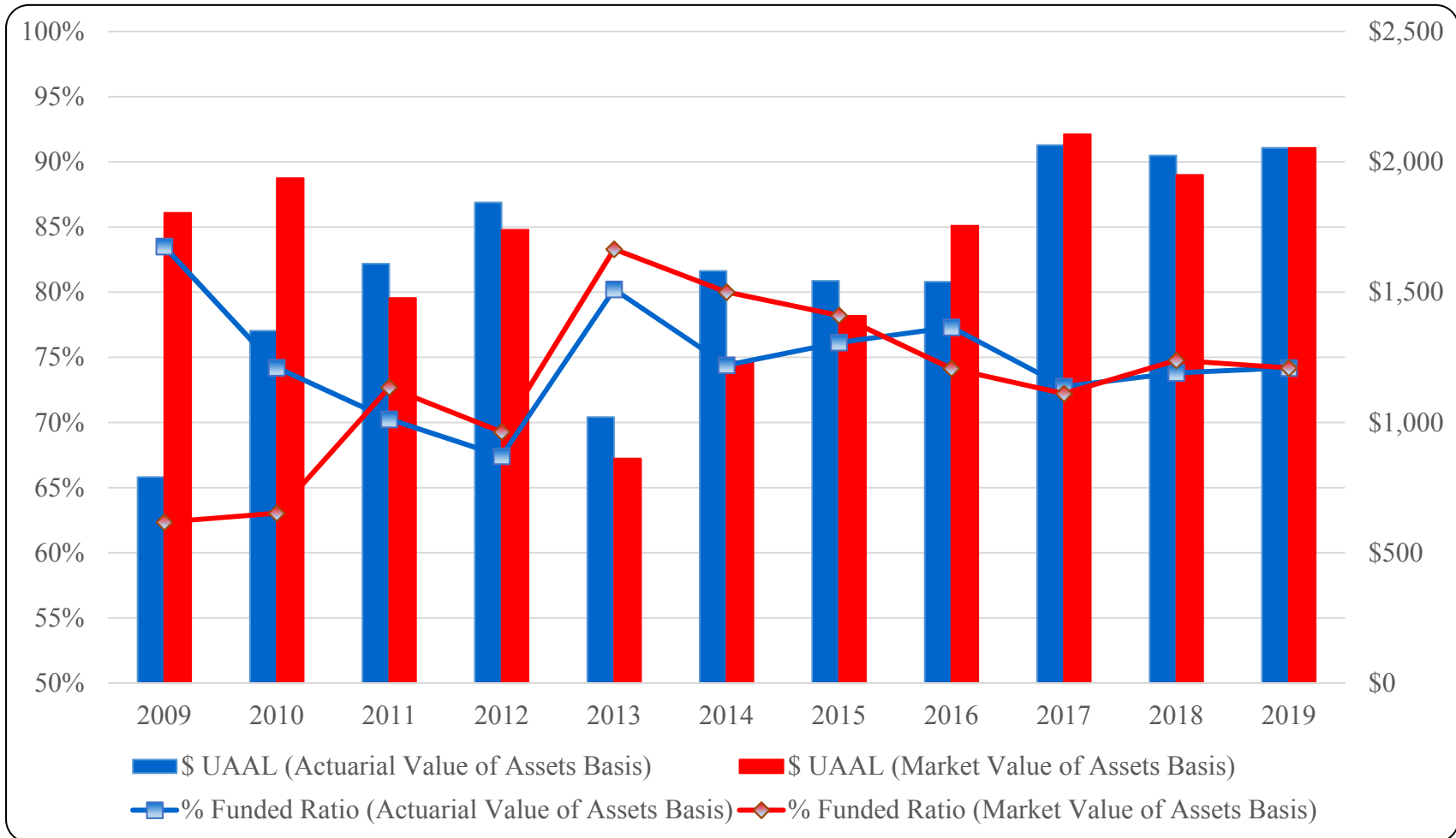# CM

Cavanaugh Macdonald
CONSULTING, LLC

Public Employees' Retirement System
Teachers' Retirement System
Risk Analysis
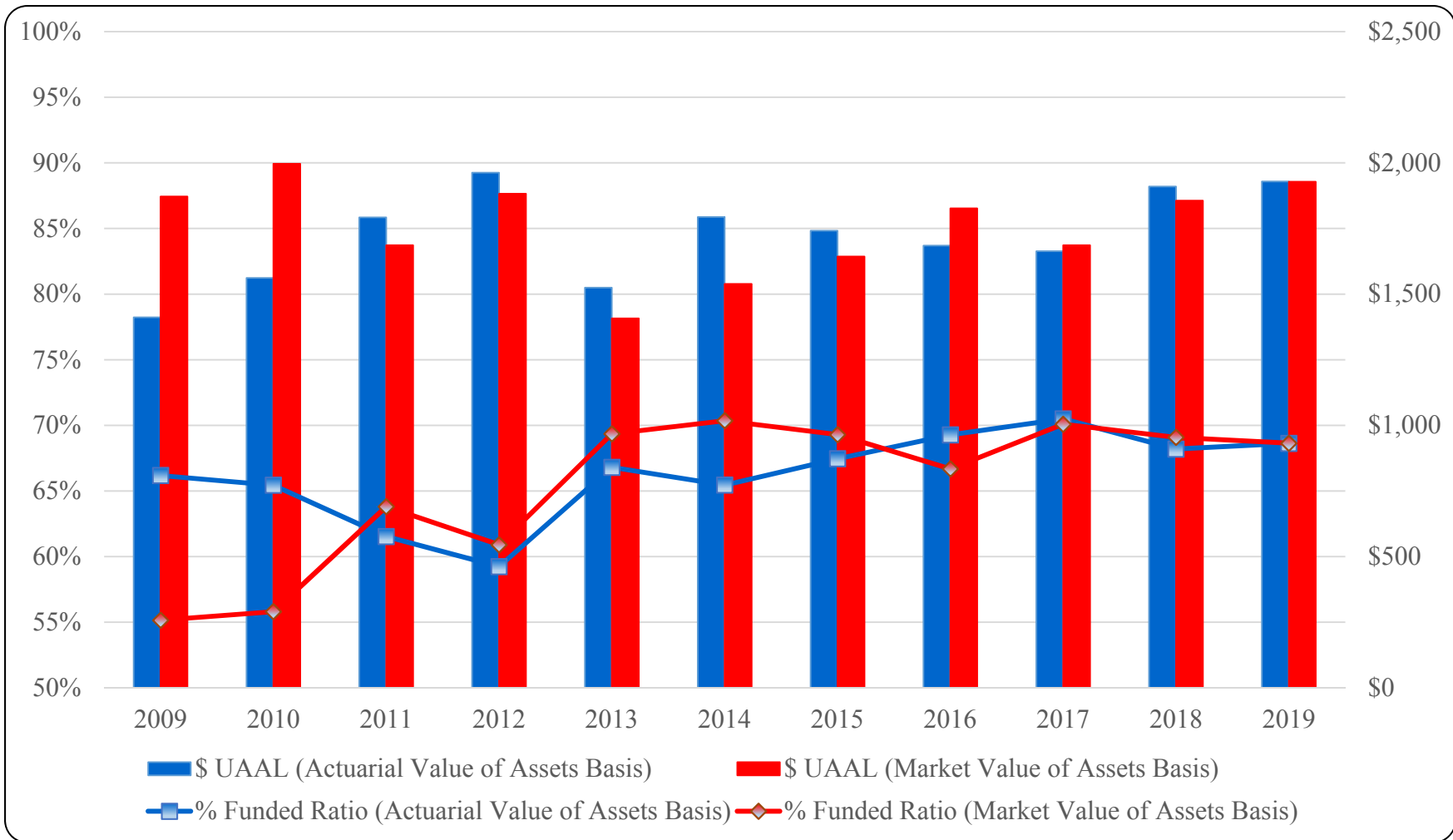
August 11, 2020

Todd Green, ASA, FCA, MAAA

Public Employees' Retirement System Funded Ratio (Percentages) and Dollar UAAL ($ Millions) in June 30, 2009 to 2019 Valuations
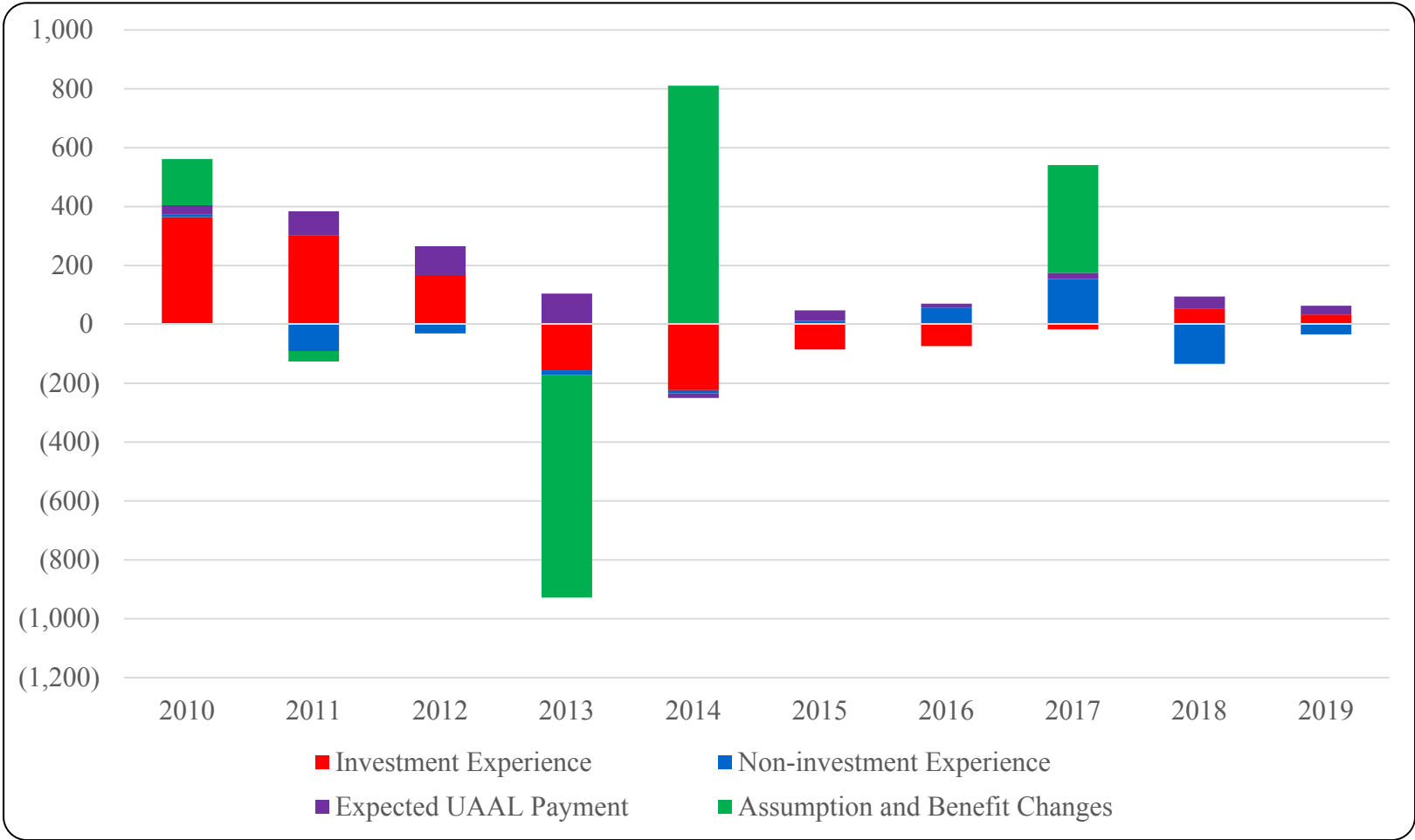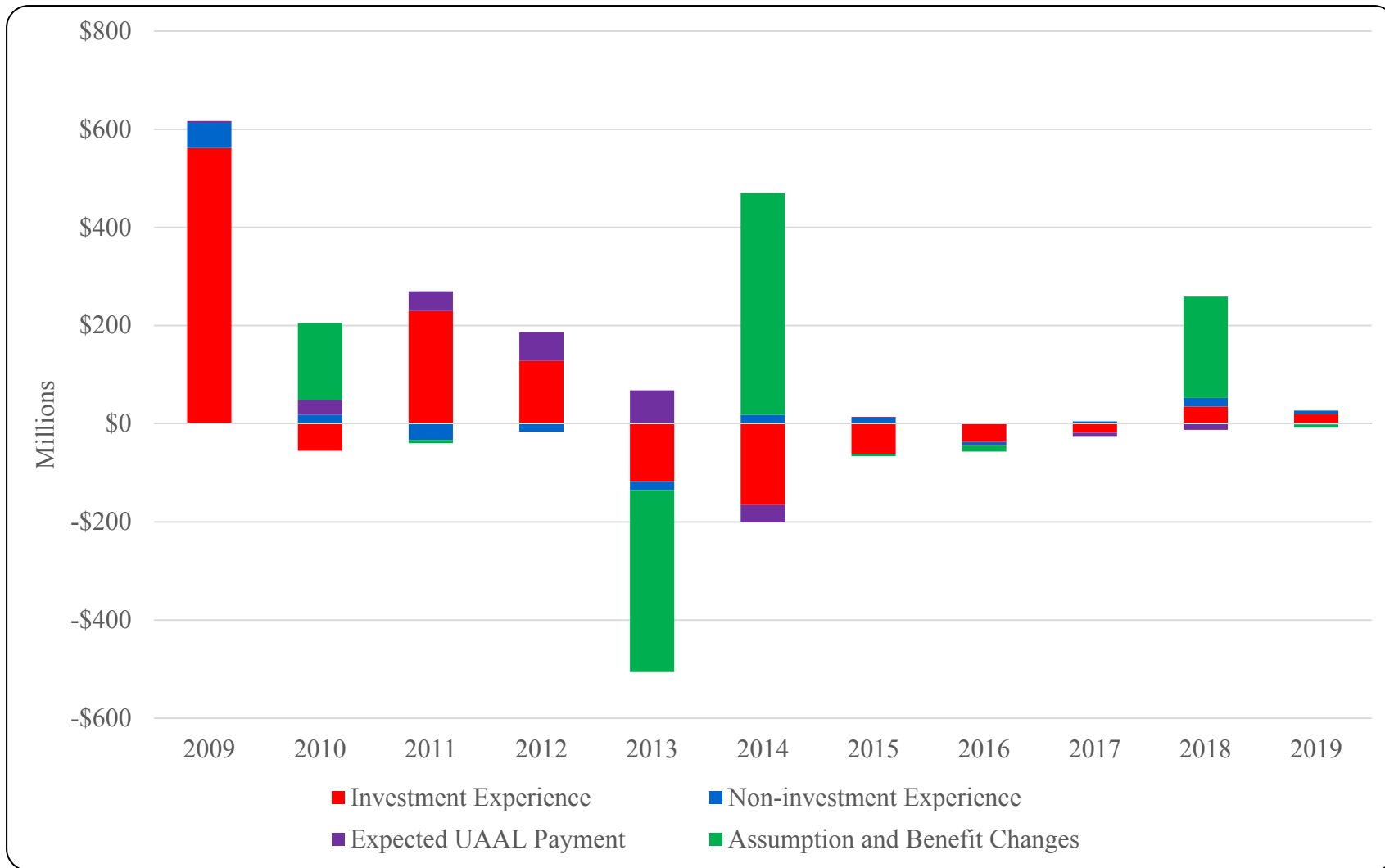
Teachers' Retirement System
Funded Ration (Percentages) and Dollar UAAL
($ Millions) in July 1, 2009 to 2019 Valuations

Public Employees' Retirement System
Factors that Changed UAAL in
June 30, 2010 to July 1, 2019 Valuation

Teachers' Retirement System
Factors that Changed UAAL in
July 1, 2009 to July 1, 2019 Valuation

Public Employees' Retirement System Maturity Measures
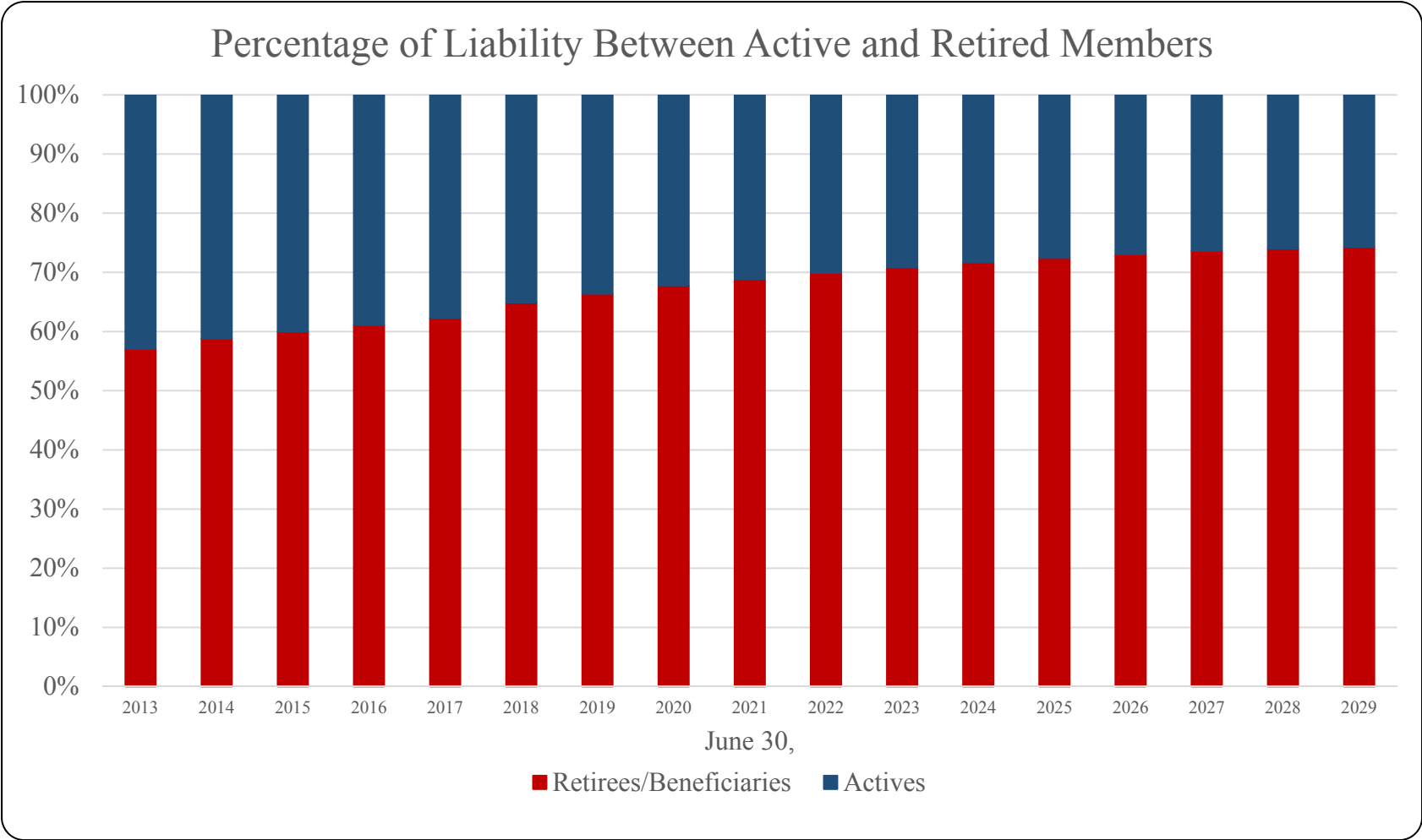
Percentage of Liability Between Active and Retired Members

Public Employees' Retirement System
Maturity Measures

Active to Retiree Ratio
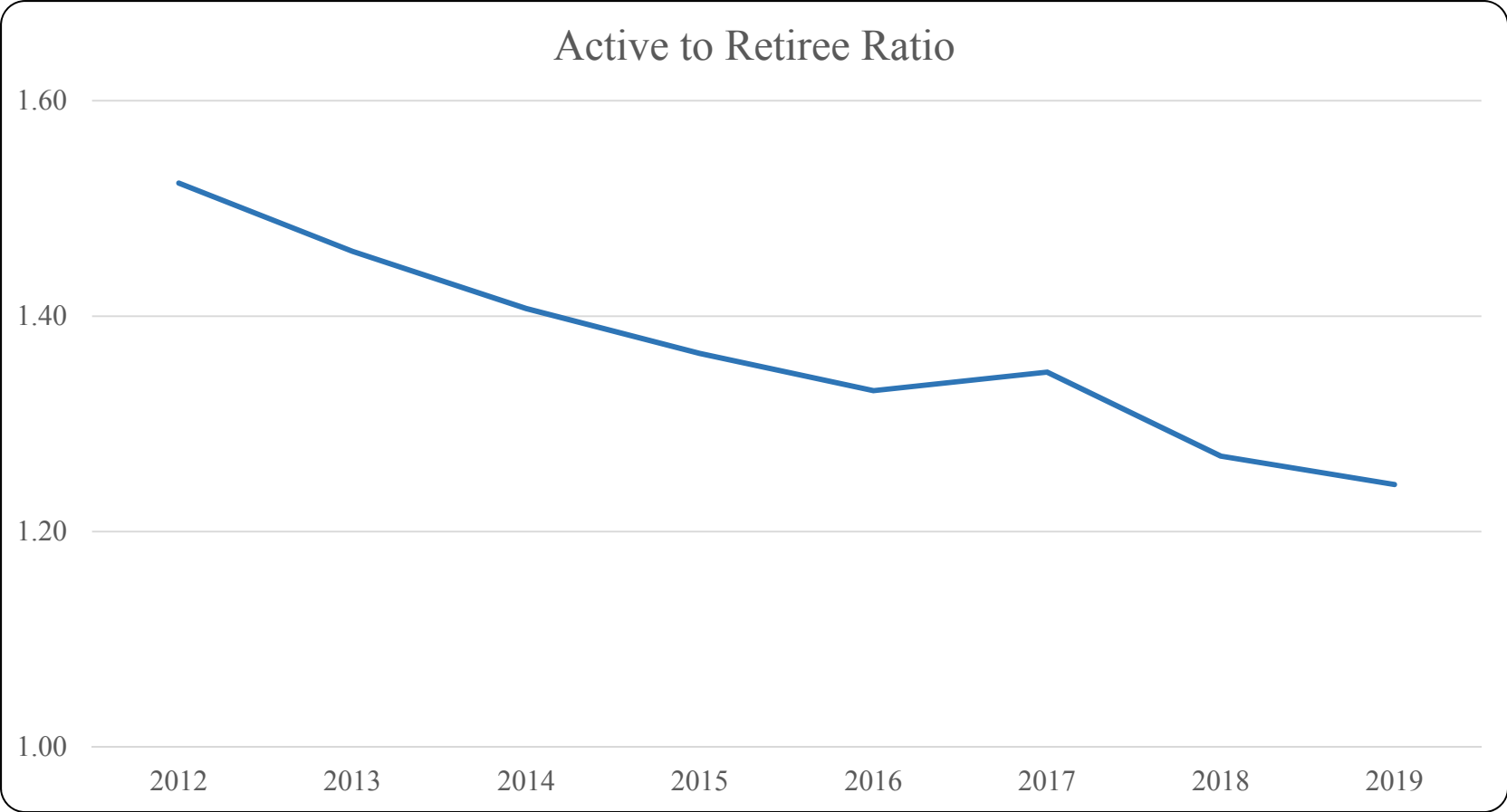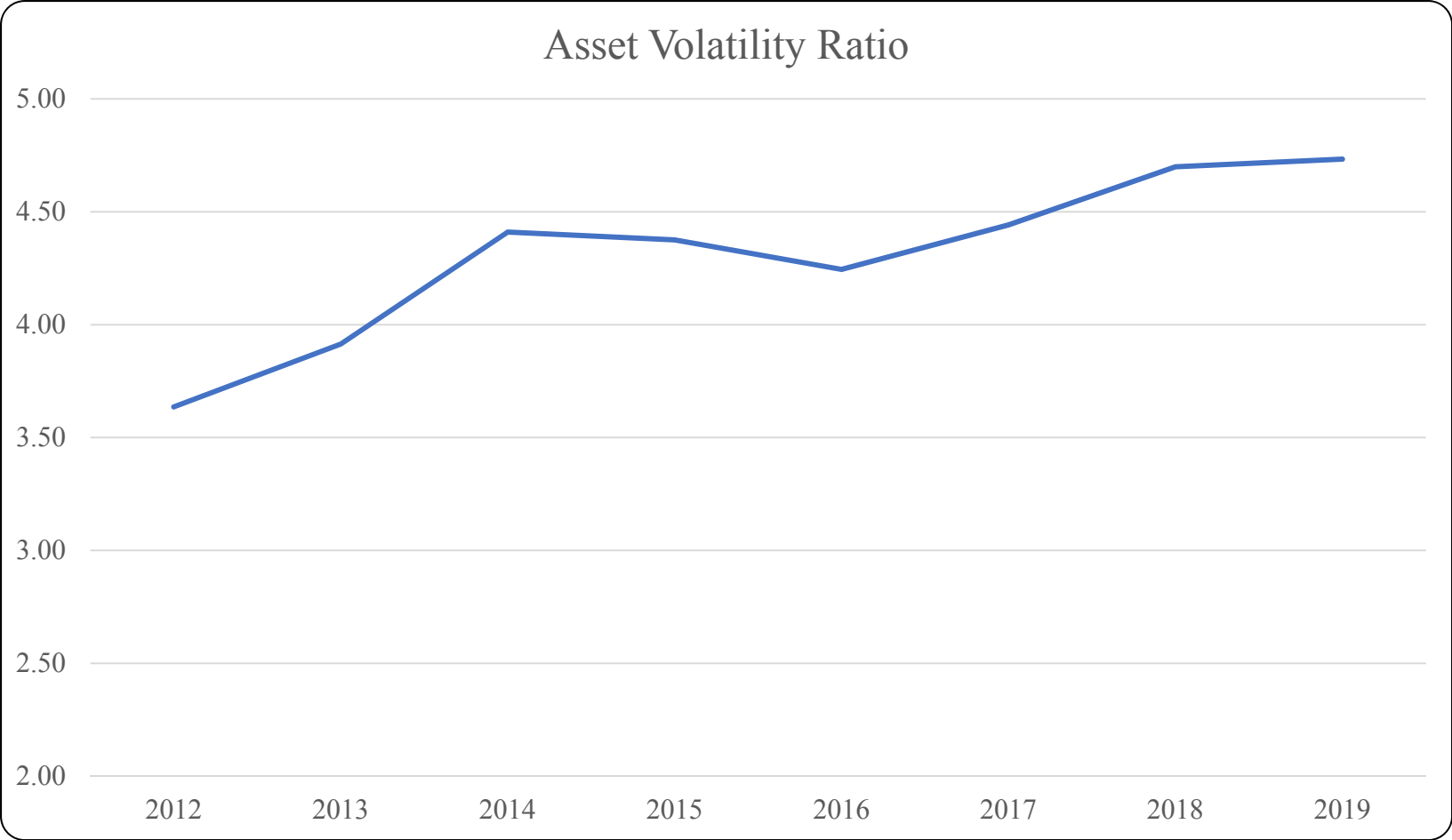
Public Employees' Retirement System
Maturity Measures

Teachers' Retirement System
Maturity Measures

Percentage of Liability Between Active and Retired Members

July 1,

■ Retirees/Beneficiaries ■ Actives

Teachers' Retirement System
Maturity Measures

Active to Retiree Ratio

Teachers' Retirement System
Maturity Measures

Asset Volatility Ratio
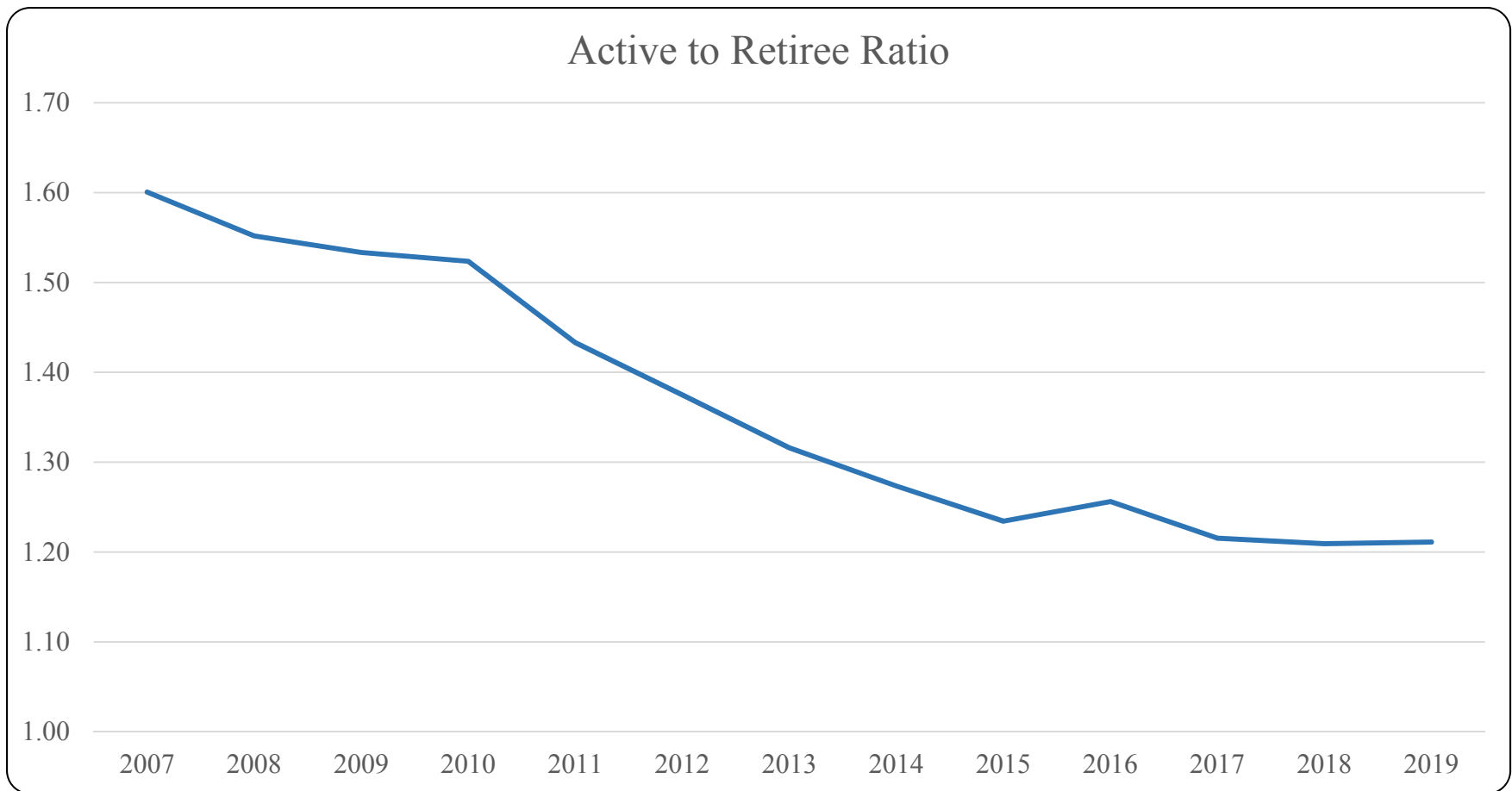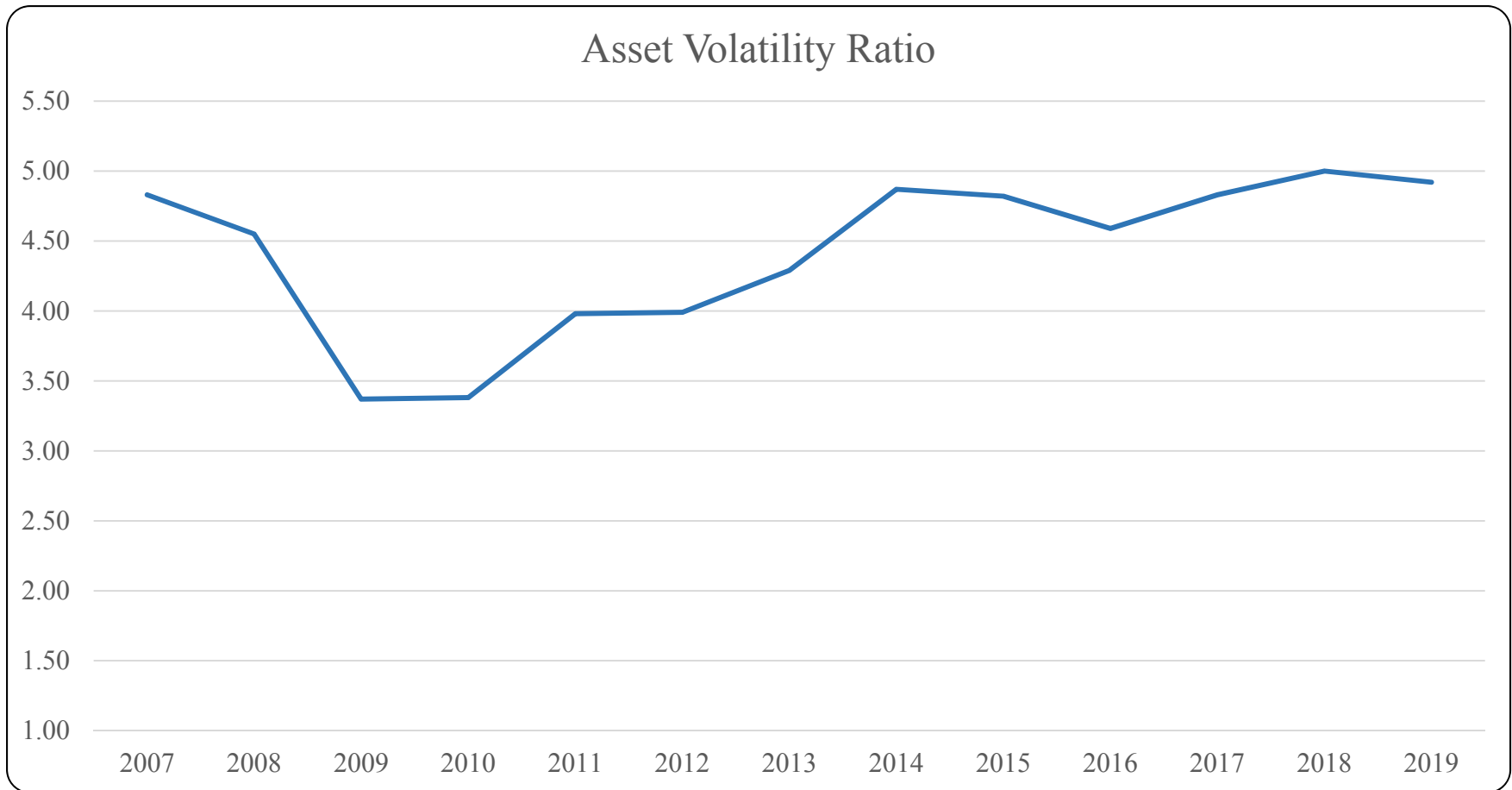
Public Employees' Retirement System

- ➢ Funding Policy
  - ▪ The primary objectives are to: 1) ensure that the system is financially sound and pay all benefits promised using assets accumulated from required employer and member contributions and investment income; and 2) achieve a well-funded status with a range of safety to absorb market volatility without creating additional unfunded actuarial accrued labilities.

- ➢ Amortization policy
  - ▪ "…the systems unfunded actuarial accrued liability should be amortized over a reasonable period of time and should not exceed 30 years on a rolling basis."

Public Employees' Retirement System
Qualitative Assessment
(Layered Amortization)
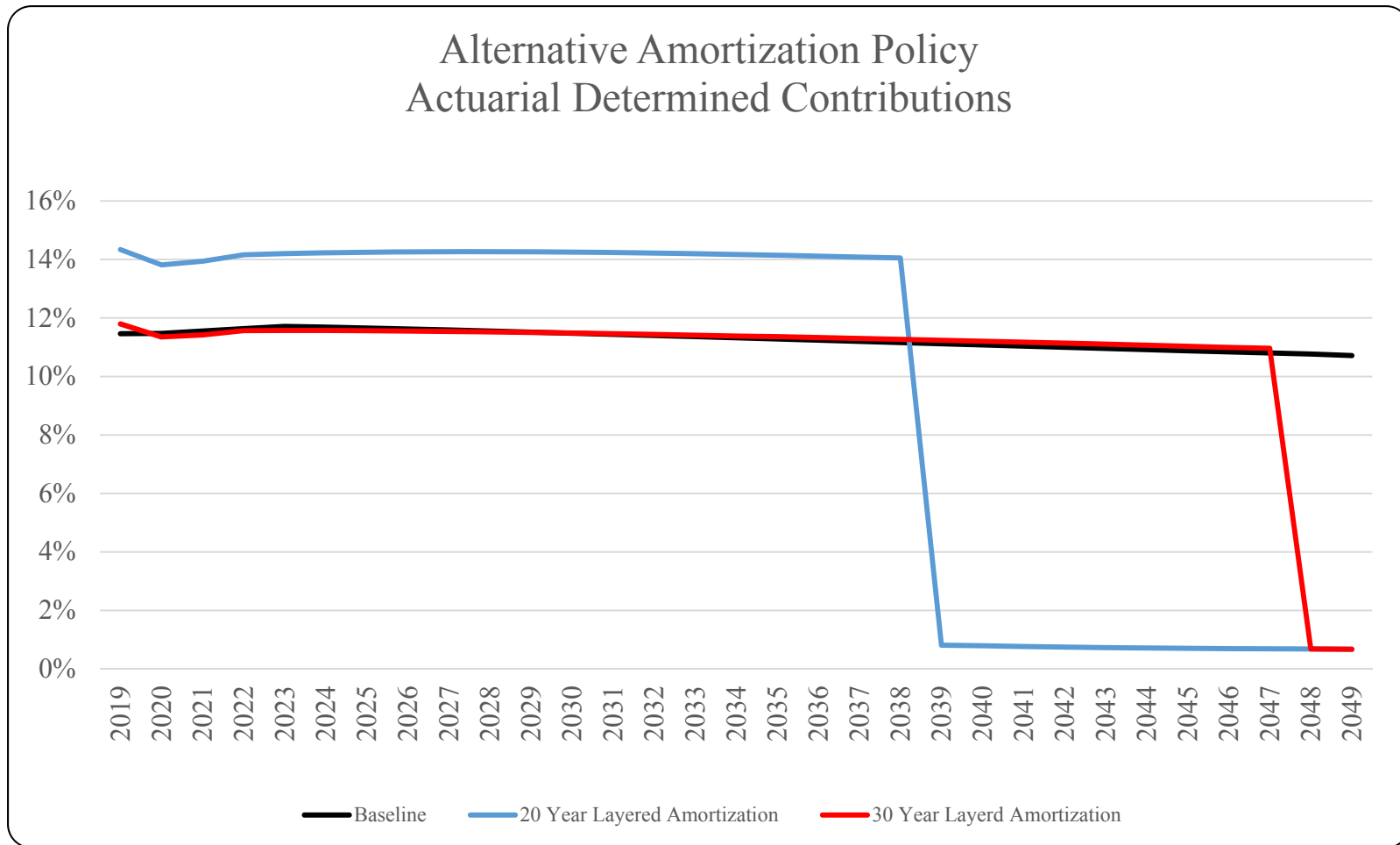
Alternative Amortization Policy
Actuarial Determined Contributions

Legend: Baseline, 20 Year Layered Amortization, 30 Year Layerd Amortization

Public Employees' Retirement System Qualitative Assessment (Layered Amortization)

Alternative Amortization Policy
Projected Funded Ratio

Legend: 20 Year Layered Amortization — 30 Year Layered Amortization — Baseline
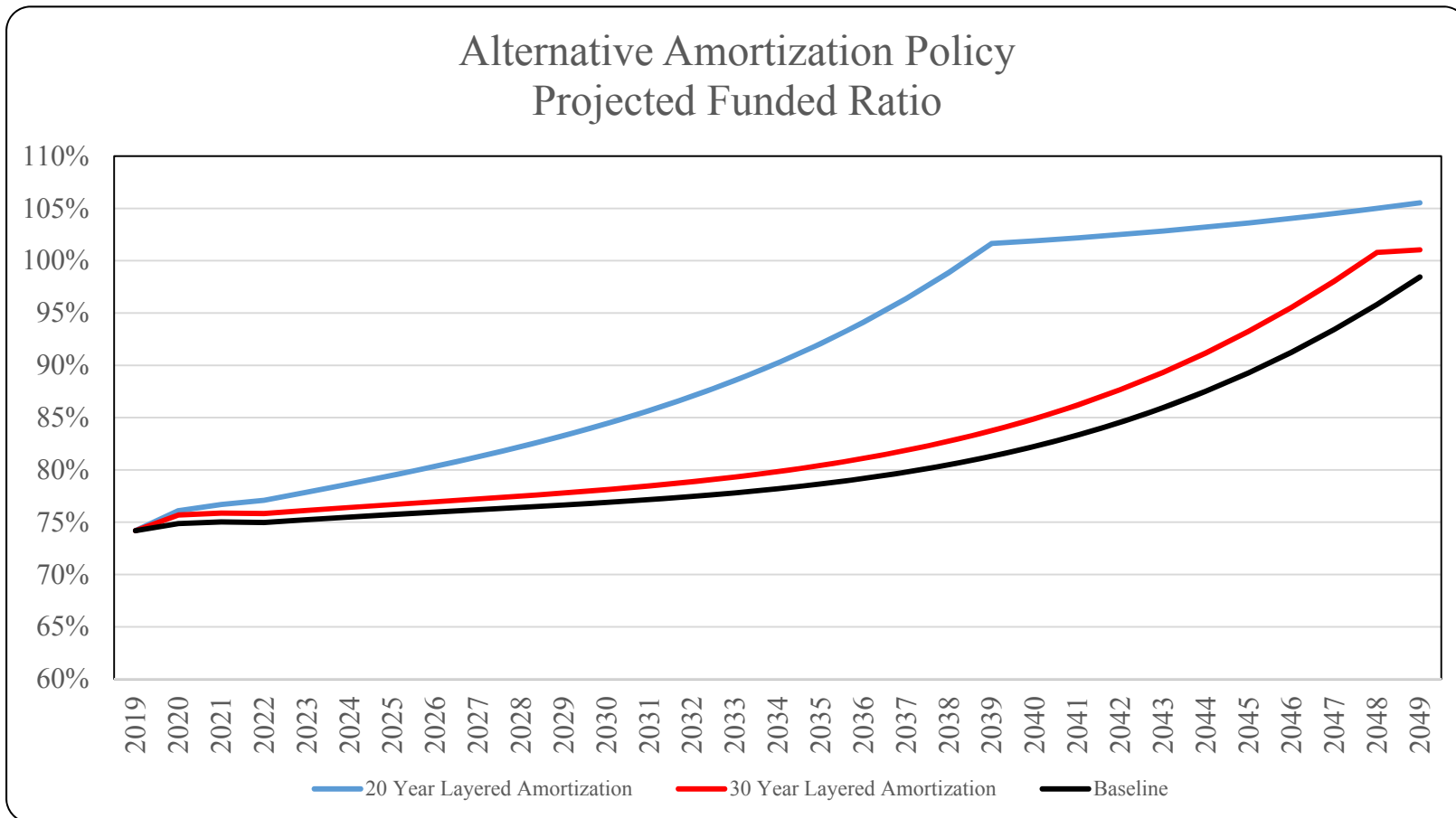
Teachers' Retirement System
Qualitative Assessment

➢ Funding Policy

1. If the amortization period is greater than 30 years, the actuary will recommend the single contribution rate increase that can reasonably expect to fully amortize the UAAL over a closed 30-year period effective July 1, following the next regular legislative session.

2. If the amortization period is less than 30 years, but greater than 0, and it is projected to continue to decline over the remainder of the closed period, the actuary will not recommend a change in the statutory contribution rates.

3. If the amortization period is less than 30 years, but has increased over prior valuations and is projected to continue to grow, the actuary will recommend a contribution rate increase that is reasonably expected to reverse the recent trend and reestablish a closed amortization period equal to that of the last valuation."

Teachers' Retirement System
Qualitative Assessment

➤ Amortization policy

"…any unfunded liabilities will be amortized over a closed period of no more than 30 years and funded as a level percent of pay. At such time as the System becomes fully funded and has as stabilization reserve of at least 10% of the actuarial accrued liability, the allowed amortization period for any subsequent unfunded liabilities will be reduced to a closed period of not greater than 20 years."

Teachers' Retirement System
Qualitative Assessment
(Layered Amortization)
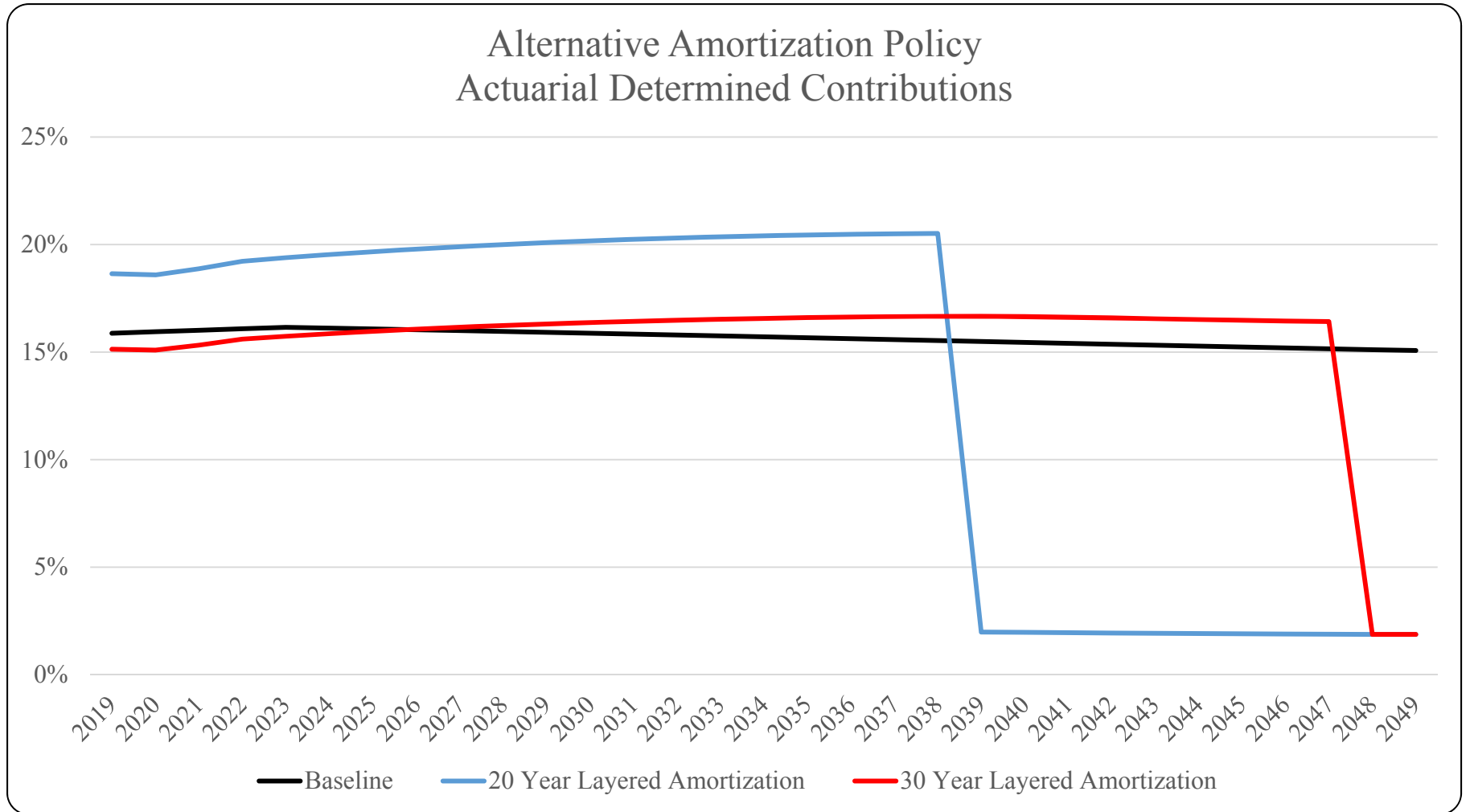
Alternative Amortization Policy
Actuarial Determined Contributions

— Baseline — 20 Year Layered Amortization — 30 Year Layered Amortization

Teachers' Retirement System
Qualitative Assessment
(Layered Amortization)

Alternative Amortization Policy
Projected Funded Ratio

Legend: 20 Year Layered Amortization — 30 Year Layered Amortization — Baseline

Public Employees' Retirement System Funded Ratio – Actuarial Value of Assets

Sensitivity to Assumed Rate of Return

Legend:
- 7.65% Assumption
- 7.40% Assumption
- 7.15% Assumption
- 6.90% Assumption
- 6.65% Assumption

Teachers' Retirement System
Funded Ratio –
Actuarial Value of Assets

Sensitivity to Assumed Rate of Return

7.50% Assumption — 7.25% Assumption — 7.00% Assumption — 6.75% Assumption — 6.50% Assumption
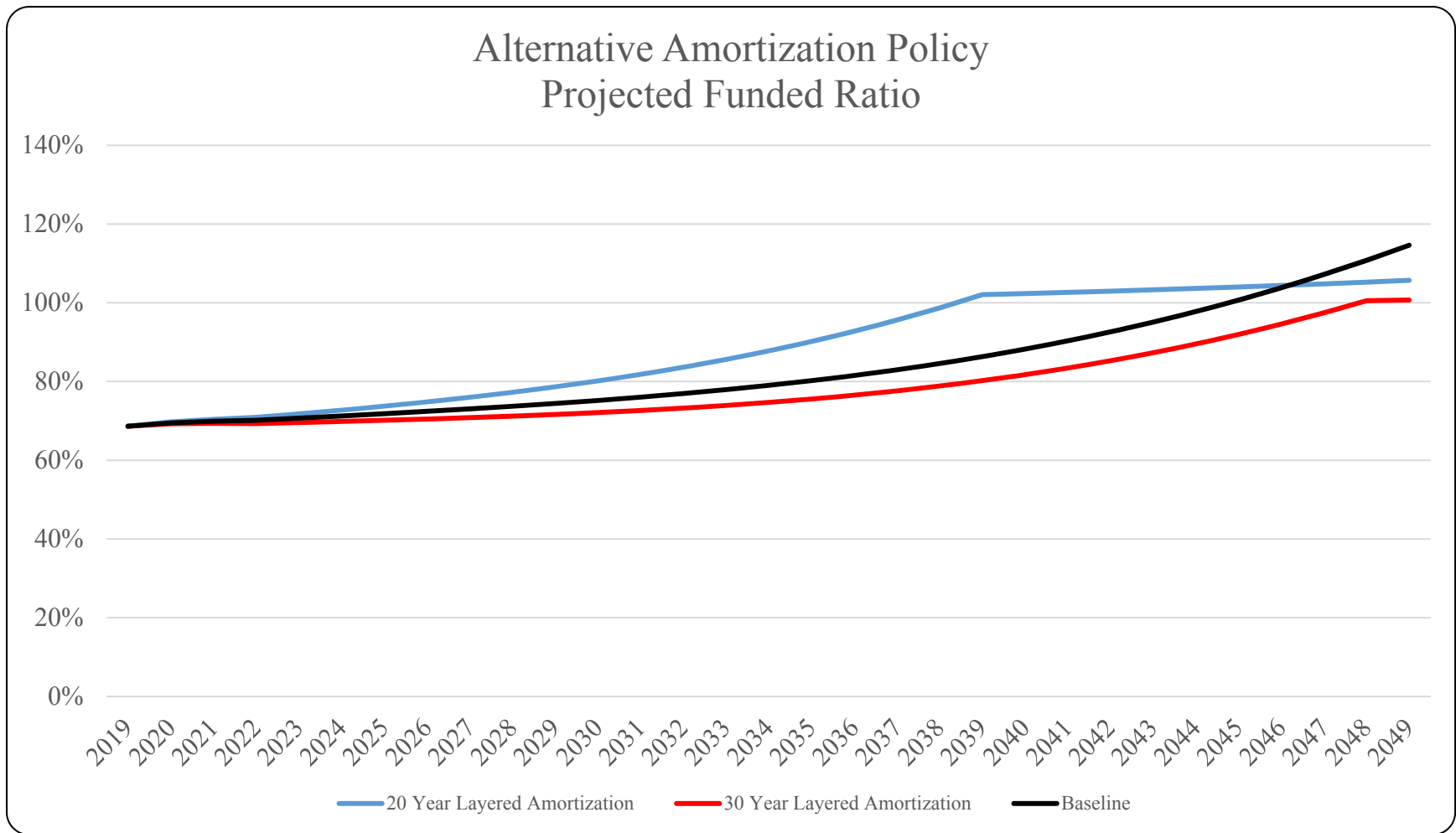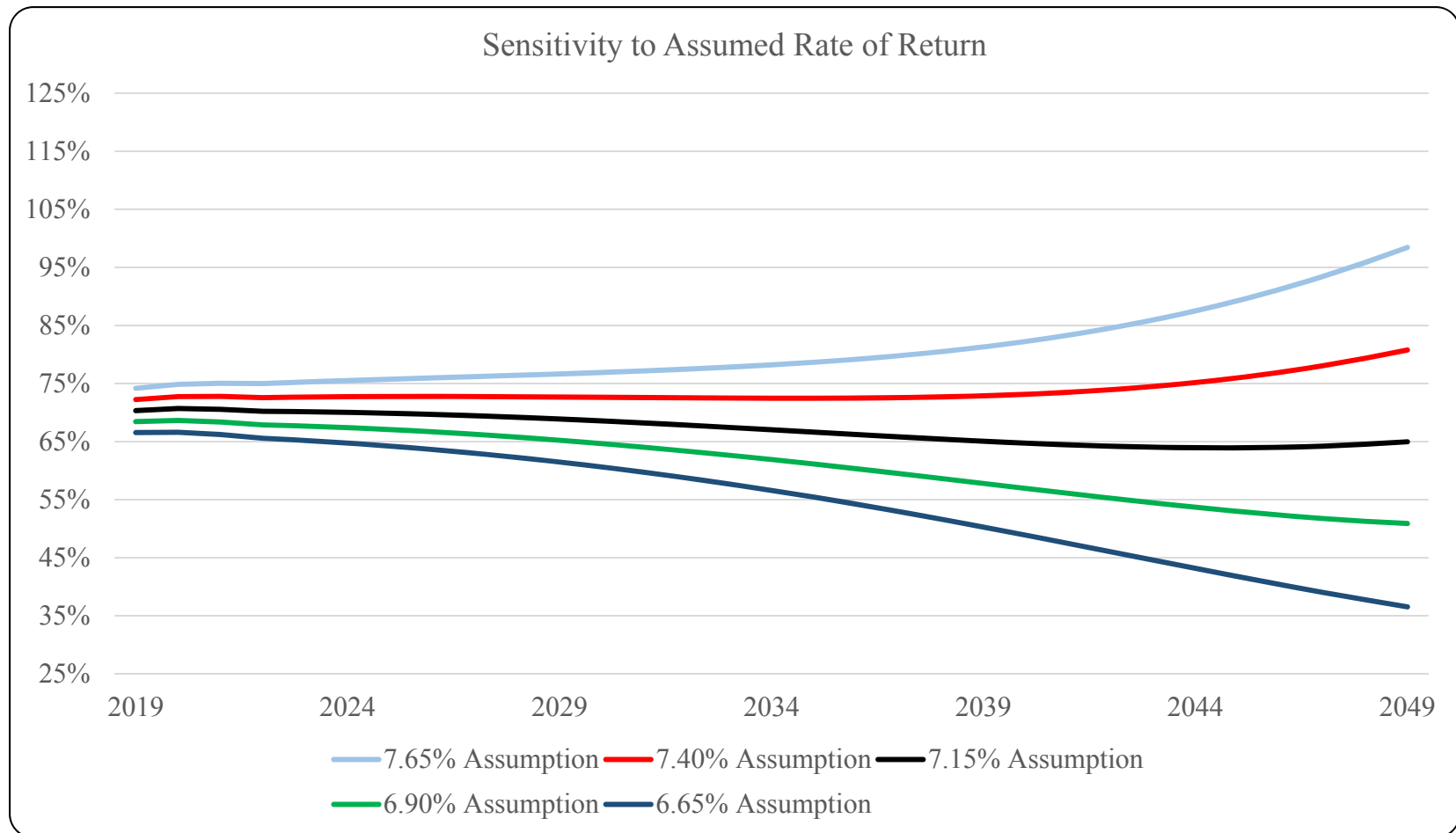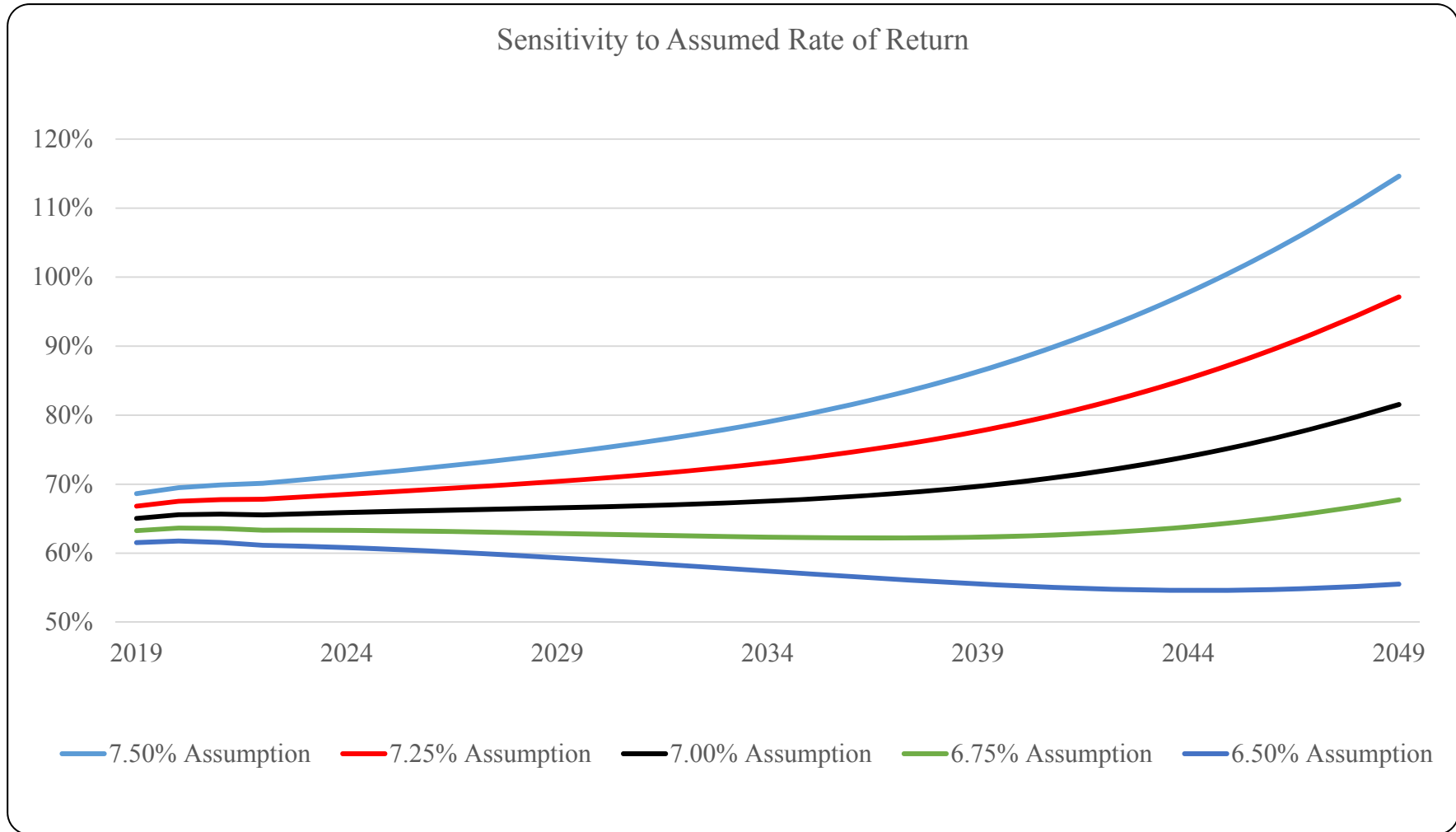
Public Employees' Retirement System
Sensitivity Analysis

Actual returns are assumed to be the rate shown over the 10 year period.

Funded Ratio at June 30 Valuation

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
5.00%	74%	74%	74%	72%	70%	68%	66%	64%	62%	59%	57%
5.25%	74%	74%	74%	72%	71%	69%	67%	65%	63%	61%	58%
5.50%	74%	74%	74%	72%	71%	69%	68%	66%	64%	62%	60%
5.75%	74%	75%	74%	73%	71%	70%	69%	67%	66%	64%	62%
6.00%	74%	75%	74%	73%	72%	71%	70%	68%	67%	65%	64%
6.25%	74%	75%	74%	73%	72%	72%	71%	69%	68%	67%	66%
6.50%	74%	75%	74%	74%	73%	72%	71%	71%	70%	69%	67%
6.75%	74%	75%	75%	74%	73%	73%	72%	72%	71%	70%	69%
7.00%	74%	75%	75%	74%	74%	74%	73%	73%	72%	72%	71%
7.25%	74%	75%	75%	74%	74%	74%	74%	74%	74%	74%	73%
7.50%	74%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%
7.75%	74%	75%	75%	75%	75%	76%	76%	76%	77%	77%	77%
8.00%	74%	75%	75%	75%	76%	77%	77%	78%	78%	79%	80%

Teachers' Retirement System
Sensitivity Analysis

Actual returns are assumed to be the rate shown over the 10 year period.

Funded Ratio at July 1 Valuation

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
5.00%	69%	69%	69%	67%	66%	65%	63%	62%	60%	58%	56%
5.25%	69%	69%	69%	68%	66%	65%	64%	63%	61%	60%	58%
5.50%	69%	69%	69%	68%	67%	66%	65%	64%	62%	61%	60%
5.75%	69%	69%	69%	68%	67%	67%	66%	65%	64%	63%	61%
6.00%	69%	69%	69%	68%	68%	67%	66%	66%	65%	64%	63%
6.25%	69%	69%	69%	69%	68%	68%	67%	67%	66%	66%	65%
6.50%	69%	69%	69%	69%	69%	69%	68%	68%	68%	67%	67%
6.75%	69%	69%	69%	69%	69%	69%	69%	69%	69%	69%	69%
7.00%	69%	69%	70%	70%	70%	70%	70%	70%	70%	70%	71%
7.25%	69%	69%	70%	70%	70%	71%	71%	71%	72%	72%	72%
7.50%	69%	70%	70%	70%	71%	71%	72%	72%	73%	74%	74%
7.75%	69%	70%	70%	70%	71%	72%	73%	74%	74%	75%	76%
8.00%	69%	70%	70%	71%	72%	73%	74%	75%	76%	77%	78%

Stress Testing

➢ **Stress test**: an analysis or simulation designed to determine the ability of a financial institution to manage an economic crisis or certain stressors

➢ **Purpose** is to **identify the stressors** to the System and **optimize policies and procedures** (assumptions, funding policy, and perhaps benefits) in order to **improve sustainability** and **educate stakeholders** of potential risks

   ▪ Focus should be on the decisions to be considered based on the outcomes of the test

Typical Procedure for Stress Test

- ➢ Project historical crisis data into the future and simulate what would happen to system's funding

- ➢ Deterministic projections using one set of assumed returns

- ➢ Take several sets of economic scenarios and project and compare key actuarial metrics
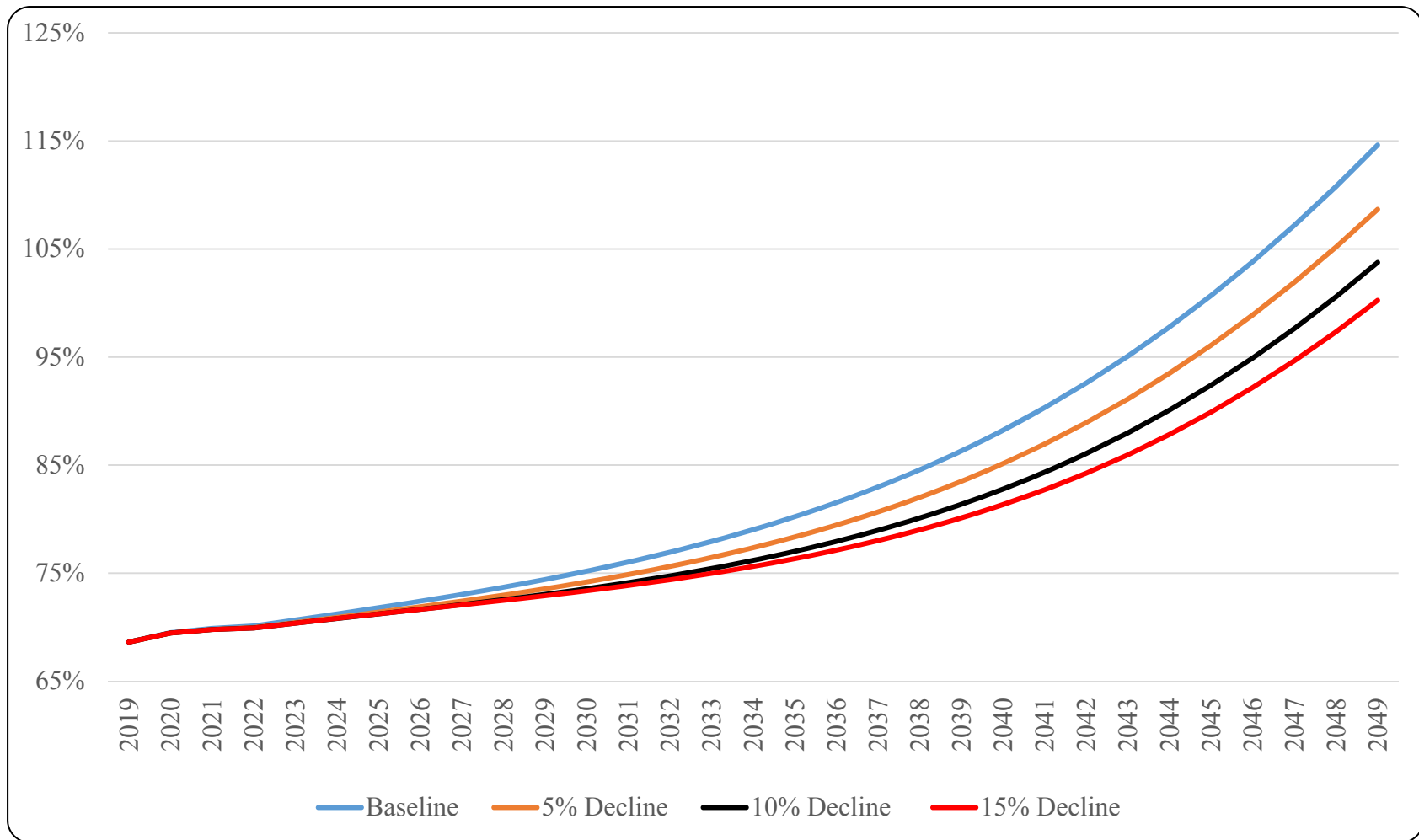
Stress Testing

➢ Size of active membership and growth in total covered payroll

- UAL amortized as level percent of payroll so an assumption is used to anticipate future changes in payroll
- If active membership decreases or salary increases are less than assumed, covered payroll may not increase as assumed
- Forces the UAL amortization period to increase

Public Employees' Retirement System Projected Funded Ratio under Population Decline Scenarios
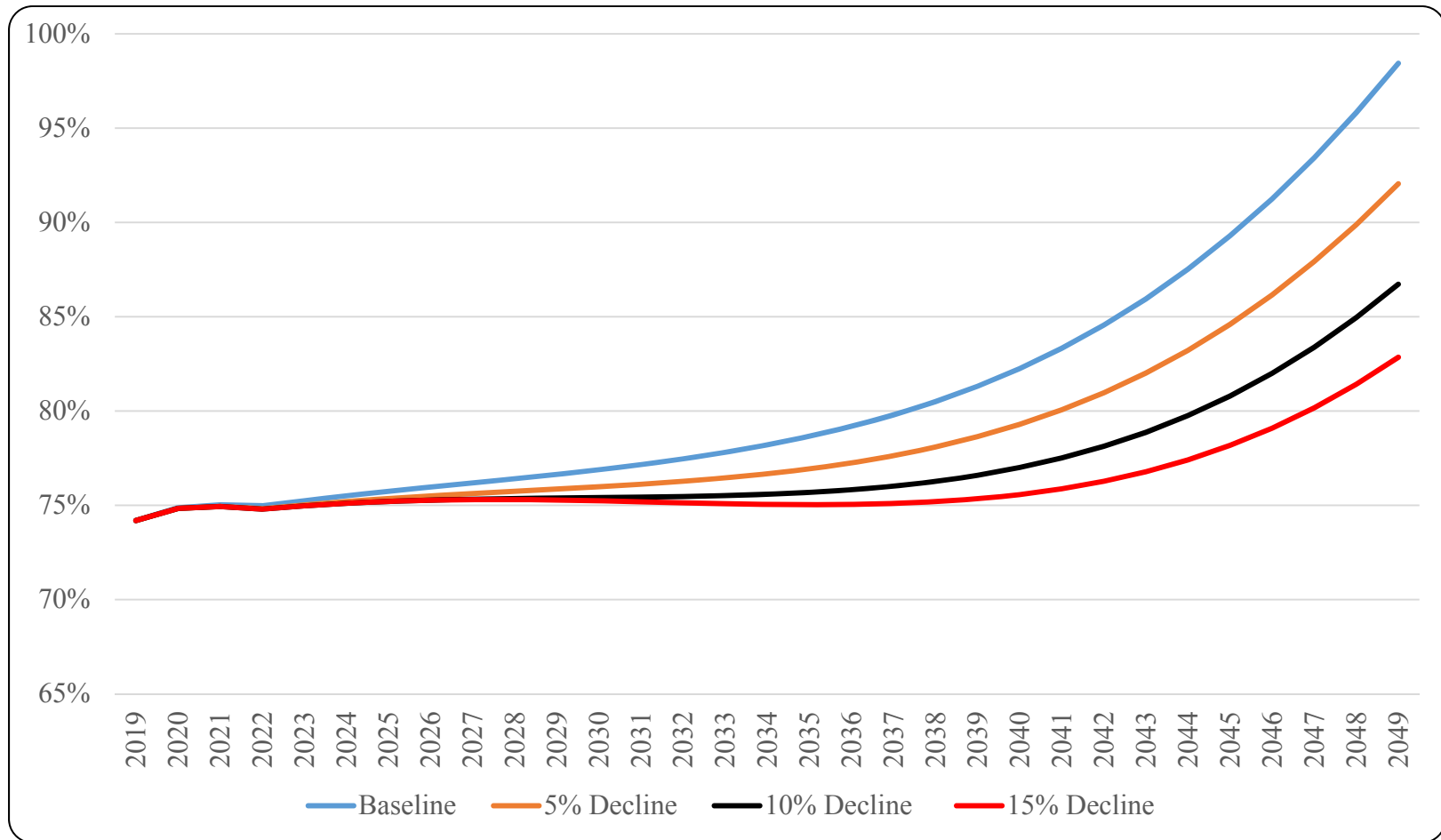
Teachers' Retirement System
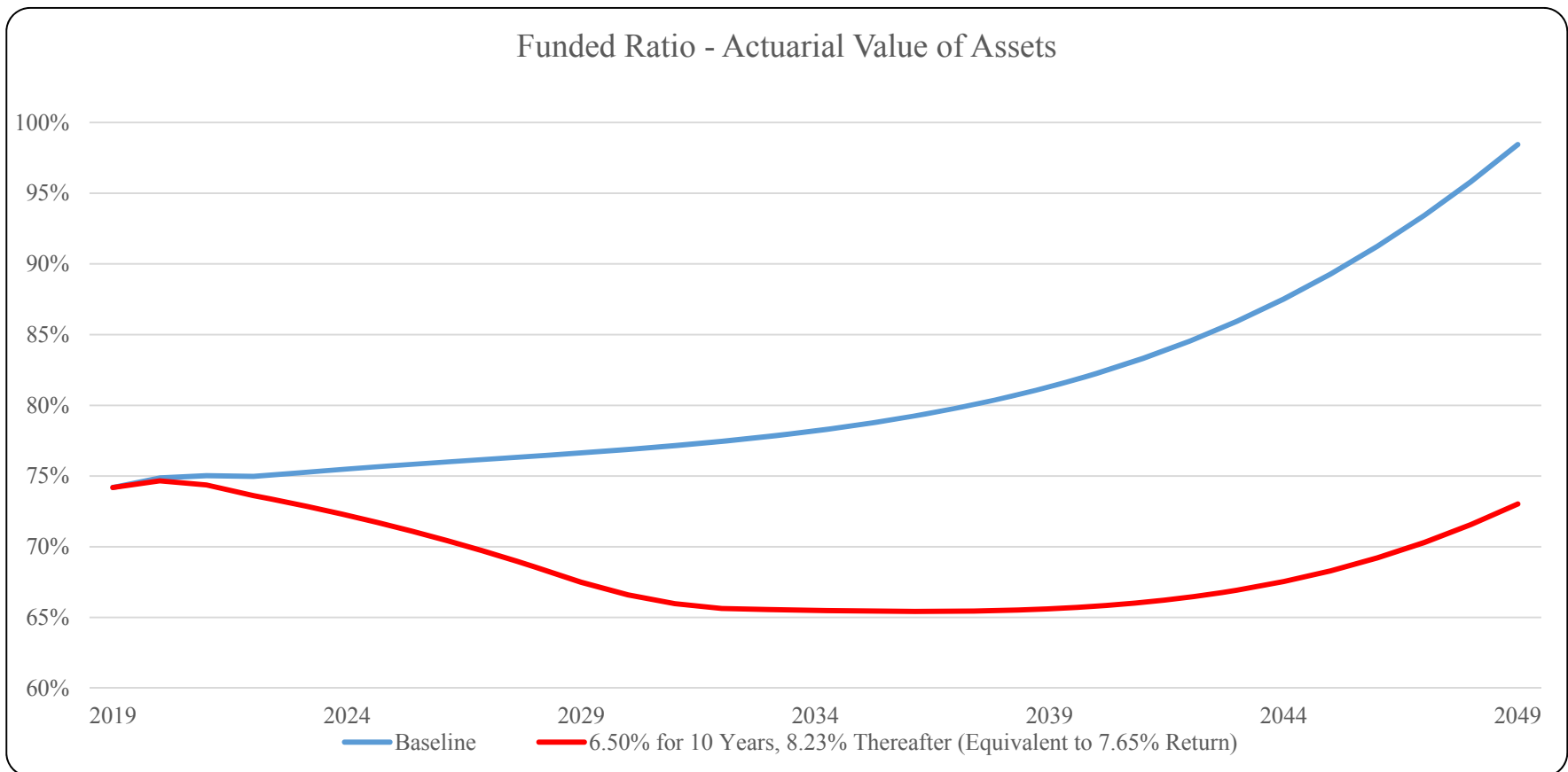# Projected Funded Ratio under
Population Decline Scenarios

Public Employees' Retirement System
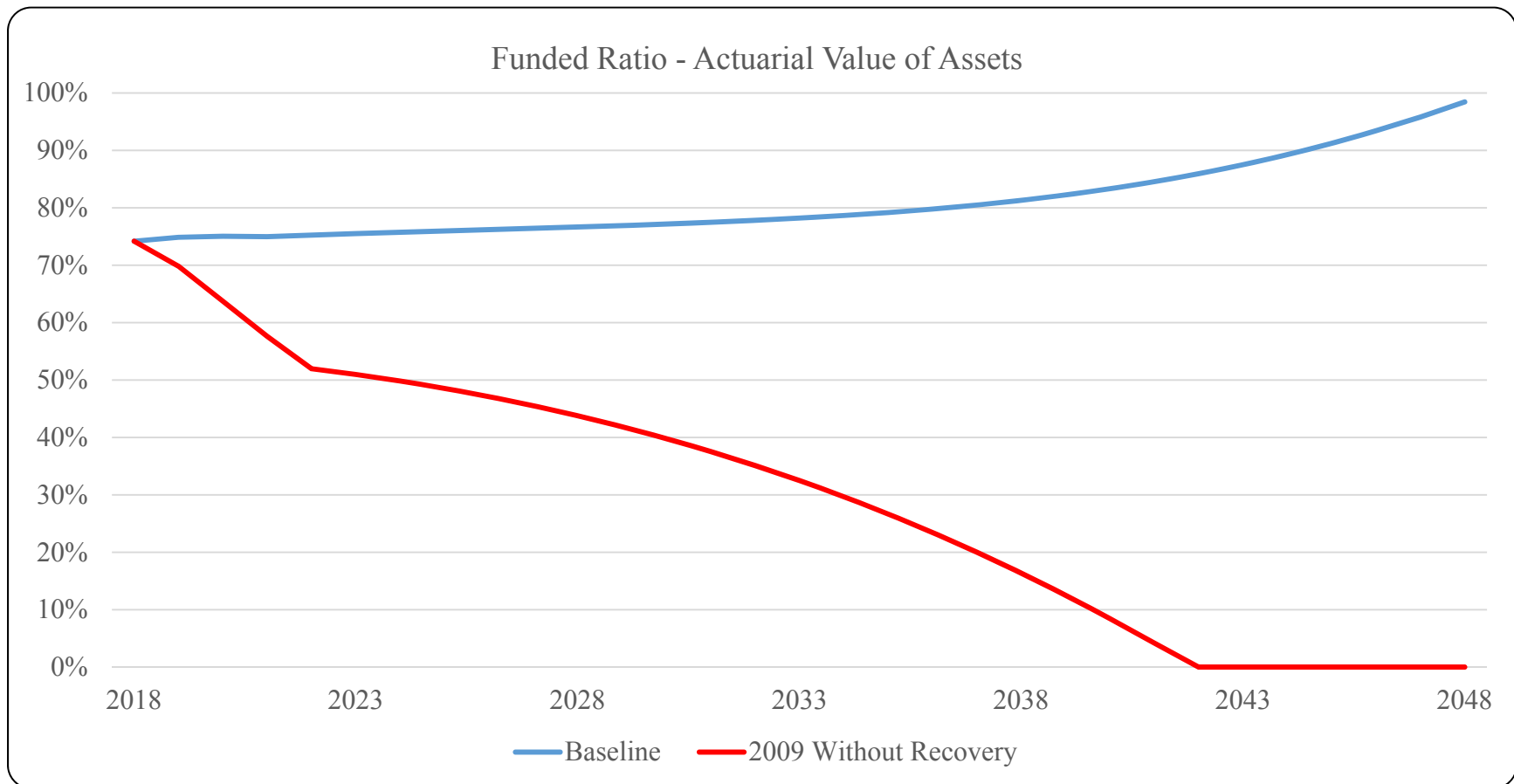## Stress Testing - Low Returns for Sustained Period

In 2049 the funded ratio is 73.0% under the prolonged low return scenario compared to 98.4% under the baseline scenario.

Funded Ratio - Actuarial Value of Assets

Legend:
- Baseline
- 6.50% for 10 Years, 8.23% Thereafter (Equivalent to 7.65% Return)

Public Employees' Retirement System
Stress Testing: Shock Return

Without the recovery, the funded ratio drops for the entire period projection period.

Funded Ratio - Actuarial Value of Assets

Legend: Baseline, 2009 Without Recovery

Public Employees' Retirement System Stress Testing: Shock Return

The black line shows that the recovery in the financial markets helps to reverse the declining funded ratio but still does not produce an ideal result in which the funded ratio begins to improve.
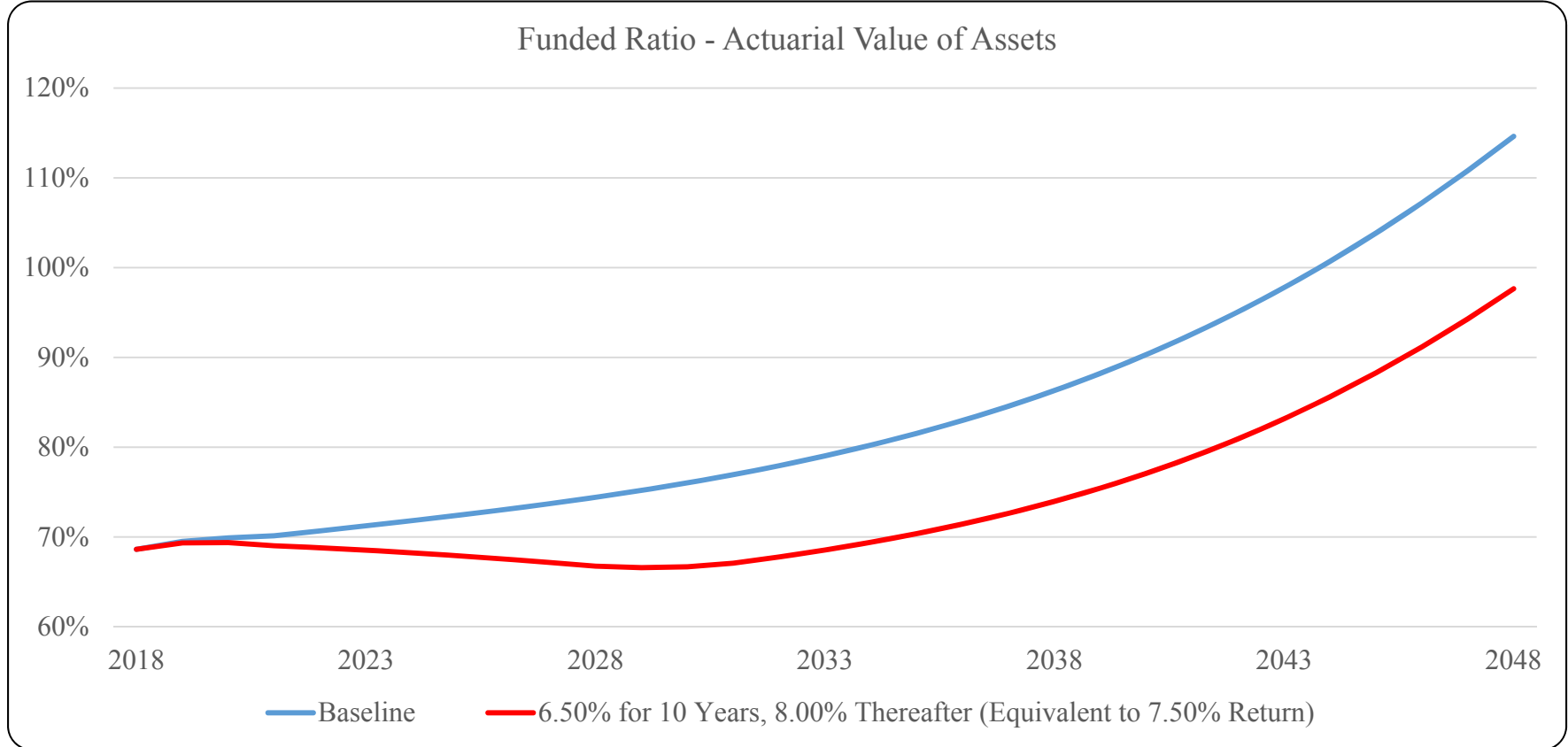

Funded Ratio - Actuarial Value of Assets

Legend: Baseline — 2009 Without Recovery — 2009 With Recovery
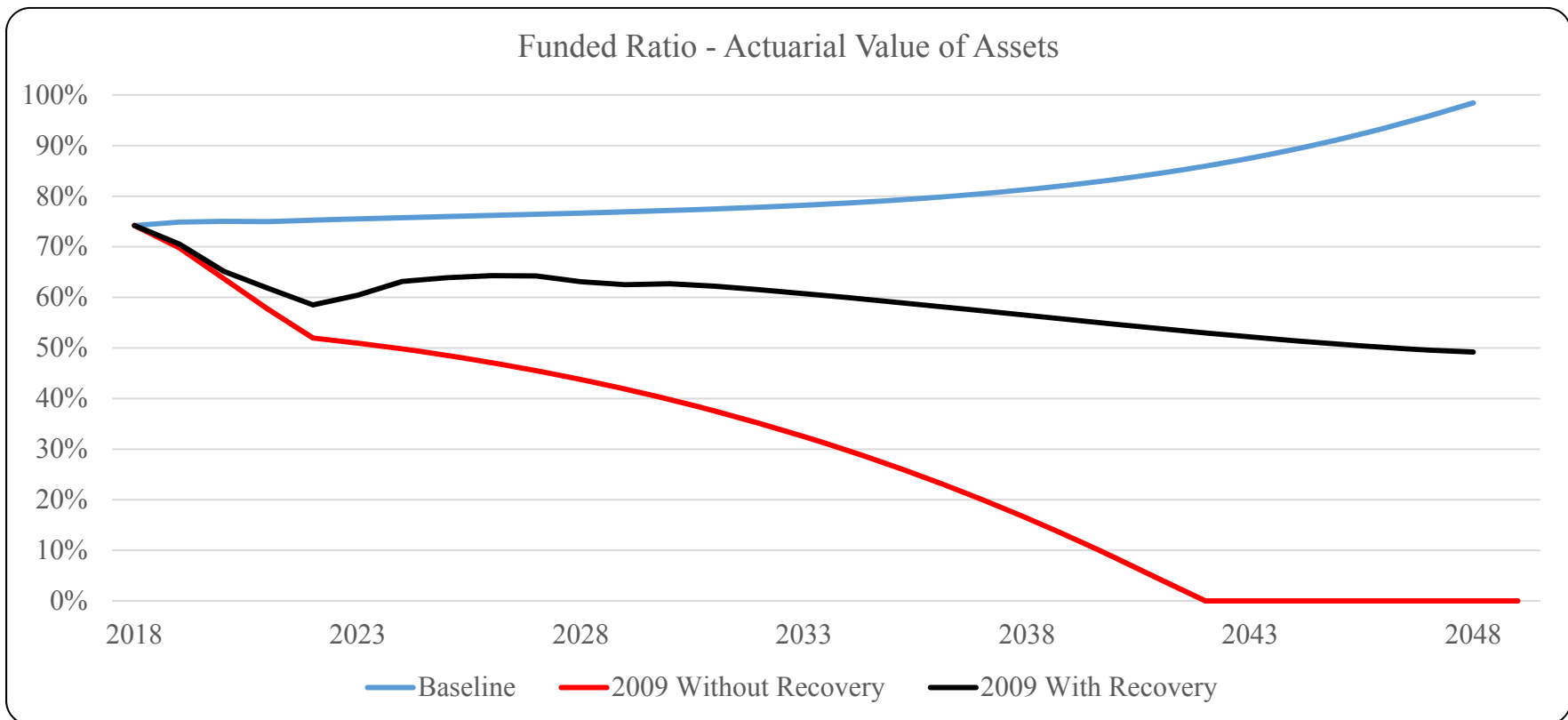
Teachers' Retirement System
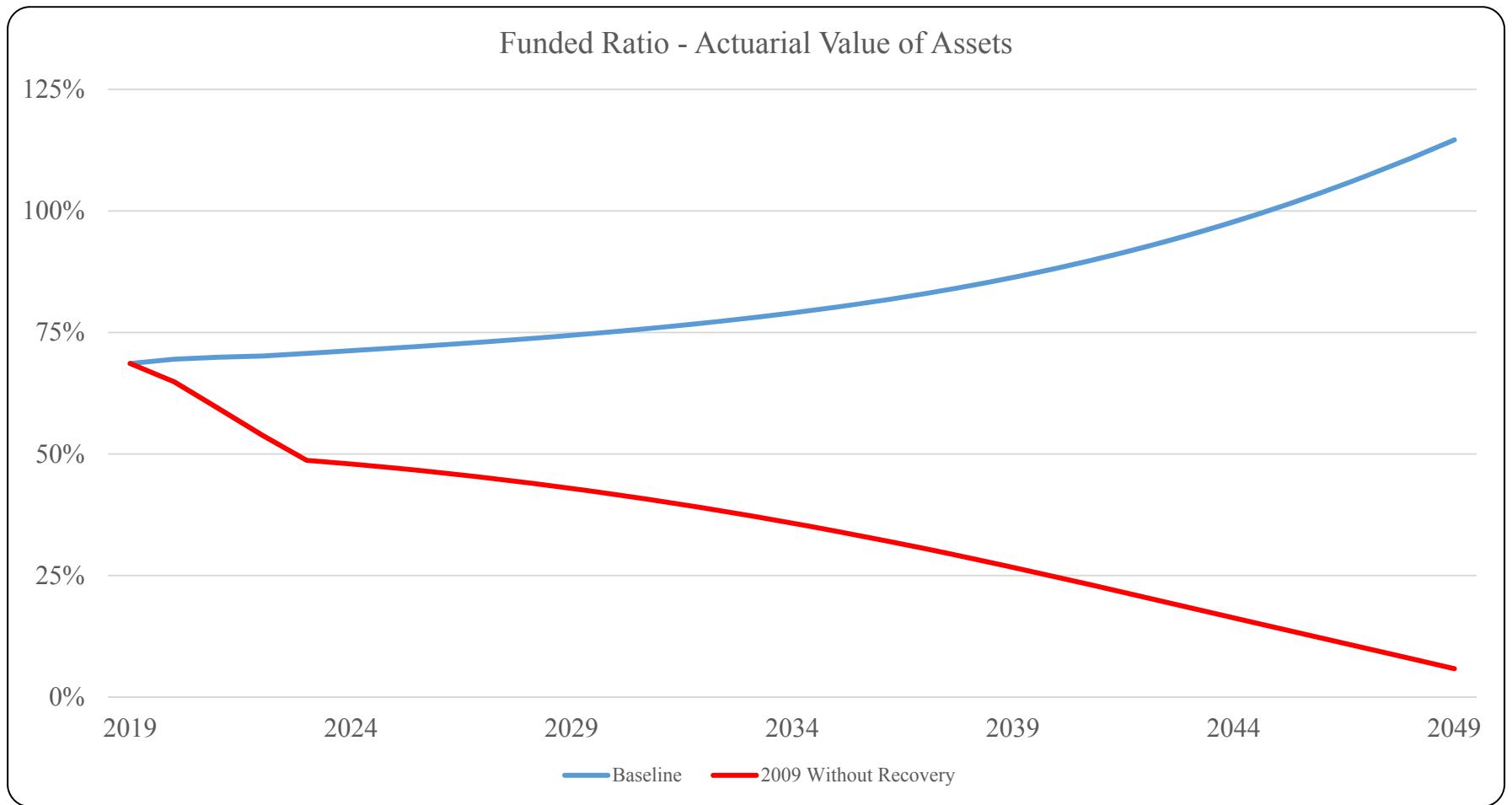# Stress Testing -
Low Returns for Sustained Period

Low Returns for the next 10 years reduce the funded ratio until 2030. The gap is greatest, reaching a 17% difference, in 2048 (97.6% funded vs. 114.6% funded, reflecting a UAAL difference of $206 million)

Funded Ratio - Actuarial Value of Assets

Legend: Baseline — 6.50% for 10 Years, 8.00% Thereafter (Equivalent to 7.50% Return)

Teachers' Retirement System
Stress Testing: Shock Return

Without the recovery, the funded ratio drops for the entire period projection period.

Funded Ratio - Actuarial Value of Assets

Legend: Baseline, 2009 Without Recovery

Teachers' Retirement System
Stress Testing: Shock Return

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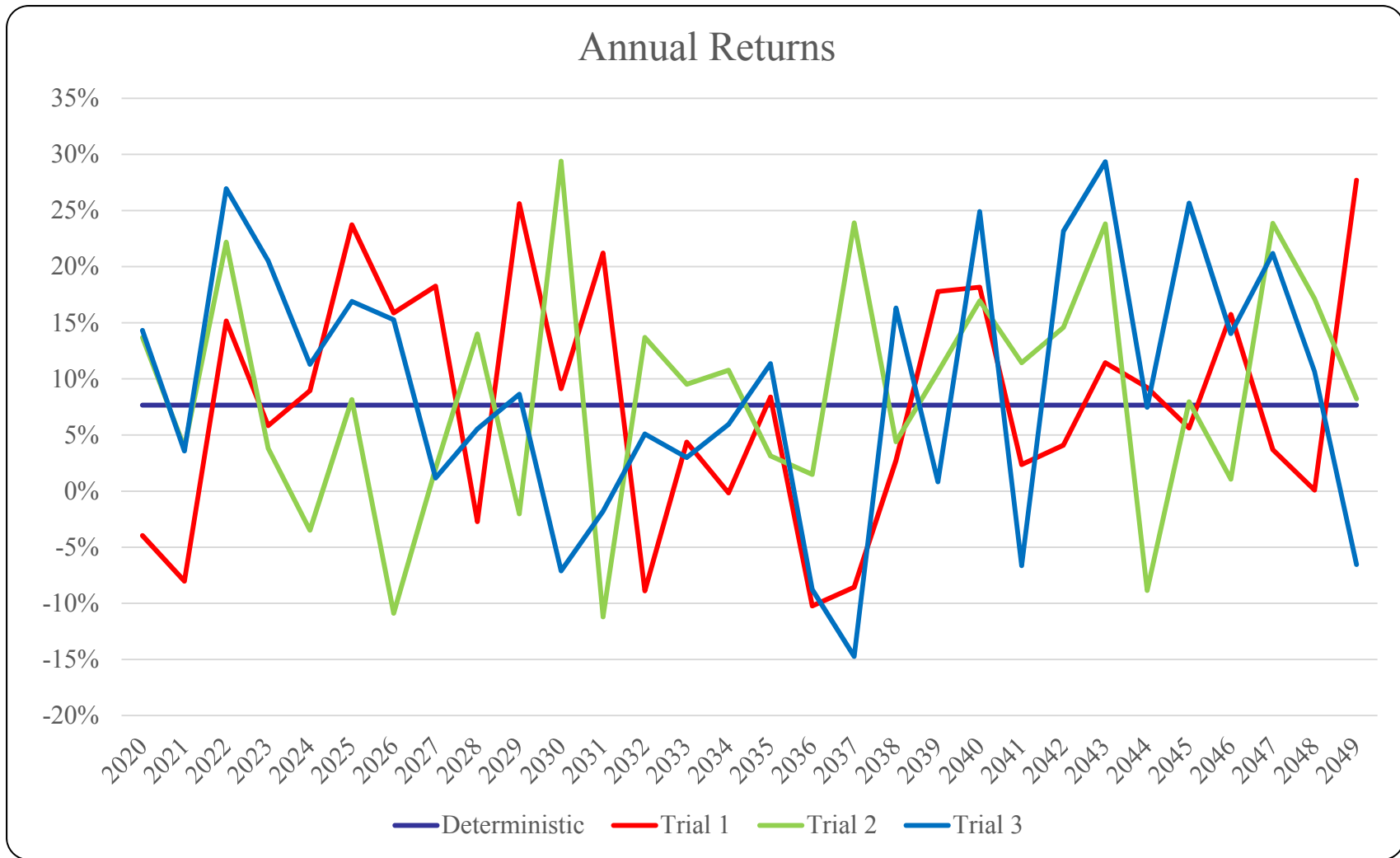

Funded Ratio - Actuarial Value of Assets

Legend: Baseline — 2009 Without Recovery — 2009 With Recovery
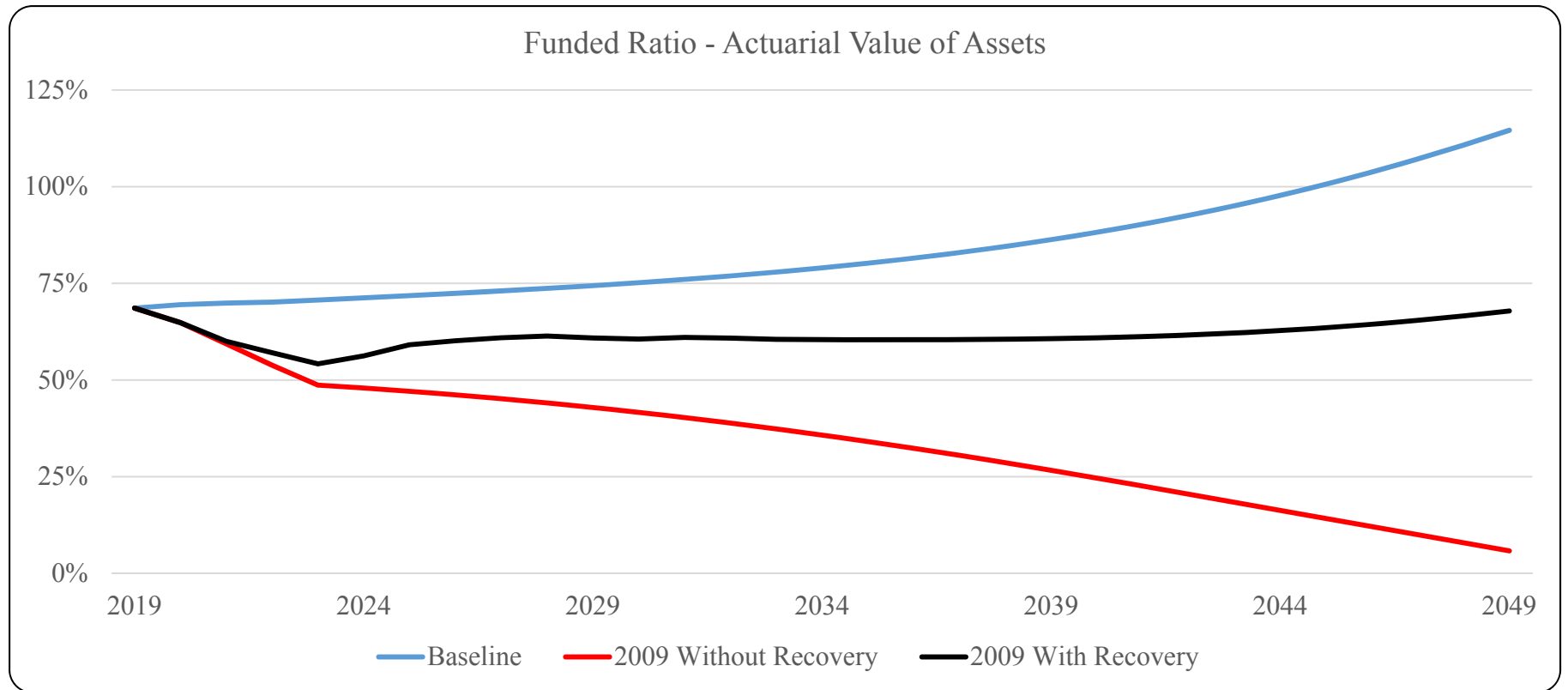
Stochastic Analysis

➢ Stochastic modeling is the most sophisticated analysis available for investment return impact

➢ Produces a distribution of possible returns, directly reflecting the impact of investment return volatility on pension funding over time

➢ More complex and, therefore, more difficult to understand
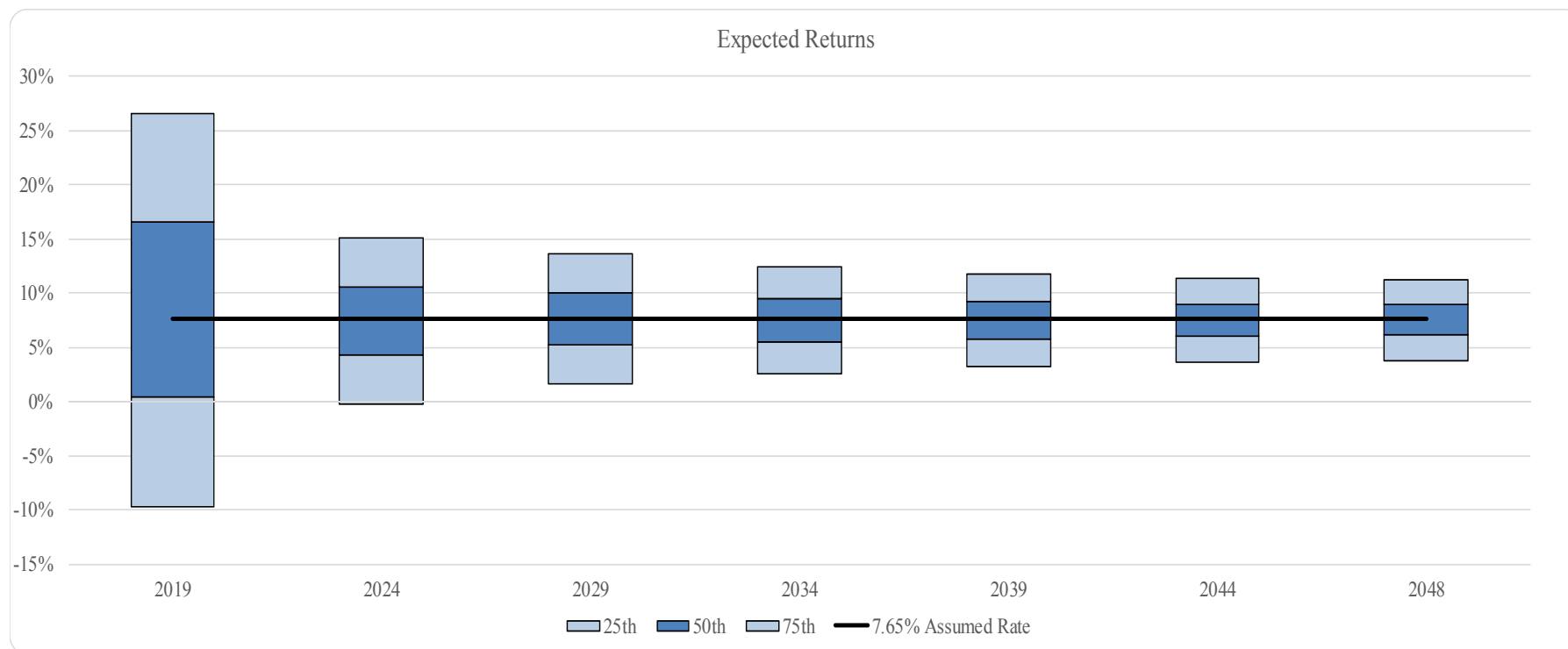
Stochastic Analysis

Annual Returns

Stochastic Analysis

Funded Ratio (AVA)
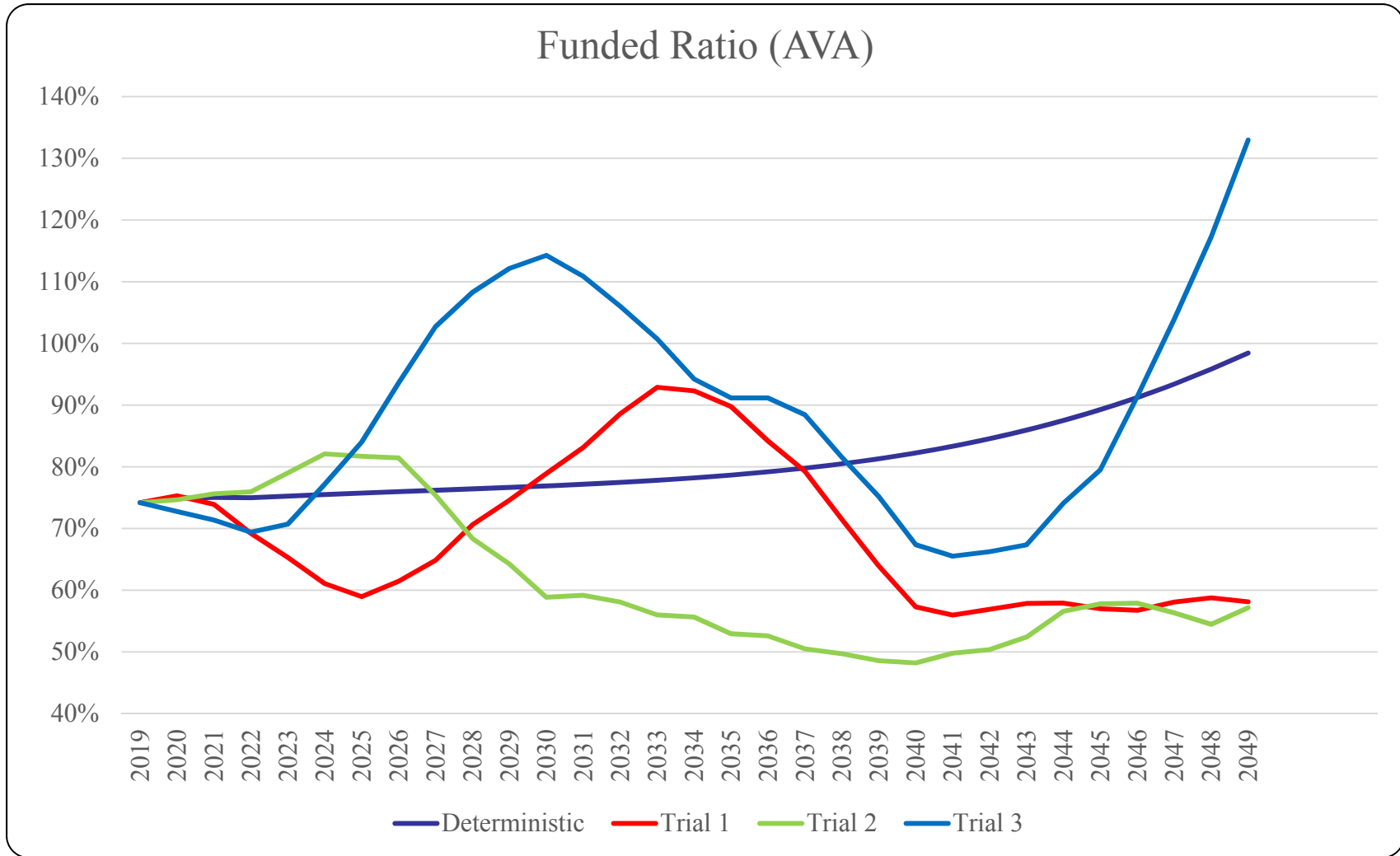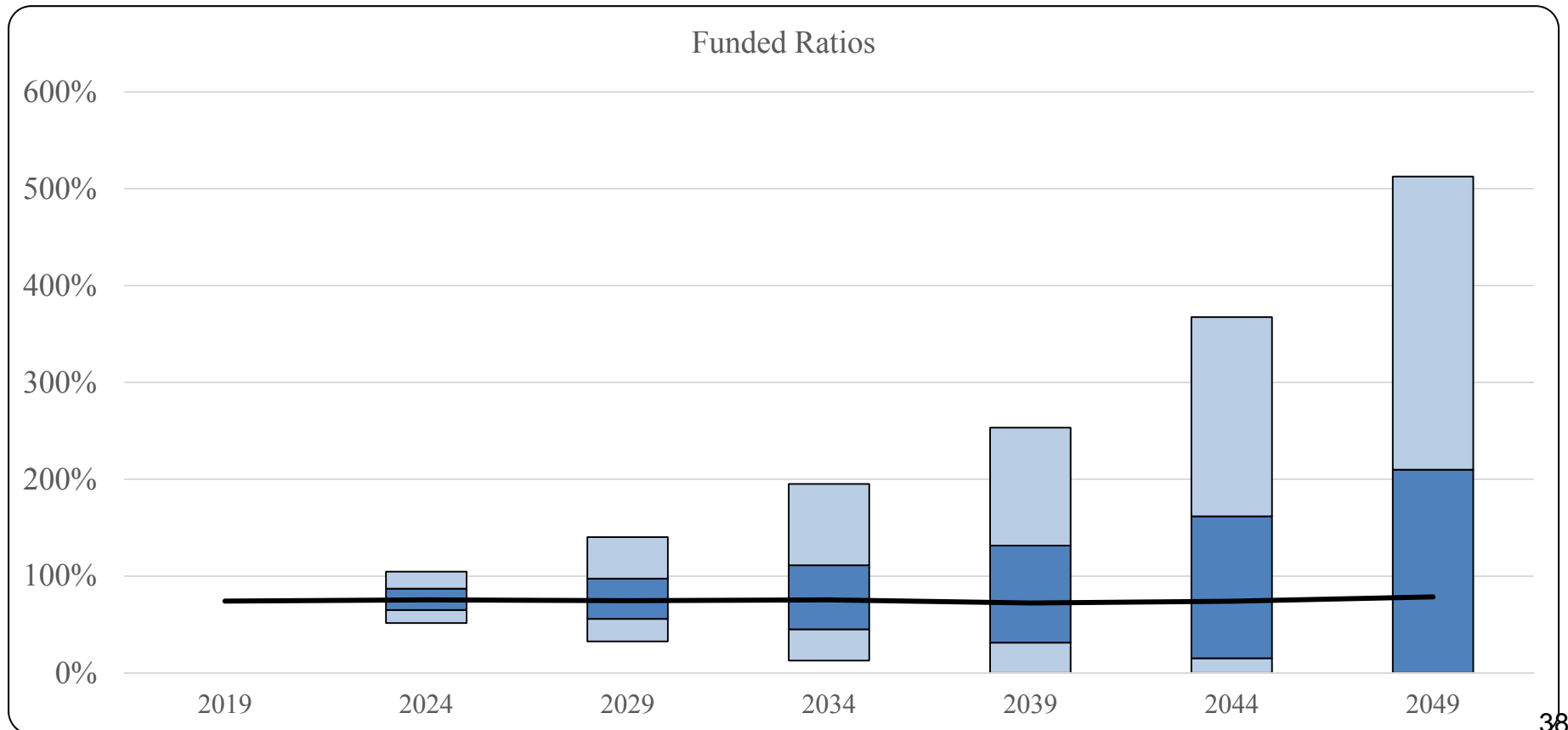
Stochastic Analysis

The chart below is based on a survey of capital market assumptions. We utilize those assumptions to produce the percentile ranks of expected returns over 30 years. The analysis indicates that over the next 30 years there is a 50% chance the cumulative market returns over the next 30 years will be between 6.29% and 8.86%.

Expected Returns

Public Employees' Retirement System
Stochastic Analysis

This graph indicates that in 10 years, the middle 50% of possible outcomes are between 97% and 56% funded. There is a 5% chance of being more than 140% funded, and a 5% chance of being less than 33% funded. In 2049, 50% of the possible outcomes are between 210% and 0% funded.
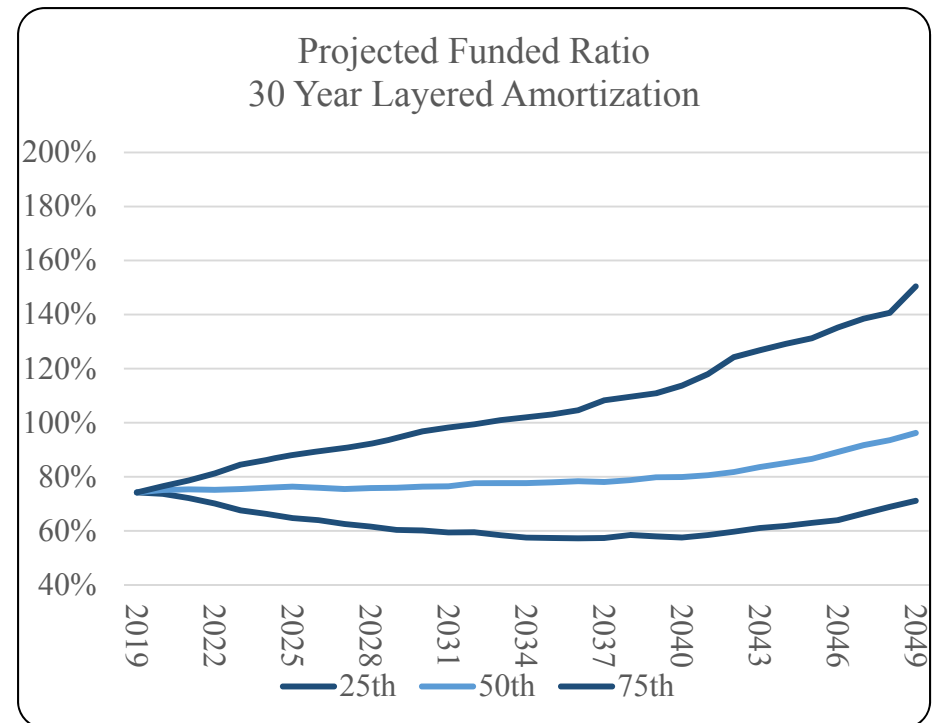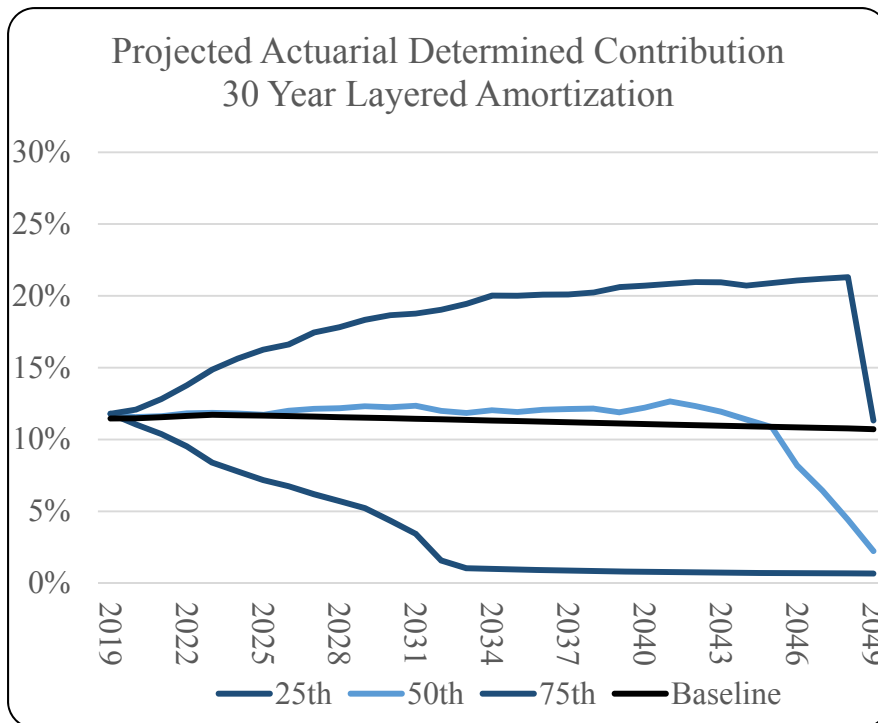

Funded Ratios

Public Employees' Retirement System
Stochastic Analysis
(Layered Amortization)

The probability is 50% that the actuarial determined contribution will range from 5% to 18% of payroll. The median (50th percentile) actuarial determined contribution is 12%.

The probability is 50% that the funded ratio will range between 60% and 94%. The median funded ratio is 76%

Projected Actuarial Determined Contribution
30 Year Layered Amortization

Projected Funded Ratio
30 Year Layered Amortization

Public Employees' Retirement System
Stochastic Analysis
(Layered Amortization)

The probability is 50% that the actuarial determined contribution will range from 2% to 23% of payroll. The median (50th percentile) actuarial determined contribution is 15%.

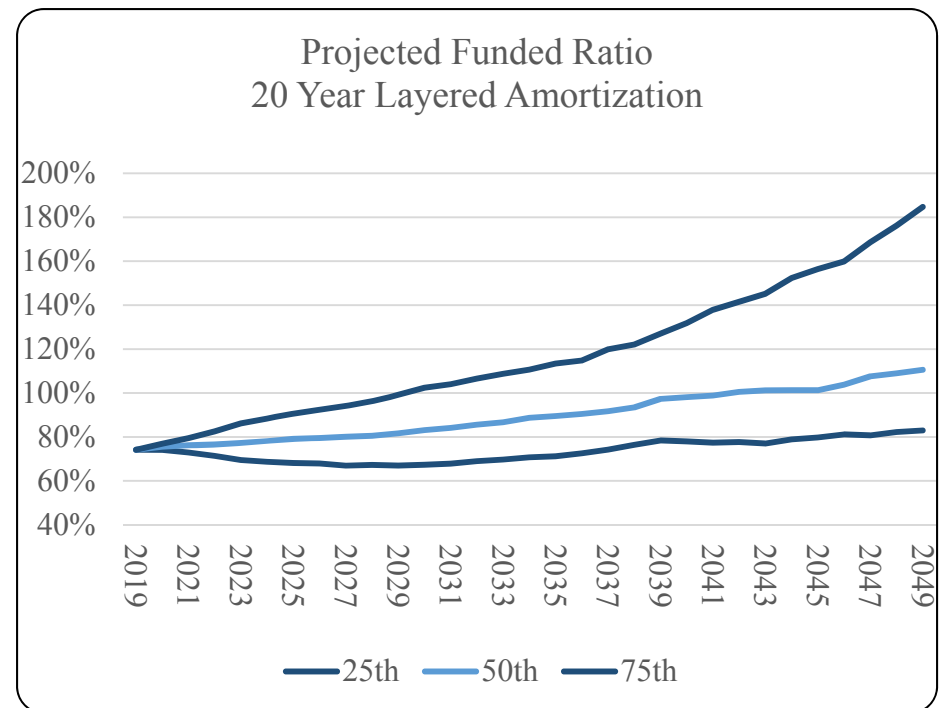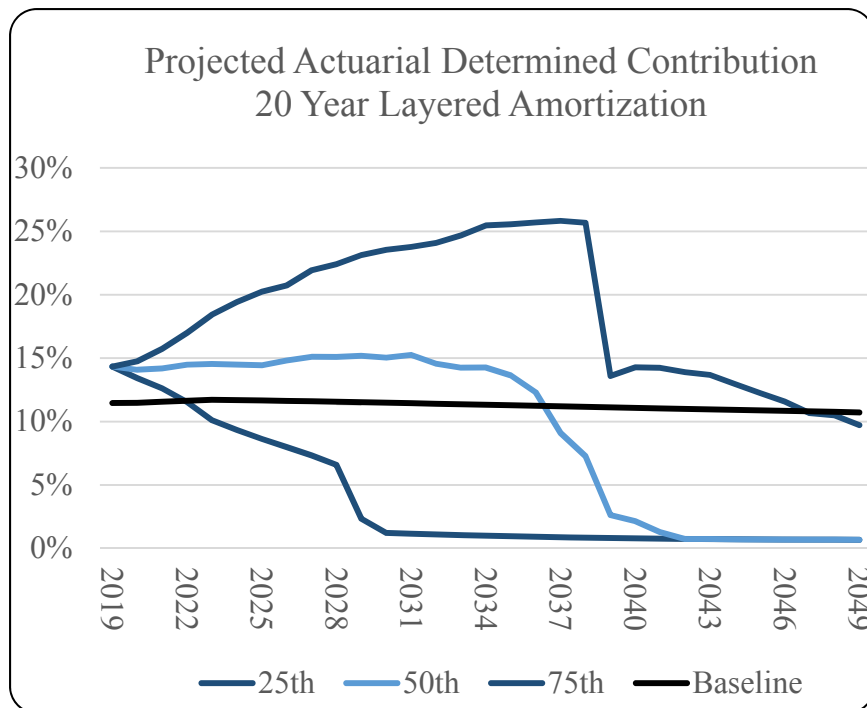The probability is 50% that the funded ratio will range between 67% and 99%. The median funded ratio is 82%

Projected Actuarial Determined Contribution
20 Year Layered Amortization

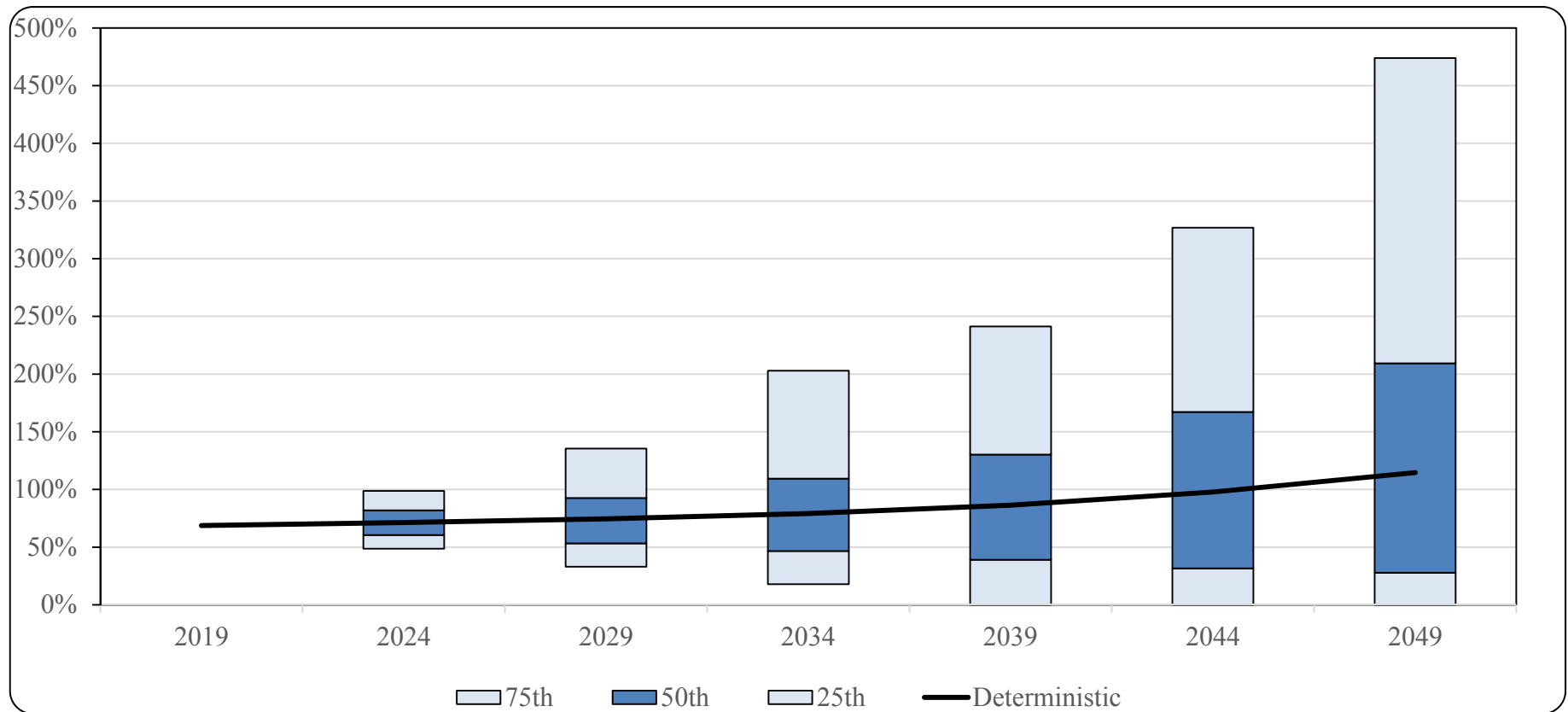Projected Funded Ratio
20 Year Layered Amortization

Teachers' Retirement System
Stochastic Analysis

This graph indicates that in 10 years, the middle 50% of possible outcomes are between 94% and 54% funded. There is a 5% chance of being more than 135% funded, and a 5% chance of being less than 33% funded.

Teachers' Retirement System
Stochastic Analysis

The probability is 50% that the actuarial determined contribution will range from 10% to 23% of payroll. The median (50th percentile) actuarial determined contribution is 17%.

The probability is 50% that the funded ratio will range between 56% and 87%. The median funded ratio is 70%

Projected Actuarial Determined Contribution
30 Year Layered Amortization

Projected Funded Ratio
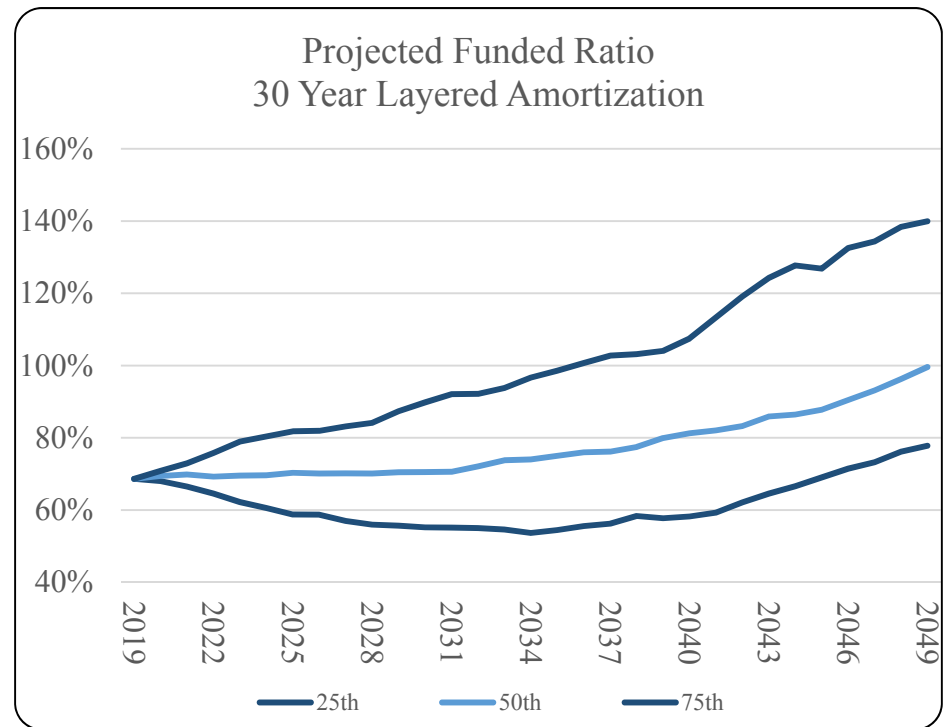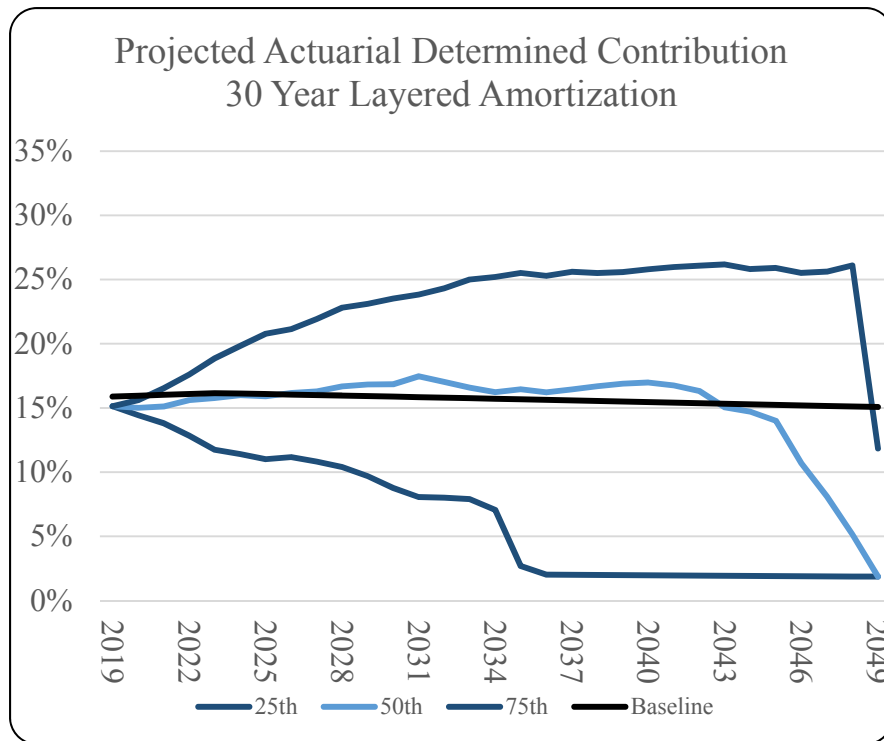30 Year Layered Amortization

Teachers' Retirement System
Stochastic Analysis

The probability is 50% that the actuarial determined contribution will range from 11% to 29% of payroll. The median (50th percentile) actuarial determined contribution is 21%.

The probability is 50% that the funded ratio will range between 63% and 94%. The median funded ratio is 77%

Projected Actuarial Determined Contribution
20 Year Layered Amortization

25th   50th   75th   Baseline

Projected Funded Ratio
20 Year Layered Amortization

25th   50th   75th

Public Employees' Retirement System Maturity Measures

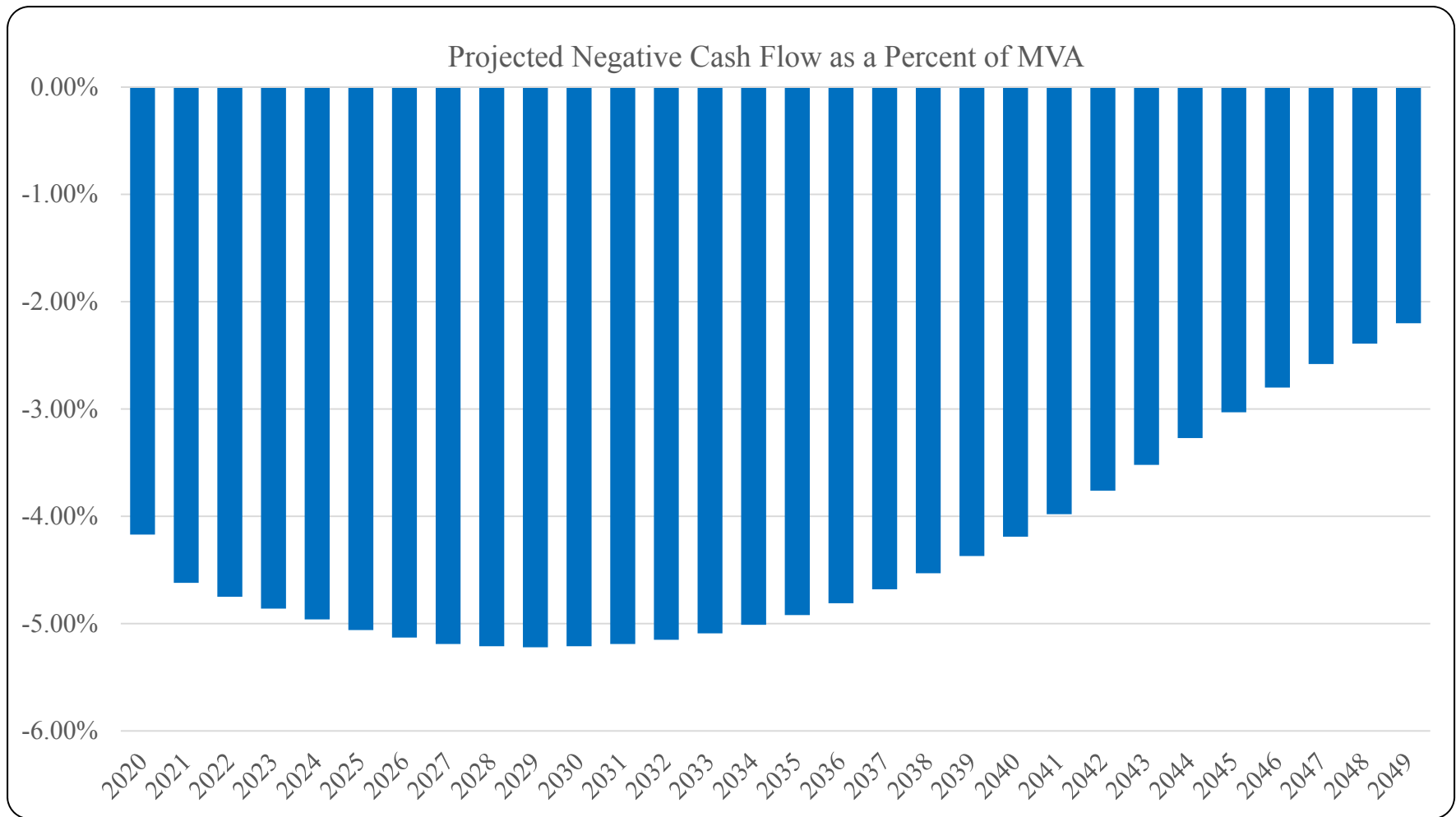Projected Negative Cash Flow as a Percent of MVA

Public Employees' Retirement System
Maturity Measures

Year End	Projected Benefit Payments	Benefit Growth Rate	Sustainable Negative Cash Flow	Projected Negative Cash Flow	Year End	Projected Benefit Payments	Benefit Growth Rate	Sustainable Negative Cash Flow	Projected Negative Cash Flow
2020	470,056,941	7.46%	**0.19%**	**3.75%**	2035	843,467,681	1.84%	**5.81%**	**6.33%**
2021	501,344,416	6.66%	**0.99%**	**4.12%**	2036	856,834,043	1.58%	**6.07%**	**6.31%**
2022	533,009,922	6.32%	**1.33%**	**4.41%**	2037	868,722,595	1.39%	6.26%	6.27%
2023	564,075,901	5.83%	**1.82%**	**4.68%**	2038	878,732,425	1.15%	6.50%	6.20%
2024	593,598,060	5.23%	**2.42%**	**4.91%**	2039	887,187,324	0.96%	6.69%	6.10%
2025	622,944,333	4.94%	**2.71%**	**5.15%**	2040	893,909,120	0.76%	6.89%	5.97%
2026	651,490,684	4.58%	**3.07%**	**5.37%**	2041	898,914,703	0.56%	7.09%	5.81%
2027	678,924,009	4.21%	**3.44%**	**5.57%**	2042	902,405,266	0.39%	7.26%	5.62%
2028	704,564,354	3.78%	**3.87%**	**5.74%**	2043	904,558,779	0.24%	7.41%	5.40%
2029	728,803,016	3.44%	**4.21%**	**5.89%**	2044	905,129,703	0.06%	7.59%	5.15%
2030	751,547,891	3.12%	**4.53%**	**6.02%**	2045	904,439,770	-0.08%	7.73%	4.88%
2031	773,100,033	2.87%	**4.78%**	**6.13%**	2046	902,327,464	-0.23%	7.88%	4.59%
2032	792,959,748	2.57%	**5.08%**	**6.21%**	2047	899,919,775	-0.27%	7.92%	4.29%
2033	811,443,412	2.33%	**5.32%**	**6.28%**	2048	897,140,550	-0.31%	7.96%	3.97%
2034	828,239,045	2.07%	**5.58%**	**6.31%**	2049	894,365,159	-0.31%	7.96%	3.67%

Teachers' Retirement System
Maturity Measures

Projected Negative Cash Flow as a Percent of MVA

Teachers' Retirement System
Maturity Measures

Year End	Projected Benefit Payments	Benefit Growth Rate	Sustainable Negative Cash Flow	Projected Negative Cash Flow	Year End	Projected Benefit Payments	Benefit Growth Rate	Sustainable Negative Cash Flow	Projected Negative Cash Flow
2020	396,993,270	6.21%	**1.29%**	**4.17%**	2035	586,355,658	2.85%	**4.65%**	**4.92%**
2021	420,198,187	6.03%	**1.47%**	**4.62%**	2036	593,646,181	2.76%	**4.74%**	**4.81%**
2022	436,160,595	5.28%	**2.22%**	**4.75%**	2037	600,395,989	2.67%	4.83%	4.68%
2023	451,310,430	4.82%	**2.68%**	**4.86%**	2038	606,841,401	2.58%	4.92%	4.53%
2024	466,226,134	4.52%	**2.98%**	**4.96%**	2039	612,396,440	2.50%	5.00%	4.37%
2025	480,832,871	4.29%	**3.21%**	**5.06%**	2040	617,027,825	2.42%	5.08%	4.19%
2026	494,403,461	4.08%	**3.42%**	**5.13%**	2041	620,727,179	2.33%	5.17%	3.98%
2027	507,176,567	3.89%	**3.61%**	**5.19%**	2042	623,728,885	2.25%	5.25%	3.76%
2028	519,107,231	3.72%	**3.78%**	**5.21%**	2043	625,869,550	2.17%	5.33%	3.52%
2029	530,292,066	3.56%	**3.94%**	**5.22%**	2044	627,088,371	2.09%	5.41%	3.27%
2030	540,935,000	3.42%	**4.08%**	**5.21%**	2045	628,408,877	2.02%	5.48%	3.03%
2031	551,207,982	3.29%	**4.21%**	**5.19%**	2046	630,372,700	1.95%	5.55%	2.80%
2032	560,914,556	3.17%	**4.33%**	**5.15%**	2047	633,612,352	1.90%	5.60%	2.58%
2033	569,854,611	3.06%	**4.44%**	**5.09%**	2048	638,042,556	1.86%	5.64%	2.39%
2034	578,487,210	2.95%	**4.55%**	**5.01%**	2049	642,544,773	1.82%	5.68%	2.20%

Summary Comments

➢ Purpose of the report

- Better understand and assess the risks inherent in funding the Systems.

➢ Findings

- In the short term the major risk facing the Systems is investment volatility