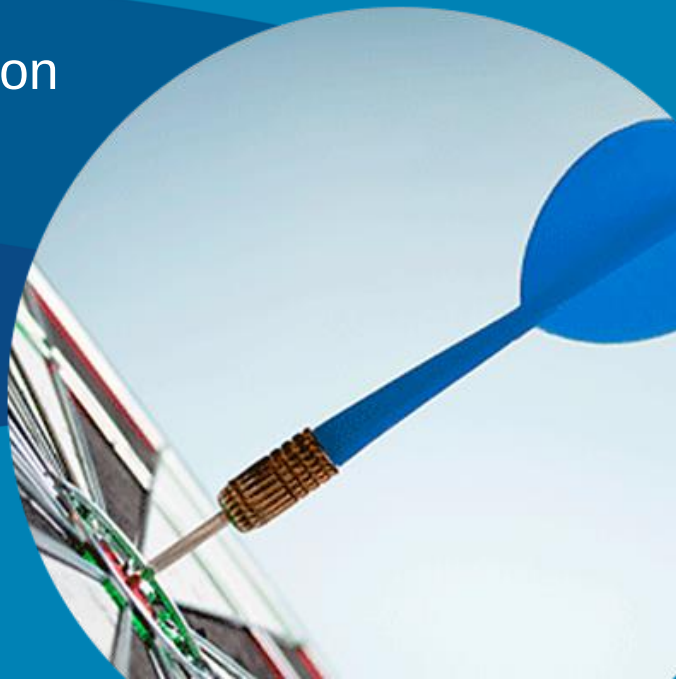
Wisconsin Retirement System

WRS Update:
1) Process of Setting Investment Return Assumption
2) WRS Analysis – Investment Return and Risk

December 2017



Process of Setting the Investment Return Assumption

Assumption Setting

- WRS uses a 3-year Experience Study cycle
  - Investigates economic and demographic assumptions
  - Upcoming experience study for 2015-2017 will be completed in 2018
- Investment return investigated
  - Each experience study
  - Reviewed during interim years by actuary
  - Separate project with State of Wisconsin Investment Board (SWIB) every few years

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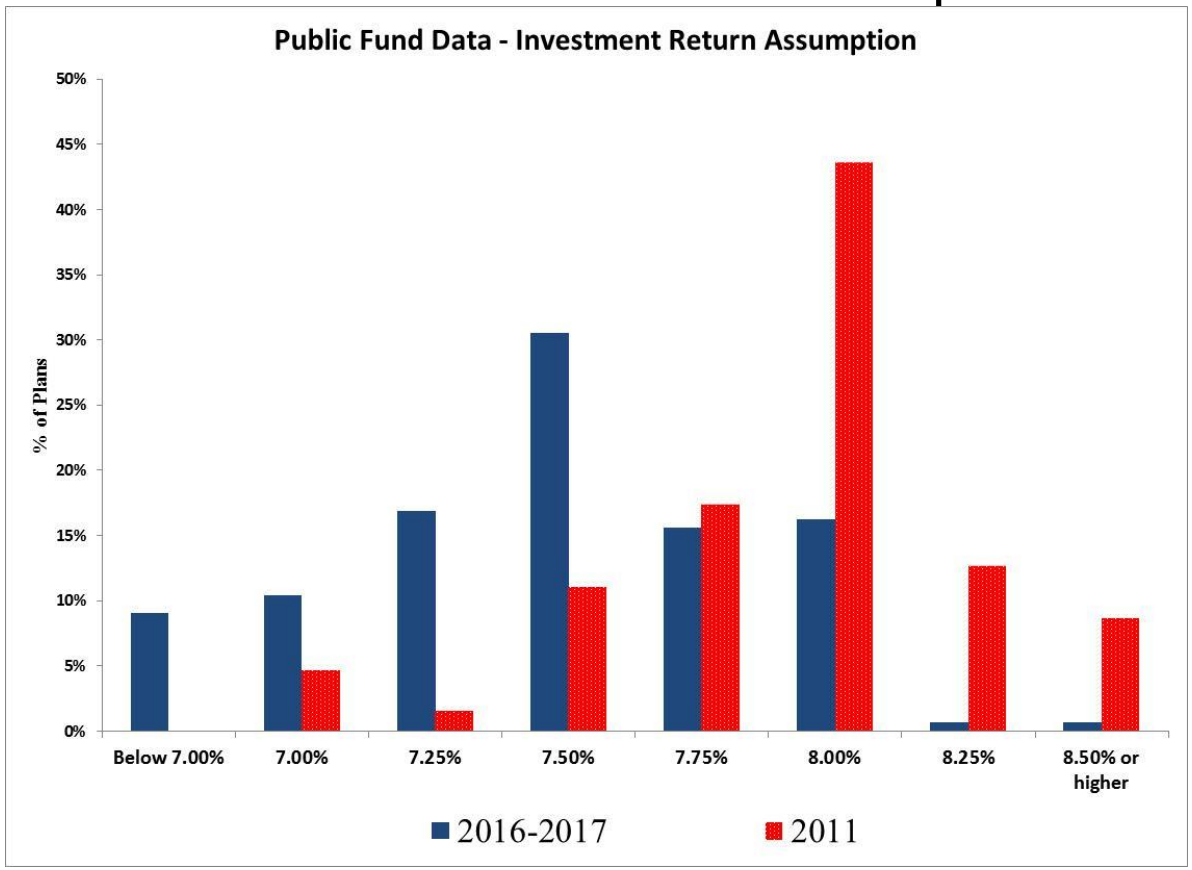
Investment Return Assumption

- Trends in investment return assumptions



Source: 2017 Public Plans Database

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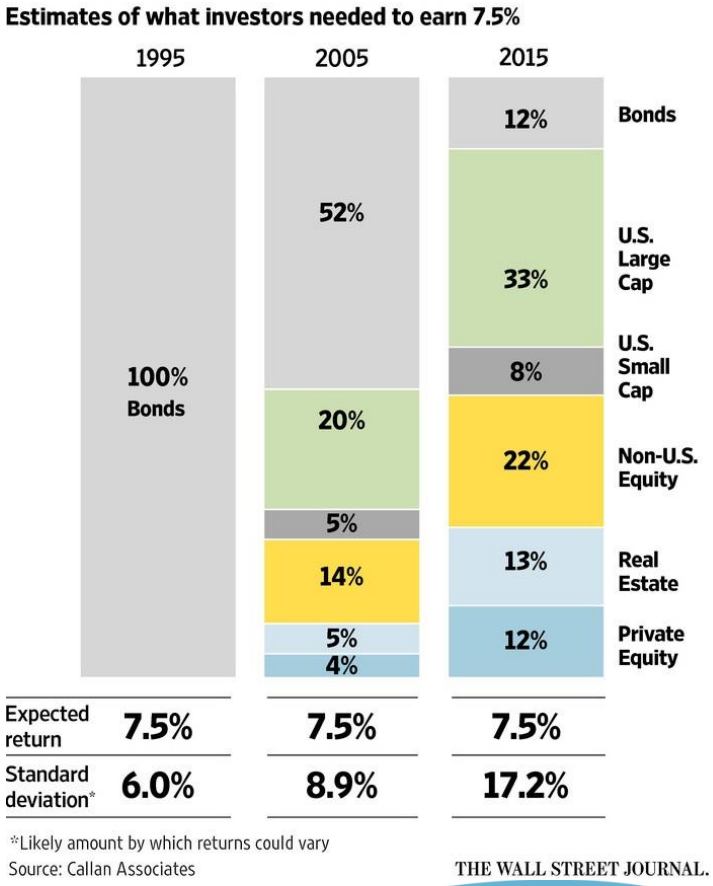
Investment Return Assumption

- Trends in investment return assumptions



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Investment Return Assumption

- The assumption selected should be reasonable
  - May be no single “correct” answer
- Assumption selected using a process that is mainly based on economic capital market expectations using the Plan’s target asset allocation:
  - Utilize a building block approach that reflects expected inflation, real rates of return, and plan related expenses
  - Take into account the volatility of the expected returns produced by the investment portfolio

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Investment Return Assumption

Four Step Approach to Setting assumption

- ***Step 1 –*** Research and Adopt an Expected Price Inflation Assumption
  - Many sources, currently around 2.5% or below
- ***Step 2 –*** Rely on formal Investment Forecasts by experts, including plan's consultant and potentially others
- ***Step 3 –*** Develop a Range of Reasonableness
- ***Step 4 –*** Consider Range of Reasonableness and Professional Judgment
  - Select an investment return assumption which could be a single rate (most common for public sector funding), a "select and ultimate" rate, or even a yield curve

Guidance regarding the selection of economic assumptions for measuring pension obligations is provided by Actuarial Standards of Practice (ASOP) No. 27

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Investment Return Assumption

Step 2 - Rely on formal Investment Forecasts by experts

- Rely on formal investment forecasts by experts:
  - Obtain professional *forward-looking* capital market forecasts from experts – "investment economists"
  - Such forecasts are usually for a 5 to 15 year horizon; some experts provide longer horizon forecasts
  - Forward-looking capital market forecasts include:
    - Expected returns for each asset class
    - Expected standard deviations for each asset class
    - Expected correlation coefficients among all asset classes

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Investment Return Assumption

Step 3 – Develop a Range of Reasonableness – Example, not based on WRS

Mapping Case Study Plan's Asset Allocation to Sample Investment Consultant's (IC) List of Asset Classes		
Asset Classes	**Case Study Plan's Asset Allocation**	**Sample IC's Expected Nominal Gross Return**
Broad Dom Eq	-	9.35%
Large Cap	32%	9.05%
Small/Mid Cap	13%	10.55%
Int'l Equity	15%	9.50%
Emerging Mkts	-	11.75%
Global ex-US Eq	-	10.06%
Defensive	-	3.25%
Domestic Fixed	21%	3.80%
Long Duration	-	4.56%
TIPS	-	3.60%
High Yield	-	6.15%
Non-US$ Fixed	4%	3.75%
Real Estate	10%	7.85%
Private Equity	-	13.10%
Absolute Return	-	6.25%
Commodities	-	6.50%
T-Bills (Cash Equiv)	5%	3.00%
Total Portfolio	100%	7.58%

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Investment Return Assumption

Step 3 – Develop a Range of Reasonableness – Example, not based on WRS

Investment Consultant	Investment Consultant Expected Nominal Return	Investment Consultant's Inflation Assumption	Expected Real Return (2)–(3)	Uniform Price Inflation Assumption	Gross Expected Nominal Return (4)+(5)	Plan Incurred Expense Assumption	Expected Nominal Return Net of Expenses (6)-(7)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	6.42%	2.30%	4.12%	2.50%	6.62%	0.48%	6.14%
2	7.15%	3.00%	4.15%	2.50%	6.65%	0.48%	6.17%
3	6.96%	2.75%	4.21%	2.50%	6.71%	0.48%	6.23%
4	7.46%	3.01%	4.45%	2.50%	6.95%	0.48%	6.47%
5	7.15%	2.50%	4.65%	2.50%	7.15%	0.48%	6.67%
6	7.29%	2.50%	4.79%	2.50%	7.29%	0.48%	6.81%
7	7.58%	2.50%	5.08%	2.50%	7.58%	0.48%	7.10%
8	7.48%	2.40%	5.08%	2.50%	7.58%	0.48%	7.10%
9	7.69%	2.50%	5.19%	2.50%	7.69%	0.48%	7.21%
10	8.32%	2.30%	6.02%	2.50%	8.52%	0.48%	8.04%
11	8.57%	2.02%	6.55%	2.50%	9.05%	0.48%	8.57%
Average	**7.46%**	**2.53%**	**4.93%**	**2.50%**	**7.43%**	**0.48%**	**6.95%**

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Investment Return Assumption

Step 3 – Develop a Range of Reasonableness

- Arithmetic Mean
  - "Expected Return"
  - Expected return for each year standing alone
- Geometric Mean
  - Average compounded annual return over time
  - Always lower than Arithmetic Mean (in the real world)
  - The compound return that is at the 50th percentile of expectation

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Investment Return Assumption - Example

Step 3 – Develop a Range of Reasonableness, Geometric vs. Arithmetic.

	Steady Return				Volatile Return		
	Beg of Yr	**Return**	**End of Yr**		**Beg of Yr**	**Return**	**End of Yr**
2016	$1,000	7.50%	$1,075		$1,000	20.00%	$1,200
2017	$1,075	7.50%	$1,156		$1,200	-5.00%	$1,140
2018	$1,156	7.50%	$1,242		$1,140	20.00%	$1,368
2019	$1,242	7.50%	$1,335		$1,368	-5.00%	$1,300
2020	$1,335	7.50%	$1,436		$1,300	20.00%	$1,560
2021	$1,436	7.50%	$1,543		$1,560	-5.00%	$1,482
2022	$1,543	7.50%	$1,659		$1,482	20.00%	$1,778
2023	$1,659	7.50%	$1,783		$1,778	-5.00%	$1,689
2024	$1,783	7.50%	$1,917		$1,689	20.00%	$2,027
2025	$1,917	7.50%	**$2,061**		$2,027	-5.00%	**$1,925**
Average Rate of Return							
Arithmetic		**7.50%**				**7.50%**	
Geometric		**7.50%**				**6.77%**	
Variance		**0.00%**				**1.56%**	
Std Dev		**0.00%**				**12.50%**	

A steady return produces a higher ending balance than a volatile return if the arithmetic average is the same. The geometric average reflects that behavior better than the arithmetic average. Basically, Volatility drags down return.

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Investment Return Assumption

Step 3 – Develop a Range of Reasonableness

- Consider percentiles and probabilities of compounded returns
  - The "Geometric Mean" is the 50th percentile of compound returns
  - Half the compounded returns are expected to exceed the 50th percentile and half are expected to fall short
  - The 50th percentile return has a 50% probability of being achieved
  - A return assumption higher than the 50th percentile of compounded returns will have less than a 50% chance of being achieved

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Investment Return Assumption

Step 3 – Develop a Range of Reasonableness – Example, not based on WRS

Investment Consultant	Distribution of 15-Year Average Geometric Net Nominal Return			Probability of exceeding
	25th	50th	75th	7.75% *
(1)	(2)	(3)	(4)	(5)
1	3.77%	5.49%	7.25%	22.7%
2	3.77%	5.51%	7.29%	23.2%
3	4.01%	5.65%	7.32%	23.2%
4	4.10%	5.83%	7.59%	26.2%
5	4.33%	6.04%	7.77%	28.2%
6	4.20%	6.06%	7.95%	30.1%
7	4.59%	6.40%	8.23%	33.3%
8	5.08%	6.60%	8.15%	33.2%
9	4.84%	6.57%	8.33%	34.7%
10	6.07%	7.56%	9.08%	47.1%
11	5.65%	7.69%	9.76%	49.3%
Average	**4.58%**	**6.31%**	**8.07%**	**31.9%**

*Plan's current return assumption net of expenses.

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Investment Return Assumption

Step 4 Consider Range of Reasonableness and Professional Judgment

- To make the ***final*** decision on a return assumption --
  - Consider the range between the two means (geometric and arithmetic)
  - Consider professional judgment
  - Consider a longer horizon, while being judged by stakeholders and other observers in a short/mid-term horizon
  - Consider probabilities of achieving the selected assumption over the mid-term horizon
  - Consider the uncertainty in the forecasts; in economics and investing, uncertainty usually provokes conservatism
  - Consider avoiding large moves all at once

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WRS Analysis – Investment Return and Risk

Objectives of WRS Analysis

- Commissioned by SWIB, presented at SWIB October 2017 Retreat
- Investigate
  - Relationship of Investment Return to Success Measures
  - Effects of bad outcomes
- Evaluate several points along the Asset Allocation spectrum against measures of success.
- Find the “Goldilocks Zone” if it exists.

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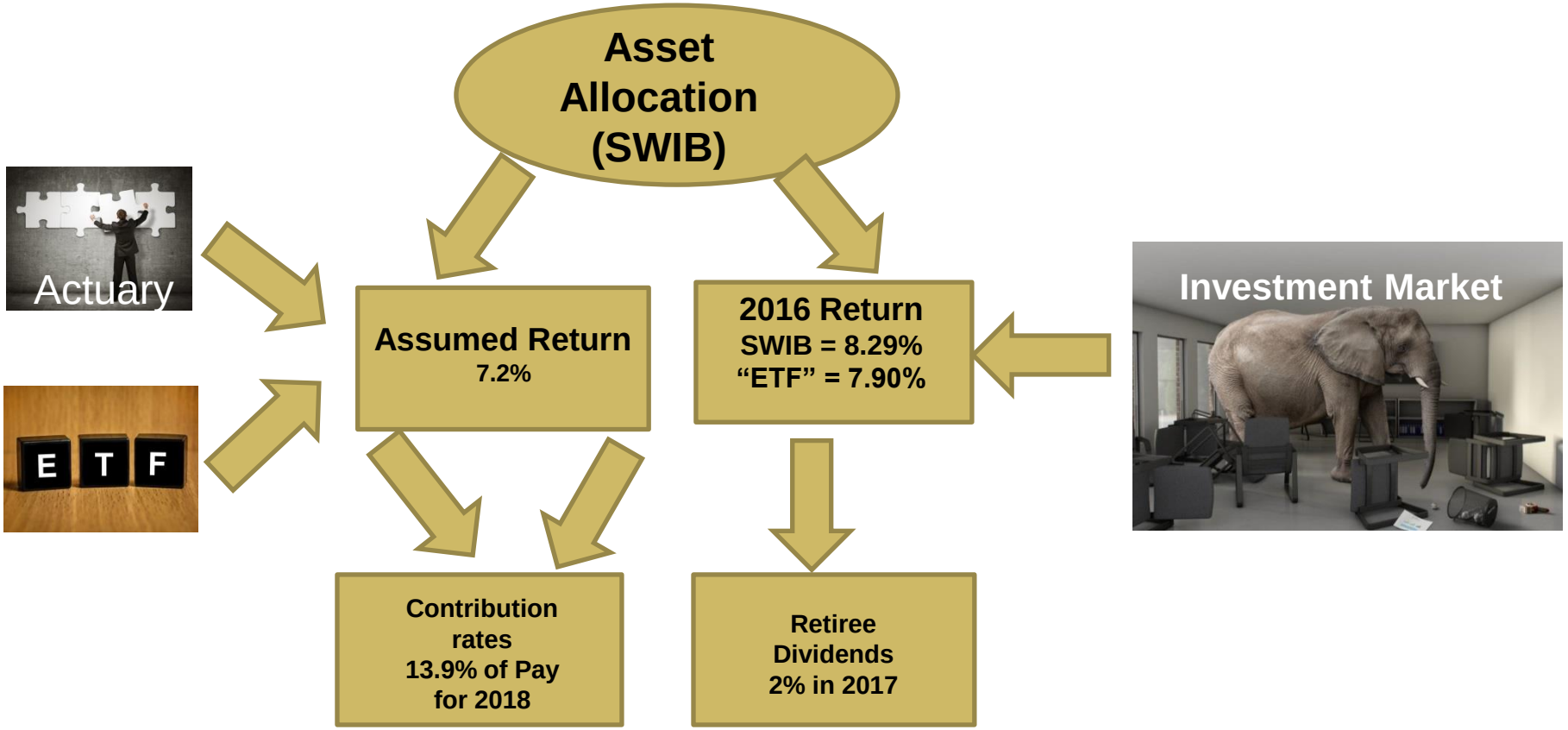
Asset Allocation and WRS



Measures of Successful Asset Allocation (WRS Perspective)

- Stable Contribution Rates
- Affordable Contribution Rates
- Generate Dividends (earnings > 5%)
- Avoid Dividend Takebacks
- Maintain fully funded retiree reserve

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Asset Allocation Spectrum

	Asset Allocation Characteristics	
	High Risk	**Low Risk**
Probability of	**High Reward**	**Low Reward**
Stable Contribution Rates	Low	High
Affordable Contribution Rates	Medium	Low
Generate Dividends	High	Low
Dividend Takebacks	Medium	Medium
Maintain Fully Funded Retire Reserve	Medium	High *

- An ideal Asset Allocation would provide stable, affordable contribution rates, generate dividends sufficient to offset inflation with no takebacks, and would maintain the retiree reserve in a fully funded position.
- There probably is no such thing, but is there a “Goldilocks Zone” that provides an optimal combined outcome of all the measures taken together?

* But not in the very long term

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Key Changes from 2015 Study

- Combined SWIB returns for 2015 and 2016 slightly lower than assumed rate of 7.2% (-0.4% return for 2015 and 8.29% return for 2016)
- Mortality table update (slightly longer expected lifetimes)
- Slightly lower Standard Deviation than 2015 Study
- Updated census data as of December 31, 2016

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Retiree Reserve

- **Retiree 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.

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Dividend Reserve

- 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

- 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.

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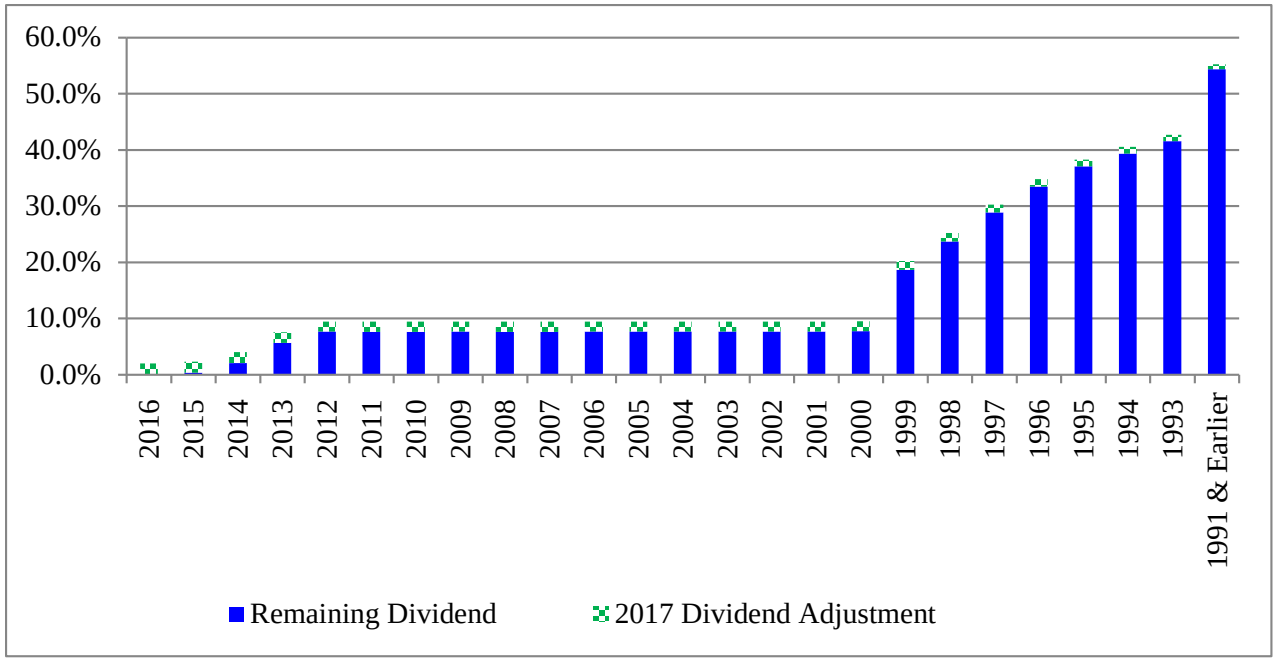
Dividend Remaining (as a Percentage of Total Benefit) by Year of Retirement



Dividend Reserve Depletion

- 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.

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Dividend Reserve Depletion: Liability Attributable to Dividends

Valuation	Liability for Dividend Remaining (billions)	Liability for Dividend Adjustment (billions)
12/31/2010	$7.2	$(0.3)
12/31/2011	6.4	(1.7)
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 (est)	6.0	

- Liability for Dividend Remaining represents the value of all previously granted dividends
- If another market event similar to 2008 were to occur again, the complete depletion of the dividend would become a real possibility

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Monte Carlo Simulations

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

	Expected Return		Standard
	Geometric	Arithmetic	Deviation
Scenario 1	5.0%	5.3%	8.2%
Scenario 2	6.0%	6.5%	11.4%
Scenario 3	7.0%	7.9%	15.2%
Scenario 4	7.2%	8.2%	16.0%
Scenario 5	8.0%	9.4%	19.4%
Scenario 6	9.0%	11.1%	24.1%
Scenario 7	10.0%	13.1%	29.5%

Current →

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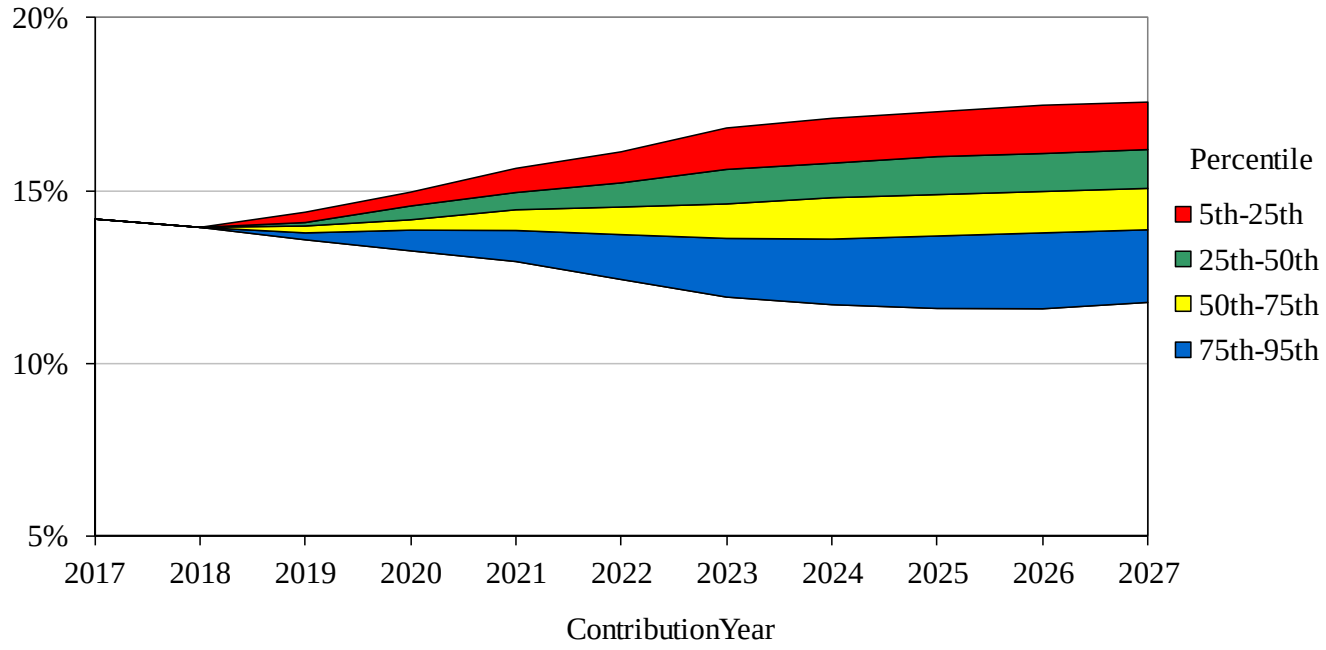
Contribution as a % of Payroll
Scenario 2 – 6.0%ER,11.4%SD



5th Percentile	14.2%	13.9%	14.4%	15.0%	15.6%	16.1%	16.8%	17.1%	17.3%	17.5%	17.6%
25th Percentile	14.2%	13.9%	14.1%	14.6%	14.9%	15.2%	15.6%	15.8%	16.0%	16.1%	16.2%
Median	14.2%	13.9%	14.0%	14.2%	14.4%	14.5%	14.6%	14.8%	14.9%	15.0%	15.1%
75th Percentile	14.2%	13.9%	13.8%	13.9%	13.8%	13.7%	13.6%	13.6%	13.7%	13.8%	13.9%
95th Percentile	14.2%	13.9%	13.6%	13.3%	12.9%	12.4%	11.9%	11.7%	11.6%	11.6%	11.8%

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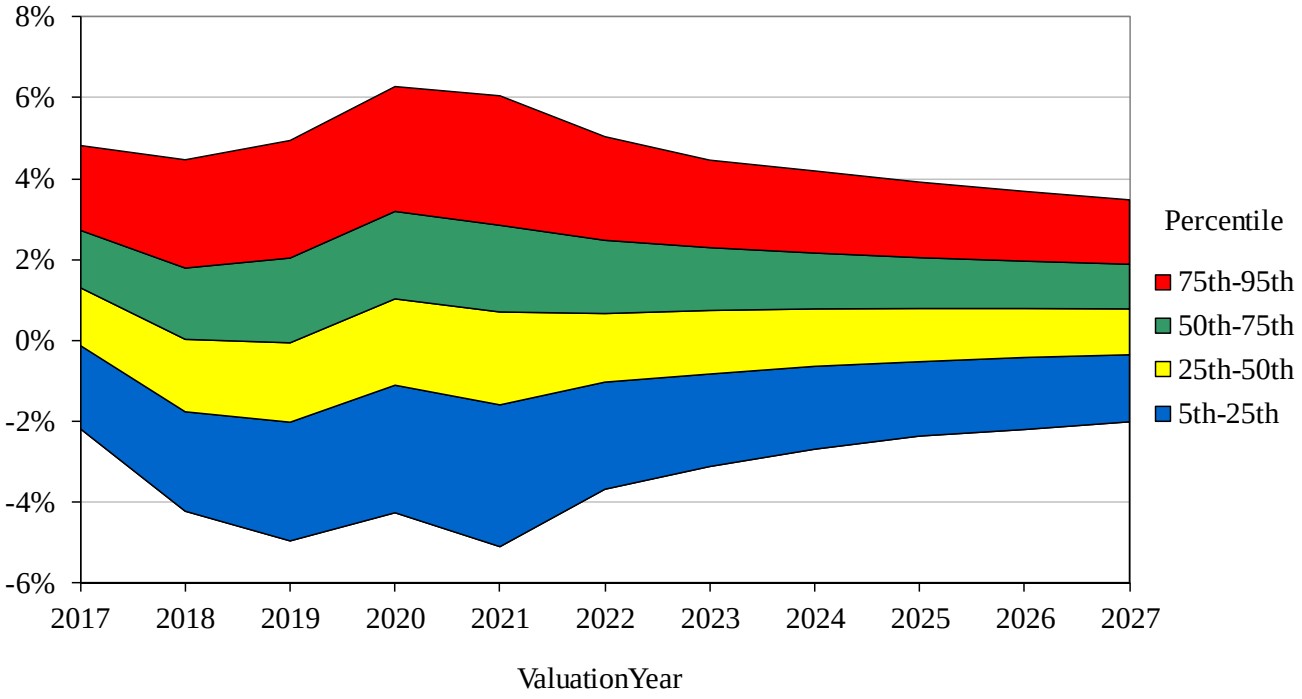
Dividend Rates
Scenario 2 – 6.0%ER,11.4%SD



5th Percentile	-2.2%	-4.2%	-5.0%	-4.3%	-5.1%	-3.7%	-3.1%	-2.7%	-2.4%	-2.2%	-2.0%
25th Percentile	-0.1%	-1.8%	-2.0%	-1.1%	-1.6%	-1.0%	-0.8%	-0.6%	-0.5%	-0.4%	-0.4%
Median	1.3%	0.0%	-0.1%	1.0%	0.7%	0.7%	0.7%	0.8%	0.8%	0.8%	0.8%
75th Percentile	2.7%	1.8%	2.0%	3.2%	2.8%	2.5%	2.3%	2.2%	2.0%	2.0%	1.9%
95th Percentile	4.8%	4.5%	4.9%	6.3%	6.0%	5.0%	4.5%	4.2%	3.9%	3.7%	3.5%

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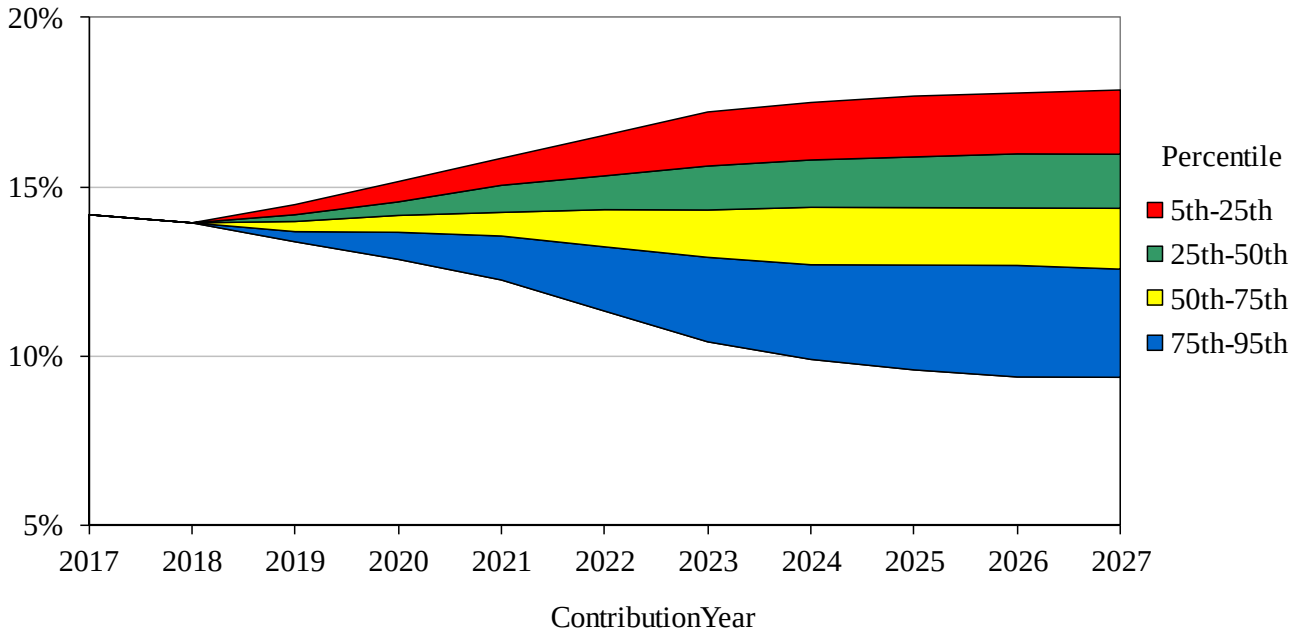
Contribution as a % of Payroll
Scenario 3 – 7.0%ER,15.2%SD



5th Percentile	14.2%	13.9%	14.5%	15.2%	15.8%	16.5%	17.2%	17.5%	17.7%	17.8%	17.9%
25th Percentile	14.2%	13.9%	14.2%	14.6%	15.0%	15.3%	15.6%	15.8%	15.9%	16.0%	16.0%
Median	14.2%	13.9%	14.0%	14.2%	14.2%	14.3%	14.3%	14.4%	14.4%	14.4%	14.4%
75th Percentile	14.2%	13.9%	13.7%	13.7%	13.5%	13.2%	12.9%	12.7%	12.7%	12.7%	12.6%
95th Percentile	14.2%	13.9%	13.4%	12.9%	12.2%	11.3%	10.4%	9.9%	9.6%	9.4%	9.4%

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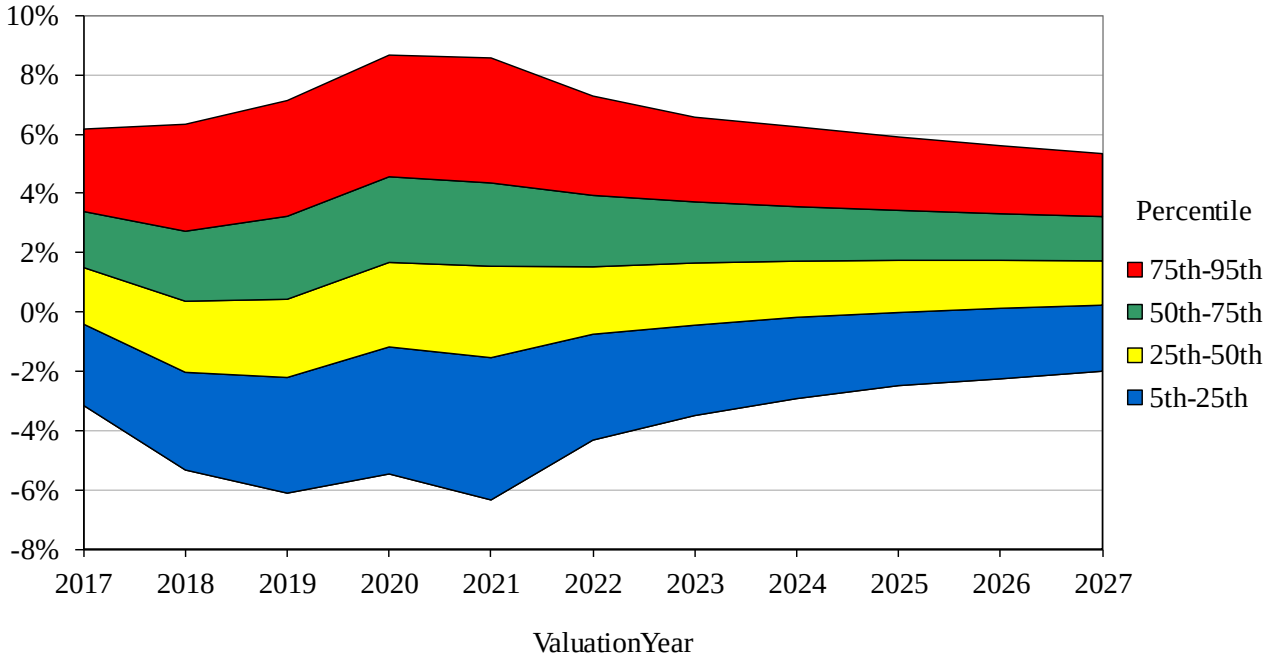
Dividend Rates
Scenario 3 – 7.0%ER,15.2%SD



5th Percentile	-3.2%	-5.3%	-6.1%	-5.5%	-6.3%	-4.3%	-3.5%	-2.9%	-2.5%	-2.3%	-2.0%
25th Percentile	-0.4%	-2.0%	-2.2%	-1.2%	-1.5%	-0.8%	-0.4%	-0.2%	0.0%	0.1%	0.2%
Median	1.5%	0.4%	0.4%	1.7%	1.5%	1.5%	1.7%	1.7%	1.7%	1.7%	1.7%
75th Percentile	3.4%	2.7%	3.2%	4.6%	4.4%	3.9%	3.7%	3.6%	3.4%	3.3%	3.2%
95th Percentile	6.2%	6.3%	7.1%	8.7%	8.6%	7.3%	6.6%	6.2%	5.9%	5.6%	5.3%

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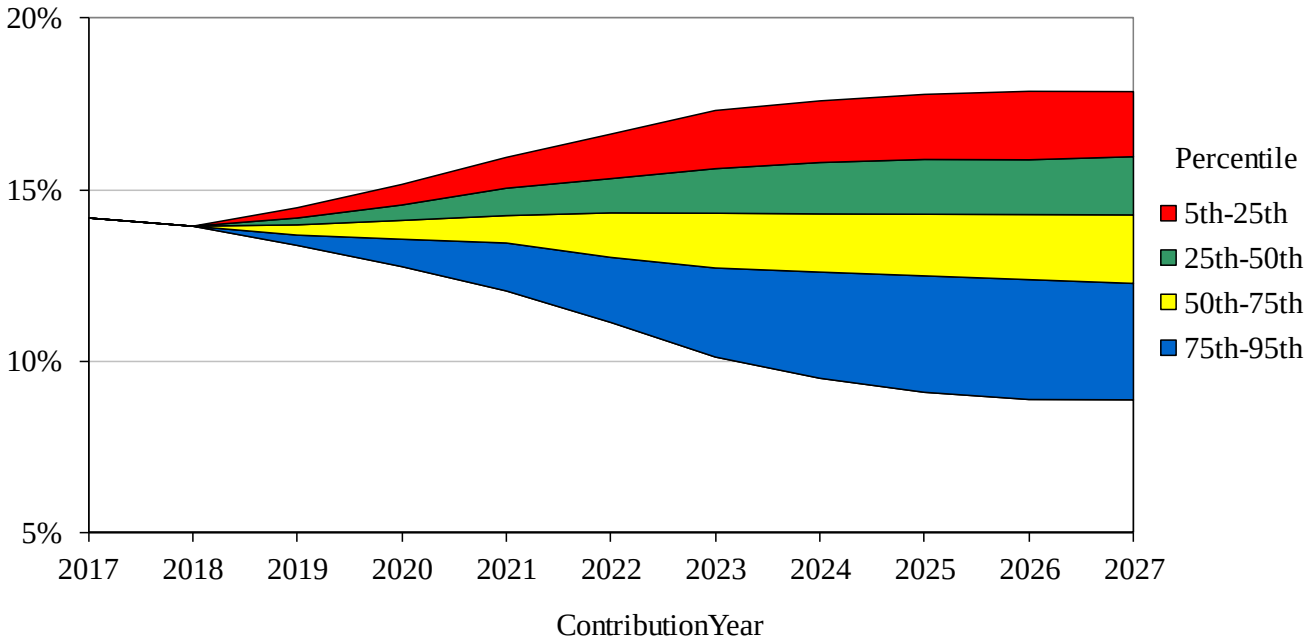
Contribution as a % of Payroll
Scenario 4 – 7.2%ER,16.0%SD



5th Percentile	14.2%	13.9%	14.5%	15.2%	15.9%	16.6%	17.3%	17.6%	17.8%	17.9%	17.9%
25th Percentile	14.2%	13.9%	14.2%	14.6%	15.0%	15.3%	15.6%	15.8%	15.9%	15.9%	16.0%
Median	14.2%	13.9%	14.0%	14.1%	14.2%	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%
75th Percentile	14.2%	13.9%	13.7%	13.6%	13.4%	13.0%	12.7%	12.6%	12.5%	12.4%	12.3%
95th Percentile	14.2%	13.9%	13.4%	12.8%	12.0%	11.1%	10.1%	9.5%	9.1%	8.9%	8.9%

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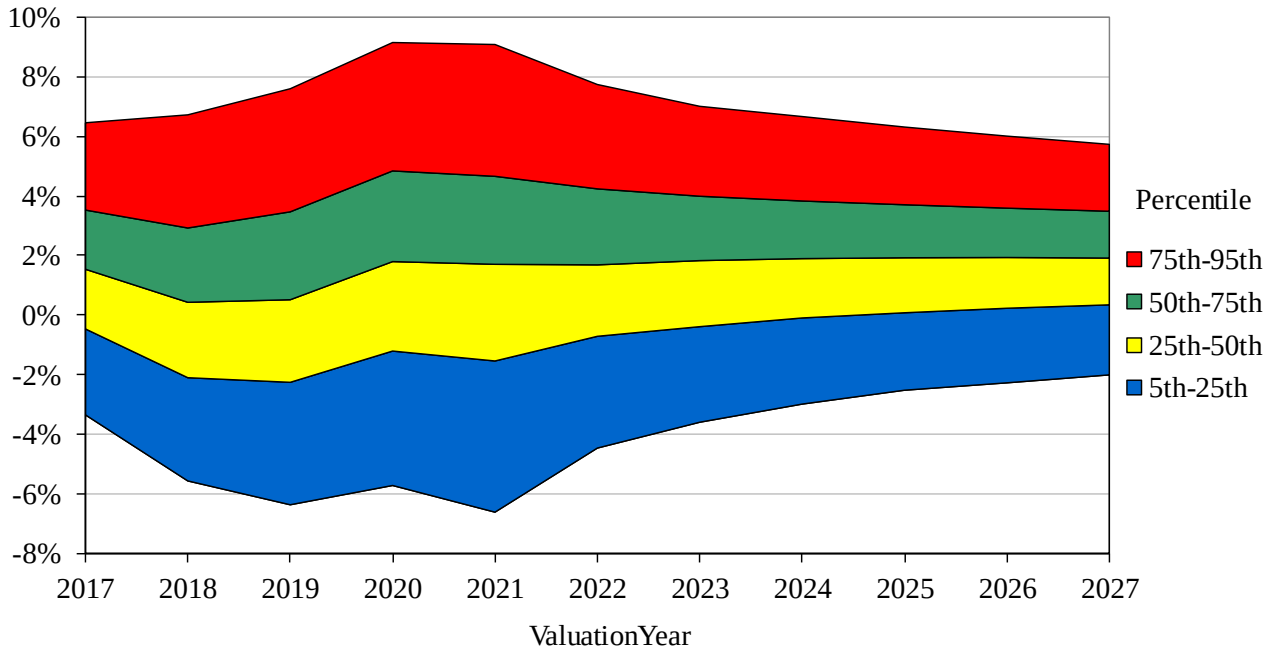
Dividend Rates
Scenario 4 – 7.2%ER,16.0%SD



5th Percentile	-3.4%	-5.6%	-6.4%	-5.7%	-6.6%	-4.5%	-3.6%	-3.0%	-2.5%	-2.3%	-2.0%
25th Percentile	-0.5%	-2.1%	-2.3%	-1.2%	-1.5%	-0.7%	-0.4%	-0.1%	0.1%	0.2%	0.3%
Median	1.5%	0.4%	0.5%	1.8%	1.7%	1.7%	1.8%	1.9%	1.9%	1.9%	1.9%
75th Percentile	3.5%	2.9%	3.5%	4.8%	4.7%	4.2%	4.0%	3.8%	3.7%	3.6%	3.5%
95th Percentile	6.5%	6.7%	7.6%	9.2%	9.1%	7.7%	7.0%	6.7%	6.3%	6.0%	5.7%

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Discussion of Dividend

Probability That Dividend Reserve Will Be Depleted in Year

	Expected ROR	Standard Deviation	Year 1	Year 5	Year 10	Year 20	Year 50
1	5.0%	8.2%	0.0%	12.5%	22.7%	30.0%	39.6%
2	6.0%	11.4%	0.0%	15.4%	17.6%	12.4%	3.9%
3	7.0%	15.2%	0.0%	18.2%	16.4%	7.7%	0.9%
4	7.2%	16.0%	0.0%	18.7%	16.4%	7.3%	0.6%
5	8.0%	19.4%	0.0%	20.9%	16.7%	6.5%	0.4%
6	9.0%	24.1%	0.3%	23.2%	18.0%	6.6%	0.3%
7	10.0%	29.5%	0.9%	26.2%	20.0%	7.5%	0.4%

Current →

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Discussion of Dividend

Probability of Negative Dividend in Year

	Expected ROR	Standard Deviation	Year				
			1	5	10	20	50
1	5.0%	8.2%	23.2%	52.7%	55.8%	54.4%	52.5%
2	6.0%	11.4%	26.6%	42.0%	33.1%	28.8%	28.1%
3	7.0%	15.2%	29.5%	37.1%	23.2%	18.5%	18.8%
4	7.2%	16.0%	29.9%	36.5%	22.0%	17.3%	17.8%
5	8.0%	19.4%	31.7%	34.8%	19.2%	14.5%	14.9%
6	9.0%	24.1%	33.5%	34.3%	17.4%	12.7%	13.3%
7	10.0%	29.5%	34.9%	35.0%	17.2%	12.5%	13.1%

Current →

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Discussion of Dividend

Worst Case Scenario of Cumulative Dividend Percent (% of Floor Benefit That Is Funded)

	Expected ROR	Standard Deviation	Year 1	Year 5	Year 10	Year 20	Year 50
1	5.0%	8.2%	109%	88%	81%	76%	66%
2	6.0%	11.4%	108%	81%	76%	77%	84%
3	7.0%	15.2%	106%	74%	69%	76%	103%
4	7.2%	16.0%	106%	72%	68%	75%	108%
5	8.0%	19.4%	105%	65%	61%	72%	122%
6	9.0%	24.1%	103%	55%	51%	65%	136%
7	10.0%	29.5%	100%	44%	39%	55%	141%

Current →

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

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Dividend Observations

- The low risk scenarios are actually risky in the sense that, for example, 5% expected return has 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

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Combination of All Scenarios

			2027 Results by %-tile of Investment Return Outcomes						
			Contribution Rates			Dividend Rates			Retiree FS
	ROR	StdDev	95th	50th	5th	95th	50th	5th	5th Percentile
1	5.0%	8.2%	13.6%	15.8%	17.5%	1.7%	-0.2%	-2.2%	76% in year 50
2	6.0%	11.4%	11.8%	15.1%	17.6%	3.5%	0.8%	-2.0%	88% in year 10
Current → 2A	6.15%	12.0%	11.4%	15.0%	17.7%	3.8%	0.9%	-2.0%	87% in year 10
3	7.0%	15.2%	9.4%	14.4%	17.9%	5.3%	1.7%	-2.0%	85% in year 10
4	7.2%	16.0%	8.9%	14.3%	17.9%	5.7%	1.9%	-2.0%	84% in year 10
5	8.0%	19.4%	6.4%	13.7%	18.2%	7.3%	2.7%	-2.1%	80% in year 10
6	9.0%	24.1%	2.7%	13.0%	18.6%	9.4%	3.6%	-2.4%	74% in year 10
7	10.0%	29.5%	0.0%	12.3%	19.2%	11.6%	4.4%	-2.9%	65% 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 5th Percentile scenario for retiree dividend pool falling below 80%
- Scenarios 2, 2A, 3 and 4 represent potential 'Goldilocks Zone'

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Measures of Successful Asset Allocation (WRS Perspective)

- Stable Contribution Rates
- Affordable Contribution Rates
- Generate Dividends (earnings > 5%)
- Avoid Dividend Takebacks
- Maintain fully funded retiree reserve

Continue to target 'Goldilocks zone' that provides for positive return with appropriate downside protection

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