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To: **State of Michigan Investment Board**

From: Max Kotary, CFA
Stephen Cummings, CFA
Phil Kivarkis, FSA, CFA
John Sullivan
Tim McEnery, CFA

Date: September 30, 2020

Re: MSERS A/L Study – Executive Summary

Overview and Summary

The purpose of this memorandum is to provide a review of the current Asset / Liability (A/L) profile of the Michigan State Employees' Retirement System (MSERS) Defined Benefit Plan and summarize the conclusions that can be drawn from the Asset / Liability Study that Aon recently completed on the Plan. We also provide answers to frequently asked questions relating to our A/L Studies, for reference.

Current A/L Profile: State of Michigan Summary

The State of Michigan offers the following pension and OPEB plans, with asset/liability characteristics shown as of September 30, 2018[1] – the most recent actuarial valuation report available.

Figure 1

		(In $ millions)				
Pension	**Discount Rate**	**Market Value of Assets**	**Actuarial Liability**	**Funded Ratio**	**Liability Growth Rate**	**Asset Hurdle Rate**
- *Michigan Public Schools Employees' Retirement System*	6.80%	$50,343.5	$83,375.3	60.38%	7.81%	12.93%
- *Michigan State Employees' Retirement System*	6.70%	$12,398.0	$18,995.2	65.27%	6.97%	10.68%
- *Michigan State Police Retirement System*	6.80%	$1,492.4	$2,271.1	65.71%	7.96%	12.11%
- *Michigan Judges' Retirement System*	6.25%	$271.1	$280.9	96.51%	7.27%	7.54%
- *Military Retirement Provisions*	6.75%	$17.2	$56.8	30.30%	7.90%	26.08%
- *Total Pension*		$64,522.2	$104,979.4	61.46%	7.66%	12.46%
OPEB						
- *Michigan Public Schools Employees' Retiree Health Benefits*	6.95%	$6,111.2	$13,748.9	44.45%	7.35%	16.53%
- *Michigan State Employees' Retiree Health Benefits*	6.90%	$2,562.8	$10,630.3	24.11%	7.89%	32.72%
- *Michigan State Police Retiree Health Benefits*	6.90%	$191.0	$777.3	24.57%	8.13%	33.08%
- *Michigan Judges' Retiree Health Benefits*	7.00%	$1.1	$8.4	12.52%	9.82%	78.44%
- *Total OPEB*		$8,866.1	$25,164.9	35.23%	7.60%	21.57%

[1] September 30, 2018 represents the starting point of our analysis as it is the most recent actuarial liability detail available for our projections, we have overlaid actual return experience through March 31, 2020 to allow our analysis to be as up-to-date as possible.

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Key Conclusions of A/L Study

Below we summarize what we view to be the key takeaways from the A/L Study on the MSERS Plan.

1) The MSERS plan is currently underfunded (65.3% as of 9/30/2018) which suggests a growth-oriented investment portfolio is reasonable.

2) MSERS' funding gap will be filled by a combination of plan contributions and investment returns.

    a. Contribution policy will take the plan to a fully funded state regardless of the investment strategy modeled due to the unique characteristics of the plan's funding policy. (These characteristics are explored in detail within the A/L Study and are addressed in summary fashion in the Q&A section of this memorandum.)

    b. The expected return for the Current asset allocation targets based on our current capital market assumptions exceeds the actuarial rate of return (6.70%); that margin will help to close the funding shortfall over time, alleviating some of the burden on future contributions.

3) MSERS' mix of return-seeking asset classes aligns reasonably well with our best thinking for portfolio construction.

    a. In Figure 2, we compare MSERS' existing asset allocation targets to Aon's Public Fund "Model Portfolios", scaled to MSERS' current level of return-seeking assets. (I.e. 87.5% R-S.) Aon's Model Portfolios are designed to be representative of Aon's best thinking for Public Defined Benefit Plan asset allocation policy across a range of different plan circumstances. (By 'plan circumstances' we are referring to things such as internal staffing levels, tolerance for illiquidity, tolerance for complexity, etc.) Our Model Portfolios are not one-size fits all; rather, they are meant to be used as a starting point for asset allocation analysis and decision making.

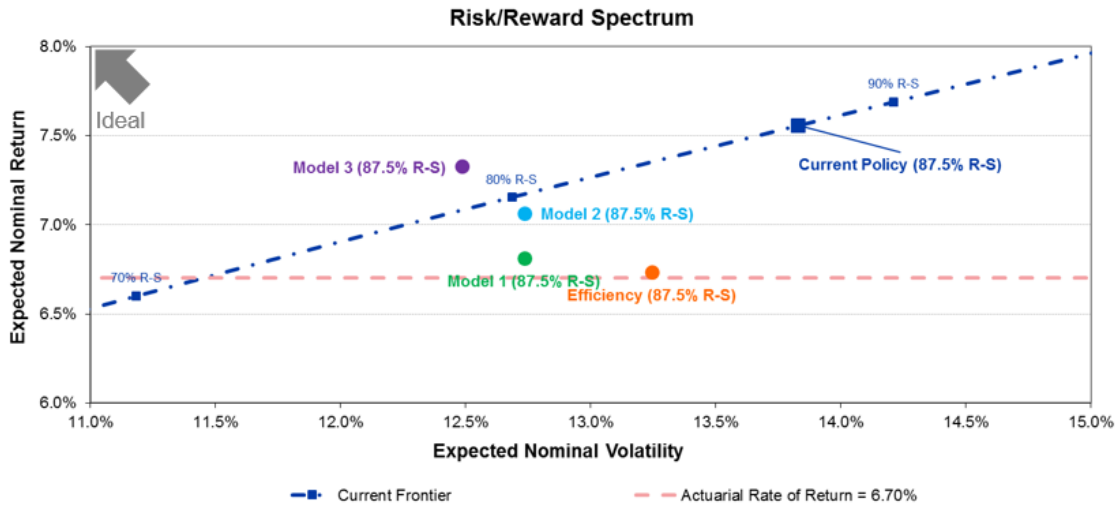
        i. Efficiency Portfolio = Appropriate for public pension plans that prefer to access markets in a simple, low cost manner.

        ii. Model 1 Portfolio = Appropriate for public pension plans with modest internal resources and a relatively low tolerance for complexity and illiquidity.

        iii. Model 2 Portfolio = Appropriate for public pension plans with an average level of internal resources and tolerance for complexity and illiquidity.

        iv. Model 3 Portfolio = Appropriate for public pension plans with deep internal resources and a high tolerance for complexity and illiquidity.

Figure 2



b. Key takeaways from Figure 2:

   i. MSERS' current policy has a higher long-term return forecast than any Aon Model Portfolio.

   ii. MSERS' current policy is more efficient than three of the four Aon Model Portfolios (I.e., its frontier plots above Aon Efficiency, Aon Model 1, and Aon Model 2.)

      1. The dashed blue line is representative of MSERS' exiting policy scaled to different levels of return-seeking (R-S) assets.

   iii. MSERS' current policy models as more volatile (i.e., has a higher standard deviation of forecasted investment returns) than the Aon Model portfolios.

      1. This is being driven, at least in part, by MSERS' existing policy having a higher allocation to equities (public + private), particularly relative to Aon Model 3.

4) From an overall investment risk-posture standpoint, we find that:

   a. Higher risk asset allocation policies will be assumed to have lower plan contributions over time but with more volatility of contributions.

   b. Lower risk asset allocation policies will be assumed to have higher plan contributions over time but with less volatility of contributions.

Figure 3

Expected Return Distributions

R-S%	30Y Expected Return	30Y Nominal Volatility	Sharpe Ratio	1Y Return (2 STD Down)
70.0%	6.60%	11.18%	0.49	-13.43%
72.5%	6.74%	11.55%	0.49	-13.88%
75.0%	6.88%	11.93%	0.48	-14.33%
77.5%	7.02%	12.31%	0.48	-14.78%
80.0%	7.15%	12.68%	0.48	-15.23%
82.5%	7.29%	13.06%	0.47	-15.68%
85.0%	7.42%	13.44%	0.47	-16.12%
87.5%	7.56%	13.83%	0.47	-16.57%
90.0%	7.69%	14.21%	0.46	-17.01%

Figure 4

Contribution Impact

(Max as a Multiple of FYE 2019 Total Contribution Dollars)

R-S%	50th Percentile	95th Percentile	99th Percentile
70.0%	1.6	5.0	5.9
72.5%	1.5	5.1	5.9
75.0%	1.5	5.1	6.0
77.5%	1.4	5.2	6.0
80.0%	1.4	5.2	6.1
82.5%	1.4	5.2	6.2
85.0%	1.4	5.2	6.2
87.5%	1.4	5.2	6.2
90.0%	1.4	5.3	6.3

c. The ideal investment allocation policy for MSERS should consider the desired balance between funding, investment returns, and risk tolerance.

5) All else equal, we believe MSERS could benefit from incrementally reducing its investment risk posture.

   a. Incremental efficiency gains. (I.e., increased return per unit of risk assumed / Sharpe Ratio.)

   b. Reduced severity of downside outcomes.

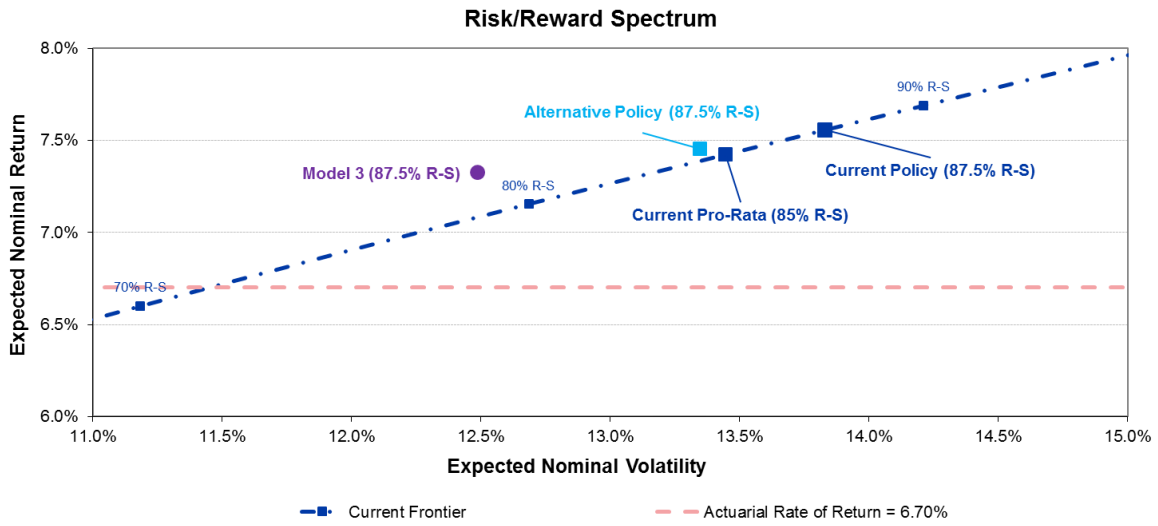
   c. More aligned with peer allocations / Aon Model Portfolios.

6) To reduce investment risk, MSERS could:

   a. Maintain current return-seeking asset mix, reduce allocation to return-seeking assets pro-rata, OR

   b. Maintain current target allocation to return-seeking assets, but reduce allocation to equities and add to exposures in diversifying assets such as Absolute Return and Real Return and Opportunistic strategies.

Figure 5



c. We find the latter approach more compelling, as it has a similar impact on forecasted volatility while retaining incrementally more upside.

   i. Please refer to Figure 5; "Alternative Policy (87.5% R-S)" is forecast to have modestly higher returns at a modestly lower level of volatility than simply moving incrementally down the Current Frontier. (E.g., "Current Pro-Rata (85% R-S)".)

7) Figure 6 includes our recommended asset allocation targets for MSERS; these targets are what is modeled as "Alternative Policy" in Figure 5.

   a. We have also included recommendations for permissible ranges around these targets in Figure 6.

Figure 6

Asset Class	Current Target	Recommended Target	Difference	Current Range	Recommended Range
Domestic Equity	28.0%	25.0%	(3.0%)	20–35%	17–32%
International Equity	16.0	15.0	(1.0)	15–25	12–22
Private Equity	18.0	16.0	(2.0)	10–20	8–18
Long Term Fixed Income	10.5	10.5	--	10–20	10–20
Real Estate & Infrastructure	10.0	10.0	--	5–15	8–18
Real Return & Opportunistic	9.5	12.5	+3.0	5–15	8–18
Absolute Return	6.0	9.0	+3.0	3–9	5–11
Short Term Fixed Income	2.0	2.0	--	1–6	1–8
Total	100.0%	100.0%	--	100.0%	*100.0%*

Frequently Asked Questions

Q: What is an A/L Study?

A: An asset/liability study is a comprehensive review of a pension/OPEB plan's assets and liabilities. Utilizing an A/L Study to assist in setting fund asset allocation policy is generally considered to be a best practice amongst public pension systems.

Q: What is the purpose of an A/L Study?

A: An A/L Study provides a toolkit for making decisions on a fund's asset allocation and level of investment risk to best align the plan's assets with the liabilities the fund supports. The study describes the balance between the potential variability of investment returns and the variability of cash flows (contributions) funding the plan. Aon believes optimal decisions regarding pension plan management are made when they are based on a clear understanding of the assets and liabilities of the plan(s) and how they interact. By conducting an A/L Study we can better ascertain the risk preferences of the plan sponsor to best achieve the plan's goals.

Q: How is the A/L Study put together?

A: Aon works with the plan's actuary, in this case GRS, to get a clear understanding of the current benefit structure and funding policy. (I.e., forecasted cash inflows and outflows.) We then use Aon's proprietary Asset/Liability Model to generate up to 5,000 economic scenarios over the next ten-to-thirty years using a Monte Carlo simulation process. Key variables we simulate for the liabilities include inflation, interest rates, and pay increases. We also simulate asset class returns. These simulations lead to a projection of assets and liabilities under all economic scenarios for various asset allocation policies, allowing us to illustrate expected risk-reward tradeoffs in terms of investment return, cash contributions, funded status, net outflow, and 'economic cost.' ('Economic cost' represents the present value of forecasted contributions + any funding shortfall at the end of the projection period.)

Q: How does one read the Study?

A: In its most basic sense, an A/L Study outlines risk/reward tradeoffs of various asset allocation policies. Instead of simply evaluating tradeoffs in terms of returns and volatility of returns, the A/L Study incorporates the liabilities to allow for the evaluation of risk/reward in terms of cash contributions, funded status, net outflow, and economic cost. The Study presents these tradeoffs in the form of a distribution of potential outcomes, highlighting the 95th, 75th, 50th, 25th, and 5th percentile outcomes for each asset allocation policy considered. To better illustrate risk vs. reward, the Study often contrasts the median outcome ("Expected") with the 95th or 5th percentile outcome ("Downside") for the various asset allocation policies considered.

Q: Does the Study rely on stochastic analysis or deterministic analysis?

A: We believe both types of analysis are important and incorporate both within our A/L Studies. Most of the forecasts presented in our A/L Study are stochastic in nature and are based on 5,000 economic scenarios that are generated using a Monte Carlo simulation process. These forecasts are designed to encompass the full range of potential economic outcomes over the period being analyzed. We also review deterministic analyses in our A/L modeling process to help answer the question "What might the impact be on the plan's funded ratio, contribution policy, etc. if X environment were to occur?" Our deterministic analyses focus on downside scenarios (e.g., Recession, Depression) and are designed to help take the concept of downside risk out of the abstract and tie it to a tangible economic scenario.

Q: What are some limitations of asset/liability modeling?

A: Asset/liability studies are best-suited to determine the optimal mix of return-seeking (e.g., equity) and risk-reducing (e.g., fixed income) assets. Asset mix is the single most important investment decision for the plan sponsor; studies have found that more than 90% of the variability of a portfolio's return is determined by the asset allocation. Decisions regarding how to divide allocations among various sub-categories that are highly correlated and have similar risk profiles are less important in an asset/liability context. Additionally, asset/liability modelling can capture the likelihood of a strategy meeting the plan sponsor's objectives. It does not 'predict' the future; i.e., we cannot say which of the economic scenarios included in our modelling will occur. The results depend on the assumptions underlying the model and the structure of the model itself. There are also variables that cannot be modelled effectively and must be considered in addition to the results of any analysis – e.g., idiosyncratic manager risk, liquidity requirements, black swan events, etc.

Q: What are the key assumptions used in this Study?

A: On the asset side of the equation, we use assumptions for capital market returns, standard deviation of returns (volatility), and correlation of returns. These assumptions are developed and maintained by our capital markets modeling team and updated on a quarterly basis; detail on these assumptions can be found in the Appendix of the Study. On the liability side, our analysis relies on data from the plan actuary combined with Michigan's specific contribution policy – inclusive of closed amortization period, Dedicated Gains Policy, etc.

Of note, our Study assumes that existing contribution / benefits structure remains in place throughout the duration of our analysis.

Q: What is Michigan's Dedicated Gains Policy and how does it work?

A: Adopted in 2017, the Dedicated Gains Policy established a framework to systematically reduce the actuarial assumed rate of investment return used to measure the plan liability when actual investment returns exceed pre-determined actuarial increments. After periods of strong returns (i.e., actual returns exceeding assumed returns), the Dedicated Gains Policy will lower the actuarial return assumption, increase the plan liability, but maintain similar plan contribution levels both before and after the change to the assumed return. After periods of poor returns (i.e., actual returns lagging assumed returns), there would be no changes to the actuarial assumption and plan contributions would increase, re-setting the floor for how low contributions can go in the future. **Therefore, annual contributions are not projected to decline under the current contribution policy until the Dedicated Gains Policy exhausts and reaches its minimum thresholds or the plan reaches full funding.**

Q: What is the amortization policy for contributions?

A: Michigan utilizes a closed amortization approach whereby all unfunded liability is amortized over a specific number of years, reducing by one annually until immediate recognition of (gains)/losses. **Due to the specific point in time that the liability is expected to be fully funded, the forecasted volatility of contributions will increase significantly as that point in time approaches as there are fewer and fewer years across which to spread the cost of any remaining unfunded liability.**

Q: Does an A/L Study consider changes to contribution policy?

A: Most typically no, but on occasion we have employed our asset/liability model to analyze the impact of various changes in the benefit structure or funding policy to the future funded status of a plan. We note that in previous versions of this study, we modeled various iterations of the Dedicated Gains Policy.

Q: How might changes to contribution policy impact the results of the study?

A: It is difficult to say and would depend upon the specifics of the changes. In very broad terms, we would comment that modifications to (or the removal of) the more unique aspects of MSERS' contribution policy – i.e., the Dedicated Gains Policy and the closed amortization period – would alter the numerical calculations throughout the analysis but would be unlikely to impact the key messages of the study.

Q: What is the typical projection period of an A/L Study?

A: Our analysis typically covers time horizons of up to 30 years. For pension/OPEB funds, we believe asset allocation decisions should be made with a long-term view, consistent with the fact that the assets support liabilities that have a very long-time horizon. MSERS' contribution policy, as it stands today, is designed to move the plan to full funded status over a finite period. The policy's applicability after that point comes into question, and it introduces a fair amount of noise into our analysis beyond

the end of the amortization period. For this reason, we have truncated our projections in this Study to align more closely with the end of MSERS' closed amortization period.

Q: Do the asset class return assumptions used in the Study represent asset class returns that are available in the market today?

A: Not necessarily. For A/L Studies, we are projecting the behavior of assets and liabilities over long-term time horizons; as such, we use our longest-term (i.e., 30 year) assumed rates of return for the capital markets. Current market conditions and valuations will impact our long-term return projections, but so will our view on long-term fair value for factors such interest rates, credit spreads, and equity market valuation. A simple example of our long-term assumptions not being reflective of current market conditions is our assumed rate of return on cash. Currently, the return on cash available in the market is ≈0%. But we do not believe that cash yields will be 0% for the next 30 years, hence our assumed rate of return on cash for the purposes of the A/L Study is > 0%.

Q: How often should an AL study be done?

We suggest conducting asset/liability studies every three-to-five years depending on client specifics, or more frequently should circumstances dictate. (Such circumstances might include material changes to the fund's liability profile or contribution policy.)

Q: What is an asset hurdle rate?

A: An asset hurdle rate is the growth needed from the assets, through both contributions and investment returns, to keep pace with the growth of the liability. It is calculated as the liability growth rate divided by the funded ratio.

Q: What is a liability growth rate?

A: Liability growth rate is the projected growth of the liability over the coming year as measured by the sum of the normal cost (i.e., new benefit accruals) and interest cost (i.e., one year of discounting).

Q: What is a funded ratio?

A: A Plan's funded ratio represents the value of plan assets (either the market value or actuarial value; the latter incorporates smoothing techniques) divided by the projected value of plan liabilities. A plan's funded ratio is an important metric, but it tells only a portion of the story. Of equal, or perhaps greater, importance to a pension/OPEB plan's financial health and long-term viability is the plan sponsor's willingness and ability to support future funding obligations.

Q: What are 'return-seeking' assets and 'risk-reducing' assets?

A: In general terms, our A/L Studies are designed to address two asset allocation-related questions: 1) What is an appropriate level of investment risk for a pension/OPEB plan, given its liability profile; and 2) what is the most optimal way to take that risk? Question 2) could be addressed without

considering plan liabilities in a separate Asset Allocation Study, but since questions 1) and 2) are related we typically address them both within the framework of an Asset/Liability Study.

Question 1) is really the crux of an A/L Study. In order to simplify the analyses that address this question, our A/L studies bucket asset classes into one of two categories: "risk-reducing" – most typically cash and high-quality fixed income, and "return-seeking" – virtually all other classes of assets. We attempt to identify the most appropriate level of investment risk for a plan sponsor to assume by dialing the return-seeking and risk-reducing allocations up and down proportionally to illustrate risk-reward tradeoffs. Once we arrive at the most appropriate level of investment risk for the portfolio, the mix of underlying asset classes can be refined, and an asset allocation policy can be set that assigns target weightings to each individual asset class that is part of either the return-seeking or risk-reducing bucket.

Q: What if MSERS put all its portfolio in return-seeking assets?

A: This would result in a roughly $344 million reduction in future contributions to the plan over the next 15 years relative to the current asset allocation policy, based on our modeling. But such a policy would come under intense scrutiny in a down market and is likely not sustainable. It could also lead to liquidity challenges. If such an asset allocation policy were adopted and then changed under the pressure of a down market, it could very well result in an increase in future contributions relative to the current asset allocation policy.

Figure 7

	Current Policy (87.5% Return-Seeking)	**90% Return Seeking**	**100% Return Seeking**
Forecasted Return	7.56%	7.69%	8.23%
Forecasted Volatility	13.83%	14.21%	15.76%
Sharpe Ratio	0.47	0.46	0.45
1 Year Return (2 Std Deviations Down)	-16.57%	-17.01%	-18.75%
Mark-to-Market Loss on a $10 billion portfolio (2 Std Dev)	$1.66 billion	$1.70 billion	$1.88 billion
Loss Relative to Current Policy	--	($0.04 billion)	($0.22 billion)

Q: What if MSERS put all its portfolio in risk-reducing assets?

A: This would result in much more certainty in future contributions, but it would also increase them dramatically. As illustrated in Figure 8 below, forecasted contributions under a 0% return-seeking (i.e., 100% risk-reducing) scenario would increase to approximately 4.7X their FYE 2019 level over the forecast period in our median outcome. The distribution of potential contribution outcomes becomes much narrower, but with a tremendous increase to average cost.

Figure 8

Contribution Impact

(Max as a Multiple of FYE 2019 Total Contribution Dollars)

Asset Allocation	50th Percentile	95th Percentile	99th Percentile
Current Policy 87.5% R-S	1.4	5.2	6.2
0% R-S*	4.7	5.3	5.4

*0% Return-Seeking = 100% Risk-Reducing

Q: So what is the right asset allocation policy for MSERS, based on the results of this Study?

A: If only it were that simple! A/L Studies are not necessarily prescriptive, and unfortunately rarely point to an obvious "right" answer. What we can say based on this Study, however, is:

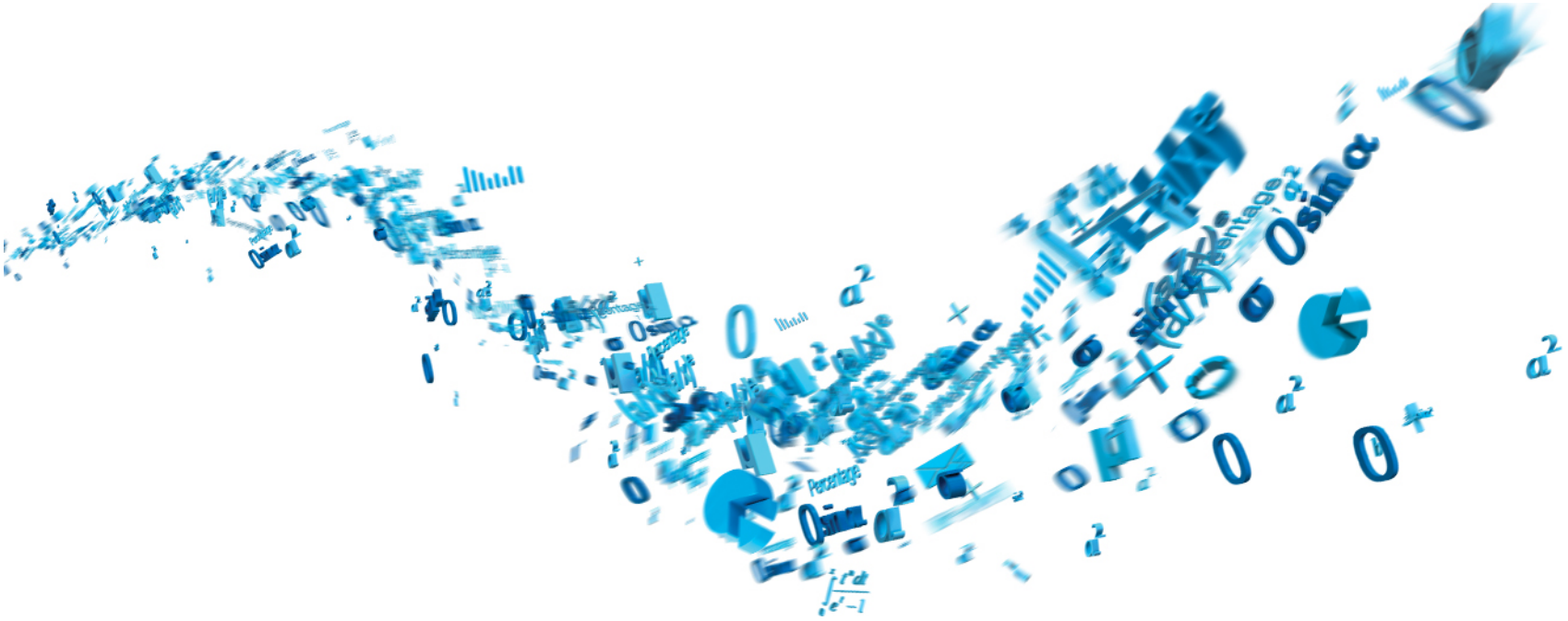
1) A relatively high allocation to return-seeking assets is supportable, given the nature of MSERS' liabilities. MSERS is currently underfunded (≈65% as of 9/30/2018), and its current contribution policy forces full funding at the end of its closed amortization period. This contribution policy results in a pretty heavy projected future contribution burden. Reducing the allocation to return-seeking assets would only add to this burden.

2) Further increasing the allocation to return-seeking assets has diminishing marginal benefits. The current target allocation (i.e., 87.5% in return-seeking assets) places a heavy emphasis on return-seeking assets. Increasing this allocation further would lead to reduced returns per unit of risk assumed (i.e., lower Sharpe Ratio), and would also lead to increasingly dire outcomes during market corrections. The latter could have implications for liquidity and the System's ability to make benefit payments under the most draconian market scenarios.

3) MSERS Current Policy allocation generally aligns well with our best thinking for portfolio construction. MSERS Current Policy plots as more efficient (i.e., more return per unit of risk assumed) than three of our four Model Portfolios. It also has a higher long-term return expectation than any of our Model Portfolios.

4) Reducing equity risk and increasing exposure to diversifying asset categories (e.g., Absolute Return, Real Return & Opportunistic) could improve the efficiency of the MSERS portfolio, at least at the margin. Taking these actions will improve forecasted downside outcomes without meaningfully reducing forecasted average outcomes. It will also bring the risk posture of the MSERS portfolio more

in line with that of our Model Portfolios. The impact would be similar to incrementally reducing the allocation to return-seeking assets under the current asset allocation policy, but with modestly more upside.



Asset-Liability Study Overview

Michigan State Employees' Retirement System (MSERS)
September 2020

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

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Asset-Liability Study Overview

1 What?

- An asset-liability study is a comprehensive toolkit for making decisions on a fund's asset allocation and investment risk that align with the liabilities those funds support.

2 Why?

- Aon believes optimal decisions regarding pension/OPEB plan management are made when they are based on a clear understanding of the assets and liabilities of the plan(s) and how they interact. From this study, we can better ascertain the risk preferences of the investment program to best achieve the plan goals.

3 When?

- For a formal review of the asset-liability modeling, Aon suggests conducting asset-liability studies every three to five years depending on client specifics, or more frequently should circumstances dictate (e.g., material changes to the liability profile, etc.).

4 How?

- Identify future trends in the financial health of the fund (e.g., funded ratio, contributions, etc.) based on economic uncertainties that may not be evident from an actuarial valuation, which provides only a snapshot at a point in time.

Key Themes

- The MSERS plan is currently underfunded (≈65% as of 9/30/2018[1]) which suggests a growth-oriented portfolio is reasonable
- The funding gap will be filled by a combination of 1) plan contributions and 2) investment returns
  - Contribution policy will take the plan to a full funded state regardless of the investment strategy modeled due to the unique characteristics of the policy
- MSERS' mix of return-seeking asset classes aligns reasonably well with our best thinking for portfolio construction
  - Reducing exposure to equity risk and adding exposure to diversifying asset categories (E.g., Absolute Return, Real Return & Opportunistic) would improve the efficiency of the MSERS portfolio, at least at the margin, based on our capital market assumptions
- The key question addressed by our A/L Study is should MSERS have less, more, or the same amount of its portfolio invested in return-seeking assets
- When looking at varying the allocation to return-seeking assets, we'll find that:
  - Higher risk strategies will be assumed to have less contributions but with more volatility
  - Lower risk strategies will be assumed to have higher contributions but with less volatility
- The ideal investment strategy for MSERS should consider the desired balance between funding, investment returns, and risk tolerance

[1] September 30, 2018 represents the starting point of our analysis as it is the most recent actuarial liability detail available; for our projections, we have overlaid actual return experience through March 31, 2020 to allow our analysis to be as up-to-date as possible

Portfolio Analysis
Current Target Asset Allocation

- The Current Target Asset Allocation is modeled to our capital market assumptions as follows:

Target Asset Allocation as of 12/31/2019		
	Alloc %	**Capital Market Assumption Mapping**
Return-Seeking		
- U.S. Equity	28.0%	90% U.S. Large Cap / 10% U.S. Small Cap
- International Equity	16.0%	75% International Developed / 25% Emerging Markets
- Private Equity	18.0%	Private Equity
- Real Estate & Infrastructure	10.0%	8.5% Real Estate (20% Core Real Estate / 80% Non-Core Real Estate) / 1.5% Infrastructure
- Absolute Return	6.0%	Broad Hedge Funds (Universe)
- Real Return / Opportunistic	9.5%	50% Private Equity / 50% Multi-Asset Credit
- Total	87.5%	
Risk-Reducing		
- Cash & Short Term Fixed Income	2.0%	Cash
- Long Term Fixed Income	10.5%	Core Fixed Income
- Total	12.5%	
Total	100.0%	

Spectrum of Aon Model Portfolios

- Aon's Model Portfolios reflect Aon's best ideas for a typical U.S. public defined benefit plan across a range of circumstances noted below
  - Intended as a starting point for asset allocation analysis and decision-making and to be customized based on client-specific needs and circumstances

	Efficiency	**Model 1**	**Model 2**	**Model 3** *(Opportunity)*
Complexity	Simple			Complex
Costs	Low Cost			Higher Cost
Resources	Light Resources			Deep Resources
Governance	Modest Governance			Strong Governance
Liquidity	More Liquid			Less Liquid

- As a general statement, moving from left-to-right on the above spectrum increases both investment portfolio return potential and risk-adjusted return potential, based on our capital markets modelling

Aon Model Portfolios vs. Current MSERS Policy

Asset Class	Current Policy (87.5% R-S)	Efficiency (87.5% R-S)	Model 1 (87.5% R-S)	Model 2 (87.5% R-S)	Model 3 (87.5% R-S)
Equity					
- U.S. Equity	28%	0%	0%	0%	0%
- International Equity	16%	0%	0%	0%	0%
- Global Equity	0%	66%	55%	49%	38%
- Private Equity	23%[2]	0%	5%	11%	16%
- Subtotal	67%	66%	60%	60%	55%
Absolute Return / Liquid Alternatives					
- Subtotal	6%	0%	11%	11%	11%
Return-Seeking Fixed Income					
- Multi-Asset Credit	5%[2]	9%	5%	5%	5%
- Subtotal	5%	9%	5%	5%	5%
Real Assets					
- Real Estate (Core)	2%	13%	8%	5%	5%
- Real Estate (Non-Core)	7%	0%	3%	3%	5%
- Infrastructure	2%	0%	0%	3%	5%
- Subtotal	10%	13%	11%	11%	16%
Risk-Reducing					
- Cash	2%	2%	2%	2%	2%
- Core Fixed Income	11%	11%	11%	11%	11%
- Subtotal	13%	13%	13%	13%	13%
Expected Return[1]	**7.56%**	**6.74%**	**6.81%**	**7.07%**	**7.33%**
Expected Risk[1]	13.83%	13.24%	12.73%	12.74%	12.48%
Sharpe Ratio	0.47	0.43	0.45	0.47	0.50

Notes:

[1] Expected returns based on Aon Investments' Q2 2020 30 year Capital Market Assumptions assuming the detailed portfolios found in the Appendix. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See Appendix for the Capital Market Assumptions.

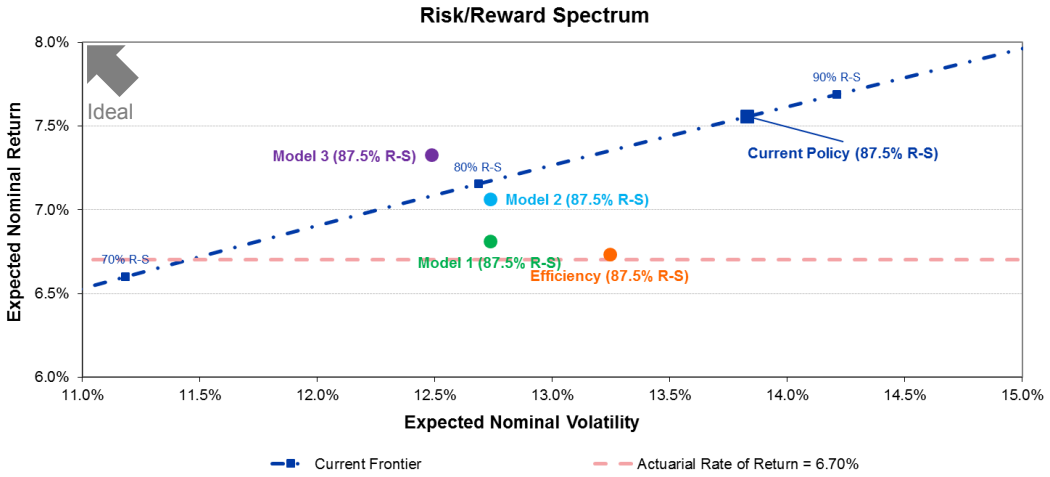
[2] For modeling purposes, Michigan's 9.5% allocation to Real Return & Opportunistic assets is split 50/50 between Private Equity and Multi-Asset Credit

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

Key Takeaways

1. Current MSERS Policy generally compares favorably to the Aon Model Portfolios
2. Current MSERS Policy's total equity exposure appears higher than Aon Model Portfolios, particularly Model 3
   - This also appears true relative to large public fund peers (please see Appendix)
3. Current MSERS Policy's higher exposure to equity risk results in higher forecasted total portfolio volatility
   - Also explains Current Policy's Sharpe Ratio < Model 3

Portfolio Analysis
Risk/Reward Spectrum



	Expected Nominal Return[1]	Expected Nominal Volatility	Sharpe Ratio
Current Policy (87.5% R-S)	7.56%	13.83%	0.47
Efficiency (87.5% R-S)	6.74%	13.24%	0.43
Model 1 (87.5% R-S)	6.81%	12.73%	0.45
Model 2 (87.5% R-S)	7.07%	12.74%	0.47
Model 3 (87.5% R-S)	7.33%	12.48%	0.50

- **Blue** Square: "Current Policy" = Michigan's current mix of Risk-Reducing assets (12.5%) and Return-Seeking assets (87.5%)
  - **Blue** Line "Current Frontier" = Michigan's Current Policy, scaled to different risk levels (Risk-Reducing assets (FI and cash) and Return-Seeking assets (all other assets) scaled up and down proportionally)
- Circles (**Orange**, **Green**, **Light Blue**, **Purple**) = "Aon Model Portfolios" – i.e., Aon's starting point for Asset Allocation discussions with clients
  - "Efficiency" is designed for clients with a low level of resources / low tolerance for portfolio complexity;
  - "Model 3" is for clients at the other end of the resource / complexity spectrum

Key Takeaways:

1. Current Policy has a higher long-term return forecast than any Aon Model Portfolio
2. Current Frontier is more efficient than three of the four Aon Model Portfolios
3. Current Policy models as more volatile (i.e., has a higher standard deviation of forecasted investment returns) than the Aon Model portfolios

[1] Expected returns are using Aon Investments' Q2 2020 Capital Market Assumptions. Assumptions do not include fees/expenses. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See Appendix for capital market assumptions disclosure pages.

Varying the Return-Seeking (R-S) Allocation

Expected Return Distributions

R-S%	30Y Expected Return	30Y Nominal Volatility	Sharpe Ratio	1Y Return (2 STD Down)
70.0%	6.60%	11.18%	0.49	-13.43%
72.5%	6.74%	11.55%	0.49	-13.88%
75.0%	6.88%	11.93%	0.48	-14.33%
77.5%	7.02%	12.31%	0.48	-14.78%
80.0%	7.15%	12.68%	0.48	-15.23%
82.5%	7.29%	13.06%	0.47	-15.68%
85.0%	7.42%	13.44%	0.47	-16.12%
87.5%	7.56%	13.83%	0.47	-16.57%
90.0%	7.69%	14.21%	0.46	-17.01%

Contribution Impact

(Max as a Multiple of FYE 2019 Total Contribution Dollars)

R-S%	50th Percentile	95th Percentile	99th Percentile
70.0%	1.6	5.0	5.9
72.5%	1.5	5.1	5.9
75.0%	1.5	5.1	6.0
77.5%	1.4	5.2	6.0
80.0%	1.4	5.2	6.1
82.5%	1.4	5.2	6.2
85.0%	1.4	5.2	6.2
87.5%	1.4	5.2	6.2
90.0%	1.4	5.3	6.3

Key Takeaways:

- All else equal, we believe MSERS would benefit from reducing its investment risk posture, at least at the margin
- Decreased return-seeking allocations are projected to result in:
  - Lower expected returns, nominal volatility, and downside (95th or 99th percentile) contribution amounts (as a multiple of FYE 2019 amounts)
  - Higher Sharpe Ratio (i.e., more efficiency), one year downside return, and expected (50th percentile) contribution amounts

Maintain the Existing the Return-Seeking (R-S) Allocation

Alternative Policy for Consideration

Asset Class	Current Policy (87.5% R-S)	Alternative Policy (87.5% R-S)	Difference	Current Rebalancing Ranges	Alternative Rebalancing Ranges
Equity					
- U.S. Equity	28.0%	25.0%	(3.0%)	20% - 35%	17% - 32%
- International Equity	16.0%	15.0%	(1.0%)	15% - 25%	12% - 22%
- Private Equity	18.0%	16.0%	(2.0%)	10% - 20%	8% - 18%
- Subtotal	62.0%	56.0%	(6.0%)		
Absolute Return / Liquid Alternatives					
- Subtotal	6.0%	9.0%	+3.0%	3% - 9%	5% - 11%
Real Return / Opportunistic					
- Subtotal	9.5%	12.5%	+3.0%	5% - 15%	8% - 18%
Real Estate & Infrastructure					
- Subtotal	10.0%	10.0%	--	5% - 15%	8% - 18%
Risk-Reducing					
- Short-Term Fixed Income (Cash)	2.0%	2.0%	--	1% - 6%	1% - 8%
- Long-Term Fixed Income (Core Fixed Income)	10.5%	10.5%	--	10% - 20%	10% - 20%
- Subtotal	12.5%	12.5%	--		
Expected Return[1]	**7.56%**	**7.46%**	**(0.10%)**		
Expected Risk[1]	13.83%	13.34%	(0.49%)		
Sharpe Ratio	0.47	0.48	+0.01		

- Above we model an alternative policy allocation (same R-S level as the Current Policy) that reduces equity exposure and adds exposure to diversifying asset categories
  - Modest reduction in forecasted return, more meaningful reduction in forecasted volatility
  - Improved portfolio efficiency (i.e., higher Sharpe Ratio)

[1] Expected returns based on Aon Investments' Q2 2020 30 year Capital Market Assumptions assuming the detailed portfolios found in the Appendix. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See Appendix for the Capital Market Assumptions.
Percentages in table may not sum to 100% due to rounding

Maintain the Existing the Return-Seeking (R-S) Allocation

Alternative Policy for Consideration (Cont'd)

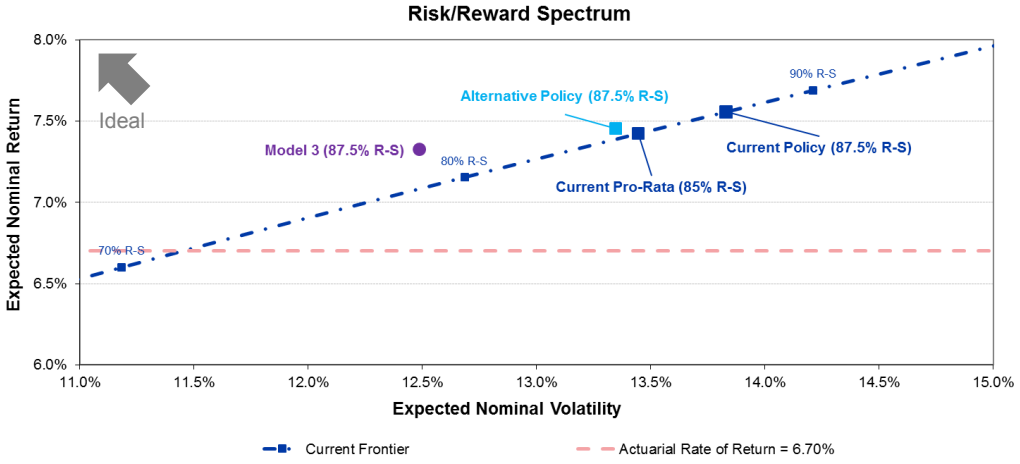
Expected Return Distributions

Asset Allocation	30Y Expected Return	30Y Nominal Volatility	Sharpe Ratio	1Y Return (2 STD Down)
Current Policy 87.5% R-S	7.56%	13.83%	0.47	-16.57%
Alternative Policy 87.5% R-S	7.46%	13.34%	0.48	-15.94%

Contribution Impact

(Max as a Multiple of FYE 2019 Total Contribution Dollars)

Asset Allocation	50th Percentile	95th Percentile	99th Percentile
Current Policy 87.5% R-S	1.4	5.2	6.2
Alternative Policy 87.5% R-S	1.4	5.2	6.2



Key Takeaways:

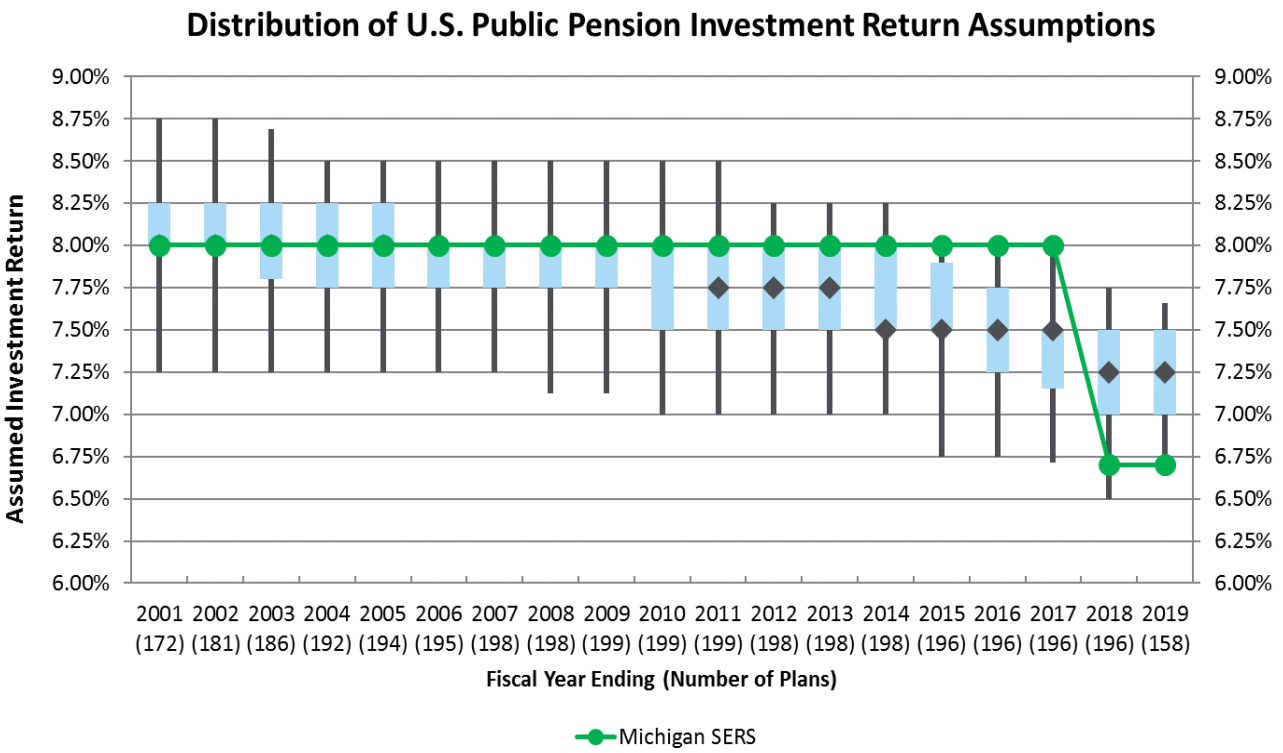
- The alternative policy is projected to result in:
  - Lower expected returns, nominal volatility, one year downside return
  - Higher Sharpe Ratio (i.e., more efficiency)
- The alternative policy offers a superior risk reward tradeoff vs. moving down the Current Frontier
  - E.g., Current Pro-Rata (85% R-S)

Appendix

- Assumptions and Methods

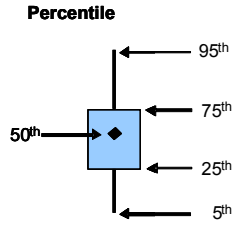
Portfolio Analysis

Expected Return Assumption versus Peers[1]



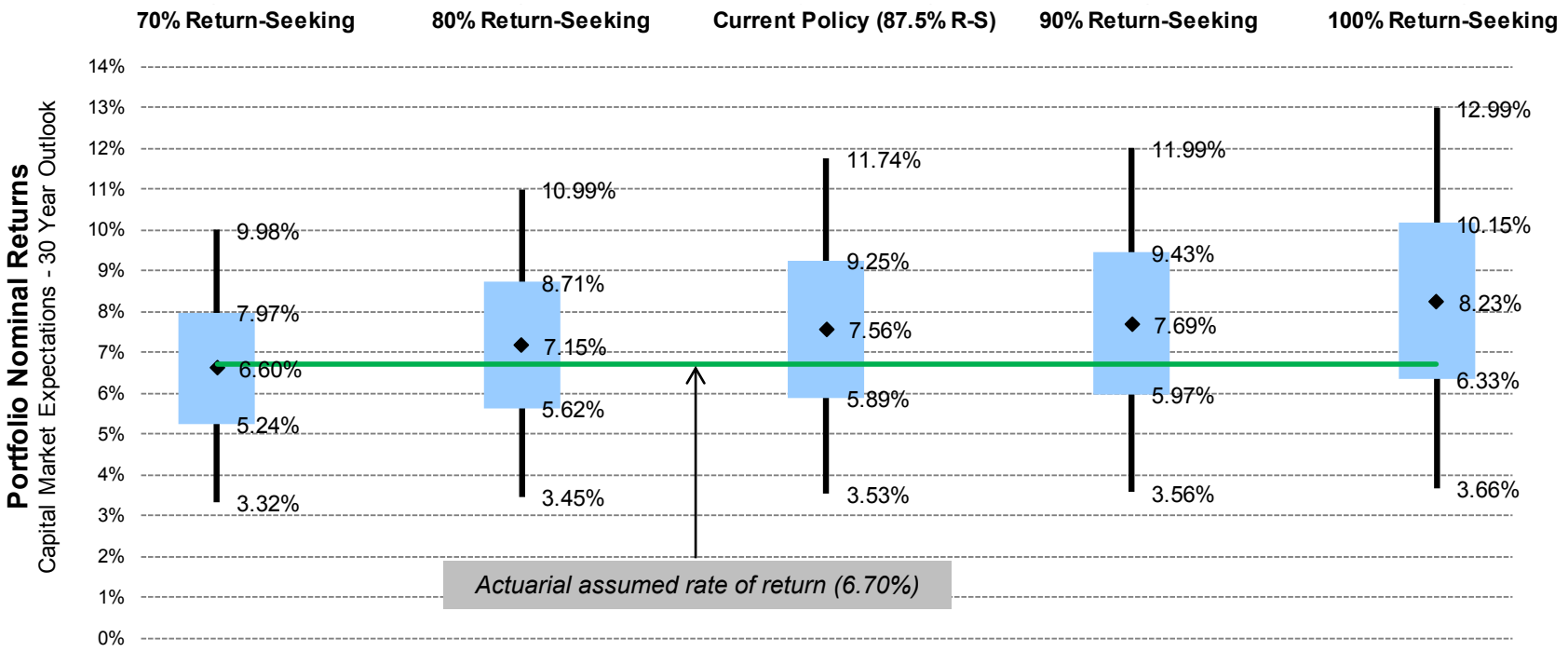
Key Takeaways:

- 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
- MSERS' assumption for FYE 2019 (6.70%) lied between the 5th and 25th percentile relative to its peers
- If MSERS exceeds (or falls short of) the actuarial return assumption, lower (or higher) funding will be needed in future years



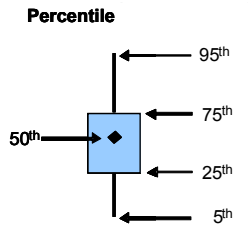
Sources: Public Plans Data (publicplansdata.org) as of July 2020; Expected Returns are the assumptions made by the plans included in the data set.
[1] Peers defined as public funds published within publicplansdata.org as of July 2020; Number of plans per year are shown in parentheses

Portfolio Analysis
Range of Nominal Returns



Key Takeaway:

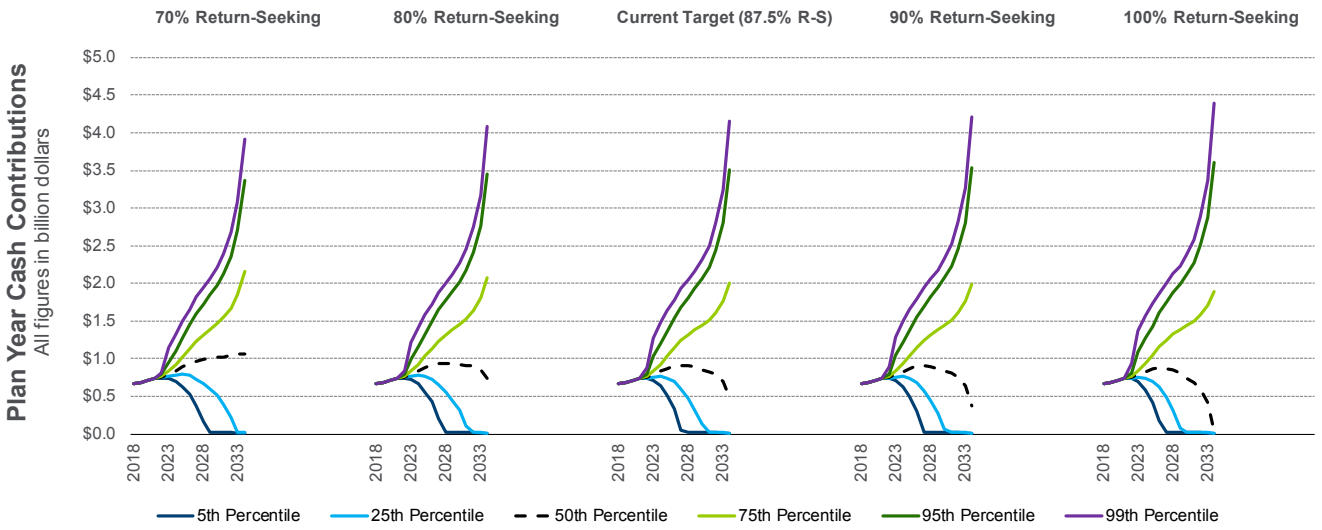
- Median expected returns for policies greater than 70% return-seeking assets are projected to exceed the actuarial assumed rate of return (6.70%)

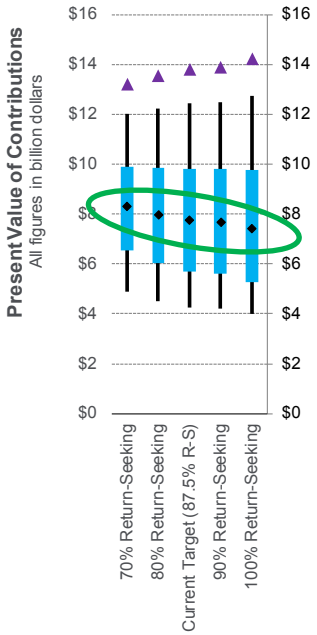


[1] Expected returns are using Aon Investments' Q2 2020 Capital Market Assumptions. Assumptions do not include fees/expenses. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See Appendix for capital market assumptions disclosure pages.

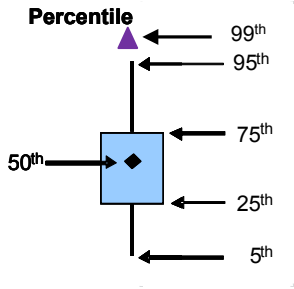
Asset-Liability Projection Results

Total Contribution Amount





Strategy	70% Return-Seeking			80% Return-Seeking			Current Target (87.5% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2023	2028	2033	2023	2028	2033	2023	2028	2033	2023	2028	2033	2023	2028	2033
5th Percentile	$0.73	$0.16	$0.01	$0.72	$0.02	$0.01	$0.71	$0.02	$0.01	$0.71	$0.02	$0.01	$0.69	$0.02	$0.01
25th Percentile	$0.77	$0.66	$0.02	$0.76	$0.56	$0.02	$0.76	$0.47	$0.02	$0.76	$0.44	$0.02	$0.75	$0.31	$0.02
50th Percentile	$0.80	$0.99	$1.06	$0.80	$0.94	$0.86	$0.80	$0.91	$0.70	$0.79	$0.90	$0.64	$0.79	$0.85	$0.42
75th Percentile	$0.84	$1.31	$1.85	$0.84	$1.31	$1.80	$0.84	$1.32	$1.77	$0.84	$1.32	$1.76	$0.84	$1.33	$1.71
95th Percentile	$0.95	$1.73	$2.70	$1.00	$1.77	$2.76	$1.03	$1.81	$2.80	$1.05	$1.82	$2.81	$1.10	$1.88	$2.87
99th Percentile	$1.15	$1.94	$3.09	$1.22	$2.00	$3.17	$1.28	$2.05	$3.24	$1.29	$2.06	$3.26	$1.37	$2.12	$3.37



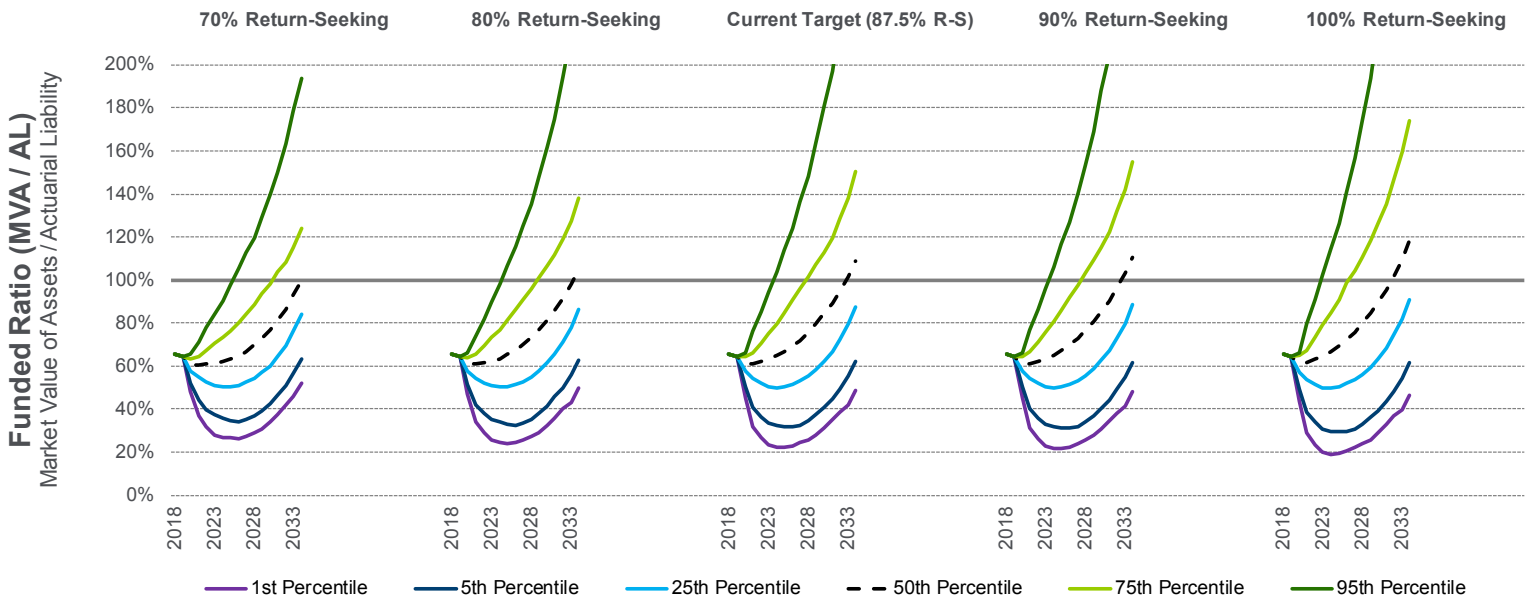
Key Takeaway:

- The higher the allocation to return-seeking assets, the lower the present value of future contributions will be on average but the greater the variability in contributions

* Liability projections assume discount rates determined via the Dedicated Gains Policy

Asset-Liability Projection Results

Funded Ratio (Market Value of Asset / Actuarial Liabilities)



Strategy	70% Return-Seeking			80% Return-Seeking			Current Target (87.5% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2023	2028	2033	2023	2028	2033	2023	2028	2033	2023	2028	2033	2023	2028	2033
1st Percentile	28%	29%	46%	25%	27%	43%	23%	26%	42%	23%	25%	41%	20%	24%	39%
5th Percentile	37%	37%	57%	35%	35%	56%	33%	35%	55%	33%	34%	55%	31%	33%	54%
25th Percentile	51%	54%	76%	51%	55%	78%	50%	55%	79%	50%	56%	80%	50%	56%	82%
50th Percentile	61%	70%	93%	62%	73%	98%	63%	76%	102%	63%	77%	103%	65%	80%	109%
75th Percentile	70%	89%	115%	73%	96%	128%	75%	102%	138%	76%	103%	142%	79%	111%	159%
95th Percentile	84%	119%	178%	90%	135%	>200%	94%	148%	>200%	96%	153%	>200%	102%	174%	>200%
Probability > 100%	<1%	18%	42%	2%	23%	48%	4%	27%	52%	4%	28%	53%	7%	34%	58%

Key Takeaway:

- Contribution policy is projected to close the funding shortfall across investment strategies modeled

* Liability projections assume discount rates determined via the Dedicated Gains Policy

Aon Investments' Capital Market Assumptions

As of March 31, 2020 (30 Years)

		Expected Real Return[1]	Expected Nominal Return[1]	Expected Nominal Volatility
	Equity			
1	Large Cap U.S. Equity	4.5%	6.7%	16.5%
2	Small Cap U.S. Equity	5.0%	7.2%	22.5%
3	Global Equity IMI	5.3%	7.5%	18.0%
4	International Equity (Developed)	5.3%	7.5%	19.5%
5	Emerging Markets Equity	5.9%	8.1%	26.5%
	Fixed Income			
6	Cash (Gov't)	-1.0%	1.1%	1.5%
7	Core Fixed Income	0.0%	2.1%	4.5%
8	Intermediate Gov't Bonds (4-Year Duration)	-0.8%	1.3%	3.5%
9	Intermediate Corporate Bonds (4-Year Duration)	0.2%	2.3%	4.0%
10	Multi-Asset Credit[2]	3.2%	5.4%	9.5%
	Alternatives			
11	Direct Hedge Funds[2,3]	2.6%	4.8%	9.0%
12	Non Core Real Estate	5.4%	7.6%	25.0%
13	Core Real Estate	3.7%	5.9%	14.5%
14	Private Equity	7.5%	9.8%	24.5%
15	Infrastructure	6.1%	8.3%	14.0%
16	Private Debt	4.4%	6.6%	17.0%
	Inflation			
17	Inflation	0.0%	2.1%	1.5%

Notes:

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

[2] Alpha incorporated in Expected Nominal Return.

[3] Represents diversified portfolio of direct hedge fund investments.

Aon Investments' Capital Market Assumptions

As of March 31, 2020

	Nominal Correlations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Large Cap U.S. Equity	**1.00**	0.92	0.96	0.78	0.72	0.09	0.05	-0.06	0.08	0.59	0.66	0.47	0.37	0.69	0.38	0.39	0.06
2	Small Cap U.S. Equity	0.92	**1.00**	0.90	0.72	0.67	0.07	0.04	-0.06	0.07	0.54	0.61	0.44	0.34	0.65	0.36	0.36	0.05
3	Global Equity IMI	0.96	0.90	**1.00**	0.90	0.84	0.08	0.05	-0.06	0.08	0.65	0.64	0.49	0.38	0.67	0.37	0.41	0.07
4	International Equity (Developed)	0.78	0.72	0.90	**1.00**	0.75	0.05	0.04	-0.05	0.07	0.60	0.55	0.44	0.34	0.56	0.31	0.36	0.08
5	Emerging Markets Equity	0.72	0.67	0.84	0.75	**1.00**	0.07	0.05	-0.05	0.08	0.63	0.47	0.41	0.31	0.53	0.29	0.39	0.07
6	Cash (Gov't)	0.09	0.07	0.08	0.05	0.07	**1.00**	0.46	0.61	0.50	0.13	-0.04	0.12	0.13	0.08	0.11	-0.01	0.54
7	Core Fixed Income	0.05	0.04	0.05	0.04	0.05	0.46	**1.00**	0.89	0.97	0.24	0.01	0.06	0.06	0.04	0.05	-0.03	0.13
8	Intermediate Gov't Bonds (4-Year Duration)	-0.06	-0.06	-0.06	-0.05	-0.05	0.61	0.89	**1.00**	0.83	-0.01	-0.25	0.01	0.02	-0.05	0.01	-0.27	0.25
9	Intermediate Corporate Bonds (4-Year Duration)	0.08	0.07	0.08	0.07	0.08	0.50	0.97	0.83	**1.00**	0.31	0.08	0.08	0.08	0.07	0.07	0.06	0.20
10	Multi-Asset Credit	0.59	0.54	0.65	0.60	0.63	0.13	0.24	-0.01	0.31	**1.00**	0.65	0.30	0.23	0.40	0.23	0.66	0.16
11	Direct Hedge Funds	0.66	0.61	0.64	0.55	0.47	-0.04	0.01	-0.25	0.08	0.65	**1.00**	0.31	0.24	0.45	0.24	0.53	0.03
12	Non Core Real Estate	0.47	0.44	0.49	0.44	0.41	0.12	0.06	0.01	0.08	0.30	0.31	**1.00**	0.96	0.38	0.21	0.21	0.08
13	Core Real Estate	0.37	0.34	0.38	0.34	0.31	0.13	0.06	0.02	0.08	0.23	0.24	0.96	**1.00**	0.31	0.18	0.16	0.08
14	Private Equity	0.69	0.65	0.67	0.56	0.53	0.08	0.04	-0.05	0.07	0.40	0.45	0.38	0.31	**1.00**	0.32	0.30	0.06
15	Infrastructure	0.38	0.36	0.37	0.31	0.29	0.11	0.05	0.01	0.07	0.23	0.24	0.21	0.18	0.32	**1.00**	0.17	0.07
16	Private Debt	0.39	0.36	0.41	0.36	0.39	-0.01	-0.03	-0.27	0.06	0.66	0.53	0.21	0.16	0.30	0.17	**1.00**	0.11
17	Inflation	0.06	0.05	0.07	0.08	0.07	0.54	0.13	0.25	0.20	0.16	0.03	0.08	0.08	0.06	0.07	0.11	**1.00**

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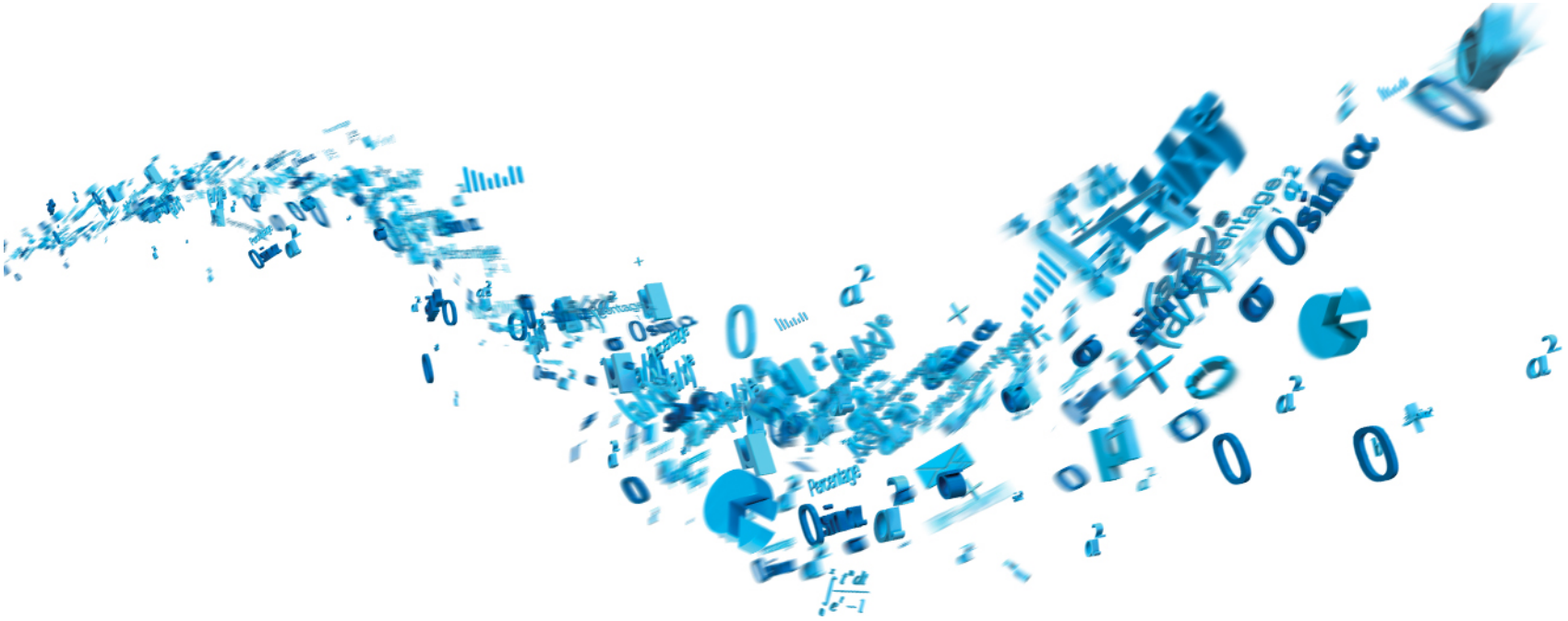

Supporting Analysis for Asset-Liability Study

Michigan State Employees' Retirement System (MSERS)
September 2020

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

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Executive Summary

Executive Summary
Current State

- As of the September 30, 2018, the Michigan State Employees' Retirement System (MSERS) has the following pension asset-liability profiles:

System	Market Value of Assets (MVA)	Actuarial Liability	Funded Status (based on MVA)	Actuarial Assumed Rate of Return
MSERS (in $ millions)	$12,398.0	$18,995.2	65.3%	6.70%

- SOM's current asset allocation policy across all plans is 87.5% return-seeking / 12.5% risk-reducing safety assets

Executive Summary
Current Target Asset Allocation

- The Current Target Asset Allocation is modeled to our capital market assumptions as follows:

Target Asset Allocation as of 12/31/2019		
	Alloc %	**Capital Market Assumption Mapping**
Return-Seeking		
- U.S. Equity	28.0%	90% U.S. Large Cap / 10% U.S. Small Cap
- International Equity	16.0%	75% International Developed / 25% Emerging Markets
- Private Equity	18.0%	Private Equity
- Real Estate & Infrastructure	10.0%	8.5% Real Estate (20% Core Real Estate / 80% Non-Core Real Estate) / 1.5% Infrastructure
- Absolute Return	6.0%	Broad Hedge Funds (Universe)
- Real Return / Opportunistic	9.5%	50% Private Equity / 50% Multi-Asset Credit
- Total	87.5%	
Risk-Reducing		
- Cash & Short Term Fixed Income	2.0%	Cash
- Long Term Fixed Income	10.5%	Core Fixed Income
- Total	12.5%	
Total	100.0%	

Executive Summary
Summary and Conclusions

Portfolio Analysis

- The current portfolio is well-diversified
- The expected return assumption for the current portfolio is 7.56%[1] over the next 30 years
- Michigan should consider its desired balance between funding, investment returns, and risk tolerance in order to determine the ideal investment portfolio

Asset-Liability Projection Analysis

- Longer time horizons are expected to reward higher levels of risk; shorter time horizons are not
- Contribution policy is projected to bring the plan to full funding, but with increased volatility as the closed amortization period declines to immediate recognition
- The Dedicated Gains Policy is projected to trend the actuarial investment return assumption down over the near-term

[1] Expected returns are using Aon Investments' Q2 2020 Capital Market Assumptions. Assumptions do not include fees/expenses. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See capital market assumptions disclosure pages in Appendix.

Analysis

- Current State

Current State Asset-Liability Profile

Asset-Liability Snapshot as of 9/30/2018		
Metric ($, Millions)	**Value**	**Fund %**
Market Value of Assets	$12,398.0	65.3%
Actuarial Value of Assets	$12,494.4	65.8%
Liability Metrics		
Actuarial Liability (AL) - Funding	$18,995.2[1]	

Estimated Asset-Liability Snapshot as of 9/30/2019		
Metric ($, Millions)	**Value**	**Fund %**
Market Value of Assets	$12,227.9	64.6%
Actuarial Value of Assets	$12,374.1	65.4%
Liability Metrics		
Actuarial Liability (AL) - Funding	$18,921.1	

Asset-Liability Growth Metrics			
Metric ($, Millions)	**Value**	**% Liability**	**% Assets**
AL Discount Cost	$1,272.7	6.70%	10.27%
AL Normal Cost	$47.4	0.25%	0.38%
Total Liability Hurdle Rate	**$1,320.1**	**6.95%**	**10.65%**
Expected Return on Assets	$936.9	4.93%	7.56%
ER + EE Contributions	$667.7	3.52%	5.39%
Total Exp. Asset Growth	**$1,604.6**	**8.45%**	**12.95%**
Hurdle Rate Shortfall/(Surplus)	**-$284.5**	**-1.50%**	**-2.30%**
Est. Benefit Payments	$1,389.8	7.32%	11.21%

Key Takeaways:

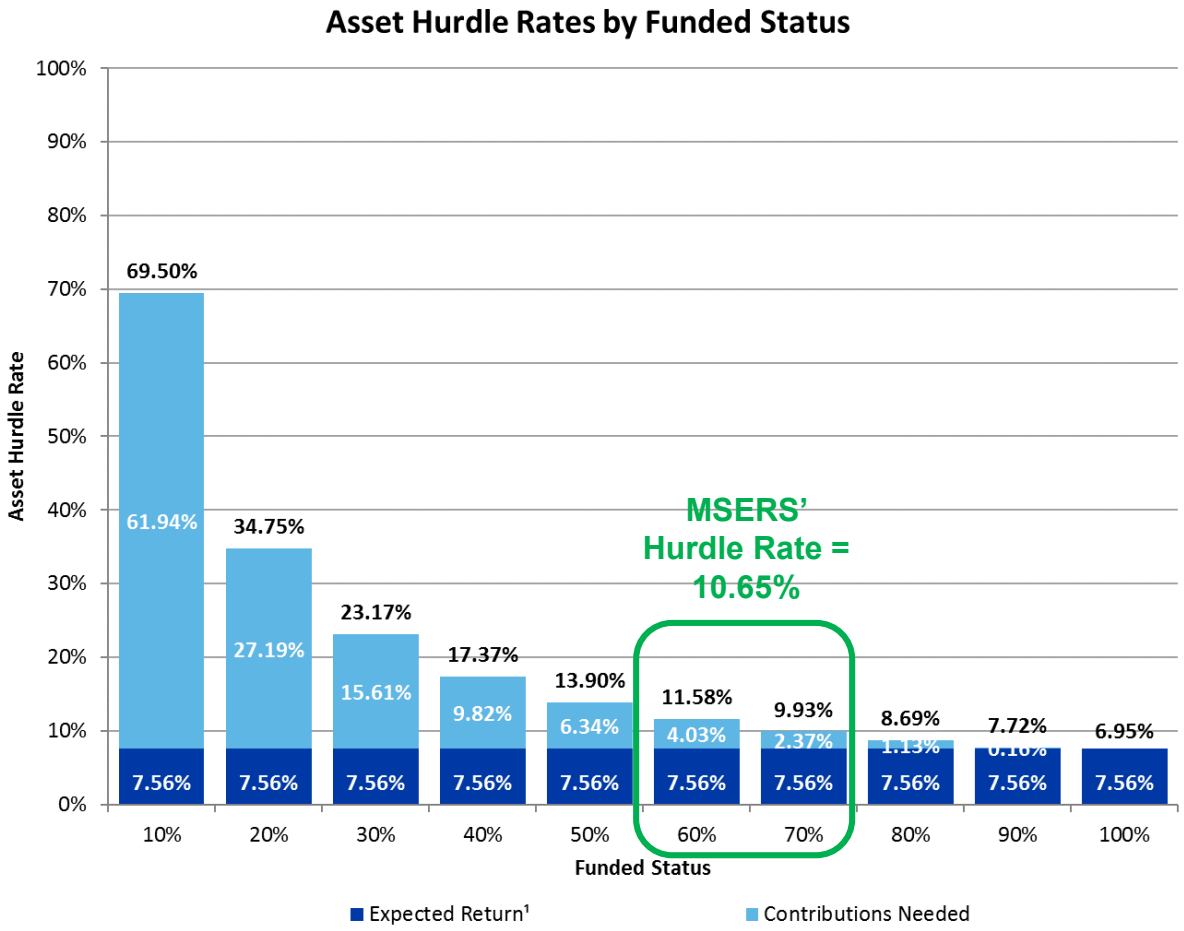
- Pension plan was 65.3% funded on a market value of assets basis as of September 30, 2018
- Asset allocation is 87.5% return-seeking assets with 12.5% risk-reducing/safety assets to withstand stressed markets
- Asset hurdle rate of 10.65%, via cash funding and investment returns, needed to maintain or improve actuarial funded status

Target Asset Allocation as of 9/30/2018		
Metric ($, Millions)	**Value**	**Alloc %**
Return-Seeking		
- U.S. Equity	$3,471.4	28.0%
- International Equity	$1,983.7	16.0%
- Private Equity	$2,231.6	18.0%
- Real Estate	$1,053.8	8.5%
- Hedge Funds	$743.9	6.0%
- Infrastructure	$186.0	1.5%
- Real Return / Opportunistic	$1,177.8	9.5%
- Total	$10,848.3	87.5%
Risk-Reducing		
- Cash & Short Duration Fixed Income	$248.0	2.0%
- Core Bonds	$1,301.8	10.5%
- Total	$1,549.8	12.5%
Total	$12,398.0	100.0%

[1] Based on a 6.80% discount rate consistent with the September 30, 2018 valuation results.
[2] Expected returns are using Aon Investments' Q2 2020 Capital Market Assumptions. Assumptions do not include fees/expenses. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See capital market assumptions disclosure pages in Appendix.

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



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Analysis

- Portfolio Analysis

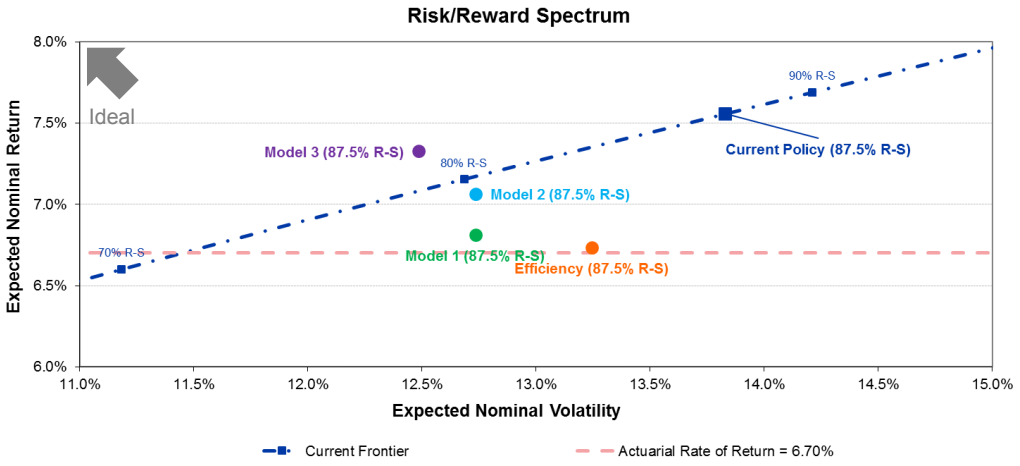
Portfolio Analysis
Spectrum of Aon Model Portfolios

- Aon's Model Portfolios reflect Aon's best ideas for a typical U.S. public defined benefit plan across a range of circumstances noted below
  - Intended as a starting point for asset allocation analysis and decision-making and to be customized based on client-specific needs and circumstances

	Efficiency	**Model 1**	**Model 2**	**Model 3** *(Opportunity)*
Complexity	Simple			Complex
Costs	Low Cost			Higher Cost
Resources	Light Resources			Deep Resources
Governance	Modest Governance			Strong Governance
Liquidity	More Liquid			Less Liquid

- As a general statement, moving from left-to-right on the above spectrum increases both investment portfolio return potential and risk-adjusted return potential, based on our capital markets modelling

Portfolio Analysis
Risk/Reward Spectrum



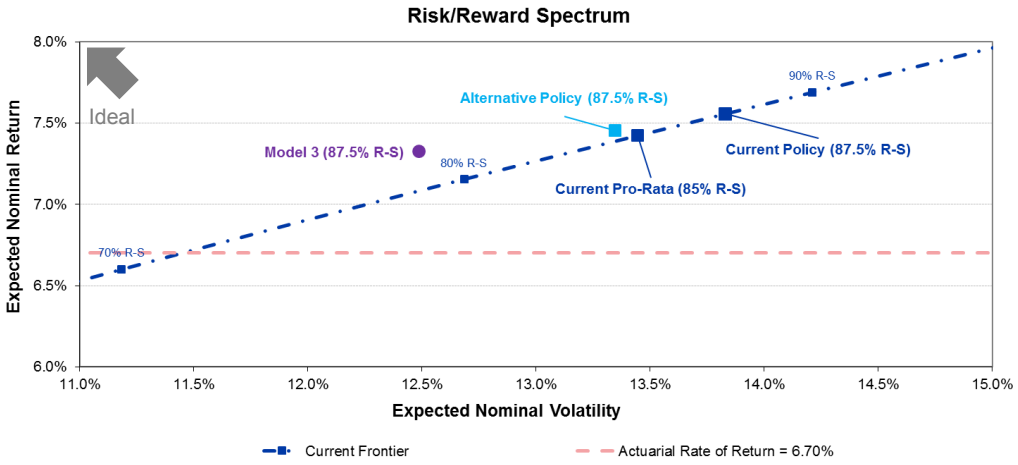
Key Takeaways:

- MSERS' current policy has a higher long-term return forecast than any Aon Model Portfolio.
- MSERS' current policy is more efficient than three of the four Aon Model Portfolios (I.e., its frontier plots above Aon Efficiency, Aon Model 1, and Aon Model 2.)
  - The dashed blue line is representative of MSERS' exiting policy scaled to different levels of return-seeking (R-S) assets.
- MSERS' current policy models as more volatile (i.e., has a higher standard deviation of forecasted investment returns) than the Aon Model portfolios.
  - This is being driven, at least in part, by MSERS' existing policy having a higher allocation to equities (public + private), particularly relative to Aon Model 3.

				Return-Seeking Assets						Risk-Reducing / Safety Assets	
	Expected Nominal Return	Expected Nominal Volatility	Sharpe Ratio	Public Equity	Private Equity	Absolute Return / Liquid Alts	Multi Asset Credit	Real Estate	Infrastructure	Cash & Short Duration Bonds	Core Bonds
Current Policy (87.5% R-S)	7.56%	13.83%	0.467	44%	23%	6%	5%	9%	2%	2%	11%
Efficiency (87.5% R-S)	6.74%	13.24%	0.426	66%	0%	0%	9%	13%	0%	2%	11%
Model 1 (87.5% R-S)	6.81%	12.73%	0.449	55%	5%	11%	5%	11%	0%	2%	11%
Model 2 (87.5% R-S)	7.07%	12.74%	0.468	49%	11%	11%	5%	8%	3%	2%	11%
Model 3 (87.5% R-S)	7.33%	12.48%	0.499	38%	16%	11%	5%	11%	5%	2%	11%

Expected returns are using Aon Investments' Q2 2020 Capital Market Assumptions. Assumptions do not include fees/expenses. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See capital market assumptions disclosure pages in Appendix.

Portfolio Analysis
Risk/Reward Spectrum



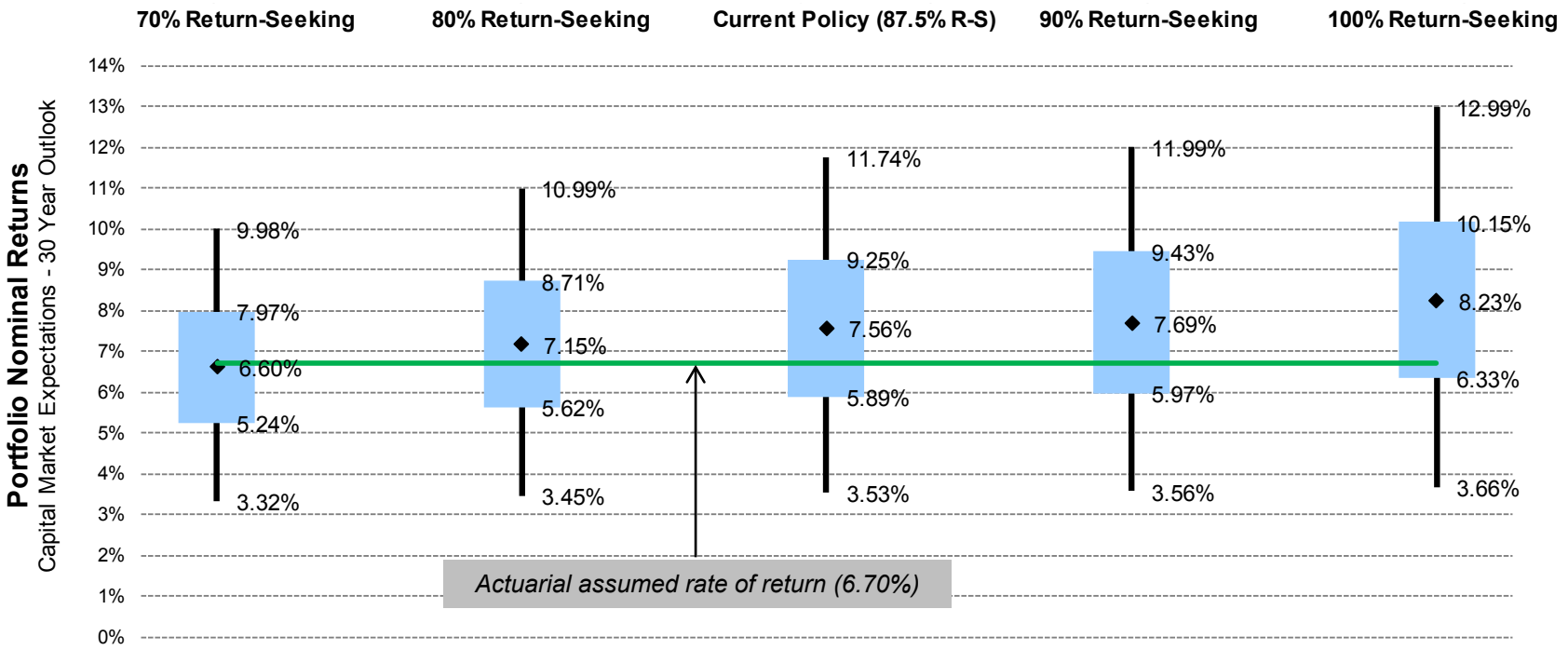
Key Takeaways:

- To reduce investment risk, MSERS could:
  - Maintain current return-seeking asset mix, reduce allocation to return-seeking assets pro-rata, OR
  - Maintain current target allocation to return-seeking assets, but reduce allocation to equities and add to exposures in diversifying assets such as Absolute Return and Real Return and Opportunistic strategies.
- We find the latter approach more compelling, as it has a similar impact on forecasted volatility while retaining incrementally more upside.
  - "Alternative Policy (87.5% R-S)" is forecast to have modestly higher returns at a modestly lower level of volatility than simply moving incrementally down the Current Frontier. (E.g., "Current Pro-Rata (85% R-S)".)

				Return-Seeking Assets						Risk-Reducing / Safety Assets	
	Expected Nominal Return	Expected Nominal Volatility	Sharpe Ratio	Public Equity	Private Equity	Absolute Return / Liquid Alts	Multi Asset Credit	Real Estate	Infrastructure	Cash & Short Duration Bonds	Core Bonds
Current Policy (87.5% R-S)	7.56%	13.83%	0.467	44%	23%	6%	5%	9%	2%	2%	11%
Current Pro-Rata (85% R-S)	7.42%	13.44%	0.470	43%	22%	6%	5%	8%	1%	2%	13%
Alternative Policy (87.5% R-S)	7.46%	13.34%	0.476	40%	22%	9%	6%	9%	2%	2%	11%
Model 3 (87.5% R-S)	7.33%	12.48%	0.499	38%	16%	11%	5%	11%	5%	2%	11%

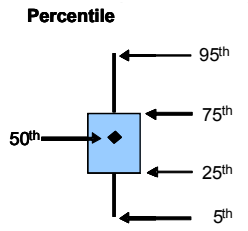
Expected returns are using Aon Investments' Q2 2020 Capital Market Assumptions. Assumptions do not include fees/expenses. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See capital market assumptions disclosure pages in Appendix.

Portfolio Analysis
Range of Nominal Returns



Key Takeaway:

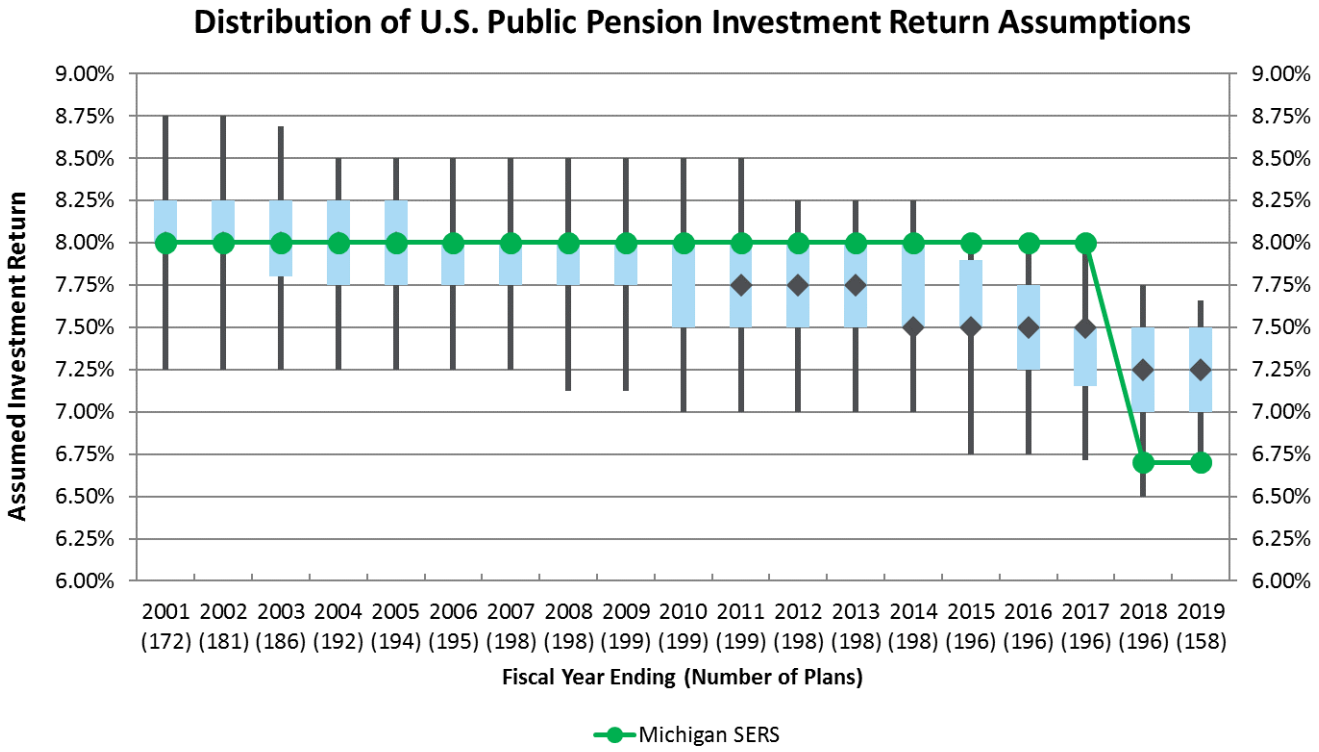
- Median expected returns for policies greater than 70% return-seeking assets are projected to exceed the actuarial assumed rate of return (6.70%)



[1] Expected returns are using Aon Investments' Q2 2020 Capital Market Assumptions. Assumptions do not include fees/expenses. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See Appendix for capital market assumptions disclosure pages.

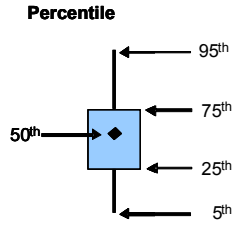
Portfolio Analysis

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
- MSERS' assumption for FYE 2019 (6.70%) lied between the 5th and 25th percentile relative to its peers
- If MSERS exceeds (or falls short of) the actuarial return assumption, lower (or higher) funding will be needed in future years



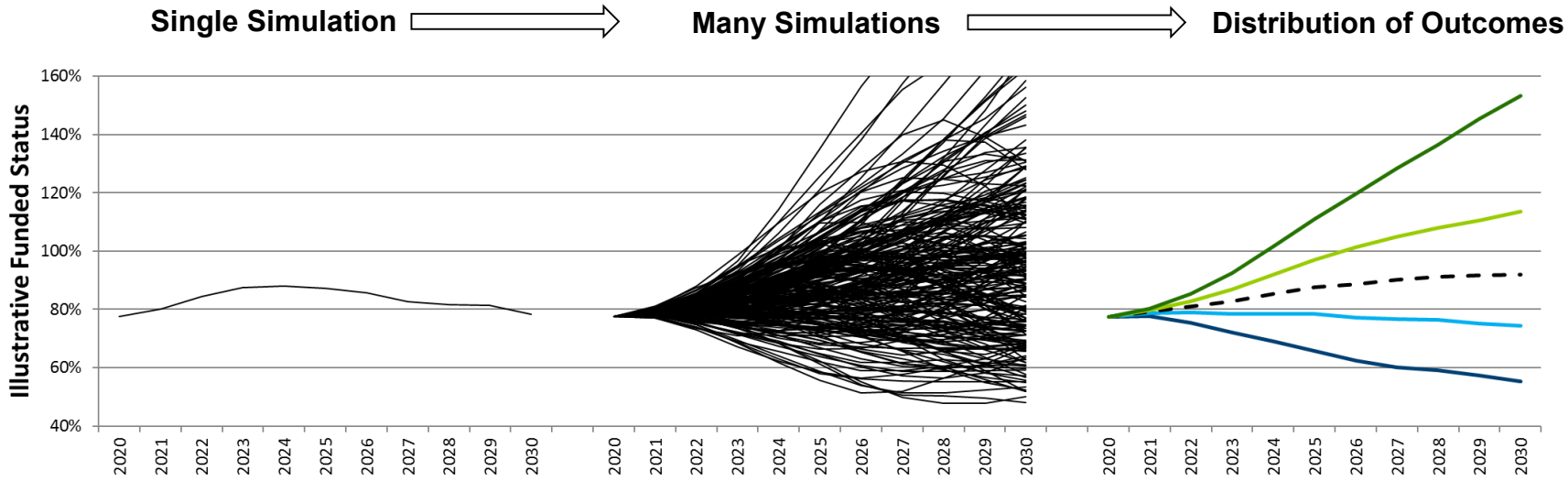
Sources: Public Plans Data (publicplansdata.org) as of July 2020; Expected Returns are the assumptions made by the plans included in the data set.
[1] Peers defined as public funds published within publicplansdata.org as of July 2020; Number of plans per year are shown in parentheses

Analysis

- Asset-Liability Projection Results

Asset-Liability Simulation Overview

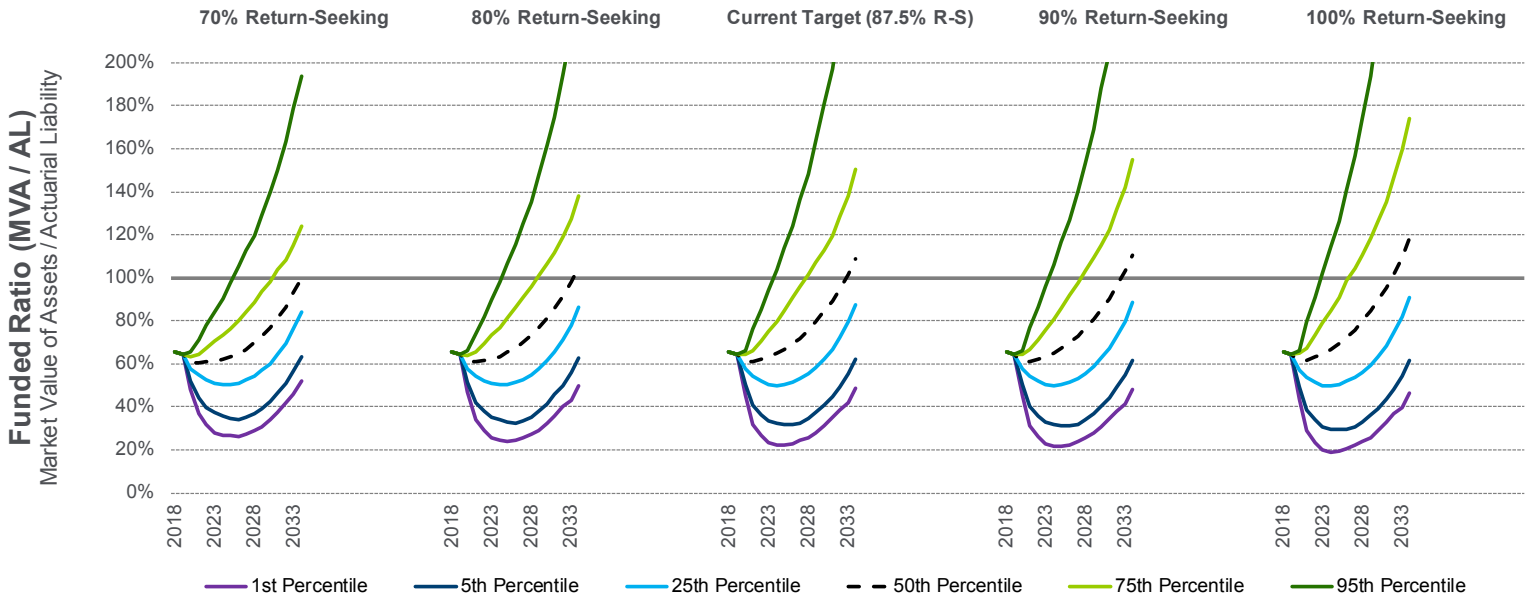
- Thousands of simulations plotted in one graph would be impossible to interpret
- Instead, we rank the simulations at each point over the future
- This produces a distribution of outcomes illustrating the degree of uncertainty of a plan's financial position over the projection period
- Different investment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

Funded Ratio (Market Value of Asset / Actuarial Liabilities)



Strategy	70% Return-Seeking			80% Return-Seeking			Current Target (87.5% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2023	2028	2033	2023	2028	2033	2023	2028	2033	2023	2028	2033	2023	2028	2033
1st Percentile	28%	29%	46%	25%	27%	43%	23%	26%	42%	23%	25%	41%	20%	24%	39%
5th Percentile	37%	37%	57%	35%	35%	56%	33%	35%	55%	33%	34%	55%	31%	33%	54%
25th Percentile	51%	54%	76%	51%	55%	78%	50%	55%	79%	50%	56%	80%	50%	56%	82%
50th Percentile	61%	70%	93%	62%	73%	98%	63%	76%	102%	63%	77%	103%	65%	80%	109%
75th Percentile	70%	89%	115%	73%	96%	128%	75%	102%	138%	76%	103%	142%	79%	111%	159%
95th Percentile	84%	119%	178%	90%	135%	>200%	94%	148%	>200%	96%	153%	>200%	102%	174%	>200%
Probability > 100%	<1%	18%	42%	2%	23%	48%	4%	27%	52%	4%	28%	53%	7%	34%	58%

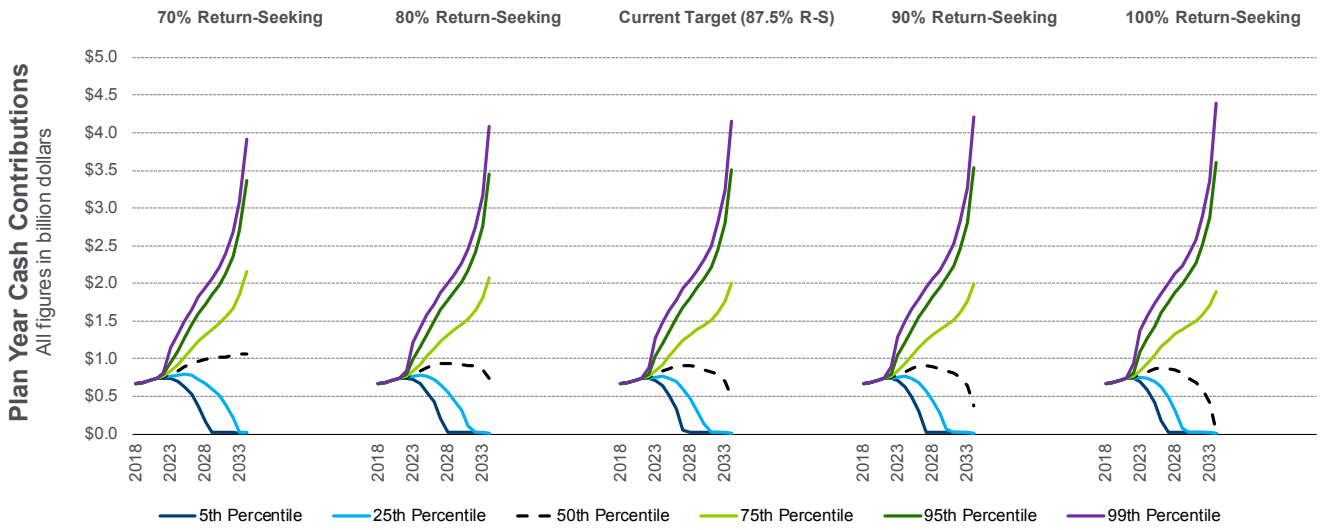
Key Takeaway:

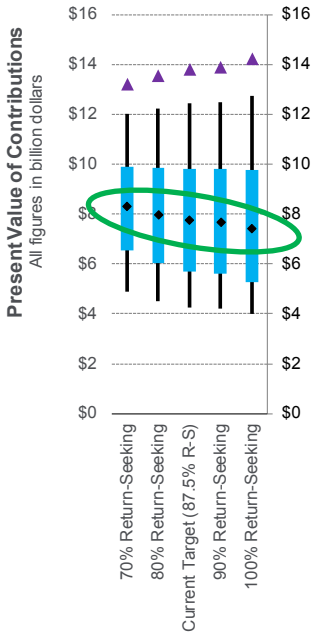
- Contribution policy is projected to close the funding shortfall across investment strategies modeled

* Liability projections assume discount rates determined via the Dedicated Gains Policy

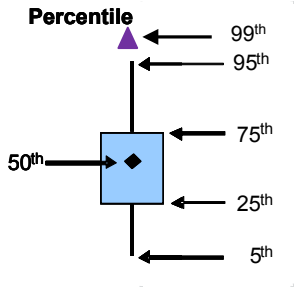
Asset-Liability Projection Results

Total Contribution Amount





Strategy	70% Return-Seeking			80% Return-Seeking			Current Target (87.5% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2023	2028	2033	2023	2028	2033	2023	2028	2033	2023	2028	2033	2023	2028	2033
5th Percentile	$0.73	$0.16	$0.01	$0.72	$0.02	$0.01	$0.71	$0.02	$0.01	$0.71	$0.02	$0.01	$0.69	$0.02	$0.01
25th Percentile	$0.77	$0.66	$0.02	$0.76	$0.56	$0.02	$0.76	$0.47	$0.02	$0.76	$0.44	$0.02	$0.75	$0.31	$0.02
50th Percentile	$0.80	$0.99	$1.06	$0.80	$0.94	$0.86	$0.80	$0.91	$0.70	$0.79	$0.90	$0.64	$0.79	$0.85	$0.42
75th Percentile	$0.84	$1.31	$1.85	$0.84	$1.31	$1.80	$0.84	$1.32	$1.77	$0.84	$1.32	$1.76	$0.84	$1.33	$1.71
95th Percentile	$0.95	$1.73	$2.70	$1.00	$1.77	$2.76	$1.03	$1.81	$2.80	$1.05	$1.82	$2.81	$1.10	$1.88	$2.87
99th Percentile	$1.15	$1.94	$3.09	$1.22	$2.00	$3.17	$1.28	$2.05	$3.24	$1.29	$2.06	$3.26	$1.37	$2.12	$3.37



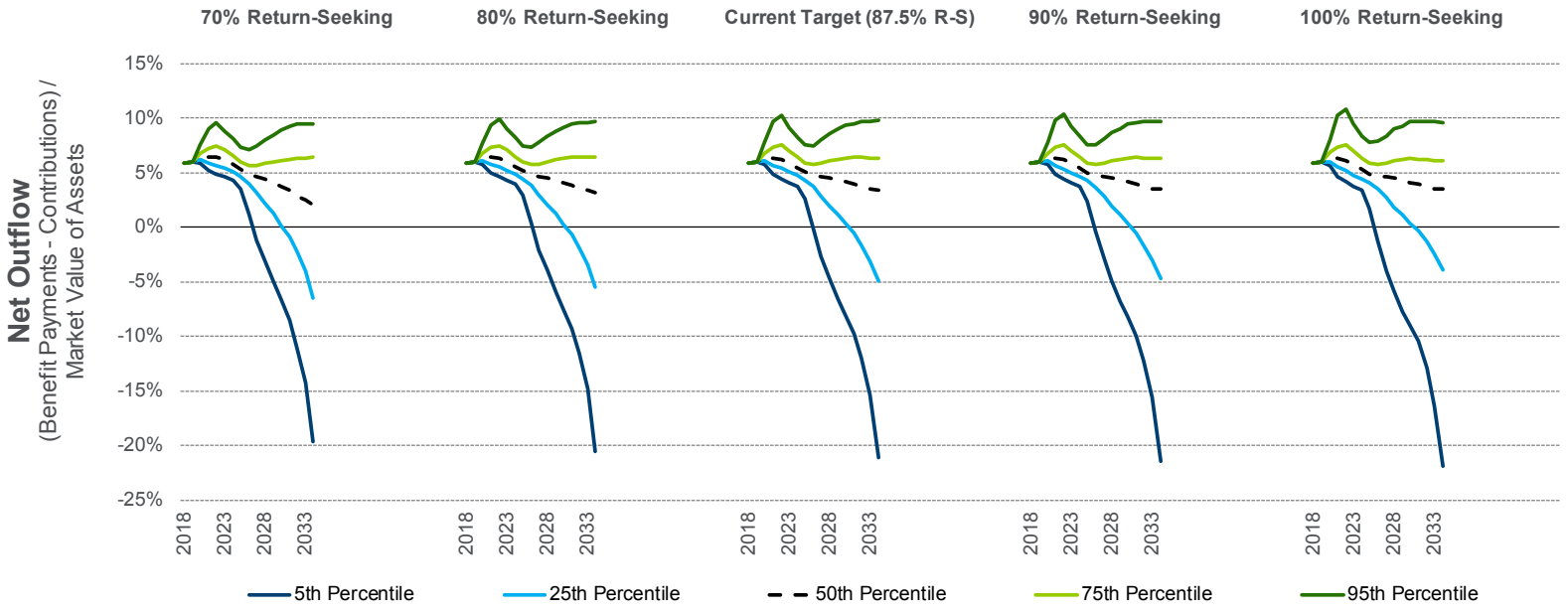
Key Takeaway:

- The higher the allocation to return-seeking assets, the lower the present value of future contributions will be on average but the greater the variability in contributions

* Liability projections assume discount rates determined via the Dedicated Gains Policy

Asset-Liability Projection Results

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



Strategy	70% Return-Seeking			80% Return-Seeking			Current Target (87.5% R-S)			90% Return-Seeking			100% Return-Seeking		
Year	2023	2028	2033	2023	2028	2033	2023	2028	2033	2023	2028	2033	2023	2028	2033
5th Percentile	5%	-3%	-14%	4%	-4%	-15%	4%	-5%	-15%	4%	-5%	-16%	4%	-6%	-16%
25th Percentile	5%	2%	-4%	5%	2%	-3%	5%	2%	-3%	5%	2%	-3%	5%	2%	-2%
50th Percentile	6%	4%	2%	6%	4%	3%	6%	4%	3%	6%	4%	4%	6%	4%	4%
75th Percentile	7%	6%	6%	7%	6%	6%	7%	6%	6%	7%	6%	6%	7%	6%	6%
95th Percentile	9%	8%	9%	9%	8%	10%	9%	9%	10%	9%	9%	10%	9%	9%	10%
Probability > 10%	3%	<1%	4%	3%	2%	4%	4%	3%	5%	4%	3%	5%	4%	4%	5%

Key Takeaway:

- Net outflow is consistent across the policies modeled with central expectations (50th percentile outcome) declining as contributions are projected to increase over time

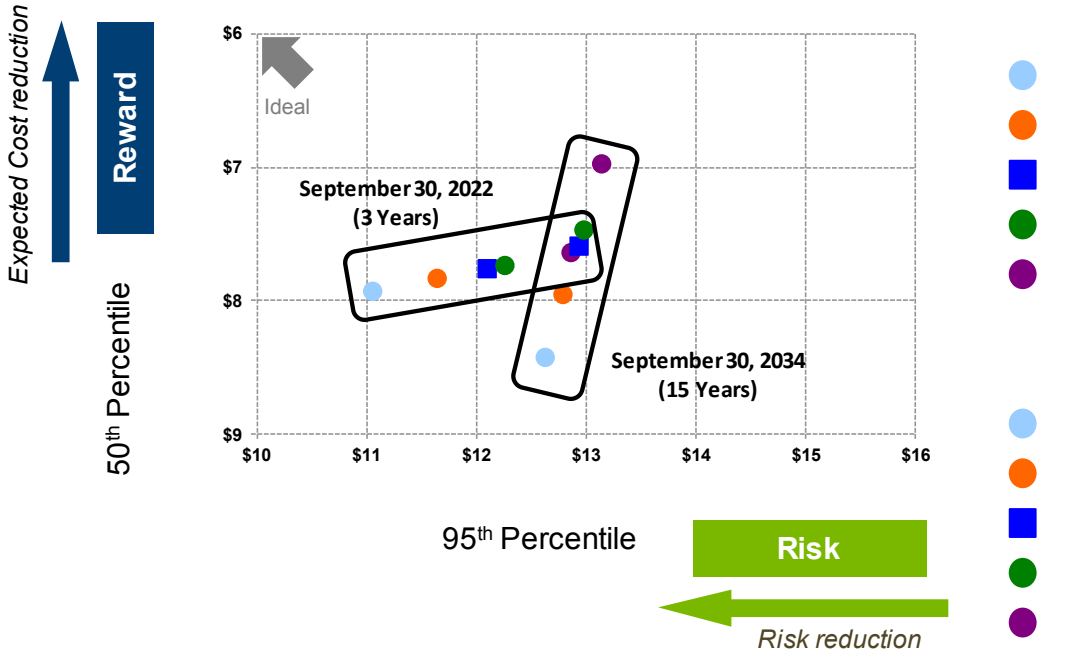
* Liability projections assume discount rates determined via the Dedicated Gains Policy

Asset-Liability Projection Results

Economic Cost Analysis—3-Year and 15-Year Horizons

Economic Cost

Present Value of Contributions plus AL Funding Shortfall/(Surplus)* at 6.70%, $billions



Strategy ($Billions)	Economic Cost September 30, 2022 Cost	Risk
70% Return-Seeking	$7.9	$11.1
80% Return-Seeking	$7.8	$11.6
Current Target (87.5% R-S)	$7.8	$12.1
90% Return-Seeking	$7.7	$12.3
100% Return-Seeking	$7.6	$12.9

Strategy ($Billions)	September 30, 2034 Cost	Risk
70% Return-Seeking	$8.4	$12.6
80% Return-Seeking	$8.0	$12.8
Current Target (87.5% R-S)	$7.6	$12.9
90% Return-Seeking	$7.5	$13.0
100% Return-Seeking	$7.0	$13.1

Key Takeaways:

- The magnitude of the risk/reward trade-off changes over a longer-term projection
- Under the Current Target asset allocation over a 15-year time horizon, the expected Economic Cost is $7.6B and the potential risk is $12.9B[1]
- Adjustments to the portfolio composition may have desirable risk/reward characteristics relative to the Current Policy

Liability projections assume discount rates of 7.25% for all investment policies studied; Reflects a *utility function:* Excludes 50% of surplus in excess of 110% of Actuarial liability, and includes twice the shortfall below 40% of Actuarial liability, on a market value basis

[1] Present value figures are calculated as of September 30, 2019

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Asset-Liability Projection Results
Summary and Conclusions

All Scenarios	15-year Present Value of Contributions		Change in 15-year PV of Contributions		15-year Ending Funded Ratio (MVA / AL)	
$ billions	Expected[1]	Downside[2]	Expected[1]	Downside[2]	Expected[1]	Downside[3]
Current Target (87.5% R-S)	$7.76	$12.42	$0.00	$0.00	109%	62%
Alternative Policy (87.5% R-S)	$7.79	$12.30	$0.03	($0.12)	108%	62%
Current Frontier						
0% Return-Seeking	$10.64	$10.99	$2.88	($1.43)	75%	65%
10% Return-Seeking	$10.30	$10.95	$2.53	($1.46)	78%	67%
20% Return-Seeking	$9.94	$11.06	$2.18	($1.35)	81%	67%
30% Return-Seeking	$9.61	$11.21	$1.84	($1.21)	84%	67%
40% Return-Seeking	$9.28	$11.39	$1.52	($1.03)	88%	66%
50% Return-Seeking	$8.95	$11.58	$1.19	($0.84)	92%	66%
60% Return-Seeking	$8.63	$11.79	$0.87	($0.63)	96%	64%
70% Return-Seeking	$8.29	$12.00	$0.53	($0.42)	100%	64%
80% Return-Seeking	$7.98	$12.24	$0.22	($0.18)	105%	63%
90% Return-Seeking	$7.69	$12.48	($0.07)	$0.06	111%	62%
100% Return-Seeking	$7.42	$12.72	($0.34)	$0.31	119%	61%

Key Findings:

- Alternative Policy offers a risk/reward trade-off relative to the Current Target
- The higher the allocation to return-seeking assets, the lower the present value of future contributions will be on average but the greater the variability in contributions

[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
Present Values calculations are as of September 30, 2019

Analysis

- Summary and Conclusions

Summary and Conclusions

Portfolio Analysis

- The current portfolio is well-diversified
- The expected return assumption for the current portfolio is 7.56%[1] over the next 30 years
- Michigan should consider its desired balance between funding, investment returns, and risk tolerance in order to determine the ideal investment portfolio

Asset-Liability Projection Analysis

- Longer time horizons are expected to reward higher levels of risk; shorter time horizons are not
- Contribution policy is projected to bring the plan to full funding, but with increased volatility as the closed amortization period declines to immediate recognition
- The Dedicated Gains Policy is projected to trend the actuarial investment return assumption down over the near-term

[1] Expected returns are using Aon Investments' Q2 2020 Capital Market Assumptions. Assumptions do not include fees/expenses. All expected returns are geometric (long-term compounded; rounded to the nearest decimal) and net of investment fees. Expected returns presented are models and do not represent the returns of an actual client account. Not a guarantee of future results. See capital market assumptions disclosure pages in Appendix.

Appendix

- Actuarial Assumptions and Methods

Actuarial Assumptions and Methods

- Actuarial projections provided by the plan actuary (GRS Consulting) as of September 30, 2017 and adjusted to sync to the September 30, 2018 actuarial valuation report

- Actuarial assumptions:
  - Valuation Rate of Interest = Varied, reflecting the Dedicated Gains Policy as of September 30, 2018
  - Inflation = 2.25%
  - Payroll Growth = 2.75%
  - Actuarial Value of Assets: determined by recognizing differences between actual and expected investment income over a closed five-year period with a 30% corridor
  - All other assumptions as documented in the Actuarial Valuation Report as of September 30, 2018 unless noted otherwise

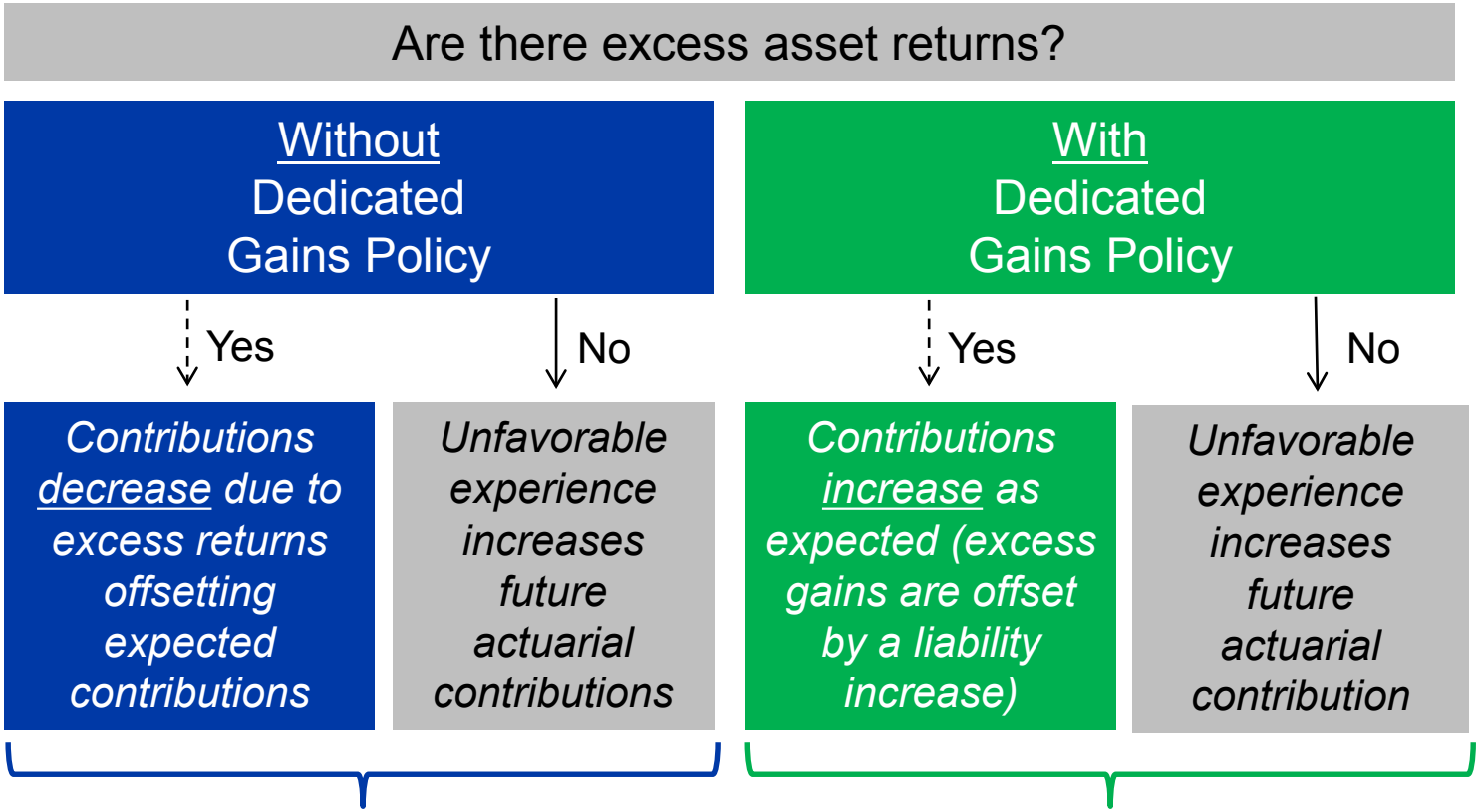
- Actuarially Determined Contribution Calculation = Normal Cost plus a level dollar amortization of the unfunded liability
  - Amortization of Unfunded Actuarial Liability uses a closed, 16-year amortization period that will decrease to immediate recognition at expiry

Actuarial Assumptions and Methods

- Dedicated Gains Policy
  - Discount rates were assumed to decrease annually should investment returns exceed expected returns in an amount such that a reduction in the investment return assumption would result in no expected increase in the employer contribution from where it would have been had investment returns equal their assumed
  - Excess investment returns were calculated based on a market value basis
  - Excess investment returns were assumed to first be used to reduce the discount rate
  - Any excess investment return not used to reduce the discount rate would apply as a gain for actuarial value of assets purposes
  - Decreases in discount rates were assumed to stop once the rate reached 6.00%

Actuarial Assumptions and Methods

Dedicated Gains Policy | Impact on Contributions



Contributions have the potential to decline sooner than under the Dedicated Gains Policy

Contributions do not decline until:

- The Dedicated Gains Policy reaches its end state; or
- The Plan reaches full funding

Appendix

- Capital Market Assumptions

Capital Market Assumption Methodology

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

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Aon Investments' Capital Market Assumptions

As of March 31, 2020 (30 Years)

		Expected Real Return[1]	Expected Nominal Return[1]	Expected Nominal Volatility
	Equity			
1	Large Cap U.S. Equity	4.5%	6.7%	16.5%
2	Small Cap U.S. Equity	5.0%	7.2%	22.5%
3	Global Equity IMI	5.3%	7.5%	18.0%
4	International Equity (Developed)	5.3%	7.5%	19.5%
5	Emerging Markets Equity	5.9%	8.1%	26.5%
	Fixed Income			
6	Cash (Gov't)	-1.0%	1.1%	1.5%
7	Core Fixed Income	0.0%	2.1%	4.5%
8	Intermediate Gov't Bonds (4-Year Duration)	-0.8%	1.3%	3.5%
9	Intermediate Corporate Bonds (4-Year Duration)	0.2%	2.3%	4.0%
10	Multi-Asset Credit[2]	3.2%	5.4%	9.5%
	Alternatives			
11	Direct Hedge Funds[2,3]	2.6%	4.8%	9.0%
12	Non Core Real Estate	5.4%	7.6%	25.0%
13	Core Real Estate	3.7%	5.9%	14.5%
14	Private Equity	7.5%	9.8%	24.5%
15	Infrastructure	6.1%	8.3%	14.0%
16	Private Debt	4.4%	6.6%	17.0%
	Inflation			
17	Inflation	0.0%	2.1%	1.5%

Notes:

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

[2] Alpha incorporated in Expected Nominal Return.

[3] Represents diversified portfolio of direct hedge fund investments.

Aon Investments' Capital Market Assumptions

As of March 31, 2020

	Nominal Correlations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Large Cap U.S. Equity	**1.00**	0.92	0.96	0.78	0.72	0.09	0.05	-0.06	0.08	0.59	0.66	0.47	0.37	0.69	0.38	0.39	0.06
2	Small Cap U.S. Equity	0.92	**1.00**	0.90	0.72	0.67	0.07	0.04	-0.06	0.07	0.54	0.61	0.44	0.34	0.65	0.36	0.36	0.05
3	Global Equity IMI	0.96	0.90	**1.00**	0.90	0.84	0.08	0.05	-0.06	0.08	0.65	0.64	0.49	0.38	0.67	0.37	0.41	0.07
4	International Equity (Developed)	0.78	0.72	0.90	**1.00**	0.75	0.05	0.04	-0.05	0.07	0.60	0.55	0.44	0.34	0.56	0.31	0.36	0.08
5	Emerging Markets Equity	0.72	0.67	0.84	0.75	**1.00**	0.07	0.05	-0.05	0.08	0.63	0.47	0.41	0.31	0.53	0.29	0.39	0.07
6	Cash (Gov't)	0.09	0.07	0.08	0.05	0.07	**1.00**	0.46	0.61	0.50	0.13	-0.04	0.12	0.13	0.08	0.11	-0.01	0.54
7	Core Fixed Income	0.05	0.04	0.05	0.04	0.05	0.46	**1.00**	0.89	0.97	0.24	0.01	0.06	0.06	0.04	0.05	-0.03	0.13
8	Intermediate Gov't Bonds (4-Year Duration)	-0.06	-0.06	-0.06	-0.05	-0.05	0.61	0.89	**1.00**	0.83	-0.01	-0.25	0.01	0.02	-0.05	0.01	-0.27	0.25
9	Intermediate Corporate Bonds (4-Year Duration)	0.08	0.07	0.08	0.07	0.08	0.50	0.97	0.83	**1.00**	0.31	0.08	0.08	0.08	0.07	0.07	0.06	0.20
10	Multi-Asset Credit	0.59	0.54	0.65	0.60	0.63	0.13	0.24	-0.01	0.31	**1.00**	0.65	0.30	0.23	0.40	0.23	0.66	0.16
11	Direct Hedge Funds	0.66	0.61	0.64	0.55	0.47	-0.04	0.01	-0.25	0.08	0.65	**1.00**	0.31	0.24	0.45	0.24	0.53	0.03
12	Non Core Real Estate	0.47	0.44	0.49	0.44	0.41	0.12	0.06	0.01	0.08	0.30	0.31	**1.00**	0.96	0.38	0.21	0.21	0.08
13	Core Real Estate	0.37	0.34	0.38	0.34	0.31	0.13	0.06	0.02	0.08	0.23	0.24	0.96	**1.00**	0.31	0.18	0.16	0.08
14	Private Equity	0.69	0.65	0.67	0.56	0.53	0.08	0.04	-0.05	0.07	0.40	0.45	0.38	0.31	**1.00**	0.32	0.30	0.06
15	Infrastructure	0.38	0.36	0.37	0.31	0.29	0.11	0.05	0.01	0.07	0.23	0.24	0.21	0.18	0.32	**1.00**	0.17	0.07
16	Private Debt	0.39	0.36	0.41	0.36	0.39	-0.01	-0.03	-0.27	0.06	0.66	0.53	0.21	0.16	0.30	0.17	**1.00**	0.11
17	Inflation	0.06	0.05	0.07	0.08	0.07	0.54	0.13	0.25	0.20	0.16	0.03	0.08	0.08	0.06	0.07	0.11	**1.00**

Aon Investments' Capital Market Assumptions

Explanation of Capital Market Assumptions—Q2 2020

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

Inflation – Expected Level (2.1%)

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

Real Returns for Asset Classes

Fixed Income

- **Cash (-1.0%)** – Over the long run, we expect the real yield on cash and money market instruments to produce a real return of -1.0% in a moderate to low-inflationary environment.
- **TIPS (0.2%)** – We expect intermediate duration Treasury Inflation-Protected Securities to produce a real return of about 0.2%.
- **Core Fixed Income (i.e., Market Duration) (0.0%)** – We expect intermediate duration Treasuries to produce a real return of about -0.8%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 0.8%, resulting in a long-term real return of 0.0%.
- **Long Duration Bonds – Government and Credit (0.2%)** – We expect Treasuries with a duration comparable to the Long Government Credit Index to produce a real return of -0.5%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 0.7%, resulting in an expected real return of 0.2%.

Aon Investments' Capital Market Assumptions

Explanation of Capital Market Assumptions—Q2 2020

- **Long Duration Bonds – Credit (0.9%)** – We expect Treasuries with a duration comparable to the Long Credit Index to produce a real return of -0.5%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 1.4%, resulting in an expected real return of 0.9%.
- **Long Duration Bonds – Government (-0.5%)** – We expect Treasuries with a duration of ~12 years to produce a real return of -0.5% during the next 30 years.
- **High Yield Bonds (2.3%)** – We expect intermediate duration Treasuries to produce a real return of about -0.8%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults and downgrades) to be 3.5%, resulting in an expected real return of 2.3%.
- **Bank Loans (2.6%)** – We expect LIBOR to produce a real return of about -0.5%. We estimate the fair value credit spread (credit risk premium - expected losses from defaults) to be 3.1%, resulting in an expected real return of 2.6%.
- **Non-US Developed Bonds: 50% Hedged (-0.3%)** – We forecast real returns for non-US developed market bonds to be -0.3% 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) (2.3%)** – We forecast real returns for emerging market sovereign bonds denominated in US dollars to be 2.3% over a 30-year period.
- **Emerging Market Bonds (Corporate; USD) (1.8%)** – We forecast real returns for emerging market corporate bonds denominated in US dollars to be 1.8% over a 30-year period.
- **Emerging Market Bonds (Sovereign; Local) (2.4%)** – We forecast real returns for emerging market sovereign bonds denominated in local currency to be 2.4% over a 30-year period.
- **Multi Asset Credit (MAC) (3.2%)** – We assume real returns from beta exposure to high yield, bank loans and emerging market debt to add 2.5% plus 0.8% from alpha (net of fees) over a 30-year period.
- **Private Debt-Direct Lending (4.4%)** – The base building block is bank loans 2.6% + spread 1.8% (net of management fees and performance incentives). There is 100% leverage included in the assumption with the cost of financing at LIBOR + 2.5%.

Aon Investments' Capital Market Assumptions

Explanation of Capital Market Assumptions—Q2 2020

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 0.5% return premium for small cap U.S. equity over large cap U.S. equity results in an expected real return of 5.0%. 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) (5.3%)** – 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 5.3% for global equity.
- **International (Non-U.S.) Equity, Developed Markets (5.3%)** – We employ a building block process similar to the U.S. equity model using the non-U.S. developed equity markets that comprise the MSCI EAFE Index.
- **Emerging Market Stocks (5.9%)** – We employ a building block process similar to the U.S. equity model using the non-U.S. emerging equity markets that comprise the MSCI Emerging Markets Index.
- **Equity Risk Insurance Premium Strategies-High Beta (4.3%)** – We expect real returns from 50% equity + 50% cash beta of 2.1% plus 2.2% insurance risk premium over the next 30 years.

Alternative Asset Classes

- **Hedge Fund-of-Funds Universe (1.3%)** – The generic category "hedge funds" encompasses a wide range of strategies accessed through "fund-of-funds" vehicles. We also assume the ***median*** manager is selected and also allow for the additional costs associated with Fund-of-Funds management. A top-tier portfolio of funds (hedge fund-of-funds buy-list) could add an additional 1.2% in return at similar volatility based on alpha, lower fees and better risk management.

Aon Investments' Capital Market Assumptions

Explanation of Capital Market Assumptions—Q2 2020

- **Hedge Fund-of-Funds Buy List (2.5%)** – The generic category of top-tier "hedge funds" encompasses a wide range of strategies accessed through "fund-of-funds" vehicles. We assume additional costs associated with Funds-of-Funds management. To use this category the funds must be buy rated or we advise on manager selection.
- **Broad Hedge Funds Universe (2.6%)** – 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 (4.0%)** – Represents a diversified portfolio of top-tier direct hedge fund investments. This investment will tend to be less diversified than a typical "fund-of-funds" strategy as there will be fewer underlying managers and will not include the extra layer of fees found in a Fund-of-Funds structure. To use this category the funds must be buy rated or we advise on manager selection.
- **Core Real Estate (3.7%)** – Our real return assumption for core real estate is based a gross income of about 3.7%, management fees of roughly 1%, and future capital appreciation near the rate of inflation during the next 30 years. We assume a portfolio of equity real estate holdings that is diversified by property and by geographic region.
- **Non-Core Real Estate (5.4%)** – Core real estate is levered approximately 100% as the base building block for this assumption. We subtract financing costs for the leverage and 2% management costs. We also assume nominal alpha of 3%. We assume a 50/50 mix of value-add and opportunistic investments.
- **U.S. REITs (5.2%)** – Our real return assumption for U.S. REITs is based on income of about 4.8% and future capital appreciation near the rate of inflation during the next 30 years. REITs are a sub-set of U.S. small/mid cap equity universe.
- **Commodities (1.5%)** – Our commodity assumption is for a diversified portfolio of commodity futures contracts. Commodity futures returns are composed of three parts: spot price appreciation, collateral return, and roll return (positive or negative change implied by the shape of the future curve). We believe that spot prices will converge with CPI over the long run (i.e., 2.1%). Collateral is assumed to be LIBOR cash (-0.5%). Also, we believe the roll effect will be near zero, resulting in a real return of about 1.5% for commodities.

Aon Investments' Capital Market Assumptions

Explanation of Capital Market Assumptions—Q2 2020

- **Private Equity (7.5%)** – Our private equity assumption reflects a diversified fund of funds with exposure to buyouts, venture capital, distressed debt, and mezzanine debt.
- **Infrastructure (6.1%)** – Our infrastructure assumption is formulated using a cash flow based approach that projects cash flows (on a diversified portfolio of assets) over a 30-year period. Income and capital growth as well as gearing levels, debt costs and terms, relevant tax and management expenses are all taken into consideration. Our approach produces an expected real return of 6.1% for infrastructure.
- **Equity Risk Insurance Premium Strategies-Low Beta (2.4%)** – We assume real returns from cash of -1.0% + 3.4% from alpha.
- **Alternative Risk Premia (ARP) (3.4%)** – Real return target LIBOR -0.5% plus 3.9% alpha (net of fees)

Volatility / Correlation Assumptions

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

Appendix

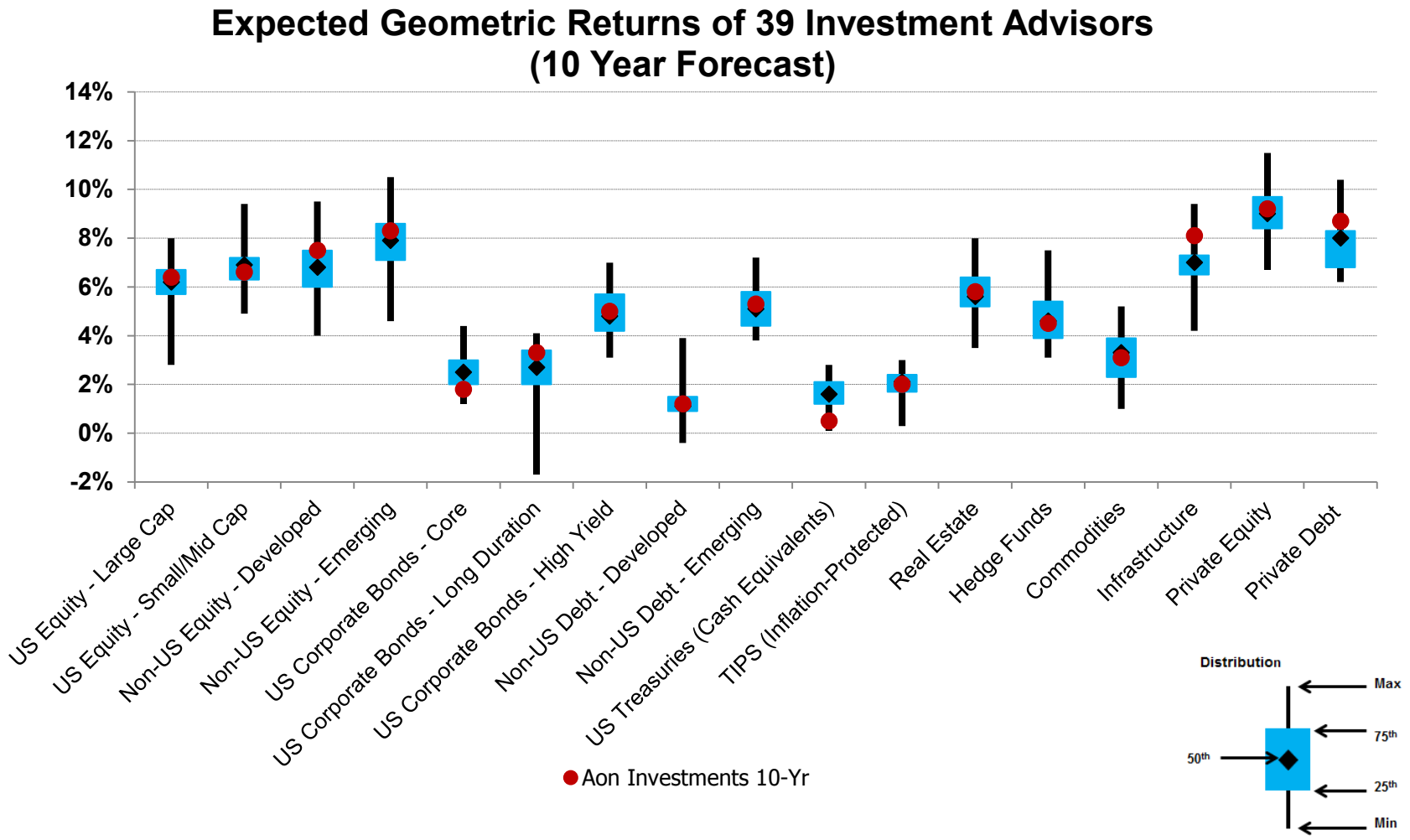
- Horizon Survey of Capital Market Assumptions

2020 Horizon Survey Results

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

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

Aon Investments' Capital Market Assumptions vs. Horizon Survey



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

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

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

Notes (Horizon Survey):

Source: Horizon Actuarial survey of 2020 capital market assumptions from 39 independent investment advisors

Expected returns are median annualized (geometric).

Notes (Aon Investments' Forecasts):

Aon Investments' Forecasts are for Q2 2020

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

Leading Methodologies & Reasons for Differences

Leading Methodologies

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

Reasons for Differences

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

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

Appendix

- How Do Public Pensions Impact Credit Ratings?

How Do Public Pensions Impact Credit Ratings?
Summary and Conclusions

Pension Impact on Credit Ratings

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

Credit Ratings and Borrowing Costs

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

Call to Action

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

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How Do Public Pensions Impact Credit Ratings?

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

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

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

Appendix

- Asset-Liability Management Background

Asset-Liability Management Background

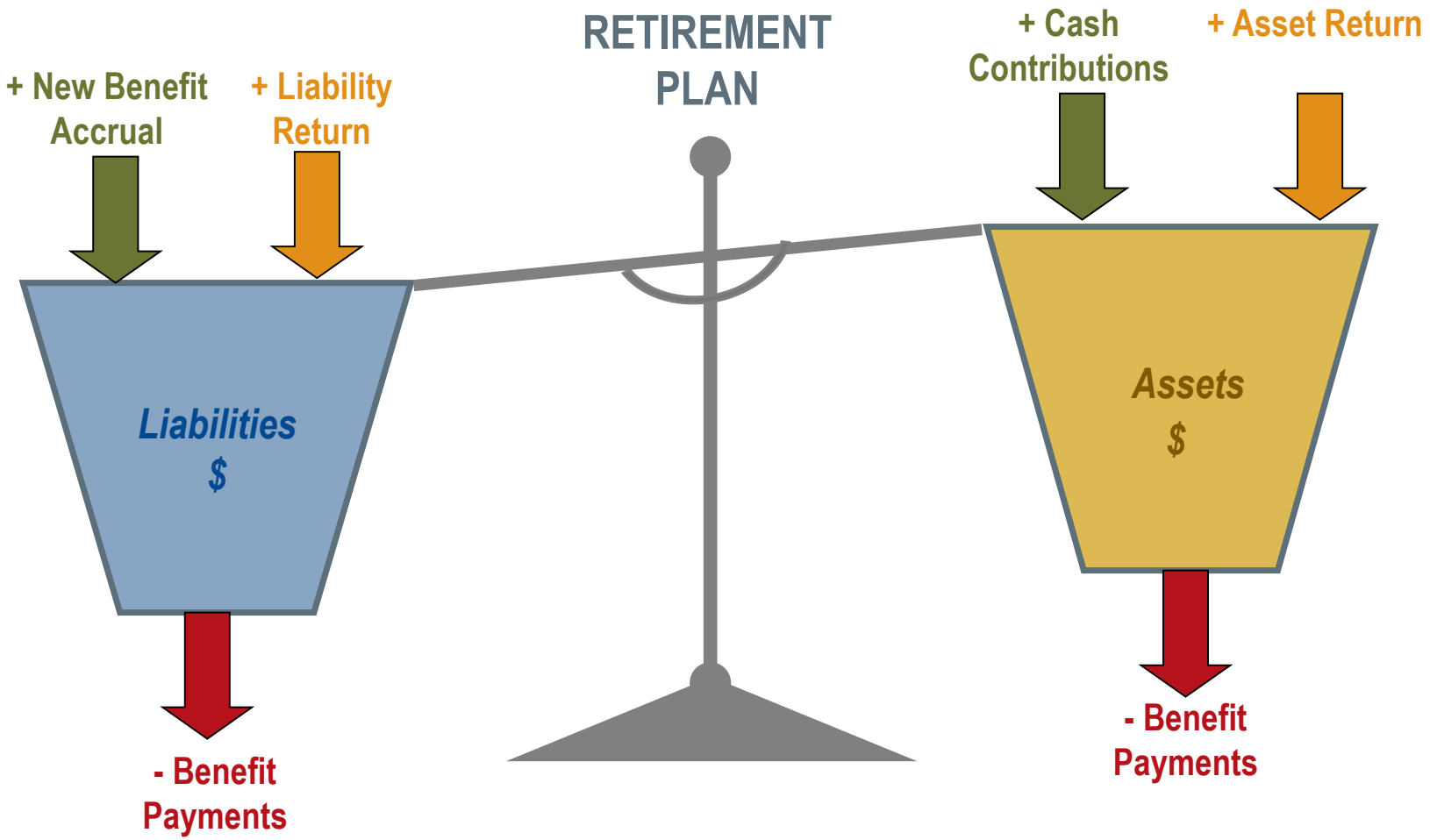
What is an Asset-Liability Study?

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

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

Asset-Liability Management Background

Balance of Liabilities and Assets



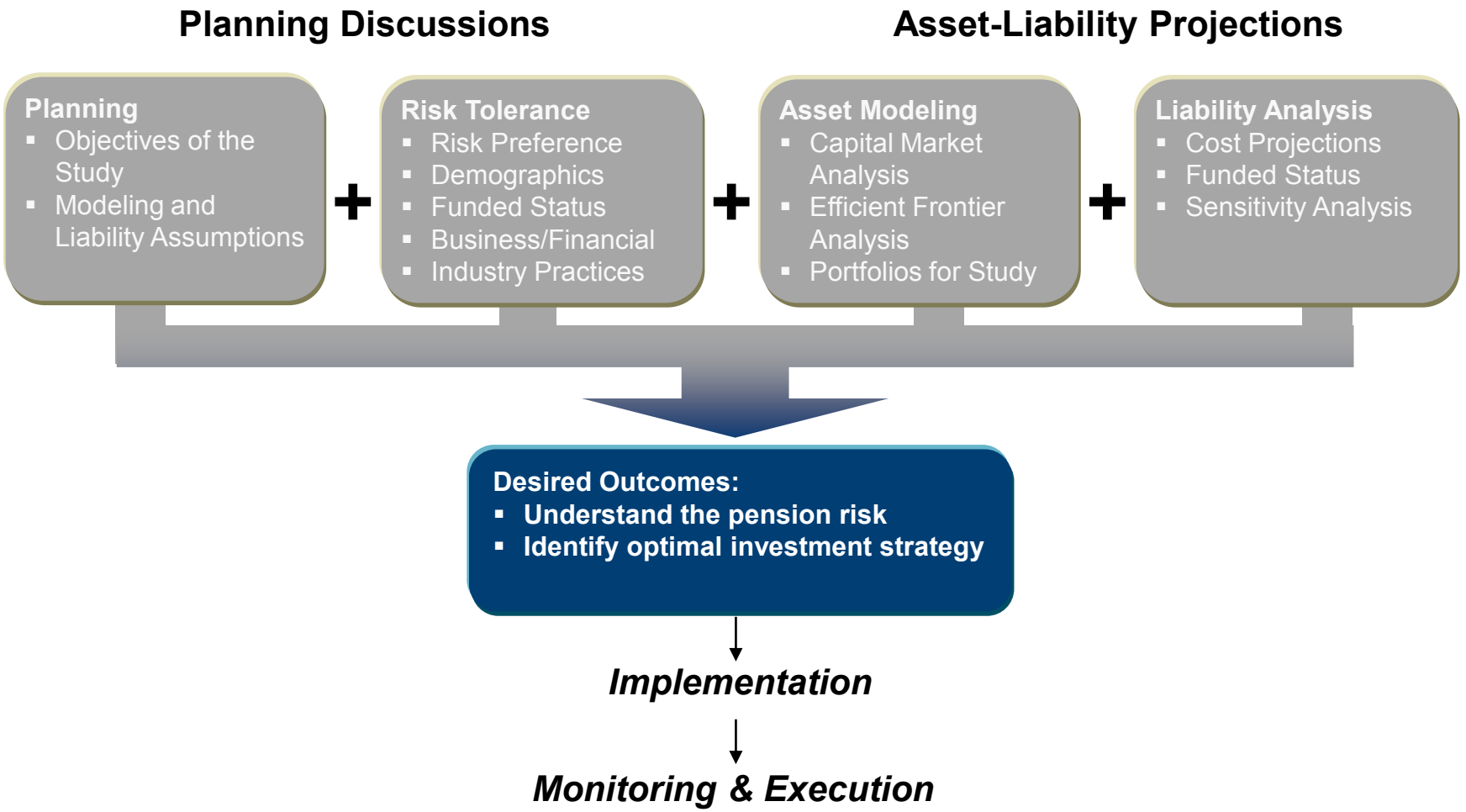
Asset-Liability Management Background

Key Risks for Public Pension Plans

Types of Risk	Time Horizon	Risk Management Tools and Controls
Return Shortfall ▪ Assets do not grow with liabilities ▪ Investment return & contribution less than liability growth	**Long-Term** (10+ years)	▪ Funding policy ▪ Plan design ▪ Investment policy ▪ Assumptions & methods
Liquidity ▪ Cannot liquidate assets efficiently to meet needs ▪ Lose control of asset allocation	**Short- to Medium-Term** (<5 years)	▪ Funding policy ▪ Benefit accruals ▪ Use of Illiquid investments ▪ Scenario analysis ▪ Monitoring
Investment ▪ Asset allocation (policy) ▪ Investment structure ▪ Manager selection ▪ Rebalancing ▪ Scenario (or path risk) ▪ Factor	**Short-to Medium-Term** (<5 years)	▪ Investment policy statement – Static/dynamic – Asset allocation – Rebalancing – Manager guidelines – Monitoring/roles & responsibilities ▪ Risk budgeting ▪ Monitoring / dashboards ▪ Medium term views ▪ Regression and scenario analysis

Asset-Liability Management Background

Overview of the Asset-Liability Study Process



Asset-Liability Management Background
Modeling Process

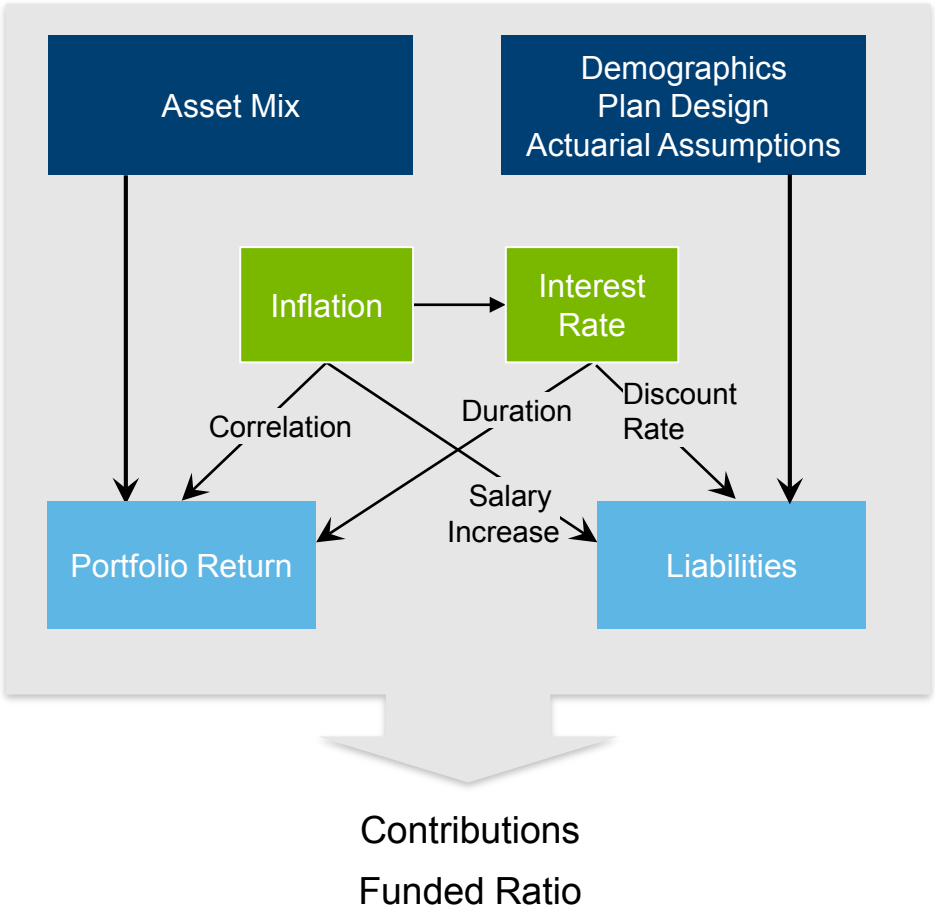
- Goals of an asset-liability study:
  - Understand the pension plan's asset-liability risk, and
  - Identify the optimal investment strategies

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

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

Asset-Liability Management Background

Mechanics of Asset-Liability Modeling Process



Asset and liability modeling integrated in single platform

- Integrates impact of key economic variables

Flexibility in modeling parameters and output to client preferences

Stochastic and deterministic modeling performed

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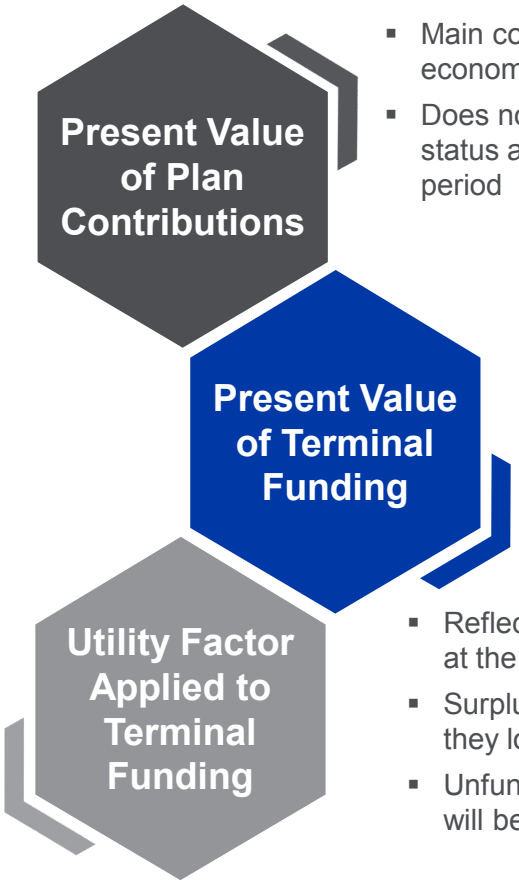
Asset-Liability Management Background
Long-Term Economic Cost of Plan

Long-Term Economic Cost =

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

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



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

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

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 the State of Michigan (SOM). 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 SOM. 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 SOM 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 September 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 associate of Aon Hewitt Investment Consulting, Inc. providing services to SOM has any direct financial interest or indirect material interest in SOM. Thus, we believe there is no relationship existing that might affect our capacity to prepare and certify this report for SOM.

Aon Hewitt Investment Consulting, Inc.

Phil Kivarkis FSA, CFA

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