





MARCH 7, 2018

Asset Liability Study: Phase 2

Fresno County Employees' Retirement Association

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Introduction

The goal of this discussion is to introduce several new asset allocation mixes for consideration by the Board.

- We will utilize our 2018 capital market assumptions for each asset class in order to generate risk and return profiles for each mix.
- We will provide background on the importance of diversification and the impact of the current return environment.
- We will also compare and contrast these portfolios through a number of different lenses to understand their sources of risk and how each behaves in different market scenarios.
- These portfolios will serve as a basis for the asset-liability modeling next month.

Verus 2018 Capital Market Assumptions





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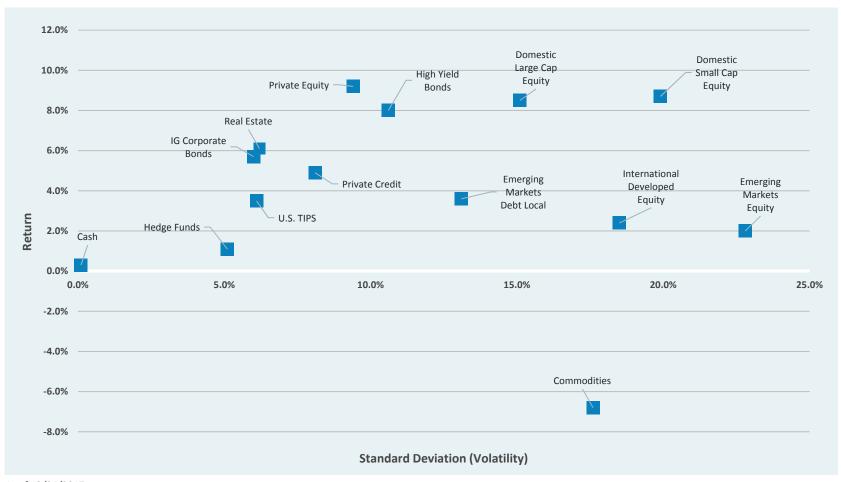
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Introduction



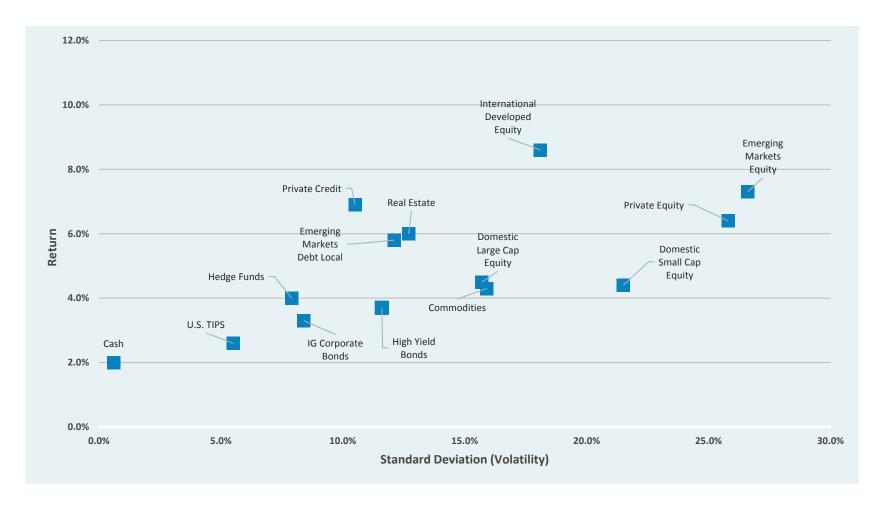
10yr historical risk vs. return







10yr expected risk vs. return



Note: Return and standard deviation based on Verus' 2018 Capital Market Assumptions



Inflation



Inflation

We use a weighted average of market expectations (50%), consumer expectations (25%), and professional forecasts (25%) to create a 10-year inflation forecast. The market's expectations for 10-year inflation can be inferred by taking the difference between the U.S. 10-year Treasury yield and the 10-year Treasury Inflation-Protected (TIPS) yield (referred to as the breakeven inflation rate). Market inflation expectations increased modestly over the past year, while consumer and forecaster expectations were relatively stable. Overall, our inflation forecast was unchanged at 2.1%.

The 10-year breakeven inflation rate was 2.0% at year-end. The market is expecting the low inflation environment to continue well into the future. Breakeven rates fell during the first half of the year, but rose in the later half, possibly influenced by upward revisions to economic growth forecasts. Consumer inflation expectations fell slightly from 2.7% to 2.4% based on the University of Michigan Consumer Sentiment Survey. Inflation expectations from the Survey of Professional Forecasters were unchanged at 2.2% - this measure has historically been fairly stable, especially in environments characterized by suppressed inflation volatility.

INFLATION EXPECTATIONS



Source: U. of Michigan, Philly Fed, as of 12/31/17

U.S. 10-YR ROLLING AVERAGE INFLATION SINCE 1923



Source: Bloomberg, as of 12/31/17

FORECAST

	10-Year Forecast
University of Michigan Survey (25% weight)	2.40%
Survey of Professional Forecasters (25% weight)	2.20%
US 10-Year TIPS Breakeven Rate (50% weight)	1.98%
Inflation Forecast	2.14%

Source: Verus, as of 12/31/17



Fixed income



Cash

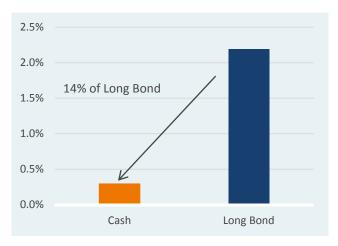
In 2017 the U.S. Treasury yield curve flattened materially, though it was still upward sloping, as inflation expectations remained steady and growth expectations increased. The Fed raised short term rates three times during the year and are forecasting three additional rate hikes in 2018.

Over rolling ten year time periods, the average historical real return to cash has been 14% of the real return to long-term bonds.

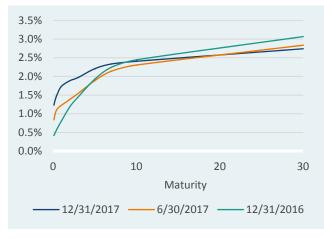
By applying this historical real return relationship, we arrive at a 4 bps expected real return to cash (14% of our 27 bps 10-year U.S. Treasury real return forecast).

Adding our inflation forecast of 2.14% results in a nominal return to cash of 2.18%.

AVERAGE REAL RETURN



U.S. TREASURY CURVE



FORECAST

	10-Year Forecast
Cash	2.18%
Inflation Forecast	2.14%
Real Return	0.04%

Source: Bloomberg, as of 12/31/17

Source: Verus, as of 12/31/17



Source: Bloomberg

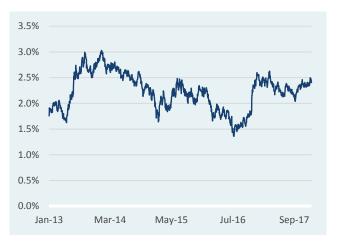
Rates

We forecast the return from rates based upon the current 10-year Treasury yield, with all cash flows reinvested at the current yield. Although there was some intra-period volatility, the 10-year yield was unchanged at 2.4% from the previous year.

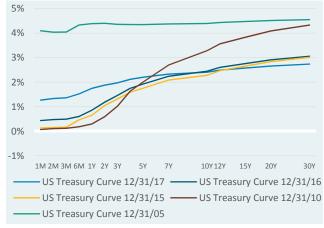
U.S. Treasury yields remain high relative to other developed nations, specifically Japan and Germany. U.S. short-term yields rose steadily throughout the year, while long-term yields fell and then rebounded by year-end on increased economic growth expectations and tax reform developments.

Central bank policies diverged across developed markets in 2017. The U.S. remained on its gradual path of tightening, while the U.K. and Canada raised rates for the first time in years. The European Union continued its stimulus program but at a slower pace and Japan maintained its negative short-term rates with the goal of higher spending and inflation.

U.S. 10-YR TREASURY YIELD



U.S. YIELD CURVE



FORECAST

	10-Year Forecast
U.S. 10-Year Treasury	2.41%
Inflation Forecast	-2.14%
Real Return	0.27%

Source: Bloomberg, as of 12/31/17

Source: Verus, as of 12/31/17



Source: Bloomberg, as of 12/31/17

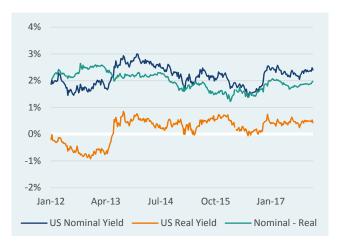
Real rates

TIPS provide high sensitivity to duration (interest rate risk) over short periods and track inflation (CPI) fairly well over longer periods. Changing inflation expectations, demand for inflation protection, and rate movements contribute to price volatility of TIPS.

The U.S. 10-year real yield was rangebound in 2017, ending the year materially unchanged at 0.4%. Breakeven inflation expectations fell mid-year following a string of missed inflation prints, but rebounded to finish the year unchanged near 2.0%.

To arrive at a nominal 10-year forecast, we add the current real TIPS yield to our 10-year inflation forecast. Our real rates forecast fell modestly over the year from 0.5% to 0.4%.

NOMINAL YIELD VS. REAL



INFLATION EXPECTATIONS



FORECAST

Forecast
12%
14%
56%

Source: Bloomberg, as of 12/31/17 Source: Verus, as of 12/31/17



Source: Bloomberg, as of 12/31/17

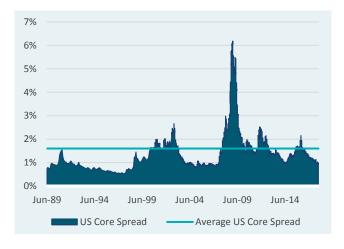
Core fixed

Credit fixed income return is composed of a bond term premium (duration) and credit spread. The bond term premium is represented by the 10-year U.S. Treasury yield.

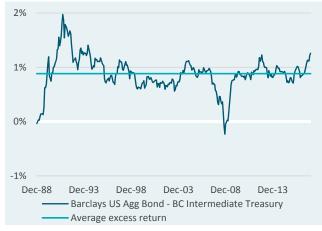
We use appropriate default rates and credit spreads for each fixed income category to provide our 10-year return forecast. Our default rate assumption is derived from a variety of sources, including historical data and academic research. The effective default that is subtracted from the return forecast is based on our assumed default and recovery rates.

Spreads are well below their 30-year average and continue to exhibit behavior consistent with later stages of the economic cycle. Credit markets appear slightly more expensive than in prior years, as compensation for taking credit risk decreases. Tighter credit spreads over the past year resulted in a 40 bps decrease in our core fixed income expected return.

U.S. CORE CREDIT SPREAD



ROLLING EXCESS RETURN (10YR)



Source: Barclays, as of 12/31/17

FORECAST

	10-Year Forecast
Barclays U.S. Option- Adjusted Spread	+0.61%
Effective Default	-0.10%
U.S. 10-Year Treasury	+2.41%
Nominal Return	2.91%
Inflation Forecast	-2.14%
Real Return	0.77%

Source: Verus, as of 12/31/17



Source: Barclays, as of 12/31/17

Credit summary

	Core	Long-Term Credit	Global Credit*	High Yield	Bank Loans	EM Debt (USD)	EM Debt (Local)	Private Credit
Index	BBgBarc U.S. Aggregate	BBgBarc Long U.S. Corporate	BBgBarc Global Credit	BBgBarc US High Yield	S&P LSTA	JPM EMBI	JPM GBI	S&P LTSA+ 2%
Method	OAS + U.S. 10-Year	OAS + U.S. 10-Year	OAS + Global 10-Year Treasuries	OAS + U.S. 10-Year	LIBOR + Spread	OAS + U.S. 10-Year	Current Yield	Bank Loans+ 2% illiquidity premium
Spread to	Intermediate U.S. Treasury	Long-Term U.S. Treasury	Global Long-Term Treasuries	Intermediate U.S. Treasury	LIBOR	Intermediate U.S. Treasury	-	-
Default Assumption	-0.5%	-4.5%	-3.0%	-3.8%	-3.5%	-0.5%	-0.5%	-
Recovery Assumption	80%	95%	40%	40%	90%	60%	40%	-
Spread	0.6%	1.3%	1.0%	3.6%	3.6%	2.9%	-	-
Yield	-	-	-	-	-	-	6.1%	-
Risk Free Yield	2.4%	2.4%	1.9%	2.4%	1.7%	2.4%	-	-
Effective Default	-0.1%	-0.2%	-1.8%	-2.3%	-0.4%	-0.2%	-0.3%	-
Expected Currency Effect	-	-	0.5%	-	-	-	-	-
Nominal Return	2.9%	3.5%	1.7%	3.7%	4.9%	5.1%	5.8%	6.9%
Inflation Forecast	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
Real Return	0.8%	1.3%	-0.%	1.6%	2.8%	3.0%	3.7%	4.4%

^{*}Global Credit expected returns are adjusted for the implied currency effect based on currency forward contract rates (see Appendix)



Equities



Equities

Investment returns in the equity space can be broken down into earnings growth, dividend yield, inflation, and repricing. Over the very long-term, repricing represents a small portion of return to equity investors, but over shorter time frames, the effect on return can vary considerably.

If investors are willing to pay more for earnings, it could signal that investors are more confident in positive earnings growth going forward, while the opposite is true if investors pay less for earnings. It is somewhat surprising that investor confidence varies so much given that the long-term earnings growth is relatively stable.

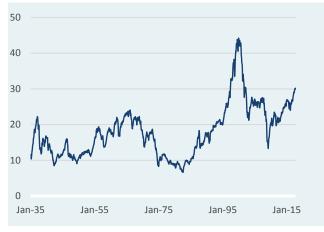
Investor confidence in earnings growth can be measured using both the Shiller P/E ratio and the trailing 12-month P/E ratio. We take an average of these two valuations metrics when determining our repricing assumption. In short, if the P/E ratio is too high (low) relative to history, we expect future returns to be lower (higher) than the long-term average. Implicit in this analysis is the assumption that P/E's will exhibit mean reversion over 10 years.

We make a conservative repricing estimate given how widely repricing can vary over time. We then skew the repricing adjustment because the percentage change in index price is larger with each incremental rise in valuations when P/E's are low, compared to when they are high.

TRAILING 10-YR S&P 500 RETURN COMPOSITION



U.S. LARGE SHILLER P/E



Source: Shiller, as of 9/30/17

P/E REPRICING ASSUMPTION

Average P/E			
Percentile Bucket	Lower P/E	Upper P/E	Repricing Assumption
Lower 10%	•	10	2.00%
LOWEI 10%	-	10	2.00%
10% - 20%	10	13	1.50%
20% - 30%	13	15	0.75%
30% - 45%	15	18	0.50%
45% - 55%	18	19	0.0%
55% - 70%	19	21	-0.25%
70% - 80%	21	22	-0.50%
80% - 90%	22	24	-1.25%
Top 10%	24	-	-1.50%

Source: Verus



Source: Shiller, Standard & Poor's, as of 9/30/17

Global equity

Global Equity is a combination of U.S. large, international developed, and emerging market equities. We can therefore combine our existing return forecasts for each of these asset classes to arrive at our global equity return forecast.

We use the MSCI ACWI Index as our benchmark for global equity and apply the country weights of this index to determine the weightings for our global equity return calculation. As with other equity asset classes, we use the historical standard deviation of the benchmark (MSCI ACWI Index) for our volatility forecast.

The valuation of global equities are driven by the richness/cheapness of the underlying markets, as indicated by the current price-to-earnings ratio.

Our return building blocks produce a local return forecast for international equities. In order to create a useable forecast for U.S.-based investors, we adjust for implied currency movements in international developed equities based on forward currency pricing. Please reference pages 32 and 33 for a detailed explanation of this adjustment.

GLOBAL EQUITY P/E RATIO HISTORY



MARKET PERFORMANCE (3-YR ROLLING)



Source: MSCI, Standard & Poor's, as of 12/31/17

FORECAST

Market	Weight	CMA return	Weighted return
US Large	52.3%	4.5%	2.8%
Developed Large	32.7%	8.6%	2.4%
Emerging Markets	12.0%	7.3%	0.9%
Canada	3.0%	8.6%	0.3%
Global equity forecast			6.3%

Source: Verus, as of 12/31/17, may not sum due to rounding



Source: MSCI, as of 12/31/17

Equity summary

	U.S. Large	U.S. Small	EAFE	EAFE Small	EM
Index	S&P 500	Russell 2000	MSCI EAFE Large	MSCI EAFE Small	MSCI EM
Method	Building Block Approach: curr	ent dividend yield + historical ave	erage real earnings growth + infla	ation on earnings + repricing + expe	ected currency effect
Current Shiller P/E Ratio	32.5	49.6	18.6	-	11.9
Regular P/E Ratio	22.5	56.9	19.9	25.3**	15.9
2017 Shiller P/E Expansion	16.1%	13.2%	28.3%	-	36.8%
2017 Regular P/E Expansion	7.7%	16.8%	-13.1%	-27.5%	3.2%
Current Shiller P/E Percentile Rank	90%	100%	36%	-	32%
Current Regular P/E Percentile Rank	85%	98%	58%	51%**	71%
Average of P/E Methods' Percentile Rank	87%	99%	47%	51%**	52%
2017 Total Return	21.8%	14.7%	25.0%	33.0%	37.3%
Shiller PE History	1982	1988	1982	Not Enough History	2005
Long-Term Average Shiller P/E	22.4	29.5	23.0	-	16.2
Current Dividend Yield	1.9%	1.2%	3.1%	2.2%	2.4%
Long-Term Average Real Earnings Growth	1.7%	2.6%	2.0%	2.1%	2.7%
Inflation on Earnings	2.1%	2.1%	1.5%*	1.5%*	2.1%
Repricing Effect (Estimate)	-1.3%	-1.5%	0.0%	0.0%	0.0%
Implied Currency Effect*	-	-	2.1%*	2.1%*	-
Nominal Return	4.5%	4.4%	8.6%	7.9%	7.3%
Inflation Forecast	2.1%	2.1%	2.1%	2.1%	2.1%
Real Return	2.4%	2.3%	6.5%	5.7%	5.1%

^{*}We use local inflation for international developed equity markets. When using local inflation rates, expected returns are adjusted for the implied currency effect based on currency forward contract rates (see Appendix)

NOTE: For all equities, we exclude data prior to 1972, which allows for a more appropriate comparison between data sets



^{**}Average trailing P/E from previous 12 months is used

Alternatives



Private equity

Private equity and public equity returns have been correlated historically because the underlying economic forces driving these asset class returns are quite similar. The return relationship between the two can vary in the short-term, but over the long-term investors have traditionally believed the return from private equity should carry a premium, driven by leverage, concentrated factor exposure (smaller and undervalued companies), skill, and possibly illiquidity.

Historically the beta of private equity relative to public equities has been high, though appraisal-based pricing and data lag effects make it necessary to use more sophisticated approaches when estimating true beta. We use a beta assumption of 1.85 to U.S. large cap equities in our capital market forecast.

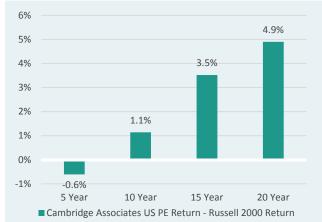
Private equity performance on average has been lackluster since the global financial crisis — on par with the returns of public equities and not rewarding investors for the greater risk and resources involved in implementing and maintaining a private equity program.

ROLLING 3YR PRIVATE EQUITY EXCESS RETURN (PE – U.S. SMALL CAP)



Source: Cambridge, Russell, as of 6/30/17

PRIVATE EQUITY EXCESS RETURN



Source: Cambridge, Russell, as of 6/30/17

FORECAST

	10-Year Forecast
U.S. Large Cap Forecast	+4.5%
1.85 beta multiplier	+1.9%
Nominal Return	+6.4%
Inflation Forecast	-2.1%
Real Return	+4.3%

Source: Verus



Hedge funds

Hedge fund performance variation through time can be partly explained by public market betas (ex: equity, rates, credit, commodities) and partly explained by non-public sources of return (ex: alternative betas, skill, luck). Certain hedge fund strategies can be mostly explained by public market betas, while other types of hedge fund strategies are driven mostly by non-public sources of return.

To forecast hedge fund returns, we identified the portion of historical hedge fund performance that can be attributed to public market betas, and the portion of hedge fund returns that cannot be attributed to public market beta. This means our forecast has two components:

the public market return (explained return) and the non-public market return (unexplained return).

To forecast the public market beta portion of hedge funds, we take the historical sensitivity of hedge funds to equity, rates, credit, and commodities and pair these with our current 10 year public market forecasts for each asset class. To forecast the non-public market return portion of hedge funds (unexplained return) we simply assume the historical performance contribution of these sources will continue over the next 10 years.

HEDGE FUND FORECAST



HEDGE FUND PU (EXPLAINED RET	JBLIC MARKET SOURCES OF RETURN URN)
Equity	
Rates	
Credit	
Commodities	
HEDGE FUND NO	DN-PUBLIC SOURCES OF RETURN RETURN)
	RETURN)
(UNEXPLAINED F	RETURN)
(UNEXPLAINED F	RETURN)

Hedge fund category	Public market % of return	Non-public market % of return	10-year forecast					
Hedge Funds (total)	2.2%	1.8%	4.0%					
Equity Hedge	2.8%	1.4%	4.2%					
Event-Driven	2.0%	2.5%	4.5%					
Relative Value	1.4%	2.5%	3.9%					
Macro	1.8%	1.5%	3.3%					

Source: Verus Source: Verus



Private core real estate/REITS

Performance of the NCREIF property index can be decomposed into an income return (cap rate) and capital return. The return coming from income has historically been more stable than the return derived from capital changes.

The cap rate is the ratio earnings less expenses to price, and does not include extraordinary expenses. A more accurate measure of the yield investors receive should include non-recurring capital expenditures; we assume a 2.0% capex expenditure. We also assume income growth will track inflation as inflation is passed through to rents.

Over the last ten years performance between private real estate and REITs is similar. Investors should be careful when comparing risk-adjusted returns of publicly traded assets to returns of appraisal priced assets. Private real estate and REITs provide an example of different volatility characteristics of public and private assets.

We assume the effects of leverage and liquidity offset each other, therefore our forecast for private real estate becomes our forecast for REITs.

TRAILING 10YR NCREIF RETURN COMPOSITION



PRIVATE REAL ESTATE

	Private Real Estate 10- Year Forecast
Current Cap Rate	+4.4%
Real Income Growth	+1.4%
Capex Assumption	-2.0%
Inflation	+2.1%
Nominal Return	6.0%
Inflation Forecast	-2.1%
Real Return	3.8%

REITS

	10-Year Forecast
Nominal Return Forecast	6.0%
Inflation Forecast	-2.1%
Real Return	3.8%

Source: Verus, as of 12/31/17 Source: Verus, as of 12/31/17



Value-add & opportunistic real estate

Value-add real estate includes properties which are in need of renovation, repositioning, and/or lease-up. Properties may also be classified as value-add due to their lower quality and/or location. Opportunistic real estate can also include development and distressed or very complex transactions. Greater amounts of leverage are usually employed within these strategies. Leverage increases beta (risk) by expanding the purchasing power of property managers via a greater debt load, which magnifies gains or losses. Increased debt also results in greater interest rate sensitivity. An increase/decrease in interest rates may result in a write-up/write-down of fixed rate debt, since debt holdings are typically marked-to-market.

Performance of value-add real estate is composed of the underlying private real estate market returns, plus a premium for additional associated risk, which is modeled here as 200 bps above our core real estate return forecast. Performance of opportunistic real estate strategies rest further out on the risk spectrum, and are modeled as 400 bps above the core real estate return forecast.

Additional expected returns above core real estate are justified by the higher inherent risk of properties which need improvement (operational or physical), price discounts built into properties located in non-core markets, illiquidity, and the ability of real estate managers to potentially source attractive deals in this less-than-efficient marketplace.

CAP RATE SPREADS



	Value-Add 10-Year Forecast	Opportunistic 10-Year Forecast
Premium above core	+2.0%	+4.0%
Current Cap Rate	+4.4%	+4.4%
Real Income Growth	+1.4%	+1.4%
Capex Assumption	-2.0%	-2.0%
Inflation	+2.1%	+2.1%
Nominal Return	8.0%	10.0%
Inflation Forecast	-2.1%	-2.1%
Real Return	5.9%	7.9%

Source: NCREIF, Bloomberg, as of 9/30/17

Source: Verus, as of 12/31/17



Infrastructure

Infrastructure includes a variety of investment types across a subset of industries. There is not one definition for what can be included within infrastructure. The asset class has grown dramatically in the last 5-7 years as investors sought assets that might provide more attractive yield relative to fixed income along with the potential for inflation protection.

Similar to real estate investment, income plays a significant role in the returns investors receive. Income yields are currently lower than average due to higher prices and competition in the space, which

might reasonably be expected to translate to lower expected future returns.

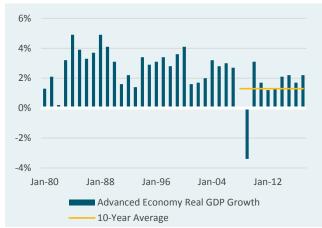
Due to the discount rate effect, infrastructure asset valuations would generally be negatively affected by material increases in interest rates. Because leverage is used in this space, higher interest rates would also impact investors in the form of higher borrowing costs.

5-YR ROLLING RETURN COMPOSITION



Source: S&P Global Infrastructure Index, as of 12/31/17

ADVANCED ECONOMY REAL GDP GROWTH



Source: IMF, as of 10/31/17

FORECAST

10-Year Forecast
1.9%
3.9%
1.3%
7.1%
-1.9%
5.2%

Source: Verus, as of 12/31/17



Commodities

Commodity returns can be decomposed into four sources: collateral return (cash), spot changes, and roll yield.

Roll return is generated by either backwardation or contango present in futures markets. Backwardation occurs when the futures price is below the spot price, which results in positive yield. Contango occurs when the futures price is above the spot price, and this results in a loss to commodity investors. Historically, futures markets have fluctuated between backwardation and contango but with a zero net effect over the very long-term (since 1877). Therefore, roll return is assumed to

be zero in our forecast. Over the most recent 10-year period, roll return has been negative, though this is likely the result of multiple commodity crises and a difficult market environment.

Our 10-year commodity forecast combines collateral (cash) return with spot return (inflation) to arrive at the nominal return, and subtracts out inflation to arrive at the real return.

TRAILING 10YR BLOOMBERG COMMODITY RETURN COMPOSITION (%)



Source: MPI, Bloomberg, as of 12/31/17

BLOOMBERG COMMODITY RETURN COMPOSITION (%)



Source: MPI, Bloomberg, as of 12/31/17

FORECAST

	10-Year Forecast
Collateral Return (Cash)	+2.15%
Roll Return	+0.00%
Inflation	+2.11%
Nominal Return	4.26%
Inflation Forecast	-2.11%
Real Return	2.15%
	-2.11%

Source: Verus



Currency beta

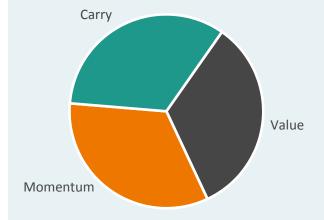
Currency beta is a long-short portfolio of G10 currencies constructed by investing in three equally weighted factors: carry, momentum, and value. A significant amount of academic research has concluded that these factors demand a risk premium in the currency market. Studies have also shown that currency beta explains a high portion of active currency managers' returns, indicating it may be a good neutral starting point or benchmark for currency investing. Currency beta portfolios gain exposure to the carry, momentum, and value factors in a systematic and transparent manner. For more detailed information on currency beta, please contact your consultant.

We model each factor in the currency beta portfolio separately, and then take a weighted average to get an overall return forecast. For the carry portfolio, the main driver of returns is the yield an investor receives from holding currencies with relatively higher interest rates. We therefore use a 12-month average of the portfolio's yield as the expected return. For value, our return forecast assumes a certain level of mean reversion to PPP fair value based on historical data. Lastly, for momentum, we simply assume the average historical return due to lack of long-term fundamental return drivers. Short-term volatility levels typically drive returns in the momentum portfolio, which is difficult to model in a 10-year return forecast.

3-YEAR ROLLING PERFORMANCE



CURRENCY BETA CONSTRUCTION



Source: Verus

RETURN FORECAST

Factor	Weight	Return Forecast	Weighted return
Carry	33.3%	2.9%	1.0%
Momentum	33.3%	1.0%	0.3%
Value	33.3%	3.0%	1.0%
Currency Beta			2.3%

Source: Verus, as of 12/31/17



Source: Russell, as of 12/31/17

Risk parity

Risk parity is built upon the philosophy of allocating to risk premia rather than to asset classes. Because risk parity by definition aims to diversify risk, the actual asset allocation can appear very different from traditional asset class allocation.

We model risk parity using an assumed Sharpe Ratio of 0.5, which considers the historical performance of risk parity. This assumed Sharpe Ratio is higher than other asset class forecasts, but is consistent with these forecasts because *portfolios* of assets tend to deliver materially higher Sharpe Ratios than individual assets.

The expected return of Risk Parity is determined by this Sharpe Ratio forecast, along with a 10% volatility assumption.

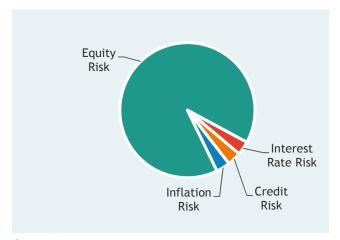
We used a 10-year historical return stream from a market-leading product to represent risk parity correlations relative to the behaviors of each asset class. Risk parity funds are suggested to be better able to withstand various difficult economic environments - reducing volatility without sacrificing return, over longer periods.

It is difficult to arrive at a single model for risk parity, since strategies can differ significantly across firms/strategies. Risk parity almost always requires explicit leverage. The amount of leverage will depend on the specific strategy implementation style, as well as expected correlations and volatility.

VS. TRADITIONAL ASSET CLASSES



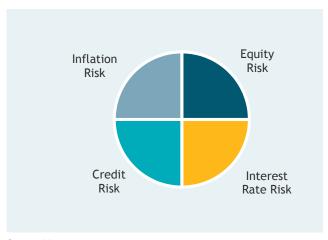
TRADITIONAL ASSET ALLOCATION



Source: Verus

Note: Risk parity is modeled here using the AQR GRP-EL 10% Volatility fund. Performance is back tested prior to February 2015

RISK PARITY



Source: Verus



Summary



Methodology

CORE INPUTS

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

Asset	Return Methodology	Volatility Methodology*
Inflation	25% weight to the University of Michigan Survey 5-10 year ahead inflation expectation and the Survey of Professional Forecasters (Fed Survey), and the remaining 50% to the market's expectation for inflation as observed through the TIPS breakeven rate	-
Cash	Real yield estimate + inflation forecast	Long-term volatility
Bonds	Nominal bonds: current yield; Real bonds: real yield + inflation forecast	Long-term volatility
International Bonds	Current yield + implied currency effect	Long-term volatility
Credit	Current option-adjusted spread + U.S. 10-year Treasury – effective default rate	Long-term volatility
International Credit	Current option-adjusted spread + foreign 10-year Treasury – effective default rate + implied currency effect	Long-term volatility
Private Credit	Bank loan forecast + 2% illiquidity premium	Long-term volatility
Equity	Current yield + real earnings growth (historical average) + inflation on earnings (inflation forecast) + expected P/E change	Long-term volatility
Intl Developed Equity**	Current yield + real earnings growth (historical average) + inflation on earnings (intl. inflation forecast) + expected P/E change + implied currency effect	Long-term volatility
Private Equity	US large cap domestic equity forecast * 1.85 beta adjustment	1.2 * Long-term volatility of U.S. small cap
Commodities	Collateral return (cash) + spot return (inflation forecast) + roll return (assumed to be zero)	Long-term volatility
Hedge Funds	Return coming from traditional betas + 15-year historical idiosyncratic return	Long-term volatility
Hedge Funds (FoF)	Return coming from traditional betas + 15-year historical idiosyncratic return – 1% expected fund of funds management fee	Long-term volatility
Core Real Estate	Cap rate + real income growth – capex + inflation forecast	65% of REIT volatility
REITs	Core real estate	Long-term volatility
Value-Add Real Estate	Core real estate + 2%	Volatility to produce Sharpe Ratio (g) equal to core real estate
Opportunistic Real Estate	Core real estate + 4%	Volatility to produce Sharpe Ratio (g) equal to core real estate
Infrastructure	Current yield + real income growth + inflation on earnings (inflation forecast)	Long-term volatility
Risk Parity	Expected Sharpe Ratio * target volatility + cash rate	Target volatility

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

^{**}We use local inflation for international developed equity markets. When using local inflation rates, expected returns are adjusted for the implied currency effect based on currency forward contract rates (see Appendix)



10-year return & risk assumptions

		Ten Year Re	turn Forecast	Standard Deviation	Sharpe Ratio	Sharpe Ratio	10-Year Historical	10-Year Historical
Asset Class	Index Proxy	Geometric	Arithmetic	Forecast	Forecast (g)	Forecast (a)	Sharpe Ratio (g)	Sharpe Ratio (a)
Equities								
U.S. Large	S&P 500	4.5%	5.6%	15.7%	0.15	0.22	0.50	0.56
U.S. Small	Russell 2000	4.4%	6.5%	21.5%	0.10	0.20	0.36	0.44
International Developed	MSCI EAFE	8.6%	10.1%	18.1%	0.35	0.44	0.11	0.2
International Developed Hedged	MSCI EAFE Hedged	8.6%	9.8%	16.2%	0.40	0.47	0.21	0.28
International Small	MSCI EAFE Small Cap	7.9%	10.2%	22.7%	0.25	0.35	0.24	0.33
International Small Hedged	MSCI EAFE Small Cap Hedged	7.9%	9.7%	20.1%	0.28	0.37	0.36	0.43
Emerging Markets	MSCI EM	7.3%	10.4%	26.6%	0.19	0.31	0.17	0.28
Global Equity	MSCI ACWI	6.3%	7.7%	17.5%	0.23	0.31	0.27	0.35
Private Equity	Cambridge Private Equity	6.4%	9.3%	25.8%	0.16	0.28	0.93	0.92
Fixed Income								
Cash	30 Day T-Bills	2.2%	2.2%	1.2%	-	-	-	-
U.S. TIPS	BBgBarc U.S. TIPS 5 - 10	2.6%	2.7%	5.5%	0.07	0.09	0.57	0.59
U.S. Treasury	BBgBarc Treasury 7-10 Year	2.4%	2.6%	6.8%	0.03	0.06	0.68	0.70
Global Sovereign ex U.S.	BBgBarc Global Treasury ex U.S.	2.7%	3.2%	9.9%	0.05	0.10	0.30	0.33
Global Sovereign ex U.S. Hedged	BBgBarc Global Treasury ex U.S. Hedged	2.7%	2.8%	3.3%	0.15	0.18	1.23	1.22
Core Fixed Income	BBgBarc U.S. Aggregate Bond	2.9%	3.1%	6.4%	0.11	0.14	1.09	1.08
Core Plus Fixed Income	BBgBarc U.S. Corporate IG	3.3%	3.6%	8.4%	0.13	0.17	0.81	0.81
Short-Term Gov't/Credit	BBgBarc U.S. Gov't/Credit 1 - 3 year	2.5%	2.6%	3.7%	0.08	0.11	1.36	1.34
Short-Term Credit	BBgBarc Credit 1-3 Year	2.4%	2.5%	3.7%	0.05	0.08	1.05	1.05
Long-Term Credit	BBgBarc Long U.S. Corporate	3.5%	3.9%	9.4%	0.14	0.18	0.64	0.67
High Yield Corp. Credit	BBgBarc U.S. Corporate High Yield	3.7%	4.3%	11.6%	0.13	0.18	0.64	0.67
Bank Loans	S&P/LSTA	4.9%	5.4%	10.5%	0.26	0.30	0.48	0.51
Global Credit	BBgBarc Global Credit	1.7%	2.0%	7.6%	-0.07	-0.03	0.59	0.61
Global Credit Hedged	BBgBarc Global Credit Hedged	1.7%	1.8%	5.0%	-0.10	-0.08	1.01	1.00
Emerging Markets Debt (Hard)	JPM EMBI Global Diversified	5.1%	5.9%	12.8%	0.23	0.29	0.74	0.76
Emerging Markets Debt (Local)	JPM GBI EM Global Diversified	5.8%	6.5%	12.1%	0.30	0.36	0.31	0.37
Private Credit	Bank Loans + 200 bps	6.9%	7.5%	10.5%	0.45	0.50	0.51	0.57
Other	Bank Loans 1 200 bps	0.570	7.570	10.5/0	0.43	0.50		
Commodities	Bloomberg Commodity	4.3%	5.5%	15.9%	0.13	0.21	-0.33	-0.25
Hedge Funds	HFRI Fund of Funds	4.0%	4.8%	7.9%	0.23	0.33	0.21	0.23
Hedge Fund of Funds	HFRI Fund of Funds	3.0%	3.8%	7.9%	0.10	0.20	0.21	0.23
Hedge Funds - Equity Hedge	HFRI Equity Hedge	4.2%	5.5%	11.1%	0.18	0.30	0.36	0.39
Hedge Funds - Event Driven	HFRI Event Driven	4.5%	5.6%	9.9%	0.22	0.34	0.55	0.57
Hedge Funds - Relative Value	HFRI Relative Value	3.9%	4.5%	6.8%	0.25	0.34	0.89	0.89
Hedge Funds - Macro	HFRI Macro	3.3%	4.7%	8.5%	0.12	0.29	0.43	0.44
Core Real Estate		6.0%	6.7%	8.5% 12.7%	0.12	0.35	0.43	0.75
	NCREIF Property							
Value-Add Real Estate	NCREIF Property + 200bps	8.0%	9.7%	19.5%	0.30	0.38	-	-
Opportunistic Real Estate	NCREIF Property + 400bps	10.0%	12.9%	26.0%	0.30	0.41	- 0.46	
REITS	Wilshire REIT	6.0%	7.7%	19.5%	0.19	0.28	0.16	0.28
Infrastructure	S&P Global Infrastructure	7.1%	8.7%	18.9%	0.26	0.34	0.27	0.34
Risk Parity	Risk Parity	7.2%	7.7%	10.0%	0.50	0.55	-	- 0.24
Currency Beta	Russell Conscious Currency	2.2%	2.3%	4.4%	0.00	0.02	0.23	0.24
Inflation		2.1%	-	-	-	-	-	-

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



Correlation assumptions

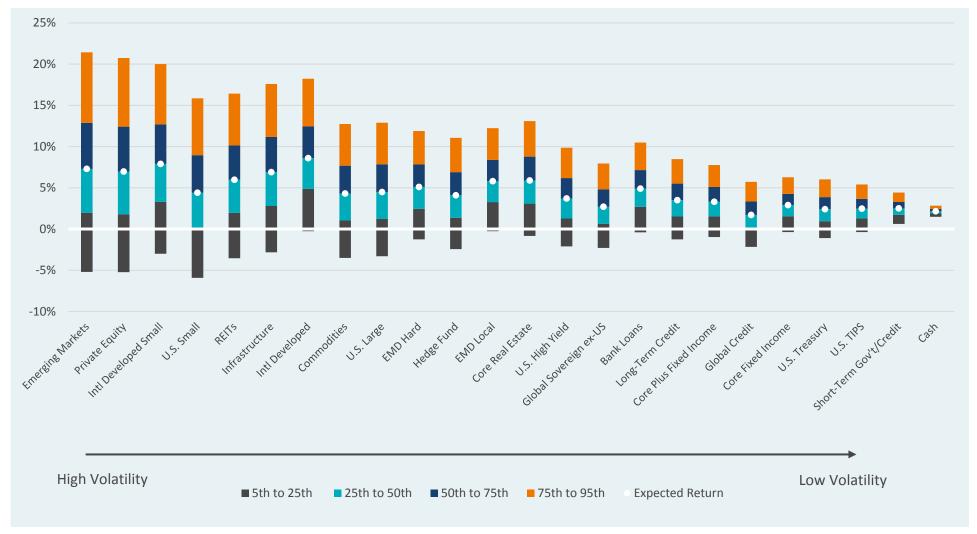
	Cash	US Large	US Small	Intl Large	Intl Large Hdg	Intl Small	Intl Small Hdg	EM	Global Equity	PE	US TIPS	US Treasury		Global Sovereign ex US Hdg	US Core		ST Govt/C redit		Term	US HY		Global Credit	Global Credit Hdg	EMD USD			Hedge Funds		REITs	Infras- tructure		Currency Beta	Inflation
Cash	1.0																																
US Large	-0.3	1.0																															
US Small	-0.2	0.9	1.0																														
Intl Large	-0.3	0.9	0.8	1.0																													
Intl Large Hdg	-0.4	0.9	0.8	0.9	1.0																												
Intl Small	-0.3	0.9	0.8	1.0	0.9	1.0																											
Intl Small Hdg	-0.4	0.8	0.8	0.9	1.0	0.9	1.0																										
EM	-0.3	0.8	0.7	0.9	0.8	0.9	0.8	1.0																									
Global Equity	-0.3	1.0	0.9	1.0	0.9	0.9	0.9	0.9	1.0																								
PE	-0.2	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.7	1.0																							
US TIPS	0.0	0.2	0.1	0.3	0.1	0.3	0.2	0.4	0.3	0.1	1.0																						
US Treasury	0.1	-0.3	-0.3	-0.2	-0.3	-0.2	-0.3	-0.2	-0.2	-0.2	0.6	1.0																					
Global Sovereign ex US	0.1	0.3	0.1	0.4	0.1	0.4	0.1	0.4	0.4	0.0	0.6	0.5	1.0																				
Global Sovereign ex US Hdg	0.1	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.1	-0.2	-0.1	0.4	0.8	0.4	1.0																			
US Core	0.0	0.0	-0.1	0.2	0.0	0.2	0.0	0.2	0.1	-0.1	0.8	0.9	0.6	0.7	1.0																		
US Core Plus	-0.2	0.4	0.3	0.5	0.4	0.5	0.4	0.5	0.5	0.1	0.7	0.5	0.5	0.4	0.8	1.0																	
ST Govt/Credit	0.3	-0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	0.0	-0.1	0.6	0.6	0.6	0.5	0.7	0.6	1.0																
Short-Term Credit	-0.1	0.3	0.3	0.5	0.4	0.5	0.4	0.5	0.4	0.1	0.6	0.2	0.4	0.2	0.5	0.8	0.7	1.0															
Long-Term Credit	-0.2	0.3	0.2	0.4	0.3	0.4	0.4	0.4	0.4	0.0	0.6	0.5	0.5	0.5	0.8	1.0	0.5	0.6	1.0														
US HY	-0.3	0.7	0.7	0.8	0.7	0.8	0.8	0.8	0.8	0.4	0.5	-0.2	0.3	-0.2	0.2	0.6	0.2	0.6	0.5	1.0													
Bank Loans	-0.4	0.6	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.4	0.3	-0.4	0.0	-0.3	0.0	0.4	-0.1	0.5	0.3	0.9	1.0												
Global Credit	-0.2	0.6	0.5	0.8	0.6	0.8	0.6	0.8	0.7	0.2	0.7	0.2	0.7	0.2	0.6	0.8	0.5	0.7	0.8	0.8	0.5	1.0											
Global Credit Hdg	-0.2	0.5	0.4	0.6	0.6	0.6	0.6	0.7	0.6	0.2	0.7	0.3	0.5	0.4	0.7	1.0	0.5	0.8	0.9	0.8	0.6	0.9	1.0										
EMD USD	-0.2	0.6	0.5	0.7	0.6	0.7	0.6	0.7	0.7	0.3	0.7	0.3	0.5	0.2	0.6	0.8	0.4	0.7	0.7	0.8	0.6	0.9	0.9	1.0									
EMD Local	0.0	0.6	0.6	0.7	0.6	0.7	0.6	0.8	0.7	0.3	0.6	0.2	0.7	0.1	0.5	0.6	0.4	0.5	0.6	0.7	0.4	0.8	0.7	0.8	1.0								
Commodities	-0.1	0.5	0.4	0.6	0.4	0.6	0.4	0.7	0.6	0.3	0.4	-0.2	0.4	-0.3	0.1	0.3	0.2	0.4	0.2	0.5	0.5	0.6	0.4	0.5	0.6	1.0							
Hedge Funds	-0.4	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.5	0.3	-0.3	0.1	-0.2	0.0	0.4	-0.1	0.5	0.3	0.7	0.7	0.6	0.5	0.5	0.5	0.6	1.0						
Real Estate	-0.1	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.1	-0.1	0.1	0.0	0.0	0.2	0.0	0.1	0.1	0.3	0.3	0.3	0.2	0.3	0.3	0.2	0.4	1.0					
REITs	-0.1	0.7	0.7	0.7	0.6	0.7	0.6	0.6	0.7	0.4	0.3	0.0	0.4	0.1	0.3	0.5	0.1	0.3	0.4	0.7	0.5	0.6	0.6	0.6	0.6	0.3	0.4	0.6	1.0				
Infrastructure	-0.3	0.8	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.2	0.4	-0.1	0.5	-0.1	0.2	0.5	0.1	0.5	0.5	0.7	0.5	0.8	0.7	0.7	0.7	0.6	0.6	0.1	0.6	1.0			
Risk Parity	-0.1	0.5	0.4	0.6	0.4	0.6	0.5	0.6	0.6	0.3	0.7	0.3	0.6	0.3	0.6	0.7	0.5	0.6	0.6	0.6	0.3	0.8	0.7	0.7	0.7	0.6	0.5	-0.1	0.5	0.7	1.0		
Currency Beta	-0.1	0.1	0.2	0.1	0.1	0.0	0.1	0.1	0.1	0.2	-0.2	-0.2	-0.1	0.0	-0.1	-0.1	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	-0.1	0.0	0.1	0.0	1.0	
Inflation	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.2	0.1	-0.3	0.0	-0.3	-0.2	-0.1	-0.2	0.0	-0.2	0.3	0.4	0.1	0.0	0.1	0.1	0.3	0.2	0.1	0.1	0.1	0.1	-0.1	1.0

Note: Correlation assumptions are based on the last ten years. Private Equity and Real Estate correlations are especially difficult to model – we have therefore used BarraOne correlation data to strengthen these correlation estimates.



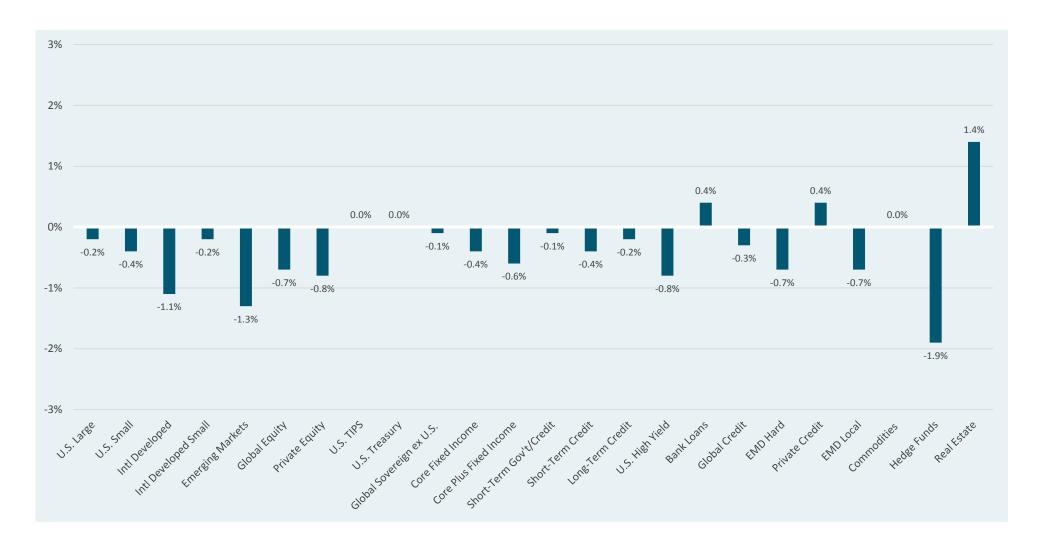
Range of likely 10 year outcomes

10 YEAR RETURN 90% CONFIDENCE INTERVAL





2018 vs. 2017 return forecast





Relevant forecast changes

- Risk premia contracted during 2017, especially in international equities and domestic credit, which resulted in lower return forecasts. High valuations across risk assets and low interest rates have resulted in lower expected returns for almost all asset classes.
- Price appreciation in international developed large cap equities helped normalize valuations, particularly the Shiller P/E ratio. Over the past year, the Shiller P/E ratio rose from 14.5 to 18.6, which placed it in the 36th percentile relative to history.
 Due to higher P/E ratios, the valuation adjustment to expected return fell from +0.5% to 0.0%.
- Higher valuations in emerging market equities caused expected returns to fall by -0.5%. The Shiller P/E ratio rose from 8.7 to 11.9 and the 12-month trailing P/E ratio rose from 15.4 to 15.9.
- U.S. interest rates were unchanged over the period, but spreads tightened further in both investment grade and high yield credit. Core fixed income spreads fell from 92 bps to 61 bps, and high yield spreads dropped from 437 bps to 356 bps.
 Tighter spreads in U.S. credit resulted in lower expected returns for almost all fixed income asset classes.
- Bank loans were an exception as a rise in LIBOR offset tighter spreads. The three-month LIBOR reference rate increased from 1.0% to 1.7%, while spreads contracted from 387 bps to 357 bps.
- Expected returns also declined for hard and local currency emerging market debt. In hard currency-denominated debt, spreads to U.S. Treasury yields dropped from 360 bps to 290 bps, while yields of local-denominated debt fell from 6.8% to 6.1%.

All data cited above is as of 12/31/17

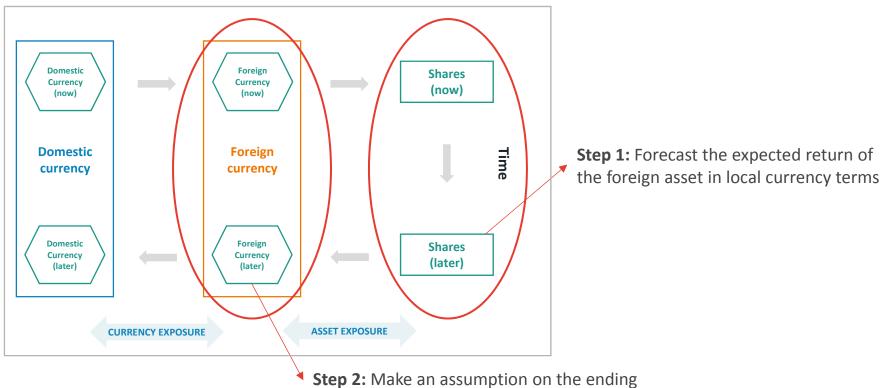


Appendix



Explanation of the currency adjustment

Our fundamental building block approach produces a return forecast in local currency. In order to create useable forecasts for non-U.S. dollar-denominated assets, we must make an assumption about future foreign exchange rates.

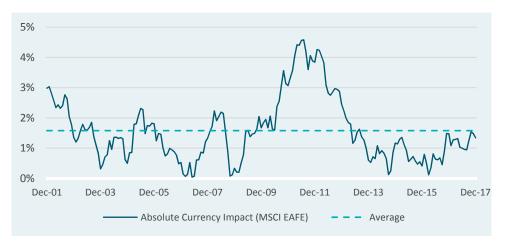


Step 2: Make an assumption on the ending foreign currency exchange rate

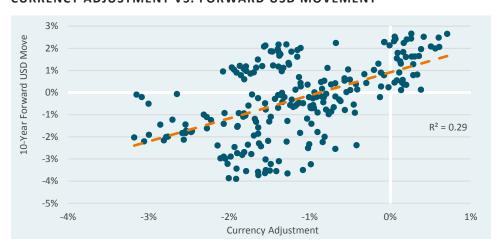
Explanation of the currency adjustment

- There are two options to adjust a local currency return forecast to a U.S. dollar forecast: make a specific exchange rate forecast or take market pricing based on the forward curve
 - It is important to note that ignoring currency is making a specific assumption that the current exchange rate will be unchanged over the next 10 years, which has rarely been the case throughout history
- Markets price future exchange rates in the forward market, which represents the SPOT currency price for FORWARD delivery
- Forward currency contracts are priced based on the interest rate differential between two currencies interest rate differentials reflect a significant amount of information, including growth, inflation, and monetary policy expectations
- A currency with a higher interest rate is priced to depreciate relative to a currency with a lower interest rate
- We adjust our local currency return forecasts based on forward market pricing because we believe this is the neutral, "no opinion" position, rather than making a specific forecast
- Historically, this currency adjustment has had a positive relationship with 10-year forward exchange rate movements

10-YEAR ROLLING ABSOLUTE CURRENCY IMPACT



CURRENCY ADJUSTMENT VS. FORWARD USD MOVEMENT



Source: Verus, MSCI, as of 12/31/17

Source: Verus, Bloomberg, using data since 1989, based on the MSCI EAFE Index



Domestic vs. international equities

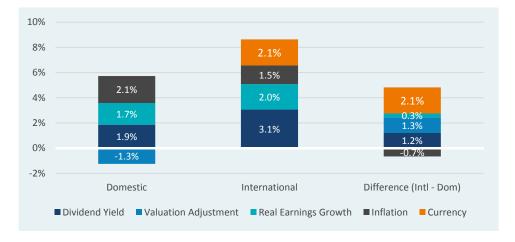
In recent years, the gap between our U.S. large cap and international large cap equity forecasts has widened – 2018 expected returns are 4.5% and 8.6%, respectively. Half of this gap is caused by differences in market fundamentals, while the other half is a result of the currency adjustment (see the previous pages for a detailed explanation of this adjustment).

This gap is fundamental and has been driven primarily by valuation differences. In the U.S., valuations are elevated based on both the Shiller and trailing 12-month P/E ratio, which results in a 1.25% deduction from return expectations since high valuations have

historically been followed by some mean reversion over the longerterm, on average. In international equities, valuations are within a normal range relative to history, implying no valuation movement. Higher valuations reduce our expectations for U.S. equities in two ways – a lower current dividend yield (1.9% vs. 3.1%) and expectations for some mean reversion (lower future valuation levels).

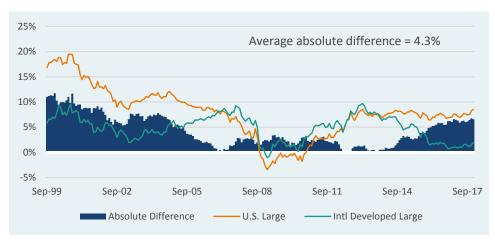
Surprisingly, it is not unusual for U.S. and international equities to exhibit large differences in performance, even over longer periods. Since 1989, the average absolute difference between S&P 500 and MSCI EAFE 10-year returns has been 4.3%.

DOMESTIC VS. INTERNATIONAL RETURN FORECASTS



Source: Verus, as of 12/31/17

10-YEAR TRAILING RETURNS



Source: MSCI, S&P, as of 12/31/17



Autocorrelation adjustment

- We adjust all volatility forecasts that use the long-term historical volatility for autocorrelation.
- Autocorrelation occurs when the future returns of a time series are described (positively correlated) by past returns.
- Time series with positive autocorrelation exhibit artificially low volatility, while time series with negative autocorrelation exhibit artificially high volatility.
- Many asset classes that we tested showed positive autocorrelation, meaning the volatility forecasts that
 we use in the forecasting process are too low for those asset classes.
- The result of this process was that several asset classes have higher volatility forecasts than if we had made no adjustment for autocorrelation.

Russell 2000 autocorrelation, among many asset classes, is statistically significant

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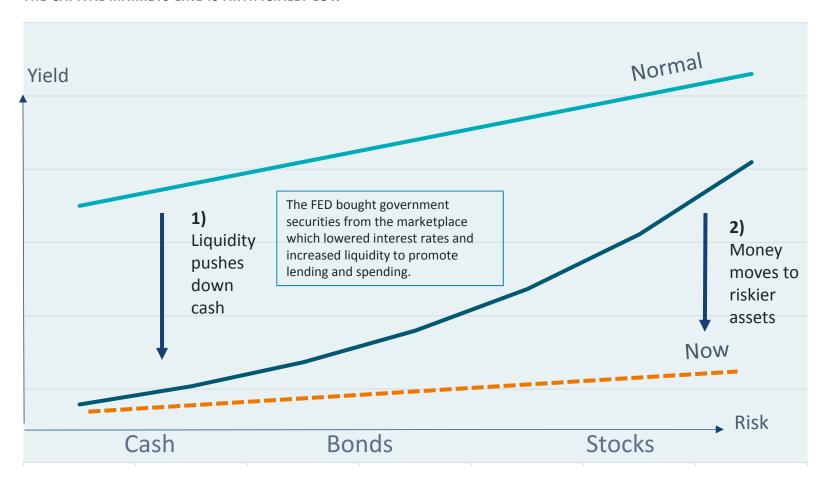


The current return environment



Liquidity and low interest rates

THE CAPITAL MARKETS LINE IS ARTIFICIALLY LOW



Liquidity has forced investors into risky investments, lowering goforward expected returns.

Source: Verus, Bridgewater



Historical policy return

Estimating the FCERA policy index return going back to 1928

- Since 1928:

 The policy outperforms the required return 87% of the time on a rolling 20 year basis and 62% of the time on a rolling 10 year basis.

— The last 40 years:

 The policy outperforms the required return 95% of the time on a rolling 20 year basis and 78% on a rolling 10 year basis.



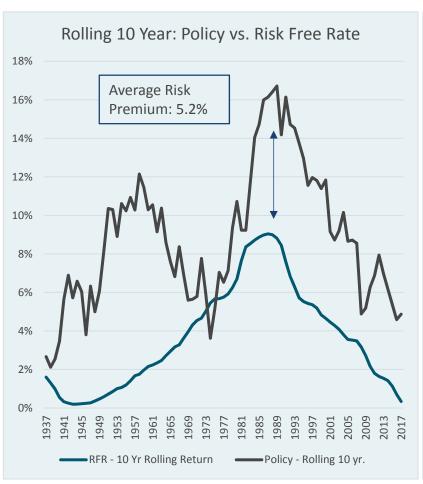
History shows that it is common for the portfolio to materially outperform or underperform for prolonged periods of time.

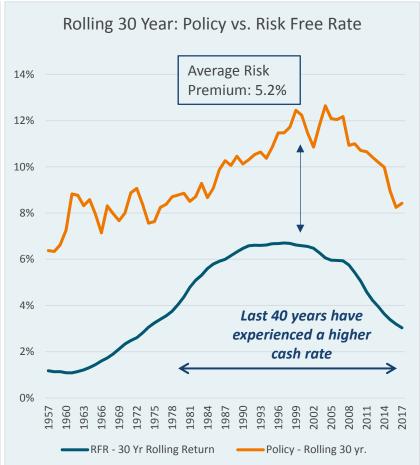
Current strategic allocation approximated using indices. Prior to 1970, 55% LC Equity, 45% 10 Yr. Treasuries. Subsequent to 1970 includes international equity and commodities. Subsequent to 1973 includes real estate. Subsequent to 1979 includes private equity. Subsequent to 1991 includes private credit. Subsequent to 1997 includes hedge funds.



Historical policy return & risk free rate

There is a relatively strong correlation between the risk free rate and the policy return.





Given today's risk free rate, a 7.0% return would necessitate an above average risk premium.

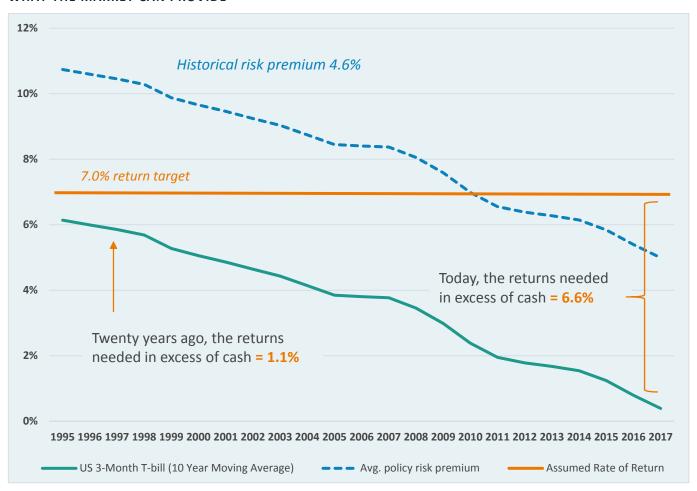
A 60/40 portfolio had an average risk premium of 4.6% for both time periods.

Risk Free Rate represents 3 Month Treasury Bills. See prior page for notes regarding the estimated policy return.



Risk free rate and expected returns

WHAT THE MARKET CAN PROVIDE



Very low interest rates make the 'math' in achieving the assumed return challenging

This analysis assumes that the Pension's assumed return was not materially higher than 7.0% in the past. Data as of 12/31/17. Avg. policy risk premium calculated using a domestic 60/40 S&P 500/Cash portfolio. 10 year trailing T-bill =0.4% on 12/31/17.



Asset allocation concepts



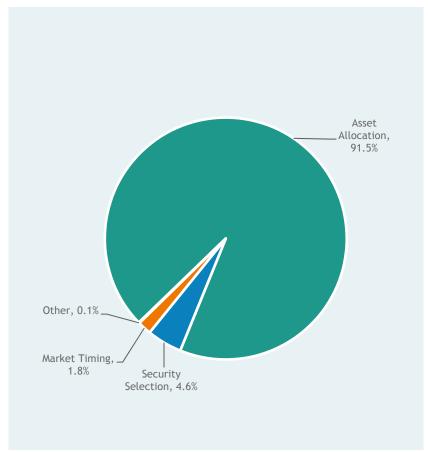
Asset allocation decision

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

ACADEMIC SUPPORT:

- Gary P. Brinson, L. Randolph Hood, and Gilbert L.
 Beebower. "Determinants of Portfolio Performance".
 Financial Analysts Journal, July/August 1986.
- Gary P. Brinson, Brian D. Singer, and Gilbert L.
 Beebower. "Determinants of Portfolio Performance
 II: An Update". Financial Analysts Journal, 47, 3
 (1991).
- Roger G. Ibbotson and Paul D. Kaplan. "Does Asset Allocation Policy Explain 40%, 90%, or 100% of Performance?" Financial Analysts Journal, January/February 2000.

PERCENT OF VARIATION EXPLAINED



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

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



The roles of asset classes

Think outside the optimizer...

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

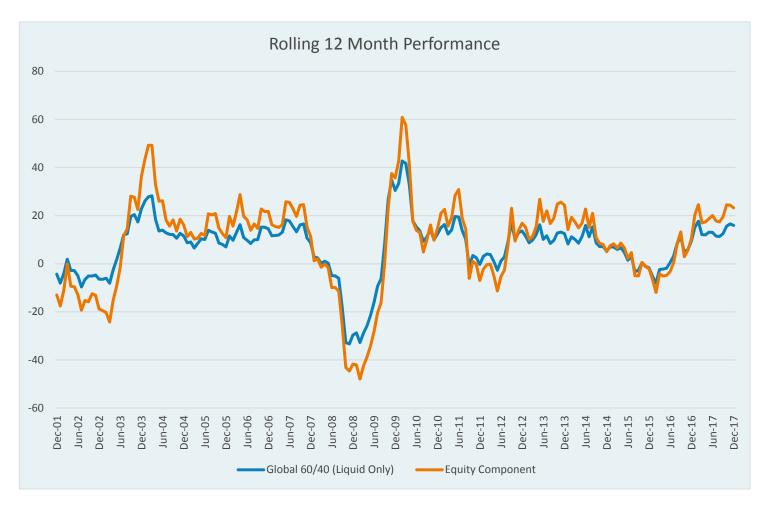
	RETURN ROLES				DIVERSIFICATION & VOLATILITY ROLES			HOW MACRO OUTLOOK/GDP AFFECTS ROLE	
	Benefit from GDP Growth	Earn Risk Premium	Produce Stable Income		Low Absolute Volatility	Low Corr. To Other Assets	Reduce Portfolio Volatility	Elements of Return for Asset Class	Sensitivity of Role to GDP
Public Equities		•	•		0	•		PEs, Dividends, Earnings Growth	
Private Equities			0	0	•			PEs (exits), Financing, Opportunity Set	•
Fixed (Treasury)	0	0						Direct Link to Yields	
Fixed (Credit)	•	•			•			Direct Link to Yields, Credit Spreads	•
Hedge Funds (Perceived role)	0		0	\bigcirc				Pes, Credit Spreads, Fat Tails	•
Real Estate	•				•			Unemployment, Vacancies, Cap Rates	

Magnitude: ● High ● Med-High ● Medium ● Low ○ None



Drivers of portfolio risk

Equity risk is a major driver of portfolio risk



The Global 60/40 (Liquid Only) portfolio exhibits a correlation of 0.97 to the equity component



Diversification

ROLLING 36 MONTH SHARPE RATIOS (JAN. 1973-DEC. 2017)

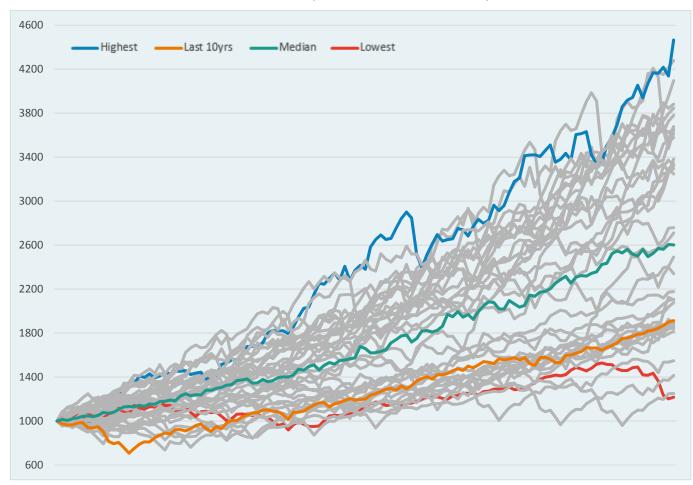


Note: Stocks are represented by the MSCI World Index, Bonds by the BBgBarc US Government Bond Index, and Commodities by the S&P GSCI Index.



A range of possible outcomes

CUMULATIVE RETURNS OF A DOMESTIC 60/40 (10YR PERIODS SINCE 1970)



Note: Domestic 60/40 Portfolio consists of 60% S&P 500 and 40% IA SBBI US IT Gov. Bond Index

Since 1970, there have been 39 different 10 year periods:

The highest return period (1982-1991) had an annual growth rate of 16.4% per year

The median annual growth rate over all periods was 10.0% per year

The last 10yrs (2008-2017) had an annual growth rate of 6.7% per year

The lowest return period (1999-2008) had an annual growth rate of 1.7% per year; this can be attributed to a -22% drawdown during the Dot-com bubble and a -21% drawdown during the beginning of the GFC



FCERA projected cash flows

PROJECTED FUTURE CASH FLOWS



These projections assume all assumptions are met, and investment returns are 7% per year

When considering asset allocation policy, it is important to understand the effects of negative cash flows on potential outcomes

Source: Segal



Compounding negative returns

Compound Return:

—10 Years at 10% return produces an annualized return of 10%

Compounding large negative returns can overwhelm otherwise positive performance

WHAT WOULD BE THE ANNUALIZED RETURN IF ON THE 10TH YEAR THE PORTFOLIO EXPERIENCES A -30% RETURN?

—9 years at 10% return plus a one year return of **-30%** produces an annualized return of **5.14%**

Drawdown history

GLOBAL 42/58 PORTFOLIO (JAN. 1990-DEC. 2017):

Drawdown	Total	Average Frequency	Average Decline
5%-10%	9	Every 3yrs	-6.3%
11%-30%	2	Every 14yrs	-21.5%
>30%	0		

GLOBAL 57/43 PORTFOLIO (JAN. 1990-DEC. 2017):

Drawdown	Total	Average Frequency	Average Decline
5%-10%	10	Every 3yrs	-7.4%
11%-30%	2	Every 14yrs	-16.7%
>30%	1	Every 27yrs	-33.9%

GLOBAL 70/30 PORTFOLIO (JAN. 1990-DEC. 2017):

Drawdown	Total	Average Frequency	Average Decline		
5%-10%	7	Every 4yrs	-6.7%		
11%-30%	4	Every 7yrs	-12.7%		
>30%	2	Every 14yrs	-35.2%		

Note: The Global 70/30 Portfolio consists of 34% S&P 500, 8% Russell 2000, 22% MSCI EAFE, 6% MSCI EM, and 30% BBgBarc Global Aggregate. The Global 57/43 Portfolio consists of 27% S&P 500, 7% Russell 2000, 18% MSCI EAFE, 5% MSCI EM, and 43% BBgBarc Global Aggregate. The Global 42/58 Portfolio consists of 20% S&P 500, 5% Russell 2000, 14% MSCI EAFE, 3% MSCI EM, and 58% BBgBarc Global Aggregate.



The impact of drawdowns

Drawdowns can have a significant impact on funded status and required contributions for FCERA

	Time Horizon (yrs)	Drawdown (%)	Drawdown Year	Total Contributions	Max Contribution (as % of Payroll)	Max Contribution (\$ Amount)	Lowest Funded Ratio	Ending Funded Ratio	Unfunded Actuarial Liability (\$ Amount)
Baseline	20	None		\$2,970,252,563	60.7% (2019)	\$267,034,428 (2019)	78% (2017)	100%	-\$15,569,947
7.5% Return Scenario	20	None		\$2,159,722,843	60.4% (2019)	\$265,794,252 (2019)	78% (2017)	102%	-\$154,951,840
Drawdown Scenario 1	20	-25	6	\$6,067,367,675	60.7% (2019)	\$354,949,778 (2030)	64% (2023)	94%	\$603,544,981
Drawdown Scenario 2	20	-35	6	\$7,041,543,058	70.6% (2027)	\$420,789,451 (2030)	56% (2023)	92%	\$716,420,843
Drawdown Scenario 3	20	-35	6	\$7,794,658,010	77.2% (2027)	\$488,703,465 (2037)	52% (2025)	90%	\$952,883,354

- The Baseline and Drawdown scenarios assume the Plan follows the current contribution policy and grows each year at the 7.0% actuarial assumed rate (other than the drawdown event).
 - Scenario 3 assumes the Plan experiences two years of 0% returns after the drawdown year before returning to the 7.0% growth rate.
- Under Scenarios 1, a -25% drawdown would require roughly \$3 billion more in contributions and bring the Plan down to a funded ratio of 64% in 2023 before finishing at 94%.
- Under Scenarios 2, a -35% drawdown would require roughly \$4 billion more in contributions and bring the Plan down to a funded ratio of 56% in 2023 before finishing at 92%.
- Relative to Scenario 2, Scenarios 3 would increase required contributions by an additional ~\$800 million, bring contributions as a percentage of payroll up to 77% in 2027, and leave the Plan with a funded ratio of 90%.



Asset allocation



Asset allocation "goal posts"

	<u>Mix 1</u>	<u>Mix 2</u>	<u>Mix 3</u>	<u>Mix 4</u>	<u>Mix 5</u>	<u>Mix 6</u>
			More Aggressive		Global 60/40	
	Very Conservative	Current Policy	Policy	SACRS Peer	(Liquid Only)	Very Aggressive
Domestic Large Cap Equity	8%	14%	20%	21%	30%	26%
Domestic Small Cap Equity	2%	3%	4%	5%	6%	6%
International Developed Equity	8%	9%	12%	17%	20%	16%
International Small Cap Equity		3%	3%			4%
Emerging Markets Equity	2%	7%	6%	4%	4%	9%
Global Equity				2%		
Total Public Equity	20%	<i>36%</i>	45%	49%	<i>60%</i>	61%
US Core Plus Fixed Income	16%			20%	25%	13%
US Credit Fixed Income	4%	5%				
High Yield Fixed Income	4%	5%	5%		5%	
Bank Loans	4%	5%	5%		5%	
Global Sovereign	10%	7%	3%	1%		
Emgerging Markets Debt	5%	5%	5%	2%		
TIPS	7%	4%	3%		5%	
Total Fixed Income	50%	31%	21%	23%	40%	13%
Private Equity	5%	6%	8%	7%		10%
Private Credit	5%	8%	8%	5%		8%
Commodities	4%	3%		3%		
Real Estate	5%	5%	7%	8%		5%
Infrastructure	3%	3%	3%			3%
Hedge Funds	8%	8%	8%	5%		
Total Alternatives/Real Assets	30%	33%	34%	28%	0 %	26 %
Total Portfolio	100%	100%	100%	100%	100%	100%



Risk and return

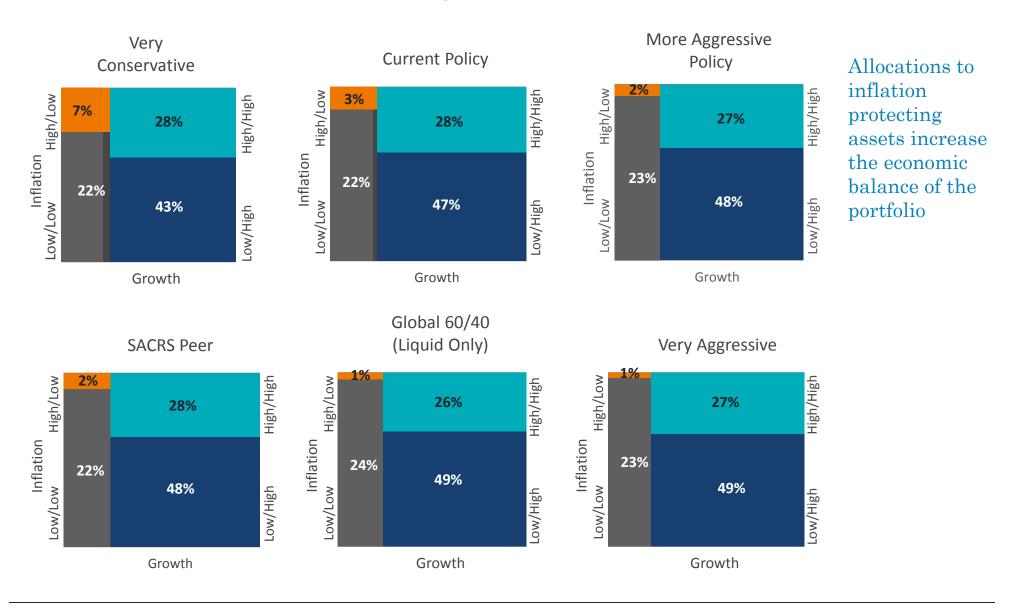
- Increasing exposure to equities impacts both expected risk and return.
- Given the lower expected returns for many public market assets, allocations to private market assets helped boost returns.
- The risk-adjusted returns of each portfolio remain in-line with the current policy.

	<u>Mix 1</u>	<u>Mix 2</u>	<u>Mix 3</u>	<u>Mix 4</u>	<u>Mix 5</u>	<u>Mix 6</u>
			More Aggressive		Global 60/40	
	Very Conservative	Current Policy	Policy	SACRS Peer	(Liquid Only)	Very Aggressive
Mean Variance Analysis						
Forecast 10 Year Return	5.2	6.0	6.3	6.0	5.3	6.5
Risk (StdDev Rtn), %	9.2	11.8	13.0	12.4	12.2	14.7
Sharpe Ratio	0.36	0.36	0.36	0.36	0.31	0.35
Equity Tail Risk	-26%	-34%	-37%	-38%	-41%	-44%

Note: Equity tail risk is calculated using BarraOne (see page 63).

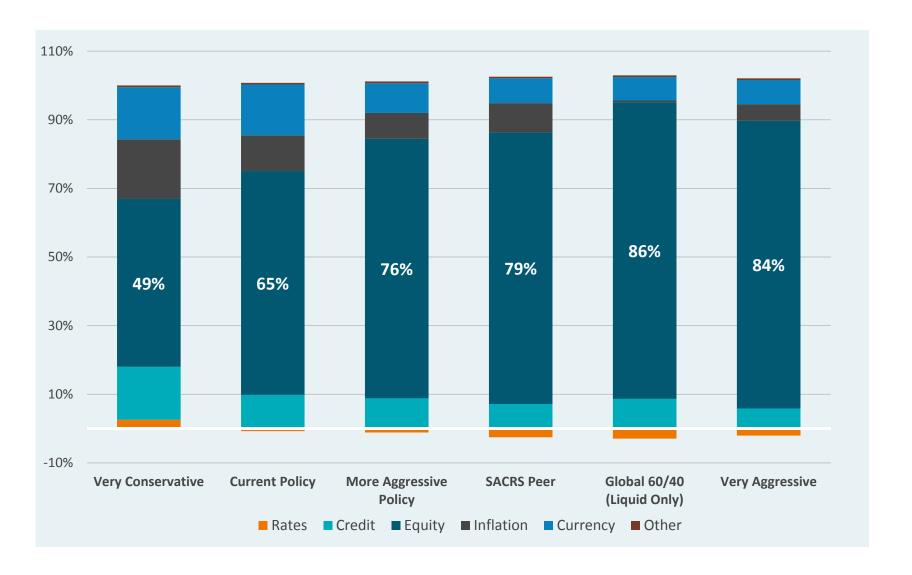


Economic sensitivity



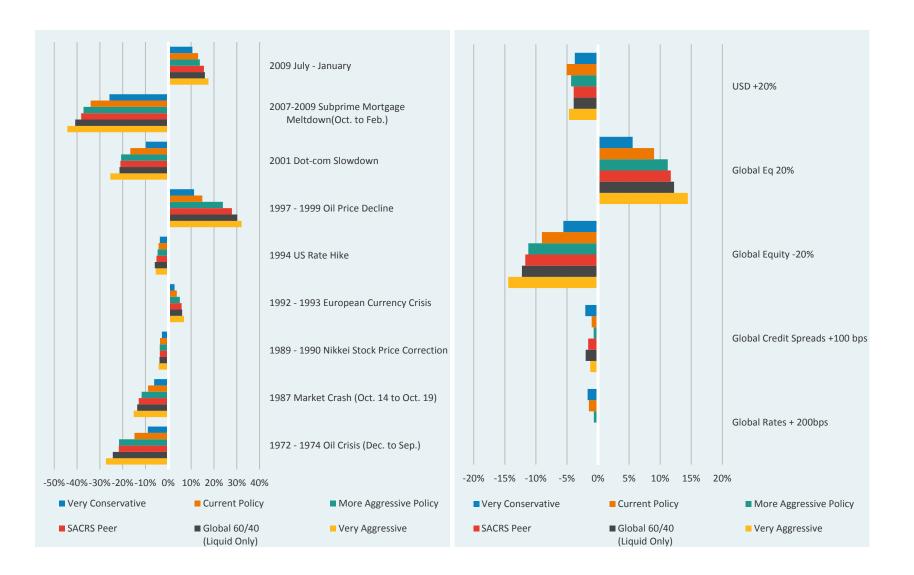


Risk decomposition



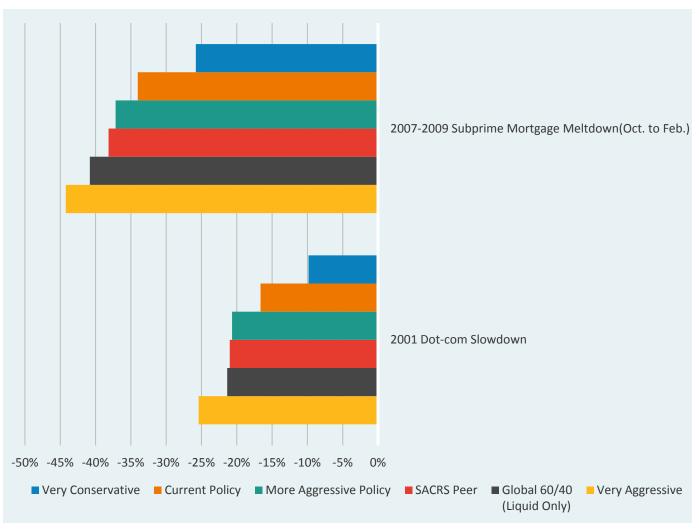


Scenario analysis





Equity tail risk



Relative to the very conservative mix and the current policy, the remaining mixes exhibit significantly more exposure to equity downturns



Next steps



2018 Asset-liability study timeline

Timeframe	Action	Description
March 7, 2018 Board Meeting	Phase 2 of ALS	Verus to review the current portfolio relative to the comparison portfolios and generate asset-only modeling for each portfolio, focused on risk, return, scenario analysis, shock analyses, and risk decomposition
+ 3 weeks	Asset-Liability Integration	Verus to load comparison portfolios into liability model framework, prepare deterministic and stochastic modeling.
April 4, 2018 Board Meeting	Phase 3 of ALS	Verus to review results of asset-liability modeling using the comparison portfolios. *Milestone #1: Narrow down which comparison portfolio offers the most attractive set of trade-offs relative to liabilities.
+ 3 weeks	Further refinement of selected comparison portfolio	Once the Board gains comfort with the broad set of risk/return characteristics of a comparison portfolio, Verus to conduct further asset-only modeling to determine several similar alternatives
May 2, 2018 Board Meeting	Phase 4 of ALS	Verus will review the similar alternatives relative to the comparison portfolio that was selected for further consideration at April meeting. *Milestone #2: Identify the new asset allocation mix to be implemented.
June 6, 2018 Board Meeting	Phase 5 of ALS	Verus will review next steps for implementing the new asset allocation. Revise IPS, manager searches, transitions, etc.

