Portfolio Priorities –
Asset Liability Management Considerations

July 18, 2016

CalPERS Board of Administration and Executive Offsite
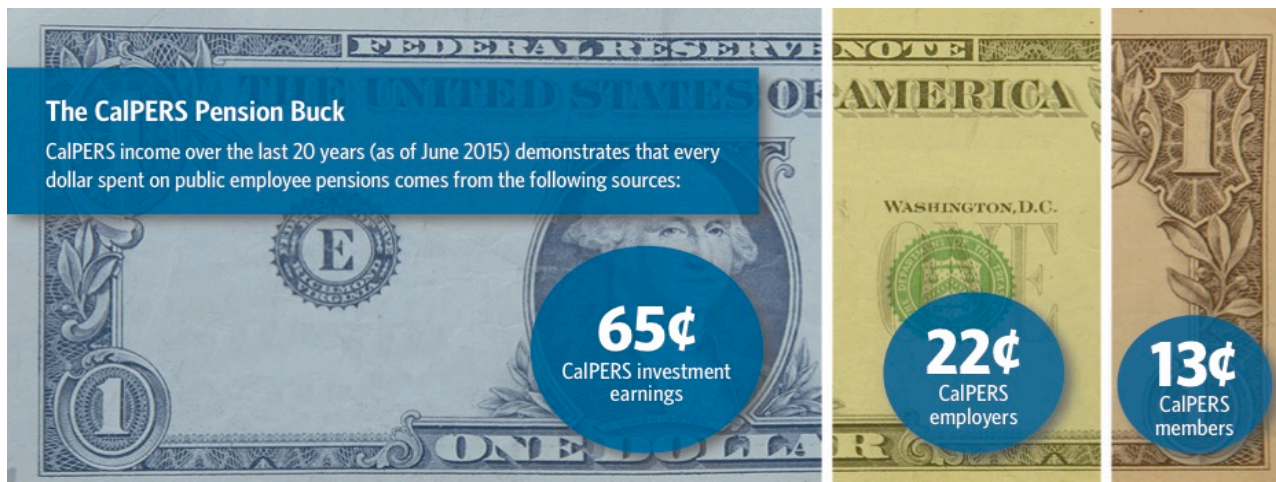
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What We Hope to Accomplish Today

- Refresh – Progress and Goals

- Discuss – More Risk-Aware Asset Allocation

- Discuss – Benchmark Review Methodology Enhancements

- Understand – Next steps and Asset Liability Management (ALM) Impacts

# Understanding Today's ALM Environment | Post 2008 Crisis

Where we are today

The CalPERS Pension Buck

CalPERS income over the last 20 years (as of June 2015) demonstrates that every dollar spent on public employee pensions comes from the following sources:

65¢ CalPERS investment earnings

22¢ CalPERS employers

13¢ CalPERS members

- **$295B Portfolio:** Stocks, bonds, real estate, private equity, and other public and private investment vehicles
- **Cost & Transparency:** Continual focus
- **Liquidity and Income:** Increasing challenge to manage risk and pay benefits in all market conditions
- **7.5% Return Target:** Very challenging
- **Cash-flow Gap:** Increasing annual shortfall (at an average of approx. $1B per year)

Collaboration| ALM Advisory Committee

Collaboration: Asset Liability Management Advisory Committee (ALMAC) plans to bring further discussion forward to the Board including January and July 2017 Offsites to obtain feedback and share progress.

Actuarial Office

Financial Office

ALM Advisory Committee

LEGO, PAOF, & STRL

Investment Office
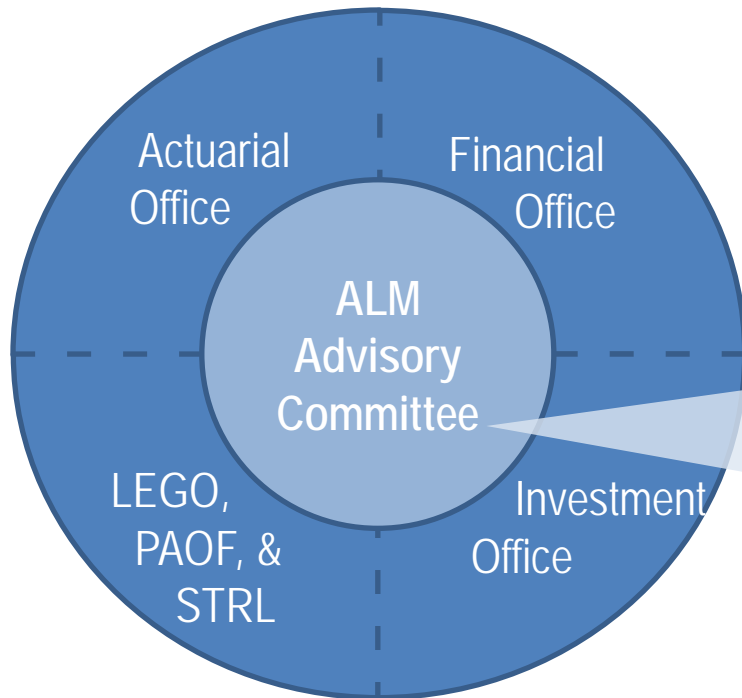
Chaired by the Chief Financial Officer, this multi-discipline advisory body oversees the planning, development, and execution of key business processes related to CalPERS' cyclical asset-liability management (ALM) processes

Portfolio Priorities | Reflects January 2016 Board Offsite Discussion

Portfolio Priorities are specific to CalPERS, implementable, and will influence portfolio construction

1. Protect the Funded Ratio (*mitigate severe drawdowns*)

2. Stabilize Employer Contribution Rates (*manage overall volatility*)

3. Achieve Long-term Required Rate of Return (*over the long run, but not in every market environment*)

Contents

Portfolio Priorities: Asset & Liability Risk Factor Relative Allocation

Portfolio Priorities: Alignment with Benchmark Assessment

Next Steps

Appendix

Background | Asset & Liability Risk Factor Relative Allocation

CalPERS Strategic Plan – Goal A (Supports Current and Future Board Planning)
Improve long-term pension and health benefit sustainability.

- Objective: Fund the System through an integrated view of pension assets and liabilities

- Strategic Initiative: Actively manage and assess funding risk through an asset liability management framework to guide investment strategy and actuarial policy

CalPERS Pension & Investment Beliefs

- Sound understanding and deployment of enterprise-wide risk management is essential to the ongoing success of a retirement system. (Pension Belief 9, Board Adopted May 2014)

- Liabilities must influence the asset structure. (Investment Belief 1, Board Adopted September 2013)

Asset & Liability Risk Factor Project Goal: Implement a more risk-aware ALM decision making process in relation to the Portfolio Priorities.
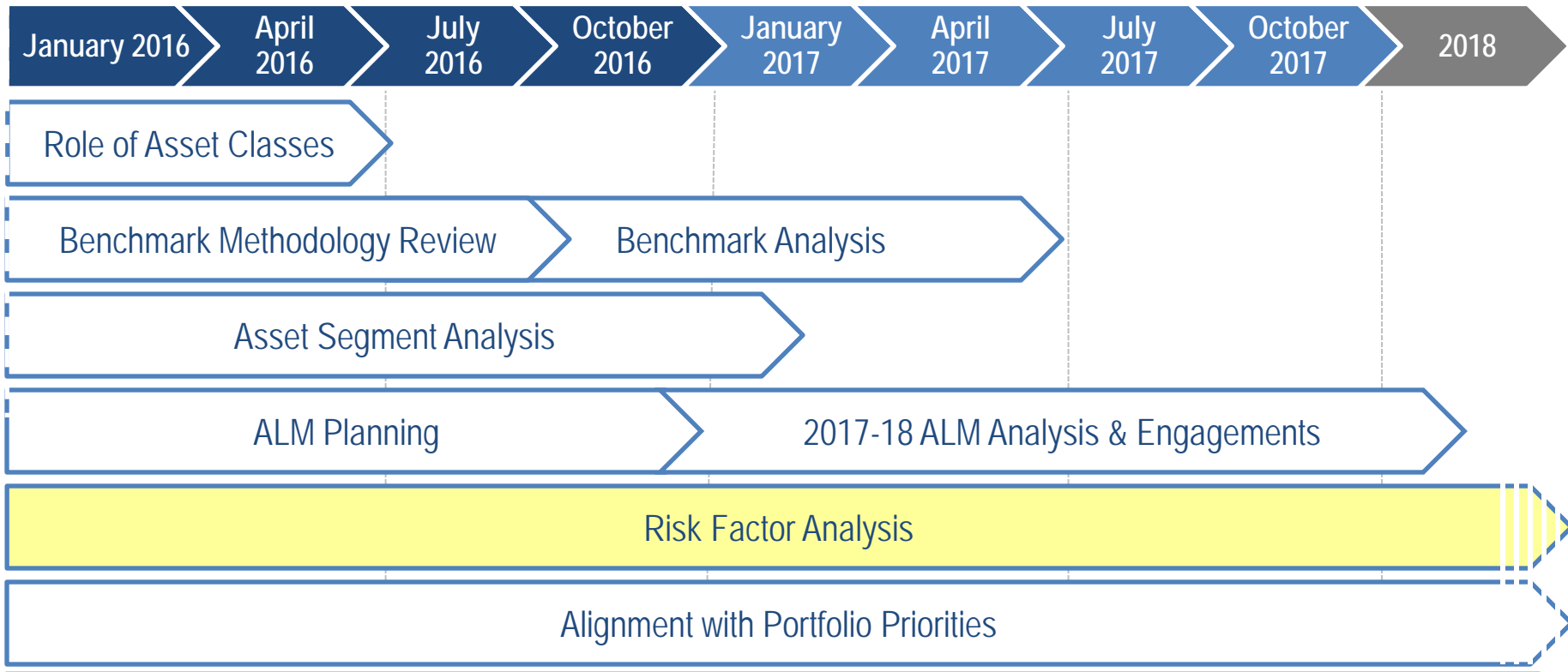
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Key Messages | Today's Presentation by EDHEC

1. What we have learned to date is that it is difficult, if not impossible, to have a single set of homogenous factors to clearly describe CalPERS assets and liabilities – regimes offer an integration path forward.

2. Project helps inform a cross-enterprise (ALMAC) understanding of the type of modeling environment necessary to achieve more enhanced ALM decision making process.

3. The impact of macro-economic factors on liabilities will be more direct while the impact on assets is less direct – today, EDHEC will focus on liabilities.

4. A regime aware strategic asset allocation process will provide a more explicit linkage between assets and liabilities that is economically meaningful.

5. An integrated and consistent ALM framework will provide a better understanding of the likelihood that the Portfolio Priorities will be achieved under alternative asset allocations and allow the Board to make more informed decisions regarding risk appetite and tolerance.

Progress | Risk Factor Analysis is Incremental

Runs parallel: to inform staff's continued work related to how we allocate assets today by asset class, and the exploration of asset segments and relevant benchmarks for use in Board decision making at this upcoming ALM cycle (2018).

January 2016	April 2016	July 2016	October 2016	January 2017	April 2017	July 2017	October 2017	2018

Role of Asset Classes

Benchmark Methodology Review → Benchmark Analysis

Asset Segment Analysis

ALM Planning → 2017-18 ALM Analysis & Engagements

Risk Factor Analysis

Alignment with Portfolio Priorities

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Progress | What does it look like?

1. **Increasing Transparency and Awareness:** of risk-return trade-off when considering interconnection of assets and liabilities throughout ALM cycle.

2. **Enhanced Modeling Capability:** to evolve knowledge of both asset and liability risk exposure specific to CalPERS.

3. **More Focused Projection of Liabilities:** to support the Board's asset allocation decision making this upcoming ALM cycle (2018).

4. **More Risk-Aware Board Decision Making:** in relation to the Portfolio Priorities which takes into account both asset and liability risk exposure applicable to CalPERS in time for the Board's next ALM cycle (2022).

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Milestones | To Support Board ALM Decision Making

Delivery Date	Deliverable
November 2017 ALM Workshop	Stochastic model designed to provide: — More flexible liability modeling to vary parameters — More robust projections of liabilities and interconnection with asset performance … leading to an enhanced understanding of the risks (percentage likelihoods) that during a defined period: — Funded status will fall below a critical % threshold — Contribution rates will increase to a critical % threshold — Contribution rates will increase by a critical % threshold in any one year
November 2021 ALM Workshop	Scalable, repeatable, and integrated risk modeling process to: — Translate macroeconomic factors impacting liabilities into factors which can be mapped to asset segments — Enhance Board's ability to establish its risk appetite and tolerances. — Increase likelihood risks are fully understood, intended and compensated within and across asset classes and segments.

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INTRODUCING A CONSISTENT ASSET-LIABILITY MANAGEMENT FRAMEWORK

PROFESSOR LIONEL MARTELLINI

EDHEC RISK INSTITUTE

EDHEC BUSINESS SCHOOL

PROFESSOR JOHN M. MULVEY

OPERATIONS RESEARCH AND FINANCIAL ENGINEERING

BENDHEIM CENTER FOR FINANCE

PRINCETON UNIVERSITY

JULY 18, 2016

Agenda

I.   A Need for a Consistent, Regime-Aware Asset-Liability Management Framework

II. Impact of Macro-Economic Factors on Liabilities

III. Difficulty Explaining Both Assets and Liabilities with Macro-Economic Factors

IV. A Regime-Aware Asset-Liability Management Framework

V.   A Consistent and Integrated Asset-Liability Management Framework

A Need for a Consistent, Regime-Aware Asset-Liability Management Framework

Our Goals

- End Goal: **Construct a more risk-aware Asset-Liability Management (ALM) decision making process**

  - Increase likelihood of achieving Portfolio Priorities

  - Inform risk tolerance

  - Apply consistent scenarios for both assets and liabilities

- Mean Goal: **Improve understanding of key drivers**

  - Explainable factors which link CalPERS liabilities and assets

  - ALM evolution (asset classes and segments)

What Do We Need?

- Enhance modeling ability
  - Stochastic modeling for both assets and liabilities
  - Enrich current liability modeling with more flexibility to vary parameters

- Design a scalable, repeatable and measurable system which can be validated to impact Portfolio Priorities

- Link micro-factors within CalPERS asset classes and/or asset segments to macro-economic regimes

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Impact of Macro-Economic Factors on Liabilities

# Macro-Economic Factors and CalPERS Liabilities

- Two potential macro-economic factors that affect CalPERS Liabilities are:

  - Gross Domestic Product (GDP) growth
    - U.S. and California

  - Inflation

- Impact on salaries and retirement benefits

# History – Benefit Payments, US GDP and US Inflation

- The Public Employees' Retirement Fund (PERF) benefit payments grew faster than US GDP and US Inflation
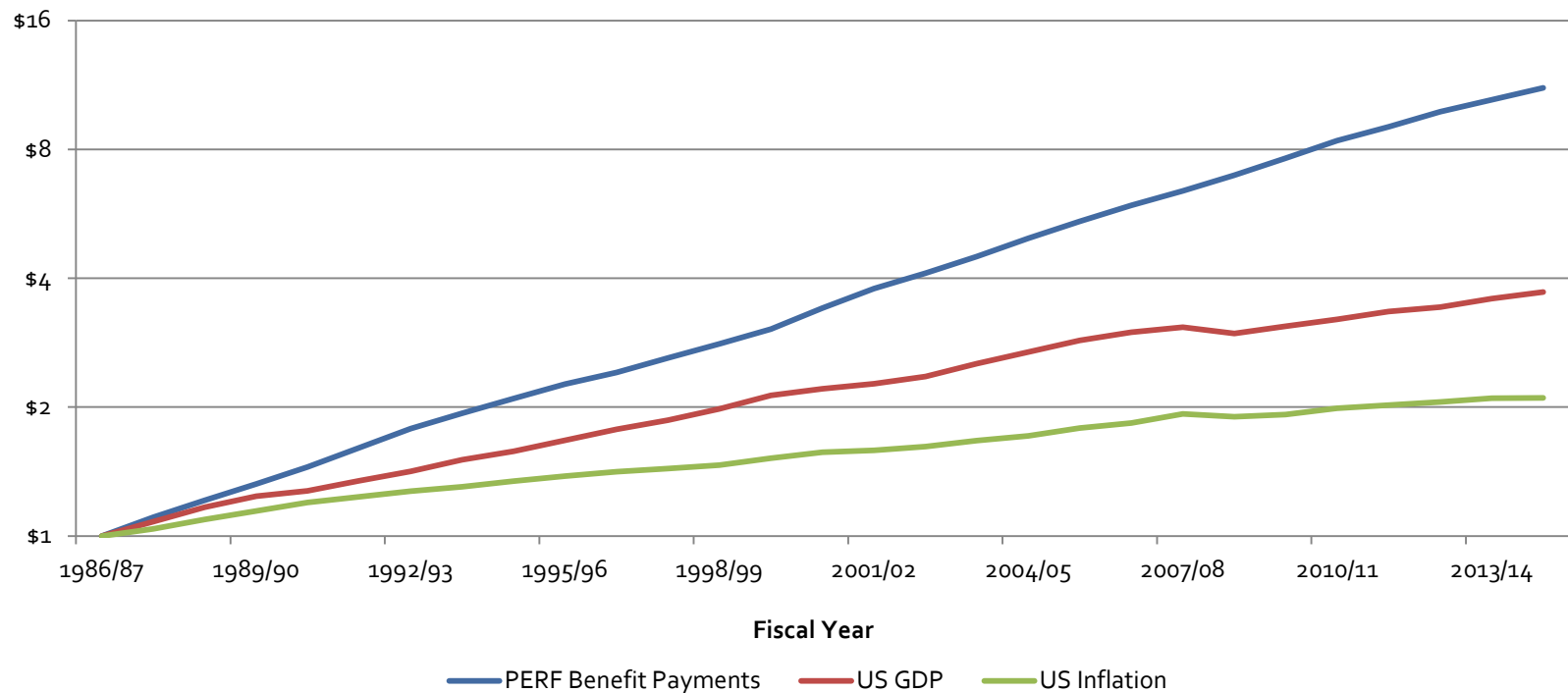
Inflation is represented by US CPI Urban Consumers NSA Index
Source: CalPERS Annual Financial Reports and Bloomberg.

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History – Payroll, CA GDP and US Inflation

- The PERF payroll and CA GDP showed a strong relationship
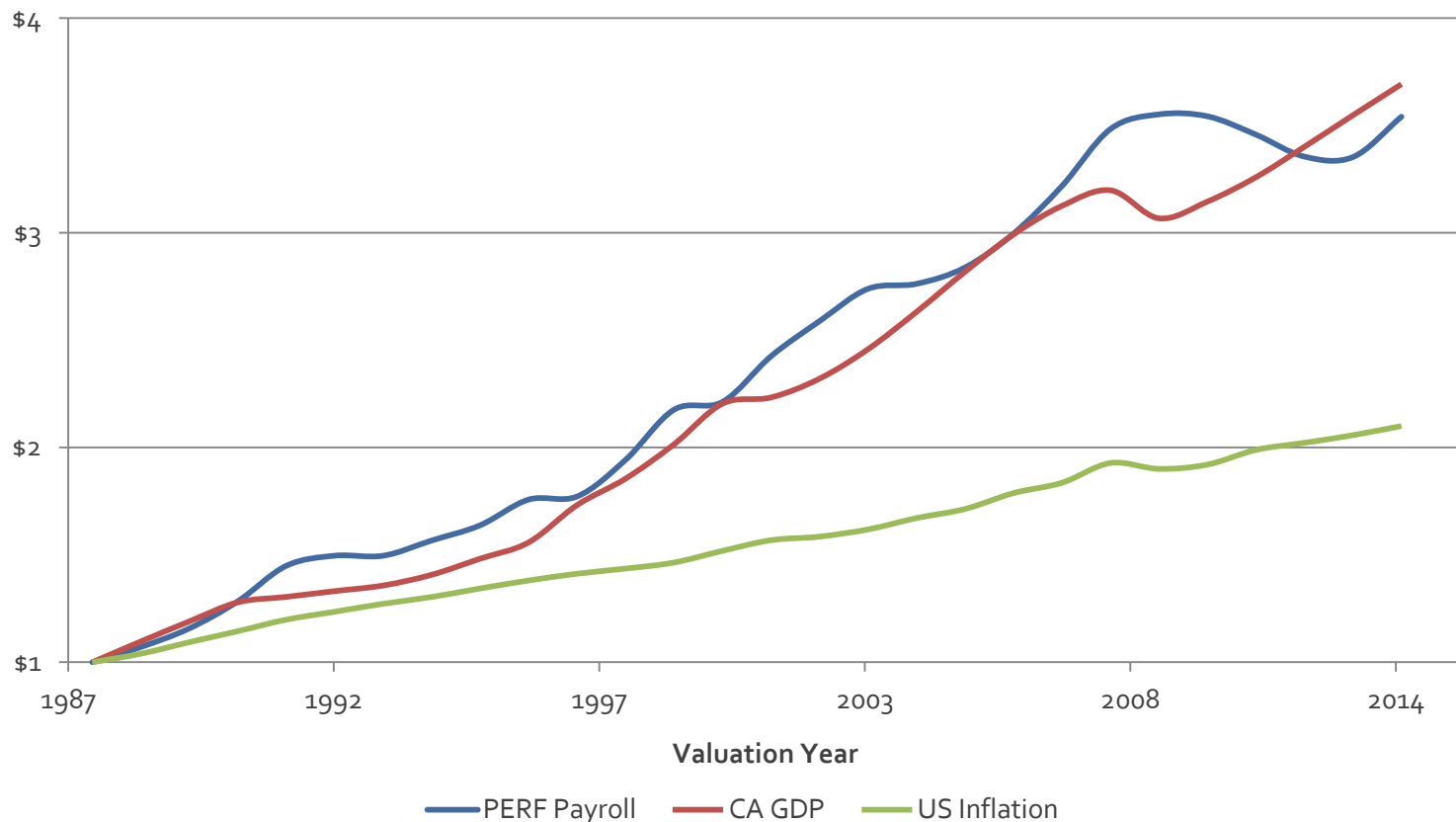
Source: CalPERS Comprehensive Annual Financial Reports and Bloomberg.

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Hypothetical Scenario – Study A*

- Increase inflation to 4.75% from 2.75%

- Limitations of this study

- Directional impacts
  - Higher employer contribution rates
  - High present value of contributions
  - Non linear relationship due to purchase power capture for retirees

- Inflation will not impact all assets in the same manner

* Study conducted in collaboration with CalPERS Actuarial Office

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Hypothetical Scenario – Study B*

- Increase payroll growth to 5% (other parameters remained the same including inflation = 2.75%)

- Economic growth in California will have a beneficial impact near-term on the pension system

  - Active-to-retiree ratio improves since more people are hired with a higher GDP

  - Funding ratio improves somewhat faster

  - Average employer contribution rate drops initially

* Study conducted in collaboration with CalPERS Actuarial Office

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Difficulty Explaining Both Assets and Liabilities with Macro-Economic Factors

Challenges in Factor-Based ALM

- Liabilities:
  - Are related to macro-economic factors (growth and inflation)
  - Are not marked-to-market
    - Smoothing of accrued liabilities
    - Salaries and benefits react slowly to changes in economic growth and inflation
    - Cash-flows are discounted at a fixed rate

- Assets:
  - Are *discounted expected cash flows*
  - Have poor linkage with macro-economic factors

Peers' Approaches

- Statistical factors on the asset side in addition to macro-economic factors

- Asset returns as factors
  - Examples:
    - Equity Returns
    - Real Rates
    - Inflation Rates
    - Private Asset Returns (possible)

- Inconsistent

Maintaining Consistency

- Growth and inflation explain changes in liabilities

  - Employee salaries react to both factors (hard to separate, intertwined)

- Growth and inflation do not explain changes in assets, but they define meaningful economic regimes for asset returns

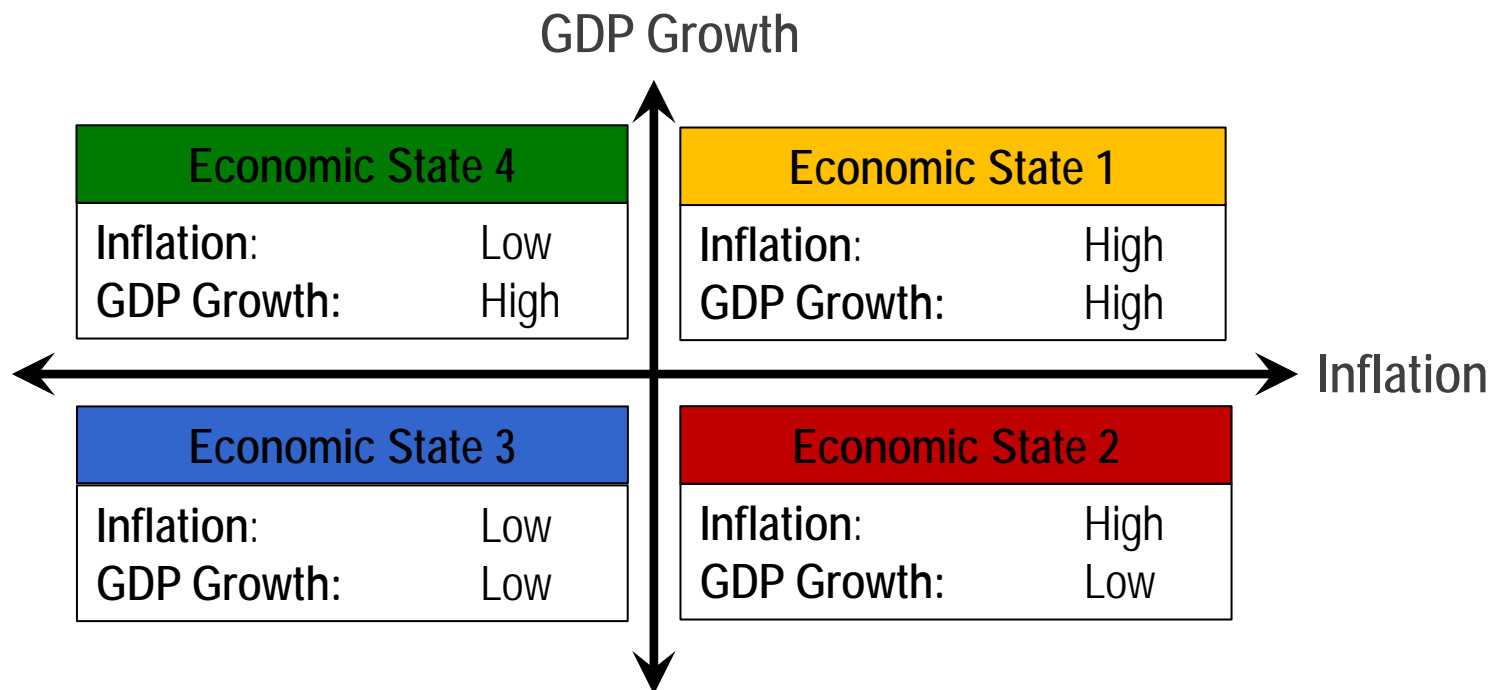# A Regime-Aware Asset-Liability Management Framework

A Regime-Aware ALM Framework

- Provide a <u>consistent</u> and meaningful <u>linkage</u> between asset return scenarios and liability cash flow scenarios

- Substantial influence (albeit highly non-linear) of macro-economic regimes on asset returns

- Capture the influence through macro-economic regimes
  - Expected returns and volatilities across the regimes are different

An Illustrative Example*

- Assume that the current state of the economy is defined by GDP growth and inflation:

GDP Growth

Economic State 4		Economic State 1	
Inflation:	Low	Inflation:	High
GDP Growth:	High	GDP Growth:	High

Inflation

Economic State 3		Economic State 2	
Inflation:	Low	Inflation:	High
GDP Growth:	Low	GDP Growth:	Low

* See the appendix for a preliminary analysis of regimes

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An Illustrative Example (continued)

- Risk and return parameters of asset classes are related to regimes

Figure 11. Performance of Asset Classes in Increasing/Decreasing
Inflation and Growth Regimes
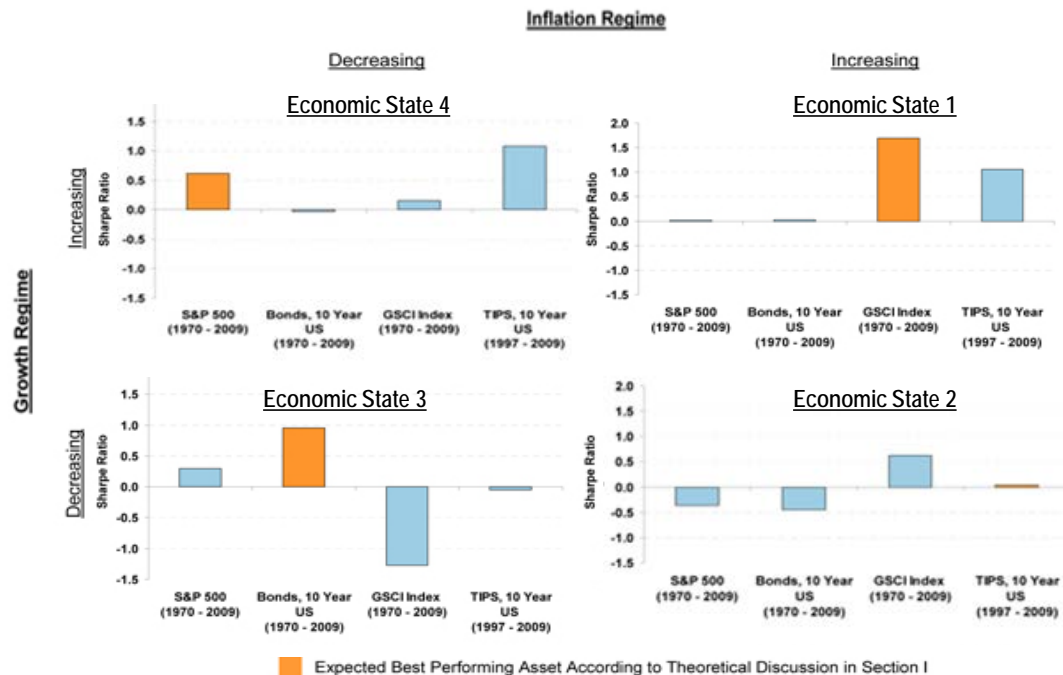
Source: Datastream, Barclays Capital and AQR.

Source: AQR, "*Inflation in 2010 and Beyond? Practical Considerations for Institutional Asset Allocation*", July 2010

A Consistent and Integrated Asset-Liability Management Framework

How to Use an ALM System?

- Focus on CalPERS Portfolio Priorities:
    1. Protect the Funded Ratio
    2. Stabilize Employer Contribution Rates
    3. Achieve Long-term Required Rate of Return

- A key tool in the decision-making process:
    - Identify candidate policy portfolios
    - Generate meaningful estimates related to the Portfolio Priorities
        - Probability and magnitude of a large shortfall
        - Volatility of contribution rates
        - Expected return

Issues to Address When Constructing a Consistent ALM System

- Macro-economic factors and regimes
  - Inflation
  - Economic growth

- Pension plan structure and rules
  - Benefits, retirement dates, cost-of-living-adjustment
  - Funding ratio (discount rates, asset performance)
  - Demographics (longevity, workforce composition)

- Goal: Identify candidate policy portfolios based on Portfolio Priorities

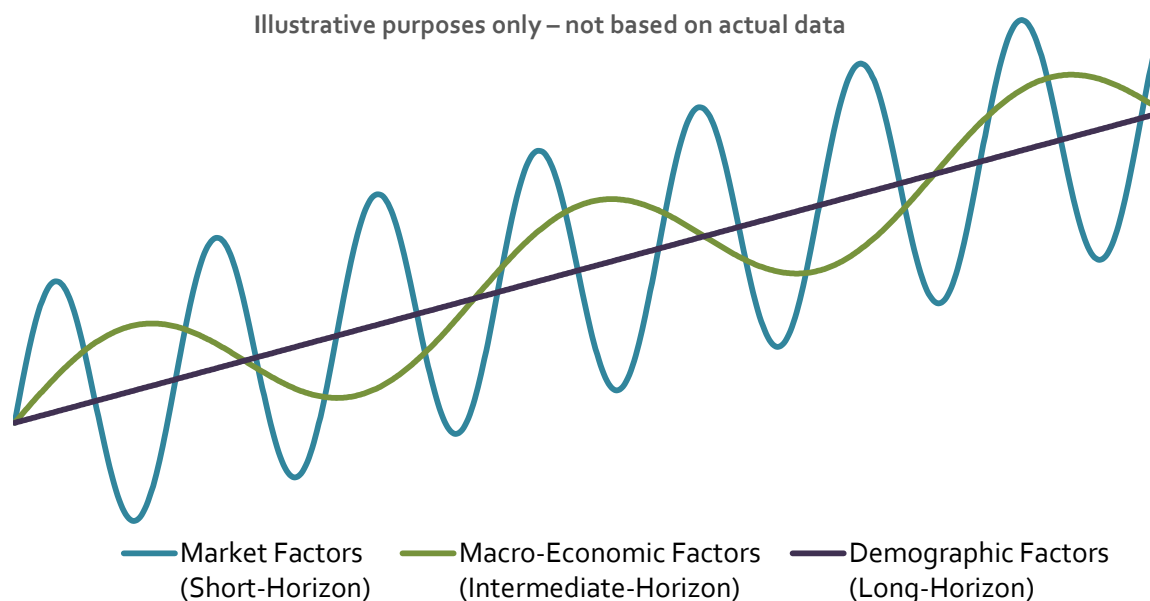# Regime/Factor Models Are Well Placed to Support ALM

- Regimes imply inflation/economic growth patterns
  - Stochastic scenarios for both asset performance and liability cash flows (consistent)

- Asset allocation decisions are modeled with reference to CalPERS Portfolio Priorities
  - Search for improving allocation

- ALM system output
  - Candidate policy portfolios
  - Risk profiles of significant issues
  - Summary statistics (e.g. volatility of employer contribution)

Next Steps

Investigate (2017)

- Identify regimes

- Link micro-factors within asset classes and segments to regimes

- Further analysis of how factors impact liabilities and assets over different time horizons

Illustrative purposes only – not based on actual data

Market Factors (Short-Horizon) —— Macro-Economic Factors (Intermediate-Horizon) —— Demographic Factors (Long-Horizon)

Next Steps (continued)

Extend ALM System (2017)

- Continue to study existing ALM systems
- Develop consistent set of scenarios between asset performance and liabilities
- Apply robust optimization across regimes
- Stochastic model

Evaluate Regime Switching and Other Improvements (2019 and beyond)

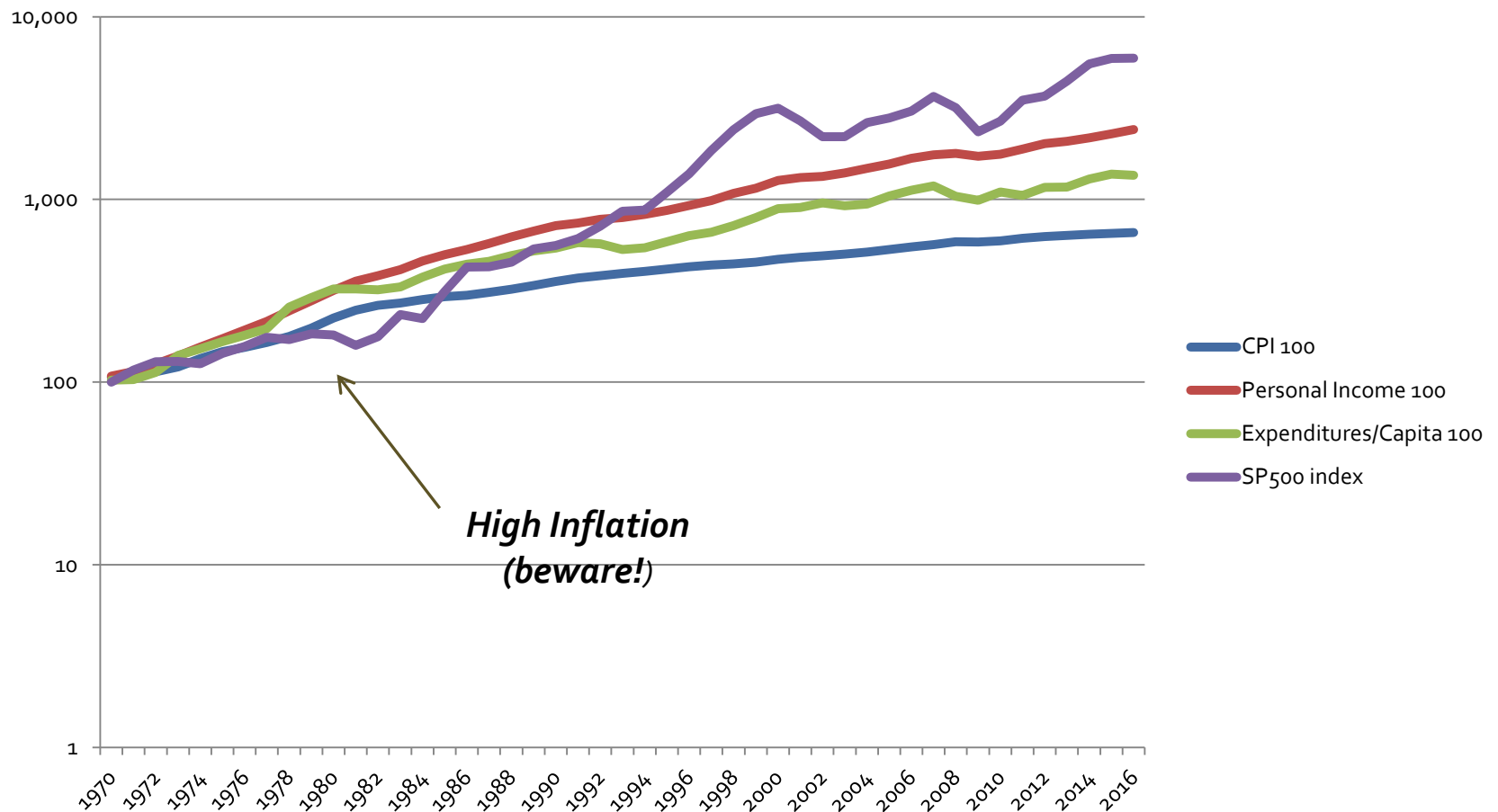- Scalable, repeatable, and integrated risk mitigation process

Wrap-Up

- What we have learned to date is that it is difficult, if not impossible, to have a single set of homogenous factors to clearly describe CalPERS assets and liabilities – regimes offer an integrated path forward.

- Project helps inform a cross-enterprise (ALMAC) understanding of the type of modeling environment necessary to achieve more enhanced ALM decision making process.

- The impact of macro-economic factors on liabilities will be more direct while the impact on assets is less direct.

- A regime-aware strategic asset allocation process will provide a more explicit linkage between assets and liabilities that is economically meaningful.

- An integrated and consistent ALM framework will provide a better understanding of the likelihood that the Portfolio Priorities will be achieved under alternative asset allocations and allow the Board to make more informed decisions regarding risk appetite and tolerance.

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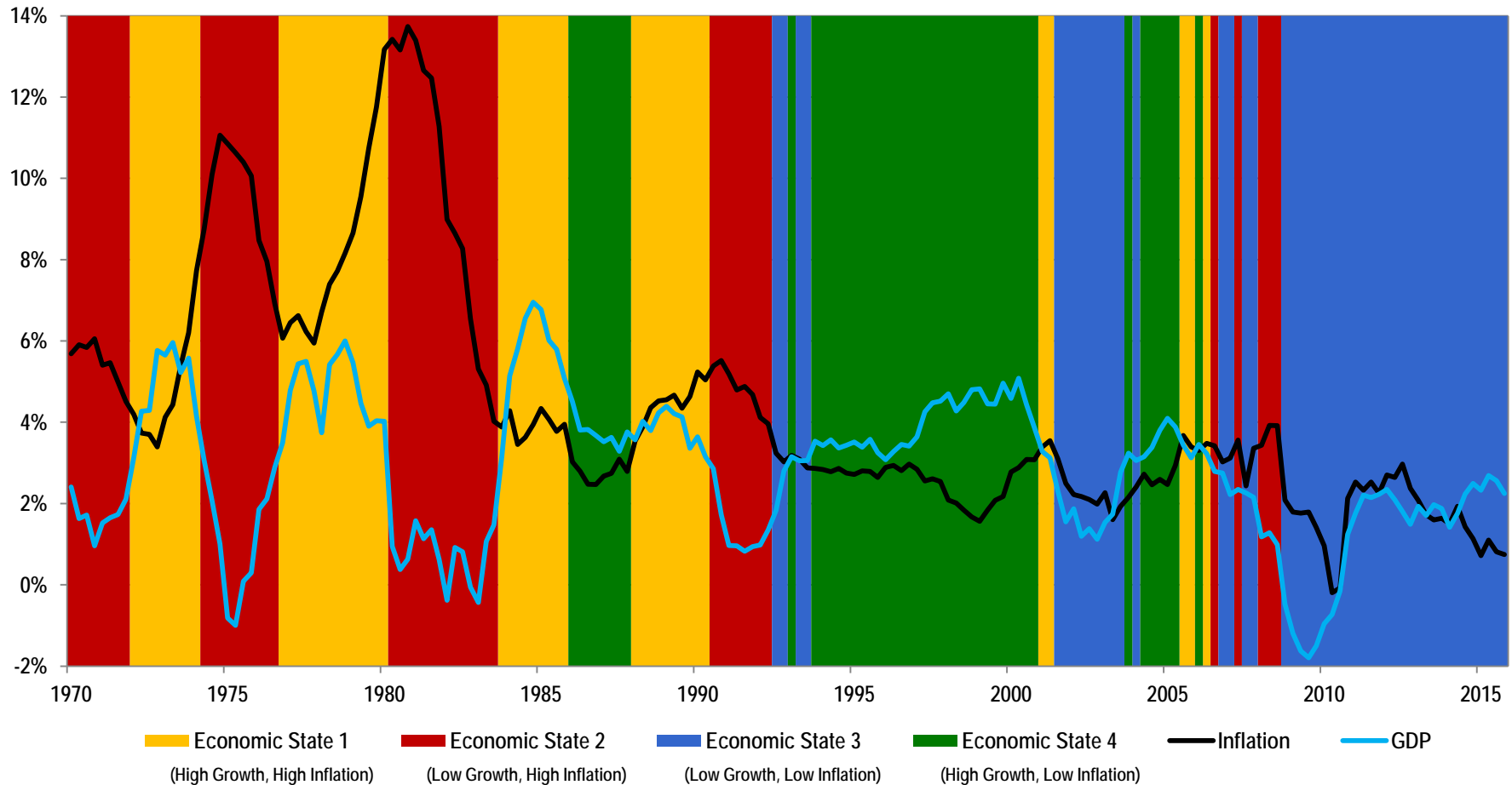
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Appendix

Appendix: Major Risk: Higher Inflation Regime
(Equities suffer, liabilities increase)

High Inflation (beware!)

Legend:
- CPI 100
- Personal Income 100
- Expenditures/Capita 100
- SP500 index

Historical Patterns

Time Series of Inflation and GDP

Legend:
- Economic State 1 (High Growth, High Inflation)
- Economic State 2 (Low Growth, High Inflation)
- Economic State 3 (Low Growth, Low Inflation)
- Economic State 4 (High Growth, Low Inflation)
- Inflation
- GDP

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Comments

Contents

Portfolio Priorities: Asset & Liability Risk Factor Relative Allocation

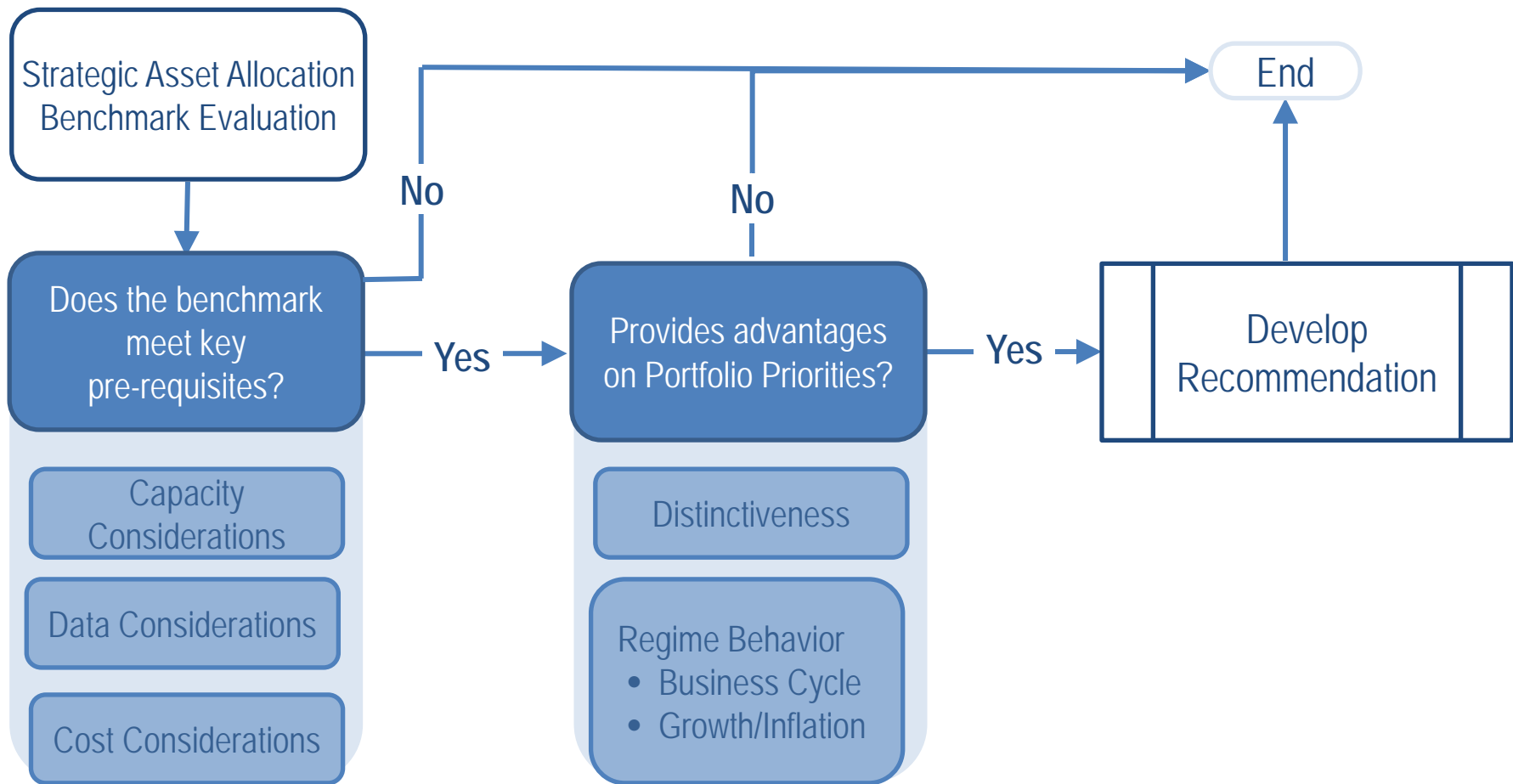**Portfolio Priorities: Alignment with Benchmark Assessment**

Next Steps

Appendix

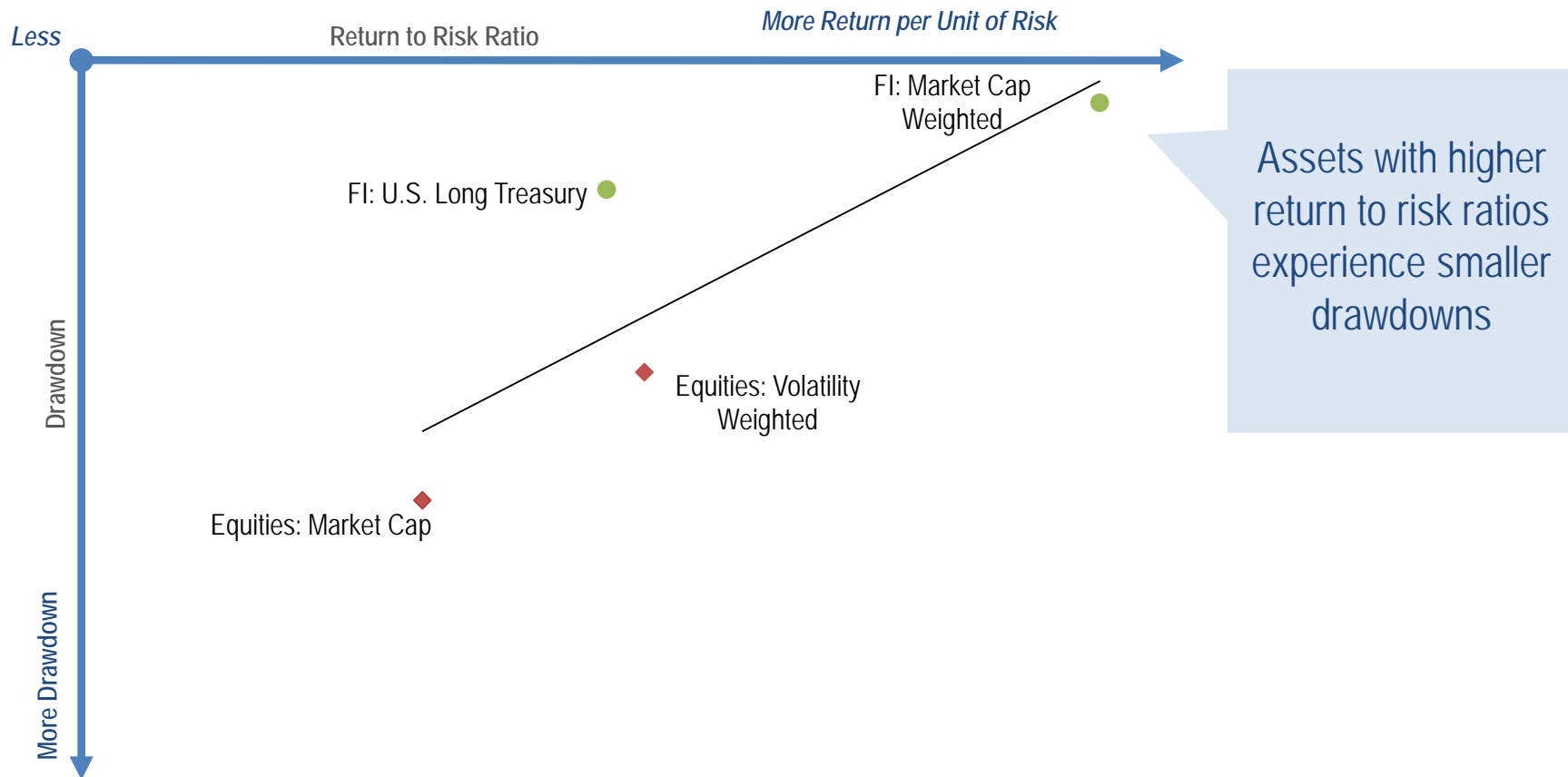# Progress From January 2016 | Check In

From	To
Benchmarks Defined by Asset Classes	Benchmarks Defined from Total Fund Perspective
Benchmarks Oriented to "Market"	Benchmarks Oriented to CalPERS Portfolio Priorities
Single Benchmark Used to Address Multiple Purposes	Multiple Benchmarks are Considered Important to Form a Mosaic of Assessment

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Benchmarks Defined from Total Fund Perspective

Consider industry best practices and CalPERS' Investment Beliefs and Portfolio Priorities

Strategic Asset Allocation Benchmark Evaluation

End

No — No

Does the benchmark meet key pre-requisites? — Yes → Provides advantages on Portfolio Priorities? — Yes → Develop Recommendation

Capacity Considerations

Data Considerations

Cost Considerations

Distinctiveness

Regime Behavior
- Business Cycle
- Growth/Inflation

The Portfolio Priorities are listed on slide 5 of this presentation

Portfolio Priority 1| Drawdown Illustrative Example

Less

Return to Risk Ratio

More Return per Unit of Risk

FI: Market Cap Weighted

FI: U.S. Long Treasury

Drawdown

Equities: Volatility Weighted

Equities: Market Cap

More Drawdown

Assets with higher return to risk ratios experience smaller drawdowns

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Portfolio Priorities Orientation | Economic Regime

Understand the behavior of asset classes in different economic regimes

GDP Growth

Economic State 4		Economic State 1	
Inflation:	Low	**Inflation**:	High
GDP Growth:	High	**GDP Growth**:	High

Economic State 3		Economic State 2	
Inflation:	Low	**Inflation**:	High
GDP Growth:	Low	**GDP Growth**:	Low

Inflation

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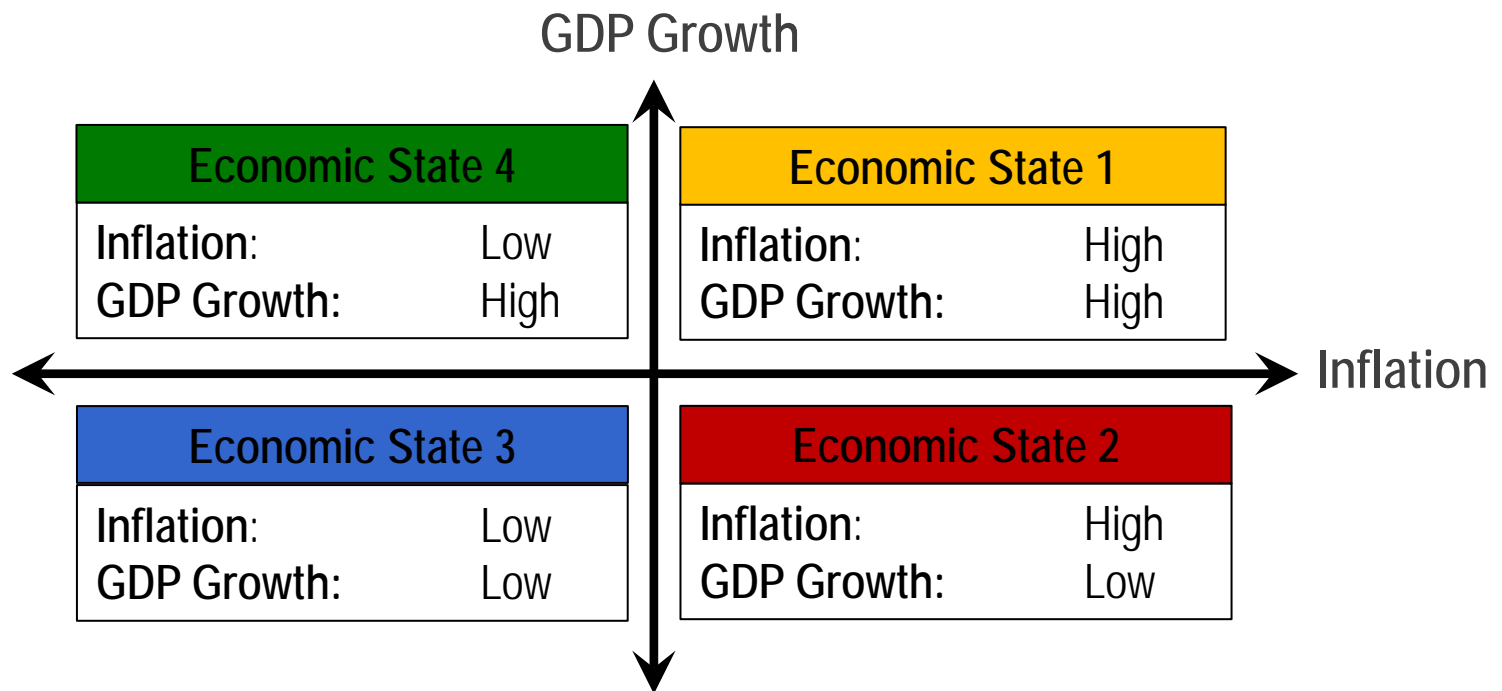
Benchmark Review Oriented to CalPERS' Portfolio Priorities
Illustrative Example| Fixed Income Benchmark Comparison

Example Fixed Income Roles:

- *Diversification*
- *Income*
- *Liquidity*

Example Criteria	Example Indices		Related Portfolio Priorities
	Market Cap Weighted	Long Treasury	
I. Capacity, Data, and Cost Considerations			
Market Capacity	●	○	
II. Role and Portfolio Priorities Considerations			
Distinctiveness			
Role: Diversify equity risk			
Drawdown	●	◐	PP1
Total Return Volatility	●	○	PP2
Sensitivity to Equities	◐	●	PP1, PP2
Role: Income			
Income Return	◐	●	PP1, PP2
Role: Liquidity			
Liquidity (cost of 5-day 5% sale of benchmark)	◐	●	
Economic Regime Behavior			
Role: Diversify equity risk			
Correlation to Equities during Recession	◐	●	PP1

Legend (relative ranking)

● Best   ◐ Middle   ○ Worst

Portfolio Priorities (PP) 1 through 3 are listed on slide 5 of this presentation

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47

Contents

Portfolio Priorities: Asset & Liability Risk Factor Relative Allocation
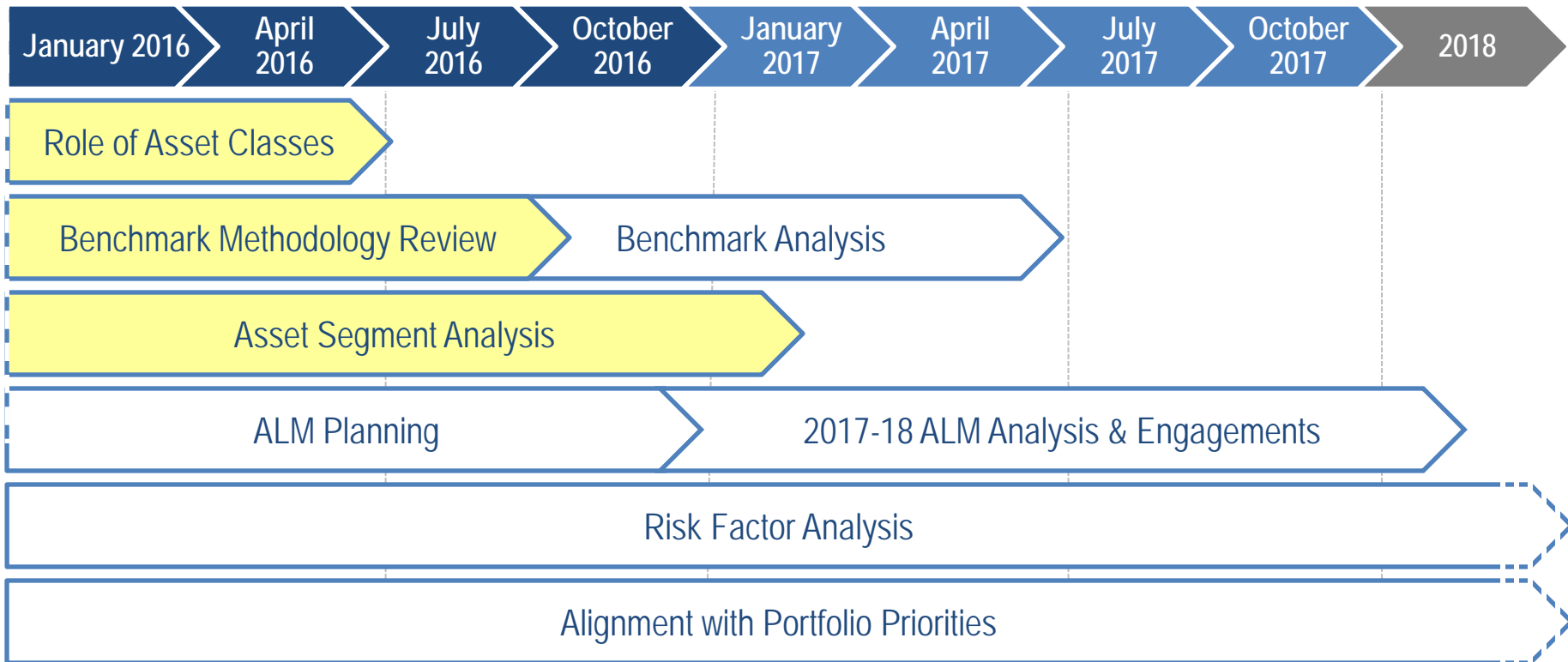
Portfolio Priorities: Alignment with Benchmark Assessment

Next Steps

Appendix

Next Steps | January 2017 Board Offsite

Offsite Session: To share progress and obtain Board feedback on staff's continued work related to the exploration of asset allocation by segment and relevant benchmarks for use in Board decision making at this upcoming ALM cycle (2018).

January 2016	April 2016	July 2016	October 2016	January 2017	April 2017	July 2017	October 2017	2018

Role of Asset Classes

Benchmark Methodology Review → Benchmark Analysis

Asset Segment Analysis

ALM Planning → 2017-18 ALM Analysis & Engagements

Risk Factor Analysis

Alignment with Portfolio Priorities

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Contents

Portfolio Priorities: Asset & Liability Risk Factor Relative Allocation

Portfolio Priorities: Alignment with Benchmark Assessment

Next Steps

Appendix

Appendix

- Glossary of Terms

Glossary

- This glossary is intended to provide "at hand" access to terms that will support discussion as part of this session.

- The definitions in this document are focused on their context within this session. Some terms may have additional meaning or uses not addressed in this document.

  – Definitions may have been adapted from their original sources for ease of reading or to better reflect the primary focus of the session.

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Contents

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Asset-Liability Management (ALM)

Definition

Integrated approach to managing CalPERS' assets and liabilities for the purpose of achieving a sound and sustainable pension fund.

Macro-Economic Factor

Definition

Measures related to the broader economy such as Gross Domestic Product (GDP) and Inflation.

Micro-Economic Factor

Definition

Measures that capture security (especially stock) characteristics such as industry membership, country membership, valuation ratios, and technical indicators. Today, the most commonly referenced micro factors are Value, Growth, Size and Momentum.

Asset Class

Definition:

> A group of financial instruments that exhibit similar characteristics, behave similarly in the marketplace, and are subject to the same laws and regulations. [1]

CalPERS Example:

> *CalPERS' Total Fund Policy defines five asset classes: 1) Growth (incl. Global and Private Equity), 2) Income, 3) Inflation Assets, 4) Real Assets (incl. Real Estate, Infrastructure, Forestland), 5) Liquidity.*

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Asset Class Role

Definition:

Different asset classes have different characteristics (i.e. risk and return profile, relative liquidity, etc.). Part of CalPERS' Asset Allocation Strategy is to ensure that these different characteristics are managed to efficiently support the long-term return target at an acceptable level of risk, while maintaining a well-diversified pool of assets.

As part of the 2013-14 ALM process asset class roles were defined based on their expected characteristics in five key areas:

1. Growth – How well does the asset class capture economic growth realized in the broad capital market

2. Risk Protection – How well does the asset class offset systematic equity risk

3. Inflation Protection – How well does the asset class hedge (attempt to offset the effects of) inflation

4. Liquidity – How fast can the asset be converted to cash without materially affecting the asset's price

5. Cash Yield – How well does the asset class support CalPERS' ongoing cash flow needs by providing sufficient and steady income

Asset Segment

Definition

Investable portions within traditional asset classes which carry stable and distinguishable characteristics of risk and returns which can be used to address Portfolio Priorities

Benchmark

Definition

A standard or point of reference against which things may be compared or assessed.[1] A comparison portfolio; a point of reference or comparison.[2]

Benchmarks can serve multiple roles, such as:

- Defining the investment opportunity set
- Measuring performance
- Expressing program goals[3]

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Capitalization-weighted Benchmark

Definition:

A type of market index in which individual components are weighted according to their market capitalization, so that companies with larger market values carry a larger percentage weighting.[1]

CalPERS Example:

CalPERS' Global Equity and Private Equity policy benchmarks are based on capitalization-weighted benchmarks.

Correlation

Definition:

A statistical measure of how two securities move in relation to each other. Correlation is computed into what is known as the correlation coefficient, which ranges between -1 and +1.

– Perfect positive correlation (a correlation co-efficient of +1) implies that as one security moves, either up or down, the other security will move identically, in the same direction.

– Alternatively, perfect negative correlation means that if one security moves, the security that is perfectly negatively correlated will move in the opposite direction.

– If the correlation is 0, the movements of the securities are said to have no correlation; their co-movements are completely random.

Perfectly correlated securities are rare, rather investors typically find that securities have some degree of positive correlation. [1]

Total Return

Definition

The rate of return taking into account capital appreciation/ depreciation and income. Often qualified as follows: Nominal returns are unadjusted for inflation; real returns are adjusted for inflation.[1]

For example, say you purchase a share for $10, which paid a dividend of a $1 per share, and the share is now trading at $12. Your capital appreciation in the investment is $2 or 20%, as the price of the share has increased $2 over your purchase price or cost basis. Your income return is $1, or 10%, for a total return on the shares is $3 or 30%.[2]

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Capital Appreciation (as a component of Total Return)

Definition

A rise in the value of an asset based on a rise in market price.

Investments targeted for capital appreciation tend to have more risk than assets chosen for capital preservation and income generation, such as government bonds, municipal bonds, or dividend-paying stocks. Because of this, capital appreciation funds are considered appropriate for risk-tolerant investors.

Capital appreciation is one of two main sources of investment returns with the other being income (dividends, interest etc.).

Source: Adapted from Investopedia

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Income (as a component of Total Return)

Definition

As a component of Total Return, income includes interest and dividends paid.

Source: Adapted from Investopedia

Maximum Drawdown

Definition

The maximum loss of a portfolio from a peak to a trough in portfolio value. Maximum drawdown is an indicator of downside risk.

Source: Adapted from Investopedia

Stochastic Modeling

Definition

A method of financial modeling in which one or more variables within the model are random.

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Volatility

Definition:

A statistical measure of the dispersion of returns for a given security, portfolio or market index. Volatility is typically measured by using the standard deviation of the security, portfolio, or index returns. Commonly, the higher the volatility, the riskier the security.

Source: Adapted from Investopedia

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