Asset Liability Management:
Public Employees' Retirement Fund
Policy Portfolio & Discount Rate Selection

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Investment Committee
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CalPERS

Summary

- At the September Investment Committee meeting, several sample candidate portfolio strategies for the Public Employees' Retirement Fund (PERF) were reviewed. The sample candidate portfolios had a wide range of characteristics to illustrate the pros and cons of different strategies.
- Feedback from the September meeting has been considered in the candidate portfolios presented, which have been developed in alignment with CalPERS' objectives of minimizing costs, maximizing projected returns, minimizing potential losses, and maintaining sufficient liquidity.
    - The candidate portfolios presented will support a discount rate of 6.5%, 6.8%, or 7.0%
    - Leverage as a strategic asset allocation is being recommended.
    - Multi-period optimized portfolios are not being recommended at this time, although they are included in the appendix for reference.
- Selection of a policy portfolio requires a careful balance of risk and returns. Lower projected returns (and risk) may increase projected costs in the near term but can help to protect funding ratios. Higher projected risk (and returns) increases the chances of lower funding ratios.

Glossary

Term	Definition	CalPERS Implementation
Downside Risk	An estimate of potential for losses (compare with Volatility)	CalPERS 2021 Asset Liability Management modelling estimates the size of large losses that could occur over any three-year period. This estimate is called conditional drawdown at risk. To estimate it, start with the range of outcomes for returns. Then focus on only the losses, the part of the range where returns are negative. Conditional drawdown is based on the larger losses. CalPERS has a constitutional objective to 'minimize the risk of loss.'
Leverage	Borrowing to acquire additional assets	CalPERS has leverage in its policy benchmarks, accompanied by a limit of 20% on additional but discretionary leverage. A leverage allocation in the strategic asset allocation would improve diversification.
Portfolio Strategy	A plan for managing assets to achieve financial objectives	CalPERS portfolio strategy balances the desire for higher returns (leading to lower employer costs) against potential risk of portfolio losses (leading to higher contributions and lower funding ratios). The CalPERS portfolio strategy includes the ALM process to regularly review and, if need be, revise Capital Market Assumptions and portfolio allocations.
Return Term Structure	A return projection that includes estimates for different investment horizons	CalPERS CMAs survey results include return projections for 5-year and 20-year investment horizons.
Volatility	An estimate of the width of a return distribution (compare with Downside Risk)	CalPERS 2021 Asset Liability Management uses volatility when estimating the range of return outcomes. As an example, the width of a Bell curve is measured using both the upside and the downside. Risk is related to loss, which involves only downside, which is why we use conditional drawdown to measure downside risk.

Pros and Cons of Key Decisions

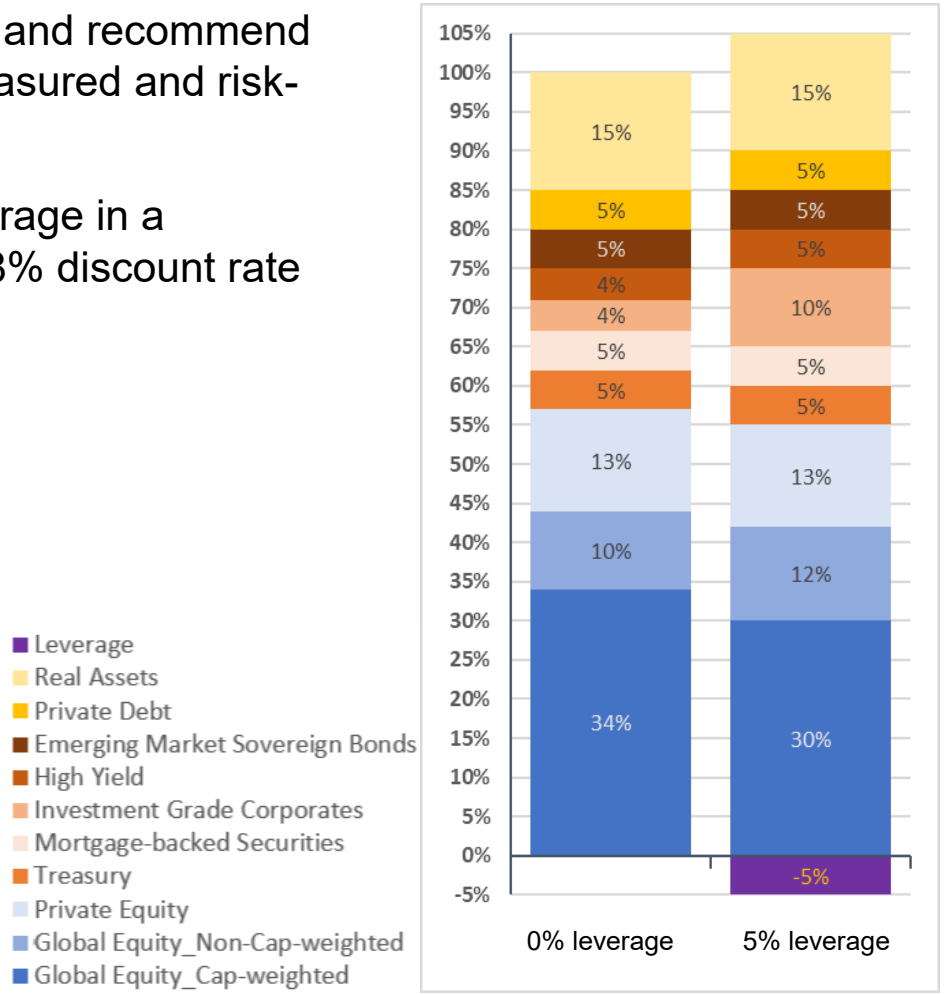
If we choose	Pros	Cons
Higher discount rate	Lower projected contributions	Increased contribution risk Increased funding ratio risk
Higher projected returns	Increased discount rate	Increased portfolio risk
Managing near-term risk	Avoid excessive risk taking in near-term horizon	Lower projected returns in near-term horizon
Leverage	Increased diversification Strategic options	Losses (and gains) may be amplified Increased complexity
Increasing private asset allocations	Increased diversification Increased projected returns	Challenging to scale, even with policy changes Potential increase in some ESG related issues Policy changes required Increased complexity
Increasing exposure to emerging markets	Improved projected returns	Potential increase in some ESG related issues Increased complexity
New asset classes	Increased diversification	Policy changes required Increased complexity
Multi-period optimized portfolio	Lower drawdown and volatility across full 20 years Higher projected returns in the near term	Higher drawdown and volatility in near term period Increased complexity
Single-period optimized portfolio	Less complexity Lower drawdown and volatility in near term period	Higher drawdown and volatility across full 20 years Lower projected returns in near term period

Leverage

- We believe that leverage is an important tool for portfolio diversification and recommend that a strategic asset allocation be adopted, to be implemented in a measured and risk-controlled manner.
- Leverage is using borrowed funds to buy assets. As an example of leverage in a portfolio, the charts on the right show the portfolio allocations for the 6.8% discount rate portfolio, single period, with and without leverage.
  - For a given portfolio target return, a strategic allocation to leverage improves portfolio diversification, relative to a portfolio without leverage[1].
  - The added diversification lowers projected risk (see table) and is reflected in reduced equity exposures and increased fixed income exposures.

Risk Measure	0% Leverage	5% Leverage
Drawdown	23.6%	23.0%
Volatility	12.1%	12.0%

- As with any investment, leverage is not without risk. Although it has a diversifying benefit, it is possible that it could result in higher losses in certain market conditions.



[1]Finance theory and practice support leverage as a tool for diversification.

Single Period and Multi-Period Optimization

- At the September Investment Committee meeting, the sample candidate portfolios were focused on Multi-Period, with one portfolio for the near-term and another portfolio for the long-term.
- Based on feedback from the September meeting, and after further consideration, the candidate portfolios presented for selection of the policy portfolio are focused on Single Period, and Multi-Period portfolios are not being recommended at this time.
- The Multi-Period portfolio information is included alongside the Single Period portfolios in the appendix.
- For reference, the table below compares Single Period and Multi-Period for two portfolios.

Portfolio Characteristics				Years 1-20			Years 1-5			Years 6-20		
Name	Projected Return[1] %	Optimization	Leverage %	Return %	Drawdown %	Volatility %	Return %	Drawdown %	Volatility %	Return %	Drawdown %	Volatility %
B2	6.8	Single Period	5.0	6.8	23.0	12.0	5.8	24.1	11.6	7.2	22.8	12.0
B4	6.8	Multi-Period	5.0	6.8	22.1	11.6	6.4	27.2	13.0	7.0	20.8	11.1

[1] Projected returns are equivalent to the proposed discount rate for each portfolio.

Drawdown

- A drawdown is a decline in value experienced during a set period of time.
- Protecting against drawdown provides a buffer for extreme losses, but also limits upside gains. The chart and table illustrate this concept:
  - During the pandemic drawdown in early 2020, equity values declined by 34.5% and the PERF declined by 18.1%.
  - Conversely, during FY20-21, equities increased by 41.5% and the PERF increased by 21.3%.

Specific Period Return	PERF (A)	Equities (B)	(A/B)
FY 20-21	21.3%	41.6%	0.5
Pandemic Drawdown*	-18.1%	-34.5%	0.5

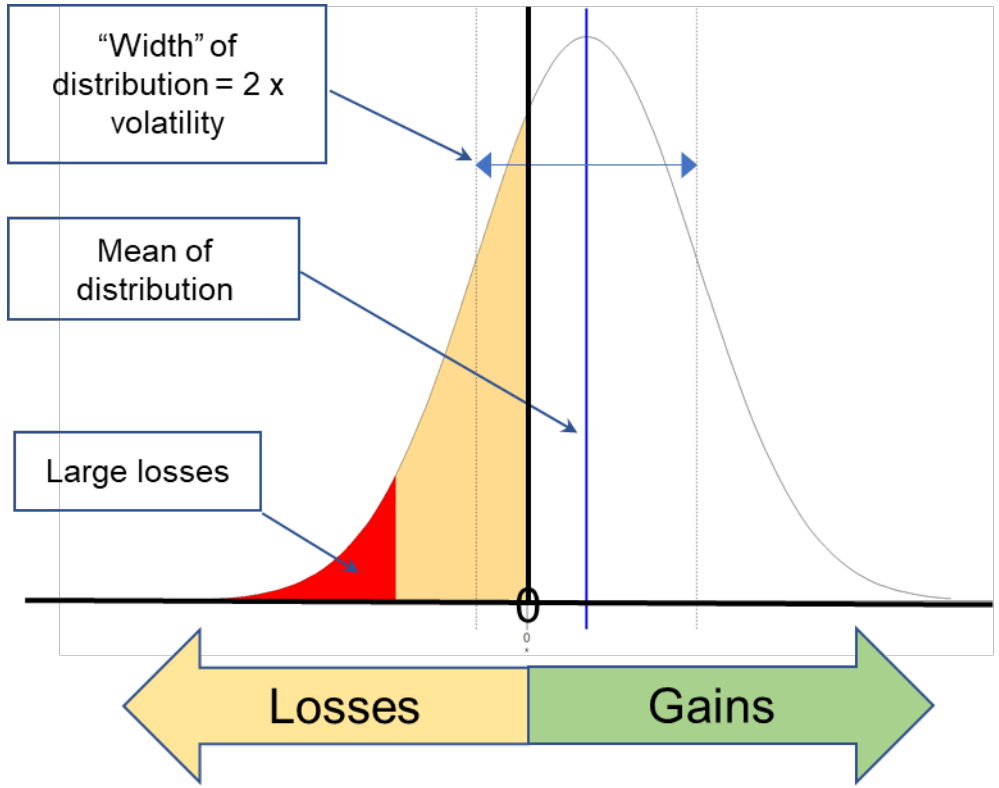
* 2/13/20 - 3/23/20

Drawdown as a Risk Measure

Minimize the risk of loss is one of our constitutional objectives. To better measure and manage downside risk, the 2021 ALM process uses conditional drawdown as a measure of risk, which aligns with the policies and portfolio decisions below:

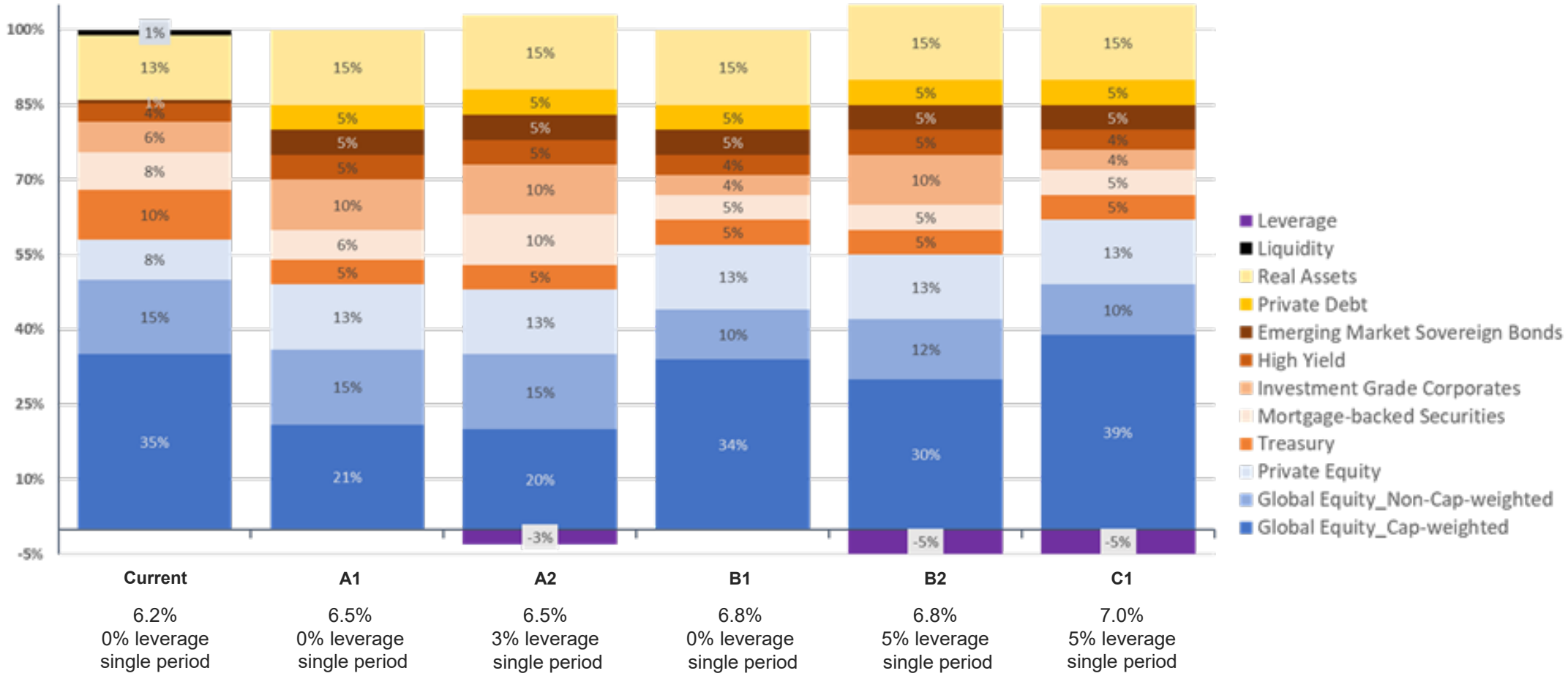
- Funding Risk Mitigation Policy, adopted in 2015
- Portfolio priorities, as determined in the 2017 ALM:
  - protect the funded ratio (mitigate severe drawdowns)
  - stabilize employer contribution rates (manage overall volatility)
  - achieve the long-term required rate of return (over the long run, but not in every market environment)
- Asset Liability Management Policy, adopted in 2017
  - migration of real assets to "core" ~ now 85+% of portfolio
  - public market segments, adopted in the 2017 ALM:
    - treasury segment
    - factor-weighted equity segment

Where volatility measures variation (gains & losses) in returns compared to expectations, conditional drawdown measures the average loss of the worst ten percent of projected losses.



The conditional drawdown measure used in the portfolio analysis is the average portfolio drawdown (loss) among the largest 10% of estimated drawdowns, using a 3-year rolling period for the 20-year investment horizon.

Candidate Portfolio Allocations

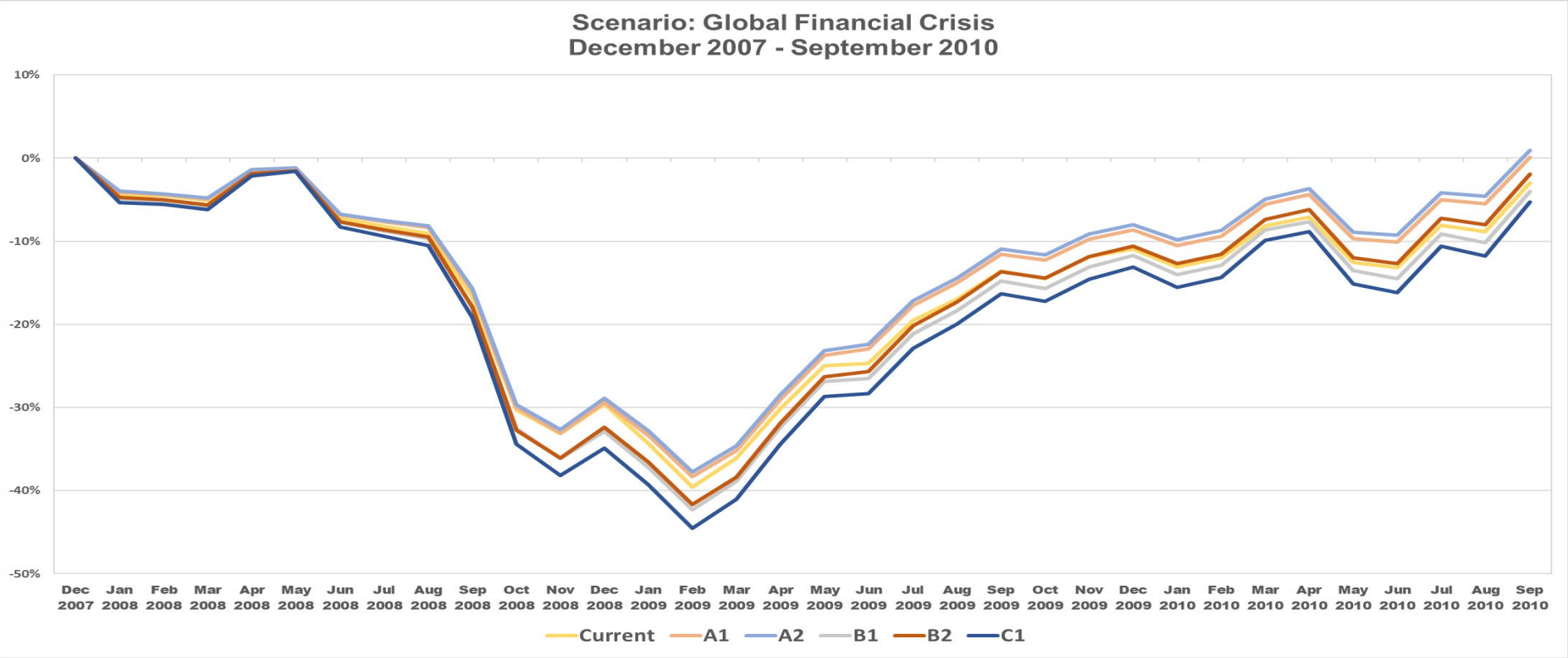


Candidate Portfolio Characteristics

This table highlights differences in projected return, drawdown, and volatility between portfolios.

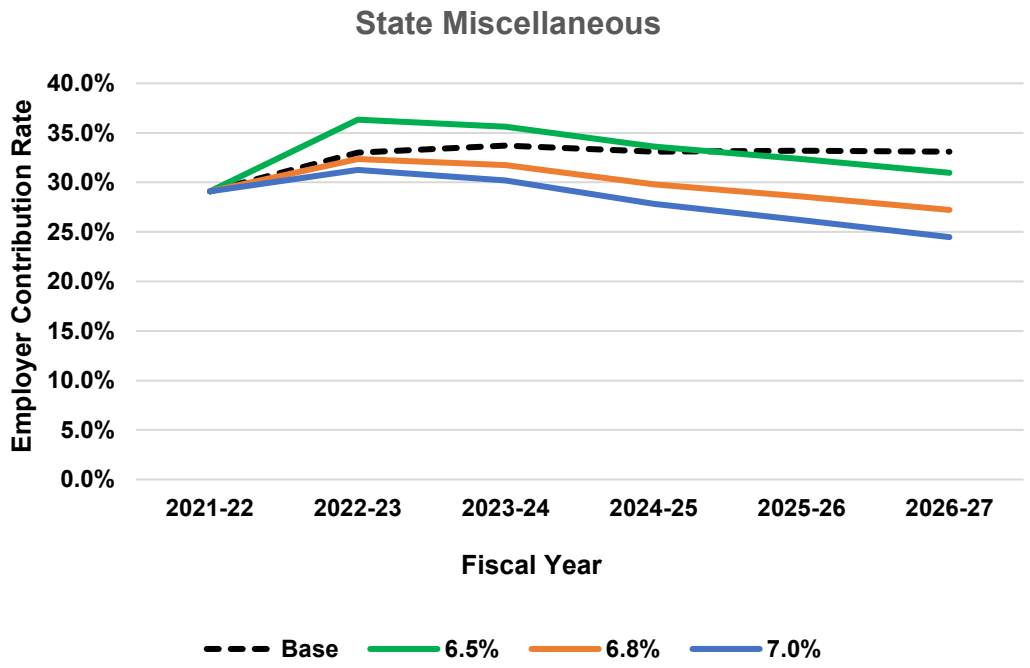
Portfolio Characteristics			Years 1 - 20		
Name	Optimization	Leverage	Projected Return	Drawdown	Volatility
Current	Single Period	0%	6.2%	22.6%	11.2%
A1	Single Period	0%	6.5%	20.4%	10.9%
A2	Single Period	3%	6.5%	20.1%	10.8%
B1	Single Period	0%	6.8%	23.6%	12.1%
B2	Single Period	5%	6.8%	23.0%	12.0%
C1	Single Period	5%	7.0%	25.5%	12.9%

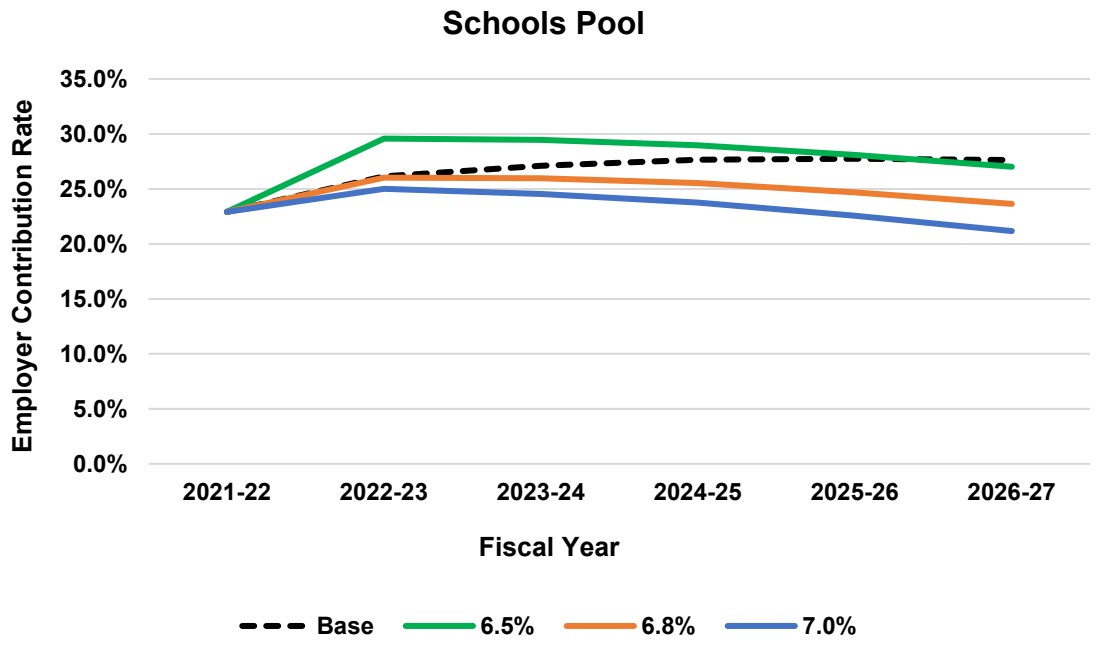
Stress Test: Candidate Portfolio Historical Returns



December 2007 – September 2010	Current Portfolio	Portfolio A1 6.5%, 0% leverage	Portfolio A2 6.5%, 3% leverage	Portfolio B1 6.8%, 0% leverage	Portfolio B2 6.8%, 5% leverage	Portfolio C1 7.0%, 5% leverage
Return	-1.11%	0.03%	0.34%	-1.48%	-0.70%	-1.96%
Volatility	19.0%	18.7%	18.5%	20.5%	20.5%	21.8%
Max Drawdown	-39.5%	-38.3%	-37.8%	-42.3%	-41.7%	-44.6%

Projected Employer Contributions: State Misc. and Schools





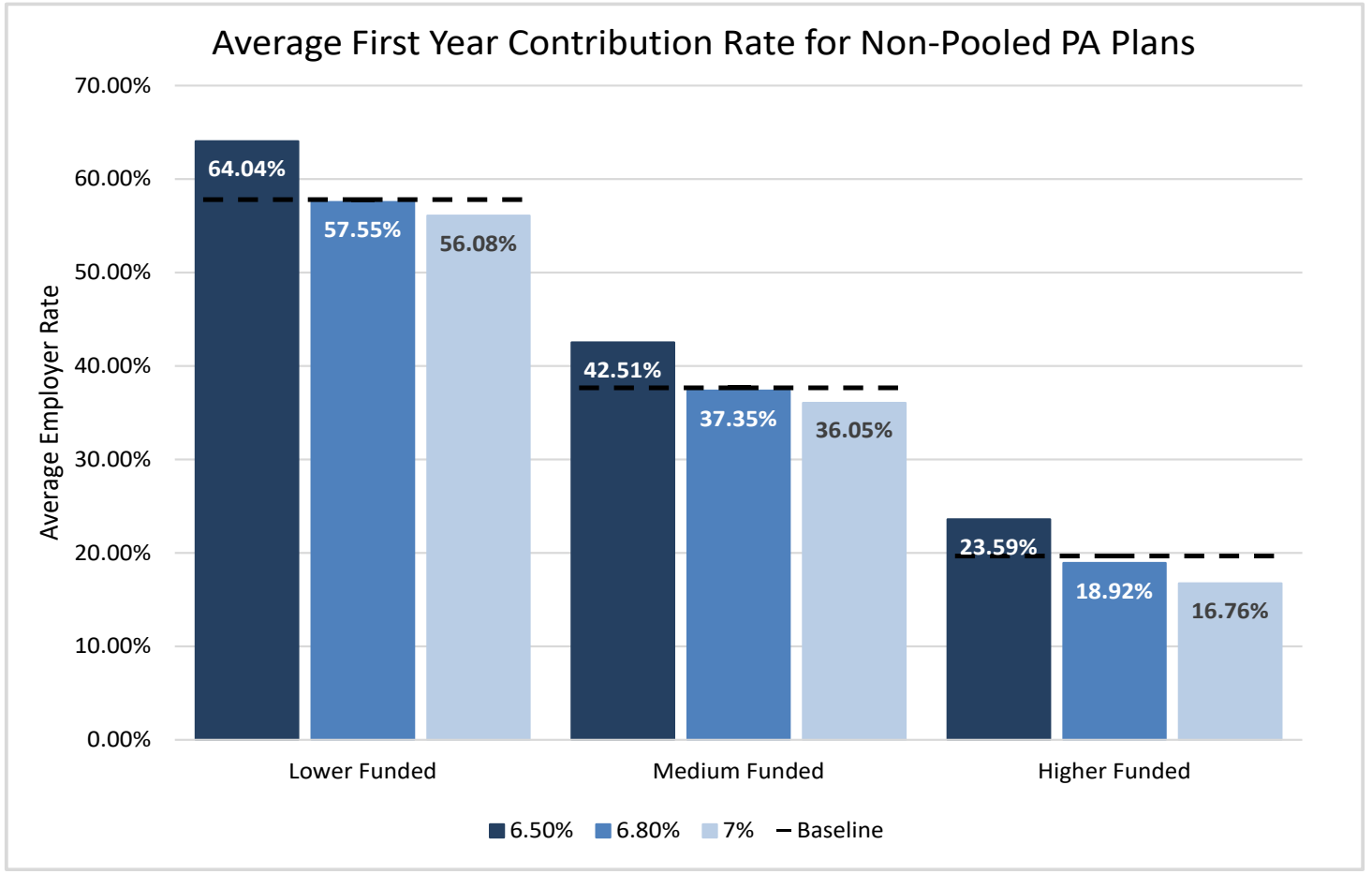
Projected “baseline” contributions were taken from the June 30, 2020 valuation results

Risks & Contribution Changes: State Miscellaneous and Schools

	Portfolio	A1	A2	B1	B2	C1
	Discount Rate	**6.50%**	**6.50%**	**6.80%**	**6.80%**	**7.00%**
	Leverage Amount	**0%**	**3%**	**0%**	**5%**	**5%**
	Drawdown Risk	**20.4%**	**20.1%**	**23.6%**	**23.0%**	**25.5%**
	Volatility	**10.9%**	**10.8%**	**12.1%**	**12.0%**	**12.9%**
State Miscellaneous		**Employer Contribution Rates Over 30-Year Projection Period**				
	75th Percentile	**35.5%**	**35.5%**	**32.4%**	**32.4%**	**31.3%**
	Median	**19.3%**	**19.6%**	**15.5%**	**15.1%**	**12.4%**
	25th Percentile	**9.6%**	**9.6%**	**8.4%**	**8.3%**	**7.6%**
	Probability of Falling Below 50% Funded	**12.8%**	**12.1%**	**19.4%**	**17.7%**	**22.7%**
Schools		**Employer Contribution Rates Over 30-Year Projection Period**				
	75th Percentile	**30.7%**	**30.7%**	**28.4%**	**28.2%**	**26.9%**
	Median	**21.2%**	**21.4%**	**17.8%**	**17.3%**	**14.2%**
	25th Percentile	**9.2%**	**9.2%**	**8.1%**	**8.1%**	**7.4%**
	Probability of Falling Below 50% Funded	**13.7%**	**13.1%**	**20.2%**	**18.6%**	**23.5%**

Discount Rate Impact on First Year Employer Contributions

For Non-Pooled Public Agency Plans



Average Employer Contribution Rate: Public Agencies

Portfolio Characteristics			Non-Pooled Plans with an Average Employer Rate Between						Median Rate
Name	Discount Rate	Leverage	0%-10%	10%-20%	20%-30%	30%-40%	40%-50%	50% +	
A1	6.50%	0.0%							24.8%
A2	6.50%	3.0%							25.1%
B1	6.80%	0.0%							20.8%
B2	6.80%	5.0%							20.3%
C1	7.00%	5.0%							17.3%

Based on 5,000 simulation scenarios for projected future investment returns

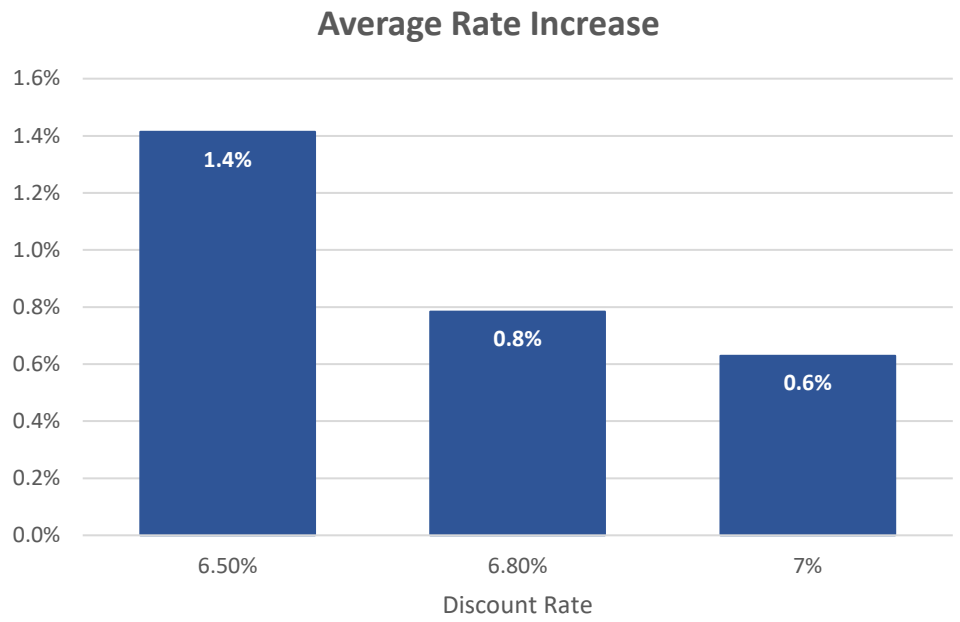
Probability of Funded Ratio < 50%: Public Agencies

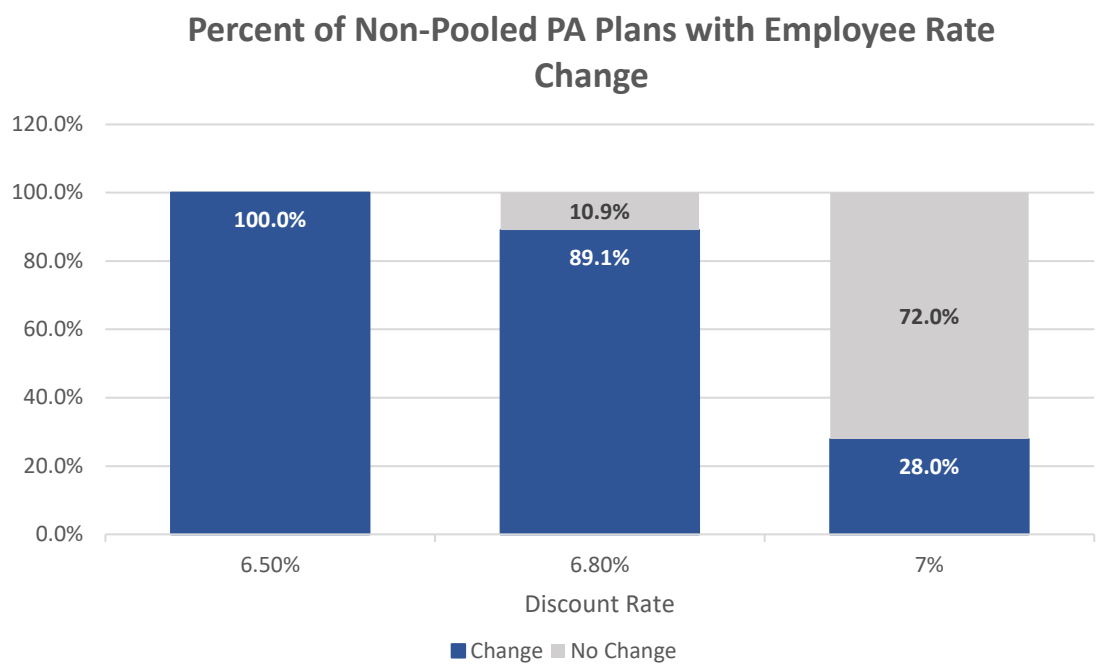
Portfolio Characteristics			Non-Pooled Plans with a Probability Between						Median
Name	Discount Rate	Leverage	0%-10%	10%-20%	20%-30%	30%-40%	40%-50%	50% +	
A1	6.50%	0.0%							15.7%
A2	6.50%	3.0%							15.1%
B1	6.80%	0.0%							22.0%
B2	6.80%	5.0%							20.1%
C1	7.00%	5.0%							24.8%

Based on 5,000 simulation scenarios for projected future investment returns

Discount Rate Impact on PEPRA Employee Contributions

For Non-Pooled Public Agencies Plans





The results above are estimates based on current data. Actual changes in member contribution rates will be determined as part of the June 30, 2021 actuarial valuation process.

Recommendation and Next Steps

Recommendation:

- Select a discount rate and policy portfolio that aligns with Board risk tolerance.
- Adopt the use of leverage in the strategic asset allocation.

Next Steps:

- In the Finance and Administration Committee meeting, adopt the Experience Study assumptions.
- Communicate Board decisions and potential implications with stakeholders
- Create implementation plan (benchmarks, ranges, timeline, etc.) and present at March Investment Committee.

Appendix

Employer Contribution Rate Changes: 6.5% Discount Rate

New Demographic Assumptions, 6.5% Discount Rate, 2.3% Inflation, Prior Year Investment Gain									
	Normal Cost %			UAL Payment %			Total ER Contribution %		
Classic Formulas	**Min**	**Median**	**Max**	**Min**	**Median**	**Max**	**Min**	**Median**	**Max**
2% @ 60 Miscellaneous	2.0%	2.5%	3.0%	0.3%	0.8%	1.6%	2.6%	3.2%	4.5%
2% @ 55 Miscellaneous	2.2%	2.7%	3.2%	-3.8%	0.9%	2.5%	-1.1%	3.5%	5.3%
2.5% @ 55 Miscellaneous	2.5%	3.1%	3.8%	-5.1%	1.1%	4.6%	-2.5%	4.1%	7.7%
2.7% @ 55 Miscellaneous	2.6%	3.4%	4.0%	-8.3%	1.4%	4.0%	-4.9%	4.8%	7.8%
3% @ 60 Miscellaneous	2.7%	3.5%	4.1%	-3.0%	1.3%	3.0%	0.9%	4.6%	6.6%
2% @ 50 Safety	2.9%	3.2%	3.4%	-1.1%	-0.6%	-0.3%	1.8%	2.6%	3.1%
3% @ 55 Safety	3.4%	4.3%	4.9%	-0.8%	0.8%	4.9%	2.9%	5.1%	9.1%
3% @ 50 Safety	3.4%	5.4%	7.2%	-6.3%	2.5%	7.2%	-0.1%	7.8%	14.4%
PEPRA									
2% @ 62 Miscellaneous	1.6%	2.3%	2.7%						
2.7% @ 57 Safety	2.8%	3.5%	4.8%						

Employer Contribution Rate Changes: 6.8% Discount Rate

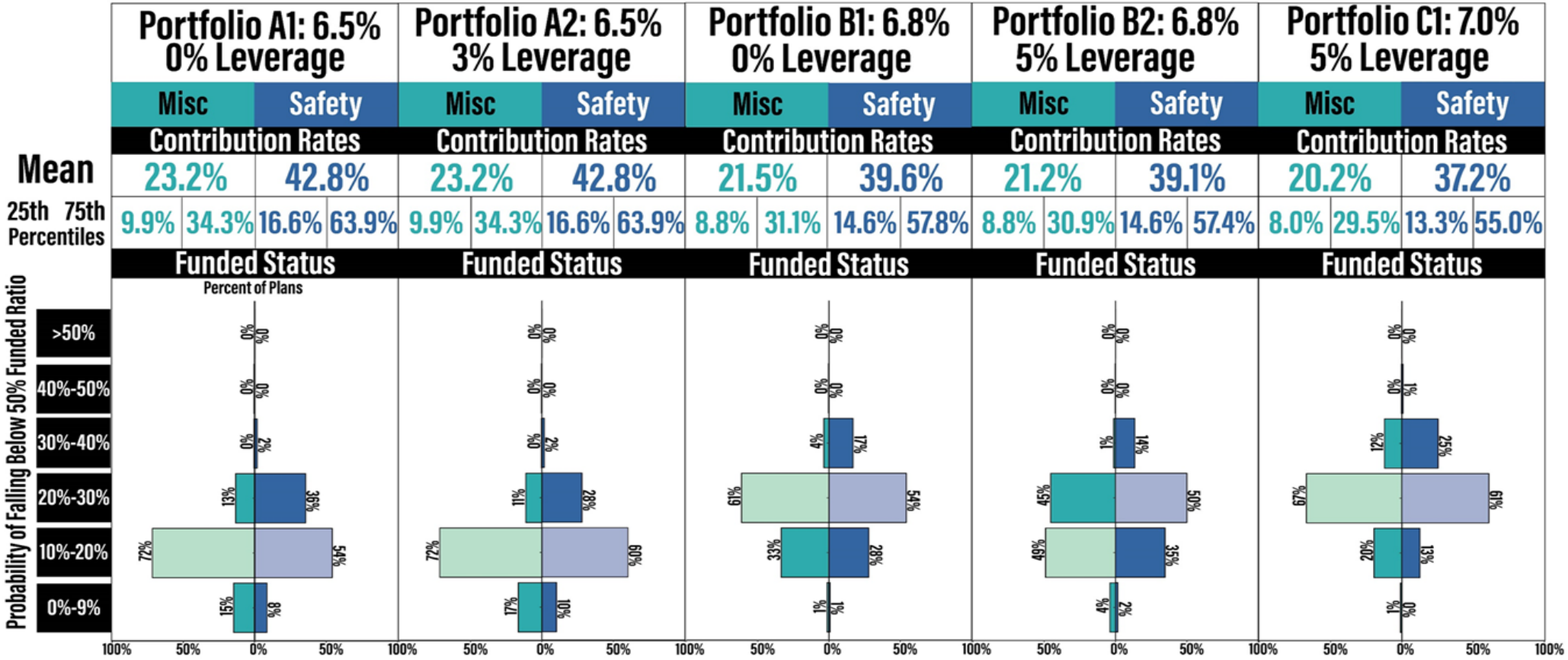
New Demographic Assumptions, 6.8% Discount Rate, 2.3% Inflation, Prior Year Investment Gain

	Normal Cost %			UAL Payment %			Total ER Contribution %		
Classic Formulas	**Min**	**Median**	**Max**	**Min**	**Median**	**Max**	**Min**	**Median**	**Max**
2% @ 60 Miscellaneous	0.9%	1.4%	1.7%	-5.4%	-1.0%	0.0%	-3.8%	0.2%	1.4%
2% @ 55 Miscellaneous	1.0%	1.5%	1.9%	-8.8%	-1.8%	0.0%	-7.2%	-0.3%	1.5%
2.5% @ 55 Miscellaneous	1.2%	1.8%	2.4%	-10.1%	-1.9%	0.1%	-8.3%	0.0%	2.0%
2.7% @ 55 Miscellaneous	1.4%	1.9%	2.3%	-8.3%	-2.1%	-0.5%	-6.5%	-0.3%	1.4%
3% @ 60 Miscellaneous	1.4%	2.1%	2.4%	-9.1%	-2.1%	-0.3%	-6.8%	-0.1%	1.5%
2% @ 50 Safety	0.9%	1.1%	1.4%	-5.4%	-4.9%	-4.2%	-4.2%	-4.0%	-2.9%
3% @ 55 Safety	1.3%	2.1%	2.7%	-4.4%	-3.9%	-0.8%	-3.0%	-2.1%	1.7%
3% @ 50 Safety	1.5%	2.9%	4.3%	-16.1%	-3.0%	0.3%	-12.9%	-0.1%	4.3%
PEPRA									
2% @ 62 Miscellaneous	0.7%	1.2%	1.6%						
2.7% @ 57 Safety	1.0%	1.5%	2.6%						

Employer Contribution Rates Changes: 7% Discount Rate

New Demographic Assumptions, 7.0% Discount Rate, 2.3% Inflation, Prior Year Investment Gain									
	Normal Cost %			UAL Payment %			Total ER Contribution %		
Classic Formulas	**Min**	**Median**	**Max**	**Min**	**Median**	**Max**	**Min**	**Median**	**Max**
2% @ 60 Miscellaneous	0.2%	0.6%	1.0%	-6.2%	-1.2%	-0.3%	-5.4%	-0.6%	0.5%
2% @ 55 Miscellaneous	0.2%	0.7%	1.1%	-8.8%	-2.1%	0.0%	-8.1%	-1.3%	0.4%
2.5% @ 55 Miscellaneous	0.4%	1.0%	1.5%	-10.1%	-2.0%	-0.3%	-9.1%	-1.1%	0.7%
2.7% @ 55 Miscellaneous	0.6%	1.0%	1.4%	-8.3%	-2.4%	-0.7%	-7.5%	-1.5%	0.3%
3% @ 60 Miscellaneous	0.6%	1.1%	1.3%	-30.4%	-2.5%	-0.3%	-29.1%	-1.4%	0.5%
2% @ 50 Safety	-0.3%	-0.1%	0.1%	-5.8%	-5.2%	-4.6%	-6.0%	-5.5%	-4.4%
3% @ 55 Safety	0.0%	0.7%	1.2%	-5.1%	-4.3%	-0.8%	-4.6%	-3.8%	0.2%
3% @ 50 Safety	0.2%	1.4%	2.5%	-19.3%	-3.3%	-0.3%	-17.9%	-2.1%	2.0%
PEPRA									
2% @ 62 Miscellaneous	0.0%	0.6%	1.0%						
2.7% @ 57 Safety	-0.3%	0.3%	1.3%						

Risk vs Reward: Non-Pooled Public Agency Plans



Risks and Contribution Changes: Public Agencies

	Portfolio	A1	A2	B1	B2	C1
	Discount Rate	**6.50%**	**6.50%**	**6.80%**	**6.80%**	**7.00%**
	Leverage Amount	**0%**	**3%**	**0%**	**5%**	**5%**
	Drawdown Risk	**20.4%**	**20.1%**	**23.6%**	**23.0%**	**25.5%**
	Volatility	**10.9%**	**10.8%**	**12.1%**	**12.0%**	**12.9%**
PA - All Plans		**Employer Contribution Rates Over 30-year Projection Period**				
	75th Percentile	**42.6%**	**42.6%**	**38.6%**	**38.3%**	**36.6%**
	Median	**24.8%**	**25.1%**	**20.8%**	**20.3%**	**17.3%**
	25th Percentile	**11.8%**	**11.8%**	**10.4%**	**10.4%**	**9.5%**
	Probability of Falling Below 50% Funded	**15.7%**	**15.1%**	**22.0%**	**20.1%**	**24.8%**
PA - Miscellaneous		**Employer Contribution Rates Over 30-year Projection Period**				
	75th Percentile	**34.3%**	**34.3%**	**31.1%**	**30.9%**	**29.5%**
	Median	**19.1%**	**19.3%**	**15.7%**	**15.3%**	**12.9%**
	25th Percentile	**9.9%**	**9.9%**	**8.8%**	**8.8%**	**8.0%**
	Probability of Falling Below 50% Funded	**15.3%**	**14.7%**	**21.6%**	**19.7%**	**24.3%**
PA - Safety		**Employer Contribution Rates Over 30-year Projection Period**				
	75th Percentile	**63.9%**	**63.9%**	**57.8%**	**57.4%**	**55.0%**
	Median	**39.6%**	**39.9%**	**33.9%**	**33.1%**	**28.6%**
	25th Percentile	**16.6%**	**16.6%**	**14.6%**	**14.6%**	**13.3%**
	Probability of Falling Below 50% Funded	**17.9%**	**17.1%**	**24.3%**	**22.5%**	**26.9%**

Portfolio Characteristics

This table highlights differences for projected return, drawdown, and volatility between portfolios across different time periods for 4 projected rates of return, single period and multi-period optimization, with and without leverage.

Portfolio Characteristics				Years 1-20			Years 1-5			Years 6-20		
Name	Projected Return[1] %	Optimization	Leverage %	Return %	Drawdown %	Volatility %	Return %	Drawdown %	Volatility %	Return %	Drawdown %	Volatility %
Current	6.2	Single Period	-	6.2	22.6	11.2	5.2	23.6	10.9	6.6	22.3	11.3
A1	6.5	Single Period	-	6.5	20.4	10.9	5.4	21.6	10.6	6.9	20.2	11.0
A2	6.5	Single Period	3.0	6.5	20.1	10.8	5.3	21.3	10.5	6.9	19.8	10.9
A3	6.5	Multi-Period	-	6.5	19.6	10.6	5.9	24.0	11.6	6.7	18.4	10.2
A4	6.5	Multi-Period	5.0	6.5	19.5	10.7	5.7	23.0	11.3	6.8	18.6	10.4
B1	6.8	Single Period	-	6.8	23.6	12.1	5.9	24.4	11.8	7.1	23.4	12.2
B2	6.8	Single Period	5.0	6.8	23.0	12.0	5.8	24.1	11.6	7.2	22.8	12.0
B3	6.8	Multi-Period	-	6.8	22.9	11.8	6.2	26.3	12.6	7.0	22.0	11.6
B4	6.8	Multi-Period	5.0	6.8	22.1	11.6	6.4	27.2	13.0	7.0	20.8	11.1
C1	7.0	Single Period	5.0	7.0	25.5	12.9	6.2	26.3	12.6	7.3	25.3	12.9
C2	7.0	Multi-Period	5.0	7.0	24.5	12.5	6.4	28.2	13.4	7.2	23.6	12.2

[1] Projected returns are equivalent to the proposed discount rate for each portfolio.

Current Portfolio: status quo

Discount rate: 6.25%, Projected Return: 6.2%

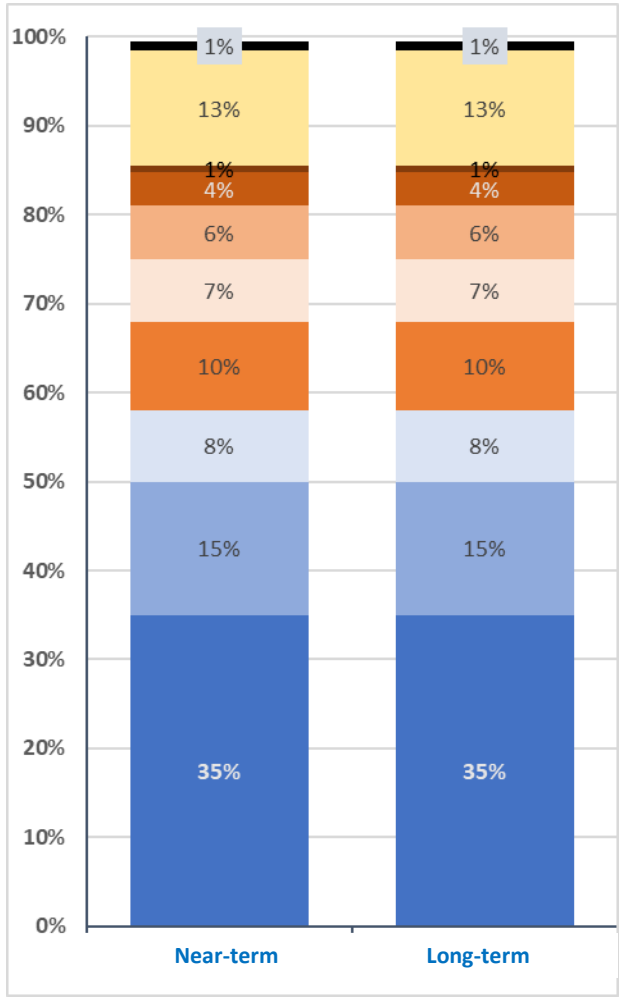
Time Horizon	Projected Return	Drawdown Risk	Volatility
20 Years	6.2%	22.6%	11.2%
Near-term	5.2%	23.6%	10.9%
Long-term	6.6%	22.3%	11.3%

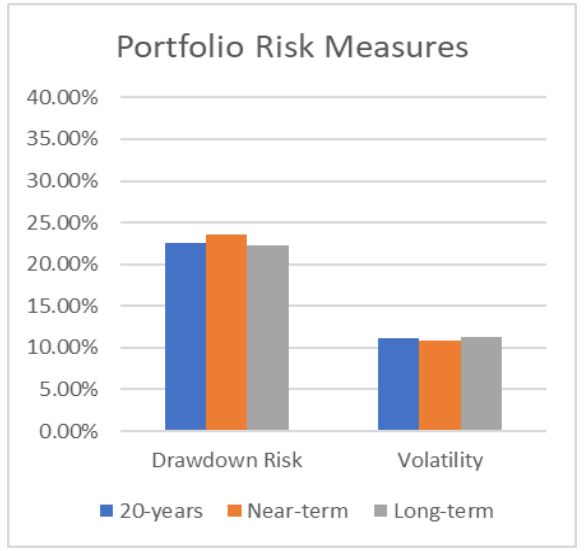
Pros

- No changes, no added complexity
- No policy changes required

Cons

- Given changes in the market since the 2017 ALM, for the same level of risk, higher projected returns are possible with another portfolio
- Lower diversification
- Higher projected contributions





Liquidity
Real Assets
Private Debt
Emerging Market Sovereign Bonds
High Yield
Investment Grade Corporates
Mortgage-backed Securities
Treasury
Private Equity
Global Equity_Non-Cap-weighted
Global Equity_Cap-weighted

Returns are geometric and net of estimated administrative expenses of .10% (10 basis points).

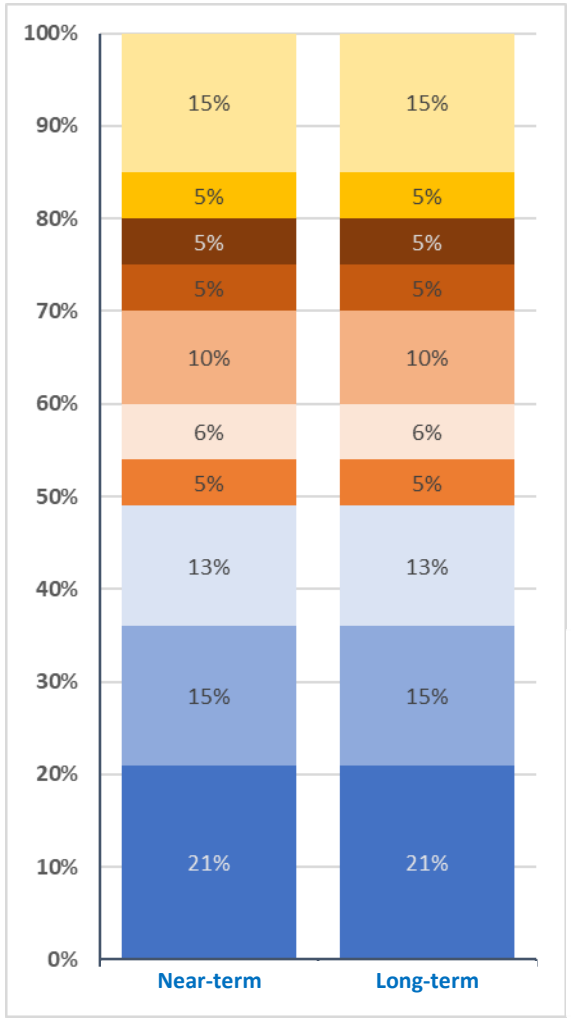
Portfolio A1: 6.5%, single period, 0% leverage

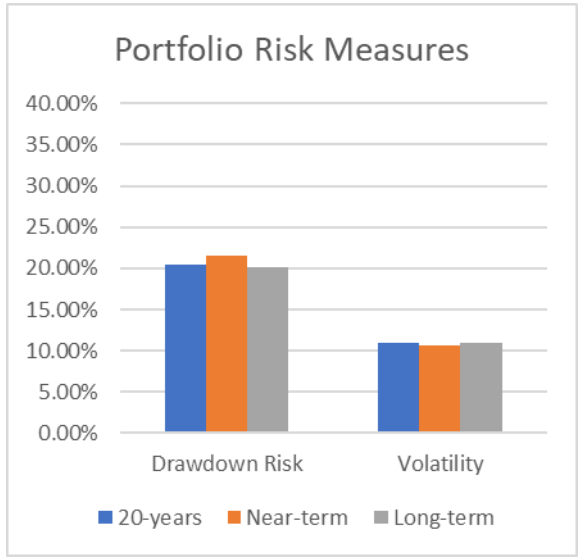
Discount rate: 6.5%, Projected Return: 6.5%

Time Horizon	Projected Return	Drawdown Risk	Volatility
20 Years	6.5%	20.4%	10.9%
Near-term	5.4%	21.6%	10.6%
Long-term	6.9%	20.2%	11.0%

Portfolio Pros and Cons

- All 6.5% portfolios, as compared to the 6.8% or 7.0% have:
  - Lower projected risk of employer funded ratio <50%
  - Higher projected employer/employee contribution levels
  - Lower projected drawdown/volatility
  - Higher liquidity, which is similar liquidity to the current portfolio
- This portfolio without leverage vs. a 6.5% portfolio with leverage has:
  - Lower diversification
  - Higher projected drawdown and volatility
  - Lower operational complexity and loss risk in certain conditions
- This single period portfolio, vs. a 6.5% multi-period portfolio has:
  - Slightly lower near-term projected returns, drawdown, volatility
  - Slightly higher 20-year projected drawdown and volatility
  - Lower implementation complexity and uncertainty
- This portfolio with increased private assets vs. current portfolio has:
  - Higher diversification and projected returns
  - Higher complexity and required policy changes





Returns are geometric and net of estimated administrative expenses of .10% (10 basis points).

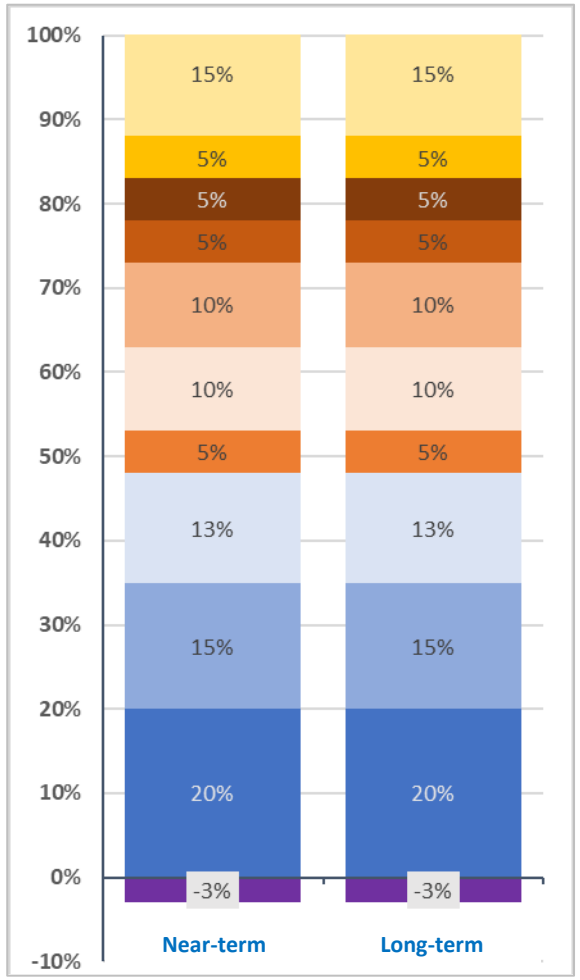
Portfolio A2: 6.5%, single period, 3% leverage

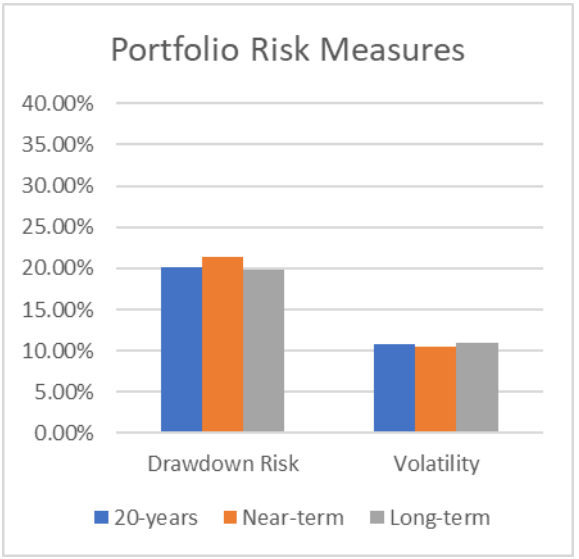
Discount rate: 6.5%, Projected Return: 6.5%

Time Horizon	Projected Return	Drawdown Risk	Volatility
20 Years	6.5%	20.1%	10.8%
Near-term	5.3%	21.3%	10.5%
Long-term	6.9%	19.8%	10.9%

Portfolio Pros and Cons

- All 6.5% portfolios, as compared to the 6.8% or 7.0% have:
  - Lower projected risk of employer funded ratio <50%
  - Higher projected employer/employee contribution levels
  - Lower projected drawdown/volatility
  - Higher liquidity, which is similar liquidity to the current portfolio
- This portfolio with leverage vs. a 6.5% portfolio without leverage has:
  - Higher diversification
  - Lower projected drawdown and volatility
  - Higher operational complexity and loss risk in certain conditions
- This single period portfolio, vs. a 6.5% multi-period portfolio has:
  - Slightly lower near-term projected returns, drawdown, volatility
  - Slightly higher 20-year projected drawdown and volatility
  - Lower implementation complexity and uncertainty
- This portfolio with increased private assets vs. current portfolio has:
  - Higher diversification and projected returns
  - Higher complexity and required policy changes





Leverage
Real Assets
Private Debt
Emerging Market Sovereign Bonds
High Yield
Investment Grade Corporates
Mortgage-backed Securities
Treasury
Private Equity
Global Equity_Non-Cap-weighted
Global Equity_Cap-weighted

Returns are geometric and net of estimated administrative expenses of .10% (10 basis points).

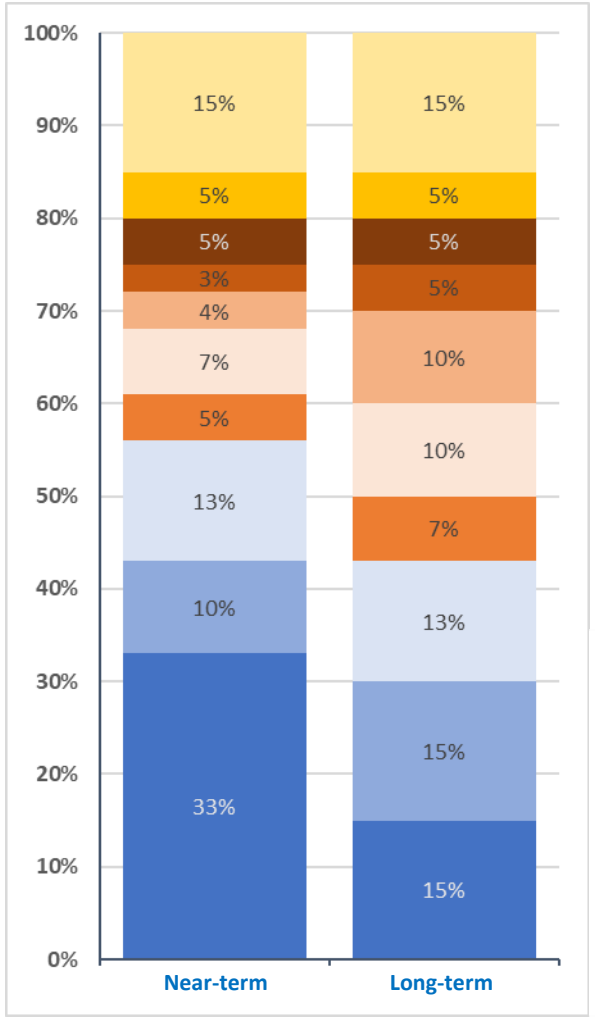
Portfolio A3: 6.5%, multi-period, 0% leverage

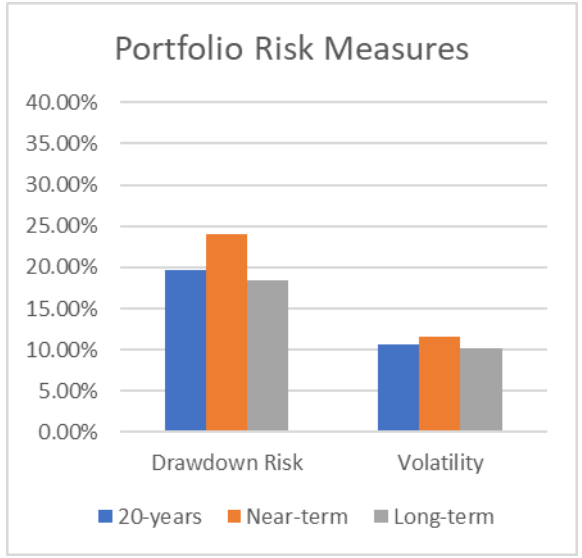
Discount rate: 6.5%, Projected Return: 6.5%

Time Horizon	Projected Return	Drawdown Risk	Volatility
20 Years	6.5%	19.6%	10.6%
Near-term	5.9%	24.0%	11.6%
Long-term	6.7%	18.4%	10.2%

Portfolio Pros and Cons

- All 6.5% portfolios, as compared to the 6.8% or 7.0% have:
  - Lower projected risk of employer funded ratio <50%
  - Higher projected employer/employee contribution levels
  - Lower projected drawdown/volatility
  - Higher liquidity, which is similar liquidity to the current portfolio
- This portfolio without leverage vs. a 6.5% portfolio with leverage has:
  - Lower diversification
  - Higher projected drawdown and volatility
  - Lower operational complexity and loss risk in certain conditions
- This multi-period portfolio vs. a 6.5% single-period portfolio has:
  - Slightly higher near-term projected returns, drawdown, volatility
  - Slightly lower 20-year projected drawdown and volatility
  - Higher implementation complexity and uncertainty
- This portfolio with increased private assets vs. current portfolio has:
  - Higher diversification and projected returns
  - Higher complexity and required policy changes





Real Assets
Private Debt
Emerging Market Sovereign Bonds
High Yield
Investment Grade Corporates
Mortgage-backed Securities
Treasury
Private Equity
Global Equity_Non-Cap-weighted
Global Equity_Cap-weighted

Returns are geometric and net of estimated administrative expenses of .10% (10 basis points).

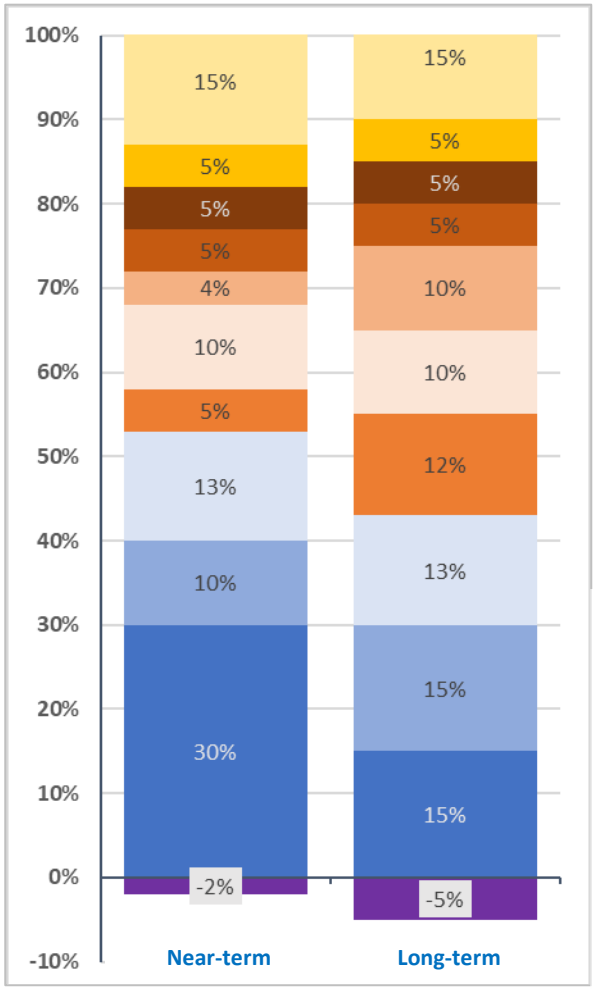
Portfolio A4: 6.5%, multi-period, 5% leverage

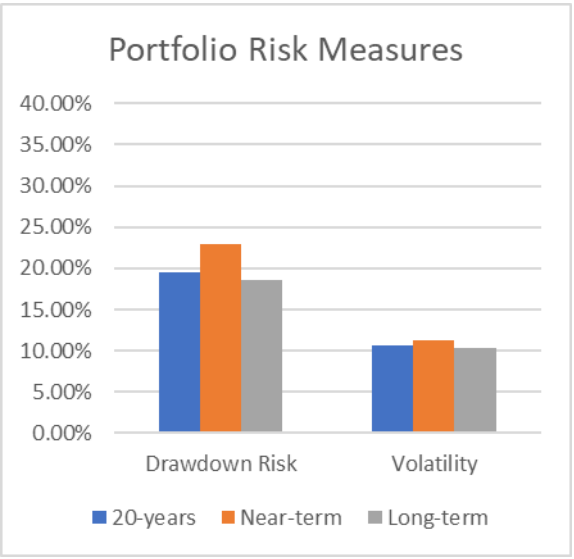
Discount rate: 6.5%, Projected Return: 6.5%

Time Horizon	Projected Return	Drawdown Risk	Volatility
20 Years	6.5%	19.5%	10.7%
Near-term	5.7%	23.0%	11.3%
Long-term	6.8%	18.6%	10.4%

Portfolio Pros and Cons

- All 6.5% portfolios, as compared to the 6.8% or 7.0% have:
  - Lower projected risk of employer funded ratio <50%
  - Higher projected employer/employee contribution levels
  - Lower projected drawdown/volatility
  - Higher liquidity, which is similar liquidity to the current portfolio
- This portfolio with leverage vs. a 6.5% portfolio without leverage has:
  - Higher diversification
  - Lower projected drawdown and volatility
  - Higher operational complexity and loss risk in certain conditions
- This multi-period portfolio vs. a 6.5% single-period portfolio has:
  - Slightly higher near-term projected returns, drawdown, volatility
  - Slightly lower 20-year projected drawdown and volatility
  - Higher implementation complexity and uncertainty
- This portfolio with increased private assets vs. current portfolio has:
  - Higher diversification and projected returns
  - Higher complexity and required policy changes





Leverage
Real Assets
Private Debt
Emerging Market Sovereign Bonds
High Yield
Investment Grade Corporates
Mortgage-backed Securities
Treasury
Private Equity
Global Equity_Non-Cap-weighted
Global Equity_Cap-weighted

Returns are geometric and net of estimated administrative expenses of .10% (10 basis points).
Optimal leverage for this portfolio is 2% in the near-term and 5% in the long-term.

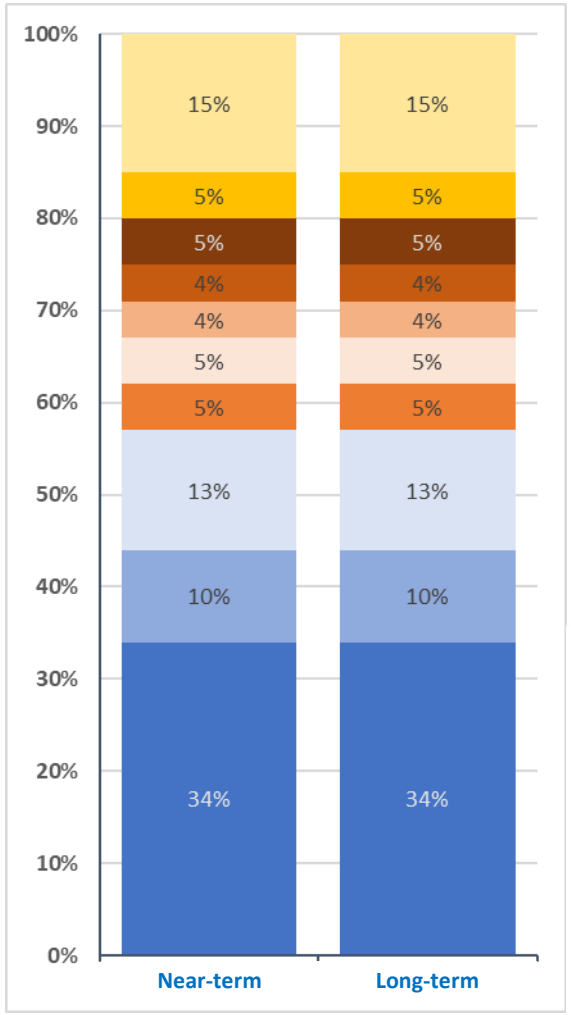
Portfolio B1: 6.8%, single period, 0% leverage

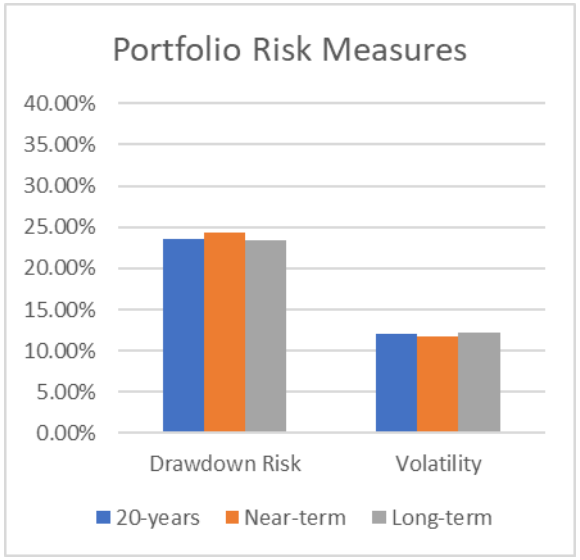
Discount rate: 6.8%, Projected Return: 6.8%

Time Horizon	Projected Return	Drawdown Risk	Volatility
20 Years	6.8%	23.6%	12.1%
Near-term	5.9%	24.4%	11.8%
Long-term	7.1%	23.4%	12.2%

Portfolio Pros and Cons

- All 6.8% portfolios, as compared to the 6.5% portfolios have:
  - Higher projected risk of employer funded ratio <50%
  - Lower projected employer/employee contribution levels
  - Higher projected drawdown/volatility
  - Lower liquidity, which is slightly less liquidity vs. current portfolio
- All 6.8% portfolios, as compared to the 7.0% portfolios have the opposite pros/cons as compared to the 6.5% portfolios above.
- This portfolio without leverage vs. a 6.8% portfolio with leverage has:
  - Lower diversification
  - Higher projected drawdown and volatility
  - Lower operational complexity and loss risk in certain conditions
- This single period portfolio, vs. a 6.8% multi-period portfolio has:
  - Slightly lower near-term projected returns, drawdown, volatility
  - Slightly higher 20-year projected drawdown and volatility
  - Lower implementation complexity and uncertainty
- This portfolio with increased private assets vs. current portfolio has:
  - Higher diversification and projected returns
  - Higher complexity and required policy changes





Returns are geometric and net of estimated administrative expenses of .10% (10 basis points).

CalPERS

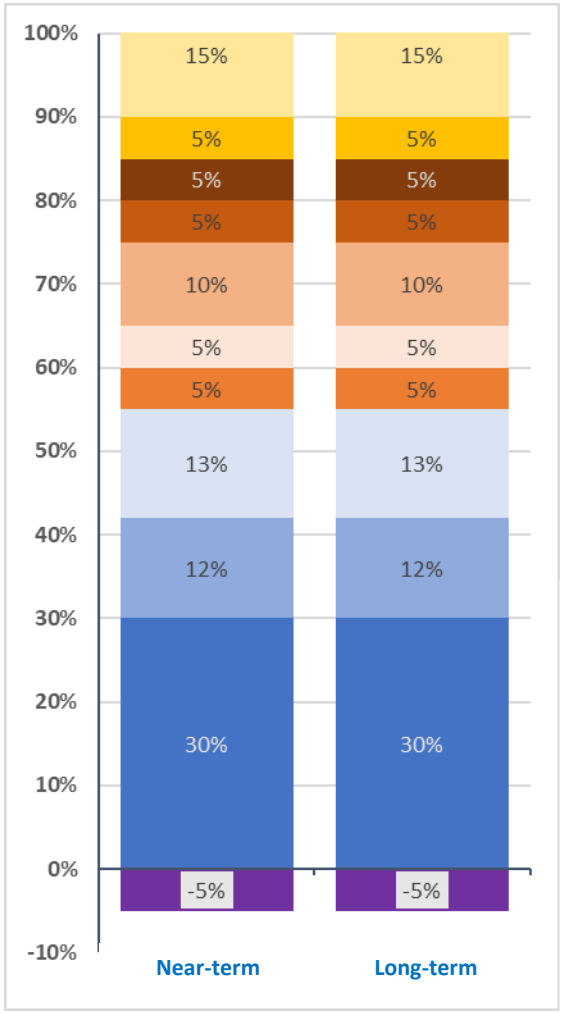
Portfolio B2: 6.8%, single period, 5% leverage

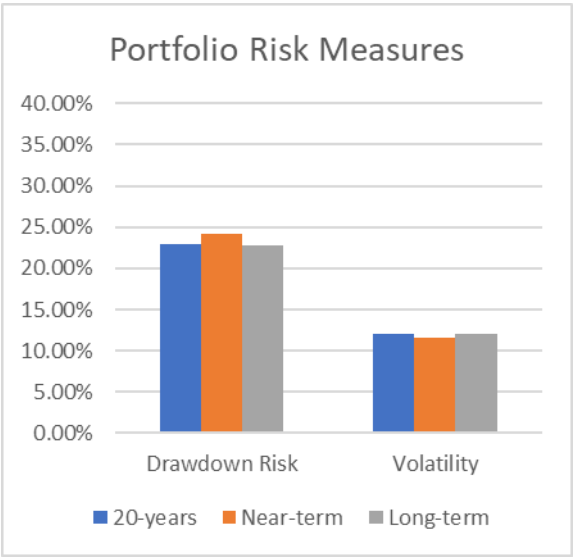
Discount rate: 6.8%, Projected Return: 6.8%

Time Horizon	Projected Return	Drawdown Risk	Volatility
20 Years	6.8%	23.0%	12.0%
Near-term	5.8%	24.1%	11.6%
Long-term	7.2%	22.8%	12.0%

Portfolio Pros and Cons

- All 6.8% portfolios, as compared to the 6.5% portfolios have:
  - Higher projected risk of employer funded ratio <50%
  - Lower projected employer/employee contribution levels
  - Higher projected drawdown/volatility
  - Lower liquidity, which is slightly less liquidity vs. current portfolio
- All 6.8% portfolios, as compared to the 7.0% portfolios have the opposite pros/cons as compared to the 6.5% portfolios above.
- This portfolio with leverage vs. a 6.8% portfolio without leverage has:
  - Higher diversification
  - Lower projected drawdown and volatility
  - Higher operational complexity and loss risk in certain conditions
- This single period portfolio, vs. a 6.8% multi-period portfolio has:
  - Slightly lower near-term projected returns, drawdown, volatility
  - Slightly higher 20-year projected drawdown and volatility
  - Lower implementation complexity and uncertainty
- This portfolio with increased private assets vs. current portfolio has:
  - Higher diversification and projected returns
  - Higher complexity and required policy changes





Leverage
Real Assets
Private Debt
Emerging Market Sovereign Bonds
High Yield
Investment Grade Corporates
Mortgage-backed Securities
Treasury
Private Equity
Global Equity_Non-Cap-weighted
Global Equity_Cap-weighted

Returns are geometric and net of estimated administrative expenses of .10% (10 basis points).

CalPERS

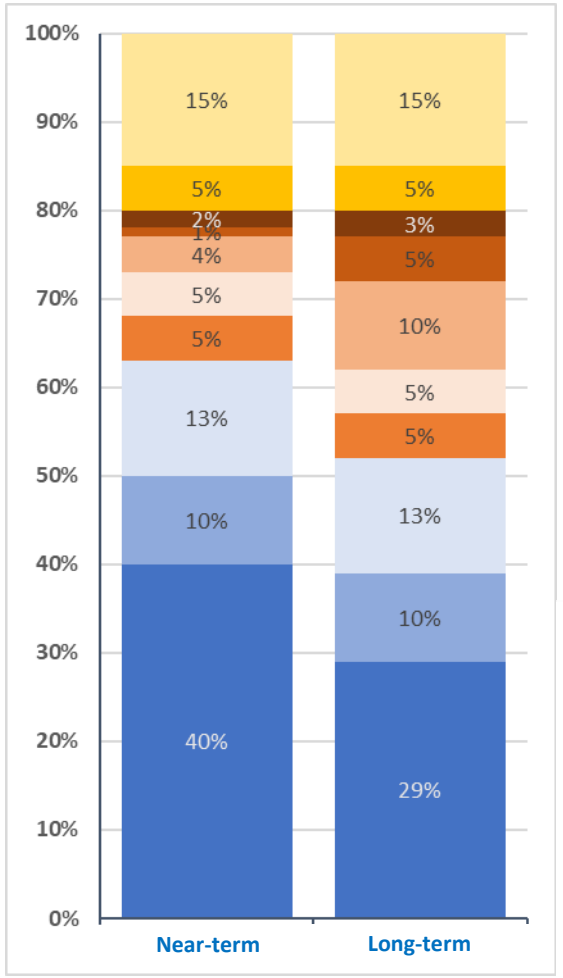
Portfolio B3: 6.8%, multi-period, 0% leverage

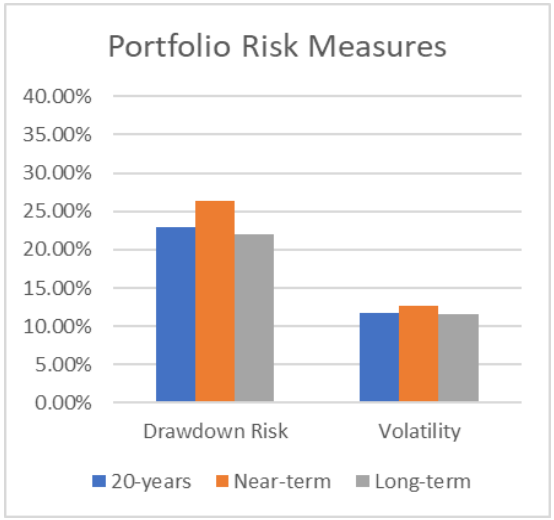
Discount rate: 6.8%, Projected Return: 6.8%

Time Horizon	Projected Return	Drawdown Risk	Volatility
20 Years	6.8%	22.9%	11.8%
Near-term	6.2%	26.3%	12.6%
Long-term	7.0%	22.0%	11.6%

Portfolio Pros and Cons

- All 6.8% portfolios, as compared to the 6.5% portfolios have:
  - Higher projected risk of employer funded ratio <50%
  - Lower projected employer/employee contribution levels
  - Higher projected drawdown/volatility
  - Lower liquidity, which is slightly less liquidity vs. current portfolio
- All 6.8% portfolios, as compared to the 7.0% portfolios have the opposite pros/cons as compared to the 6.5% portfolios above.
- This portfolio without leverage vs. a 6.8% portfolio with leverage has:
  - Lower diversification
  - Higher projected drawdown and volatility
  - Lower operational complexity and loss risk in certain conditions
- This multi-period portfolio vs. a 6.8% single-period portfolio has:
  - Slightly higher near-term projected returns, drawdown, volatility
  - Slightly lower 20-year projected drawdown and volatility
  - Higher implementation complexity and uncertainty
- This portfolio with increased private assets vs. current portfolio has:
  - Higher diversification and projected returns
  - Higher complexity and required policy changes





Returns are geometric and net of estimated administrative expenses of .10% (10 basis points).

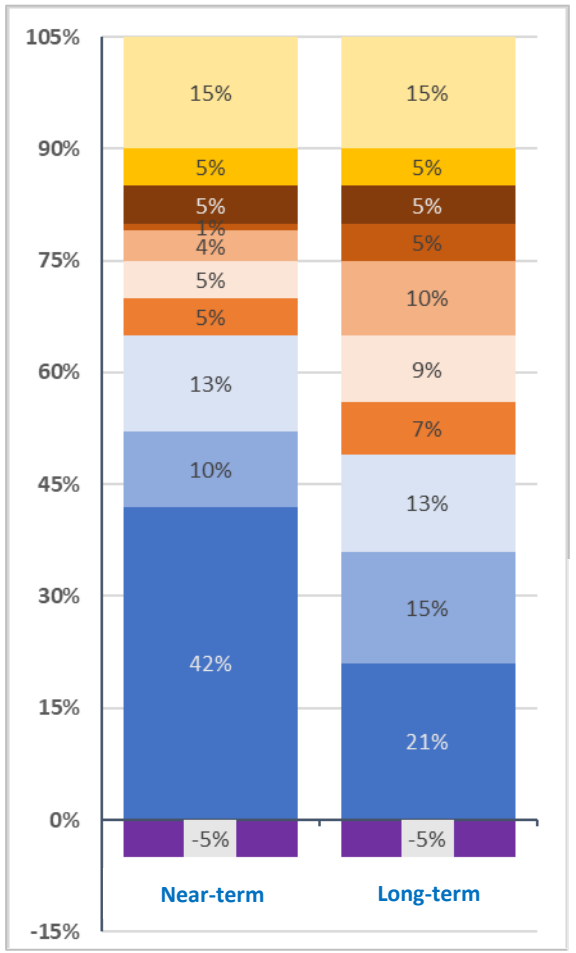
Portfolio B4: 6.8%, multi-period, 5% leverage

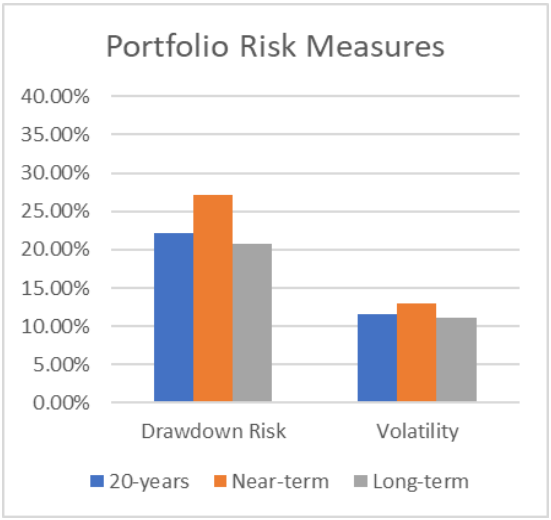
Discount rate: 6.8%, Projected Return: 6.8%

Time Horizon	Projected Return	Drawdown Risk	Volatility
20 Years	6.8%	22.1%	11.6%
Near-term	6.4%	27.2%	13.0%
Long-term	7.0%	20.8%	11.1%

Portfolio Pros and Cons

- All 6.8% portfolios, as compared to the 6.5% portfolios have:
  - Higher projected risk of employer funded ratio <50%
  - Lower projected employer/employee contribution levels
  - Higher projected drawdown/volatility
  - Lower liquidity, which is slightly less liquidity vs. current portfolio
- All 6.8% portfolios, as compared to the 7.0% portfolios have the opposite pros/cons as compared to the 6.5% portfolios above.
- This portfolio with leverage vs. a 6.8% portfolio without leverage has:
  - Higher diversification
  - Lower projected drawdown and volatility
  - Higher operational complexity and loss risk in certain conditions
- This multi-period portfolio vs. a 6.8% single-period portfolio has:
  - Slightly higher near-term projected returns, drawdown, volatility
  - Slightly lower 20-year projected drawdown and volatility
  - Higher implementation complexity and uncertainty
- This portfolio with increased private assets vs. current portfolio has:
  - Higher diversification and projected returns
  - Higher complexity and required policy changes





Returns are geometric and net of estimated administrative expenses of .10% (10 basis points).

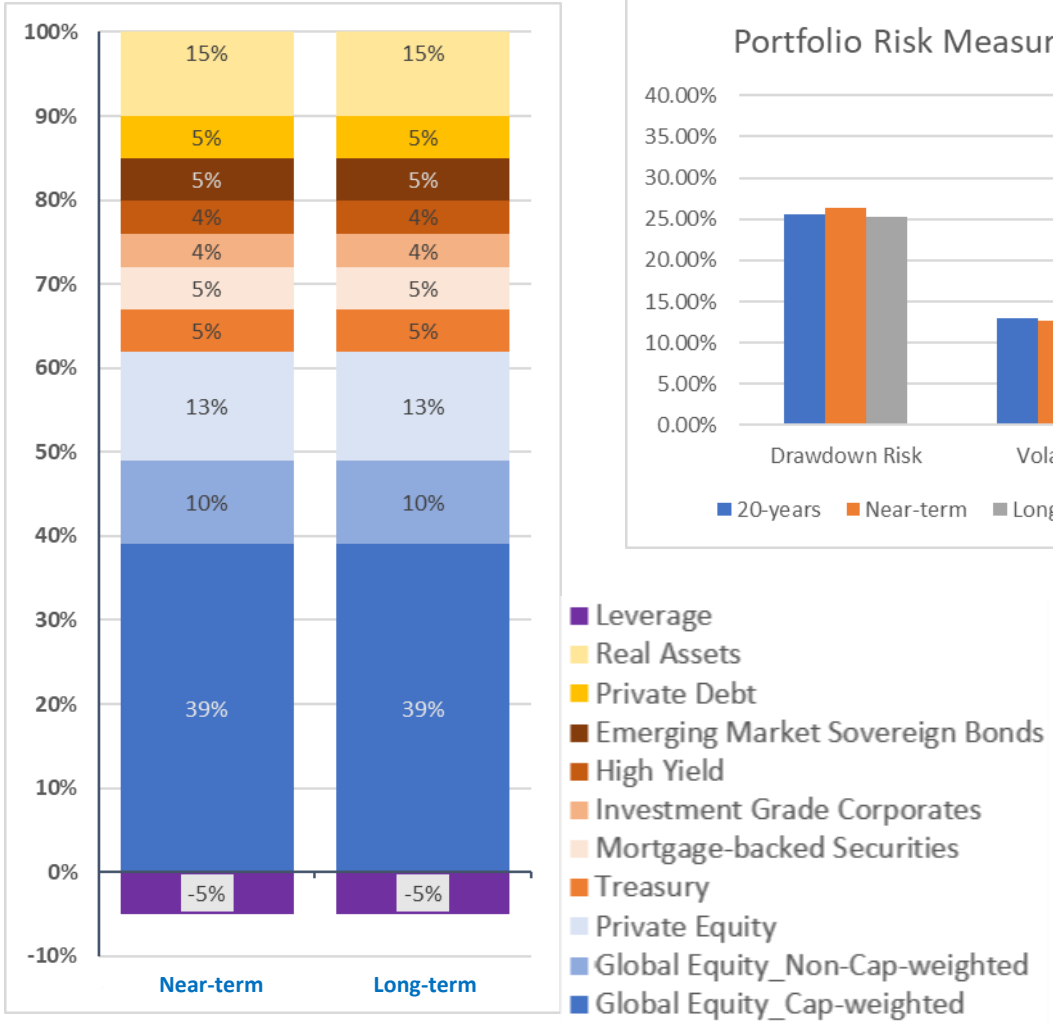
Portfolio C1: 7.0%, single period, 5% leverage

Discount rate: 7.0%, Projected Return: 7.0%

Time Horizon	Projected Return	Drawdown Risk	Volatility
20 Years	7.0%	25.5%	12.9%
Near-term	6.2%	26.3%	12.6%
Long-term	7.3%	25.3%	12.9%

Portfolio Pros and Cons

- All 7.0% portfolios, as compared to the 6.5% or 6.8% portfolios have:
  - Higher projected risk of employer funded ratio <50%
  - Lower projected employer/employee contribution levels
  - Higher projected drawdown/volatility
  - Lower liquidity, moderately lower liquidity vs. current portfolio
- This portfolio with leverage is the only option at 7.0%, as it is not possible to achieve the 7.0% without leverage.
- This single period portfolio, vs. a 7.0% multi-period portfolio has:
  - Slightly lower near-term projected returns, drawdown, volatility
  - Slightly higher 20-year projected drawdown and volatility
  - Lower implementation complexity and uncertainty
- This portfolio with increased private assets vs. current portfolio has:
  - Higher diversification and projected returns
  - Higher complexity and required policy changes



Returns are geometric and net of estimated administrative expenses of .10% (10 basis points).

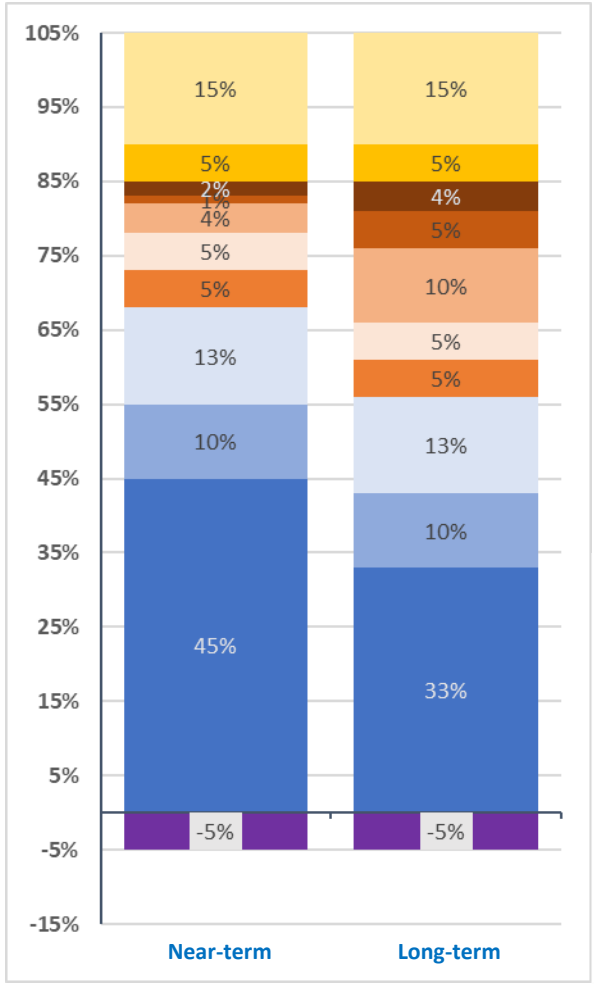
Portfolio C2: 7.0%, multi-period, 5% leverage

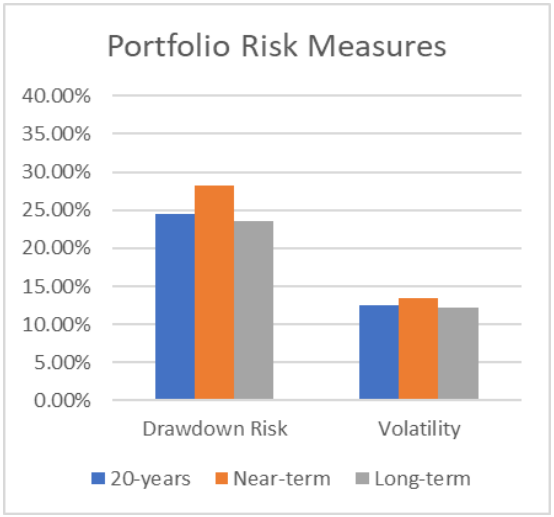
Discount rate: 7.0%, Projected Return: 7.0%

Time Horizon	Projected Return	Drawdown Risk	Volatility
20 Years	7.0%	24.5%	12.5%
Near-term	6.4%	28.2%	13.4%
Long-term	7.2%	23.6%	12.2%

Portfolio Pros and Cons

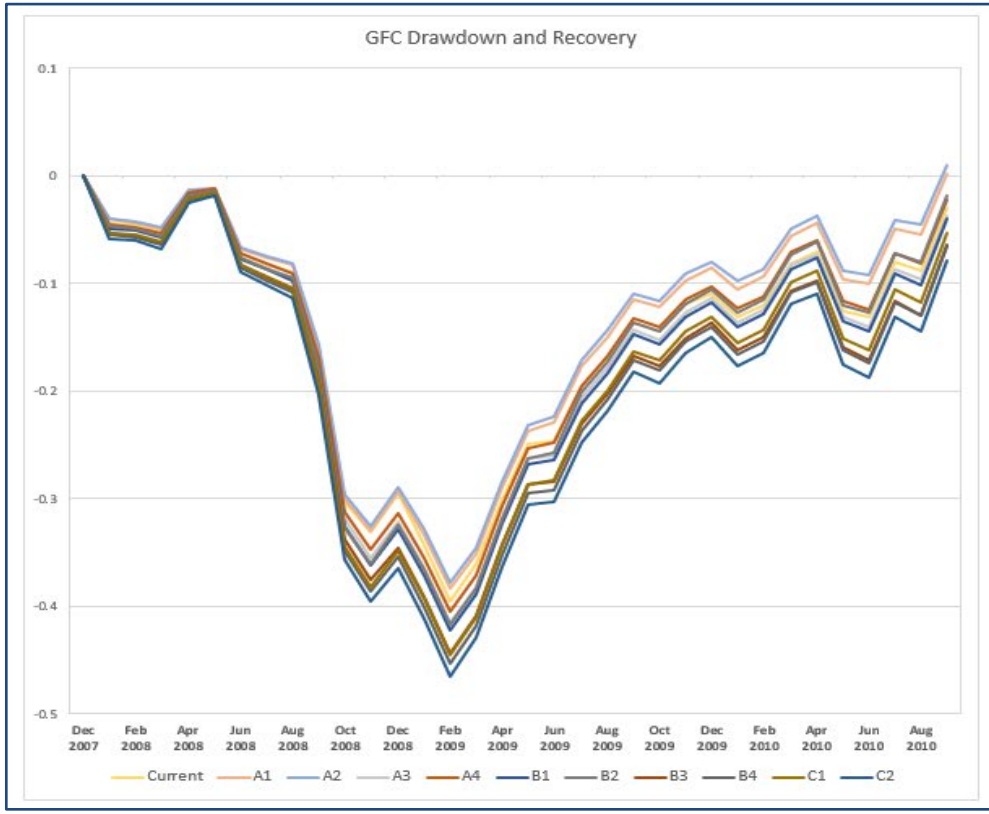
- All 7.0% portfolios, as compared to the 6.5% or 6.8% portfolios have:
  - Higher projected risk of employer funded ratio <50%
  - Lower projected employer/employee contribution levels
  - Higher projected drawdown/volatility
  - Lower liquidity, moderately lower liquidity vs. current portfolio
- This portfolio with leverage is the only option at 7.0%, as it is not possible to achieve the 7.0% without leverage.
- This multi-period portfolio vs. a 7.0% single-period portfolio has:
  - Slightly higher near-term projected returns, drawdown, volatility
  - Slightly lower 20-year projected drawdown and volatility
  - Higher implementation complexity and uncertainty
- This portfolio with increased private assets vs. current portfolio has:
  - Higher diversification and projected returns
  - Higher complexity and required policy changes

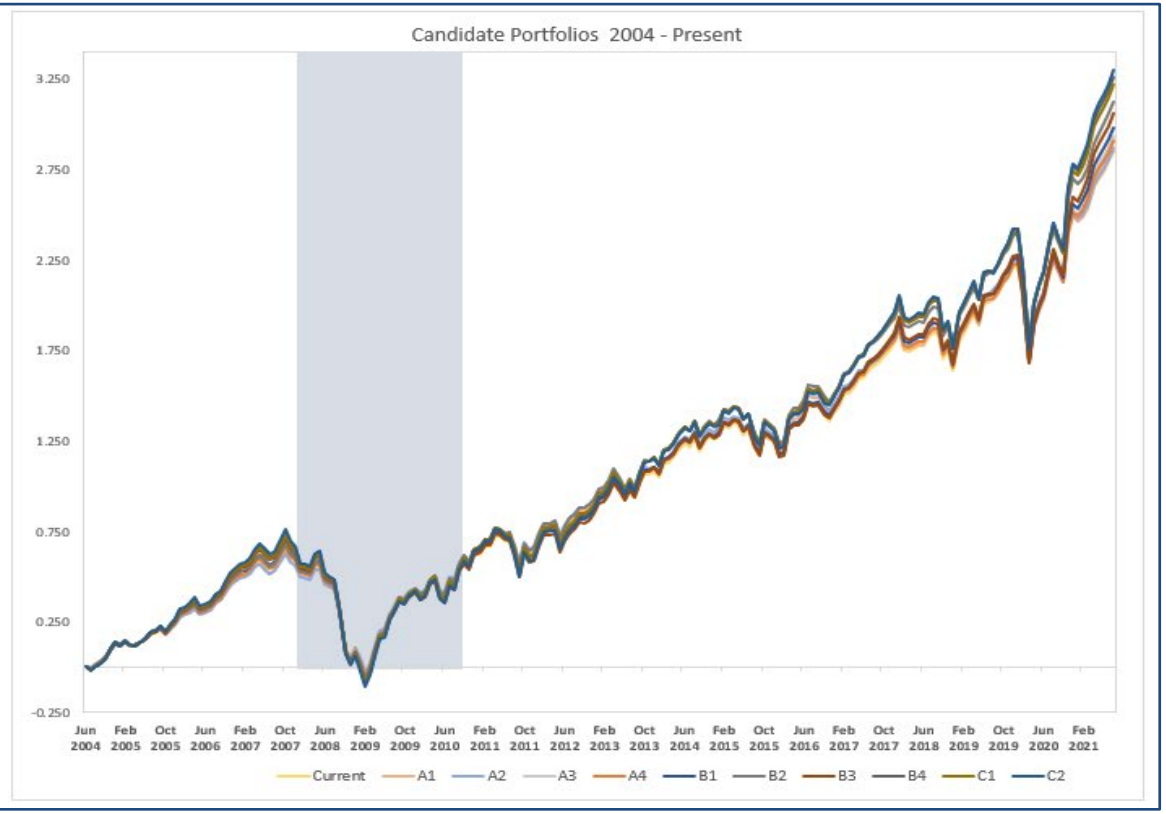




Returns are geometric and net of estimated administrative expenses of .10% (10 basis points).

Portfolio Stress Test: Historical Returns

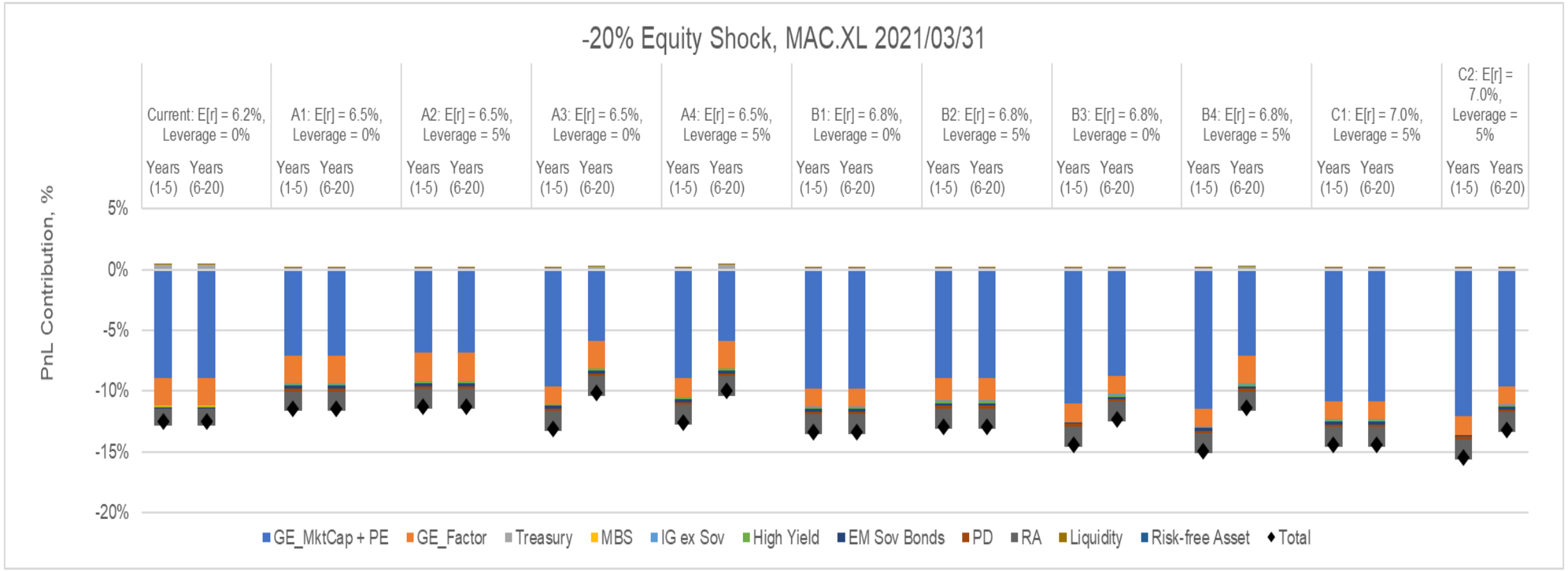




June 2004 - Aug 2021	Current	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2
Return	8.3%	8.2%	8.2%	8.3%	8.3%	8.4%	8.6%	8.5%	8.8%	8.7%	8.9%
Volatility	11.0%	10.7%	10.6%	11.6%	11.3%	11.8%	11.8%	12.4%	12.9%	12.6%	13.2%
Maximum Drawdown	-42%	-41%	-40%	-44%	-43%	-45%	-44%	-47%	-48%	-47%	-49%

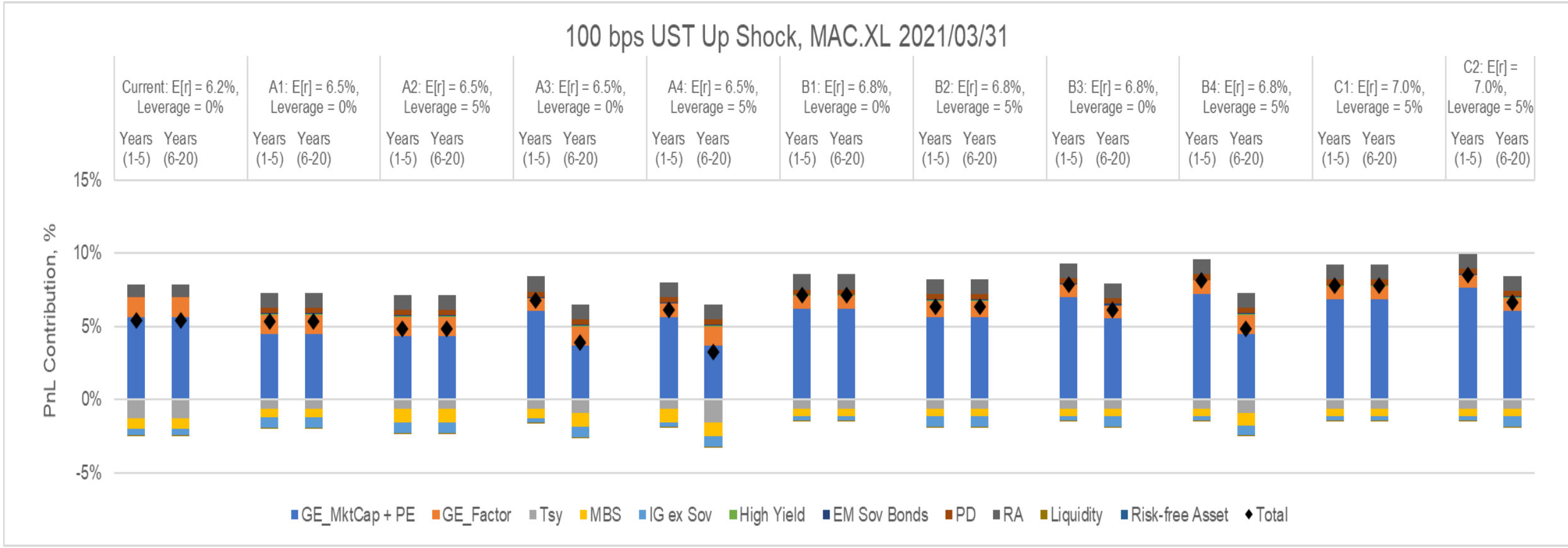
Data: Candidate Portfolio Historical Return Profile with PERF Benchmarks, 1-5 Year MPO Asset Weights

Portfolio Stress Test: Equities Down 20%



Data : Candidate Portfolio Historical Return Profile with PERF Benchmarks and MPO Asset Weights
Results : MSCI Barra Application

Portfolio Stress Test: Interest Rates Up 1%



Data : Candidate Portfolio Historical Return Profile with PERF Benchmarks and MPO Asset Weights
Results : MSCI Barra Application

Portfolio Economic Scenario Analysis

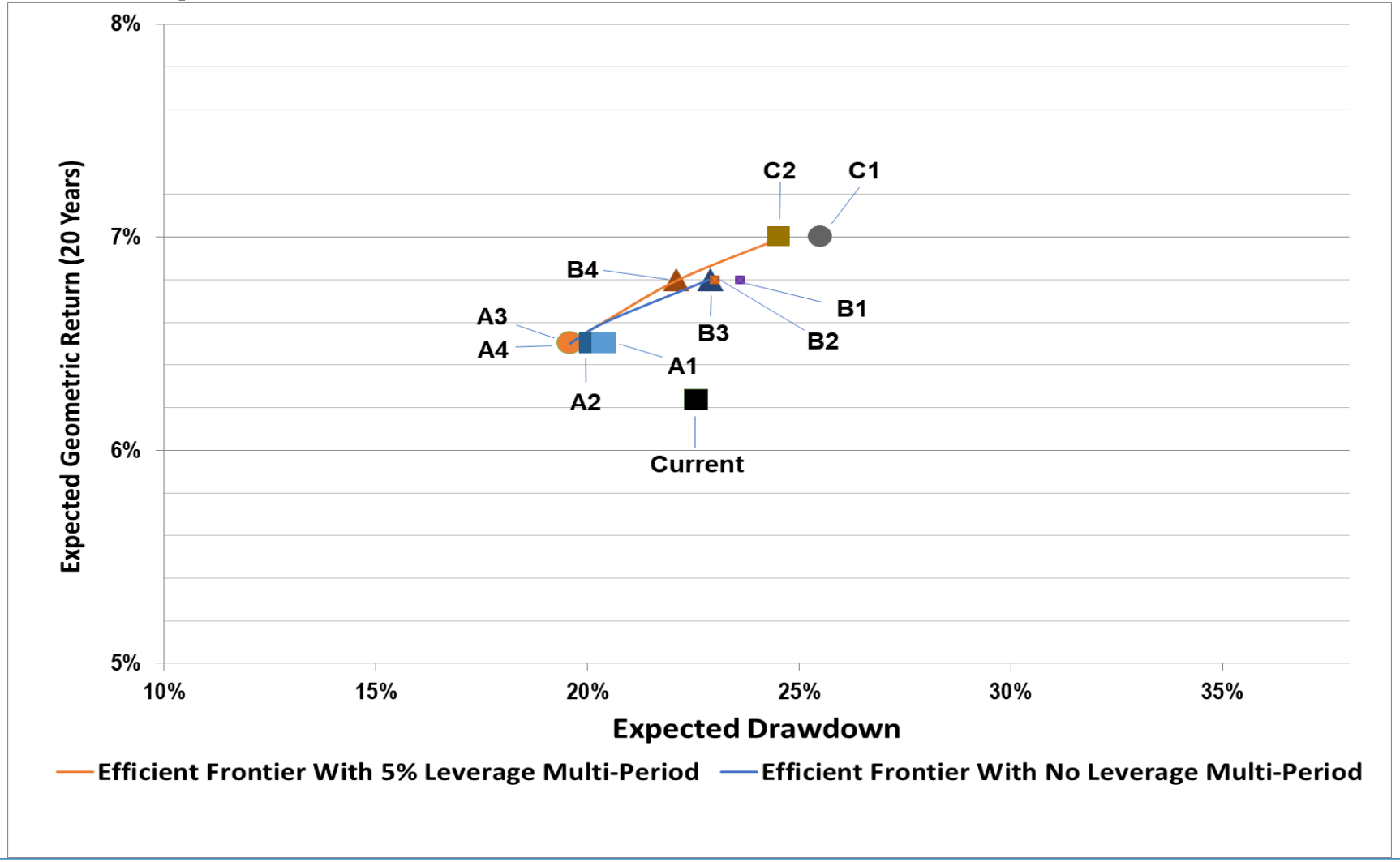
In general, though overall projected returns differ by economic upside or downside scenario, the base portfolio compares well to risk equivalent optimal portfolios in the upside and downside scenario.

Projected Returns by Economic Scenario

Portfolio	Baseline Economic Scenario	Downside Economic Scenario	Downside Optimal Portfolio	Upside Economic Scenario	Upside Optimal Portfolio
Current	6.2%	5.8%	5.8%	6.8%	6.8%
A1: 6.5%, 0% leverage, single period	6.5%	6.0%	6.0%	7.0%	7.0%
A2: 6.5%, 3% leverage, single period	6.5%	6.0%	6.0%	7.0%	7.0%
A3: 6.5%, 0% leverage, multi-period	6.5%	6.0%	6.0%	7.0%	7.0%
A4: 6.5%, 5% leverage, multi-period	6.5%	6.0%	6.0%	7.0%	7.0%
B1: 6.8%, 0% leverage, single period	6.8%	6.2%	6.2%	7.4%	7.4%
B2: 6.8%, 5% leverage, single period	6.8%	6.3%	6.3%	7.4%	7.4%
B3: 6.8%, 0% leverage, multi-period	6.8%	6.2%	6.3%	7.4%	7.5%
B4: 6.8%, 5% leverage, multi-period	6.8%	6.2%	6.3%	7.3%	7.4%
C1: 7.0%, 5% leverage, single period	7.0%	6.4%	6.4%	7.6%	7.6%
C2: 7.0%, 5% leverage, multi-period	7.0%	6.4%	6.4%	7.6%	7.6%

Data: Current Portfolio and Candidate Portfolios MPO Key Performance Indicators
Source: FactSet

Portfolio Comparison – Efficient Frontier



Data: Candidate Portfolios and Current Portfolio MPO Key Performance Indicators

Capital Market Assumptions[1] – Returns and Volatility

Asset Class	Asset Segment	Near-Term Projected Return (5-year)	Long-Term Projected Return (20-year)	Projected Volatility (20-year)
Growth	Global Equity – Cap Weighted	6.8%	6.8%	17.0%
	Global Equity – Non-Cap Weighted	5.1%	6.1%	13.5%
	Private Equity	8.9%	9.6%	30.1%
Income	Long U.S. Treasuries	0.1%	2.6%	12.4%
	Spread Product – Mortgage-Backed Securities	1.2%	2.8%	3.1%
	Spread Product – Investment Grade Corporates	0.1%	3.9%	8.5%
	Spread Product – High Yield	2.2%	4.7%	9.2%
	Spread Product – Sovereigns	3.2%	4.5%	10.4%
	High Yield Segment	2.2%	4.6%	9.0%
Real Assets	Real Estate	5.3%	5.5%	12.2%
Liquidity	Liquidity	0.3%	1.7%	0.8%
Other	Private Debt	6.8%	5.9%	9.9%
	Emerging Market Debt	2.7%	4.8%	10.3%

[1] Capital Market Assumptions for the PERF were adopted by the Investment Committee on September 13, 2021.

Capital Market Assumptions[1] - Asset Class Correlations

	Global Equity Cap-weighted	Global Equity Non-Cap-weighted	Private Equity	Treasury	Mortgage-backed Securities	Sovereign Bonds	Investment Grade Corporates	High Yield CP	High Yield Segment	Emerging Market Debt	Private Debt	Real Assets	Liquidity	Risk-free Asset
Global Equity Cap-weighted	1.00	0.97	0.62	0.11	0.13	0.21	0.29	0.38	0.46	0.27	0.42	0.36	0.11	0.11
Global Equity Non-Cap-weighted	0.97	1.00	0.61	0.11	0.14	0.21	0.28	0.37	0.45	0.27	0.42	0.36	0.17	0.16
Private Equity	0.62	0.61	1.00	0.08	0.09	0.15	0.20	0.27	0.33	0.19	0.33	0.22	0.06	0.06
Treasury	0.11	0.11	0.08	1.00	0.77	0.96	0.91	0.79	0.36	0.59	0.07	0.09	0.09	0.09
Mortgage-backed Securities	0.13	0.14	0.09	0.77	1.00	0.78	0.72	0.66	0.41	0.50	0.10	0.13	0.19	0.19
Sovereign Bonds	0.21	0.21	0.15	0.96	0.78	1.00	0.94	0.86	0.49	0.64	0.11	0.11	0.11	0.11
Investment Grade Corporates	0.29	0.28	0.20	0.91	0.72	0.94	1.00	0.93	0.65	0.66	0.14	0.13	0.10	0.10
High Yield CP	0.38	0.37	0.27	0.79	0.66	0.86	0.93	1.00	0.85	0.65	0.18	0.15	0.10	0.10
High Yield Segment	0.46	0.45	0.33	0.36	0.41	0.49	0.65	0.85	1.00	0.49	0.21	0.15	0.12	0.12
Emerging Market Debt	0.27	0.27	0.19	0.59	0.50	0.64	0.66	0.65	0.49	1.00	0.13	0.10	0.09	0.09
Private Debt	0.42	0.42	0.33	0.07	0.10	0.11	0.14	0.18	0.21	0.13	1.00	0.20	0.21	0.21
Real Assets	0.36	0.36	0.22	0.09	0.13	0.11	0.13	0.15	0.15	0.10	0.20	1.00	0.16	0.16
Liquidity	0.11	0.17	0.06	0.09	0.19	0.11	0.10	0.10	0.12	0.09	0.21	0.16	1.00	0.98
Risk-free Asset	0.11	0.16	0.06	0.09	0.19	0.11	0.10	0.10	0.12	0.09	0.21	0.16	0.98	1.00

[1] Capital Market Assumptions for the PERF were adopted by the Investment Committee on September 13, 2021.