Improving Asset Allocation Decisions

Steve Foresti, Chief Investment Officer
Thomas Toth, CFA, Managing Director
Ali Kazemi, Managing Director

July 2020

IMPORTANCE OF ASSET ALLOCATION

- The goal of asset allocation is to select a diversified mix of suitable asset classes that minimizes risk for a given level of expected return (or maximize return at a given level of risk)
- The purpose of the exercise is to build a portfolio that can help to meet CalPERS' financial objectives
- Include additional measures beyond return and risk when selecting asset allocation
  - Ability to support pension commitments for CalPERS' beneficiaries in perpetuity
  - Maintain adequate liquidity to meet capital requirements
  - Balance risk factor exposures
- Strategic asset allocation is not a guide to outperforming in every market

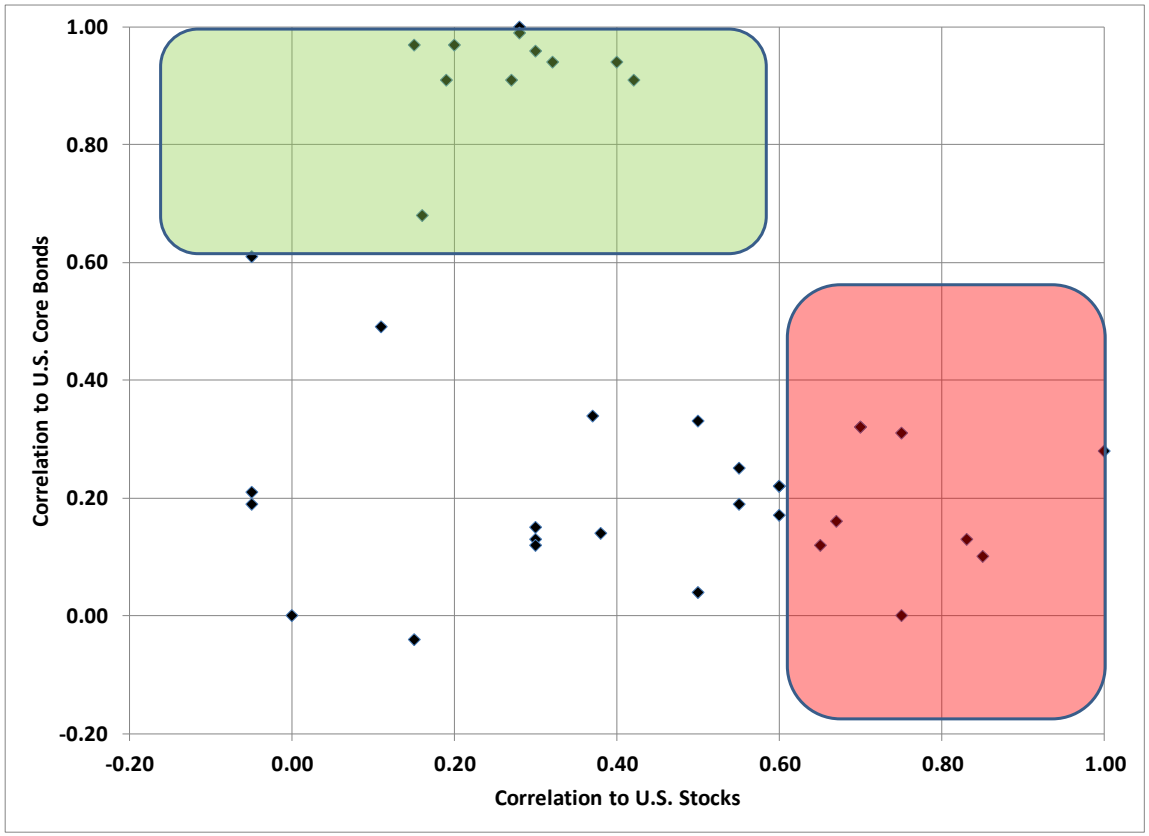
  … but it should provide a roadmap for success over a market cycle

ASSET ALLOCATION AND CALPERS' MISSION

- Wilshire believes the mission of a defined benefit plan is to **fund benefits promised to participants**
- The role of asset allocation is to manage risk around fulfilling that core mission
  - *Maximize safety* of promised benefits by managing drawdown and liquidity risk
  - *Minimize cost* of funding these benefits by managing inflation and shortfall risk
- Asset Liability Management (ALM) provides a framework for selecting a policy portfolio that considers both goals across multiple dimensions
- The appropriate asset allocation policy is determined by an investor's **risk tolerance** and **return expectation** requirements
- Each investor's risk tolerance and return requirements should be viewed in the context of the **liabilities (i.e. commitments)** that the assets are supporting

MARKET OPPORTUNITY SET

- Asset buckets are composed of financial assets with similar correlation to fundamental economic factors
  - Combines assets that play similar roles in a portfolio while creating a better understanding of risk and diversification
  - All asset classes do not fit neatly into an assigned category, providing some opportunities for diversification

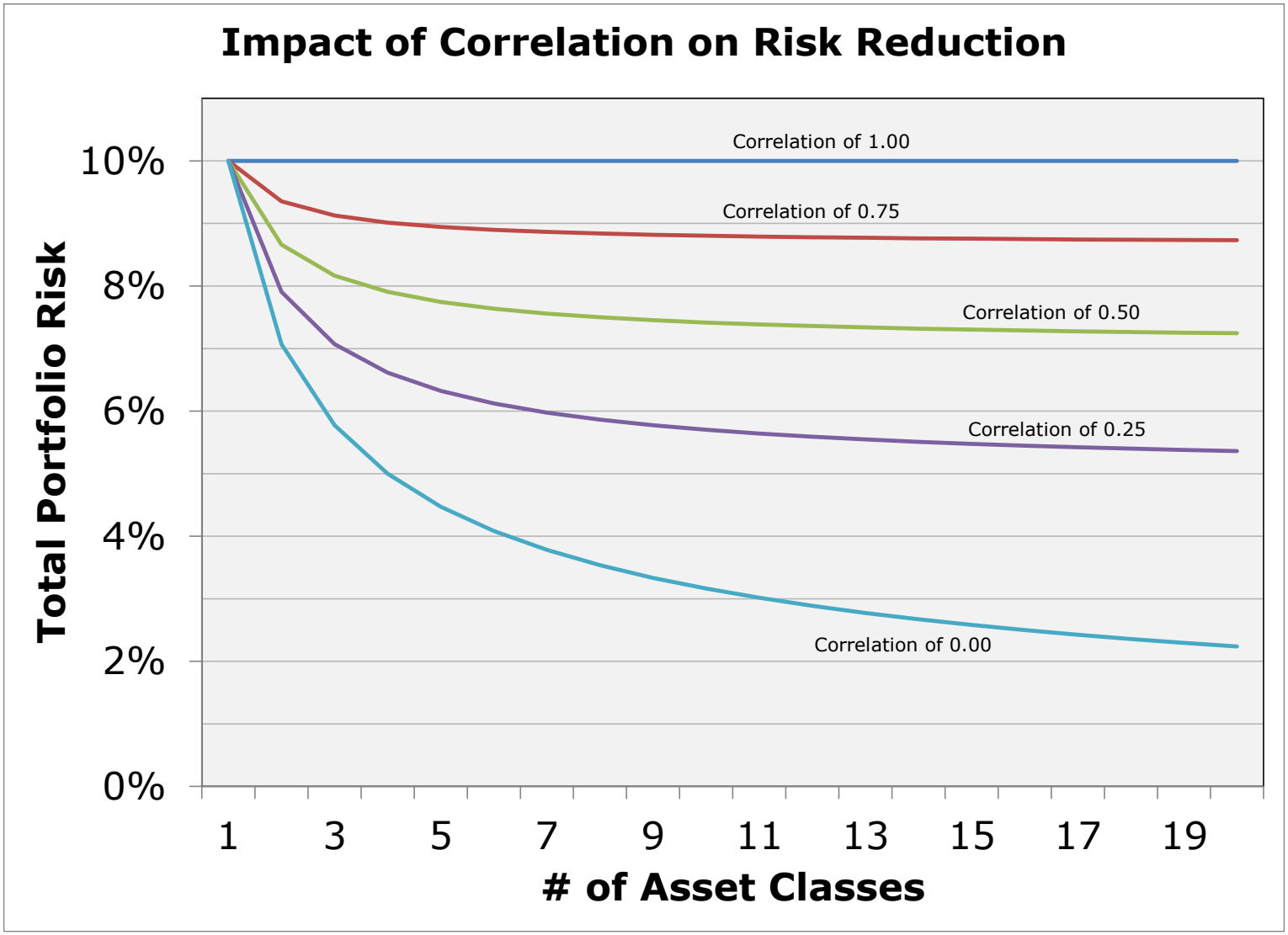


Growth Macro-Asset Class	
Asset	Correlation
US Stocks (anchor)	1.00
Global ex-US Stocks	0.85
Developed ex-US Stocks	0.83
Emerging Stocks	0.75
Private Markets	0.75
Buyouts	0.70
Mezzanine Debt	0.70
Global Real Estate Securities	0.67
Non-US RE Securities	0.65
US Real Estate Securities	0.60
Venture Capital	0.60
Non-US Buyouts	0.60

Income/Safety Macro-Asset Class	
Asset	Correlation
U.S. Core Bonds (anchor)	1.00
Short/Int Core Bonds	0.99
Treasuries	0.97
Govt Related Bonds	0.97
Securitized	0.96
LT Core Bonds	0.94
Corporate Bonds	0.94
LT Treasuries	0.91
LT Govt Related Bonds	0.91
LT Corporate Bonds	0.91
Developed ex-US Bonds (Hdg)	0.68
TIPS	0.61

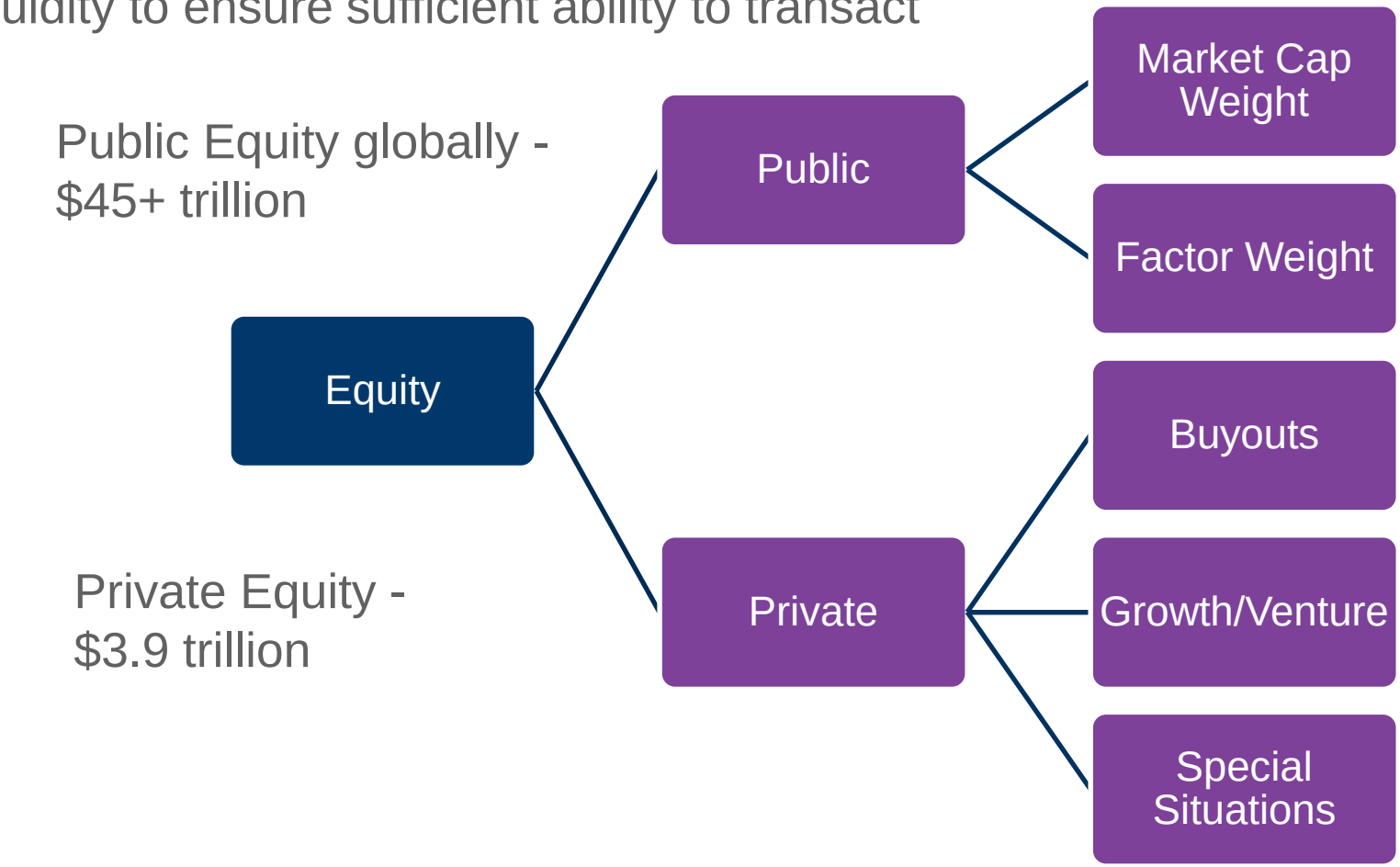
MARKET OPPORTUNITY SET

- Diminishing risk reduction benefit by simply adding asset classes – even with uncorrelated assets



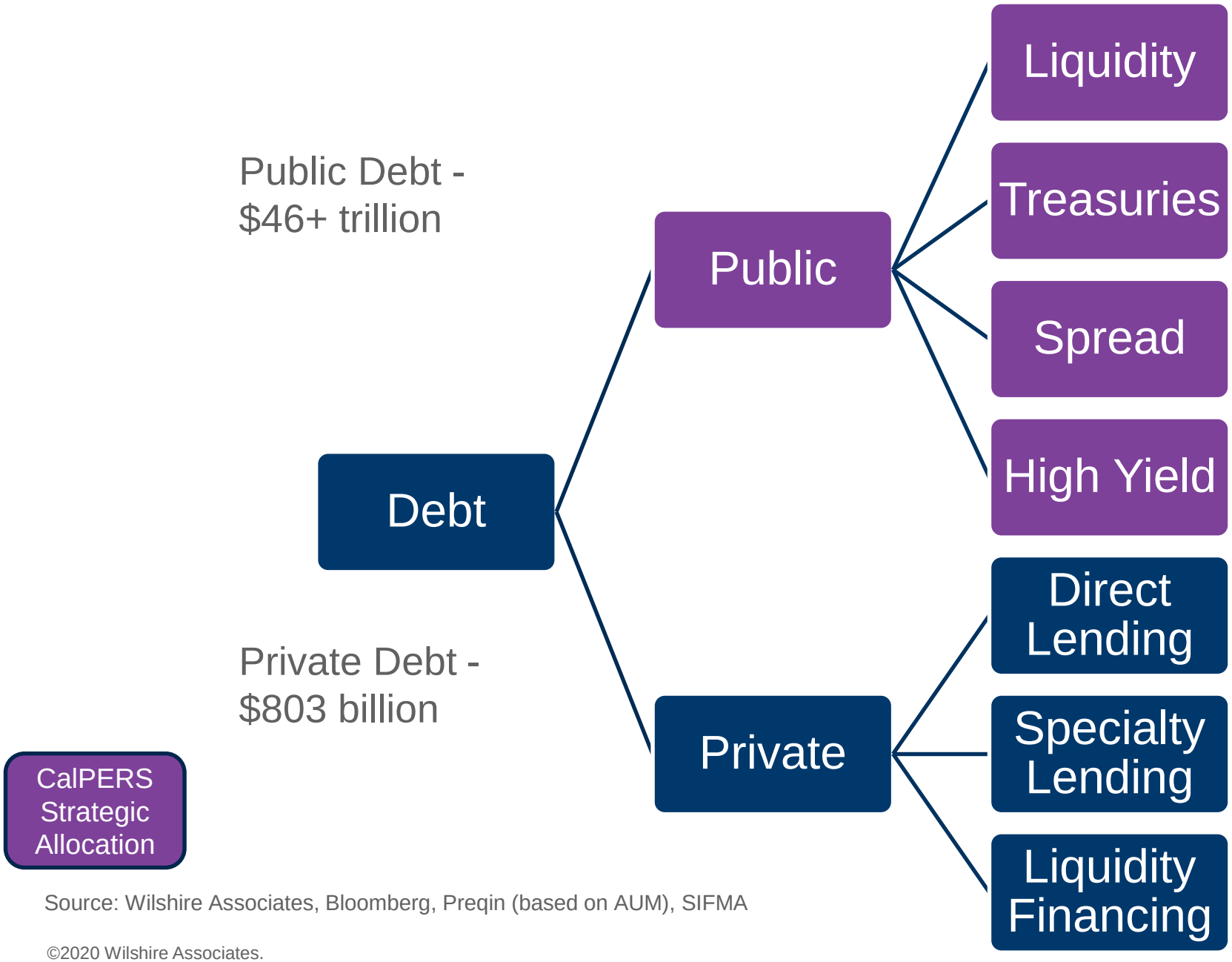
MARKET OPPORTUNITY SET

- Considerations for applicability to large institutional investors
  - Market depth
  - Liquidity to ensure sufficient ability to transact



Source: Wilshire Associates, Bloomberg, Preqin (based on AUM), SIFMA

MARKET OPPORTUNITY SET



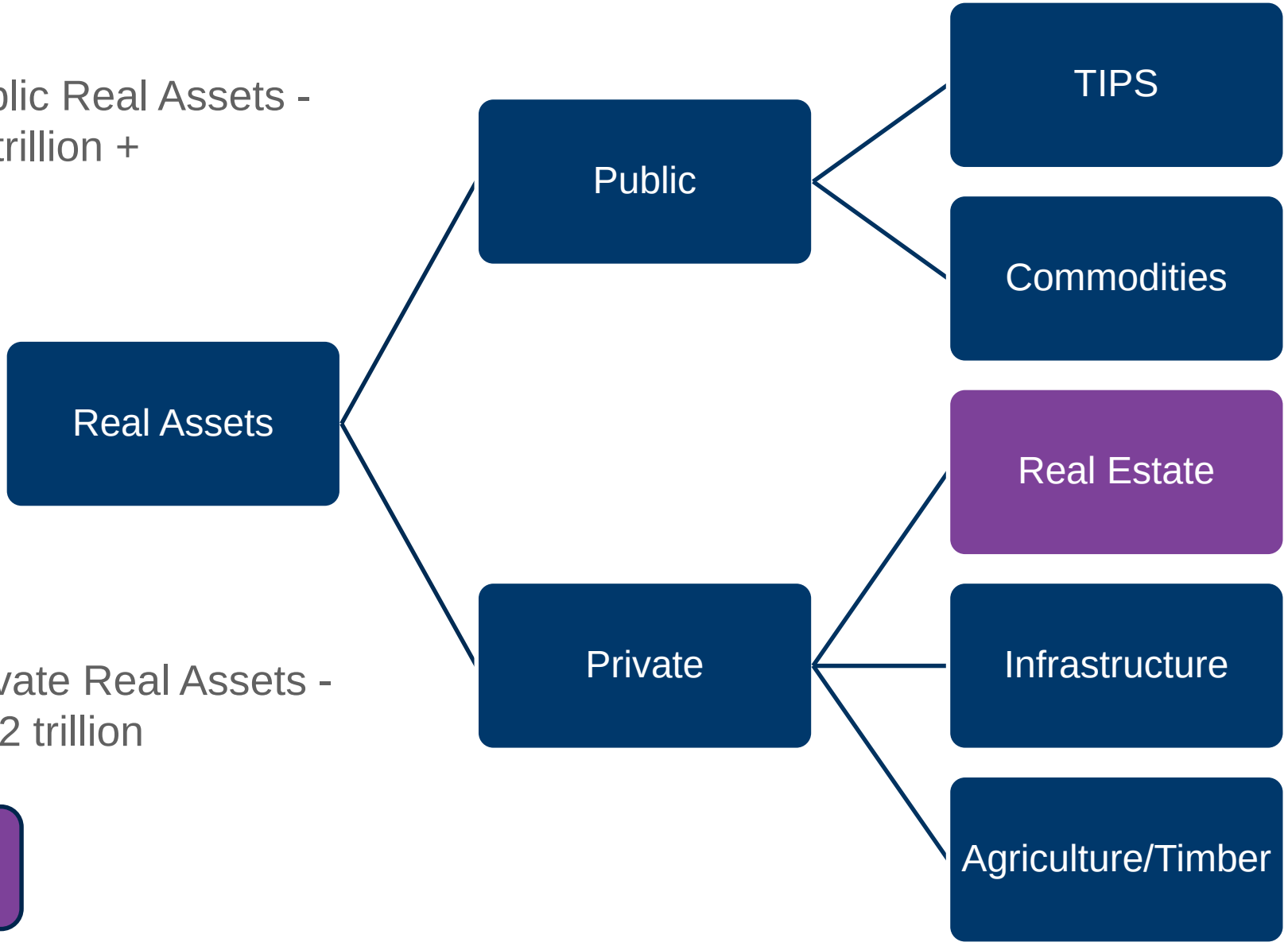
Source: Wilshire Associates, Bloomberg, Preqin (based on AUM), SIFMA

Wilshire Consulting

MARKET OPPORTUNITY SET

Public Real Assets -
$3 trillion +

Private Real Assets -
$2.2 trillion



CalPERS Strategic Allocation

Source: Wilshire Associates, Bloomberg, Preqin (based on AUM)

BENCHMARKING PURPOSE

- Benchmarking provides Board and Staff a realistic and achievable goal and serves as a clear and objective means of evaluating performance
- The purpose of benchmarking can be summarized as follows:

Performance Attribution	Decomposition of sources of return, such as asset allocation, active vs. passive management, skill, etc.
Insight on Risk/Returns	Insight into level of risk being taken to generate return and the volatility of return over time
Evaluation	Measure against which Staff performance can be evaluated

BENCHMARK SELECTION

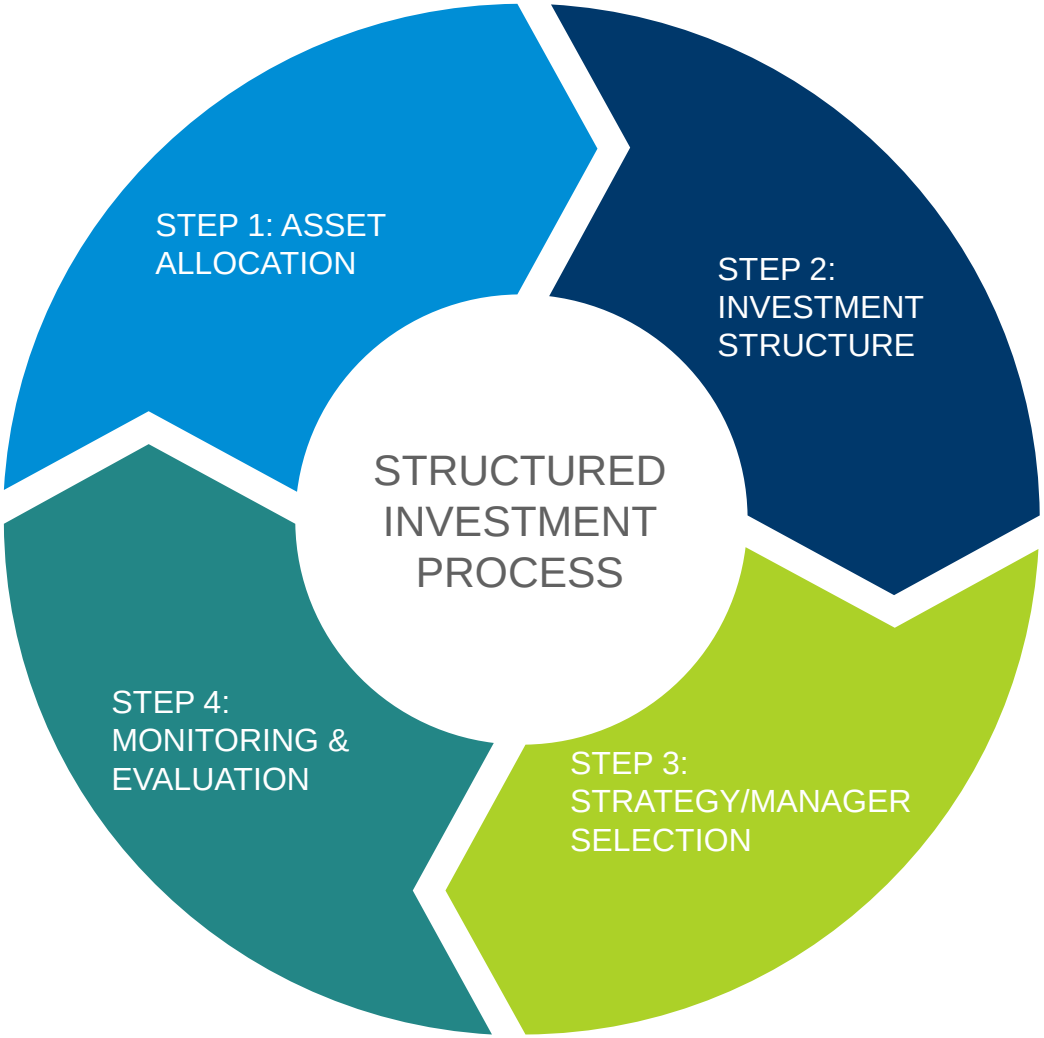
Total Fund Benchmark	Does it appropriately match the plan sponsor's investment philosophy and objectives and reflect the overall structure of the fund?
Asset Class Benchmark	Does it reflect a broad universe of investment opportunities in an asset class and offer a "target" for combining multiple strategies within the asset class?
Strategy Benchmark	Does it appropriately reflect the objective of the strategy and is it consistent with the asset class objective?

CHARACTERISTICS OF AN IDEAL BENCHMARK

Unambiguous	Benchmark components and construction methodology are clearly identifiable.
Investable	It is possible to replicate and simply hold the benchmark.
Measurable	The benchmark's return is readily calculable on an on-going basis.
Appropriate	The benchmark is consistent with the composite's objective or 's investor's style.
Reflective of current investment options	The investor is knowledgeable of the securities or factor exposures within the benchmark.
Pre-specified	The benchmark is agreed upon prior to the start of the monitoring period.

Source : CFA Institute

INVESTMENT STRUCTURE



- Investment structure deals with the type of investments within asset classes.
  - Secondary to the asset allocation decision
- Provide a platform for diversifying risk exposures within asset classes
  - Related to style (e.g., value or growth) and size (e.g., large, mid, small capitalization stocks), quality
- Address “active” versus “passive” investment management issues
- Establish structure targets for controlling risk and capturing market opportunity

ASSET CLASS EXPECTATIONS

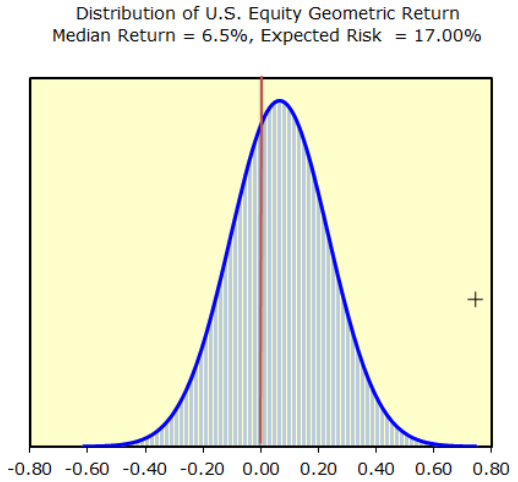
Once the market opportunity set is established, expectations for future returns and risk need to be formulated for those markets

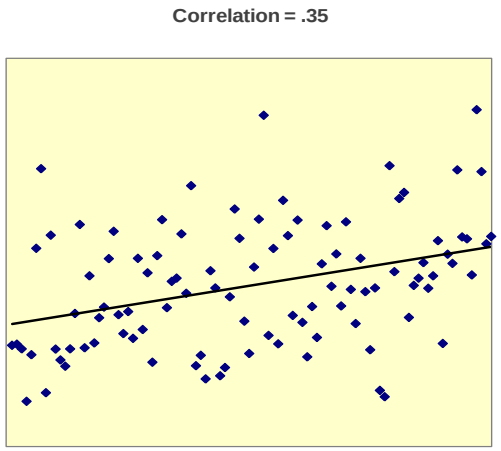
Median Return

- 50% probability that the return will be greater than the expected return.
- 50% probability that it will be less than the expected return.

Measures the dispersion of asset class returns around the expected return.

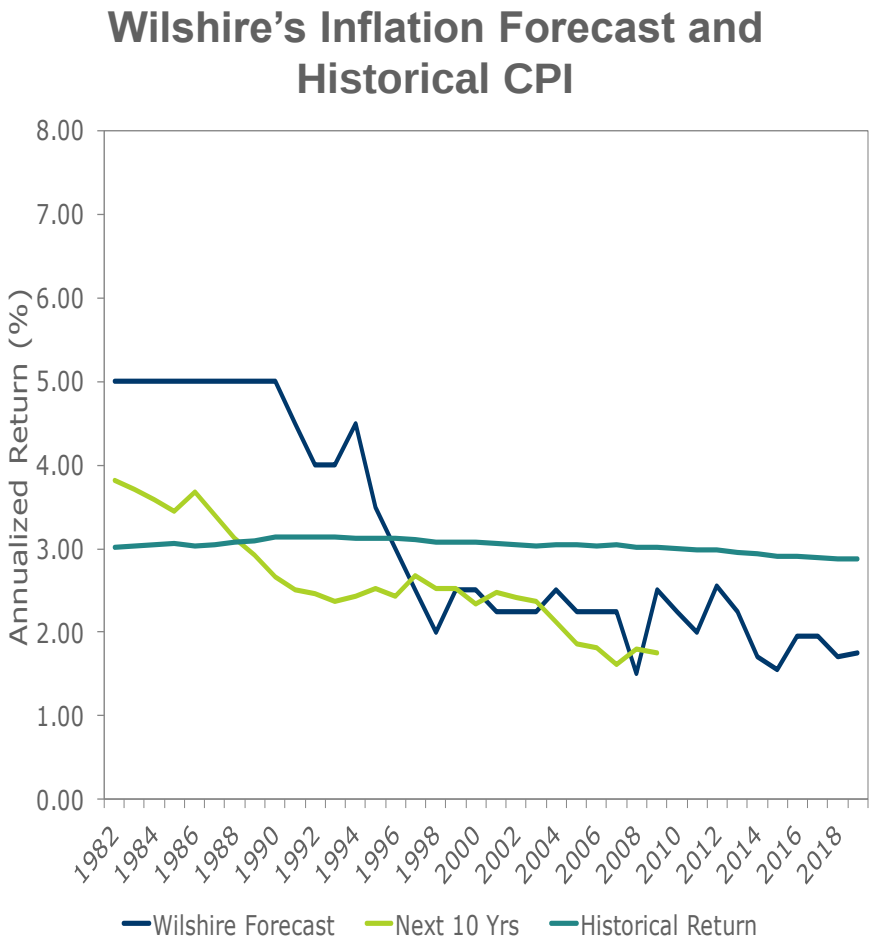
Measures the movement of asset class returns in relation to one another.





INFLATION ASSUMPTION

- Market-based inflation forecast
  - TIPS are used to forecast inflation
  - Subtract TIPS YTM from nominal Treasury YTM with same maturity
- Inflation assumption is down 60 basis points from December 2019
  - Market signal = 0.87%
  - Extreme liquidity conditions likely distorted bond prices, and therefore breakeven



FIXED INCOME MODEL FRAMEWORK

- Components of fixed income returns:
  - Yield to Maturity (dominant return diver)
  - Return on principal from interest rates/yield changes and appropriate spread factors

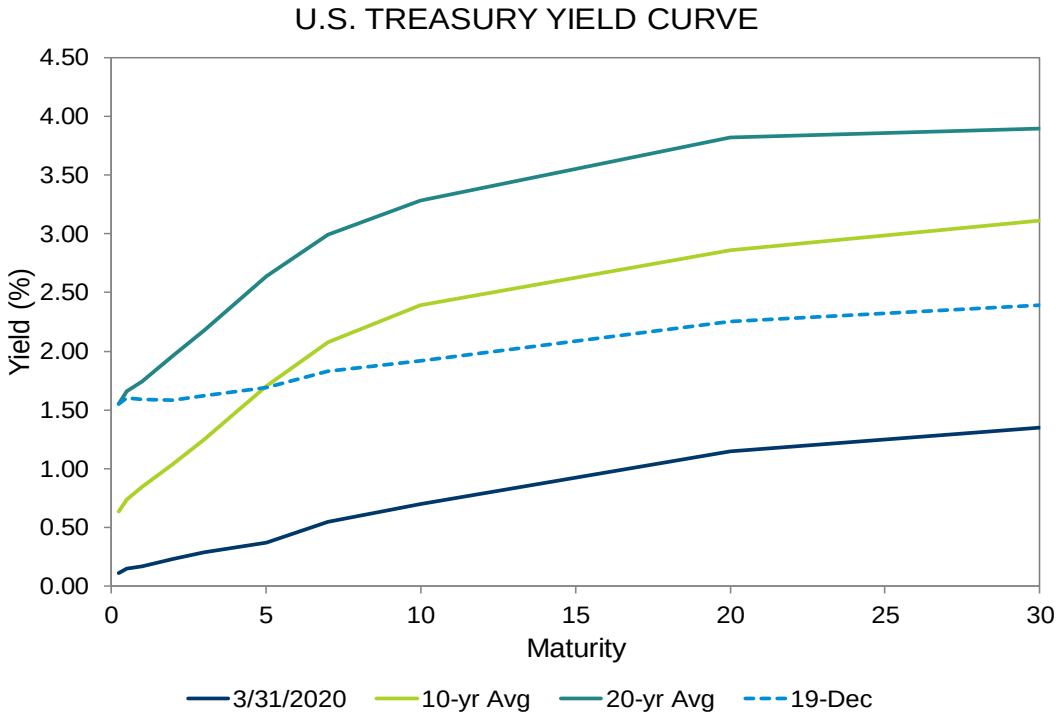
- Wilshire fixed income return assumptions build off of key inputs:
  - Inflation assumption
  - Current observed yield and spread levels
  - Historical spread and real yield levels; forward yield curve

- Current observed maturity and credit risk premiums are normalized to historical levels over our forecast period to calculate fixed income return assumptions

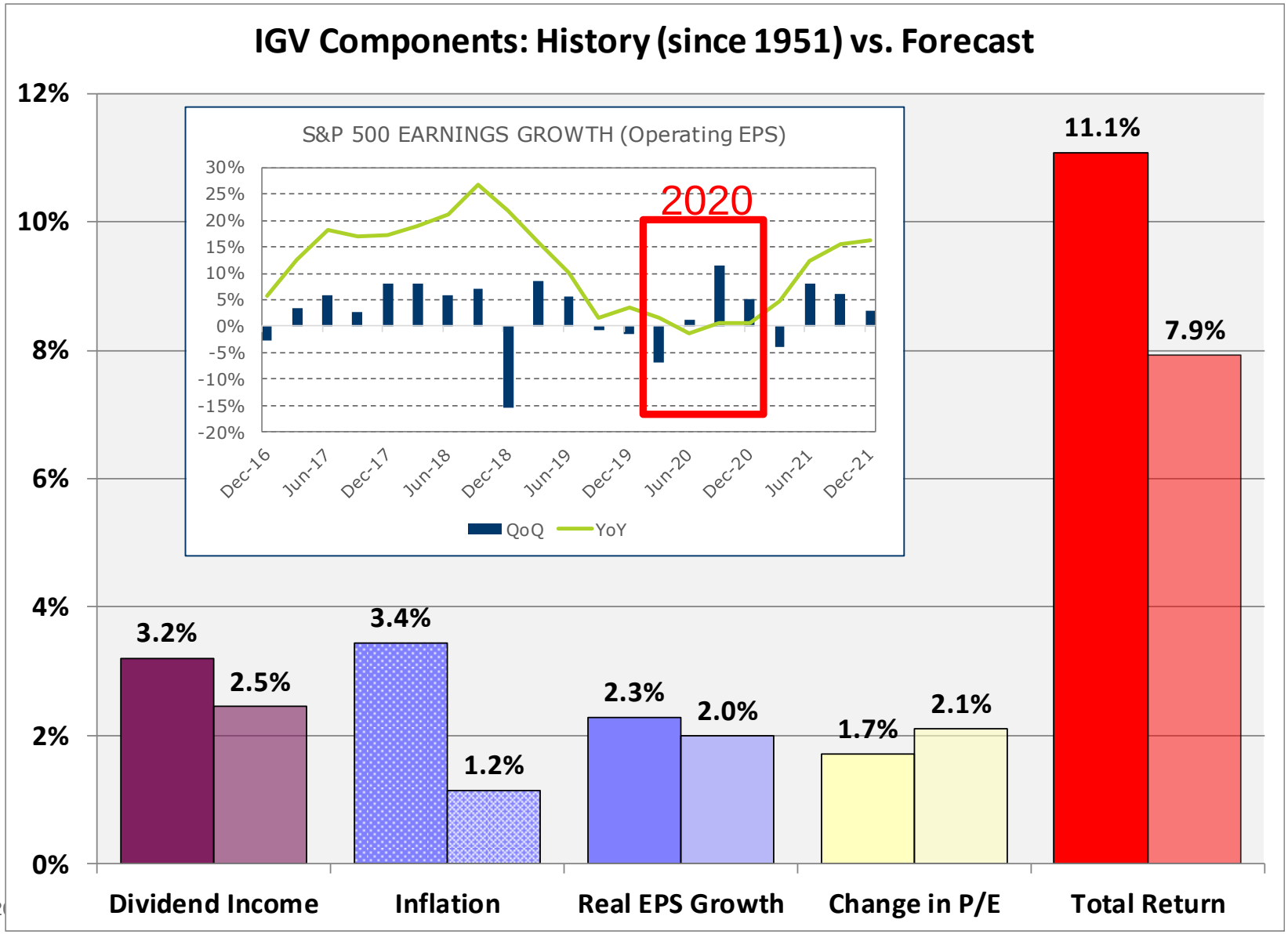
FIXED INCOME ASSUMPTIONS

- Investment grade fixed income assumptions are down for the quarter on a much lower yield curve
  - Yield on 10-year Treasury is down 1.24%, currently at 0.70%
  - Yield curve is down across the maturity spectrum
- Wilshire utilizes a high yield bond model to forecast returns, which accounts for credit yield spreads, defaults, recoveries & appreciation/depreciation of principal
  - High yield spreads are up big this quarter, +5.42%
  - Average spread on the index was 8.99% on March 31st

	TOTAL RETURN (%)			RISK (%)
	MAR 2020	DEC 2019	CHANGE	
CASH EQUIVALENTS	0.70	1.85	-1.15	1.25
CORE BONDS	1.80	2.85	-1.05	5.15
LT CORE BONDS	2.70	3.25	-0.55	9.85
U.S. TIPS	0.70	2.15	-1.45	6.00
HIGH YIELD BONDS	5.40	4.30	1.10	10.00
EMD LOCAL CURRENCY (HDG)	5.10	4.35	0.75	5.00

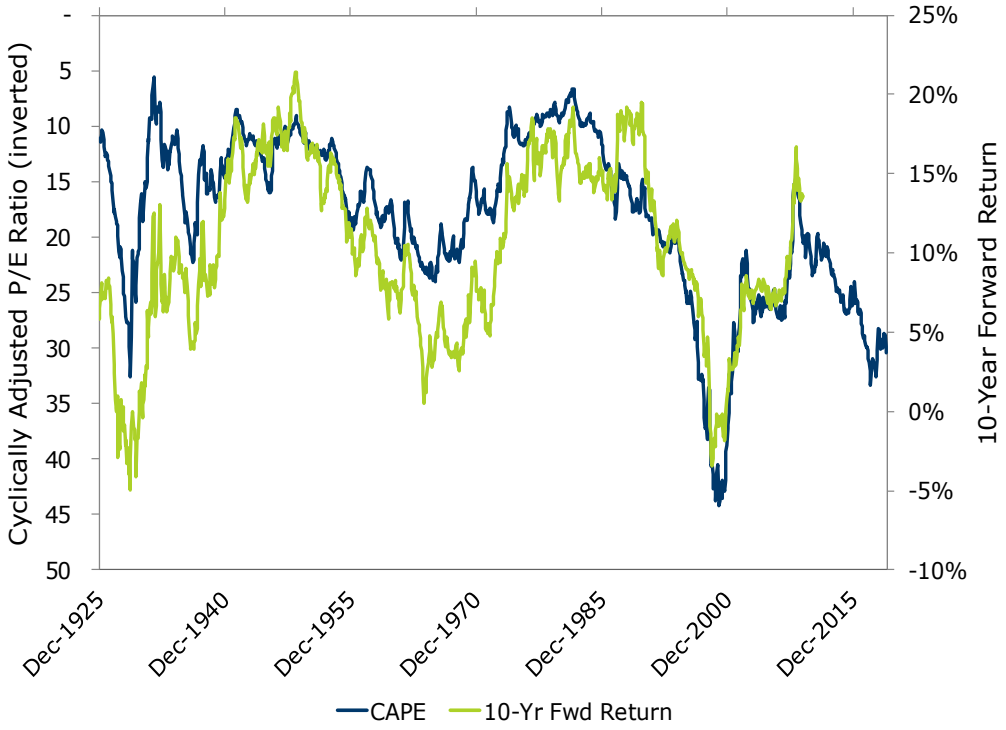


EQUITY FRAMEWORK – HIGHLY UNCERTAIN OUTLOOK…

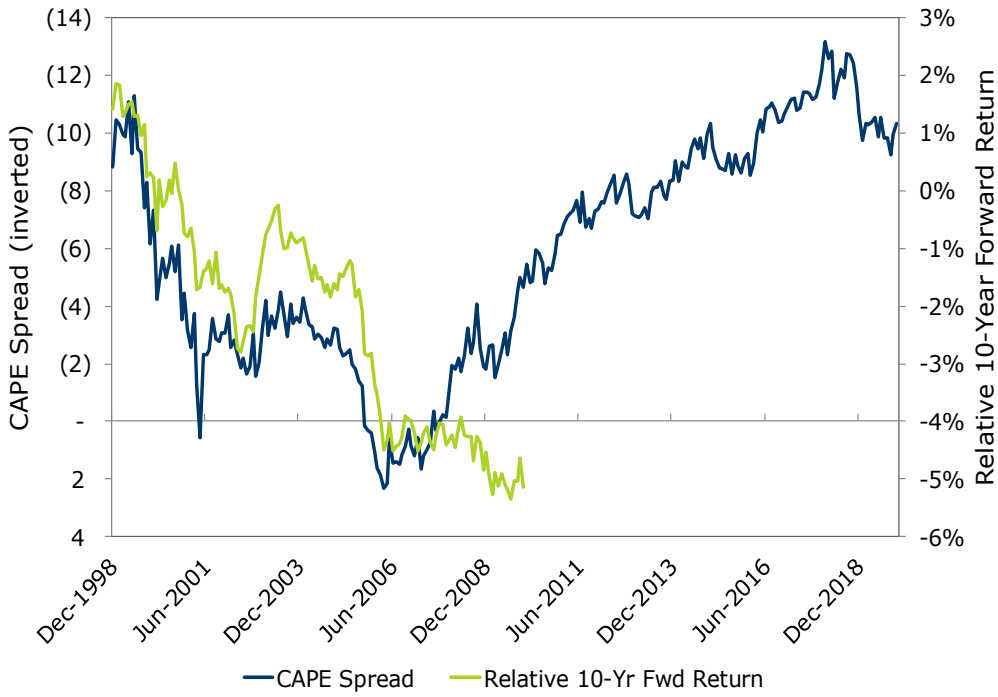


EQUITY FRAMEWORK – HIGHLY UNCERTAIN OUTLOOK

U.S. EQUITY: ADJUSTED P/E RATIO VS FORWARD RETURN



RELATIVE DEV. - U.S. EQUITY: CAPE VS FORWARD RETURN



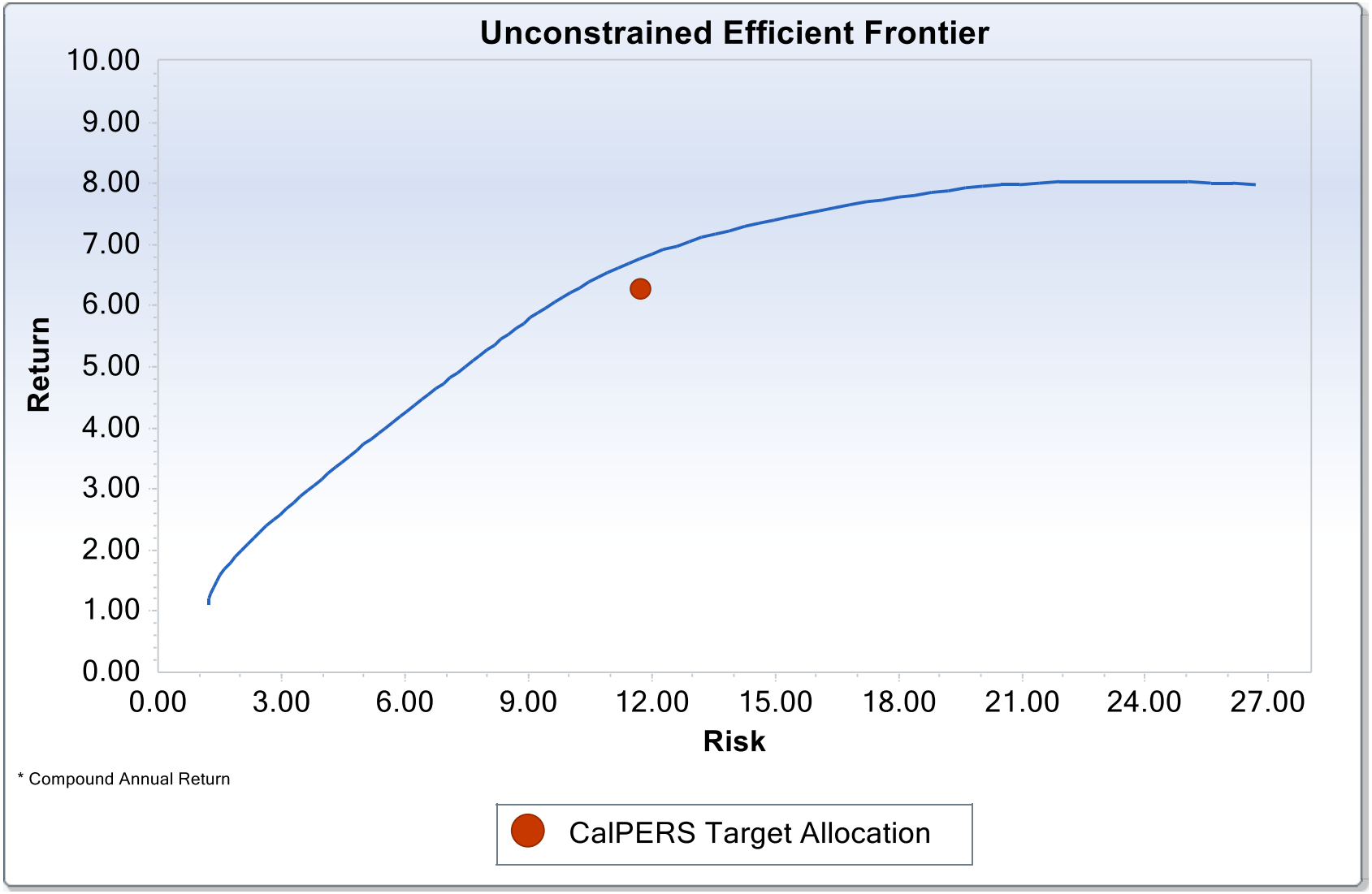
- CAPE ratio's cyclical nature of smoothing historical earnings provides additional and valuable insights into anchoring long-term return prospects
- Strong relationship between the raw CAPE ratio and 10-year forward equity returns (left chart)
- Current pricing points to relatively attractive non-U.S. valuations, which lead us to project a return premium for non-U.S. stocks (right chart)

MARCH 2020 VS DEC 2019 ASSUMPTIONS

	TOTAL RETURN (%)			RISK (%)
	MAR 2020	DEC 2019	CHANGE	
U.S. STOCKS	6.75	5.75	1.00	17.00
DEV. EX-U.S. STOCKS	7.25	6.25	1.00	18.00
EMERGING MARKET STOCKS	7.25	6.25	1.00	26.00
GLOBAL STOCKS	7.20	6.20	1.00	17.10
PRIVATE EQUITY	8.40	7.95	0.45	28.00
CASH EQUIVALENTS	0.70	1.85	-1.15	1.25
CORE BONDS	1.80	2.85	-1.05	5.15
LT CORE BONDS	2.70	3.25	-0.55	9.85
U.S. TIPS	0.70	2.15	-1.45	6.00
HIGH YIELD BONDS	5.40	4.30	1.10	10.00
PRIVATE REAL ESTATE	7.00	6.60	0.40	14.00
COMMODITIES	1.85	3.60	-1.75	15.00
PRIVATE INFRASTRUCTURE	8.35	6.95	1.40	25.00
REAL ASSET BASKET	5.65	5.90	-0.25	8.75
INFLATION	1.15	1.75	-0.60	1.75
RETURNS MINUS INFLATION				
U.S. STOCKS	5.60	4.00	1.60	
U.S. BONDS	0.65	1.10	-0.45	
CASH EQUIVALENTS	-0.45	0.10	-0.55	
STOCKS MINUS BONDS	4.95	2.90	2.05	
BONDS MINUS CASH	1.10	1.00	0.10	

PORTFOLIO OPTIMIZATION

According to Modern Portfolio Theory ("MPT"), investments can be combined so that the portfolio maximizes expected return for a given level of expected return volatility.



CONSTRAINTS

- Prudent portfolio design depends on judicious constraints
- Without constraints, the optimization can result in impractical portfolios
- Constraints can be broadly defined:
  - Target allocations growth-oriented assets versus income-oriented assets
- And/or geared to specific fund management issues
  - Minimum allocations to Liquidity to fulfill cash flow requirements
  - Maximum allocations to illiquid assets
  - Return requirements and risk tolerance
  - Time horizon
  - Income needs and liquidity

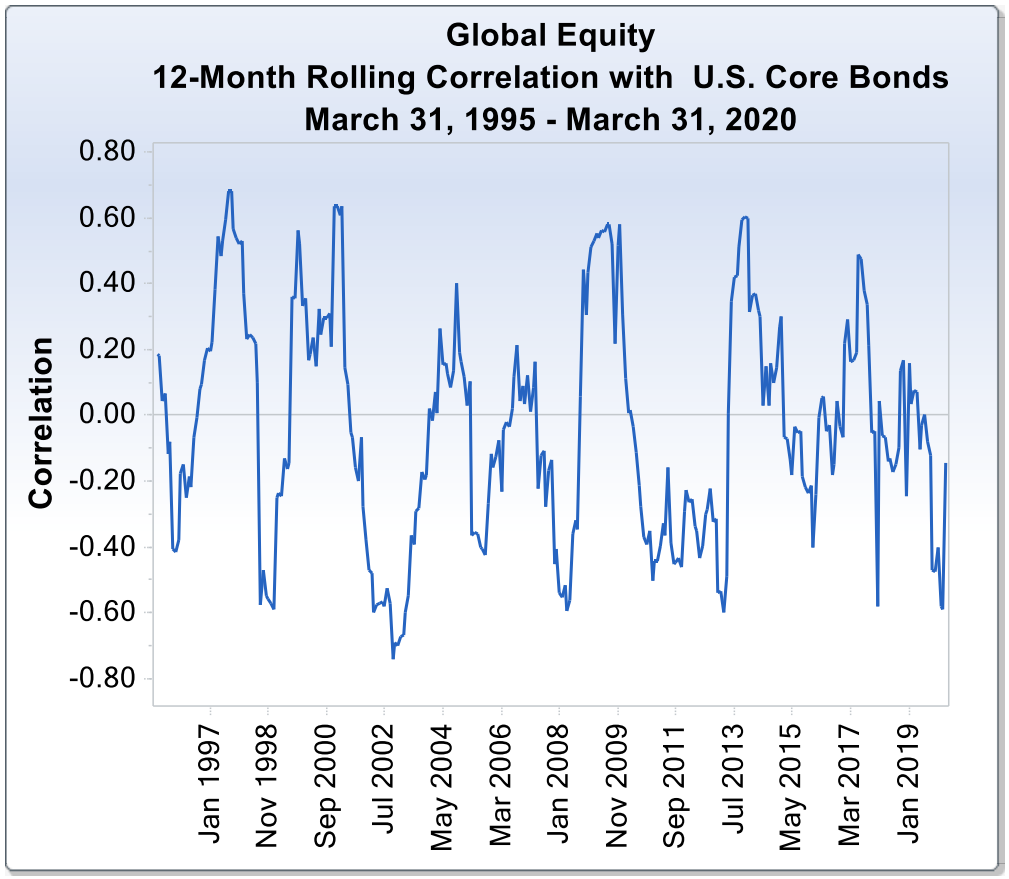
STRENGHTS AND CHALLENGES OF MVO (Mean Variance Optimization)

Strengths

- Quantifies investment tradeoffs between risk and return
- Mathematically rigorous, yet efficient
- Limited data requirements
- Well understood

Challenges

- Sensitivity to input estimation error
- Assumes stable correlations
- Two-dimensional decision criteria
- Prone to extreme outcomes
- Oversimplification of problem
- May not be best holistic decision



ECONOMIC FACTORS IN ASSET ALLOCATION

IDENTIFYING KEY ECONOMIC FACTORS

- Factors measure the sensitivity of asset classes to changes in expected macroeconomic variables (i.e. surprises)
- Ideal factors are the primary economic drivers to which investments respond and should include the following attributes:
  - Relationship with returns is straightforward, intuitive and easily understood
  - Explanatory power/statistical value in describing asset class behavior
  - Has a low correlation to other factors
  - Measurable with reasonable frequency
  - Contemporaneous, free from significant timing lags

IMPROVING OPTIMIZATION WITH FACTORS

- Including factors within the asset allocation process provides an opportunity to measure asset class (and portfolio) exposures to key economic factors.
- If the underlying economic activity that drives asset performance can be identified, perhaps it can be used to assist in building economically-efficient portfolios.
- Macroeconomic risk factors – when separated from the valuation component inherent in investment pricing – may exhibit more stable correlations and, therefore, can better inform the allocation process.

Strengths of factor-based asset allocation

- Includes additional decision criteria
- Helps compensate for unstable correlations
  - Factor exposures can help capture asset behavior where correlations struggle
- Reduces sensitivity to input estimation error
- Less prone to extremes
- Better informed more complete decisions

Challenges of adding additional criteria

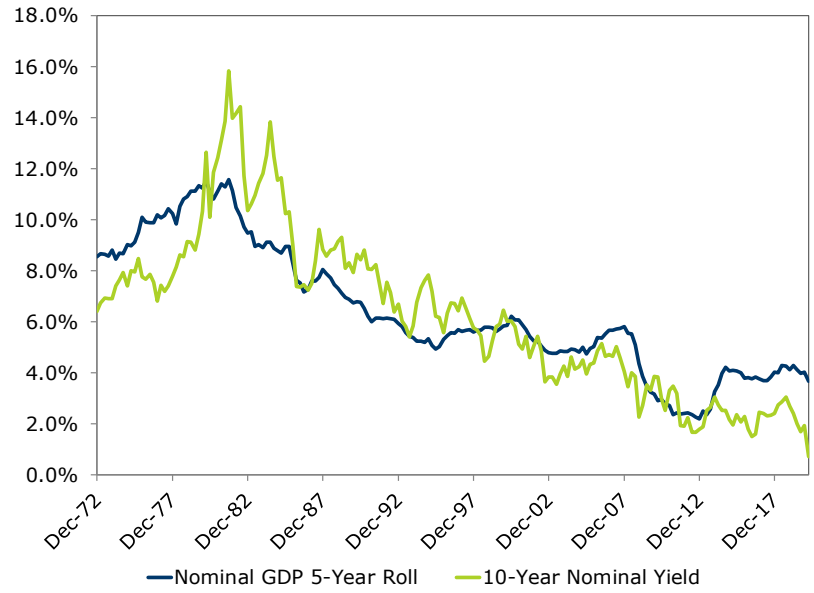
- Increased complexity
- Increased data requirements, more input

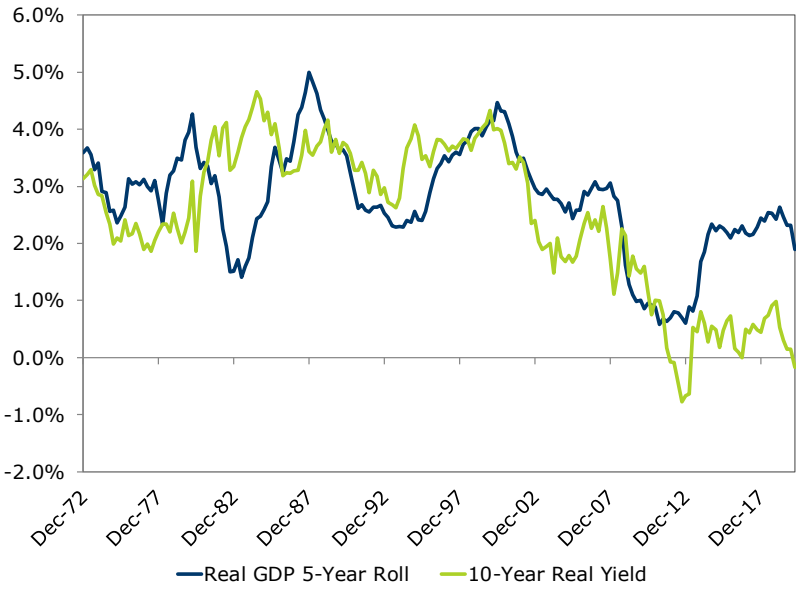
Wilshire Consulting

WILSHIRE FACTOR MODEL

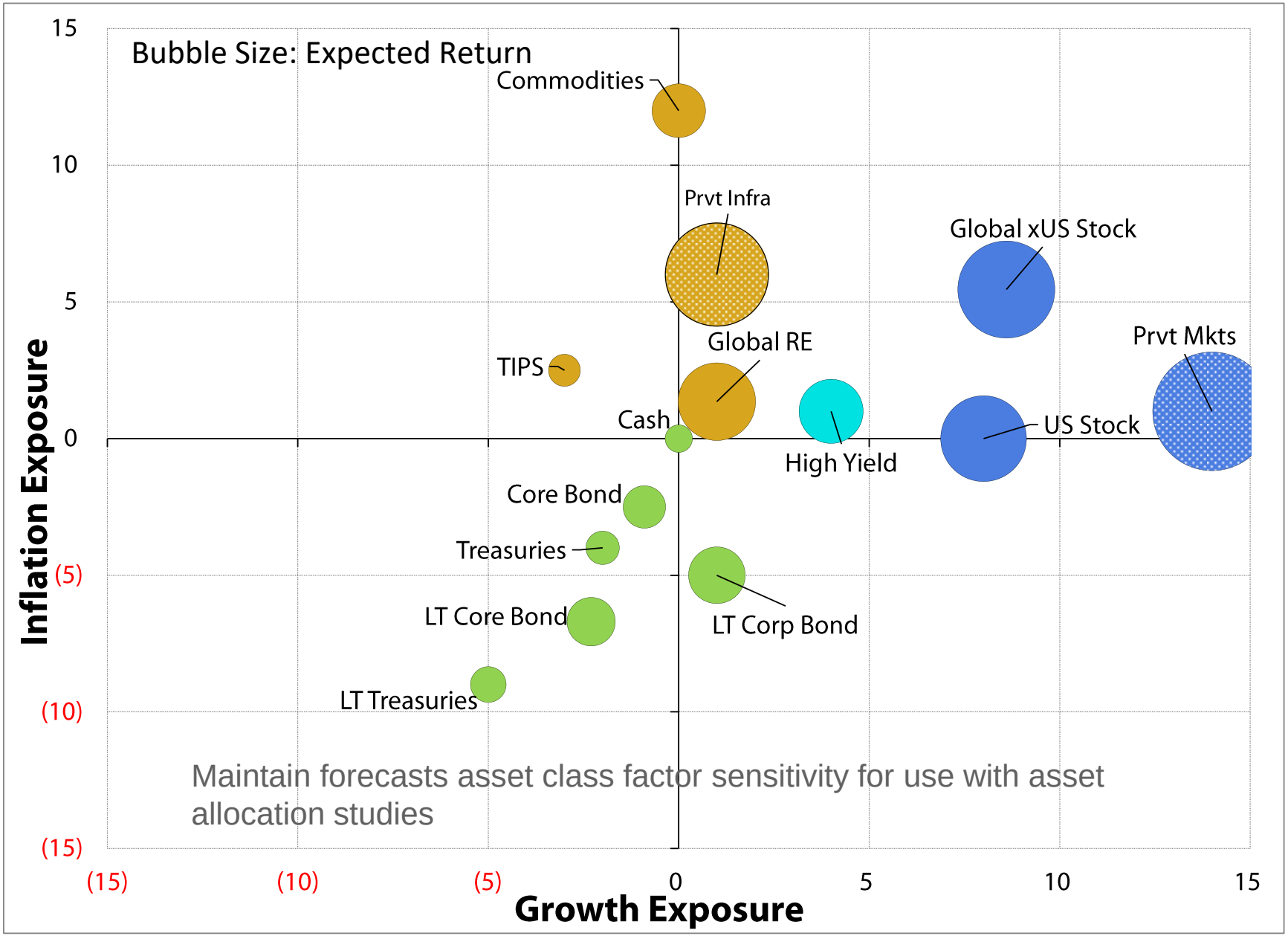
A two-factor model that looks to interest rates for investor expectations/discounting of…

- Growth: Real rates follow real GDP growth as investors demand a greater return to compete with other market opportunities
- Inflation: Breakeven inflation (the market's inflation forecast) follows inflationary growth as investors demand a higher yield to protect their real purchasing power
- Regression analysis used to determine sensitivity to factors over long periods





WILSHIRE FACTOR EXPOSURES



MANAGING LIQUIDITY RISK IN ASSET ALLOCATION

THE WORLD THROUGH RISK LENSES

- Liquidity Risk is one of Wilshire's six essential Risk Lenses faced by all investors
- Its interaction with other risks may make managing illiquidity risk the single most important risk to address in avoiding financial calamity
- Liquidity management is the exercise of ensuring sufficient cash is on hand to meet financial commitments (i.e. pay the bills when they come due)
- May seem simple on the surface, but properly balancing liquidity requirements against other portfolio objectives can sometimes prove to be a complex risk to manage in practice

WHY LIQUIDITY MATTERS

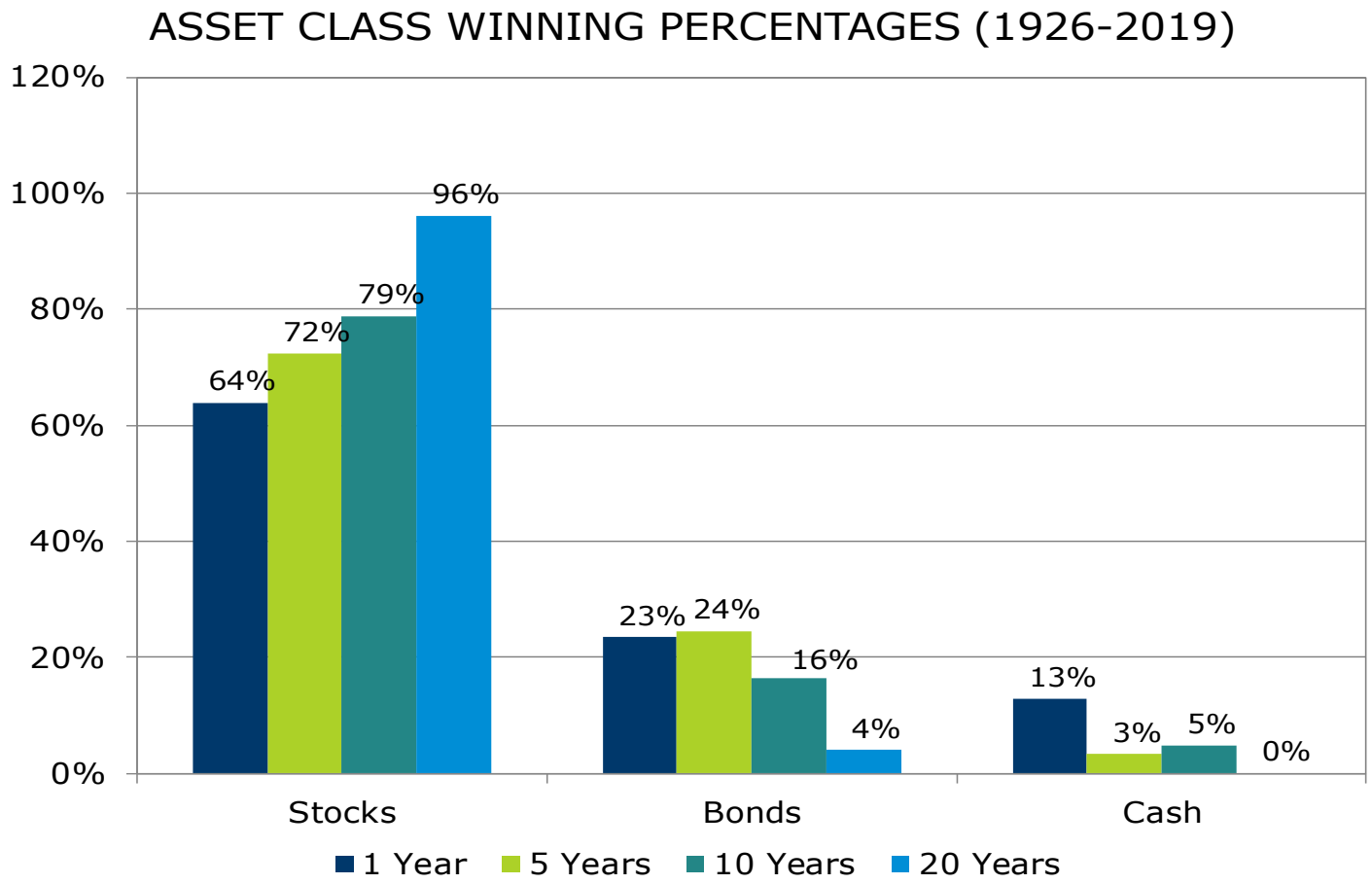
Default/Insolvency is the most severe outcome from having insufficient liquidity, but…

There are many other, more likely, disruptive impacts that a lack of liquidity can impose on an investment portfolio

Liquidity breaches can rob an investor of their biggest advantage: a long-term investment horizon

The timing and price of such sales dictated by liquidity needs rather than by explicit investment rationale

Can destroy portfolio value and effectively strip a portfolio from its ability to recover from market sell-offs



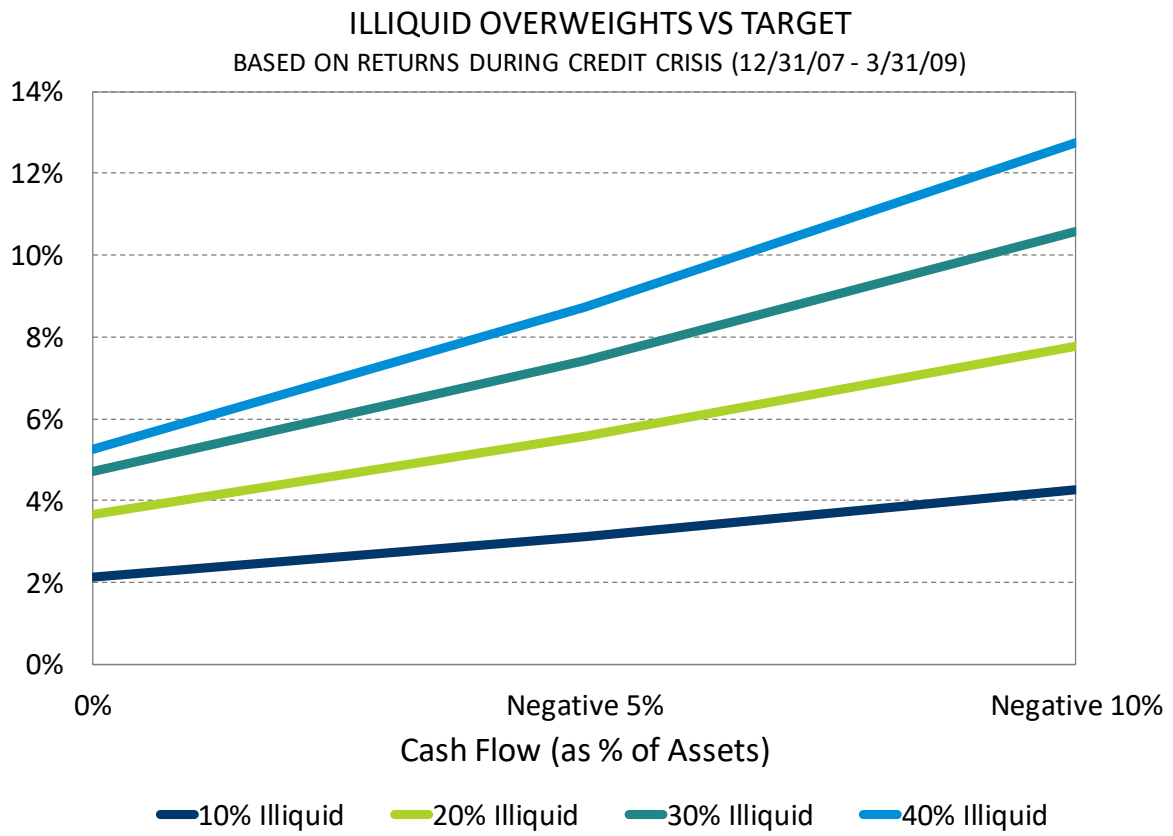
WHY LIQUIDITY MATTERS

Meeting liquidity needs with a “sell as you go” process can tear portfolios away from their asset allocation targets during stressed market environments

Potentially leading to undesirable risk characteristics and/or increased market vulnerability

The threat of being pushed away from allocation targets increases…

1. With larger required cash outflows (i.e., greater liquidity needs)
2. With larger allocations to illiquid assets



A DEFINITIONAL FRAMEWORK

In its purest sense, full liquidity represents full, unencumbered and immediate access to one's assets or wealth.

We more clearly define liquidity via a structural hierarchy that moves from its purest sense to three other investment classifications that typically provide lower levels of liquidity.

Liquidity Definitional Hierarchy

- Full Liquidity: Purest form of liquidity, consisting of cash that has not been allocated to any other purpose (i.e., it is not callable or committed to other investments)
- Encumbered Liquidity: Cash that has been set aside for a specific future purpose (e.g., allocated cash not deployed by investment managers, known capital calls, projected benefit payments etc.)
- Convertible Liquidity: A level of access to liquidity from assets that can be sold (i.e., liquidated) within X days at a maximum discount of Y% of their current market value
- Delayed Liquidity: Captures all remaining assets that could be sold (or liquidated), but at greater expense and/or over longer timeframes than for "Convertible Liquidity" (e.g., private market investments, public market investment through limited partners with infrequent openings, hedge fund investments, funds with longer commitments and other related fund vehicles with lengthy redemption periods or restrictive terms, etc.)

Full liquidity exist within the CalPERS portfolio with the 1% Liquidity allocation target

APPROACHES FOR MANAGING LIQUIDITY

Two basic approaches (best if used in combination):

- Direct Approach – appropriate to set governance guidelines and ensure liquidity is available on an ongoing basis
- Indirect Approach – useful for evaluating strategic alternative policy targets during the asset allocation process

Direct Approach

- Set a minimum % of assets aside to meet X months of net cash outflows ("Encumbered Liquidity") plus additional funds to manage against unexpected outflows ("Full Liquidity")
- Cash allocation size is dependent on investor's liquidity risk tolerance and the volatility of non-cash ("Convertible Liquidity") assets

Advantage: can dampen the risk of forced selling in a down market through a more manageable and orderly cash harvesting process

DIRECT APPROACH

For portfolio management and governance purposes, guidelines can be set for Convertible and Delayed categories to ensure adequate liquidity exists to meet CalPERS obligations over time

Simplified framework described below, though CalPERS Liquidity Dashboard offers finer granularity on uses and sources of liquidity over multiple time horizons

- Convertible Liquidity
  - » Liquidity
  - » Treasuries
  - » Income - Spread
  - » Public Equity
  - » High Yield
- Delayed Liquidity
  - » Private equity
  - » Private credit
  - » Private real estate
  - » Infrastructure

INDIRECT APPROACH

Indirect Approach

- Approach attempts to constrain asset class weights to manage liquidity risk
- Public (“liquid”) vs. private (“illiquid”) asset classes, where constraints are applied on the maximum allocation to private assets
- While simple, this approach generally ignores the volatility and liquidity characteristics of public market (“liquid”) asset classes

Wilshire’s Liquidity Metric

- Improves on the indirect approach by attaching liquidity metrics, or scores, to all asset classes and was a decision factor in the asset allocation process.
  - Provide more information than the simple “liquid” or “illiquid” binary approach
  - Allows for trade-offs within public market (“liquid”) asset classes
  - Designed to capture distinguishing characteristics within “Convertible Liquidity” and “Delayed Liquidity” assets (i.e., from the definitional framework)

WILSHIRE LIQUIDITY METRIC

Wilshire's Liquidity Metric framework has multiple levels:

- Market Level of Liquidity
- Stressed Liquidity Metric

Market Level of Liquidity

- Quantified on scale from 0% (low liquidity) to 100% (high liquidity)
- Designed to capture general notion of marketable versus private/off-market transactions
  - Marketable asset classes typically reflect a 90% or 100%
  - Private asset classes reflect 0%

Stressed Liquidity Metric

Includes a penalty process to reflect the loss in practical liquidity due to asset class volatility and sensitivity to particular economic environments

Penalty Components

Growth Penalty:

- Impacts asset classes with vulnerability to slowing growth
- Recognizes the hit to liquidity that can occur during growth related bear markets

Inflation Penalty:

- Impacts asset classes with vulnerability to rising inflation
- Recognizes the hit to liquidity that can occur during inflation driven bear markets

Volatility Penalty:

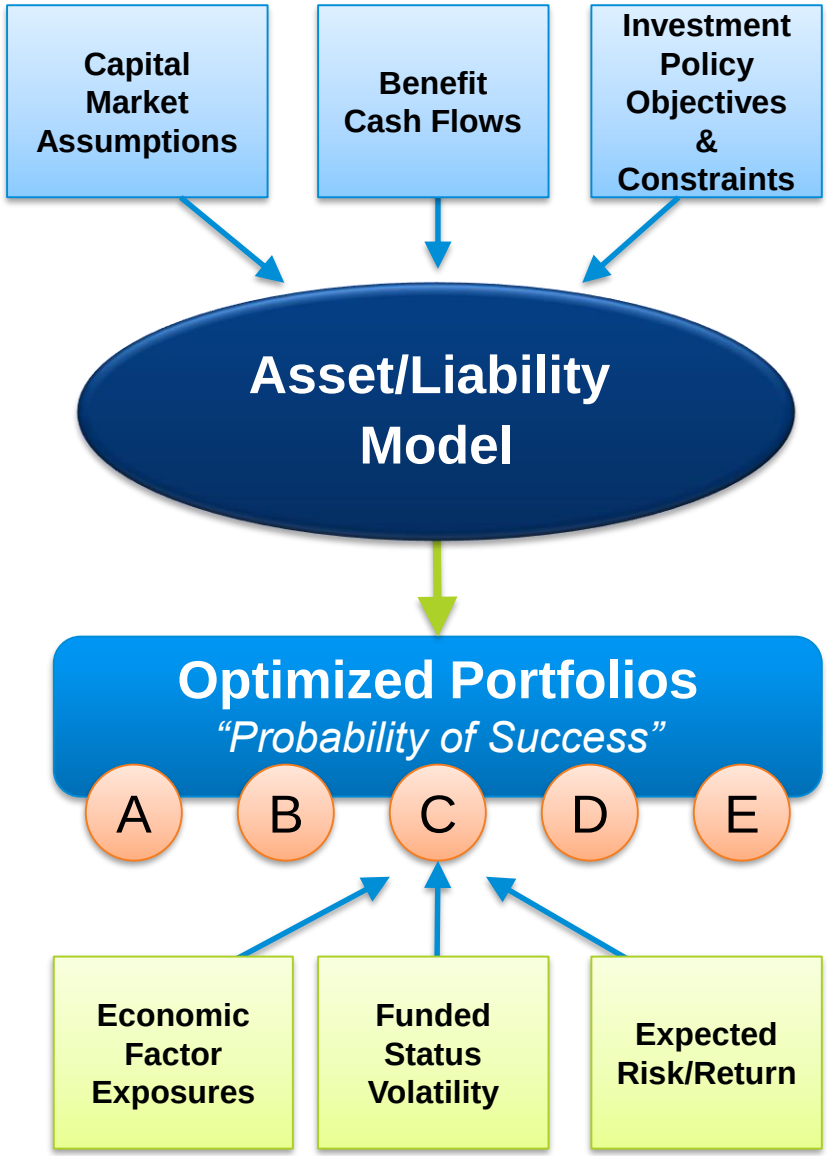
- Impacts higher volatility asset classes
- Recognizes the hit to liquidity that can occur from any form of volatility

EXPANDING THE INPUTS

	Public Equity - Cap Weighted	Public Equity - Factor Weighted	Private Equity	Income - Long Spread	Income - Long Treasury	Income - High Yield	Real Assets	Liquidity
COMPOUND RETURN (%)	7.20	7.21	7.98	3.70	1.15	5.40	5.75	0.70
EXPECTED RISK (%)	17.10	13.58	26.70	9.50	11.00	10.00	12.00	1.25
CASH YIELD (%)	2.80	3.15	0.00	3.50	1.60	7.40	3.80	0.70
FACTOR EXPOSURE - GROWTH	8.25	6.13	13.60	0.00	-5.00	4.00	6.00	0.00
FACTOR EXPOSURE - INFLATION	2.40	1.47	0.82	-5.00	-9.00	1.00	0.00	0.00
LIQUIDITY - MARKET	90.0%	90.0%	0.0%	100.0%	100.0%	80.0%	0.0%	100.0%
LIQUIDITY - STRESSED	2.5%	2.5%	0.0%	70.3%	70.3%	10.0%	0.0%	100.0%
CORRELATIONS								
Public Equity - Cap Weighted	1.00							
Public Equity - Factor Weighted	0.97	1.00						
Private Equity	0.73	0.76	1.00					
Income - Long Spread	0.31	0.30	0.45	1.00				
Income - Long Treasury	0.13	0.12	0.26	0.85	1.00			
Income - High Yield	0.51	0.50	0.36	0.43	0.21	1.00		
Real Assets	0.53	0.63	0.53	0.27	0.16	0.57	1.00	
Liquidity	-0.07	-0.05	0.00	0.09	0.12	-0.10	-0.05	1.00

- Rather than focus purely on risk and return, the expanded inputs introduce new decision factors into the asset allocation process for more robust discussion

ASSET ALLOCATION PROCESS

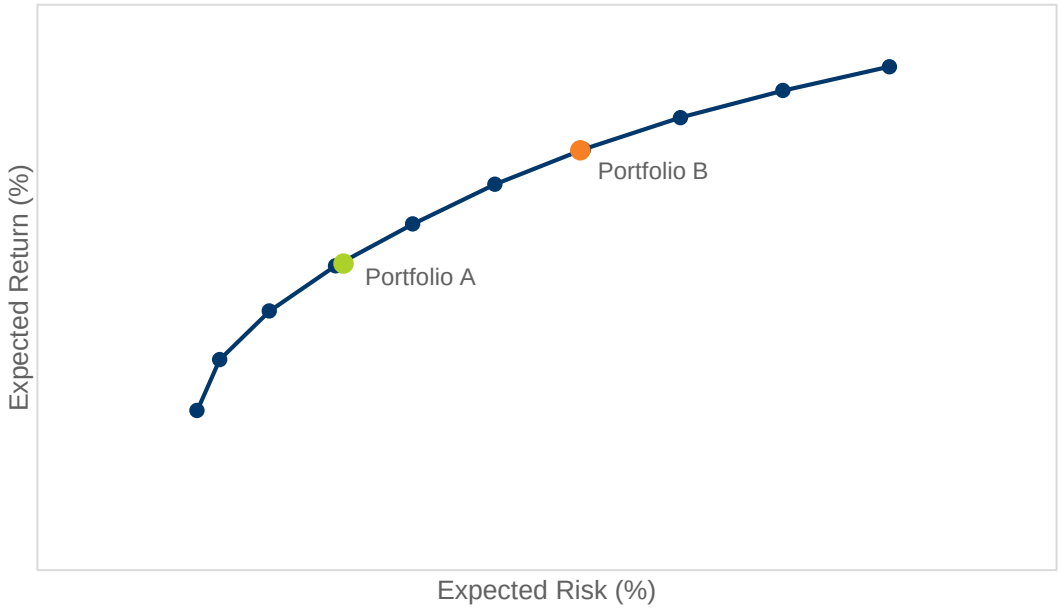


- The role of asset allocation is to manage risk in order to fulfill that core mission
  - *Maximize safety* of promised benefits (*Addressed by managing drawdown and liquidity risk)*
  - *Minimize cost* of funding these benefits *(Addressed by managing inflation and shortfall risk)*
- Asset Liability framework provides a methodology for selecting a policy portfolio that considers both goals
- Given that short-term volatility is also important, examine the impact of the asset allocation decision on funded ratios, expected funded status volatility, annual contribution requirements, and other metrics.

LEVERAGE AS A TOOL IN ASSET ALLOCATION

REACHING FOR RETURN

- Portfolio diversification is often overlooked in order to achieve higher return targets
  - Portfolio A is well balanced – in allocation and risk contribution – but expected return is a modest 4.3%
  - Portfolio B has a 1% higher expected return, but…
    - » Over half of the portfolio is in equity and nearly 92% of the risk comes from equity



	Weight	Ctrb to Risk
Global Equity	30.0	66.0
U.S. Core Fixed Income	65.0	33.0
Cash	5.0	1.0
Total Assets	100.0	100.0

	Portfolio B (%)	
	Weight	Ctrb to Risk
Global Equity	57.0	91.5
U.S. Core Fixed Income	43.0	8.5
Cash	0.0	0.0
Total Assets	100.0	100.0

PORTFOLIO CONSTRUCTION

- High portfolio risk concentration stems from a combination of return objectives, market opportunities, and constraints
  - If an investor knows with certainty that an asset class will outperform, a concentrated portfolio in that asset will produce the best results
  - Portfolio diversification acknowledges that uncertainty is inherent in all investing
- Which can we change?
  - Return targets?
    - Sure, but at what cost?
  - Market opportunities?
    - We can keep looking for new opportunities, but few are truly unique (i.e. diversifying)
    - CalPERS utilizes broad market opportunity set across the portfolio, public and private
  - Loosen portfolio construction constraints?
    - Sure, but it is important to understand risk

LEVERAGE CONSTRAINT

- **Leverage** is the use of borrowed capital (explicit) or through financial instruments (embedded) to increase potential returns on invested capital
- **Accounting Leverage** results when "total assets are greater than net assets, i.e., whenever some part of the assets are financed by liabilities or borrowing."
- **Economic Leverage** results when "the return from a portfolio is expected to be proportionately more volatile than the return from a benchmark (unleveraged) portfolio."
  - Example: Equity index futures used to gain or increase market beta or interest rate futures used to increase portfolio duration.
- CalPERS has examples of leverage in different areas of the portfolio already.
  - **Private Equity and Private Real Estate, for example**

Source: AIMR

LEVERAGE AVERSION

- Leverage is a tool that investors often . . .
  - Consider too risky
  - Under-utilize
- Leverage Aversion
  - Many market participants are not willing or able to utilize leverage in their portfolio
    - » Explicit statutory restrictions
    - » Lack of expertise in managing leverage
  - To meet return targets, those investors overweight riskier assets and bid up prices, reducing their expected returns going forward
  - Underweight less risky assets, increasing their expected returns going forward
    - » **Opportunity for higher risk-adjusted returns for those without leverage constraints**
- Leverage can serve as a tool for risk reduction, balancing contributions to risk, and improving diversification while increasing total return

LEVERAGE IN ASSET ALLOCATION

BALANCE RISK ALLOCATION

Asset classes at lower risk levels typically offer favorable Sharpe ratio (which measures the return generated per unit of risk)

Even though the risk balanced portfolio is more effectively deploying risk, the return falls short of the target of most asset owners.

	Dollar Allocation	Risk Contribution
Global Equity	65.8%	82.3%
Core Bonds	0.0%	0.0%
U.S. High Yield	34.2%	17.7%
Public Real Assets	0.0%	0.0%
Expected Return	5.9%	
Expected Risk	13.3%	
Sharpe Ratio	0.30	

	Dollar Allocation	Risk Contribution
Global Equity	12.0%	25.0%
Core Bonds	46.0%	25.0%
U.S. High Yield	19.5%	25.0%
Public Real Assets	22.5%	25.0%
Expected Return	4.6%	
Expected Risk	6.0%	
Sharpe Ratio	0.44	

LEVERAGE IN ASSET ALLOCATION

SCALE TO ACHIEVE TARGET

If an investor is not averse to leverage, then a risk balanced portfolio can be scaled to meet a return (or risk) target.

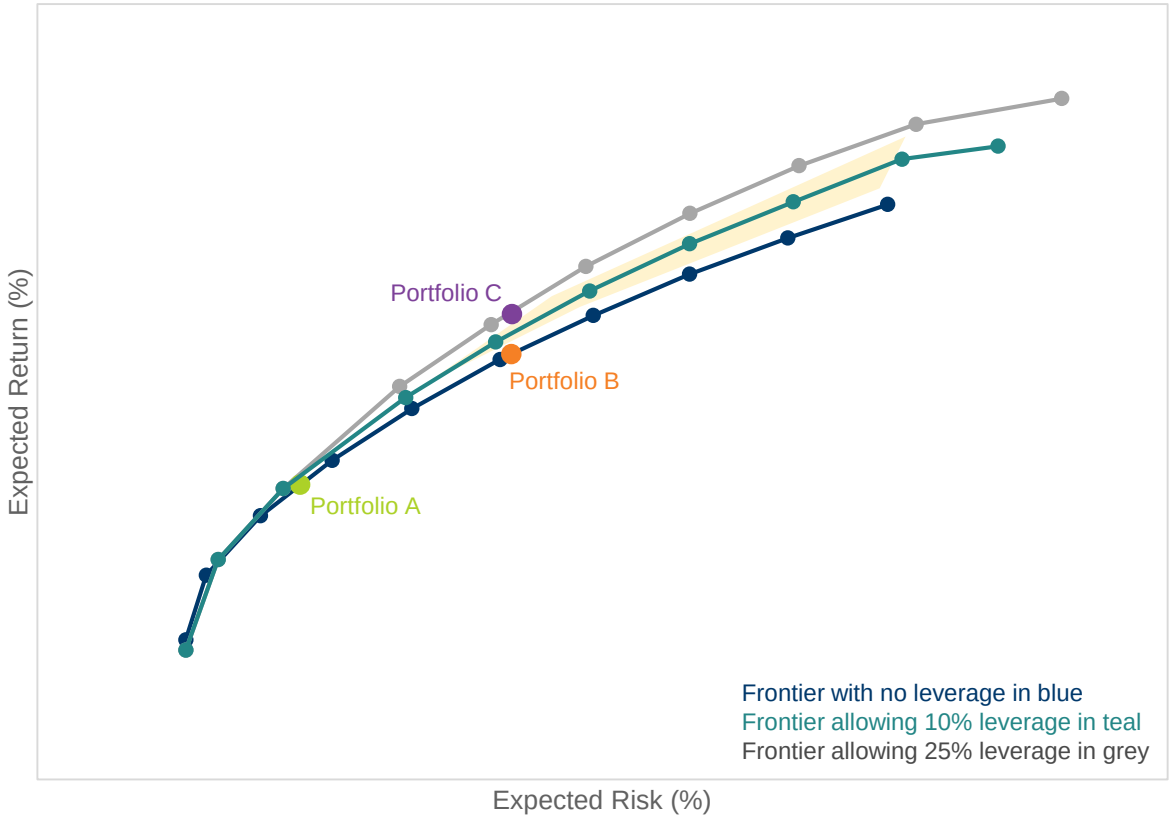
A balanced risk portfolio utilizes leverage to achieve the target return that is not achievable along the traditional efficient frontier; higher Sharpe Ratio is maintained.

unlevered	Dollar Allocation	Risk Contribution
Global Equity	12.0%	25.0%
Core Bonds	46.0%	25.0%
U.S. High Yield	19.5%	25.0%
Public Real Assets	22.5%	25.0%
Expected Return	4.6%	
Expected Risk	6.0%	
Sharpe Ratio	0.44	

levered 1x	Dollar Allocation	Risk Contribution
Global Equity	23.7%	25.0%
Core Bonds	91.3%	25.0%
U.S. High Yield	40.0%	25.0%
Public Real Assets	45.0%	25.0%
Expected Return	6.6%	
Expected Risk	12.0%	
Sharpe Ratio	0.39	

IMPROVING THE FRONTIER

- Leverage improves the efficient frontier where each step up in return sacrifices less diversification
  - Portfolios C has similar expected risk as Portfolio B, but higher expected return



	Portfolio A (%)	
	Weight	Ctrb to Risk
Global Equity	30.0	66.0
U.S. Core Fixed Income	65.0	33.0
Cash	5.0	1.0
Total Assets	100.0	100.0

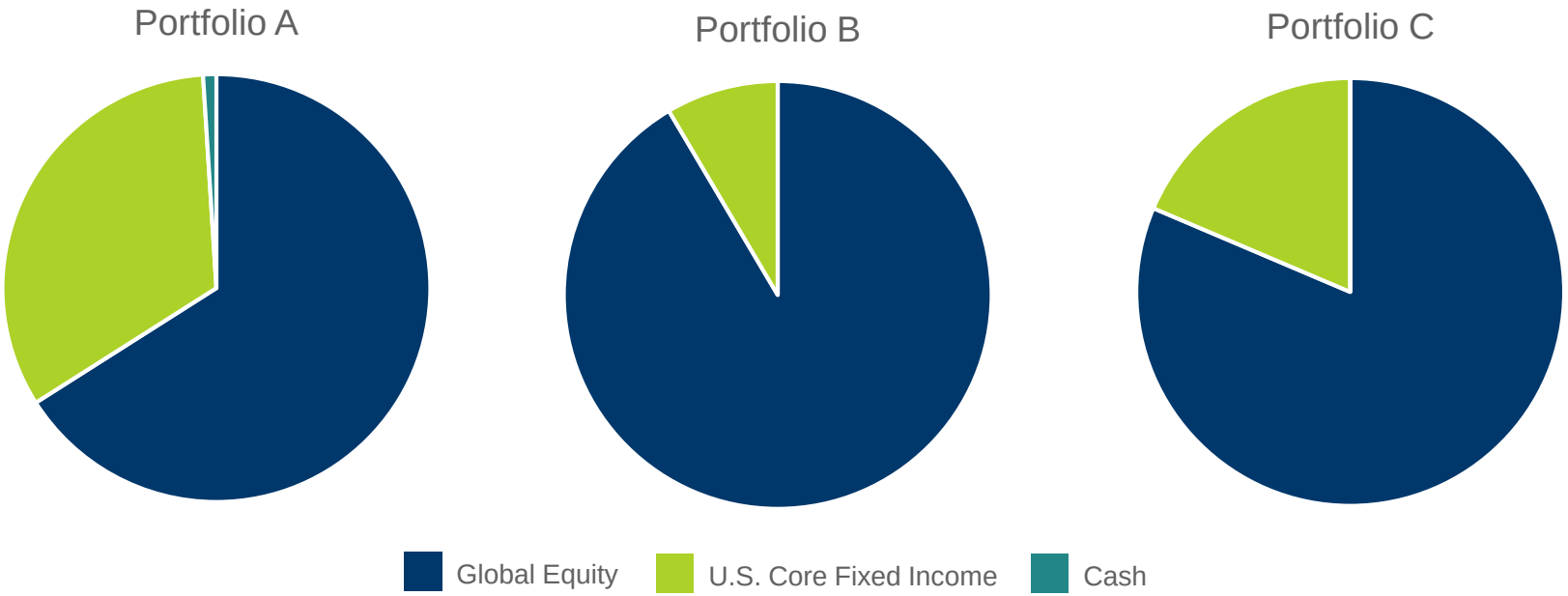
	Portfolio B (%)	
	Weight	Ctrb to Risk
Global Equity	57.0	91.5
U.S. Core Fixed Income	43.0	8.5
Cash	0.0	0.0
Total Assets	100.0	100.0

	Portfolio C (%)	
	Weight	Ctrb to Risk
Global Equity	53.0	81.4
U.S. Core Fixed Income	72.0	18.6
Cash	0.0	0.0
Leverage	25.0	-
Total Assets	125.0	100.0

Efficient Frontier graph for illustration purpose only

IMPROVING RISK BALANCE

- From a contribution to risk perspective, Portfolio C provides greater risk balance than Portfolio B - more similar to the risk allocation of Portfolio A
  - However, Portfolio C has an expected return that is 1.1% greater than that of Portfolio A



LEVERAGE

- **Governance**
  - Addressing leverage in a comprehensive framework is best practice
  - The Board sets asset allocation policy to target risk and return and should, therefore, also specify guidelines and constraints on leverage
  - Objective is to adopt a standardized measure of leverage that allows for aggregation of leverage to the total portfolio level including explicit and embedded leverage
    - » Explicit leverage is directly controlled by CalPERS
    - » Embedded leverage is incorporated in strategies across the portfolio such that reporting requirements are necessary to aggregate information
  - Identify not only what investment purpose is sought with leverage, but also develop contingency plans when certain risks (e.g. liquidity) materialize during stressed market periods

LEVERAGE IMPLEMENTATION

- Leverage is fungible
  - Cost and liquidity play a role in what markets are utilized to provide leverage across the Total Fund
- Considerations when obtaining leverage
  - Some form of derivative is necessary, each with variable financing costs
  - Derivatives involve margin and collateral requirements which are marked-to-market
  - Non-OTC derivatives involve counterparty risk management

LEVERAGE IMPLEMENTATION

- Leverage introduces additional complexities into portfolio management
  - Cash flow uncertainty
  - Amplification of upside and downside movements in asset values
- Leverage necessitates sophisticated risk management
  - Liquidity risk (leverage assets that naturally self-finance through their cash flows)
  - Counterparty risk (reduced through use of listed derivatives and improved regulation)
  - Market risk (different impact from leveraging risky assets versus diversifying assets)

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