Perspectives on Investment Risk

Derek Walker
Managing Investment Director

Michael Krimm
Investment Director

Dmitry Pevzner
Investment Manager

Lauren Rosborough Watt
Investment Manager

Investment Committee

November 17, 2026

Agenda

Investment Risk Overview

Volatility

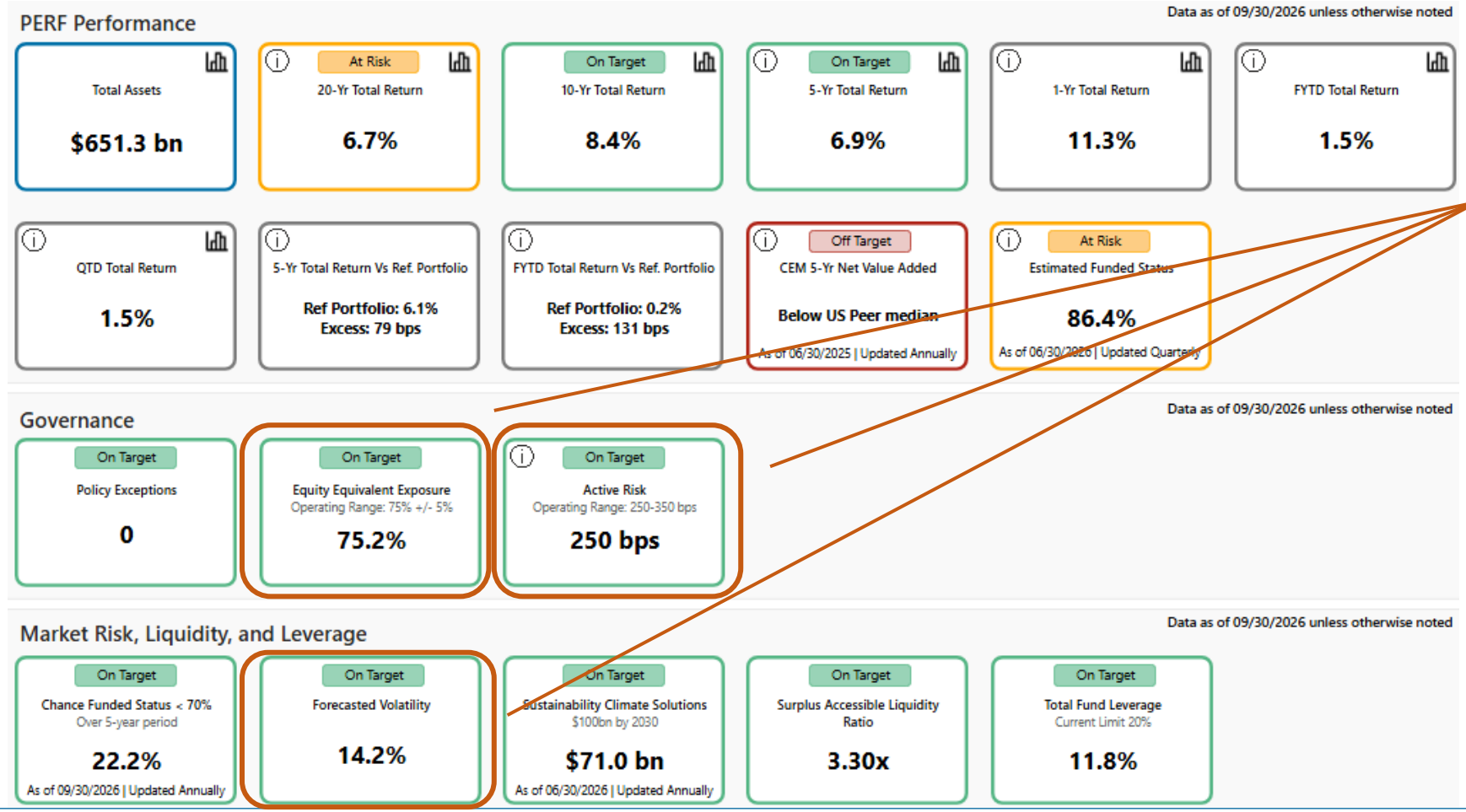
Equity Equivalent Exposure

Scenario Analysis

Active Risk

Appendix

New Dashboard, New TPA Metrics



Today's Focus

Volatility

Equity Equivalent Exposure (EEE)

Active Risk

Scenario Analysis

Investment Risk is Pension Sustainability Risk



Investment Return Volatility

⬇

Contribution Rate Volatility

⬇

Cost of System Participation

Employer Ability to Pay

Strategic Goal



PENSION SUSTAINABILITY
Strengthen the long-term sustainability of the pension fund

Objectives	Measures
Balance the costs of future pension payments with the expected future investment risks and returns through the Asset Liability Management process	Funded Status
Mitigate the risk of significant investment loss while balancing contribution levels and volatility	Total Expected Fund Volatility Employer Contribution Rates
Deliver risk-adjusted investment returns to meet or exceed the expected rate of return	Annualized 5-Yr Excess Returns Relative to Total Fund Policy Benchmark
Integrate sustainable investment strategies	% Diverse Managers, Human Capital Management, Just Transition to Net Zero by 2050, Financial Markets Policy, Private Assets Data Transparency

Pension Sustainability Risk Profile

A set of controls to mitigate and manage drivers of investment risk

The Risk: Failure to Meet Pension Benefit Obligations

Some of the Risk Drivers

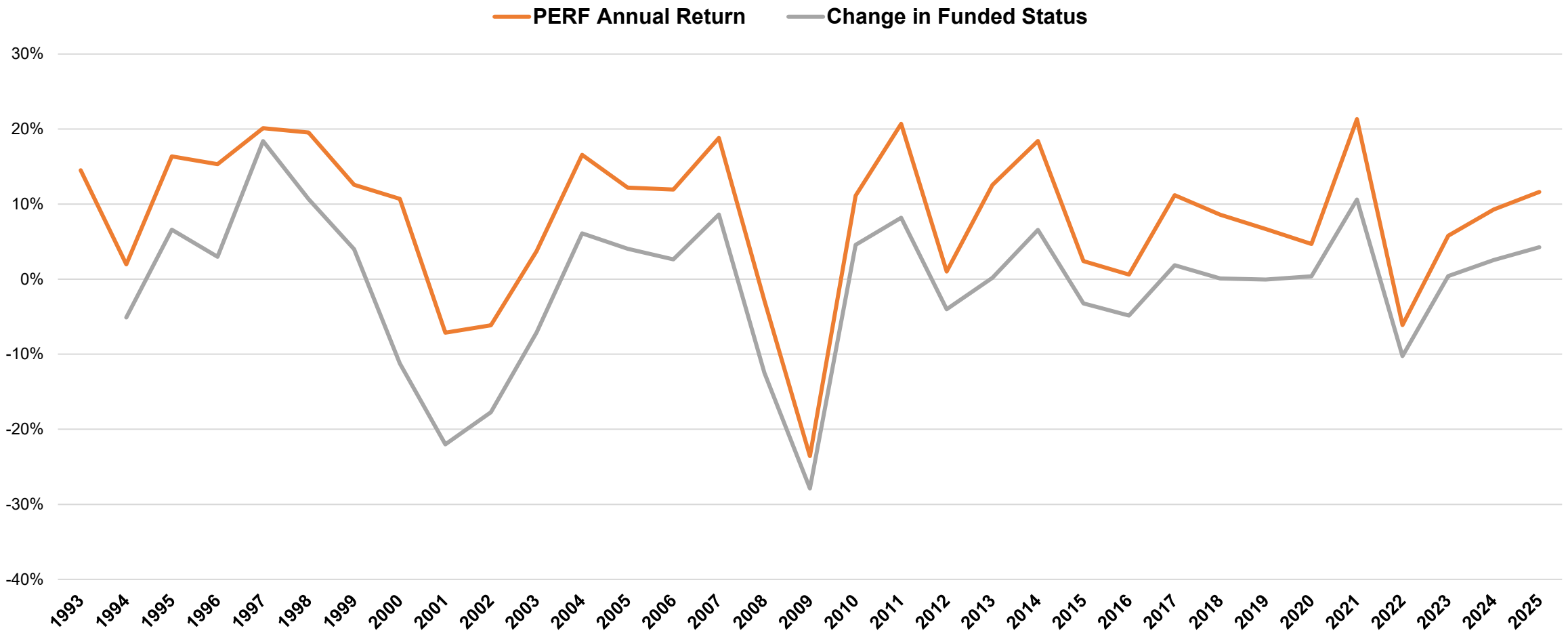
- Severe Market Downturn
- Long-term Investment Return Underperformance
- Investment Options Limited by Available Liquidity
- Government and Regulatory Constraints Limit Diversification
- Major Events Impact Employer Budgets
- Portfolio Size and Complexity Limit Investment Options
- More Portfolio Risk to Achieve the Same Future Return

Some of the Controls in Place

- Board Reporting and Oversight
- Investment, Financial, Actuarial Policies
- ALM
- Internal Governance Committees
- Total Fund Risk, Strategy, Portfolio Construction, and Operating Model
- Diversification
- Management of Liquidity and Leverage
- Actuarial Amortization, Costing, Assumptions
- Employer Education

Climate Change is captured separately in its own risk profile.

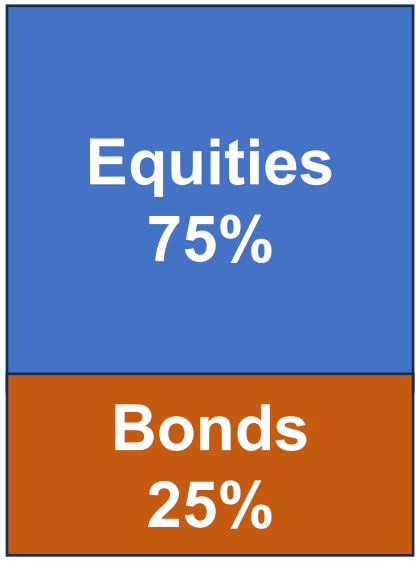
Funded Status is Closely Linked to Investment Returns



Investment Risk Management Governance

Board establishes PERF risk level

Reference Portfolio (RP)



Establishes PERF's overall risk level

Active Risk Limit (Management Discretion)



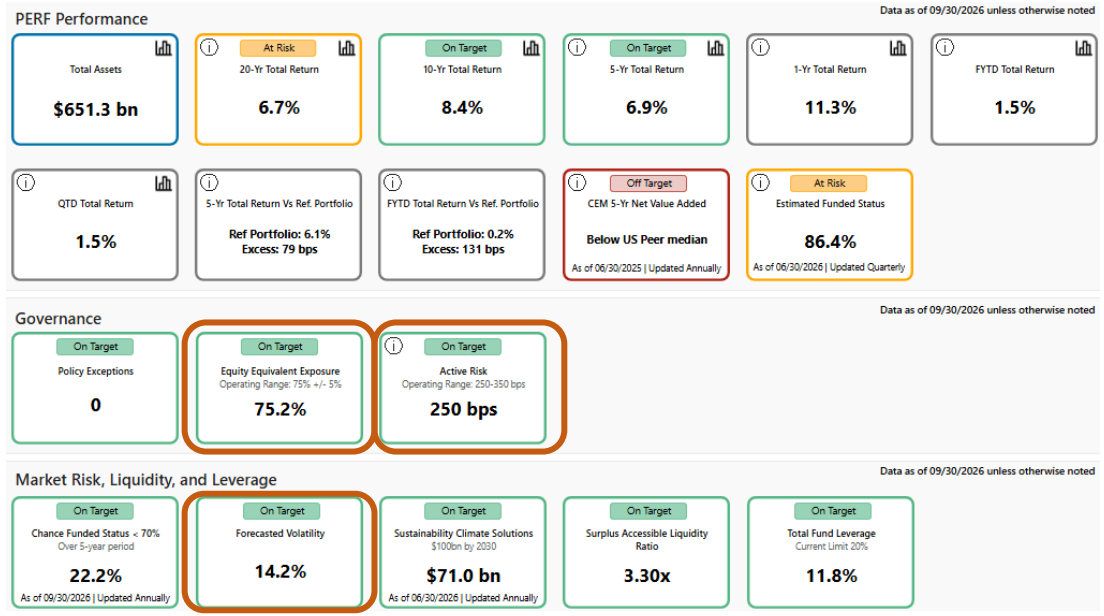
For investment team to outperform the Reference Portfolio by investing away from it

The investment team manages the portfolio within these parameters

A Variety of Tools Used to Manage Investment Risk

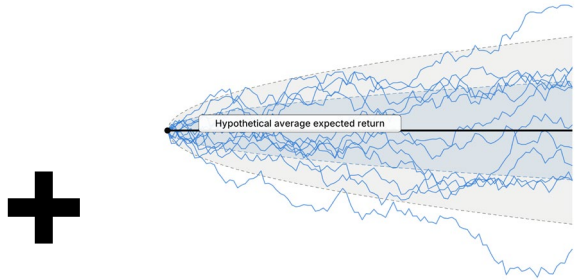
"Integrated" Metrics

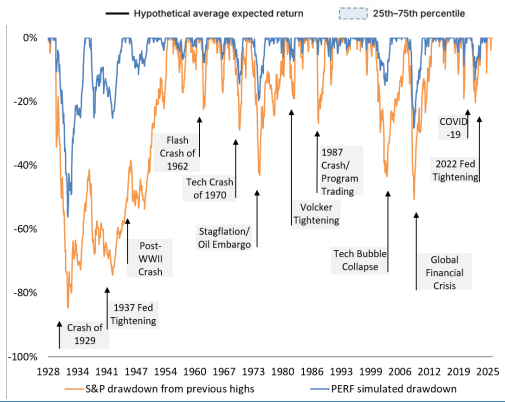
Seek to quantify investment risk in a single number



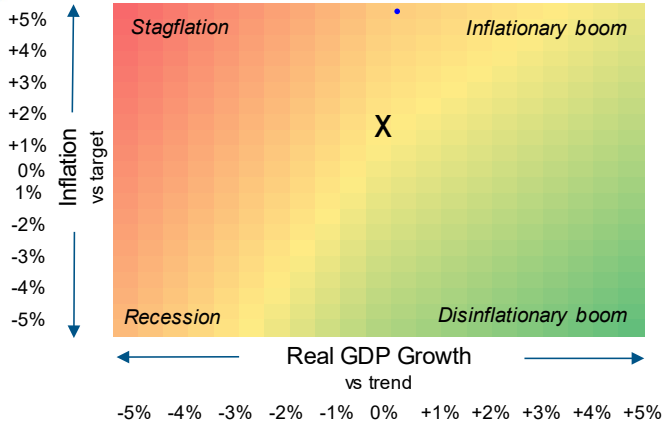
Scenarios

Diverse approaches that add depth, build understanding, and spur discussion





Historical returns for a 75/25 Reference Portfolio in one year's time, given growth and inflation shocks



Risk is Complex and Requires Judgement

No single metric that can fully capture investment risk

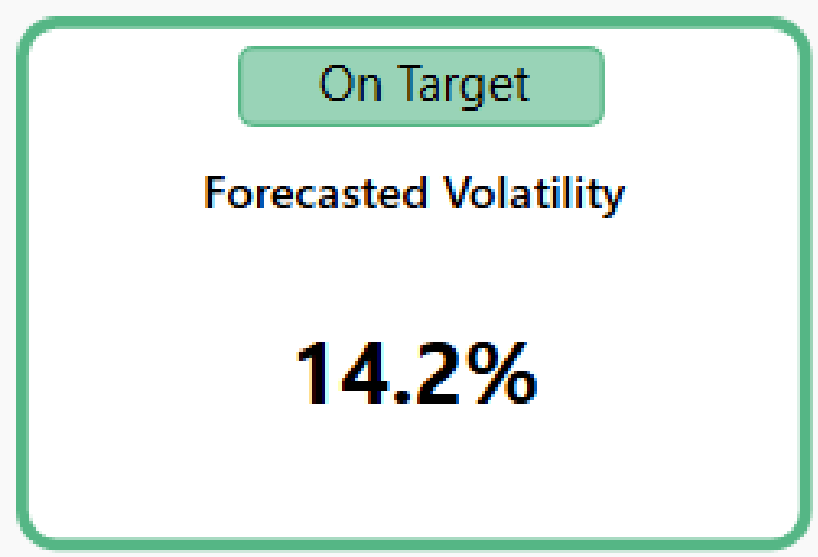
Investment Belief #9

Risk to CalPERS is multi-faceted and not fully captured through measures such as volatility or tracking error

Management Uses Multiple Risk Metrics and Scenarios for the Best Possible View on the Portfolio

Volatility

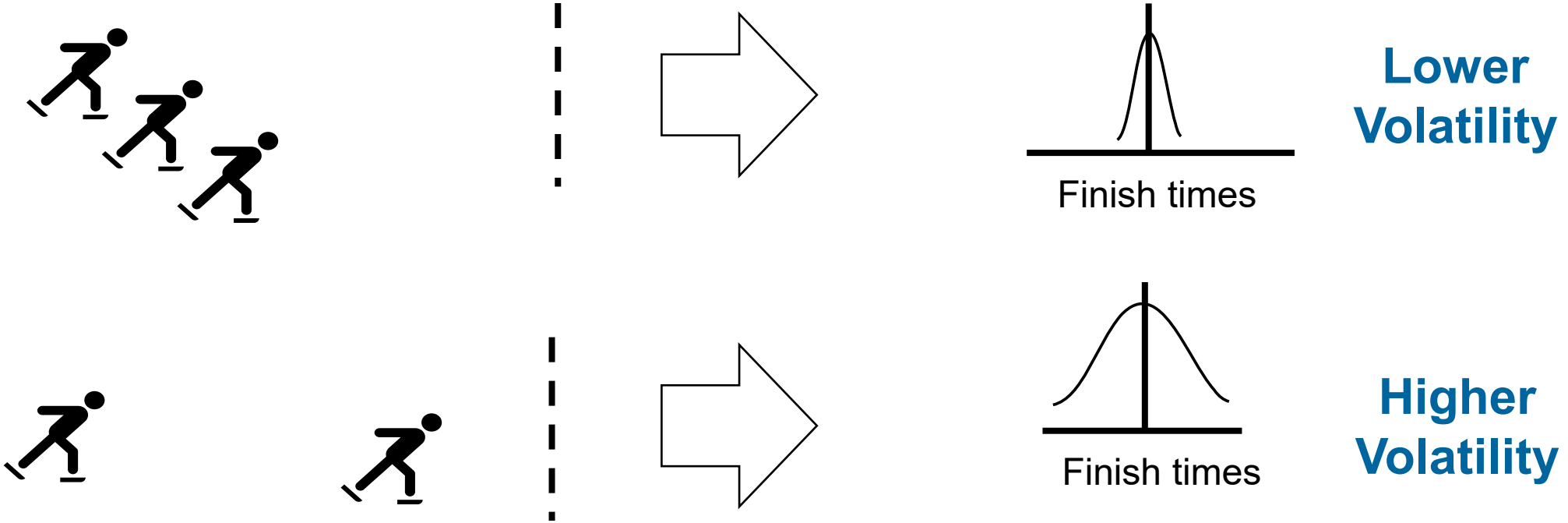
The Spread of Outcomes



Volatility Measures the Spread of Outcomes

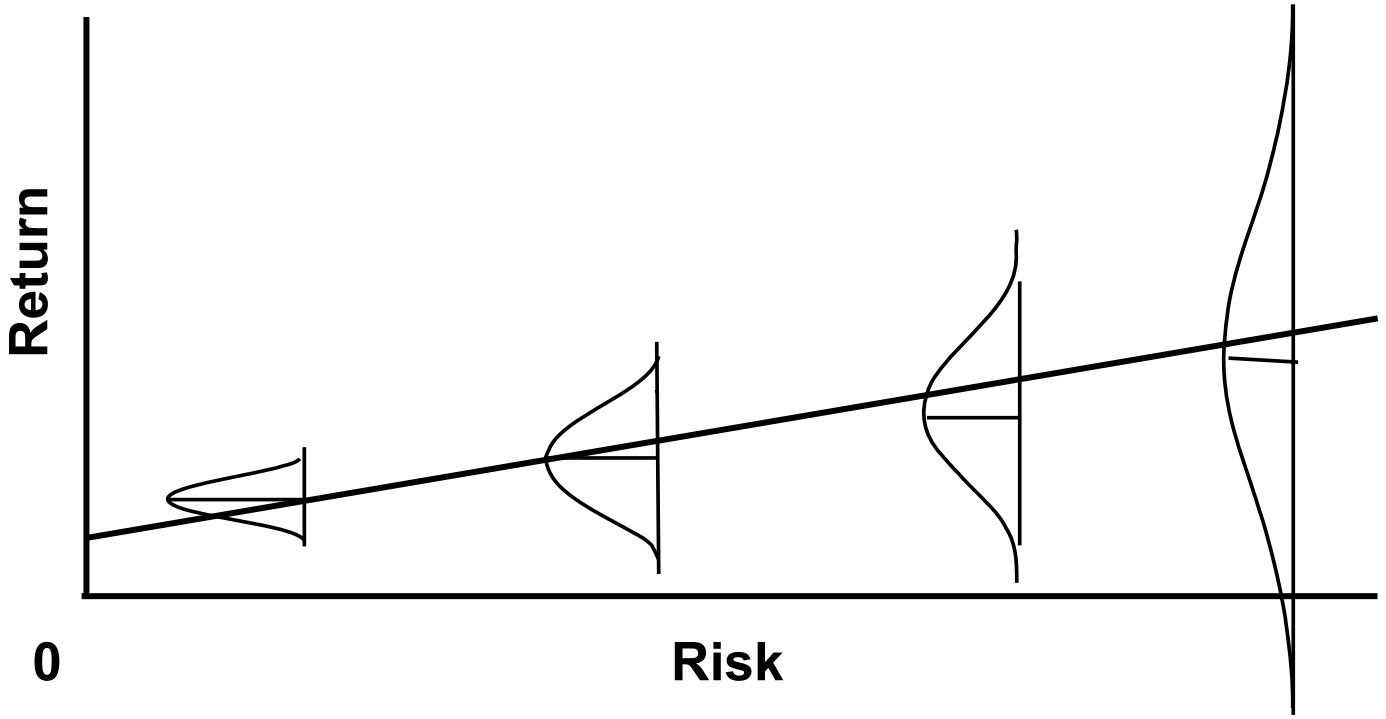
Commonly used investment risk metric measures dispersion of returns

Race Example: A race with a cluster of racers finishing close to each other has a low volatility of outcomes. A race where the racers finish far apart has a high volatility of outcomes.



Relating Volatility to Risk

The relationship between risk and return



As Risk Increases...

...the expected return rises,...

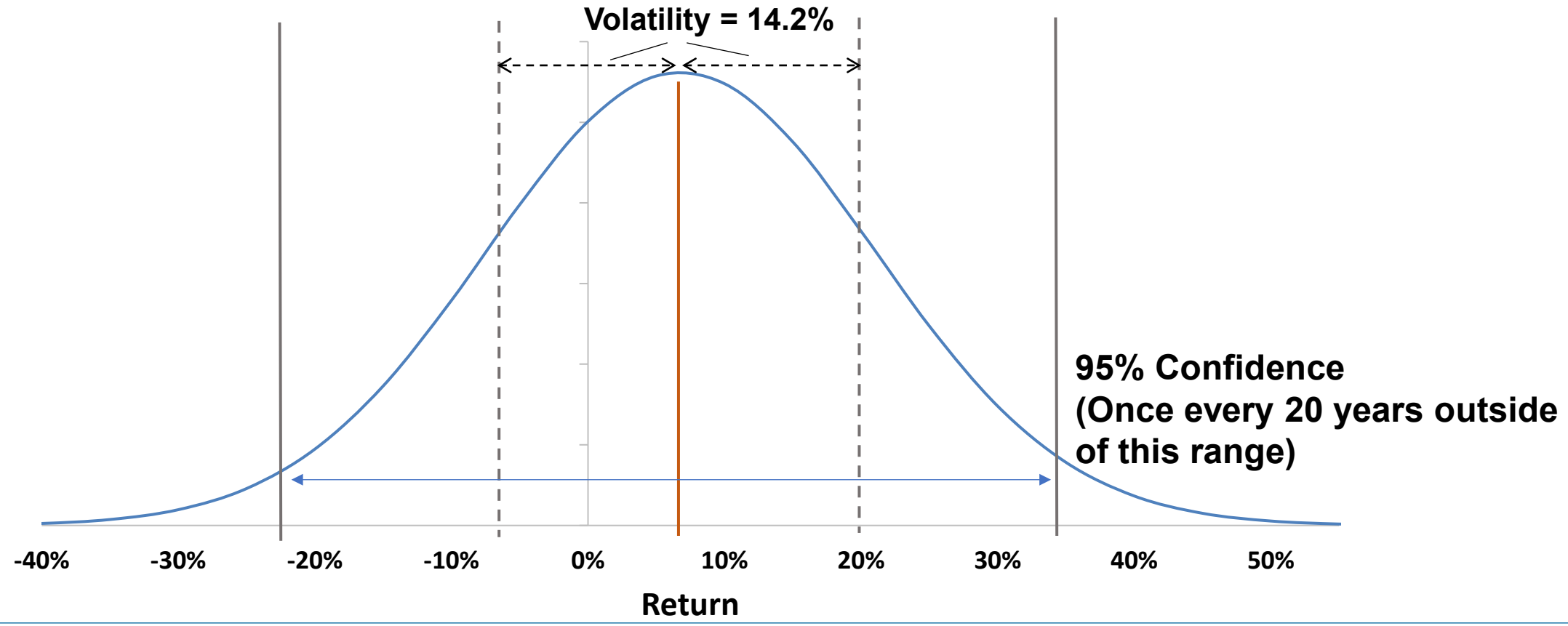
...the range of possible outcomes becomes wider, and...

...the worst outcome worsens

This slide content is the intellectual property of Oaktree Capital Management, which has given express written consent for CalPERS to use publicly in board presentations.

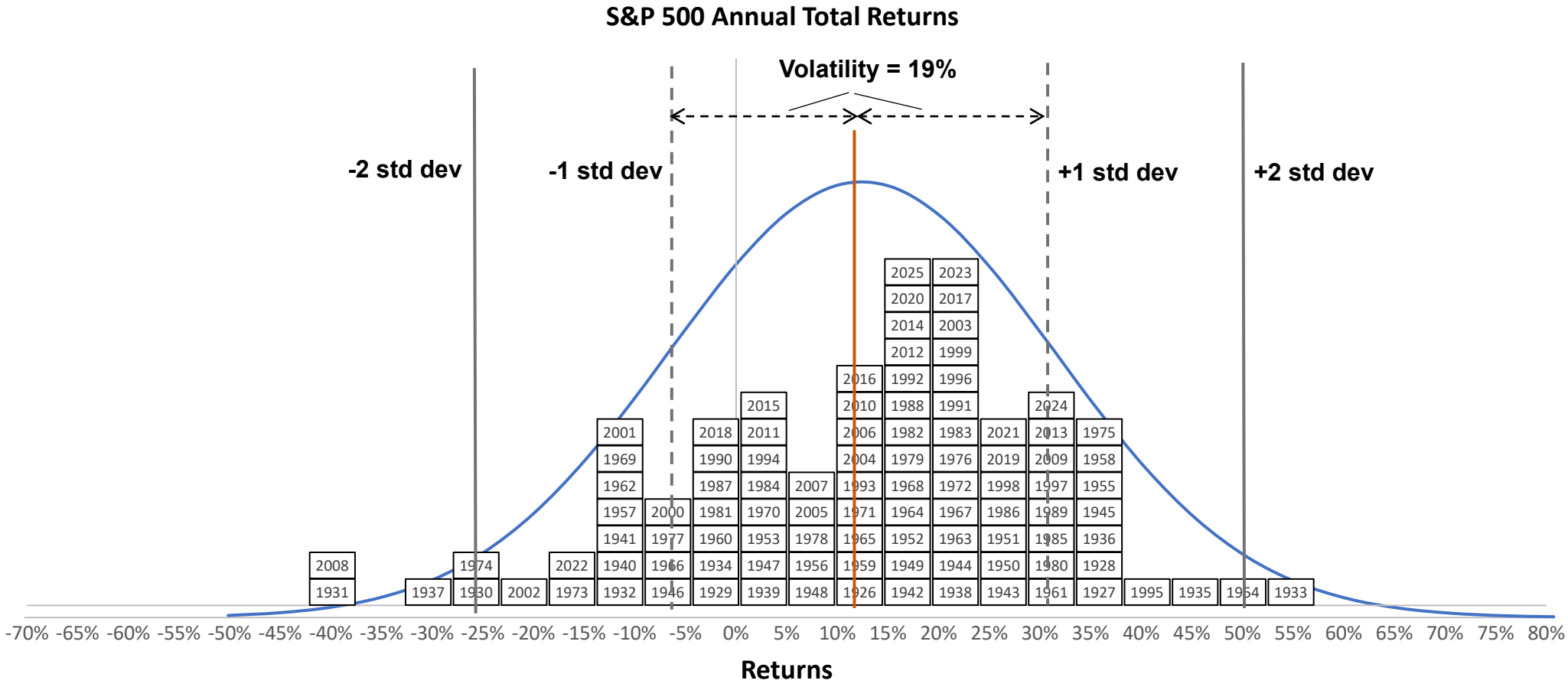
What Does a Volatility of 14.2% Mean?

With 95% confidence, the 1-Yr PERF return expected to be between -22% & +35%



Volatility in Financial Markets

Historical returns mostly align with volatility



Source: Robert J. Shiller, Yale University
(www.econ.yale.edu/~shiller/data.htm

Reducing Volatility for a Given Level of Return Can Improve Value Creation

Example of two portfolios:

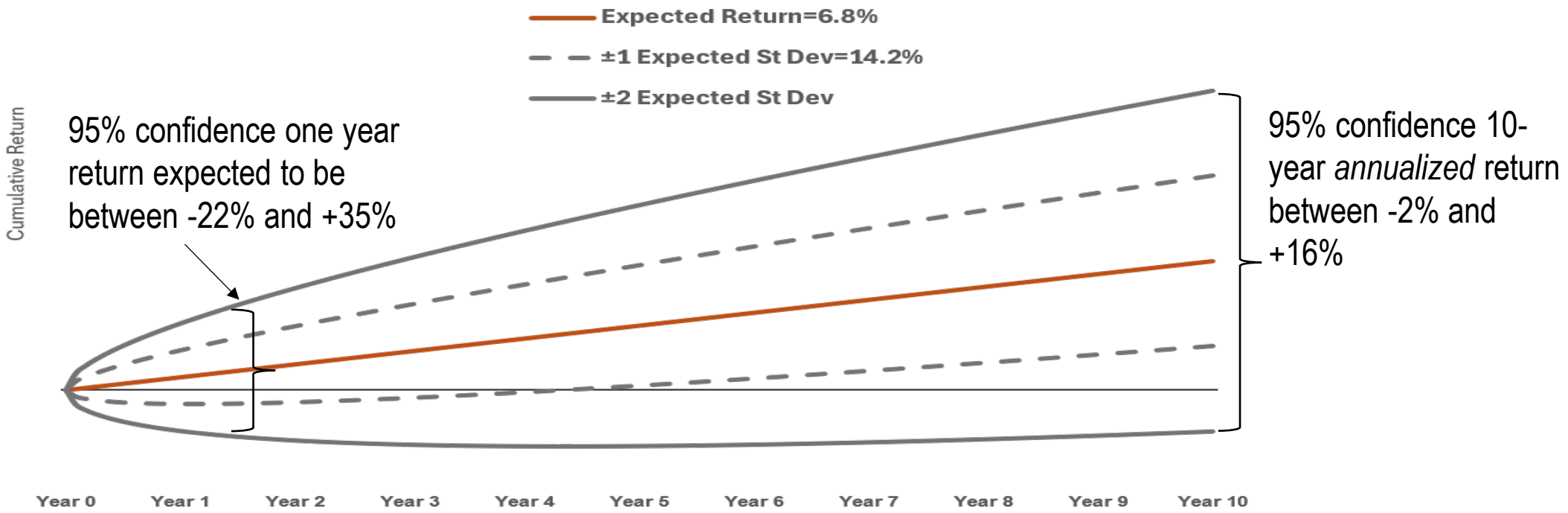
- Same average return, but less volatile portfolio has a better outcome
- This effect is further amplified by negative pension cashflows

Hypothetical Annual Returns

	Year 1	Year 2	Year 3	Year 4	Year 5	Average Annual Return	Volatility	Value of 100$ in Year 5
Portfolio A	2%	-10%	33%	2%	10%	7.5%	16%	**$137.6**
Portfolio B (diversified)	4%	-2%	20%	7%	9%	7.5%	8%	**$142.1**
						Same return	*Lower vol* →	*Higher ending value*

Use: Inform Future Expectations

Volatility is helpful to define a range of future outcomes

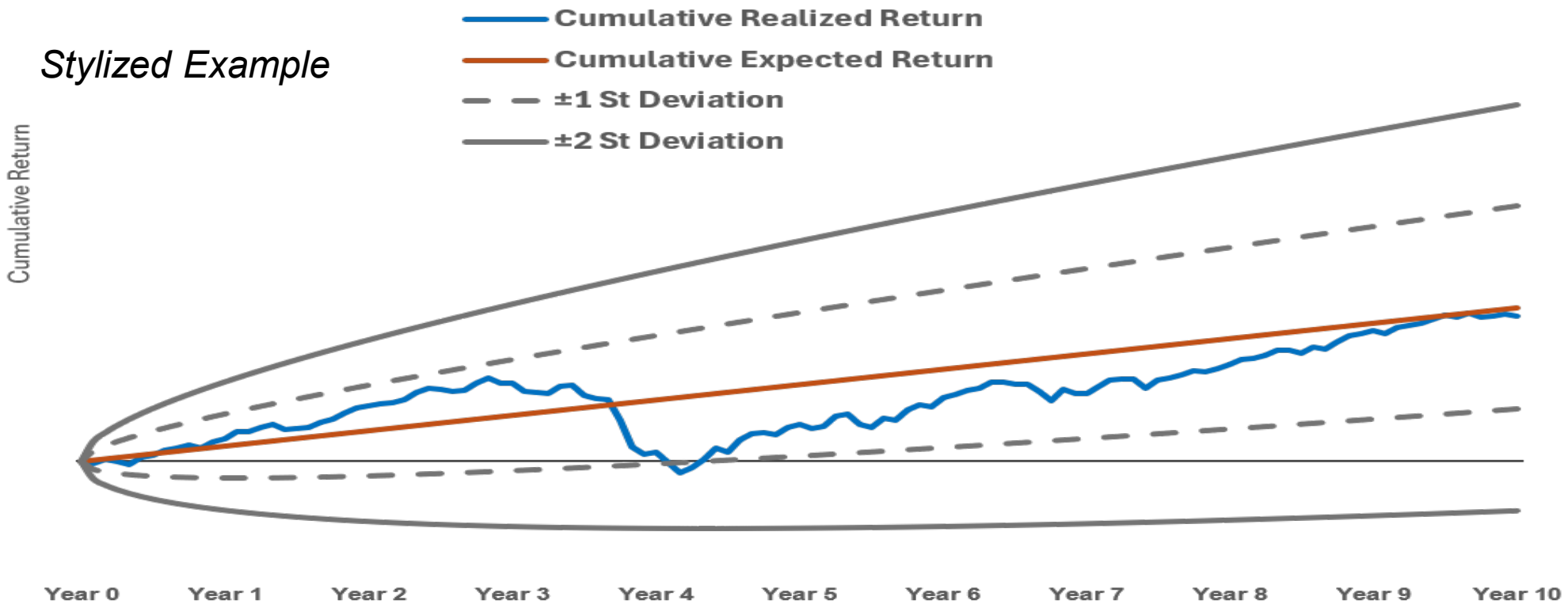


Other interpretations:

- There is a ~ 65% chance of experiencing a peak to trough drawdown of 20% over the next five years
- There is a ~ 20% chance of a 20% drawdown from today's levels over the next five years

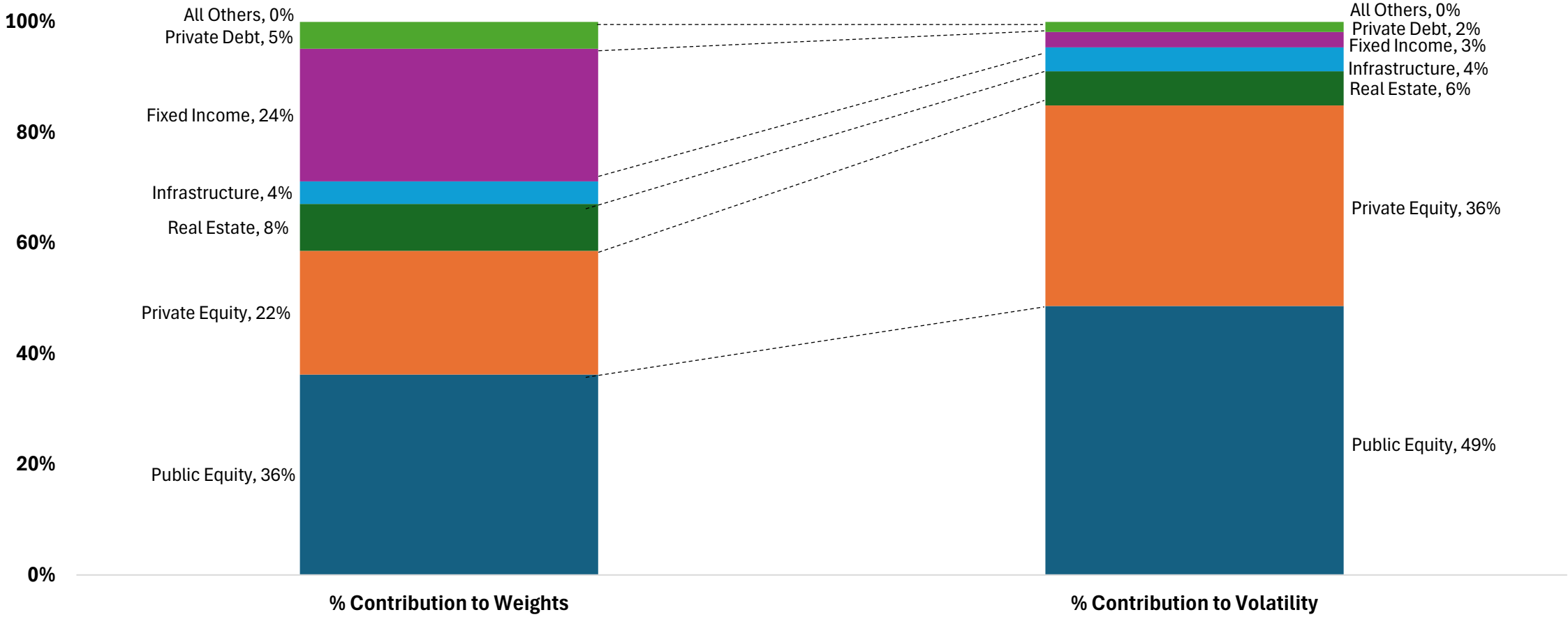
Use: Contextualize Past Outcomes

Return outcomes can be evaluated relative to volatility-based expectations



Use: Examine Portfolio Risk Drivers

Volatility toolkit lets us analyze risk in terms of contributions to the total



As of 9/30/2026

Benefits and Limitations of Volatility

Benefits

Holistic – captures all market risk factors in a single number

Convenient – many applications, such as setting expectations or attributing risk drivers

Widely accepted – routinely reported metric across the industry

Limitations

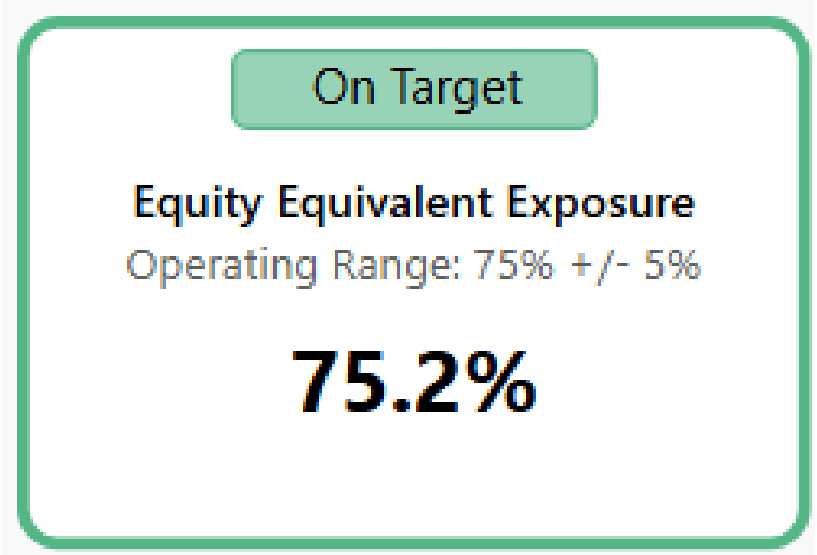
Only an estimate – The true distribution of future outcomes is unknown, and it tends to understate extreme events

Not intuitive – The statistical interpretation can be confusing; Calculation can require complex inputs

Private Asset Valuations – Over short horizons, reported outcomes have lower volatility than predicted due to quarterly valuations

Equity Equivalent Exposure (EEE or Triple E)

The Equity Market is a Primary Risk Driver and Comparison Point



What is Equity Equivalent Exposure?

Equity returns are closely linked to economic growth. We measure the equity-like exposure of assets in the portfolio. But not all assets have the same amount of this exposure.

Example: different drinks can have the same amount of caffeine with different volumes, or the same volume with different amounts of caffeine.



Brewed coffee: 100mg
e.g. Public equity



Cup of tea: 50mg
e.g. Infrastructure



Espresso: 100mg
e.g. Private equity

Demonstrating Active Decisions with EEE

$100 billion Portfolio → Reference Portfolio 75/25 Equity-Treasury → $75 billion in Equity, $25 billion in Treasury

EEE = 0.75

To Buy $10 billion in Infrastructure → If Infrastructure had EEE of 0.5 → Funding the Purchase Requires Selling: $5 billion in Equity, $5 billion in Treasury

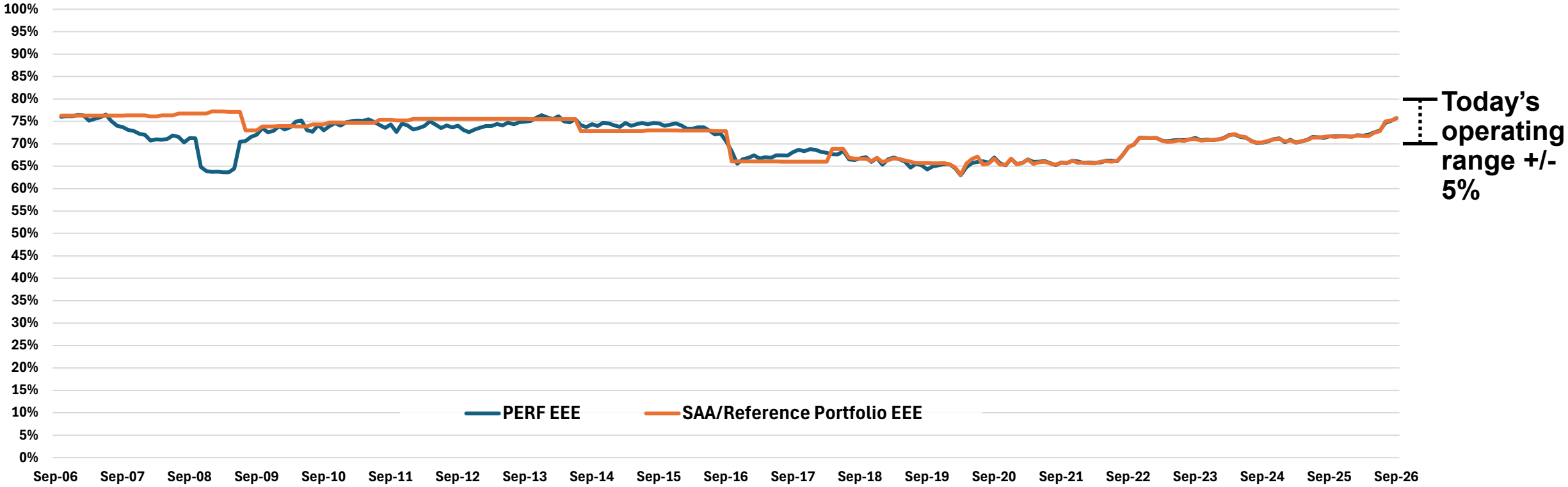
New $100 billion Portfolio

EEE = 0.75

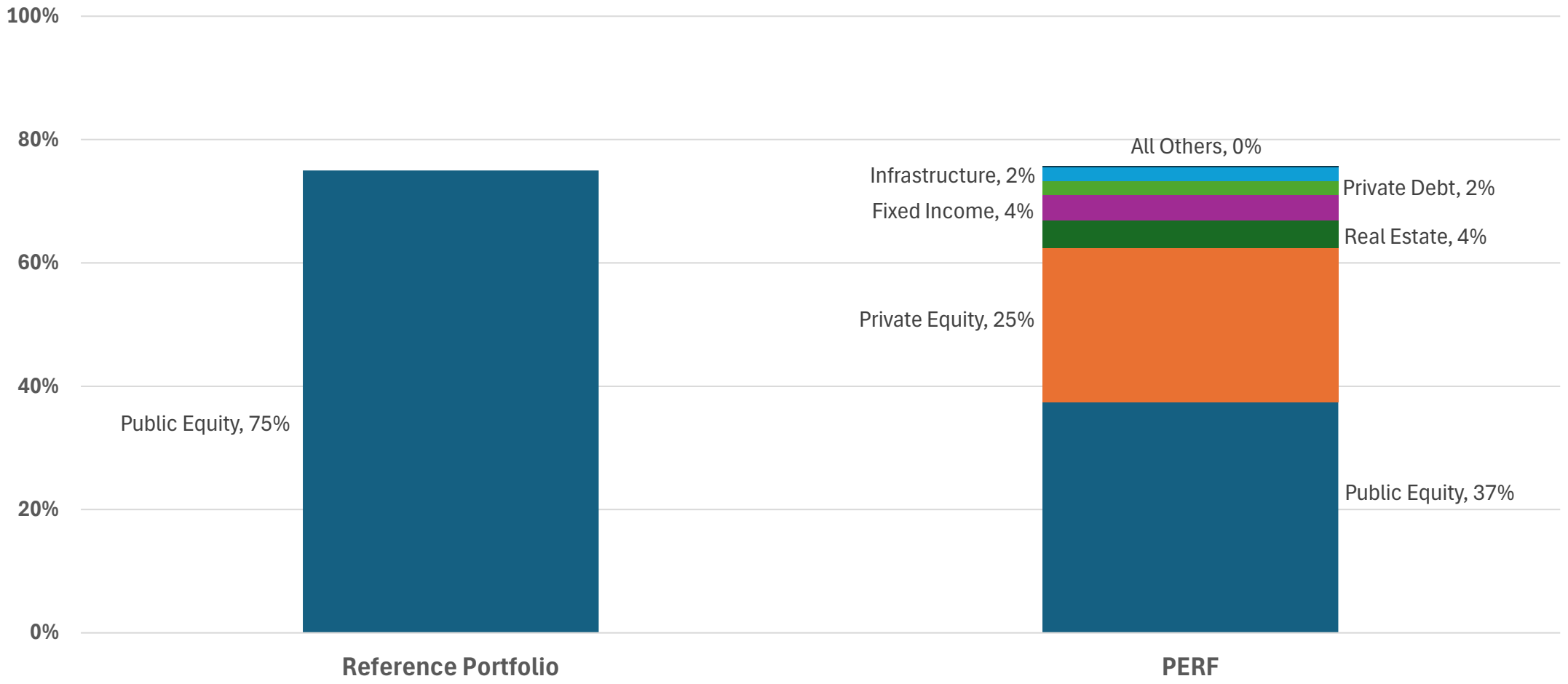
$70 billion Equity, $20 billion Treasury, $10 billion Infrastructure

PERF Closely Managed to EEE of Reference Portfolio

Occasional departures from RP EEE can still be expected, for example to take advantage of market dislocations



Current contributors to PERF EEE



As of 9/30/2026

Benefits and Limitations of EEE as a Metric

Benefits

Intuitive – Tied to the risk of a familiar asset class (Equities)

Relevant – Equity drawdowns align with challenging economic periods

Transparent – Asset-level EEEs can be individually evidenced and debated

Limitations

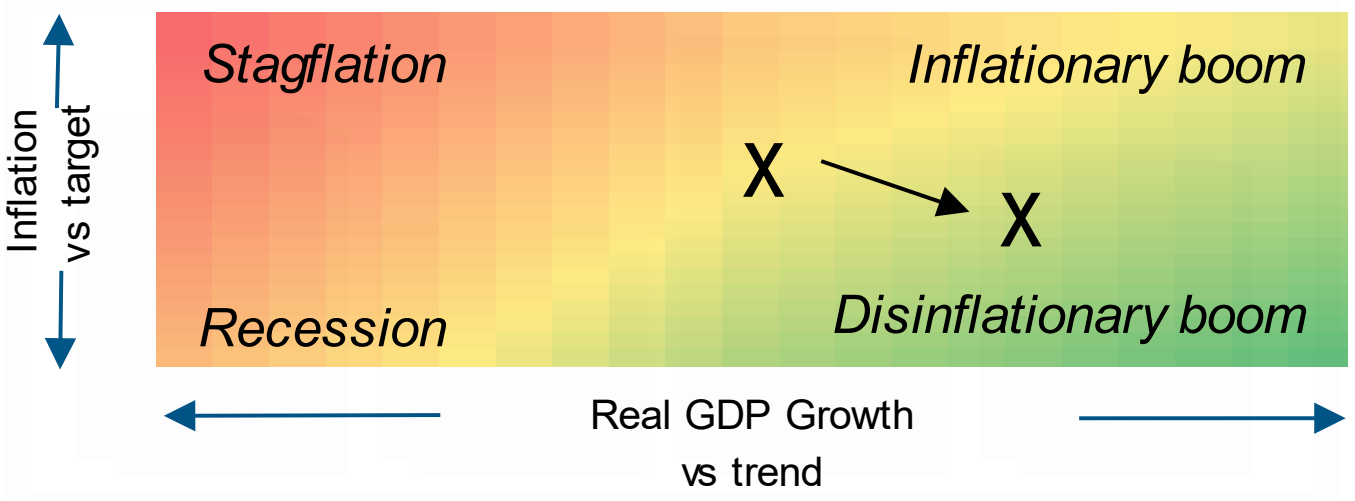
Not holistic – Could miss impact of other risk factors (e.g. interest rates, foreign currency)

Still an Estimate – Outcomes can diverge from expectations

Private Asset Valuations – Reported outcomes have lower EEE than predicted due to quarterly valuations

Scenario Analysis

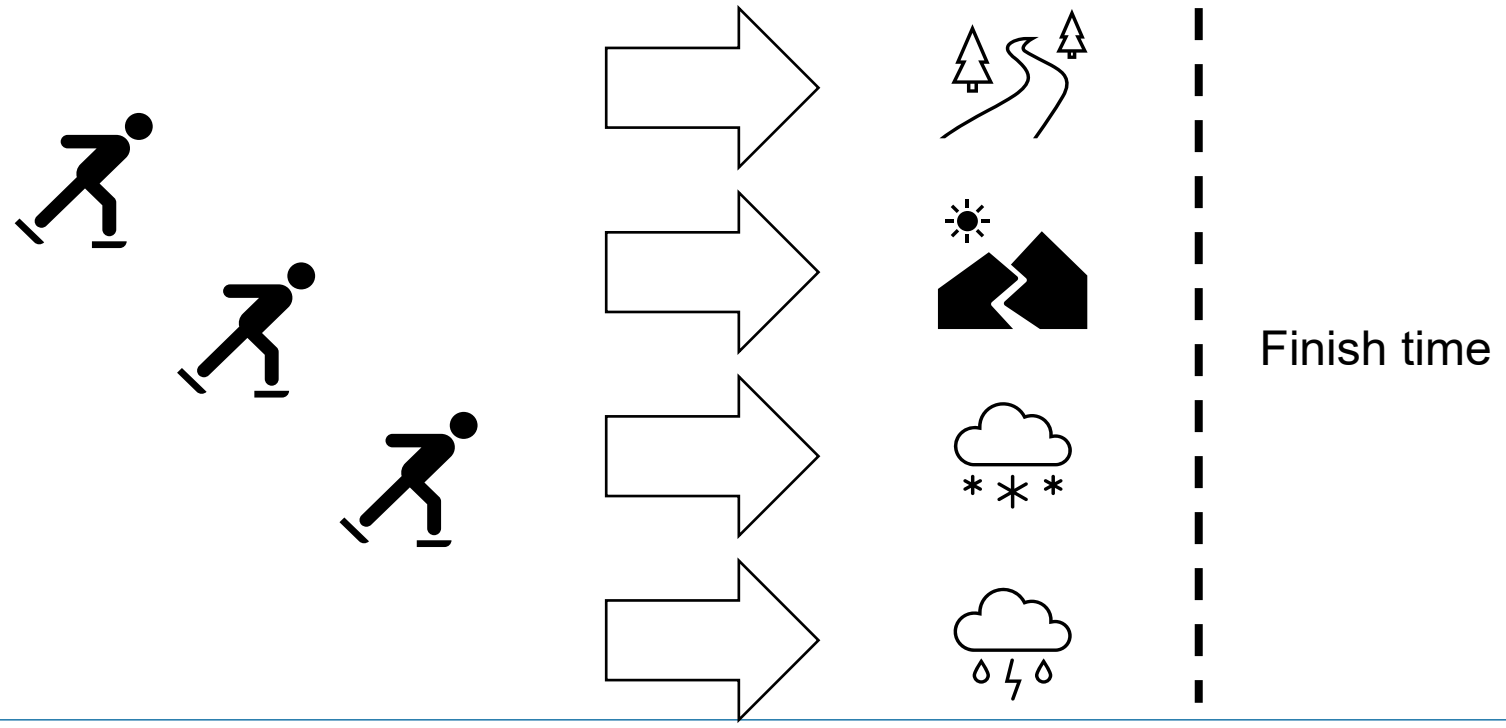
Giving Richness and Context to Investment Metrics



Scenario Analysis is a measure of “What-ifs”

How different circumstances affect portfolio outcomes

Example: racers train through different terrain and conditions to ensure they are prepared



Scenario Analysis and Why We Use it

Important complement to metrics like Volatility and EEE

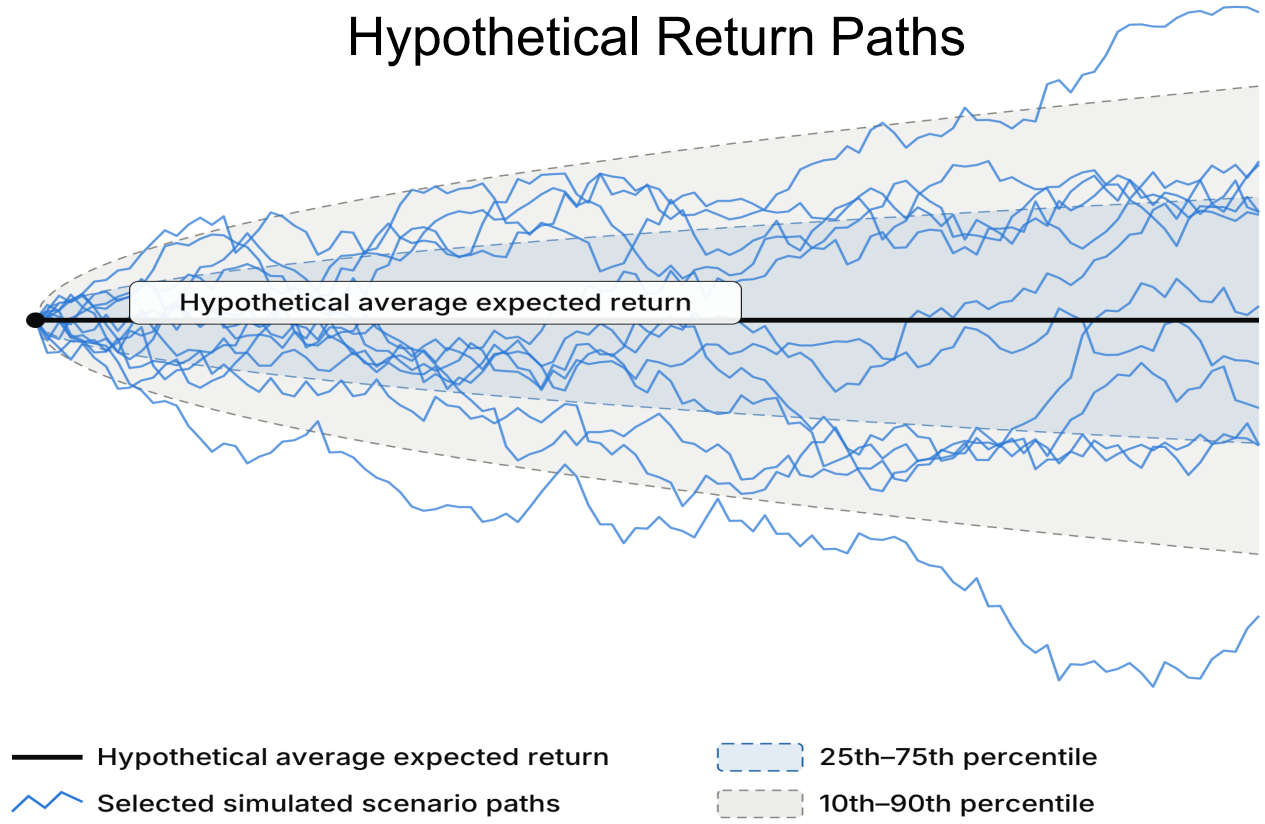
Scenario analysis assesses the potential impact of events on asset returns or a portfolio, based on a set of assumptions and shocks

Volatility and EEE are single metrics and cannot capture how returns unfold over time

Scenarios complement these indicators, are intuitive, and add richness to risk analysis

Scenarios Add Richness to Metrics Like Volatility

Simulations can show a range of return paths



Simulations show the full range of outcomes, not just the average

For any single expected return, there are many potential paths that are equally likely

Scenario Approaches are Wide and Varied

Each approach provides a different perspective on portfolio risk

Narrative-based

ALM and SAA

Historical Simulations

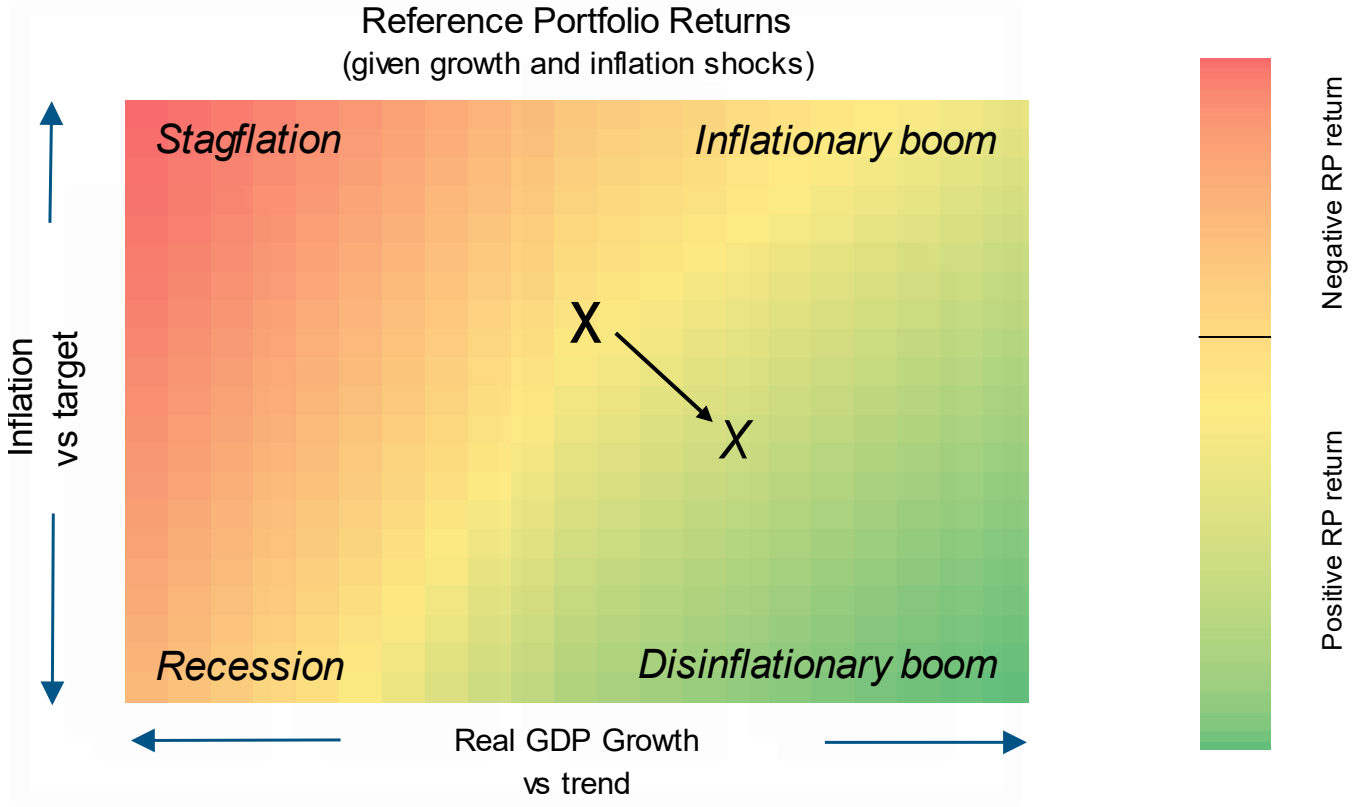
Stress Testing

Sensitivity Analysis

Future-proofing and Resilience

Scenario Example: Narrative & Understanding

How news & events impact future reference portfolio returns



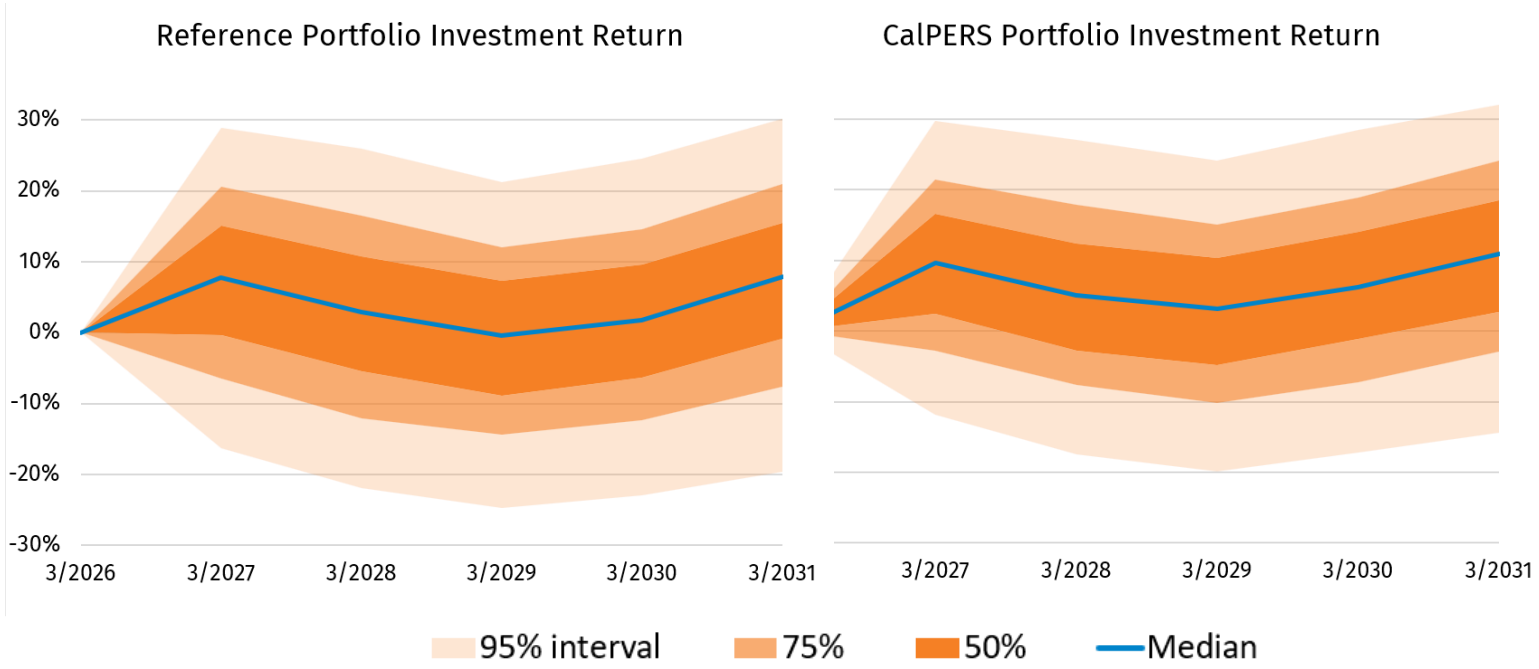
- Links the real world to the Reference Portfolio return
- Events today are reflected by market pricing, as shown by 'X'
- Unexpected events occur, shifting 'X' from its starting position
- The colors show the historical RP return, based on the size of the surprises

The 'X' mark illustrates expectations for the median macroeconomic outcomes a year ahead compared with trend growth and target inflation

Scenario Example: Resilience

How a portfolio may perform in a different future state

Persistent Stagflation Scenario



- Hypothetical shock and how it transmits through the Reference Portfolio and CalPERS portfolio
- Provides plausible different future states
- Tests investment strategy and portfolio resilience to various shocks

Results estimated by Ortec Finance. Estimated returns are illustrative, not ALM expected returns. Actual returns for 2026 are excluded to equalize the starting point in order to demonstrate the forward impact into year 1 and beyond.

Benefits and Limitations of Scenario Analysis

Benefits

Dynamic – can capture the journey, not just the destination

Forward or backward looking – can demonstrate historical and future (hypothetical) regimes

Intuitive – can directly relate back to what's happening today

Limitations

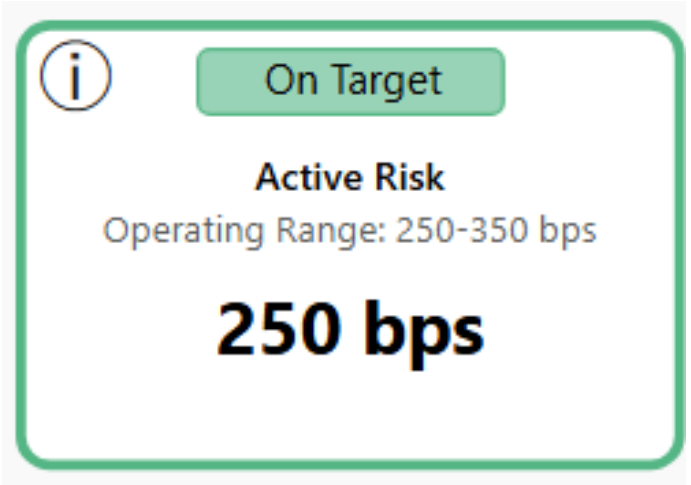
Subjective – scenario construction is a subjective exercise

Not exhaustive – it is not possible to enumerate scenarios for all possible outcomes

Not probabilistic – it is difficult to determine how likely a scenario is

Active Risk

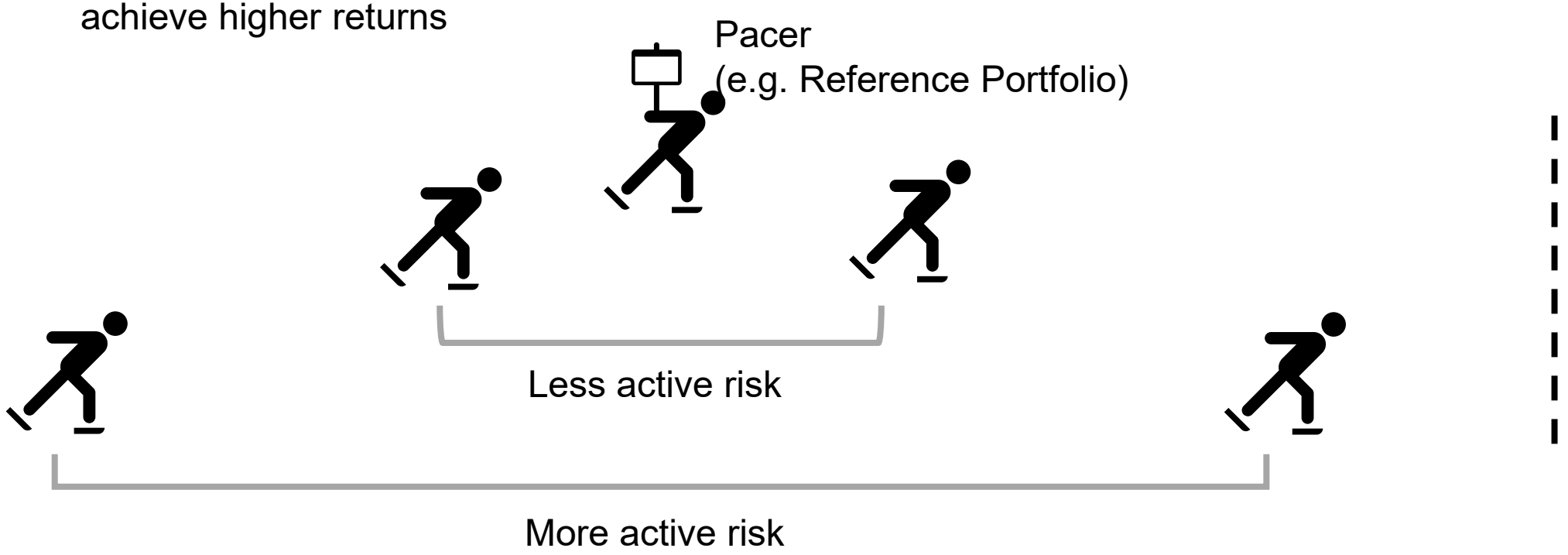
Measuring How Management Uses its Discretion



Active Risk is a Measure of Difference

Example: the closer a racer sticks with a pacer in a race, the more likely they are to finish at that time. They can try and run faster, but risk tiring themselves out and falling behind

Active Risk (use of discretion) measures how “different” an investor wants to be from their benchmark to achieve higher returns

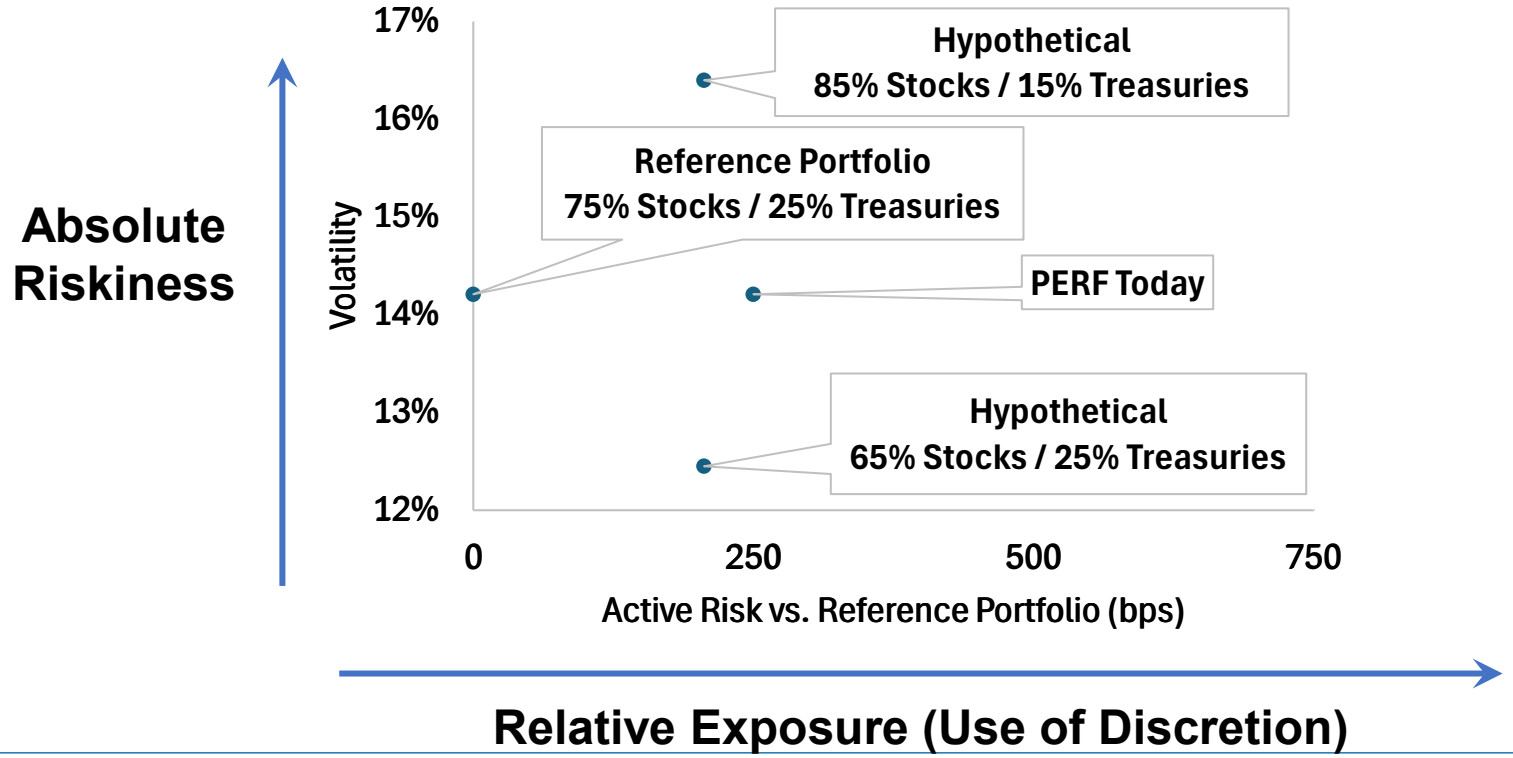


Active Risk vs Volatility

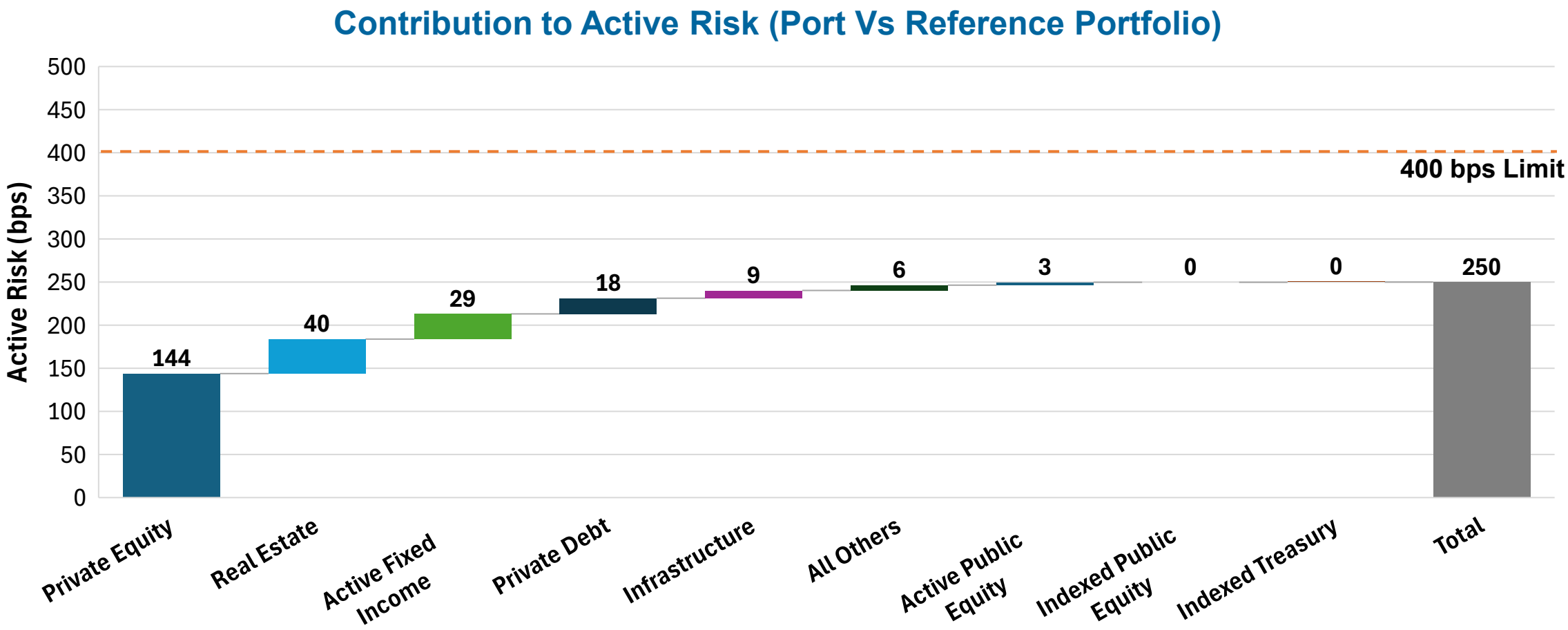
Volatility seeks to measure the absolute risk of a portfolio

Active Risk seeks to measure the *difference in exposure* between two portfolios

Active Risk can increase or decrease absolute risk, or leave it the same



Use of Discretion Today



Source: CalPERS Active Risk Model (as of 9/30/2026)

Benefits and Limitations of Active risk

Benefits

Holistic – Encapsulates the use of discretion in a single metric

Thorough – Captures differing asset characteristics that simple range limits can miss

Convenient – Integrates with existing volatility-based framework

Limitations

Model-dependent – Relies on a complex model, requiring appropriate governance

Volatility-based – Shares similar challenges: only an estimate, true distribution is unknown

Private Asset Valuations – Reported outcomes will have higher Active Risk than predicted due to quarterly valuations

Takeaways

Sound risk management draws on a variety of metrics and tools as no single metric captures the full picture

CalPERS' key governance metrics are Equity Equivalent Exposure (EEE) and Active Risk (Use of Discretion). These are augmented by scenario analysis

CalPERS' investment risk governance clearly delineates accountabilities and aligns with the Fund's objectives

Appendix

Pension Sustainability Risk Profile

Risk Driver Example

The Risk

Failure to Meet Pension Benefit Obligations

The Risk Driver

Financial Markets Suffer a Severe Downturn

Risk Event's Probability* & Impact*
(Financial, Reputational, Regulatory, Legal, Operational)

High Probability, High Impact

The Controls in Place

- Strategic portfolio construction
- Diversification
- Total fund perspective on risk, strategy, transparency, and accountability
- Liquidity and leverage management
- Internal governance by the Total Fund Management Committee reviewing allocation, risk, and sustainability
- Cost-effective total fund risk mitigation strategies

CalPERS

* Thresholds for risk probabilities and event impact are set by the Enterprise Compliance, Risk, and Governance Division. High impact is $1 billion or greater. High probability is expected to occur at least once per year.

Investment Beliefs Guide Risk Management

Balancing the Tradeoffs for Investment Decisions

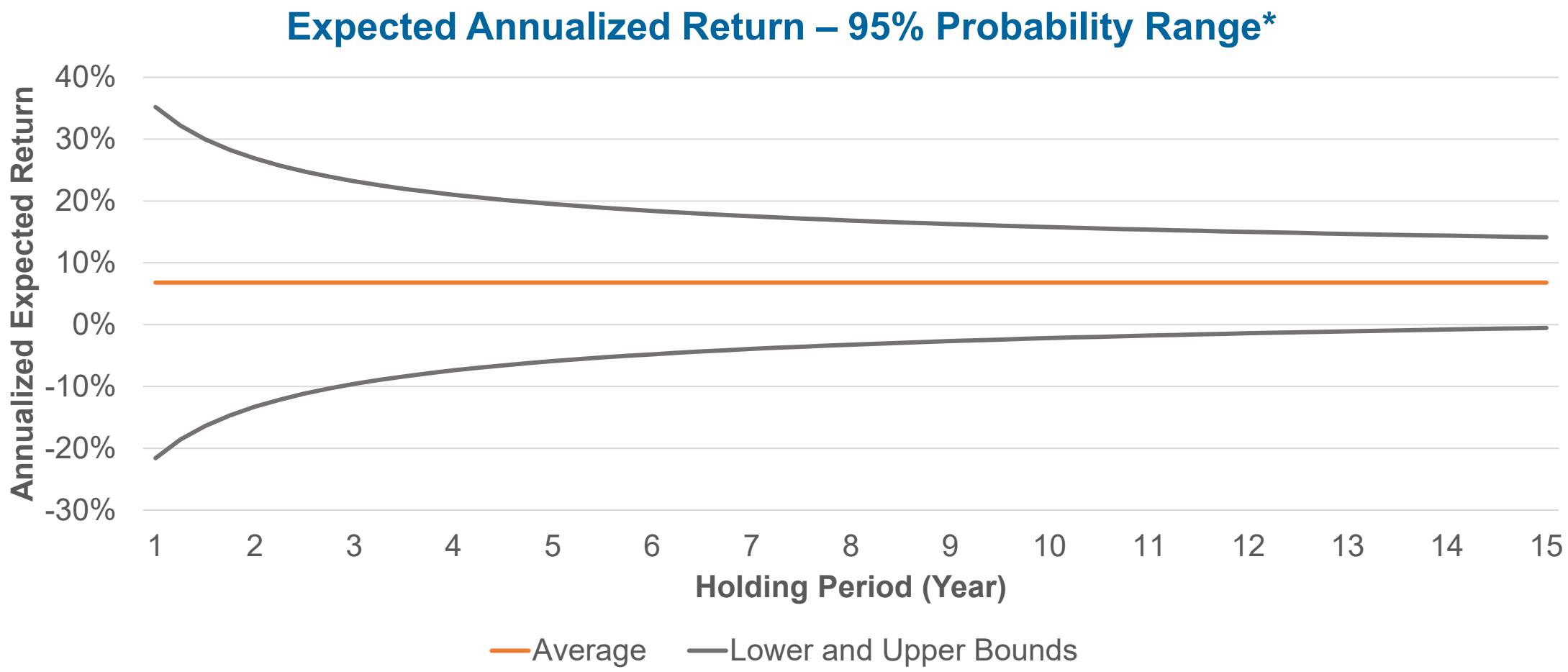
1. Liabilities must influence the asset structure.
2. A long time investment horizon is a responsibility and an advantage.
5. CalPERS must articulate its investment goals and performance measures and ensure clear accountability for their execution.
6. Asset allocation is the dominant determinant of portfolio risk and return.
7. CalPERS will take risk only where we have a strong belief we will be rewarded for it.
8. Costs matter and need to be effectively managed.
9. Risk to CalPERS is multi-faceted and not fully captured through measures such as volatility or tracking error.
10. Strong processes and teamwork and deep resources are needed to achieve CalPERS goals and objectives.

The Many Types of Investment Risks Managed

Standard Investment Risks	Operational Risks
Market	Investment Operations
Relative / Benchmark	Enterprise
Liquidity	Compliance / Regulatory
Counterparty	Cybersecurity
Concentration	Technology
Leverage	Reputational
Sustainability	Ethics / Values
Behavioral / Peer	

Covered Today

Longer Horizons Can Reduce Spread of Outcomes



*6.8% Expected Return, 14.2% Volatility

EEE Calculation Example (1/2)

EEE of Reference Portfolio

Asset	EEE		Asset Weight in Portfolio		EEE Contribution
Equities	1.0	x	75%	=	0.75
Treasuries	0.0	x	25%	=	0.0
					0.75

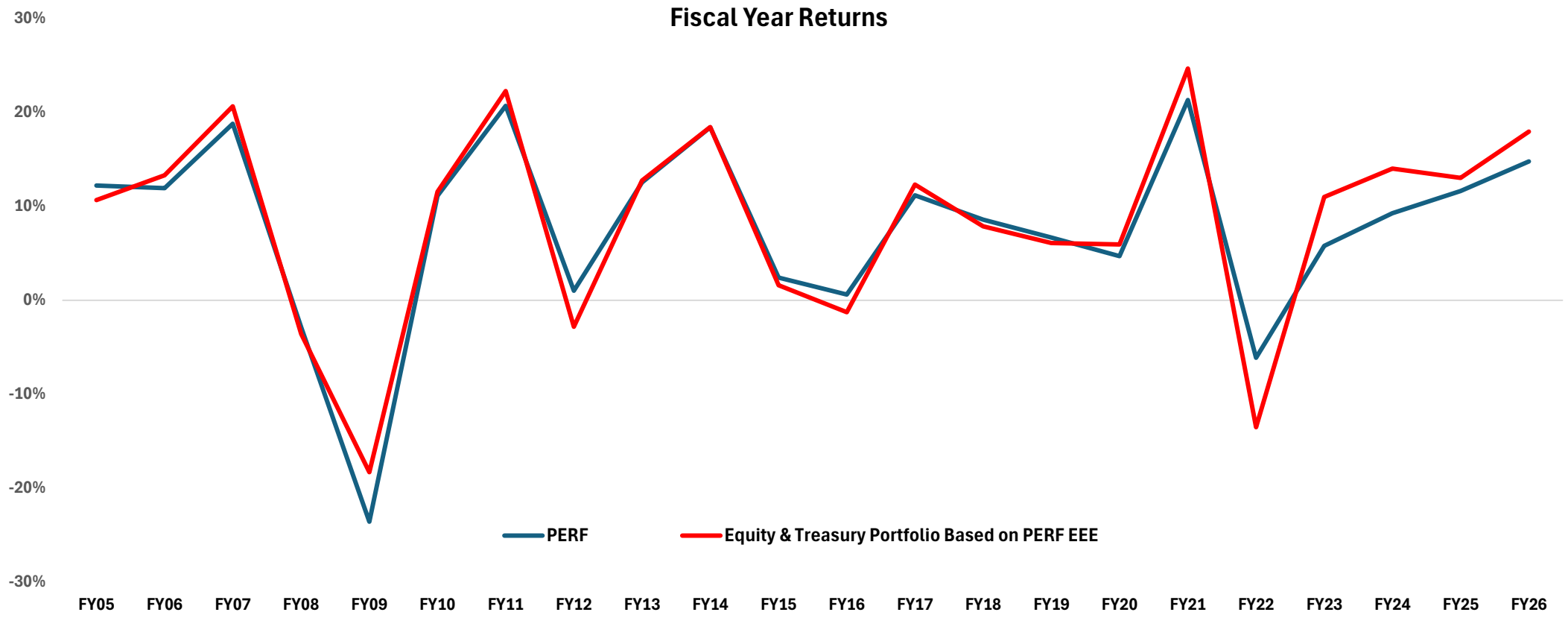
EEE Calculation Example (2/2)

In the example below, we show how a portfolio that includes a hypothetical active position still maintains EEE of 0.75

Asset	EEE (Illustrative)		Asset Weight in Portfolio (Illustrative)		EEE Contribution
Equities	1.0	x	70%	=	0.7
Treasuries	0.0	x	20%	=	0.0
Infrastructure	0.5	x	10%	=	0.05
					0.75 Portfolio EEE

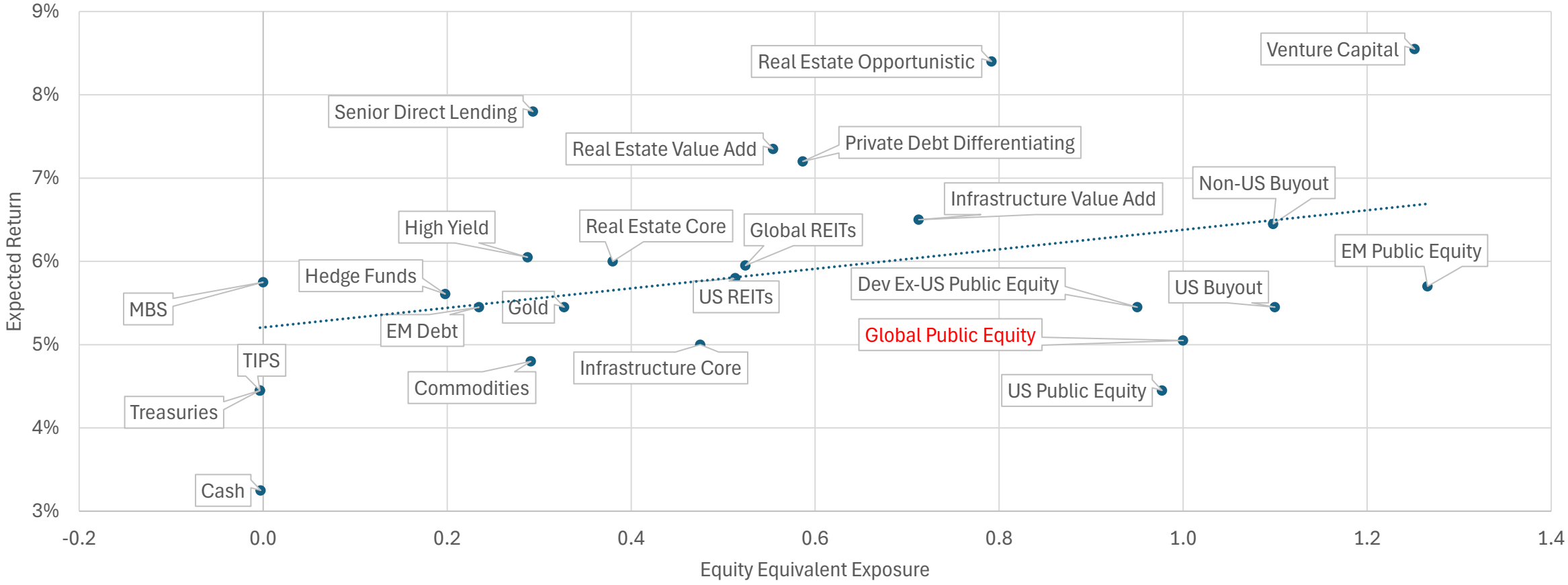
EEE can explain much of PERF return

A simple portfolio based on EEE approximated PERF return variability



EEE vs Returns for Major Asset Classes

Higher returning assets tend to have higher EEE



Source: Wilshire 2026 Asset Allocation Return & Risk Assumptions as of December 2025, 10-year return & risk assumptions, with CalPERS analysis for Equity Equivalent Exposure

Active Risk Calculation Example

Volatility is calculated by a risk model, using the asset weights of a portfolio

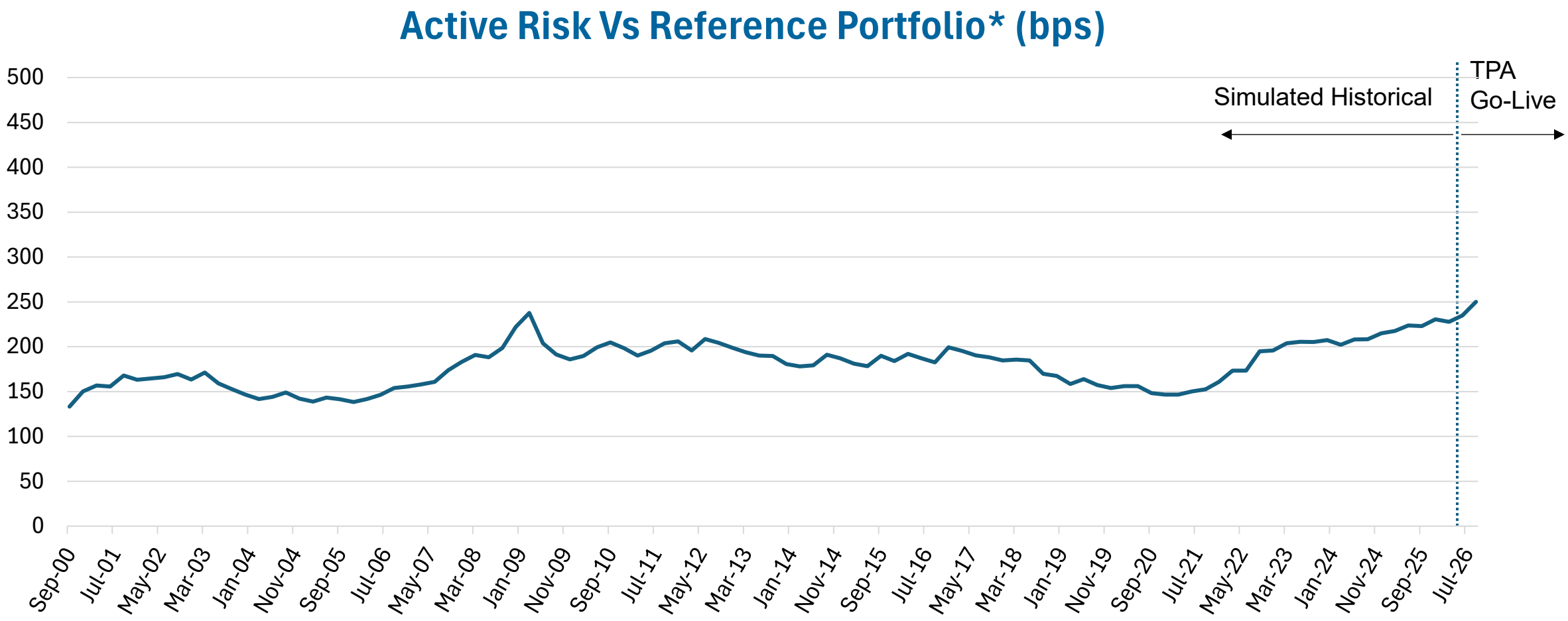
Active Risk is calculated with the same model, but using the differences in asset weights between two portfolios

Asset Class	Portfolio Weights (%)		
	Reference Portfolio	**PERF**	**PERF Versus Reference Portfolio**
Equities	75	15.8	-59.2
Treasuries	25	5.1	-19.9
Active Equities		20.5	20.5
Active Fixed Income		14.9	14.9
Private Equity		22.4	22.4
Real Estate		8.5	8.5
Private Debt		4.8	4.8
Infrastructure		4.1	4.1
Other		10.2	10.2
Cash/Financing		-6.3	-6.3
Total Weight	**100**	**100**	**0**



Volatility	**14.4%**	**14.2%**	
Active Risk			**250 bps**

Evolution of CalPERS Active Risk



*Simulated historical Reference Portfolio based on risk profile of historical Strategy Asset Allocation

Calibration of 400 bps Active Risk Limit

- PERF's current 400 bps Active Risk constraint was calibrated to be slightly more conservative than the level implied by the previous policy constraints and Strategic Asset Allocation
- The overall calibration is dependent on the risk model used (currently Blackrock Aladdin)

	Active Risk	Description
Pre-TPA Strategic Asset Allocation Vs Reference Portfolio	2.5%	Active Risk of Pre-TPA Strategic Asset Allocation (CalPERS Total Fund Investment Policy as of 6/10/2024, Appendix 4) Vs TPA Reference Portfolio*
Total Fund Actionable Tracking Error Limit	1.0%	Active management within public asset strategies and allocation within public asset policy ranges (CalPERS Total Fund Investment Policy as of 6/10/2024, Appendix 6)
Private Strategies Upper Bounds Allocation	0.9%	Pre-TPA Strategic Asset Allocation private assets upper bounds (CalPERS Total Fund Investment Policy as of 6/10/2024, Appendix 4)
Private Sub-Strategy Tilt	2.0%	Allowed tilts into higher risk segments *within* private asset classes (CalPERS Total Fund Investment Policy as of 6/10/2024, Private Assets sections)
Diversification	-1.8%	Diversification effect across constraints**
Total	**4.6%**	

*Estimate from the Reference Portfolio implied by Strategic Asset Allocation
**Correlation between Total Fund Actionable TE and all other assumptions = 0.5. Correlations for all other assumptions = 0.2