Board of Retirement Regular Meeting

Sacramento County Employees' Retirement System

Agenda Item 19

MEETING DATE: **January 17, 2024**

SUBJECT: **Education: ALM Study Overview**

SUBMITTED FOR: **__ Consent** **___ Deliberation and Action** **__X__ Receive and File**

RECOMMENDATION

Receive and file the Asset Liability Modeling (ALM) Study Overview education presentation by SCERS' staff and general investment consultant, Verus Advisory.

PURPOSE

This item complies with the Master Investment Policy Statement requirement for SCERS to conduct an ALM study at least every five years.

INTRODUCTION

At the January meeting, Verus and Staff will review the upcoming ALM study and process. The presentation will provide:

- an overview of SCERS' investment objectives and philosophy,
- the evolution of SCERS' strategic asset allocation,
- considerations for the ALM study,
- an update on capital market assumptions,
- an overview of asset allocation concepts, and
- next steps in the ALM process.

SCERS last conducted an asset liability modeling study in 2021, which concluded with the approval of the current strategic asset allocation (SAA) in August 2021. The ALM process is an iterative one that will progress over the next three quarters. The ALM process includes:

- Verus' enterprise risk tolerance (ERT) analysis and discussion
- Developing a liability model
- Combing asset and liability data to model asset portfolio mixes
- Reviewing ALM results and approving a strategic asset allocation
- Updating investment policy statements

Some considerations going into the ALM study include:

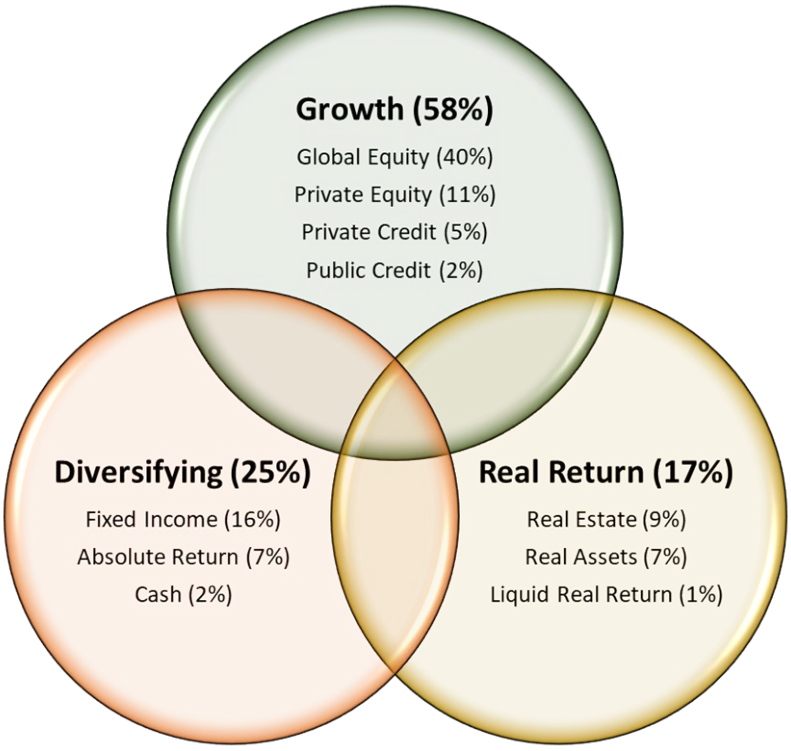
- Recognition of a change in economic regimes and the higher interest rate environment
- Role and sizing of asset classes, and proper categorization of asset classes
- Level of private market exposure in line with plan liquidity considerations
- Proper level of risk given SCERS' targeted actuarial rate and economic/market dynamics

Prior to the start of the ALM process, Staff and consultants will be providing an education series with a deep dive into SCERS' various asset classes over the first few quarters of 2024. The objective of the asset class educational series is to:

- Assist the Board in understanding the role and objective of each asset class
- Review asset class construction
- Provide an overview of asset class performance in meeting their objectives
- Discuss macro trends within asset classes

STRATEGIC ASSET ALLOCATION EVOLUTION

SCERS' current asset allocation is as follows:



The most significant change to the asset allocation in the last decade occurred during the 2017 ALM study, which moved the SCERS portfolio into a functional asset allocation framework. The framework groups and classifies segments of the portfolio that are exposed to similar economic environments and risk factors, and which would be expected to have similar roles and outcomes

in a portfolio. The functional grouping breaks the portfolio into three asset categories: (1) Growth; (2) Diversifying; and, (3) Real Return, with asset classes that underlie these asset categories.

SCERS' current strategic asset allocation takes a risk-balanced approach that emphasizes having enough return-generating assets to drive performance toward the actuarial rate of return. However, it also maintains meaningful diversification, especially to investment strategies with low and negative correlations to equity markets that can reduce portfolio volatility and protect against significant market drawdowns. The asset allocation also contains inflation-hedging assets and segments that generate meaningful cash flow for SCERS' plan. The strategic asset allocation also contains a meaningful allocation to alternative assets and less liquid private market investments, so tracking SCERS' liquidity profile to maintain sufficient liquidity and cash flows in order to meet benefit payment obligations is a key focus.

The move towards greater allocations to alternative assets occurred after the Global Financial Crisis (GFC), with an emphasis from the Board to increase diversification within the portfolio subsequent to the dramatic collapse in values during the GFC. Previously, SCERS held small allocations to Private Equity and Equity Long/Short Hedge Funds, which were implemented through Fund of Funds (FoFs). The 2011 ALM study increased the allocations to Private Equity and Hedge Funds, transitioned from FoFs to direct allocations to funds, and also took a more diversified approach within those asset classes. The Real Assets allocation was also introduced in 2011 to provide an inflation hedge, cash flows, and added diversification. The Private Credit asset class was added during the 2017 ALM study given its attractive risk/return profile and cash flow generation. With the greater focus on alternatives, and direct allocations within alternatives, in 2011 SCERS also hired its first dedicated alternative assets consultant, Cliffwater, to assist in implementation. SCERS also added a dedicated real estate consultant, Townsend, at that time.

The outcome of the 2021 ALM study resulted in moderate revisions to the asset allocation. Key changes included:

- Increases to the Private Equity (9% to 11%), Private Credit (4% to 5%), and Real Estate (7% to 9%) allocations
- Reduction in the Fixed Income allocation by 2%, in particular the elimination of a global fixed income mandate
- Elimination of a 3% Growth Absolute Return allocation (equity and credit centric funds)
    - SCERS kept Diversifying Absolute Return allocation at 7% (uncorrelated strategies)

During 2023, SCERS also made a small asset allocation revision by increasing the Dedicated Cash allocation from 1% to 2%, and reducing the Liquid Real Return allocation from 2% to 1%.

APPROACHES TO ALM

The strategic asset allocation contributes to the majority of portfolio performance, which makes the ALM study a significant project for the Board, Staff, and consultants There historically have been several approaches to conducting an ALM study, and many of these have evolved over time, particularly since the Global Financial Crisis (GFC). There is not one approach that works

best and fits all, and though the modeling is quantitative, the final outcome is as much art as it is science.

Mean variance optimization (MVO) has been considered the foundation to asset liability modeling and designing a strategic asset allocation. MVO takes the expected returns and historical standard deviations (volatility), along with correlations of defined assets classes, and forms capital market expectations. These expectations are run through an optimizer to arrive at optimal mixes of asset classes along the efficient frontier (a graph that plots optimal portfolios that have the highest expected return for a given level of risk).

MVO is effective at diversifying across asset classes and geographies, but the MVO approach has some shortcomings, including: (1) utilizing standard deviation as the sole measure of risk; (2) utilizing capital market projections based off historical data to forecast the future, which can prove challenging; and (3) using normal return distribution assumptions, which underestimates the frequency and severity of 'left tail' events. MVO can mask certain risks that are inherent within asset classes, which can result in over diversification within some asset classes and under diversification within others.

In the aftermath of the GFC, alternative approaches and perspectives to asset allocation became more prevalent in constructing asset allocations, and particularly in measuring risk. Verus has evolved its approach to asset liability modeling over the past decade to incorporate these alternative approaches, including better understanding exposure to risk factors and economic environments, as well as measuring liquidity risk. Other tools that Verus uses to conduct an ALM study include stochastic forecasting, deterministic projections, and stress tests.

ENTERPRISE RISK TOLERANCE DISCUSSION

During the 2017 and 2021 ALM studies, Verus conducted an enterprise risk tolerance (ERT) analysis and discussion with the SCERS Board to assess a plan's ability and the Board's willingness to accept risk. The analysis is used as a guide in designing and recommending asset allocation mixes for the Board to consider.

An ERT analysis will be conducted as part of this year's ALM study during the second and third quarters of 2024. It will include a combination of a survey and virtual interviews with SCERS Board members.

2024 ALM EXPECTATIONS

As part of the presentation, Verus modeled SCERS' existing SAA using updated 2024 capital market assumptions. The results show that SCERS' current portfolio models to an expected return of 7.4%. This is similar to how the SCERS portfolio modeled in 2023. The 7.4% expected return is meaningfully higher than the 5.7% return that the SCERS portfolio modeled to in 2021, during the last ALM study. While capital market assumptions are higher across most market segments compared to 2021, a key driver of the higher return expectations is the higher interest rate environment and increased return expectations within fixed income and credit.

SCERS models its investment portfolio with a mix of assets that is expected to meet SCERS' actuarial rate of return; however, the reality is that actual outcome falls with a range of outcomes that can vary significantly from what is 'expected'.

While it is important that the strategic asset allocation is designed to put SCERS on a reasonable path to meet SCERS' actuarial return target, there are other considerations that go into the process. These include protecting against significant drawdowns, reducing volatility around contributions, improving funded status, and maintaining a sufficient liquidity profile to ensure SCERS' ability to pay benefit payment obligations, particularly given SCERS' meaningful allocation to illiquid private market assets.

NEXT STEPS

Looking ahead, the Board, Staff, and consultants will work together to identify asset allocation revisions to consider for SCERS given the Board's desired objectives and risk tolerances, in combination with SCERS' actuarial liability characteristics. This iterative process is expected to generate recommendations in the fourth quarter of 2024 with Board approval targeted for the first quarter of 2025.

ATTACHMENTS

- Board Order
- ALM Study Overview presentation

Prepared by:

/s/

Steve Davis
Chief Investment Officer

Reviewed by:

/s/

Eric Stern
Chief Executive Officer

Retirement Board Order

Sacramento County Employees' Retirement System

Before the Board of Retirement
January 17, 2024

AGENDA ITEM:

Education: ALM Study Overview

THE BOARD OF RETIREMENT hereby approves Staff's recommendation to receive and file the Asset Liability Modeling (ALM) Study Overview education presentation by SCERS' staff and general investment consultant, Verus Advisory.

I HEREBY CERTIFY that the above order was passed and adopted on January 17, 2024 by the following vote of the Board of Retirement, to wit:

AYES:

NOES:

ABSENT:

ABSTAIN:

ALTERNATES:
(Present but not voting)

_____
James Diepenbrock
Board President

_____
Eric Stern
Chief Executive Officer and
Board Secretary

SCERS

Education – Asset Liability Modeling Study Overview

January 17, 2024

Introduction

- Staff presentation
  - Overview of SCERS' investment objectives and philosophy
  - Evolution of SCERS' strategic asset allocation
  - Considerations for ALM study

- Verus presentation
  - Capital market assumption update
  - Asset allocation concepts overview
  - Steps in the ALM process

Investment Objectives

Primary and overarching objectives:

- Provide for current and future benefit payments
- Achieve funding goals
- Preserve a degree of liquidity ample to meet benefit payments and capital calls
- Diversify plan assets as the main defense against large market drawdowns, while maintaining reasonable risk exposure to meet return requirements
- Incur costs that are reasonable and consistent with industry standards

Investment Objectives (cont.)

Performance objectives:

- Achieve returns at the total fund level that are at or above the actuarial real return over complete market cycles
- Achieve returns in excess of policy benchmarks at the total fund and asset class levels over rolling three-year periods
- For asset classes and actively managed portfolios, achieve net returns that exceed policy benchmarks, and rank in the top half of a competitive, after-fee universe

Investment Philosophy

Strategic asset allocation has the greatest impact on long-term investment returns and volatility

The strategic asset allocation target is a well-diversified portfolio across asset categories and asset classes

An allocation to low-cost investment strategies, including passive strategies, will be used in the most efficient asset classes

- Active management strategies are acceptable when expected excess returns compensate SCERS for the active risk taken

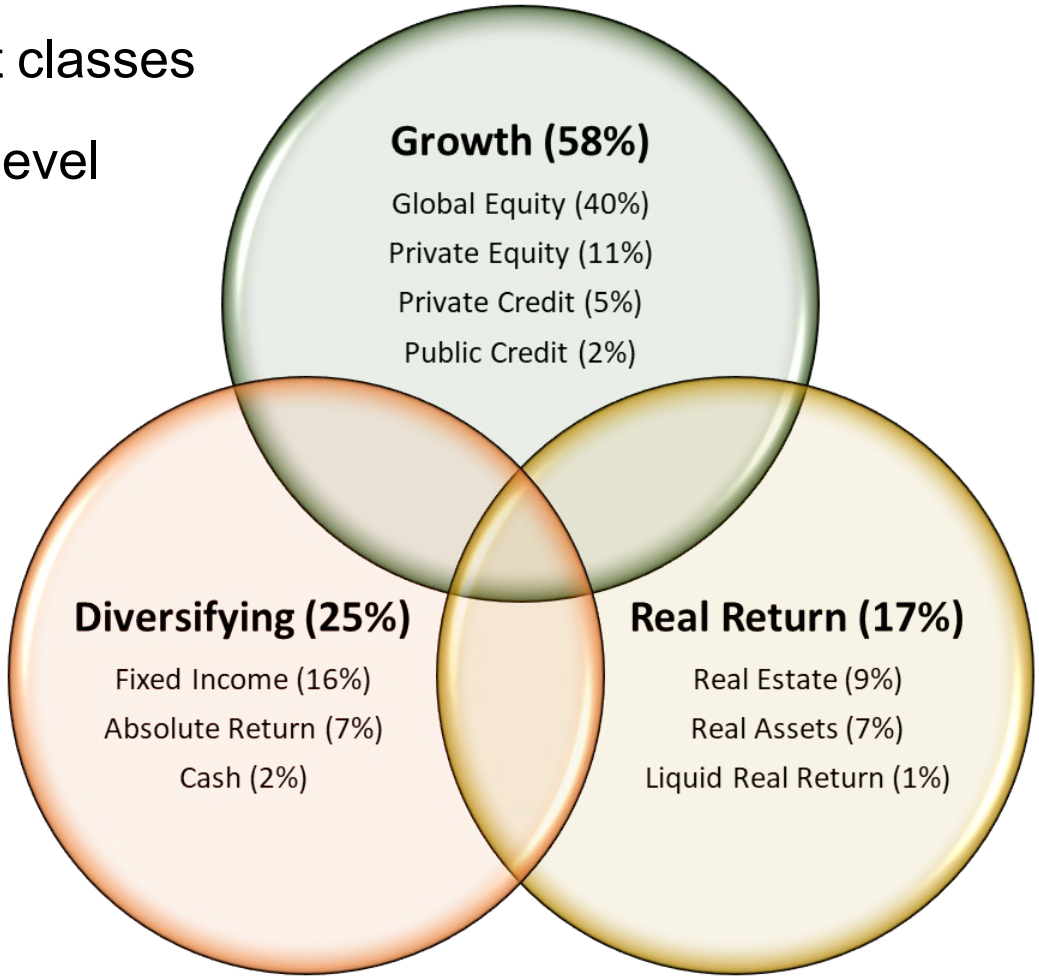
Investment Philosophy (cont.)

Investments that offer an illiquidity premium in return for a longer holding or lock-up period will be utilized to the extent that overall liquidity is not imperiled

The strategic asset allocation should generate sufficient levels of cash flow to support the System in meeting its benefit payment obligations

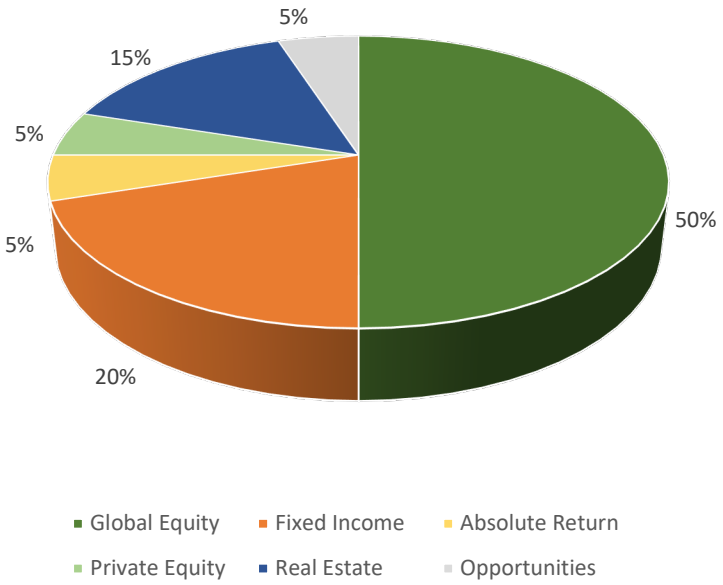
Strategic Asset Allocation

- Functional approach - categorize assets based on economic environment and risk factors
- Better identifies the roles that various segments play in the portfolio
- Blends traditional and alternative asset classes
- Simplified approach at asset category level
  - Growth
  - Diversifying
  - Real Return
- Asset categories supported by underlying asset classes

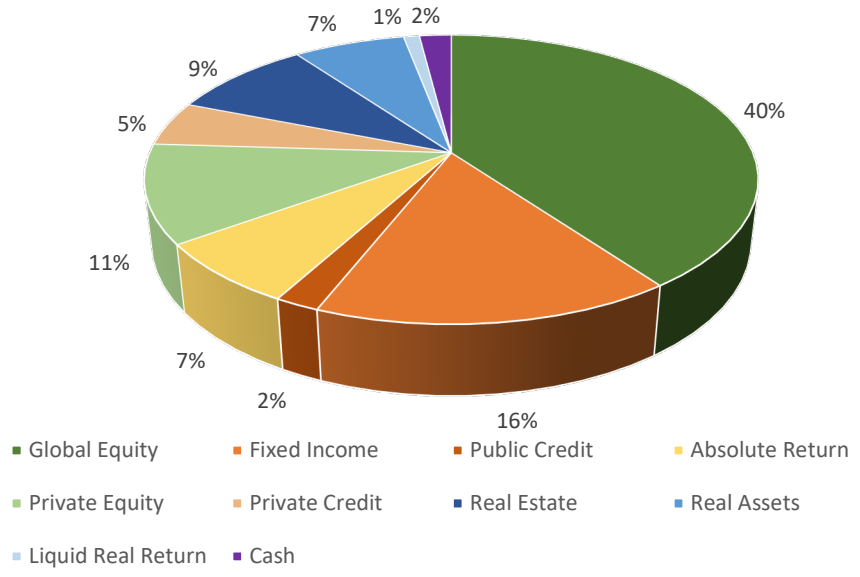


Strategic Asset Allocation Evolution

2010
$5.0 billion

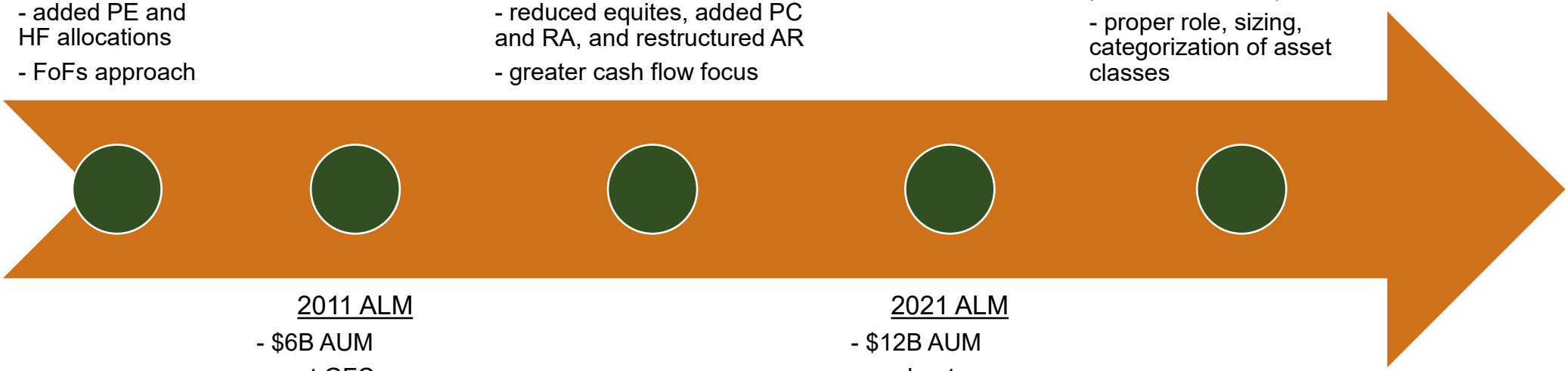


2023
$12.8 billion



- Strategic asset allocation has evolved to a more risk-balanced approach
  - Increases to alternative and private market assets for enhanced returns, diversification, and cash flows
- Ample return-generating assets combined with meaningful diversification to low correlated and cash-flowing assets

Strategic Asset Allocation Timeline



2005 ALM

- $4B AUM
- added PE and HF allocations
- FoFs approach

2011 ALM

- $6B AUM
- post GFC diversification emphasis
- increased alts and direct approach to alts
- added alts/real estate consultants

2017 ALM

- $9B AUM
- moved to functional approach
- increased diversification
- reduced equites, added PC and RA, and restructured AR
- greater cash flow focus

2021 ALM

- $12B AUM
- moderate revisions
- reduced AR and FI; added to PE and RE

2024 ALM Considerations

- $13B AUM
- change in economic regime/higher interest rates
- proper level of risk and private market exposure
- proper role, sizing, categorization of asset classes

How Did SCERS Do?

- Will evaluate the impact of strategic asset allocation changes/decisions during the ALM process
  - Were changes/decisions additive to SCERS?
  - Evaluation points include: enhanced returns, better diversification, reduced risk, increased cash flow generation

2024 ALM Considerations

- Change in economic regime/higher interest rates
- Evaluate proper level of risk and private market exposure
- Assess role and sizing of asset classes, and proper categorization of asset classes
- Strategic asset allocation is not starting from a blank slate
  - Expect additive changes to existing framework and structure
- Board will play an integral role throughout the process

Verus

PERSPECTIVES THAT DRIVE ENTERPRISE SUCCESS

JANUARY 2024

ALM Study Overview

Sacramento County Employees' Retirement Association

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VERUSINVESTMENTS.COM

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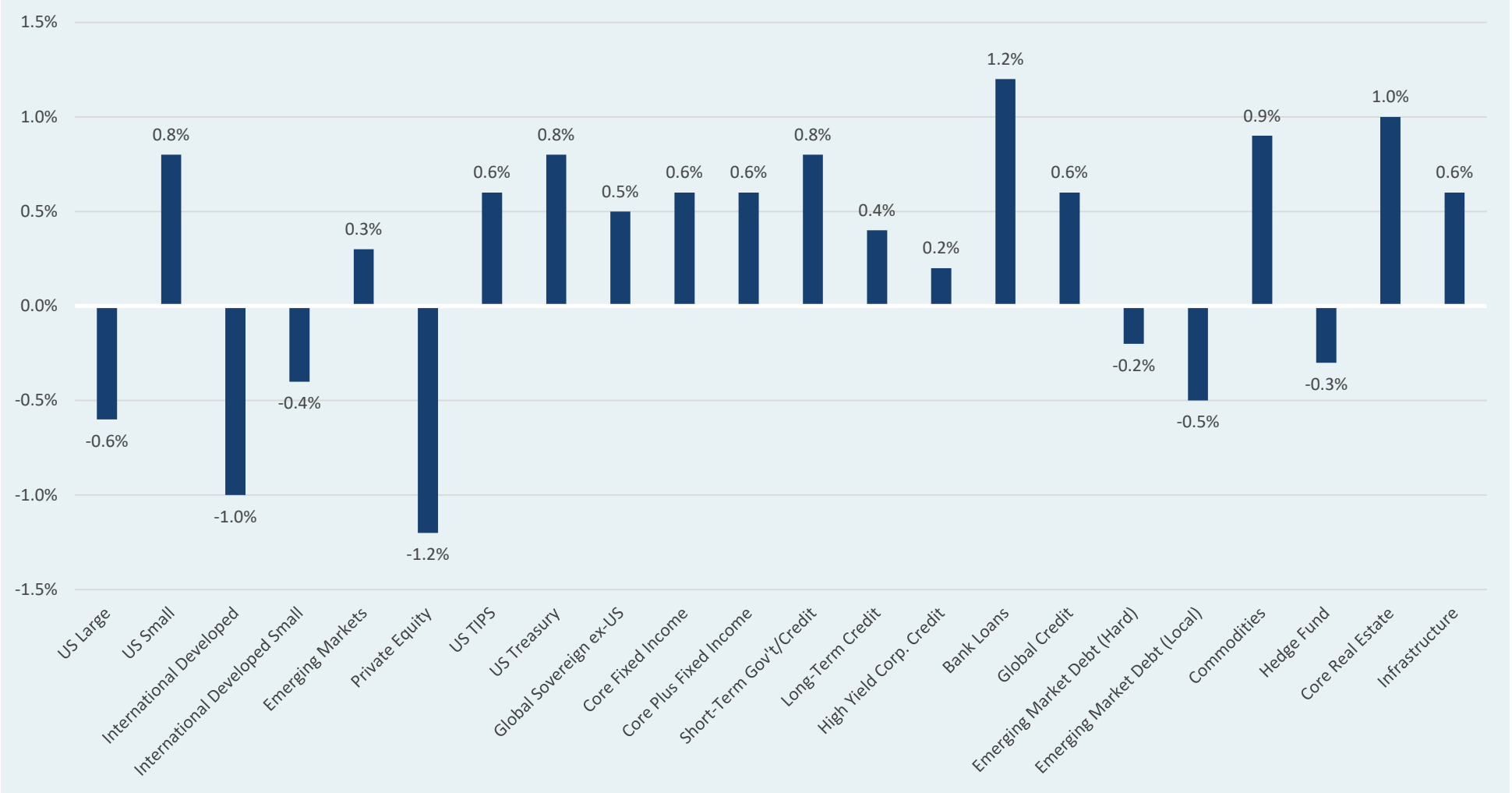
PITTSBURGH 412.784.6678
LOS ANGELES 310.297.1777
SAN FRANCISCO 415.362.3484

I. Capital market assumption update

2024 vs. 2023 return forecast



Source: Verus, as of 9/30/23

SCERS Policy Allocation

	Policy	Verus 2024 CMAs Return (g)	Standard Deviation	Sharpe Ratio (g)
US Large	18.0	*5.9*	*15.5*	*0.12*
US Small	2.0	*6.2*	*21.4*	*0.10*
International Developed	9.0	*8.1*	*17.6*	*0.23*
International Developed Small	2.0	*8.8*	*21.7*	*0.22*
Emerging Markets	5.0	*8.8*	*24.6*	*0.19*
Global Equity	4.0	*6.9*	*16.7*	*0.17*
High Yield Corp. Credit	1.0	*6.6*	*11.0*	*0.23*
Bank Loans	1.0	*8.0*	*9.0*	*0.43*
Private Equity	11.0	*8.0*	*25.6*	*0.15*
Private Credit	5.0	*9.2*	*11.9*	*0.43*
Total Growth Assets	***58***			
Core Plus Fixed Income	12.0	*5.2*	*4.5*	*0.24*
US Treasury	4.0	*4.6*	*7.1*	*0.07*
Diversifying Absolute Return*	6.0	*5.4*	*6.4*	*0.20*
Cash	2.0	*4.1*	*1.1*	-
Total Diversifying	***25***			
Core Real Estate	6.0	*6.8*	*12.5*	*0.22*
Value Add Real Estate	1.5	*8.8*	*15.4*	*0.31*
Opportunistic Real Estate	1.5	*9.8*	*21.1*	*0.27*
Liquid Real Return*	1.0	*6.6*	*16.1*	*0.16*
Private Real Assets*	7.0	*8.4*	*16.9*	*0.25*
Total Real Return	***17***			
Total Allocation	**100**			

	Policy	2023
Mean Variance Analysis		
Forecast 10 Year Return	***7.42***	***7.40***
Standard Deviation	11.8	11.8
Return/Std. Deviation	*0.6*	*0.6*
1st percentile ret. 1 year	*-16.7*	*-16.7*
Sharpe Ratio	0.33	0.39
% in Liquid Assets	62%	61%
% in Illiquid Assets	38%	39%

SCERS' portfolio expected return increased slightly in 2024

Higher returns in fixed income and real return more than offset lower returns in equities

**Diversifying Absolute Return modeled with Asymmetric Hedge Funds; Liquid Real Return modeled with Commodities; Private Real Assets modeled with Infrastructure*

II. Asset allocation concepts overview

Asset allocation decision

Asset allocation drives the bulk of the variation in portfolio returns over time

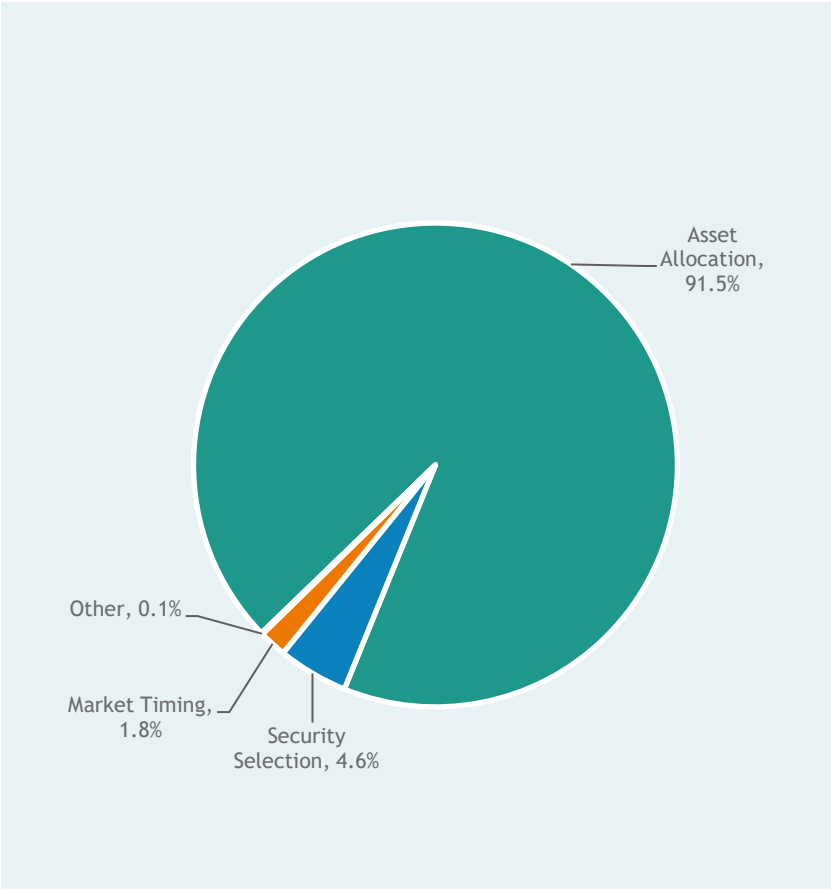
ACADEMIC SUPPORT:

— Gary P. Brinson, L. Randolph Hood, and Gilbert L. Beebower. "Determinants of Portfolio Performance". Financial Analysts Journal, July/August 1986.

— Gary P. Brinson, Brian D. Singer, and Gilbert L. Beebower. "Determinants of Portfolio Performance II: An Update". Financial Analysts Journal, 47, 3 (1991).

— Roger G. Ibbotson and Paul D. Kaplan. "Does Asset Allocation Policy Explain 40%, 90%, or 100% of Performance?" Financial Analysts Journal, January/February 2000.

PERCENT OF VARIATION EXPLAINED



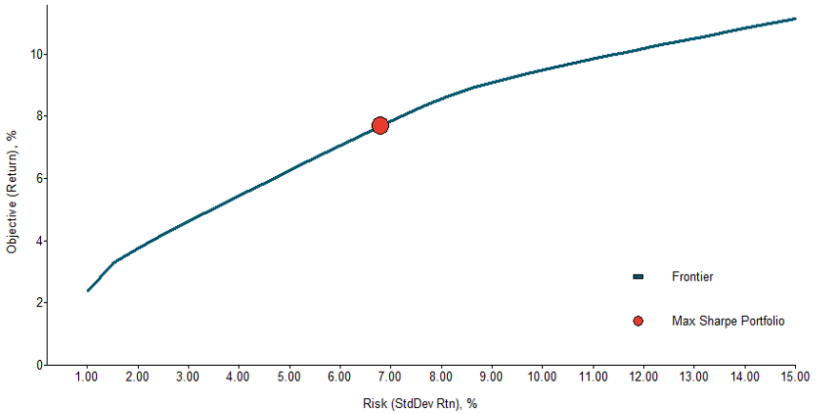
Asset allocation is usually the most important decision we make as investors

Source: Brinson, Singer & Beebower: Determinants of Portfolio Performance II: An Update

Solving the asset allocation question

Requires using multiple lenses

MEAN-VARIANCE ANALYSIS & OPTIMIZATION

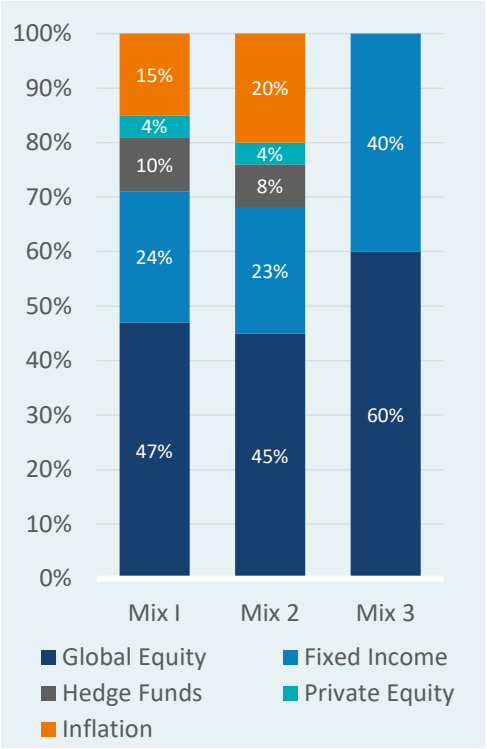


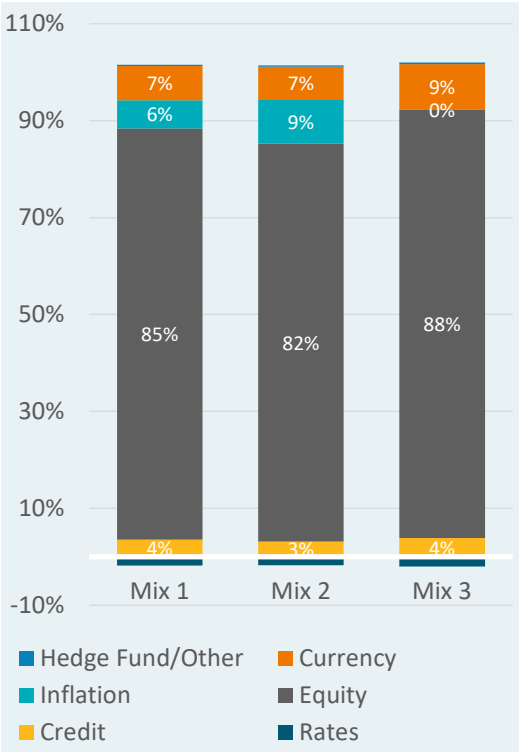
— Established in 1952, MVO[1] is the cornerstone of Modern Portfolio Theory, and was the primary method by which most asset allocations were determined for decades.

— For a given set of expected returns, correlations, and standard deviations, an investor can maximize return per unit of risk, and determine a single "efficient portfolio"

— MVO requires precise inputs, which is a practical limitation.

RISK FACTOR ALLOCATION





— Decomposing asset classes by sources of risk can provide additional perspective.

— Over-reliance on equity risk can create significant tail-risk.

[1] MVO = Mean-variance optimization

Economic conditions & asset class returns

Rising Growth

Equities	Emerging Market Debt
Commodities	Real Estate
Corporate Bonds	Infrastructure

Falling Growth

Government Bonds	Inflation Linked Bonds
Corporate Bonds	
Emerging Market Debt	

Rising Inflation

Inflation Linked Bonds	Infrastructure
Commodities	
Real Estate	

Falling Inflation

Equities	Emerging Market Debt
Government Bonds	
Corporate Bonds	

Diversification by economic regime is another approach to answering the same question

‘Functional’ asset allocation

Think outside the optimizer to identify the role of asset classes

— Why do we invest in various asset classes?
— What is it we practically expect them to contribute to the portfolio over time?
— What will determine whether or not they serve the desired role?

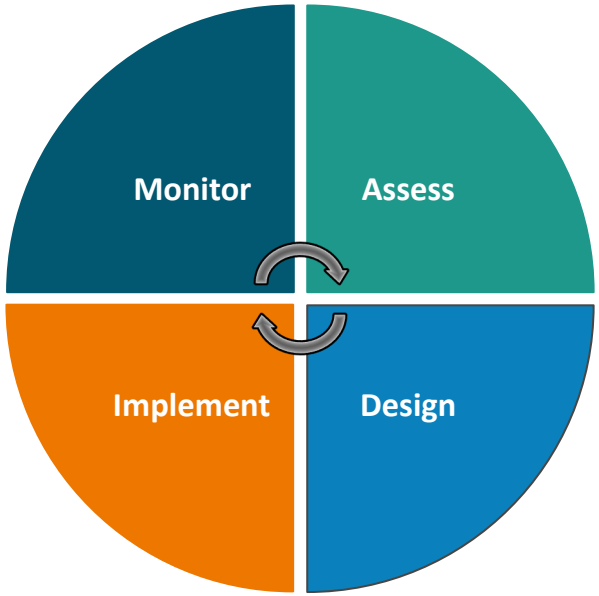
	RETURN ROLES				DIVERSIFICATION & VOLATILITY ROLES			HOW MACRO OUTLOOK/GDP AFFECTS ROLE	
	Benefit from GDP Growth	Earn Risk Premium	Produce Stable Income	Hedge Against Inflation	Low Absolute Volatility	Low Corr. To Other Assets	Reduce Portfolio Volatility	Elements of Return for Asset Class	Sensitivity of Role to GDP
Public Equities	●	◕	◔	◑	○	◔	◔	PEs, Dividends, Earnings Growth	●
Private Equities	●	●	○	○	◔	◑	◑	PEs (exits), Financing, Opportunity Set	◕
Fixed (Treasury)	○	○	●	◔	●	◑	●	Direct Link to Yields	◑
Fixed (Credit)	◑	◔	●	◔	◕	◑	◕	Direct Link to Yields, Credit Spreads	◕
Hedge Funds (Perceived role)	○	◔	○	○	●	●	●	PEs, Credit Spreads, Fat Tails	◑
Real Estate	◕	◑	◕	●	◑	◕	◑	Unemployment, Vacancies, Cap Rates	●

Magnitude: ● High ◕ Med-High ◑ Medium ◔ Low ○ None

III. Steps in the ALM process

Institutional investing process

- Re-balance
  - Asset allocation
  - Risk allocation
- Manager performance
- Tactical tilts



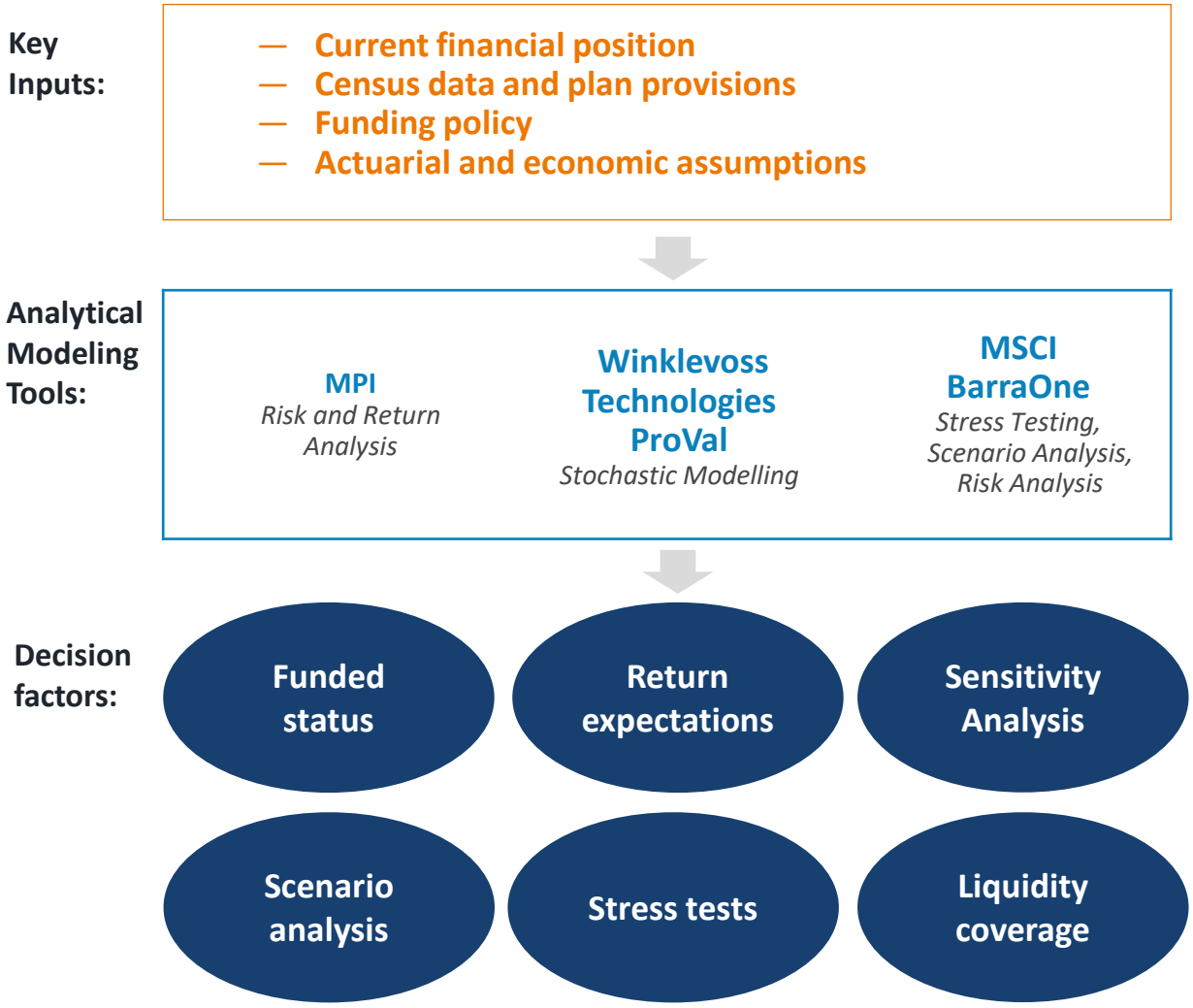
- Current state
- Risk tolerance
- Governance structure
- Investment philosophy

- Manager structure
- Manager searches
- Transition management
- Cash overlay
- Securities lending

- Investment strategy
- Asset allocation
- Risk budget
- Investment policy

Asset-liability process overview

- Setting the strategic asset allocation is the single-largest determinant of future investment performance
- It is important to develop a thoughtful strategic asset allocation based on your enterprise objectives and risk tolerance
- An AL study's objective is to choose an asset allocation based on an understanding of how investment alternatives may behave in different economic environments
- Asset allocation decisions should be reviewed not just in isolation, but in the context of the liabilities they are intended to satisfy. This involves asking not only what we think may happen (deterministic) but also, what could happen (stochastic).
- To evaluate different asset allocations, we use a variety of approaches



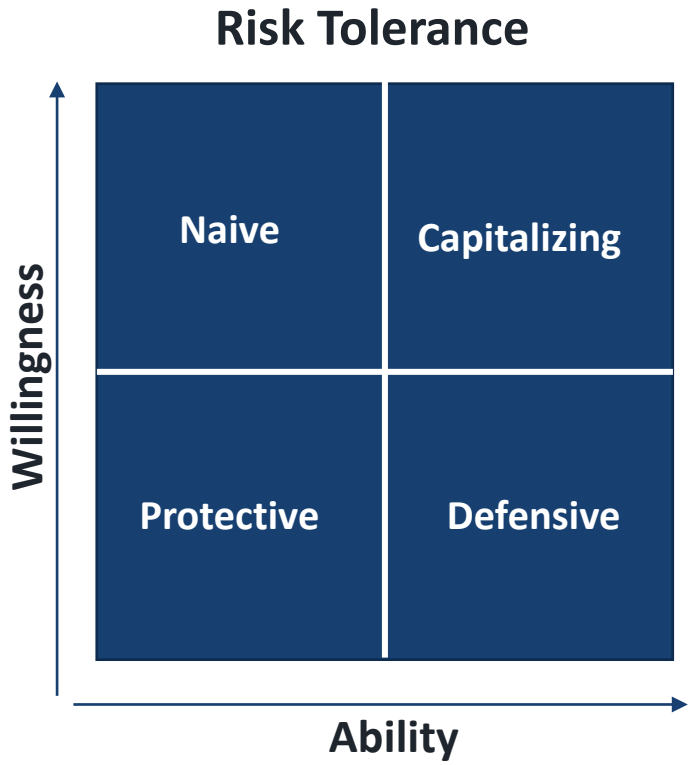
Enterprise risk tolerance in context

— Properly assessing Enterprise Risk Tolerance has important and practical implications for investment strategy development.

— It involves assessing the Plan's ability and the Board's willingness to accept risk.

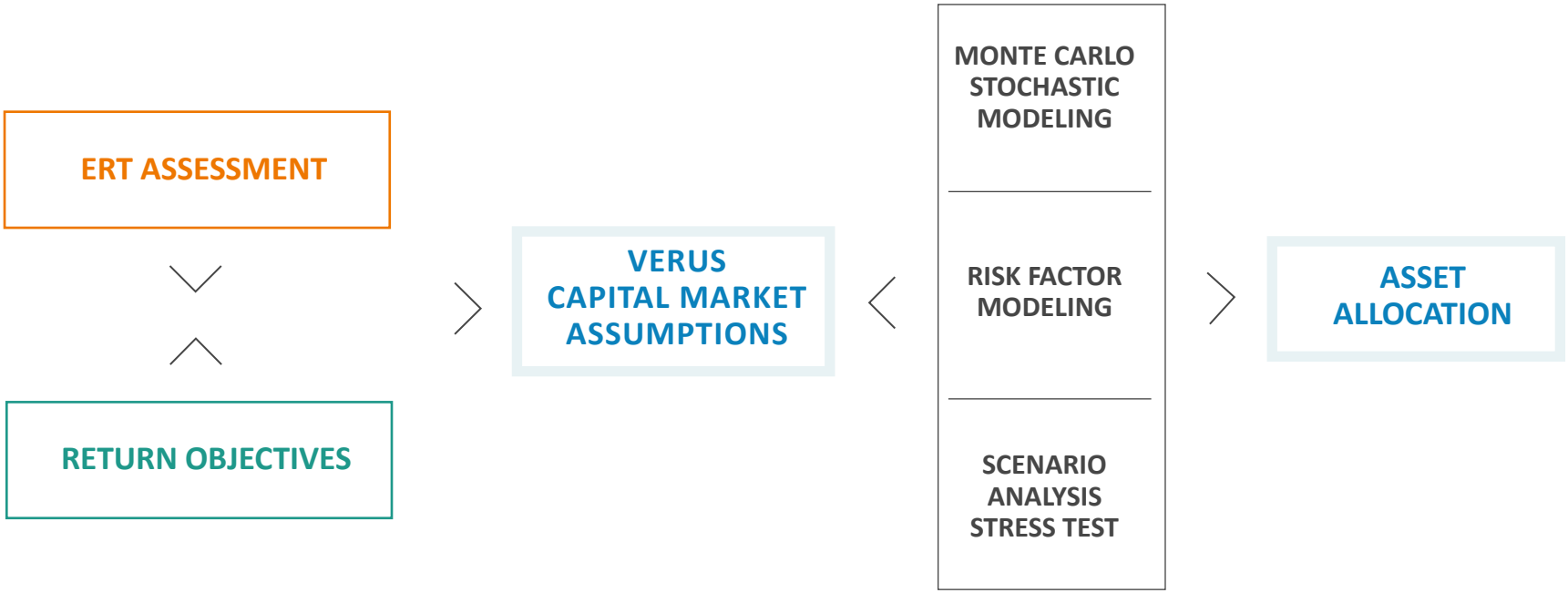
— We plan to conduct an electronic survey and virtual interviews with each of the SCERS Trustees.

— Results of the ERT Survey will help facilitate discussion and provide direction to Staff and Consultant on potential asset allocations



ERT as input into A/L studies

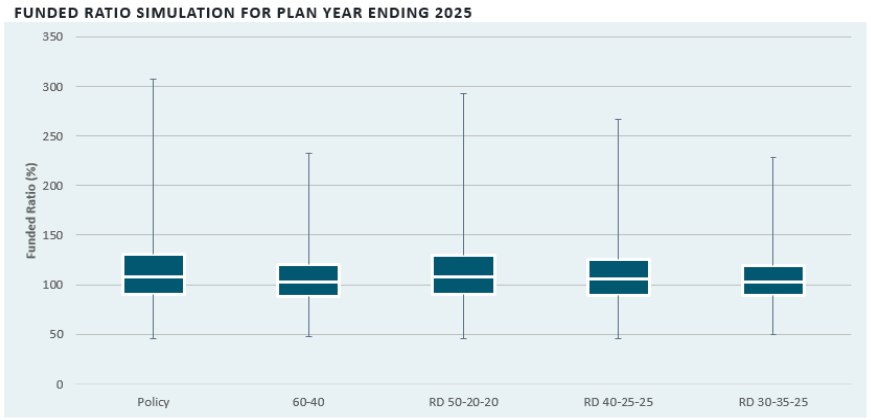
Results from Board and Staff interviews are combined with a holistic assessment of plan sponsor health and incorporated into the modeling of different potential long-term strategic asset allocation portfolios to determine an appropriate overall investment strategy.



Stochastic forecasting

- Under a stochastic approach, the results of thousands of independent and path dependent simulations are aggregated to develop a distribution of potential outcomes
- This allows us to assign probabilities to an unknown future to develop median, volatility, range, and percentile metrics for a variety of variables
- This is a useful technique for quantifying risk

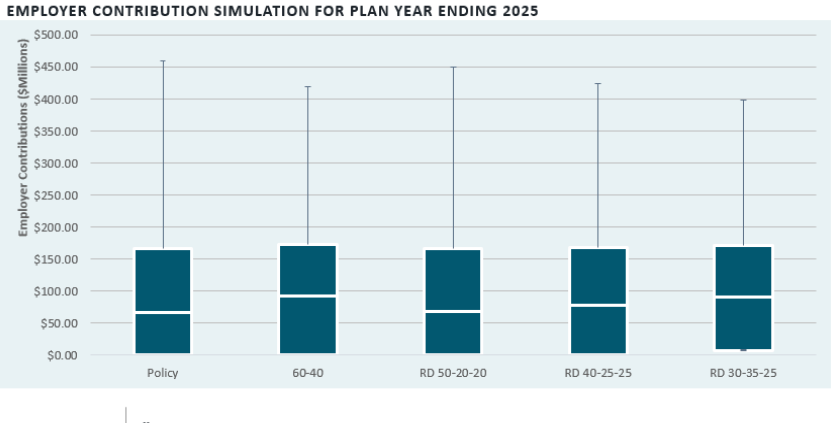
Expected funded ratio



	Policy	60-40	RD 50-20-20	RD 40-25-25	RD 30-35-25
Best Case	307	232	293	267	229
Median	108	103	108	106	103
Worst Case	45	48	45	46	50

Based on 5,000 independent simulations. Best case defined as 100th percentile. Worst case defined as 0th percentile. Median outcome is the 50th percentile.

Expected employer contributions



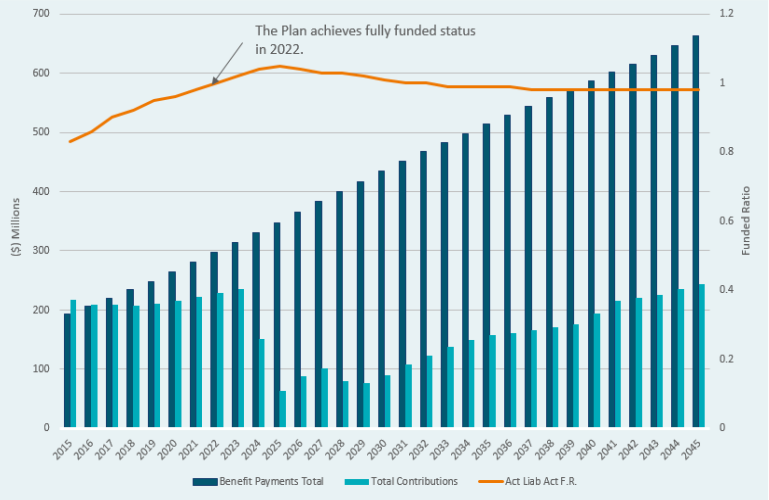
	Policy	60-40	RD 50-20-20	RD 40-25-25	RD 30-35-25
Best Case	-	-	-	-	-
Median	65,858,027.00	91,613,558.00	68,193,586.00	77,115,728.00	90,921,010.00
Worst Case	458,822,661.00	419,259,361.00	448,838,819.00	424,592,345.00	398,329,377.00

Based on 5,000 independent simulations. Best case defined as 0th percentile. Worst case defined as 100th percentile. Median outcome is the 50th percentile.

Deterministic forecasting

- Under a deterministic approach, we analyze the impact of a pre-determined event
- This is a useful technique for answering specific questions
  - Base Case: “what happens if I achieve my expected performance?”
  - Economic Regimes: “what happens if we enter a recessionary environment?”
  - Underperforming assumptions or economic shocks: “what happens to my annual contributions if I underperform the assumed rate of return by 50 bps per year?”

Base case: the plan earns 7.0% every year for next 20 years



The Plan achieves fully funded status during 2022 if the base case were to hold true.

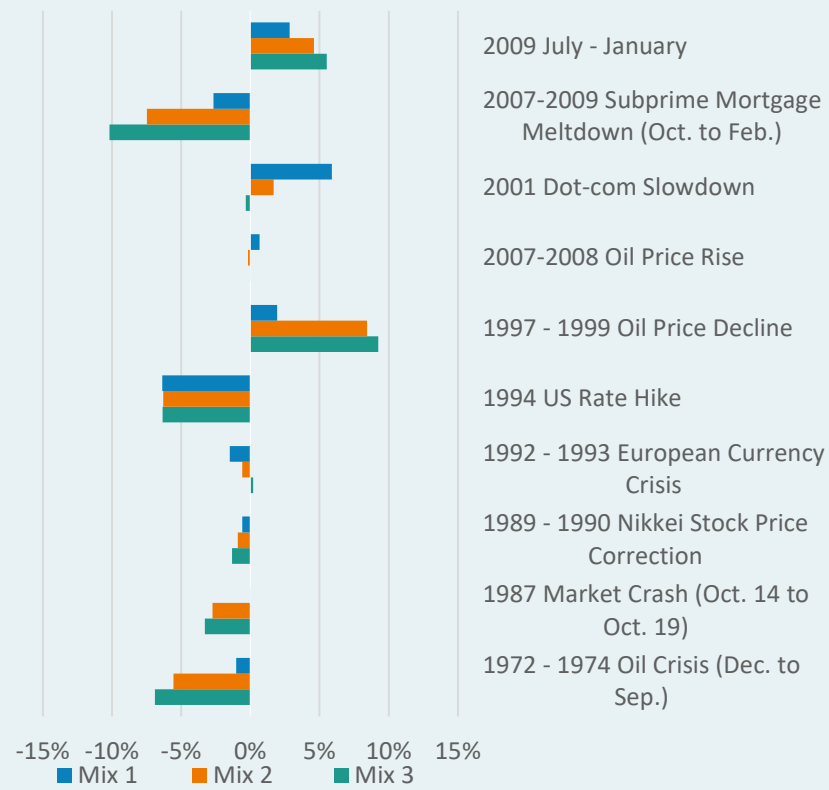
Notes: Contributions consist of employer and employee contributions. Funded status for all deterministic projections is based on the actuarial value of assets.

		Growth Portfolio Return						
		-15%	-10%	-5%	0%	5%	10%	15%
Parallel Yield Curve Shock	-1.00%	78.9%	82.9%	87.0%	91.0%	95.1%	99.1%	103.2%
	-0.75%	80.8%	84.9%	89.1%	93.2%	97.4%	101.6%	105.7%
	-0.50%	82.7%	86.9%	91.2%	95.5%	99.8%	104.0%	108.3%
	-0.25%	84.6%	89.0%	93.3%	97.7%	102.1%	106.5%	110.9%
	0.00%	86.5%	91.0%	95.5%	100.0%	104.5%	109.0%	113.5%
	0.25%	88.4%	93.1%	97.7%	102.3%	106.9%	111.5%	116.1%
	0.50%	90.4%	95.1%	99.8%	104.6%	109.3%	114.0%	118.8%
	0.75%	92.4%	97.2%	102.0%	106.9%	111.7%	116.6%	121.4%
	1.00%	94.3%	99.3%	104.2%	109.2%	114.2%	119.1%	124.1%

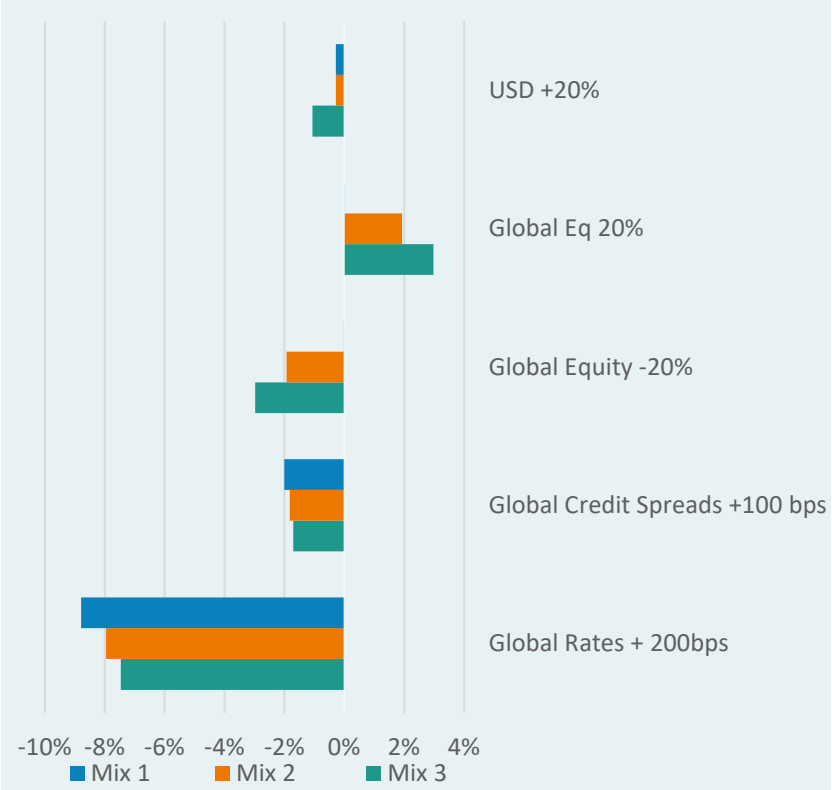
Deterministic forecasting

Scenario analysis provides another lens to portfolio design

TAIL RISK – SCENARIO ANALYSIS



TAIL RISK – SCENARIO ANALYSIS (ONLY DIRECTLY IMPACTED ASSETS MOVE)



Scenario analysis incorporates historical capital market events. Stress tests are plausible future economic environments. Both are types of deterministic analysis.

Source: MSCI Barra.

LEFT: Barra measures how the current portfolio would be expected to perform if it was held during a historical period, based on the portfolio's current risk factor exposures. The same market behavior of the historical event is applied to the portfolio. For example, if during the historical period interest rate factors fell by -5%, for example, Barra applies a -5% interest rate factor drop to assets exposed to that factor.

RIGHT: This analysis measures the total portfolio performance impact, where a specific individual asset class is shocked, with the assumption that no other asset classes are impacted by the shock. For example, a "Global Equity -20%" shock measures how much the equities in the current portfolio would be impacted by the shock, and assumes no other asset classes are impacted. The "Global Rates +200bps" shock measures how much the fixed income holdings in the current portfolio would be impacted by the shock to rates, and assumes no other asset classes are impacted. Once the individual asset class impact is measured, the total portfolio performance impact is measured given the weight of the underlying asset class in the portfolio.

Liquidity risk management

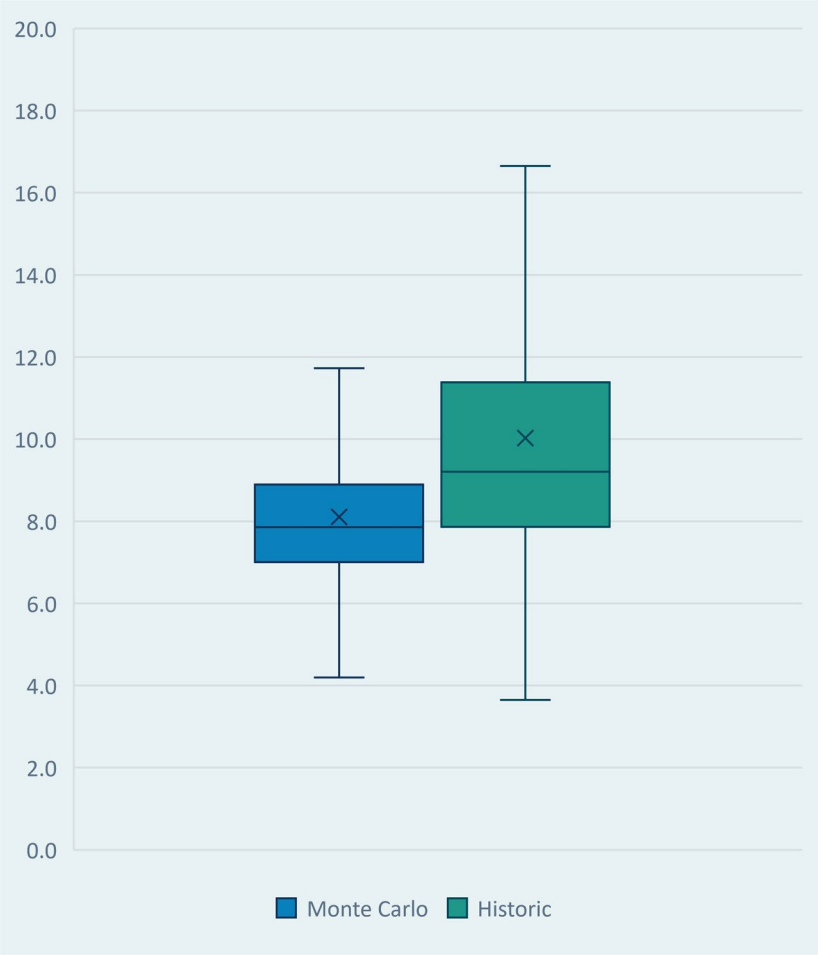
- Liquidity risk is critical for portfolios with variable cash flows and/or large private market programs.
- Verus utilizes our proprietary Liquidity Coverage Ratio (LCR) to analyze and communicate about liquidity risk management.

$$Liquidity\ Coverage\ Ratio\ (LCR) = \frac{Liquid\ Financial\ Assets\ (normal\ market\ condition)}{\sum(Distributions\ from\ Illiquid\ Assets) \sum\left(\frac{Employer}{Employee} Contributions\right) \sum(Investment\ Income)}{\sum(Benefit\ Payments) \sum(Capital\ Calls\ for\ Illiquid\ Assets) \sum(Plan\ Expenses)}$$

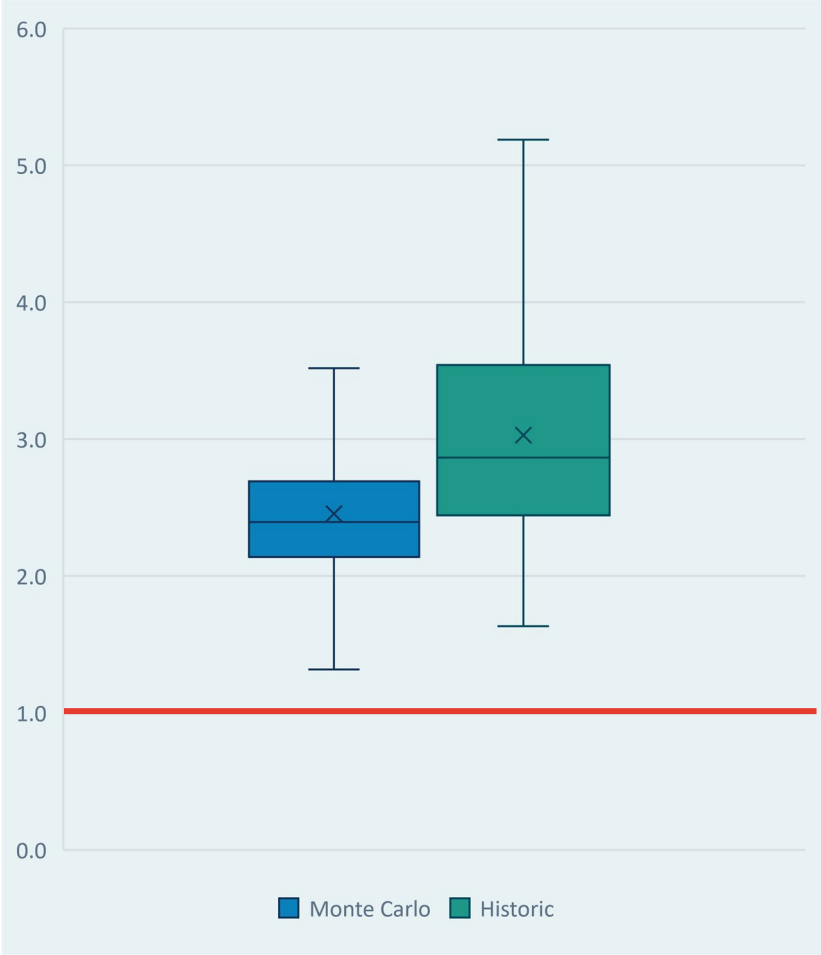
LCR Value	Implication
<1	The plan will need to sell illiquid assets to cover cash flows
1	The plan has sufficient liquidity to cover all cash flows
>1	The plan will not be required to sell illiquid assets to cover liquidity needs

Liquidity Coverage Ratio – 2023

1-YEAR LCR



5-YEAR LCR



Sample output of the liquidity model from SCERS' liquidity study in 2023

– *Actuarial information provided by Segal*
– *Private market projections for capital calls and distributions provided by Cliffwater and Townsend*

ALM Process Timeline

Current Meeting Dates	Deliverable
January	ALM introduction
February – June	Asset class education series
Q3’24	Enterprise Risk Tolerance (ERT) discussion
Q4’24-Q1’25	ALM study

IV. Appendix

Methodology

CORE INPUTS

- We use a fundamental building block approach based on several inputs, including historical data and academic research to create asset class return forecasts.
- For most asset classes, we use the long-term historical volatility after adjusting for autocorrelation.
- Correlations between asset classes are calculated based on the last 10 years. For illiquid assets, such as private equity and private real estate, we use BarraOne correlation estimates.

Asset	Return Methodology	Volatility Methodology*
Inflation	25% weight to the University of Michigan Survey 5-10 year ahead inflation expectation and the Survey of Professional Forecasters (Fed Survey), and the remaining 50% to the market's expectation for inflation as observed through the 10-year TIPS breakeven rate	-
Cash	1/3 * current federal funds rate + 1/3 * U.S. 10-year Treasury yield + 1/3 * Federal Reserve long-term interest rate target	Long-term volatility
Bonds	Nominal bonds: current yield; Real bonds: real yield + inflation forecast	Long-term volatility
International Bonds	Current yield	Long-term volatility
Credit	Current option-adjusted spread + U.S. 10-year Treasury – effective default rate	Long-term volatility
International Credit	Current option-adjusted spread + foreign 10-year Treasury – effective default rate	Long-term volatility
Private Credit	Levered gross return (SOFR + spread + original issuance discounts) – management fees – carried interest	Estimated volatility
Equity	Current yield + real earnings growth (historical average) + inflation on earnings (inflation forecast) + expected P/E change	Long-term volatility
Intl Developed Equity	Current yield + real earnings growth (historical average) + inflation on earnings (intl. inflation forecast) + expected P/E change	Long-term volatility
Private Equity**	US large cap domestic equity forecast * 1.85 beta adjustment	1.2 * Long-term volatility of U.S. small cap
Commodities	Collateral return (cash) + spot return (inflation forecast) + roll return (assumed to be zero)	Long-term volatility
Hedge Funds	Return coming from traditional betas + 15-year historical idiosyncratic return	Long-term volatility
Core Real Estate	Cap rate + real income growth – capex + inflation forecast	65% of REIT volatility
REITs	Core real estate	Long-term volatility
Value-Add Real Estate	Core real estate + 2%	Volatility to produce Sharpe Ratio (g) equal to core real estate
Opportunistic Real Estate	Core real estate + 3%	Volatility to produce Sharpe Ratio (g) equal to core real estate
Infrastructure	Current yield + real income growth + inflation on earnings (inflation forecast)	Long-term volatility
Risk Parity	Modeled as the 10-year return expectations of a *representative selection of Risk Parity strategies*	Target volatility

**Long-term historical volatility data is adjusted for autocorrelation (see Appendix)*

***Private Equity is modeled assuming an 8.0% floor for expected return, and a 3% return premium ceiling over U.S. Large Cap Equity. These adjustments are in place to recognize that higher interest rates (cost of leverage) act as a drag on expected Private Equity returns but that this drag has had limits historically, and to recognize that future Private Equity total universe performance is likely to be more anchored to public equity performance than in past times, given a more competitive market environment*

10-year return & risk assumptions

Asset Class	Index Proxy	Ten Year Return Forecast		Standard Deviation Forecast	Sharpe Ratio Forecast (g)	Sharpe Ratio Forecast (a)	10-Year Historical Sharpe Ratio (g)	10-Year Historical Sharpe Ratio (a)
		Geometric	Arithmetic					
Equities								
U.S. Large	S&P 500	5.9%	7.0%	15.5%	0.12	0.19	0.72	0.75
U.S. Small	Russell 2000	6.2%	8.2%	21.4%	0.10	0.19	0.28	0.37
International Developed	MSCI EAFE	8.1%	9.5%	17.6%	0.23	0.31	0.18	0.25
International Small	MSCI EAFE Small Cap	8.8%	10.9%	21.7%	0.22	0.31	0.20	0.27
Emerging Markets	MSCI EM	8.8%	11.4%	24.6%	0.19	0.30	0.06	0.14
Global Equity	MSCI ACWI	6.9%	8.2%	16.7%	0.17	0.25	0.44	0.50
Global Equity ex USA	MSCI ACWI ex USA	8.5%	10.2%	19.5%	0.23	0.31	0.15	0.22
Private Equity	CA Private Equity	8.0%	10.9%	25.6%	0.15	0.27	-	-
Private Equity Direct	CA Private Equity	9.0%	11.8%	25.6%	0.19	0.30	-	-
Private Equity (FoF)	CA Private Equity	7.0%	9.9%	25.6%	0.11	0.23	-	-
Fixed Income								
Cash	30 Day T-Bills	4.1%	4.1%	1.1%	-	-	-	-
U.S. TIPS	Bloomberg U.S. TIPS 5-10	4.7%	4.8%	5.5%	0.11	0.13	0.13	0.15
Non-U.S. Inflation Linked Bonds	Bbg World Govt. Inflation Linked Bond ex U.S.	3.9%	4.2%	7.4%	(0.03)	0.01	(0.15)	(0.11)
U.S. Treasury	Bloomberg Treasury 7-10 Year	4.6%	4.8%	7.1%	0.07	0.10	(0.05)	(0.02)
Long U.S. Treasury	Bloomberg Treasury 20+ Year	4.7%	5.5%	13.2%	0.05	0.11	0.00	0.25
Global Sovereign ex U.S.	Bloomberg Global Treasury ex U.S.	2.7%	3.2%	9.9%	(0.14)	(0.09)	(0.40)	(0.36)
Global Aggregate	Bloomberg Global Aggregate	4.1%	4.3%	6.6%	0.00	0.03	(0.27)	(0.24)
Core Fixed Income	Bloomberg U.S. Aggregate Bond	4.9%	5.0%	4.8%	0.17	0.19	0.00	0.02
Core Plus Fixed Income	Bloomberg U.S. Universal	5.2%	5.3%	4.5%	0.24	0.27	0.07	0.09
Investment Grade Corp. Credit	Bloomberg U.S. Corporate Investment Grade	5.7%	6.0%	8.4%	0.19	0.23	0.17	0.20
Short-Term Gov't/Credit	Bloomberg U.S. Gov't/Credit 1-3 Year	4.7%	4.8%	3.6%	0.17	0.19	(0.07)	(0.07)
Short-Term Credit	Bloomberg Credit 1-3 Year	5.1%	5.2%	3.6%	0.28	0.31	0.23	0.24
Long-Term Credit	Bloomberg Long U.S. Credit	5.7%	6.3%	10.9%	0.15	0.20	0.15	0.20
High Yield Corp. Credit	Bloomberg U.S. Corporate High Yield	6.6%	7.2%	11.0%	0.23	0.28	0.42	0.44
Bank Loans	Morningstar LSTA Leveraged Loan	8.0%	8.4%	9.0%	0.43	0.48	0.58	0.59
Global Credit	Bloomberg Global Credit	5.1%	5.4%	7.7%	0.13	0.17	0.01	0.04
Emerging Markets Debt (Hard)	JPM EMBI Global Diversified	8.7%	9.2%	10.6%	0.43	0.48	0.15	0.20
Emerging Markets Debt (Local)	JPM GBI-EM Global Diversified	6.5%	7.2%	12.2%	0.20	0.25	(0.17)	(0.12)
Private Credit	Morningstar LSTA Leveraged Loan	9.2%	9.8%	11.9%	0.43	0.48	-	-
Private Credit (Direct Lending - Unlevered)	Morningstar LSTA Leveraged Loan	8.0%	8.4%	9.0%	0.43	0.48	-	-
Private Credit (Direct Lending - Levered)	Morningstar LSTA Leveraged Loan	9.5%	10.2%	12.6%	0.43	0.48	-	-
Private Credit (Credit Opportunities)	Morningstar LSTA Leveraged Loan	9.6%	10.3%	12.8%	0.43	0.48	-	-
Private Credit (Junior Capital / Mezzanine)	Morningstar LSTA Leveraged Loan	9.0%	9.6%	11.4%	0.43	0.48	-	-
Private Credit (Distressed)	Morningstar LSTA Leveraged Loan	9.1%	12.7%	29.1%	0.17	0.30	-	-

Investors wishing to produce expected geometric return forecasts for their portfolios should use the arithmetic return forecasts provided here as inputs into that calculation, rather than the single-asset-class geometric return forecasts. This is the industry standard approach, but requires a complex explanation only a heavy quant could love, so we have chosen not to provide further details in this document – we will happily provide those details to any readers of this who are interested.

10-year return & risk assumptions

Asset Class	Index Proxy	Ten Year Return Forecast		Standard Deviation Forecast	Sharpe Ratio Forecast (g)	Sharpe Ratio Forecast (a)	10-Year Historical Sharpe Ratio (g)	10-Year Historical Sharpe Ratio (a)
		Geometric	Arithmetic					
Other								
Commodities	Bloomberg Commodity	6.6%	7.8%	16.1%	0.16	0.23	(0.13)	(0.06)
Hedge Funds	HFRI Fund Weighted Composite	4.3%	4.6%	7.5%	0.03	0.07	0.48	0.49
Hedge Fund of Funds	HFRI Fund of Funds Composite	3.3%	3.6%	7.5%	(0.11)	(0.07)	-	-
Hedge Funds (Equity Style)	Custom HFRI Benchmark Mix*	7.2%	8.1%	14.1%	0.22	0.28	-	-
Hedge Funds (Credit Style)	Custom HFRI Benchmark Mix*	7.3%	7.7%	9.4%	0.34	0.38	-	-
Hedge Funds (Asymmetric Style)	Custom HFRI Benchmark Mix*	5.4%	5.6%	6.4%	0.20	0.23	-	-
Real Estate Debt	Bloomberg CMBS IG	7.4%	7.7%	7.5%	0.44	0.48	0.14	0.15
Core Real Estate	NCREIF Property	6.8%	7.5%	12.5%	0.22	0.27	-	-
Value-Add Real Estate	NCREIF Property + 200bps	8.8%	9.9%	15.4%	0.31	0.38	-	-
Opportunistic Real Estate	NCREIF Property + 300bps	9.8%	11.7%	21.1%	0.27	0.36	-	-
REITs	Wilshire REIT	6.8%	8.5%	19.2%	0.14	0.23	0.35	0.42
Global Infrastructure	S&P Global Infrastructure	8.4%	9.7%	16.9%	0.25	0.33	0.20	0.28
Risk Parity**	S&P Risk Parity 10% Vol Index	7.2%	7.8%	10.0%	0.31	0.37	-	-
Currency Beta	MSCI Currency Factor Index	2.3%	2.4%	3.4%	(0.52)	(0.49)	(0.06)	0.21
Inflation		2.5%	-	-	-	-	-	-

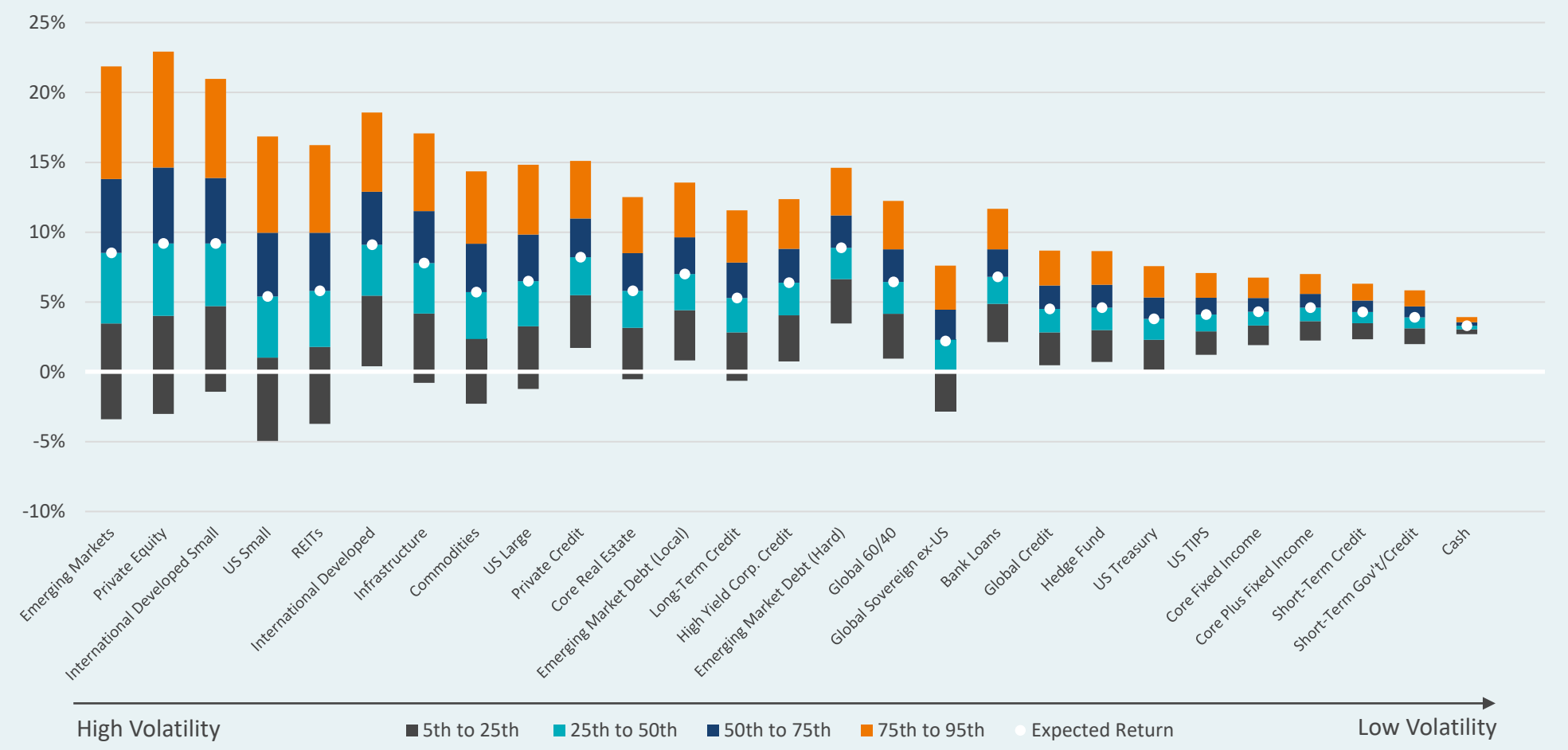
Investors wishing to produce expected geometric return forecasts for their portfolios should use the arithmetic return forecasts provided here as inputs into that calculation, rather than the single-asset-class geometric return forecasts. This is the industry standard approach, but requires a complex explanation only a heavy quant could love, so we have chosen not to provide further details in this document – we will happily provide those details to any readers of this who are interested.

**To represent hedge fund styles, we use a combination of HFRI benchmarks: Equity Style = 33% HFRI Fundamental Growth, 33% HFRI Fundamental Value, 33% HFRI Activist. Credit Style = 20% HFRI Distressed/Restructuring, 20% HFRI Credit Arbitrage, 20% HFRI Fixed Income-Corporate, 20% HFRI Fixed Income-Convertible Arbitrage, 20% HFRI Fixed Income-Asset Backed. Asymmetric Style = 50% HFRI Relative Value, 50% HFRI Macro*

***The Risk Parity forecast shown here assumes a 10% target volatility strategy. We recommend customizing this forecast to the target volatility specifications of the risk parity strategy that an investor wishes to model. Please speak with your Verus consultant for customization needs.*

Range of likely 10-year outcomes

10-YEAR RETURN 90% CONFIDENCE INTERVAL



Source: Verus, MPI