# MEKETA
## INVESTMENT GROUP

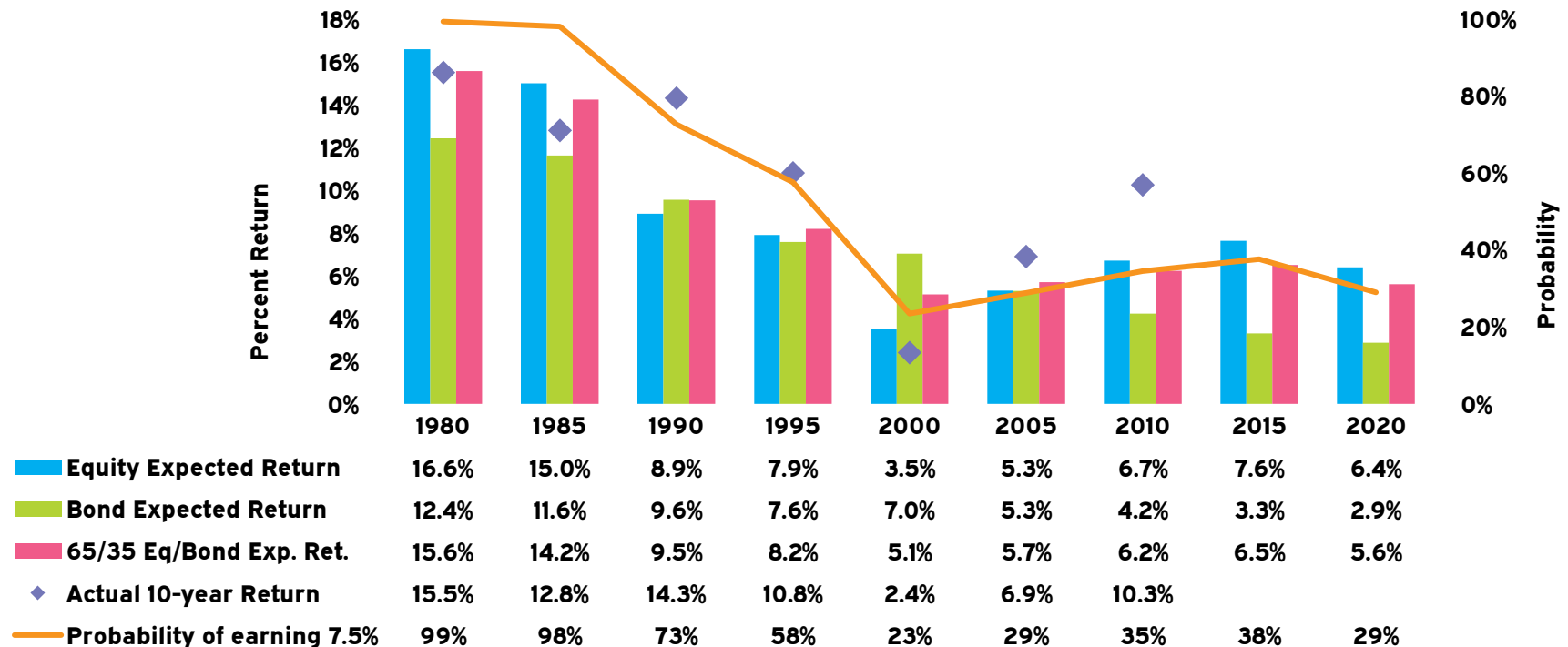## City of San Jose Police and Fire Department Retirement Plan

### March 2020

### Updated Asset Allocation Analysis

## Introduction

- This document evaluates the current asset allocation policy and presents alternative asset allocation options for the City of San Jose Police and Fire Department Retirement Plan. Since the March 18 meeting, we have added four asset allocation mixes with increased equity allocations.

- The asset allocation review process highlights the natural tension between long-term goals and short-term risks, and should allow the Plan's decision-makers to make more informed decisions regarding portfolio positioning. The Police and Fire Plan has historically had a lower equity weighting than peers, which resulted in peer-relative underperformance during the very strong equity markets of 2019, but also allowed the portfolio to protect on the downside during early 2020. Meketa Investment Group has worked with San Jose Staff to develop and analyze a wide variety of potential alternative asset allocation policies, each of which has a higher equity allocation than the current portfolio. While we do not attempt to time financial markets, considering an increase to the equity weighting following an equity market downturn of historical proportions could be prudent.

- Throughout the following slides, we provide various approaches to assessing risk in order to provide a "mosaic" of the risks faced by the Plan, including mean-variance analysis using Meketa's capital markets expectations, historical scenario analysis, and forward-looking stress testing and Economic Regime Management® analysis. The goal of this review is not to declare one portfolio the "right" choice or the only prudent choice, but to highlight the risk and return tradeoffs of different policy portfolios.

## The Secular Decline in Investment Returns[1]

| | 1980 | 1985 | 1990 | 1995 | 2000 | 2005 | 2010 | 2015 | 2020 |
|---|---|---|---|---|---|---|---|---|---|
| Equity Expected Return | 16.6% | 15.0% | 8.9% | 7.9% | 3.5% | 5.3% | 6.7% | 7.6% | 6.4% |
| Bond Expected Return | 12.4% | 11.6% | 9.6% | 7.6% | 7.0% | 5.3% | 4.2% | 3.3% | 2.9% |
| 65/35 Eq/Bond Exp. Ret. | 15.6% | 14.2% | 9.5% | 8.2% | 5.1% | 5.7% | 6.2% | 6.5% | 5.6% |
| Actual 10-year Return | 15.5% | 12.8% | 14.3% | 10.8% | 2.4% | 6.9% | 10.3% | | |
| Probability of earning 7.5% | 99% | 98% | 73% | 58% | 23% | 29% | 35% | 38% | 29% |

- The chart above illustrates that a portfolio made up of 65% domestic stocks and 35% investment grade bonds has produced diminishing expected as well as actual returns over the past 30 years.

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[1] Expected return assumptions for 1) Bonds equals the yield of the ten-year Treasury plus 100 basis points, and 2) Equities equals the dividend yield plus the earnings yield of the S&P 500 index (using the inflation-adjusted trailing 10-year earnings). Probability calculation is for the subsequent ten years.

## Mean Variance Optimization

- MVO is the traditional starting point for determining asset allocation.

- MVO mathematically determines an "efficient frontier" of policy portfolios with the highest risk-adjusted returns.

- All asset classes exhibit only three characteristics, which serve as inputs to the model:

  – Expected return.

  – Expected volatility.

  – Expected covariance with all other assets.

- The model assumes:

  – Normal return distribution.

  – Stable volatility and covariances over time.

  – Returns are not serially correlated.

- The MVO model tends to underestimate the risks of large negative events.

## Investable Universe over Time: Less Return for the Same or More Risk[1]
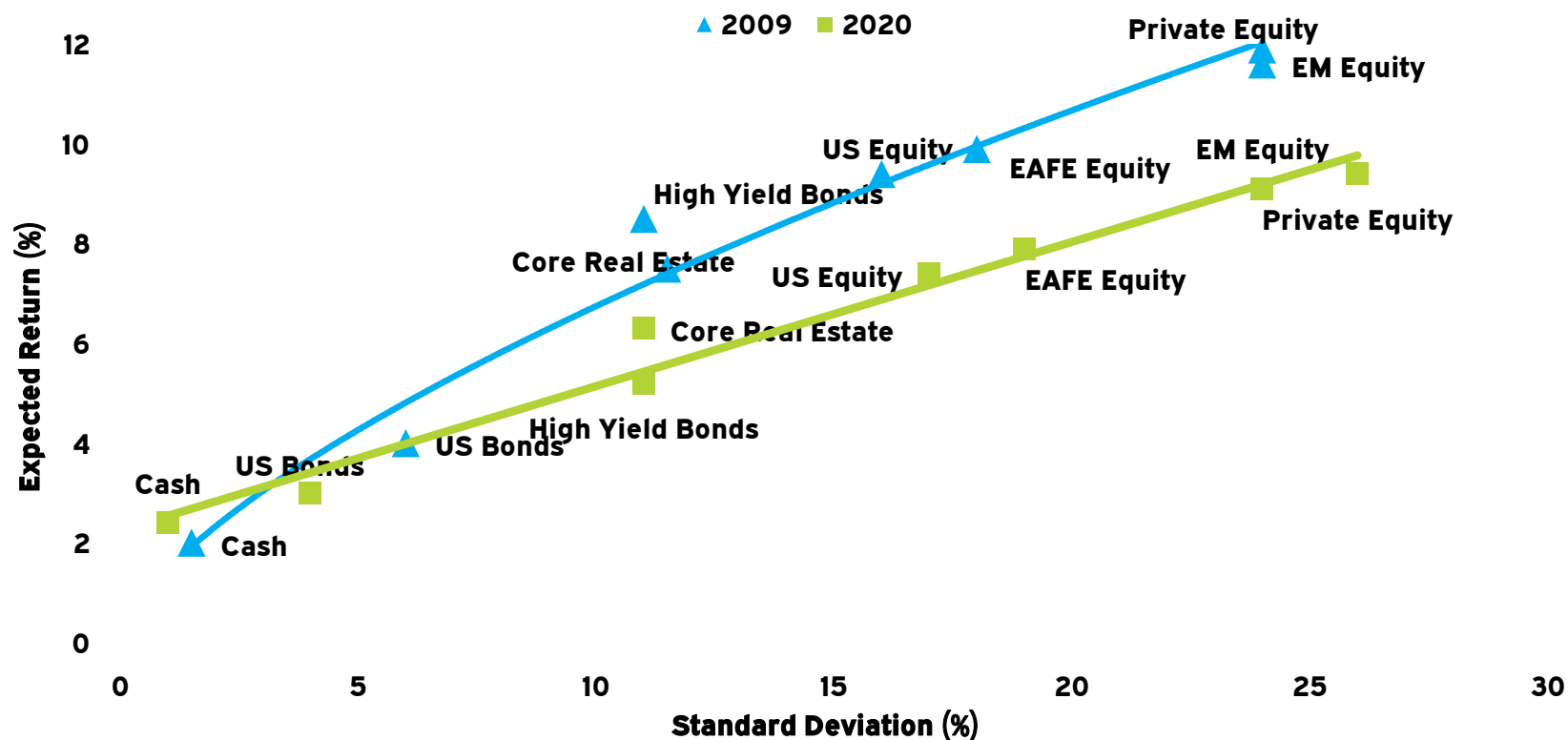


- A positive relationship exists between long-term return expectations and the level of risk accepted.

- However, this relationship is not static.

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[1] Expected return and standard deviation are based upon Meketa Investment Group's Annual Asset Study.

## Asset Allocation Policy Comparison[1]

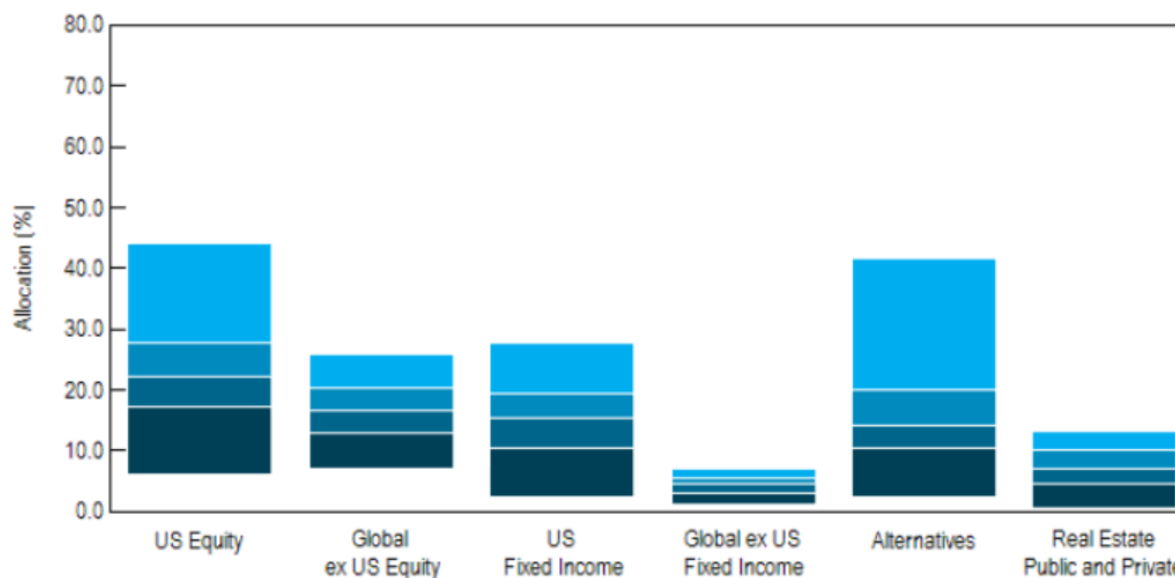| | P&F Current (%) | Mix A (%) | Mix B (%) | Mix C (%) | Mix D (%) | Mix E – Peer Risk (%) | Mix F - Peer Median (%) | Mix G (%) | Mix H (%) | Mix I (%) | Mix J (%) | 60-40 (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Growth | 64 | 67 | 68 | 69 | 70 | 71 | 69 | 75 | 70 | 79 | 74 | 60 |
| US Equity | 14 | 16 | 19 | 22 | 23 | 21 | 23 | 25 | 30 | 26 | 33 | 0 |
| Dev. Market Equity (non-US) | 12 | 10 | 8 | 10 | 11 | 10 | 17 | 12 | 11 | 12 | 13 | 0 |
| Emerging Market Equity | 13 | 12 | 12 | 12 | 12 | 12 | 5 | 12 | 12 | 13 | 13 | 0 |
| Global Equity | NA | NA | NA | NA | NA | NA | 5 | NA | NA | NA | NA | 60 |
| Buyouts | 8 | 8 | 8 | 7 | 6 | 7 | 7 | 8 | 7 | 8 | 6 | 0 |
| Venture Capital | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 5 | 3 | 0 |
| Private Debt | 4 | 4 | 4 | 3 | 3 | 4 | 0 | 3 | 3 | 4 | 2 | 0 |
| Private Real Estate | 3 | 4 | 4 | 3 | 3 | 3 | 4 | 3 | 2 | 3 | 2 | 0 |
| Private Real Assets | 3 | 4 | 4 | 3 | 3 | 4 | 2 | 3 | 2 | 3 | 2 | 0 |
| Emerging Market Bonds | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 0 | 3 | 0 | 0 |
| High Yield Bonds | 0 | 2 | 2 | 2 | 2 | 2 | 0 | 2 | 0 | 2 | 0 | 0 |
| Low Beta | 24 | 8 | 8 | 8 | 8 | 8 | 7 | 8 | 8 | 5 | 5 | 0 |
| Absolute Return | 5 | 3 | 3 | 3 | 3 | 3 | 5 | 3 | 3 | 0 | 0 | 0 |
| Short-Term Investment Grade Bonds | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cash Equivalents (Immunized CFs) | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 5 | 5 | 5 | 5 | 0 |
| Other | 12 | 25 | 24 | 23 | 22 | 21 | 25 | 17 | 22 | 16 | 21 | 40 |
| Core Real Estate | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 5 | 5 | 6 | 6 | 40 |
| Commodities | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TIPS | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 2 | 2 | 0 |
| Investment Grade Bonds | 3 | 15 | 14 | 13 | 12 | 11 | 20 | 8 | 13 | 6 | 11 | 0 |
| Long-term Govt Bonds | 0 | 3 | 3 | 3 | 3 | 3 | 0 | 2 | 2 | 2 | 2 | 0 |
| *Meketa Expected Return (10 years)* | *6.6* | *6.7* | *6.7* | *6.6* | *6.6* | *6.7* | *6.5* | *6.9* | *6.6* | *7.1* | *6.7* | *5.4* |
| *Meketa Expected Return (20 years)* | *7.4* | *7.5* | *7.5* | *7.5* | *7.5* | *7.5* | *7.3* | *7.8* | *7.5* | *8.0* | *7.7* | *6.3* |
| *Meketa Standard Deviation* | *12.5* | *12.2* | *12.3* | *12.6* | *12.7* | *12.7* | *12.7* | *13.6* | *13.2* | *14.3* | *13.8* | *10.4* |
| *Probability of Achieving 6.75% over 20 Years* | *58* | *60* | *60* | *60* | *60* | *60* | *58* | *63* | *60* | *65* | *62* | *42* |

[1] Expected return and standard deviation are based upon Meketa Investment Group's 2020 Annual Asset Study. Throughout this document, returns for periods longer than one year are annualized.

## Review of Proposed Asset Allocation Policies

- San Jose Staff and Meketa Investment Group discussed several alternative policies.

- We show the following allocations:

  – The Police and Fire Current Policy

  – Then we show ten options which incorporate additional risk into the portfolio compared to the current policy. Each of the alternative policies increase the Growth bucket in the range of 67 – 71%. Mix F shows the peer median asset allocation, and Mix E shows an allocation option that would match the risk of the peer median allocations, with allocations that take into account the current and preferred positioning of the portfolio by Staff and Meketa.

  – Lastly, we also show a 60% global equity/40% investment grade bond allocation, for comparison purposes.

## Peer Information - InvestorForce Public DB > $1B Net Peer Universe



**Total Plan Allocation vs. InvMetrics Public DB > $1B Net**
**As of December 31, 2019**

Allocation (Rank)

| | US Equity | Global ex US Equity | US Fixed Income | Global ex US Fixed Income | Alternatives | Real Estate Public and Private |
|---|---|---|---|---|---|---|
| 5th Percentile | 44.1 | 26.0 | 27.7 | 7.0 | 41.6 | 13.1 |
| 25th Percentile | 27.8 | 20.2 | 19.4 | 5.3 | 19.9 | 10.0 |
| Median | 22.3 | 16.6 | 15.5 | 4.4 | 14.1 | 7.0 |
| 75th Percentile | 17.4 | 12.8 | 10.5 | 3.0 | 10.4 | 4.7 |
| 95th Percentile | 6.1 | 7.0 | 2.3 | 1.3 | 2.5 | 0.4 |
| # of Portfolios | 47 | 55 | 48 | 29 | 55 | 53 |

## MVO-Based Risk Analysis

| Scenario | P&F Current (%) | Mix A (%) | Mix B (%) | Mix C (%) | Mix D (%) | Mix E – Peer Risk (%) | Mix F - Peer Median (%) | Mix G (%) | Mix H (%) | Mix I (%) | Mix J (%) | 60-40 (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Worst Case Returns (1)** | | | | | | | | | | | | |
| One Year | -17.9 | -17.3 | -17.5 | -18.0 | -18.1 | -18.1 | -18.3 | -19.5 | -18.9 | -20.3 | -19.7 | -15.2 |
| Three Years (annualized) | -8.0 | -7.7 | -7.8 | -8.1 | -8.2 | -8.1 | -8.4 | -9.0 | -8.6 | -9.4 | -9.1 | -6.7 |
| Five Years (annualized) | -4.8 | -4.5 | -4.5 | -4.8 | -4.8 | -4.8 | -5.0 | -5.4 | -5.2 | -5.8 | -5.6 | -3.9 |
| Ten Years (annualized) | -1.4 | -1.1 | -1.2 | -1.3 | -1.4 | -1.4 | -1.6 | -1.8 | -1.7 | -2.0 | -1.9 | -1.0 |
| Twenty Years (annualized) | 1.1 | 1.3 | 1.3 | 1.2 | 1.1 | 1.1 | 0.9 | 0.9 | 0.9 | 0.8 | 0.8 | 1.1 |
| **Probability of Experiencing Negative Returns** | | | | | | | | | | | | |
| One Year | 26.9 | 26.2 | 26.4 | 26.8 | 26.9 | 26.8 | 27.4 | 27.7 | 27.5 | 28.0 | 27.9 | 26.5 |
| Three Years | 14.4 | 13.5 | 13.7 | 14.2 | 14.3 | 14.2 | 14.9 | 15.2 | 15.0 | 15.6 | 15.6 | 13.8 |
| Five Years | 8.5 | 7.8 | 7.9 | 8.3 | 8.4 | 8.4 | 9.0 | 9.2 | 9.1 | 9.6 | 9.6 | 8.0 |
| Ten Years | 2.6 | 2.2 | 2.3 | 2.5 | 2.6 | 2.5 | 2.9 | 3.0 | 2.9 | 3.2 | 3.2 | 2.4 |
| Twenty Years | 0.3 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.5 | 0.4 | 0.2 |
| **Probability of Achieving at least a 6.75% Return** | | | | | | | | | | | | |
| One Year | 51.9 | 52.2 | 52.3 | 52.2 | 52.3 | 52.3 | 51.7 | 52.8 | 52.3 | 53.3 | 52.7 | 48.2 |
| Three Years | 53.2 | 53.8 | 53.9 | 53.8 | 53.9 | 54.1 | 53.0 | 54.9 | 54.0 | 55.8 | 54.6 | 47.0 |
| Five Years | 54.1 | 54.9 | 55.1 | 54.9 | 55.0 | 55.2 | 53.9 | 56.3 | 55.1 | 57.4 | 56.0 | 46.1 |
| Ten Years | 55.9 | 57.0 | 57.2 | 57.0 | 57.1 | 57.4 | 55.5 | 58.9 | 57.2 | 60.4 | 58.4 | 44.5 |
| Twenty Years | 58.2 | 59.8 | 60.1 | 59.8 | 60.0 | 60.4 | 57.7 | 62.5 | 60.2 | 64.6 | 61.8 | 42.2 |

- The alternative portfolio options, which have higher expected returns, are expected to have the highest probability of reaching the actuarial assumed rates of return, but have the lowest return in a worst case scenario.

## Historical Negative Scenario Analysis[1]
### (*Cumulative* Return)

| Scenario | P&F Current (%) | Mix A (%) | Mix B (%) | Mix C (%) | Mix D (%) | Mix E – Peer Risk (%) | Mix F - Peer Median (%) | Mix G (%) | Mix H (%) | Mix I (%) | Mix J (%) | 60-40 (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Taper Tantrum (May - Aug 2013) | -0.5 | -1.0 | -0.8 | -0.9 | -0.9 | -0.9 | -0.5 | -0.5 | -0.3 | -0.3 | -0.3 | -1.9 |
| Global Financial Crisis (Oct 2007 - Mar 2009) | -25.7 | -23.6 | -24.0 | -25.7 | -26.5 | -25.7 | -28.1 | -29.1 | -28.8 | -30.2 | -30.9 | -26.2 |
| 2008 Calendar Year | -24.1 | -22.0 | -22.3 | -23.6 | -24.2 | -23.7 | -24.7 | -26.4 | -25.9 | -27.3 | -27.5 | -23.2 |
| Popping of the TMT Bubble (Apr 2000 - Sep 2002) | -11.7 | -8.9 | -9.5 | -12.3 | -13.3 | -12.1 | -15.1 | -16.5 | -17.8 | -18.3 | -20.6 | -16.6 |
| LTCM (Jul - Aug 1998) | -9.0 | -8.3 | -8.5 | -9.2 | -9.4 | -9.4 | -9.2 | -10.0 | -9.4 | -10.2 | -10.0 | -7.7 |
| Asian Financial Crisis (Aug 1997 - Jan 1998) | -0.7 | 0.8 | 1.0 | 0.4 | 0.2 | 0.4 | 1.4 | 0.2 | 0.3 | 0.1 | -0.3 | 0.1 |
| Rate spike (1994 Calendar Year) | 3.5 | 1.9 | 1.9 | 1.8 | 1.8 | 1.6 | 3.2 | 2.4 | 2.3 | 2.5 | 2.2 | 1.8 |
| Crash of 1987 (Sep - Nov 1987) | -9.6 | -9.4 | -10.0 | -11.2 | -11.7 | -11.1 | -11.8 | -12.5 | -13.3 | -12.9 | -14.5 | -12.0 |
| Strong dollar (Jan 1981 - Sep 1982) | 4.2 | 5.7 | 5.7 | 4.7 | 4.2 | 4.1 | 3.7 | 2.4 | 3.5 | 2.1 | 2.8 | 5.3 |
| Stagflation (Jan - Mar 1980) | -3.3 | -4.0 | -3.9 | -4.1 | -4.1 | -3.9 | -4.5 | -3.8 | -4.2 | -3.7 | -4.2 | -7.0 |
| Stagflation (Jan 1973 - Sep 1974) | -16.0 | -18.1 | -18.7 | -20.5 | -21.2 | -20.5 | -22.1 | -23.1 | -23.2 | -24.0 | -25.1 | -20.4 |

- The Current policy would have performed the best in environments of declining equity markets or stagflation, due to its less risky positioning.

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[1] See the Appendix for our scenario inputs.  In periods where the ideal benchmark was not yet available we used the next closest benchmark(s) as a proxy.

## Historical Positive Scenario Analysis[1]
### (Cumulative Return)

| Scenario | P&F Current (%) | Mix A (%) | Mix B (%) | Mix C (%) | Mix D (%) | Mix E – Peer Risk (%) | Mix F - Peer Median (%) | Mix G (%) | Mix H (%) | Mix I (%) | Mix J (%) | 60-40 (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Global Financial Crisis Recovery (Mar 2009 - Nov 2009) | 34.1 | 32.5 | 32.8 | 35.0 | 35.9 | 35.0 | 35.5 | 37.5 | 37.5 | 38.4 | 39.8 | 39.5 |
| Best of Great Moderation (Apr 2003 - Feb 2004) | 30.7 | 28.8 | 28.8 | 30.3 | 30.9 | 30.3 | 31.1 | 32.5 | 32.2 | 33.2 | 34.1 | 29.5 |
| Peak of the TMT Bubble (Oct 1998 - Mar 2000) | 59.0 | 56.9 | 57.4 | 58.4 | 58.7 | 59.0 | 53.2 | 61.6 | 56.3 | 66.5 | 57.5 | 33.6 |
| Pre-Recession (Jun - Oct 1990) | -3.2 | -4.7 | -5.0 | -5.7 | -6.0 | -5.8 | -5.1 | -6.5 | -6.5 | -6.9 | -7.3 | -5.2 |
| Plummeting Dollar (Jan 1986 - Aug 1987) | 55.9 | 51.3 | 50.3 | 54.4 | 56.1 | 54.0 | 62.3 | 58.5 | 57.9 | 59.6 | 62.5 | 70.8 |
| Volcker Recovery (Aug 1982 - Apr 1983) | 27.3 | 29.1 | 30.0 | 31.8 | 32.3 | 31.0 | 33.0 | 32.7 | 34.8 | 33.1 | 36.6 | 36.3 |
| Bretton Wood Recovery (Oct 1974 - Jun 1975) | 25.0 | 25.8 | 26.7 | 28.6 | 29.2 | 28.2 | 29.8 | 30.6 | 31.7 | 31.4 | 33.8 | 30.5 |

- The alternative portfolio options and the 60/40 portfolio would have performed the best during sharply increasing market environments historically.

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[1] See the Appendix for our scenario inputs. In periods where the ideal benchmark was not yet available we used the next closest benchmark(s) as a proxy.

## Stress Testing:  Impact of Market Movements
### (Expected Return under Stressed Conditions)[1]

| Scenario | P&F Current (%) | Mix A (%) | Mix B (%) | Mix C (%) | Mix D (%) | Mix E – Peer Risk (%) | Mix F - Peer Median (%) | Mix G (%) | Mix H (%) | Mix I (%) | Mix J (%) | 60-40 (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10-year Treasury Bond rates rise 100 bps | 5.0 | 3.9 | 3.9 | 4.1 | 4.3 | 4.2 | 4.4 | 4.9 | 4.6 | 5.2 | 4.9 | 2.9 |
| 10-year Treasury Bond rates rise 200 bps | 2.2 | 0.1 | 0.2 | 0.4 | 0.5 | 0.5 | 0.7 | 1.4 | 0.9 | 1.7 | 1.4 | -1.4 |
| 10-year Treasury Bond rates rise 300 bps | -0.6 | -3.2 | -2.9 | -2.7 | -2.5 | -2.4 | -2.3 | -1.3 | -1.8 | -0.8 | -1.2 | -5.1 |
| Baa Spreads widen by 50 bps, High Yield by 200 bps | 0.1 | 0.5 | 0.5 | 0.4 | 0.3 | 0.3 | 0.4 | 0.0 | 0.1 | -0.1 | 0.0 | 0.5 |
| Baa Spreads widen by 300 bps, High Yield by 1000 bps | -20.2 | -19.4 | -19.6 | -20.6 | -21.0 | -20.6 | -21.5 | -22.5 | -22.0 | -23.3 | -23.3 | -20.0 |
| Trade Weighted Dollar gains 10% | -3.1 | -2.3 | -2.1 | -2.4 | -2.5 | -2.5 | -2.9 | -2.9 | -2.6 | -3.0 | -2.9 | -2.7 |
| Trade Weighted Dollar gains 20% | -4.3 | -1.9 | -1.7 | -1.9 | -2.0 | -2.1 | -2.4 | -2.4 | -1.6 | -2.5 | -1.7 | -2.0 |
| US Equities decline 10% | -5.3 | -5.0 | -5.2 | -5.5 | -5.7 | -5.6 | -5.7 | -6.3 | -6.1 | -6.6 | -6.5 | -4.9 |
| US Equities decline 25% | -15.5 | -14.8 | -15.1 | -15.8 | -16.1 | -15.9 | -16.5 | -17.4 | -17.0 | -18.0 | -17.9 | -14.6 |
| US Equities decline 40% | -25.0 | -23.6 | -23.9 | -25.2 | -25.8 | -25.2 | -26.9 | -27.6 | -27.2 | -28.6 | -29.0 | -25.0 |

- Each policy portfolio has a different sensitivity to four major risk factors:  interest rates, credit spreads, currency fluctuations, and equity values.

- The Plan's primary risk factors would continue to be an equity market decline and a widening of credit spreads, no matter the policy.

[1] Assumes that assets not directly exposed to the factor are affected nonetheless.  See the Appendix for further details.

## Stress Testing: Impact of Positive Market Movements
### (Expected Return under Stressed Conditions)[1]

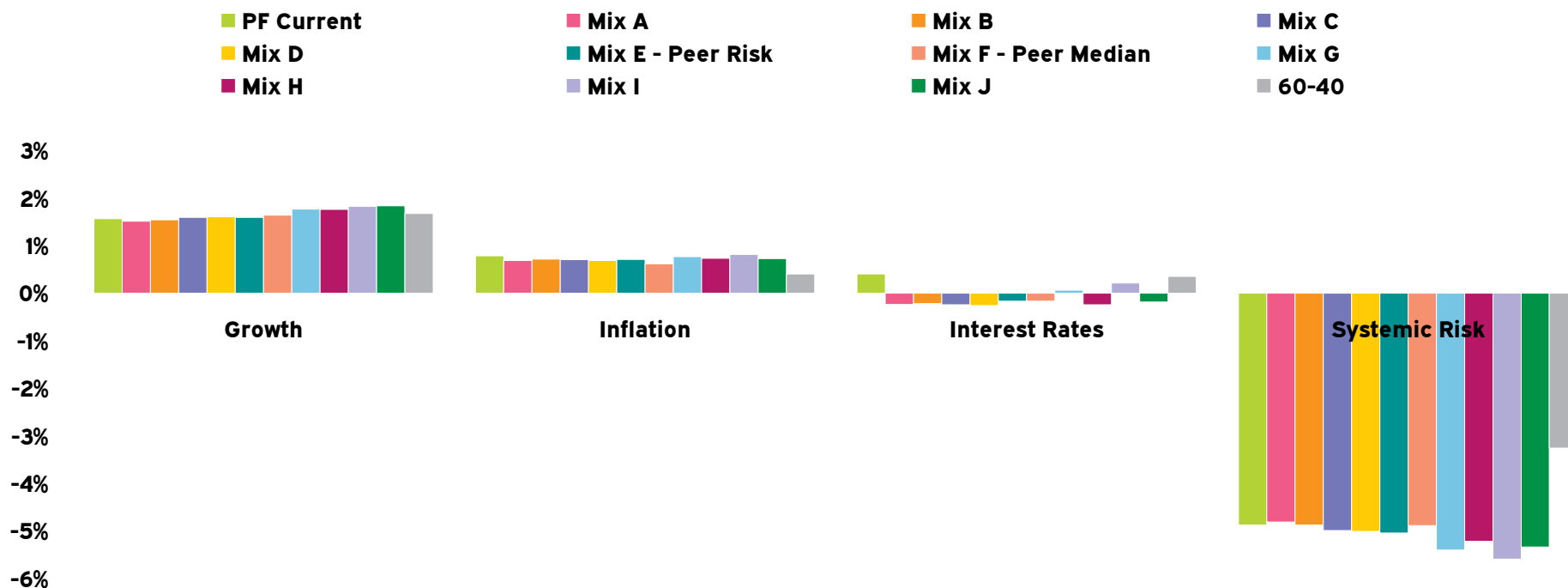| Scenario | P&F Current (%) | Mix A (%) | Mix B (%) | Mix C (%) | Mix D (%) | Mix E – Peer Risk (%) | Mix F - Peer Median (%) | Mix G (%) | Mix H (%) | Mix I (%) | Mix J (%) | 60-40 (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10-year Treasury Bond rates drop 100 bps | 3.2 | 4.6 | 4.7 | 4.6 | 4.5 | 4.5 | 4.2 | 4.1 | 4.4 | 4.0 | 4.2 | 4.9 |
| 10-year Treasury Bond rates drop 200 bps | 11.5 | 13.5 | 13.5 | 14.1 | 14.2 | 13.7 | 14.2 | 13.9 | 14.4 | 14.0 | 14.9 | 16.3 |
| Baa Spreads narrow by 30bps, High Yield by 100 bps | 7.1 | 7.3 | 7.4 | 7.6 | 7.7 | 7.6 | 7.7 | 8.1 | 8.0 | 8.3 | 8.3 | 6.8 |
| Baa Spreads narrow by 100bps, High Yield by 300 bps | 14.2 | 14.0 | 14.1 | 14.7 | 14.9 | 14.7 | 14.2 | 15.5 | 14.9 | 15.9 | 15.5 | 14.0 |
| Trade Weighted Dollar drops 10% | 8.0 | 7.4 | 7.3 | 7.6 | 7.7 | 7.6 | 7.9 | 8.0 | 7.6 | 8.1 | 8.0 | 7.7 |
| Trade Weighted Dollar drops 20% | 20.2 | 20.2 | 20.0 | 21.0 | 21.3 | 20.9 | 22.4 | 22.1 | 21.9 | 22.6 | 23.2 | 22.9 |
| US Equities rise 10% | 6.7 | 6.7 | 6.8 | 7.0 | 7.1 | 7.0 | 7.0 | 7.4 | 7.3 | 7.6 | 7.5 | 6.1 |
| US Equities rise 30% | 15.5 | 15.7 | 16.1 | 17.1 | 17.3 | 16.9 | 17.4 | 18.2 | 18.4 | 18.8 | 19.4 | 17.0 |

- **The portfolios with the least downside risk are the portfolios that participate least in upside scenarios.**

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[1] Assumes that assets not directly exposed to the factor are affected nonetheless.  See the Appendix for further details.

## Economic Regime Management®

- The Economic Regime Management® (ERM) approach focuses on understanding the dynamics of the most important macro level forces that drive returns across asset classes.

- We find the most important factors to be:

  - Interest Rate Surprise — Unexpected changes in the 10 year interest rate (related to Duration).

  - Inflation Surprise — Unexpected changes in the CPI growth rate.

  - Growth Surprise — Unexpected changes in the Real GDP growth rate.

  - Systemic Risk — "System-wide" risk that propagates through all asset classes (e.g., 2008).

- We focus on surprises because expectations matter.

  - What was considered "low" inflation in the 1970s would be considered "high" today.

- These factors explain the majority of volatility across asset classes.

- Understanding these dynamics explain the "why" not just the "what."

## Portfolio Sensitivity Comparison

Legend:
- PF Current
- Mix A
- Mix B
- Mix C
- Mix D
- Mix E - Peer Risk
- Mix F - Peer Median
- Mix G
- Mix H
- Mix I
- Mix J
- 60-40



- The chart above shows the resulting change in portfolio return given a one standard deviation event in the respective risk factor.

- There is more concentration in Growth and Systematic Risk because these sources of risk tend to pay better (have higher expected returns) than the other risk factors.

## Summary

- Meketa Investment Group looks forward to discussing this analysis with the members of the Investment Committee.

# Setting Capital Market Expectations

## Overview of Annual Asset Study Methodology

- In order to construct an optimal portfolio from a risk-return standpoint, conventional financial wisdom dictates that one develop return, volatility, and correlation expectations over the relevant investing horizon.

- Given the uncertainty surrounding financial and economic forecasts, expectations development is challenging, and any of several methodological approaches may meaningfully contribute to this complex task.

- Meketa Investment Group's process relies on both quantitative and qualitative methodologies.

- First, we employ a large set of quantitative models to arrive at a set of baseline expected ten-year annualized returns for major asset classes.

- These models attempt to forecast a gross "beta" return for each *public market* asset class; that is, we specifically do not model "alpha," nor do we apply an estimate for management fees or other operational expenses.[1]

- Our models are fundamentally based (based on some theoretically defined return relationship with current observable factors).

- Some of these models are more predictive than others. For this reason, we next overlay a qualitative analysis, which takes the form of a data-driven deliberation among the research team and our Investment Policy Committee.

- Return assumptions for hard-to-predict asset classes as well as those with limited data will be influenced more heavily by our qualitative analysis.

- As a result of this process, we form our ten-year annualized return expectations, which serve as the primary foundation of our longer-term, twenty-year expectations.

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[1] Our expectations are net of fees where passive management is not available (e.g., private markets and hedge funds).

## Overview of Annual Asset Study Methodology (continued)

- We form our twenty-year annualized return expectations by systematically considering historical returns on an asset class by asset class level. Specifically, we construct a weighted average of our ten-year expectations and average historical returns in each asset class.

- The weights are determined by a qualitative assessment of the value of the historical data. Generally, if we have little confidence that the historical average return is representative of what an investor can expect,[1] we will weight our ten-year forecast more heavily. Therefore, the weight on our ten-year forecasts ranges from 0.5 to 0.9.

- We develop our twenty-year volatility and correlation expectations differently. We rely primarily on historical averages, with an emphasis given to the experience of the trailing ten years.

- Qualitative adjustments, when applied, usually serve to increase the correlations and volatility over and above the historical estimates (e.g., using the higher correlations usually observed during a volatile market).

- We also make adjustments to the volatility based on the historical skewness of each asset class (e.g., increasing the volatility for an asset class that has been negatively skewed).

- In the case of private markets and other illiquid asset classes where historical volatility and correlations have been artificially dampened, we seek public market equivalents on which to base our estimates before applying any qualitative adjustments.

- These volatility and correlation expectations are then combined with our twenty-year return expectations to assist us in subsequent asset allocation work, including mean-variance optimization and scenario analyses.

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[1] For example, we have less confidence in historical data that do not capture many possible market scenarios or that are overly polluted by survivorship bias.

## Overview of Annual Asset Study Methodology (continued)

- Each year, we review and set our capital market expectations via our Asset Study.

- This involves setting long-term expectations for a variety of asset classes for:

    - Returns.

    - Standard Deviation.

    - Correlations.

- Our process relies on both quantitative and qualitative methodologies.
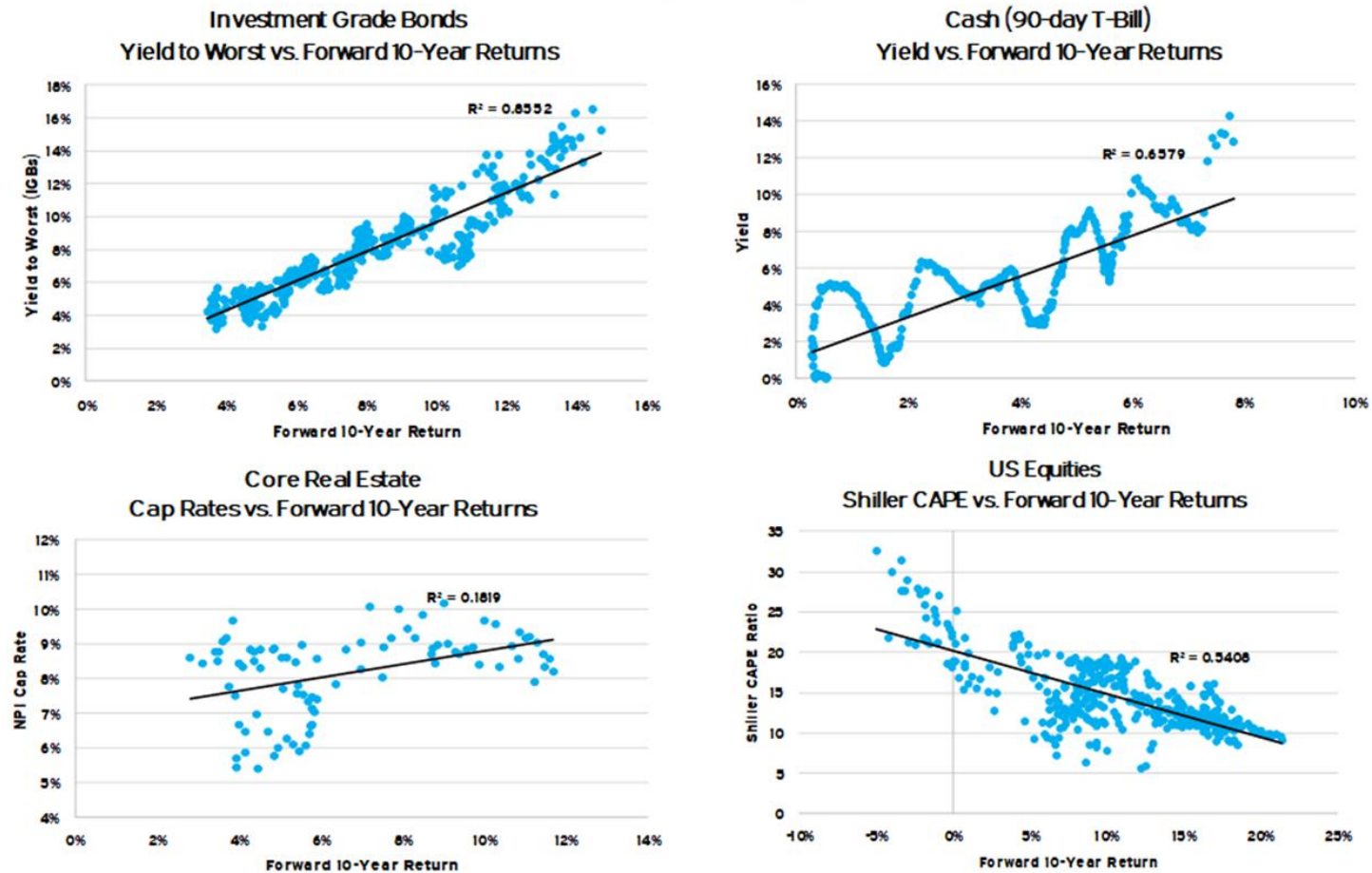
## Asset Class Definitions

- Meketa Investment Group utilizes an approach that identifies asset classes that are appropriate for long-term allocation of funds, and that also are investable.

- Three considerations influence this process: unique return behavior, an observable historical track record, and a robust market.

- We then make forecasts for each unique asset class.

## Our Process

- The first step is to build our 10-year forecasts.

    - Our fundamental models are primarily valuation based.

- Each model falls in one of eight groups, based on the most important factors that drive their returns:

| Asset Class Category | Major Factors |
|---|---|
| Equities | Dividend Yield, GDP Growth, Valuation |
| Bonds | Yield to Worst, Default Rate, Recovery Rate |
| Commodities | Collateral Yield, Roll Yield, Inflation |
| Infrastructure | Public IS Valuation, Income, Growth |
| Natural Resources | Price per Acre, Income, Public Market Valuation |
| Real Estate | Cap Rate, Yield, Growth |
| Private Equity | EBITDA Multiple, Debt Multiple, Public VC Valuation |
| Hedge Funds and Other | Leverage, Alternative Betas |

## Our Process (continued)



Investment Grade Bonds
Yield to Worst vs. Forward 10-Year Returns

Cash (90-day T-Bill)
Yield vs. Forward 10-Year Returns

Core Real Estate
Cap Rates vs. Forward 10-Year Returns

US Equities
Shiller CAPE vs. Forward 10-Year Returns

- Some models are naturally more predictive than others.

## Our Process (continued)

- The next step is to move from ten-year to our twenty-year forecasts.

- We do this by combining our ten-year forecasts with the historical returns for each asset class.

  - How much we apply to each depends on our confidence in them (both the model and the data).

- The ten-year model weighting varies between 50% and 100%.

- It only hits 100% when there is a lack of reliable historical data.

- We then infer a forecast of ten-year returns in ten years (i.e., years 11-20).

  - This allows us to test our assumptions with finance theory.

  - Essentially, we assume mean-reversion over the first ten years, then consistency with CAPM thereafter.

## Our Process (continued)

- The final step is to make any qualitative adjustments.

- The Investment Committee reviews the output and may make adjustments due to:

    – Quality of the underlying data.

    – Confidence in the model.

    – External inputs (e.g., perceived risks).

## Capital Market Assumption Development

### Example Equities

- We use a fundamental model for equities that combines income and capital appreciation:

$$E(R) = Dividend\ Yield + Expected\ Earnings\ Growth + Multiple\ Effect + Currency\ Effect$$

- Meketa Investment Group evaluates historical data statistically to develop expectations for dividend yield, earnings growth, the multiple effect, and currency effect.

- Our models assume that there is a reversion to the mean over long time periods.

### Bonds

- The short version for investment grade bond models is:

$$E(R) = Current\ YTW\ (yield\ to\ worst)$$

- Our models assume that there is a reversion to the mean for spreads (though not yields).

- For TIPS, we add the real yield of the TIPS index to the breakeven inflation rate.

- As with equities, we make currency adjustments when necessary for foreign bonds.

- For bonds with credit risk, Meketa Investment Group estimates default rates and loss rates, in order to project an expected return:

$$E(R) = YTW - (Annual\ Default\ Rate * Loss\ Rate)$$

## The Other Inputs: Standard Deviation and Correlation

### Standard Deviation

- We review the trailing ten-year standard deviation, as well as the trailing ten-year skewness.

- Historical standard deviation serves as the base for our assumptions.

- We increase or decrease the assumptions based on the size and sign of the historical skewness.

| Asset Class | Standard Deviation | Skewness | Assumption |
|---|---|---|---|
| Bank Loans | 6.6% | -2.3 | 9.0% |

- We consider performance during the GFC to see if further changes are warranted (e.g., hedge funds).

- We also adjust for private market asset classes with "smoothed" return streams.

### Correlation

- We use trailing ten-year correlations as our guide.

- Again, we make adjustments for performance during the GFC and "smoothed" return streams.

- Most of our adjustments are conservative in nature (i.e., they increase the standard deviation and correlation).

## Horizon Study

- Annually, Horizon Actuarial Services, LLC publishes a survey of capital market assumptions that they collect from various investment advisors.

  – In the 2019[1] survey there were 34 respondents.

- The Horizon survey is a useful tool for Board members to determine whether their consultant's expectations for returns (and risk) are reasonable.

| Asset Class | 10-Year Average (%) | 20-Year Average (%) | MIG 20-Year (%) |
|---|---|---|---|
| US Equity (large cap) | 6.0 | 7.1 | 8.1 |
| Non-US – Developed | 6.8 | 7.7 | 8.5 |
| Non-US – Emerging | 7.8 | 8.7 | 10.4 |
| US Corporate Bonds – Core | 3.6 | 4.3 | 4.6 |
| US Corporate Bonds – High Yield | 5.1 | 5.8 | 6.5 |
| Non-US Debt – Developed | 2.6 | 3.4 | 2.3 |
| Non-US Debt – Emerging | 5.6 | 6.1 | 5.3 |
| US Treasuries (cash) | 2.7 | 3.0 | 2.9 |
| TIPS | 3.1 | 3.5 | 3.6 |
| Real Estate | 5.8 | 6.8 | 7.0 |
| Hedge Funds | 5.3 | 6.2 | 5.4 |
| Commodities | 3.9 | 4.7 | 5.0 |
| Infrastructure | 6.8 | 7.2 | 6.5 |
| Private Equity | 9.0 | 10.1 | 10.1 |
| Private Debt | 7.4 | 7.8 | 7.3 |
| Inflation | 2.2 | 2.3 | 2.6 |

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[1] The 10-year horizon includes all 34 respondents and the 20-year horizon includes 16 respondents.

# Appendices

## Notes and Disclaimers

[1]  The returns shown in the Policy Options and Risk Analysis sections rely on estimates of expected return, standard deviation, and correlation developed by Meketa Investment Group.  To the extent that actual return patterns to the asset classes differ from our expectations, the results in the table will be incorrect.  However, our inputs represent our best unbiased estimates of these simple parameters.

[2]  The returns shown in the Policy Options and Risk Analysis sections use a lognormal distribution, which may or may not be an accurate representation of each asset classes' future return distribution.  To the extent that it is not accurate in whole or in part, the probabilities listed in the table will be incorrect.  As an example, if some asset classes' actual distributions are even more right-skewed than the lognormal distribution (i.e., more frequent low returns and less frequent high returns), then the probability of the portfolio hitting a given annual return will be lower than that stated in the table.

[3]  The standard deviation bars in the chart in the Risk Analysis section do not indicate the likelihood of a 1, 2, or 3 standard deviation event—they simply indicate the return we expect if such an event occurs.  Since the likelihood of such an event is the same across allocations regardless of the underlying distribution, a relative comparison across policy choices remains valid.

## Scenario Return Inputs

| Asset Class | Benchmark Used |
|---|---|
| Investment Grade Bonds | Barclays Aggregate |
| TIPS | Barclays US TIPS |
| Intermediate-term Government Bonds | Barclays Treasury Intermediate |
| Long-term Government Bonds | Barclays Long US Treasury |
| EM Bonds (local) | JPM GBI-EM Global Diversified Composite |
| Bank Loans | CSFB Leveraged Loan |
| High Yield Bonds | Barclays High Yield |
| Direct Lending - First Lien | Cliffwater Direct Lending Index |
| Direct Lending - Second Lien | Cliffwater Direct Lending Index |
| Mezzanine Debt | Cambridge Associates Mezzanine |
| Distressed Debt | Cambridge Associates Distressed Debt Index |
| Core Real Estate | NCREIF Property |
| Value-Added RE | NCREIF Townsend Value Added |
| Opportunistic RE | NCREIF Townsend Opportunistic |
| REITs | NAREIT Equity |
| Infrastructure (private) | S&P Global Infrastructure |
| Natural Resources (private) | S&P Global Natural Resources |
| Timber | NCREIF Timberland |
| Commodities | Bloomberg Commodity Index |
| US Equity | Russell 3000 |
| Public Foreign Equity (Developed) | MSCI EAFE |
| Public Foreign Equity (Emerging) | MSCI Emerging Markets |
| Private Equity | Cambridge Associates Private Equity Composite |
| Long-short Equity | HFRI Equity Hedge |
| Global Macro | HFRI Macro |
| Hedge Funds | HFRI Fund Weighted Composite |
| Private Debt | Weighted average of Distressed Debt, Mezzanine Debt and Direct Lending (2nd Lien) |

## Negative Historical Scenario Returns - Sample Inputs

| | Taper Tantrum (May - Aug 2013) | Global Financial Crisis (Oct 2007 - Mar 2009) | 2008 Calendar Year | Popping of the TMT Bubble (Apr 2000 - Sep 2002) | LTCM (Jul - Aug 1998) | Asian Financial Crisis (Aug 1997 - Jan 1998) | Rate spike (1994 Calendar Year) | Crash of 1987 (Sep - Nov 1987) | Strong dollar (Jan 1981 - Sep 1982) | Stagflation (Jan - Mar 1980) | Stagflation (Jan 1973 - Sep 1974) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cash Equivalents | 0.0 | 3.1 | 1.7 | 9.9 | 0.8 | 2.4 | 3.9 | 1.4 | 24.4 | 2.9 | 13.5 |
| Short-term Investment Grade Bonds | -0.1 | 8.7 | 5.0 | 21.9 | 1.6 | 3.5 | 0.5 | 2.3 | 29.9 | -2.6 | 4.3 |
| Investment Grade Bonds | -3.7 | 9.3 | 5.2 | 28.6 | 1.8 | 4.9 | -2.9 | 2.2 | 29.9 | -8.7 | 7.9 |
| Long-term Corporate Bonds | -9.3 | -9.4 | -5.2 | 26.9 | -0.6 | 5.4 | -5.8 | 1.5 | 29.6 | -14.1 | -12.0 |
| Long-term Government Bonds | -11.6 | 24.5 | 24.0 | 35.5 | 4.1 | 8.6 | -7.6 | 2.6 | 28.4 | -13.6 | -1.8 |
| TIPS | -8.5 | 9.6 | -2.4 | 37.4 | 0.7 | 2.0 | -7.5 | 2.8 | 15.6 | -7.8 | 4.3 |
| Global ILBs | -7.4 | -1.5 | -7.7 | 39.7 | 0.7 | 2.2 | -7.9 | 2.9 | 16.5 | -8.3 | 4.5 |
| High Yield Bonds | -2.0 | -20.7 | -26.2 | -6.3 | -5.0 | 5.6 | -1.0 | -3.6 | 6.9 | -2.3 | -15.5 |
| Bank Loans | 0.8 | -22.5 | -28.8 | 6.3 | 0.7 | 3.3 | 10.3 | -1.7 | 3.3 | -1.1 | -7.5 |
| Direct Lending - First Lien | 3.4 | -2.1 | -5.8 | -0.7 | -0.7 | 1.7 | 0.7 | -0.2 | 2.0 | -0.6 | -4.4 |
| Direct Lending - Second Lien | 4.6 | -2.9 | -7.8 | -1.0 | -0.9 | 2.3 | 1.0 | -0.3 | 2.6 | -0.8 | -5.9 |
| Foreign Bonds | -3.2 | 5.3 | 4.4 | 8.5 | 3.5 | 3.3 | 5.3 | -0.3 | 34.8 | -6.5 | -1.4 |
| Mezzanine Debt | 4.6 | -25.5 | -25.9 | -2.0 | -2.6 | 10.3 | 7.6 | 0.4 | 3.2 | -1.0 | -7.2 |
| Distressed Debt | 4.6 | -25.5 | -25.9 | -2.0 | -2.6 | 10.3 | 7.6 | 0.4 | 3.2 | -1.0 | -7.2 |
| Emerging Market Bonds (major) | -11.5 | -2.7 | -9.7 | 6.3 | -28.2 | -1.8 | -18.9 | -9.2 | -1.6 | -2.6 | -20.2 |
| Emerging Market Bonds (local) | -14.3 | -2.3 | -5.2 | 7.2 | -34.1 | -2.4 | -22.8 | -11.0 | -2.0 | -3.2 | -23.9 |
| US Equity | 3.0 | -43.8 | -37.0 | -43.8 | -15.4 | 3.6 | 1.3 | -29.5 | -2.3 | -4.1 | -42.6 |
| Developed Market Equity (non-US) | -2.2 | -49.6 | -43.4 | -46.7 | -11.5 | -5.8 | 7.8 | -14.5 | -18.0 | -7.0 | -36.3 |
| Emerging Market Equity | -9.4 | -45.8 | -53.3 | -43.9 | -26.7 | -31.8 | -7.3 | -25.3 | -12.1 | -6.6 | -44.2 |
| Global Equity | -0.7 | -46.6 | -42.2 | -46.7 | -14.0 | -3.2 | 5.0 | -21.5 | -11.2 | -5.8 | -39.3 |
| Private Equity/Debt | 5.7 | -25.6 | -27.2 | -23.4 | -3.2 | 15.7 | 13.2 | 0.6 | -2.7 | -2.5 | -18.2 |
| Private Equity | 5.8 | -25.8 | -27.6 | -26.0 | -3.3 | 16.7 | 14.2 | 0.6 | -3.9 | -2.7 | -20.1 |
| Private Debt Composite | 4.6 | -21.3 | -22.5 | -1.7 | -2.3 | 8.7 | 6.2 | 0.2 | 3.0 | -1.0 | -6.9 |
| REITs | -13.3 | -61.3 | -37.7 | 45.4 | -15.3 | 9.8 | -3.5 | -19.5 | 2.5 | -3.6 | -33.9 |
| Core Private Real Estate | 3.6 | -7.3 | -6.5 | 23.6 | 2.3 | 8.5 | 6.4 | 0.7 | 23.9 | 5.5 | -4.4 |
| Value-Added Real Estate | 3.8 | -18.0 | -13.4 | 177.0 | 1.8 | 11.4 | 11.2 | 1.2 | 44.2 | 9.6 | -7.6 |
| Opportunistic Real Estate | 4.0 | -24.7 | -21.8 | 21.4 | 1.5 | 20.0 | 18.8 | 0.9 | 30.7 | 7.0 | -5.6 |
| Natural Resources (Private) | 2.5 | -26.2 | -34.1 | -3.9 | -16.9 | -7.8 | 12.6 | -10.8 | -9.4 | -9.2 | 19.3 |
| Timberland | 1.3 | 25.4 | 9.5 | -1.5 | 0.5 | 12.0 | 15.4 | 3.8 | 23.6 | -7.4 | 5.5 |
| Farmland | 3.3 | 30.2 | 15.8 | 11.4 | 0.8 | 3.9 | 9.4 | 2.2 | 13.3 | -4.2 | 3.1 |
| Commodities (naïve) | -2.4 | -31.8 | -35.6 | 18.5 | -12.0 | -6.2 | 16.6 | 1.8 | -16.0 | -9.6 | 139.5 |
| Core Infrastructure | 3.7 | 0.2 | -0.6 | 24.8 | -0.3 | 6.1 | -11.5 | 0.0 | -0.2 | -0.1 | -0.5 |
| Hedge Funds | -0.4 | -15.6 | -19.0 | -2.1 | -9.4 | 1.7 | 4.1 | -7.8 | -3.8 | -1.9 | -15.7 |
| Long-Short | 1.0 | -24.0 | -26.6 | -8.8 | -8.3 | 7.9 | 2.6 | -10.0 | -4.9 | -2.5 | -19.8 |
| Hedge Fund of Funds | -0.5 | -17.8 | -21.4 | -0.4 | -7.7 | 0.5 | -3.5 | -5.7 | -2.7 | -1.4 | -11.5 |

## Positive Historical Scenario Returns - Sample Inputs

| | Global Financial Crisis Recovery (Mar 2009 - Nov 2009) | Best of Great Moderation (Apr 2003 - Feb 2004) | Peak of the TMT Bubble (Oct 1998 - Mar 2000) | Pre-Recession (Jun - Oct 1990) | Plummeting Dollar (Jan 1986 - Aug 1987) | Volcker Recovery (Aug 1982 - Apr 1983) | Bretton Wood Recovery (Oct 1974 - Jun 1975) |
|---|---|---|---|---|---|---|---|
| Cash Equivalents | 0.1 | 0.9 | 6.7 | 3.3 | 10.0 | 6.0 | 4.5 |
| Short-term Investment Grade Bonds | 4.3 | 2.8 | 5.3 | 4.5 | 13.2 | 15.4 | 5.0 |
| Investment Grade Bonds | 9.0 | 4.6 | 1.7 | 3.8 | 14.4 | 26.4 | 9.2 |
| Long-term Corporate Bonds | 28.8 | 11.3 | -3.1 | 1.5 | 15.9 | 42.1 | 17.5 |
| Long-term Government Bonds | 2.0 | 4.9 | -2.3 | 2.4 | 15.4 | 33.6 | 11.8 |
| TIPS | 14.3 | 9.1 | 6.3 | 2.2 | 10.2 | 11.5 | 4.1 |
| Global ILBs | 24.7 | 9.6 | 6.6 | 2.3 | 10.8 | 12.1 | 4.3 |
| High Yield Bonds | 49.1 | 21.8 | 2.1 | -12.9 | 24.9 | 23.3 | 19.3 |
| Bank Loans | 32.9 | 10.1 | 6.1 | -6.1 | 11.1 | 10.4 | 8.7 |
| Direct Lending - First Lien | 10.6 | 5.7 | 1.1 | -1.9 | 5.8 | 5.0 | 5.1 |
| Direct Lending - Second Lien | 14.3 | 7.7 | 1.4 | -2.5 | 7.8 | 6.7 | 6.8 |
| Foreign Bonds | 23.4 | 15.2 | -7.0 | 15.8 | 44.5 | 32.3 | 17.9 |
| Mezzanine Debt | 30.8 | 23.7 | 26.8 | 0.7 | 5.4 | 8.2 | 8.3 |
| Distressed Debt | 30.8 | 23.7 | 26.8 | 0.7 | 5.4 | 8.2 | 8.3 |
| Emerging Market Bonds (major) | 27.0 | 20.6 | 49.0 | -8.7 | 38.9 | 21.6 | 21.0 |
| Emerging Market Bonds (local) | 37.5 | 25.2 | 61.0 | -10.5 | 48.4 | 26.5 | 25.7 |
| US Equity | 51.6 | 37.2 | 50.2 | -14.7 | 64.8 | 59.3 | 55.1 |
| Developed Market Equity (non-US) | 60.5 | 56.7 | 53.0 | -9.7 | 140.0 | 29.6 | 34.6 |
| Emerging Market Equity | 94.6 | 79.4 | 101.3 | -15.9 | 126.5 | 52.1 | 53.4 |
| Global Equity | 59.9 | 46.2 | 54.8 | -11.1 | 108.4 | 43.0 | 44.6 |
| Private Equity/Debt | 15.4 | 23.3 | 84.6 | 4.6 | 19.1 | 13.7 | 18.4 |
| Private Equity | 13.0 | 23.7 | 92.1 | 5.5 | 21.7 | 14.8 | 20.2 |
| Private Debt Composite | 27.5 | 20.4 | 21.4 | 0.1 | 5.9 | 7.9 | 8.0 |
| REITs | 82.5 | 44.6 | -5.2 | -15.6 | 51.8 | 47.4 | 42.5 |
| Core Private Real Estate | -16.4 | 9.0 | 18.1 | 1.9 | 13.1 | 6.8 | 4.5 |
| Value-Added Real Estate | -32.7 | 11.4 | 19.6 | 3.2 | 23.6 | 11.9 | 7.8 |
| Opportunistic Real Estate | -19.0 | 13.6 | 27.9 | 0.4 | 16.7 | 8.6 | 5.7 |
| Natural Resources (Private) | 57.8 | 36.1 | 22.2 | 6.0 | 78.3 | 30.2 | 14.8 |
| Timberland | -3.3 | 8.5 | 20.5 | 5.7 | 28.6 | 20.0 | 8.7 |
| Farmland | 5.4 | 9.6 | 10.4 | 3.3 | 15.9 | 11.3 | 5.0 |
| Commodities (naïve) | 28.9 | 30.6 | 17.1 | 43.5 | 27.6 | 6.2 | -20.2 |
| Core Infrastructure | 2.1 | 8.5 | 33.0 | 0.0 | 1.4 | 0.6 | 0.6 |
| Hedge Funds | 20.1 | 22.4 | 52.8 | -1.9 | 30.6 | 13.8 | 14.5 |
| Long-Short | 25.9 | 25.3 | 81.4 | 5.1 | 40.8 | 18.0 | 18.9 |
| Hedge Fund of Funds | 10.3 | 13.3 | 36.8 | 11.9 | 21.3 | 9.7 | 10.3 |

## 'Anti' Stress Test Return Assumptions – Sample Inputs[1]

| | 10-year Treasury Bond rates drop 100 bps | 10-year Treasury Bond rates drop 200 bps | Baa Spreads narrow by 30bps, High Yield by 100 bps | Baa Spreads narrow by 100bps, High Yield by 300 bps | Trade Weighted Dollar drops 10% | Trade Weighted Dollar drops 20% | US Equities rise 10% | US Equities rise 30% |
|---|---|---|---|---|---|---|---|---|
| Cash Equivalents | 1.6 | 1.8 | 0.5 | 0.2 | 1.8 | 3.9 | 2.0 | 2.9 |
| Short-term Investment Grade Bonds | 3.7 | 5.6 | 0.7 | 2.2 | 1.8 | 3.4 | 1.0 | 2.2 |
| Investment Grade Bonds | 8.7 | 14.7 | 1.8 | 4.3 | 2.8 | 8.5 | 1.8 | 4.3 |
| Long-term Corporate Bonds | 18.3 | 32.6 | 5.0 | 15.1 | 5.7 | 13.9 | 3.3 | 7.9 |
| Long-term Government Bonds | 20.3 | 38.1 | 1.6 | -0.3 | 2.9 | 19.2 | 3.0 | 6.8 |
| TIPS | 8.8 | 15.4 | 1.8 | 6.2 | 4.0 | 6.5 | 1.6 | 2.6 |
| Global ILBs | 3.0 | 5.3 | 2.8 | 7.7 | 6.0 | 6.9 | 1.9 | 3.8 |
| High Yield Bonds | 5.0 | 10.2 | 7.6 | 26.3 | 6.6 | 7.5 | 5.3 | 11.7 |
| Bank Loans | 1.4 | 2.1 | 4.3 | 16.7 | 3.3 | 1.0 | 2.7 | 5.5 |
| Direct Lending - First Lien | 0.7 | 0.5 | 5.7 | 6.9 | 1.3 | 4.5 | 2.1 | 3.3 |
| Direct Lending - Second Lien | 1.4 | 1.8 | 7.6 | 9.2 | 2.1 | 7.4 | 3.3 | 5.4 |
| Foreign Bonds | 7.2 | 13.9 | 2.6 | 7.9 | 10.3 | 18.4 | 2.6 | 7.6 |
| Mezzanine Debt | 3.0 | 3.8 | 9.0 | 17.2 | 5.7 | 8.2 | 6.4 | 7.9 |
| Distressed Debt | 2.8 | 4.2 | 9.2 | 17.6 | 5.8 | 10.0 | 6.7 | 9.1 |
| Emerging Market Bonds (major) | 4.7 | 8.8 | 6.3 | 16.2 | 7.0 | 14.2 | 5.6 | 11.8 |
| Emerging Market Bonds (local) | 5.6 | 10.0 | 6.2 | 18.3 | 10.1 | 18.2 | 6.6 | 15.2 |
| US Equity | 4.8 | 17.6 | 11.0 | 18.1 | 6.7 | 23.5 | 10.0 | 30.0 |
| Developed Market Equity (non-US) | -0.6 | 18.0 | 10.2 | 18.8 | 13.9 | 41.3 | 6.8 | 18.9 |
| Emerging Market Equity | 2.0 | 18.9 | 10.7 | 35.4 | 18.6 | 43.2 | 10.4 | 29.1 |
| Global Equity | 2.3 | 17.3 | 10.2 | 20.4 | 10.9 | 32.6 | 8.9 | 25.5 |
| Private Equity/Debt | 3.9 | 6.9 | 10.0 | 10.7 | 6.7 | 17.3 | 10.2 | 16.6 |
| Private Equity | 4.1 | 7.5 | 10.2 | 9.8 | 6.7 | 18.1 | 10.8 | 18.4 |
| Private Debt Composite | 2.4 | 3.2 | 8.3 | 14.3 | 4.4 | 8.1 | 5.2 | 7.1 |
| REITs | 5.2 | 16.4 | 10.7 | 27.2 | 6.6 | 25.0 | 11.1 | 25.6 |
| Core Private Real Estate | 2.5 | 3.8 | 4.7 | 4.2 | 1.9 | 6.9 | 3.1 | 3.4 |
| Value-Added Real Estate | 4.8 | 9.1 | 5.1 | 3.4 | 2.0 | 13.4 | 5.7 | 6.9 |
| Opportunistic Real Estate | 3.0 | 7.4 | 4.9 | 3.8 | 0.7 | 13.2 | 4.7 | 5.6 |
| Natural Resources (Private) | 1.4 | 13.3 | 10.1 | 19.7 | 14.6 | 22.9 | 9.5 | 18.0 |
| Timberland | 6.9 | 11.2 | 4.5 | 3.3 | 4.2 | 13.4 | 6.1 | 5.9 |
| Farmland | 4.0 | 5.9 | 7.0 | 6.6 | 3.7 | 9.6 | 5.2 | 4.8 |
| Commodities (naïve) | -1.0 | -0.9 | 3.1 | 9.6 | 11.6 | 2.6 | 3.6 | 3.3 |
| Core Infrastructure | 3.5 | 2.4 | 6.9 | 4.6 | 3.7 | 6.5 | 2.2 | 3.4 |
| Hedge Funds | 5.1 | 7.0 | 5.7 | 11.5 | 5.3 | 8.7 | 5.9 | 10.1 |
| Long-Short | 4.9 | 8.1 | 6.5 | 12.5 | 6.7 | 14.0 | 7.1 | 13.1 |
| Hedge Fund of Funds | 4.0 | 5.9 | 4.6 | 10.2 | 4.2 | 7.5 | 4.8 | 8.8 |

[1] Assumptions are based on performance for each asset class during historical periods that resembled these situations.

## Stress Test Return Assumptions - Sample Inputs[1]

| | 10-year Treasury Bond rates rise 100 bps | 10-year Treasury Bond rates rise 200 bps | 10-year Treasury Bond rates rise 300 bps | Baa Spreads widen by 50 bps, High Yield by 200 bps | Baa Spreads widen by 300 bps, High Yield by 1000 bps | Trade Weighted Dollar gains 10% | Trade Weighted Dollar gains 20% | US Equities decline 10% | US Equities decline 25% | US Equities decline 40% |
|---|---|---|---|---|---|---|---|---|---|---|
| Cash Equivalents | 1.1 | 0.9 | 0.6 | 2.5 | 1.0 | 4.2 | 0.9 | 2.6 | 1.9 | 0.3 |
| Short-term Investment Grade Bonds | -0.1 | -2.0 | -3.9 | 2.5 | 1.8 | 2.7 | 1.2 | 1.5 | 1.0 | 0.7 |
| Investment Grade Bonds | -3.5 | -9.6 | -15.6 | 3.8 | -0.4 | 3.3 | 3.7 | 2.3 | 1.0 | -0.3 |
| Long-term Corporate Bonds | -10.0 | -24.0 | -37.9 | 2.2 | -12.6 | 2.3 | 5.8 | 0.4 | -7.1 | -12.3 |
| Long-term Government Bonds | -14.9 | -32.4 | -49.9 | 7.0 | 7.5 | 5.4 | 12.7 | 4.0 | 6.4 | 12.0 |
| TIPS | -4.4 | -10.9 | -17.5 | 2.7 | -1.5 | -0.5 | -1.0 | 2.3 | -1.4 | -8.8 |
| Global ILBs | -1.8 | -6.6 | -12.0 | 2.2 | -11.2 | -1.6 | -5.4 | 2.3 | -4.2 | -15.7 |
| High Yield Bonds | 2.0 | -3.0 | -4.4 | -2.0 | -23.0 | -2.3 | -2.3 | -4.3 | -13.8 | -21.0 |
| Bank Loans | 3.8 | 3.4 | 3.1 | -2.2 | -19.8 | -2.2 | -1.0 | -3.1 | -10.7 | -15.9 |
| Direct Lending - First Lien | 3.1 | 2.7 | 2.7 | -1.0 | -7.8 | -2.3 | 1.2 | -3.1 | -6.1 | -5.1 |
| Direct Lending - Second Lien | 4.1 | 3.4 | 3.7 | -0.7 | -10.5 | -2.3 | 1.7 | -3.6 | -7.9 | -6.9 |
| Foreign Bonds | -5.8 | -12.3 | -19.1 | 5.5 | -2.9 | -4.8 | -11.1 | 1.6 | -3.8 | -8.9 |
| Mezzanine Debt | 4.4 | 1.7 | -1.5 | -1.4 | -19.5 | -2.1 | -4.4 | -4.5 | -13.9 | -18.9 |
| Distressed Debt | 4.3 | 1.5 | -1.0 | -1.6 | -21.5 | -2.8 | -6.4 | -5.1 | -15.6 | -20.5 |
| Emerging Market Bonds (major) | 0.9 | -3.7 | -3.5 | 0.3 | -14.0 | 0.2 | -4.3 | -3.0 | -11.1 | -15.6 |
| Emerging Market Bonds (local) | 0.7 | -4.1 | -3.3 | 0.0 | -13.1 | -4.1 | -14.7 | -3.0 | -13.0 | -21.7 |
| US Equity | 6.7 | 2.7 | 4.3 | -1.3 | -30.6 | -1.5 | 2.0 | -10.0 | -25.0 | -40.0 |
| Developed Market Equity (non-US) | 8.0 | 4.9 | -1.8 | -1.5 | -34.6 | -10.9 | -9.3 | -8.9 | -23.5 | -42.1 |
| Emerging Market Equity | 8.9 | 7.3 | 2.3 | -3.1 | -42.0 | -12.6 | -16.6 | -11.7 | -30.5 | -48.0 |
| Global Equity | 7.1 | 4.0 | 1.9 | -1.7 | -33.1 | -6.7 | -5.9 | -9.7 | -25.0 | -41.5 |
| Private Equity/Debt | 6.5 | 2.6 | -2.4 | 0.4 | -22.3 | -3.0 | -4.9 | -8.8 | -20.1 | -23.6 |
| Private Equity | 6.9 | 2.7 | -2.5 | 0.7 | -22.6 | -2.8 | -4.6 | -9.5 | -20.9 | -24.1 |
| Private Debt Composite | 3.5 | 1.0 | -1.3 | -1.3 | -16.7 | -2.5 | -2.8 | -4.4 | -12.0 | -14.9 |
| REITs | 3.7 | -0.9 | 2.5 | -4.0 | -37.9 | -0.9 | 8.3 | -7.4 | -30.8 | -55.8 |
| Core Private Real Estate | 3.9 | 4.4 | 6.2 | 2.4 | -7.0 | 3.0 | 8.6 | 0.0 | -6.2 | -13.7 |
| Value-Added Real Estate | 5.6 | 8.5 | 12.5 | 6.7 | -13.1 | 7.5 | 8.8 | 0.9 | -10.0 | -22.1 |
| Opportunistic Real Estate | 5.1 | 8.0 | 9.7 | 2.5 | -20.3 | 1.8 | 15.8 | -1.4 | -13.2 | -25.2 |
| Natural Resources (Private) | 13.3 | 7.6 | -0.2 | -1.2 | -25.0 | -5.6 | -19.1 | -4.9 | -18.2 | -32.7 |
| Timberland | 3.3 | 2.9 | -0.8 | 5.1 | 6.7 | 2.7 | 8.9 | 0.7 | 2.7 | 3.2 |
| Farmland | 3.8 | 1.1 | -1.3 | 4.6 | 10.4 | 1.5 | 9.1 | 1.1 | 4.4 | 9.0 |
| Commodities (naïve) | 10.0 | 6.7 | 0.3 | -4.0 | -24.3 | -6.1 | -25.7 | 3.5 | -9.1 | -34.5 |
| Core Infrastructure | 3.9 | 1.0 | 0.5 | 2.4 | -0.1 | -0.7 | 3.0 | -0.8 | -4.3 | -8.4 |
| Hedge Funds | 3.4 | 0.7 | -2.5 | -0.1 | -13.7 | -1.0 | -1.3 | -3.8 | -10.7 | -14.7 |
| Long-Short | 4.4 | 1.2 | -1.9 | 0.5 | -19.9 | -1.6 | -3.6 | -6.3 | -15.6 | -22.1 |
| Hedge Fund of Funds | 2.4 | -0.2 | -3.3 | -1.0 | -14.3 | -1.8 | -2.2 | -4.5 | -11.5 | -15.7 |

[1] Assumptions are based on performance for each asset class during historical periods that resembled these situations.

# Meketa Investment Group 2020 Annual Asset Study
## Twenty-Year Annualized Return and Volatility Expectations for Major Asset Classes

| Asset Class | Annualized Compounded Return (%) | Annualized Average Return (%) | Annualized Standard Deviation (%) |
|---|---|---|---|
| **Rate Sensitive** | | | |
| Cash Equivalents | 2.4 | 2.4 | 1.0 |
| Investment Grade Bonds | 3.0 | 3.1 | 4.0 |
| Long-term Government Bonds | 3.2 | 3.9 | 12.0 |
| TIPS | 2.9 | 3.1 | 7.0 |
| **Credit** | | | |
| High Yield Bonds | 5.2 | 5.8 | 11.0 |
| Bank Loans | 5.0 | 5.4 | 9.0 |
| Emerging Market Bonds (major; unhedged) | 4.5 | 5.1 | 11.0 |
| Emerging Market Bonds (local; unhedged) | 4.8 | 5.8 | 14.0 |
| Direct Lending - First Lien | 6.2 | 6.8 | 11.0 |
| Direct Lending - Second Lien | 7.5 | 8.6 | 15.0 |
| Mezzanine Debt | 7.0 | 8.1 | 15.0 |
| Distressed Debt | 7.0 | 9.0 | 20.0 |
| **Equities** | | | |
| Public US Equity | 7.4 | 8.8 | 17.0 |
| Public Developed Market Equity | 7.9 | 9.7 | 19.0 |
| Public Emerging Market Equity | 9.1 | 12.0 | 24.0 |
| Private Equity Composite | 9.4 | 12.8 | 26.0 |
| **Real Assets** | | | |
| REITs | 7.0 | 10.4 | 26.0 |
| Core Private Real Estate | 6.3 | 6.9 | 11.0 |
| Value Added Real Estate | 8.4 | 10.0 | 18.0 |
| Opportunistic Real Estate | 9.9 | 12.8 | 24.0 |
| High Yield Real Estate Debt | 6.0 | 7.6 | 18.0 |
| Natural Resources (Private) | 8.8 | 11.0 | 21.0 |
| Commodities | 4.3 | 5.7 | 17.0 |
| Infrastructure (Core) | 6.7 | 7.7 | 14.0 |
| Infrastructure (Non-Core) | 9.1 | 11.5 | 22.0 |
| **Other** | | | |
| Hedge Funds | 4.9 | 5.1 | 7.0 |

## Meketa Investment Group 2020 Annual Asset Study: Correlation Expectations

| | Investment Grade Bonds | TIPS | High Yield Bonds | US Equity | Developed Market Equity | Emerging Market Equity | Private Equity | Real Estate | Natural Resources (private) | Commodities | Core Infrastructure (private) | Hedge Funds |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Investment Grade Bonds | 1.00 | | | | | | | | | | | |
| TIPS | 0.80 | 1.00 | | | | | | | | | | |
| High Yield Bonds | 0.20 | 0.30 | 1.00 | | | | | | | | | |
| US Equity | 0.05 | 0.00 | 0.70 | 1.00 | | | | | | | | |
| Developed Market Equity | 0.05 | 0.15 | 0.70 | 0.90 | 1.00 | | | | | | | |
| Emerging Market Equity | 0.05 | 0.15 | 0.70 | 0.80 | 0.90 | 1.00 | | | | | | |
| Private Equity | 0.05 | 0.05 | 0.65 | 0.85 | 0.80 | 0.75 | 1.00 | | | | | |
| Real Estate | 0.20 | 0.10 | 0.50 | 0.50 | 0.45 | 0.40 | 0.45 | 1.00 | | | | |
| Natural Resources (private) | 0.10 | 0.10 | 0.45 | 0.65 | 0.60 | 0.60 | 0.55 | 0.45 | 1.00 | | | |
| Commodities | 0.05 | 0.30 | 0.40 | 0.35 | 0.55 | 0.60 | 0.30 | 0.15 | 0.65 | 1.00 | | |
| Core Infrastructure (private) | 0.30 | 0.30 | 0.60 | 0.55 | 0.55 | 0.50 | 0.45 | 0.60 | 0.60 | 0.35 | 1.00 | |
| Hedge Funds | 0.05 | 0.20 | 0.70 | 0.80 | 0.85 | 0.85 | 0.65 | 0.45 | 0.65 | 0.65 | 0.60 | 1.00 |

## Asset Allocation Review

| | P&F Current (%) | Global 60/40 (%) |
|---|---|---|
| **Growth** | **61** | **60** |
| US Equity | 13 | 0 |
| Dev. Market Equity (non-US) | 10 | 0 |
| Emerging Market Equity | 13 | 0 |
| Global Equity | 0 | 60 |
| Buyouts | 8 | 0 |
| Venture Capital | 4 | 0 |
| Private Real Estate | 3 | 0 |
| Natural Resources (Private) | 3 | 0 |
| Private Debt | 4 | 0 |
| Emerging Market Bonds | 3 | 0 |
| **Low Beta** | **27** | **0** |
| Cash Equivalents | 5 | 0 |
| S-T Investment Grade Bonds | 17 | 0 |
| Hedge Funds | 5 | 0 |
| **Other** | **12** | **40** |
| Investment Grade Bonds | 0 | 40 |
| TIPS | 2 | 0 |
| Foreign Bonds | 3 | 0 |
| Core Private Real Estate | 5 | 0 |
| Commodities | 2 | 0 |
| *2019 Meketa Expected Return (20 years)* | *7.8* | *7.1* |
| *2020 Meketa Expected Return (20 years)* | *7.2* | *6.3* |
| *2019 Meketa Standard Deviation* | *11.9* | *10.4* |
| *2020 Meketa Standard Deviation* | *11.9* | *10.4* |

## Long-Term Capital Markets Expectations

| Expected Return | BlackRock[1] 20 Yr (%) | GMO[1,2] 7 Yr (%) | Goldman Sachs[1] 10 Yr (%) | Verus[3] 10 Yr (%) | Meketa 10 Yr (%) | Meketa 20 Yr (%) |
|---|---|---|---|---|---|---|
| Global Equity | N/A | -0.6 | N/A | 6.4 | 6.8 | 7.8 |
| US Equity | 6.3 | -4.7 | 6.8 | 5.4 | 5.5 | 7.4 |
| Emerging Markets Equity | 8.0 | 3.9 | 9.8 | 7.6 | 8.8 | 9.1 |
| Private Equity | 13.1 | N/A | 10.4 | 8.5 | 8.4 | 9.4 |
| US Fixed Income | 2.6 | -2.5 | 2.4 | 2.2 | 2.3 | 3.0 |
| Emerging Markets Debt | 3.2 | -0.8 | 4.7 | 5.4 | 4.3 | 4.7 |
| TIPS | 2.3 | -2.1 | 3.2 | 2.1 | 2.3 | 2.9 |
| Real Estate | 5.8 | N/A | 7.0 | 6.6 | 7.8 | 7.5 |
| Hedge Funds | 6.1 | N/A | 4.2 | 4.0 | 3.8 | 4.9 |
| Commodities | N/A | N/A | 4.0 | 3.8 | 4.9 | 4.3 |

- The table above compares recently released capital markets assumptions (expected returns per year) from a variety of investment firms. Unsurprisingly, the short-term return expectations for most asset classes tend to be lower than the long-term expectations.

[1] Source: Long Term Expected Returns from BlackRock 2020 Investment Institute.

[2] Inflation estimate has been added to real return expectation assumptions.

[3] Source: Verus' 2020 10-year geometric capital markets assumptions.