2017 Asset Liability Management Workshop

CalPERS

Overview

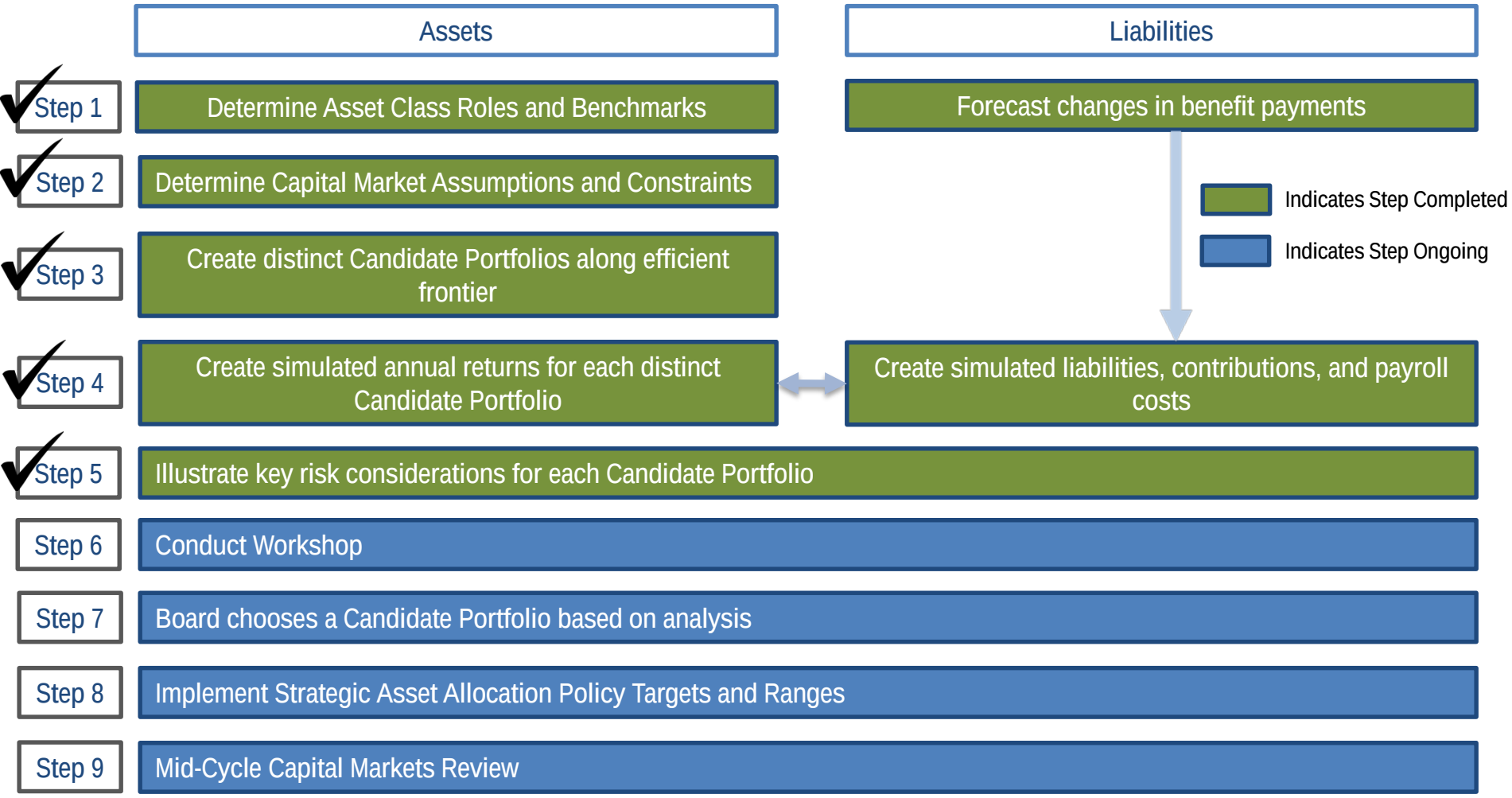
- Asset Liability Management Objectives & Review
- Review of Candidate Portfolios
- Review of Investment Decision Factors
- Review of Actuarial Decision Factors
- ALM Model Results (Cost vs. Volatility Trade-off)
- Recap & Next Steps

Today's Objective

Conduct the Asset Liability Management (ALM) Workshop

- Evaluate potential policy portfolios that best balance the long-term investment objectives, risk tolerances, and liquidity constraints of the Public Employees' Retirement Fund (PERF)
- Gather feedback from the CalPERS Board and stakeholders
- Prepare for December 2017 Action item resulting in CalPERS Board Policy Portfolio selection

Steps to Obtain Policy Portfolio



Candidate Portfolios

Asset Allocation of Preliminary Candidate Portfolios					Allocation 9/30/2017 □	Interim Policy 9/30/2016 □	ALM Policy 2013 □
Asset Class Component	Candidate A ○	Candidate B ○	Candidate C △	Candidate D ○			
Global Equity	34%	42%	50%	59%	50%	46%	47%
Private Equity	8%	8%	8%	8%	8%	8%	12%
Fixed Income	44%	36%	28%	19%	19%	20%	19%
Real Assets	13%	13%	13%	13%	-	-	-
Real Estate	-	-	-	-	9%	11%	11%
Infrastructure/Forestland	-	-	-	-	2%	2%	3%
Inflation Assets	0%	0%	0%	0%	8%	9%	6%
Liquidity	1%	1%	1%	1%	4%	4%	2%
Expected Compound Return (1-10 yrs.)	5.6%	5.8%	6.1%	6.4%	6.0%	5.9%	6.2%
Long Term Expected Return (11-60 yrs.)	7.8%	8.0%	8.3%	8.5%	8.1%	8.0%	8.3%
Blended Return (1-60 yrs.)	6.50%	6.75%	7.00%	7.25%	6.85%	6.77%	7.09%
Expected Volatility	9.1%	10.2%	11.4%	12.8%	11.5%	11.0%	12.0%
Cash Yield:	3.1%	3.0%	2.9%	2.7%	-	-	-

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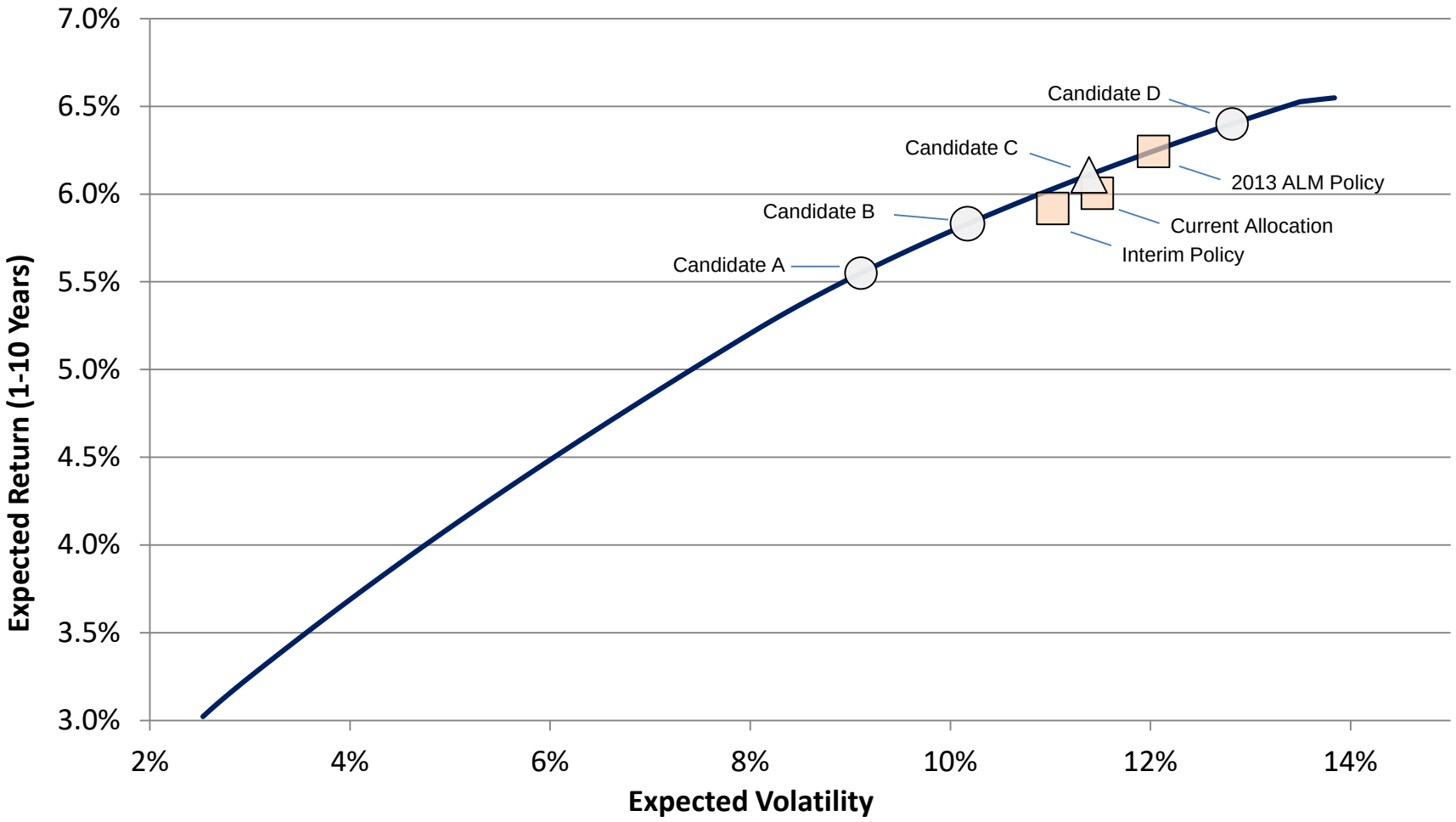
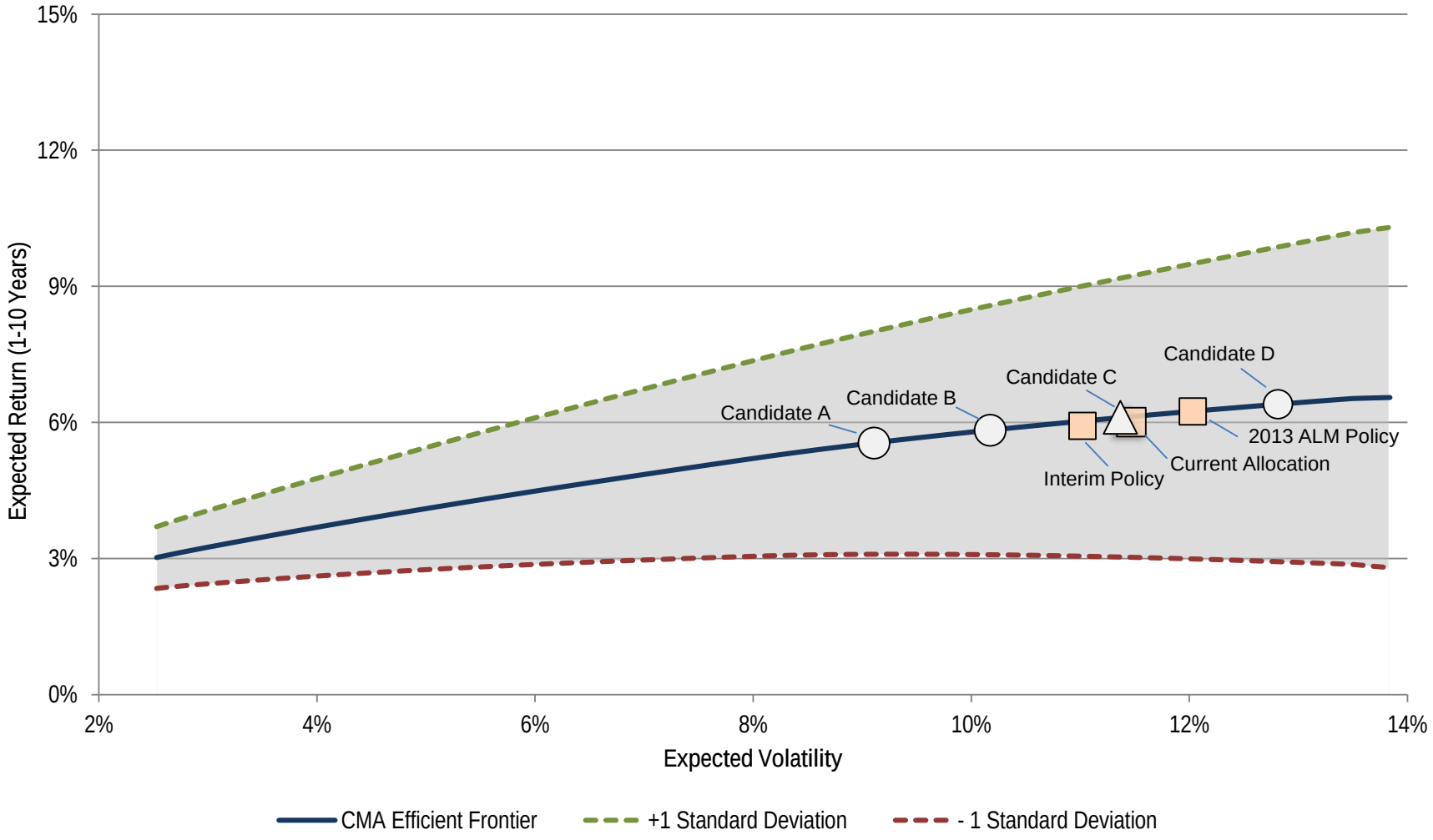
- With the 2013 Capital Market Assumptions, the ALM Policy Portfolio had an expected compound return of 7.15% for years 1 through 10, expected compound return of 8.39% for the long term (i.e., years greater than 10), blended return of 7.56%, and expected volatility of 11.76%.
- Blended Return is the weighted expected compound rate of return of years 1 though 10 and the long term, minus 15 bps for admin fees.
- Circles correspond to Candidate Portfolios A,B, and D. Squares correspond to Current Allocation, Interim Policy, and ALM policy portfolios. Triangle corresponds to Candidate Portfolio C which is most similar to Current Allocation. Symbols illustrated on pages 6 and 7.

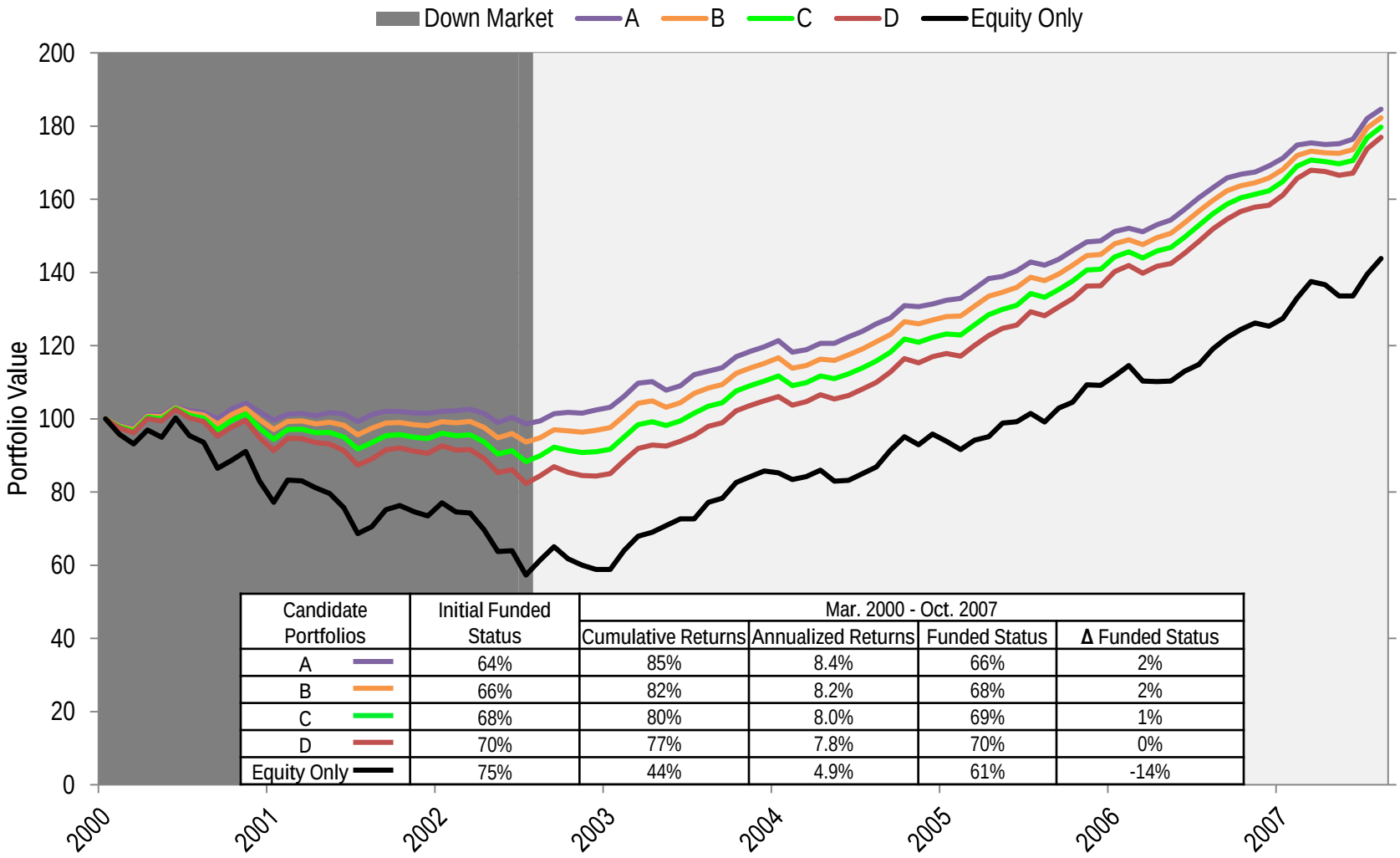
Candidate Portfolios - Efficient Frontier



Each Candidate Portfolio Represents a Range of Outcomes



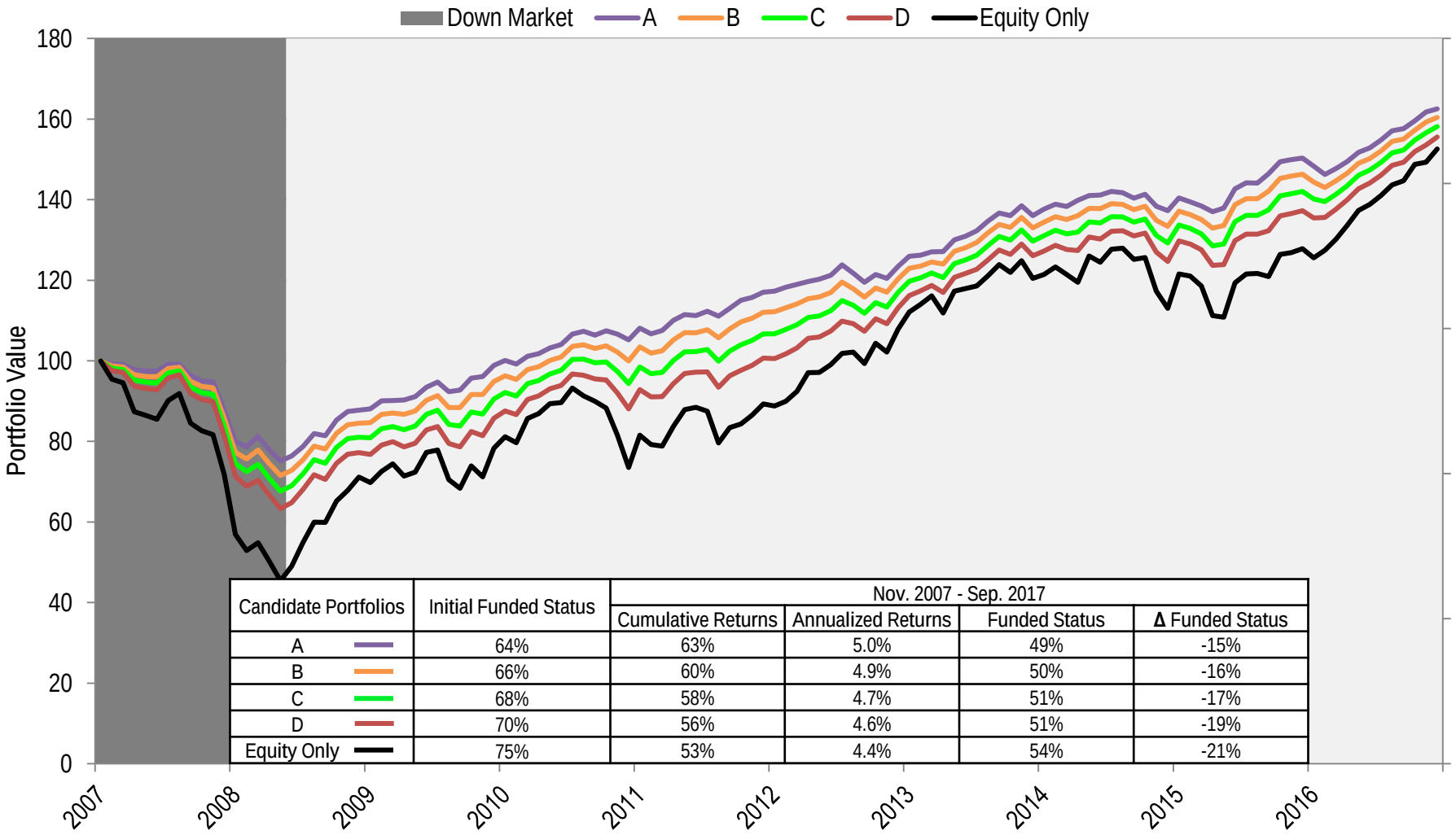
Scenario Analysis (Dot Com Crisis & Recovery)



Candidate Portfolios	Initial Funded Status	Mar. 2000 - Oct. 2007			
		Cumulative Returns	Annualized Returns	Funded Status	Δ Funded Status
A	64%	85%	8.4%	66%	2%
B	66%	82%	8.2%	68%	2%
C	68%	80%	8.0%	69%	1%
D	70%	77%	7.8%	70%	0%
Equity Only	75%	44%	4.9%	61%	-14%

- Analysis assumes no rebalancing.
- The Funded Status calculation assumes a liability growth rate of 7.9%.

Scenario Analysis (Global Financial Crisis & Recovery)



Candidate Portfolios	Initial Funded Status	Nov. 2007 - Sep. 2017			
		Cumulative Returns	Annualized Returns	Funded Status	Δ Funded Status
A	64%	63%	5.0%	49%	-15%
B	66%	60%	4.9%	50%	-16%
C	68%	58%	4.7%	51%	-17%
D	70%	56%	4.6%	51%	-19%
Equity Only	75%	53%	4.4%	54%	-21%

- Analysis assumes no rebalancing.
- The Funded Status calculation assumes a liability growth rate of 7.9%.

Key Risk Considerations

- Accepting investment risk will be rewarded
- Historic hierarchy of risk premia will be stable
- Short-term and long-term expected return variance
- Market valuation levels
- No certainty of any market outcome

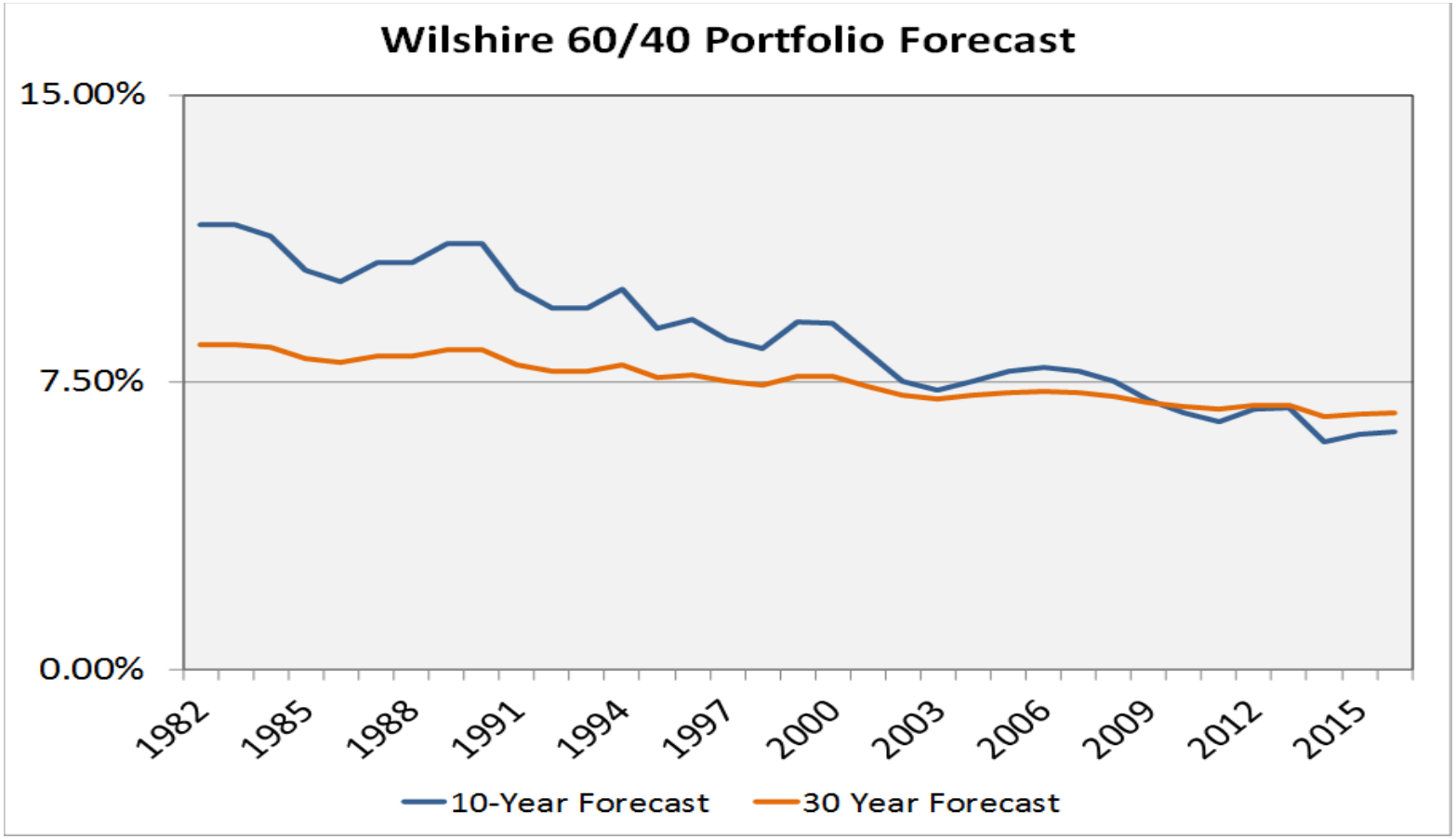
Pros/Cons Relative to Current Interim Policy Target

Portfolio	+/-	Context
A and B	+	• Shift to less speculative sources of return • Diversification of equity risk • Reduced volatility • Increased cash flow
	-	• Exposure to interest rate risk • Reduced overall expected blended return • Discount rate reduction • Material transition activity required
C[1]	+	• Maintain discount rate at the target 7% from December 2016 Board decision • Does not increase exposure to interest rate risk • Reduces transition activity
	-	• Retains current concentration of equity risk • Maintains current expected volatility and potential for contribution changes
D	+	• Increased expected blended return • Supports increase in discount rate or maintain at 7% (December 2016 Board decision) with a margin for adverse deviation
	-	• More equity risk concentration • Subject to more drawdown in an equity sell-off • Material transition activity required

[1] Candidate Portfolio C is most similar to our current allocation and current path towards a 7% discount rate.

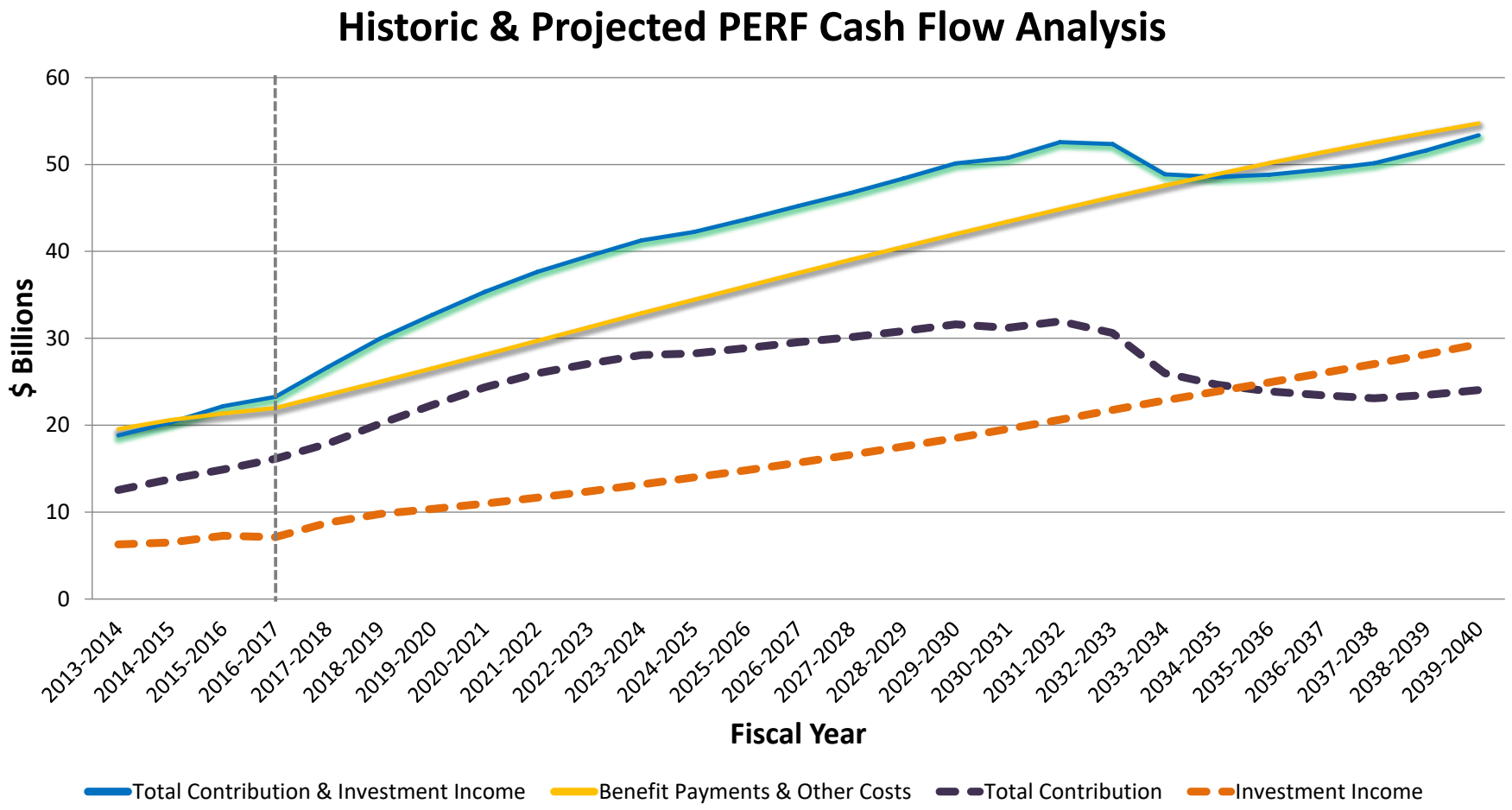
Difference in Short and Long Term CMAs

Current low real yield is primary driver of difference



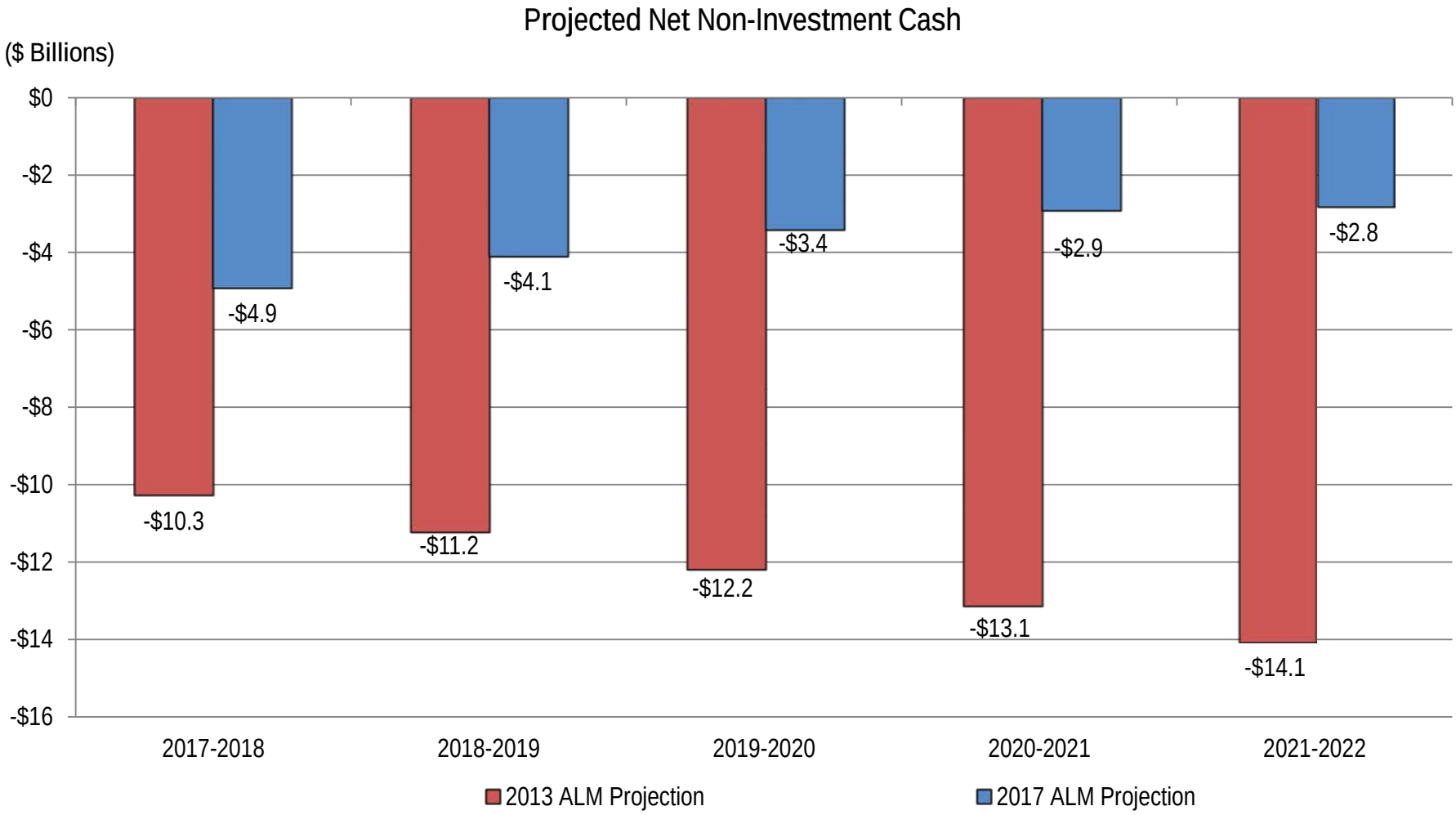
- Source: Wilshire Associates

Total Fund Cash Flows are Improving



- Data Source: Historical information from Comprehensive Annual Financial Report (CAFR). Contribution estimates assume a 7% discount rate. Benefit Payments incorporate changes in actuarial assumptions to be presented in Finance and Administration Committee on 11/14/2017.
- Investment Income assumes implementation of "Candidate Portfolio C." Investment income only includes income from Global Equity (dividends), Global Fixed Income (coupons) and Real Assets (rent).
- Other Costs include refunds, administrative costs of retirement and investment base fees.

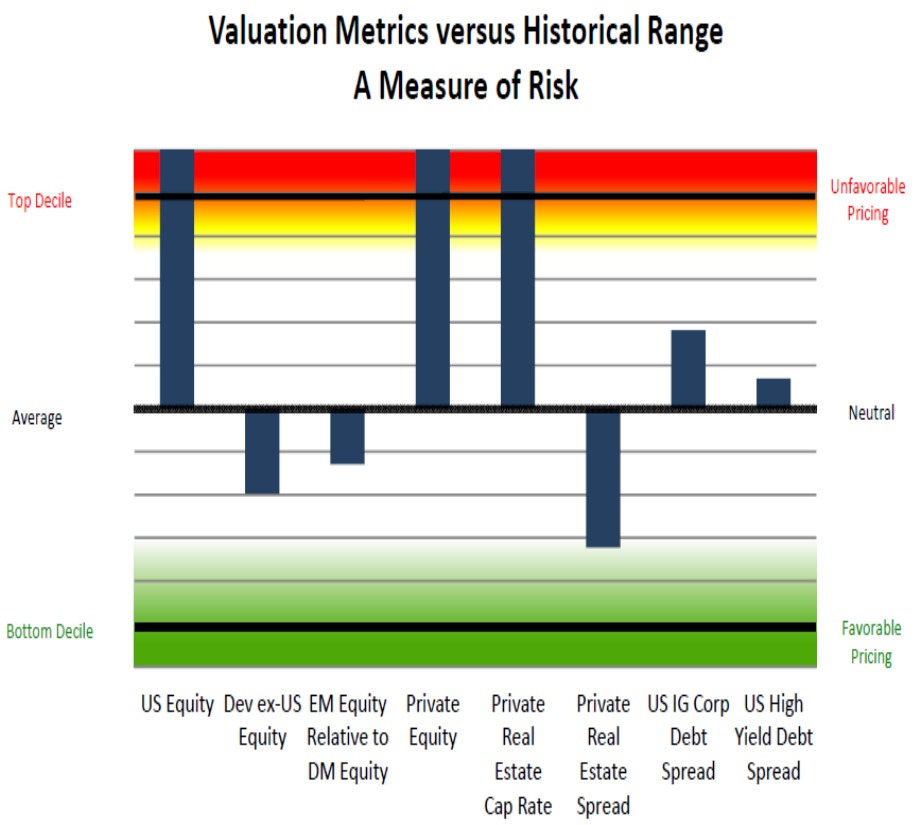
Reduced Reliance on Investment Cash Flows



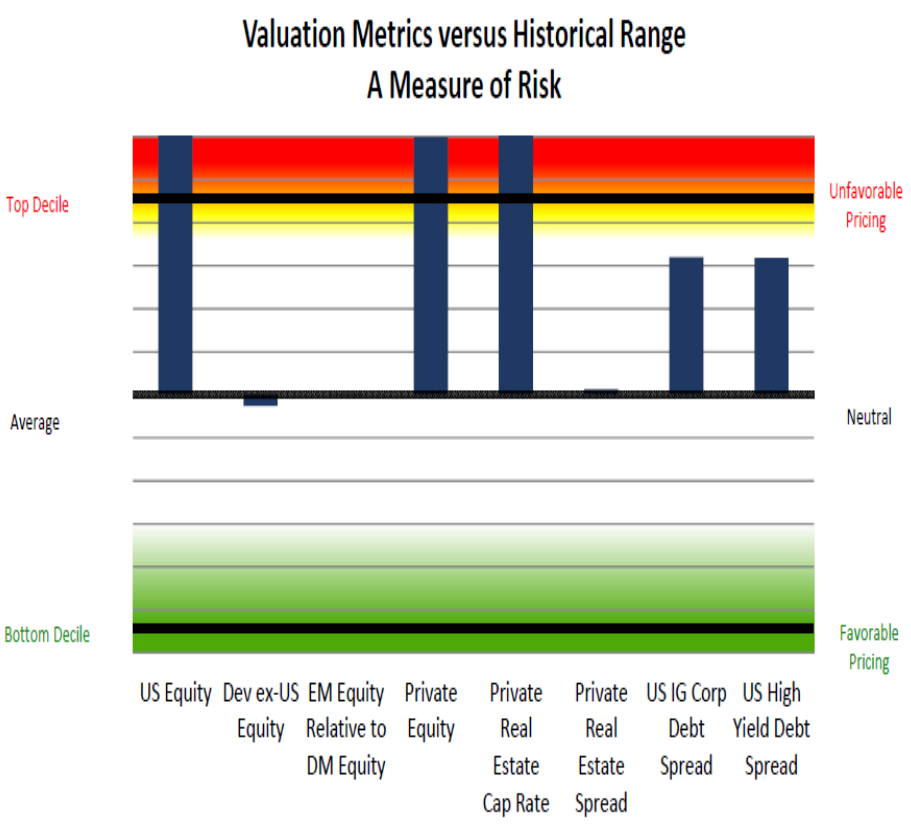
- Net Non-Investment Cash Flows defined as follows:
  Estimated Contributions - Estimated Benefit Payments - Refunds - Administrative costs

2016 Vs. Today – Market Valuations

As of September 2016



As of September 2017



- Source: Pension Consulting Alliance

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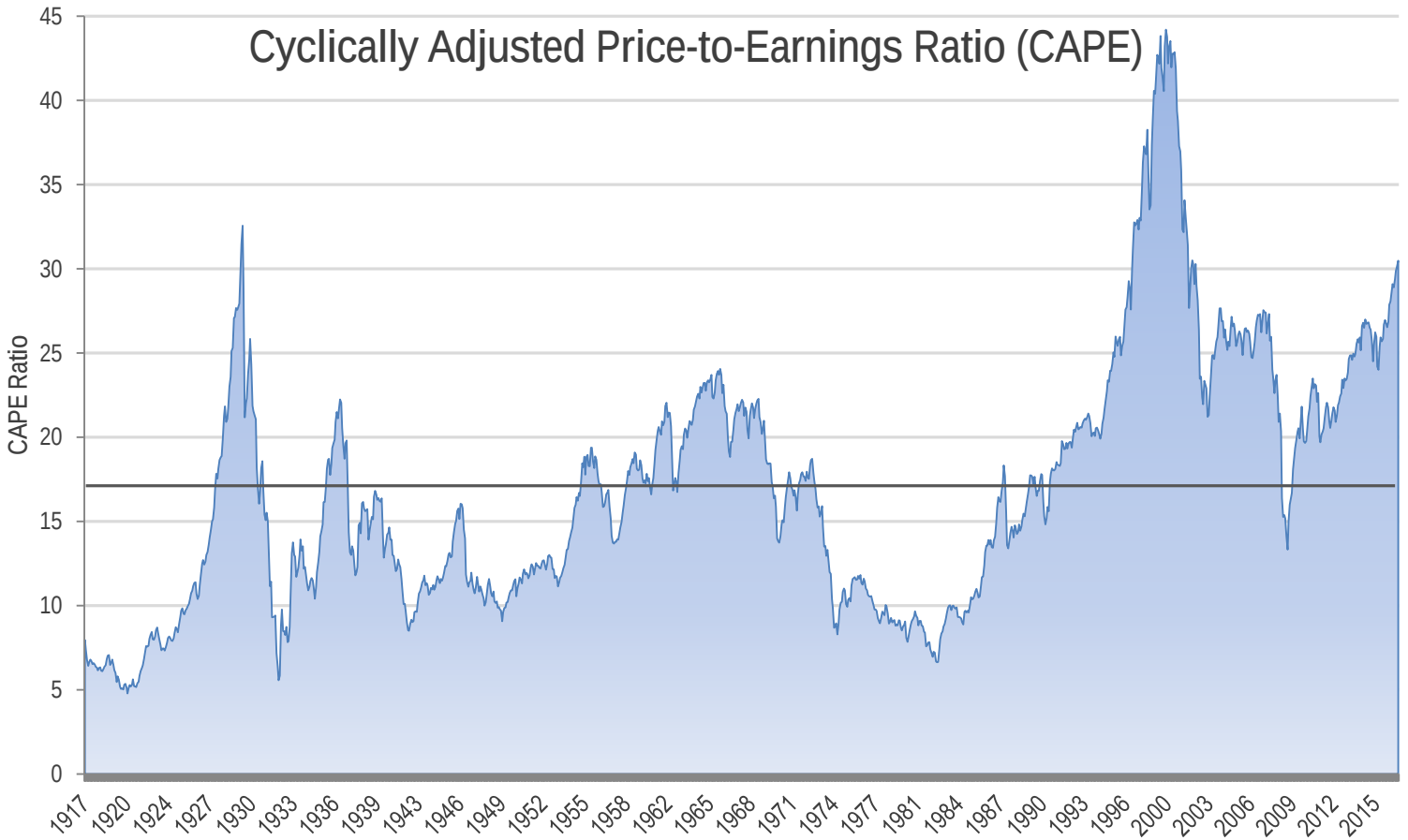
Historical CAPE Measure

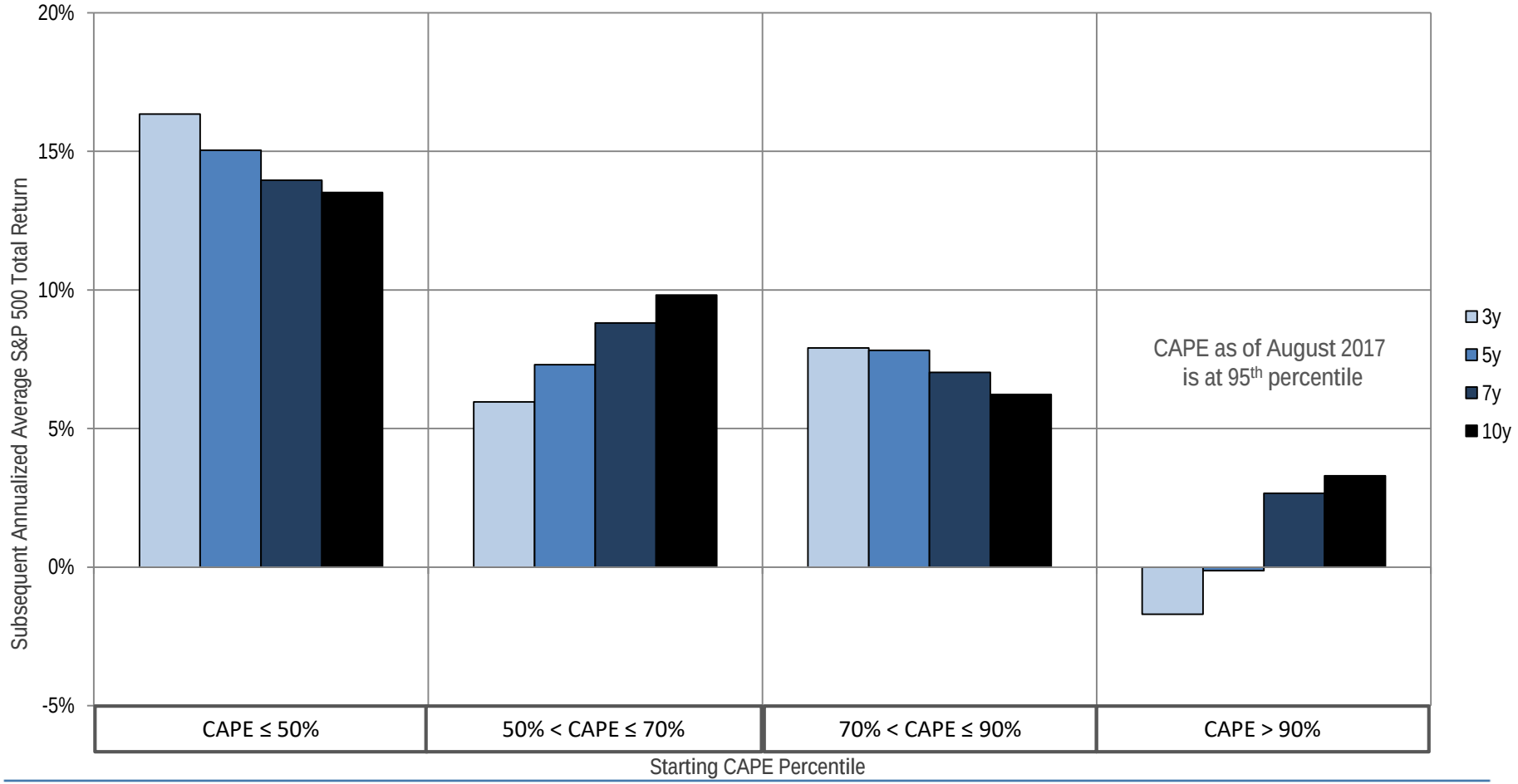


August 2017
CAPE = 31

1917 - 2017
Average
CAPE = 17

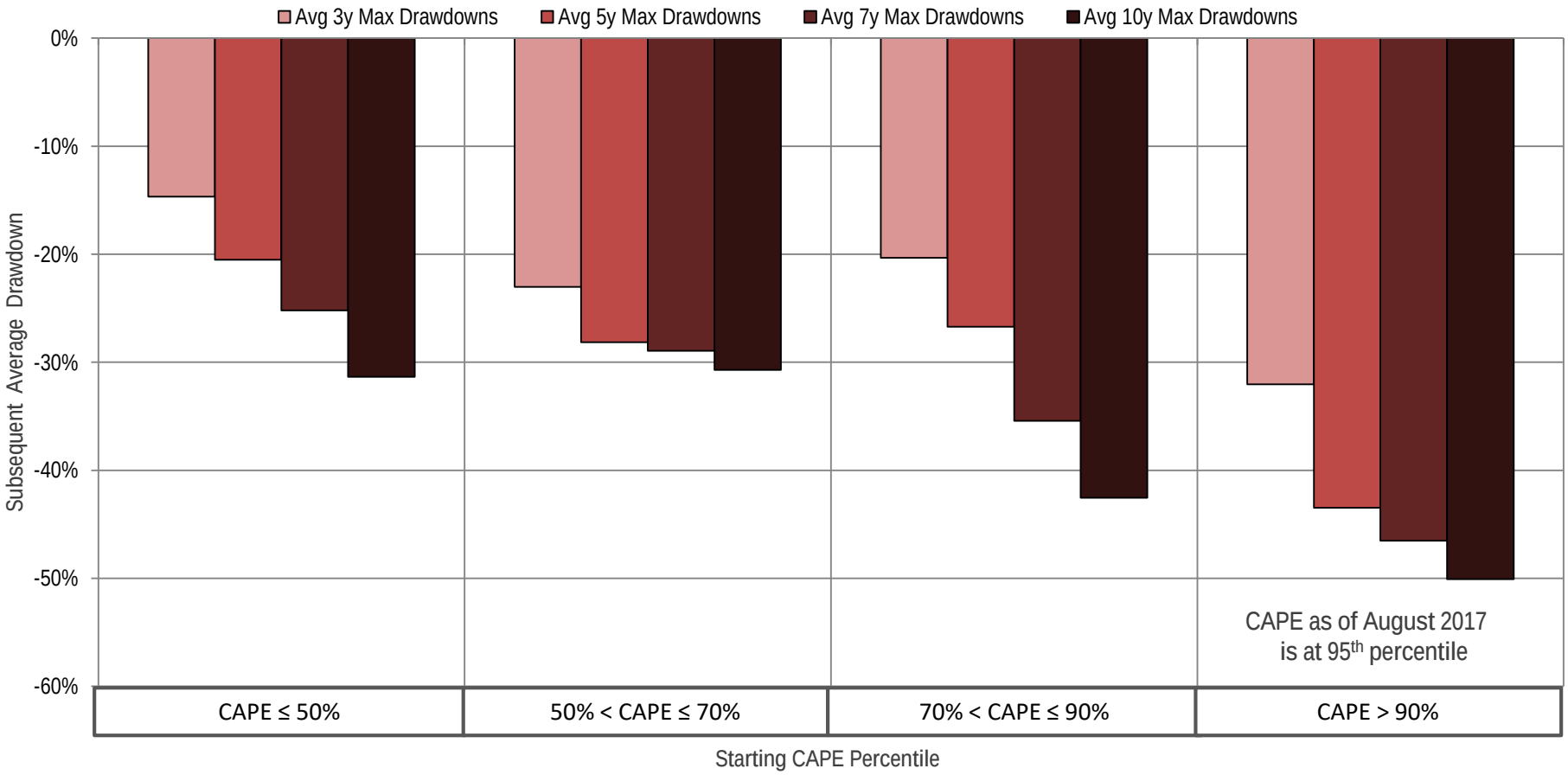
- Data Source: Stock Market Data Used in "Irrational Exuberance" Princeton University Press, Robert J. Shiller

Historical CAPE and 3, 5, 7 and 10-year Subsequent Average S&P 500 Annualized Total Returns



- CAPE data: September 1917 – August 2007
- Data Source: Stock Market Data Used in "Irrational Exuberance" Princeton University Press, Robert J. Shiller

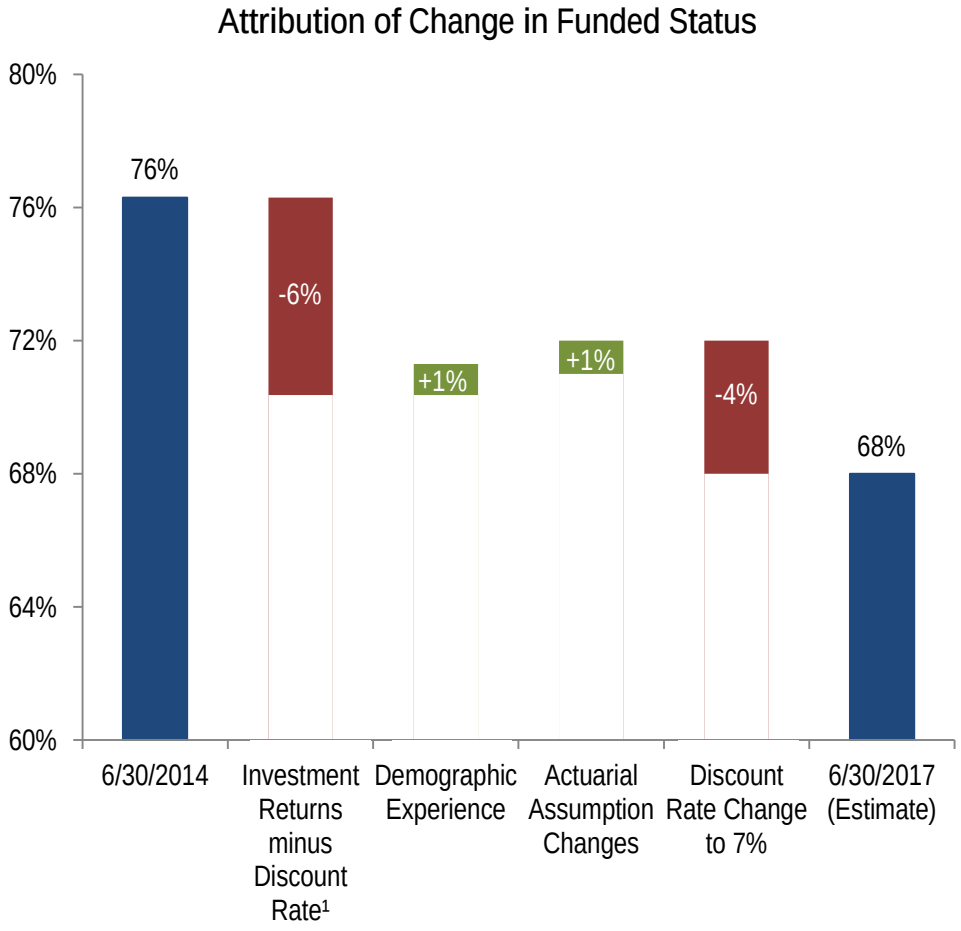
Historical CAPE and 3, 5, 7 and 10-year Subsequent Average S&P 500 Maximum Drawdowns

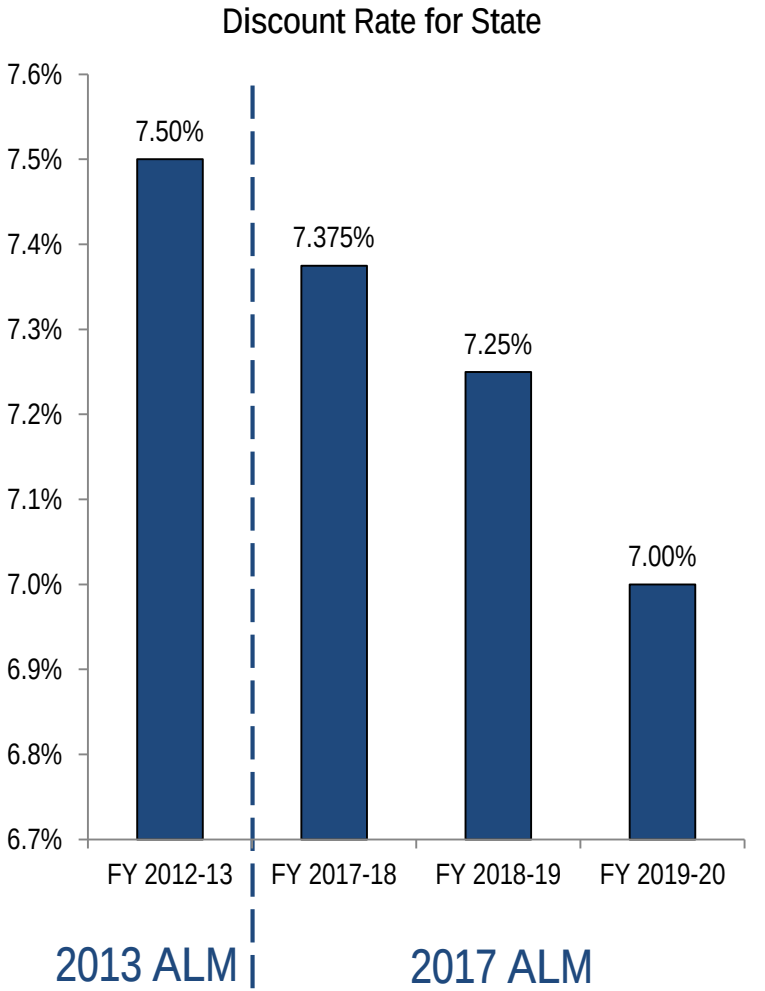


- CAPE data: September 1917 – August 2007
- Data Source: Stock Market Data Used in "Irrational Exuberance" Princeton University Press, Robert J. Shiller

Review of Actuarial Decision Factors

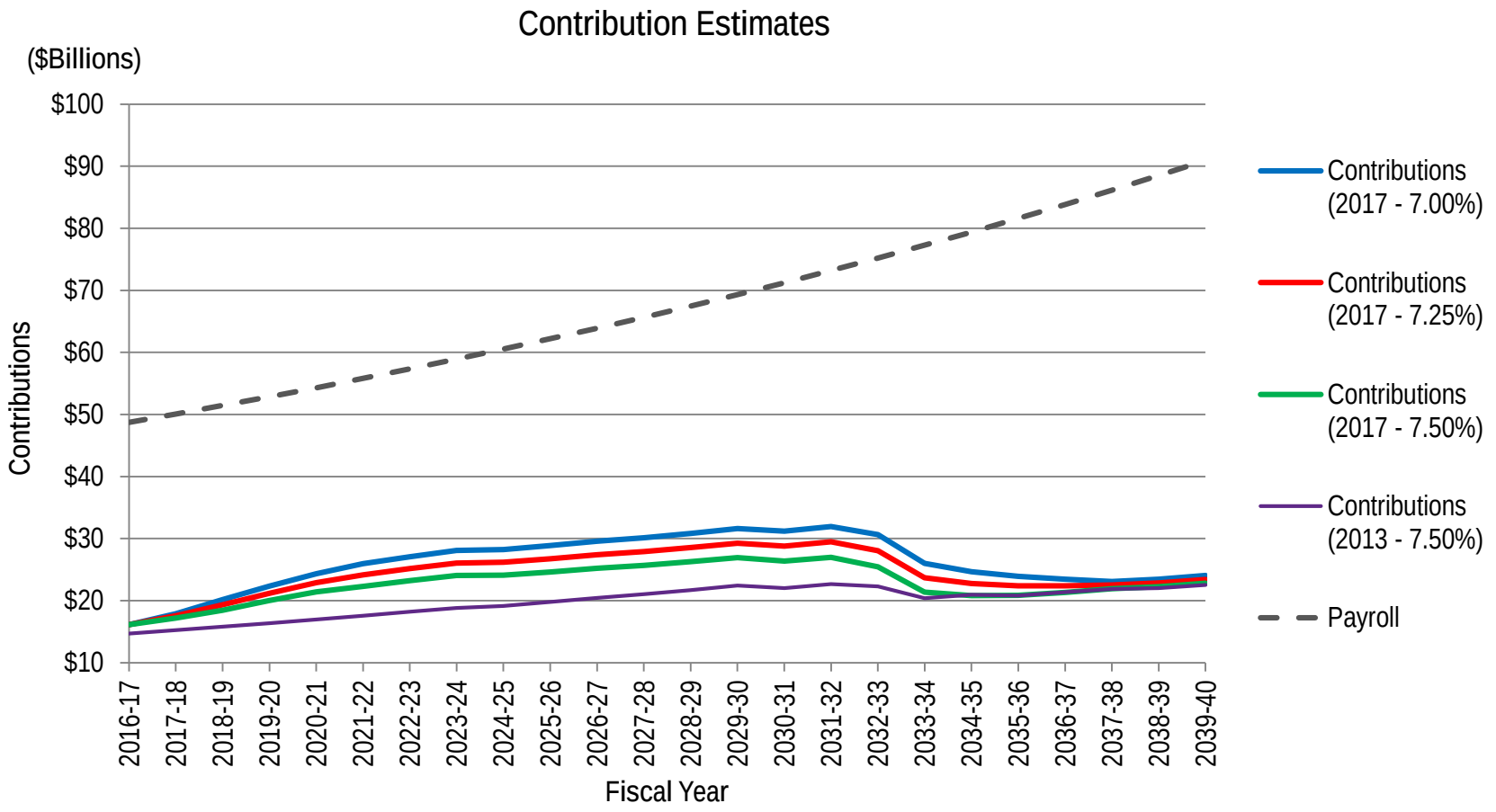
2013 Vs. Today – Drivers of Lower Funded Ratio





[1]4.64% Compound Return for the Total Fund over the last 3 fiscal years:
(FY2014-15: 2.41%; FY2015-16: 0.62%; FY2016-17: 11.18%)

2013 Vs Today – Drivers of Higher Contribution Rates



- Payroll estimated to grow at 2.75%

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Key Risk Considerations

Funded Status	The market value of assets divided by the accrued liabilities
Employer Contribution Rate	The payment rate made to the plan by the employer
Employer Contribution Rate Volatility	The annual change of the payment rate made to the plan by the employer

Key Risk Consideration Thresholds
(2013 Strategic Asset Allocation breaching the thresholds)

		State Misc.	PA[1] Misc.	Schools
2013 ALM Workshop Probability	Funded Status Falling Below 50%	40%	32%	32%
	Employer Contribution Rate Volatility Exceeding 3%	51%	38%	34%
	Employer Contribution Rate Exceeding 35%	38%	14%	8%
Current Level	Estimated Funded Status (June 30, 2017)	66.0%	70.5%	70.2%
	Employer Contribution Rate Volatility	2.7%[2]		1.8%[2]
	Employer Contribution Rate	28.325% (FY 2017-18)		15.531% (FY 2017-18)

[1] Public Agency (PA)
[2] FY 2013-14 to FY 2017-18
Data Source: CalPERS Actuarial Valuations

Key Risk Considerations

Funded Status	The market value of assets divided by the accrued liabilities
Employer Contribution Rate	The payment rate made to the plan by the employer
Employer Contribution Rate Volatility	The annual change of the payment rate made to the plan by the employer

Key Risk Consideration Thresholds
(2013 Strategic Asset Allocation breaching the thresholds)

		CHP[1]	PA[2] Safety	POFF[3]
2013 ALM Workshop Probability	Funded Status Falling Below 50%	40%	35%	35%
	Employer Contribution Rate Volatility Exceeding 5%	46%	38%	33%
	Employer Contribution Rate Exceeding 55%	64%	50%	45%
Current Level	Estimated Funded Status (June 30, 2017)	58.8%	67.5%	64.1%
	Employer Contribution Rate Volatility	6.7%[4]		4.7%[4]
	Employer Contribution Rate	52.785% (FY 2017-18)		42.598% (FY 2017-18)

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[1] California Highway Patrol (CHP)
[2] Public Agency (PA)
Data Source: CalPERS Actuarial Valuations

[3] Peace Officers and Fire Fighters (POFF)
[4] FY 2013-14 to FY 2017-18

ALM Model Building Blocks

- Starting Point
  - Assets and Liabilities at June 30, 2016
  - Benefit payments for FY 2016-2017
  - Contributions for FY 2016-2017
  - Investment return for FY 2016-17 (11.2%)

- Liability Projection for 30 Years
  - Liabilities projected for each discount rate
  - Open Group (New members join in future years)

- Asset Projection for 30 Years
  - For each discount rate 5,000 investment return paths over 30 years are randomly simulated

Discount Rate Determination

Starting Point

- CMAs Year 1 to 10 (short term)
- CMAs Year 10 and Beyond (long term)
  - Foundation of CMAs Year 10 and Beyond is long term average per asset class
  - Examples of historical measures used:

Asset Class	Source	Period	Number of Years
Global Equity	S&P 500	1926 – 2016	90 years
Fixed Income	US Aggregate Bond Index	1926 – 2016	90 years
Real Assets	Average REIT	1972 – 2016	44 years

Discount Rate Determination (continued)

- Based on Blended CMA rates and projected Cash Flows

Portfolio	Discount Rate[1]	Volatility
A	6.50%	9.1%
B	6.75%	10.2%
C	7.00%	11.4%
D	7.25%	12.8%

[1] Does not include any provision for adverse deviation.

Generating Investment Return Paths

- Develop Expected Returns & Volatility
  - For first 10 years
  - For years 11 and beyond
    - Performed for each potential candidate portfolio

- Generate 30 Year simulations using statistical modeling techniques
  - 5,000 paths generated for each potential discount rate

ALM Model Improvements since 2013

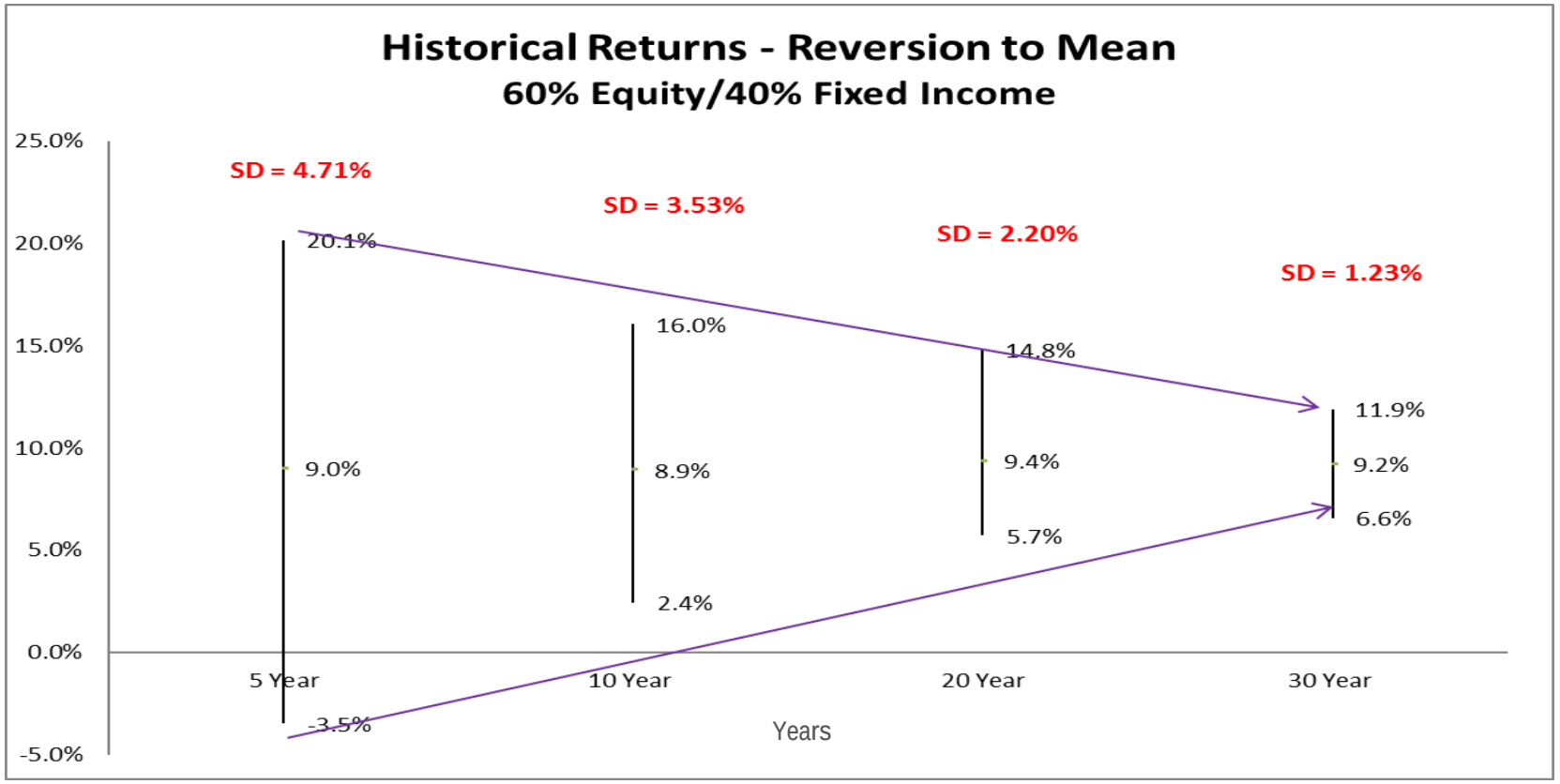
Simulations Reflect Mean Reversion

- Capital market annual returns are not independent and identically distributed (IID)

- Simulations consistent with historical market returns reflecting negative serial correlation

- Realistic long-term investment scenarios
  - Overly optimistic/pessimistic scenarios removed

Historical Returns Exhibit Mean Reversion



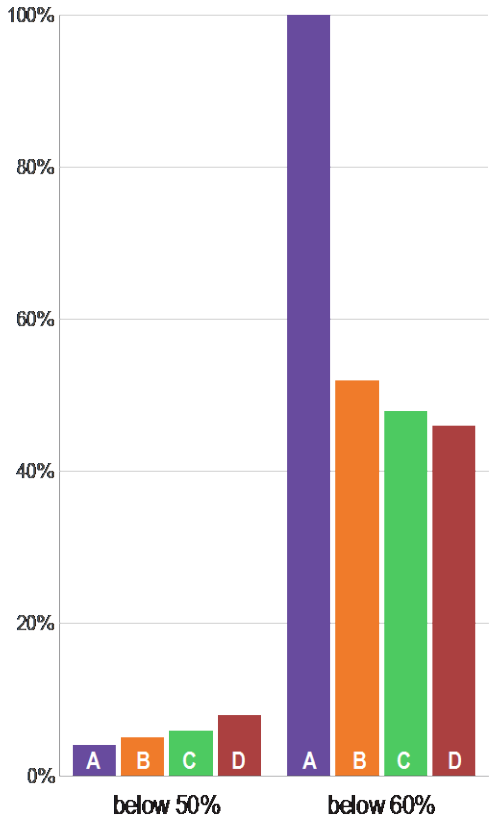
Simulations with Mean Reversion

ALM Model Results
Cost vs. Volatility Trade-off

State Miscellaneous

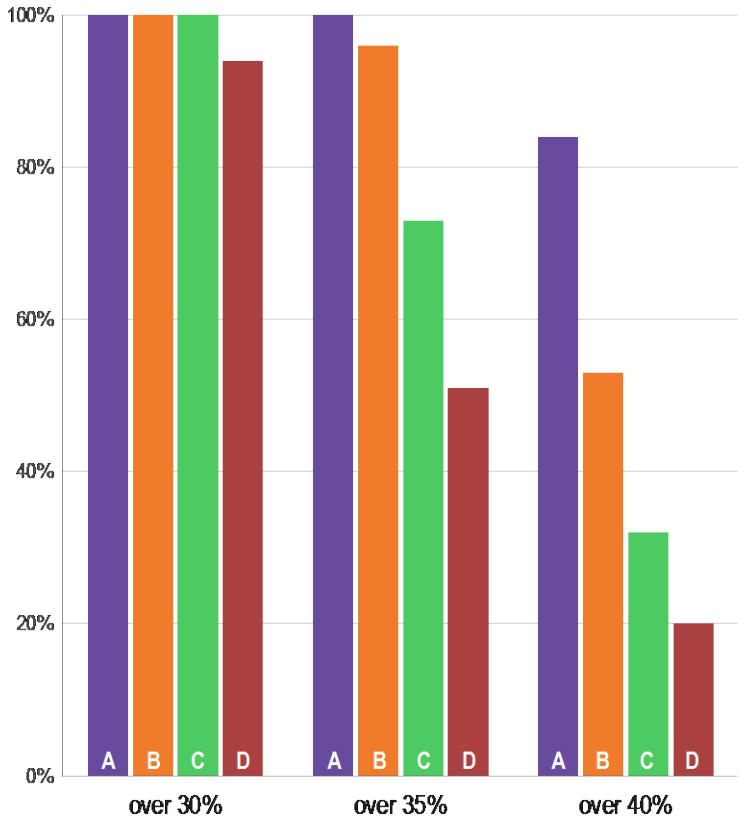
Measure 1:

Probability of PERF **funded status falling below 50% or 60%** over the next 30 years



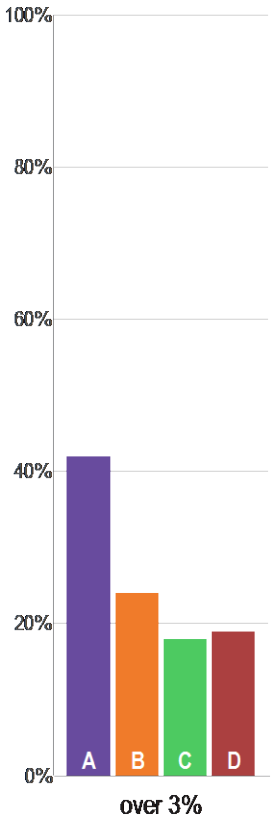
Measure 2:

Probability of high **employer contribution rates over 30% / 35% / 40%**



Measure 3:

Probability of sharp **increase in annual employer contribution rates over 3%**



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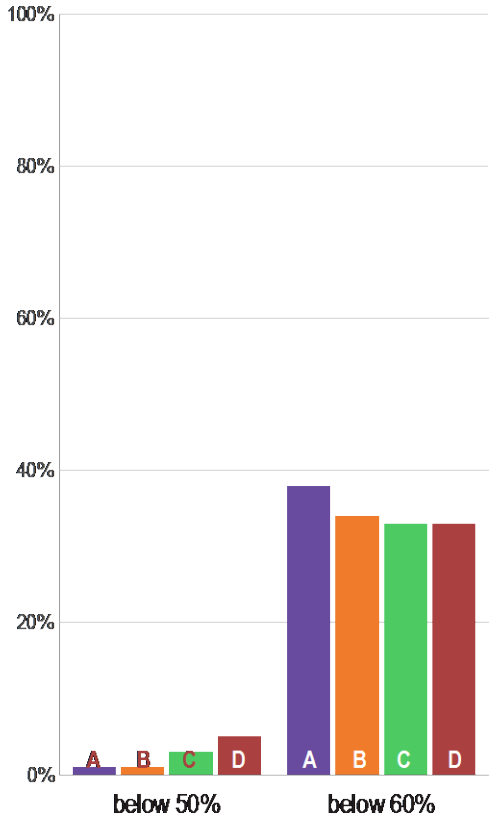
Schools

Measure 1:

Probability of PERF **funded status falling below 50% or 60%** over the next 30 years



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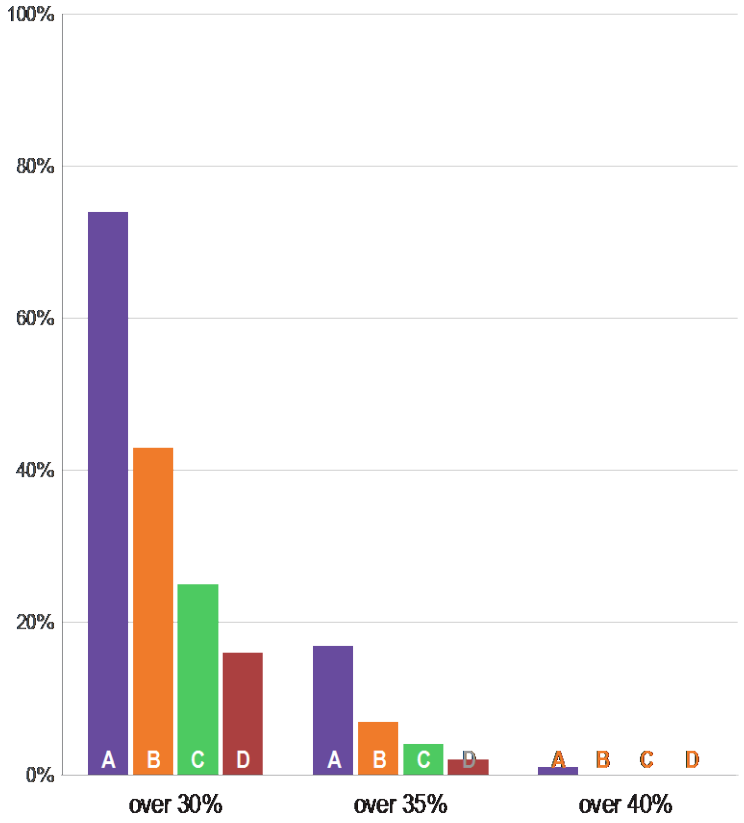

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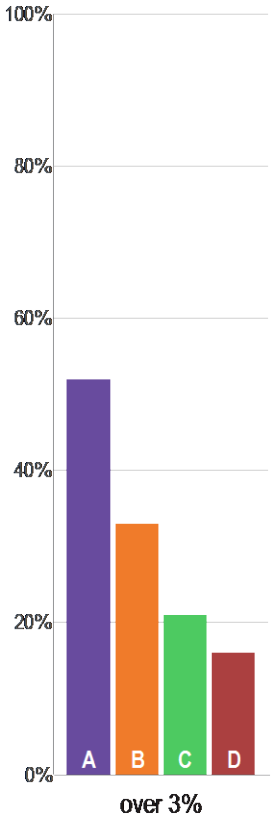
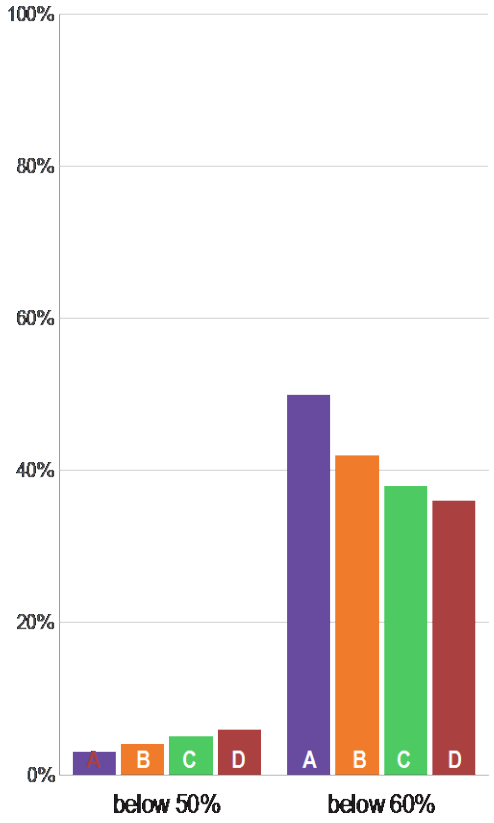


Public Agency Miscellaneous

Measure 1:

Probability of PERF **funded status falling below 50% or 60%** over the next 30 years



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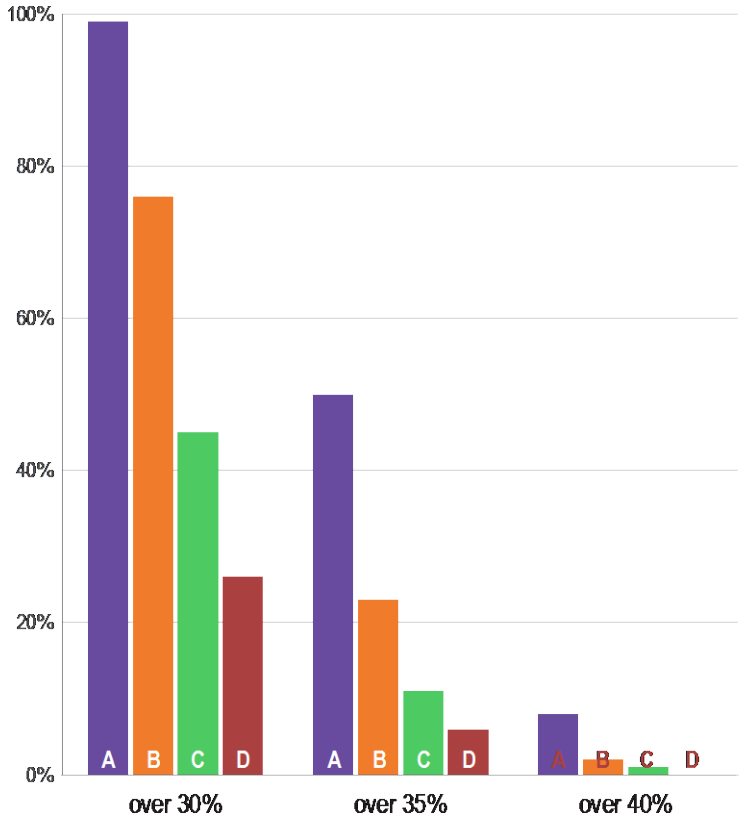
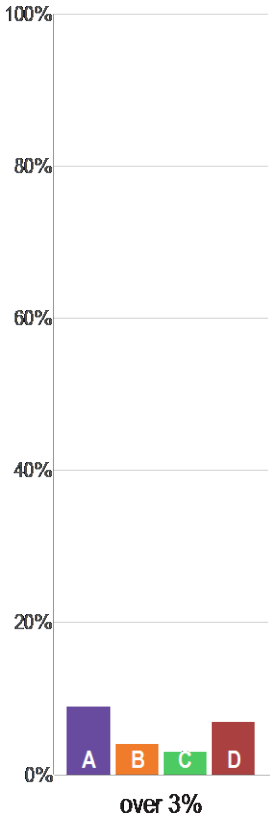
Probability of high **employer contribution rates over 30% / 35% / 40%**



Measure 3:

Probability of sharp **increase in annual employer contribution rates over 3%**



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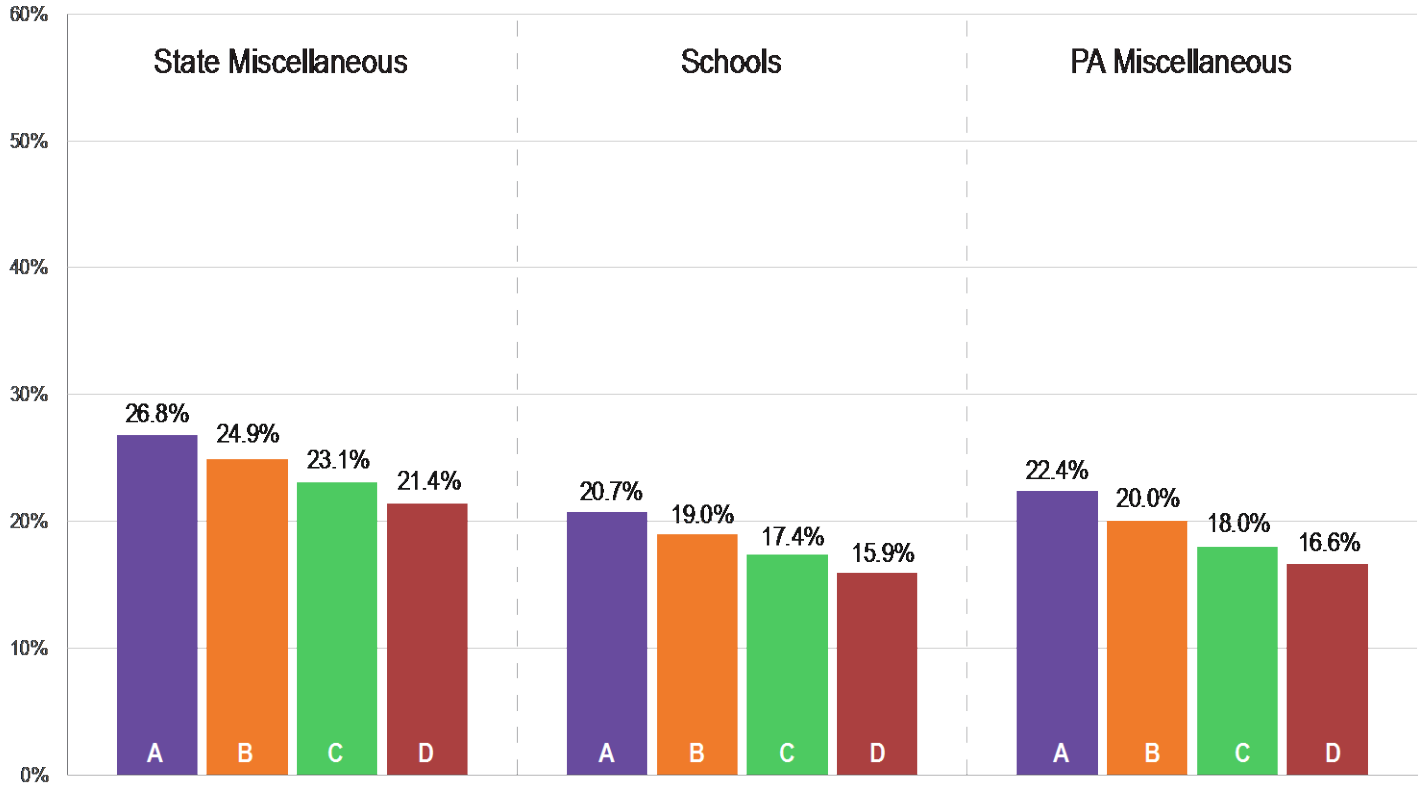
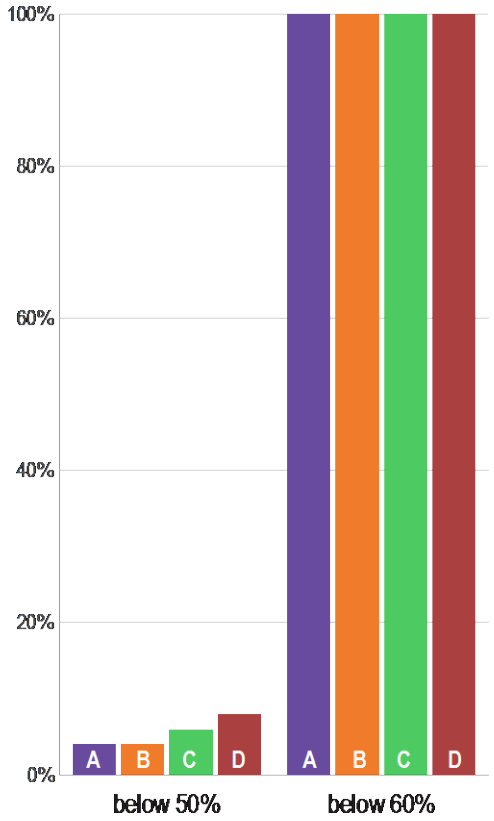
Average Employer Contribution Rates Over Next 30 years (percentage of payroll)



State Peace Officers and Fire Fighters (POFF)

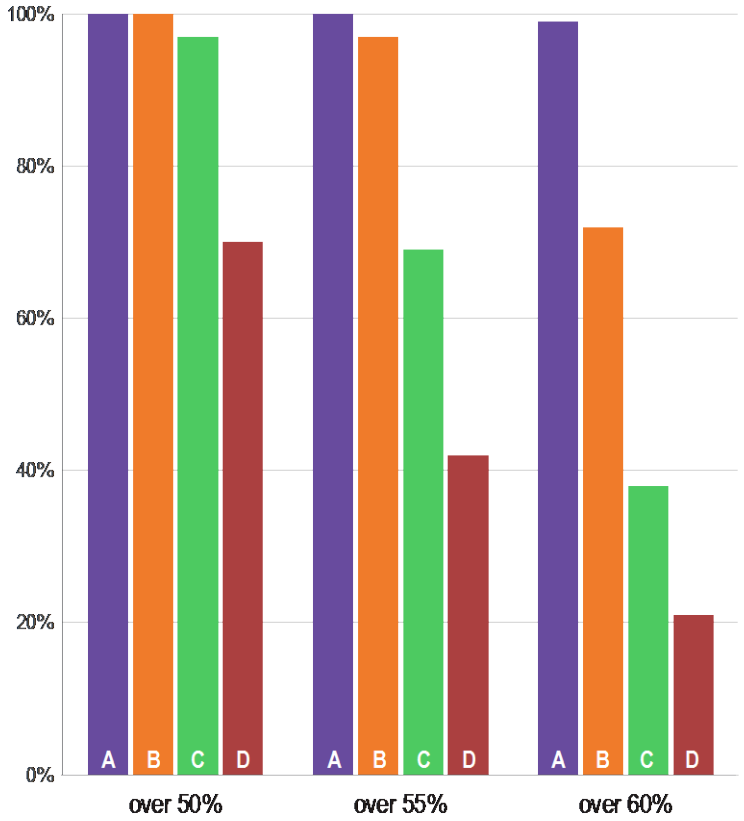
Measure 1:

Probability of PERF **funded status falling below 50% or 60%** over the next 30 years



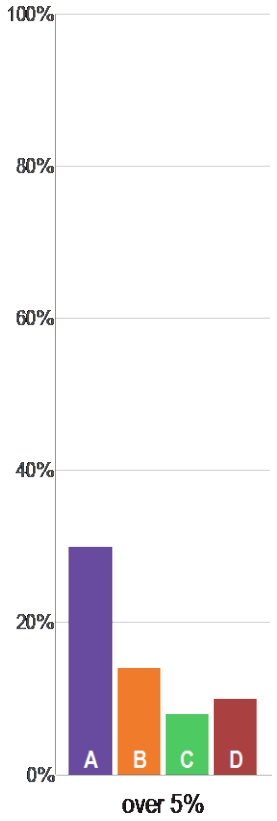
Measure 2:

Probability of high **employer contribution rates over 50% / 55% / 60%**



Measure 3:

Probability of sharp **increase in annual employer contribution rates over 5%**



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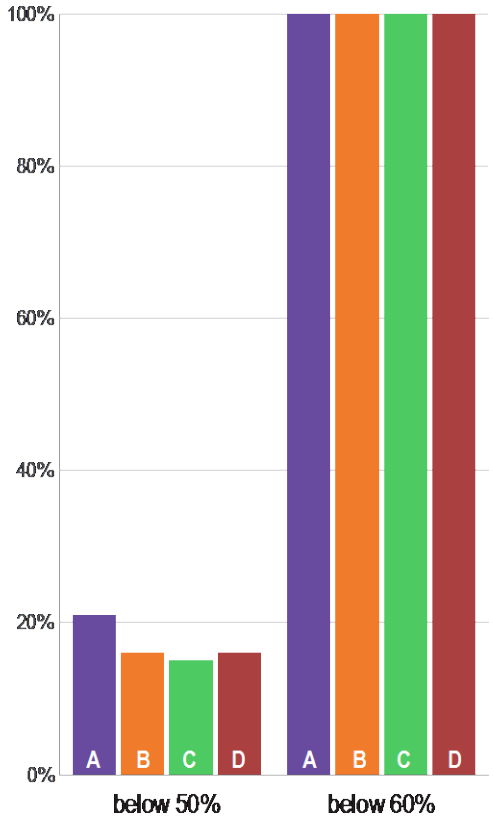
California Highway Patrol (CHP)

Measure 1:

Probability of PERF **funded status falling below 50% or 60%** over the next 30 years



Measure 2:

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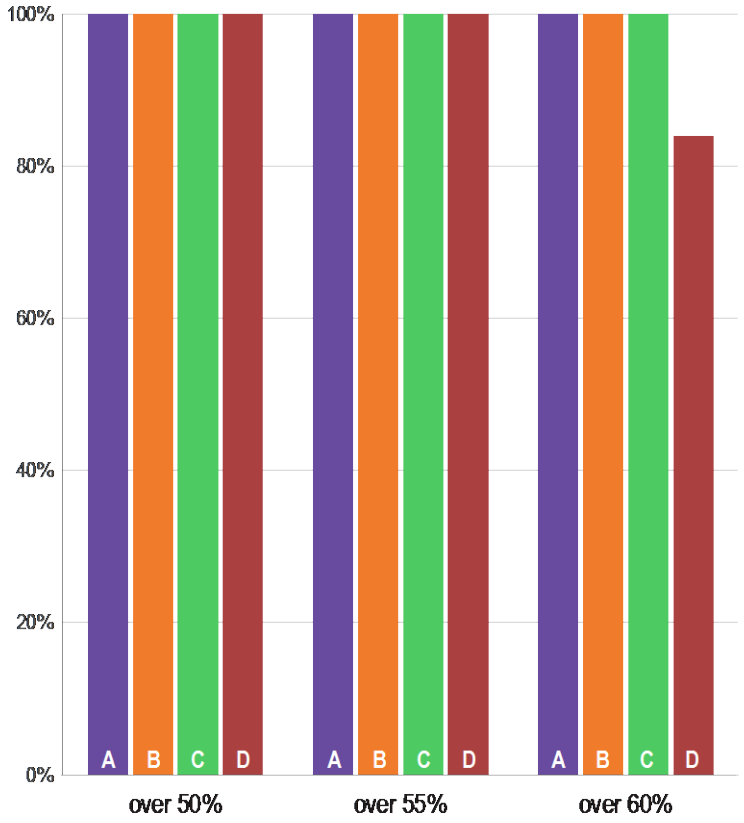

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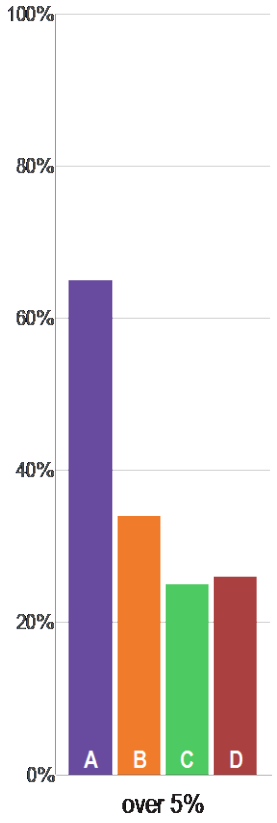

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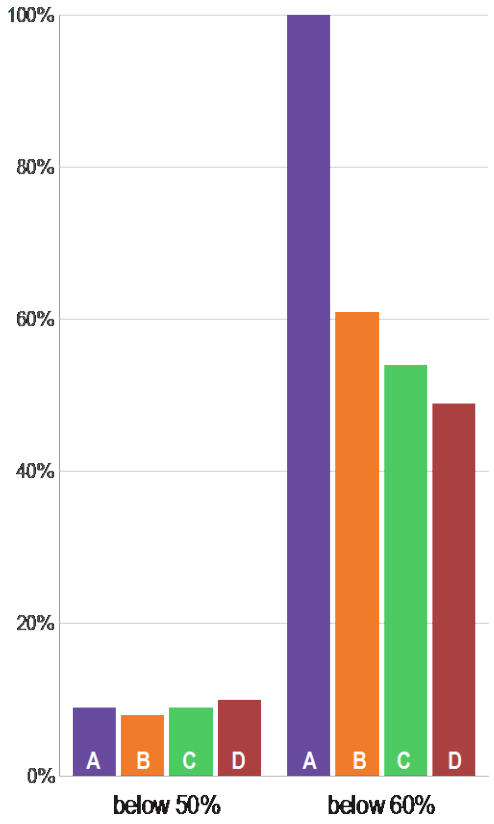
Public Agency Safety

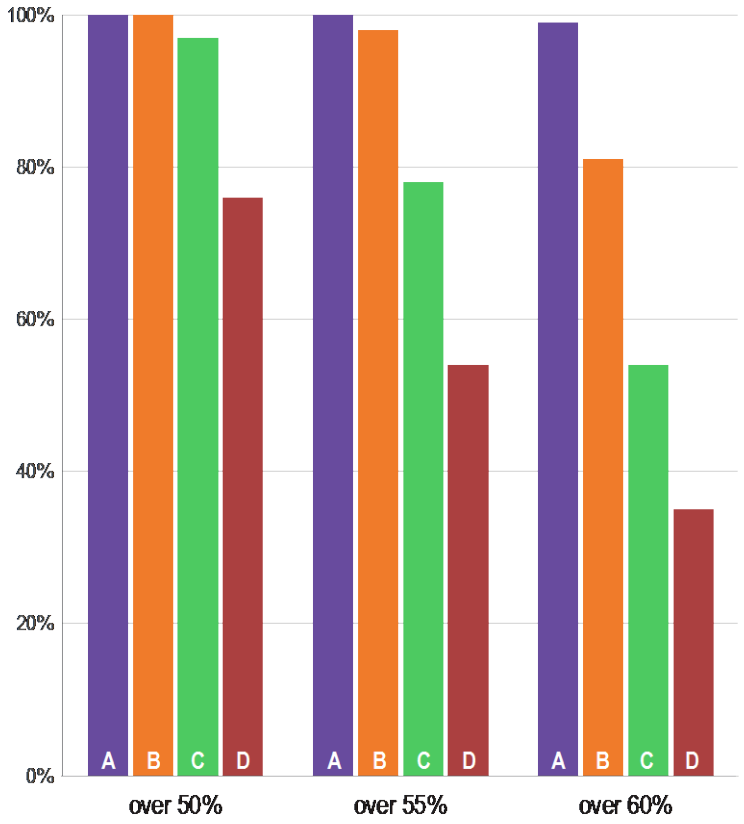
Measure 1:

Probability of PERF **funded status falling below 50% or 60%** over the next 30 years



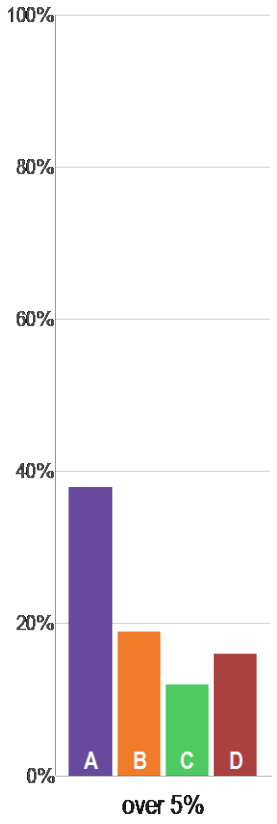
Measure 2:

Probability of high **employer contribution rates over 50% / 55% / 60%**

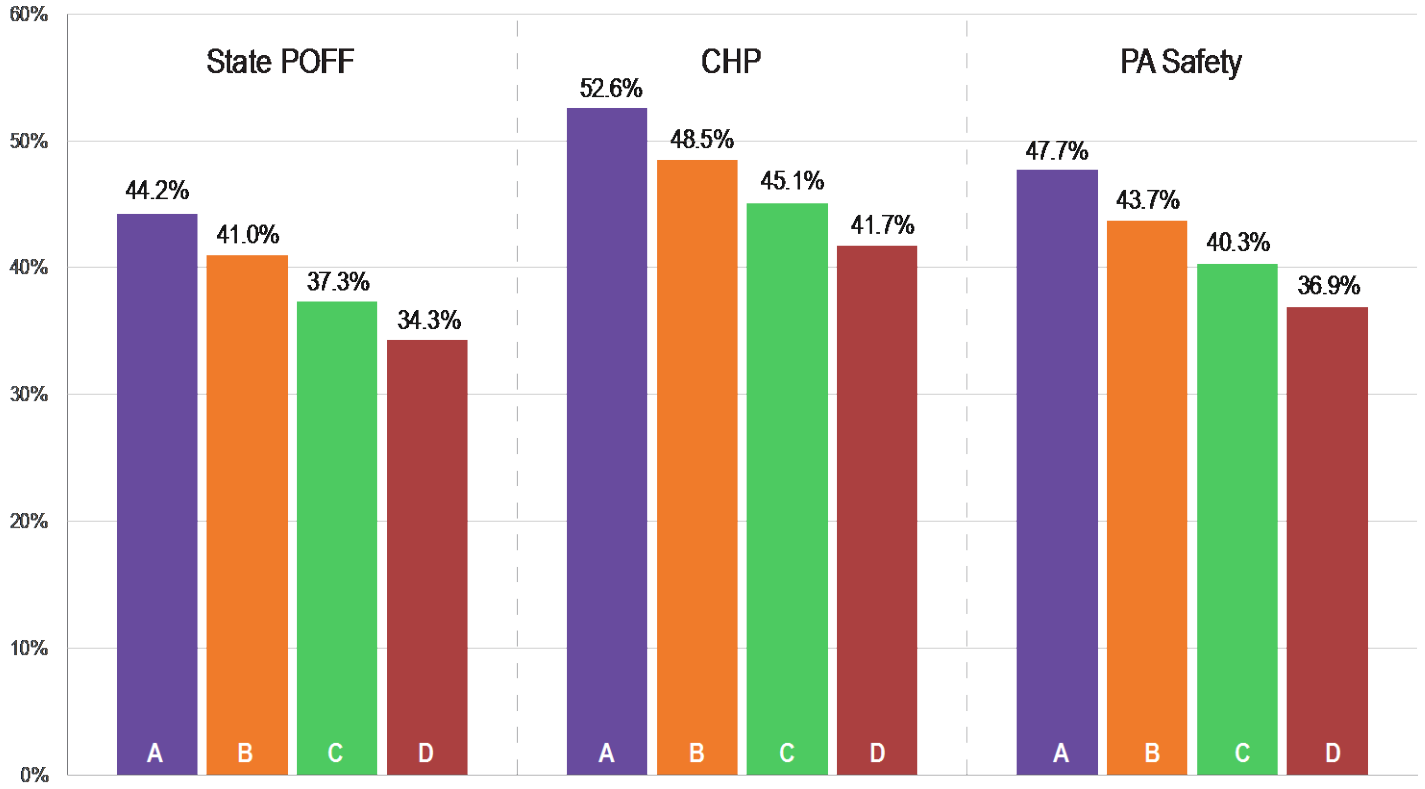


Measure 3:

Probability of sharp **increase in annual employer contribution rates over 5%**



Average Employer Contribution Rates Over Next 30 yrs (percentage of payroll)



CalPERS Pension Beliefs

- Pension Belief 4

  A retirement plan should…have professionally managed funds with a long-term horizon, and incorporate pooled investments and pooled risks

- Pension Belief 5

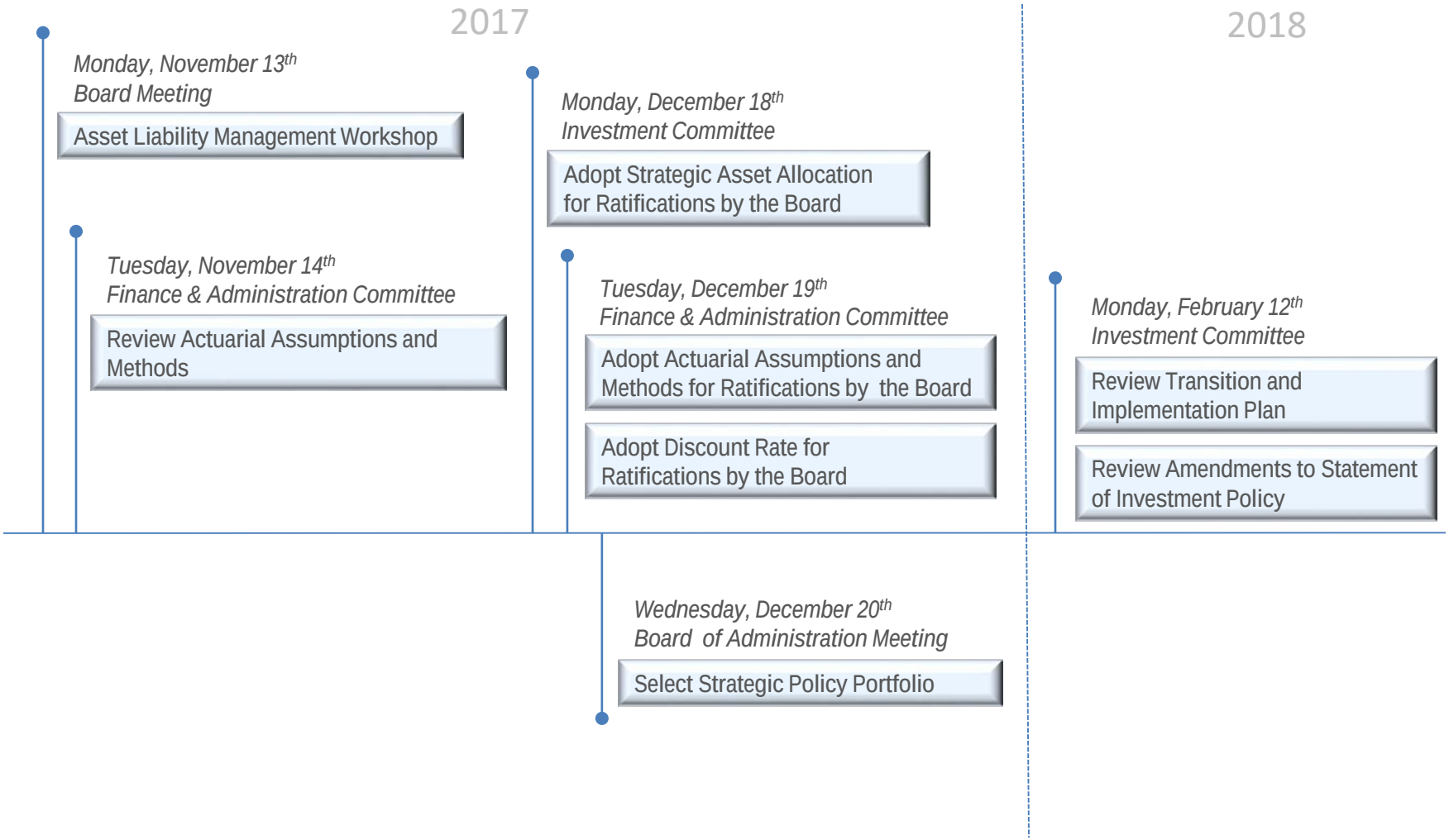
  Funding policies should be applied in a fair, consistent manner, accommodate investment return fluctuations and support rate stability

- Pension Belief 7

  Retirement system decisions must give precedence to the fiduciary duty owed to members, but should also consider the interests of other stakeholders

Recap and Next Steps

2017-18 ALM Timeline



Appendix

Asset Liability Management Related Activities – Workshop and Open Session

Jul 2015	Offsite Workshop - Investment Portfolio Priorities
Jul 2015	Offsite Workshop – Investment Beliefs
Sep 2015	Investment Committee – Investment Beliefs Implementation Findings
Nov 2015	Investment Committee Workshop – Private Equity
Jan 2016	Offsite Workshop - Investment Portfolio Priorities (three identified)
Apr 2016	Investment Committee – Private Asset Class Roles and Benchmarks
May 2016	Investment Committee – Private Asset Class Roles and Benchmarks
Jun 2016	Investment Committee – Interim Asset Allocation Targets Review
Jul 2016	Offsite Workshop – Investment Portfolio Priorities (EDHEC Risk Factor review, Benchmark review)
Sep 2016	Investment Committee - Risk reduction
Nov 2016	Finance and Administration Committee – Securing CalPERS Future – Managing Funding Risks, Stakeholder Outreach and Engagement
Dec 2016	Finance and Administration Committee Workshop – Securing CalPERS Future – Managing Funding Risks, Stakeholder Outreach and Engagement (Phase in discount rate reduction to 7%)
Apr 2017	Investment Committee – Private Asset Class Roles and Benchmarks
May 2017	Investment Committee – Private Asset Class Roles and Benchmarks
Jun 2017	Investment Committee – Adoption of Capital Markets Assumptions
Jul 2017	Offsite Workshop – Use of Leverage in Strategic Asset Allocation

Investment Portfolio Priorities

Specific to CalPERS, implementable, and will influence portfolio construction:

1. Protect the Funded Ratio

   (*mitigate severe drawdowns*)

2. Stabilize Employer Contribution Rates

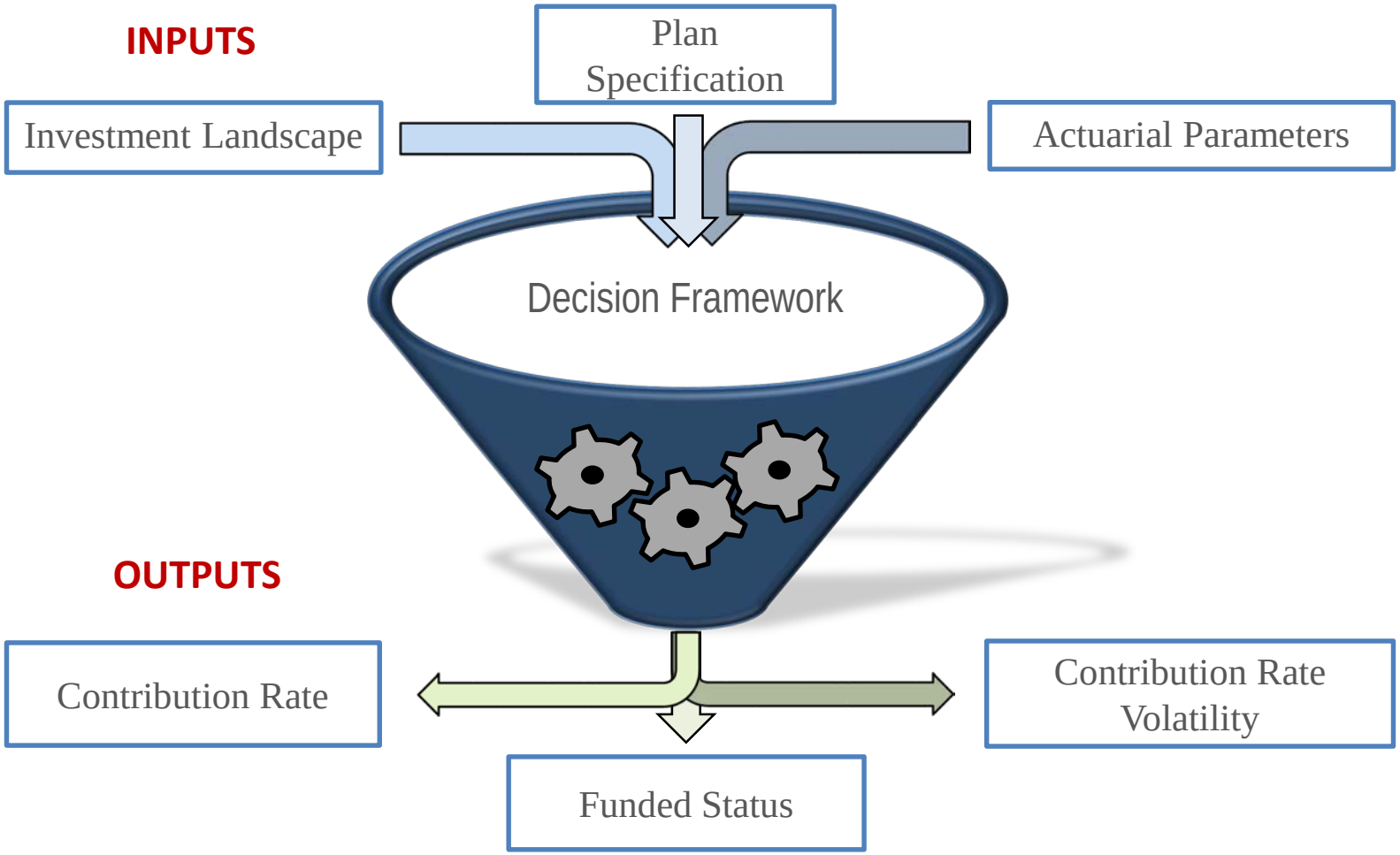
   (*manage overall volatility*)

3. Achieve Long-term Required Rate of Return

   (*over the long run, but not in every market environment*)

"Asset allocation is the dominant determinant of portfolio risk and return"
Investment Belief 6

Asset Liability Decision-Making Framework



ALM Objectives Reflect Investment Beliefs

	Short Name	Investment Belief
1	Liabilities	Liabilities must influence the asset structure.
2	Long-Term Horizon	A long time investment horizon is a responsibility and an advantage.
3	Stakeholders	CalPERS investment decisions may reflect wider stakeholder views.
4	Three Forms of Capital	Long-term value creation requires effective management of three forms of capital: financial, physical, and human.
5	Accountability	CalPERS must articulate its investment goals and performance measure and ensure clear accountability for their execution.
6	Strategic Allocation	Strategic asset allocation is the dominant determinant of portfolio risk and return.
7	Risk Reward	CalPERS will take risk only where we have a strong belief we will be rewarded.
8	Costs Matter	Costs matter and need to be effectively managed.
9	Multi-faceted Risk	Risk of CalPERS is multi-faceted and not fully captured through measures such as volatility or tracking error.
10	Resources / Process	Strong processes and teamwork and deep resources are needed to achieve CalPERS' goals and objectives.

Asset Class Roles & Benchmarks

Global Equity

- Role: Total return oriented and to capture the equity risk premium (ERP), defined as the excess return over risk-free Government Bonds, by means of ownership risk in companies and exposure to corporate earnings growth. The major driver is appreciation, with some cash yield.
  - Growth
  - Liquidity
- Benchmark: Global All-World All Capitalization

Private Equity

- Role: Enhance equity returns through an active, value-added approach. The major driver for returns is appreciation, aided by leverage, with negligible cash yield.
  - Growth
- Benchmark: Global All-World All Capitalization + Return Premium

Asset Class Roles & Benchmarks - Continued

Global Fixed Income

- Role: Serve as an economic diversifier to equity risk and be a reliable source of income.
  - Diversification
  - Income
  - Liquidity

- Benchmark: 90% Long Liabilities + 10% International Fixed Income Index

Real Assets

- Role: Own real assets with stable cash yield and act as an economic diversifier to equity risk.
  - Diversification
  - Income
  - Inflation

- Benchmark: U.S. Core Fund Index

Asset Class Roles & Benchmarks - Continued

Inflation Assets

- Role: Provide strong liquid protection against inflation.
  - Inflation
  - Liquidity

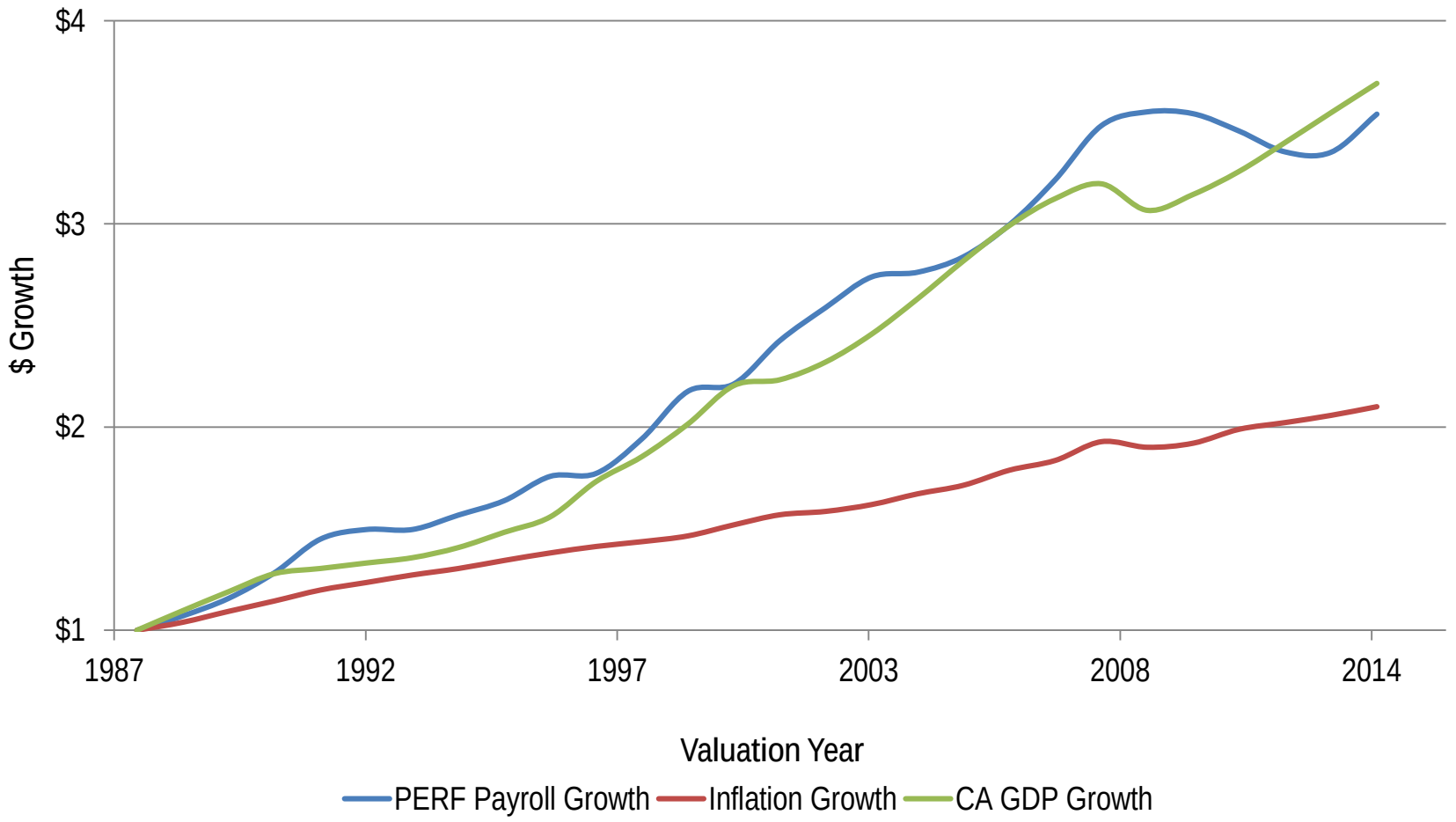
- Benchmark: 75% Inflation Linked Bond + 25% Commodities

Liquidity

- Role: Exhibit safety and capital preservation properties.
  - Liquidity

- Benchmark: 91 Day Treasury Bill

Common Factors for Liabilities & Assets



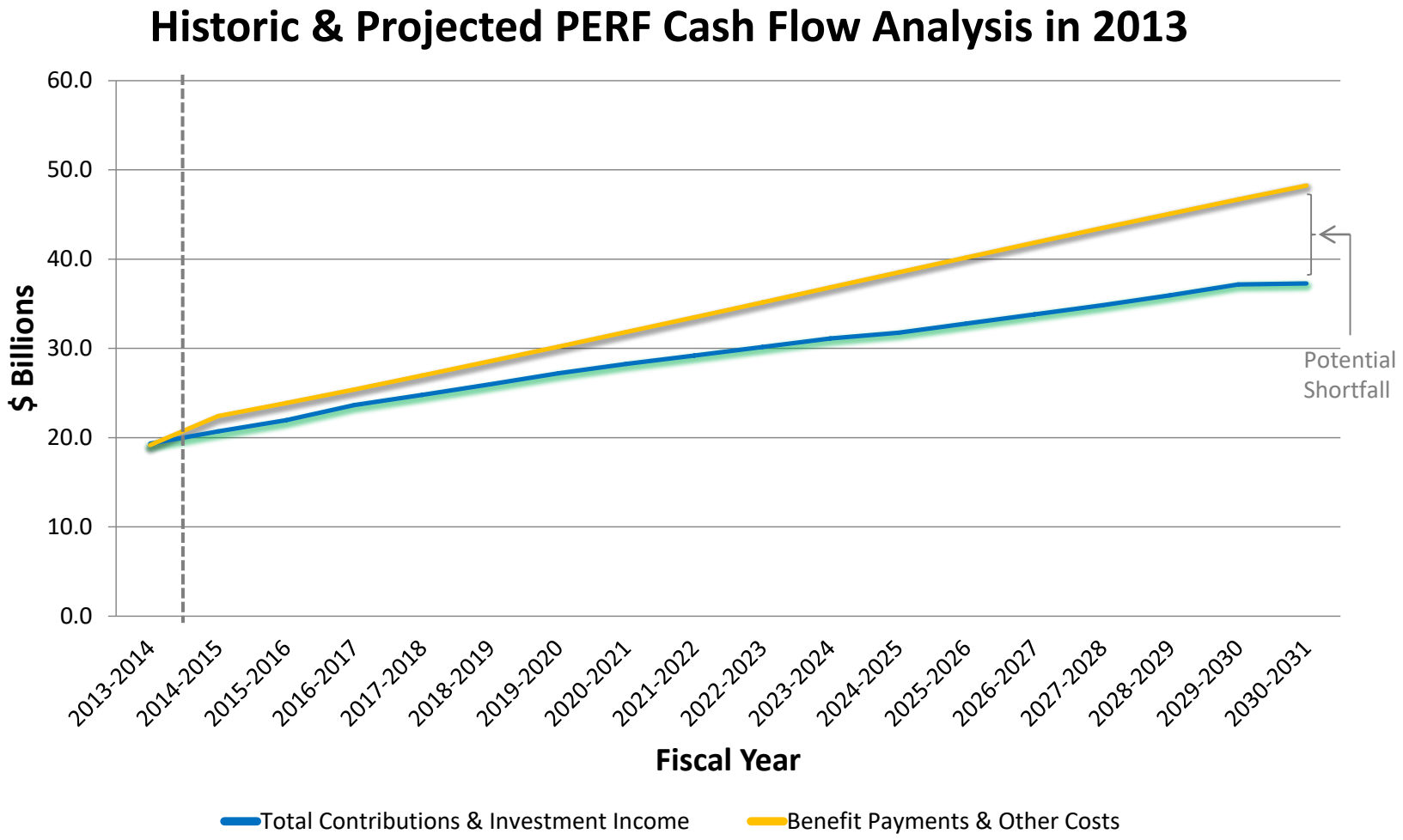
- Data Source: CalPERS Comprehensive Annual Financial Reports and Bloomberg

2017 Capital Market Assumptions

Asset Class	Arithmetic Return	Compound Return	Volatility (Std. Dev)	Correlation						Constraints (%)	
				Global Equity	Private Equity	Fixed Income	Real Asset	Inflation Asset	Liquidity	Floor	Cap
Global Equity	8.14%	6.80%	17.00%	1.00	0.81	0.01	0.59	0.39	0.00	0%	100%
Private Equity	11.26%	8.30%	25.50%	0.81	1.00	0.00	0.48	0.33	0.00	5%	8%
Fixed Income	3.21%	3.00%	6.58%	0.01	0.00	1.00	0.09	0.40	0.31	15%	100%
Real Asset	6.49%	5.75%	12.55%	0.59	0.48	0.09	1.00	0.21	0.00	9%	13%
Inflation Asset	3.08%	2.77%	8.00%	0.39	0.33	0.40	0.21	1.00	0.08	0%	12%
Liquidity	2.00%	2.00%	1.00%	0.00	0.00	0.31	0.00	0.08	1.00	1%	100%

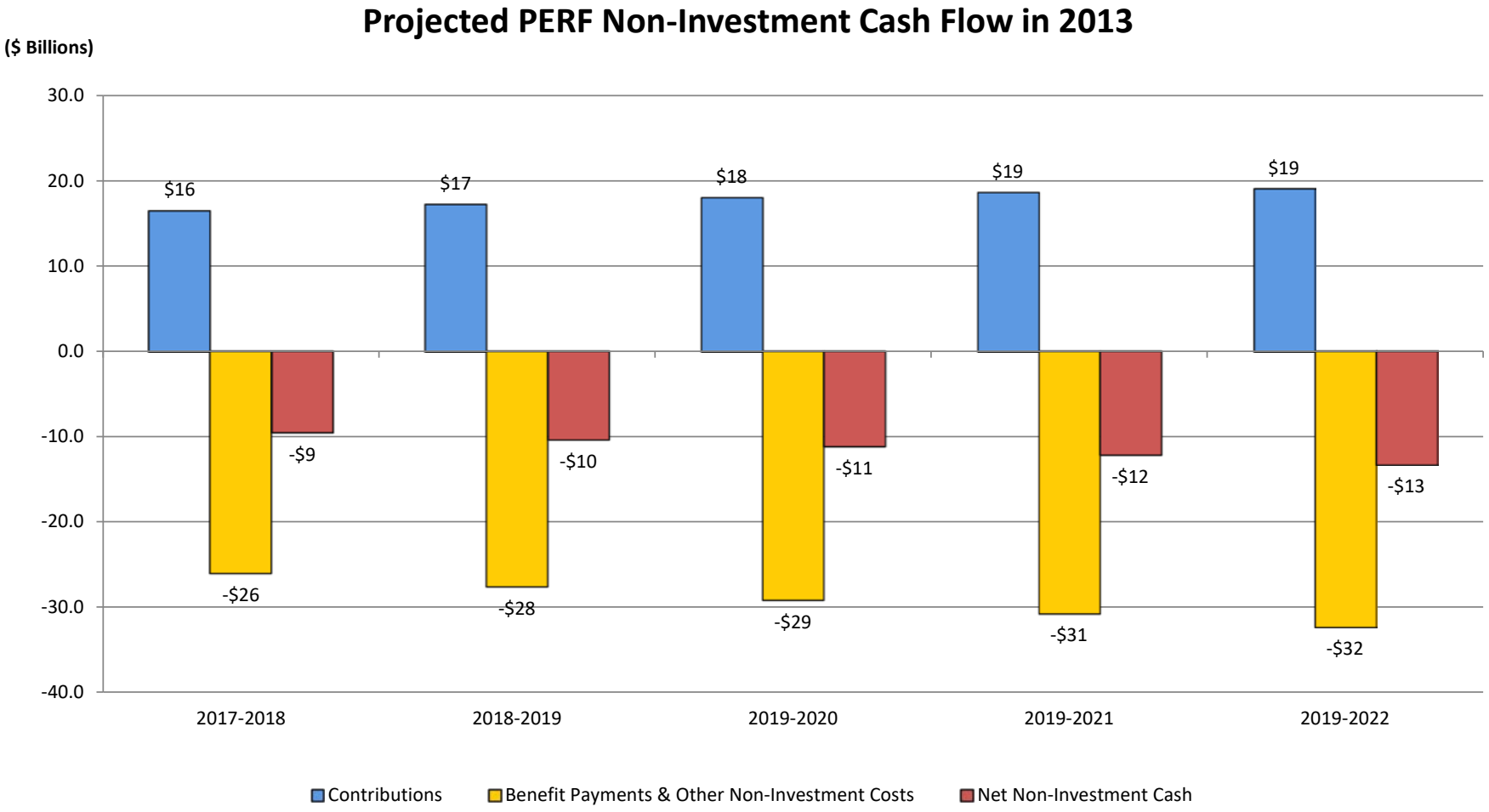
U.S. Inflation Assumption: 2.00%

Cash Flows with 7.5% Discount Rate and 2013 Allocation



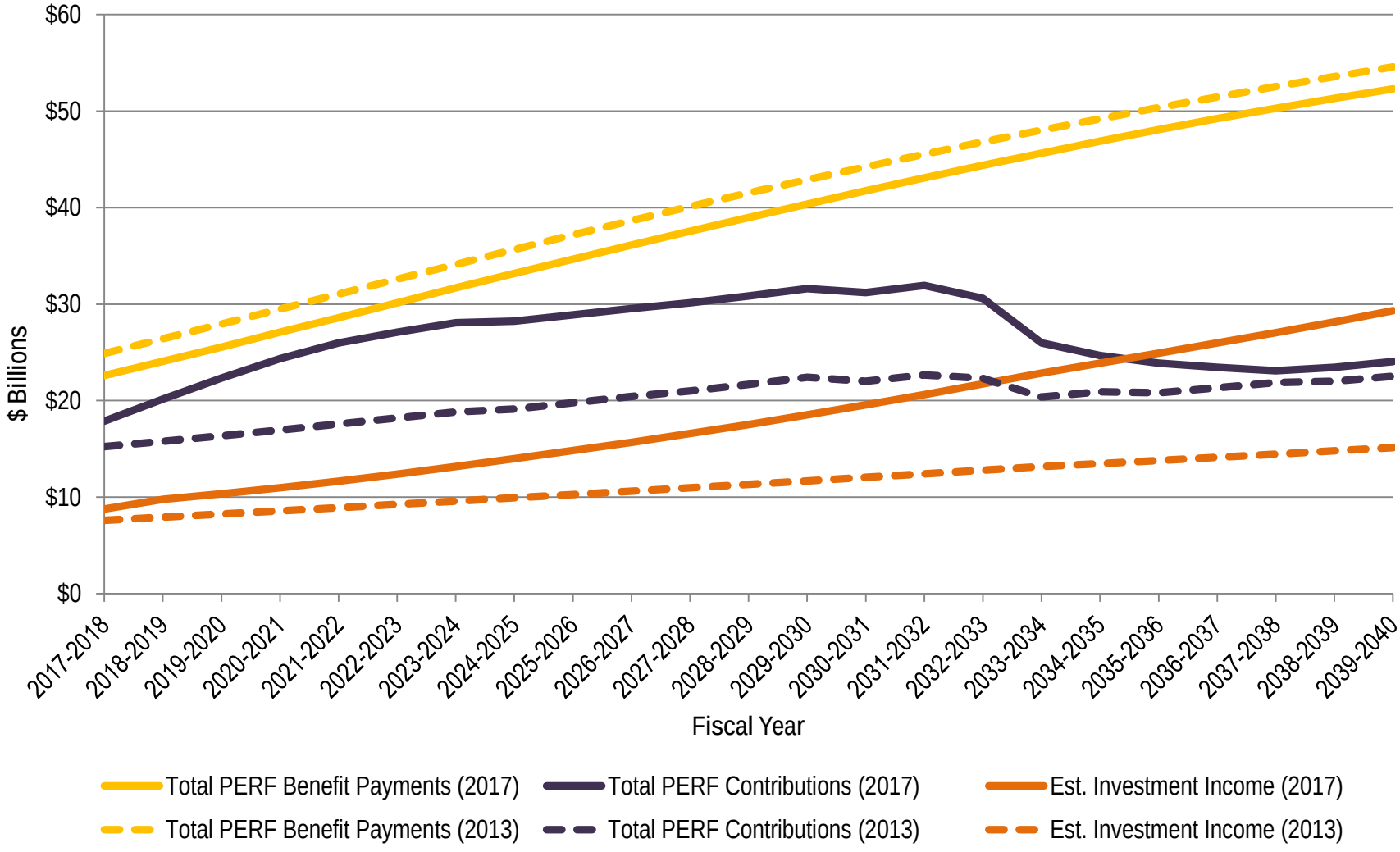
- Investment Income has an assumed cash yield of 2.37% based on PERF policy asset allocation.
- Investment income only includes income from Global Equity (dividends), Global Fixed Income (coupons), and Real Assets (rent).
- Other Costs include refunds, administrative costs of retirement, and investment base fees

Cash Flows with 7.5% Discount Rate and 2013 Allocation



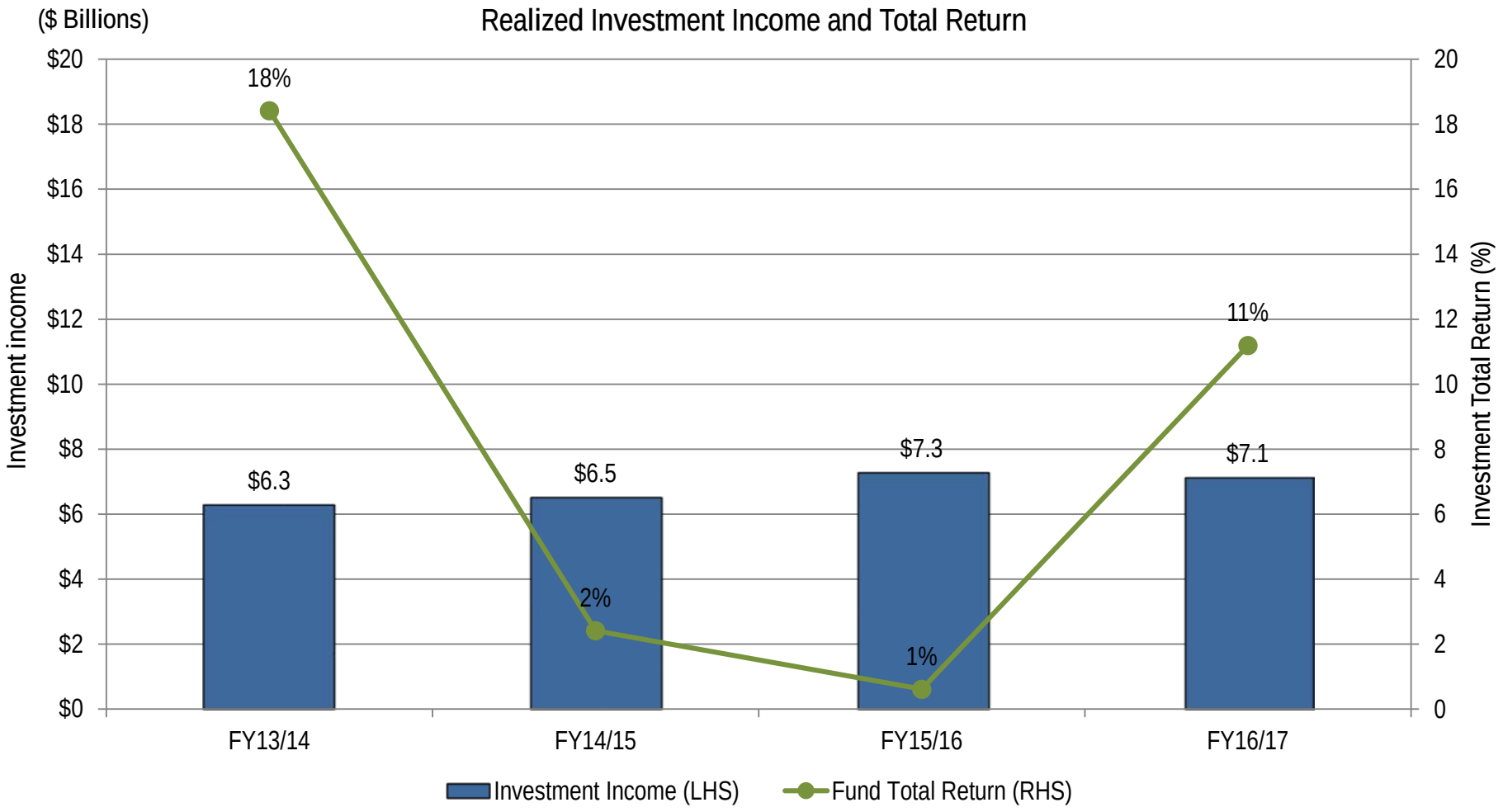
- Net Non-Investment Cash Flows defined as follows:
  Estimated Contributions - Estimated Benefit Payments - Refunds - Administrative costs
- Other Costs include refunds, administrative costs of retirement, and investment base fees

Contribution, Benefit Payments and Investment Income 2013 and Today



- Data Source: 2013 and 2017 Contribution and Benefit Payments are from ACTO.
- Investment Income assumes implementation of "Candidate Portfolio C." Investment income only includes income from Global Equity (dividends), Global Fixed Income (coupons), and Real Assets (rent).

Stability of Investment Income



- Investment income defined as cash income from:
  Global Equity (dividends), Global Fixed Income (coupons), Real Assets (rent)