%
Total Equity Exposure	**30.00%**
Fixed Income Exposure	
Investment Grade	
Bloomberg Barclays US Aggregate Bond TR Index	4.00%
Bloomberg Barclays GDP Global Aggregate Bond Developed Market ex US TR Index (Hedged to USD)	0.00%
Bloomberg Barclays U.S. Long Treasury TR Index	6.00%
Credit-Related	
Public:	
J.P. Morgan GBI-EM Broad Diversified Index (34%), J.P. Morgan EMBI Global Diversified Index (33%), ICE BofAML EM Corporate Plus Index (Hedged to USD) (33%)	1.00%
Bloomberg Barclays US Corporate High Yield Bond Index	0%
Private:	
S&P LSTA Leveraged Loan TR Index	10.00%

Inflation Protected

Bloomberg Barclays US Government Inflation-Linked Bond All Maturities TR Index	7.50%
Bloomberg Barclays World Government ex US Inflation-Linked Bond All Maturities TR Index (Hedged to USD)	7.50%
Total Fixed Income Exposure	**36.00%**

Infrastructure

Public:	
Alerian Midstream Energy TR Index	3.00%
FTSE Developed Core Infrastructure 50/50 Net TR Index (Hedged to USD)	2.00%
Private:	
FTSE Developed Core Infrastructure 50/50 Net TR Index (Hedged to USD), one-quarter lagged	1.00%

Commodities

Bloomberg Commodity TR Index	5.00%
Bloomberg Gold TR Subindex	3.00%

Real Estate

Public:	
FTSE EPRA/NAREIT Developed, Net TR Index (Hedged to USD)	2.00%
Private	
FTSE NAREIT Composite TR Index (90%), FTSE EPRA/NAREIT Developed ex US TR Index (Hedged to USD) (10%)	8.00%
Total Real Asset Exposure	**24.00%**

Risk Parity

MSCI ACWI Net TR Index (50%); Bloomberg Barclays US Treasury TR Index (75%); Bloomberg Barclays World Inflation-Linked Bond All Maturities TR Index (Hedged to USD) (55%); Bloomberg Commodity TR Index (15%); Bloomberg Gold TR Subindex (5%); and ICE LIBOR 3 Month Index (-100%)	**8.00%**
Absolute Return	
HFRI Fund of Funds Conservative Index	**10.00%**
Net Leverage	
Cash	
ICE BofAML 0-3 Month US Treasury Bill Index	6.00%
Financing Cost of Leverage	
ICE LIBOR 3 Month Index	-14.00%
Net Leverage	**-8.00%**
TOTAL	**100.00%**

Investment Manager Target Ranges

All allocations to individual Investment Manager portfolios shall be subject to the limits established by the Board through the Current Target Allocation in the **Strategic Asset Allocation** section. IOS is permitted to manage the allocation of capital to each Investment Manager portfolio within the target ranges to of the total fund noted below. The CIO shall have discretion on the timing of reducing any Investment Manager portfolio exceeding the maximum ranges approved below. However, the CIO is not permitted to allocate additional capital to those portfolios currently above the target ranges.

	Target Capital Ranges as a Percentage of the Total Fund
Equity Portfolios:	
Public Markets U.S. Equity Portfolios	
Internally Managed S&P 500 Index	0.0% - 20.0%
Internally Managed S&P 400 Index	0.0% - 5.0%
Internally Managed S&P 600 Index	0.0% - 5.0%
Internally Managed Synthetic Beta Replication[1]	0.0% - 5.0%
Public Markets Non-U.S. Equity Portfolios	
Internally Managed MSCI ACW Index ex. U.S.	0.0% - 15.0%
Internally Managed MSCI World Small Cap Index ex. U.S.	0.0% - 2.5%
Internally Managed MSCI Emerging Markets Index	0.0% - 2.5%

The overall return objective is to realize a return sufficient to achieve funding adequacy on an inflation-adjusted basis. Funding adequacy is achieved when the actuarial market value of assets is at least equal to the System's projected benefit obligations. The System has a return objective of meeting or exceeding the actuarial rate (currently 7.25%) over the long-term. In addition, the Board has the following broad objectives:

- The assets of the System shall be invested to maximize the returns for the level of Risk taken; and,
- The System shall strive to achieve a return that exceeds the Policy Index.

Policy Index

The Board adopts the following weighted policy benchmarks for the Current Target Allocation to measure the performance of the System beginning October 1, 2019, subject to footnotes 1 & 4:

	Policy Weight	
Equity Exposure		
Public:		
S&P 500 TR Index (75%), S&P MidCap 400 TR Index (12.5%), S&P Small Cap 600 TR Index (12.5%)	4.80%	1
MSCI ACWI ex USA IMI with Developed Market Currencies (75% Hedged to USD) Net TR Index	8.70%	1
MSCI Emerging Markets IMI Net TR Index	1.50%	
Private:		
Burgiss TR, one-quarter lagged[2]	15.00%	1
Total Equity Exposure	**30.00%**	
Fixed Income Exposure		
Investment Grade		
Bloomberg Barclays US Aggregate Bond TR Index	4.00%	
Bloomberg Barclays GDP Global Aggregate Bond Developed Market ex US TR Index (Hedged to USD)	0.00%	
Bloomberg Barclays U.S. Long Treasury TR Index	6.00%	
Credit-Related		
Public:		
J.P. Morgan GBI-EM Broad Diversified Index (34%), J.P. Morgan EMBI Global Diversified Index (33%), ICE BofAML EM Corporate Plus Index (Hedged to USD) (33%)	1.00%	
Bloomberg Barclays US Corporate High Yield Bond Index	0%	
Private:		
S&P LSTA Leveraged Loan TR Index + 200bps	10.00%	
Inflation Protected		
Bloomberg Barclays US Government Inflation-Linked Bond All Maturities TR Index	7.50%	

Bloomberg Barclays World Government ex US Inflation-Linked Bond All Maturities TR Index (Hedged to USD)	7.50%	
Total Fixed Income Exposure	**36.00%**	
Infrastructure		
Public:		
Alerian Midstream Energy TR Index	3.00%	
FTSE Developed Core Infrastructure 50/50 Net TR Index (Hedged to USD)	2.00%	
Private:		
FTSE Developed Core Infrastructure 50/50 Net TR Index (Hedged to USD), one-quarter lagged	1.00%	
Commodities		
Bloomberg Commodity TR Index	5.00%	
Bloomberg Gold TR Subindex	3.00%	
Real Estate		
Public:		
FTSE EPRA/NAREIT Developed, Net TR Index (Hedged to USD)	2.00%	[4]
Private		
NFI and Burgiss TR, one-quarter lagged[3]	8.00%	[4]
Total Real Asset Exposure	**24.00%**	
Risk Parity		
Custom Benchmark[5]	**8.00%**	
Absolute Return		
HFRI Fund of Funds Conservative Index + 100bps	**10.00%**	
Net Leverage		
Cash		
ICE BofAML 0-3 Month US Treasury Bill Index	6.00%	
Financing Cost of Leverage[6]		
ICE LIBOR 3 Month Index	-14.00%	
Net Leverage	**-8.00%**	
TOTAL	**100.00%**	

Footnotes to Policy Index:

[1] As the Private Markets allocation is funded (or distributions received) and/or the allocation increases/decreases due to the total market value of the Fund changing, the Publicly-traded Global Equity policy weight (specifically, the combination of US Equity Indices and MSCI ACWI ex USA IMI with Developed Market Currencies hedged to USD Index policy weights) will be proportionately and conversely revised to reflect these changes using a 60-40 split between the ex. USA (60%) and USA (40%) indices. For example, if the allocation to Private Markets increases by 100 basis points due to a change in the market value of the total Fund in the fourth quarter, then starting with the first quarter the policy weight will include this 100 basis points increase in the Private

Markets benchmark and the Publicly-traded Global Equity policy weights will also be proportionately reduced by 100 basis points. Adjustments to the Private Markets policy weight will be completed in 50 basis point increments (adjustment will be made to the nearest 0.50%) on a quarterly basis.

[2] The benchmark returns are calculated using the rolling 5-year (20 quarters) total returns obtained from Burgiss Private IQ relevant universe (i.e. Generalist, Expansion Capital, Buyout, Debt, Infrastructure, Natural Resources, Secondary Fund of Funds, and North America-focused Venture Capital).

[3] PSERS weights each of the real estate investment strategies actual net asset values of the System's private real estate investments quarterly to produce a customized, blended benchmark return. The NFI-ODCE (NCREIF Open-end Diversified Core Equity) is used for the core strategy whereas returns for value-added and opportunistic strategies are calculated using the total returns obtained from Burgiss Private IQ. This provides a single blended Real Estate policy benchmark return for the System.

[4] As the Private Real Estate allocation is funded (or distributions received) and/or the allocation increases/decreases due to the total market value of the Fund changing, the Publicly-traded Real Estate policy weight will be proportionately and conversely revised to reflect these changes. For example, if the allocation to Private Real Estate increases by 100 basis points due to a change in the market value of the total Fund in the fourth quarter, then starting with the first quarter the policy weight will include this 100 basis points increase in the Private Real Estate benchmark and the Publicly-traded Real Estate policy weight will also be proportionately reduced by 100 basis points. Adjustments to the Private Real Estate policy weight will be completed in 50 basis point increments (adjustment will be made to the nearest 0.50%) on a quarterly basis.

[5] Custom benchmark is structure as follows: MSCI ACWI Net TR Index (50%); Bloomberg Barclays US Treasury TR Index (75%); Bloomberg Barclays World Inflation-Linked Bond All Maturities TR Index (Hedged to USD) (55%); Bloomberg Commodity TR Index (15%); Bloomberg Gold TR Subindex (5%); and ICE LIBOR 3 Month Index (-100%).

[6] Financing Cost of Leverage represents the amount of leverage embedded in the asset allocation. Financing may be deployed across any asset class in the portfolio where it is prudent to do so, based on efficient use of leverage within the constraints of the policy range and maximum net leverage permissible under this Policy.

VI. Risk Management and Controls

Risk Objectives

1. The assets of the System shall be diversified to minimize the Risk of losses within any one asset class, investment type, industry or sector exposure, maturity date, or geographic location. Failure to do so could seriously impair the System's ability to achieve its funding and long-term investment goals and objectives; and,
2. The System's assets shall be invested so that the probability of investment losses (as measured by the Policy Index) in excess of 15% in any one year is no greater than 2.5% (or two standard deviations below the expected return).

Constraints

1. The System shall maintain adequate liquidity to meet required benefit payments to the System's beneficiaries.
2. The System's assets shall be invested in a manner that is consistent with the System's long-term investment horizon.
3. As a tax-exempt investor, the System's assets may be invested without distinction between returns generated from income and returns generated from capital gains.

Risk Benchmarks

The Board adopts the following benchmarks, weighted for the Current Target Allocation, as a framework for risk measurement.

	Policy Weight
Equity Exposure	
Public:	
S&P 500 TR Index (75%), S&P MidCap 400 TR Index (12.5%), S&P Small Cap 600 TR Index (12.5%)	4.80%
MSCI ACWI ex USA IMI with Developed Market Currencies (75% Hedged to USD) Net TR Index	8.70%
MSCI Emerging Markets IMI Net TR Index	1.50%
Private:	
MSCI USA Small Cap TR Index (65%), MSCI ACWI ex USA Small Cap Net TR Index (35%)	15.00%
Total Equity Exposure	**30.00%**
Fixed Income Exposure	
Investment Grade	
Bloomberg Barclays US Aggregate Bond TR Index	4.00%
Bloomberg Barclays GDP Global Aggregate Bond Developed Market ex US TR Index (Hedged to USD)	0.00%
Bloomberg Barclays U.S. Long Treasury TR Index	6.00%
Credit-Related	
Public:	
J.P. Morgan GBI-EM Broad Diversified Index (34%), J.P. Morgan EMBI Global Diversified Index (33%), ICE BofAML EM Corporate Plus Index (Hedged to USD) (33%)	1.00%
Bloomberg Barclays US Corporate High Yield Bond Index	0%
Private:	
S&P LSTA Leveraged Loan TR Index	10.00%
Inflation Protected	
Bloomberg Barclays US Government Inflation-Linked Bond All Maturities TR Index	7.50%
Bloomberg Barclays World Government ex US Inflation-Linked Bond All Maturities TR Index (Hedged to USD)	7.50%
Total Fixed Income Exposure	**36.00%**
Infrastructure	
Public:	
Alerian Midstream Energy TR Index	3.00%
FTSE Developed Core Infrastructure 50/50 Net TR Index (Hedged to USD)	2.00%
Private:	
FTSE Developed Core Infrastructure 50/50 Net TR Index (Hedged to USD), one-quarter lagged	1.00%

Commodities	
Bloomberg Commodity TR Index	5.00%
Bloomberg Gold TR Subindex	3.00%
Real Estate	
Public:	
FTSE EPRA/NAREIT Developed, Net TR Index (Hedged to USD)	2.00%
Private	
FTSE NAREIT Composite TR Index (90%), FTSE EPRA/NAREIT Developed ex US TR Index (Hedged to USD) (10%)	8.00%
Total Real Asset Exposure	**24.00%**
Risk Parity	
MSCI ACWI Net TR Index (50%); Bloomberg Barclays US Treasury TR Index (75%); Bloomberg Barclays World Inflation-Linked Bond All Maturities TR Index (Hedged to USD) (55%); Bloomberg Commodity TR Index (15%); Bloomberg Gold TR Subindex (5%); and ICE LIBOR 3 Month Index (-100%)	**8.00%**
Absolute Return	
HFRI Fund of Funds Conservative Index	**10.00%**
Net Leverage	
Cash	
ICE BofAML 0-3 Month US Treasury Bill Index	6.00%
Financing Cost of Leverage	
ICE LIBOR 3 Month Index	-14.00%
Net Leverage	**-8.00%**
TOTAL	**100.00%**