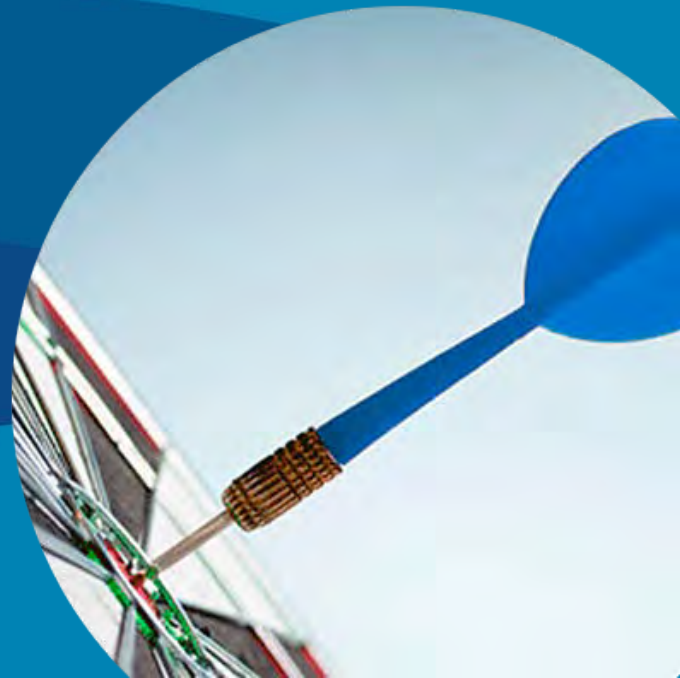


# State of Wisconsin Investment Board

## Wisconsin Retirement System Actuarial Overview and Stress Testing Scenarios

October 2019



# Objectives of this Presentation

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- Provide an overview of the WRS
  - Relationship of Investment Return to Success Measures
  - Effects of bad outcomes
- Investigate inflation vs. WRS dividends
- Evaluate several points along the asset allocation spectrum against the measures of success
  - Deterministic stress tests
  - Stochastic simulations
- Find the “Sweet Spot” if it exists

# 2019 Executive Summary

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- New this year: deterministic stress test of WRS  
Single year Black Swan investment scenarios show:
  - Contribution rate increases by up to ~ 3.5% of payroll once loss fully works into the Market Recognition Account
  - Series of negative dividends, depletion of Dividend Reserve and several years until Dividends resume
  - Contribution Rates are generally more stable than retiree Dividends
- Overall stochastic stress test results similar to 2017 study
  - Slightly higher probability of depleting dividend reserve due to lower than expected returns

# 2019 Executive Summary

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## Result of this year's stress testing of the Wisconsin Retirement System

- Continue to target 'Goldilocks zone' that provides for positive return with appropriate downside protection
  - Expected Rate of Return = 6-7%
  - Corresponding Standard Deviations of Returns = 10.7%-14.7%

# WRS Operation

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- Benefits
- Plan Governance
  - ETF Board Role
  - SWIB Role
- WRS Accounts and Reserves
- Actuarial Valuation of WRS
  - Sharing Asset Experience
  - Dividend Reserve Depletion

# Key Changes from 2017 Study

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- Compounded returns over 2017-2018 slightly < than assumed rate of 7.2% (15.8% return in 2017 & -3.6% return in 2018 or 5.7% compounded over 2 years)
- Experience study update
  - Investment return assumption from 7.2 to 7.0%
  - Mortality table (slightly longer expected lifetimes)
- Slightly lower Standard Deviation than 2017 SWIB Study
- Updated census data as of December 31, 2018

# Covered Population

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at 12/31/2016

	Number	Financial Information		
		Total \$ Millions	Average	Type
Retirees	197,647	\$ 4,887	\$ 24,725	Annual Benefit
Active Members	256,208	13,486	52,637	Annual Pay
Inactive Members	160,897	2,392	14,865	Money Purchase Balance
<b>Total</b>	<b>614,752</b>			

at 12/31/2018

	Number	Financial Information		
		Total \$ Millions	Average	Type
Retirees	211,126	\$ 5,466.7	\$ 25,893	Annual Benefit
Active Members	256,933	14,041.3	54,650	Annual Pay
Inactive Members	167,778	2,714.6	16,180	Money Purchase Balance
<b>Total</b>	<b>635,837</b>			

# WRS Investment Funds

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- Core Fund
  - Diversified Portfolio
  - 5 Year Smoothing through Market Recognition Account
- Variable Fund
  - Equity Portfolio
  - Marked to Market each year

Variable Fund represents ~ 7% of total assets as of December 31, 2018



# Market Recognition Account

	For the Year Ended December 31						
	2016	2017	2018	2019	2020	2021	2022
Beginning of year							
a. Funding value	\$88,695,483,883	\$92,268,055,484	\$96,763,496,611	\$98,085,174,233	\$96,273,249,855	\$95,805,301,550	\$95,217,878,640
b. Market value	85,291,480,633	89,181,973,662	100,036,600,775	93,169,113,454	93,169,113,454	93,169,113,454	93,169,113,454
End of year							
c. Market value	89,181,973,662	100,036,600,775	93,169,113,454				
d. Non-investment cash flow (contributions minus benefits)	(2,985,477,640)	(2,987,822,636)	(3,282,228,177)				
e. Investment income							
e1. Total investment income	6,875,970,669	13,842,449,749	(3,585,259,145)				
e2. Assumed rate	7.2%	7.2%	7.0%				
e3. Amount for immediate recognition	6,278,597,645	6,535,738,380	6,658,566,777	-	-	-	-
e4. Amount for phased-in recognition: e1-e3	597,373,024	7,306,711,369	(10,243,825,921)	-	-	-	-
f. Phased-in recognition of investment income							
f1. Current year: 0.2 x e4	119,474,605	1,461,342,274	(2,048,765,184)	-	-	-	-
f2. First prior year	(1,343,976,073)	119,474,605	1,461,342,274	(2,048,765,184)	-	-	-
f3. Second prior year	(242,736,599)	(1,343,976,073)	119,474,605	1,461,342,274	(2,048,765,184)	-	-
f4. Third prior year	953,421,177	(242,736,599)	(1,343,976,073)	119,474,605	1,461,342,274	(2,048,765,184)	-
f5. Fourth prior year	<u>793,268,488</u>	<u>953,421,177</u>	<u>(242,736,599)</u>	<u>(1,343,976,073)</u>	<u>119,474,605</u>	<u>1,461,342,274</u>	<u>(2,048,765,184)</u>
f6. Total MRA recognition	279,451,597	947,525,383	(2,054,660,978)	(1,811,924,378)	(467,948,305)	(587,422,910)	(2,048,765,184)
f7. Amount for MRA recognition	-	-	-	-	-	-	-
f8. Total recognized gain (loss)	279,451,597	947,525,383	(2,054,660,978)	(1,811,924,378)	(467,948,305)	(587,422,910)	(2,048,765,184)
g. Total recognized investment income: e3 + f8	6,558,049,242	7,483,263,763	4,603,905,799	(1,811,924,378)	(467,948,305)	(587,422,910)	(2,048,765,184)
h. Funding value end of year: a + d + e3 + f8	92,268,055,484	96,763,496,611	98,085,174,233	96,273,249,855	95,805,301,550	95,217,878,640	93,169,113,456
i. Difference between market and funding values	(3,086,081,822)	3,273,104,164	(4,916,060,779)	(3,104,136,399)	(2,636,188,094)	(2,048,765,184)	-
j. Recognized rate of return	7.5%	8.2%	4.8%				
k. Market rate of return (net of fee)	8.2%	15.8%	-3.6%				

# WRS Benefits

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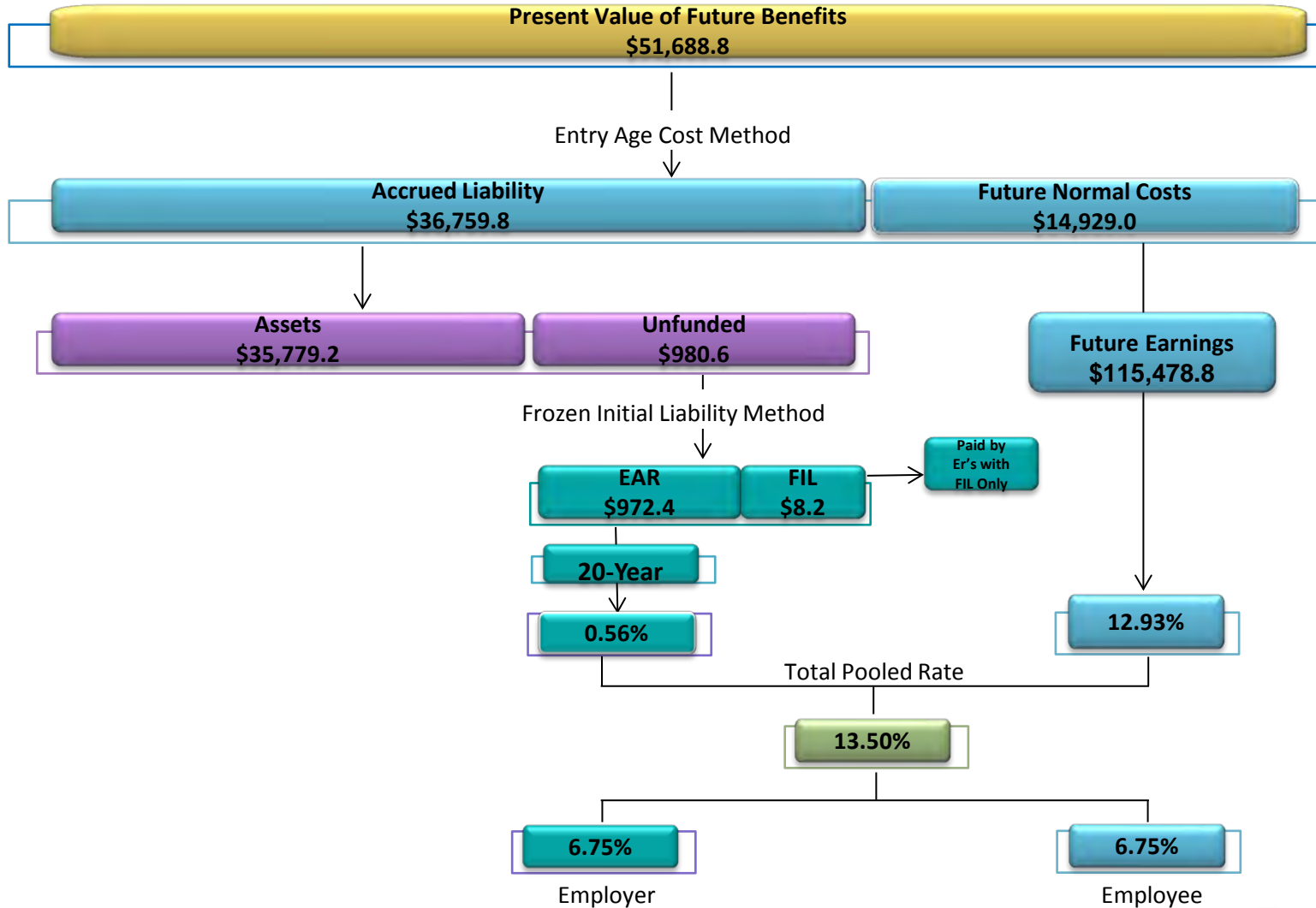
- Hybrid Plan
  - Defined Benefit:  $1.6\% \times \text{FAC} \times \text{Service}$  (Most participants)
  - Not less than twice value of member account (a form of employer match)
- Adjustments are made to the above for members participating in Variable

# WRS Contributions

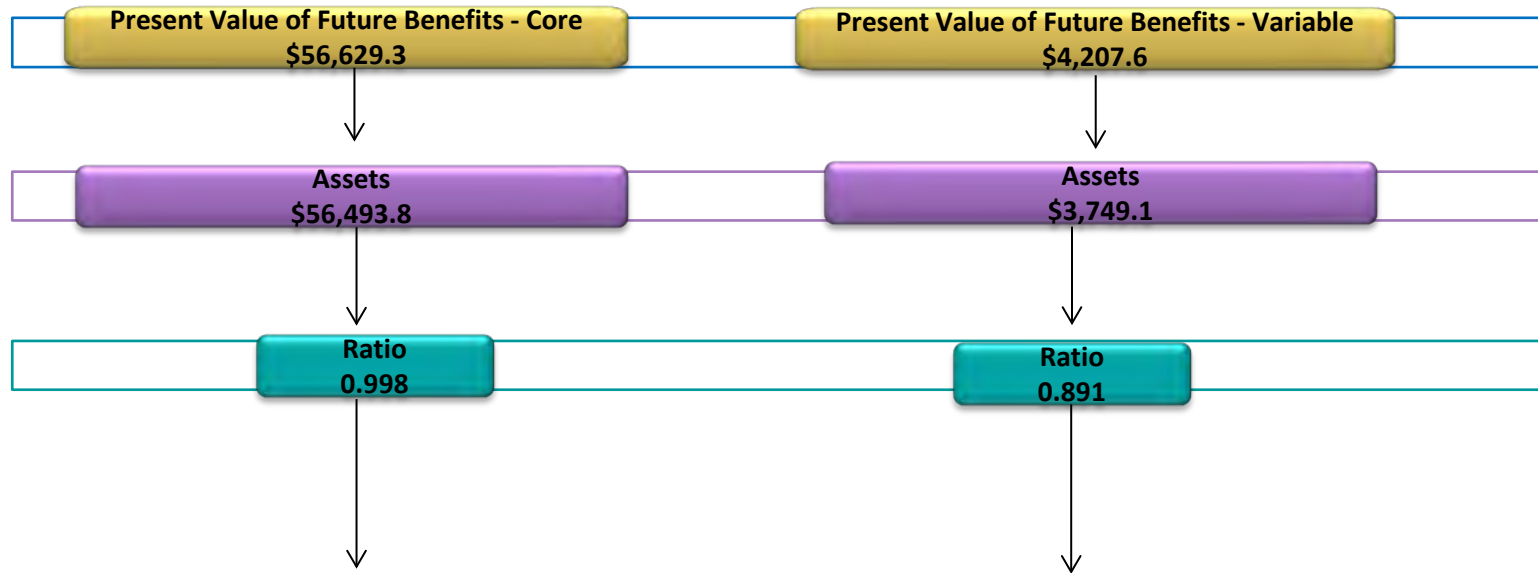
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- Three rate Groups: General/Executive, Protective with and without Social Security.
- Actuarial Valuation determines contributions by rate group
- General and Executive are now combined - participants split cost equally with employers
- Protective participants pay the same rate as General participants and employers pay the difference

# Actuarial Valuation Process – 2018 Active Lives Valuation Illustration for General/Elected Group (\$ Millions)



## Actuarial Valuation Process – 2018 Retired Lives Valuation Illustration (\$ Millions)



Core effective earnings rate = 5.0% → dividend adjustment = 0.0%.  
Variable effective earnings rate = -7.0% → variable adjustment = -10.0%.

# WRS Comparative Statement of Total Average Contribution Rates

<b>Valuation 12/31</b>	<b>General</b>	<b>Executive &amp; Elected</b>	<b>Protective with Soc. Sec.</b>	<b>Protective without Soc. Sec.</b>
1998	11.00%	14.70%	12.10%	17.70%
2003	10.50%	11.20%	13.00%	14.60%
2008	11.15%	11.95%	14.14%	15.46%
2013	13.60%	15.40%	16.30%	20.20%
2014	13.20%	15.60%	16.00%	20.00%
2015	13.67%	13.67%	17.50%	21.80%
2016	13.43%	13.43%	17.43%	21.65%
2017	13.12%	13.12%	17.10%	21.59%
2018	13.54%	13.54%	18.41%	23.02%

WRS Has Long History of Stable Contribution Rates

# WRS Contribution Rate Smoothing Mechanisms

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- Market Recognition Account (MRA) spreads asset experience over 5 years
- Plan Design – MRA Asset changes shared by Retirees, Employers and Employees
- Experience Amortization Reserve (EAR) spreads gain/loss over 20 years
- Resulting dollars are spread over active member payroll of ~\$14 billion

# WRS Accounts and Reserves

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- **Retired Reserve:** Intended to hold exactly the right amount of money so that **IF**
  - each person **lives** exactly the right number of years,
  - **and** gets exactly the same benefit each year
  - **and** the reserve earns exactly 5% each year,
- **Then** the reserve will be exhausted the day the last person dies



# Dividend Reserve

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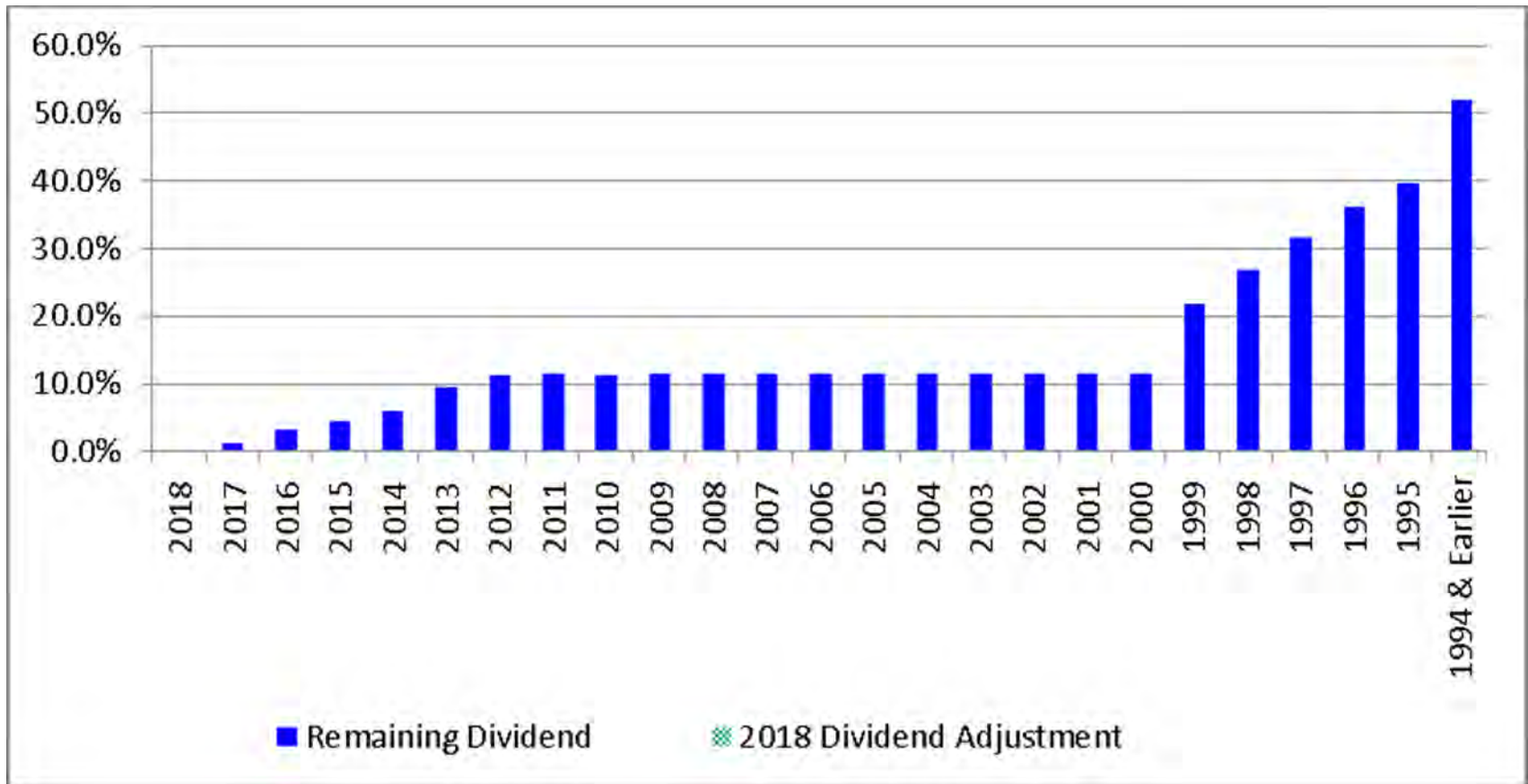
- Retirees share in investment gains, but also share in investment losses. Prior dividends can be reduced if less than 5% is credited to the Core Annuity Division.
- Only dividends can be reduced. The original core benefit is protected.
- The present value of the excess of total core benefits over original benefits is called the “Dividend Reserve”, although there is no formal definition of such a reserve.

# Dividend Reserve

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- A positive dividend reserve means that retirees are getting some inflation protection, but also provides a means by which the effect of investment losses on employer rates can be dampened
- A \$0 dividend reserve means that retirees have lost all inflation protection and one of the shock absorbers on employer rates is gone

# Dividend Remaining (as a Percentage of Total Benefit) by Year of Retirement



# Dividend Reserve Depletion

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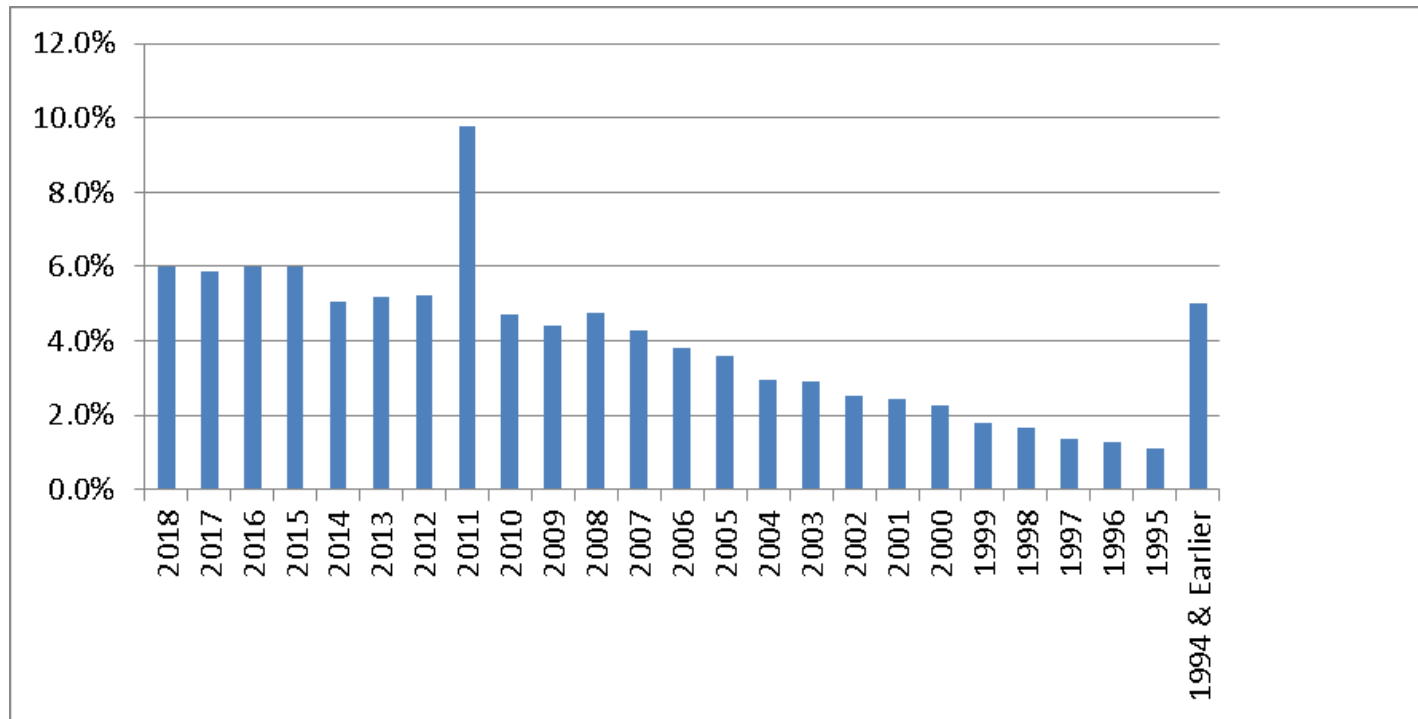
- The probability of such an event is low. Even 2008 did not produce depletion.
- In a low and volatile return market environment, realizing a return low enough to deplete the dividend reserve is more likely.
- The following slides explore in general terms what a deficit in the retiree reserve means for the System.

# Liability Attributable to Dividends

<u>Valuation</u>	<u>Liability for Dividend Remaining (billions)</u>	<u>Liability for Dividend Adjustment (billions)</u>
12/31/2012	\$4.5	\$(1.3)
12/31/2013	3.0	2.0
12/31/2014	4.6	1.3
12/31/2015	5.5	0.2
12/31/2016	5.4	1.0
12/31/2017	6.1	1.3
12/31/2018	6.9	0.0
12/31/2019 (est)	6.5	

- Liability for dividend remaining represents the value of all previously granted dividends (= \$9.2B at 12/31/2008)
- If a market event similar to 2008 were to occur, the complete depletion of the dividend could occur
- Statutes do not define what would happen in such a case

# Retiree Liabilities (as a Percentage of Total) by Year of Retirement



(December 31, 2018 Retired  
Lives Report- Page 7)

# INFLATION PROTECTION

# Dividend Process

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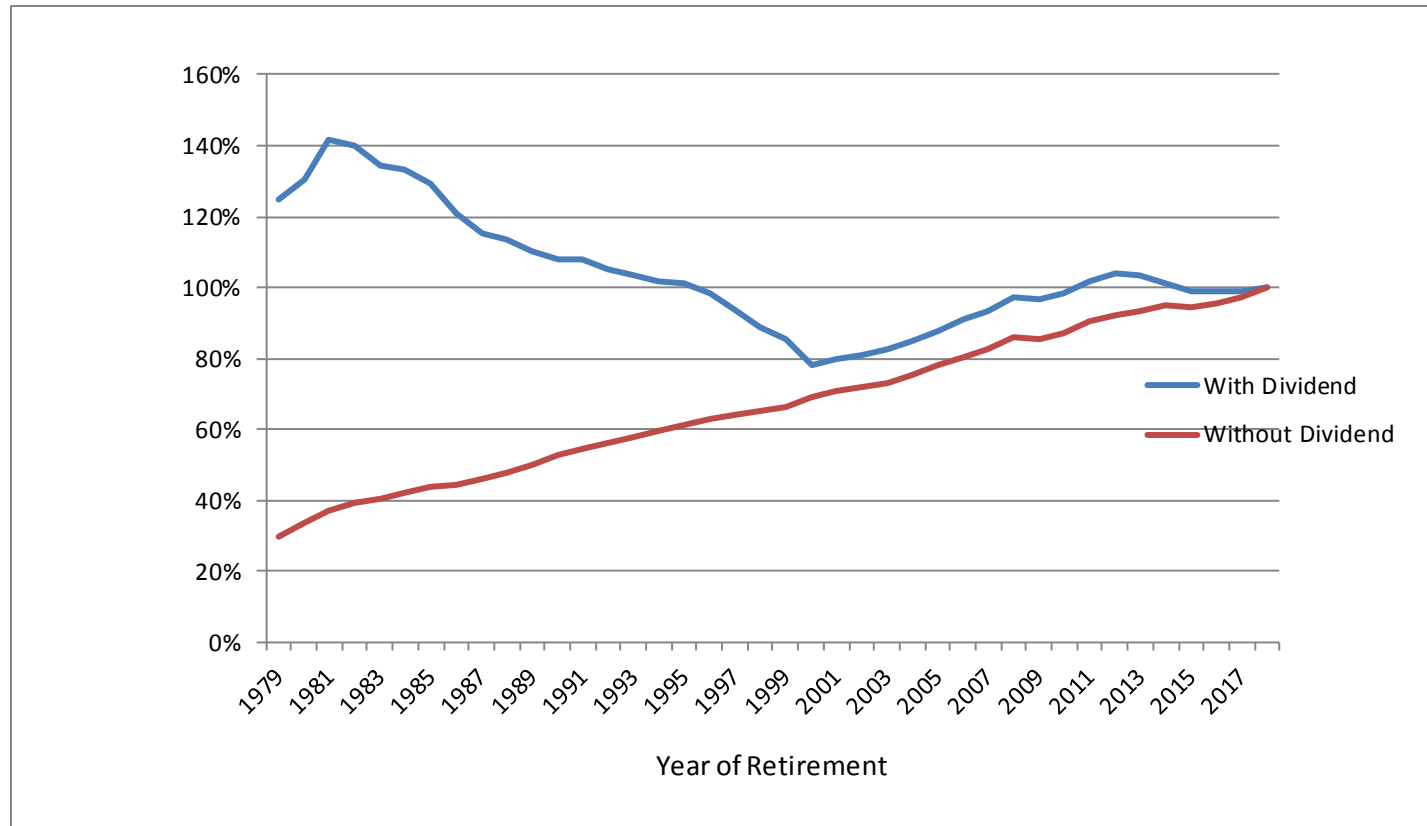
- 5% Benchmark
- 7% Return assumption
- Implies 1.9% Expected dividends
- Actual past dividends have varied greatly over time
- Inflation has also varied greatly over time



# INFLATION VS. DIVIDENDS

– A Backward Look

# Purchasing Power of Core Benefits by Year of Retirement as a % of Original Purchasing Power



Based on CPI-W

# Comments

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- People who retired in the early years of the chart benefited from the high investment return of the 1980's and early 1990's
- People who retired from the mid 1990's to about 2007 have lost ground to inflation.
- People who retired since then have mostly been made whole for inflation.
- WHY??

# WHY ???

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- Dividends can be positive or negative. By statute, the operation of a negative dividend cannot reduce a retiree's benefit below the original amount at retirement.
- Positive dividends affect everyone equally percentage-wise.
- Negative dividends also affect everyone equally percentage-wise *except for people whose benefits are at or close to the original amount*
- So when there is an extended period of negative dividends, people who have been retired a long time are likely to lose more percentage-wise than recent retirees, because they have more dividends to lose.

# The Backstory

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- The statute does not protect the original purchasing power at retirement – it protects the original benefit at retirement.
- After the 2013 negative dividend, everyone who retired after 1999 had either lost all of their prior dividends (and any inflation protection that the dividend process provided) or had never received any.
- But when positive dividends resumed in 2014, everyone got the same percentage dividend. So purchasing power that was lost to negative dividends was not restored uniformly.
- Since 2013, dividends have averaged about 2.1% while inflation has averaged about 1.5%. This Gap allowed post 2007 retirees to mostly catch up to inflation.

# Act 11 of 1999

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- Eliminated TAA and Created MRA effectively changing asset smoothing period from about 14 years to 5 years.
- \$4 Billion of prior gains released all at once.
- 9.6% “special” dividend granted in 2000 (17.1% total)
- 10.6% extra credit to employee accounts (24.1% total)
- Many other changes

# Some Effects of Act 11

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- People who retired before 2000 were benefited directly by the extra dividend, but it was taken away by the negative dividends that occurred later.
- People who retired in 2000 and shortly after were benefited indirectly by the effect of the extra interest credit on their money purchase benefits. That effect was protected from the negative dividends that occurred later.
- The change to the smoothing period increased the potential volatility of WRS dividends and employer contributions.

# INFLATION VS. DIVIDENDS

– A forward look



# Experience Study

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- Experience during 2015-2017
- Forward looking forecasts from 12 Investment Consultants
- Inflation assumption of 2.5%
- Average Expected return of 7.27%
- Standard Deviation of 13.14%

# Investment Return (Arithmetic Expectation)

Investment Consultant	Investment Consultant Expected Nominal Return	Investment Consultant Inflation Assumption	Expected Real Return (2)–(3)	Actuary Inflation Assumption	Expected Nominal Return (4)+(5)	Plan Incurred Administrative Expenses	Expected Nominal Return Net of Expenses (6)-(7)	Standard Deviation of Expected Return (1-Year)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	6.03%	2.20%	3.83%	2.50%	6.33%	0.05%	6.28%	12.96%
2	6.55%	2.26%	4.29%	2.50%	6.79%	0.05%	6.74%	11.21%
3	6.86%	2.50%	4.36%	2.50%	6.86%	0.05%	6.81%	13.62%
4	6.48%	2.00%	4.48%	2.50%	6.98%	0.05%	6.93%	11.07%
5	6.77%	2.21%	4.55%	2.50%	7.05%	0.05%	7.00%	14.31%
6	7.14%	2.50%	4.64%	2.50%	7.14%	0.05%	7.09%	13.74%
7	6.70%	2.00%	4.70%	2.50%	7.20%	0.05%	7.15%	12.80%
8	7.15%	2.26%	4.89%	2.50%	7.39%	0.05%	7.34%	14.58%
9	7.37%	2.31%	5.07%	2.50%	7.57%	0.05%	7.52%	12.74%
10	7.10%	1.95%	5.15%	2.50%	7.65%	0.05%	7.60%	12.96%
11	7.83%	2.25%	5.58%	2.50%	8.08%	0.05%	8.03%	16.51%
12	8.28%	2.00%	6.28%	2.50%	8.78%	0.05%	8.73%	11.20%
<b>Average</b>	<b>7.02%</b>	<b>2.20%</b>	<b>4.82%</b>	<b>2.50%</b>	<b>7.32%</b>	<b>0.05%</b>	<b>7.27%</b>	<b>13.14%</b>

# Forward Looking Inflation Forecasts

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<b>Congressional Budget Office</b>	
5-Year Annual Average	2.46%
10-Year Annual Average	2.38%
<b>Federal Reserve Bank of Philadelphia</b>	
5-Year Annual Average	2.25%
10-Year Annual Average	2.21%
<b>Federal Reserve Bank of Cleveland</b>	
10-Year Expectation	1.97%
20-Year Expectation	2.13%
30-Year Expectation	2.25%

<b>Federal Reserve Bank of St. Louis</b>	
10-Year Breakeven Inflation	1.71%
20-Year Breakeven Inflation	1.82%
30-Year Breakeven Inflation	1.85%
<b>U.S. Department of the Treasury</b>	
10-Year Breakeven Inflation	1.77%
20-Year Breakeven Inflation	1.78%
30-Year Breakeven Inflation	1.95%
50-Year Breakeven Inflation	1.98%
100-Year Breakeven Inflation	2.01%

In addition to the above the Social Security Ultimate Intermediate Assumption is 2.6% and the average expectation of the 12 investment consultants we currently monitor is 2.18%

# Comments on Inflation

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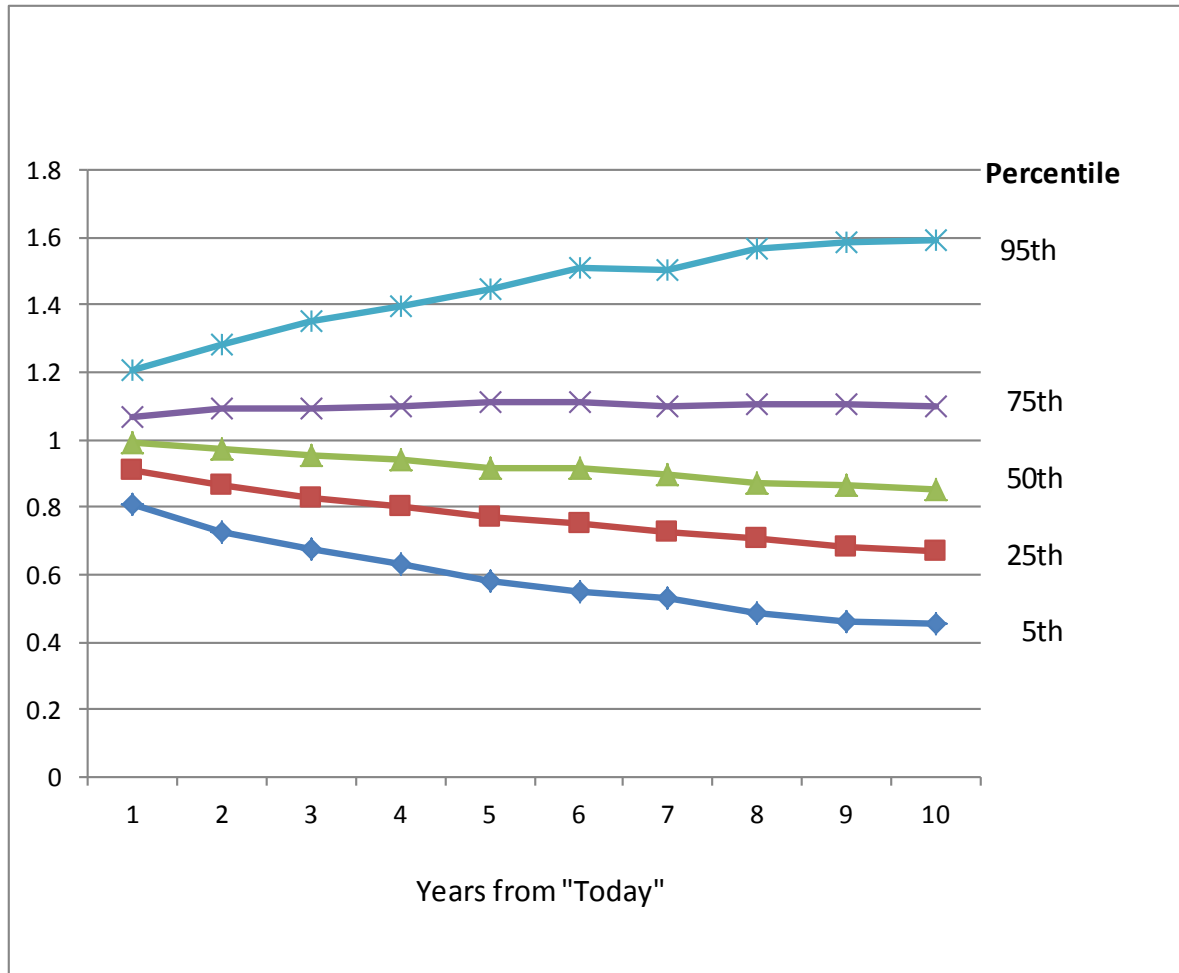
- Projections range from 1.7% to 2.6% with only the Social Security Intermediate assumption providing support for 2.6%
- The 10 and 20 year ranges are narrower than that
- The actuarial valuation is currently based on an inflation assumption of 2.5%, giving weight to the longer term forecasts
- For purposes of investigation of potential future inflation protection in the WRS, this study focuses on the ten year expectations, which are for the most part close to 2.2%
- Use of 2.2% as an inflation assumption would imply a near term expectation for investment return of 6.97% rather than the 7.27% shown previously

# Forward Looking Inflation Protection

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- The next chart is based on a stochastic simulation of investment return. It assumes a constant level of inflation at 2.2%, 6.97% Investment return with standard deviation of 13.14%
- It projects the probability of preserving today's purchasing power for the next 10 years.

# Can Dividend Process Preserve Today's Purchasing Power?



# Comments

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- At the 50% percentile of results, retirees are expected to lose purchasing power over the next ten years
- Returns at about the 60<sup>th</sup> percentile would be required in order to preserve today's purchasing power
- Preservation of purchasing power is a desirable outcome, but not a specific objective of the dividend process

# WRS STRESS TESTING

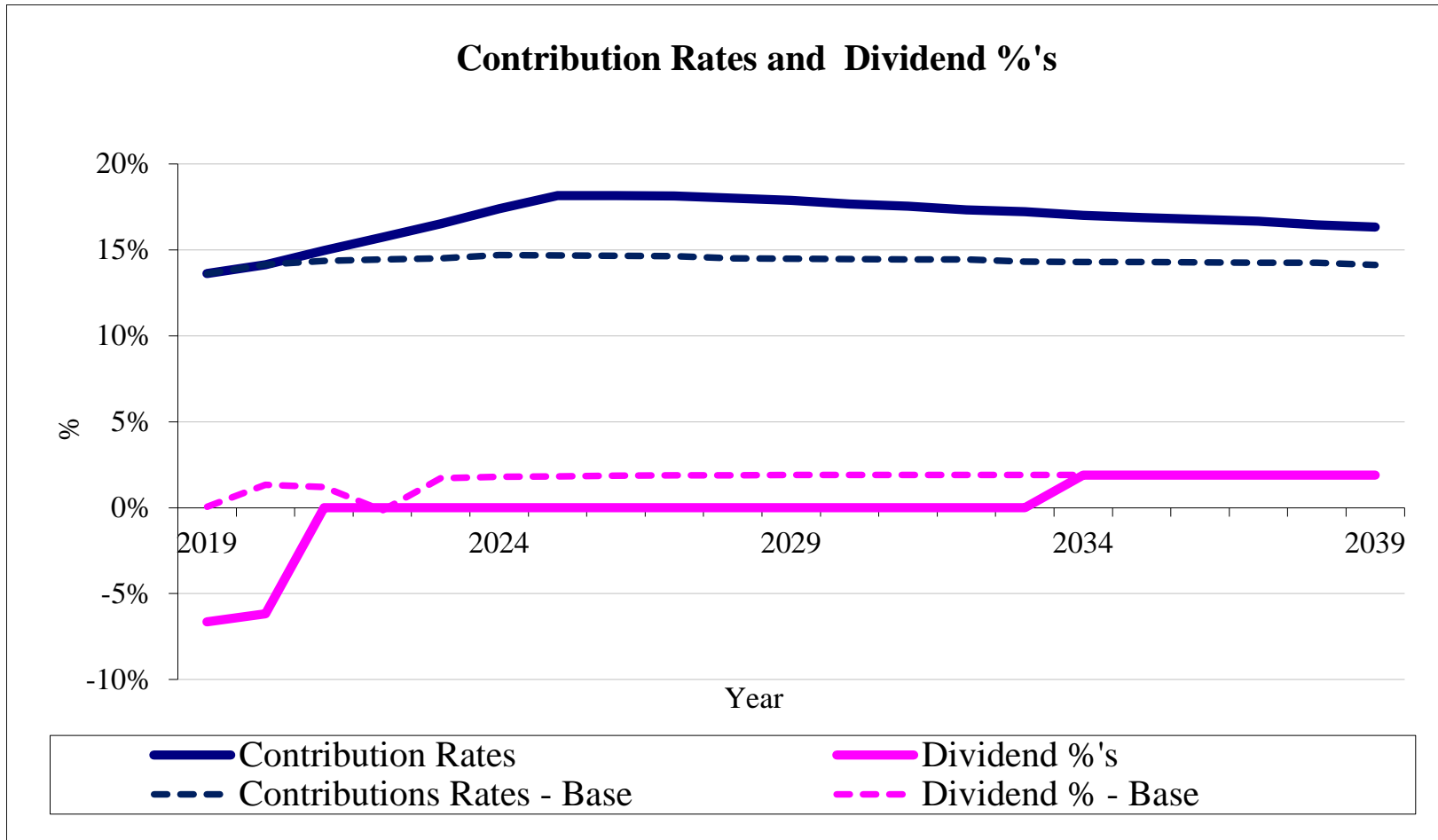


# Stress Testing

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- Stress test provides insight into how the System would respond to severely unfavorable markets
- For the WRS, it can answer questions like:
  - What would it take to deplete the dividend reserve?
  - How would contribution rates be impacted?
- Deterministic stress tests studied:
  - Negative 30% return in year 1, followed by assumed return of 7% thereafter
  - Negative 10% return in year 1, followed by assumed return of 7% thereafter

# Stress Test 1 – Negative 30% Return in 2019 Followed by 7.0% Thereafter

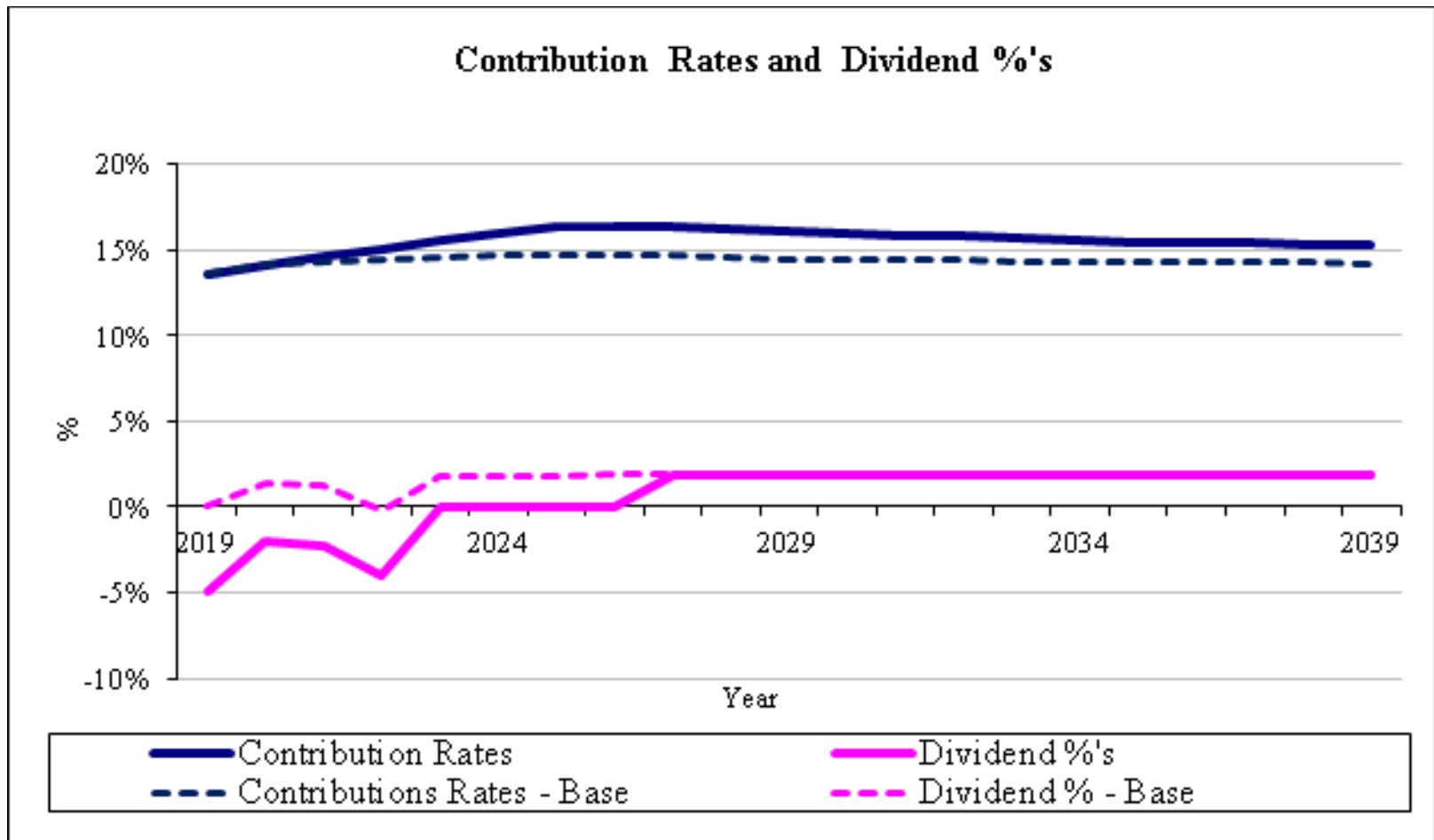


# Stress Test 1 – Negative 30% Return in 2019 Followed by 7.0% Thereafter

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- Dividend Reserve is depleted by 2020
- Retiree Liability becomes underfunded
- There will be series of negative dividends, until most people are at the floor, followed by an extended period of no dividends
- Dividends could resume in 2033
- Contribution Rate gradually increases by about 3.5% of payroll in year 5 and beyond

# Stress Test 2 – Negative 10% Return in 2019 Followed by 7.0% Thereafter



## Stress Test 2 – Negative 10% Return in 2019 Followed by 7.0% Thereafter

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- Dividend Reserve is depleted by 2022
- Retiree Liability becomes underfunded
- There will be series of negative dividends, until most people are at the floor, followed by a short period of no dividends
- Dividends could resume in 2026
- Contribution Rate gradually increases by about 1.7% of payroll in year 5 and beyond

# Stress Test Observations

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- Contribution rates are generally more stable than dividend rates
- Asset losses are shared between:
  - Retirees (roughly 60%)
  - Employers (roughly 20%)
  - Employees (roughly 20%)
  - These ratios evolve and change over time based on demographic and market conditions

Contribution rates not impacted by Retired Lives Valuation Results

# Stress Test Observations

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- Contribution rate also smoothed via operation of Experience Amortization Reserve (EAR)
- Example: \$10 billion asset loss (-5% return)
  - MRA recognizes 20% in year 1 - \$2 billion
  - 20% flows through to the EAR = \$400 million
  - EAR loss is amortized over 20 years = \$29 million
  - This is spread over active payroll (approx. \$14 billion)
  - Result is 0.2% of payroll increase in year 1
  - Accumulates to 1% of payroll by year 5 and spread over a rolling 20 years

# STRESS TESTING WRS THROUGH STOCHASTIC PROJECTIONS



# Monte Carlo Simulations

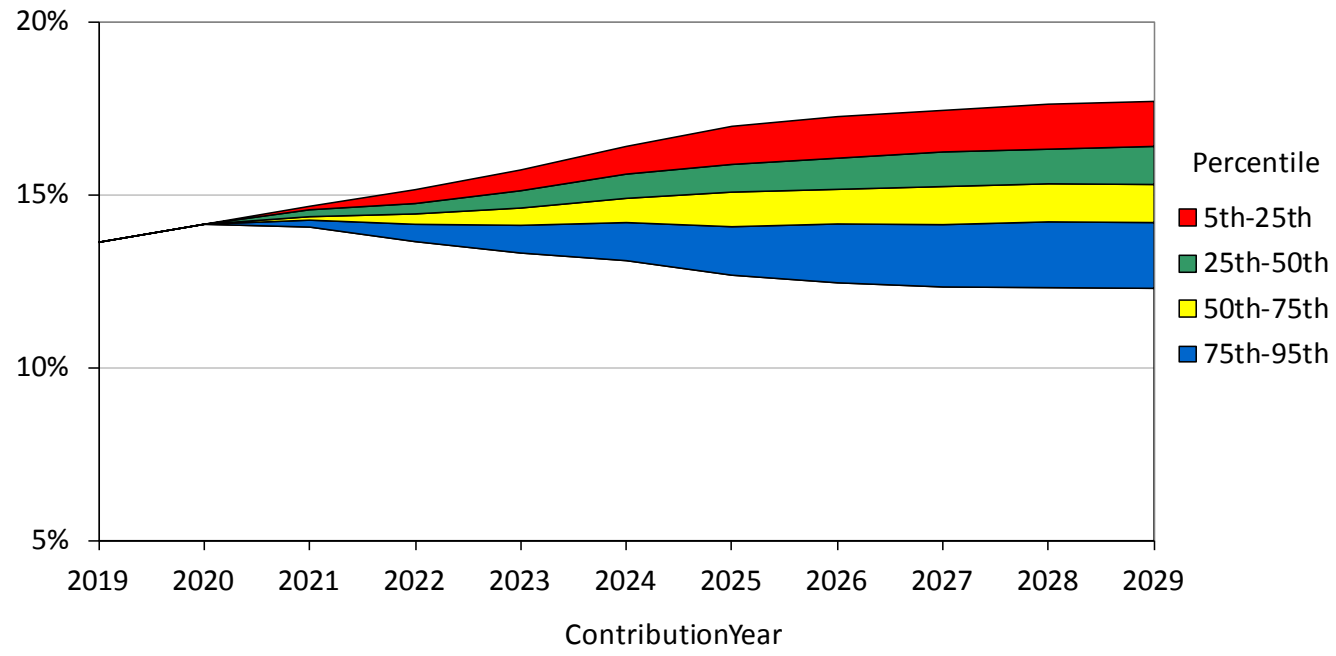
- Based on 10,000 random trials
- Valuation Assumptions held constant
- Assumes seven sets of expected return/standard deviations (provided by NEPC)

	Expected Return		Standard Deviation
	Geometric	Arithmetic	
<b>Scenario 1</b>	4.0%	4.1%	4.3%
<b>Scenario 2</b>	5.0%	5.2%	7.4%
<b>Scenario 3</b>	6.0%	6.4%	10.7%
<b>Scenario 4</b>	7.0%	7.8%	14.7%
<b>Scenario 5</b>	8.0%	9.3%	19.0%
<b>Scenario 6</b>	9.0%	11.1%	24.1%
<b>Scenario 7</b>	10.0%	13.1%	29.9%

Actuarial Rate →

# Contribution as a % of Payroll

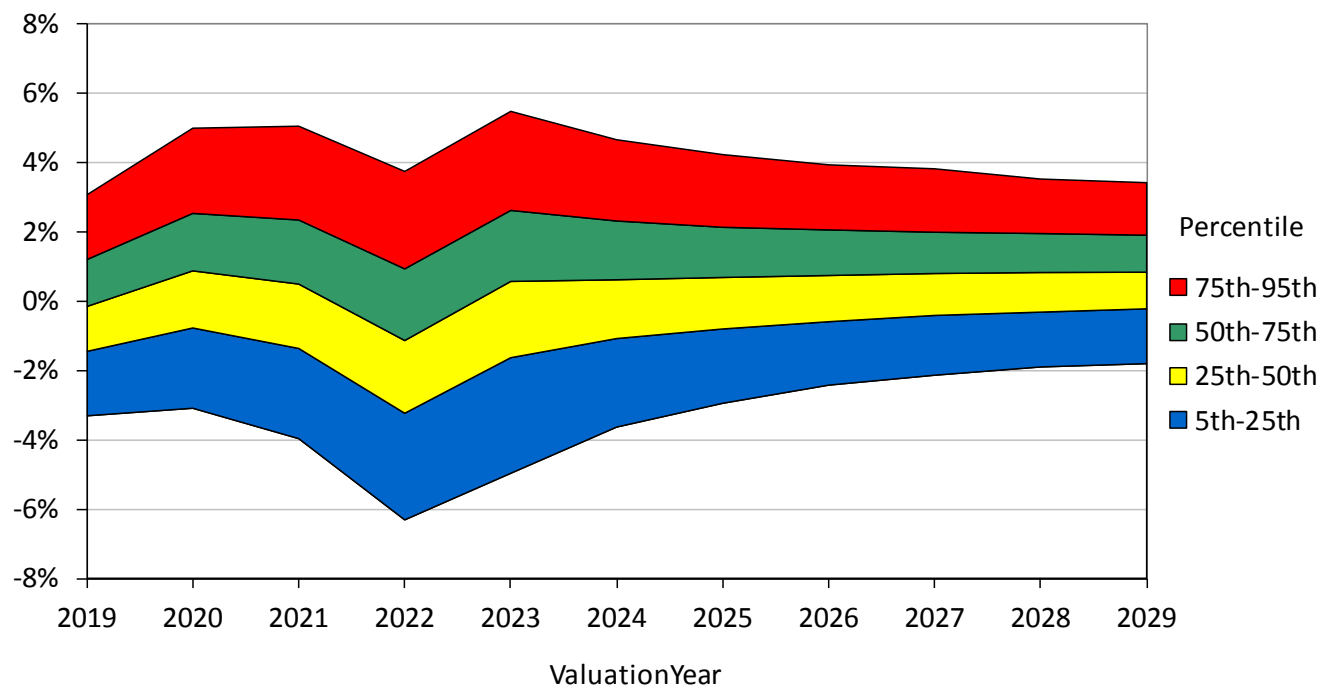
## Scenario 3 – 6.0%Return, 10.7%Volatility



	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
<b>5th Percentile</b>	13.6%	14.1%	14.7%	15.1%	15.7%	16.4%	17.0%	17.3%	17.4%	17.6%	17.7%
<b>25th Percentile</b>	13.6%	14.1%	14.6%	14.7%	15.1%	15.6%	15.9%	16.1%	16.2%	16.3%	16.4%
<b>Median</b>	13.6%	14.1%	14.4%	14.4%	14.6%	14.9%	15.1%	15.2%	15.2%	15.3%	15.3%
<b>75th Percentile</b>	13.6%	14.1%	14.3%	14.1%	14.1%	14.2%	14.1%	14.2%	14.1%	14.2%	14.2%
<b>95th Percentile</b>	13.6%	14.1%	14.1%	13.6%	13.3%	13.1%	12.7%	12.5%	12.3%	12.3%	12.3%

# Dividend Rates

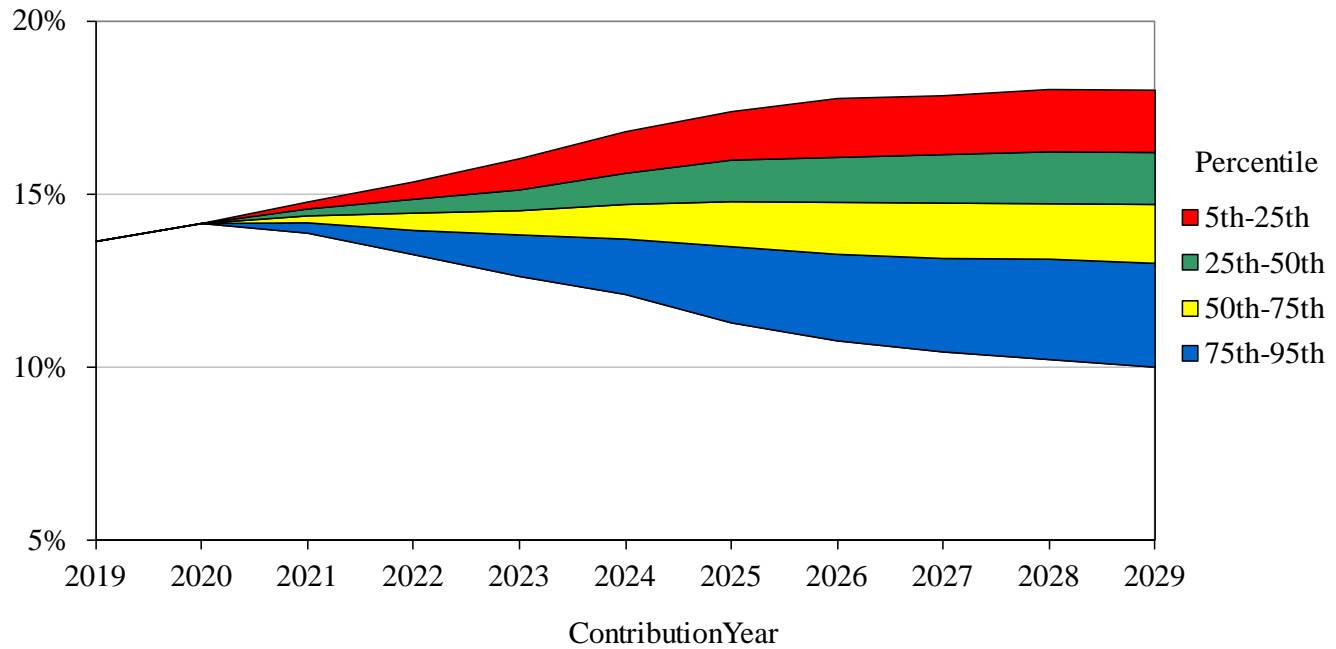
## Scenario 3 – 6.0%Return, 10.7%Volatility



<b>5th Percentile</b>	-3.3%	-3.1%	-4.0%	-6.3%	-5.0%	-3.6%	-3.0%	-2.4%	-2.1%	-1.9%	-1.8%
<b>25th Percentile</b>	-1.5%	-0.8%	-1.4%	-3.2%	-1.6%	-1.1%	-0.8%	-0.6%	-0.4%	-0.3%	-0.2%
<b>Median</b>	-0.2%	0.9%	0.5%	-1.1%	0.6%	0.6%	0.7%	0.7%	0.8%	0.8%	0.8%
<b>75th Percentile</b>	1.2%	2.5%	2.3%	0.9%	2.6%	2.3%	2.1%	2.0%	2.0%	1.9%	1.9%
<b>95th Percentile</b>	3.1%	5.0%	5.0%	3.7%	5.5%	4.6%	4.2%	3.9%	3.8%	3.5%	3.4%

# Contribution as a % of Payroll

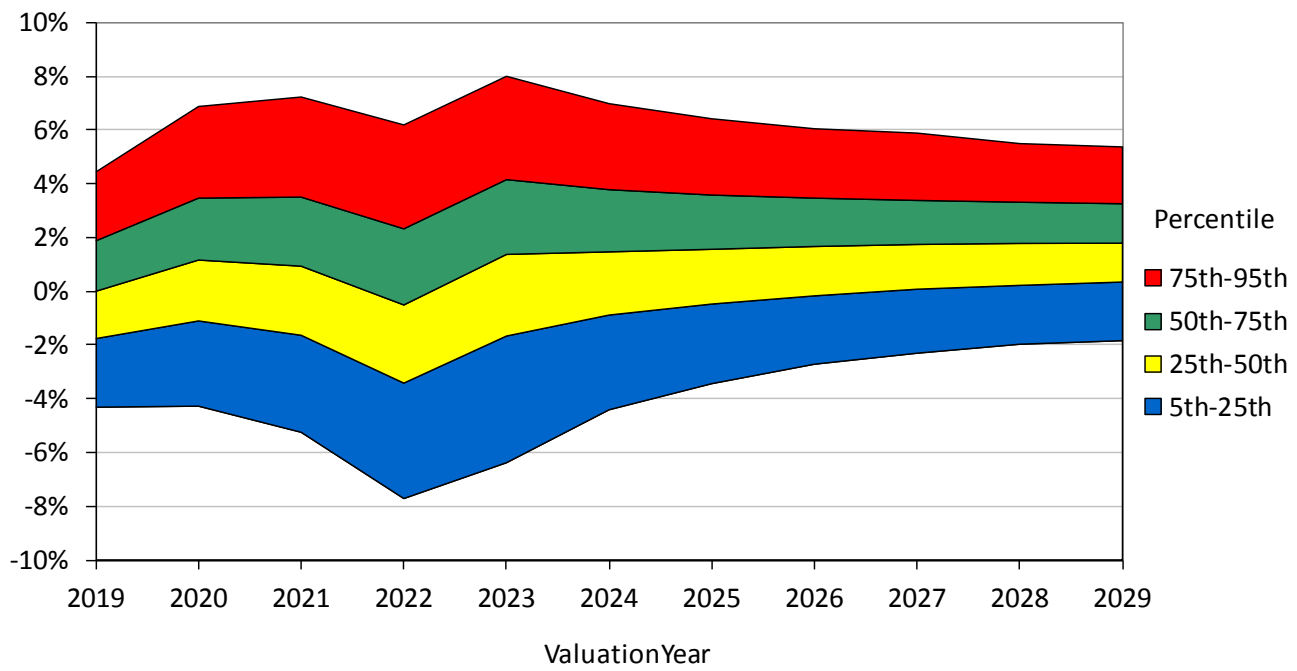
## Scenario 4 – 7.0%Return, 14.7%Volatility



	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
<b>5th Percentile</b>	13.6%	14.1%	14.8%	15.3%	16.0%	16.8%	17.4%	17.8%	17.8%	18.0%	18.0%
<b>25th Percentile</b>	13.6%	14.1%	14.6%	14.8%	15.1%	15.6%	16.0%	16.1%	16.1%	16.2%	16.2%
<b>Median</b>	13.6%	14.1%	14.4%	14.4%	14.5%	14.7%	14.8%	14.8%	14.7%	14.7%	14.7%
<b>75th Percentile</b>	13.6%	14.1%	14.2%	13.9%	13.8%	13.7%	13.5%	13.3%	13.1%	13.1%	13.0%
<b>95th Percentile</b>	13.6%	14.1%	13.9%	13.2%	12.6%	12.1%	11.3%	10.8%	10.4%	10.2%	10.0%

# Dividend Rates

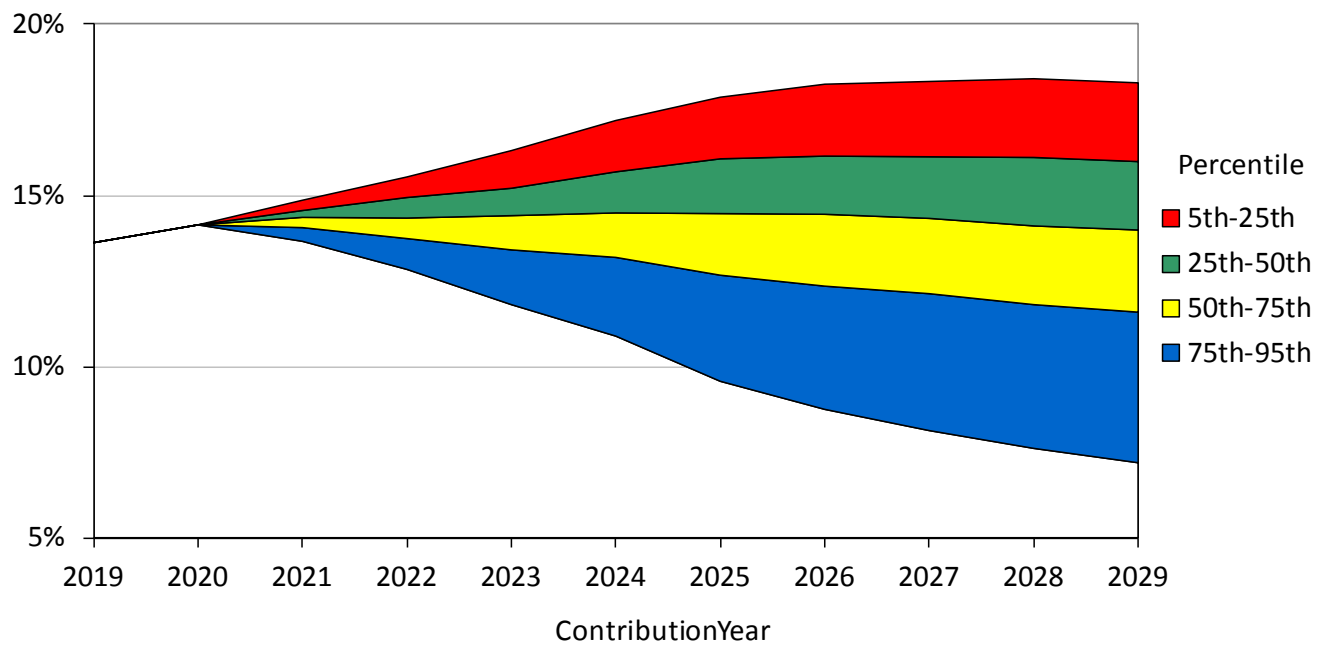
## Scenario 4 – 7.0%Return, 14.7%Volatility



	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
<b>5th Percentile</b>	-4.3%	-4.3%	-5.2%	-7.7%	-6.4%	-4.4%	-3.4%	-2.7%	-2.3%	-2.0%	-1.8%
<b>25th Percentile</b>	-1.8%	-1.1%	-1.6%	-3.4%	-1.7%	-0.9%	-0.5%	-0.2%	0.1%	0.2%	0.3%
<b>Median</b>	0.0%	1.2%	0.9%	-0.5%	1.4%	1.5%	1.6%	1.7%	1.7%	1.8%	1.8%
<b>75th Percentile</b>	1.9%	3.5%	3.5%	2.3%	4.2%	3.8%	3.6%	3.5%	3.4%	3.3%	3.3%
<b>95th Percentile</b>	4.4%	6.9%	7.2%	6.2%	8.0%	7.0%	6.4%	6.0%	5.9%	5.5%	5.4%

# Contribution as a % of Payroll

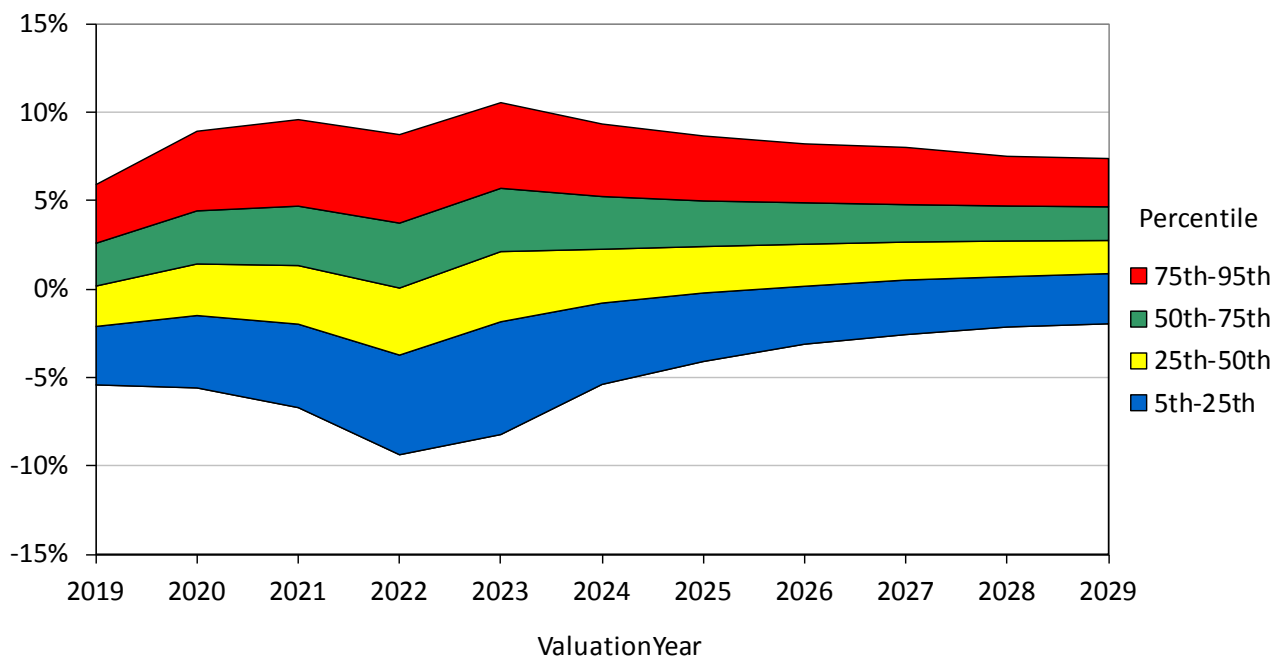
## Scenario 5 – 8.0%Return, 19.0%Volatility



<b>5th Percentile</b>	13.6%	14.1%	14.9%	15.5%	16.3%	17.2%	17.9%	18.3%	18.3%	18.4%	18.3%
<b>25th Percentile</b>	13.6%	14.1%	14.6%	14.9%	15.2%	15.7%	16.1%	16.2%	16.1%	16.1%	16.0%
<b>Median</b>	13.6%	14.1%	14.4%	14.3%	14.4%	14.5%	14.5%	14.5%	14.3%	14.1%	14.0%
<b>75th Percentile</b>	13.6%	14.1%	14.1%	13.7%	13.4%	13.2%	12.7%	12.4%	12.1%	11.8%	11.6%
<b>95th Percentile</b>	13.6%	14.1%	13.7%	12.8%	11.8%	10.9%	9.6%	8.8%	8.1%	7.6%	7.2%

# Dividend Rates

## Scenario 5 – 8.0%Return, 19.0%Volatility



<b>5th Percentile</b>	-5.4%	-5.6%	-6.7%	-9.4%	-8.2%	-5.4%	-4.1%	-3.1%	-2.6%	-2.1%	-2.0%
<b>25th Percentile</b>	-2.1%	-1.5%	-2.0%	-3.7%	-1.8%	-0.8%	-0.2%	0.2%	0.5%	0.7%	0.9%
<b>Median</b>	0.2%	1.4%	1.3%	0.1%	2.1%	2.3%	2.4%	2.5%	2.7%	2.7%	2.8%
<b>75th Percentile</b>	2.6%	4.4%	4.7%	3.7%	5.7%	5.2%	5.0%	4.9%	4.8%	4.7%	4.7%
<b>95th Percentile</b>	5.9%	8.9%	9.6%	8.7%	10.6%	9.3%	8.7%	8.2%	8.0%	7.5%	7.4%

# Dividend Stress Test

## Probability That Dividend Reserve Will Be Depleted in Year

	Expected ROR	Standard Deviation	Year				
			1	5	10	20	50
1	4.0%	4.3%	0.0%	6.4%	39.0%	87.7%	100%
2	5.0%	7.4%	0.0%	12.0%	22.1%	29.2%	41.5%
3	6.0%	10.7%	0.0%	15.6%	17.4%	11.7%	3.8%
4	7.0%	14.7%	0.0%	19.2%	16.9%	7.7%	0.8%
5	8.0%	19.0%	0.0%	21.8%	17.6%	6.7%	0.3%
6	9.0%	24.1%	0.2%	24.7%	19.2%	7.3%	0.3%
7	10.0%	29.9%	0.8%	27.5%	21.7%	8.7%	0.5%

Actuarial Rate →



# Number of Paths Leading to Dividend Depletion (10,000 Scenarios)

	Expected ROR	Standard Deviation	Year				
			1	5	10	20	50
1	4.0%	4.3%	0	639	3901	8780	9999
2	5.0%	7.4%	0	1202	2377	3549	5496
3	6.0%	10.7%	0	1562	2203	2454	2657
4	7.0%	14.7%	0	1929	2376	2490	2522
5	8.0%	19.0%	2	2196	2585	2665	2676
6	9.0%	24.1%	15	2504	2892	2969	2976
7	10.0%	29.9%	84	2806	3241	3313	3320

Actuarial Rate →

# Dividend Stress Test

## Worst Case Scenario of Retiree Funded Status (% of Floor Benefit That Is Funded)

Actuarial  
Rate  
→

	Expected ROR	Standard Deviation	Year				
			1	5	10	20	50
1	4.0%	4.3%	111%	96%	87%	76%	51%
2	5.0%	7.4%	111%	96%	90%	86%	77%
3	6.0%	10.7%	109%	84%	78%	79%	86%
4	7.0%	14.7%	107%	76%	70%	77%	105%
5	8.0%	19.0%	105%	67%	61%	73%	124%
6	9.0%	24.1%	103%	57%	51%	64%	133%
7	10.0%	29.0%	100%	45%	39%	52%	130%

Worst Case Scenario based on 1<sup>st</sup> Percentile (i.e., 1% probability)

# Dividend Stress Test Observations

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- The low risk scenarios are actually risky in the sense that, for example, 4% and 5% expected return has a much higher chance of dividend depletion in later years than higher risk scenarios
- Must balance short and long term volatility
- Consider probability of dividend depletion
- Consider level of worst case scenario that is acceptable

# Combination of All Scenarios

2029 Results by %-tile of Investment Return Outcomes

	ROR	StdDev	Contribution Rates			Dividend Rates			Retiree FS/Year occurred
			95th	50th	5th	95th	50th	5th	5th Percentile
1	4.0%	4.3%	15.6%	16.6%	17.5%	-0.1%	-1.1%	-2.2%	55% in year 50
2	5.0%	7.4%	14.1%	16.0%	17.6%	1.6%	-0.2%	-2.0%	77% in year 50
Actuarial Rate → 3	6.0%	10.7%	12.3%	15.3%	17.7%	3.4%	0.8%	-1.8%	88% in year 8
4	7.0%	14.7%	10.0%	14.7%	18.0%	5.4%	1.8%	-1.8%	84% in year 8
5	8.0%	19.0%	7.2%	14.0%	18.3%	7.4%	2.8%	-2.0%	77% in year 8
6	9.0%	24.1%	3.4%	13.3%	18.9%	9.6%	3.7%	-2.4%	69% in year 10
7	10.0%	29.9%	-1.5%	12.7%	19.5%	11.9%	4.6%	-3.0%	59% in year 10

Lower assumed rates of return result in higher expected contributions and lower expected dividends

Higher assumed rates of return are associated with higher standard deviation (i.e., risk) and 5<sup>th</sup> percentile scenario for retiree dividend pool falling below 80%

Scenarios 3 and 4 represent potential 'Goldilocks Zone'

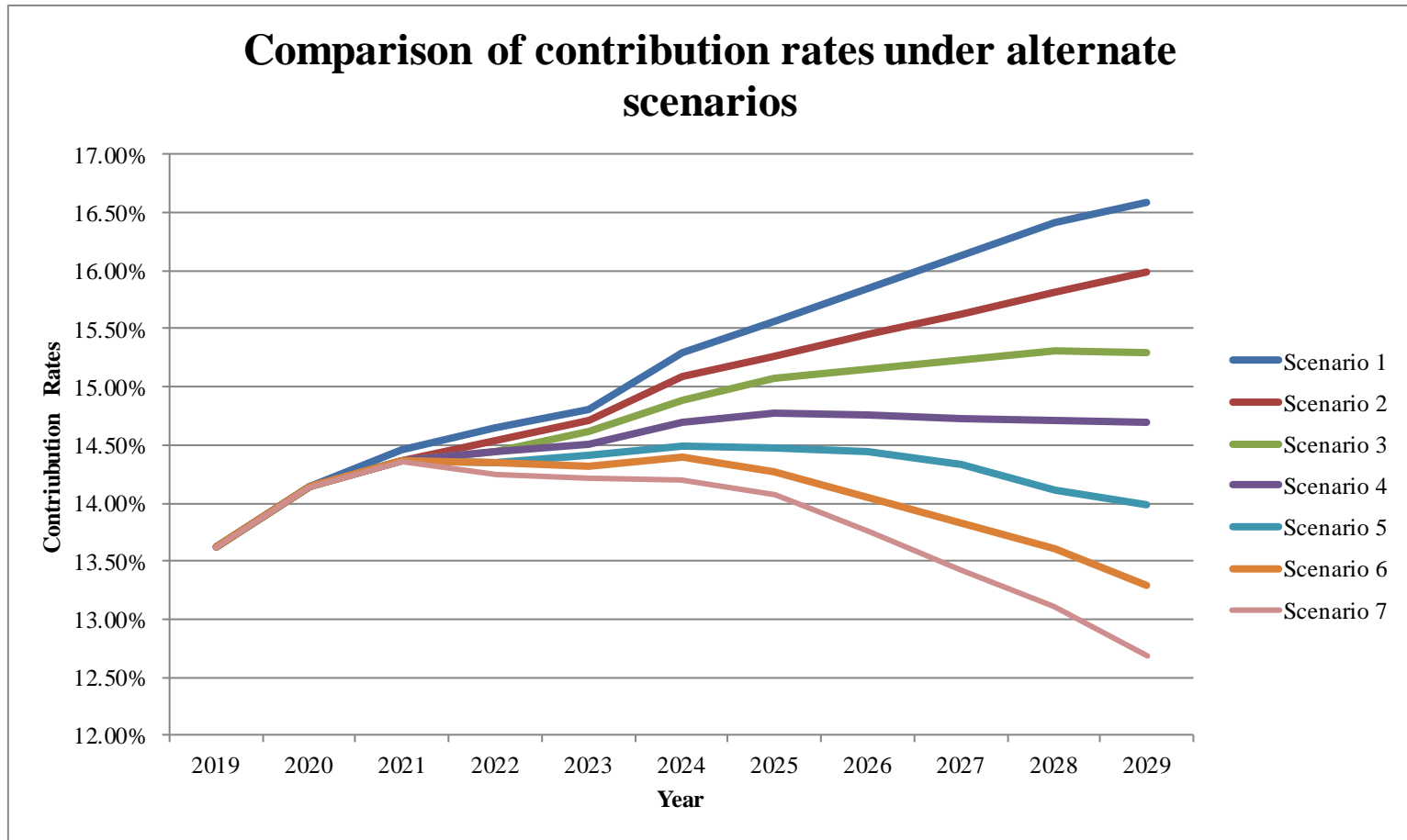
# 2019 Observations

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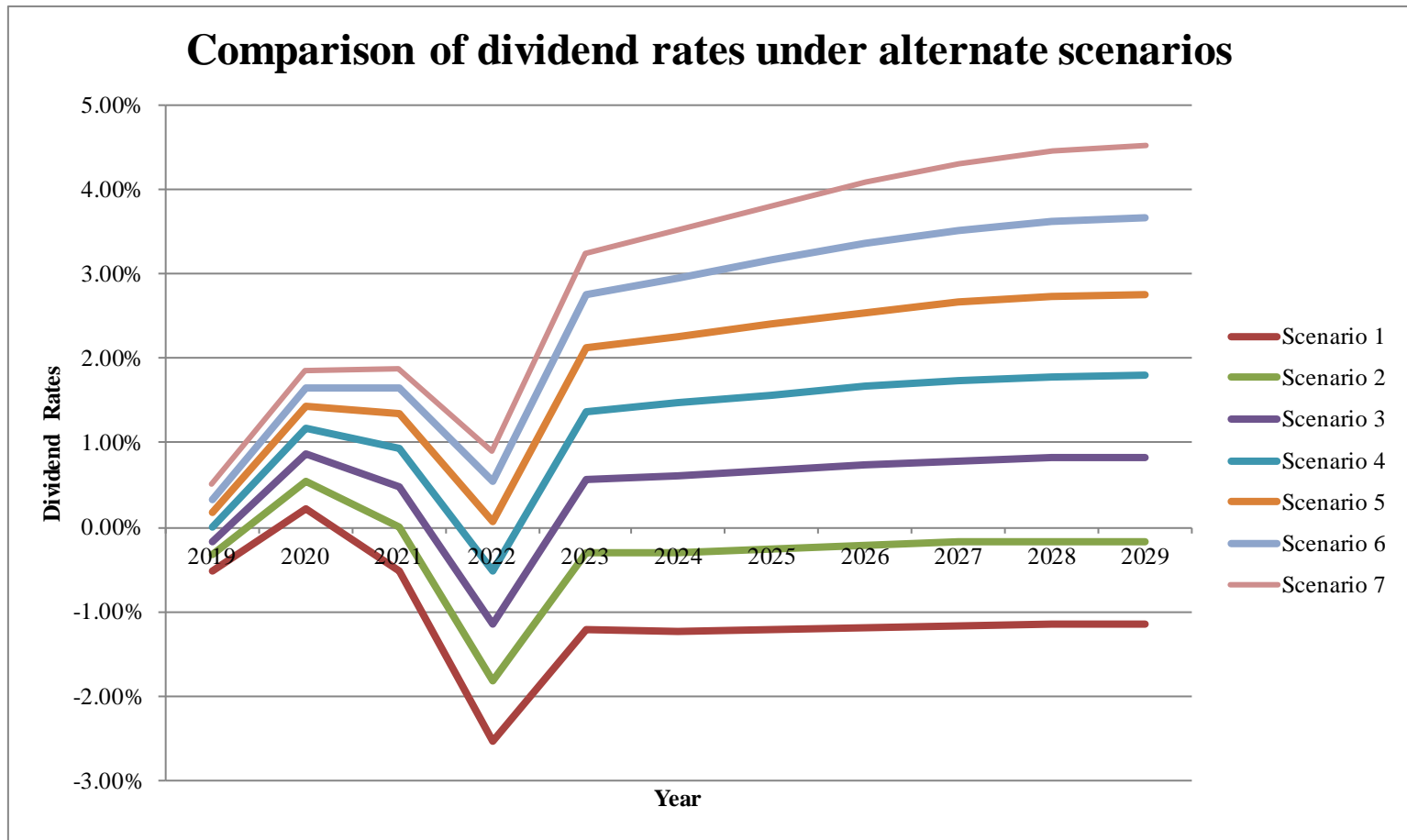
- Changes from 2017 Study
  - Compounded returns over 2017 and 2018 slightly lower than assumed rate of 7.2% (15.8% return for 2017 and -3.6% return for 2018 or 5.7% compounded over 2 years)
  - Mortality table update (slightly longer expected lifetimes)
  - Assumed investment return lowered from 7.2% to 7.0%
  - Slightly lower Standard Deviation than 2017 Study
- Overall results are similar to 2017 study
  - Slightly higher probability of depleting dividend reserve due to lower than expected returns
- Continue to target 'Goldilocks zone' that provides for positive return with appropriate downside protection

# APPENDIX

# Contribution Rate Summary under Alternate Scenarios – Median



# Dividend Rate Summary under Alternate Scenarios – Median





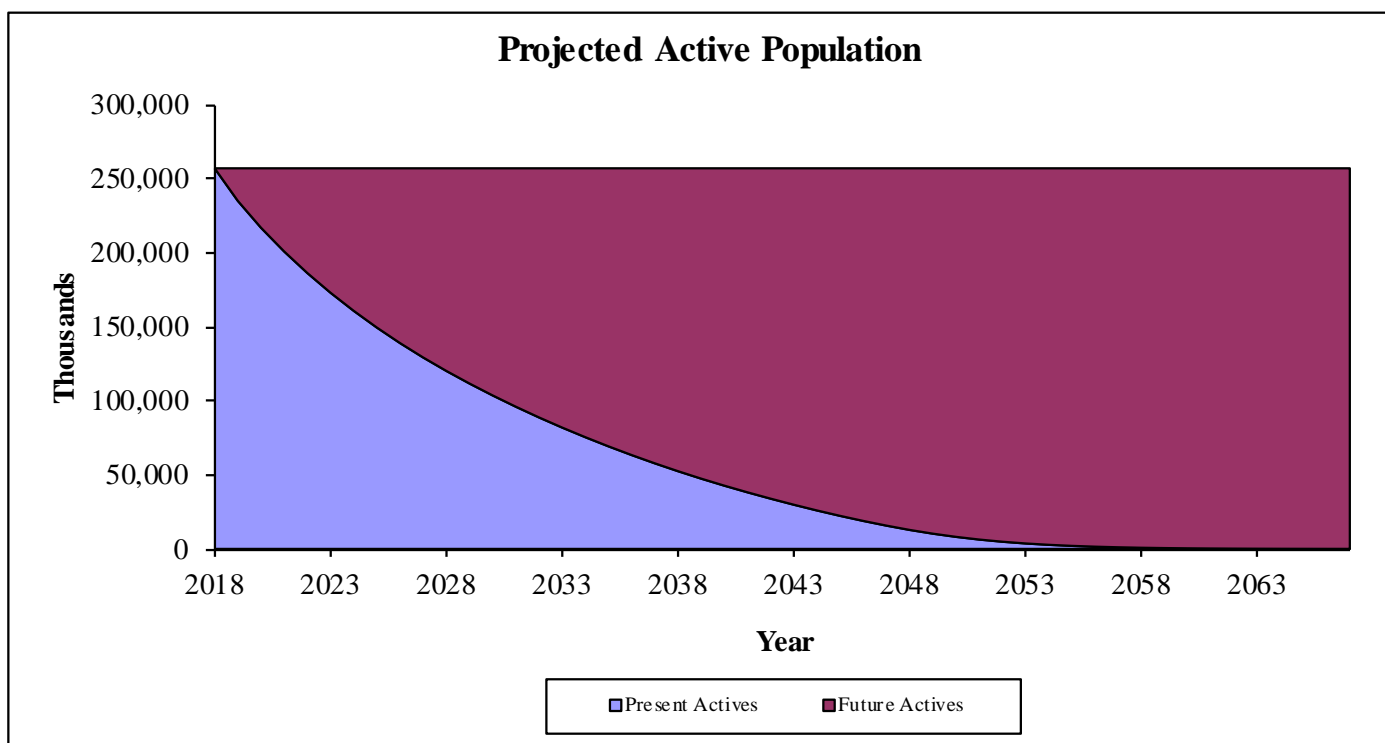
# Present & Future Actives

## Year by Year results

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Year	Present Actives	Future Actives	Year	Present Actives	Future Actives
2018	256,933	-	2043	29,827	227,106
2019	234,938	21,995	2044	25,946	230,987
2020	216,813	40,120	2045	22,293	234,640
2021	200,787	56,146	2046	18,876	238,057
2022	186,238	70,695	2047	15,708	241,225
2023	172,945	83,988	2048	12,812	244,121
2024	160,738	96,195	2049	10,287	246,646
2025	149,435	107,498	2050	8,130	248,803
2026	138,951	117,982	2051	6,321	250,612
2027	129,216	127,717	2052	4,847	252,086
2028	120,146	136,787	2053	3,677	253,256
2029	111,640	145,293	2054	2,763	254,170
2030	103,600	153,333	2055	2,054	254,879
2031	95,987	160,946	2056	1,505	255,428
2032	88,751	168,182	2057	1,090	255,843
2033	81,907	175,026	2058	783	256,150
2034	75,413	181,520	2059	558	256,375
2035	69,225	187,708	2060	393	256,540
2036	63,351	193,582	2061	276	256,657
2037	57,763	199,170	2062	193	256,740
2038	52,461	204,472	2063	134	256,799
2039	47,434	209,499	2064	93	256,840
2040	42,691	214,242	2065	63	256,870
2041	38,191	218,742	2066	42	256,891
2042	33,912	223,021	2067	27	256,906

# Present & Future Actives



The present population has a “half life” of about 10 years.

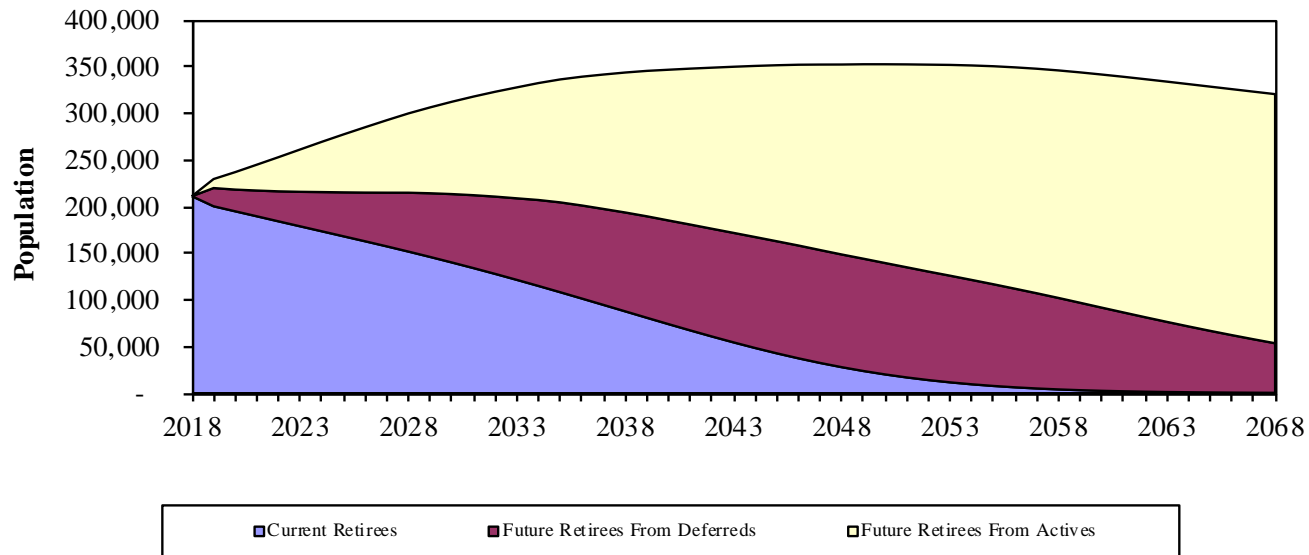
# Retiree Population – Present and Future

## Year by Year Results

Year	Present Retirees	Future From Deferred	Future From Active	Year	Present Retirees	Future From Deferred	Future From Active
2018	211,126	-	-	2043	54,474	117,354	178,023
2019	200,323	19,521	9,652	2044	48,436	118,922	183,391
2020	194,925	23,281	18,730	2045	42,716	120,117	188,635
2021	189,575	27,608	27,738	2046	37,363	120,899	193,759
2022	184,163	32,157	36,655	2047	32,403	121,001	198,777
2023	178,826	36,999	45,392	2048	27,867	120,776	203,595
2024	173,495	42,049	53,886	2049	23,767	120,361	208,390
2025	168,131	47,097	62,127	2050	20,104	119,396	213,010
2026	162,785	52,203	70,066	2051	16,873	118,051	217,450
2027	157,335	57,563	77,689	2052	14,050	116,285	221,763
2028	151,737	63,125	85,016	2053	11,614	114,299	225,914
2029	146,001	68,271	92,046	2054	9,528	111,830	229,868
2030	140,095	73,305	98,935	2055	7,763	108,984	233,652
2031	134,059	78,144	105,703	2056	6,282	105,671	237,229
2032	127,850	82,835	112,364	2057	5,052	102,056	240,615
2033	121,451	87,392	118,900	2058	4,040	98,042	243,829
2034	114,921	92,123	125,336	2059	3,218	93,694	246,894
2035	108,236	96,274	131,757	2060	2,554	89,134	249,804
2036	101,445	99,735	138,003	2061	2,023	84,522	252,544
2037	94,595	102,860	144,065	2062	1,600	79,838	255,090
2038	87,720	105,957	149,985	2063	1,266	75,188	257,464
2039	80,840	108,742	155,845	2064	1,003	70,567	259,670
2040	74,023	111,103	161,526	2065	797	66,036	261,713
2041	67,331	113,419	167,081	2066	635	61,613	263,604
2042	60,793	115,466	172,593	2067	509	57,307	265,351

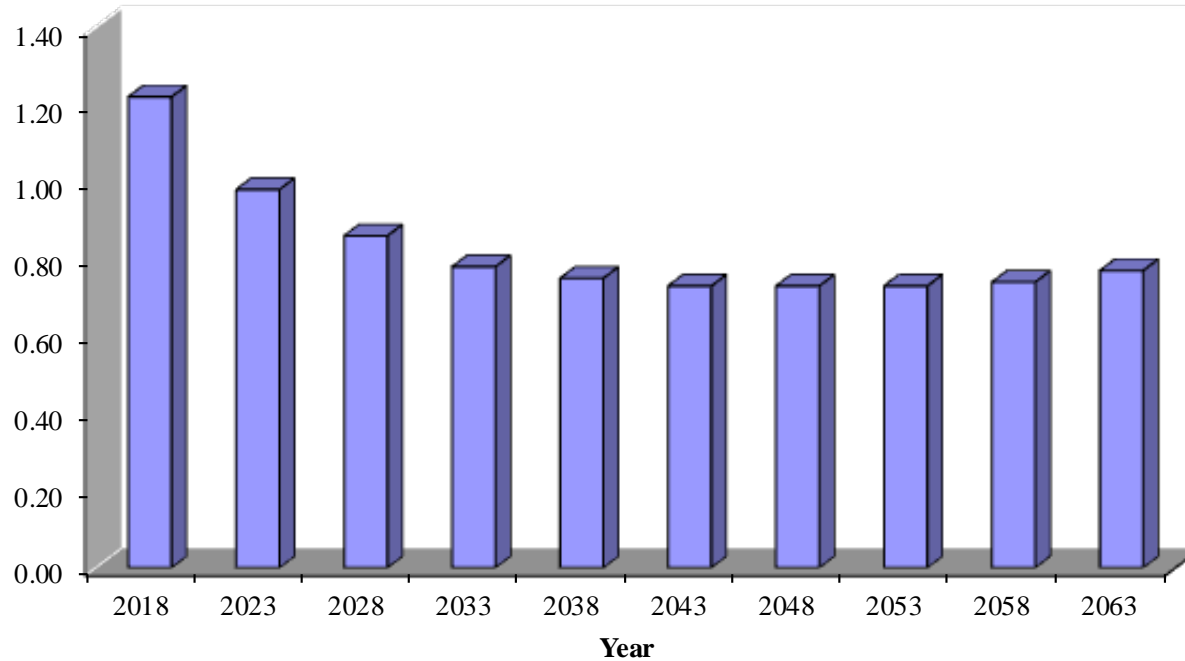
# Retiree Population Present and Future

**Projected Retiree Population**

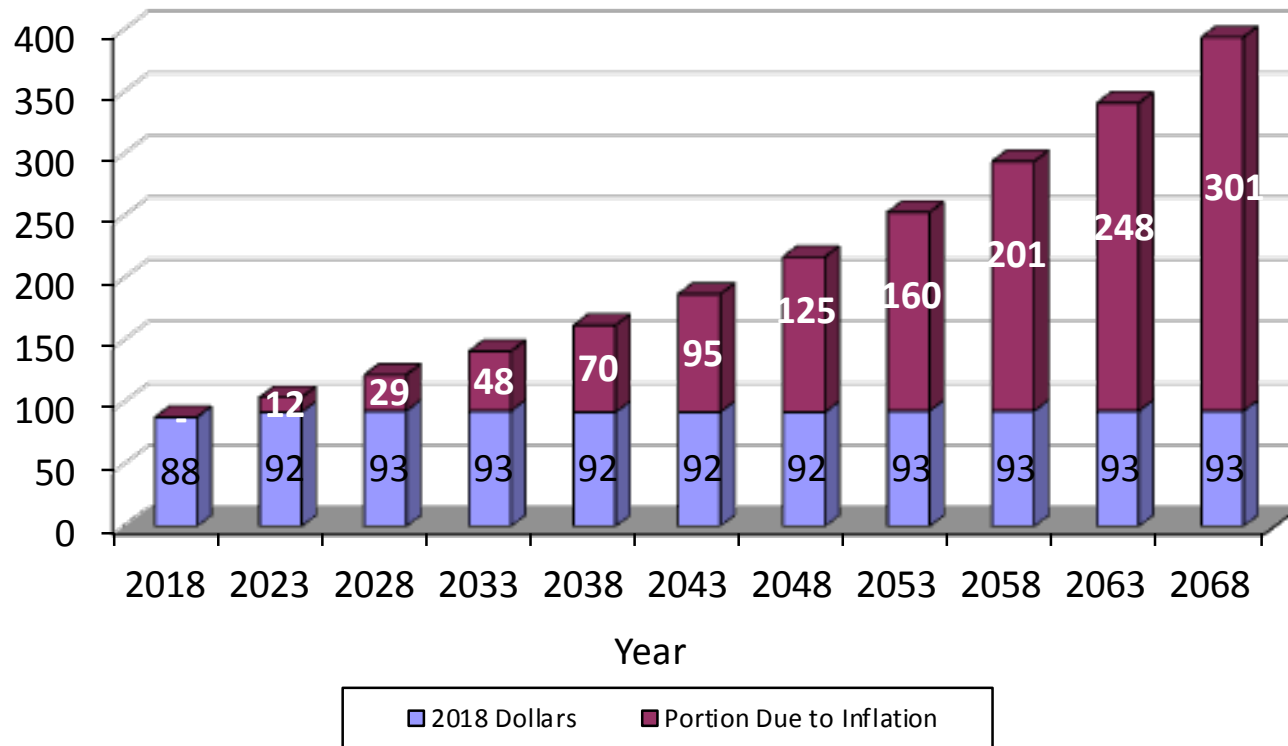


# Ratio of Active Members to Retirees

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# Projected Core Trust Fund Assets (\$Billions)



# Projected Net External Cash Flow\*

## Valuation Assumptions

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Year	\$ (Millions)	% of Assets	% of Payroll
2019	\$ (3,324)	(3.8)%	(22.9)%
2029	(4,647)	(3.8)%	(23.4)%
2039	(6,509)	(4.0)%	(23.9)%
2049	(8,135)	(3.8)%	(21.9)%
2059	(11,329)	(3.8)%	(22.7)%
2069	(15,568)	(4.0)%	(23.2)%

*\*Contribution income minus benefit payout.*

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