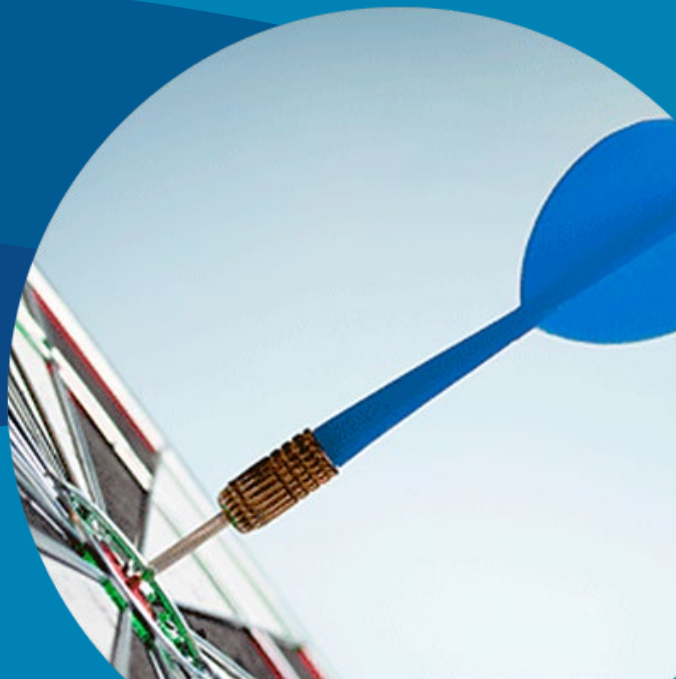
Wisconsin Retirement System

Wisconsin Retirement System Stress Testing

December 10, 2020



Today's Discussion

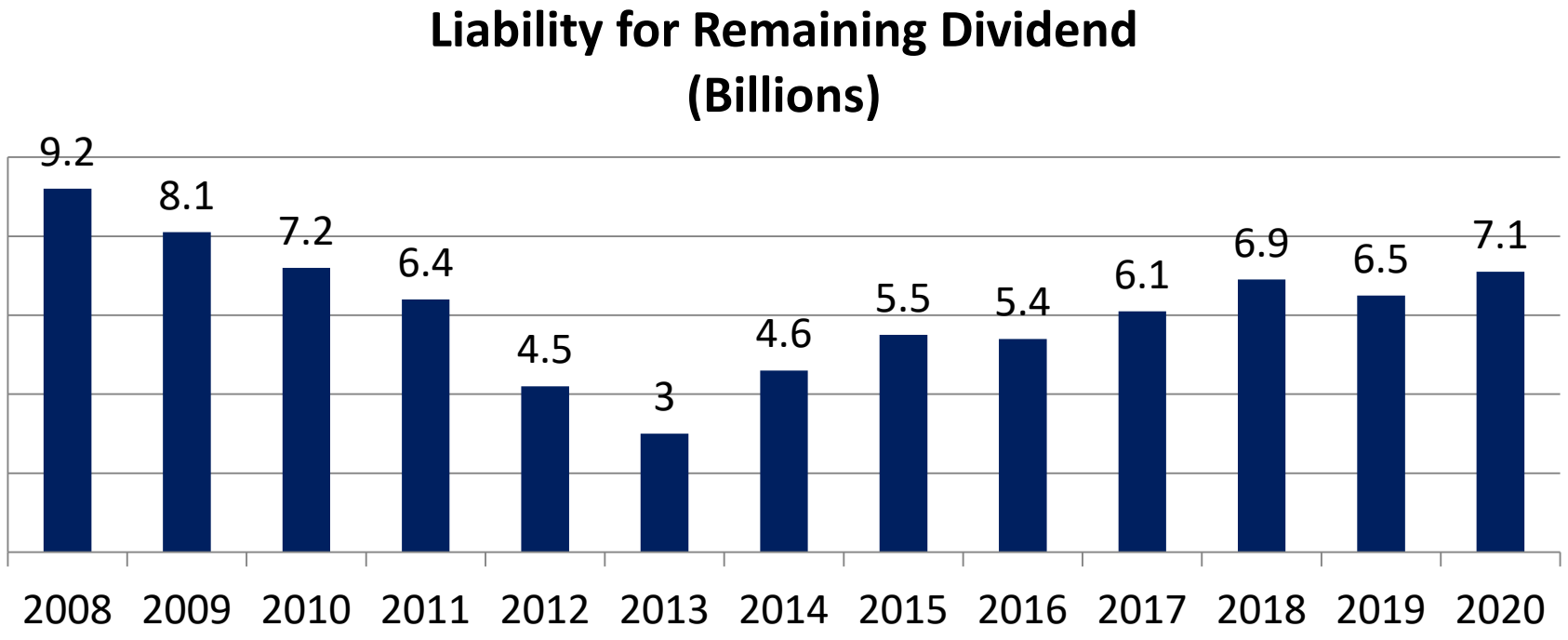
- WRS Deterministic Stress Testing
- WRS Stochastic Stress Testing

WRS DETERMINISTIC STRESS TESTING

Nature of Deterministic Stress Testing

- Investigation of dire scenarios
  - What *could* happen in the realm of possibility, a black swan event that is unexpected
  - In a highly diversified portfolio like WRS', actual large one year asset losses (-20%, -30%) would reflect asset market meltdown in total
- Note that deterministic stress testing herein does not reflect the usual asset market bounceback in following years

Historic Dividend Liability ("Past Dividend Liability")



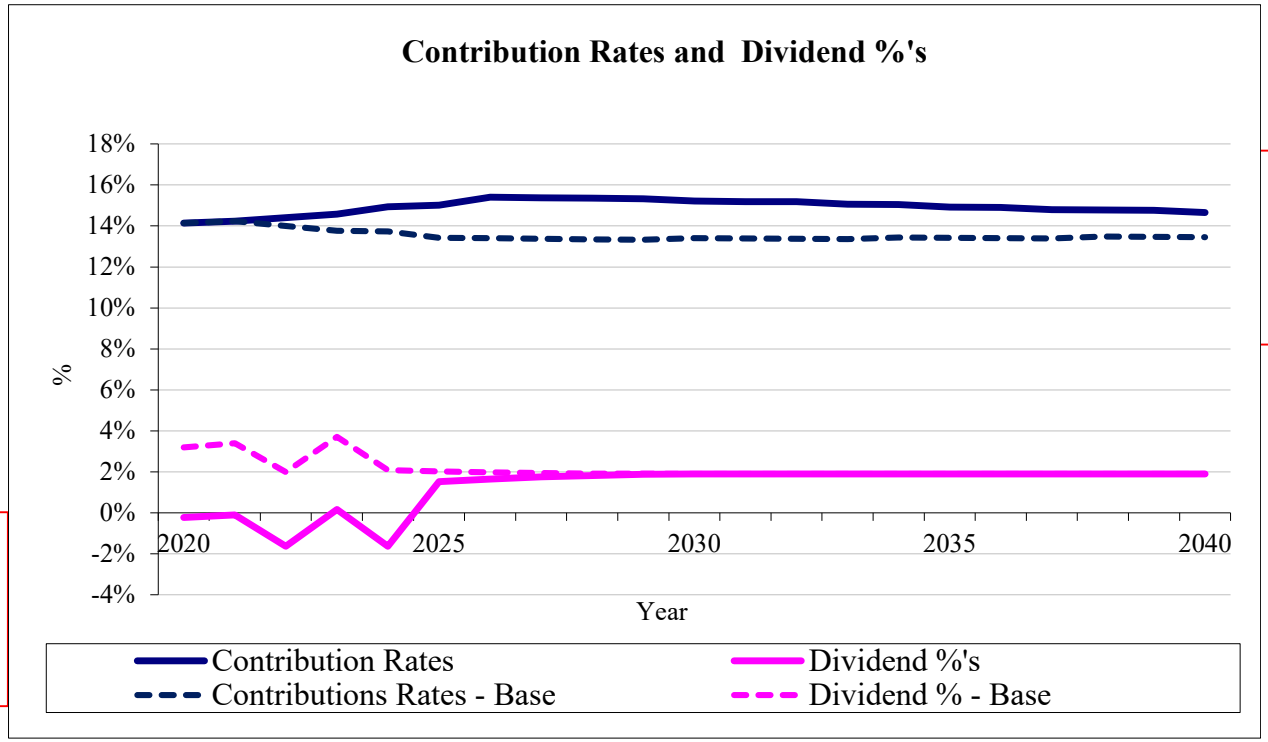
Notes: 1) drawdown of the reserve via dividend reductions in 2008- 2013 followed by the dividend buildup affects different cohorts of retirees differently.
2) Mortality impacts the past dividend liability in 2015-2016, 2018-2019.

Deterministic Scenario Description

Scenario 1	a. Negative 10% Return in 2020, 7% thereafter b. Negative 20% Return in 2020, 7% thereafter c. Negative 30% Return in 2020, 7% thereafter
Scenario 2	Receiving lower contributions than expected for 2 years: a. 25% b. 50% c. 75% (Negative 20% Scenario)

Scenario 1a – Negative 10% Return in 2020, 7% Thereafter

($6.5 Billion) Dividend Adjustment

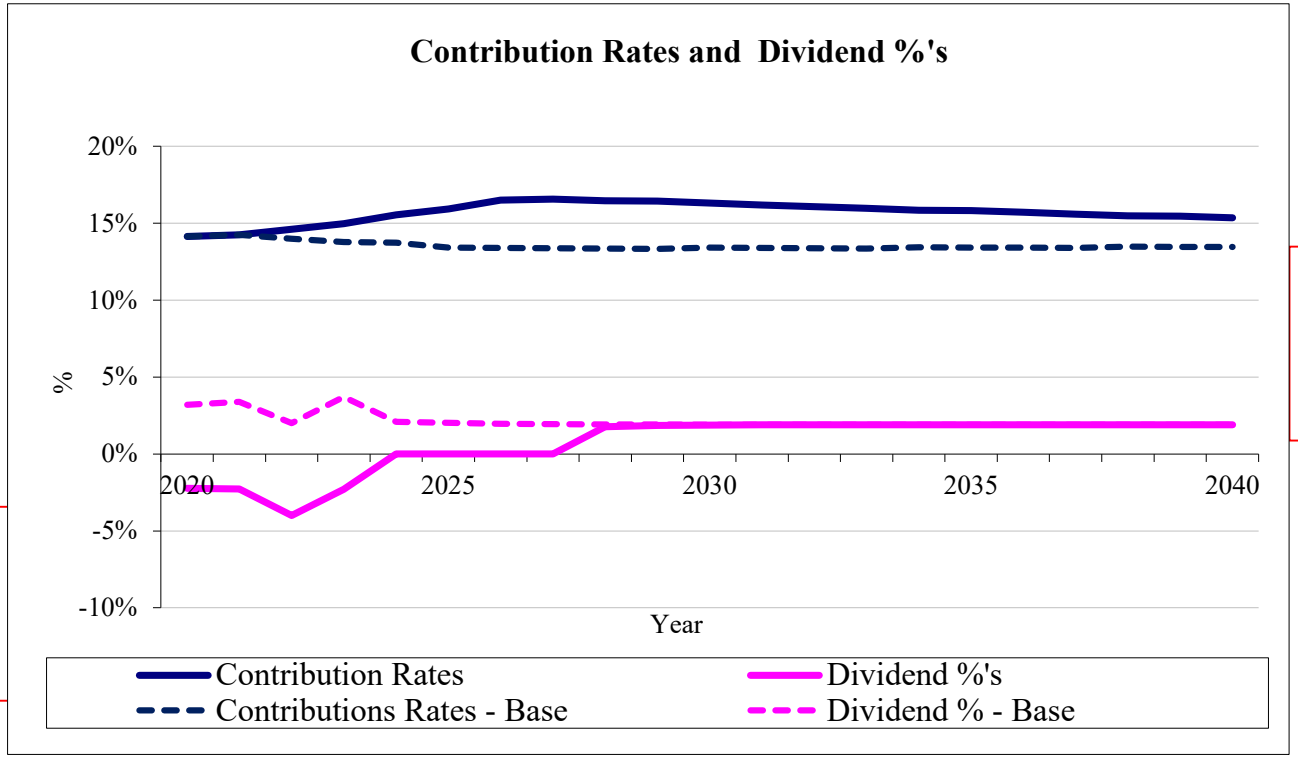


$6.5 Billion Contrib. Increase

Scenario 1a – Negative 10% Return in 2020, 7% Thereafter

- Past Dividend Liability is not depleted
- Dividends will be 0% or negative through 2024
- Contribution Rate gradually increases by about 2.0% of payroll in year 5 and beyond

Scenario 1b – Negative 20% Return in 2020 , 7% Thereafter



($11.5 Billion) Dividend Adjustment

$10 Billion Contrib. Increase

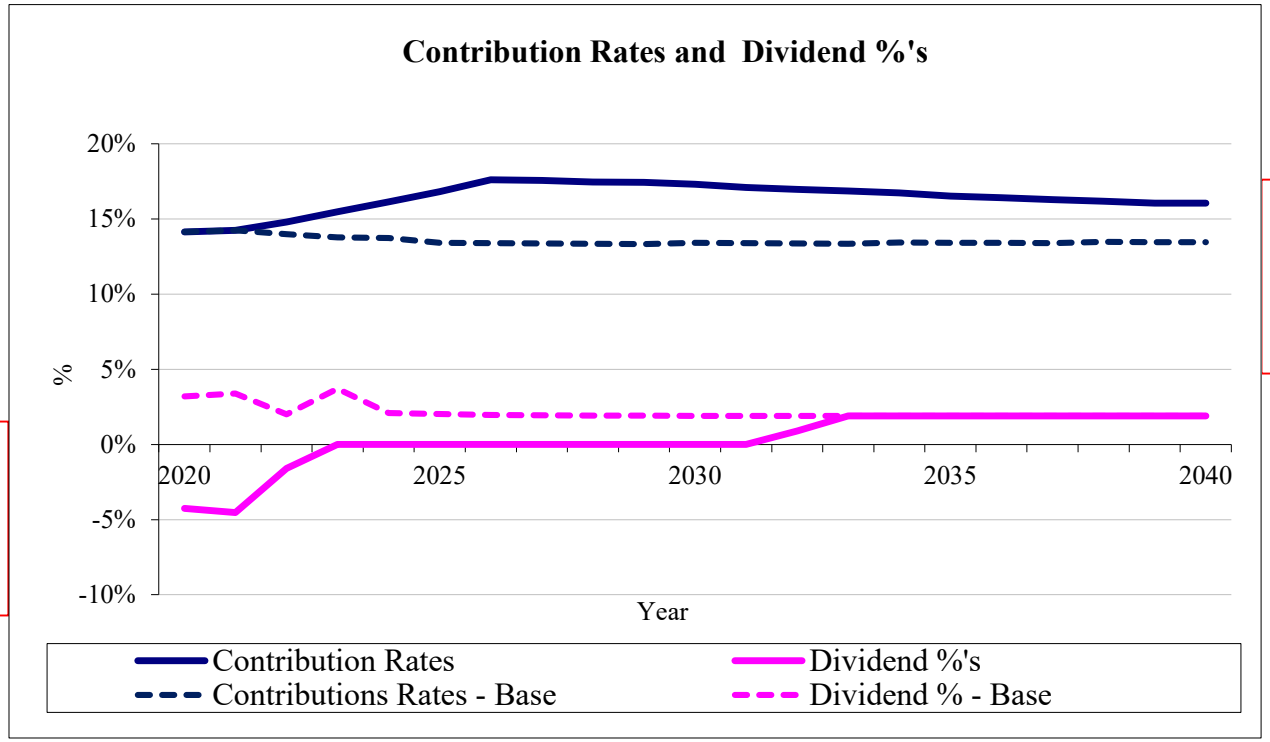
"Past Dividend Liability" depleted by 2023, restored by 2028 when member dividends might be payable again

Scenario 1b – Negative 20% Return in 2020, 7% Thereafter

- Past Dividend Liability is depleted in 2023
- Retiree Liability becomes underfunded
- There will be a series of negative dividends, until most people are at the floor, followed by an extended period of no dividends
- Dividends could resume in 2028
- Between 2024 and 2028, returns are used to fully fund the retiree liability
- Contribution Rate gradually increases by about 3% of payroll in year 5 and beyond

Scenario 1c – Negative 30% Return in 2020 , 7% Thereafter

($15.5 Billion) Dividend Adjustment



$13 Billion Contrib. Increase

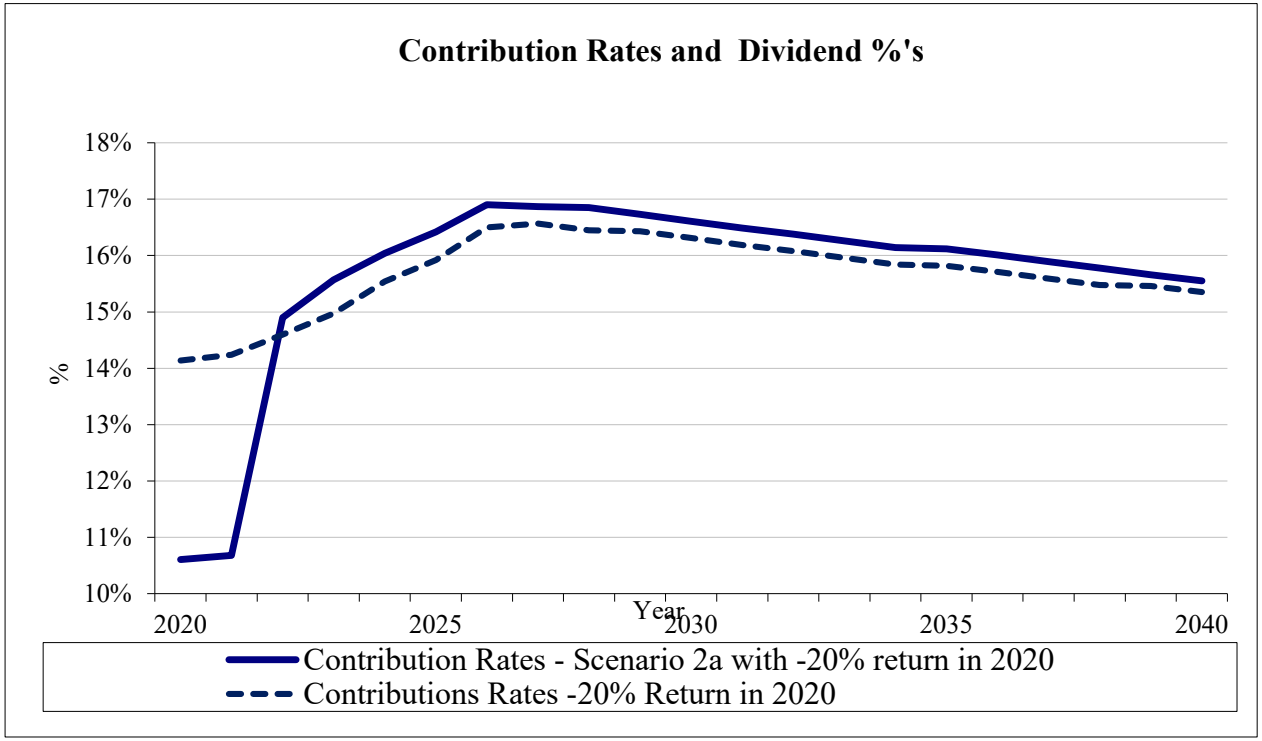
"Past Dividend Liability " depleted by 2022, restored by 2032 when member dividends begin again

Scenario 1c – Negative 30% Return in 2020, 7% Thereafter

- Past Dividend Liability is depleted in 2022
- Retiree Liability becomes underfunded
- There will be a series of negative dividends, until most people are at the floor, followed by an extended period of no dividends
- Dividends could resume in 2032
- Between 2022 and 2032, returns are used to fully fund the retiree liability
- Contribution Rate gradually increases by about 4% of payroll in year 5 and beyond

Scenario 2a – Receive contribution = 25% lower than expected for 2 years (Negative 20% Scenario in Base Scenario)

$1.1 Billion Savings over 2 years



$1.3 Billion Cost over 18 years

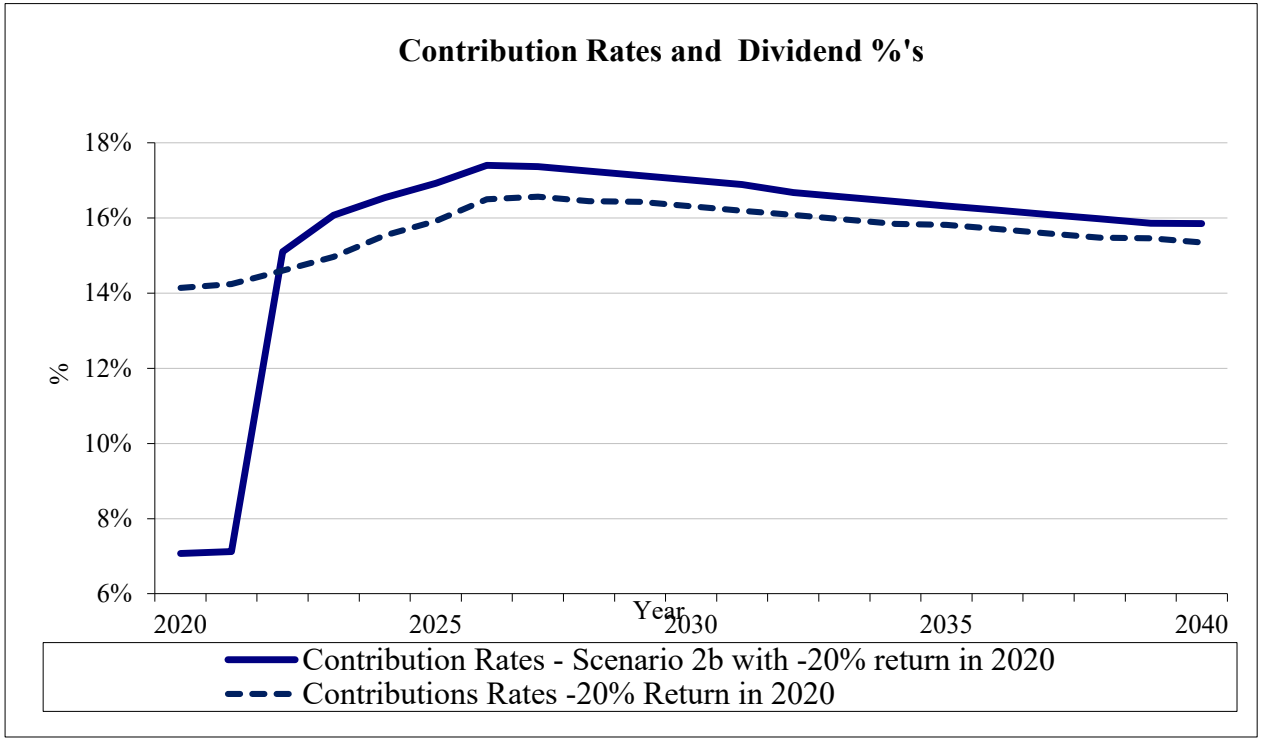
No dividend shown because no impact

Scenario 2a – Receive contribution = 25% lower than expected for 2 years (Negative 20% Scenario in Base Scenario)

- Contribution deferral only impacts contribution stream
  - Dividend process set via Retired Lives valuation
- Early 2 year “savings” must be paid back plus interest in future
- Resulting in higher overall contributions
- On following two slides, the impact is magnified

Scenario 2b – Receive contribution = 50% lower than expected for 2 years (Negative 20% Scenario in Base Scenario)

$2.2 Billion Savings over 2 years

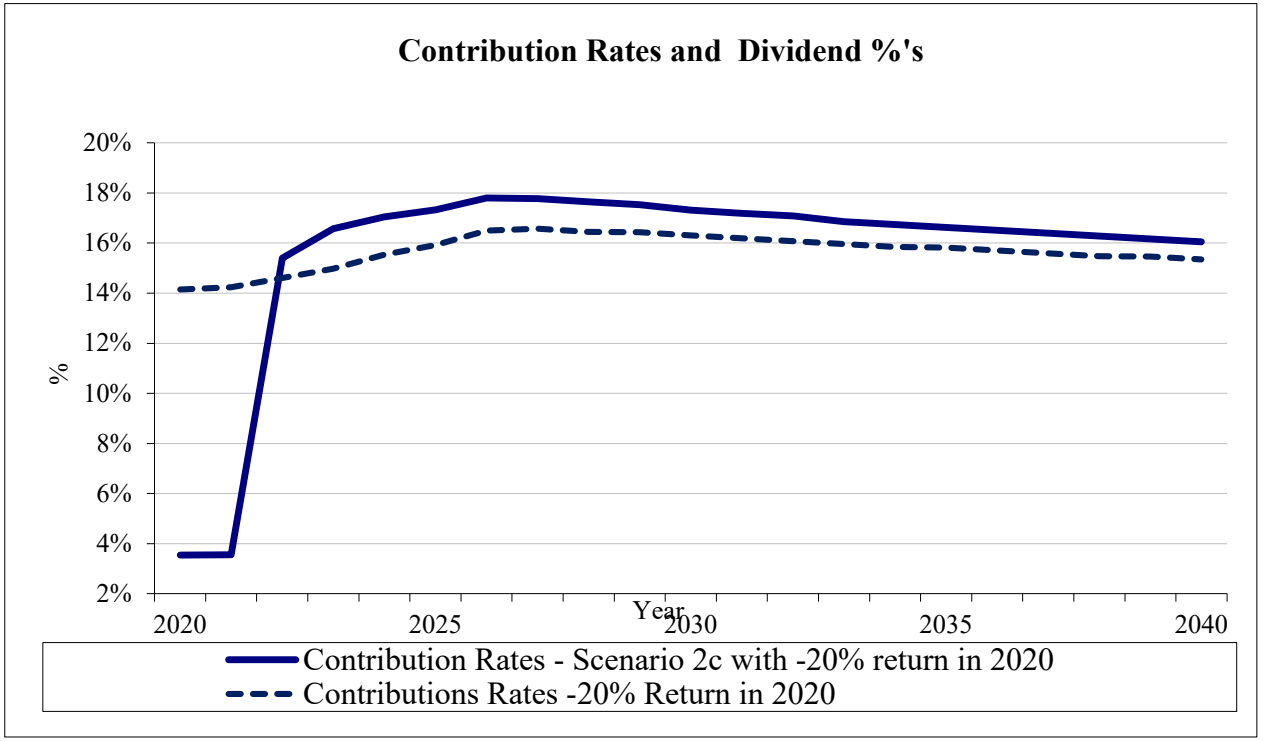


$2.7 Billion Cost over 18 years

No dividend shown because no impact

Scenario 2c – Receive contribution = 75% lower than expected for 2 years (Negative 20% Scenario in Base Scenario)

$3.3 Billion Savings over 2 years



$4.1 Billion Cost over 18 years

No dividend shown because no impact

STOCHASTIC STRESS TESTING

Stochastic Stress Testing

- Stress test provides insight into how the System would respond to severely unfavorable markets
- For the WRS, can answer questions like:
  - What would it take to deplete the Past Dividend Liability ?
  - How would contribution rates be impacted?
- Stochastic stress tests studied:
  - Probable range of contribution rates & funded status
  - Probability of depleting the Past Dividend Liability
  - Probability of a negative dividend in any given year

Stochastic (Monte Carlo) Simulations

- Based on 1000 random trials
- Valuation Assumptions held constant
- Expected return is 7.0% for all future years
  - Also modeled -10.0%, -20.0% and -30.0% for 2020
- Standard Deviation (measure of volatility) is 14.7%
- Stochastic simulations will not predict the future
  - Results can vary significantly with very minor changes to parameters
  - They are useful for comparing relative likelihood of different scenarios

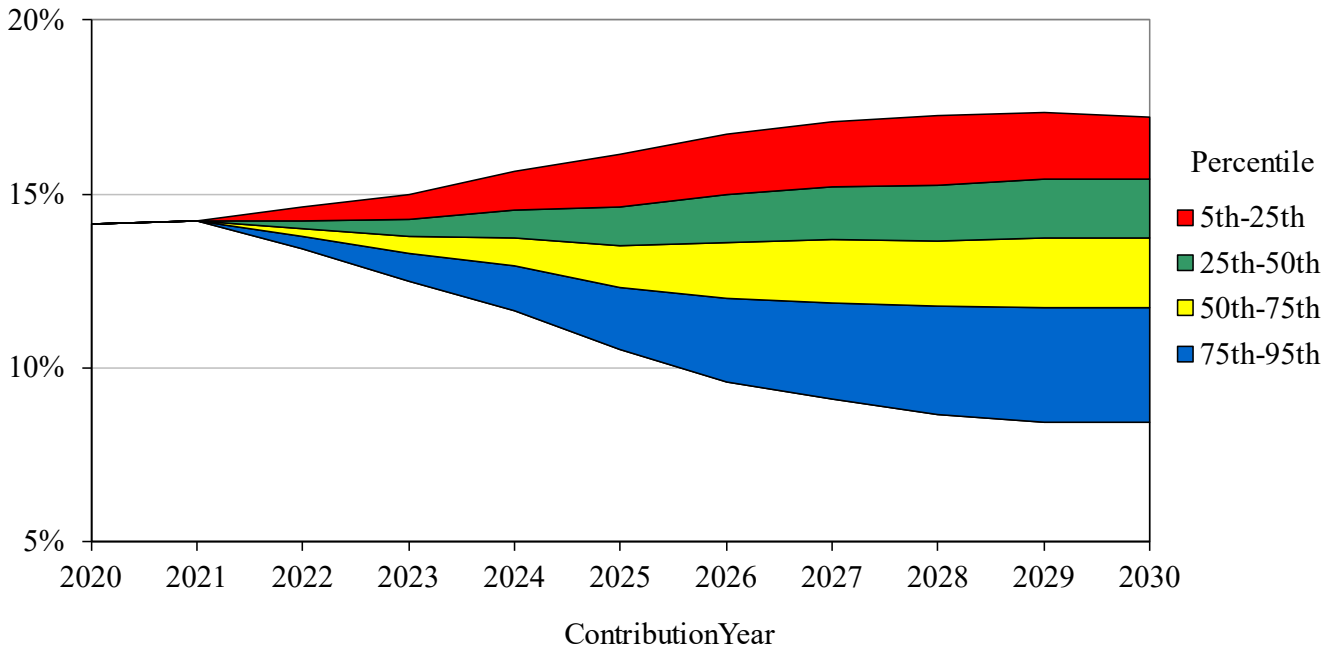
Dividend Process

- 5% Benchmark
- 7% Return assumption
- Implies 1.9% Expected dividends
- Actual past dividends have varied greatly over time
- Inflation has also varied greatly over time

Updated Stochastic Stress Testing

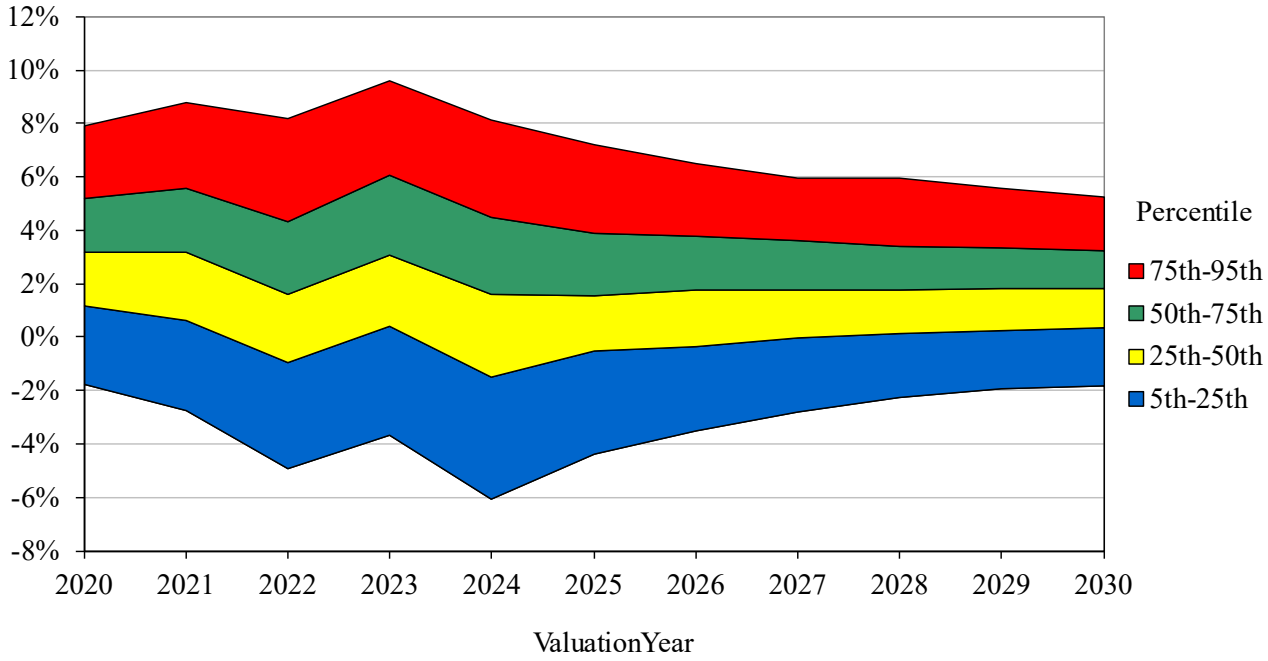
- The following slides show results of updated Stochastic projections, based on December 31, 2019 data
- Items of interest displayed:
  - Contribution rates
  - Dividend rates
  - Funded status
  - Past Dividend Liability

Contribution as a % of Payroll



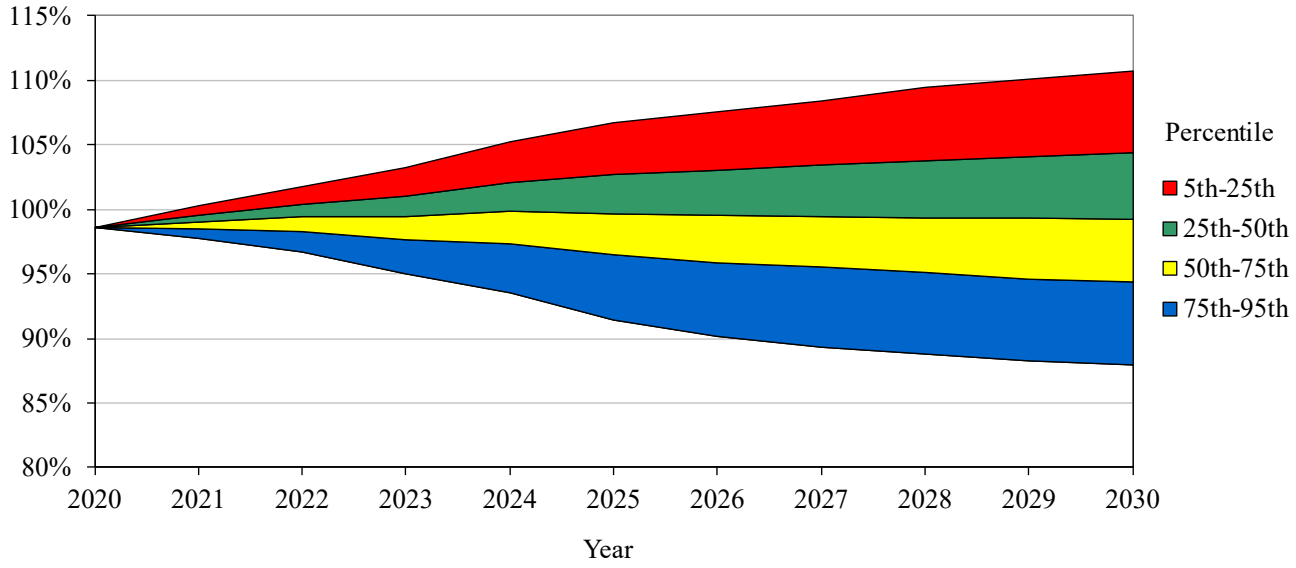
5th Percentile	14.1%	14.2%	14.6%	15.0%	15.6%	16.1%	16.7%	17.1%	17.3%	17.3%	17.2%
25th Percentile	14.1%	14.2%	14.2%	14.3%	14.5%	14.6%	15.0%	15.2%	15.3%	15.4%	15.4%
Median	14.1%	14.2%	14.0%	13.8%	13.7%	13.5%	13.6%	13.7%	13.7%	13.7%	13.7%
75th Percentile	14.1%	14.2%	13.8%	13.3%	12.9%	12.3%	12.0%	11.9%	11.8%	11.7%	11.7%
95th Percentile	14.1%	14.2%	13.4%	12.5%	11.6%	10.5%	9.6%	9.1%	8.7%	8.4%	8.4%

Dividend Rates



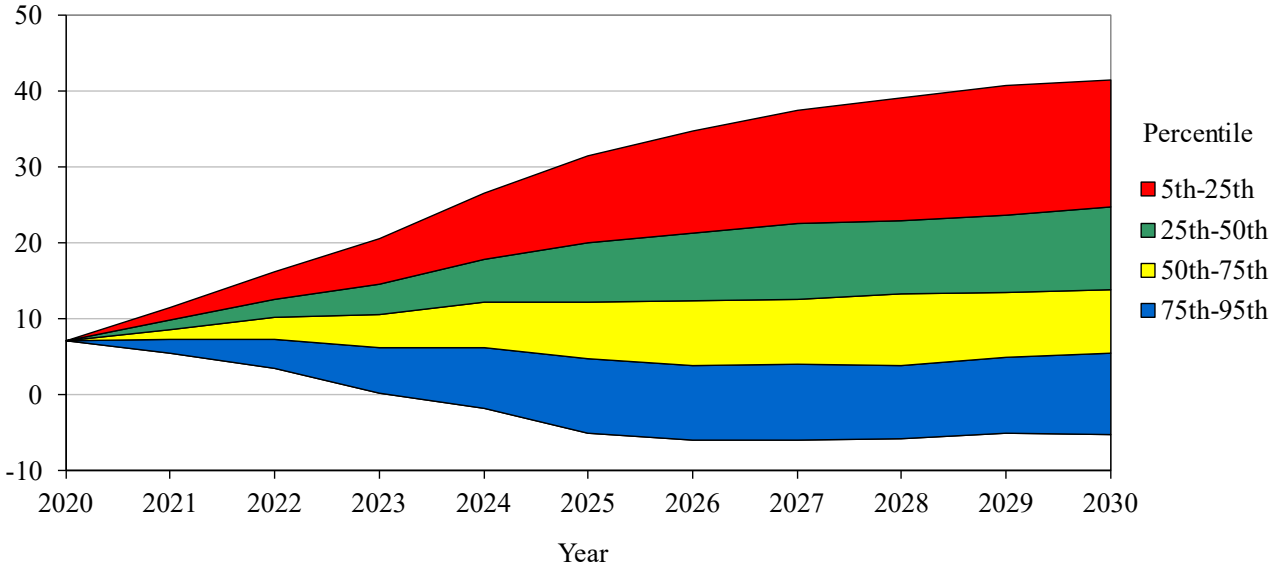
5th Percentile	-1.8%	-2.8%	-4.9%	-3.7%	-6.1%	-4.4%	-3.5%	-2.8%	-2.3%	-2.0%	-1.8%
25th Percentile	1.2%	0.6%	-1.0%	0.4%	-1.5%	-0.5%	-0.3%	0.0%	0.1%	0.3%	0.4%
Median	3.2%	3.2%	1.6%	3.0%	1.6%	1.5%	1.7%	1.8%	1.8%	1.8%	1.8%
75th Percentile	5.2%	5.5%	4.3%	6.0%	4.5%	3.9%	3.8%	3.6%	3.4%	3.3%	3.2%
95th Percentile	7.9%	8.8%	8.2%	9.6%	8.1%	7.2%	6.5%	6.0%	6.0%	5.6%	5.2%

Funded Status



5th Percentile	98.6%	100.2%	101.8%	103.2%	105.2%	106.7%	107.5%	108.5%	109.4%	110.1%	110.7%
25th Percentile	98.6%	99.5%	100.4%	101.0%	102.1%	102.7%	103.1%	103.4%	103.8%	104.1%	104.4%
Median	98.6%	99.0%	99.4%	99.4%	99.9%	99.7%	99.6%	99.4%	99.3%	99.3%	99.2%
75th Percentile	98.6%	98.5%	98.3%	97.6%	97.4%	96.5%	95.8%	95.5%	95.1%	94.6%	94.3%
95th Percentile	98.6%	97.8%	96.7%	95.0%	93.5%	91.4%	90.1%	89.3%	88.8%	88.3%	87.9%

Past Dividend Liability (billions)



5th Percentile	7.1	11.5	16.1	20.5	26.5	31.5	34.7	37.4	39.0	40.8	41.4
25th Percentile	7.1	9.8	12.5	14.5	17.8	20.1	21.3	22.6	22.9	23.7	24.7
Median	7.1	8.5	10.2	10.6	12.2	12.2	12.3	12.5	13.2	13.6	13.9
75th Percentile	7.1	7.3	7.3	6.3	6.3	4.7	3.9	4.0	3.9	4.9	5.4
95th Percentile	7.1	5.4	3.5	0.2	(1.9)	(5.1)	(6.0)	(5.9)	(5.8)	(5.0)	(5.3)

Stochastic Projection Observations

- The projections incorporate 2019 data
  - Including very favorable market rates of asset return during 2019
- WRS Cost sharing mechanisms result in much more narrow contribution and funded status impacts at the tails (5th and 95th%-tiles)
- The following pages provide probabilities related to future dividends based on single year asset return shocks of -10%, -20%, -30%

Dividend Discussion

Probability that Past Dividend Liability will be Depleted by Year

Val Date	Assuming 2020 Return of			
	7.0%	-10.0%	-20.0%	-30.0%
2020	0.0%	0.0%	0.0%	0.0%
2021	0.0%	0.0%	0.0%	0.0%
2022	0.3%	0.0%	0.2%	18.9%
2023	4.6%	3.9%	43.9%	95.5%
2024	8.5%	17.3%	63.2%	97.0%
2025	13.9%	35.1%	79.7%	98.6%

Dividend Discussion

Probability of a Negative Dividend by Year

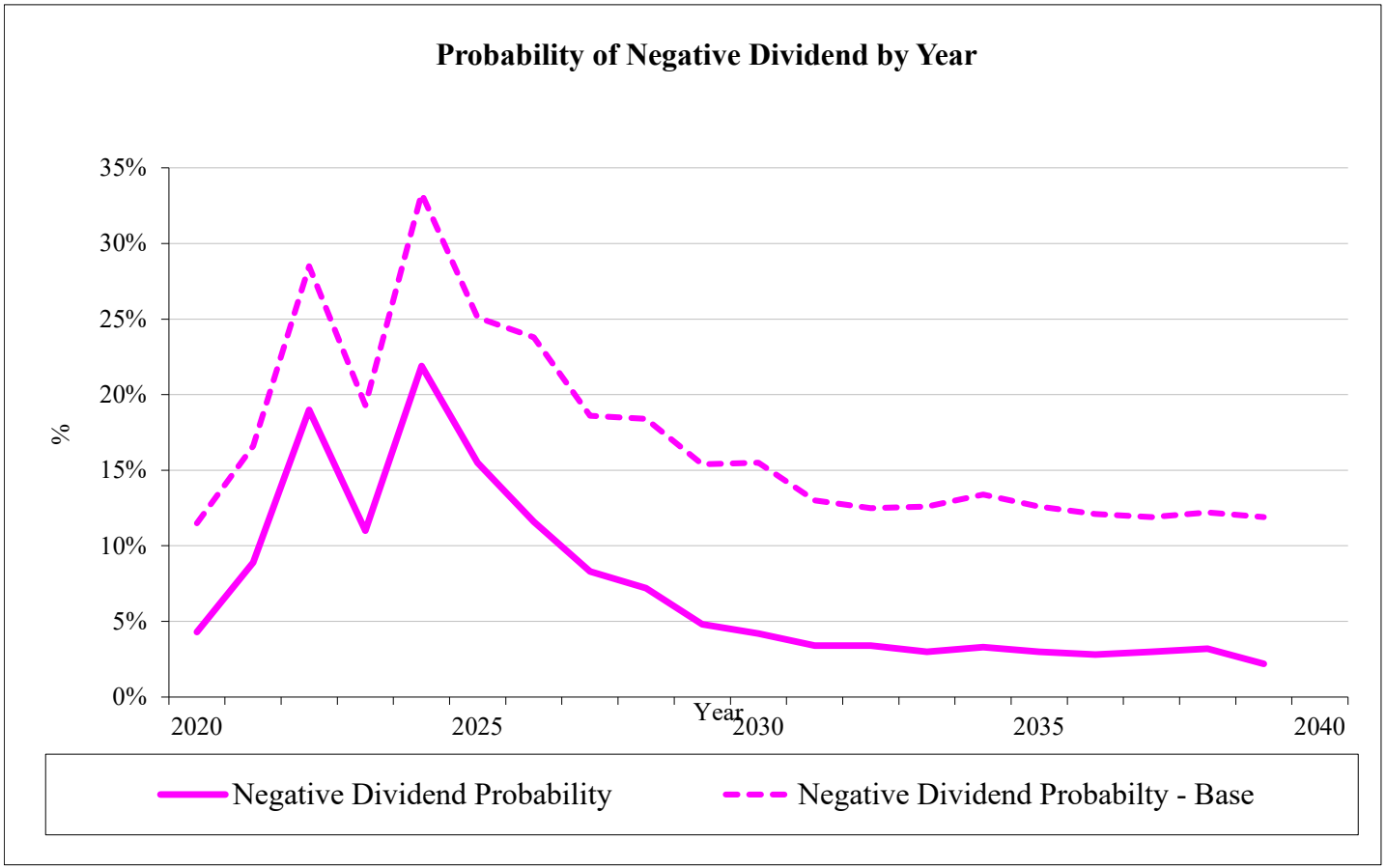
Val Date	Assuming 2020 Return of			
	7.0%	-10.0%	-20.0%	-30.0%
2020	0.0%	0.0%*	100.0%	100.0%
2021	16.6%	44.5%	88.6%	99.7%
2022	28.5%	72.6%	94.6%	99.8%
2023	19.3%	45.4%	78.2%	95.5%
2024	33.3%	68.3%	90.1%	98.5%
2025	25.1%	29.5%	34.4%	39.6%

* Probability in 2020 is either 0% or 100%. The true rate in this scenario is negative, but rounded to zero since less than -.05%.

Stochastic Dividend Scenarios

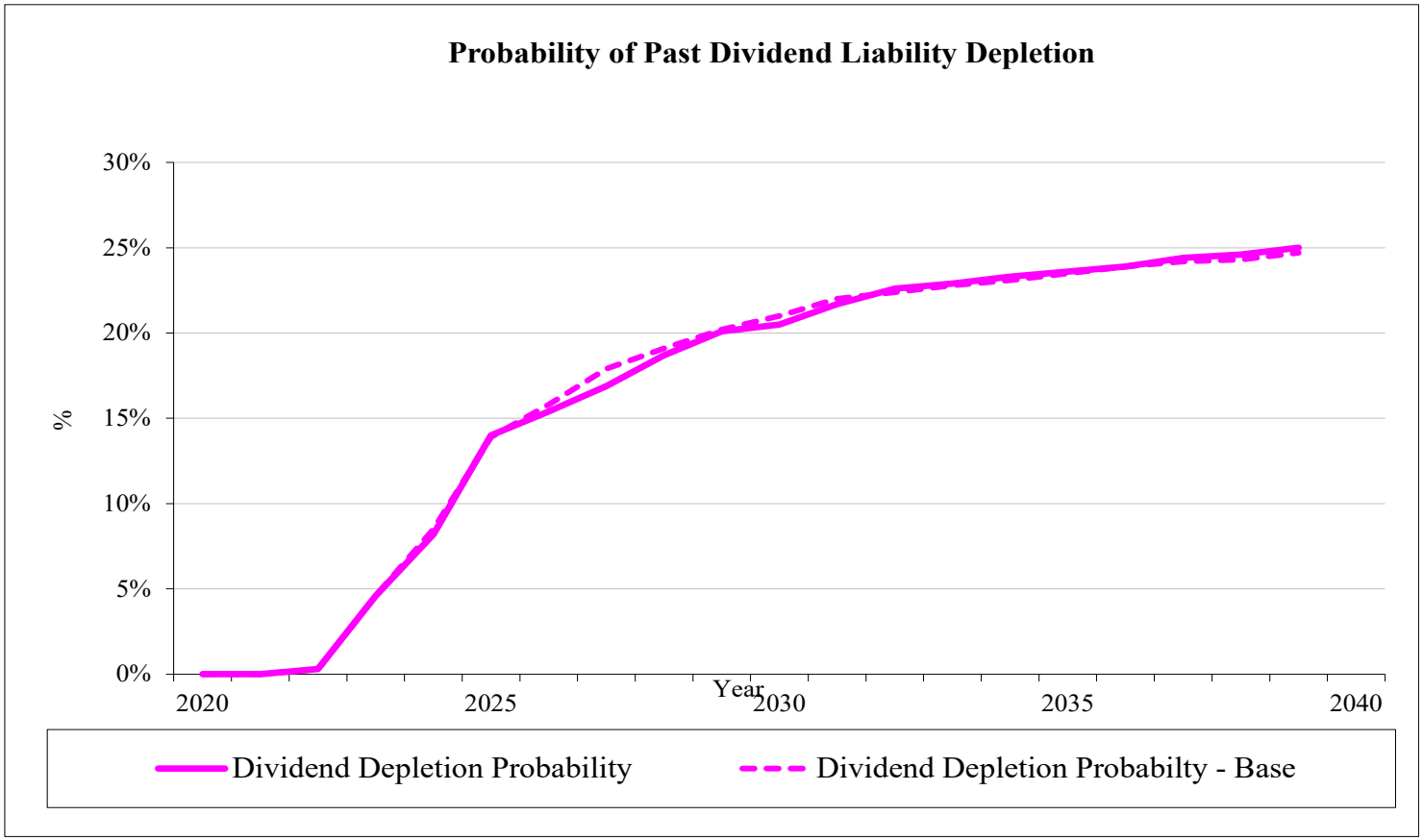
Scenario 1	Increase the Core dividend threshold to 2%
Scenario 2	Cap positive dividends at 3% and create reserve
Scenario 3	Limit dividend reductions to -2%

Scenario 1 – Increase Dividend Threshold to 2%



Funded status and Contribution not impacted

Scenario 1 – Increase Dividend Threshold to 2%

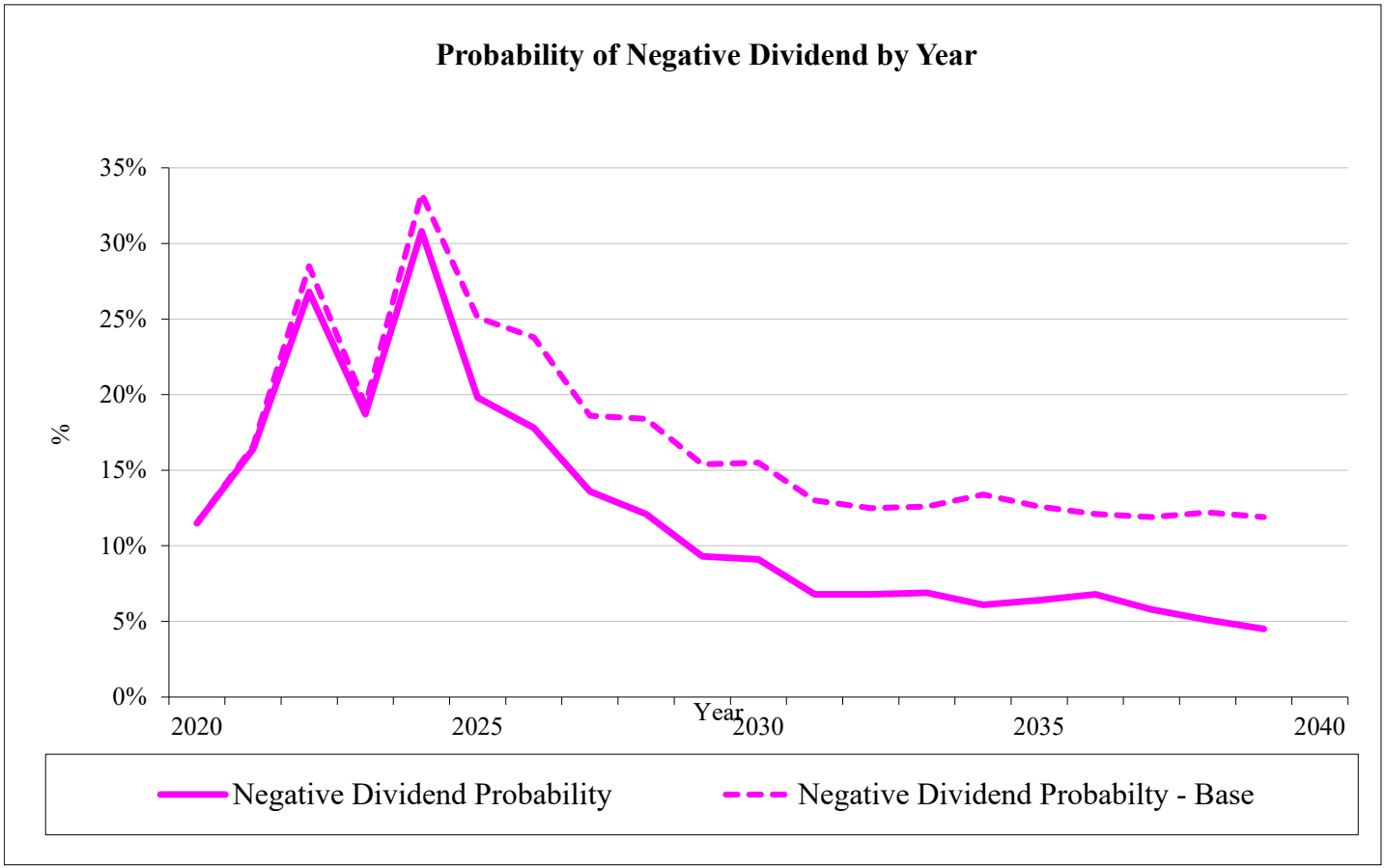


Funded status and Contribution not impacted

Scenario 1 – Increase Dividend Threshold to 2% Observations

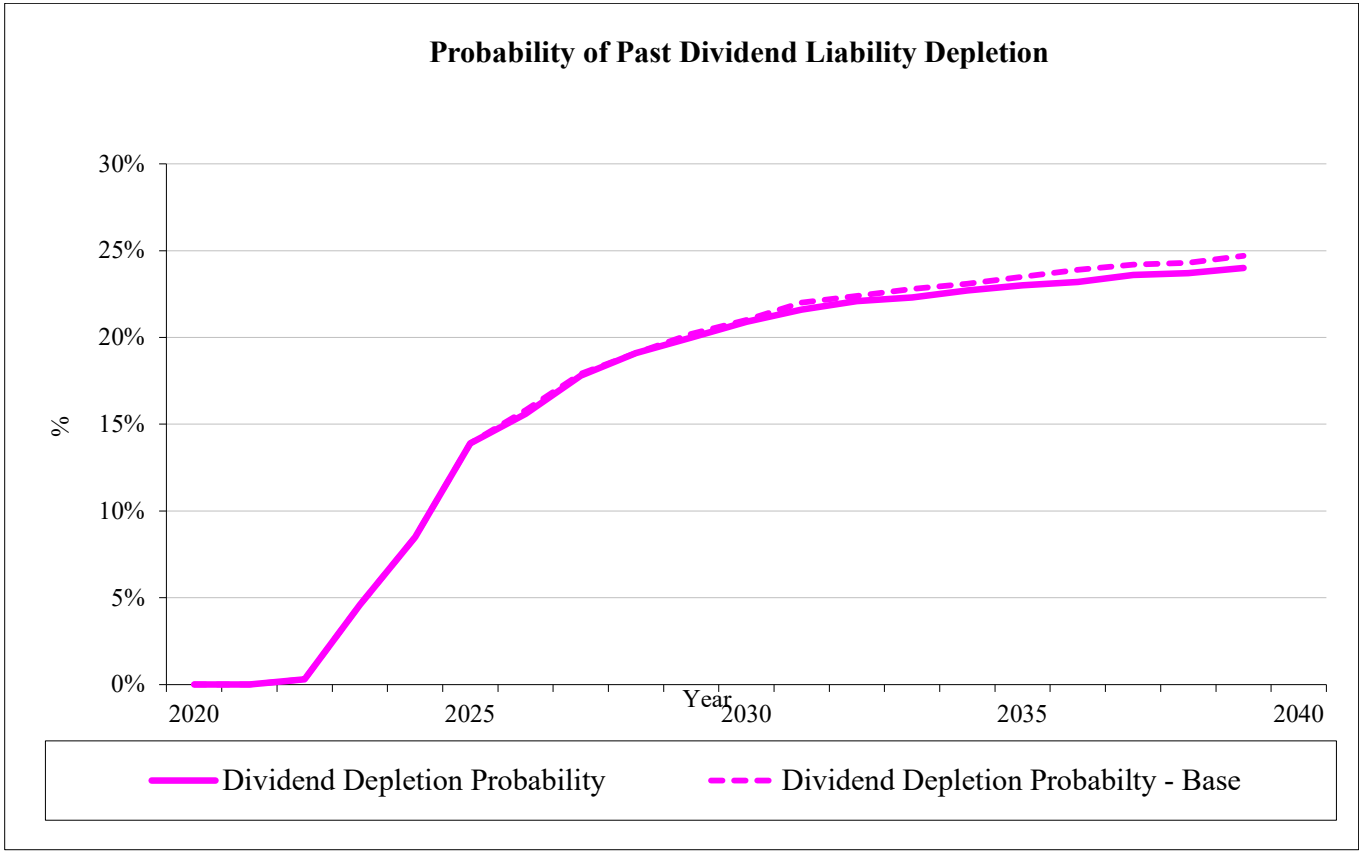
- Current Core dividend threshold: [-0.5%,0.5%]
- Increasing threshold to [-2%,2%]:
  - Probability of a negative dividend is reduced
  - Probability of the Past Dividend Liability being depleted is not significantly changed
  - There may be many years of no dividend adjustment

Scenario 2 – Cap Positive Dividends at 3% and Reserve



Funded status and Contribution not impacted

Scenario 2 – Cap Positive Dividends at 3% and Reserve

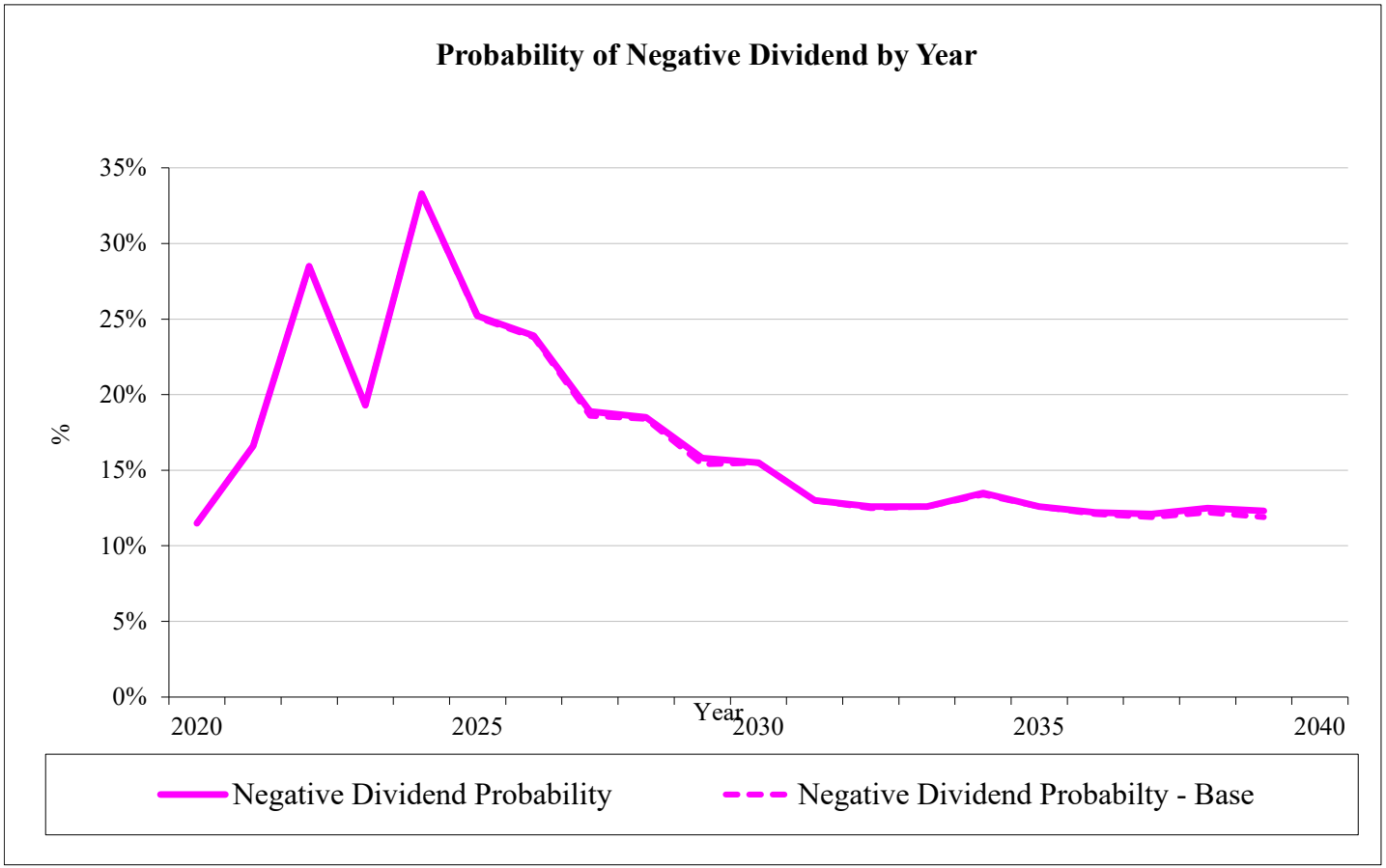


Funded status and Contribution not impacted

Scenario 2 – Cap Positive Div. at 3% and Reserve Observations

- Probability of a negative dividend is reduced over the long term
- Probability of the Past Dividend Liability being depleted is only slightly reduced
- Positive dividends are capped at 3%, reducing overall average dividend
- Can result in some transfer of dividends from cohort of retirees to another

Scenario 3 – Limit Negative Dividends to -2%



Funded status and Contribution not impacted

Scenario 3 Observations

- As expected, very little impact to probability of negative dividend
- May help retirees weather a significant downturn in the market, by not taking the hit all at once

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