



PERSPECTIVES THAT DRIVE ENTERPRISE SUCCESS



APRIL 4, 2018

Asset Liability Study: Phase 3

Fresno County Employees' Retirement Association

Table of Contents



VERUSINVESTMENTS.COM

SEATTLE 206-622-3700

LOS ANGELES 310-297-1777

SAN FRANCISCO 415-362-3484

Executive summary	3	Stochastic projections	28
2013 Verus forecasts	4	Next steps	33
Capital market assumptions comparison	8	Appendix	35
Asset-Liability modeling: setting the stage	14		
Deterministic projections	18		

Past performance is no guarantee of future results. This document is provided for informational purposes only and is directed to institutional clients and eligible institutional counterparties only and is not intended for retail investors. Nothing herein constitutes investment, legal, accounting or tax advice, or a recommendation to buy, sell or hold a security or pursue a particular investment vehicle or any trading strategy. This document may include or imply estimates, outlooks, projections and other “forward-looking statements.” No assurance can be given that future results described or implied by any forward looking information will be achieved. Investing entails risks, including possible loss of principal. Verus Advisory Inc. and Verus Investors, LLC (“Verus”) file a single form ADV under the United States Investment Advisors Act of 1940, as amended. Additional information about Verus Advisory, Inc. and Verus Investors, LLC is available on the SEC’s website at www.adviserinfo.sec.gov. Verus – also known as Verus Advisory™ or Verus Investors™.

Executive summary

The goal of this discussion is to revisit a couple of follow-up items relating to our Capital Market Assumptions as well as review the completed asset-liability modeling.

- At the March meeting, we reviewed our 2018 Capital Market Assumptions as a part of the second phase of the Asset-Liability Study. This discussion prompted a couple of questions that Verus committed to following-up on:
 - How well have our 2013 Capital Market Assumptions forecasted returns?
 - For the most part, actual returns realized over the last five years have been consistent with the range of expected outcomes associated with our 2013 Capital Market Assumptions.
 - What do our 2018 Capital Market Assumptions look like relative to other firms?
 - Verus' 2018 Capital Market Assumptions fall mostly in-line with the long-term assumptions of several other leading investment firms.
- To better understand the set of risk and return trade-offs relative to liabilities, we have modeled the impact of various scenarios and stress tests on FCERA and the “goal post” portfolios discussed at the March meeting.
 - Moving from today (78% funded) to fully funded is primarily a function investment returns and contributions.
 - While the Plan can get close to fully funded over 10 years, the cost of a volatile employer contributions (% of pay) outcome is uncertain.
- The set of risk and return characteristics determined by the Board as appropriate for FCERA will be used to conduct further asset-only modeling.

2013 Verus forecasts

Verus' 2013 Capital Market Assumptions at the half way point

Asset Class	Index Proxy	10 Yr (2013) Return Forecast (%)	5 Yr Actual Return (%) (Jan. 2013-Dec. 2017)	10 Yr (2013) Risk Forecast (%)	5 Yr Actual Risk (%) (Jan. 2013-Dec. 2017)
Equities					
US Large	S&P 500	6.3	15.8	16.8	9.5
US Small	Russell 2000	6.9	14.1	21.1	13.9
International Dev.	MSCI EAFE	8.0	8.4	19.1	11.7
International Small	MSCI EAFE Small Cap	8.3	13.2	22.8	11.6
Emerging Markets	MSCI EM	9.6	4.7	27.6	14.4
Private Equity	Cambridge Private Equity	9.9	12.4	32.8	6.5
Fixed Income					
Cash	30 Day T-Bills	1.7	0.2	1.0	0.1
US TIPS	BBgBarc US TIPS Index	2.2	0.1	4.6	4.5
Core Fixed Income	BBgBarc US Aggregate Bond	2.0	2.1	3.8	2.8
IG Credit	BBgBarc US Credit	3.0	3.2	5.2	3.9
High Yield Credit	BBgBarc High Yield	4.9	5.8	9.9	5.2
Global Sovereign	BBgBarc Global Treasury ex US	2.2	-0.4	3.5	7.2
Global Credit	BBgBarc Global Credit	3.7	3.1	7.0	4.3
EMD (Hard)	JPM EMBI Global Diversified	5.0	4.6	12.8	6.2
EMD (Local)	JPM GBI EM Global Diversified	5.7	-1.4	11.3	11.7
Other					
Commodities	S&P GSCI	4.3	-12.2	16.6	17.8
Hedge Funds	HFR Fund of Funds	5.4	4.0	11.5	3.3
Core Real Estate	NCREIF Property	5.6	10.2	10.9	4.2
REITs	Wilshire REIT	5.6	9.3	21.8	13.7

We use a data driven and systematic process for constructing 10 year forecasts with the intent of capturing asset class variability over an entire market cycle.

Over shorter time periods asset classes can perform very differently.

Note: Risk is measured by standard deviation. 5 Yr actual risk for Private Equity is smoothed due to the Cambridge Private Equity Index.

Range of likely 10 year outcomes

10 YEAR RETURN 90% CONFIDENCE INTERVAL

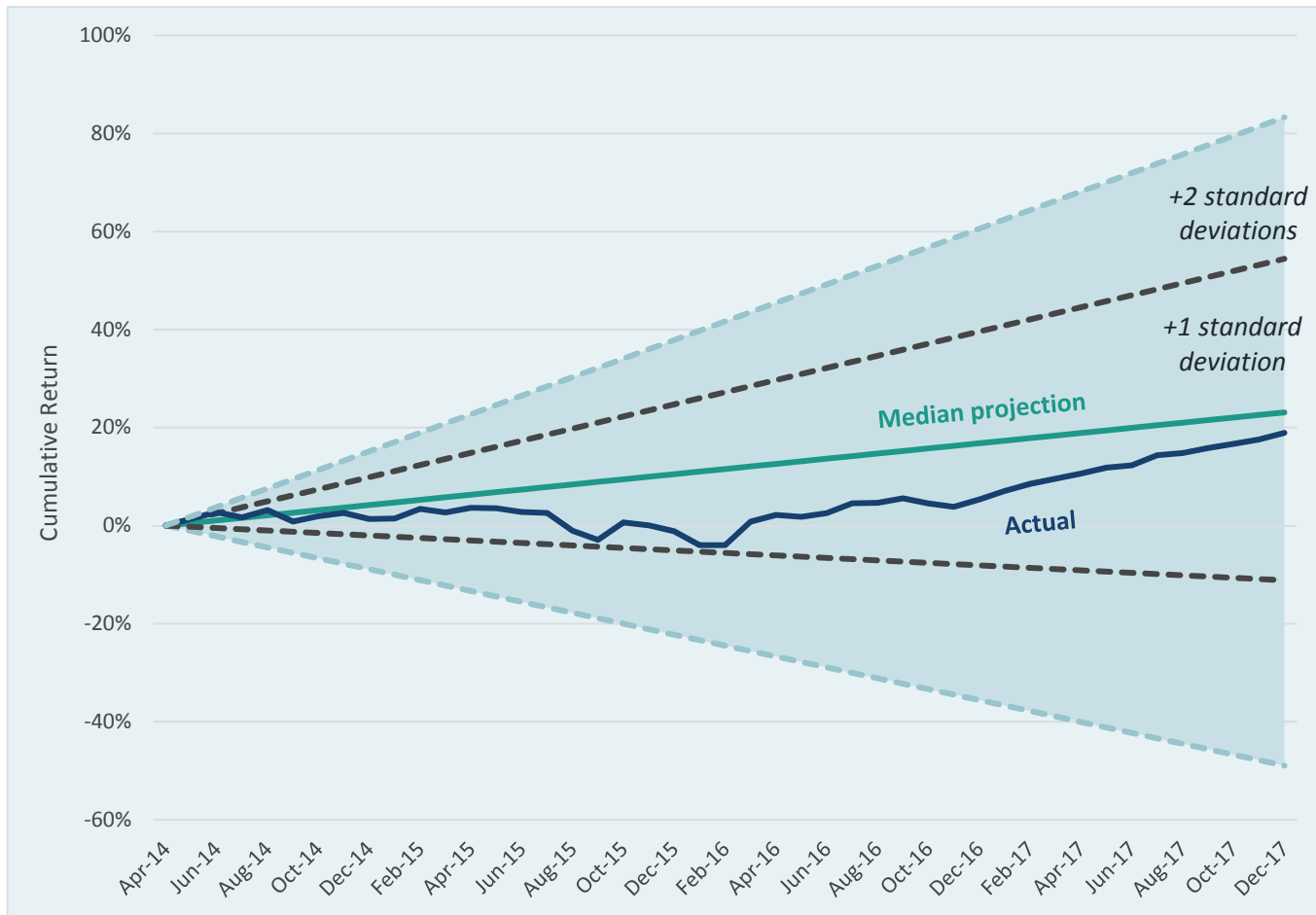


For the most part, actual asset class returns over the last five years have been consistent with the range of expected outcomes over ten years.

Commodities have experienced a significant bear market.

FCERA realized performance

FCERA'S REALIZED PERFORMANCE VS. 2013 AL STUDY PROJECTIONS



Note: Asset allocation approved during the 2013 AL Study did not go into effect until April 2014. Sharpe Ratio Projection used Risk Free Rate Projection of (1.7%). Realized Sharpe Ratio used Cash Return during period (0.2%).

The realized performance has been below the projected 6.5% return but well within the range of expected outcomes.

2013 AL Study Projection:

6.5% return
9.5% standard deviation
0.50 Sharpe Ratio

Actual since 5/1/2014:

5.3% return
5.4% standard deviation
0.92 Sharpe Ratio

Capital market assumptions comparison

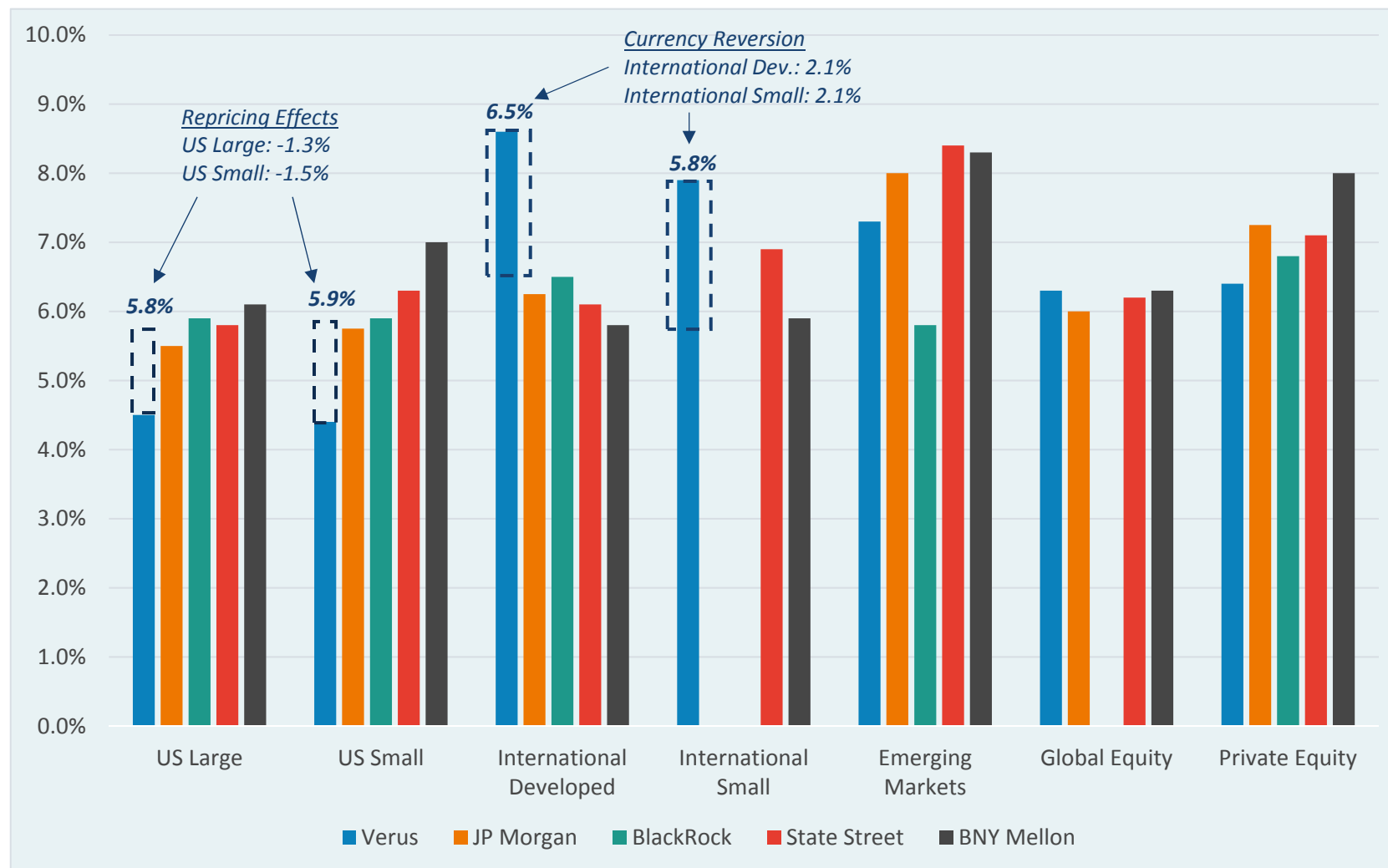
CMA methodologies

- In January of each year, Verus prepares forward looking 10 year return and risk assumptions for various asset classes.
 - At a high level, the method utilized is a “building block” approach, analyzing the return drivers of each asset class (i.e. inflation, earnings growth, starting yields, etc.).
- While we do not incorporate forecasts from other firms into our assumptions, we do gather this data for comparison purposes. Today, we will review similar long-term assumptions from several other leading investment firms.
 - JP Morgan:
 - Utilizes a proprietary process that draws on quantitative and qualitative inputs as well as insights from employees across J.P. Morgan Asset Management to construct expectations for risks and returns over a 10-to-15 year time horizon.
 - BlackRock:
 - BlackRock’s assumptions reflect ‘equilibrium’ or ‘valuation-neutral’ market conditions expected over the long run (i.e., greater than 5 years). Its approach is based on the capital asset pricing model, which holds that each asset class earns a return equal to the risk-free rate plus a risk premium.
 - State Street:
 - State Street constructs 10+ year forward-looking estimates of return and risk generated through a combined assessment of current valuation measures, income payouts, economic growth, inflation prospects, and historical risk premia.
 - BNY Mellon:
 - Utilizes a number of quantitative and qualitative factors to construct assumptions based on a 10 year investment time horizon.

One-to-one comparisons between firms are often difficult to due differing time horizons and methodologies.

Source: Verus, JP Morgan, BlackRock, State Street, BNY Mellon

Equity forecasted returns

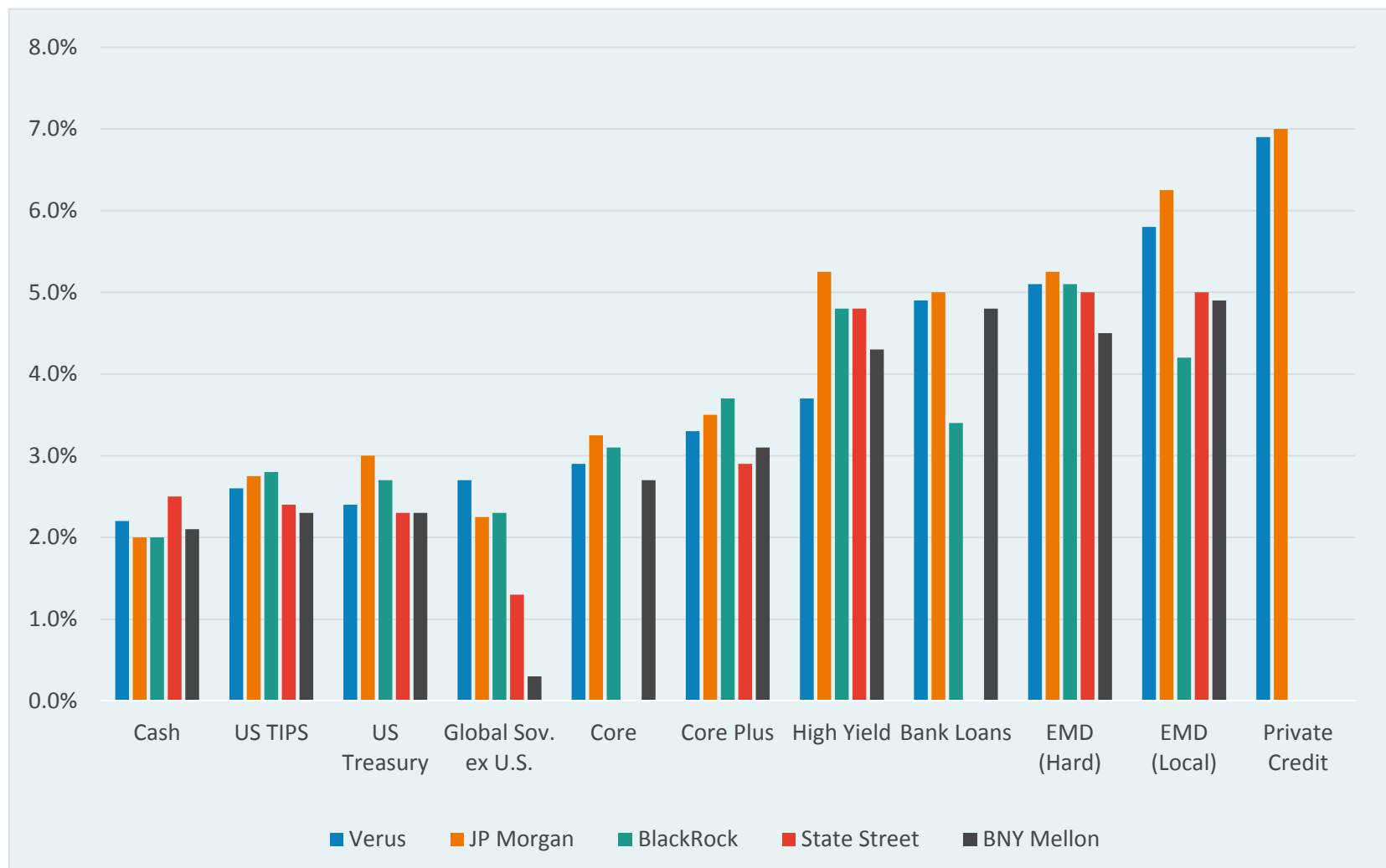


Our 10 year equity return forecasts fall mostly in-line with the other firms.

The biggest differences occur in US Equities and International Equities (Developed and Small Cap).

Source: Verus, JP Morgan, BlackRock, State Street, BNY Mellon

Fixed income forecasted returns

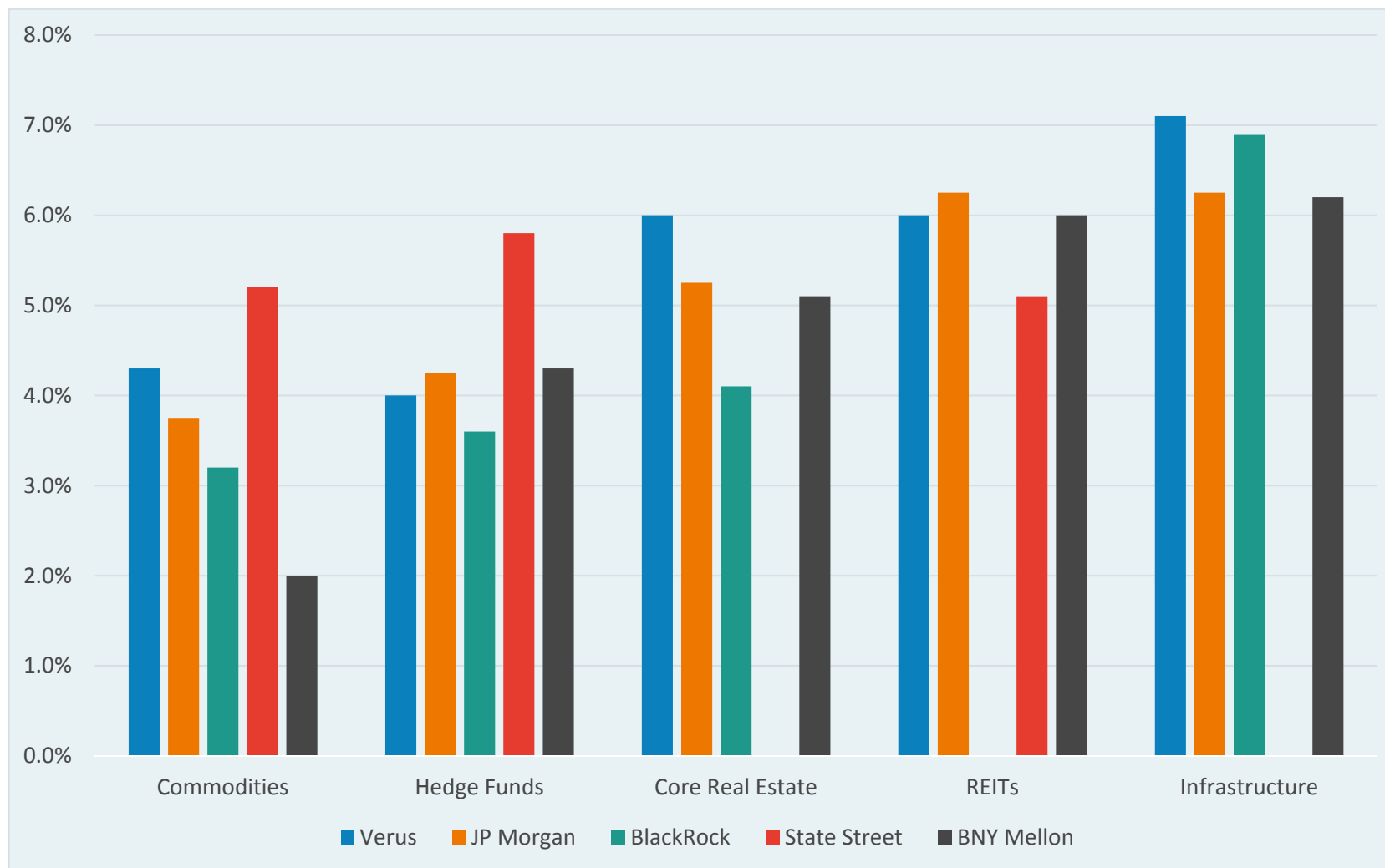


Our 10 year fixed income return forecasts fall mostly in-line with the other firms.

The biggest difference occurs in High Yield Bonds.

Source: Verus, JP Morgan, BlackRock, State Street, BNY Mellon

Other forecasted returns

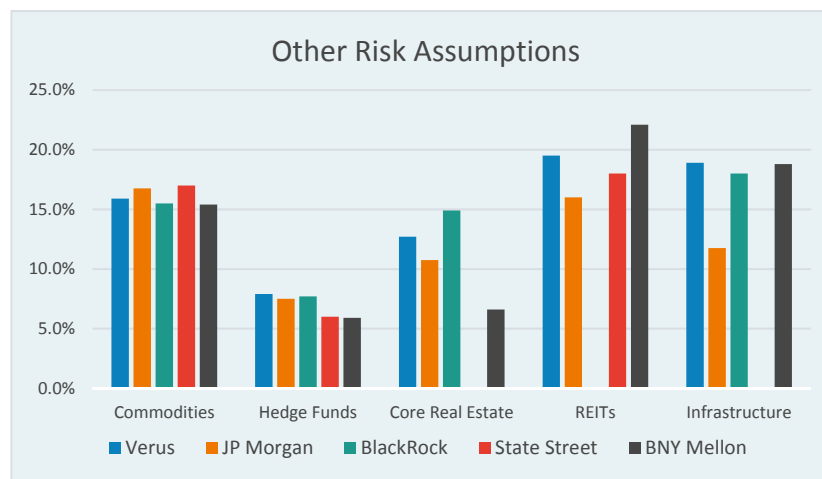
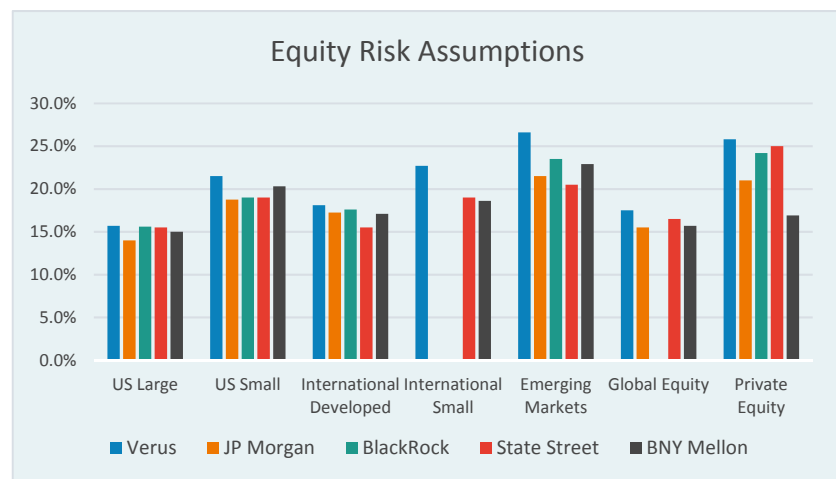
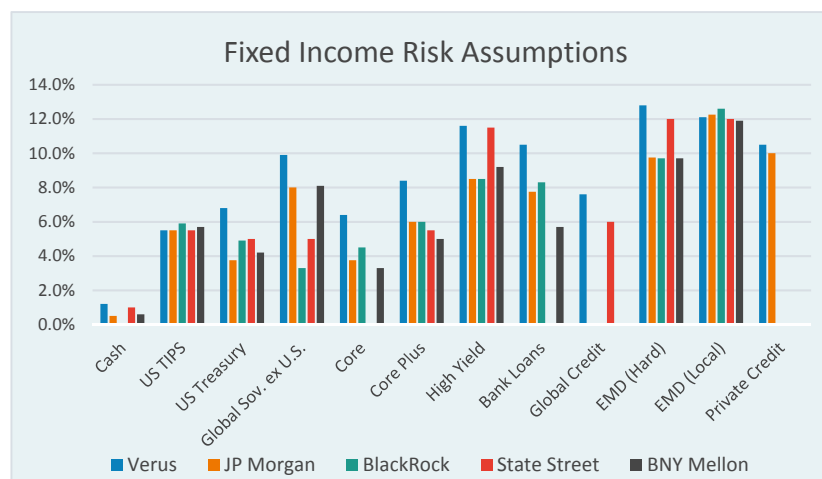


Our other 10 year return forecasts fall mostly in-line with the other firms.

Source: Verus, JP Morgan, BlackRock, State Street, BNY Mellon

Forecasted risk assumptions

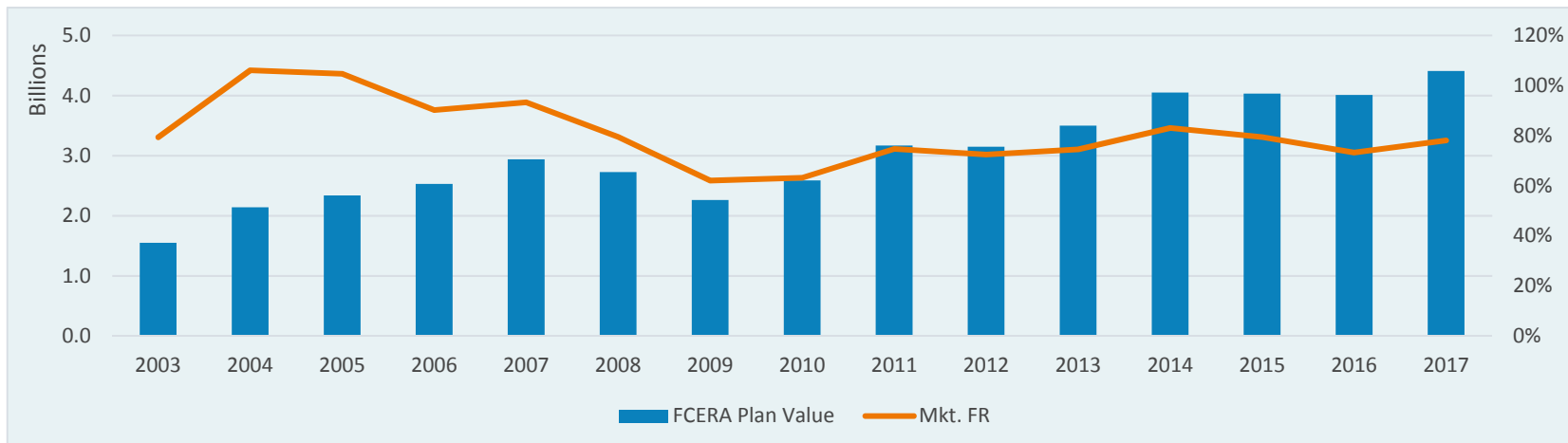
- Our 10 year risk forecasts fall mostly in-line with the other firms.
- The biggest differences occur within fixed income asset classes.



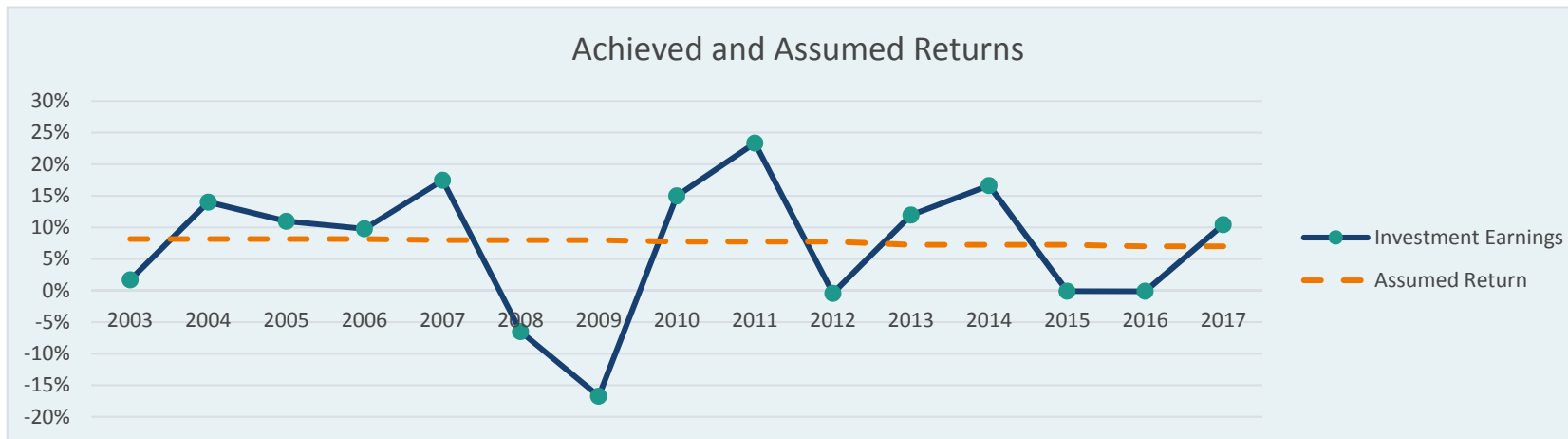
Source: Verus, JP Morgan, BlackRock, State Street, BNY Mellon

Asset-Liability modeling: setting the stage

Plan value and performance

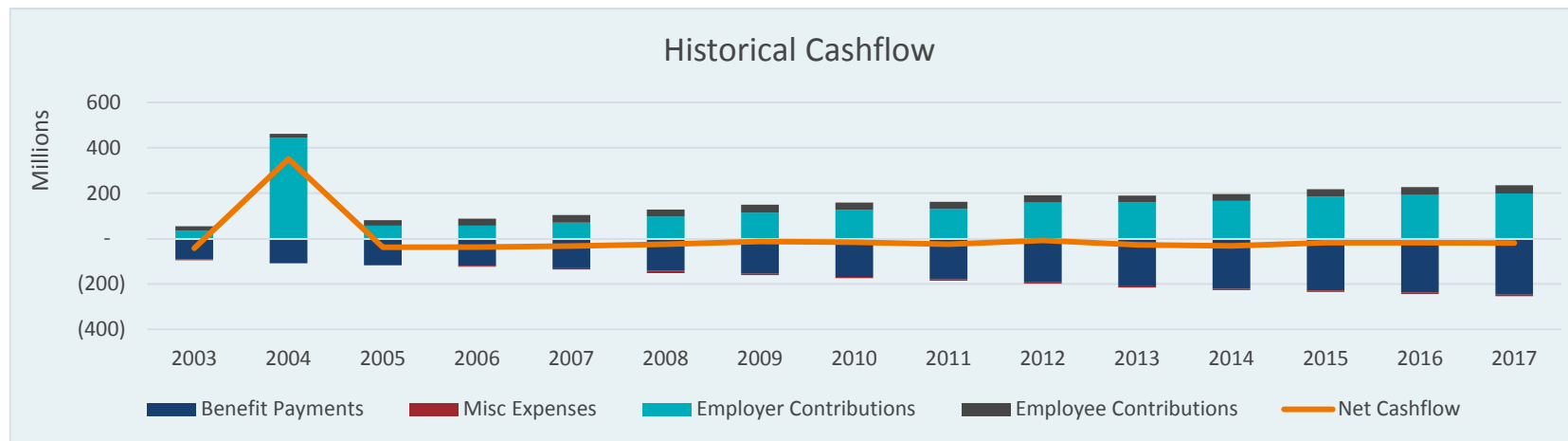


Although historical returns have not consistently met the assumed rate, assets have recovered significantly since the Global Financial Crisis.

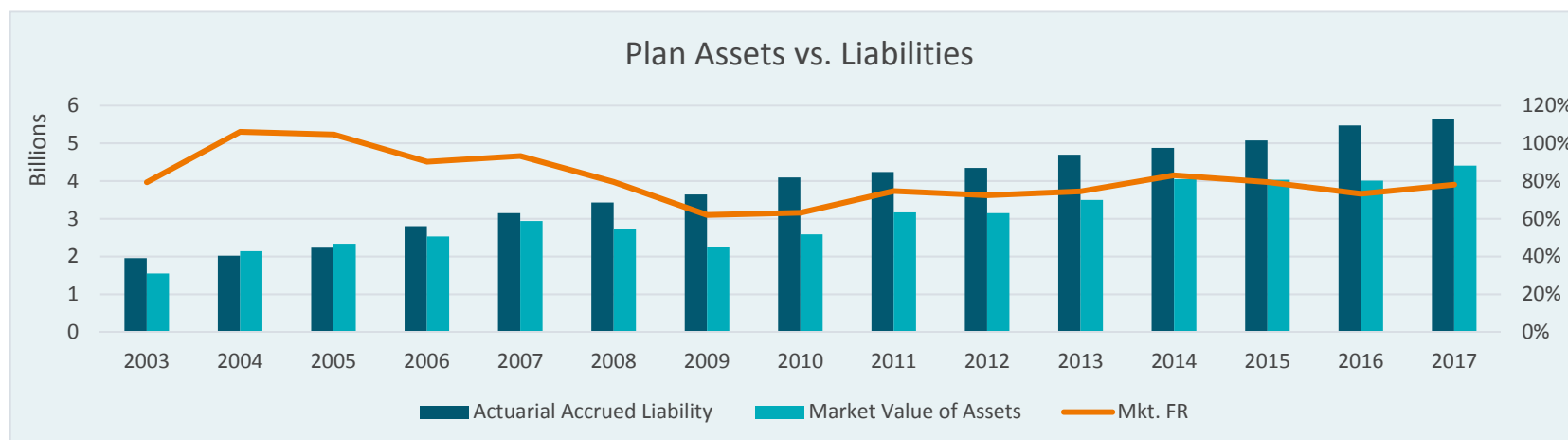


Data taken from FCERA Actuarial Valuations. Dates represented as Fiscal Year ending June 30th. Investment earnings are represented by annual returns.

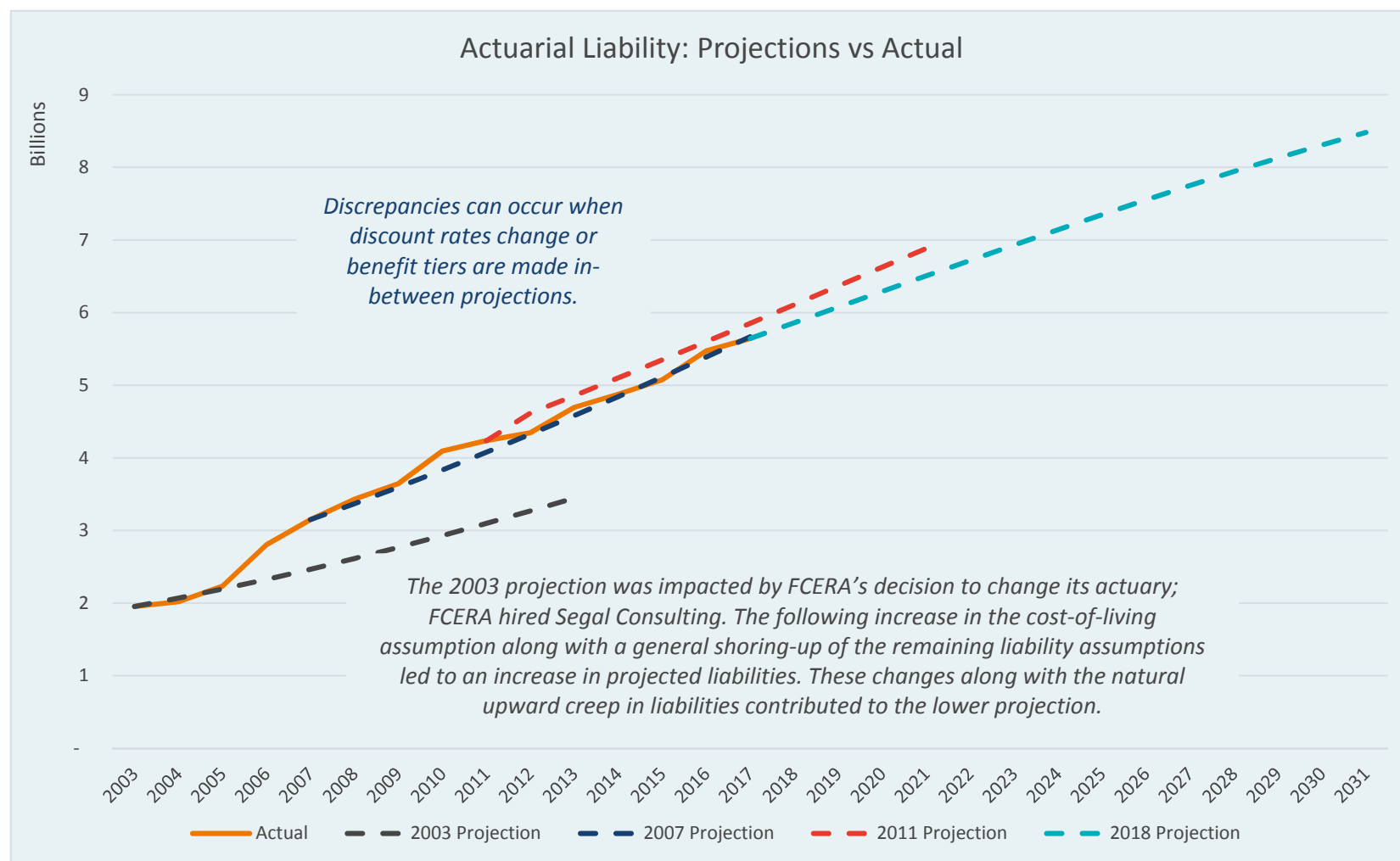
Benefit payments and contributions



Aggregate benefits have increased steadily along with plan sponsor contributions.



Actuarial projections



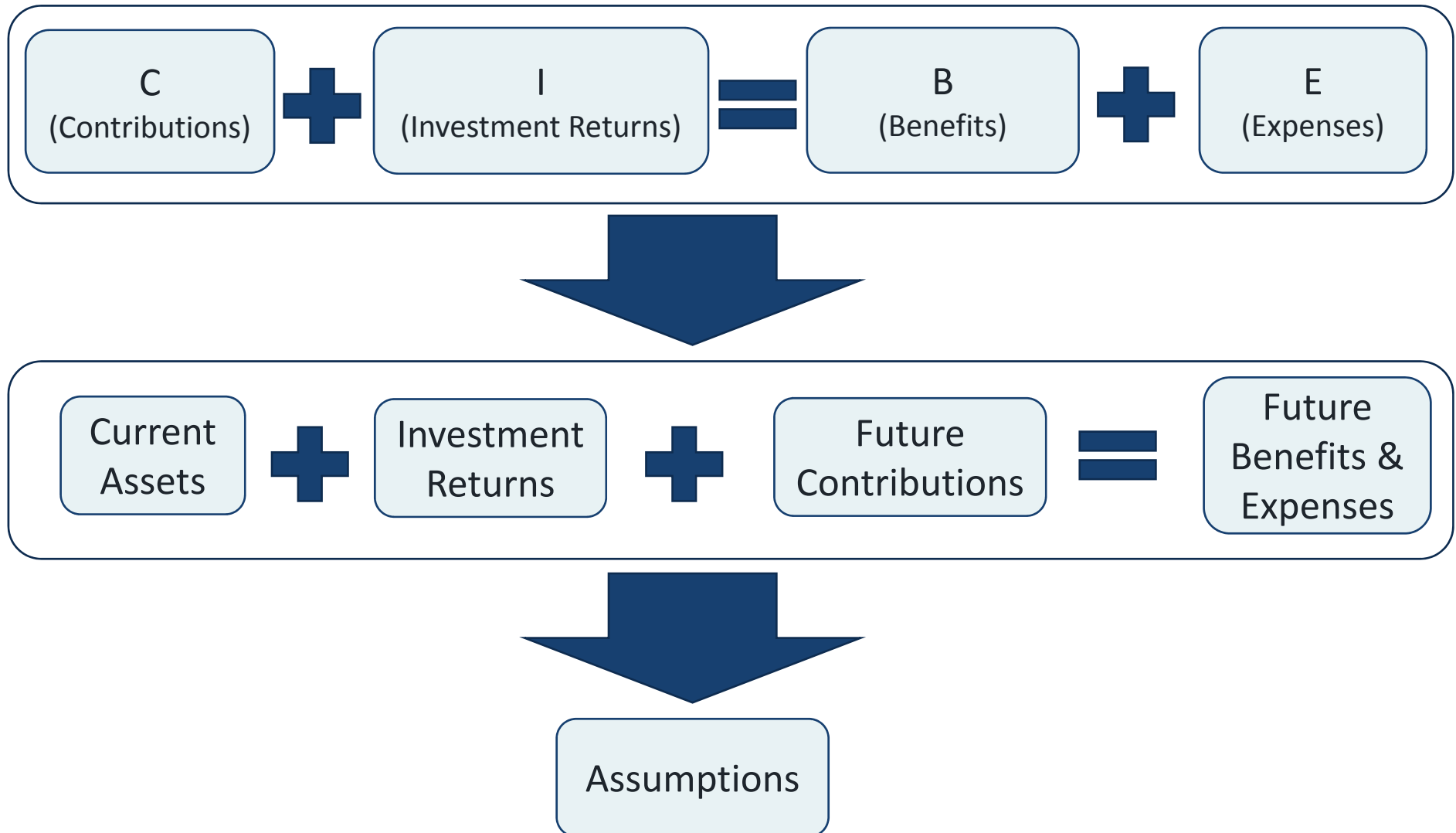
This will be the fourth asset-liability study completed by Verus.

To become fully funded by 2031, the plan will require roughly \$8.5 billion in assets.

Projection from prior Asset Liability studies done for FCERA by Verus. Actual liability data taken from FCERA actuarial valuations from 2003 till 2017.

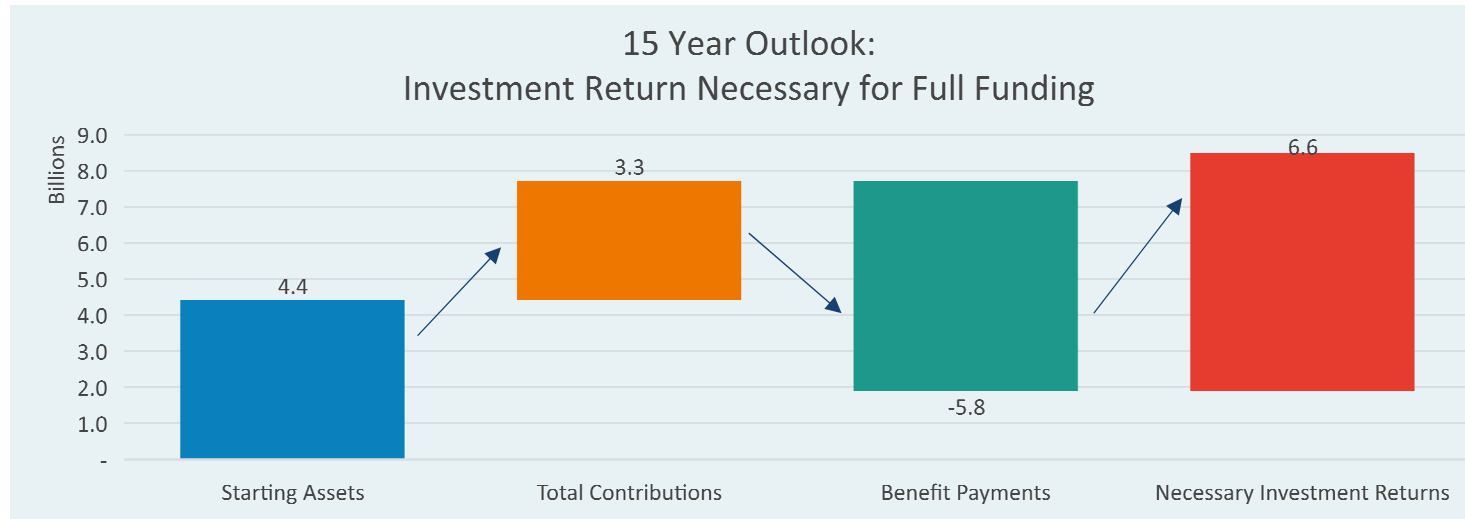
Deterministic projections

The pension equation

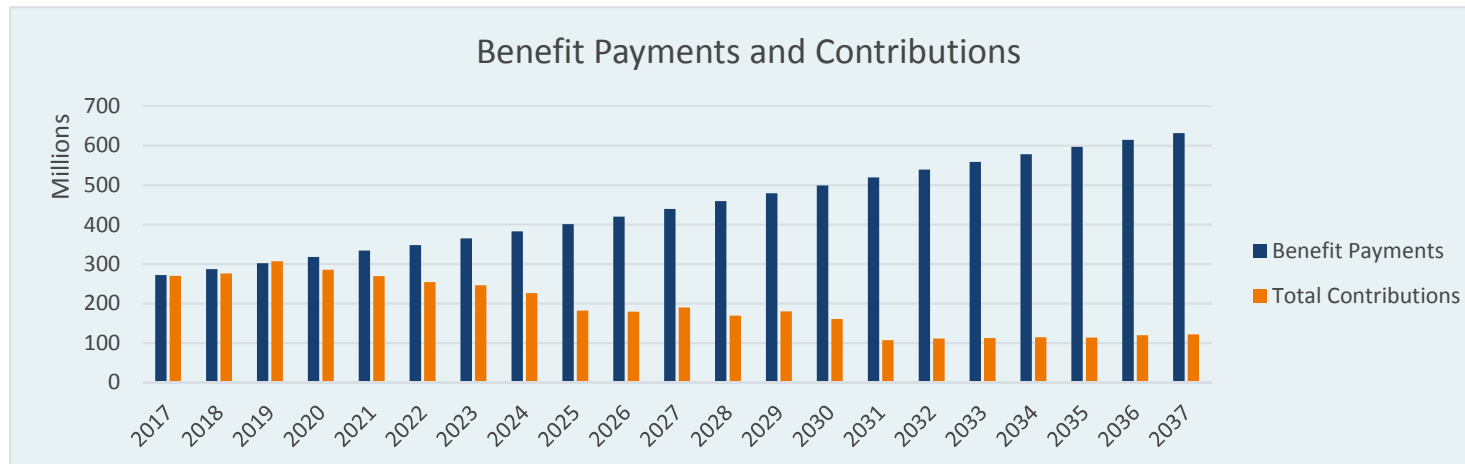


The pension equation in action

$$\boxed{} + \boxed{} + \boxed{} = \boxed{}$$



Assuming the Plan met the return target of 7.0% and followed the current funding policy, approximately \$6.6 billion in investment returns would be required to become fully funded by 2031.



As the plan matures it becomes increasingly dependent on investment performance to meet cashflow needs.

Contribution policy

Member Contributions:

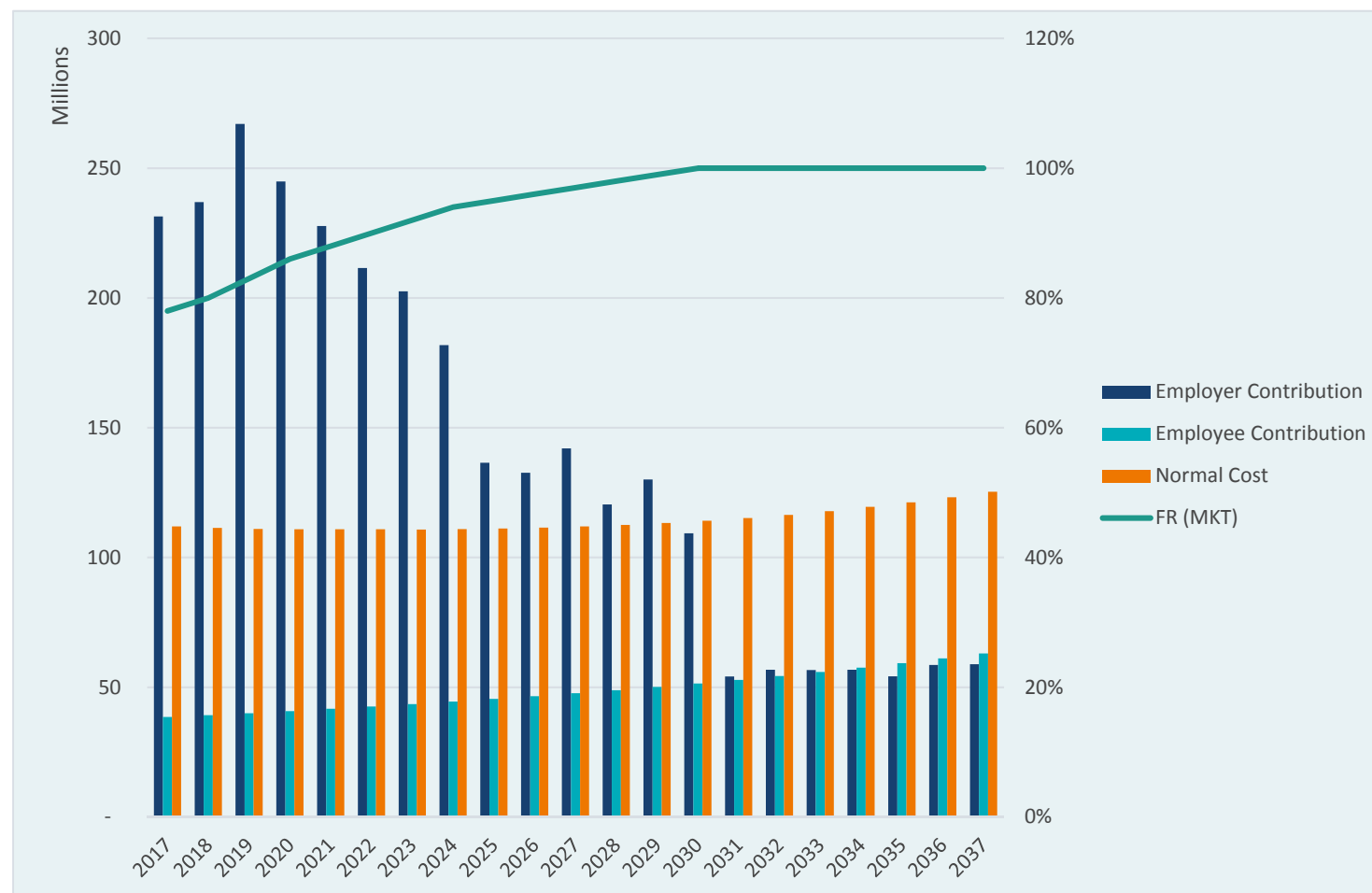
- The contribution rate is dependent on membership tier.
 - For Benefit Tiers 1-4, the contribution rate is dependent on membership tier and calculated so that the accumulation of basic contributions will be sufficient to fund an annuity at retirement that is equal to a portion of average final compensation.
 - For Benefit Tier 5, contribution rates are defined as 50% of the Total Normal Cost Rate.

County Contributions:

- Normal Cost
 - The sum of normal cost and a contribution toward any amortized unfunded actuarial liability
 - Normal Cost
 - The annual contribution rate that, if paid annually from first year of membership to the year of retirement, would accumulate the actuarial present value of the member's retirement benefits.
- Contribution to the Unfunded Actuarial Accrued Liability
 - The annual contribution rate that if paid annually over the UAAL amortization period, would accumulate the amount necessary to fully fund the UAAL.

Baseline deterministic projection

BASELINE DETERMINISTIC FORECAST (7% RETURN)



If all our assumptions hold true, the Plan would be fully funded in 15 years.

Once the UAAL is paid, employer contributions revert to roughly 50% of normal cost.

Funded ratios & employer contributions

FUNDED RATIO – MARKET VALUE (7% ACTUARIAL ASSUMED RETURN)

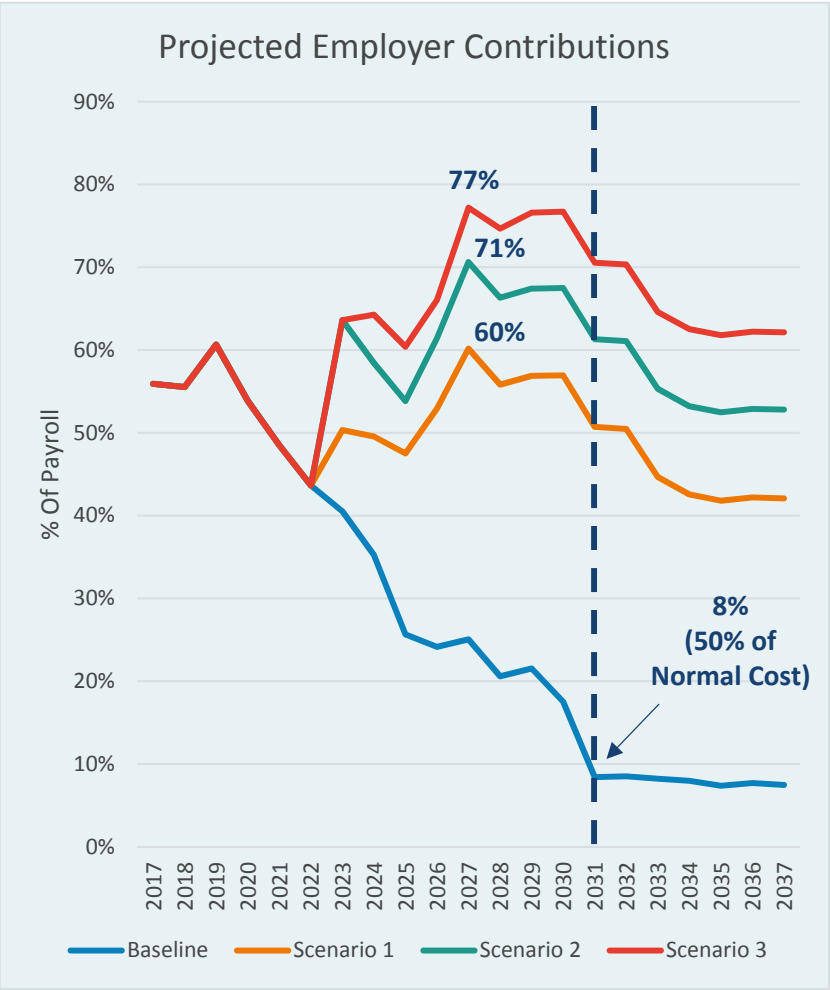
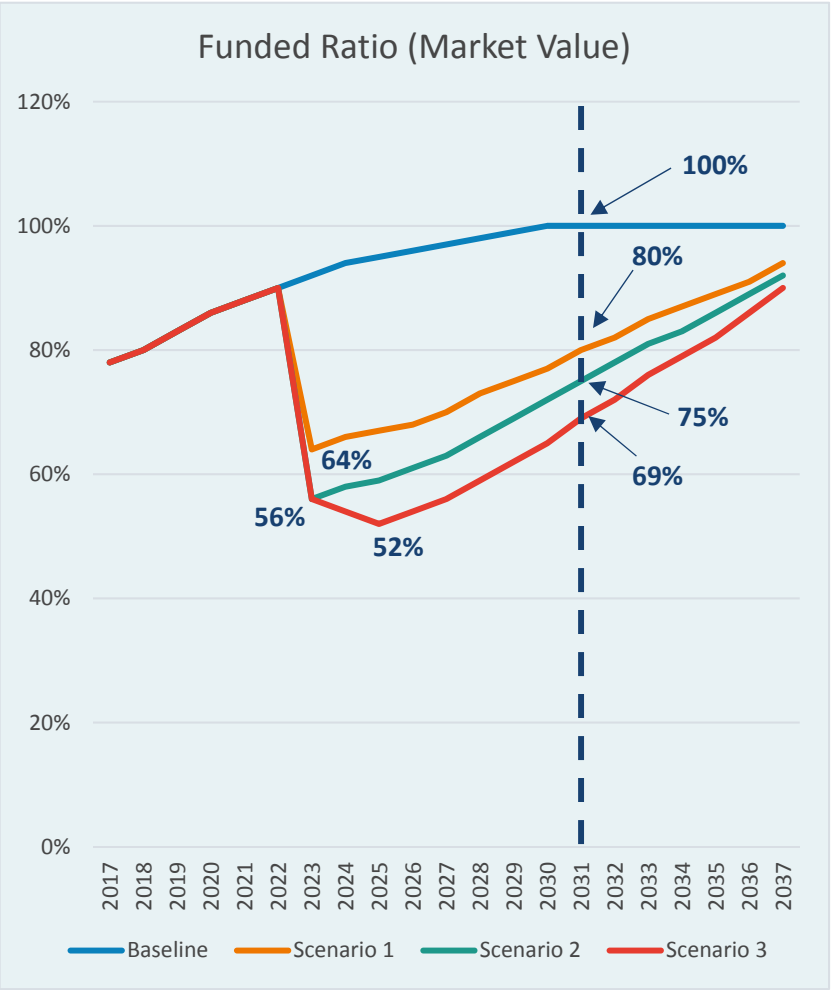
	0%	2%	4%	6%	6.50%	6.75%	7%	7.25%	7.50%	7.75%	8%
2017	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%	78%
2018	75%	77%	78%	80%	80%	80%	80%	81%	81%	81%	81%
2019	72%	75%	78%	81%	82%	82%	83%	83%	84%	84%	84%
2020	70%	74%	79%	83%	84%	85%	86%	86%	87%	87%	88%
2021	68%	73%	79%	85%	86%	87%	88%	89%	90%	90%	91%
2022	66%	72%	79%	86%	88%	89%	90%	91%	92%	93%	94%
2023	64%	71%	79%	87%	90%	91%	92%	93%	95%	96%	97%
2024	62%	70%	78%	88%	91%	93%	94%	95%	97%	98%	100%
2025	60%	68%	78%	89%	92%	94%	95%	97%	99%	100%	102%
2026	58%	67%	77%	89%	93%	95%	96%	98%	100%	102%	103%
2027	56%	66%	77%	90%	93%	95%	97%	99%	101%	102%	103%

Investment returns over the next 10 years will have a large impact on funded status and employer contributions (as a % of payroll).

EMPLOYER CONTRIBUTIONS – AS A % OF PAYROLL (7% ACTUARIAL ASSUMED RETURN)

	0%	2%	4%	6%	6.50%	6.75%	7%	7.25%	7.50%	7.75%	8%
2017	55.9	55.9	55.9	55.9	55.9	55.9	55.9	55.9	55.9	55.9	55.9
2018	56.7	56.4	56.0	55.7	55.6	55.6	55.5	55.5	55.5	55.4	55.4
2019	64.5	63.4	62.3	61.2	60.9	60.8	60.7	60.5	60.4	60.2	60.1
2020	61.7	59.6	57.3	55.0	54.4	54.2	53.9	53.6	53.3	53.0	52.7
2021	61.6	58.0	54.3	50.5	49.5	49.0	48.5	48.0	47.5	47.0	46.5
2022	62.9	57.8	52.3	46.6	45.1	44.4	43.6	42.9	42.1	41.4	40.6
2023	65.9	59.2	52.1	44.5	42.5	41.5	40.5	39.5	38.5	37.4	36.4
2024	66.5	58.5	49.8	40.3	37.8	36.5	35.3	34.0	32.7	31.3	30.0
2025	62.7	53.4	43.1	31.8	28.7	27.2	25.7	24.1	22.5	20.9	13.0
2026	66.8	56.3	44.5	31.3	27.8	26.0	24.2	22.3	20.4	9.4	0.0
2027	73.1	61.5	48.3	33.3	29.3	27.2	25.1	22.9	11.9	0.0	0.0

Cost of a drawdown

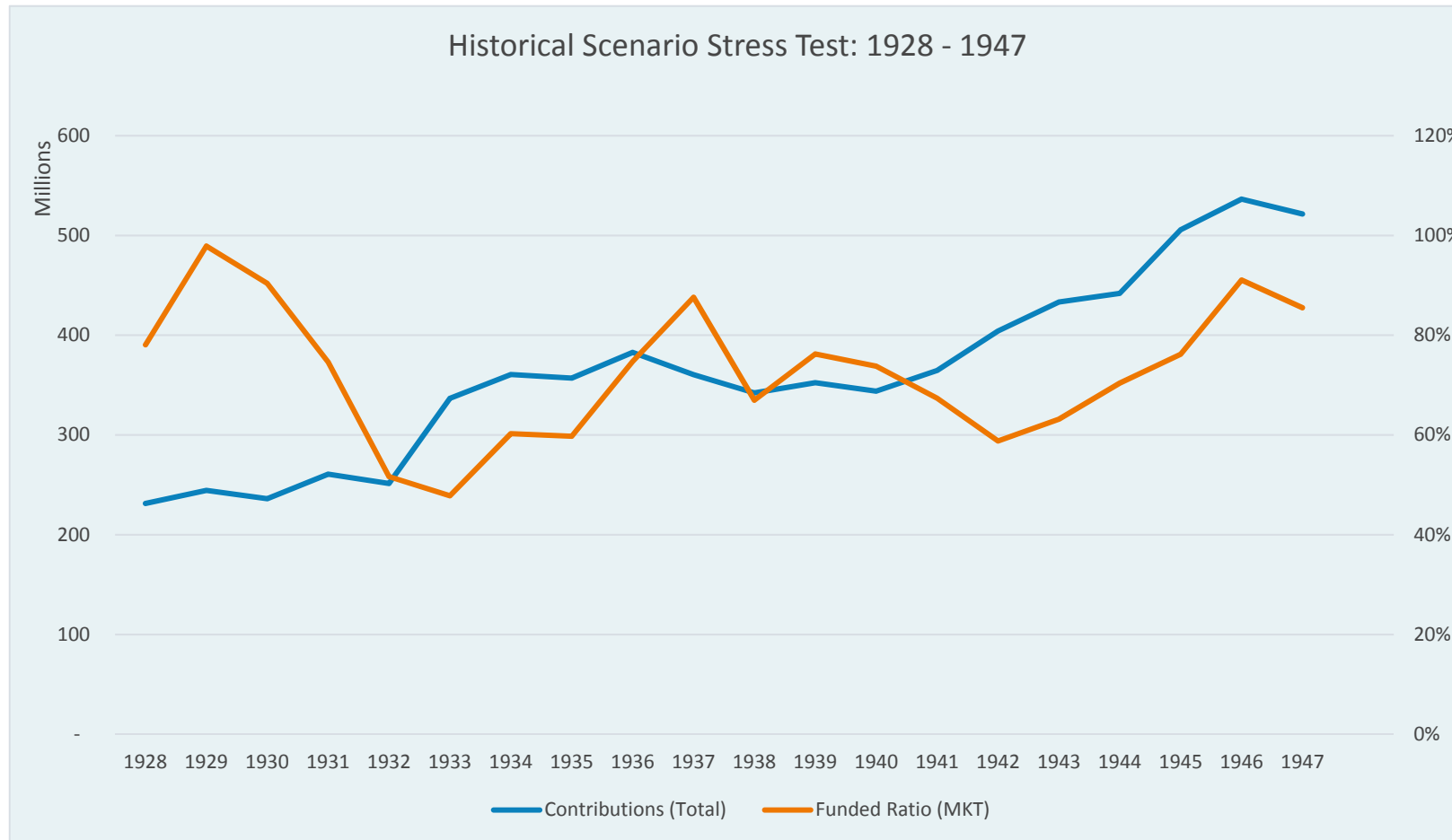


A large drawdown could significantly increase required contributions.

Scenario 1: -25% Return in year 6, 7% return in every other year
Scenario 2: -35% Return in year 6, 7% return in every other year
Scenario 3: -35% Return in year 6, 0% return in year 7, 0% return in year 8, 7% return in every other year

Historical stress tests – 60/40 portfolio

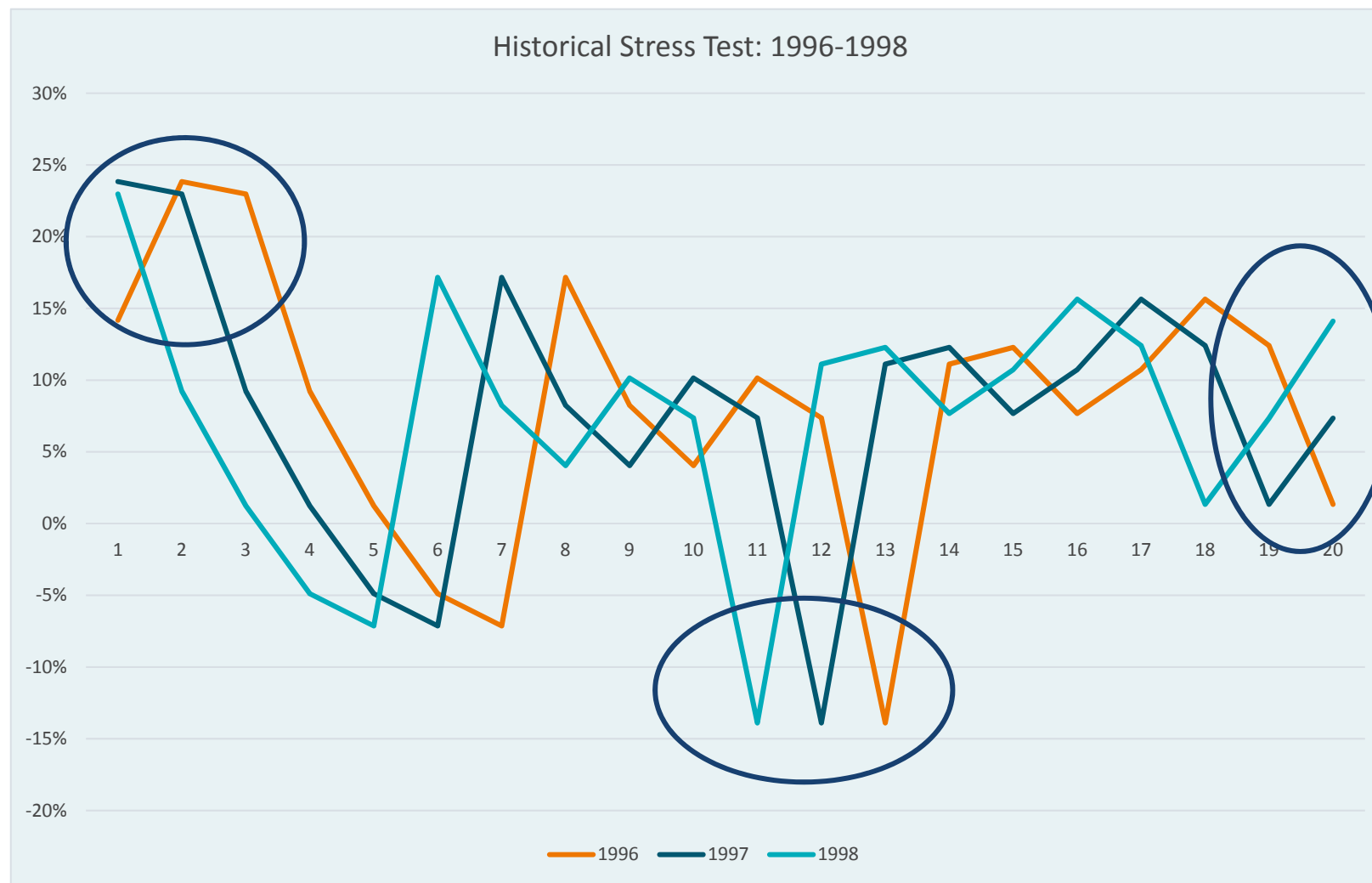
Giving the pension a 60/40 asset allocation and assuming the next 20 years (beginning July 1, 2017) equates to a given historical period



This evaluation starts at the current funded status (78%) and uses the current contribution policy.

Return performance is based on an allocation of 60% S&P 500 and 40% 10 year US Treasury assets. Evaluation begins 1/1/1928.

Historical stress tests – return timing



1996: Began with a 14% return, drawdown occurred latest, ended with 1% return.

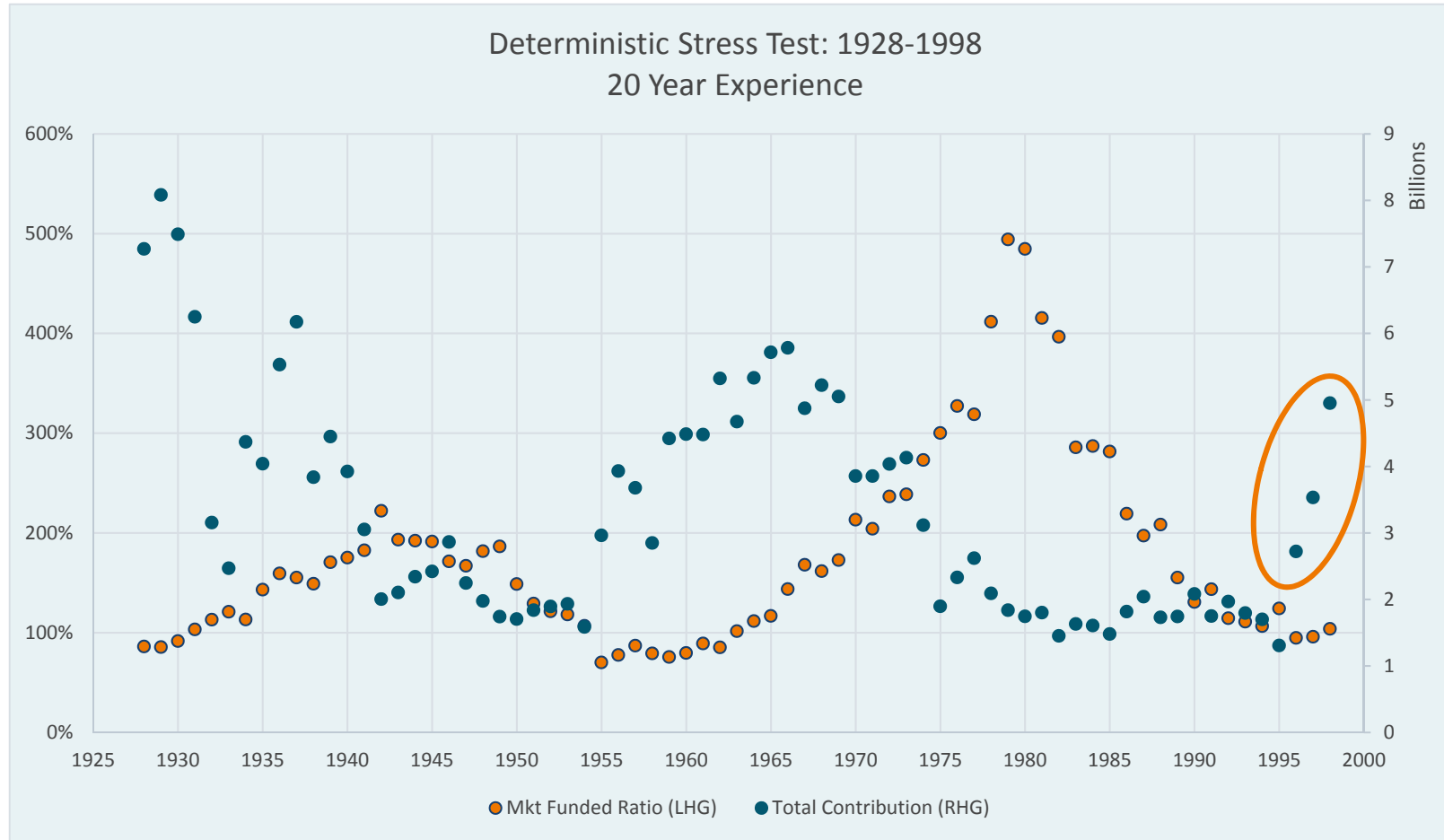
1997: Began with a 24% return, drawdown occurred one year earlier, ended with 7% return.

1998: Began with a 23% return, drawdown earliest, end with 14%.

Return performance is based on an allocation of 60% S&P 500 and 40% 10 year US Treasury assets.

Historical stress tests – 20 year periods

Taking every possible 20 year historical period and comparing plan outcomes with plan costs (71 historical periods)



Certain historical periods reveal important relationships within the plan.

For example, beginning our analysis on 1996 vs. 1998 creates a difference of roughly \$3 billion in contributions.

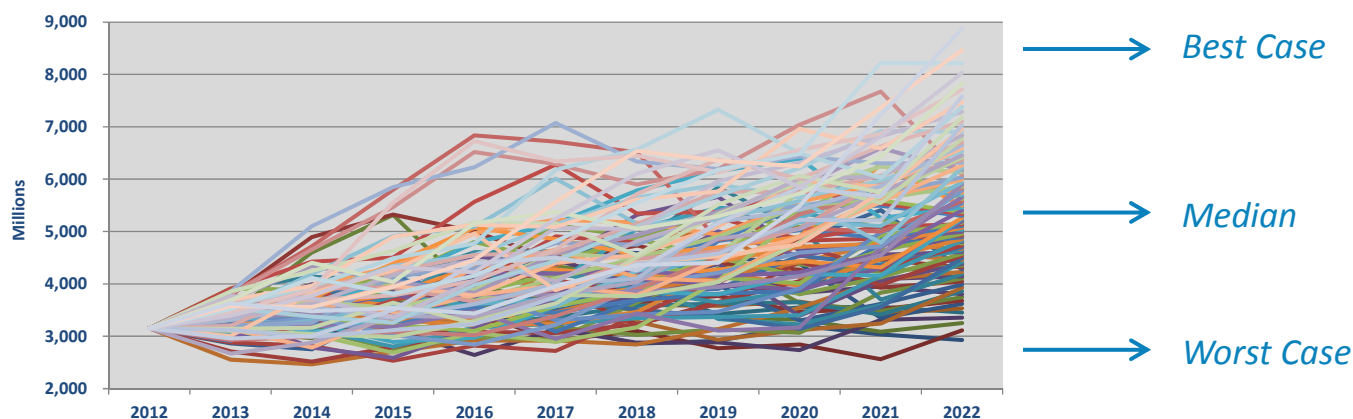
Total contributions is equal to the sum of all contributions (both employer and employee) over the 20 year period. Assumes plan follows its existing funding policy.

Stochastic projections

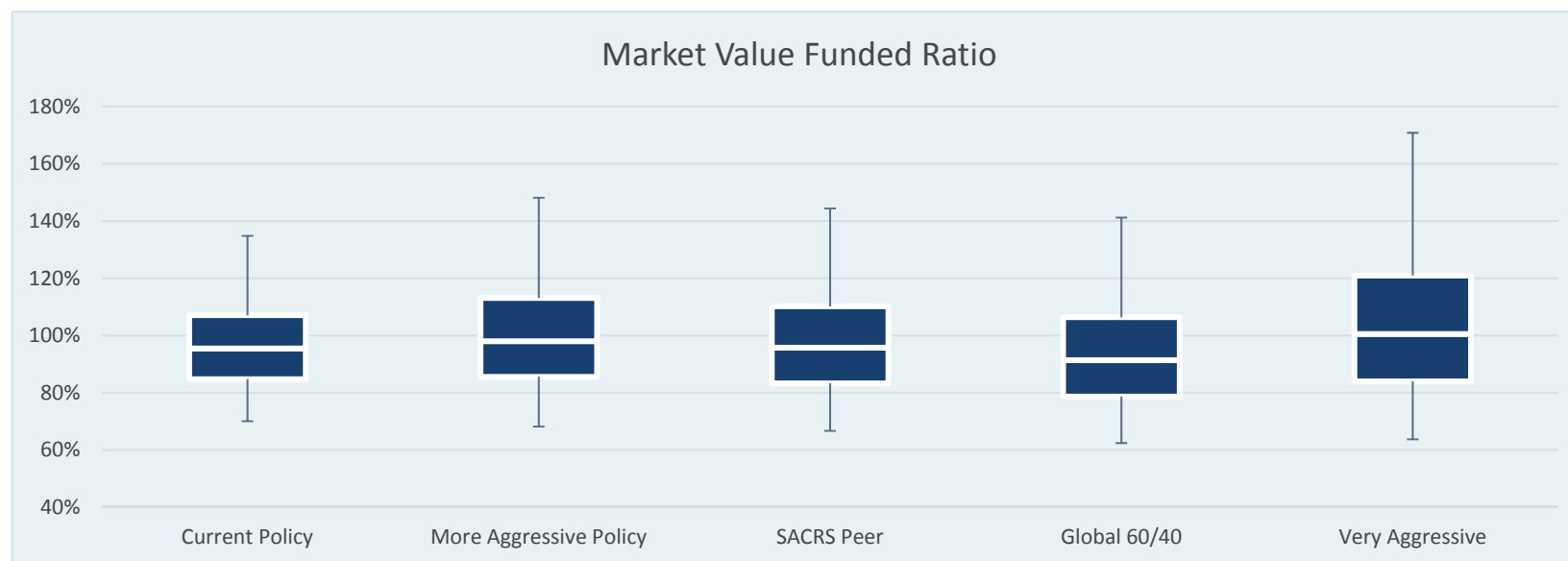
Introduction to stochastic modeling

- Verus partnered with Winklevoss Technologies to generate forecasts of FCERA's key metrics.
- The model incorporates:
 - Verus' 2018 Capital Market Assumptions
 - Liabilities as calculated by Segal.
 - FCERA's contribution & benefits policies
- By compiling the results, we can compare the 1st, 25th, 50th, 75th, & 100th percentile outcome for each year under 5,000 independent trials.
- Each trial is a simulated random outcome; the randomness is determined by a lognormal distribution curve. While this may help to determine a “most likely outcome”, it understates the magnitude or probability of tail risk.

MONTE CARLO SIMULATION: ENDING MARKET VALUE OF ASSETS



Funded status – 10 year forecast

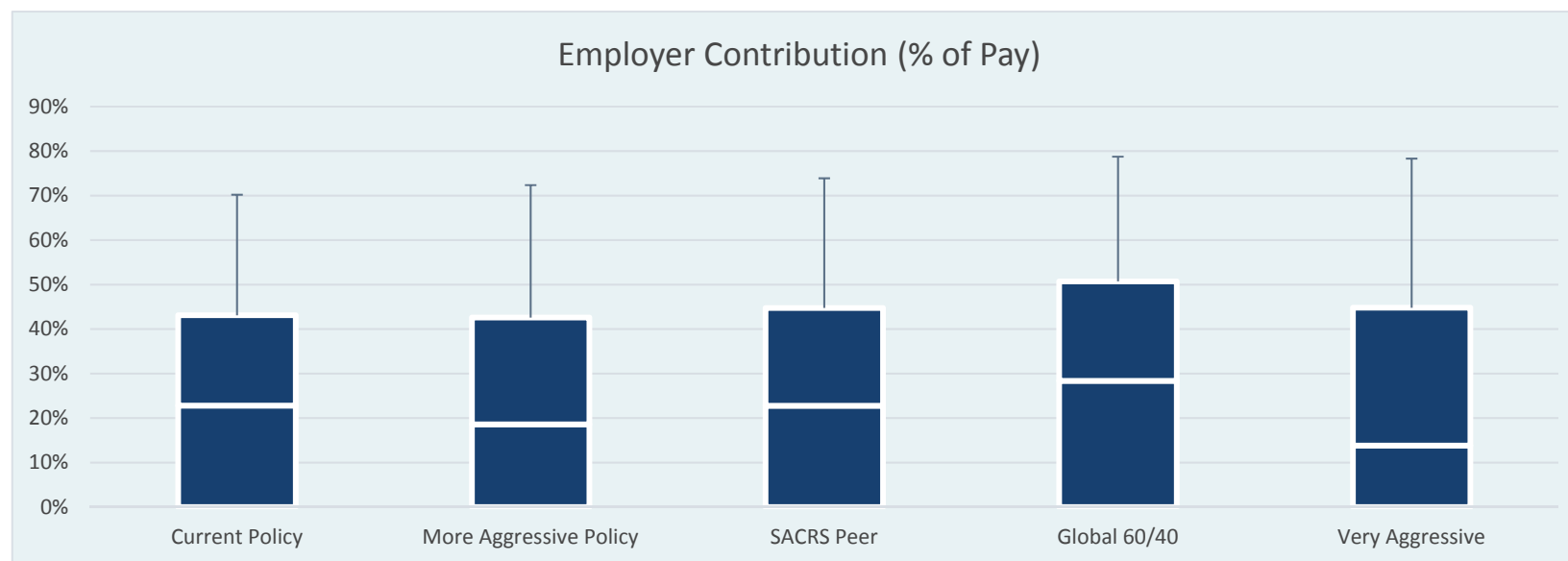


FUNDED STATUS – STOCHASTIC OUTCOMES IN 10 YEARS

	Current Policy	More Aggressive Policy	SACRS Peer	Global 60/40	Very Aggressive
Best Case (95%)	134.8%	148.1%	144.4%	141.2%	170.9%
Median Outcome (50%)	95.5%	98.0%	95.7%	91.4%	100.5%
Worst Case (5%)	70.0%	65.3%	64.4%	61.3%	62.0%
CVAR (5%)	51.2%	49.1%	47.9%	44.4%	44.7%
Range (Best-Worst Case)	64.8%	82.8%	80.0%	79.9%	108.9%

Source: ProVal, Verus

Employer contributions – 10 year forecast



EMPLOYER CONTRIBUTIONS – STOCHASTIC OUTCOMES IN 10 YEARS

	Current Policy	More Aggressive Policy	SACRS Peer	Global 60/40	Very Aggressive
Best Case (95%)	0.0%	0.0%	0.0%	0.0%	0.0%
Median Outcome (50%)	22.8%	18.6%	22.8%	28.4%	13.8%
Worst Case (5%)	70.2%	72.4%	73.9%	78.8%	78.3%
CVAR (5%)	80.8%	83.9%	85.5%	91.1%	90.4%

Source: ProVal, Verus

Observations

- On a funded status basis, the range of outcomes increases significantly for the more aggressive mixes relative to the Current Policy.
- The Very Aggressive mix was the only portfolio to reach fully funded under the median outcome.
- On an employer contribution basis, the Global 60/40 mix has the largest possible downside.
- The median outcome for the Current Policy was in-line with the SACRS Peer mix on both a funded status and employer contributions basis.

Next steps

2018 Asset-liability study timeline

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



Appendix

Asset allocation “goal posts”

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

Risk and return

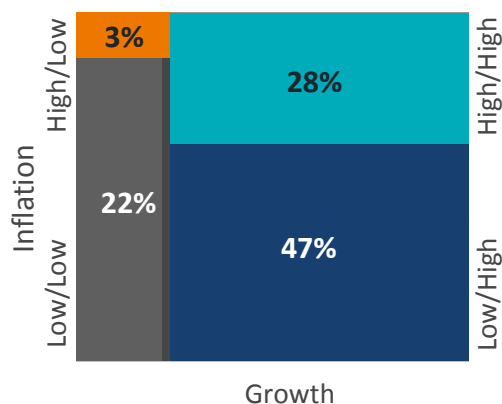
- Increasing exposure to equities impacts both expected risk and return.
- Given the lower expected returns for many public market assets, allocations to private market assets helped boost returns.
- The risk-adjusted returns of each portfolio remain in-line with the current policy.

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

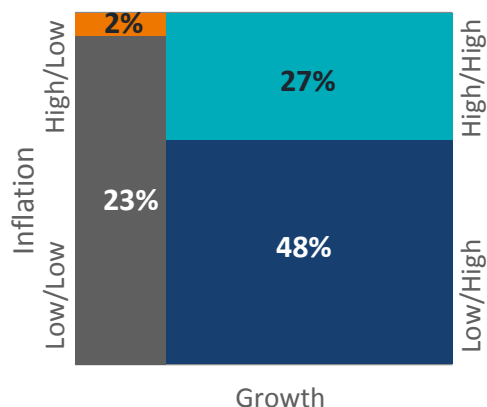
Note: Equity tail risk is calculated using BarraOne (see page 63).

Economic sensitivity

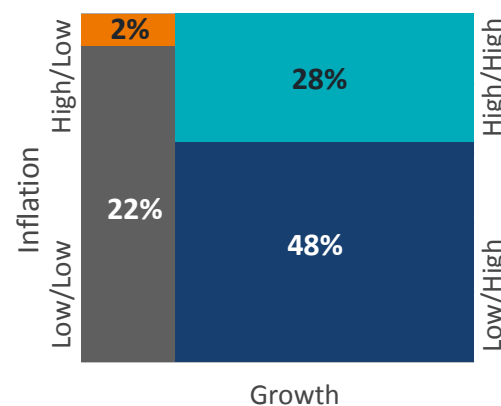
Current Policy



More Aggressive Policy

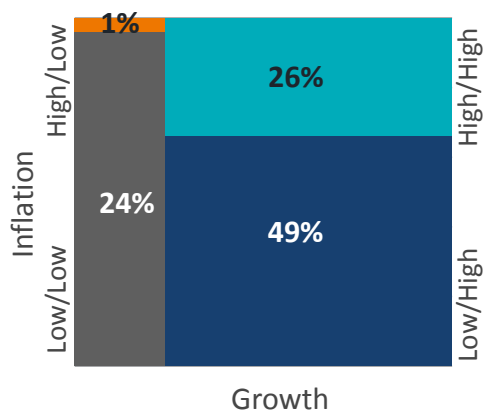


SACRS Peer

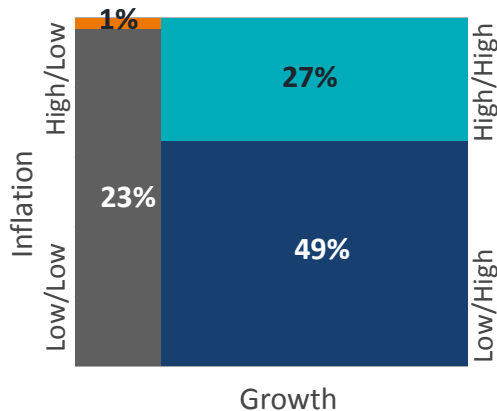


Allocations to inflation protecting assets increase the economic balance of the portfolio

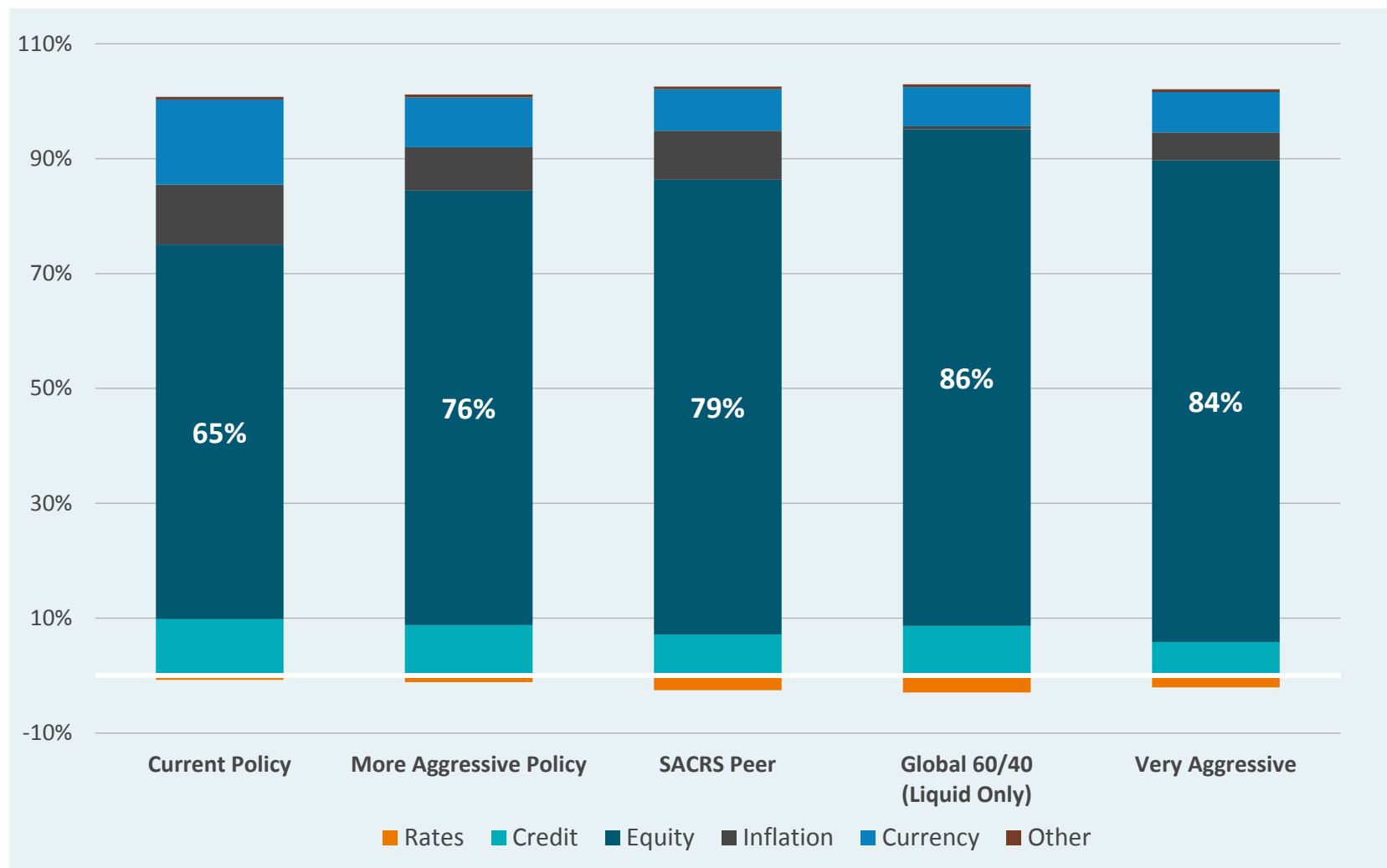
Global 60/40 (Liquid Only)



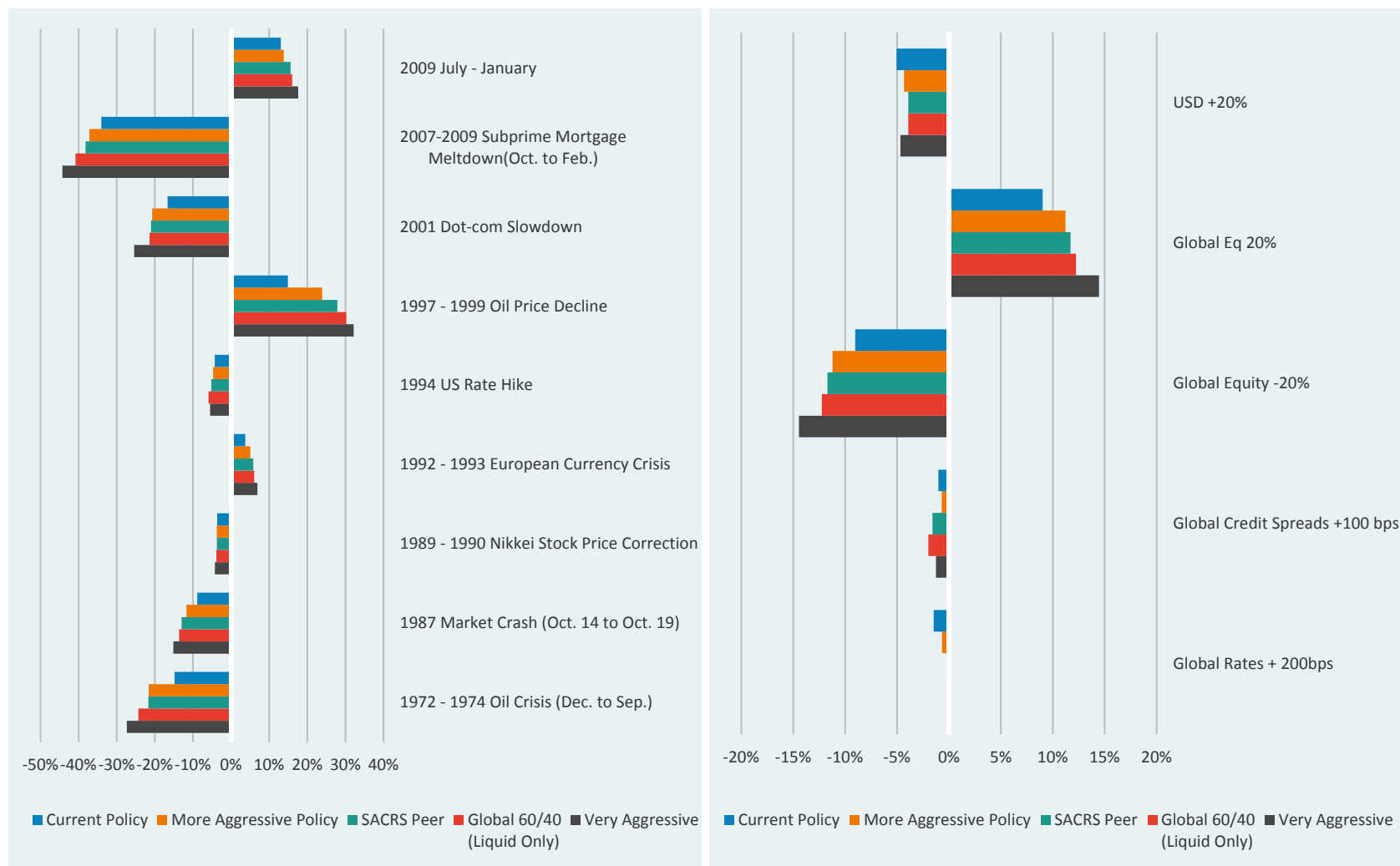
Very Aggressive



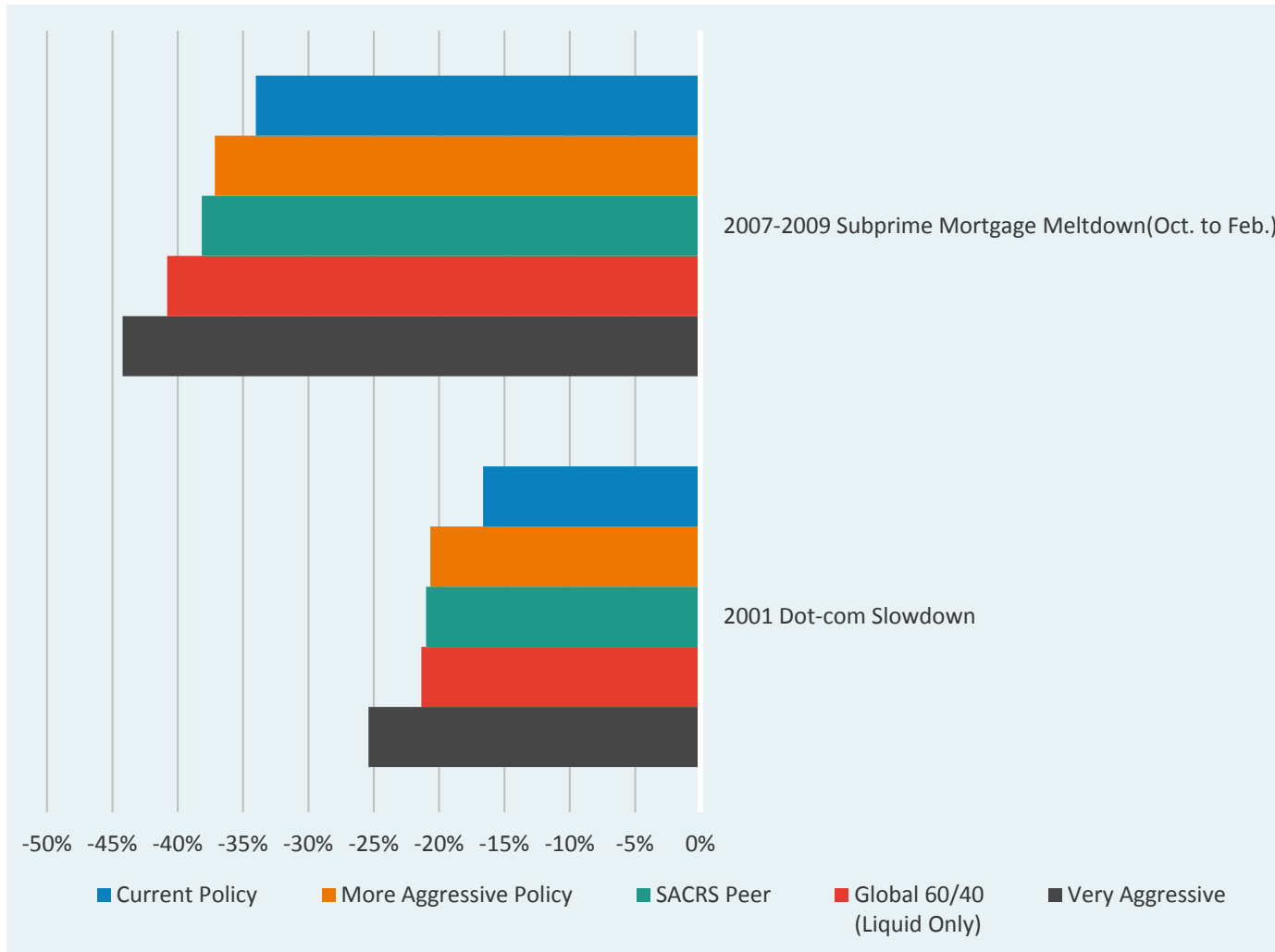
Risk decomposition



Scenario analysis



Equity tail risk



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

10-year return & risk assumptions

Asset Class	Index Proxy	Ten Year Return Forecast		Standard Deviation	Sharpe Ratio	Sharpe Ratio	10-Year Historical	10-Year Historical
		Geometric	Arithmetic					
Equities								
U.S. Large	S&P 500	4.5%	5.6%	15.7%	0.15	0.22	0.50	0.56
U.S. Small	Russell 2000	4.4%	6.5%	21.5%	0.10	0.20	0.36	0.44
International Developed	MSCI EAFE	8.6%	10.1%	18.1%	0.35	0.44	0.11	0.2
International Developed Hedged	MSCI EAFE Hedged	8.6%	9.8%	16.2%	0.40	0.47	0.21	0.28
International Small	MSCI EAFE Small Cap	7.9%	10.2%	22.7%	0.25	0.35	0.24	0.33
International Small Hedged	MSCI EAFE Small Cap Hedged	7.9%	9.7%	20.1%	0.28	0.37	0.36	0.43
Emerging Markets	MSCI EM	7.3%	10.4%	26.6%	0.19	0.31	0.17	0.28
Global Equity	MSCI ACWI	6.3%	7.7%	17.5%	0.23	0.31	0.27	0.35
Private Equity	Cambridge Private Equity	6.4%	9.3%	25.8%	0.16	0.28	0.93	0.92
Fixed Income								
Cash	30 Day T-Bills	2.2%	2.2%	1.2%	-	-	-	-
U.S. TIPS	BBgBarc U.S. TIPS 5 - 10	2.6%	2.7%	5.5%	0.07	0.09	0.57	0.59
U.S. Treasury	BBgBarc Treasury 7-10 Year	2.4%	2.6%	6.8%	0.03	0.06	0.68	0.70
Global Sovereign ex U.S.	BBgBarc Global Treasury ex U.S.	2.7%	3.2%	9.9%	0.05	0.10	0.30	0.33
Global Sovereign ex U.S. Hedged	BBgBarc Global Treasury ex U.S. Hedged	2.7%	2.8%	3.3%	0.15	0.18	1.23	1.22
Core Fixed Income	BBgBarc U.S. Aggregate Bond	2.9%	3.1%	6.4%	0.11	0.14	1.09	1.08
Core Plus Fixed Income	BBgBarc U.S. Corporate IG	3.3%	3.6%	8.4%	0.13	0.17	0.81	0.81
Short-Term Gov't/Credit	BBgBarc U.S. Gov't/Credit 1 - 3 year	2.5%	2.6%	3.7%	0.08	0.11	1.36	1.34
Short-Term Credit	BBgBarc Credit 1-3 Year	2.4%	2.5%	3.7%	0.05	0.08	1.05	1.05
Long-Term Credit	BBgBarc Long U.S. Corporate	3.5%	3.9%	9.4%	0.14	0.18	0.64	0.67
High Yield Corp. Credit	BBgBarc U.S. Corporate High Yield	3.7%	4.3%	11.6%	0.13	0.18	0.64	0.67
Bank Loans	S&P/LSTA	4.9%	5.4%	10.5%	0.26	0.30	0.48	0.51
Global Credit	BBgBarc Global Credit	1.7%	2.0%	7.6%	-0.07	-0.03	0.59	0.61
Global Credit Hedged	BBgBarc Global Credit Hedged	1.7%	1.8%	5.0%	-0.10	-0.08	1.01	1.00
Emerging Markets Debt (Hard)	JPM EMBI Global Diversified	5.1%	5.9%	12.8%	0.23	0.29	0.74	0.76
Emerging Markets Debt (Local)	JPM GBI EM Global Diversified	5.8%	6.5%	12.1%	0.30	0.36	0.31	0.37
Private Credit	Bank Loans + 200 bps	6.9%	7.5%	10.5%	0.45	0.50	-	-
Other								
Commodities	Bloomberg Commodity	4.3%	5.5%	15.9%	0.13	0.21	-0.33	-0.25
Hedge Funds	HFRI Fund of Funds	4.0%	4.8%	7.9%	0.23	0.33	0.21	0.23
Hedge Fund of Funds	HFRI Fund of Funds	3.0%	3.8%	7.9%	0.10	0.20	0.21	0.23
Hedge Funds - Equity Hedge	HFRI Equity Hedge	4.2%	5.5%	11.1%	0.18	0.30	0.36	0.39
Hedge Funds - Event Driven	HFRI Event Driven	4.5%	5.6%	9.9%	0.22	0.34	0.55	0.57
Hedge Funds - Relative Value	HFRI Relative Value	3.9%	4.5%	6.8%	0.25	0.34	0.89	0.89
Hedge Funds - Macro	HFRI Macro	3.3%	4.7%	8.5%	0.12	0.29	0.43	0.44
Core Real Estate	NCREIF Property	6.0%	6.7%	12.7%	0.30	0.35	0.77	0.75
Value-Add Real Estate	NCREIF Property + 200bps	8.0%	9.7%	19.5%	0.30	0.38	-	-
Opportunistic Real Estate	NCREIF Property + 400bps	10.0%	12.9%	26.0%	0.30	0.41	-	-
REITs	Wilshire REIT	6.0%	7.7%	19.5%	0.19	0.28	0.16	0.28
Infrastructure	S&P Global Infrastructure	7.1%	8.7%	18.9%	0.26	0.34	0.27	0.34
Risk Parity	Risk Parity	7.2%	7.7%	10.0%	0.50	0.55	-	-
Currency Beta	Russell Conscious Currency	2.2%	2.3%	4.4%	0.00	0.02	0.23	0.24
Inflation		2.1%	-	-	-	-	-	-

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

Correlation assumptions

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

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

Range of likely 10 year outcomes

10 YEAR RETURN 90% CONFIDENCE INTERVAL

