# SWIB Board Workshop Materials for October 17-18, 2023

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# AGENDA / NOTICE

SWIB STATE OF WISCONSIN INVESTMENT BOARD

**Name of Meeting:** **Regular Meeting of the Board of Trustees**

**Date/Time** Tuesday, October 17, 2023 10:30 am
**Room:** Sandstone Ballroom
**Address:** Heidel House Hotel & Conference Center
635 Illinois Avenue
Green Lake, WI 54941

| **OPEN SESSION** |
|---|
| Trustee Welcome |
| **EXECUTIVE CLOSED SESSION*** <br> ***(Trustees and invited guests only)*** |
| **RECONVENE IN OPEN SESSION** |
| Announcement of Matters Taken Up in Closed Session |
| Workshop Welcome & Kickoff |
| Artificial Intelligence: Implications for Investors and Beyond |
| Break |
| WRS Actuarial Overview and Projections |
| Break |
| Asset Allocation |

**Motion to Recess**



*The motion to go into closed session at this meeting is made pursuant to: (i) Sections 19.36(5) and 19.85(1)(e) of the Wisconsin Statutes to consider confidential and proprietary strategies for the investment of public funds relating to specific proprietary investment strategies of internal WRS portfolios; and (ii) Section 19.85(1)(c) of the Wisconsin Statutes to discuss performance evaluation data for SWIB's Board of Trustees. The Board may convene in additional closed sessions or announce additional closed session items at the meeting in accordance with the procedure outlined in the Attorney General's Opinion reported at 66 OAG 106 (1977). Whenever a closed session is held, the Board will subsequently reconvene in open session to cover remaining agenda items.

**Name of Meeting:** **Regular Meeting of the Board of Trustees**

**Date/Time:** Wednesday, October 18, 2023 9:00 am
**Room:** Sandstone Ballroom
**Address:** Heidel House Hotel & Conference Center
635 Illinois Avenue
Green Lake, WI 54941

| |
|---|
| **OPEN SESSION** |
| Implementation Working Group and Strategic Framework |
| Break |
| A View of the Markets |
| Break |
| **CLOSED SESSION*** |
| **EXECUTIVE CLOSED SESSION**<br>***(Trustees and invited guests only)*** |
| **RECONVENE IN OPEN SESSION** |
| Announcement of Matters Taken Up in Closed Session |

**Motion to Adjourn**



* The motion to go into closed session at this meeting is made pursuant to: (i) Sections 19.36(5) and 19.85(1)(e) of the Wisconsin Statutes to consider confidential and proprietary strategies for the investment of public funds relating to specific proprietary investment strategies of internal WRS portfolios; and (ii) Section 19.85(1)(c) of the Wisconsin Statutes to discuss performance evaluation data for SWIB's Board of Trustees. The Board may convene in additional closed sessions or announce additional closed session items at the meeting in accordance with the procedure outlined in the Attorney General's Opinion reported at 66 OAG 106 (1977). Whenever a closed session is held, the Board will subsequently reconvene in open session to cover remaining agenda items.

**Bradley Betts Bio**:

Bradley J. Betts, PhD, Managing Director, is a member of the Global Equity Research team within BlackRock's Systematic Active Equity group. He focuses on the use of machine learning, artificial intelligence, and natural language processing for generating alpha. Dr. Betts' service with the firm dates back to 2008. Prior to joining BlackRock, Dr. Betts was a Scientist at Quantcast where he developed statistical models using large data sets for behavioral targeting of online advertising. Prior to that, he was a Principal Computer Scientist at NASA's Ames Research Center, a Lecturer and Research Scientist in the School of Medicine at Stanford University, and a Member of the Technical Staff at the MITRE Corporation. Dr. Betts is a member of the Association for Computing Machinery (ACM), the Institute of Electrical and Electronics Engineers (IEEE), the American Mathematical Society (AMS), and the American Association for the Advancement of Science (AAAS). He earned a BASc degree in computer engineering from the University of Waterloo in 1993, a MS degree in electrical engineering from Stanford University in 1995, and a PhD degree in electrical engineering from Stanford University in 1999.

**Frances Schwiep**

Partner, Two Sigma Ventures

Frances partners with founders who are building compelling technologies across B2B applications and infrastructure, applied AI and DataOps, FinTech, and vertical software around the future of work. She is passionate about leveraging new technologies and digital assets to redefine businesses and build new categories. Before joining Two Sigma Ventures in 2018, Frances invested across early to late-stage technology and data-driven software companies at Comcast Ventures and Highland Capital. She began her career on the operating side as a data scientist and then as a product manager at mc10, a wearable computing company. Frances studied Applied Math and Economics at Boston College and received her master's from Harvard Business School.

# State of Wisconsin Investment Board (SWIB)

Wisconsin Retirement System
Actuarial Overview and Stress Testing Scenarios

October 2023

# Topics

# SECTION 1

# Executive Summary

# Objectives of this Presentation


- Provide an overview of the WRS
  - Relationship of Investment Return to Success Measures
  - Effects of bad outcomes
- Evaluate several points along the asset allocation spectrum against the measures of success
  - Deterministic stress tests
  - Stochastic simulations
- Find the “Sweet Spot” if it exists

# 2023 Executive Summary

- Deterministic stress test of WRS

  Single year Black Swan investment scenarios show:

  - Contribution rate increases by up to ~ 2.5%-4% of payroll once loss fully works into the Market Recognition Account
  - Series of negative dividends, depletion of dividend liability and several years until dividends resume
    - Dividend depletion at -15% return (vs. -30% return in 2021 study)
  - Contribution rates are generally more stable than retiree dividends

# 2023 Executive Summary

- Changes from 2021 Study:
  - Market returns varied during 2021-2022
  - Much lower standard deviation of future returns
  - Smaller ultimate dividend liability ‘cushion’
  - Evaluated smaller intervals of expected return (50 basis points) to refine sweet spot
  - Updated actuarial assumptions (primarily 6.8% investment return)

# 2023 Observations

- Overall results are similar to 2021 study
  - Stochastic probability of depleting dividend liability varies due to factors above
  - Smaller range of dividend/contribution results due to lower standard deviation of returns
  - Wider range of goldilocks zone due to additional incremental scenarios studied

# 2023 Executive Summary

Result of this year's stress testing of the Wisconsin Retirement System

- Continue to target 'Goldilocks zone' that provides for positive return with appropriate downside protection
  - Expected Rate of Return = 6.0%-7.5%
    - Corresponding Standard Deviations of Returns = 9.4%-17.1%


# SECTION 2

# WRS – The Big Picture

# All Participants at December 31, 2022

Active Lives Valuation

| Valuation Group | Number | Average Annual Earnings/Benefits[1] |
|---|---|---|
| Actives | 259,592 | $61,735 |
| Inactives | 181,758 | $20,892 |
| Retirees & Beneficiaries | 233,804 | $29,889 |
| **Total Participants** | **675,154** | |

Retired Lives Valuation

[1] *For inactives, average money purchase balance.*

# WRS Benefits


- Defined Benefit Plan:
  - 1.6% x Final Average Compensation x Service (most participants)
  - Different benefits for protective occupations
  - Provides benefits in the case of death or disability prior to retirement

# WRS Investments

- Core Fund (Most Assets)
  - Diversified portfolio with results smoothed for WRS purposes via the Market Recognition Account (MRA)
- Variable Fund (Some Assets)
  - 100% Common Stock -- no smoothing of results
  - Participants can choose to invest up to half of their own contributions in this fund
    - They bear the risks and reap the rewards of this choice

# WRS Actuarial Assumptions

- Non-Retired Assets: 6.8%
- Retired Assets: 5%
  - A statutory assumption that is really a benefit condition
- Other assumptions relate to active participants salary, rates of turnover, disability, mortality, etc.
- Investment return assumption (6.8%) is the most important

# WRS Risk Sharing

- Investment earnings increase (or decrease) active and inactive member account balances
  - Potentially affects their benefits when they retire via the operation of the Money Purchase Minimum benefit (MPM)
- Investment earnings (smoothed) above or below 5% affect dividends paid to retirees
- Active members and employers share in contribution rate changes

# SECTION 3
# Understanding Dividend Liability

# Understanding Dividend Liability

- Retirees share in investment gains, but also share in investment losses
  - Prior dividends can be reduced if less than 5% is credited to the Core Annuity Division
- Only dividends can be reduced, the original core benefit is protected
- The present value of the excess of total core benefits over original benefits is called the "Dividend Liability"

# Liability Attributable to Dividends – "Dividend Liability"

| Valuation | Liability for Dividend Remaining (billions) | Liability for Dividend Adjustment (billions) | Liability after Dividend Adjustment (billions) |
|---|---|---|---|
| 12/31/2013 | $3.0 | $2.0 | $5.0 |
| 12/31/2014 | 4.6 | 1.3 | 5.9 |
| 12/31/2015 | 5.5 | 0.2 | 5.7 |
| 12/31/2016 | 5.4 | 1.0 | 6.4 |
| 12/31/2017 | 6.1 | 1.3 | 7.4 |
| 12/31/2018 | 6.9 | 0.0 | 6.9 |
| 12/31/2019 | 6.5 | 1.0 | 7.5 |
| 12/31/2020 | 7.0 | 3.1 | 10.1 |
| 12/31/2021 | 9.4 | 4.8 | 14.2 |
| 12/31/2022 | 13.4 | 1.1 | 14.5 |

- "Liability for dividend remaining" = value of all previously granted dividends (=$9.2B at 12/31/2008)
- 2023 "liability for dividend remaining" is >2008, BUT as a percentage of total liabilities, it is smaller
- Substantial asset losses could decrease the "liability for dividend remaining" to low levels

# Dividend Liability Measure – MRA Basis

- Dividend Liability as a % of Base Liability
- Dividend Liability (MRA basis)
  - Total Retiree Assets (Core MRA) = 72.1 billion
  - Base Benefit Liability = 57.6 billion
  - Dividend Liability = (72.1 – 57.6) = 14.5 billion
  - Dividend Liability % = 14.5B/57.6B = 25.2%
- In other words, there is a 25.2% ‘cushion’ before Dividend Liability is depleted

# Dividend Liability Measure – MVA Basis

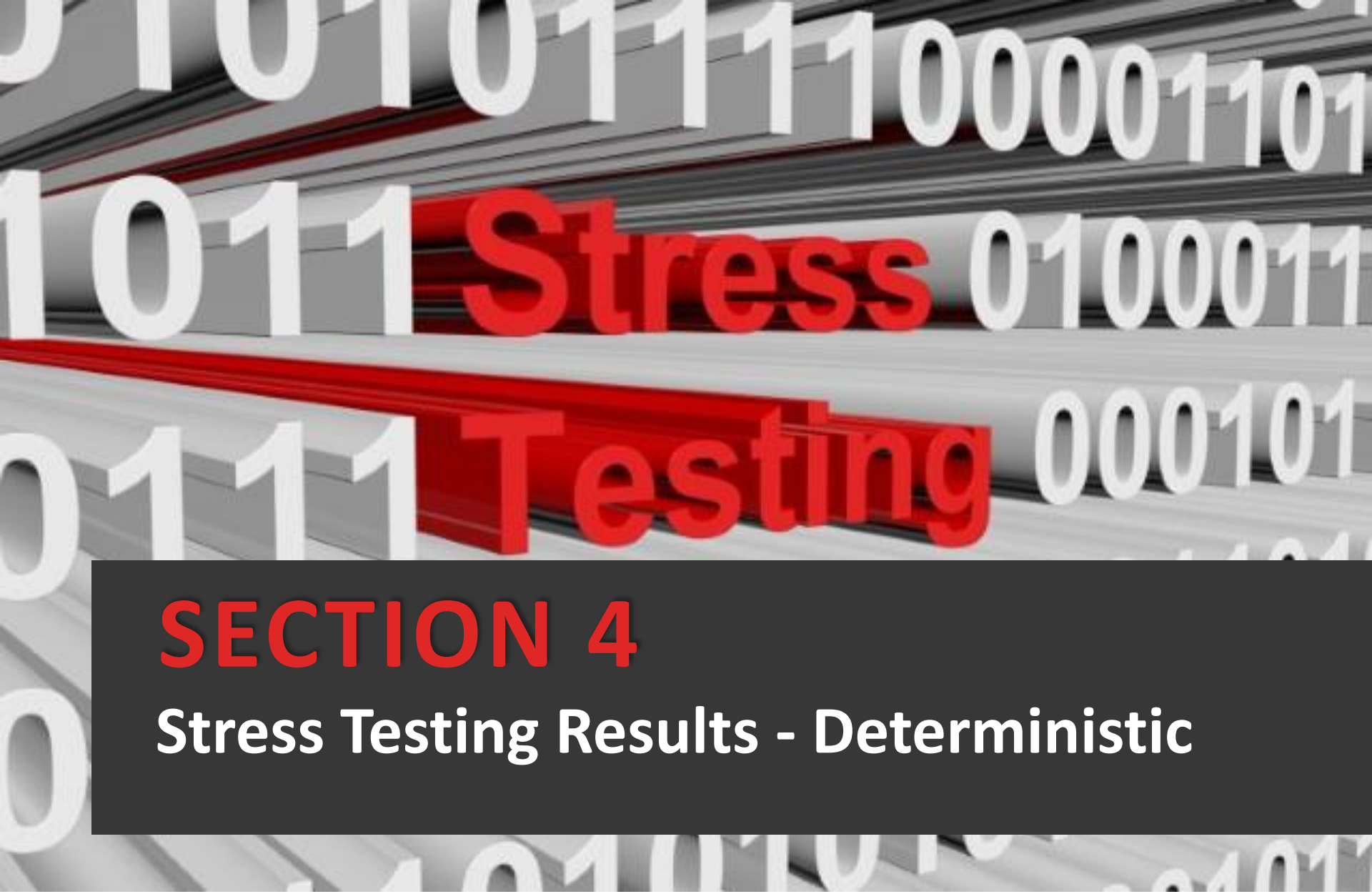
- However, this is on an MRA (smoothed) basis
- Dividend Liability (MVA basis)
  - Total Retiree Assets (Core MVA) ~ 68.0 billion
  - Base Benefit Liability = 57.6 billion
  - Dividend Liability (MVA) ~ (68.0 – 57.6) = 10.4 billion
  - Dividend Liability (MVA) % ~ 10.4B/57.6B = 18.0%
- Given all assumptions are met, over time, on a market value basis the cushion will decrease to 18% with Phase-in of unrecognized losses

# Dividend Liability Measure

- On MRA basis, 2023 dividend liability results look better than 2021, however:
  - At 12/31/2020 there were $11.1B in deferred asset gains – looking forward things are better than they appear
  - At 12/31/2022 there are $7.0B in deferred asset losses – looking forward things are worse than they appear

| Dividend Liability % | 2021 | 2023 |
|---|---|---|
| MRA basis | 18.6% | 25.2% |
| MVA basis | 30.7% | 18.0% |

- The ultimate dividend liability 'cushion' decreased from 30.7% to 18.0%




# SECTION 4

## Stress Testing Results - Deterministic

# Deterministic Stress Testing

- Stress testing provides insight into how the System would respond to severely unfavorable markets
- For WRS, stress testing can answer questions:
  - What would it take to deplete the dividend liability?
  - What would it take to increase contribution rates 25%?

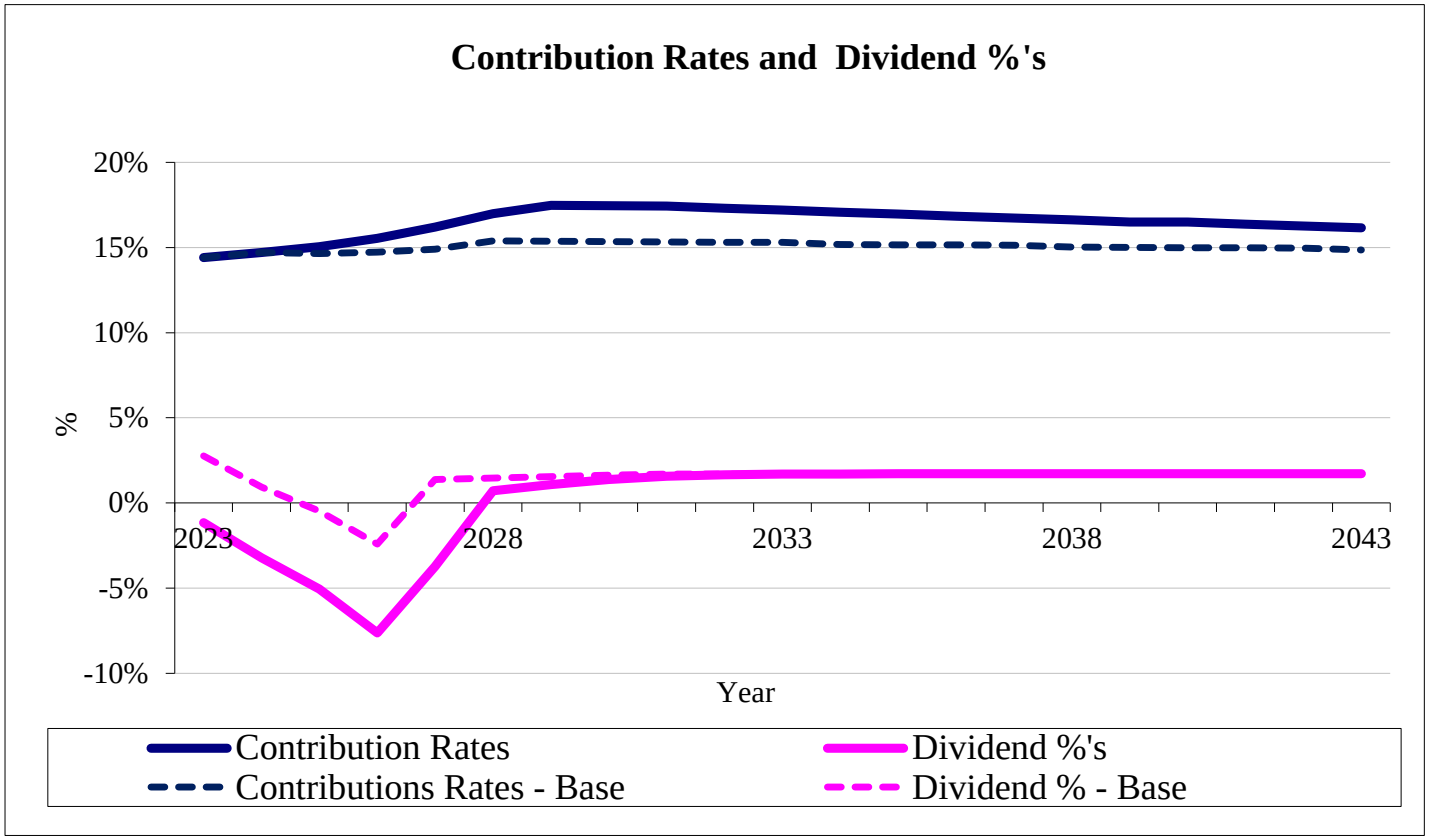
# Deterministic Stress Testing

- Deterministic stress tests studied herein:

| Stress Test | Asset Return Year 1 | Asset Return Year 2 | Asset Return Thereafter |
|---|---|---|---|
| 1 | -15% | 6.8% | 6.8% |
| 2 | -20% | 6.8% | 6.8% |
| 3 Bounce Back | -20% | 20% | 6.8% |
| 4 | -30% | 6.8% | 6.8% |

Underlying valuation assumptions held constant, including 6.8% investment return and 3.0% wage inflation assumptions

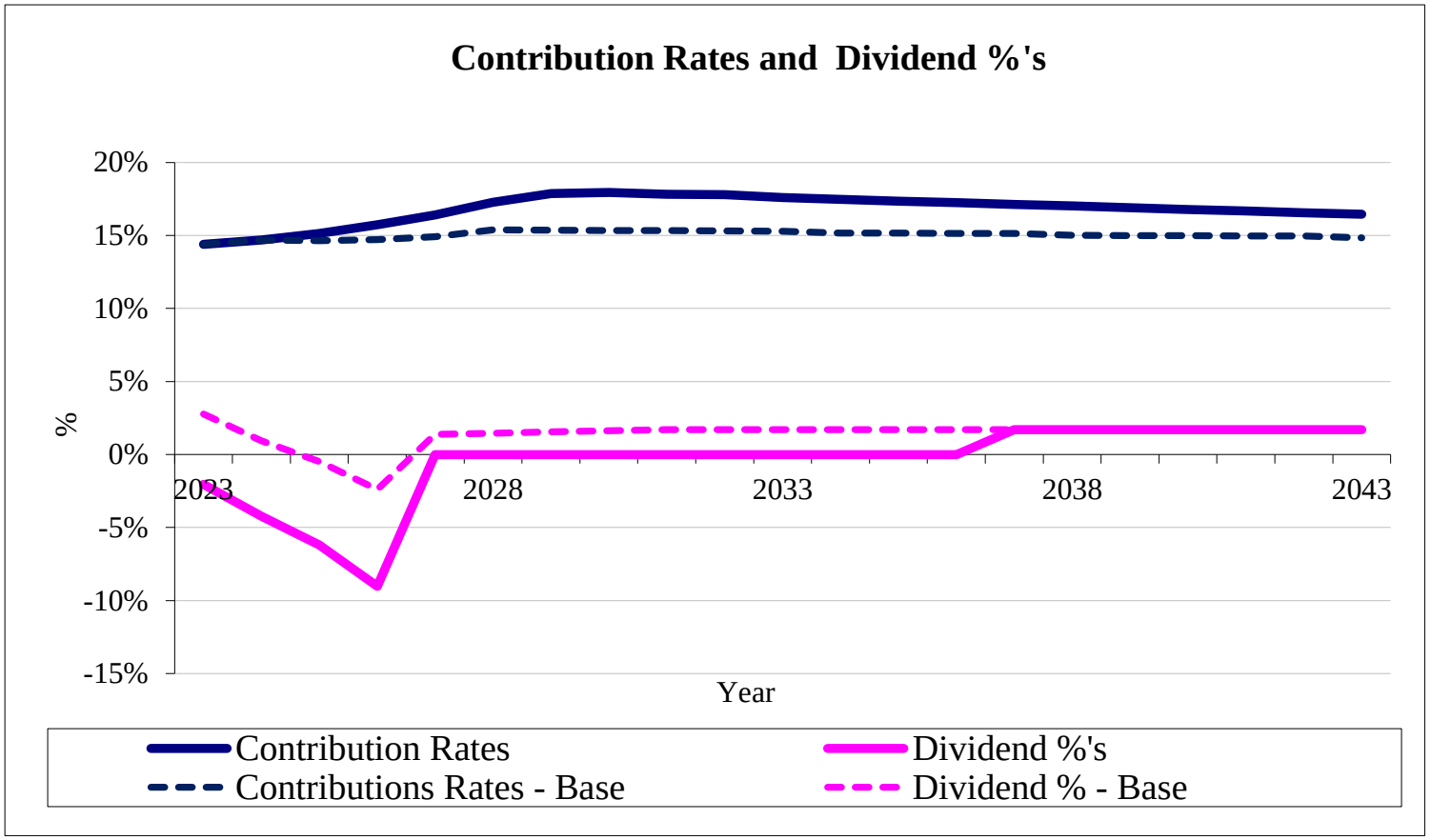
# Stress Test 1 – Negative 15% Return in 2023 Followed by 6.8% Thereafter



# Stress Test 1 – Negative 15% Return in 2023 Followed by 6.8% Thereafter

- Dividend Liability is depleted by 2027
- There will be a series of negative dividends, until most people are at the floor
- Positive dividends would resume in 2028
- Contribution Rate gradually increases by about 2.5% of payroll in year 5 and slowly declines thereafter

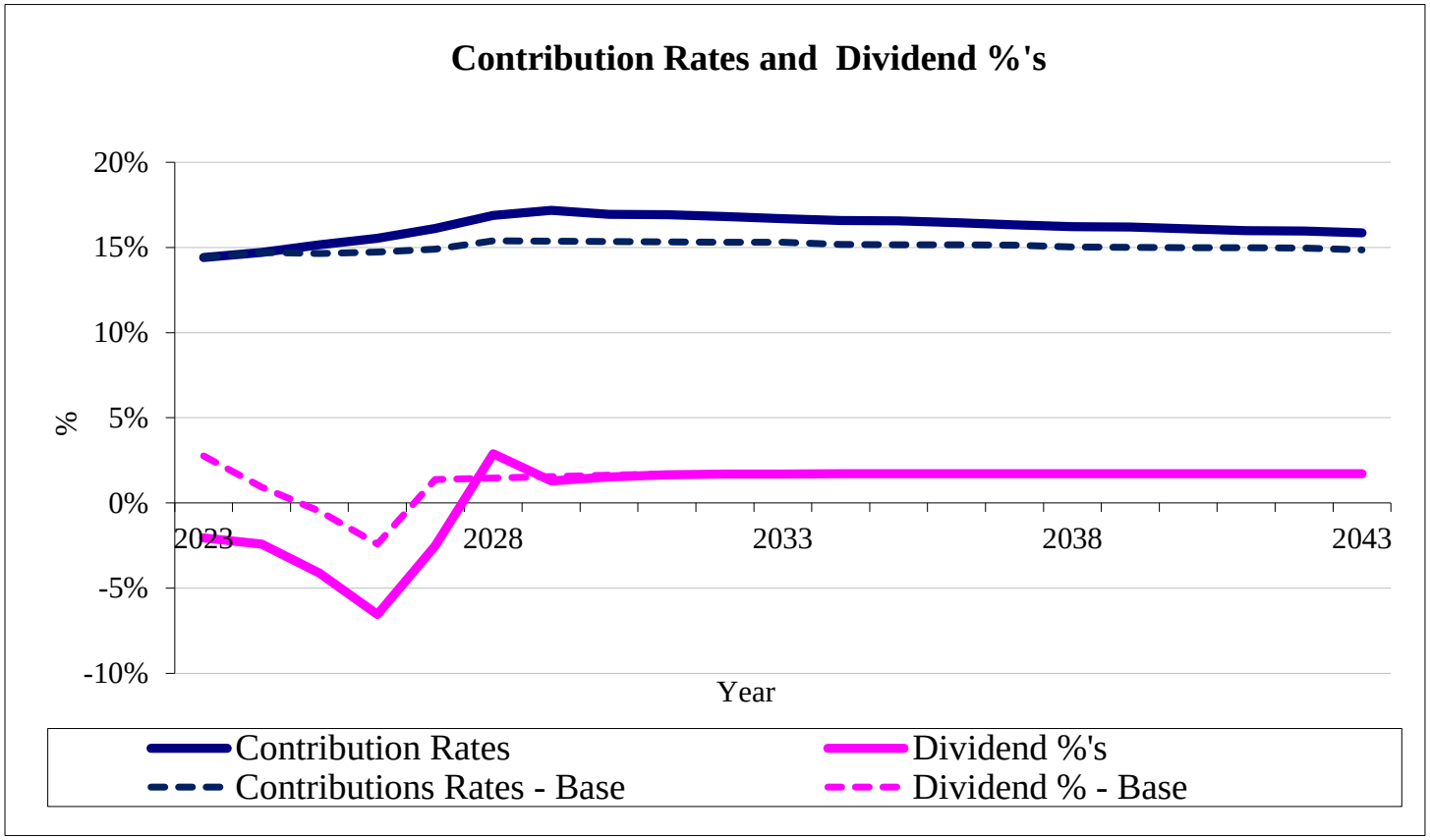
# Stress Test 2 – Negative 20% Return in 2023 Followed by 6.8% Thereafter



# Stress Test 2 – Negative 20% Return in 2023 Followed by 6.8% Thereafter

- Dividend Liability is depleted by 2026
- Retiree Liability becomes underfunded
- There will be a series of negative dividends, until all retirees are at the floor, followed by an extended period of no dividends
- Dividends could resume in 2037
- Contribution Rate gradually increases by about 3% of payroll in year 5 and slowly declines thereafter

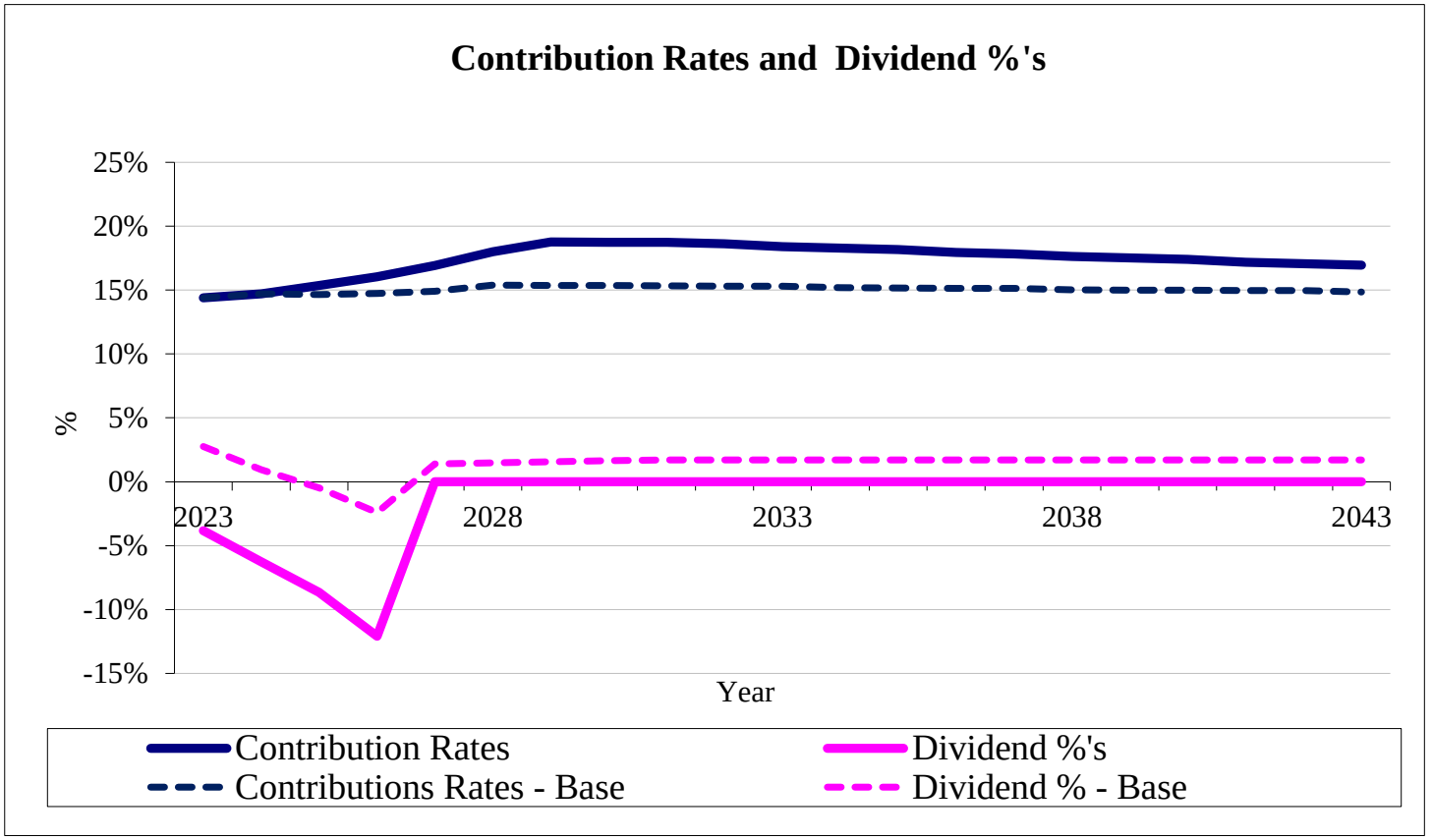
# Stress Test 3 – Negative 20% Return in 2023, Positive 20% in 2024 and 6.8% thereafter



# Stress Test 3 – Negative 20% Return in 2023, Positive 20% in 2024 and 6.8% thereafter

- Dividend Liability is not depleted, but Dividend Liability "cushion" falls to 3% in 2027
- There will be a series of negative dividends, pushing some retirees to the floor, followed by a rebuild of dividends for all retirees
- Contribution Rate gradually increases by about 2% of payroll in year 5 and slowly declines thereafter

# Stress Test 4 – Negative 30% Return in 2023 Followed by 6.8% Thereafter



# Stress Test 4 – Negative 30% Return in 2023 Followed by 6.8% Thereafter

- Dividend Liability is depleted by 2026
- Retiree Liability becomes underfunded
- There will be a series of negative dividends, until all people are at the floor, followed by a long period of no dividends
- Dividends could resume in 2049
- Contribution Rate gradually increases by about 4% of payroll in year 5 and slowly declines thereafter

# Deterministic Stress Test Summary

## All tests show a 4-year negative dividend period

| Stress Test/MVA Return | Year Dividend Liability Depleted | Year Positive Dividends Resume | Retiree Liability Underfunded | Year 5 Projected Contribution Rate Increase |
|---|---|---|---|---|
| 1/-15% | 2027 | 2028 | No | 2.5% of Payroll |
| 2/-20% | 2026 | 2037 | Yes | 3.0% of Payroll |
| 3/-20% +20% | N/A | 2028 | No | 2.0% of Payroll |
| 4/-30% | 2026 | 2049 | Yes | 4.0% of Payroll |

Given all assumptions are met, including 6.8% return after shocks and bounceback

# Stress Test Observations

- Contribution rates are generally more stable than dividend rates
- A large negative return would be detrimental to retirees (dividends are depleted)
- Retiree assets are almost 65% of the total
- Proportions allocated to retiree reserve, money purchase minimum and EAR evolve over time


# SECTION 5

## Stress Testing Results - Stochastic

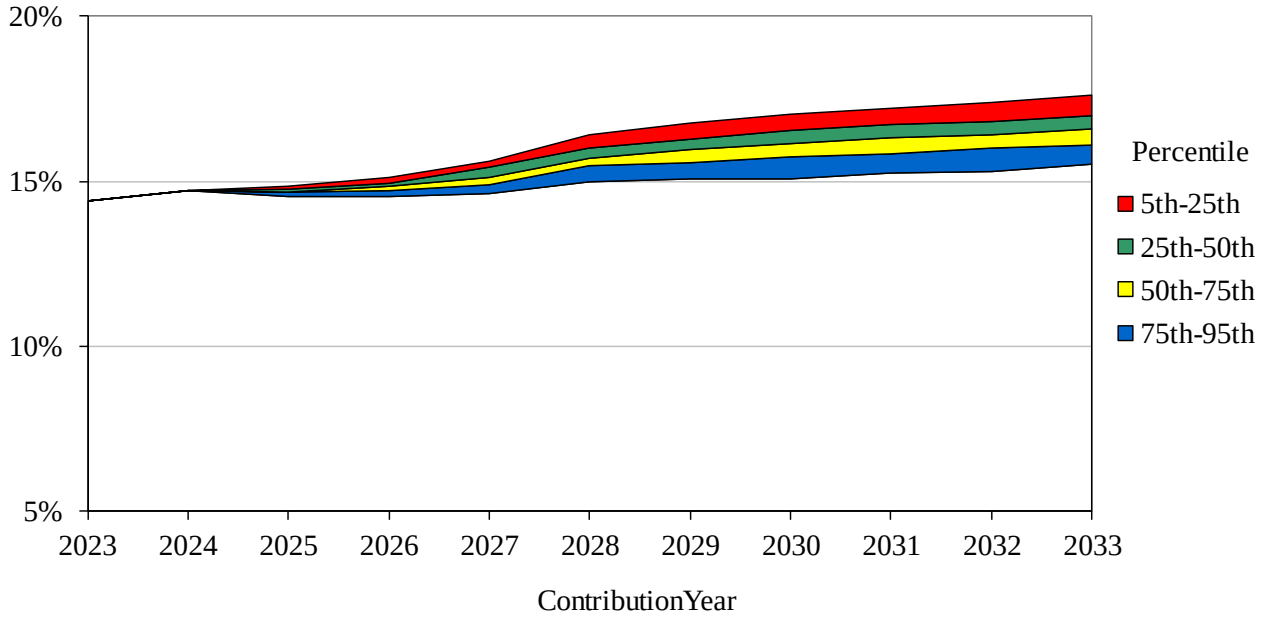
# Monte Carlo Simulations

- Based on 10,000 random trials (normal distribution)
- Valuation Assumptions held constant
- Assumes nine sets of expected return/standard deviations (provided by NEPC)

Actuarial Rate 6.8%

| | Expected Return | | Standard Deviation | |
|---|---|---|---|---|
| | Geometric | Arithmetic | 2023 | 2021 |
| Scenario 1 | 4.0% | 4.1% | 3.8% | 6.9% |
| Scenario 2 | 5.0% | 5.1% | 4.6% | 11.3% |
| Scenario 3 | 5.5% | 5.6% | 5.5% | N/A |
| Scenario 4 | 6.0% | 6.4% | 9.4% | 15.5% |
| Scenario 5 | 6.5% | 7.2% | 12.9% | N/A |
| Scenario 6 | 7.0% | 7.8% | 13.6% | 20.4% |
| Scenario 7 | 7.5% | 8.7% | 17.1% | N/A |
| Scenario 8 | 8.0% | 10.0% | 22.4% | 26.3% |
| Scenario 9 | 9.0% | 12.1% | 28.1% | 33.7% |

# Contribution as a % of Payroll
# Scenario 2 – 5.0% Return, 4.6% Volatility

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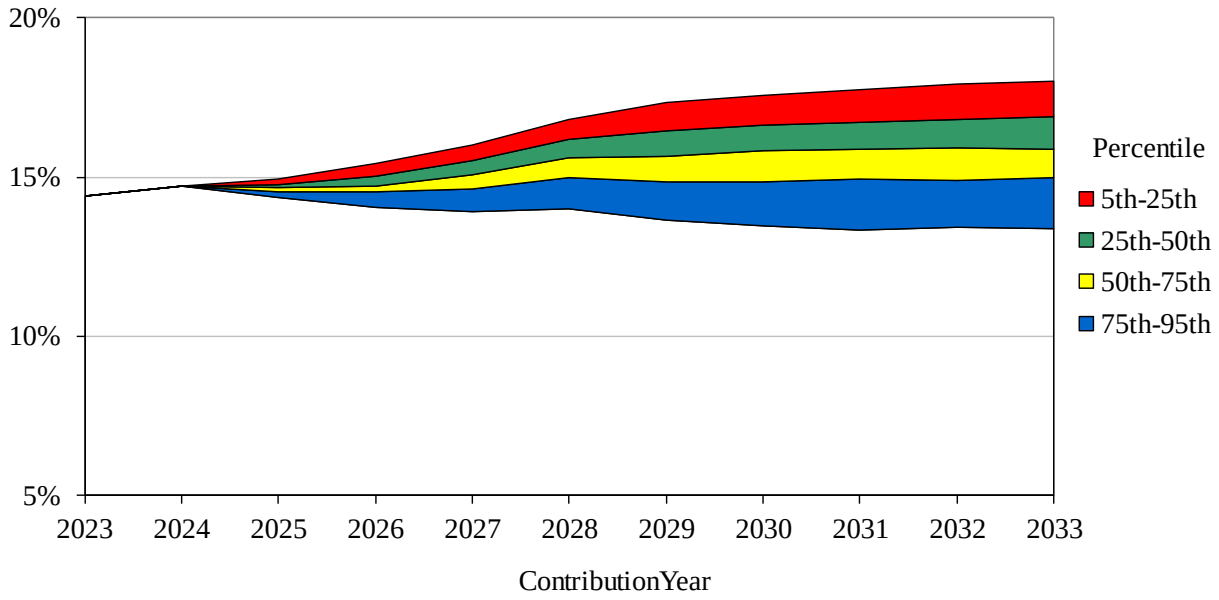
|---|---|---|---|---|---|---|---|---|---|---|---|
| **5th Percentile** | 14.4% | 14.7% | 14.9% | 15.1% | 15.6% | 16.4% | 16.8% | 17.0% | 17.2% | 17.4% | 17.6% |
| **25th Percentile** | 14.4% | 14.7% | 14.8% | 14.9% | 15.4% | 16.0% | 16.3% | 16.5% | 16.7% | 16.8% | 17.0% |
| **Median** | 14.4% | 14.7% | 14.7% | 14.8% | 15.1% | 15.7% | 16.0% | 16.1% | 16.3% | 16.4% | 16.6% |
| **75th Percentile** | 14.4% | 14.7% | 14.7% | 14.7% | 14.9% | 15.5% | 15.6% | 15.7% | 15.8% | 16.0% | 16.1% |
| **95th Percentile** | 14.4% | 14.7% | 14.6% | 14.5% | 14.6% | 15.0% | 15.1% | 15.0% | 15.2% | 15.3% | 15.5% |

# Contribution as a % of Payroll
# Scenario 4 – 6.0% Return, 9.4% Volatility

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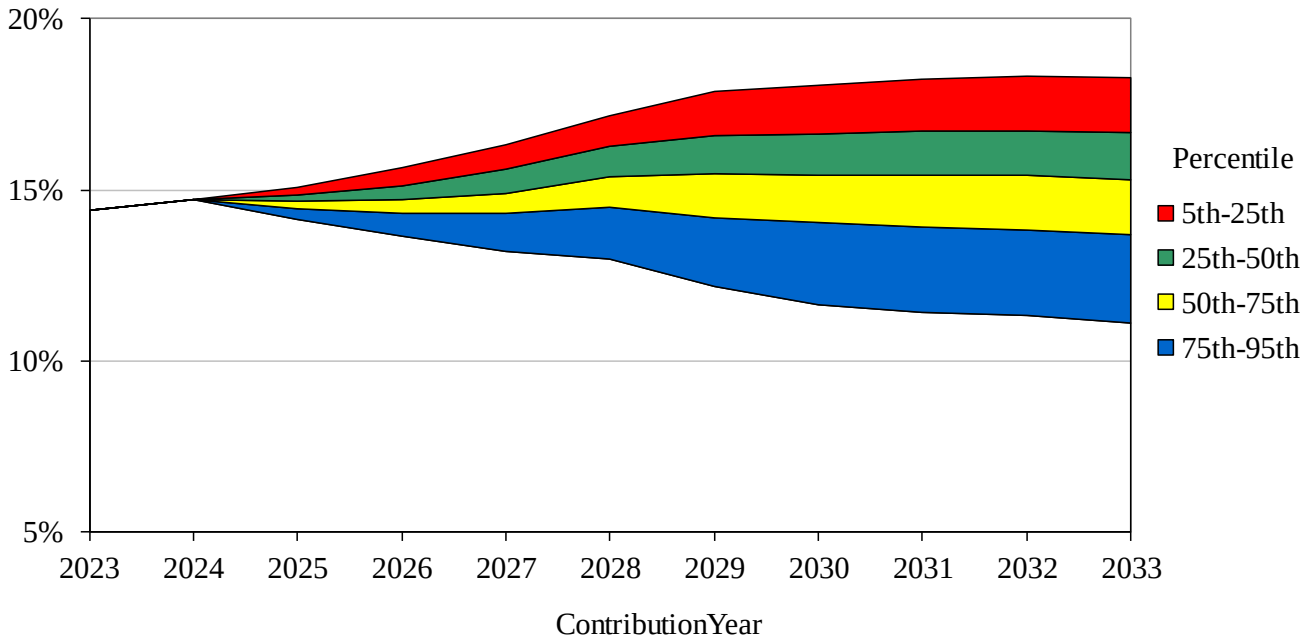
|---|---|---|---|---|---|---|---|---|---|---|---|
| **5th Percentile** | 14.4% | 14.7% | 15.0% | 15.4% | 16.0% | 16.8% | 17.4% | 17.5% | 17.7% | 17.9% | 18.0% |
| **25th Percentile** | 14.4% | 14.7% | 14.8% | 15.0% | 15.5% | 16.2% | 16.5% | 16.6% | 16.7% | 16.8% | 16.9% |
| **Median** | 14.4% | 14.7% | 14.7% | 14.7% | 15.1% | 15.6% | 15.7% | 15.8% | 15.9% | 15.9% | 15.9% |
| **75th Percentile** | 14.4% | 14.7% | 14.6% | 14.5% | 14.6% | 15.0% | 14.9% | 14.8% | 14.9% | 14.9% | 15.0% |
| **95th Percentile** | 14.4% | 14.7% | 14.4% | 14.0% | 13.9% | 14.0% | 13.7% | 13.4% | 13.3% | 13.4% | 13.4% |

# Contribution as a % of Payroll
# Scenario 6 – 7.0% Return, 13.6% Volatility

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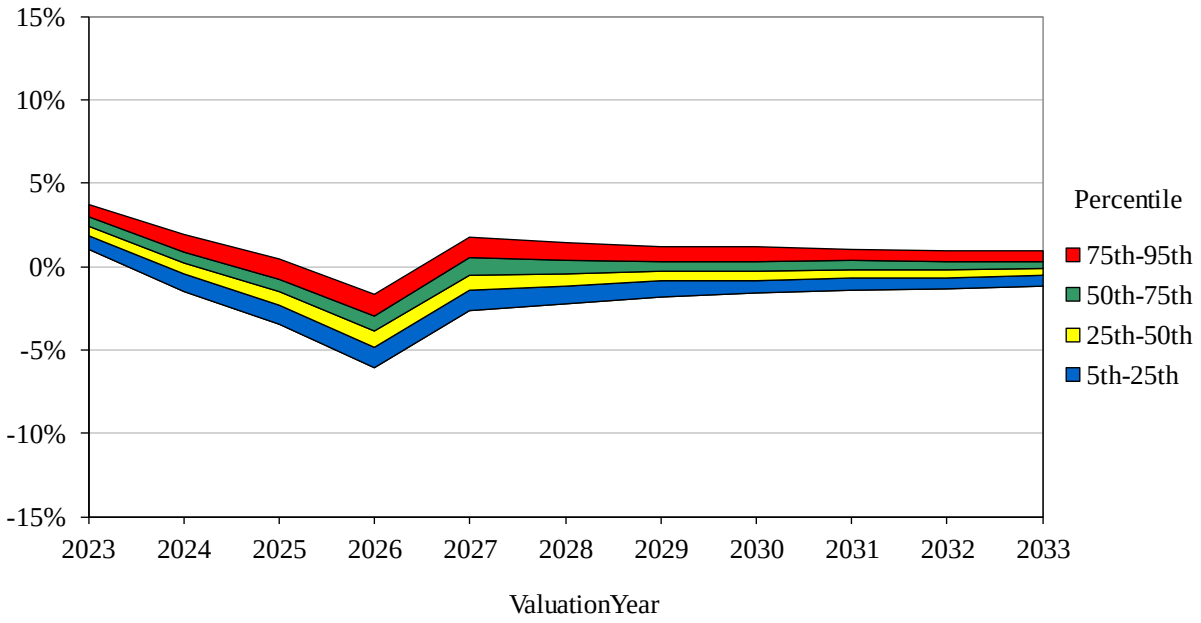
|---|---|---|---|---|---|---|---|---|---|---|---|
| **5th Percentile** | 14.4% | 14.7% | 15.1% | 15.6% | 16.3% | 17.2% | 17.9% | 18.0% | 18.2% | 18.3% | 18.3% |
| **25th Percentile** | 14.4% | 14.7% | 14.9% | 15.1% | 15.6% | 16.3% | 16.6% | 16.6% | 16.7% | 16.7% | 16.7% |
| **Median** | 14.4% | 14.7% | 14.7% | 14.7% | 14.9% | 15.4% | 15.5% | 15.4% | 15.4% | 15.4% | 15.3% |
| **75th Percentile** | 14.4% | 14.7% | 14.5% | 14.3% | 14.3% | 14.5% | 14.2% | 14.0% | 13.9% | 13.8% | 13.7% |
| **95th Percentile** | 14.4% | 14.7% | 14.2% | 13.6% | 13.2% | 13.0% | 12.2% | 11.6% | 11.4% | 11.3% | 11.1% |

# Dividend Rates
# Scenario 2 – 5.0% Return, 4.6% Volatility

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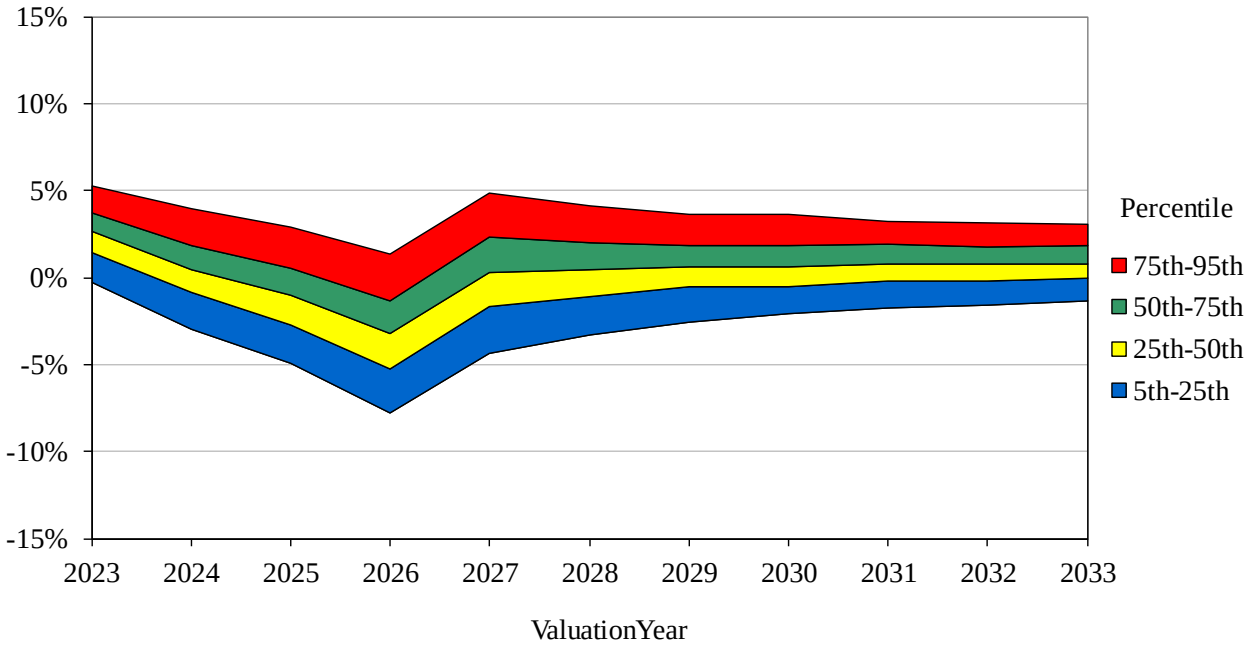
|---|---|---|---|---|---|---|---|---|---|---|---|
| **5th Percentile** | 1.0% | -1.5% | -3.4% | -6.1% | -2.7% | -2.2% | -1.8% | -1.6% | -1.4% | -1.3% | -1.2% |
| **25th Percentile** | 1.9% | -0.4% | -2.3% | -4.9% | -1.4% | -1.2% | -0.9% | -0.8% | -0.7% | -0.7% | -0.5% |
| **Median** | 2.4% | 0.2% | -1.5% | -3.9% | -0.5% | -0.4% | -0.3% | -0.3% | -0.2% | -0.2% | -0.1% |
| **75th Percentile** | 3.0% | 0.9% | -0.8% | -3.0% | 0.5% | 0.4% | 0.3% | 0.3% | 0.4% | 0.3% | 0.3% |
| **95th Percentile** | 3.7% | 1.9% | 0.4% | -1.7% | 1.8% | 1.4% | 1.2% | 1.2% | 1.0% | 1.0% | 1.0% |

# Dividend Rates
# Scenario 4 – 6.0% Return, 9.4% Volatility

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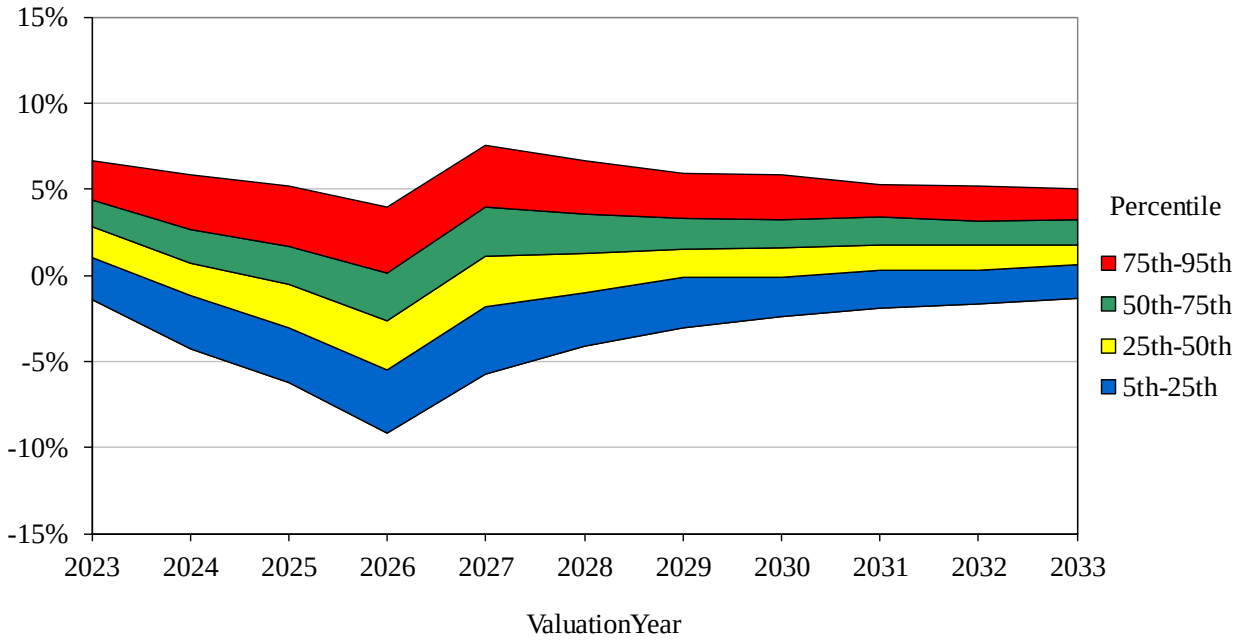
|---|---|---|---|---|---|---|---|---|---|---|---|
| **5th Percentile** | -0.3% | -3.0% | -4.9% | -7.7% | -4.3% | -3.3% | -2.5% | -2.1% | -1.7% | -1.6% | -1.3% |
| **25th Percentile** | 1.4% | -0.9% | -2.8% | -5.2% | -1.7% | -1.1% | -0.5% | -0.5% | -0.2% | -0.2% | 0.0% |
| **Median** | 2.6% | 0.5% | -1.0% | -3.2% | 0.3% | 0.5% | 0.6% | 0.7% | 0.8% | 0.8% | 0.8% |
| **75th Percentile** | 3.7% | 1.8% | 0.5% | -1.3% | 2.3% | 2.0% | 1.8% | 1.8% | 1.9% | 1.8% | 1.8% |
| **95th Percentile** | 5.3% | 4.0% | 2.9% | 1.3% | 4.9% | 4.2% | 3.7% | 3.7% | 3.3% | 3.2% | 3.1% |

# Dividend Rates
# Scenario 6 – 7.0% Return, 13.6% Volatility




| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **5th Percentile** | -1.4% | -4.3% | -6.2% | -9.2% | -5.7% | -4.1% | -3.0% | -2.4% | -1.9% | -1.7% | -1.4% |
| **25th Percentile** | 1.1% | -1.2% | -3.1% | -5.5% | -1.8% | -1.0% | -0.1% | -0.1% | 0.3% | 0.3% | 0.6% |
| **Median** | 2.8% | 0.7% | -0.5% | -2.6% | 1.1% | 1.3% | 1.5% | 1.6% | 1.8% | 1.8% | 1.8% |
| **75th Percentile** | 4.4% | 2.7% | 1.7% | 0.2% | 4.0% | 3.6% | 3.3% | 3.3% | 3.4% | 3.2% | 3.2% |
| **95th Percentile** | 6.7% | 5.9% | 5.2% | 4.0% | 7.6% | 6.6% | 5.9% | 5.9% | 5.2% | 5.2% | 5.0% |

# Stress Testing Dividend Depletion and Retiree Funded Status

- Definitions
  - Dividend Liability = Total Retiree Liability (w/div.) less Base Benefit Liability (w/o div.)
  - Retiree Funded Status = Total Retiree Liability (w/div.) / Base Benefit Liability (w/o div.)
- Dividend Stress Test studied
  - Probability that dividend liability will be depleted
  - Number of paths leading to Dividend Depletion
  - Worst case scenario of Retiree Funded Status
  - Depletion Severity measure

# Stress Testing Dividend Depletion and Retiree Funded Status

Probability {Dividend Depletion in Year i}

Represents the number of times the Retiree Funded Status is less than 1 in year i divided by 10,000 (allows for recovery in future years)

# Dividend Stress Test

## Probability That Dividend Liability Will Be Depleted in Year (allows for recovery in future year)

| | Expected ROR | Standard Deviation | Year 1 | Year 5 | Year 10 | Year 20 | Year 50 |
|---|---|---|---|---|---|---|---|
| 1 | 4.0% | 3.8% | 0% | 0% | 20% | 91% | 100% |
| 2 | 5.0% | 4.6% | 0% | 0% | 4% | 18% | 71% |
| 3 | 5.5% | 5.5% | 0% | 0% | 3% | 6% | 12% |
| 4 | 6.0% | 9.4% | 0% | 5% | 10% | 8% | 5% |
| 5 | 6.5% | 12.9% | 0% | 10% | 14% | 10% | 3% |
| 6 | 7.0% | 13.6% | 0% | 10% | 12% | 7% | 1% |
| 7 | 7.5% | 17.1% | 0% | 15% | 15% | 8% | 1% |
| 8 | 8.0% | 22.4% | 0% | 22% | 21% | 12% | 2% |
| 9 | 9.0% | 28.1% | 0% | 25% | 24% | 13% | 2% |

Actuarial Rate 6.8% →

# Stress Testing Dividend Depletion and Retiree Funded Status

## Percentage of Paths Leading to Dividend Depletion on or before i

Counts the number of times on or before year i the Retiree Funded Status is less than 1 (does not allow for recovery in future years)

# Dividend Stress Test

## Percentage of Paths Leading to Dividend Depletion on or before Year i

Actuarial Rate 6.8% →

| | Expected ROR | Standard Deviation | Year | | | | |
|---|---|---|---|---|---|---|---|
| | | | 1 | 5 | 10 | 20 | 50 |
| 1 | 4.0% | 3.8% | 0% | 0% | 20% | 91% | 100% |
| 2 | 5.0% | 4.6% | 0% | 0% | 4% | 18% | 73% |
| 3 | 5.5% | 5.5% | 0% | 0% | 3% | 7% | 18% |
| 4 | 6.0% | 9.4% | 0% | 5% | 12% | 14% | 18% |
| 5 | 6.5% | 12.9% | 0% | 10% | 17% | 20% | 21% |
| 6 | 7.0% | 13.6% | 0% | 10% | 16% | 17% | 18% |
| 7 | 7.5% | 17.1% | 0% | 15% | 21% | 22% | 23% |
| 8 | 8.0% | 22.4% | 0% | 22% | 28% | 29% | 29% |
| 9 | 9.0% | 28.1% | 0% | 25% | 32% | 32% | 33% |

# Stress Testing Dividend Depletion and Retiree Funded Status


## Worst Case Scenario of Retiree Funded Status

Finds the 5th percentile of retiree funded status for any given year in any given scenario (very unlikely scenario)

# Dividend Stress Test

## Worst Case Scenario of Retiree Funded Status (% of Floor Benefit That Is Funded)

| | Expected ROR | Standard Deviation | Year 1 | Year 5 | Year 10 | Year 20 | Year 50 |
|---|---|---|---|---|---|---|---|
| 1 | 4.0% | 3.8% | 126% | 107% | 96% | 81% | 51% |
| 2 | 5.0% | 4.6% | 126% | 108% | 101% | 94% | 78% |
| 3 | 5.5% | 5.5% | 126% | 108% | 103% | 100% | 95% |
| 4 | 6.0% | 9.4% | 124% | 100% | 95% | 96% | 101% |
| 5 | 6.5% | 12.9% | 123% | 94% | 89% | 91% | 108% |
| 6 | 7.0% | 13.6% | 123% | 94% | 91% | 97% | 131% |
| 7 | 7.5% | 17.1% | 122% | 88% | 84% | 92% | 139% |
| 8 | 8.0% | 22.4% | 120% | 77% | 73% | 80% | 131% |
| 9 | 9.0% | 28.1% | 118% | 67% | 64% | 74% | 148% |

Actuarial Rate 6.8% →

Worst Case Scenario based on 5th percentile (i.e., 5% probability)

# Stress Testing Dividend Depletion and Retiree Funded Status

## Depletion Severity Measure

Of the stress test simulations that result in a Retiree Funded Status of less than 1, finds the average Retiree Funded Status (or degree of depletion)

# Dividend Stress Test
# Depletion Severity Measure

## Average Retiree Funded Status for Depletion Scenarios

| | Expected ROR | Standard Deviation | Year 1 | Year 5 | Year 10 | Year 20 | Year 50 |
|---|---|---|---|---|---|---|---|
| 1 | 4.0% | 3.8% | N/A | 97% | 96% | 90% | 60% |
| 2 | 5.0% | 4.6% | N/A | 98% | 97% | 95% | 89% |
| 3 | 5.5% | 5.5% | N/A | 96% | 96% | 95% | 93% |
| 4 | 6.0% | 9.4% | N/A | 94% | 93% | 92% | 89% |
| 5 | 6.5% | 12.9% | N/A | 91% | 89% | 88% | 87% |
| 6 | 7.0% | 13.6% | N/A | 91% | 89% | 89% | 91% |
| 7 | 7.5% | 17.1% | N/A | 88% | 85% | 85% | 87% |
| 8 | 8.0% | 22.4% | N/A | 84% | 80% | 81% | 80% |
| 9 | 9.0% | 28.1% | N/A | 79% | 75% | 76% | 77% |

Actuarial Rate 6.8% →

# Dividend Stress Test Observations

- The low risk scenarios are actually risky in the sense that, for example, 4% and 5% expected return has a much higher chance of dividend depletion in later years than higher risk scenarios
- Must balance short and long term volatility
- Consider probability of dividend depletion
- Consider level of worst case scenario that is acceptable

# Combination of All Scenarios

| | 2033 Results by %-tile of Investment Return Outcomes | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Contribution Rates | | | Dividend Rates | | | Highest | Worst Retiree |
| | ROR | StdDev | 95th | 50th | 5th | 95th | 50th | 5th | Div. Dep. PRB | Funded % |
| 1 | 4.0% | 3.8% | 16.4% | 17.2% | 18.0% | -0.2% | -1.1% | -2.0% | 100%/Year50 | 51%/Year50 |
| 2 | 5.0% | 4.6% | 15.5% | 16.6% | 17.6% | 1.0% | -0.1% | -1.2% | 73%/Year50 | 78%/Year50 |
| 3 | 5.5% | 5.5% | 14.9% | 16.2% | 17.5% | 1.7% | 0.4% | -0.9% | 18%/Year50 | 95%/Year50 |
| 4 | 6.0% | 9.4% | 13.4% | 15.9% | 18.0% | 3.1% | 0.8% | -1.3% | 18%/Year50 | 95%/Year10 |
| 5 | 6.5% | 12.9% | 11.9% | 15.6% | 18.4% | 4.4% | 1.3% | -1.7% | 21%/Year50 | 89%/Year10 |
| 6 | 7.0% | 13.6% | 11.1% | 15.3% | 18.3% | 5.0% | 1.8% | -1.4% | 18%/Year50 | 91%/Year10 |
| 7 | 7.5% | 17.1% | 9.3% | 15.0% | 18.7% | 6.3% | 2.3% | -1.7% | 23%/Year50 | 84%/Year10 |
| 8 | 8.0% | 22.4% | 6.5% | 14.7% | 19.4% | 8.0% | 2.7% | -2.5% | 29%/Year50 | 73%/Year10 |
| 9 | 9.0% | 28.1% | 2.1% | 14.1% | 20.0% | 10.3% | 3.5% | -3.0% | 33%/Year50 | 64%/Year10 |

Actuarial Rate 6.8% →

Portfolios with lower expected return result in higher expected contributions and lower expected dividends

Higher assumed rates of return are associated with higher standard deviation (i.e., risk) and 5th percentile scenario for retiree dividend pool falling below 75% (Worst Retiree Funded %)

Scenarios 4 through 7 represent potential 'Goldilocks Zone'

# 2023 Observations

- Changes from 2021 Study
  - Returns over 2021 and 2022 were 16.9% and (12.9)%
    - MRA returns of 12.9% and 6.5%
    - 2021 – 11B in unrecognized gains, 2023 – 7B in unrecognized losses
  - Much lower Standard Deviation than 2021 Study
  - Changes in assumptions (7.0% to 6.8%, mortality, retirement)
  - Additional return breakpoint scenarios (50 bp increments)

# 2023 Observations

- Overall results are similar to 2021 study
  - Probability of depleting dividend liability varies due to factors on previous slide
  - Smaller range of dividend/contribution results due to lower standard deviation
- ‘Goldilocks zone’ has widened to 6.0% to 7.5%
  - Provides for positive return with appropriate downside protection


# Questions


# SECTION 6

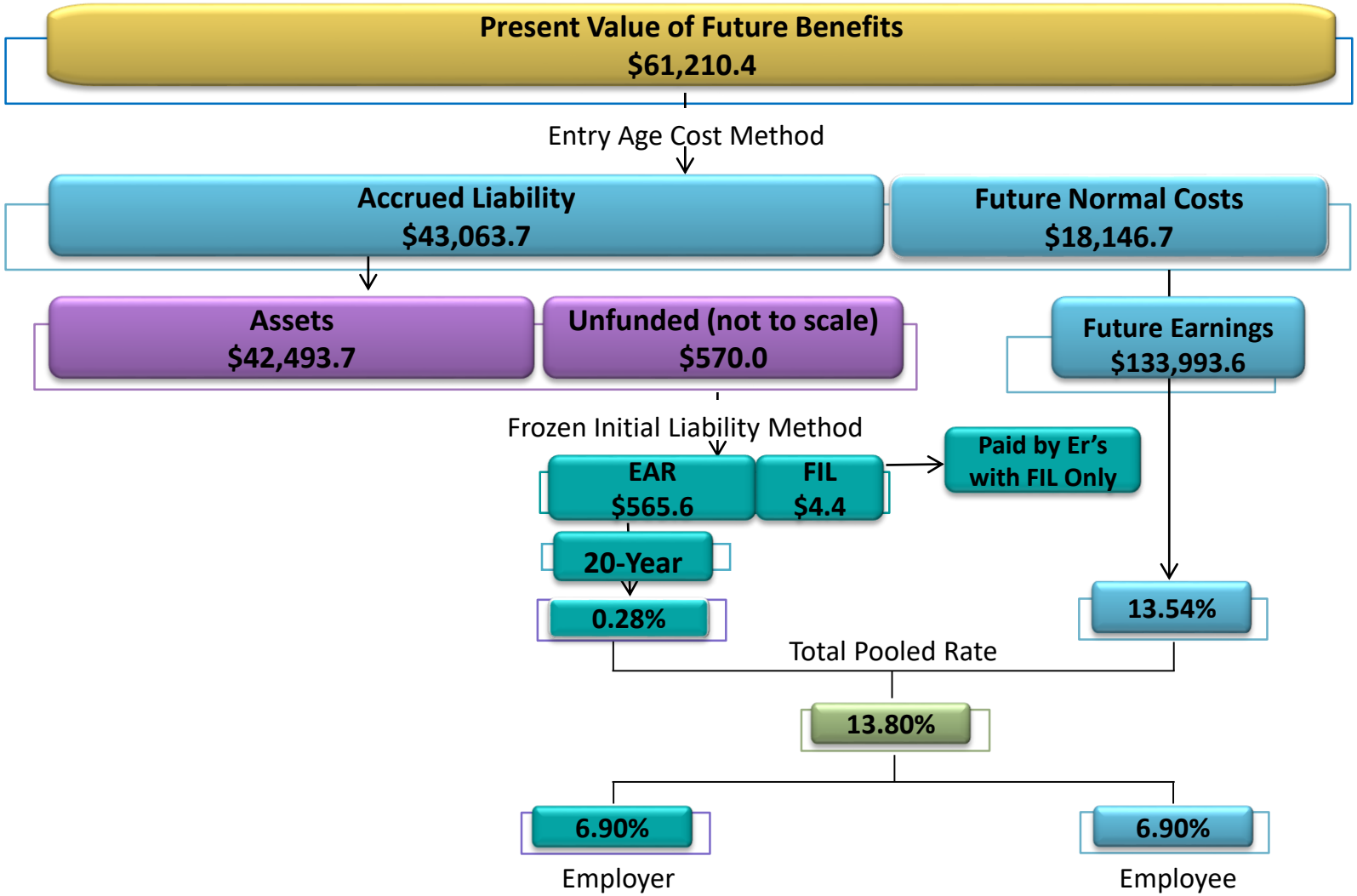
## Appendix

# Operation of Market Recognition Account (MRA) – $ Millions 2022 Valuation

| | 2022 | 2023 | 2024 | 2025 | 2026 |
|---|---|---|---|---|---|
| Actual Investment Earnings | $ (17,445) | | | | |
| Assumed Investment Earnings | 7,894 | | | | |
| Gain/(Loss) to be phased-in | (25,339) | | | | |
| Phased-in recognition | | | | | |
| • Current year | $ (5,068) | ? | ? | ? | ? |
| • First prior year | 2,495 | $ (5,068) | ? | ? | ? |
| • Second prior year | 1,774 | 2,495 | $(5,068) | ? | ? |
| • Third prior year | 2,204 | 1,774 | 2,495 | $ (5,068) | ? |
| • Fourth prior year | (2,049) | 2,204 | 1,774 | 2,495 | $ (5,068) |
| Total recognized gain (loss) | $ (644) | $ 1,405 | $ (799) | $ (2,573) | $ (5,068) |

**2023-2026: Expect $7.0 billion in deferred asset *LOSSES***
**-- Shared by annuitants, actives and employers**

# Actuarial Valuation Process
## Illustration for General/Elected Group ($ Millions)



# Comparative Statement of Total Average Contribution Rates

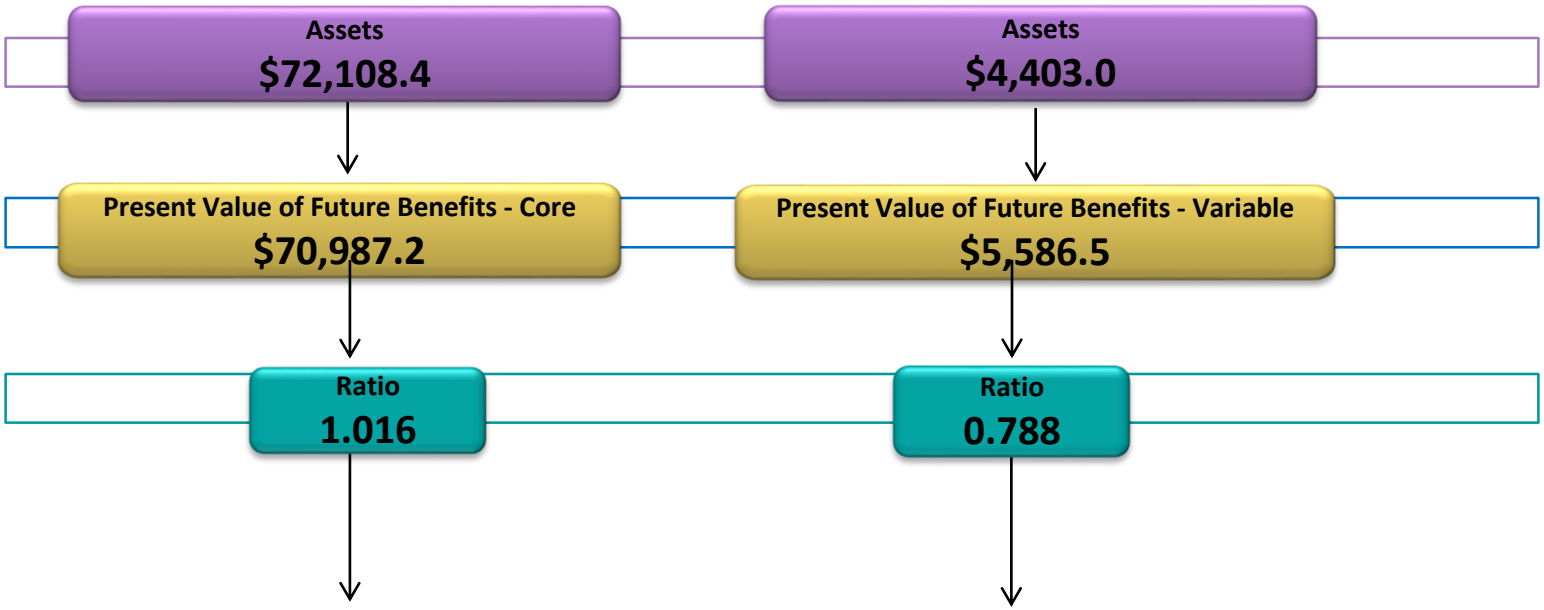
| Valuation 12/31 | General | Executive & Elected | Protective with Soc. Sec. | Protective without Soc. Sec. |
|---|---|---|---|---|
| 2002 | 10.82% | 11.51% | 12.52% | 15.01% |
| 2007 | 10.58% | 11.55% | 13.15% | 14.09% |
| 2012 | 14.00% | 15.50% | 17.10% | 21.00% |
| 2017 | 13.12% | 13.12% | 17.10% | 21.59% |
| 2018 | 13.54% | 13.54% | 18.41% | 23.02% |
| 2019 | 13.53% | 13.53% | 18.51% | 23.11% |
| 2020 | 13.00% | 13.00% | 18.52% | 23.86% |
| 2021 | 13.60% | 13.60% | 20.03% | 24.90% |
| 2022 | 13.81% | 13.81% | 21.20% | 26.00% |

Executive and Elected employee and employer rates for CY 2016 and beyond are made in accordance with the combined General/Exec & Elected results.

GRS

Pages B-5 & B-6

# Actuarial Valuation Process – 2022 Retired Lives Valuation
# Illustration ($ Millions)



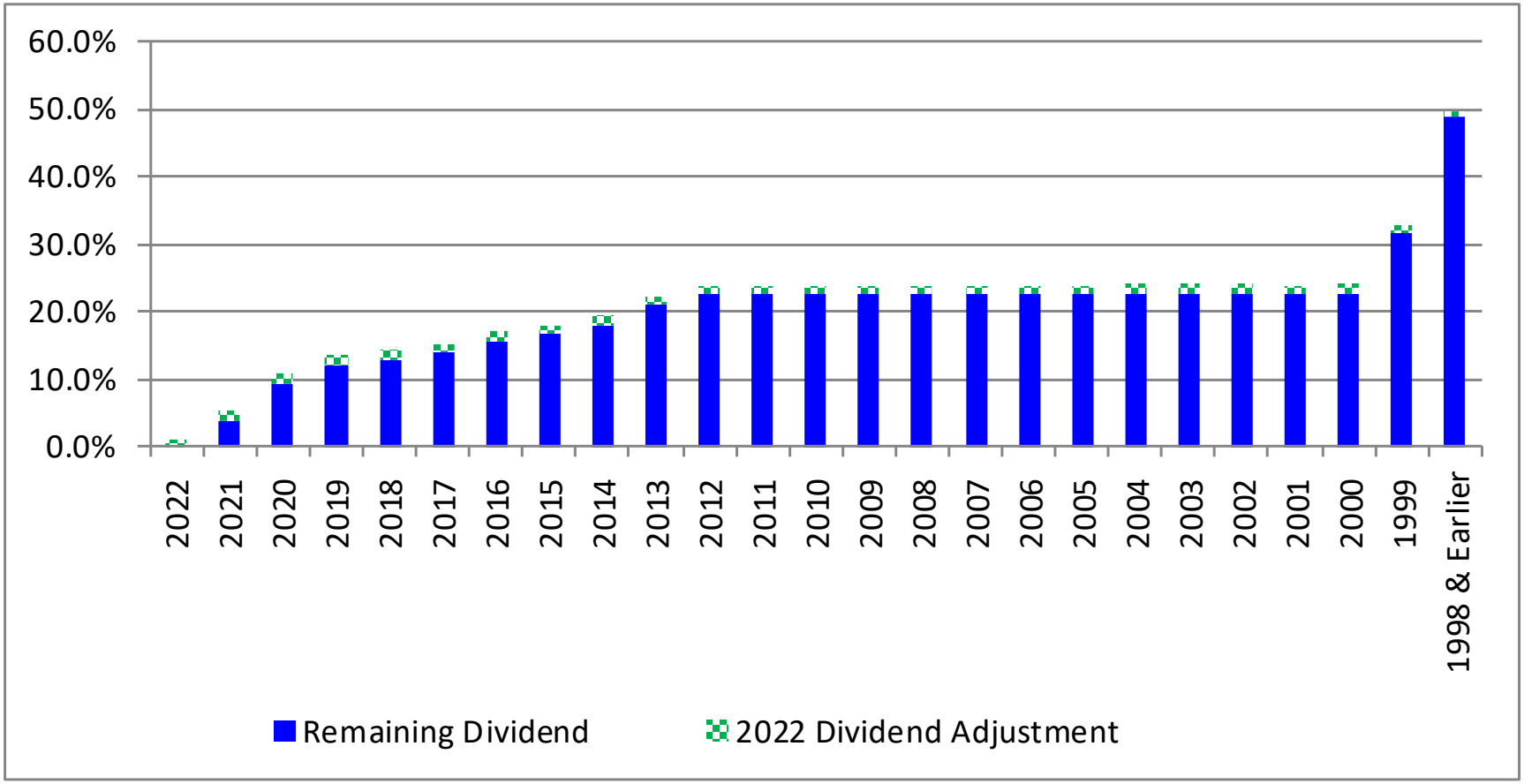

Core effective earnings rate = 6.5%, dividend adjustment = 1.6%
Variable effective earnings rate = -18.0%, and the variable adjustment = -21.0%

# Primary Sources of Core Dividend

| | % of APV[(1)] |
|---|---|
| 1. SWIB net of fee investment return | (12.92)% |
| 2. MRA adjustment | 19.42% |
| 3. Published effective earnings rate | 6.50% |
| 4. Adjustment to relate earnings to average core annuity fund balance | (0.30)% |
| 5. Earnings rate based on average balance | 6.20% |
| 6. Expected dividend before adjustments: 1.062/1.05-1 | 1.14% |
| 7. Adjustment to relate average asset to ending liability | 0.05% |
| 8. Carryover from last year due to timing of dividend, accounting adjustments and rounding | 0.34% |
| 9. Experience study adjustment | 0.00% |
| 10. Experience and other effects | 0.05% |
| 11. Statutory adjustment to round to nearest one-tenth percent | 0.02% |
| 12. **Computed average dividend rate: (6)+(7)+(8)+(9)+(10)+(11)** | **1.6%** |
| 13. Adjustment for members at or near the statutory floor | 0.0% |
| 14. **Final computed dividend rate: (12)+(13), if greater than 0.5% (or less than -0.5%) of core annuities, otherwise 0%** | **1.6%** |

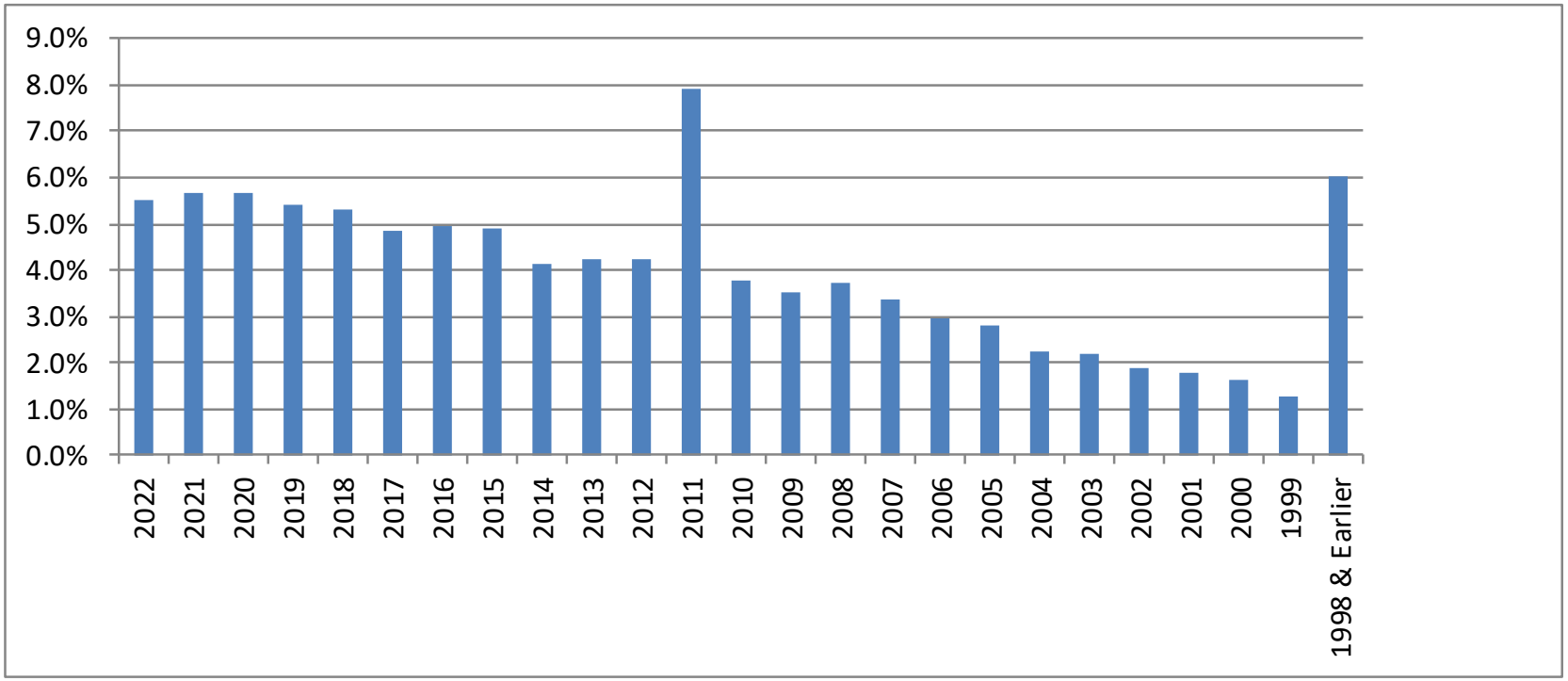
(1) *Actuarial Present Value*

# Dividend Remaining (as a Percentage of Total Benefit) by Year of Retirement



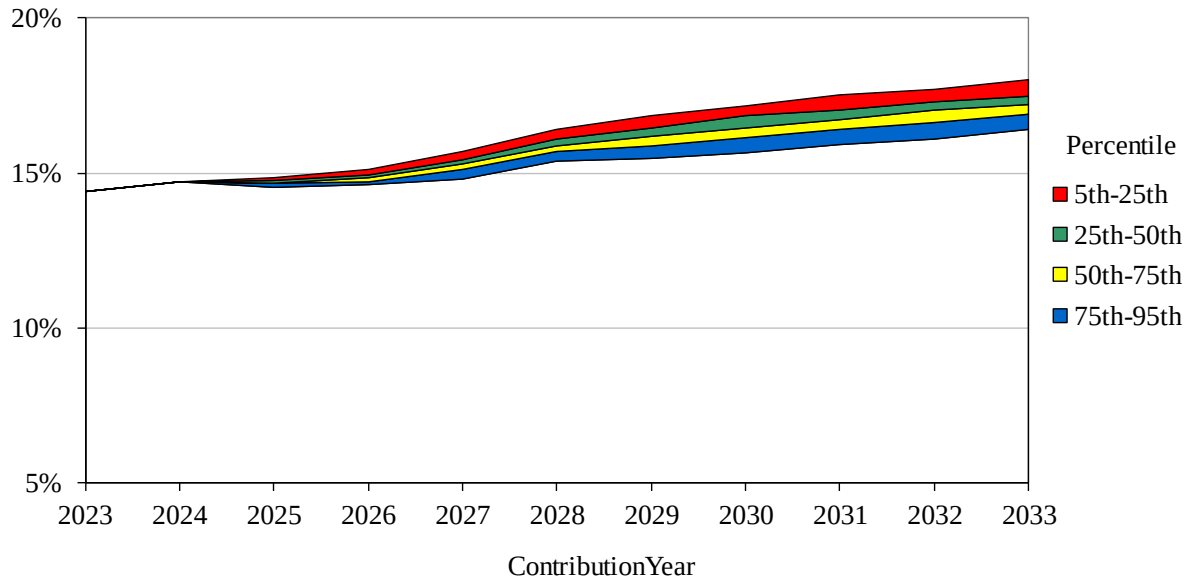

**(Report-7)**

# Liabilities (as a Percentage of Total) by Year of Retirement



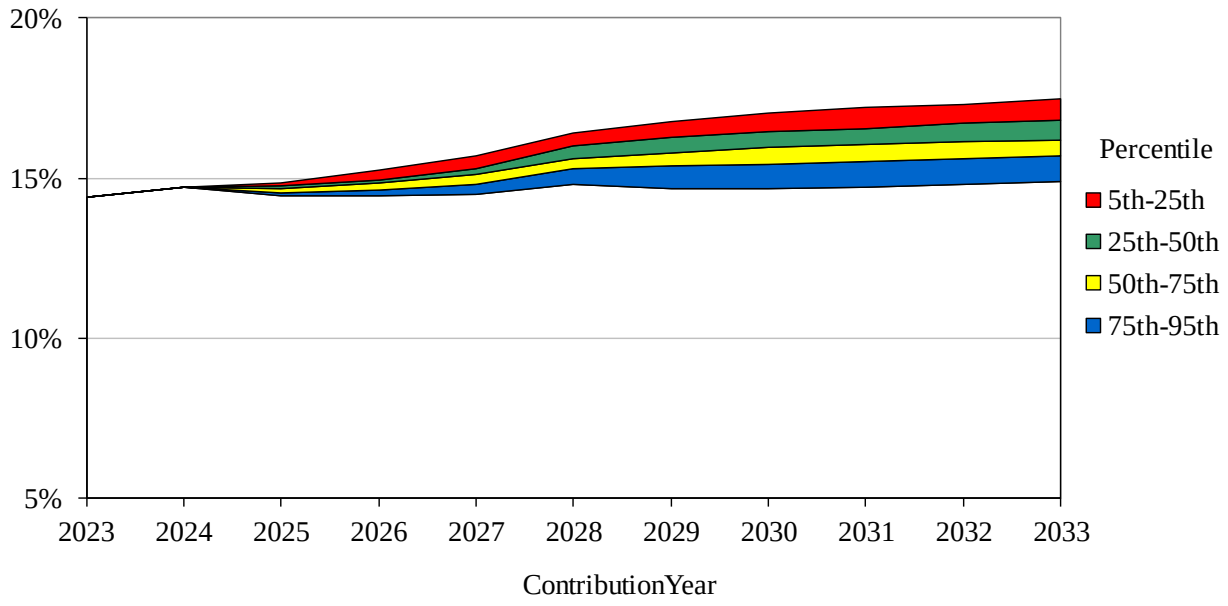

**(Report-7)**

# Contribution as a % of Payroll
# Scenario 1 – 4.0% Return, 3.8% Volatility



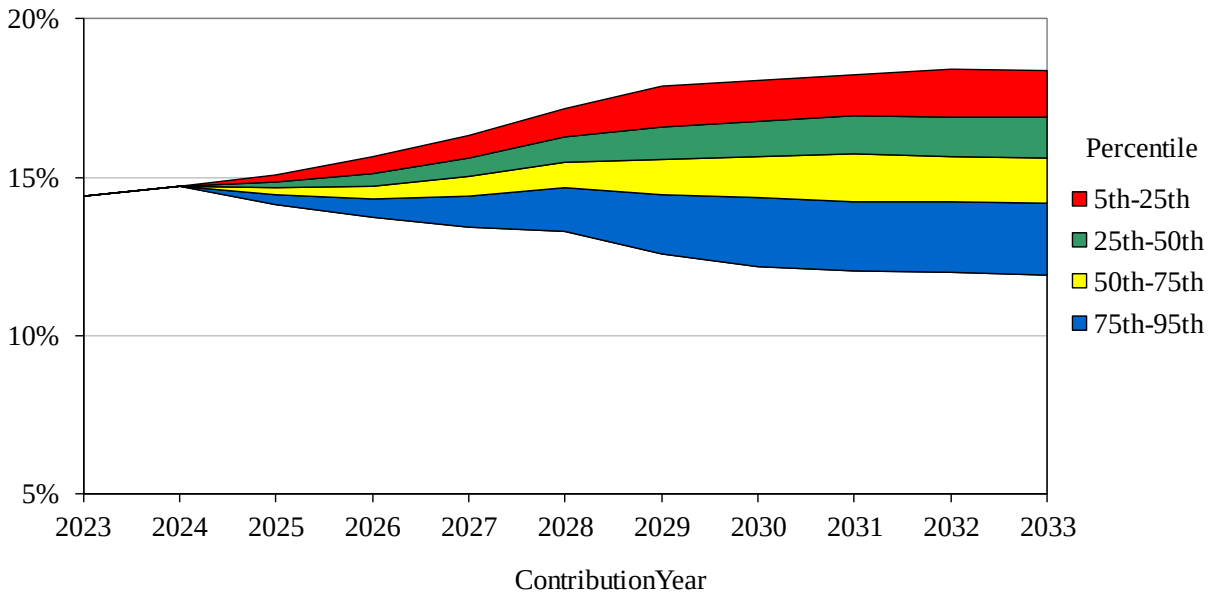

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **5th Percentile** | 14.4% | 14.7% | 14.9% | 15.1% | 15.7% | 16.4% | 16.9% | 17.1% | 17.5% | 17.7% | 18.0% |
| **25th Percentile** | 14.4% | 14.7% | 14.8% | 14.9% | 15.4% | 16.1% | 16.5% | 16.8% | 17.0% | 17.3% | 17.5% |
| **Median** | 14.4% | 14.7% | 14.7% | 14.8% | 15.3% | 15.9% | 16.2% | 16.4% | 16.7% | 17.0% | 17.2% |
| **75th Percentile** | 14.4% | 14.7% | 14.7% | 14.7% | 15.1% | 15.7% | 15.9% | 16.1% | 16.4% | 16.6% | 16.9% |
| **95th Percentile** | 14.4% | 14.7% | 14.6% | 14.6% | 14.8% | 15.4% | 15.5% | 15.6% | 15.9% | 16.1% | 16.4% |

# Contribution as a % of Payroll
# Scenario 3 – 5.5% Return, 5.5% Volatility



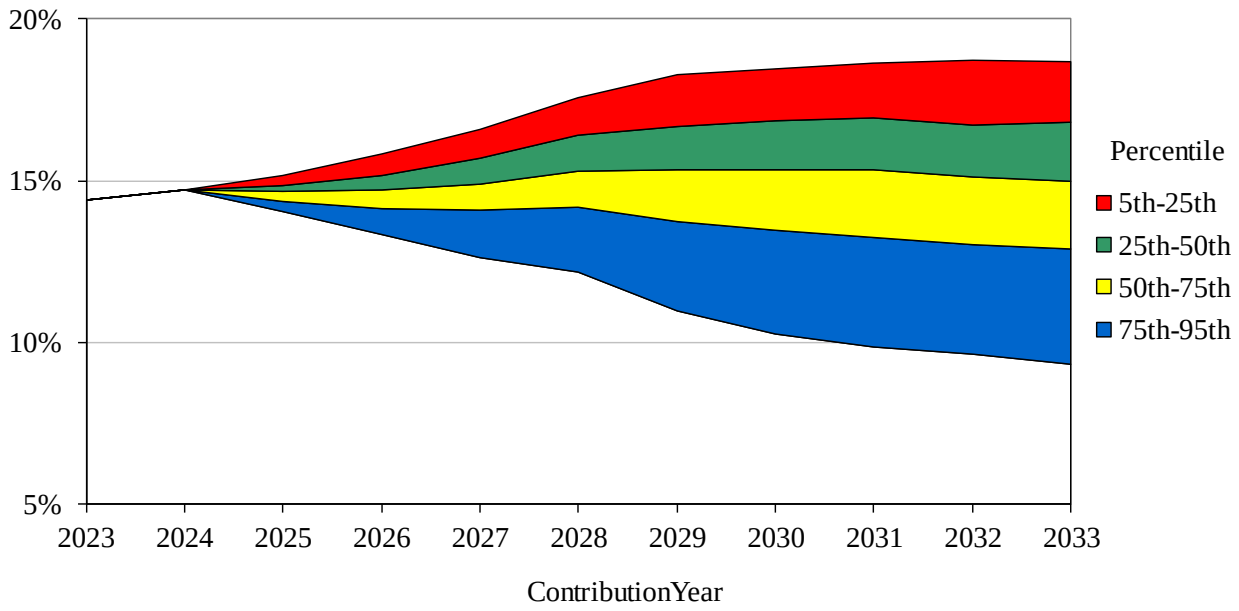

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **5th Percentile** | 14.4% | 14.7% | 14.9% | 15.2% | 15.7% | 16.4% | 16.8% | 17.0% | 17.2% | 17.3% | 17.5% |
| **25th Percentile** | 14.4% | 14.7% | 14.8% | 14.9% | 15.3% | 16.0% | 16.3% | 16.4% | 16.5% | 16.7% | 16.8% |
| **Median** | 14.4% | 14.7% | 14.7% | 14.8% | 15.1% | 15.6% | 15.8% | 15.9% | 16.0% | 16.2% | 16.2% |
| **75th Percentile** | 14.4% | 14.7% | 14.6% | 14.6% | 14.8% | 15.3% | 15.4% | 15.4% | 15.5% | 15.6% | 15.7% |
| **95th Percentile** | 14.4% | 14.7% | 14.5% | 14.4% | 14.5% | 14.8% | 14.7% | 14.6% | 14.7% | 14.8% | 14.9% |

# Contribution as a % of Payroll
# Scenario 5 – 6.5% Return, 12.9% Volatility



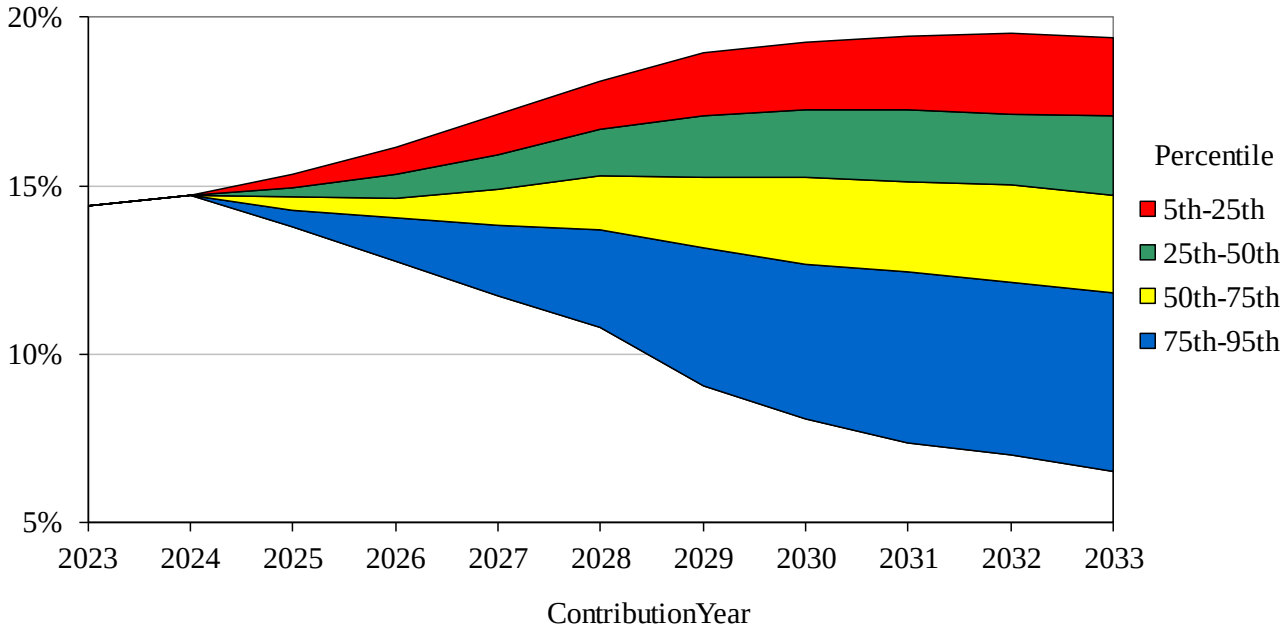

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **5th Percentile** | 14.4% | 14.7% | 15.1% | 15.6% | 16.3% | 17.2% | 17.9% | 18.0% | 18.2% | 18.4% | 18.4% |
| **25th Percentile** | 14.4% | 14.7% | 14.9% | 15.1% | 15.6% | 16.3% | 16.6% | 16.7% | 16.9% | 16.9% | 16.9% |
| **Median** | 14.4% | 14.7% | 14.7% | 14.7% | 15.0% | 15.5% | 15.6% | 15.6% | 15.7% | 15.7% | 15.6% |
| **75th Percentile** | 14.4% | 14.7% | 14.5% | 14.3% | 14.4% | 14.7% | 14.5% | 14.3% | 14.2% | 14.2% | 14.2% |
| **95th Percentile** | 14.4% | 14.7% | 14.2% | 13.7% | 13.4% | 13.3% | 12.6% | 12.1% | 12.0% | 12.0% | 11.9% |

# Contribution as a % of Payroll
# Scenario 7 – 7.5% Return, 17.1% Volatility



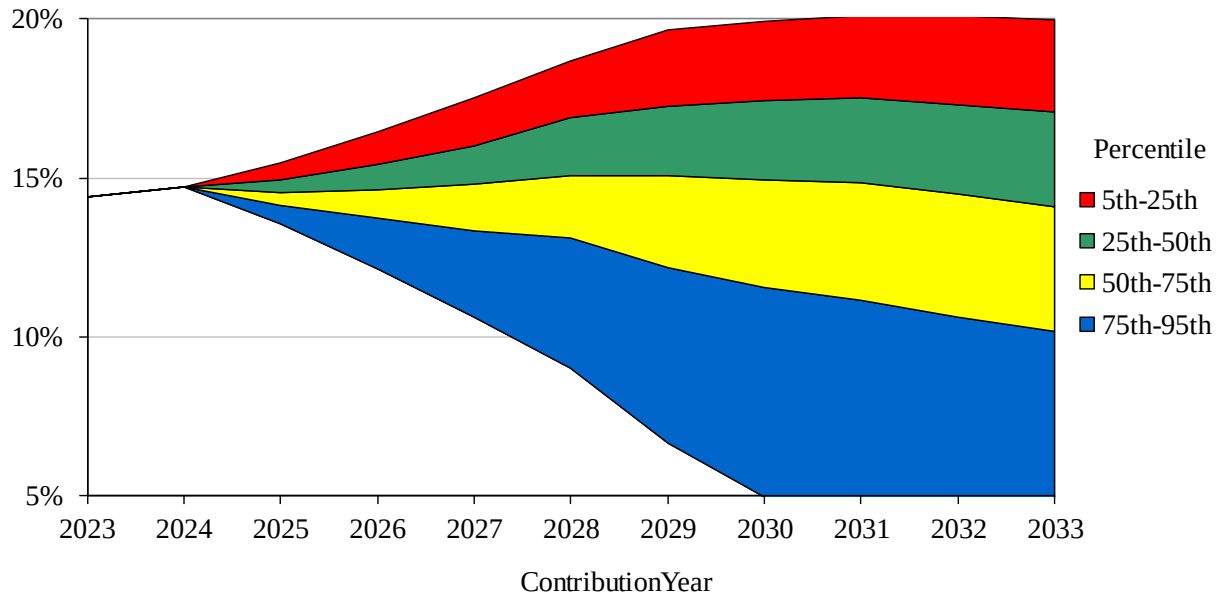

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **5th Percentile** | 14.4% | 14.7% | 15.2% | 15.8% | 16.6% | 17.6% | 18.3% | 18.5% | 18.6% | 18.7% | 18.7% |
| **25th Percentile** | 14.4% | 14.7% | 14.9% | 15.2% | 15.7% | 16.4% | 16.7% | 16.8% | 16.9% | 16.7% | 16.8% |
| **Median** | 14.4% | 14.7% | 14.7% | 14.7% | 14.9% | 15.3% | 15.3% | 15.3% | 15.3% | 15.1% | 15.0% |
| **75th Percentile** | 14.4% | 14.7% | 14.4% | 14.1% | 14.1% | 14.2% | 13.7% | 13.4% | 13.2% | 13.0% | 12.9% |
| **95th Percentile** | 14.4% | 14.7% | 14.0% | 13.3% | 12.6% | 12.2% | 11.0% | 10.2% | 9.8% | 9.6% | 9.3% |

# Contribution as a % of Payroll
# Scenario 8 – 8.0% Return, 22.4% Volatility



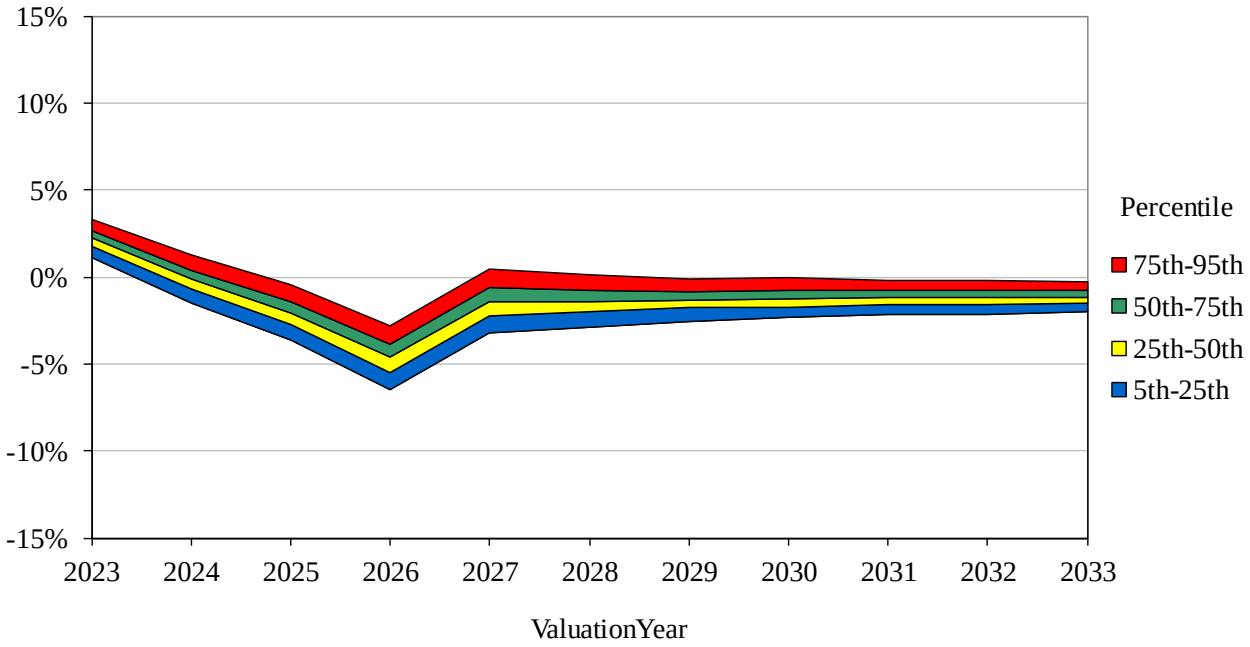

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **5th Percentile** | 14.4% | 14.7% | 15.4% | 16.1% | 17.1% | 18.1% | 19.0% | 19.2% | 19.4% | 19.5% | 19.4% |
| **25th Percentile** | 14.4% | 14.7% | 15.0% | 15.3% | 15.9% | 16.7% | 17.1% | 17.2% | 17.3% | 17.1% | 17.1% |
| **Median** | 14.4% | 14.7% | 14.7% | 14.6% | 14.9% | 15.3% | 15.3% | 15.2% | 15.1% | 15.0% | 14.7% |
| **75th Percentile** | 14.4% | 14.7% | 14.3% | 14.0% | 13.8% | 13.7% | 13.1% | 12.6% | 12.4% | 12.1% | 11.8% |
| **95th Percentile** | 14.4% | 14.7% | 13.8% | 12.7% | 11.7% | 10.8% | 9.1% | 8.0% | 7.3% | 7.0% | 6.5% |

# Contribution as a % of Payroll
# Scenario 9 – 9.0% Return, 28.1% Volatility



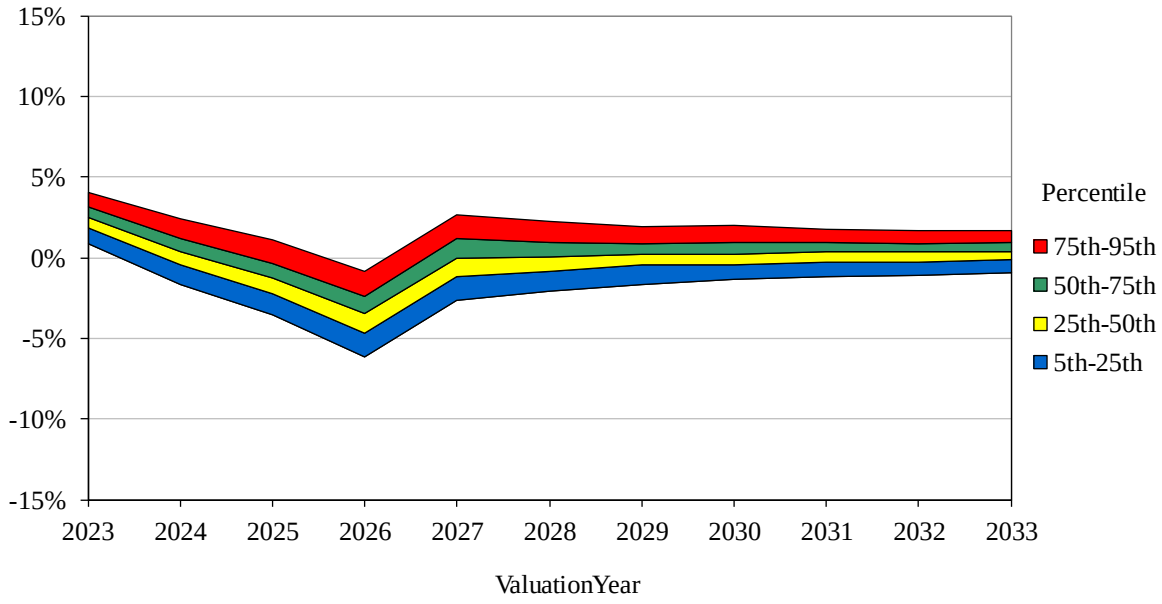

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **5th Percentile** | 14.4% | 14.7% | 15.5% | 16.4% | 17.5% | 18.7% | 19.7% | 19.9% | 20.1% | 20.1% | 20.0% |
| **25th Percentile** | 14.4% | 14.7% | 15.0% | 15.4% | 16.0% | 16.9% | 17.3% | 17.4% | 17.5% | 17.3% | 17.1% |
| **Median** | 14.4% | 14.7% | 14.6% | 14.6% | 14.8% | 15.1% | 15.1% | 14.9% | 14.8% | 14.5% | 14.1% |
| **75th Percentile** | 14.4% | 14.7% | 14.2% | 13.7% | 13.3% | 13.1% | 12.2% | 11.5% | 11.1% | 10.6% | 10.2% |
| **95th Percentile** | 14.4% | 14.7% | 13.6% | 12.1% | 10.6% | 9.0% | 6.7% | 4.9% | 3.9% | 3.1% | 2.1% |

# Dividend Rates
# Scenario 1 – 4.0% Return, 3.8% Volatility



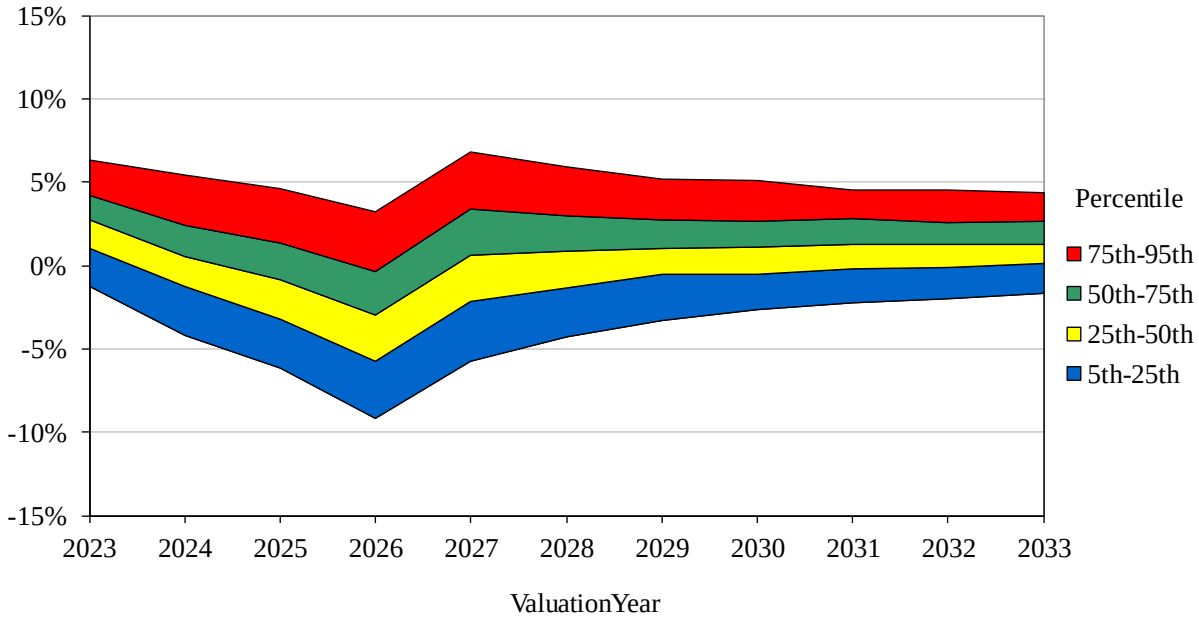

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **5th Percentile** | 1.1% | -1.5% | -3.6% | -6.5% | -3.2% | -2.9% | -2.6% | -2.3% | -2.2% | -2.1% | -2.0% |
| **25th Percentile** | 1.8% | -0.7% | -2.7% | -5.5% | -2.2% | -2.0% | -1.8% | -1.7% | -1.6% | -1.6% | -1.5% |
| **Median** | 2.3% | -0.1% | -2.0% | -4.6% | -1.4% | -1.4% | -1.3% | -1.3% | -1.2% | -1.2% | -1.1% |
| **75th Percentile** | 2.7% | 0.4% | -1.4% | -3.9% | -0.6% | -0.8% | -0.8% | -0.8% | -0.7% | -0.8% | -0.8% |
| **95th Percentile** | 3.3% | 1.3% | -0.5% | -2.8% | 0.5% | 0.1% | -0.1% | 0.0% | -0.2% | -0.2% | -0.2% |

# Dividend Rates
# Scenario 3 – 5.5% Return, 5.5% Volatility



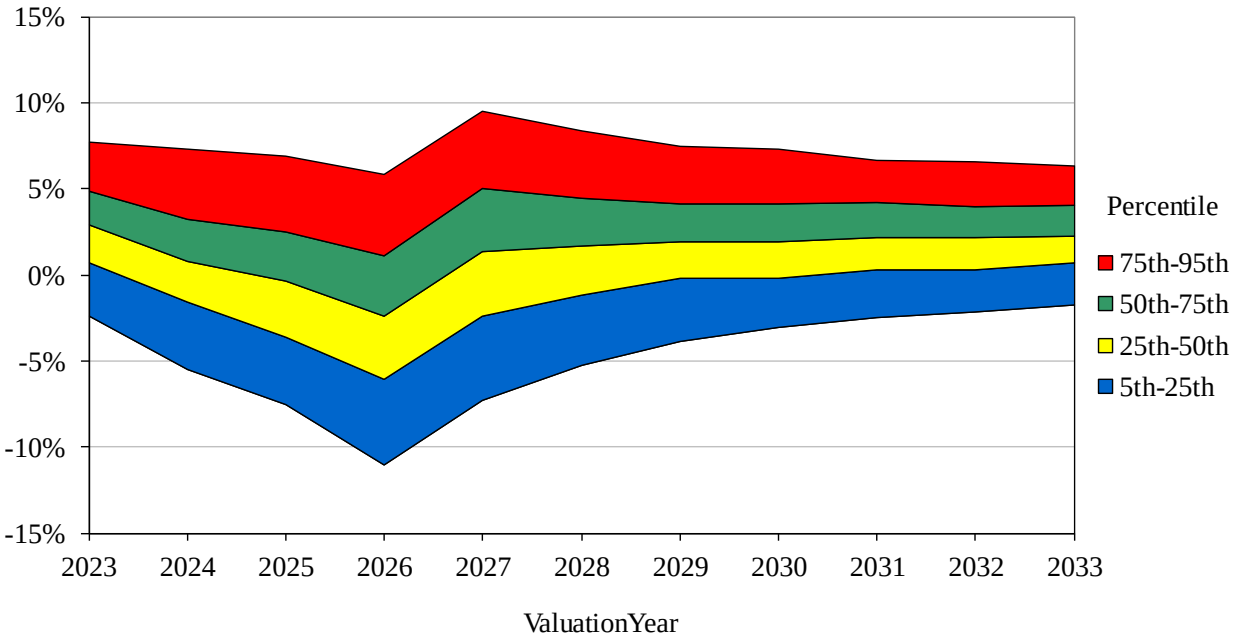

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **5th Percentile** | 0.8% | -1.6% | -3.5% | -6.2% | -2.6% | -2.1% | -1.6% | -1.3% | -1.1% | -1.1% | -0.9% |
| **25th Percentile** | 1.8% | -0.4% | -2.2% | -4.7% | -1.2% | -0.8% | -0.5% | -0.4% | -0.3% | -0.2% | -0.1% |
| **Median** | 2.5% | 0.4% | -1.2% | -3.5% | 0.0% | 0.1% | 0.2% | 0.2% | 0.3% | 0.3% | 0.4% |
| **75th Percentile** | 3.2% | 1.2% | -0.3% | -2.4% | 1.2% | 1.0% | 0.9% | 0.9% | 1.0% | 0.9% | 0.9% |
| **95th Percentile** | 4.1% | 2.4% | 1.1% | -0.9% | 2.7% | 2.2% | 2.0% | 2.0% | 1.8% | 1.7% | 1.7% |

# Dividend Rates
# Scenario 5 – 6.5% Return, 12.9% Volatility



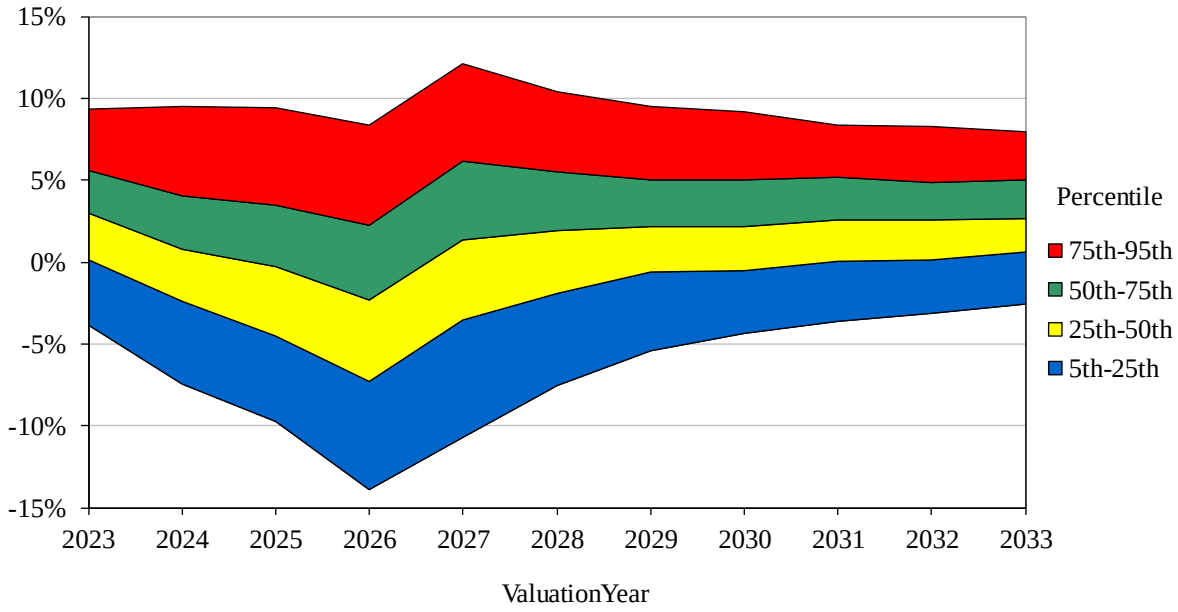

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **5th Percentile** | -1.2% | -4.2% | -6.2% | -9.2% | -5.8% | -4.3% | -3.3% | -2.6% | -2.2% | -2.0% | -1.7% |
| **25th Percentile** | 1.1% | -1.3% | -3.2% | -5.7% | -2.1% | -1.3% | -0.5% | -0.5% | -0.2% | -0.1% | 0.2% |
| **Median** | 2.7% | 0.6% | -0.8% | -2.9% | 0.6% | 0.8% | 1.0% | 1.1% | 1.3% | 1.3% | 1.3% |
| **75th Percentile** | 4.2% | 2.4% | 1.3% | -0.4% | 3.4% | 3.0% | 2.7% | 2.7% | 2.8% | 2.6% | 2.7% |
| **95th Percentile** | 6.4% | 5.4% | 4.6% | 3.3% | 6.8% | 5.9% | 5.2% | 5.2% | 4.6% | 4.5% | 4.4% |

# Dividend Rates
# Scenario 7 – 7.5% Return, 17.1% Volatility



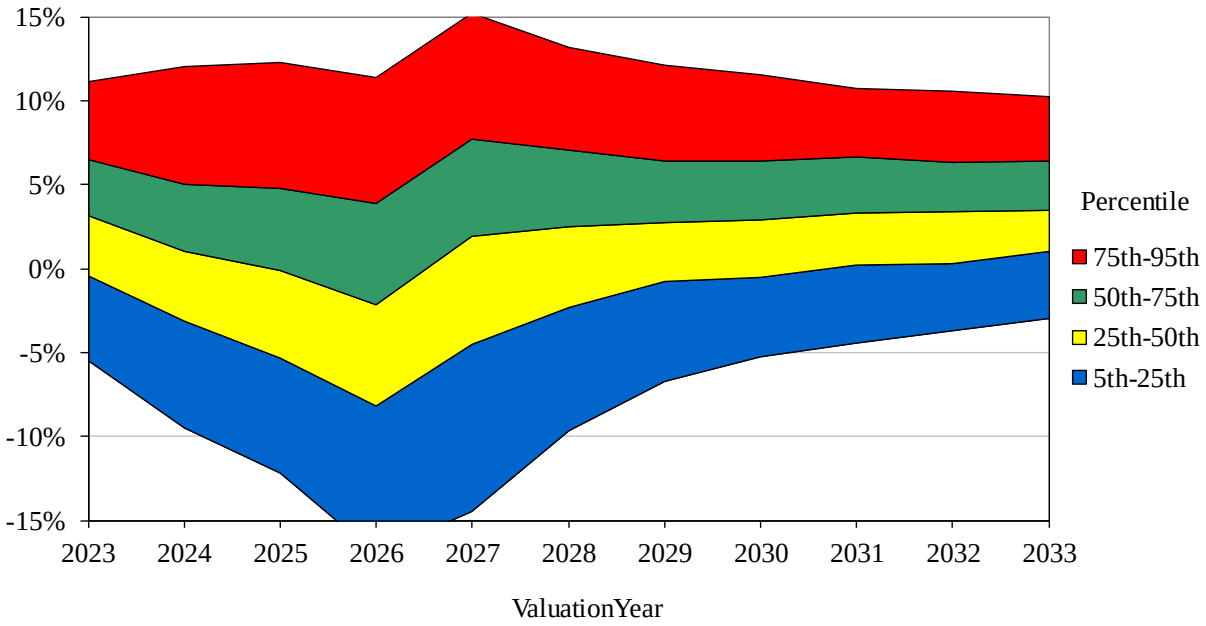

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **5th Percentile** | -2.4% | -5.5% | -7.5% | -11.1% | -7.3% | -5.3% | -3.8% | -3.1% | -2.5% | -2.1% | -1.7% |
| **25th Percentile** | 0.7% | -1.6% | -3.6% | -6.1% | -2.4% | -1.2% | -0.2% | -0.2% | 0.3% | 0.3% | 0.7% |
| **Median** | 2.9% | 0.8% | -0.3% | -2.4% | 1.3% | 1.7% | 1.9% | 2.0% | 2.2% | 2.2% | 2.3% |
| **75th Percentile** | 4.9% | 3.3% | 2.5% | 1.1% | 5.0% | 4.5% | 4.1% | 4.1% | 4.2% | 4.0% | 4.0% |
| **95th Percentile** | 7.7% | 7.4% | 6.9% | 5.8% | 9.5% | 8.3% | 7.5% | 7.3% | 6.6% | 6.6% | 6.3% |

# Dividend Rates
# Scenario 8 – 8.0% Return, 22.4% Volatility




| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **5th Percentile** | -3.9% | -7.5% | -9.7% | -13.9% | -10.7% | -7.5% | -5.4% | -4.3% | -3.6% | -3.1% | -2.5% |
| **25th Percentile** | 0.1% | -2.4% | -4.5% | -7.3% | -3.6% | -1.9% | -0.6% | -0.5% | 0.1% | 0.1% | 0.7% |
| **Median** | 3.0% | 0.8% | -0.3% | -2.3% | 1.4% | 1.9% | 2.1% | 2.2% | 2.6% | 2.6% | 2.7% |
| **75th Percentile** | 5.6% | 4.0% | 3.5% | 2.3% | 6.2% | 5.5% | 5.1% | 5.0% | 5.2% | 4.9% | 5.0% |
| **95th Percentile** | 9.3% | 9.5% | 9.4% | 8.4% | 12.1% | 10.5% | 9.5% | 9.2% | 8.4% | 8.3% | 8.0% |

# Dividend Rates
# Scenario 9 – 9.0% Return, 28.1% Volatility




| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **5th Percentile** | -5.5% | -9.5% | -12.2% | -17.0% | -14.5% | -9.6% | -6.7% | -5.2% | -4.5% | -3.7% | -3.0% |
| **25th Percentile** | -0.4% | -3.1% | -5.3% | -8.2% | -4.5% | -2.3% | -0.7% | -0.5% | 0.2% | 0.3% | 1.0% |
| **Median** | 3.2% | 1.0% | -0.1% | -2.2% | 1.9% | 2.5% | 2.8% | 2.9% | 3.4% | 3.4% | 3.5% |
| **75th Percentile** | 6.5% | 5.0% | 4.8% | 3.9% | 7.8% | 7.1% | 6.5% | 6.4% | 6.6% | 6.3% | 6.4% |
| **95th Percentile** | 11.1% | 12.1% | 12.3% | 11.4% | 15.2% | 13.2% | 12.2% | 11.6% | 10.8% | 10.6% | 10.3% |

# WRS Stress Testing (Limitations and Simplifications)

- Goal is to understand the potential effect of various levels of stress on the system (not calculate exact predictions)
- Simplifying assumptions
  - Retiree funded status allowed to become negative and recover over time
  - Typical dividend adjustments (mortality improvements, carryover, timing, etc.) assumed to average to zero
  - Iterative impact between Money Purchase Minimum and contribution rates assumed to average to zero
  - Modified Normal Distribution in future years (standard deviation gradually declines in future years)

# Combination of All Scenarios

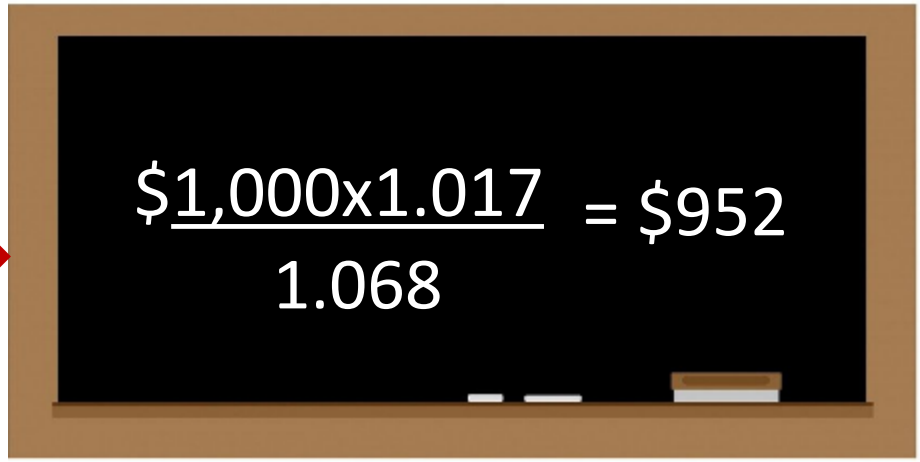
**2043 Results by %-tile of Investment Return Outcomes**

| | | | Contribution Rates | | | Dividend Rates | | | Highest | Worst Retiree |
|---|---|---|---|---|---|---|---|---|---|---|
| | ROR | StdDev | 95th | 50th | 5th | 95th | 50th | 5th | Div. Dep. PRB | Funded % |
| 1 | 4.0% | 3.8% | 18.4% | 19.1% | 19.8% | -0.2% | -1.0% | -1.9% | 100%/Year50 | 51%/Year50 |
| 2 | 5.0% | 4.6% | 16.8% | 17.8% | 18.7% | 1.0% | 0.0% | -1.1% | 73%/Year50 | 78%/Year50 |
| 3 | 5.5% | 5.5% | 15.7% | 17.1% | 18.2% | 1.7% | 0.5% | -0.8% | 18%/Year50 | 95%/Year50 |
| 4 | 6.0% | 9.4% | 13.8% | 16.4% | 18.3% | 3.2% | 1.0% | -1.2% | 18%/Year50 | 95%/Year10 |
| 5 | 6.5% | 12.9% | 11.6% | 15.6% | 18.4% | 4.5% | 1.5% | -1.5% | 21%/Year50 | 89%/Year10 |
| 6 | 7.0% | 13.6% | 10.1% | 14.7% | 17.8% | 5.2% | 2.0% | -1.2% | 18%/Year50 | 91%/Year10 |
| 7 | 7.5% | 17.1% | 7.4% | 13.8% | 17.9% | 6.6% | 2.6% | -1.6% | 23%/Year50 | 84%/Year10 |
| 8 | 8.0% | 22.4% | 3.2% | 13.0% | 18.4% | 8.4% | 3.1% | -2.3% | 29%/Year50 | 73%/Year10 |
| 9 | 9.0% | 28.1% | 0.0% | 11.0% | 18.4% | 10.8% | 4.1% | -2.9% | 33%/Year50 | 64%/Year10 |

Actuarial Rate →

# Follow up from August 21 Discussion
# Present Value – Active Member (6.8%)

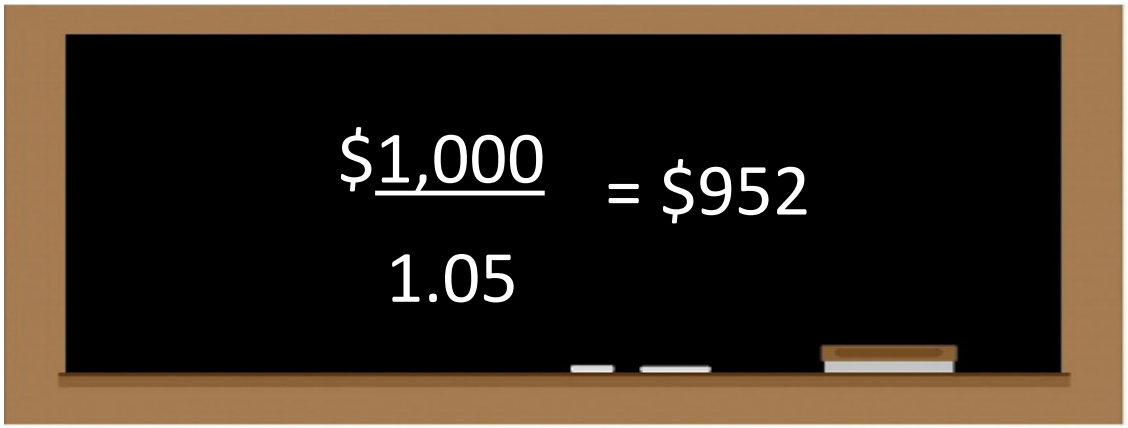
Active member has accrued $1,000 benefit. What is the Present Value based on benefit payable at end of the year with a 1.7% dividend?




Observation: As an active member, we fund for and assume a 1.7% dividend based on earning 6.8% on the Fund?

# Follow up from August 21 Discussion
# Present Value – Retired Member (5%)

The active member retires the very next day with $1,000 accrued benefit. What is the present value at 5% (assuming no dividend)?




Observation: At retirement, the present value of the $952 annuity at 5% is transferred to the retiree reserve account and ultimately compared to assets to derive the actual dividend

# Disclaimers

- This presentation shall not be construed to provide tax advice, legal advice or investment advice.
- Mark Buis, James Anderson and Rich Koch are Members of the American Academy of Actuaries and meet the Qualification Standards of the American Academy of Actuaries to render the actuarial opinions contained herein.
- This is one of multiple documents comprising the actuarial report. Additional information regarding actuarial assumptions and methods, and important additional disclosures are provided in the full report entitled "Forty-Second Annual Actuarial Valuation and Gain Loss Analysis."
- If you need additional information to make an informed decision about the contents of this presentation or the contents of the full report, or if anything appears to be missing or incomplete, please contact us before making use of the information.

SWIB STATE OF WISCONSIN INVESTMENT BOARD

# ASSET ALLOCATION REVIEW

## WORKSHOP

OCTOBER 17, 2023

Joseph Nankof, Principal
Christopher Levell

NEPC

# TOPICS

- Review of Current Asset Allocation
- Summary Recommendations
- Markets Update
- Background and Assumptions
- Policy Leverage Framework
- Recommendations
- Appendix

# SUMMARY

- **Significant changes in financial markets**
  - Fed continuing to fight inflation
  - Inverted yield curve
  - Recession or "soft landing"?
  - US Equity rally concentrated in largest tech companies
- **Themes of asset allocation analysis**
  - Incorporate updated "goldilocks zone" from GRS
  - Increase focus on long-term (30 year) model portfolio
  - Examine leverage and public fixed income/equity mix
- **Preliminary recommendations**
  - Reflect private equity/debt allocation (18%) as strategic target
  - Maintain real estate target at 8%
  - Fund higher private equity/debt target by decreasing public equity
  - Decrease policy leverage to 12% given higher funding costs have lessened the policy excess return

# ASSET ALLOCATION FRAMEWORK

## A MULTI-DIMENSIONAL APPROACH TO ASSET ALLOCATION

**STRATEGIC VIEWS**
Long-term

**Focus of this review and today's discussion:** Serves as an implementation guide for strategic asset allocation targets and investment policy benchmarks

**CURRENT OPPORTUNITIES**
Intermediate

Recommended actions to improve investment outcomes relative to strategic asset allocation targets

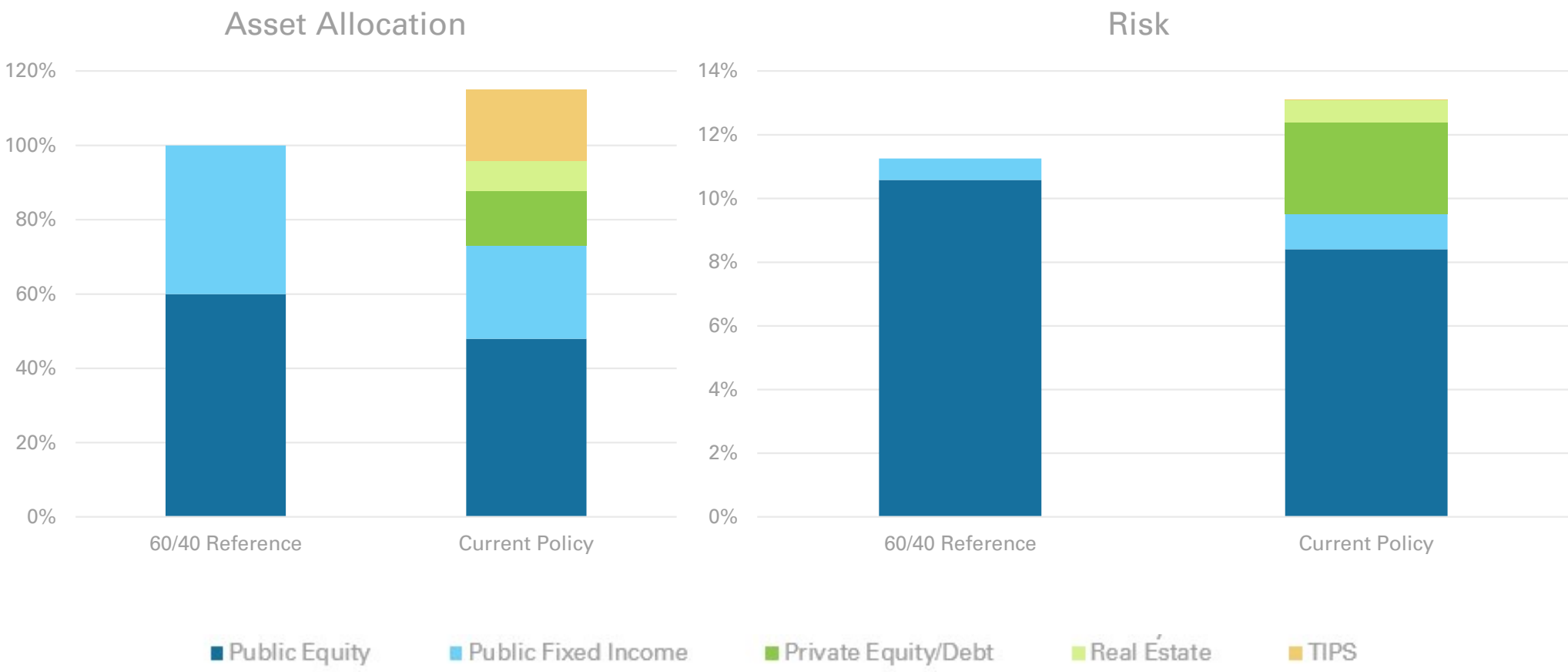
**DYNAMIC TILTS**
Short-term

Represent an active tilt for public market asset classes relative to strategic asset allocation targets

# REVIEW OF CURRENT ASSET ALLOCATION

# CURRENT POLICY: HIGH LEVEL ALLOCATION

Through a number of strategic decisions, the Current Policy has a more diversified risk profile than the 60/40 Reference* portfolio.

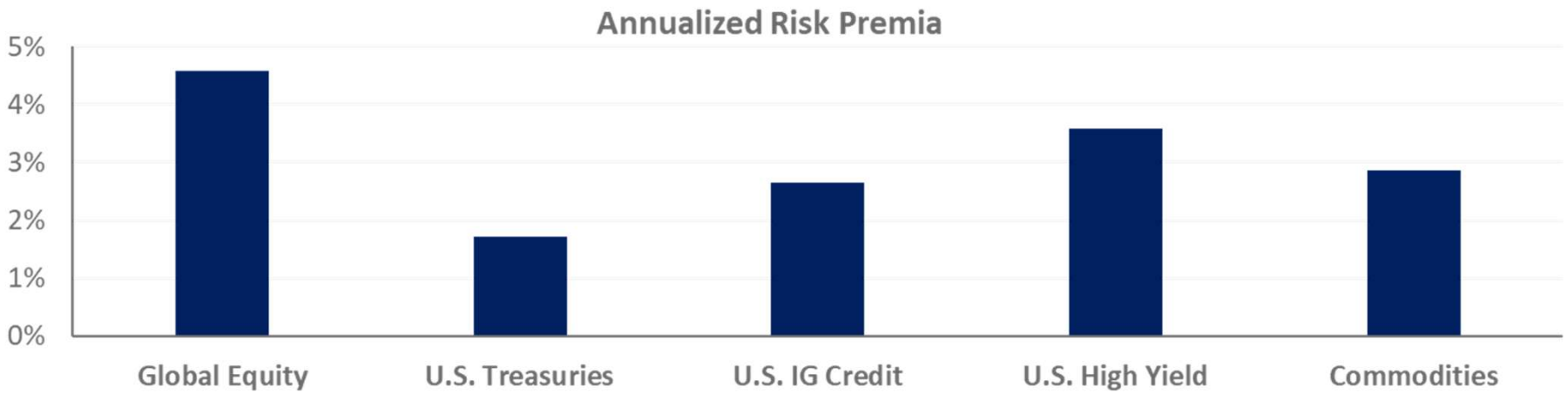



*60/40 Reference portfolio is 60% MSCI ACWI IMI/40% Bloomberg Aggregate

# PUBLIC MARKET EQUITY

## STRATEGIC VIEWS

- **Public market equities serve as the primary return generating asset, with the objective of delivering long-term portfolio wealth gains**
  - Equity generally exhibits the highest volatility among public market assets, but long-term return potential warrants a large exposure in most portfolios
- **Sizing public equity exposure is a strategic exercise and should reflect investor return objectives, risk-tolerance, and liquidity needs**
  - Dynamic tilts may be additive to long-term returns as changes in equity valuations, fundamentals, and market sentiment dictate relative opportunities
- **The MSCI ACWI IMI represents the global opportunity cost and is the ideal benchmark for evaluating strategic asset allocation decisions**
  - As the equity opportunity cost, MSCI ACWI IMI is used to assess tracking error risk and acts as a starting point for evaluating implementation options

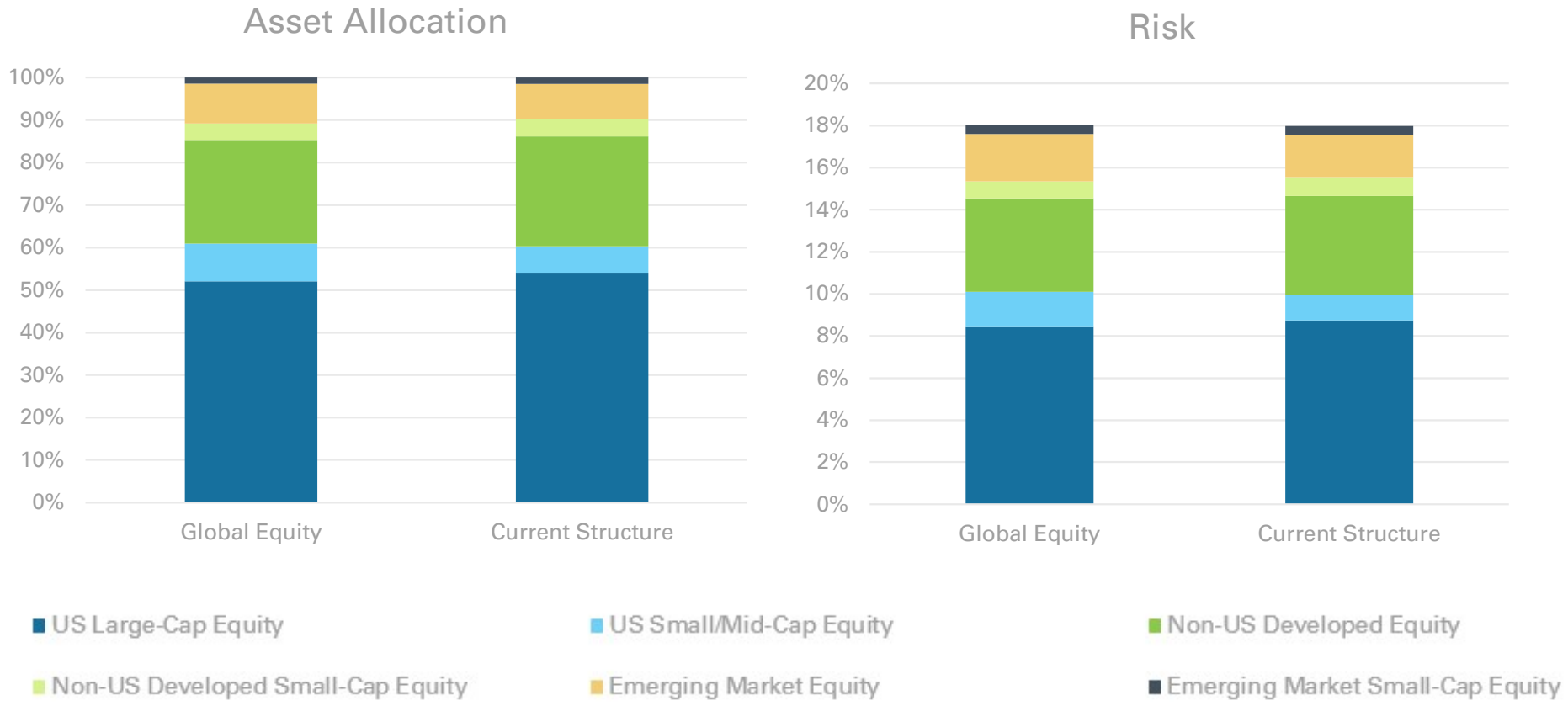



Notes: Risk premia calculated from 1/31/1970. Global Equity reflects the MSCI World Index through 1/31/1988 and the MSCI ACWI Index thereafter.
Sources: MSCI, S&P, Bloomberg, FactSet

# CURRENT POLICY: EQUITY STRUCTURE

The Current equity portfolio structure is generally aligned with the global market capitalization portfolio

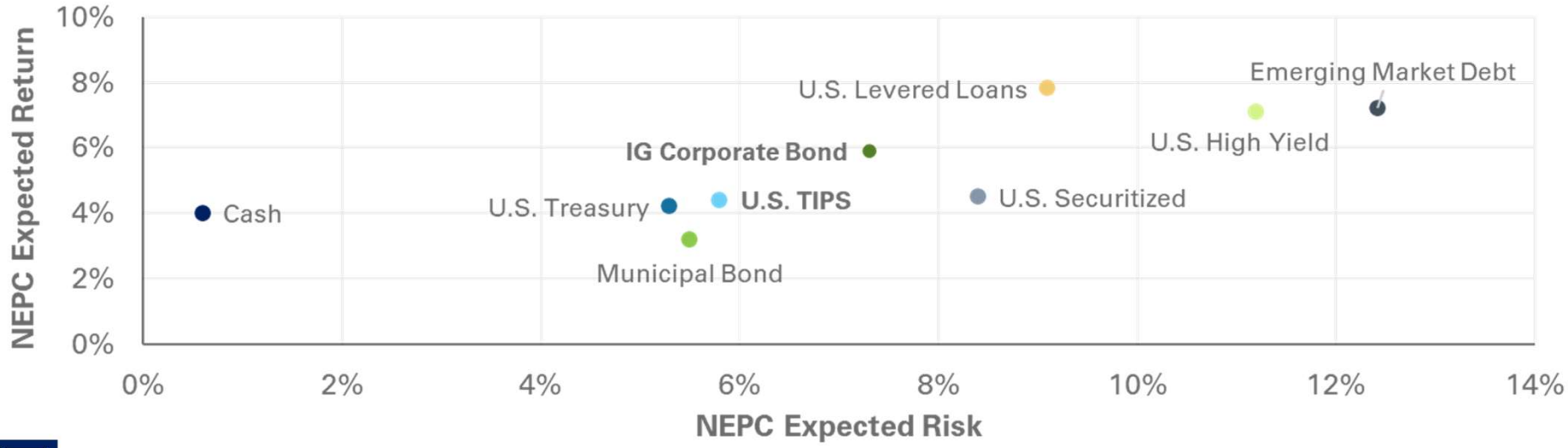
- One relative minor exception is the Current Structure China half-weight



# FIXED INCOME

## STRATEGIC VIEWS

- **For many investors, strategic policy targets to fixed income are applied with a broad brush and hold conflicting investment objectives**
  - Each investor's goals with respect to safety, income, and diversification are unique
- **We recommend investors create distinct strategic asset allocation targets for high-quality fixed income and return-seeking credit**
  - Separate targets for high-quality fixed income and return-seeking credit align the objective and benchmark with each mandate and clarify their portfolio role
  - Various fixed income sectors offer distinct characteristics which can serve unique roles in a portfolio context; Treasuries, for example, can provide an important deflation hedge




Sources: NEPC 12-31-22 Asset Class Assumptions

# FIXED INCOME
## STRATEGIC VIEWS

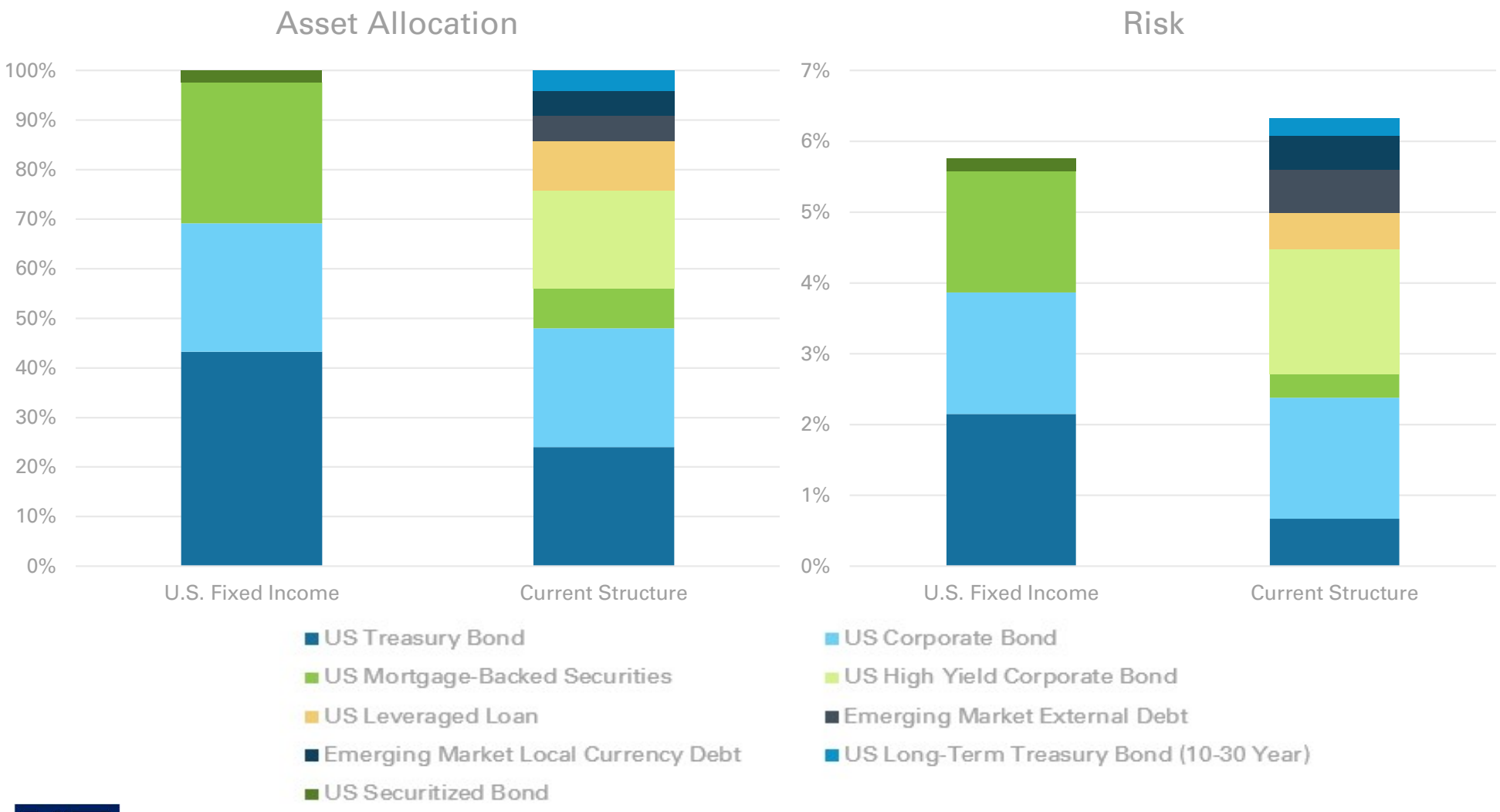
- **We recommend developing strategic targets to TIPS, high-quality fixed income and return-seeking credit**
  - Shifts in credit spreads, real rates, and inflation expectations can also present opportunities to adjust allocations through time
  - As a diversifying exposure, we recommend the use of high-quality fixed income in portfolios
  - We believe the strategic blend of TIPS and Investment-Grade Fixed Income is a preferred implementation approach relative to Core Bonds and is a better complement to return-seeking credit and other portfolio exposures
  - Ultimately, target allocations to sectors will be a function of strategic views, risk management and bottom up views on market opportunity and alpha potential

### Fixed Income Allocation Spectrum

| Safe-Haven Fixed Income | High-Quality Fixed Income | Return-Seeking Credit |
|---|---|---|
| • Advise 10% minimum for all portfolios and investors<br>• Required for portfolio liquidity and downside protection needs | • Heavily utilized for lower volatility portfolios and high fixed income allocations<br>• Will compete with other diversifying asset classes in a strategic asset allocation | • Common exposure for total return-focused investors<br>• Will compete with other risk assets in a strategic asset allocation and can be viewed as a funding source for private credit |

# CURRENT POLICY: FIXED INCOME STRUCTURE

By developing targets weights to Investment-Grade and Return-Seeking Credit sectors, the Current Fixed Income structure risk is similar in magnitude but much more diversified than the U.S. Investment-Grade market.



# SUMMARY RECOMMENDATIONS

# CURRENT POLICY AND RECOMMENDATION

The biennial asset/liability review is an opportunity to review the asset allocation relative to the liabilities and consider adjustments to long-term investment policy. This exercise is intended to evaluate the long-term strategic decisions outlined in the table below.

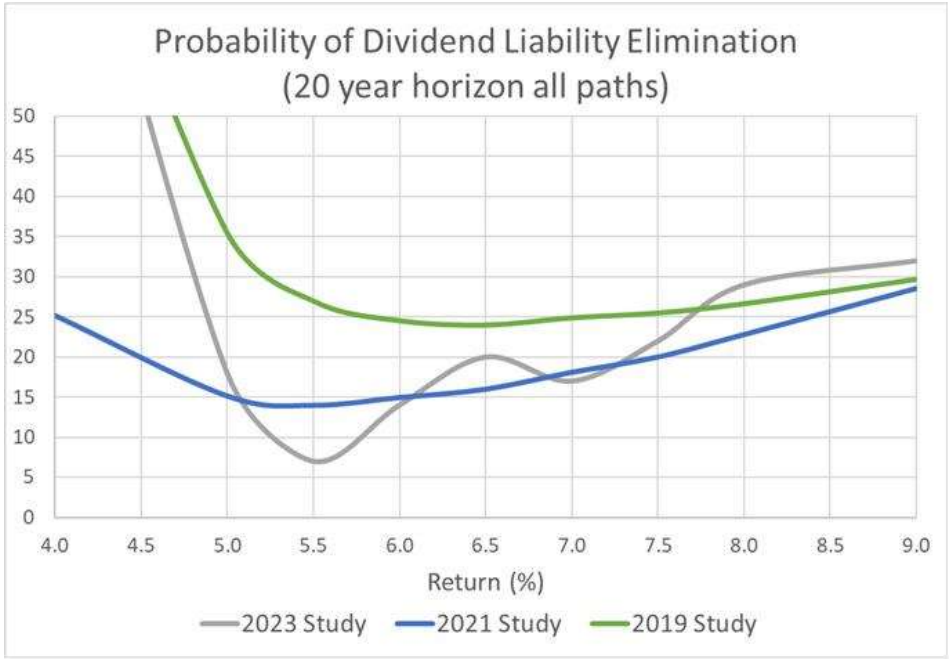
| Decision | Current Policy Targets | Recommended Targets |
|---|---|---|
| Public Markets Allocation | 48% Equity/25% Fixed Income/19% TIPS | 42% Equity/25% Fixed Income/19% TIPS |
| Private Markets Allocation | 15% Private Equity & Debt/8% Real Estate | 18% Private Equity & Debt/8% Real Estate* |
| Leverage Level | 15% | 12% |
| Public Equity Structure | Global Market Capitalization (China Half Weight) | No Change |
| Public Fixed Income Structure | 60% Investment-Grade/40% Below Investment-Grade and Emerging Markets Debt | No Change |
| Private Markets Portfolio Composition | Equity & Debt: 85% Equity/15% Debt<br>Real Estate: 100% Core | No Change |

*Current Actual Weight for Private Equity/Debt

# ANALYSIS OF DIVIDEND LIABILITY DEPLETION UPDATE

- **Markets facing inflation, an inverted yield curve, and uncertain growth prospects**
- **With rates higher, the statutory 5% annuitization rate is easier to achieve in fixed income markets**
- **Gains from 2021 and losses from 2022 are still being recognized**

- **GRS (WRS Actuary) suggests a "Goldilocks Zone" with returns able to grow dividends without undue volatility**
- **A target return of 6.5-7.5% should provide sufficient balance to exceed the 5% hurdle and limit the possibility of additional future shortfalls**




Source: SWIB ARA and NEPC interpolation of GRS stochastic analysis of cumulative probability of exhausting dividends over 20 years

# MARKETS UPDATE

# THE BULLS ARE (TECHNICALLY) BACK

## S&P CUMULATIVE TOTAL RETURNS


Sources: S&P, FactSet

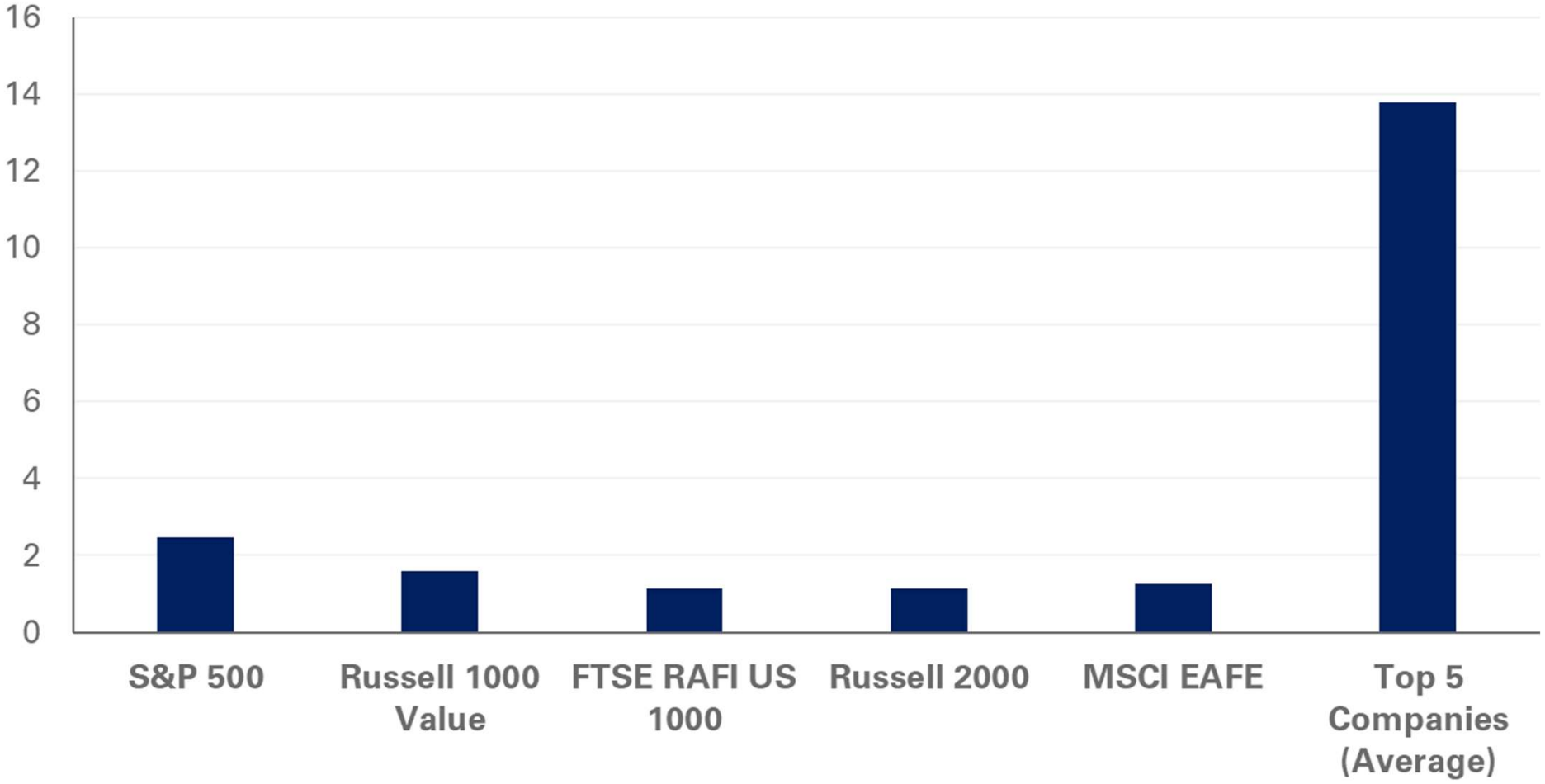
# LARGE-CAP TECH NEARING PEAK VALUATIONS

## MARKET CAPITALIZATION: NASDAQ 100 VERSUS RUSSELL 2000


Sources: Nasdaq, Russell, FactSet

# S&P 500 AND MEGA-CAPS APPEAR EXPENSIVE

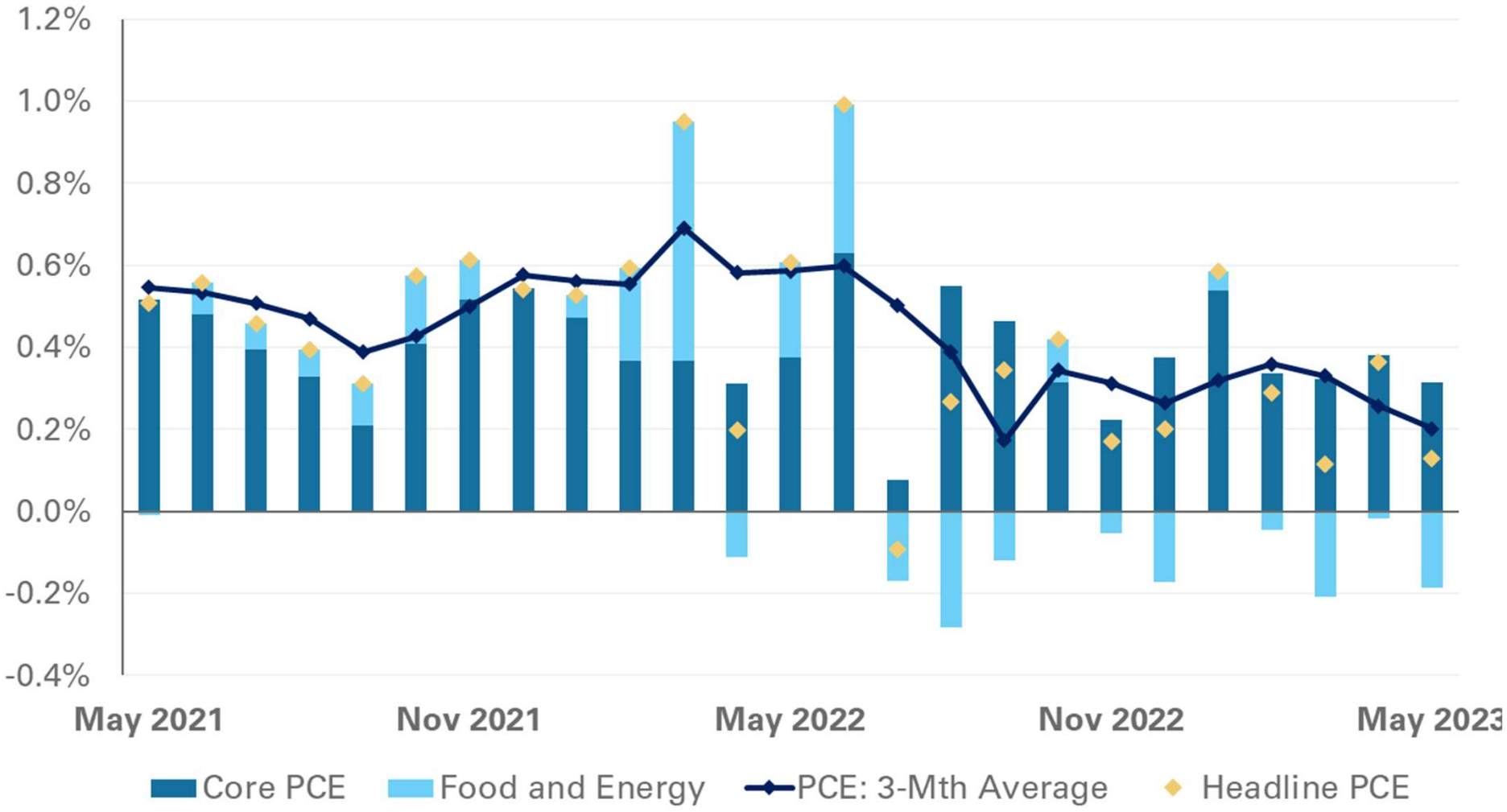
## PRICE TO SALES: LAST TWELVE MONTHS




Sources: S&P, FactSet

# CORE INFLATION REMAINED ELEVATED

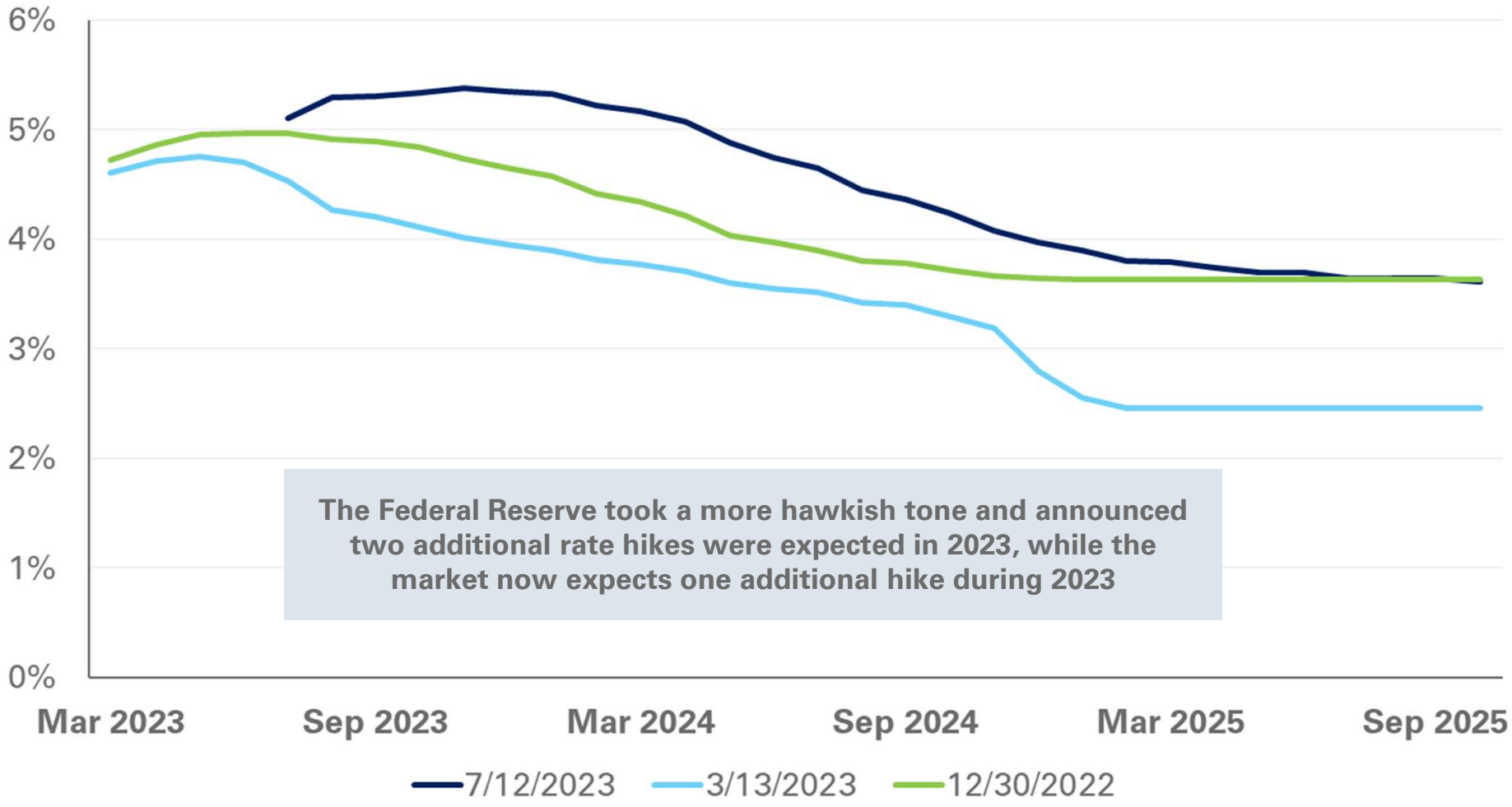
## MONTHLY U.S. PCE PRICE INDEX CHANGES




Sources: Bureau of Economic Analysis, FactSet

# MARKET RATE HIKE EXPECTATIONS ROSE

## FEDERAL FUNDS FUTURES




3/13/2023 represents the Monday after the collapse of Silicon Valley Bank
Source: FactSet

# THE YIELD CURVE FURTHER INVERTED

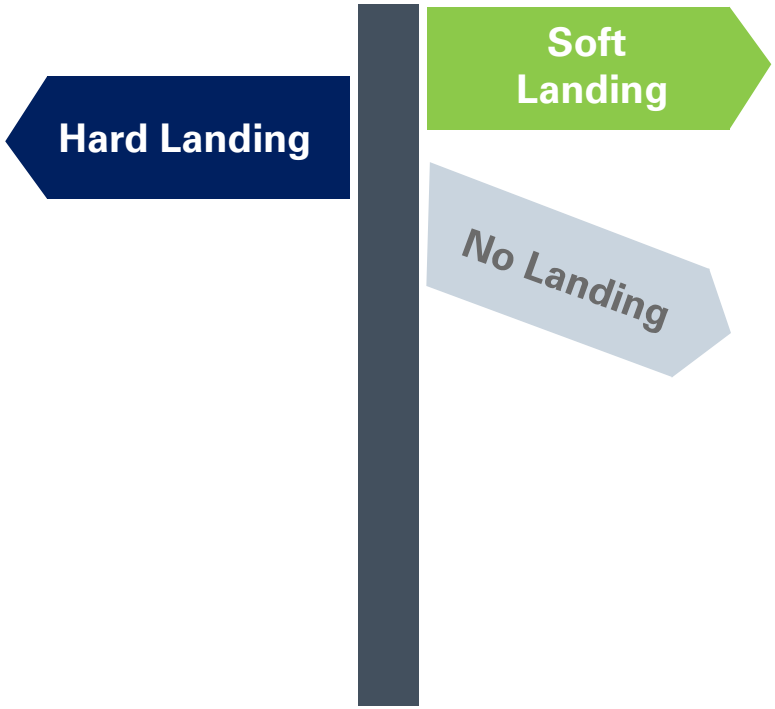
## 10-2 U.S. TREASURY YIELD SPREAD


Source: FactSet

# A DATA CONUNDRUM

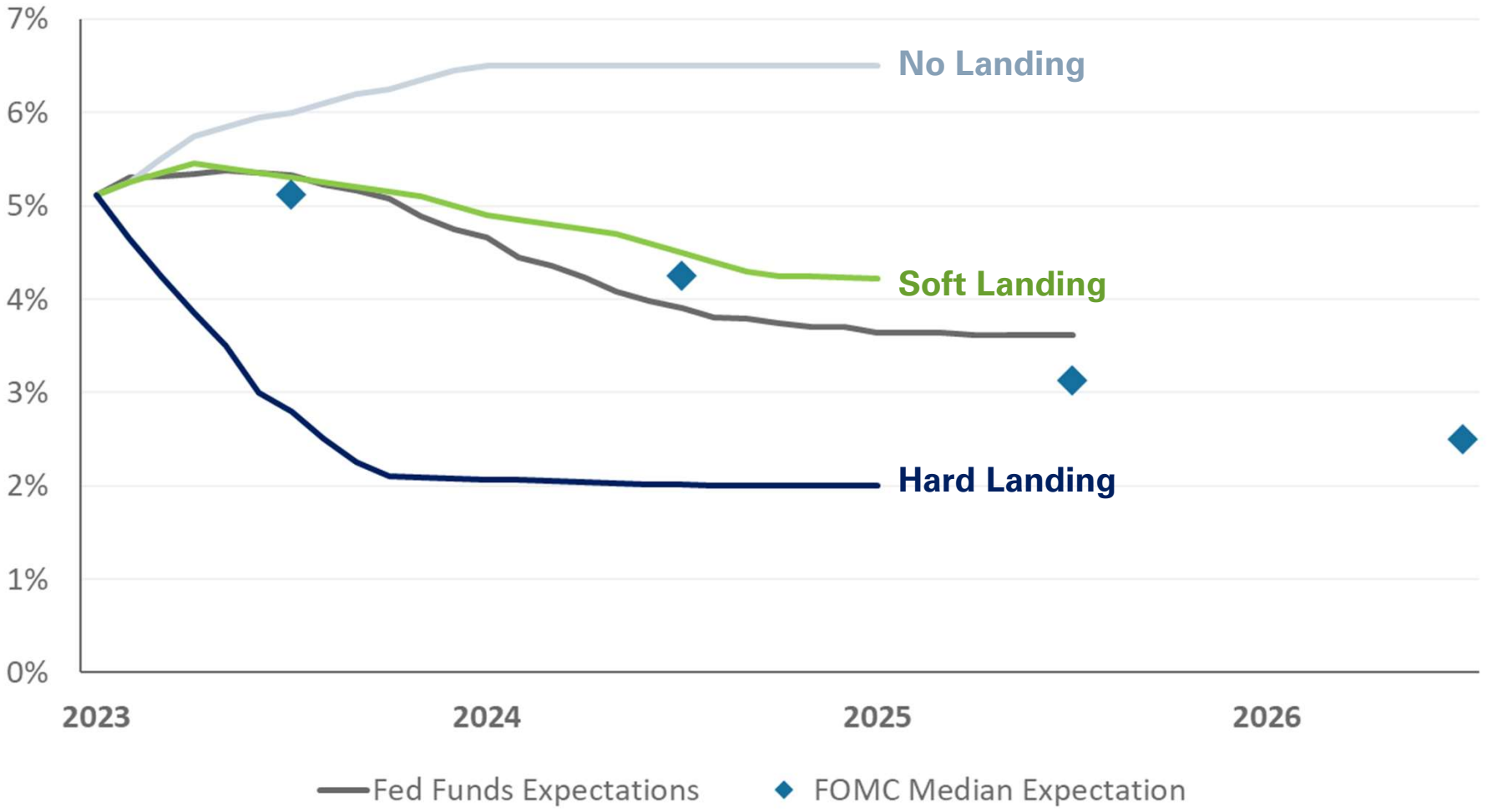
## THE MARKET IS DIGESTING THREE DISTINCT ECONOMIC OUTCOMES

| | |
|---|---|
| Investor Sentiment | No Landing |
| Labor Market | No Landing |
| Economic Growth | Soft Landing |
| Inflation | No Landing |
| Consumer Spending | Soft Landing |
| Fed Funds Expectations | Soft Landing |
| FOMC Expectations | Soft Landing |
| Yield Curve | Hard Landing |
| Manufacturing Sector | Hard Landing |
| Services Sector | No Landing |
| Commercial Real Estate | Hard Landing |



# MARKET PRICING CONVERGING WITH THE FOMC

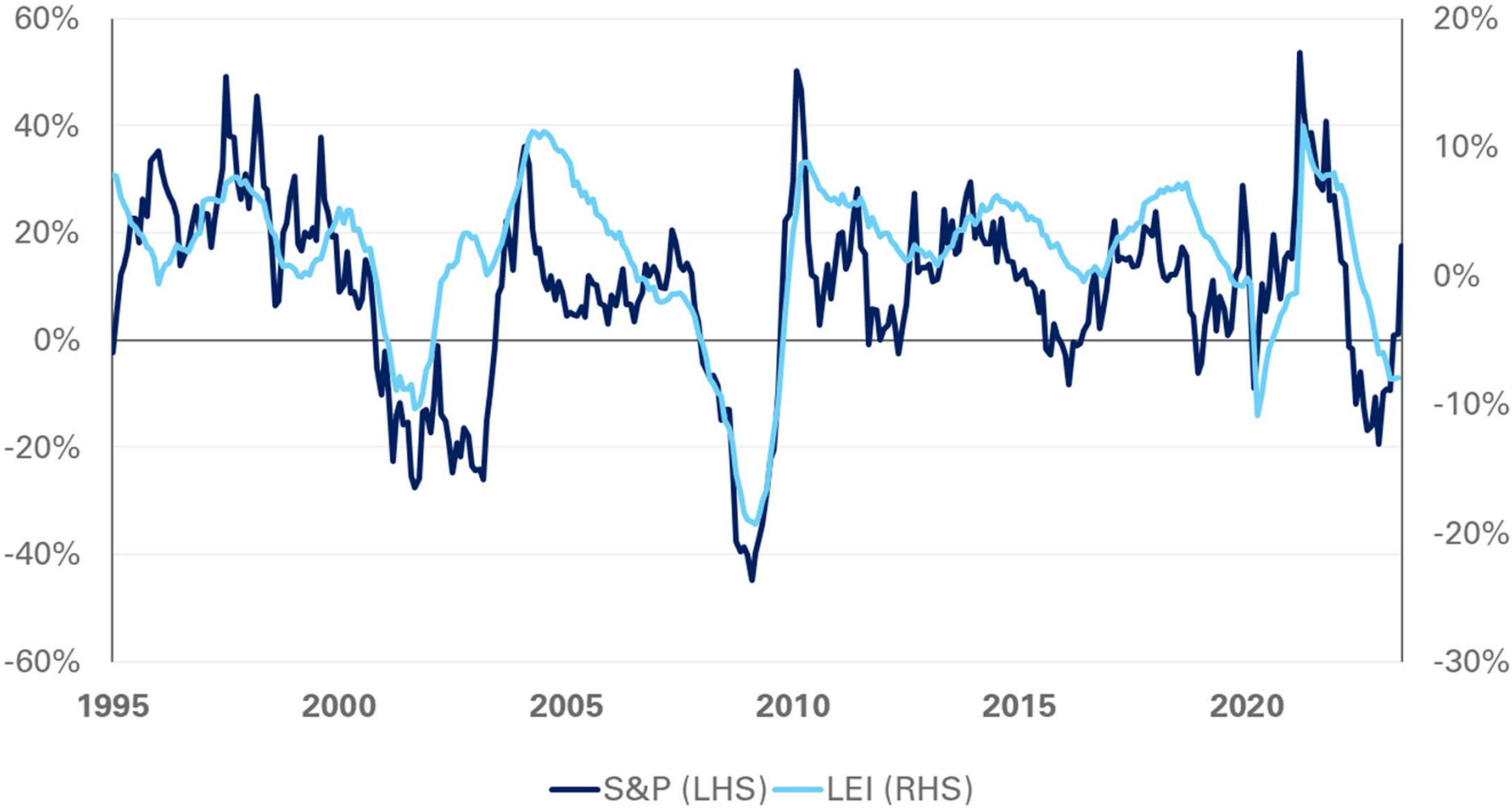
## THE FED DOT PLOT VERSUS FED FUNDS FUTURES




Notes: "No landing", "Soft landing", and "Hard landing" paths are illustrative; Fed Funds expectations as of 07/12/2023
Sources: Federal Reserve, FactSet

# LEADING INDICATORS POINT TO A RECESSION

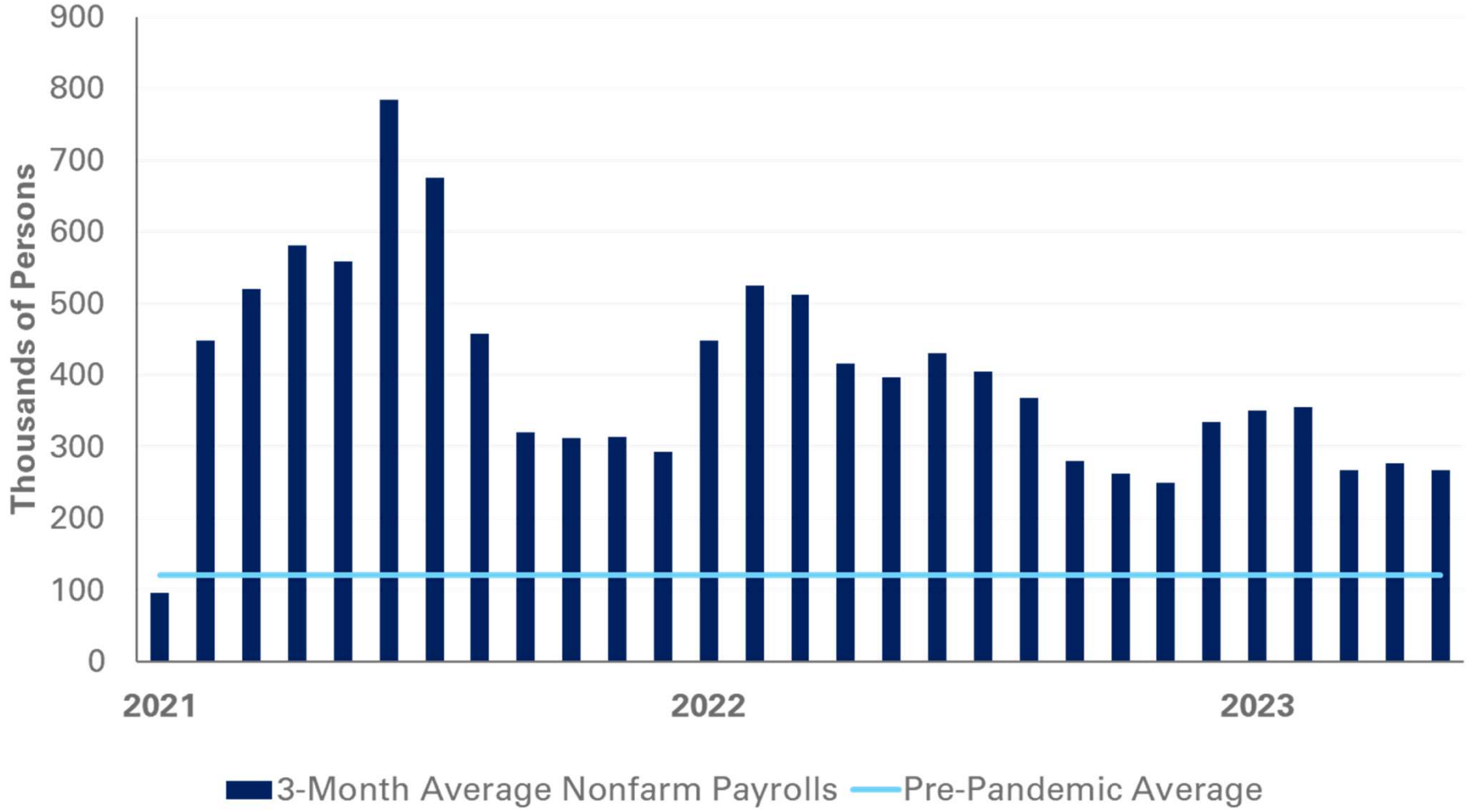
## 12-MONTH CHANGE IN S&P 500 INDEX AND LEI




Sources: Conference Board U.S., S&P, FactSet

# LABOR MARKET DEMAND IS STILL STRONG

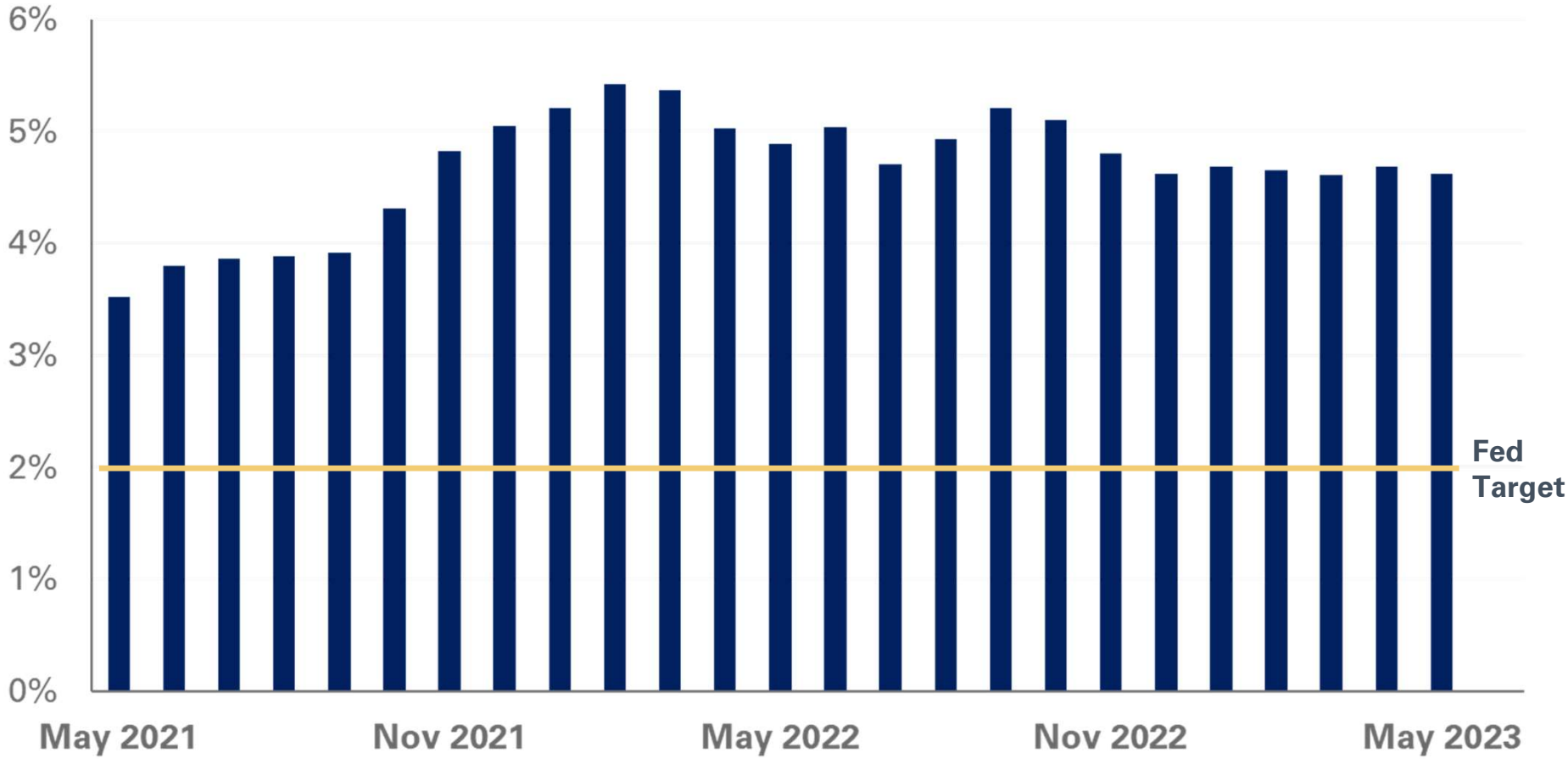
## U.S. EMPLOYEES ON NONFARM PAYROLLS




Sources: U.S. Department of Labor, FactSet, NEPC

# INFLATION REMAINS ABOVE THE FED'S TARGET

## ANNUAL CHANGE IN CORE PCE




Sources: U.S. Bureau of Economic Analysis, FactSet

# STICKY INFLATION FACTORS ARE ELEVATED

## FLEXIBLE VERSUS STICKY INFLATION PRESSURES


Notes: "Sticky" refers to a weighted basket of items that change price relatively slowly.
Source: Federal Reserve Bank of Atlanta

# U.S. ECONOMIC OUTLOOK

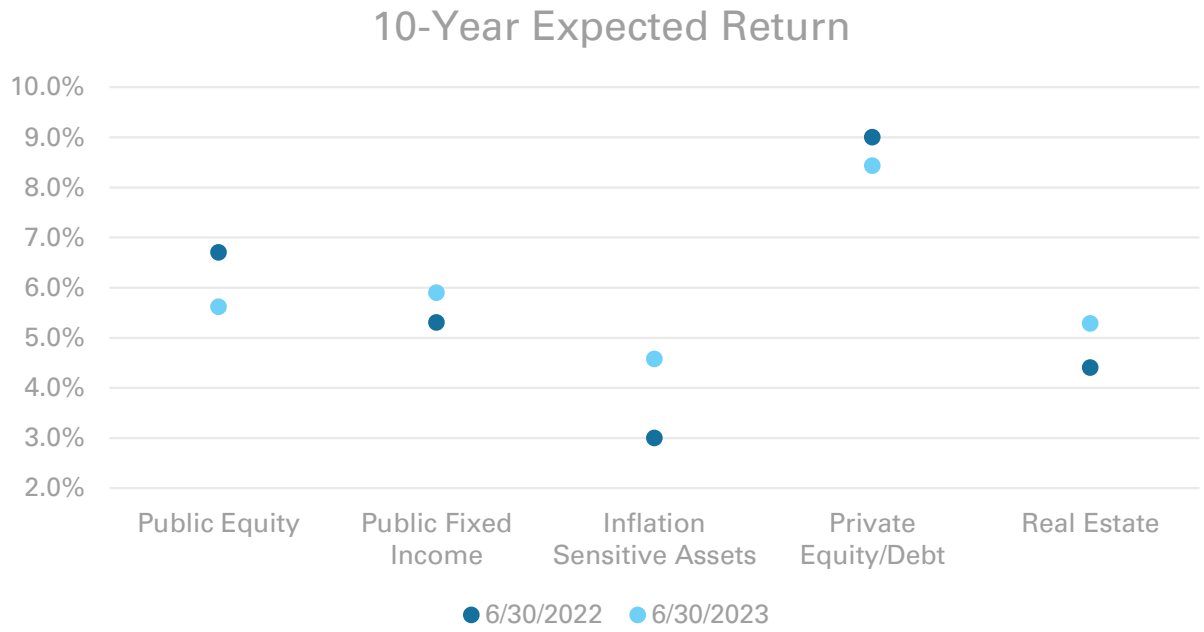
**Market expectations for interest rates have converged with FOMC projections – signaling a higher-for-longer bias**

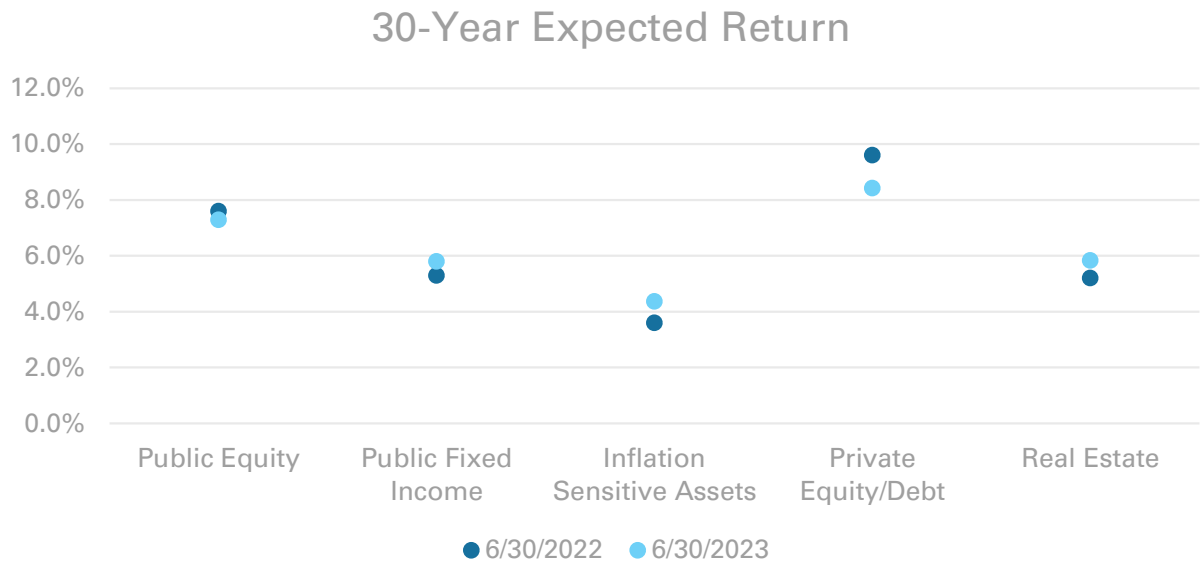
**Interest rate-sensitive sectors of the economy are still realizing the impact of a tighter monetary policy environment**

**Resilient data from the services sector and labor market strength continue to underpin "no landing" and "soft landing" outcomes**

# BACKGROUND AND ASSUMPTIONS

# 2023 & 2022 ASSUMPTIONS




Sources: S&P, FactSet

# ASSET CLASS ASSUMPTIONS

## OVERVIEW

- **NEPC's capital market assumptions are available each quarter and reflect June 30, 2023 market data**
- **Higher interest rates have lifted fixed income return expectations, while equity valuation expansion has weighed on future returns**
- **Public fixed income returns offer an increasingly attractive risk-return profile relative to public equities**
- **Inflation modeling enhancements raised return expectations for asset classes directly tied to changes in the U.S. Consumer Price Index (CPI)**
- **NEPC's expectation for inflation is elevated over the near-term, but the long-term outlook reflects a more stable inflation environment consistent with the Federal Reserve target of 2-3%**

# ASSET CLASS ASSUMPTIONS

## DEVELOPMENT

- **Assumptions are published for over 70 asset classes**
  - NEPC publishes return forecasts for 10-year and 30-year periods
- **Market data as of 06/30/2023**
  - Assumptions are developed with NEPC valuations models and rely on a building block approach
- **A combination of the 10-year and 30-year return outlooks are intended to support strategic asset allocation analysis**

### Asset Allocation Process

1. Finalize list of new asset classes
2. Calculate asset class volatility and correlation assumptions
3. Set model terminal values, growth, and inflation inputs
4. Model data updated at quarter-end
5. Review model outputs and produce asset class return assumptions
6. Assumptions released on the 15th calendar day after quarter-end

# ASSET CLASS BUILDING BLOCKS

## METHODOLOGY

- **Asset models reflect current and forecasted market data to inform expected returns**
- **Systematic inputs are paired with a long-term trend to terminal values**
- **Model inputs are aggregated to capture key return drivers for each asset class**
- **Building block inputs will differ across asset class categories**

# CORE ASSET CLASS RETURN ASSUMPTIONS

| | Asset Class | 06/30/23 10-Year Return | 06/30/22 10-Year Return | Delta |
|---|---|---|---|---|
| | Cash | 4.0% | 2.9% | +1.1% |
| | U.S. Inflation | 2.7% | 2.4% | +0.3% |
| Equity | U.S. Large-Cap Equity | 4.6% | 5.8% | -1.2% |
| | Non-U.S. Developed Equity | 5.0% | 6.4% | -1.4% |
| | Emerging Market Equity | 9.2% | 9.6% | -0.4% |
| | Global Equity* | 5.7% | 6.8% | -1.1% |
| | Private Equity* | 9.1% | 9.8% | -0.7% |
| Fixed Income | U.S. Treasury Bond | 4.2% | 3.2% | +1.0% |
| | U.S. Municipal Bond | 4.1% | 4.0% | +0.1% |
| | U.S. Aggregate Bond* | 4.7% | 3.8% | +0.9% |
| | U.S. TIPS | 4.6% | 3.0% | +1.6% |
| | U.S. High Yield Corporate Bond | 6.8% | 6.9% | -0.1% |
| | Private Debt* | 8.6% | 8.0% | +0.6% |
| Real Assets | Commodity Futures | 4.8% | 3.4% | +1.4% |
| | REIT | 6.4% | 6.1% | +0.3% |
| | Gold | 5.3% | 4.4% | +0.9% |
| | Real Estate - Core | 5.3% | 4.4% | +0.9% |
| | Private Real Assets - Infrastructure | 6.3% | 6.1% | +0.2% |
| Multi-Asset | 60% S&P 500 & 40% U.S. Aggregate | 4.9% | 5.3% | -0.4% |
| | 60% MSCI ACWI & 40% U.S. Agg. | 5.6% | 6.0% | -0.4% |
| | Hedge Fund* | 6.3% | 6.0% | +0.3% |

*Calculated as a blend of other asset classes

# PUBLIC EQUITY ASSUMPTIONS

## OVERVIEW

- **Current valuation multiples across public equities have moved higher and weighed on forward-looking return expectations**
  - U.S. mega-cap outperformance has driven current index valuations above terminal P/E levels

- **Non-U.S. Developed Market assumptions reflect negative real earnings growth as current profit margins remain near cyclical highs**

- **The inflation methodology change will impact nominal earnings expectations for markets with significant U.S. revenue exposure**

# PUBLIC EQUITY ASSUMPTIONS

## BUILDING BLOCKS

| | |
|---|---|
| **Illiquidity Premium** | The return expected for assets with illiquidity risk |
| **Valuation** | Represents P/E multiple contraction or expansion relative to long-term trend |
| **Inflation** | Market-specific inflation based on country-level revenue exposure |
| **Real Earnings Growth** | Market-specific real growth based on a weighted-average of country revenue exposure and GDP growth |
| **Dividend Yield** | Income distributed to shareholders adjusted to reflect market trends |

| Asset Class | 06/30/23 10-Yr Return | 12-Month Change |
|---|---|---|
| U.S. Large-Cap Equity | 4.6% | -1.2% |
| U.S. Small/Mid-Cap Equity | 6.5% | -0.7% |
| Non-U.S. Developed Equity | 5.0% | -1.4% |
| Non-U.S. Developed Small-Cap Equity | 7.3% | -0.1% |
| Emerging Market Equity | 9.2% | -0.4% |
| Emerging Market Small-Cap Equity | 8.6% | -0.7% |
| China Equity | 9.9% | +0.5% |
| Hedge Fund - Equity | 5.7% | +0.2% |
| Global Equity* | 5.7% | -1.1% |
| Private Equity* | 9.1% | -0.7% |

Source: NEPC

*Calculated as a blend of other asset classes

# FIXED INCOME ASSUMPTIONS

## OVERVIEW

- **Fixed income return assumptions are higher, reflecting the impact of tighter monetary policy backdrop and higher real interest rates**
- **The inflation methodology change impacts U.S. TIPS and Global Inflation-Linked bonds through higher inflation principal adjustments**
- **We encourage a dedicated safe-haven fixed income allocation to serve as a critical liquidity source for the portfolio**
  - Sizing of the safe-haven exposure is a strategic exercise and reflects investor return objectives, risk-tolerance, and private market pacing plan needs
- **High-quality fixed income is an asset class group designed to support lower volatility portfolios and larger strategic targets to fixed income**
  - Investment grade credit and TIPS offer exposure to nominal and real interest rates plus cyclical diversification benefits to the overall fixed income portfolio
- **We encourage the use of return-seeking credit investments, specifically high yield bonds, in a strategic asset allocation policy**

# FIXED INCOME ASSUMPTIONS

## BUILDING BLOCKS

| | |
|---|---|
| **Illiquidity Premium** | The return expected for assets with illiquidity risk |
| **Government Rates Price Change** | Change due to shifts in current yields relative to forecasted rates |
| **Credit Deterioration** | The average loss for credit assets due to defaults and recovery rates |
| **Spread Price Change** | Valuation change due to changes in credit spreads relative to long-term targets |
| **Credit Spread** | Yield premium provided by securities with credit risk |
| **Government Rates** | The yield attributed to sovereign bonds that do not have credit risk |

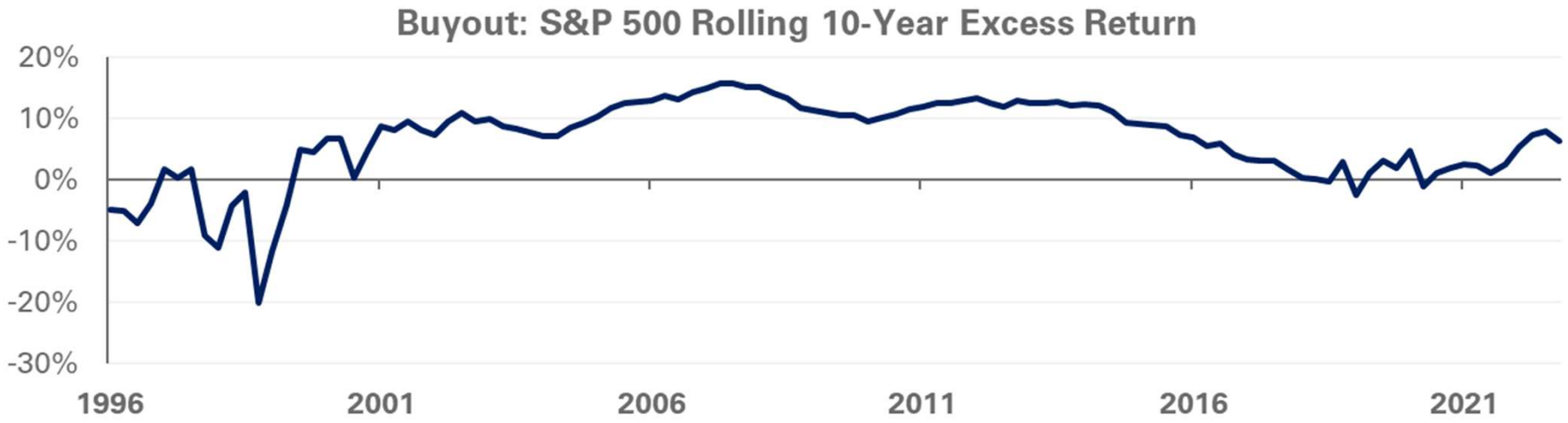
| Asset Class | 06/30/23 10-Yr Return | 12-Month Change |
|---|---|---|
| U.S. TIPS | 4.6% | +1.6% |
| U.S. Treasury Bond | 4.2% | +1.0% |
| U.S. Corporate Bond | 5.7% | +0.5% |
| U.S. MBS | 4.5% | +1.1% |
| U.S. High Yield Corporate | 6.8% | -0.1% |
| U.S. Leveraged Loan | 7.6% | +1.0% |
| EMD External Debt | 7.7% | +0.4% |
| EMD Local Currency Debt | 6.5% | -0.4% |
| Non-U.S. Govt. Bond | 2.6% | +0.5% |
| U.S. Muni Bond (1-10 Year) | 3.2% | +0.2% |
| U.S. High Yield Muni Bond | 5.8% | +0.8% |
| Hedge Fund – Credit | 6.9% | +0.4% |
| U.S. Aggregate Bond* | 4.7% | +0.9% |
| Private Debt* | 8.6% | +0.6% |

Source: NEPC

*Calculated as a blend of other asset classes

# ALTERNATIVE ASSETS

## METHODOLOGY

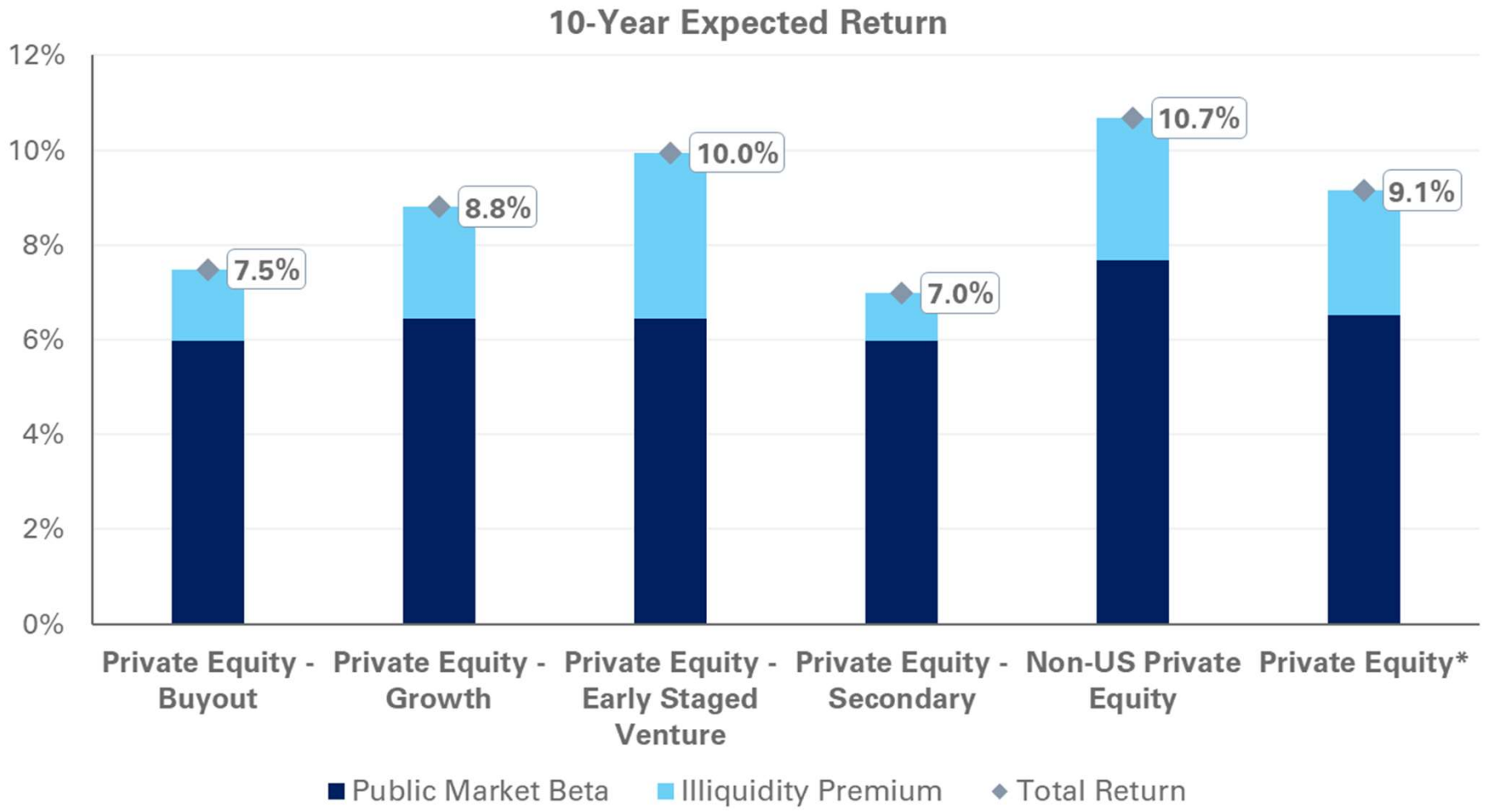



- **Private market assumptions are constructed from betas to public markets with an added illiquidity premia**
  - Historically, the observed illiquidity premium has been a significant component driving private market returns

Sources: Thomson One, S&P, FactSet

# PRIVATE EQUITY

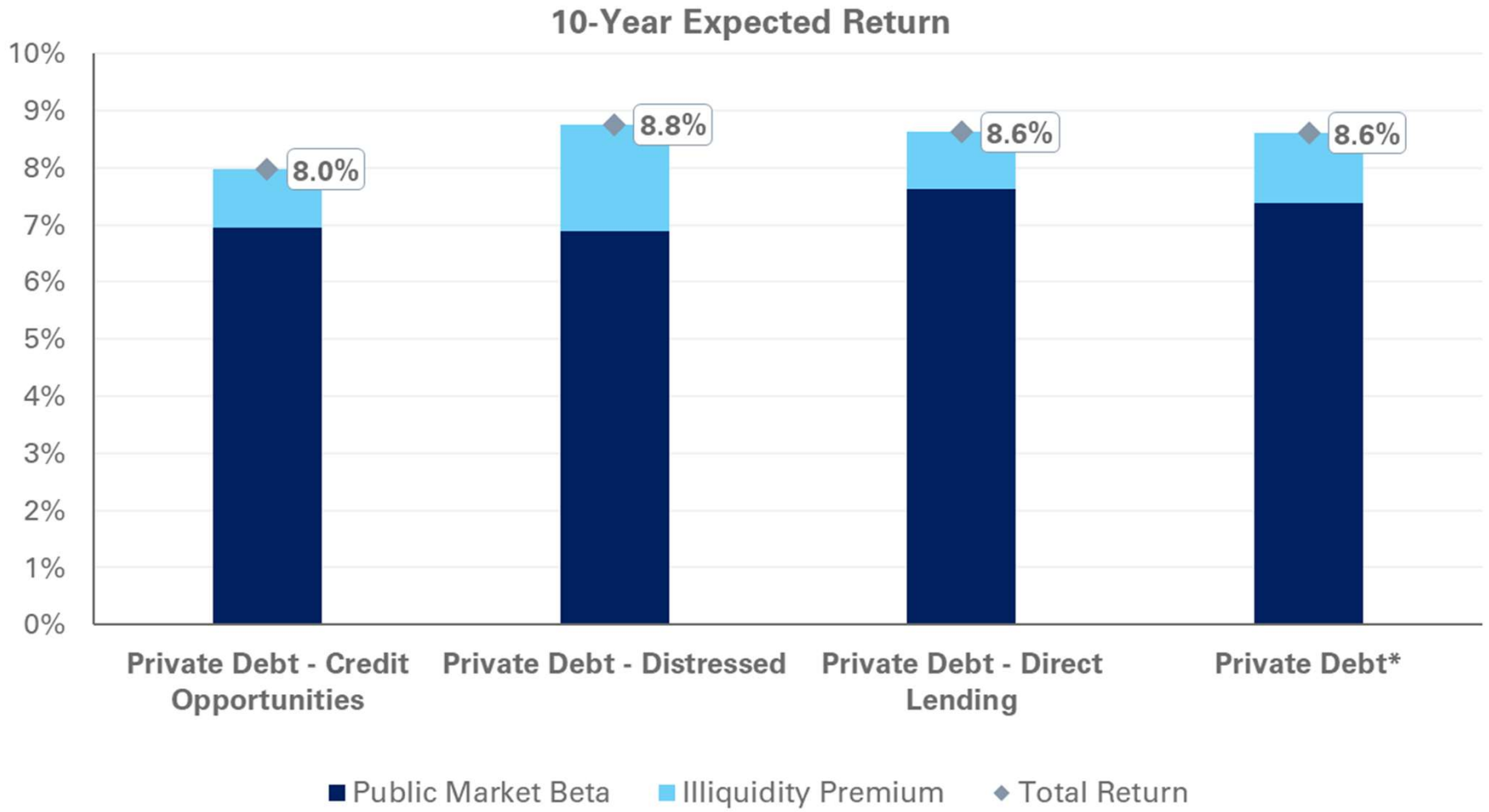
## BUILDING BLOCKS




Source: NEPC

*Private Equity is a derived composite of 34% U.S. Buyout, 34% U.S. Growth, 8.5% U.S. Secondary, 8.5% U.S. Venture, 15% Non-U.S. PE

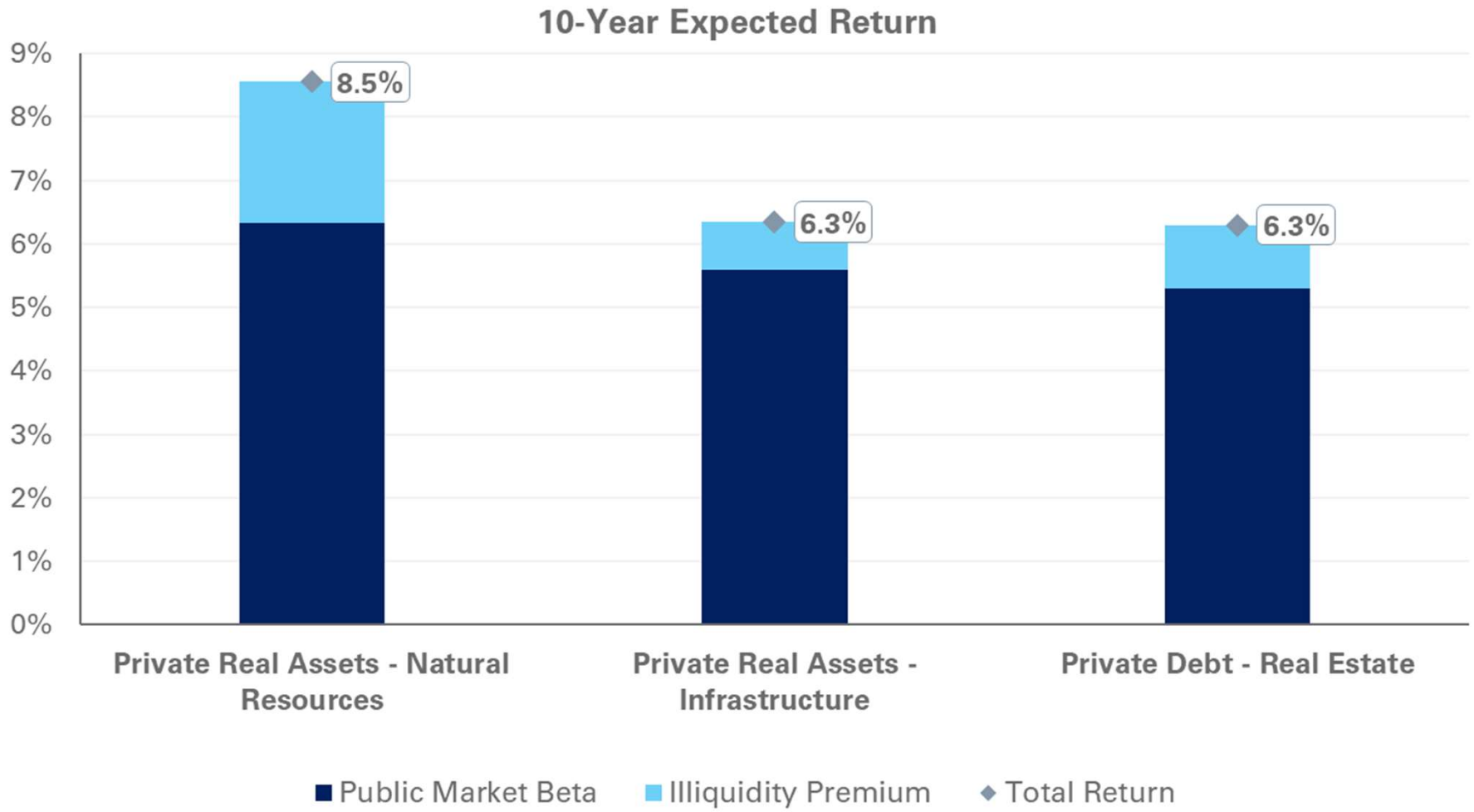
# PRIVATE DEBT
## BUILDING BLOCKS




Source: NEPC
*Private Debt is a derived composite of 25% Mezzanine, 25% Distressed, 50% Direct Lending

# PRIVATE REAL ASSETS

## BUILDING BLOCKS




Source: NEPC

# POLICY LEVERAGE FRAMEWORK

# POLICY LEVERAGE BACKGROUND
## (ALLOCATION INITIATIVE FROM 2009 OCTOBER WORKSHOP)

**Initiative Objectives**:

- Reduce total plan risk and maintain return
- Reduce allocation to Public Equity and increase allocations to Public Fixed Income and TIPS
- Deploy ~20% leverage across total fund
- Re-allocate risk in a more diversified fashion
  - Reduce equity contribution to risk
  - Position the Policy Portfolio to perform better across multiple economic environments
- Recognize additional liquidity risk regarding maintaining leverage

### Potential Third-Year Target Asset Allocation

| | Current Target | Potential Target | Difference |
|---|---|---|---|
| Public Equity | 55.0% | 41.0% | -14.0% |
| Fixed Income x TIPS | 26.1% | 35.1% | 9.0% |
| Real Estate | 6.0% | 7.0% | 1.0% |
| Private Equity | 6.0% | 7.0% | 1.0% |
| Multi-Asset | 4.0% | 8.0% | 4.0% |
| TIPS | 2.9% | 21.9% | 19.0% |
| Other/Commodity | - | 0.0% | 0.0% |
| Cash | 0.0% | -20.0% | -20.0% |
| Total | 100.0% | 100.0% | 0.0% |
| | | | |
| Beta Return | 7.93% | 7.46% | |
| Alpha Return | 0.53% | 0.67% | |
| Total Return | 8.45% | 8.14% | |
| | | | |
| Beta Risk | 11.41% | 9.80% | |
| Alpha Risk | 1.22% | 1.32% | |
| Total Risk | 11.47% | 9.88% | |
| | | | |
| % Contribution to Variance from Equities | 91% | 83% | |
| | | | |
| Sharpe Ratio | 0.432 | 0.469 | |

Source: SIS Beta assumptions, SWIB Internal Alpha Assumptions

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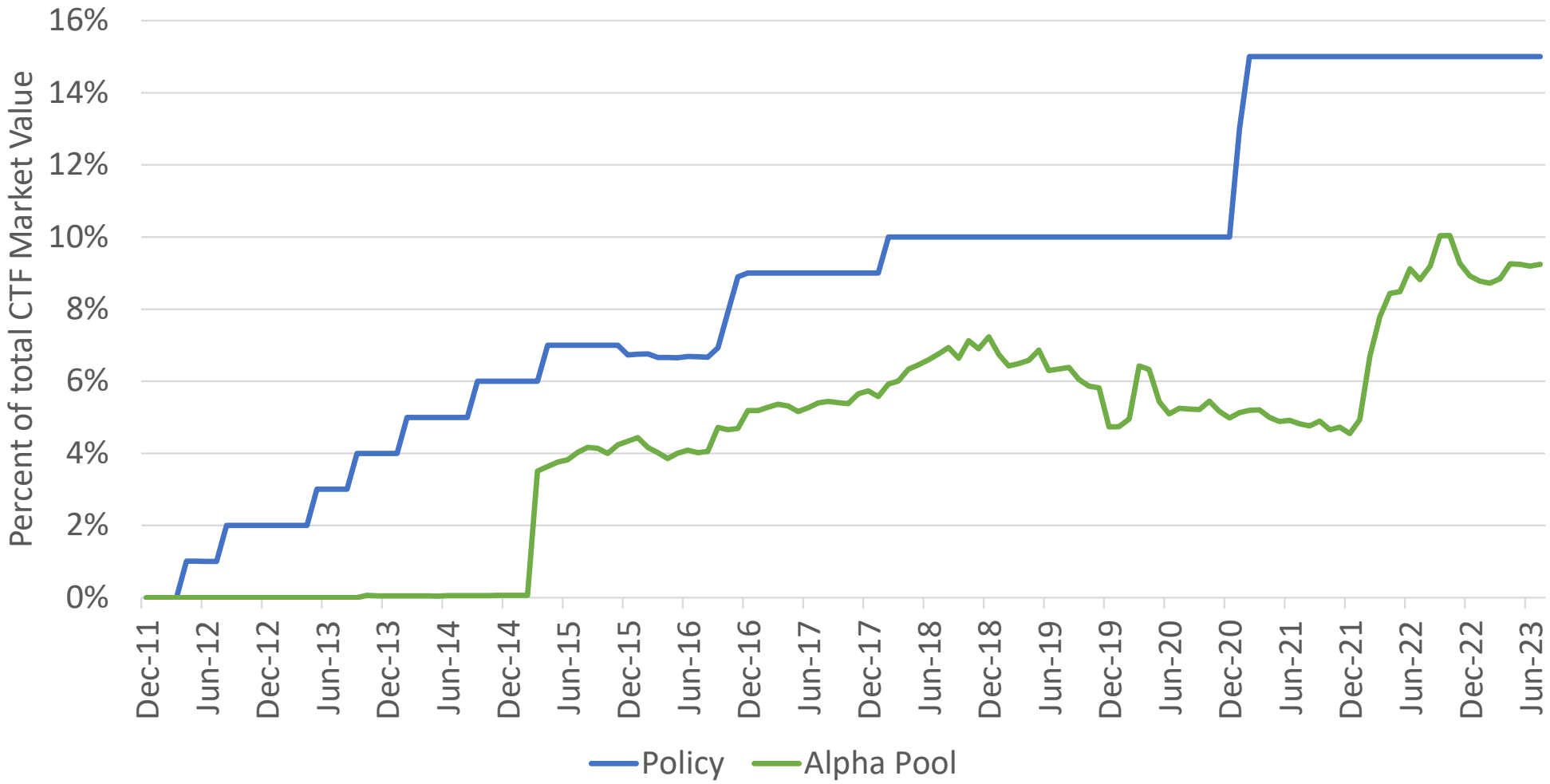
08/Oct/09
EX-90-195
State of WI Investment Bd

# CTF POLICY AND ALPHA POOL LEVERAGE

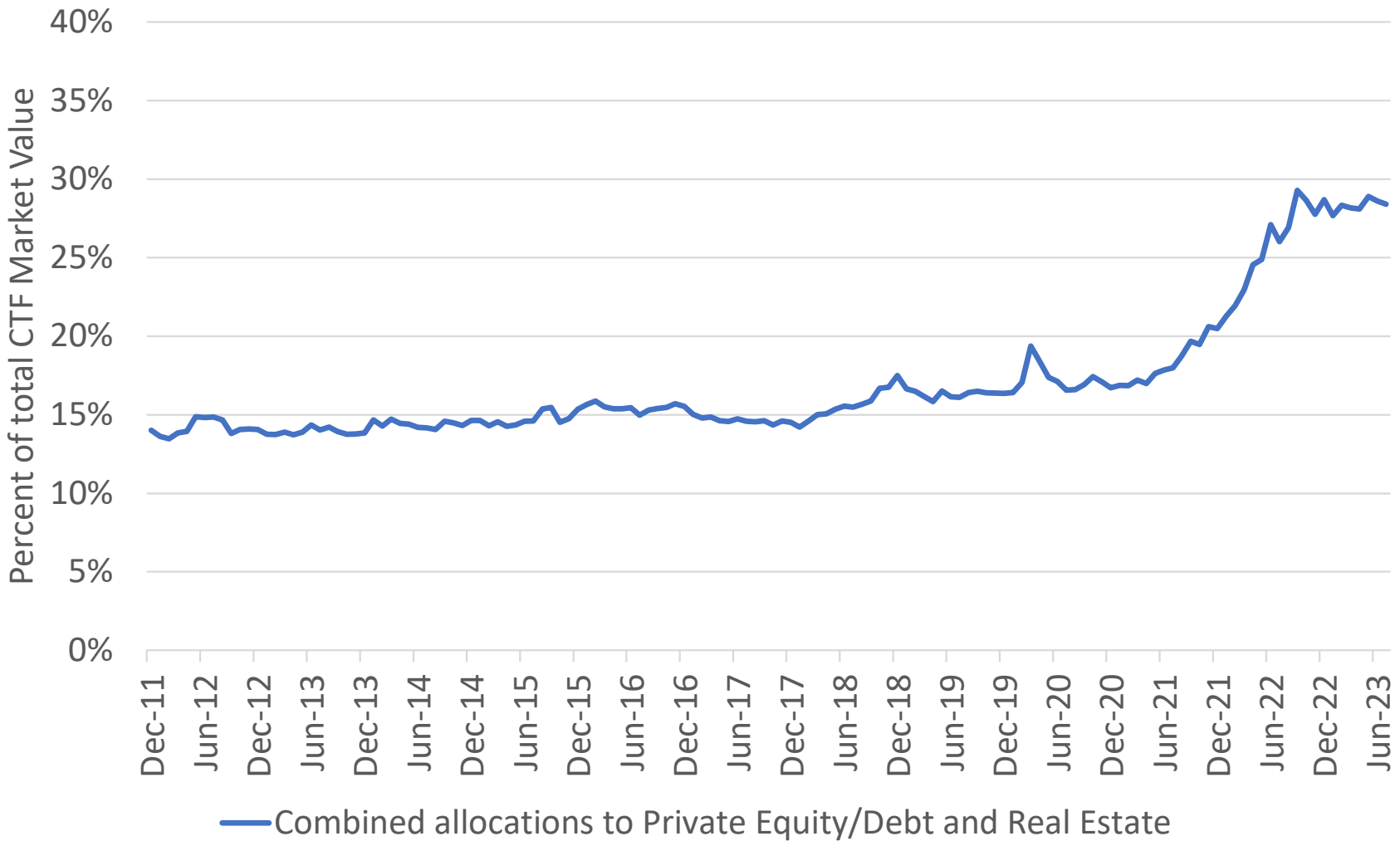
## (HISTORY OF CTF LEVERAGE)




* Other sources of leverage may be present in the Core Trust Fund due to derivatives use or otherwise embedded within active portfolios. This leverage is managed to be consistent with the active risk target approved by the Board.

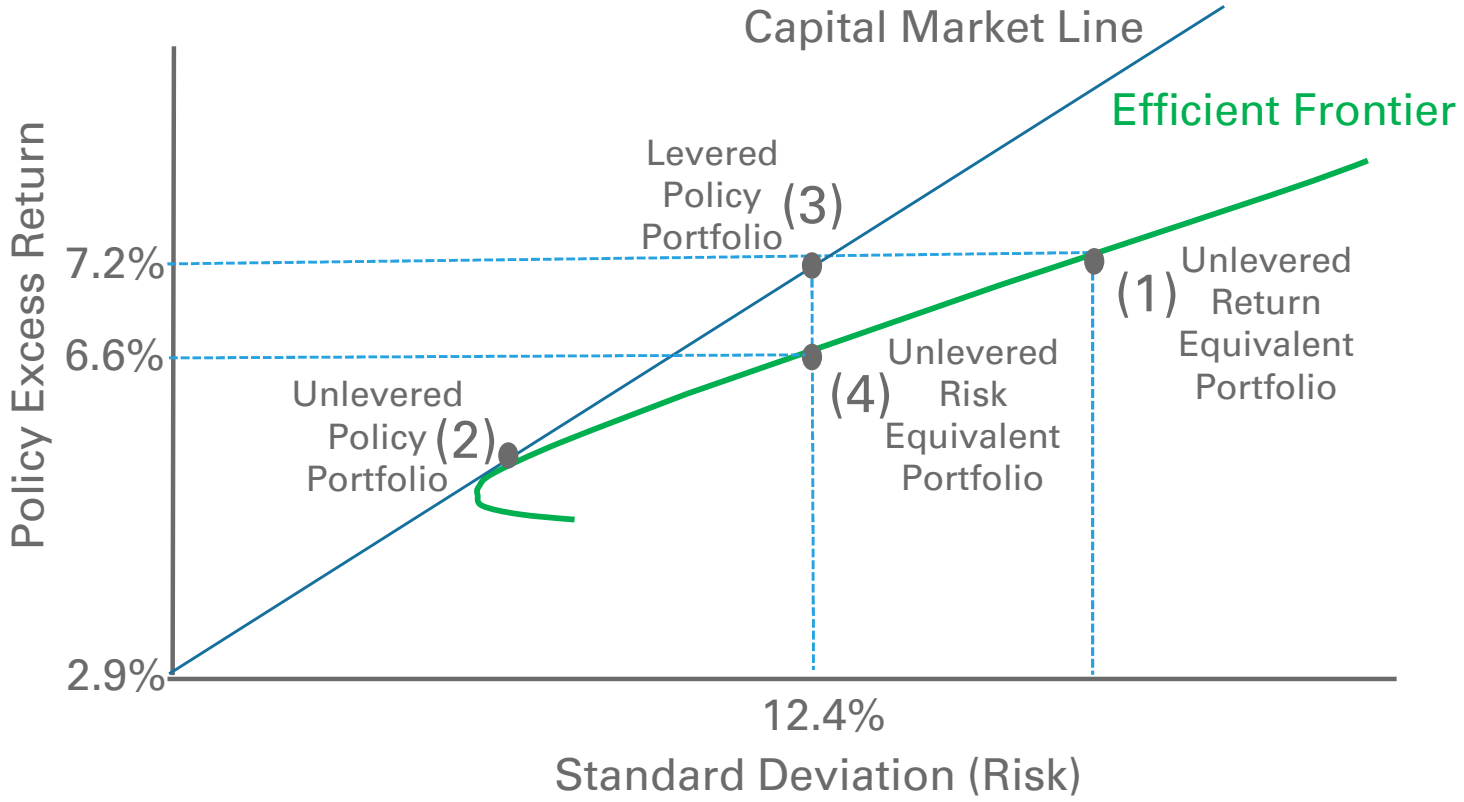
# CTF PRIVATE MARKET ALLOCATIONS

## (ALLOCATIONS TO LESS LIQUID STRATEGIES INCREASING)



# POLICY LEVERAGE FRAMEWORK

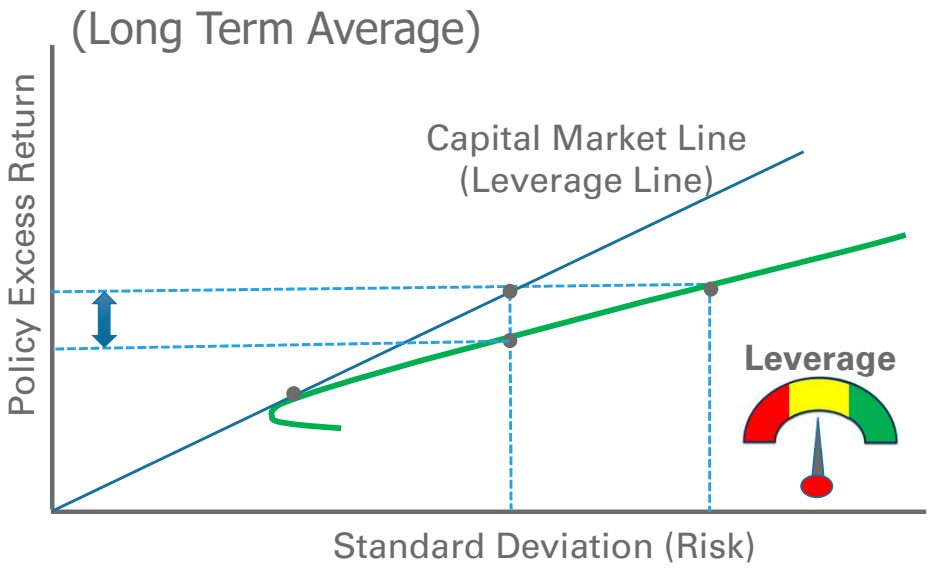
## (HISTORICAL LEVERAGE PREFERENCE)

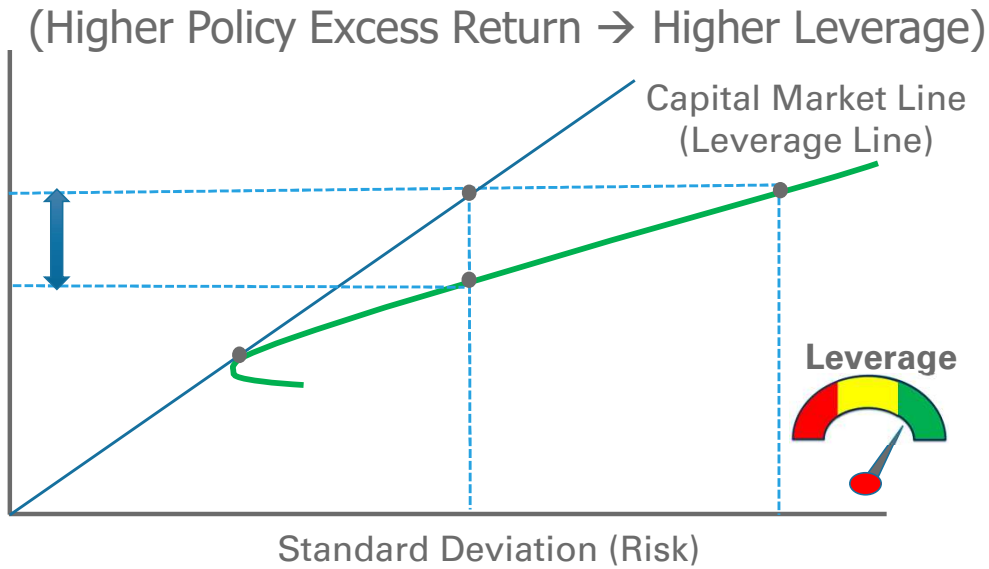


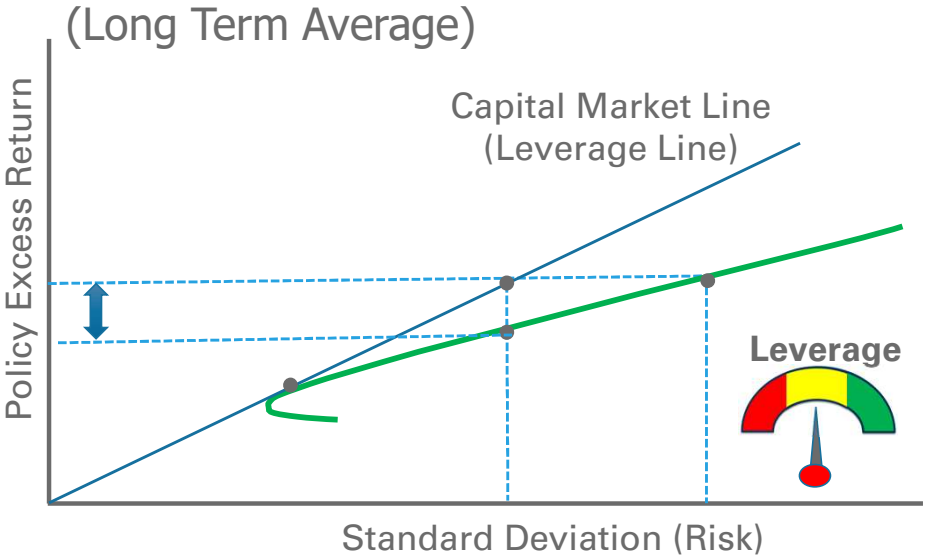

Steps:

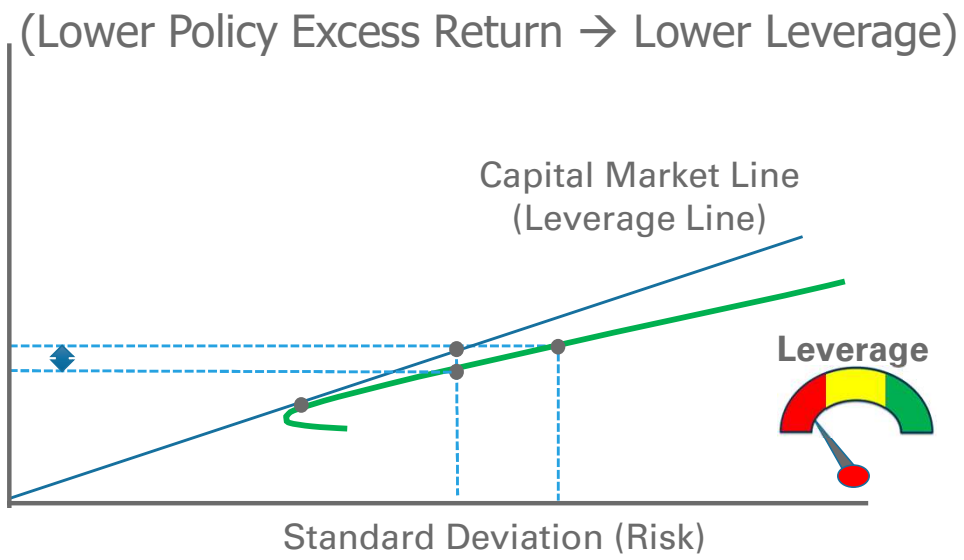
1. Determine long term average return and risk for Policy Portfolio and cash
2. Determine long term average return of Unlevered Risk Equivalent Portfolio
3. Implied leverage preference over long term has averaged 1.16x.
4. Leverage changes over time:
   - Sharpe Ratio near term > Sharpe Ratio long term, Leverage ratio > 1.16x
   - Sharpe Ratio near term < Sharpe Ratio long term, Leverage ratio < 1.16x

# POLICY LEVERAGE FRAMEWORK



# POLICY LEVERAGE FRAMEWORK

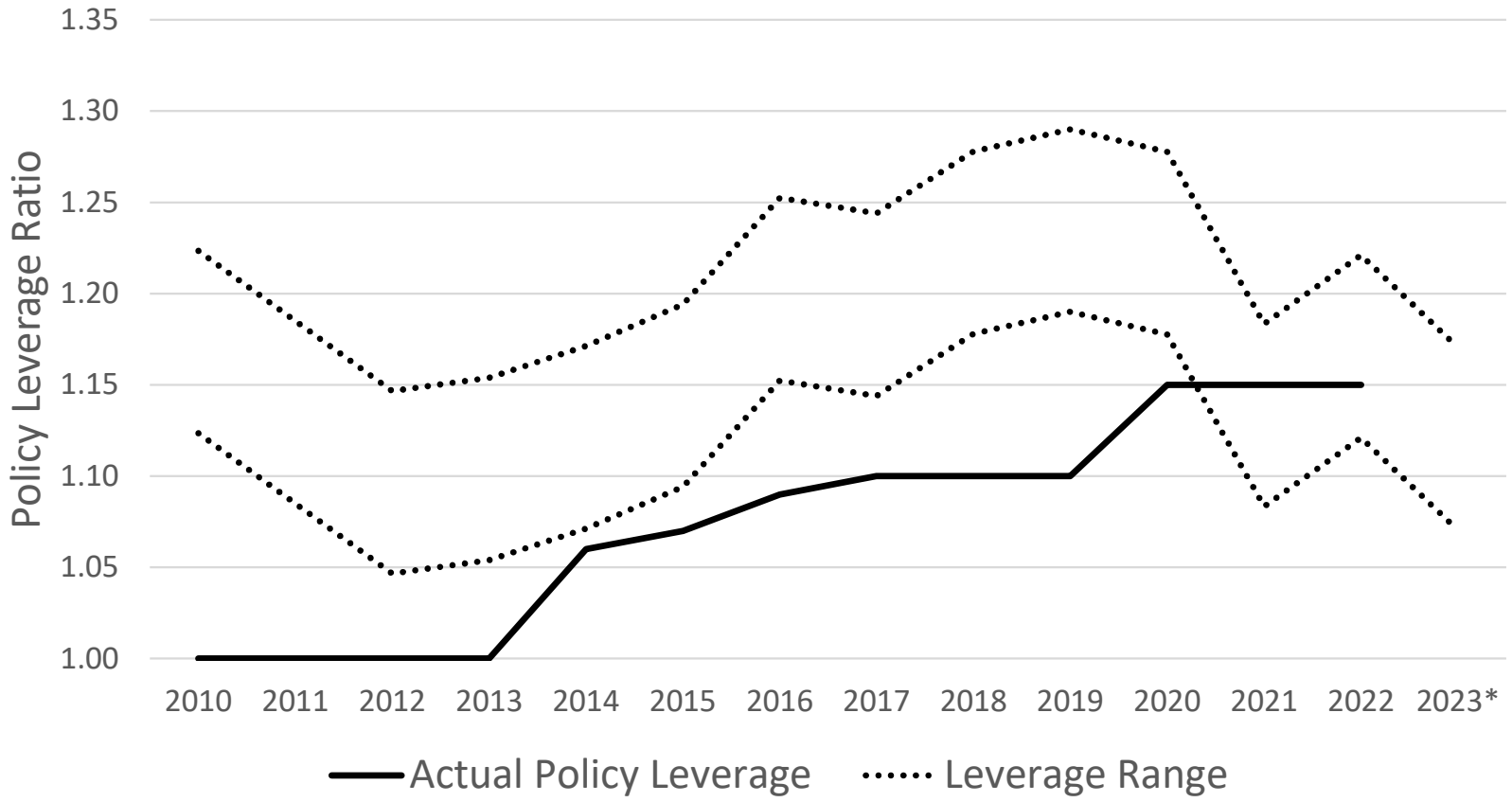
## (LEVERAGE ADJUSTMENTS WITH HYPOTHETICAL SCENARIOS)

| | Scenario | Policy Return | Cash Return | Excess Return | Standard Deviation (Risk) | Sharpe Ratio | Risk Equivalent Sharpe Ratio* | Leverage Ratio |
|---|---|---|---|---|---|---|---|---|
| | Long Term | 7.22 | 2.94 | 4.28 | 12.38 | 0.35 | 0.30 | 1.16x |
| Change in Policy Return | Higher Policy Return | 7.62 | 2.94 | 4.68 | 12.38 | 0.38 | 0.30 | 1.27x |
| | Lower Policy Return | 6.82 | 2.94 | 3.88 | 12.38 | 0.31 | 0.30 | 1.05x |
| Change in Cash Return | Lower Cash Return | 7.22 | 2.54 | 4.68 | 12.38 | 0.38 | 0.30 | 1.27x |
| | Higher Cash Return | 7.22 | 3.34 | 3.88 | 12.38 | 0.31 | 0.30 | 1.05x |
| Change in Policy Risk | Lower Policy Risk | 7.22 | 2.94 | 4.28 | 11.35 | 0.38 | 0.30 | 1.27x |
| | Higher Policy Risk | 7.22 | 2.94 | 4.28 | 13.70 | 0.31 | 0.30 | 1.05x |

* Long Term Risk Equivalent Portfolio's Sharpe Ratio: 0.30 = (6.62 - 2.94)/12.38

# POLICY LEVERAGE FRAMEWORK: HISTORY VS MODEL

## (ACTUAL LEVERAGE COMPARED TO MODEL-BASED LEVERAGE RANGE)




* 2023 Leverage Range based on preliminary policy allocation

# RECOMMENDATIONS

# CURRENT AND RECOMMENDED ALLOCATIONS

## SUMMARY

| Asset Class | 10 Year Return Geometric Return | 10 Year Sharpe Ratio | 30 Year Return Geometric Return | 30 Year Sharpe Ratio | Standard Deviation | Current Policy | Recommended Targets | Recommended Rebalance Ranges |
|---|---|---|---|---|---|---|---|---|
| Public Equity | 5.6% | 0.09 | 7.3% | 0.22 | 18.0% | 48% | 42% | 36 - 48% |
| Public Fixed Income | 5.9% | 0.30 | 5.8% | 0.38 | 6.3% | 25% | 25% | 19 - 31% |
| Private Equity/Debt | 8.4% | 0.22 | 8.4% | 0.30 | 20.3% | 15% | 18% | 10 - 26% |
| Real Estate | 5.3% | 0.08 | 5.8% | 0.16 | 15.0% | 8% | 8% | 4 - 12% |
| TIPS | 4.6% | 0.09 | 4.4% | 0.16 | 6.1% | 19% | 19% | 14 - 24% |
| Cash | 4.0% | N/A | 3.4% | N/A | 0.6% | 0% | 0% | |
| Leverage | 4.3% | N/A | 3.7% | N/A | 0.6% | 15% | 12% | |
| Total | | | | | | **115%** | **112%** | **104 - 120%*** |
| | | | | | | | | |
| 10 Year Compound Return | | | | | | 6.4% | 6.5% | |
| 10 Year Sharpe Ratio | | | | | | 0.18 | 0.19 | |
| 30 Year Compound Return | | | | | | 7.5% | 7.4% | |
| 30 Year Sharpe Ratio | | | | | | 0.31 | 0.32 | |
| Standard Deviation | | | | | | 13.1% | 12.6% | |
| | | | | | | | | |
| Target Active Risk** | | | | | | 1.2% | 1.2% | |

* SWIB Staff allowed to eliminate leverage, i.e., down to 100%

** Target Active Risk has a range of +/- 0.6%

# PUBLIC EQUITY STRUCTURE

| | Current Equity Allocation* | % of Total Portfolio | Recommended Equity Allocation* | % of Total Portfolio |
|---|---|---|---|---|
| Global Equities | 80.6% | 38.7% | 80.6% | 33.9% |
| US Small Cap Equities | 5.9% | 2.8% | 5.9% | 2.5% |
| Int'l Small Cap Equities | 3.9% | 1.9% | 3.9% | 1.6% |
| Emerging Market Large Cap | | | | |
| China | 1.4% | 0.7% | 1.4% | 0.6% |
| x-China | 6.7% | 3.2% | 6.7% | 2.8% |
| Emerging Market Small Cap | 1.5% | 0.7% | 1.5% | 0.6% |
| Total | | **48%** | | **42%** |
| | | | | |
| 10 Year Compound Return | 5.6% | | 5.6% | |
| 30 Year Compound Return | 7.3% | | 7.3% | |
| Standard Deviation | 18.0% | | 18.0% | |
| 10 Year Sharpe Ratio | 0.09 | | 0.09 | |
| 30 Year Sharpe Ratio | 0.22 | | 0.22 | |

* Market capitalization weights as of June 30, 2023; Actual market capitalization weights will float with market moves over time

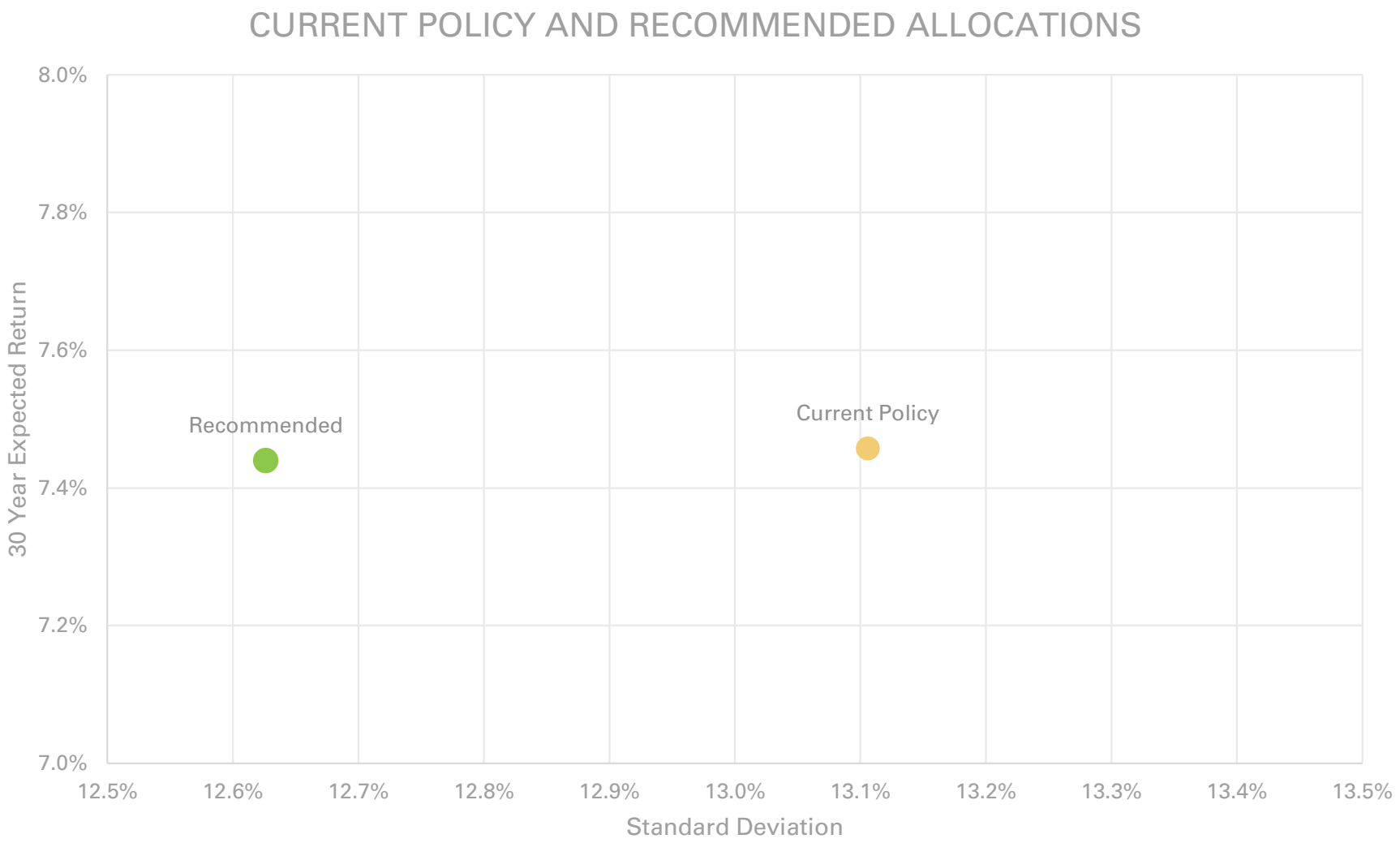
Source: Bloomberg, FactSet

# PUBLIC FIXED INCOME STRUCTURE

| | Current Fixed Income Allocation | % of Total Portfolio | Recommnded Fixed Income Allocation | % of Total Portfolio |
|---|---|---|---|---|
| US Treasuries | 24.0% | 6.0% | 24.0% | 6.0% |
| US Investment Grade Credit | 24.0% | 6.0% | 24.0% | 6.0% |
| Mortgage-Backed | 8.0% | 2.0% | 8.0% | 2.0% |
| Long Treasuries | 4.0% | 1.0% | 4.0% | 1.0% |
| High Yield Bonds | 20.0% | 5.0% | 20.0% | 5.0% |
| Leveraged Loans | 10.0% | 2.5% | 10.0% | 2.5% |
| Emerging Market Debt* | 10.0% | 2.5% | 10.0% | 2.5% |
| Total | | **25%** | | **25%** |
| | | | | |
| 10 Year Compound Return | 5.9% | | 5.9% | |
| 30 Year Compound Return | 5.8% | | 5.8% | |
| Standard Deviation | 6.3% | | 6.3% | |
| 10 Year Sharpe Ratio | 0.30 | | 0.30 | |
| 30 Year Sharpe Ratio | 0.38 | | 0.38 | |

Source: Bloomberg, FactSet

# CURRENT POLICY AND RECOMMENDED

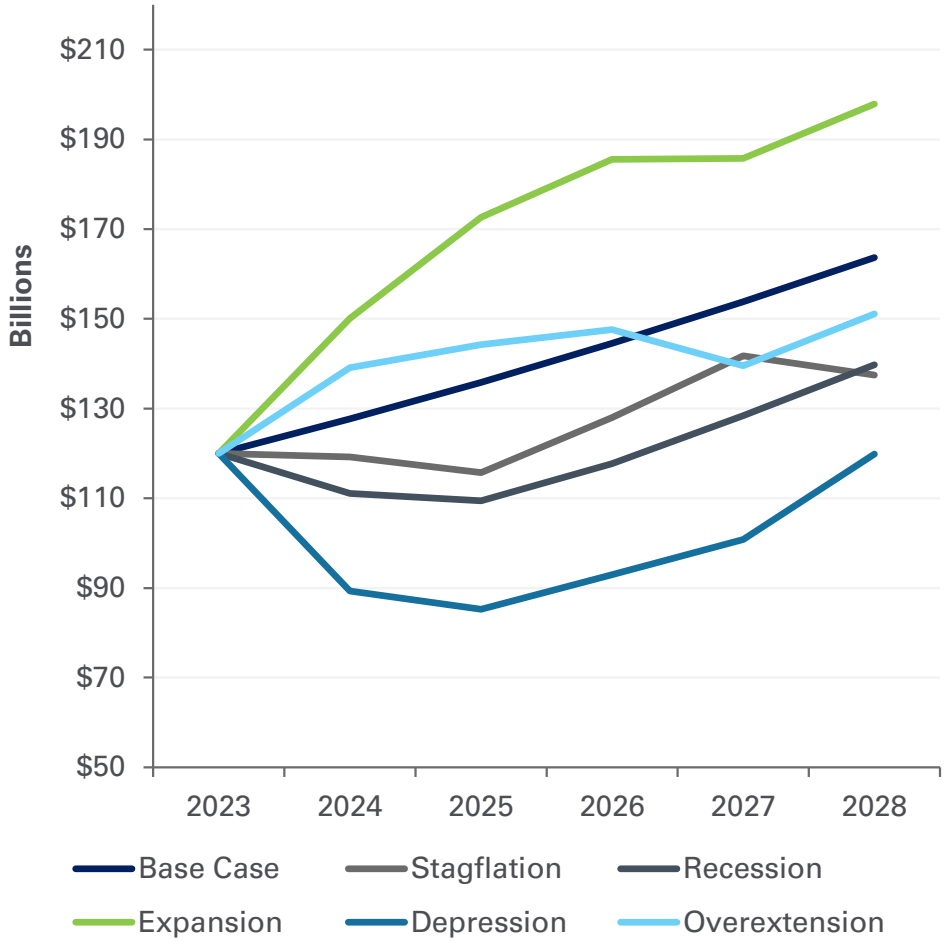



Source: Bloomberg, FactSet

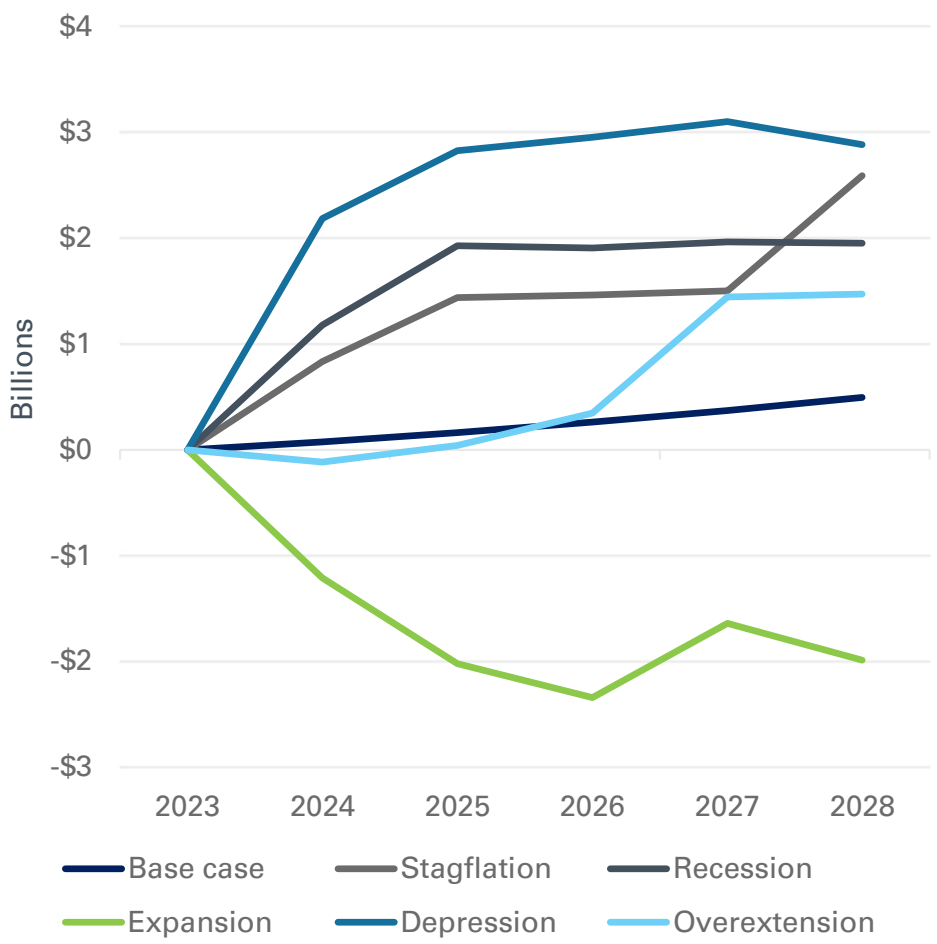
# SCENARIO ANALYSIS

## CURRENT AND RECOMMENDED

### Current Policy




### Recommended v. Current Policy



# REFERENCE PORTFOLIO ATTRIBUTION

| | 10 Year Expected Return | Standard Deviation | 30 Year Expected Return |
|---|---|---|---|
| Reference Portfolio | 5.65% | 11.26% | 6.62% |
| Private Markets | 0.56% | 0.14% | 0.45% |
| Portfolio Structure | 0.16% | 0.36% | 0.14% |
| Leverage | 0.11% | 0.87% | 0.23% |
| Recommended Portfolio | 6.47% | 12.63% | 7.44% |

# ACTIVE RETURN ENHANCES TOTAL RETURN

| | Return Contribution | Risk |
|---|---|---|
| **10 Years** | | |
| Proposed Policy Portfolio | 6.5% | 12.6% |
| Active Return | 0.3-0.8% | 0.6-1.8% |
| Total | 6.8-7.3% | 12.7-13.1% |
| **30 Years** | | |
| Proposed Policy Portfolio | 7.4% | 12.6% |
| Active Return | 0.3-0.8% | 0.6-1.8% |
| Total | 7.7-8.2% | 12.7-13.1% |

# VARIABLE RETIREMENT TRUST ALLOCATION

| | Current & Recommended Policy Portfolio | Rebalancing Range |
|---|---|---|
| US Equities | 70% | 65 - 75% |
| Int'l Equities incl. Emerging | 30% | 25 - 35% |
| | | |
| 10 Year Compound Return | 5.5% | |
| 30 Year Compound Return | 7.3% | |
| Standard Deviation | 17.7% | |
| 10 Year Sharpe Ratio | 0.09 | |
| 30 Year Sharpe Ratio | 0.22 | |
| | | |
| Target Active Risk* | 0.6% | |

* Target Active Risk has a range of +/- 0.3%

Source: Bloomberg, FactSet

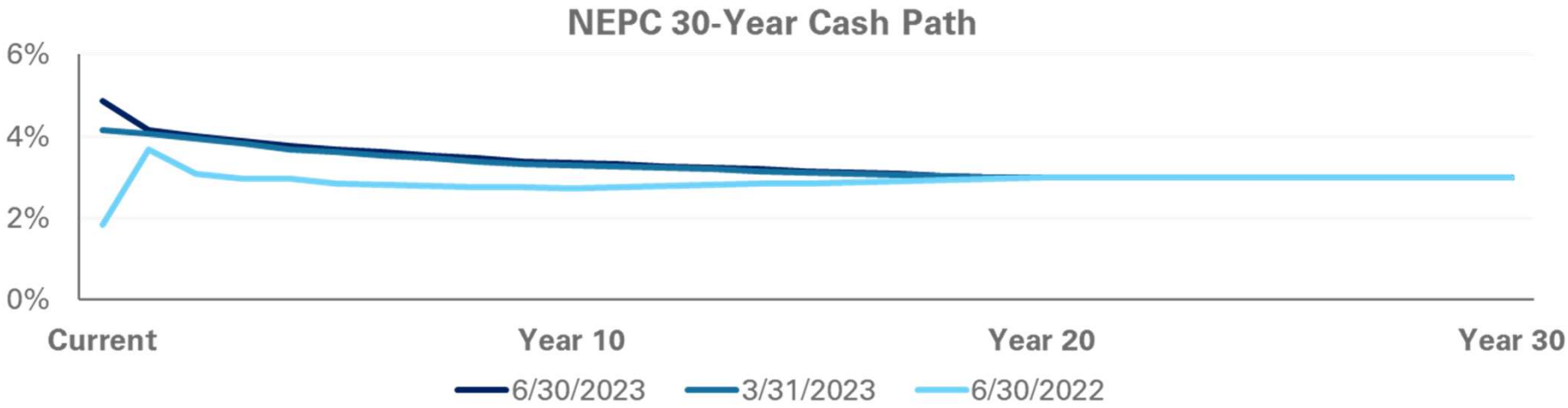
# ACTIVE RETURN ENHANCES TOTAL RETURN

| | Return Contribution | Risk |
|---|---|---|
| **10 Years** | | |
| Proposed Policy Portfolio | 5.5% | 17.7% |
| Active Return | 0.1-0.4% | 0.3-0.9% |
| Total | 5.6-5.9% | 17.8-17.9% |
| **30 Years** | | |
| Proposed Policy Portfolio | 7.3% | 17.7% |
| Active Return | 0.1-0.4% | 0.3-0.9% |
| Total | 7.4-7.7% | 17.9-17.9% |

# APPENDIX

# JUNE 30, 2023 CAPITAL MARKET ASSUMPTIONS DETAIL

# U.S. CASH
## EXPECTATIONS




- **Cash is a foundational input for all asset class return expectations**
  - Cash + risk premia is an input for long-term asset class return projections
- **Cash assumptions reflect inflation and real interest rates**
- **U.S. nominal rate forecasts reflect continued tighter policy in the near-term, but long-term expectations remain subdued relative to history**

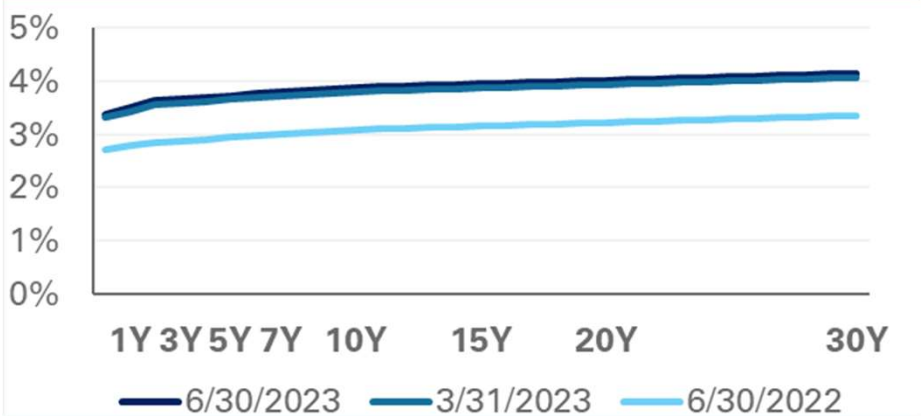
Sources: Bloomberg, FactSet, NEPC

# GLOBAL INTEREST RATES

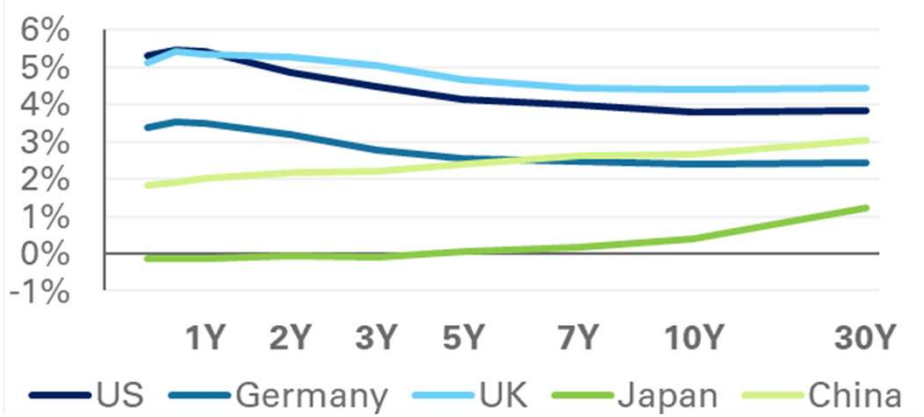
## EXPECTATIONS

- **Real yields have normalized, reflecting a tighter policy environment**
  - Higher real rates support returns in the long-term, but also signal a shift in risk posture for markets
- **More restrictive Fed policy has lifted bond yield forecasts**
- **The outlook is relatively poor for non-U.S. developed markets due to the nominal yield differential**
- **Emerging market real rates and nominal interest rates are higher relative to the developed world**

**NEPC 10-Year Forward Curve**




**Global Yield Curves**



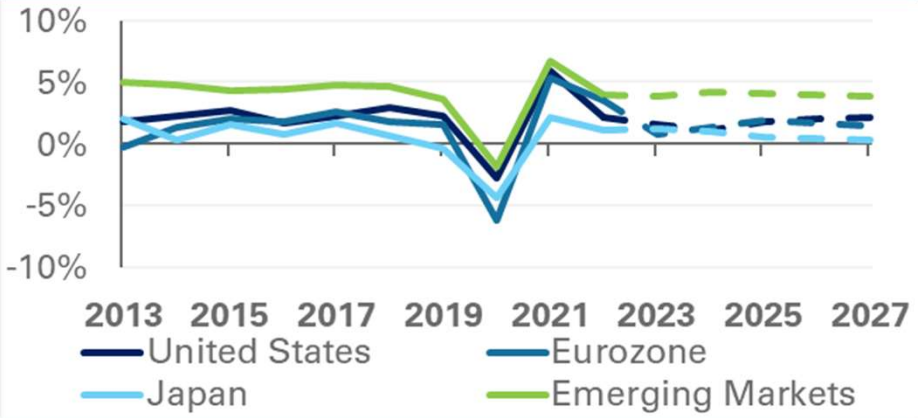

Sources: FactSet, NEPC

# PUBLIC EQUITY

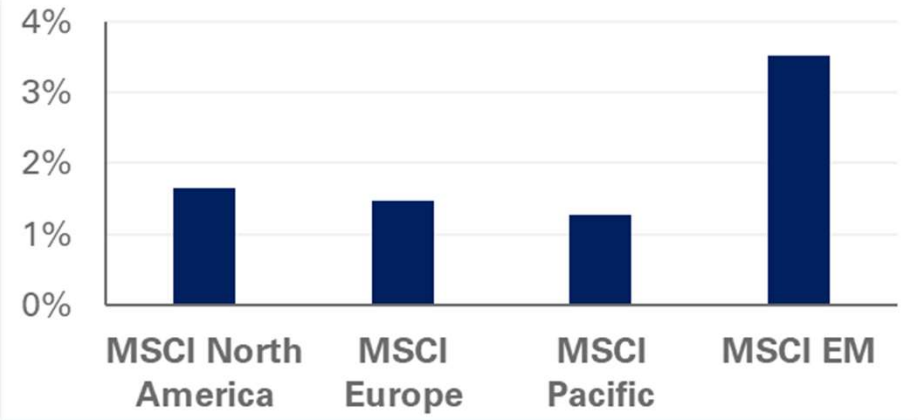
## REAL EARNINGS GROWTH

- **Regions reliant on revenue from emerging markets are forecasted to benefit from higher earnings growth**
  - Non-U.S. stocks benefit from a greater portion of revenue from EM than U.S. stocks
- **We expect elevated real earnings growth for small-caps over the long-term relative to large-cap**
  - Over the long-term we expect a forward-looking risk premium for small-cap and mid-cap equities relative to large-cap stocks

**Real GDP Growth Projections**




**Expected 5-Year Real Growth**

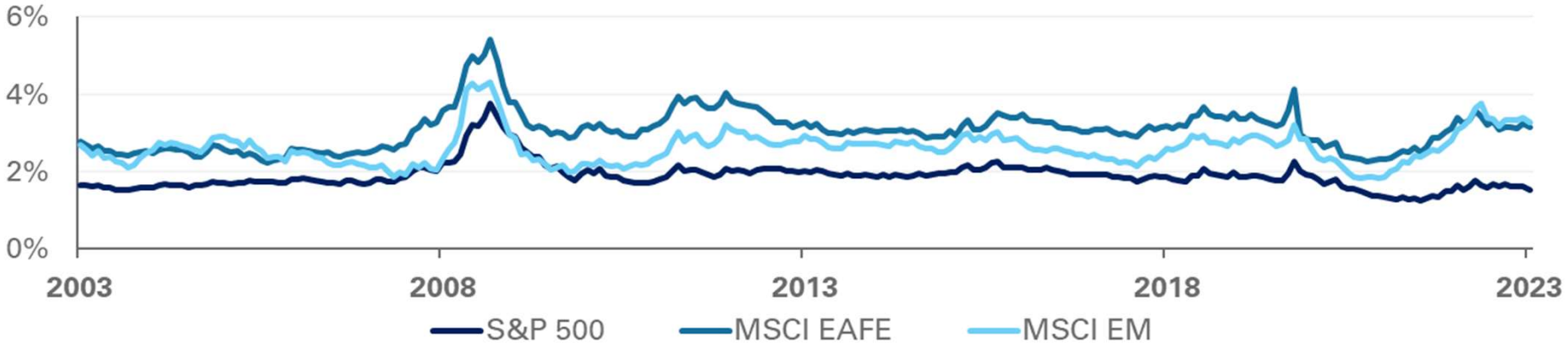



Sources: IMF, MSCI, FactSet, NEPC

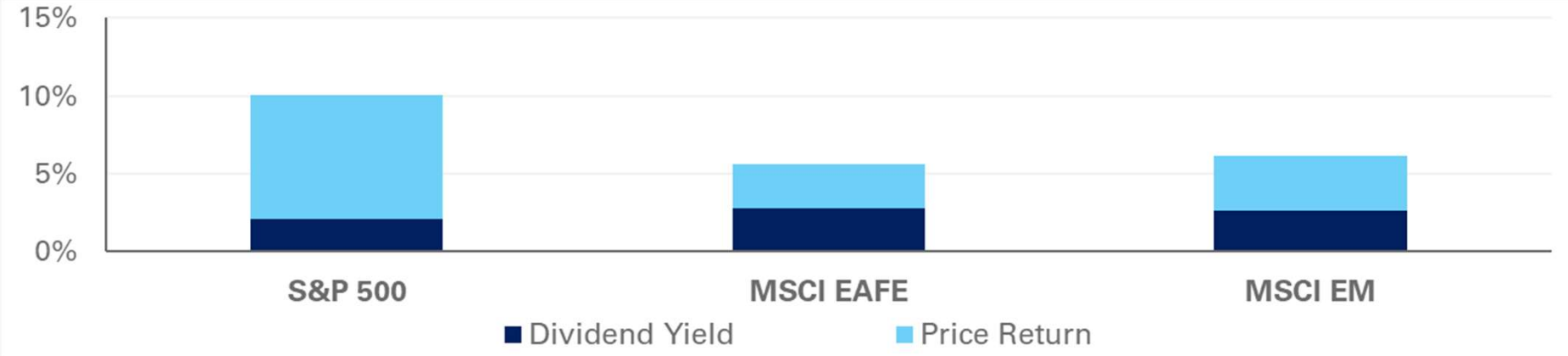
# PUBLIC EQUITY DIVIDEND YIELDS

## NON-U.S. EQUITY OFFERS HIGHER YIELDS RELATIVE TO THE U.S.

### Dividend Yield




### 30-Year Annualized Return

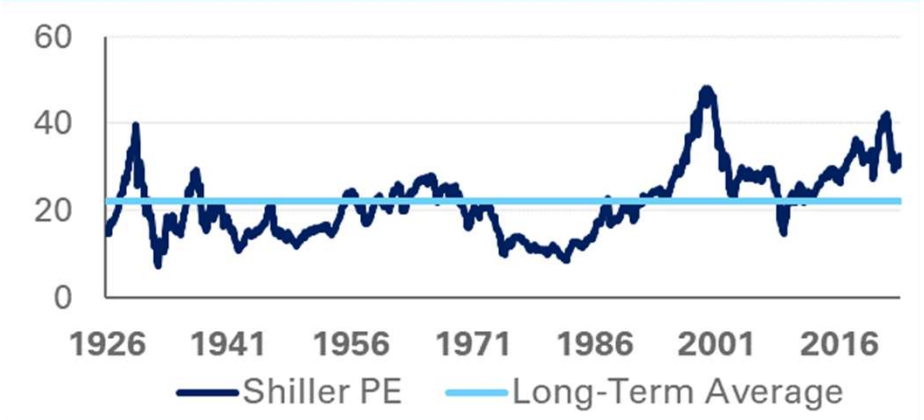



Sources: S&P, MSCI, FactSet

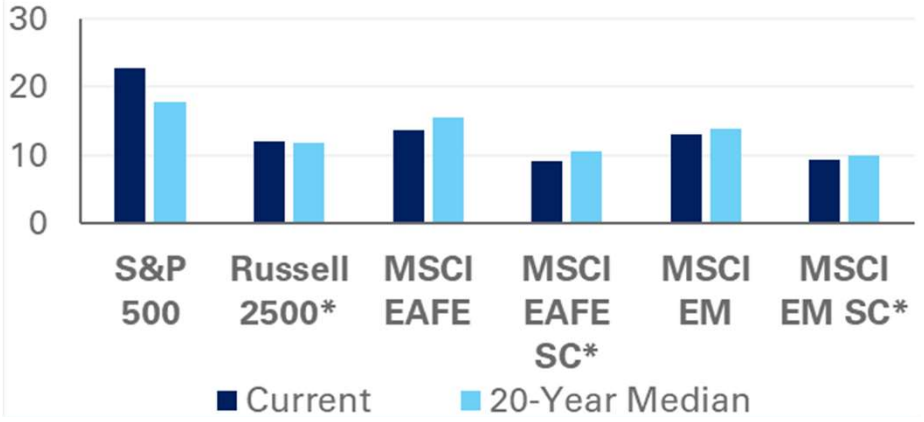
# PUBLIC EQUITY
## VALUATION

- **Valuations in the U.S. rose and remain elevated relative to long-term averages**
  - Non-U.S. equity valuations increased, but remain below 20-year historical medians levels
- **EAFE valuation inputs are lower relative to the US and reflect the economic growth profile**
- **Emerging market stocks offer an elevated total return opportunity relative to developed markets**

**S&P 500 Shiller PE Ratio**



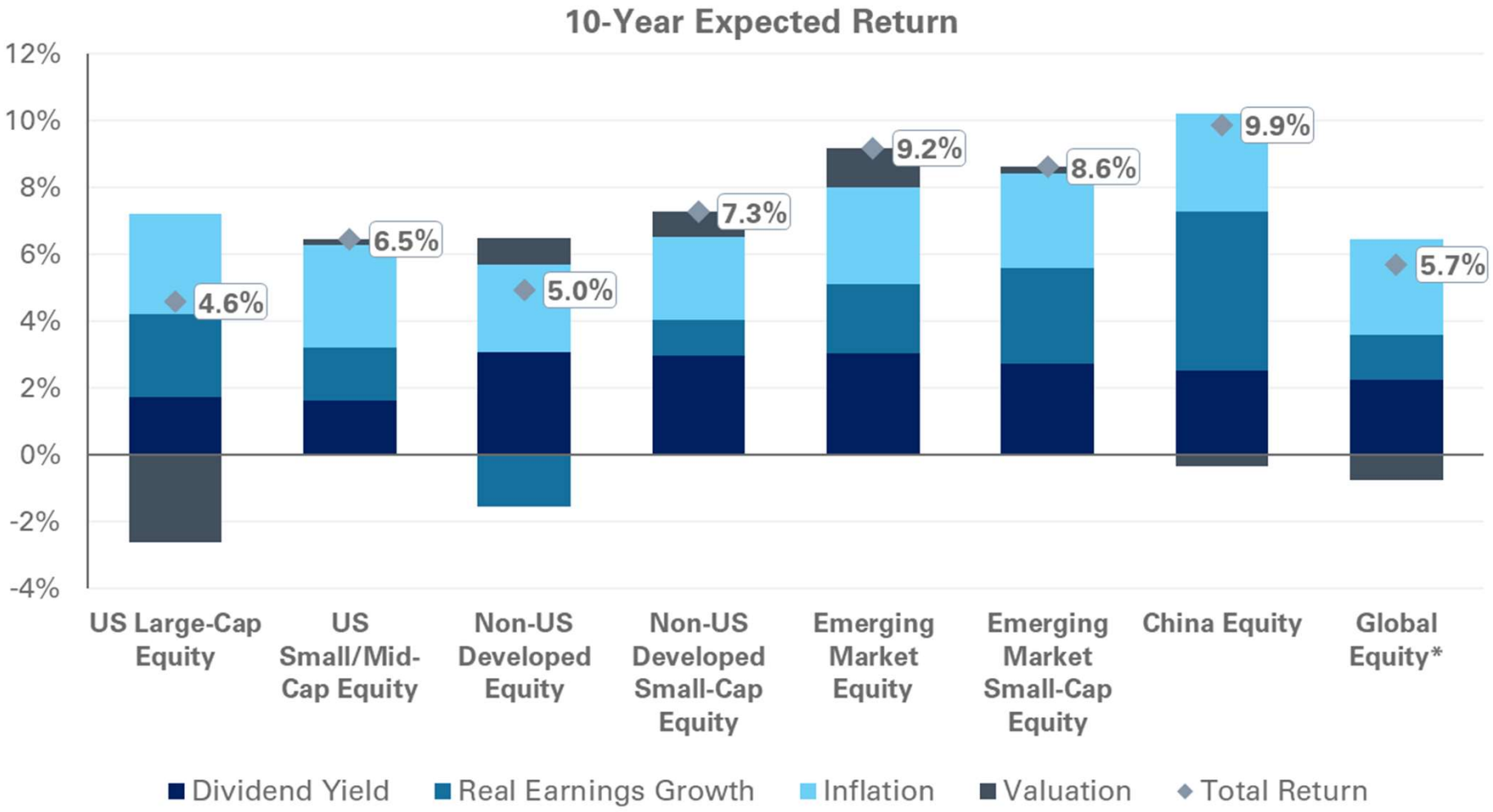

**Trailing PE Relative Median**




Sources: S&P, Shiller, Russell, MSCI, FactSet, NEPC; Shiller PE long-term average beginning in 1926
Note: *Small cap indices valuations based on EV/EBITDA multiples; MSCI EM Small Cap median calculated since 3/31/2003

# PUBLIC EQUITY

## BUILDING BLOCKS




Source: NEPC

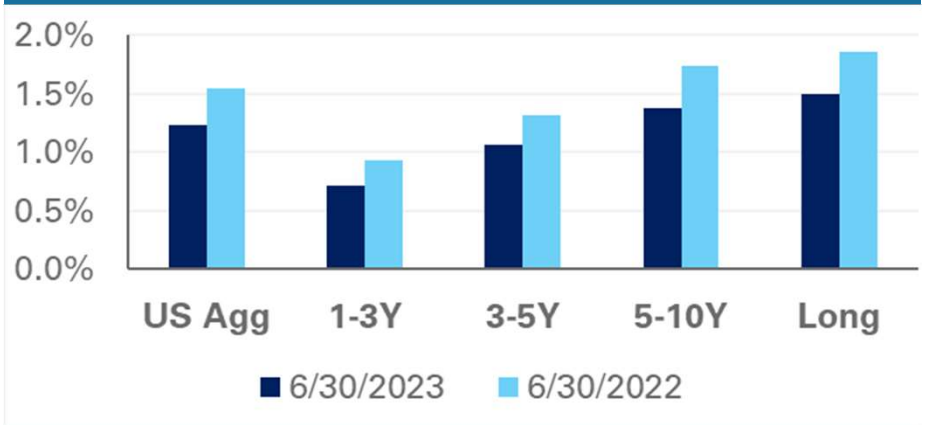
*Calculated as a blend of other classes

# FIXED INCOME

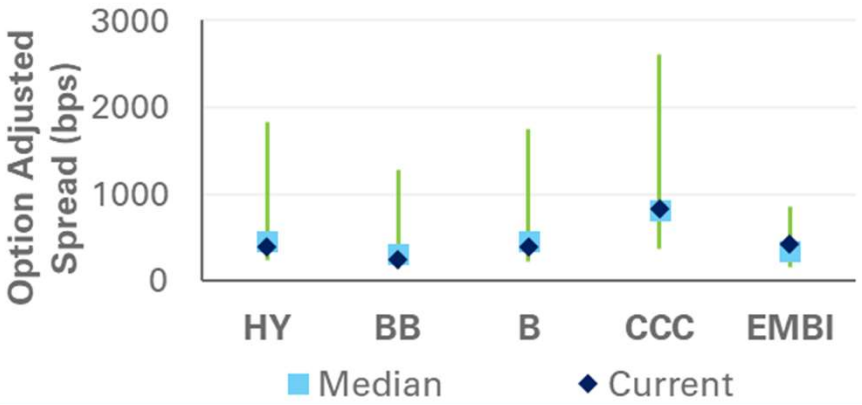
## CREDIT SPREADS

- **Credit spreads tightened and are moderately below median levels**
- **Lower credit spread levels weigh on future return expectations**
- **Credit spread assumptions reflect a multi-year path for default rates**
  - CCC spreads relative to expected default rates reflect heightened economic concerns and are a drag on high yield return assumptions
- **Default and recovery rates are informed by long-term history**

**U.S. Corporate OAS by Maturity**




**Return-Seeking Credit Spreads**



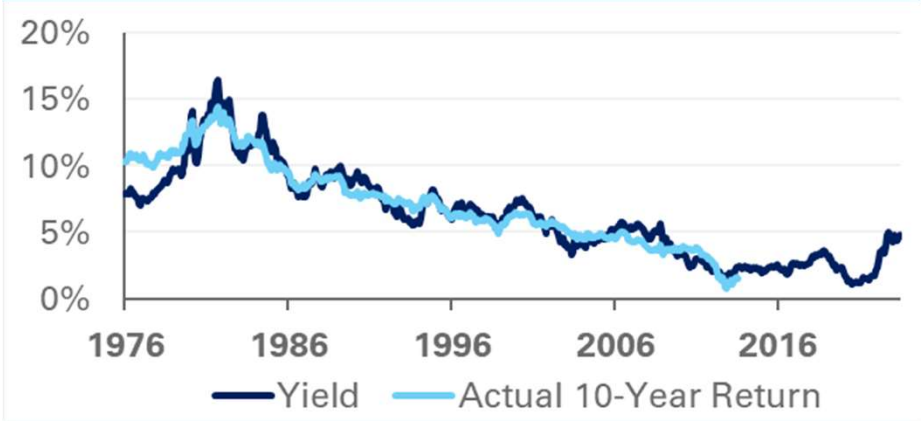

Sources: Barclays, JPM, FactSet, NEPC; Spread medians as of 12/31/2000

# FIXED INCOME

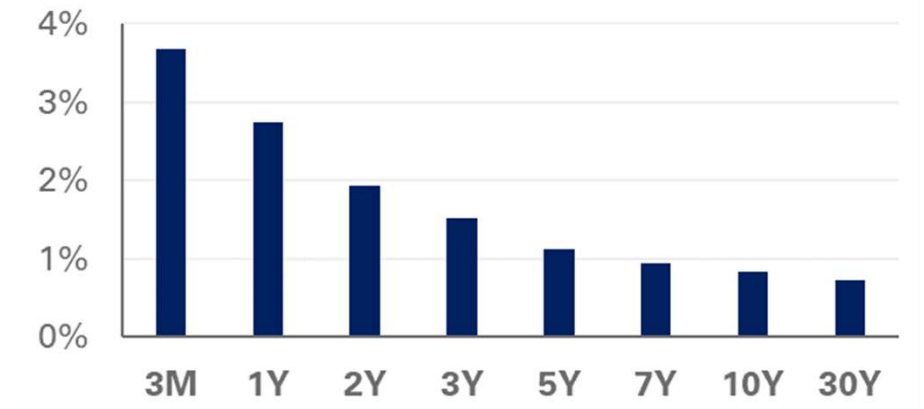
## GOVERNMENT RATES

- **Government rates price change reflects shifts in interest rates, the yield curve, and roll down**
  - Roll down refers to the price change due to the aging of a bond along the yield curve
- **Expectations for rising rates are a headwind for return expectations**
  - However, higher interest rates boost the long-term return due to the increased yield benefit
- **A steeper yield curve relative to forward interest rates can offer relief from rising rates**

**Barclays U.S. Aggregate Bond**



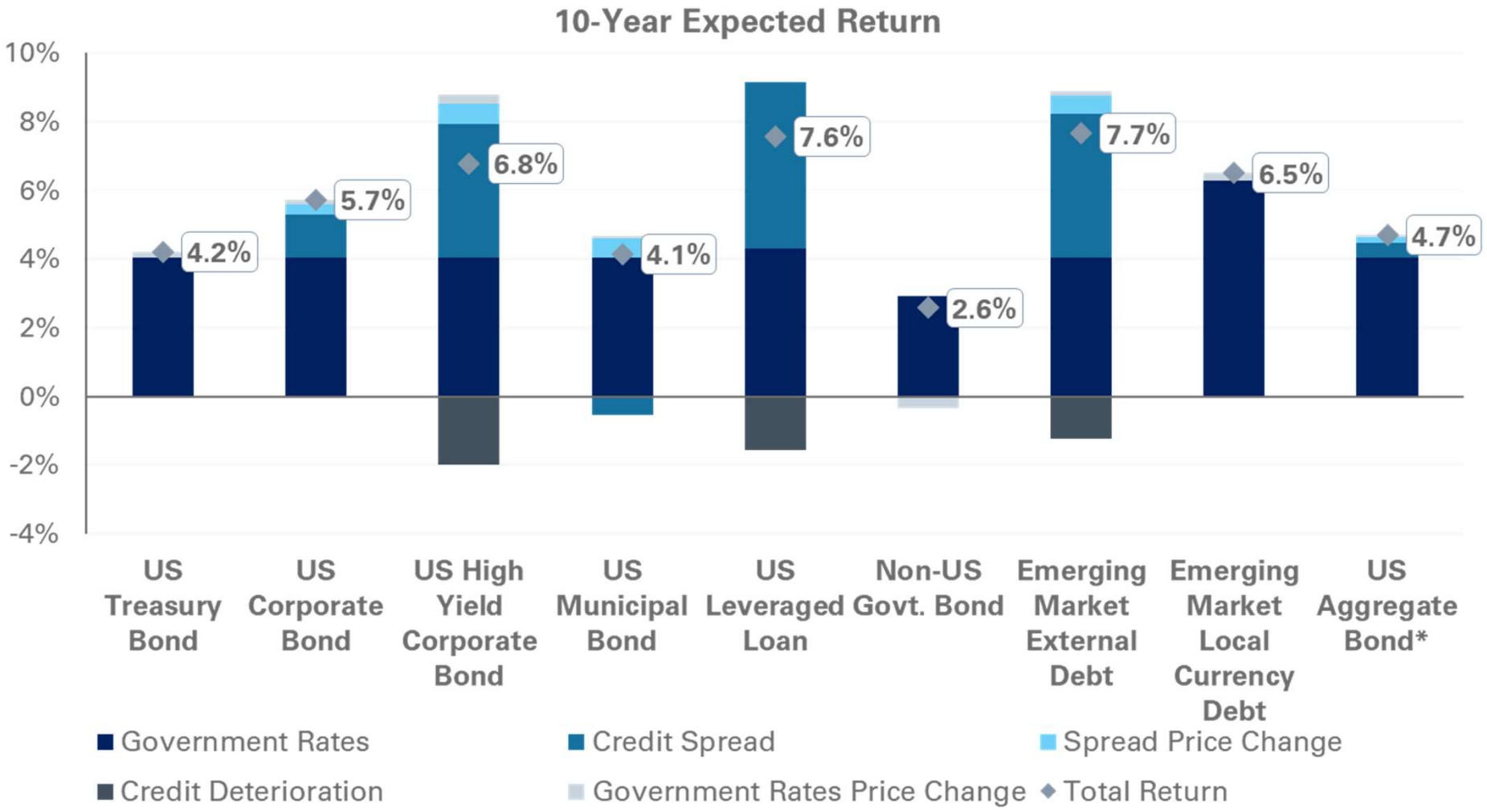

**Annual Change in Treasury Yields**




Sources: Barclays, FactSet, NEPC

# FIXED INCOME

## BUILDING BLOCKS

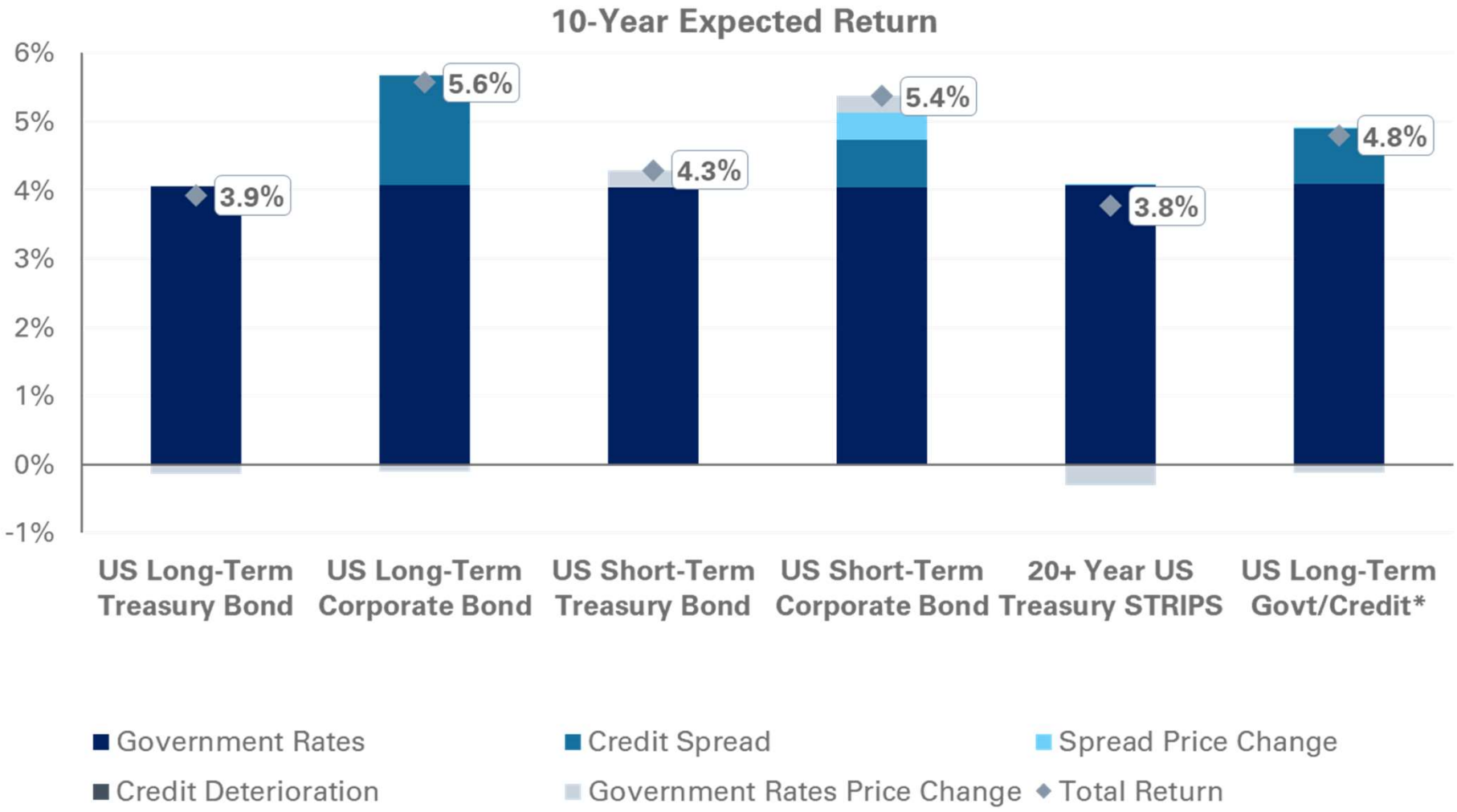



Source: NEPC

*Calculated as a blend of other classes

# FIXED INCOME

## BUILDING BLOCKS




Source: NEPC

*Calculated as a blend of other classes

# 10-YEAR RETURN FORECASTS

## EQUITY

| Geometric Expected Return | | | |
|---|---|---|---|
| **Asset Class** | **06/30/2023** | **06/30/2022** | **Delta** |
| U.S. Large-Cap Equity | 4.6% | 5.8% | -1.2% |
| U.S. Small/Mid-Cap Equity | 6.5% | 7.2% | -0.7% |
| Non-U.S. Developed Equity | 5.0% | 6.4% | -1.4% |
| Non-U.S. Developed Equity (USD Hedge) | 5.1% | 6.5% | -1.4% |
| Non-U.S. Developed Small-Cap Equity | 7.3% | 7.4% | -0.1% |
| Emerging Market Equity | 9.2% | 9.6% | -0.4% |
| Emerging Market Small-Cap Equity | 8.6% | 9.3% | -0.7% |
| Hedge Fund - Equity | 5.7% | 5.5% | +0.2% |
| Private Equity - Buyout | 7.5% | 8.3% | -0.8% |
| Private Equity - Growth | 8.8% | 9.3% | -0.5% |
| Private Equity - Early Stage Venture | 10.0% | 10.5% | -0.5% |
| Private Equity - Secondary | 7.0% | 7.8% | -0.8% |
| Non-U.S. Private Equity | 10.7% | 11.0% | -0.3% |
| China Equity | 9.9% | 9.4% | +0.5% |
| U.S. Microcap Equity | 7.4% | 8.0% | -0.6% |
| Global Equity* | 5.7% | 6.8% | -1.1% |
| Private Equity* | 9.1% | 9.8% | -0.7% |

*Calculated as a blend of other asset classes

# 10-YEAR RETURN FORECASTS

## FIXED INCOME

| Geometric Expected Return | | | |
|---|---|---|---|
| **Asset Class** | **06/30/2023** | **06/30/2022** | **Delta** |
| Cash | 4.0% | 2.9% | +1.1% |
| US TIPS | 4.6% | 3.0% | +1.6% |
| US Treasury Bond | 4.2% | 3.2% | +1.0% |
| US Corporate Bond | 5.7% | 5.2% | +0.5% |
| US Corporate Bond - AAA | 4.7% | 4.3% | +0.4% |
| US Corporate Bond - AA | 4.9% | 4.3% | +0.6% |
| US Corporate Bond - A | 5.5% | 4.8% | +0.7% |
| US Corporate Bond - BBB | 6.1% | 5.5% | +0.6% |
| US Mortgage-Backed Securities | 4.5% | 3.4% | +1.1% |
| US Securitized Bond | 5.3% | 4.1% | +1.2% |
| US Collateralized Loan Obligation | 5.8% | 4.7% | +1.1% |
| US Municipal Bond | 4.1% | 4.0% | +0.1% |
| US Municipal Bond (1-10 Year) | 3.2% | 3.0% | +0.2% |
| US Taxable Municipal Bond | 5.3% | 4.5% | +0.8% |

# 10-YEAR RETURN FORECASTS

## FIXED INCOME

| Geometric Expected Return | | | |
|---|---|---|---|
| **Asset Class** | **06/30/2023** | **06/30/2022** | **Delta** |
| Non-US Government Bond | 2.6% | 2.1% | +0.5% |
| Non-US Government Bond (USD Hedge) | 2.8% | 2.3% | +0.5% |
| Non-US Inflation-Linked Bond (USD Hedge) | 3.8% | 1.7% | +2.1% |
| US Short-Term TIPS (1-3 Year) | 4.6% | 2.8% | +1.8% |
| US Short-Term Treasury Bond (1-3 Year) | 4.3% | 3.1% | +1.2% |
| US Short-Term Corporate Bond (1-3 Year) | 5.4% | 4.4% | +1.0% |
| US Intermediate-Term TIPS (3-10 Year) | 4.6% | 3.1% | +1.5% |
| US Intermediate-Term Treasury Bond (3-10 Year) | 4.3% | 3.2% | +1.1% |
| US Intermediate-Term Corporate Bond (3-10 Year) | 6.0% | 5.3% | +0.7% |
| US Long-Term TIPS (10-30 Year) | 4.5% | 3.5% | +1.0% |
| US Long-Term Treasury Bond (10-30 Year) | 3.9% | 3.2% | +0.7% |
| US Long-Term Corporate Bond (10-30 Year) | 5.6% | 5.4% | +0.2% |
| 20+ Year US Treasury STRIPS | 3.8% | 3.1% | +0.7% |
| 10 Year US Treasury Bond | 4.0% | 3.4% | +0.6% |
| 10 Year Non-US Government Bond (USD Hedge) | 2.1% | 1.4% | +0.7% |
| US Aggregate Bond* | 4.7% | 3.8% | +0.9% |

*Calculated as a blend of other asset classes

# 10-YEAR RETURN FORECASTS

## FIXED INCOME

| Geometric Expected Return | | | |
|---|---|---|---|
| **Asset Class** | **06/30/2023** | **06/30/2022** | **Delta** |
| US High Yield Corporate Bond | 6.8% | 6.9% | -0.1% |
| US Corporate Bond - BB | 7.5% | 7.2% | +0.3% |
| US Corporate Bond - B | 6.9% | 7.4% | -0.5% |
| US Corporate Bond - CCC/Below | 2.0% | 2.3% | -0.3% |
| US Short-Term High Yield Corporate Bond (1-3 Year) | 5.9% | 5.5% | +0.4% |
| US Leveraged Loan | 7.6% | 6.6% | +1.0% |
| Emerging Market External Debt | 7.7% | 7.3% | +0.4% |
| Emerging Market Local Currency Debt | 6.5% | 6.9% | -0.4% |
| US High Yield Securitized Bond | 8.9% | 6.6% | +2.3% |
| US High Yield Collateralized Loan Obligation | 8.5% | 7.3% | +1.2% |
| US High Yield Municipal Bond | 5.8% | 5.0% | +0.8% |
| Hedge Fund - Credit | 6.9% | 6.5% | +0.4% |
| Private Debt - Credit Opportunities | 8.0% | 7.9% | +0.1% |
| Private Debt - Distressed | 8.8% | 8.7% | +0.1% |
| Private Debt - Direct Lending | 8.6% | 7.6% | +1.0% |
| Private Debt* | 8.6% | 8.0% | +0.6% |

*Calculated as a blend of other asset classes

# 10-YEAR RETURN FORECASTS

## REAL ASSETS

| Geometric Expected Return | | | |
|---|---|---|---|
| **Asset Class** | **06/30/2023** | **06/30/2022** | **Delta** |
| Commodity Futures | 4.8% | 3.4% | +1.4% |
| Midstream Energy | 6.0% | 6.0% | - |
| REIT | 6.4% | 6.1% | +0.3% |
| Global Infrastructure Equity | 5.9% | 6.1% | -0.2% |
| Global Natural Resources Equity | 6.8% | 6.4% | +0.4% |
| Gold | 5.3% | 4.4% | +0.9% |
| Real Estate - Core | 5.3% | 4.4% | +0.9% |
| Real Estate - Non-Core | 6.7% | 5.7% | +1.0% |
| Private Debt - Real Estate | 6.3% | 5.3% | +1.0% |
| Private Real Assets - Natural Resources | 8.5% | 7.9% | +0.6% |
| Private Real Assets - Infrastructure | 6.3% | 6.1% | +0.2% |

# 30-YEAR RETURN FORECASTS

## EQUITY

| Geometric Expected Return | | | |
|---|---|---|---|
| **Asset Class** | **06/30/2023** | **06/30/2022** | **Delta** |
| U.S. Large-Cap Equity | 6.7% | 6.9% | -0.2% |
| U.S. Small/Mid-Cap Equity | 7.5% | 7.5% | - |
| Non-U.S. Developed Equity | 6.5% | 7.0% | -0.5% |
| Non-U.S. Developed Equity (USD Hedge) | 6.7% | 7.2% | -0.5% |
| Non-U.S. Developed Small-Cap Equity | 7.8% | 7.8% | - |
| Emerging Market Equity | 9.4% | 9.5% | -0.1% |
| Emerging Market Small-Cap Equity | 9.3% | 9.6% | -0.3% |
| Hedge Fund - Equity | 6.1% | 5.9% | +0.2% |
| Private Equity - Buyout | 8.8% | 8.9% | -0.1% |
| Private Equity - Growth | 9.8% | 9.9% | -0.1% |
| Private Equity - Early Stage Venture | 10.6% | 10.7% | -0.1% |
| Private Equity - Secondary | 8.3% | 8.3% | - |
| Non-U.S. Private Equity | 10.9% | 11.0% | -0.1% |
| China Equity | 9.5% | 9.3% | +0.2% |
| U.S. Microcap Equity | 8.3% | 8.4% | -0.1% |
| Global Equity* | 7.4% | 7.7% | -0.3% |
| Private Equity* | 10.2% | 10.3% | -0.1% |

*Calculated as a blend of other asset classes

# 30-YEAR RETURN FORECASTS

## FIXED INCOME

| Geometric Expected Return | | | |
|---|---|---|---|
| **Asset Class** | **06/30/2023** | **06/30/2022** | **Delta** |
| Cash | 3.4% | 2.9% | +0.5% |
| US TIPS | 4.4% | 3.6% | +0.8% |
| US Treasury Bond | 4.1% | 3.4% | +0.7% |
| US Corporate Bond | 5.8% | 5.3% | +0.5% |
| US Corporate Bond - AAA | 5.0% | 4.4% | +0.6% |
| US Corporate Bond - AA | 4.9% | 4.4% | +0.5% |
| US Corporate Bond - A | 5.4% | 4.8% | +0.6% |
| US Corporate Bond - BBB | 6.0% | 5.5% | +0.5% |
| US Mortgage-Backed Securities | 4.3% | 3.7% | +0.6% |
| US Securitized Bond | 5.1% | 4.5% | +0.6% |
| US Collateralized Loan Obligation | 5.1% | 4.6% | +0.5% |
| US Municipal Bond | 3.8% | 3.5% | +0.3% |
| US Municipal Bond (1-10 Year) | 3.4% | 3.1% | +0.3% |
| US Taxable Municipal Bond | 5.8% | 5.2% | +0.6% |

# 30-YEAR RETURN FORECASTS

## FIXED INCOME

| Geometric Expected Return | | | |
|---|---|---|---|
| **Asset Class** | **06/30/2023** | **06/30/2022** | **Delta** |
| Non-US Government Bond | 3.1% | 2.8% | +0.3% |
| Non-US Government Bond (USD Hedge) | 3.3% | 3.0% | +0.3% |
| Non-US Inflation-Linked Bond (USD Hedge) | 3.7% | 2.6% | +1.1% |
| US Short-Term TIPS (1-3 Year) | 3.9% | 3.2% | +0.7% |
| US Short-Term Treasury Bond (1-3 Year) | 3.8% | 3.2% | +0.6% |
| US Short-Term Corporate Bond (1-3 Year) | 4.9% | 4.3% | +0.6% |
| US Intermediate-Term TIPS (3-10 Year) | 4.4% | 3.7% | +0.7% |
| US Intermediate-Term Treasury Bond (3-10 Year) | 4.2% | 3.6% | +0.6% |
| US Intermediate-Term Corporate Bond (3-10 Year) | 5.9% | 5.4% | +0.5% |
| US Long-Term TIPS (10-30 Year) | 4.6% | 3.8% | +0.8% |
| US Long-Term Treasury Bond (10-30 Year) | 4.2% | 3.4% | +0.8% |
| US Long-Term Corporate Bond (10-30 Year) | 6.0% | 5.5% | +0.5% |
| 20+ Year US Treasury STRIPS | 4.2% | 3.3% | +0.9% |
| 10 Year US Treasury Bond | 4.0% | 3.9% | +0.1% |
| 10 Year Non-US Government Bond (USD Hedge) | 3.0% | 2.5% | +0.5% |
| US Aggregate Bond* | 4.7% | 4.0% | +0.7% |

*Calculated as a blend of other asset classes

# 30-YEAR RETURN FORECASTS

## FIXED INCOME

| Geometric Expected Return | | | |
|---|---|---|---|
| **Asset Class** | **06/30/2023** | **06/30/2022** | **Delta** |
| US High Yield Corporate Bond | 7.1% | 6.9% | +0.2% |
| US Corporate Bond - BB | 7.7% | 7.3% | +0.4% |
| US Corporate Bond - B | 7.0% | 7.0% | - |
| US Corporate Bond - CCC/Below | 1.8% | 1.7% | +0.1% |
| US Short-Term High Yield Corporate Bond (1-3 Year) | 5.4% | 5.0% | +0.4% |
| US Leveraged Loan | 6.8% | 6.3% | +0.5% |
| Emerging Market External Debt | 7.1% | 6.5% | +0.6% |
| Emerging Market Local Currency Debt | 5.7% | 5.9% | -0.2% |
| US High Yield Securitized Bond | 8.1% | 6.8% | +1.3% |
| US High Yield Collateralized Loan Obligation | 7.7% | 7.1% | +0.6% |
| US High Yield Municipal Bond | 5.7% | 5.2% | +0.5% |
| Hedge Fund - Credit | 7.0% | 6.6% | +0.4% |
| Private Debt - Credit Opportunities | 8.4% | 8.1% | +0.3% |
| Private Debt - Distressed | 9.3% | 9.1% | +0.2% |
| Private Debt - Direct Lending | 9.0% | 8.6% | +0.4% |
| Private Debt* | 9.1% | 8.7% | +0.4% |

*Calculated as a blend of other asset classes

# 30-YEAR RETURN FORECASTS

## REAL ASSETS

| Geometric Expected Return | | | |
|---|---|---|---|
| **Asset Class** | **06/30/2023** | **06/30/2022** | **Delta** |
| Commodity Futures | 3.6% | 3.3% | +0.3% |
| Midstream Energy | 6.8% | 6.7% | +0.1% |
| REIT | 7.4% | 7.3% | +0.1% |
| Global Infrastructure Equity | 6.7% | 6.7% | - |
| Global Natural Resources Equity | 7.2% | 6.7% | +0.5% |
| Gold | 4.9% | 4.4% | +0.5% |
| Real Estate - Core | 5.8% | 5.2% | +0.6% |
| Real Estate - Non-Core | 7.3% | 6.7% | +0.6% |
| Private Debt - Real Estate | 6.3% | 5.7% | +0.6% |
| Private Real Assets - Natural Resources | 8.8% | 8.4% | +0.4% |
| Private Real Assets - Infrastructure | 6.9% | 6.8% | +0.1% |

SWIB

# Implementation Working Group and Strategic Framework

*October 18, 2023*

STATE OF WISCONSIN
INVESTMENT BOARD

# Agenda

- Purpose / Objectives of the Working Group
- Historical Implementation Trends
- Implementation Framework:
  - Active vs. passive (for internal and external strategies)
  - Internal vs. external (for active strategies)
  - Internal vs. external (for passive strategies)
- Next Steps



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# Purpose / Objectives of the Working Group

- Align with agency stakeholders on the rationale for active/passive and internal/external implementation
- Develop a general framework for decision-making on strategy implementation to complement SWIB's other strategic processes for asset allocation and active risk budgeting
- Identify operational, staffing, and other constraints to more effective implementation



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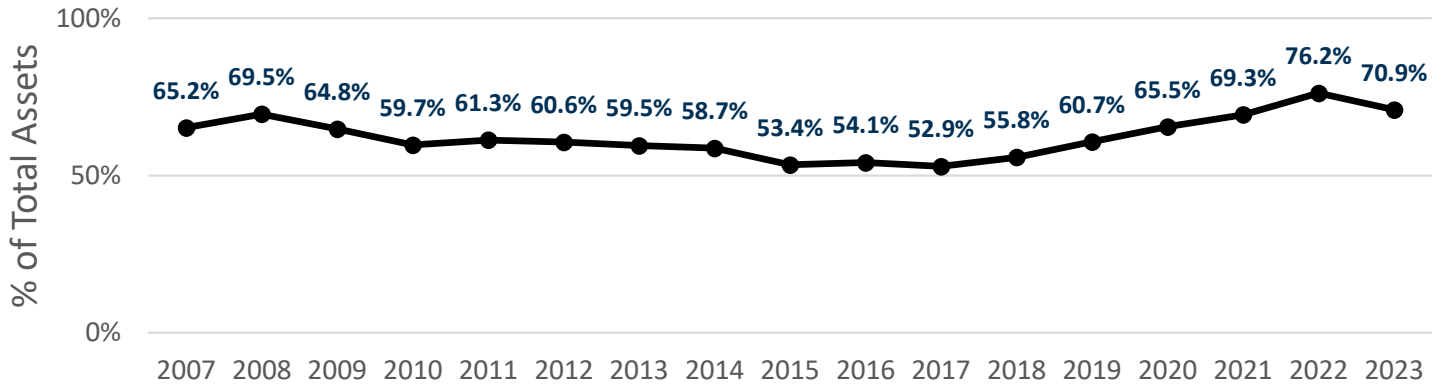
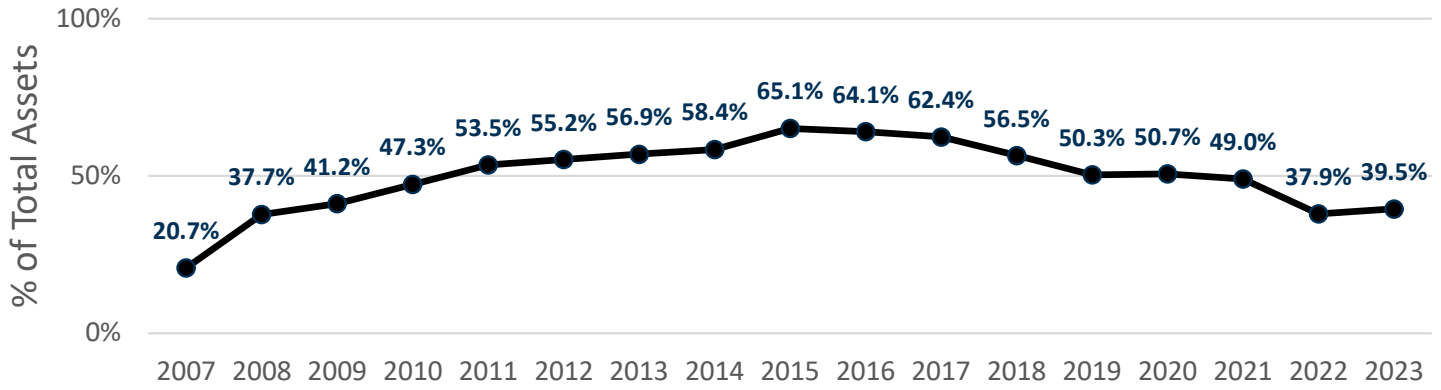
# Historical Implementation Trends

## Actively Managed WRS Assets




## Internally Managed WRS Assets



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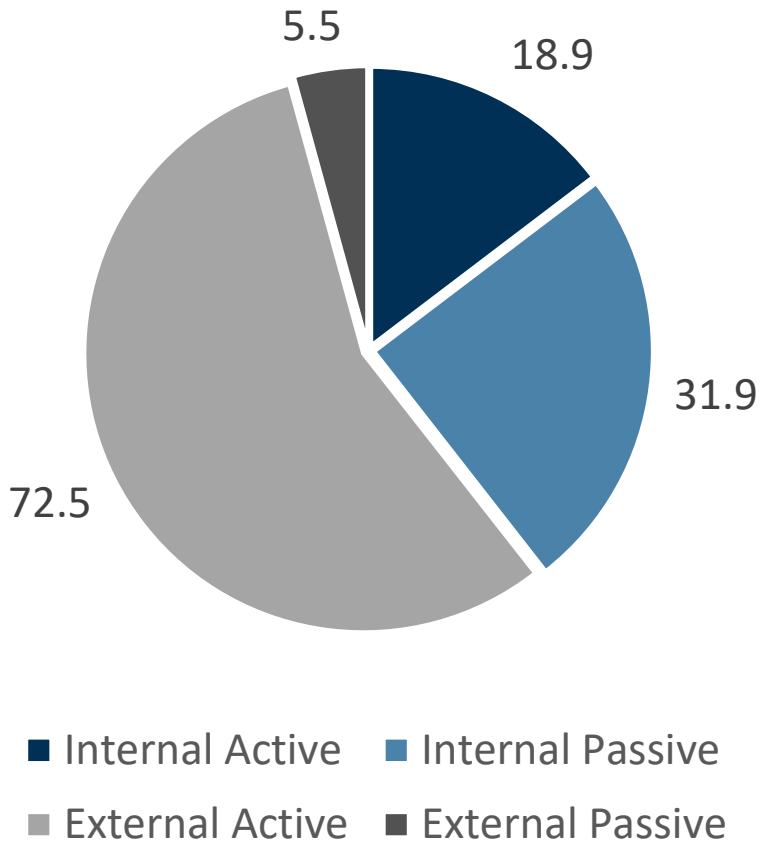
# Current Implementation

*WRS AUM as of June 2023 ($ Bln.)*



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# Implementation Framework: Active vs. Passive

*(for Internal and External Strategies)*

**Active management opportunity**

- Evaluate the building blocks of an active opportunity: asset class breadth, skill, and 'transfer coefficient'

**Scalability and expected gross alpha**

- Consider capacity of the active strategy to add value when operating at a large enough scale for the CTF

**Non-separable beta and active components of total return**

- Minimize uncompensated risk by actively managing those asset classes that do not have easily separated 'beta' and 'active' components of total return

**Illiquidity and other considerations**

- Illiquid strategies, such as private market investments, cannot be implemented in a passive manner



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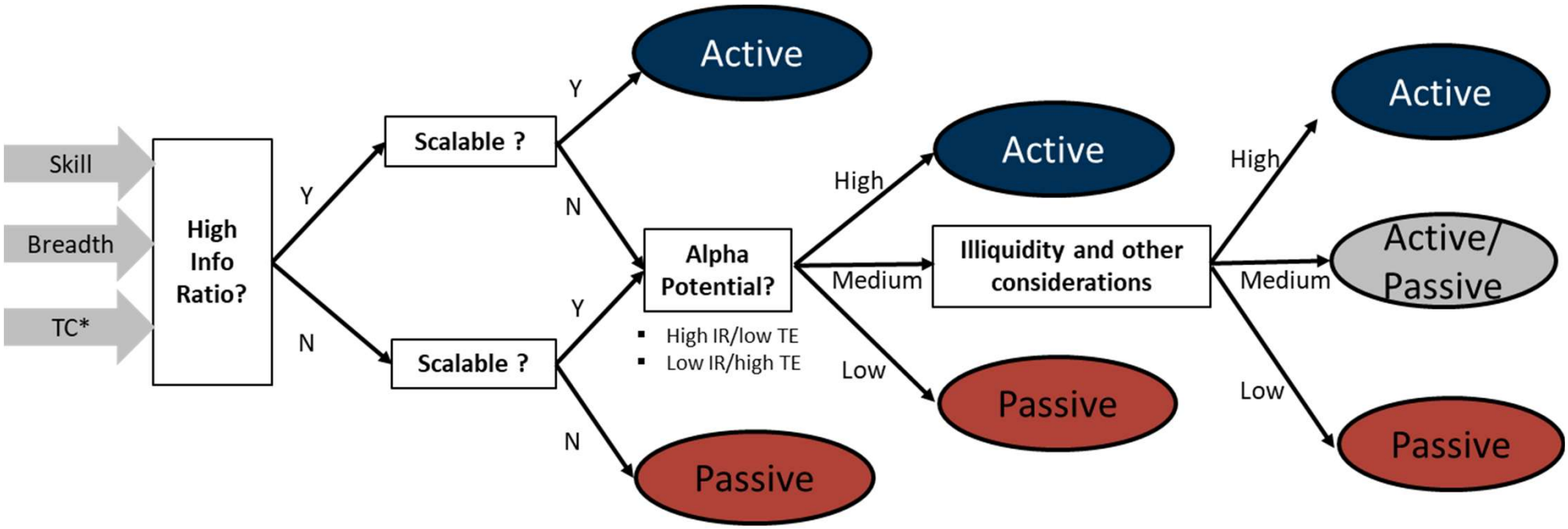
# Implementation Framework: Active vs. Passive

*(for Internal and External Strategies)*




Note: Transfer Coefficient (i.e., how effectively investment skill can be translated into active returns)



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# Implementation Framework: Internal vs External

*(for Active Strategies)*

**Operational readiness and staffing**

- Ensure that SWIB can staff an in-house investment team and implement the required back- and middle-office capabilities to support the active strategy.

**Structural advantages and other sources of 'edge'**

- Consider external strategies with structural and hard-to-replicate sources of edge. Favor strategies with a long investment horizon and strong balance sheet, which play to SWIB's natural advantages.
- Liquid and capital efficient strategies provide additional advantages that favor in-house management.

**Internal cost vs external management fee**

- In-house management generally involves lower incremental cost than external management. Evaluate expected risk-adjusted active returns net of costs.

**Benefit of diversified implementation**

- Diversifying implementation of policy allocations with both internal and external managers can reduce operational and idiosyncratic manager risks.



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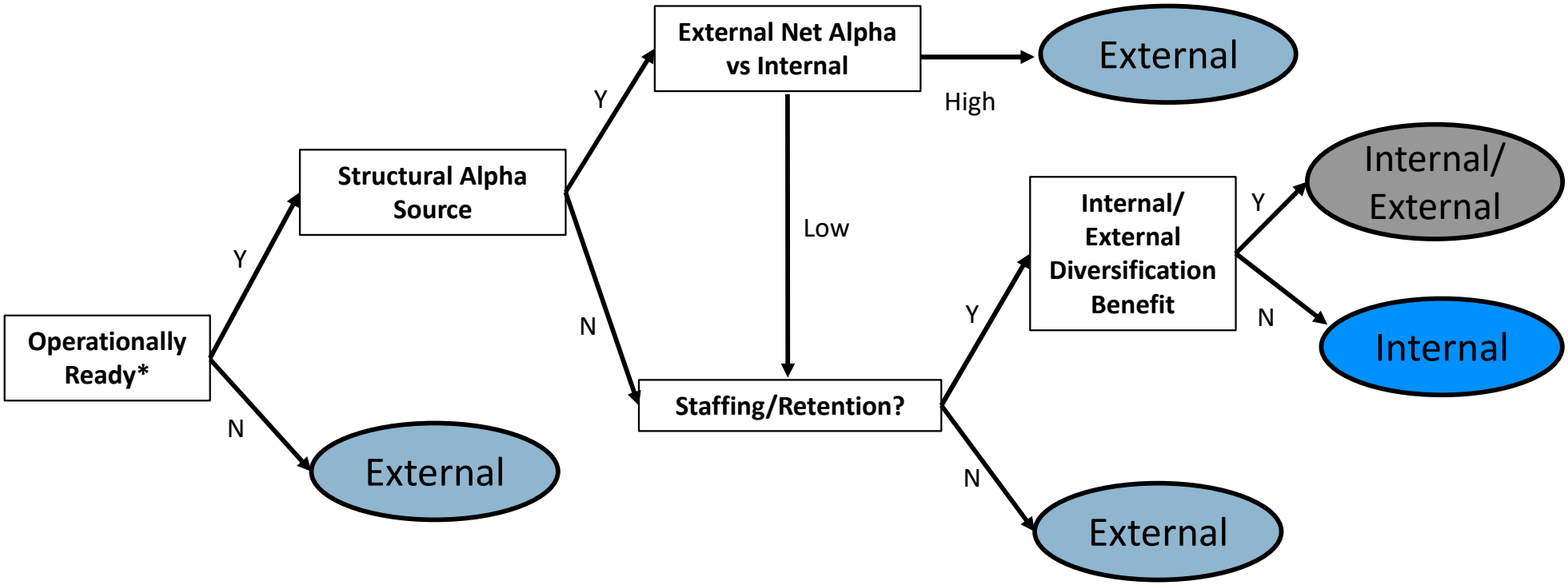
# Implementation Framework: Internal vs External

*(for Active Strategies)*




Note: Operationally Ready relates to the underlying physical investments - direct private equity companies for example. Does not relate to the vehicle used to access the underlying investments, for example, limited partnerships and/or commingled funds.



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# Implementation Framework: Internal vs External

*(for Passive Strategies)*

**Operational readiness and staffing**

- Ensure SWIB can staff an investment team and support the back- and middle-office capabilities required for passive replication of an asset class index return.

**Ease of beta replication**

- Explore in-house passive management when replicating an asset class return is possible with limited tracking error relative to a benchmark index.

**Low internal cost**

- Favor internal passive management when implementation costs are low, including staffing a team with the required skillsets, access to market data, and trading infrastructure.

**Benefit of diversified implementation**

- Diversifying implementation of policy allocations with both internal and external managers can reduce operational and idiosyncratic manager risks.



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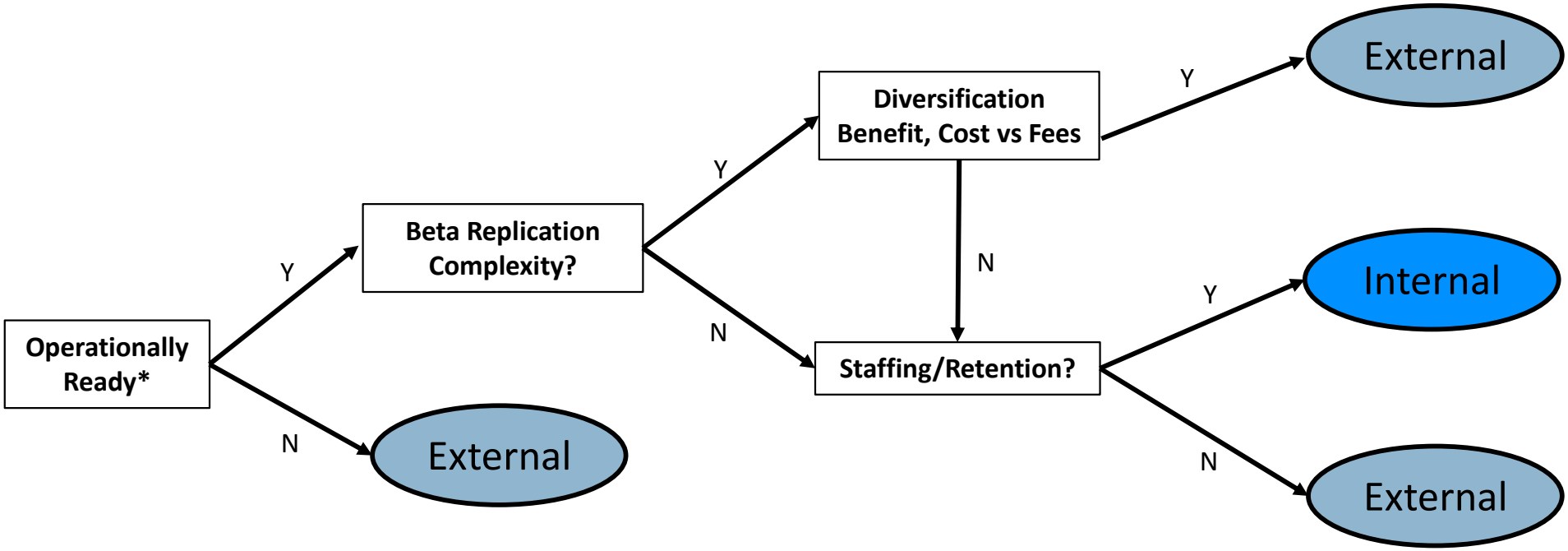
# Implementation Framework: Internal vs External

*(for Passive Strategies)*




Note: Operationally Ready relates to the underlying physical investments - direct private equity companies for example. Does not relate to the vehicle used to access the underlying investments, for example, limited partnerships and/or commingled funds.



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# Next Steps

- Implementation framework will be integrated into SWIB decision-making processes
  - Useful for communicating to external stakeholders
  - Integrate into SWIB's active risk budgeting process
  - Align with investment guidelines and RPMs

- Framework will help identify operational and staffing constraints that limit in-house implementation of value-adding strategies



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# Appendix



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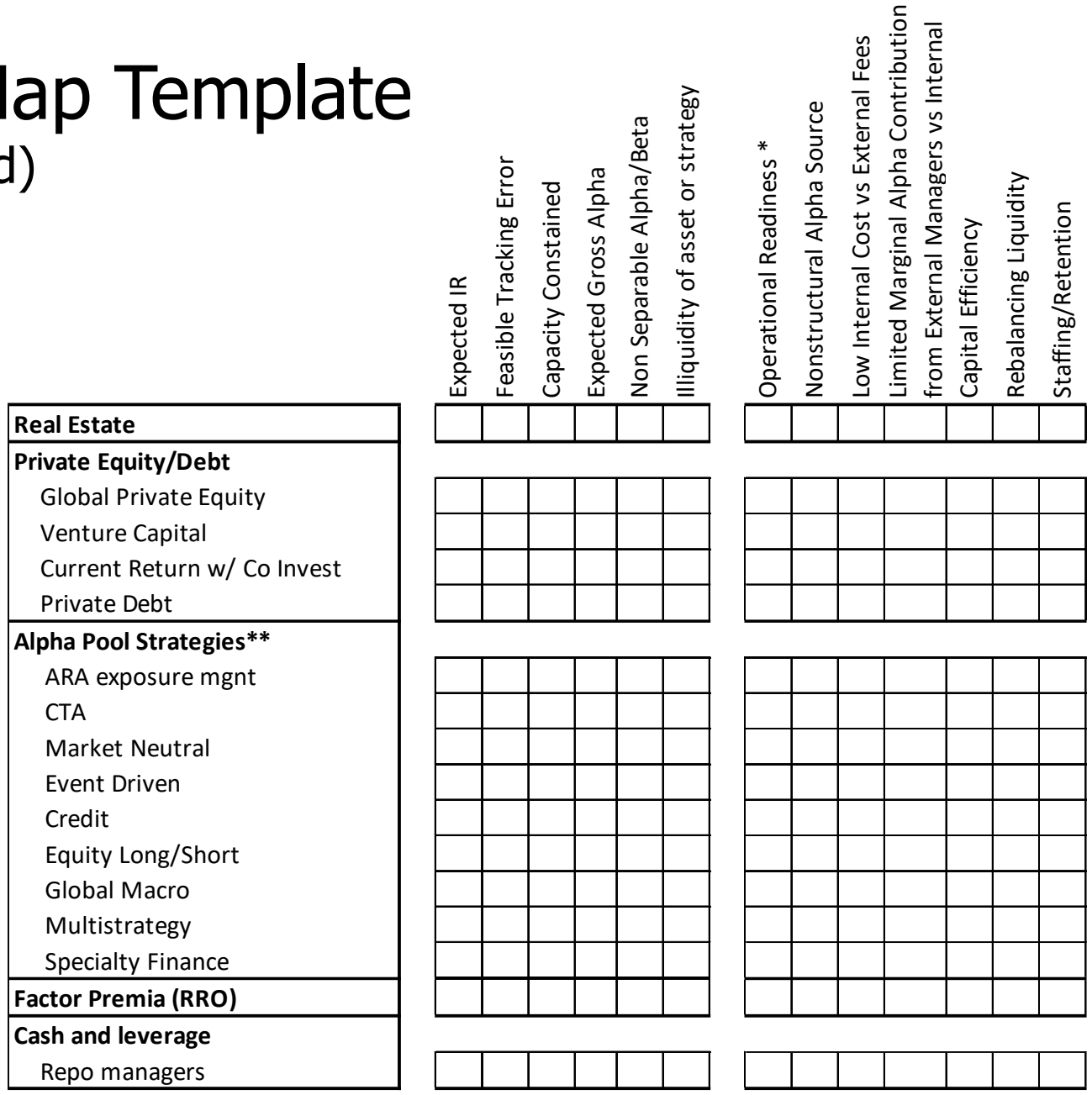
# Heat Map Template

| | Expected IR | Feasible Tracking Error | Capacity Constained | Expected Gross Alpha | Non Separable Alpha/Beta | Illiquidity of asset or strategy | Operational Readiness * | Nonstructural Alpha Source | Low Internal Cost vs External Fees | Limited Marginal Alpha Contribution from External Managers vs Internal | Capital Efficiency | Rebalancing Liquidity | Staffing/Retention | Operational Readiness * | Ease of Beta Replication | Low Internal Cost vs External Fees | Limited Marginal TE Reduction from Externally Sourced Beta Replication | Staffing/Retention |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Public Equity** | | | | | | | | | | | | | | | | | | |
| US Developed | | | | | | | | | | | | | | | | | | |
| Int'l Developed | | | | | | | | | | | | | | | | | | |
| US Small Cap | | | | | | | | | | | | | | | | | | |
| Int'l Small Cap | | | | | | | | | | | | | | | | | | |
| EM Large Cap ex China | | | | | | | | | | | | | | | | | | |
| EM Large Cap China | | | | | | | | | | | | | | | | | | |
| EM Small Cap | | | | | | | | | | | | | | | | | | |
| **Public Fixed Income** | | | | | | | | | | | | | | | | | | |
| IG: Credit | | | | | | | | | | | | | | | | | | |
| IG: MBS | | | | | | | | | | | | | | | | | | |
| IG: Treasury | | | | | | | | | | | | | | | | | | |
| IG: Long Treasuries | | | | | | | | | | | | | | | | | | |
| High Yield | | | | | | | | | | | | | | | | | | |
| Leveraged Loans | | | | | | | | | | | | | | | | | | |
| EMD: USD Debt | | | | | | | | | | | | | | | | | | |
| EMD: Local Currency Debt | | | | | | | | | | | | | | | | | | |
| **Inflation Sensitive (TIPS)** | | | | | | | | | | | | | | | | | | |

* Operationally Ready relates to the underlying physical investments - direct private equity companies, for example. It does not relate to the vehicle used to access the underlying investments, such as limited partnerships and/or commingled funds, for example.

# Heat Map Template
(Continued)




* Operationally Ready relates to the underlying physical investments - direct private equity companies, for example. It does not relate to the vehicle used to access the underlying investments, such as limited partnerships and/or commingled funds, for example.

** Indicators are based on average characteristics in a broad universe of managers. Dispersion will exist across the universe based on differences in the investment approach, including quant vs fundamental methods.

# Criteria Definitions: Active/Passive Indicators

***Expected IR:*** For security selection and beta-timing strategies, expected IR encompasses manager skill, effective breadth (opportunity set) and the transfer coefficient of skill into alpha (i.e., constraints on shorting, leverage, asset universe, rebalancing frequency and other factors can limit the transfer of skill into alpha). For SWIB's manager selection programs, greater dispersion in excess returns across the universe of active managers implies a larger opportunity set to add value from skilled manager selection.

***Scalability:*** This indicator assesses potential tracking error. Highly scalable active strategies can add more alpha in dollar terms. In addition, the scalability indicator can relate to the management capacity of an active strategy. Is the strategy overcrowded (i.e., FX Carry in 2007-2008) or an individual manager's AUM limiting their capacity to add value efficiently?

***Expected gross alpha:*** This indicator evaluates expected excess returns before fees and costs. This indicator ties together the expected IR and scalability indicators.

- For a low-to-medium range of expected IR, the prospective strategy needs to be highly scalable in potential active risk to generate a given target of expected alpha.
- For strategies with a higher range of expected IR, less scalable strategies can still be appropriate if they can achieve the target level of alpha in dollar terms.

# Criteria Definitions: Active/Passive Indicators
(Continued)

***Non-separable beta/alpha:*** For certain asset classes, separating the active component from the beta component of expected total return can be practically difficult. Active strategies are generally preferable for strategies that would require high and uncompensated tracking error to achieve the beta component of the expected total return. Separable beta/alpha components allow for more capital efficient allocation to active strategies, and lower cost exposure to the beta component.

***Illiquidity:*** Strategies involving illiquid investments generally require active management implementation. Illiquidity under this definition refers to the following: (1) private market investments, (2) public market strategies with investments in relatively illiquid underlying securities, and (3) strategies with lock-up periods or penalties for an early deallocation. In the above cases, deallocations would be excessively costly and/or disruptive to the management of the strategy. Asset classes and active strategies with a high share of illiquid holdings cannot be passively tracked and implemented based on a benchmark index given a lack of real-time pricing transparency.

# Criteria Definitions: Internal/External (Active)

***Operational readiness:*** This indicator captures the agency's readiness to manage the underlying physical investment and trading capabilities for a strategy. For example, operational readiness is currently low for the internal management of direct investments in physical infrastructure or a high-frequency trading strategy. This criterion does not refer to readiness for partnerships, commingled funds or other external vehicles. Considerations for operational readiness capture all levels of the agency's platform, including back/middle/front office teams. Relevant factors include supporting data requirements, type of instrument (complex derivatives vs common shares), and trading frequency that are required to implement the strategy.

***Nonstructural alpha source:*** Asset classes and investment strategies that require a structural (difficult-to-replicate) source of edge will be generally implemented externally. A high-frequency trading strategy that requires physical proximity to the exchange or a proprietary dataset are structural sources of alpha. Other potential structural advantages include proprietary infrastructure and technology. In all cases, the structural edge is hard to replicate and provides the external manager with an information edge that increases expected alpha.

***Low internal cost vs external fees:*** Internal costs include direct and indirect operating costs related to the running of an internal strategy, including the cost of recruiting a team with the appropriate skillsets, new databases, technology and general overhead. Internal costs should be considered net of offsetting income or leverage advantages to the agency, such as potential securities lending and cash release from controlling physical securities by running the strategy internally.



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# Criteria Definitions: Internal/External (Active) (Continued)

***Limited marginal alpha contribution from external manager vs internal:*** In some cases, there are advantages from allocating to both internal and external managers for a given asset class or strategy. Potential advantages include diversifying implementation to improve expected value-add (or reduce risk) and to scale up the fund's total active risk.

***Capital efficiency:*** Capital efficiency refers to greater flexibility and control for the agency in determining the level of capital to support the activity strategy. Capital efficient strategies provide greater expected alpha per unit of capital and active risk. Strategies that provide greater in-house flexibility to control capital/leverage/active risk are generally more desirable for internal management. Leverage aversion may even create value-adding opportunities given SWIB's large balance sheet and ample liquidity.

***Staffing and retention:*** Staffing and retention refer to the business reality of finding and retaining skilled investment professionals to build an in-house capability. This criterion complements the indicator on operational readiness, which focuses on other aspects of the SWIB investment platform like data and infrastructure.

# Criteria Definitions: Internal/External (Passive)

***Operational readiness:*** Consistent with previous slide, this indicator captures the agency's readiness to manage the underlying physical investment and trading capabilities for a passive replication strategy.

***Ease of beta replication*** : This indicator relates to the effectiveness of internal management to replicate a given type of beta. Low tracking error effectively measures ease of replication.

***Low internal cost vs external fees:*** This indicator mirrors the considerations described in previous slide. Control of physical assets is particularly advantageous for in-house replication of beta sources to allow for securities lending, internal repo and cash release programs for leverage sourcing.

***Limited marginal TE reduction from externally sourced beta replication:*** Consistent with the indicator in internal/external active section, this criterion refers to the marginal expected benefit of increasing externally sourced beta replication.

***Staffing/retention:*** This indicator mirrors the definition outlined in previous slide.



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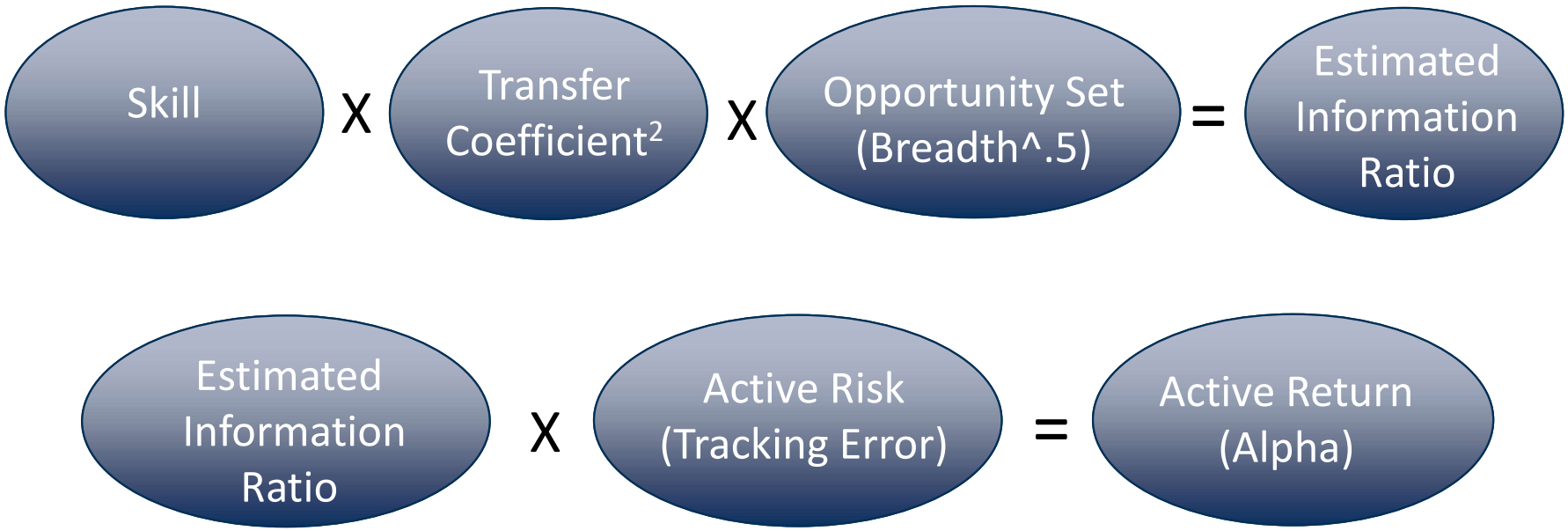
# Law of Active Portfolio Management[1]

$$IR = \frac{Active\ Return}{Active\ Risk}$$




[1] The Fundamental Law of Active Portfolio Management, Journal of Investment Management, 2006.

[2] Portfolio constraints lower the transfer coefficient to less than 1.



SWIB STATE OF WISCONSIN INVESTMENT BOARD

## Jan Hatzius

Global Investment Research
*New York*

Jan is chief economist and head of Global Investment Research. He is a member of the Management Committee and the Firmwide Client Franchise Committee. Prior to assuming his current role, Jan was head of Global Economics and Markets Research. He joined Goldman Sachs in the Frankfurt office in 1997 and transferred to New York in 1999. He was named managing director in 2004 and partner in 2008.

Prior to joining Goldman Sachs, Jan was a research officer at the London School of Economics.

Jan is the No. 1 ranked global economist in the annual Institutional Investor Global Fixed-Income Research Team, a position he has held in the global or US category for the past decade.

He is a member of the economic advisory panels of the Federal Reserve Bank of Chicago and the Congressional Budget Office.

Jan earned a DPhil in Economics from Oxford University, as well as degrees from the University of Wisconsin-Madison and the Kiel Institute for the World Economy.

Goldman Sachs

Global Investment Research

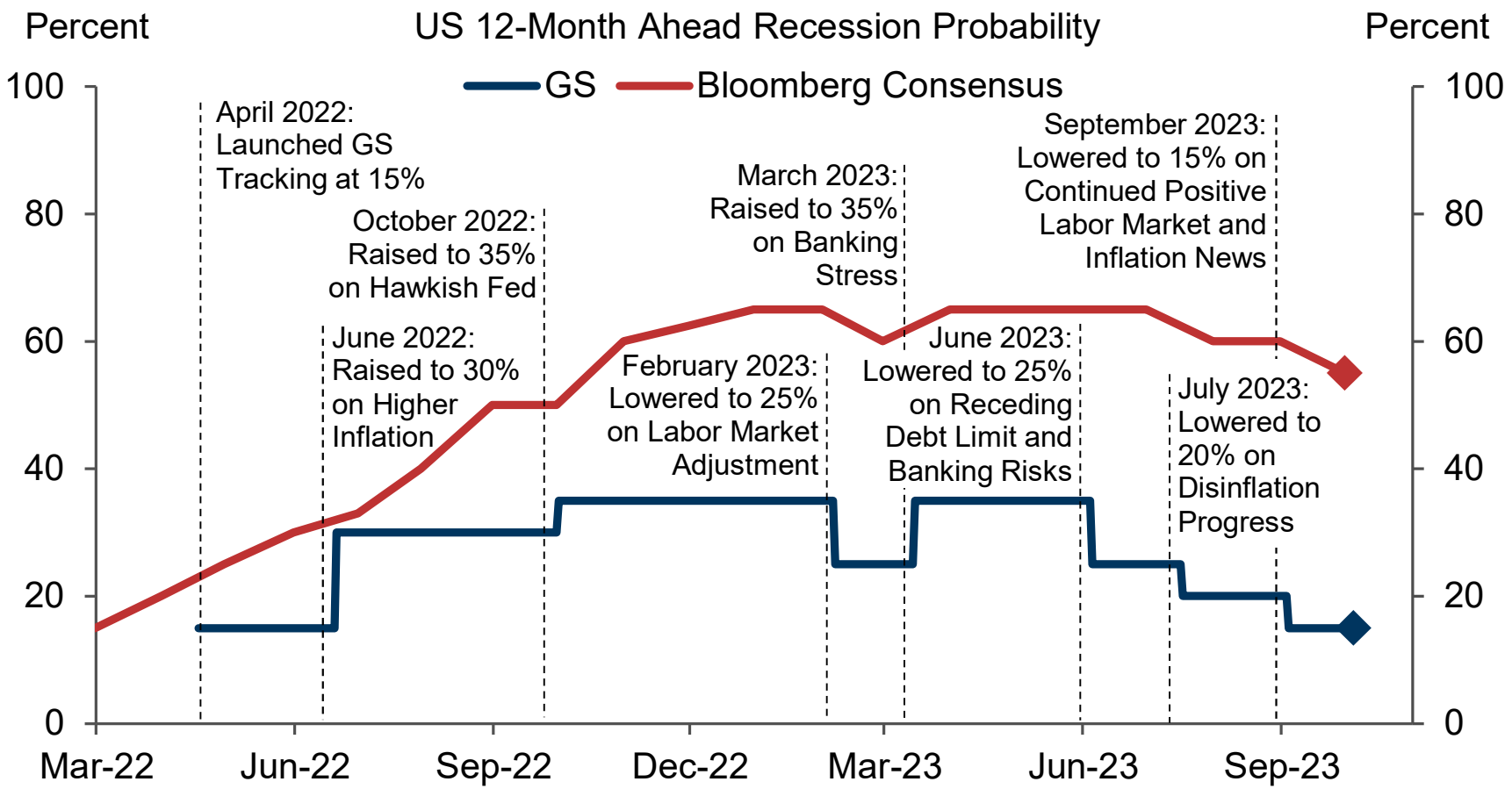
# Economic Outlook

## Approaching a Soft Landing

October 18, 2023

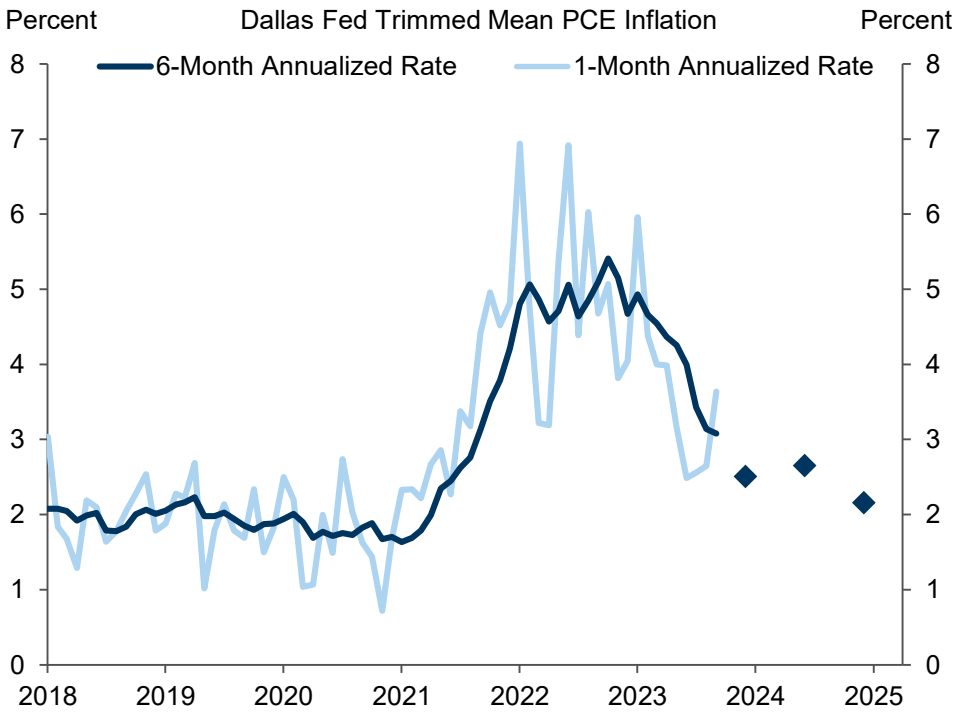
**Jan Hatzius** | **Goldman, Sachs & Co.** Chief Economist | +1 212-902-0394 | jan.Hatzius@gs.com

# Our US Recession Risk Estimate Is Far Below Consensus

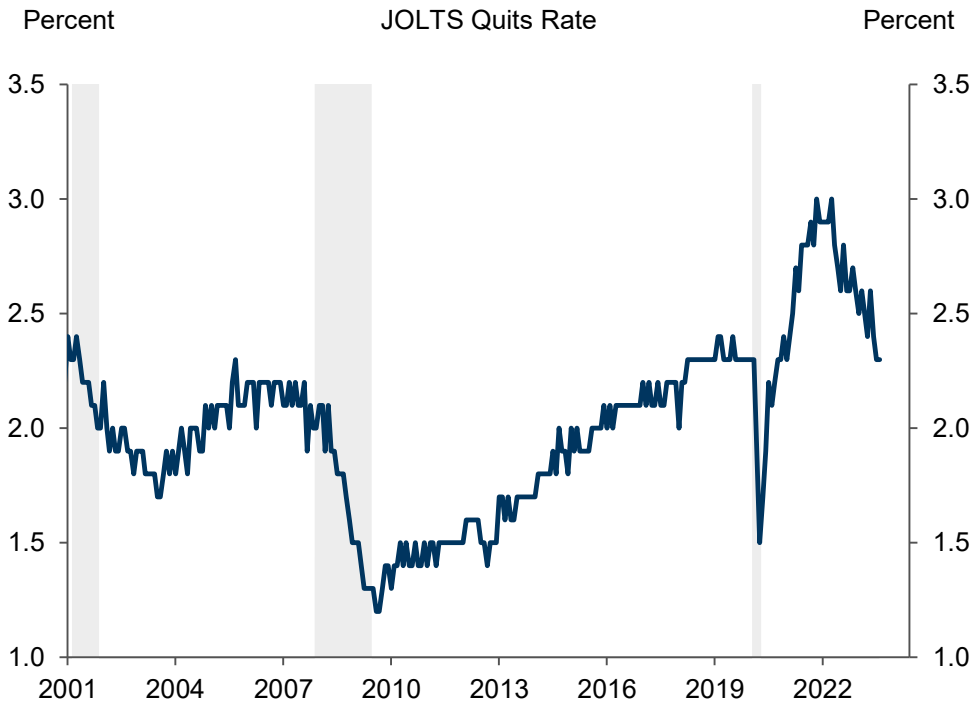



*Source: Goldman Sachs Global Investment Research.*

# Underlying Inflation Has Plummeted; Declining Quit Rate Suggests Return to Labor Market Balance

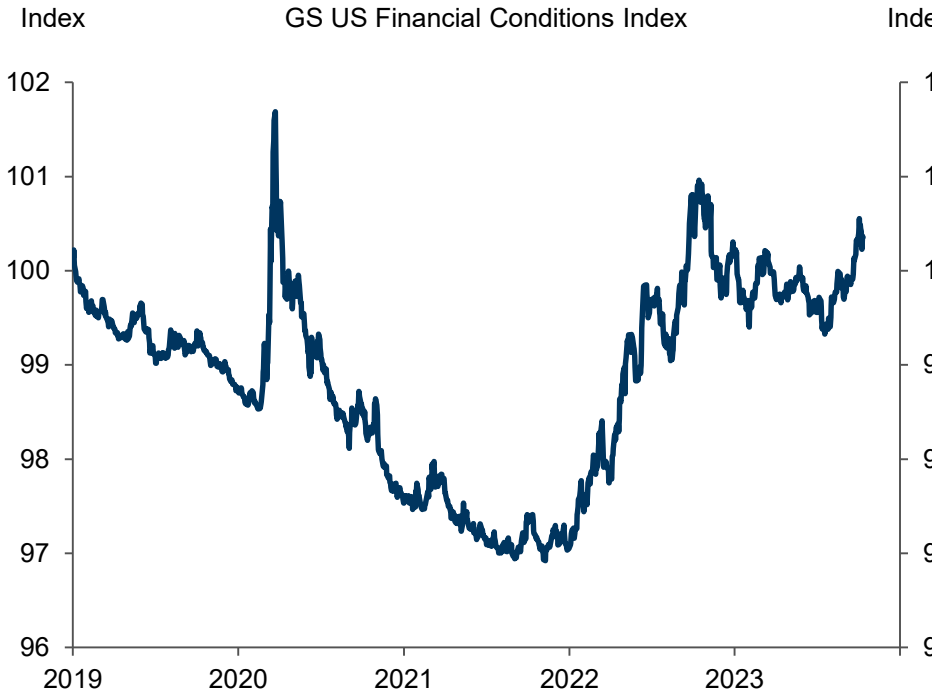



Markers indicate GS forecast for 6-month annualized core PCE in 2023H2/2024H1/2024H2.
Latest value is GS tracking estimate based on details in the September CPI and PPI reports.

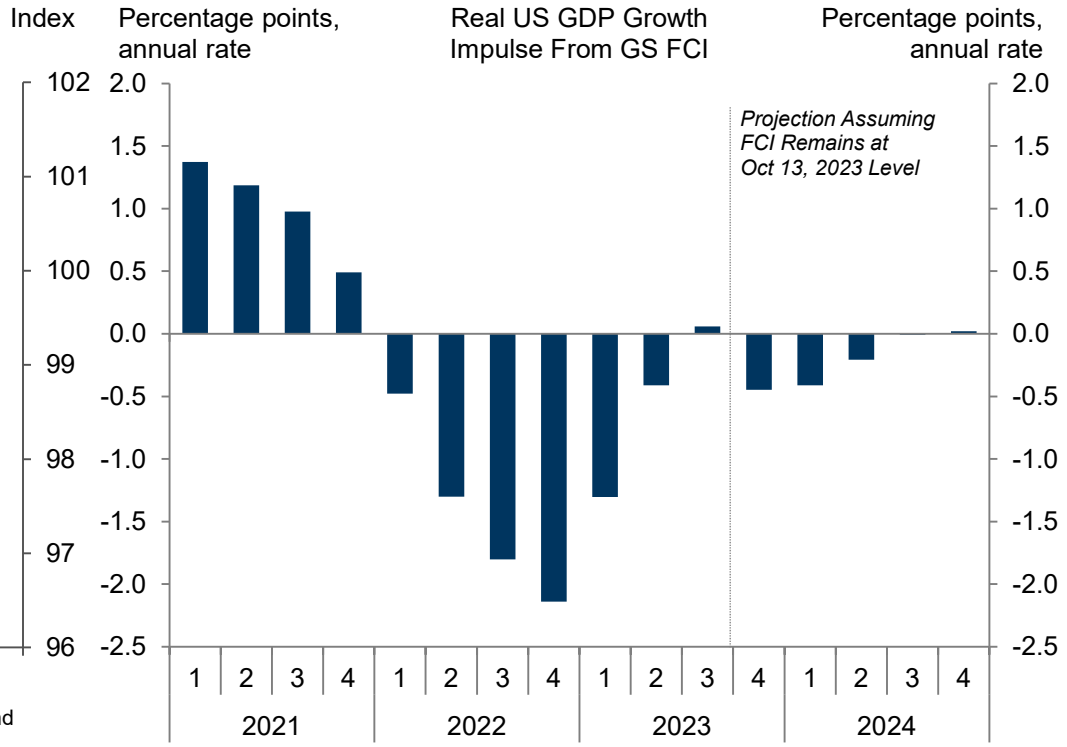



*Source: Haver Analytics, Goldman Sachs Global Investment Research.*

# Our FCI Remains at Levels Similar to Mid-2022, and the Upcoming Growth Drag Should be Moderate

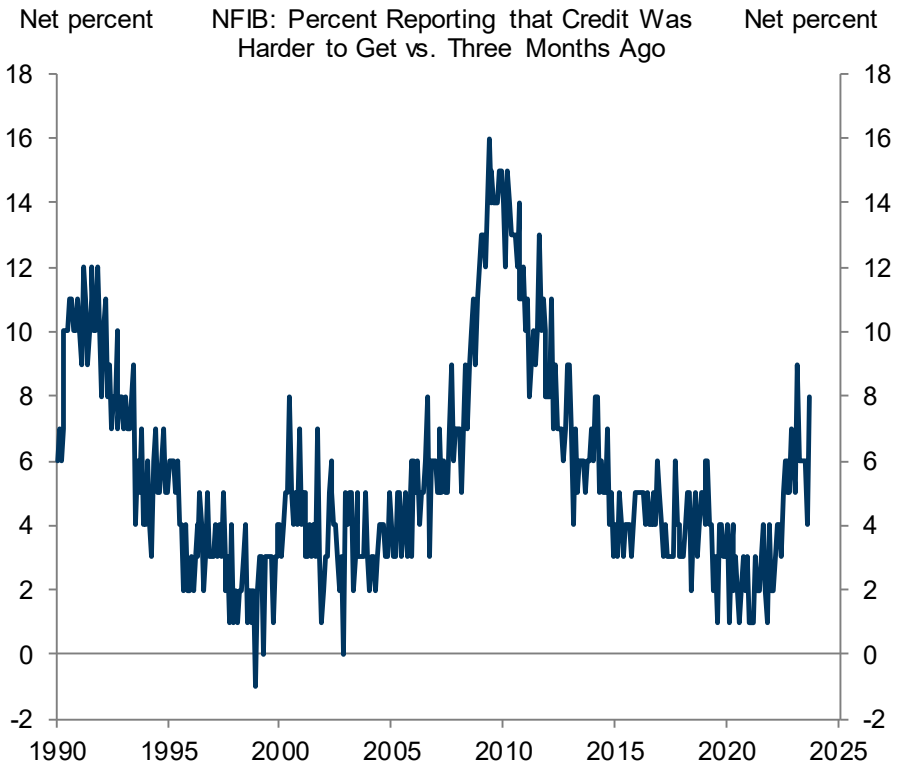


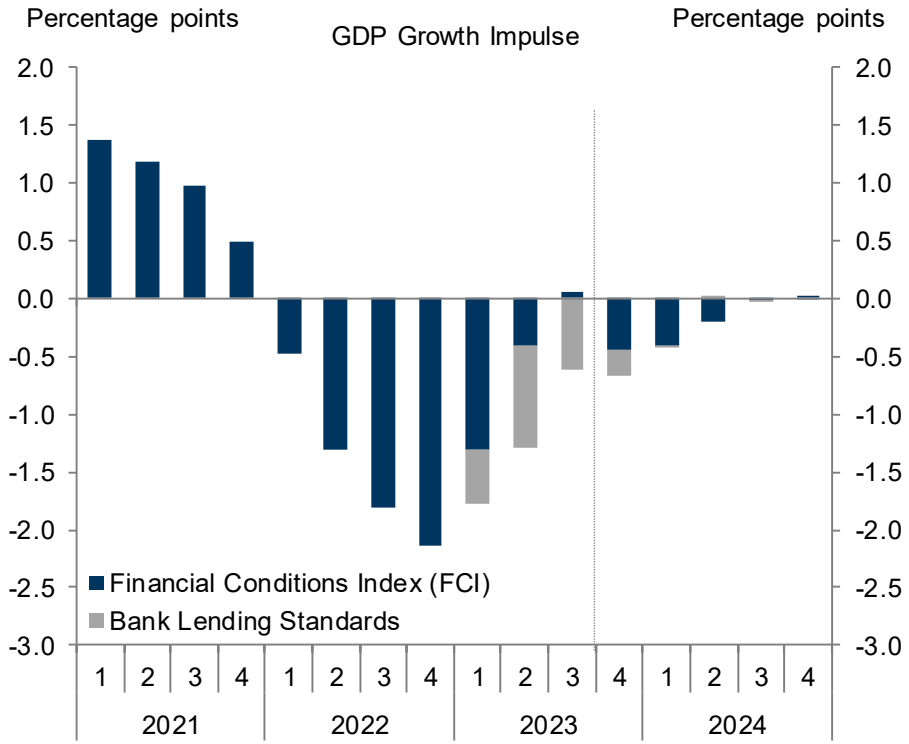

Note: Weighted average of funds rate, 10-year UST yield, Baa credit spreads, S&P 500, and trade-weighted dollar, with weights that mirror impact on GDP growth over next year.




*Source: Goldman Sachs Global Investment Research.*

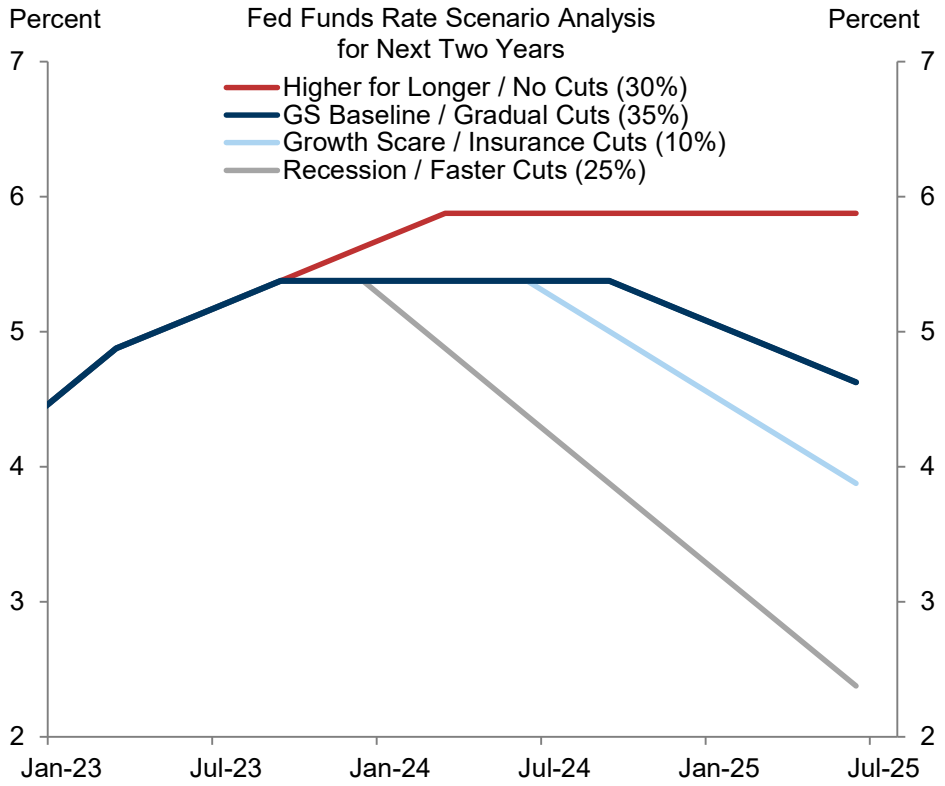
# The Impact From Tighter Lending Standards Looks Limited

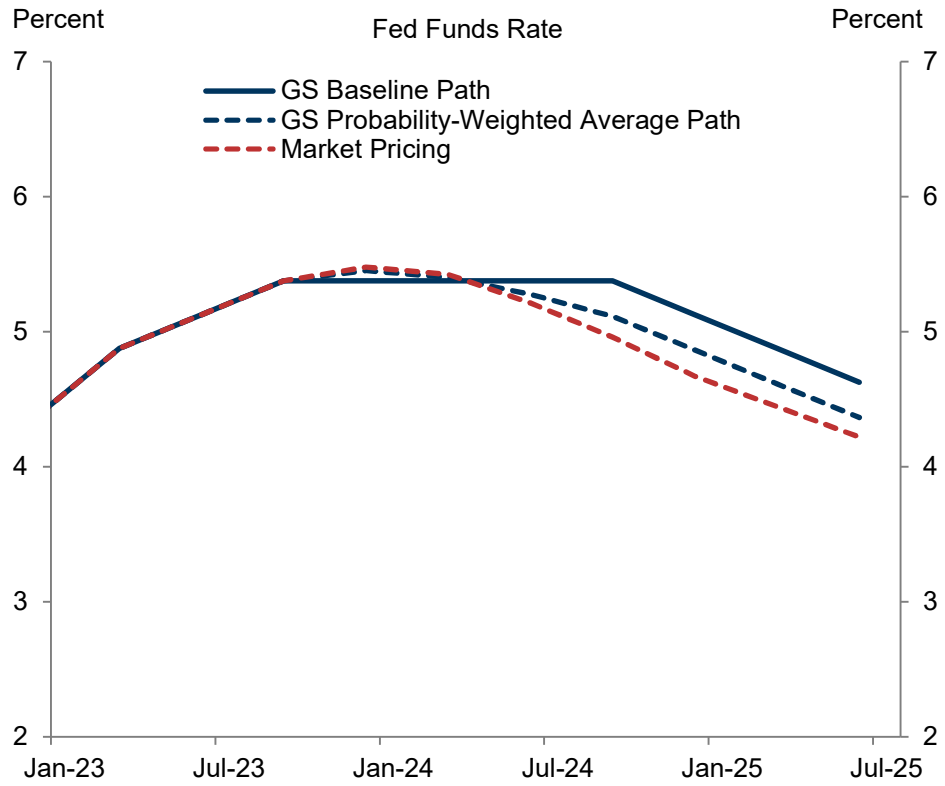



*Source: Haver Analytics, Goldman Sachs Global Investment Research.*

# Higher for Longer Is the Baseline, But the Risks Are Mostly on the Downside

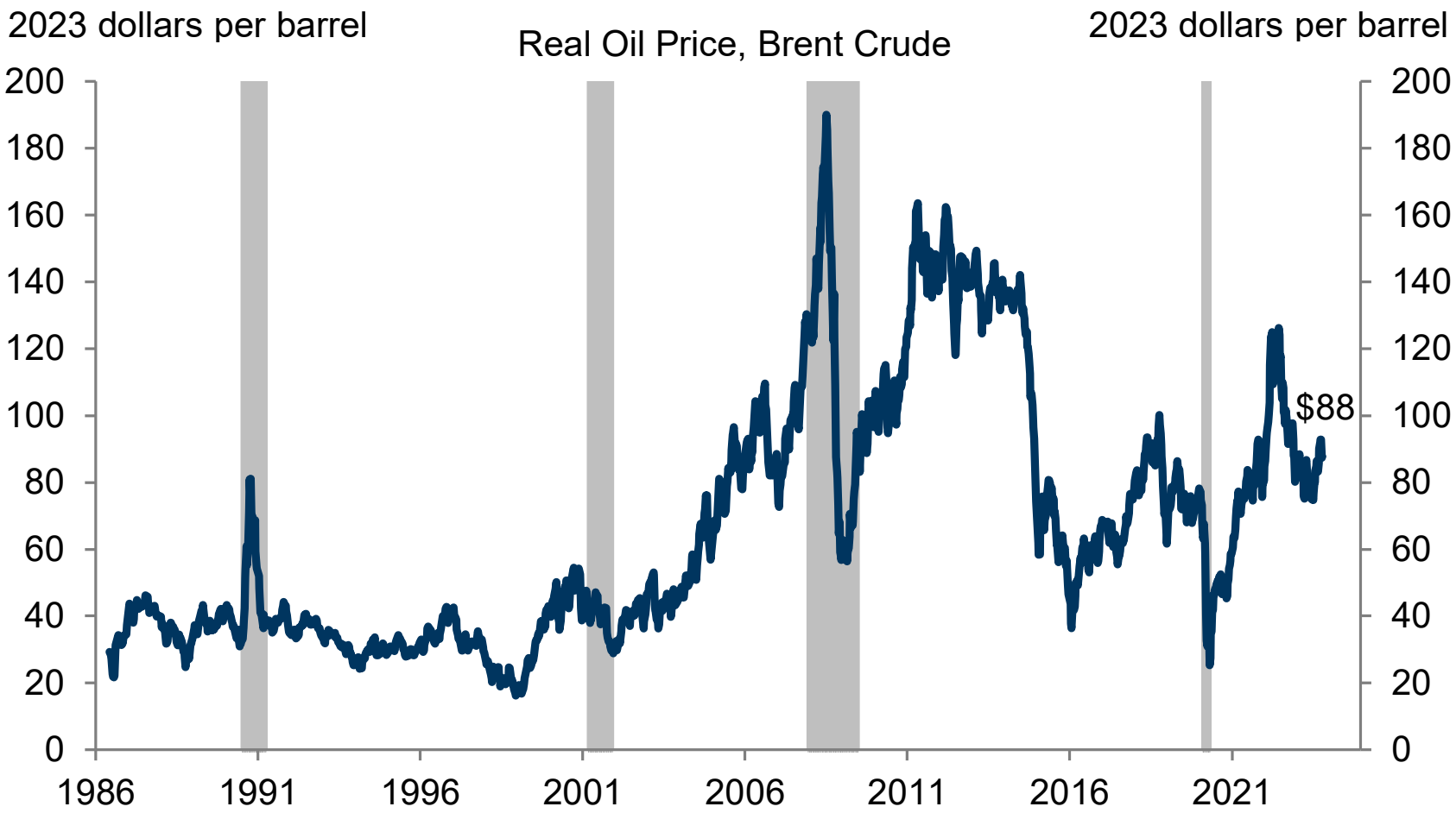



* The recession scenarios show unrealistically slow cuts to capture many sub-scenarios of recessions starting at various points in time. The recession scenarios reflect our subjective recession probability of 15% over the next 12 months and similar modest risk in the following year.

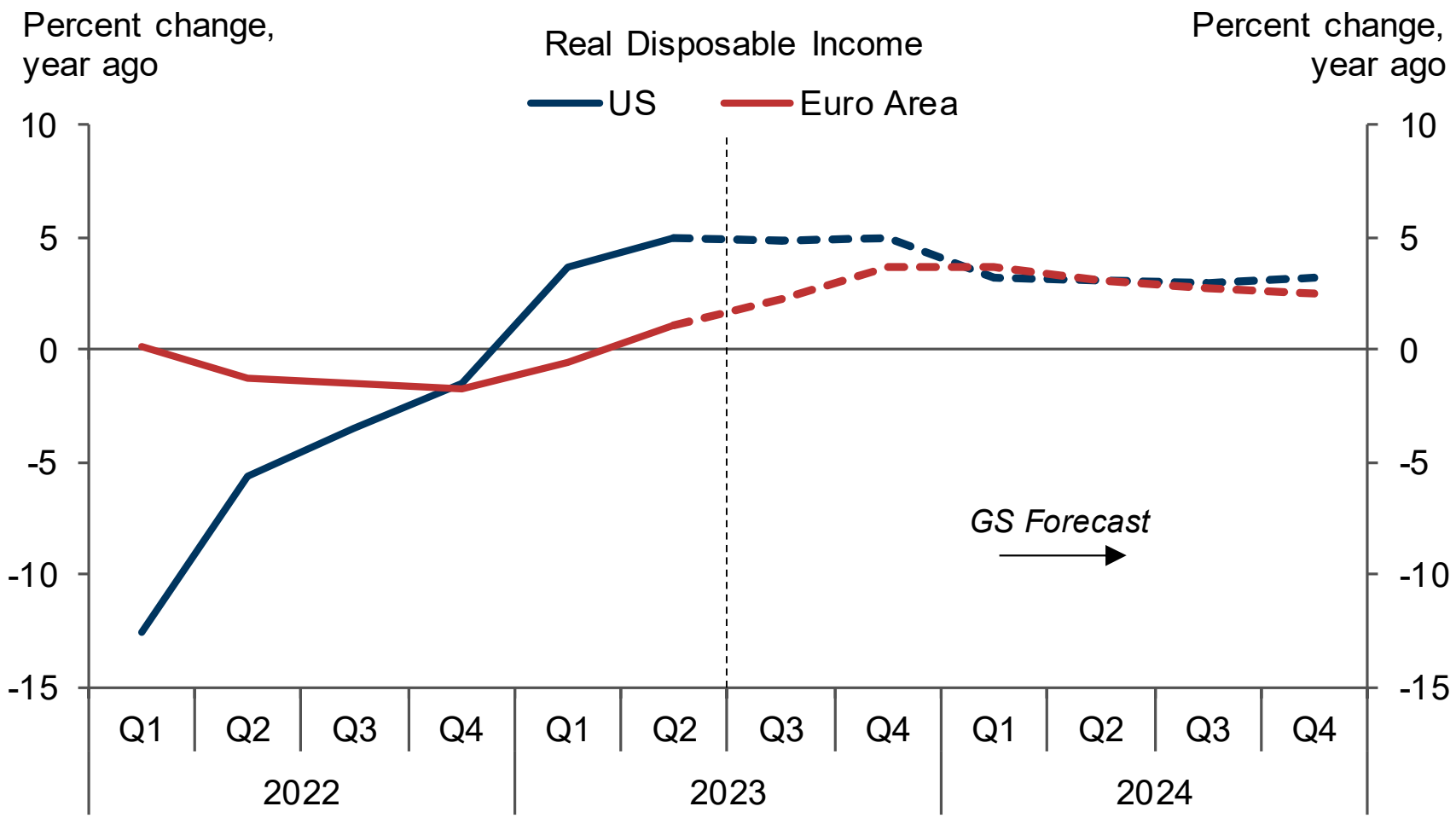
*Source: Bloomberg, Goldman Sachs Global Investment Research.*

# Oil Prices Have Rebounded, But So Far, the Spike Looks Small Relative to History



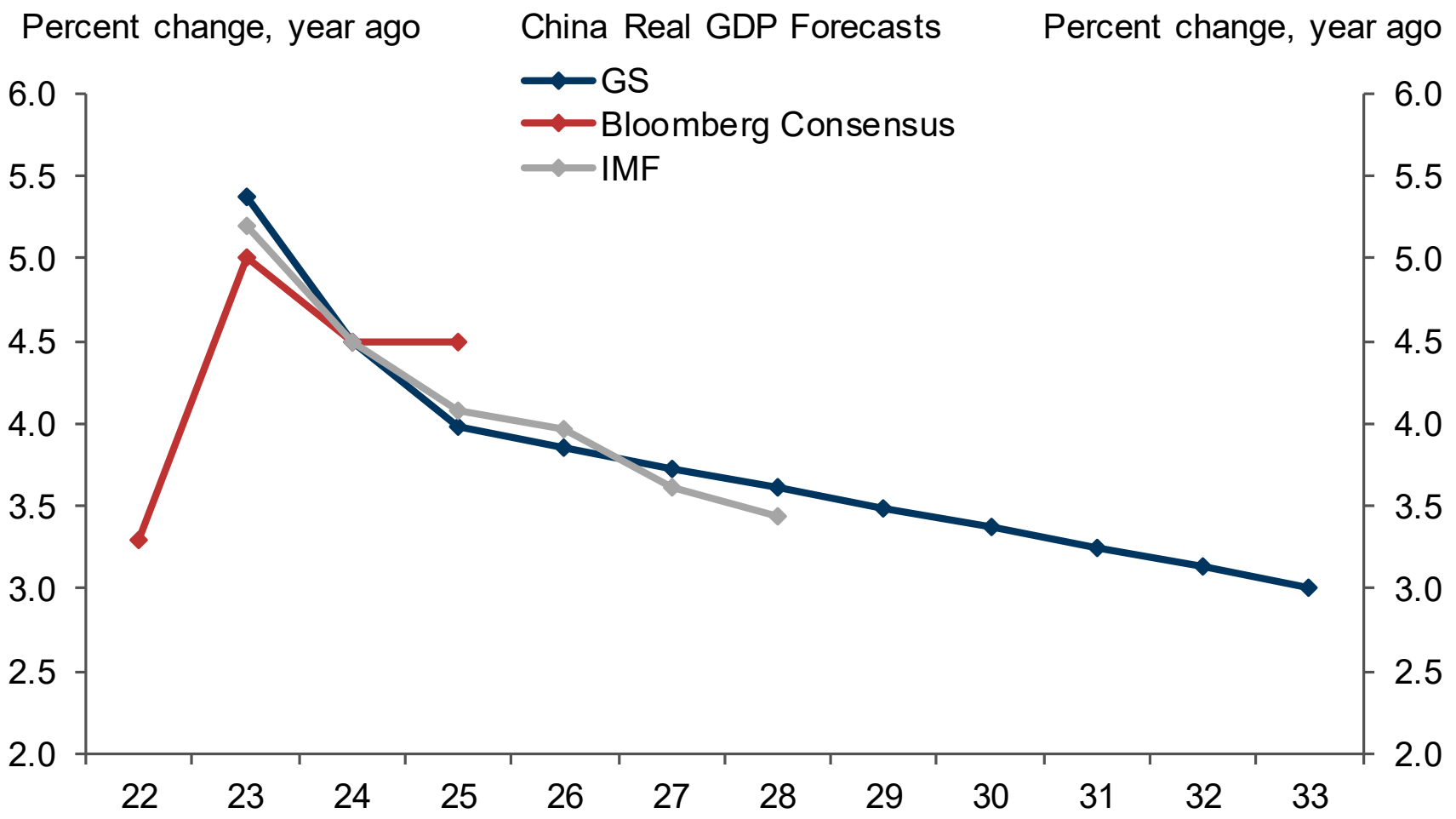

*Source: Bloomberg, Goldman Sachs Global Investment Research.*

# European Real Income Rebounds Because of 1) Lower Energy Prices and 2) Less Mortgage Rate Drag



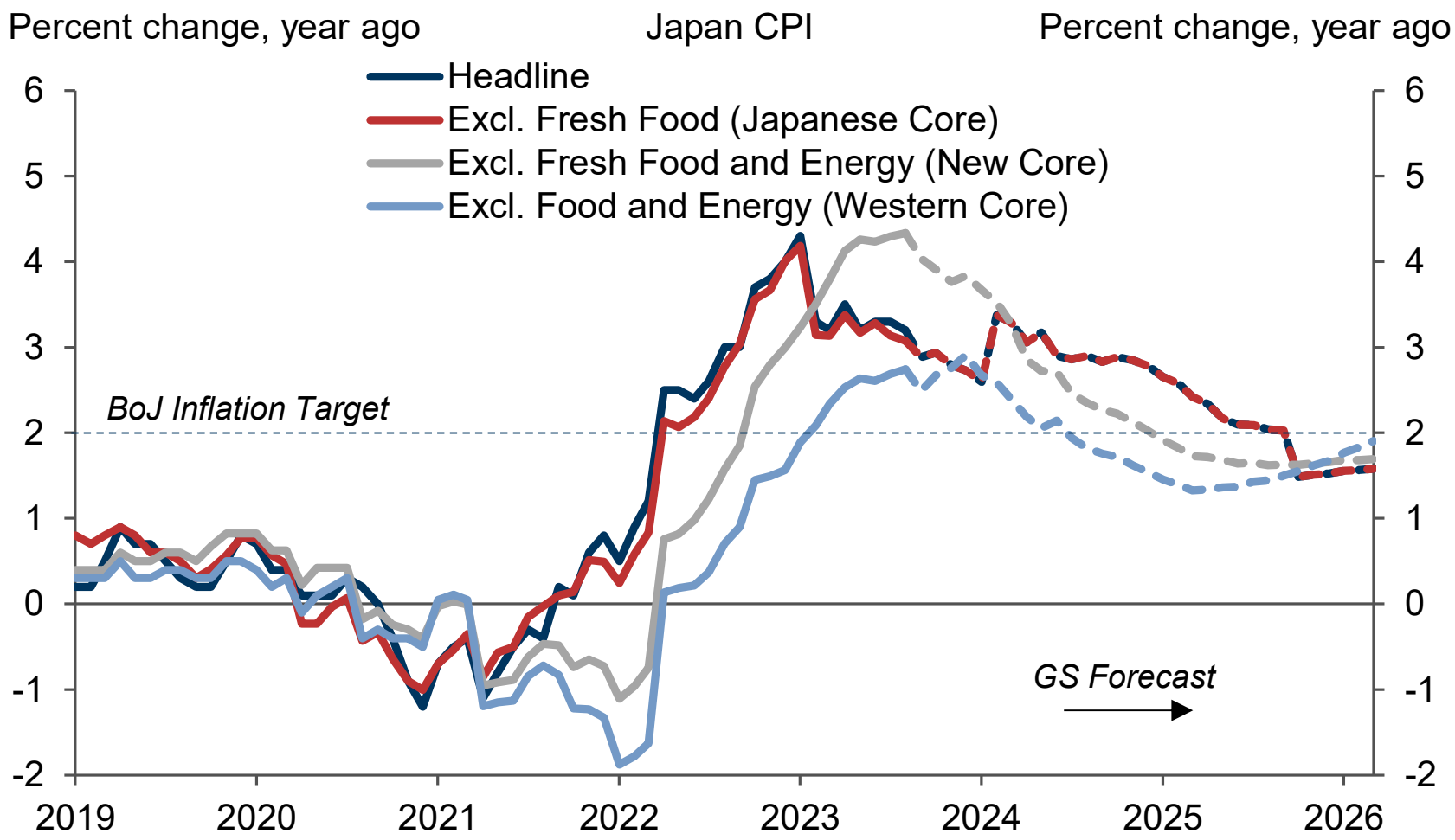

*Source: Haver Analytics, Goldman Sachs Global Investment Research.*

# A Long Slide for China's Trend Growth Due to Property Slowdown and Demographics



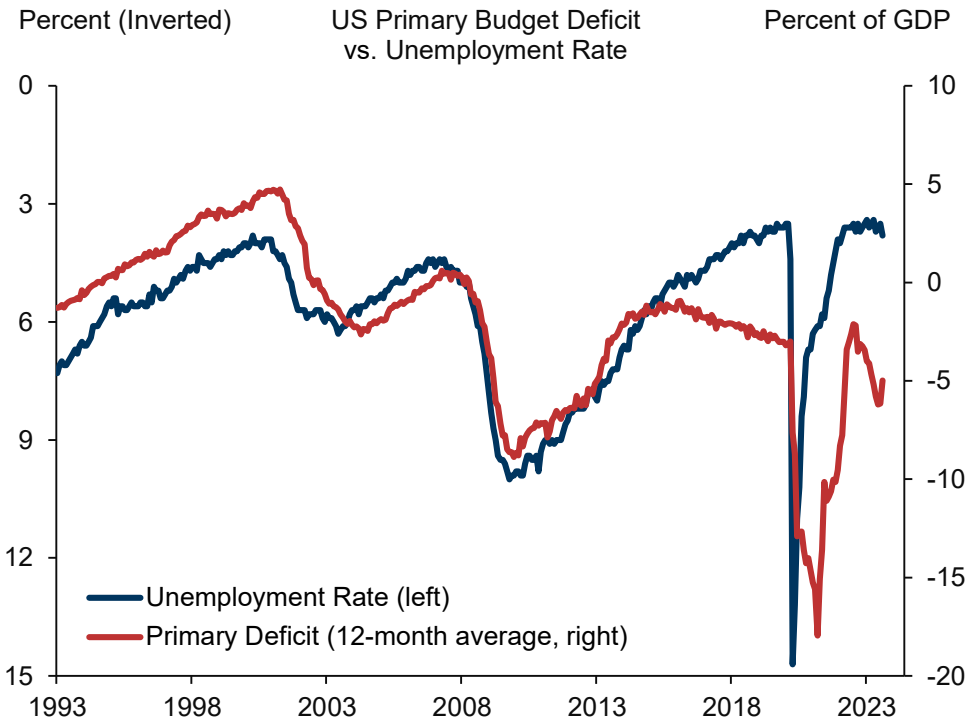

*Source: Bloomberg, IMF, Goldman Sachs Global Investment Research.*

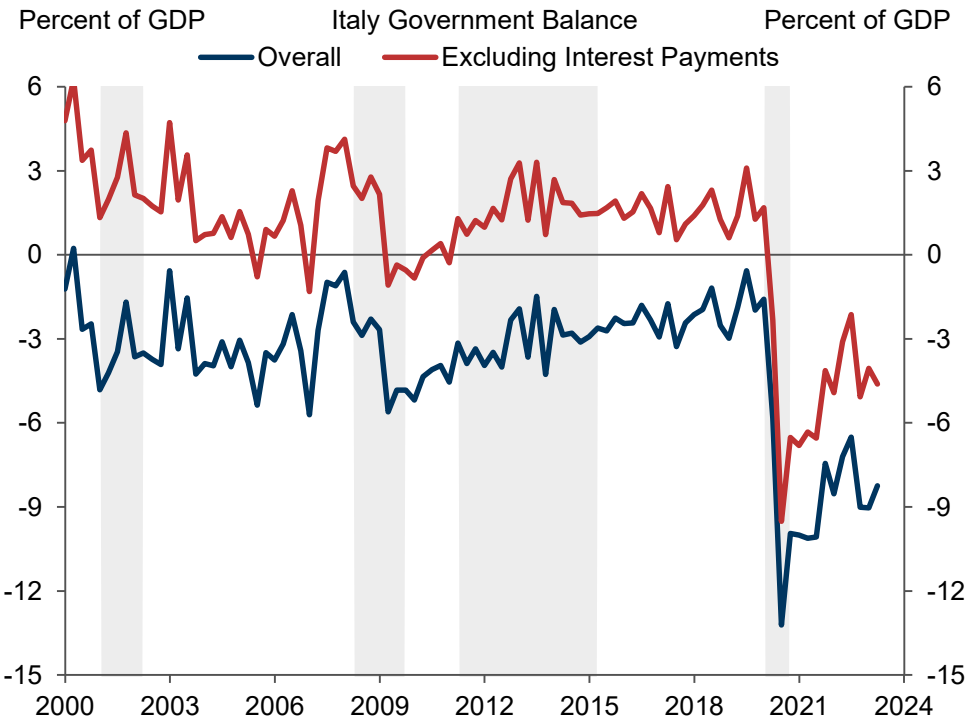
# Japan's Inflation Is Well Above the BoJ's Target, at Least for Now




*Source: Haver Analytics, Goldman Sachs Global Investment Research.*

# Advanced Economies Are Running Large Primary Deficits Relative to Their Point in the Cycle

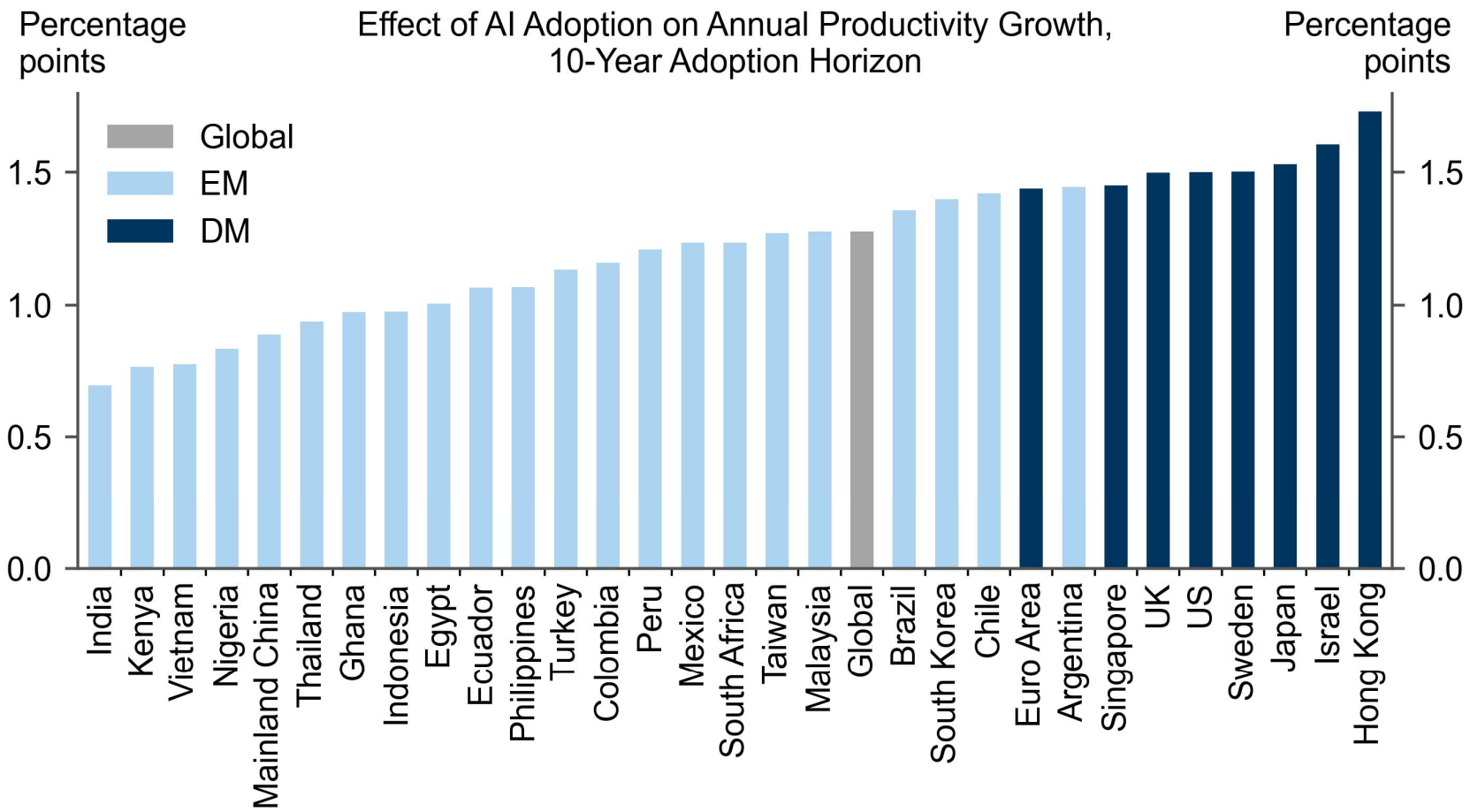



Note: Grey bars denote Italy recessions.

*Source: Haver Analytics, Goldman Sachs Global Investment Research.*

# AI Could Sharply Raise Global Productivity Growth




*Source: Goldman Sachs Global Investment Research.*

# Disclosure Appendix

October 18, 2023

# Disclosure Appendix

## Reg AC

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