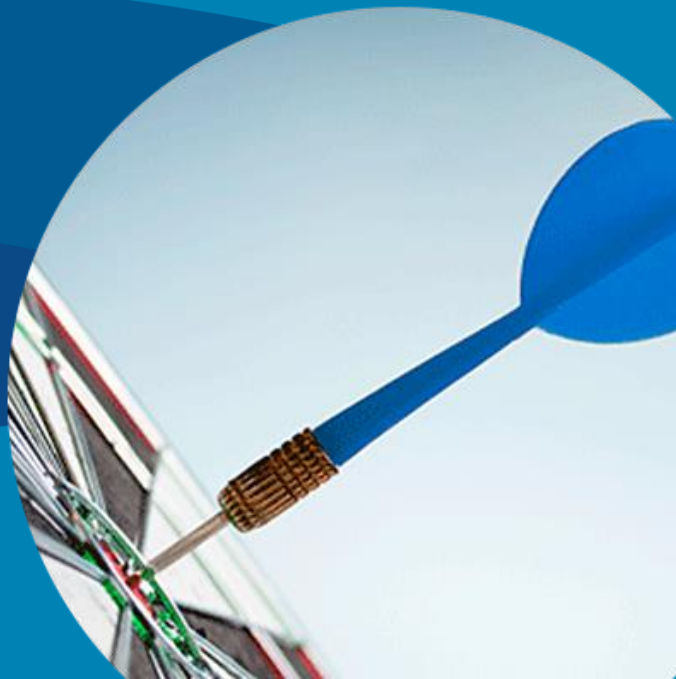
Wisconsin Retirement System

37th Annual Actuarial Valuation of Retired Lives

December 31, 2019



Operation of the System (simplified description)

	Core Annuities	Variable Annuities
Investment Return Hurdle to Trigger Annuity Adjustment	Returns over/under 5%	Returns over/under 5%
Ratio of Assets to Liabilities	If > 0.5%, dividend may be granted If <-0.5%, prior dividends reduced	If > 2%, variable annuity increased If <-2%, variable annuity decreased
Increase/Decrease Rounding Conventions	Rounded to nearest 0.1%	Truncated, carried to next year
Adjustment Effective Date	April following 12/31 valuation	April following 12/31 valuation

Smoothing Mechanisms

Core

- Undesirable for retirees to experience wide swings in monthly benefits from year to year (especially downward swings)
- Mitigated in Core division by asset smoothing process and portfolio mix
- Asset smoothing has worked well historically, but could not prevent negative dividends in 2009-2013

Smoothing Mechanisms

Variable

- Variable fund is marked to market each year and subject to wide swings
- Dropping fractions of a percent from the adjustment is a form of smoothing
- Usually has very little effect due to the magnitude of the gains and losses

Summary of Results – December 31, 2019

$ Millions

	Core	Variable
Number of Annuitants	216,944	41,777
Annual Amount of Annuities Paid	$ 5,183.7	$ 379.7
Fund Balance	59,138.4	4,519.4
Actuarial Reserve	58,157.0	3,728.6
Ratio	**1.017**	**1.212**

Core effective earnings rate = 7.7%, dividend adjustment = 1.7%.
Variable effective earnings rate = 29.0%, and the variable adjustment = 21.0%.

(Report- Cover Letter & Pages 6 and 16)

Summary of Results

Due to smoothing via Market Recognition Account, as of December 31, 2019 there are approximately $5.7 billion in unrecognized **gains** in the Core fund

- Last year was $4.9 billion in unrecognized losses
- Will be recognized over the next 4 years
- Roughly ½ of gain applies to the annuitant reserve, the other half shared by active members and employers
- Will put upward pressure on dividends in the coming years

Operation of Market Recognition Account (MRA) – $ Millions **2018 Valuation**

	2018	2019	2020	2021	2022
Actual Investment Earnings	$(3,585)				
Assumed Investment Earnings	6,657				
Gain/(Loss) to be phased-in	(10,242)				
Phased-in recognition					
• Current year	$(2,048)	?	?	?	?
• First prior year	1,461	$(2,048)	?	?	?
• Second prior year	119	1,461	$(2,048)	?	?
• Third prior year	(1,344)	119	1,461	$(2,048)	?
• Fourth prior year	(243)	(1,344)	119	1,461	$(2,048)
Total recognized gain (loss)	$(2,055)	$ (1,812)	$ (468)	$ (587)	$ (2,048)

2019-2022: Expect $4.9 billion in deferred asset *LOSSES*

Operation of Market Recognition Account (MRA) – $ Millions **2019 Valuation**

	2019	2020	2021	2022	2023
Actual Investment Earnings	$ 17,765				
Assumed Investment Earnings	6,744				
Gain/(Loss) to be phased-in	11,021				
Phased-in recognition					
• Current year	$ 2,204	?	?	?	?
• First prior year	(2,048)	$ 2,204	?	?	?
• Second prior year	1,461	(2,048)	$ 2,204	?	?
• Third prior year	119	1,461	(2,048)	$ 2,204	?
• Fourth prior year	(1,344)	119	1,461	(2,048)	$ 2,204
Total recognized gain (loss)	$ 392	$ 1,736	$ 1,617	$ 156	$ 2,204

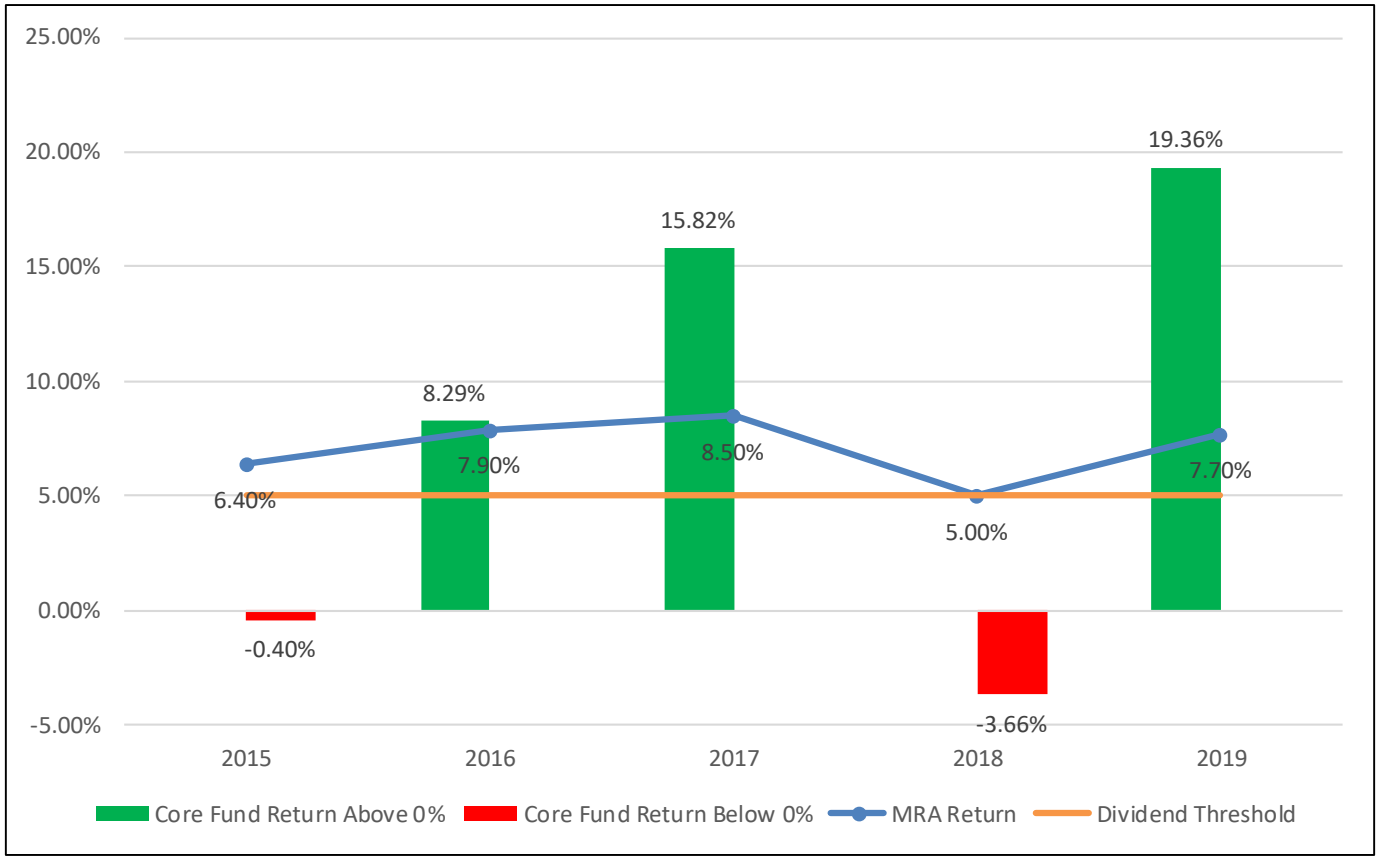
2020-2023: Expect $5.7 billion in deferred asset *GAINS*

Asset Rate of Return Calculation

Rate of Return = Investment Earnings / Asset Value

- Rate of Return will vary based on calculation inputs:
  - Asset value could be smoothed or unsmoothed
  - Asset value could be beginning, middle or end of year
  - Timing of Contributions and Benefit Payments will vary
- Result is different Rate of Return calculated by:
  - SWIB (investment manager)
  - ETF (calculations governed by statute)
  - GRS (actuaries)

Core Fund Returns – Market Value vs. Market Recognition Account



Translating Asset Rate of Return to Core Dividend "R-e-S-F-A P"

Return: 2019 SWIB net of fee return = 19.36%

Smooth vs. 7.0% Investment Return Assumption

- Return > assumption Smoothed over 5 years
  - **Leads to $6 billion in unrecognized Core Fund gains**
- Core fund return available for dividend = **7.34%**

Fund annuities at Investment Return 5% Threshold

- Core fund return > threshold provides **dividend before adjustments**: 1.0734/1.05-1 = **2.23%**

Adjustments result in 1.7% dividend Paid

Primary Sources of Core Dividend

	% of APV
1. SWIB net of fee investment return	19.36%
2. MRA adjustment	(11.66)%
3. Published effective earnings rate	7.70%
4. Adjustment to relate earnings to average core annuity fund balance	(0.36)%
5. Earnings rate based on average balance	7.34%
6. Expected dividend before adjustments: 1.0734/1.05-1	2.23%
7. Adjustment to relate average asset to ending liability	0.00%
8. Carryover from last year due to timing of dividend accounting adjustments and rounding	(0.24)%
9. Experience study/mortality reserve adjustment	(0.20)%
10. Experience and other effects	(0.10)%
11. Statutory adjustment to round to nearest one-tenth percent	0.01%
12. **Computed average dividend rate: (6)+(7)+(8)+(9)+(10)+(11)**	**1.7%**
13. Adjustment for members at or near the statutory floor	0.0%
14. **Final computed dividend rate: (12)+(13), if greater than 0.5% (or less than -0.5%) of core annuities, otherwise 0%**	**1.7%**

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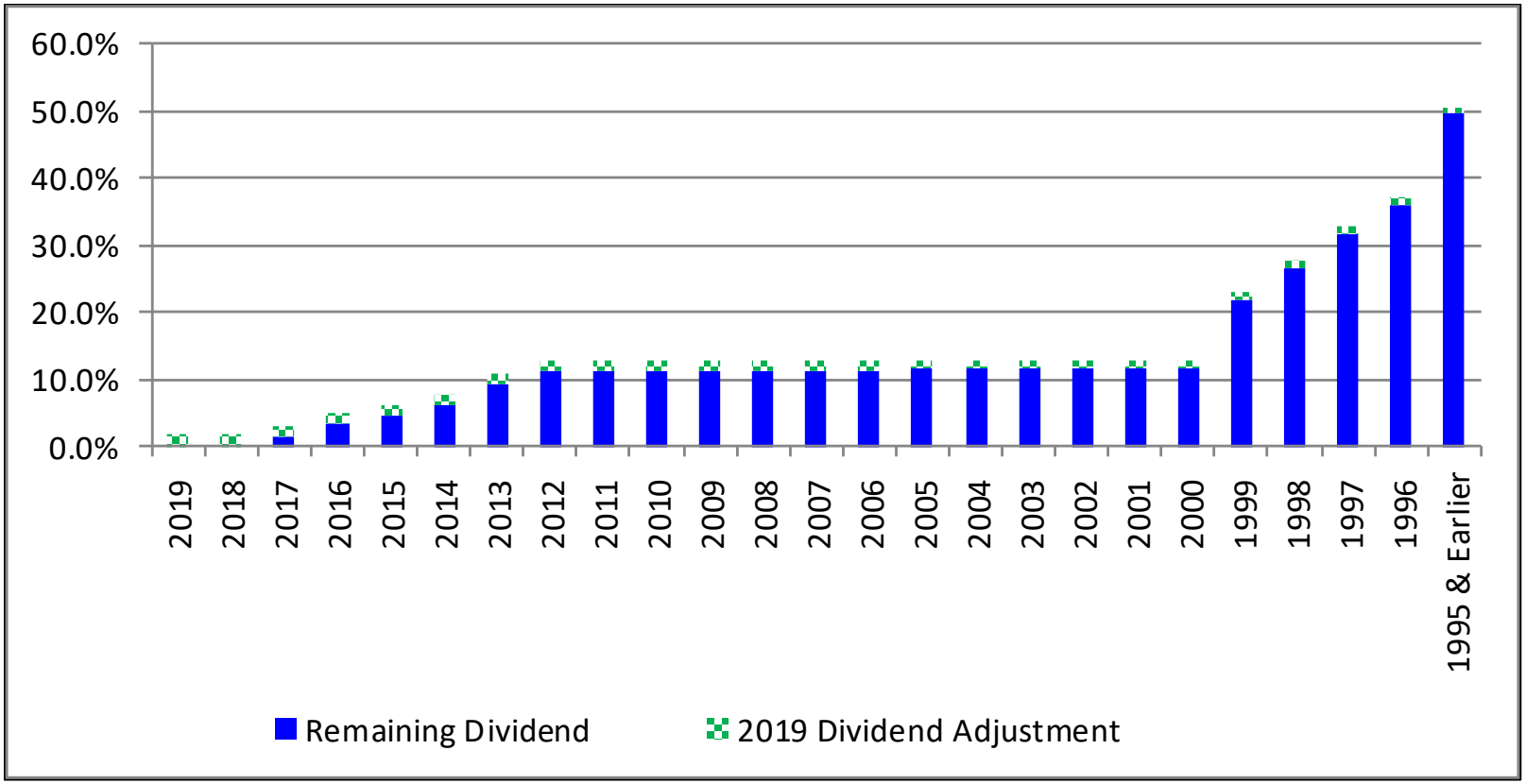
Liability Attributable to Dividends

Valuation	Liability for Dividend Remaining (billions)	Liability for Dividend Adjustment (billions)
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	6.5	1.0
12/31/2020 (est)	7.1	

- 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

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



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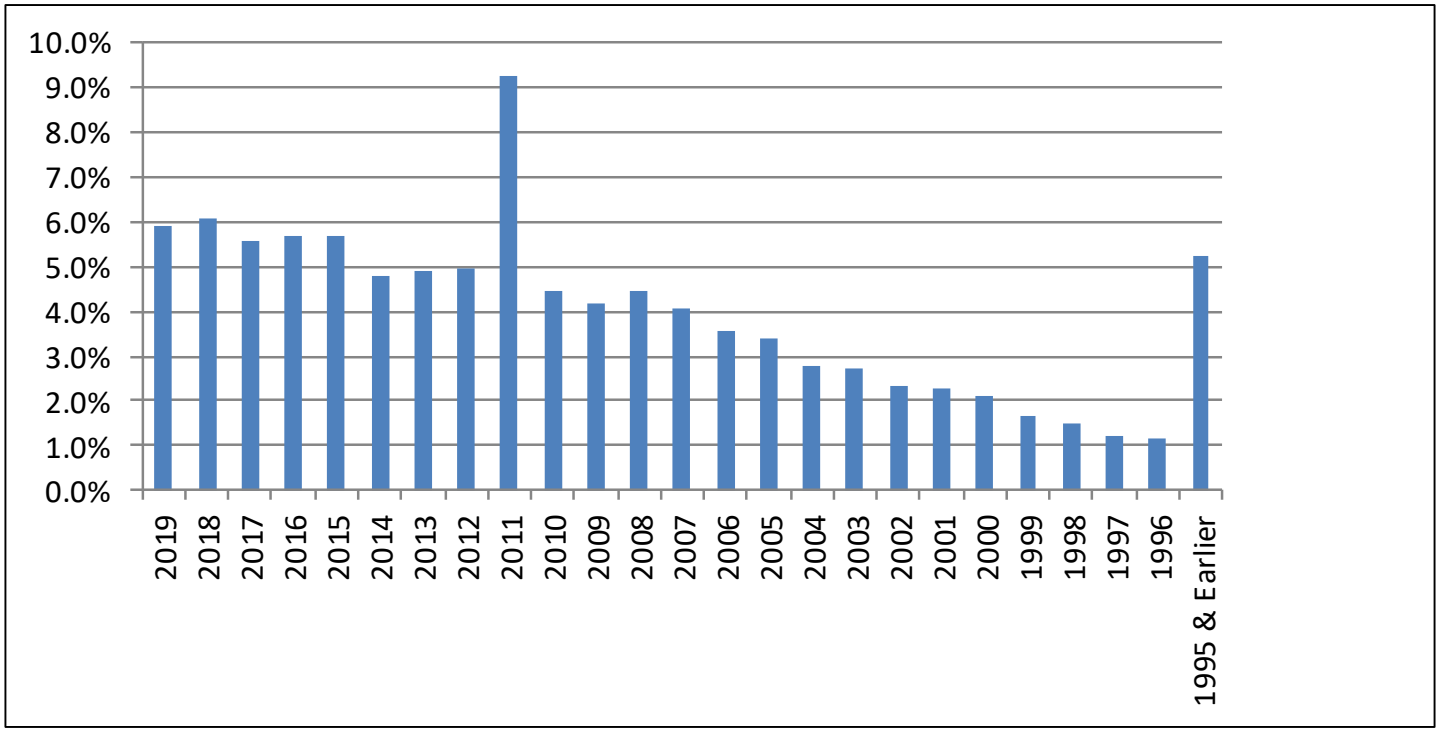
Liabilities (as a Percentage of Total) by Year of Retirement



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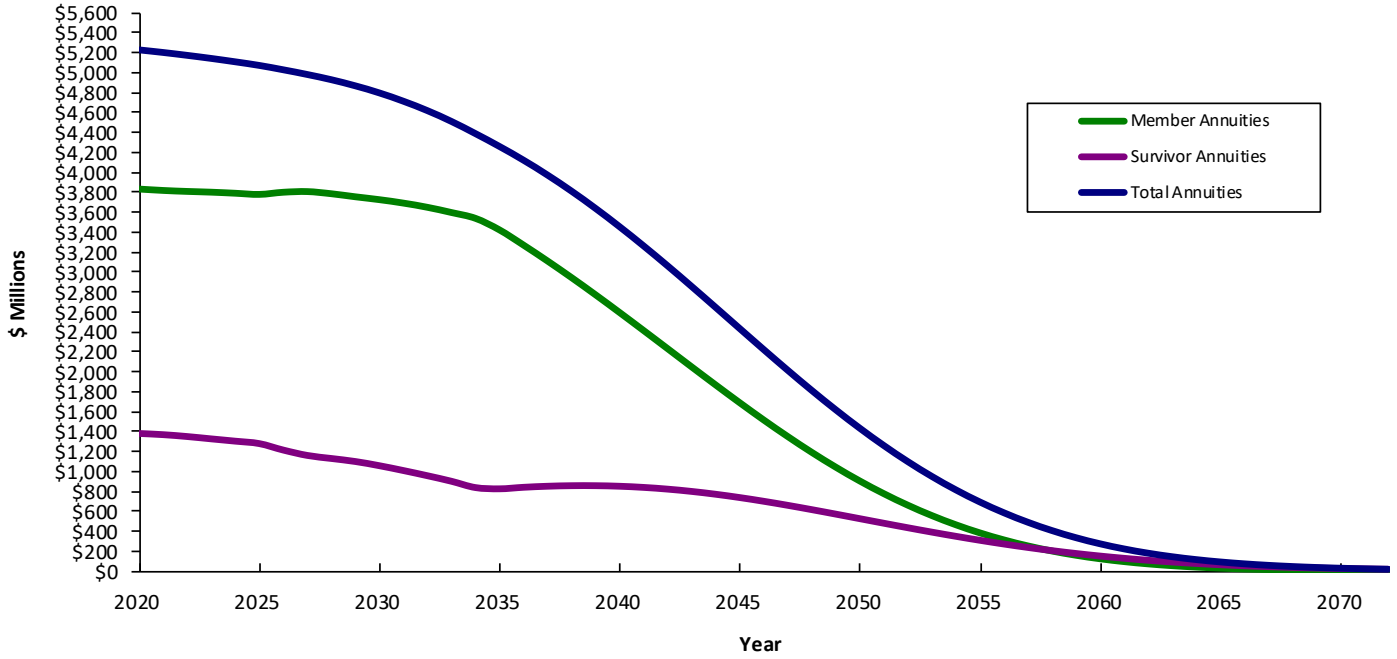
Projected Future Core Annuities



$ Billions

	With Expected Dividends	Without Expected Dividends
Total Future Benefit Payments	$128.1	$98.6
Present Assets	59.1	59.1
Future Investment Return Needed	69.0	39.5

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Based upon the assumptions used in the valuation, future dividends are expected to be approximately 1.9% per year. Of course actual dividends will be based upon actual future investment return and the operation of the Market Recognition Account.

Primary Sources of Variable Adjustment

	% of APV
1. SWIB net of fee investment return	28.5%
2. Adjustment to published effective rate	0.5%
3. Published effective earnings rate	29.0%
4. Adjustment to relate earnings to average variable annuity fund balance	(0.8)%
5. Earnings rate based on average balance	28.2%
6. Expected change before adjustments: (1.282)/1.05-1	22.1%
7. Adjustment to relate average asset to ending liability	0.3%
8. Carryover from last year due to timing of distribution, accounting adjustments and truncation	(1.3)%
9. Experience study/mortality reserve adjustment	(0.2)%
10. Experience and other effects	0.3%
11. Statutory adjustment: (truncate to whole percent)	(0.2)%
12. Variable annuity change: (6)+(7)+(8)+(9)+(10)+(11)	**21.0%**

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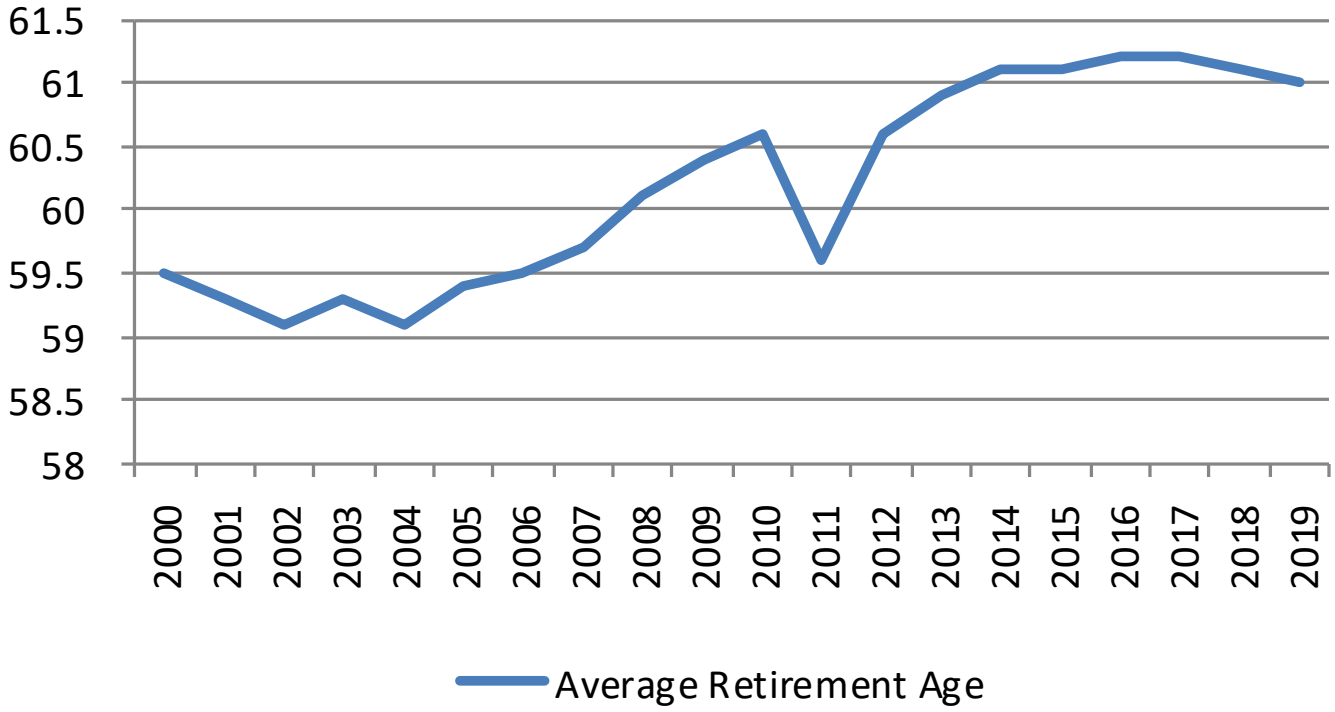
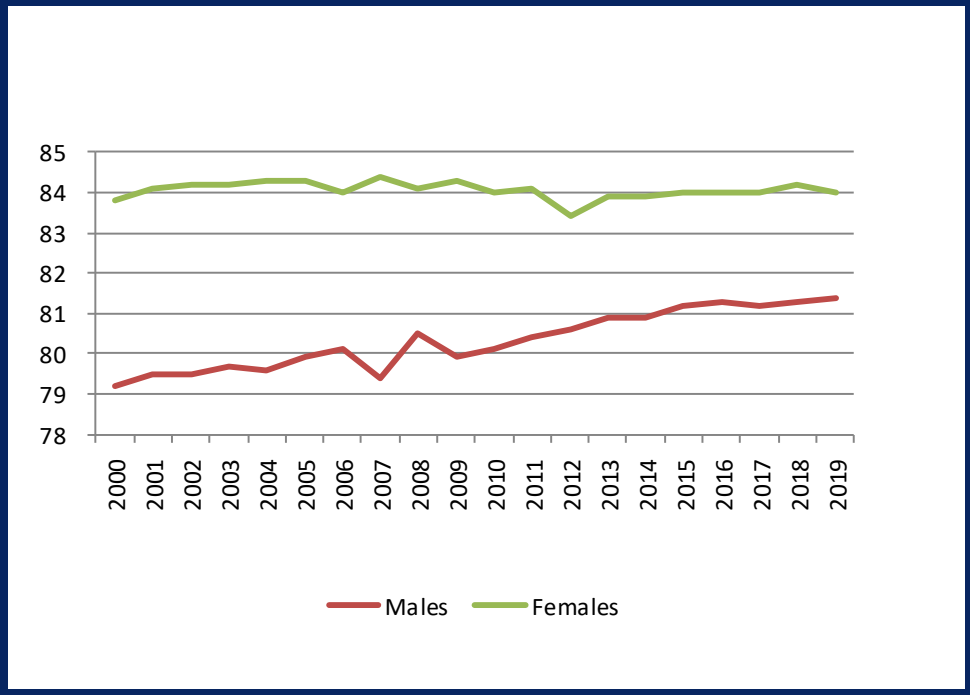
Average Retirement Age



Average Age at Death

Average age at death, while an interesting statistic, is not a proper measure of life expectancy, because it does not include people who have not yet died. The expected age at death for a 65-year-old is 86.3 for males and 88.7 for females.



The Concept of Generational Mortality

Illustration:

Years of Future Life Expectancy of a 60 Year Old					
Year of Birth	1959	1969	1979	1989	1999
Year Turn Age 60	2019	2029	2039	2049	2059
Male	25.78	26.27	26.75	27.24	27.73
Female	28.37	28.83	29.29	29.76	30.23

The 2014 WRS Experience Study introduced Mortality rates based on Birth Year

Actual versus Expected Deaths (Normal Retirement Only)

	Male Deaths			Female Deaths			Total Deaths		
Age	Actual	Expected	Exposure	Actual	Expected	Exposure	Actual	Expected	Exposure
30-34						1			1
35-39						1			1
40-44			1			10			11
45-49			16	1		64	1		80
50-54	4	2	952			507	4	2	1,459
55-59	19	25	5,240	16	20	6,937	35	45	12,177
60-64	64	75	11,462	69	76	17,929	133	151	29,391
65-69	194	192	18,557	163	192	29,792	357	384	48,349
70-74	277	311	18,905	255	292	26,525	532	603	45,430
75-79	400	362	12,658	346	341	16,797	746	703	29,455
80-84	441	438	8,129	466	447	11,397	907	885	19,526
85-89	447	472	4,824	569	582	7,442	1,016	1,054	12,266
90-94	365	328	2,015	552	520	3,934	917	848	5,949
95-99	126	119	438	289	282	1,222	415	401	1,660
100 & Up	16	13	39	68	58	199	84	71	238
Totals	**2,353**	**2,337**	**83,236**	**2,794**	**2,810**	**122,757**	**5,147**	**5,147**	**205,993**

Comparative Statement – Core

Valuation Date	Number	$ Millions Annual Annuities	$ Millions Fund Balance	$ Millions Actuarial Reserve	Ratio	Change in Annuities Average	Change in Annuities Maximum	CPI*
2010	155,775	3,532.4	37,798.4	38,148.5	0.991	(0.9)%	(1.2)%	1.5 %
2011	167,453	3,842.0	40,411.5	42,078.3	0.960	(4.0)%	(7.0)%	3.0 %
2012	173,655	3,806.3	40,591.6	41,852.4	0.970	(3.0)%	(9.6)%	1.7 %
2013	180,056	3,800.7	44,273.2	42,300.5	1.047	4.7 %	4.7 %	1.5 %
2014	185,605	4,102.3	47,135.7	45,790.7	1.029	2.9 %	2.9 %	0.8 %
2015	191,795	4,364.9	49,147.0	48,897.5	1.005	0.5 %	0.5 %	0.7 %
2016	197,647	4,523.1	51,972.0	50,941.4	1.020	2.0 %	2.0 %	2.1 %
2017	203,202	4,747.0	54,900.0	53,590.0	1.024	2.4 %	2.4 %	2.1 %
2018	211,126	5,040.9	56,493.8	56,629.3	0.998	0.0 %	0.0 %	1.9 %
2019	216,944	5,183.7	59,138.4	58,157.0	1.017	1.7 %	1.7 %	2.3 %
35-Year Average						**3.6 %**		**2.6 %**
20-Year Average						**1.3 %**		**2.1 %**
10-Year Average						**0.6 %**		**1.8 %**
5-Year Average						**1.3 %**		**1.8 %**

**Based on December CPI-U67 index.*

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Comparative Statement – Variable

Valuation Date	Number	$ Millions Annual Annuities	Fund Balance	Actuarial Reserve	Ratio	Change in Annuities	CPI*
2010	35,866	288.4	3,340.6	3,005.4	1.111	11.0 %	1.5 %
2011	38,949	330.3	3,197.9	3,462.9	0.924	(7.0)%	3.0 %
2012	39,873	304.6	3,463.9	3,169.6	1.093	9.0 %	1.7 %
2013	40,317	324.5	4,187.3	3,347.0	1.251	25.0 %	1.5 %
2014	39,420	386.5	3,995.4	3,917.1	1.020	2.0 %	0.8 %
2015	40,152	387.8	3,704.8	3,910.1	0.947	(5.0)%	0.7 %
2016	40,647	363.6	3,792.0	3,645.1	1.040	4.0 %	2.1 %
2017	40,877	369.9	4,324.9	3,682.1	1.175	17.0 %	2.1 %
2018	41,187	425.8	3,738.6	4,207.6	0.891	(10.0)%	1.9 %
2019	41,777	379.7	4,519.4	3,728.6	1.212	21.0 %	2.3 %
35-Year Average						**4.4 %**	**2.6 %**
20-Year Average						**0.4 %**	**2.1 %**
10-Year Average						**6.1 %**	**1.8 %**
5-Year Average						**4.7 %**	**1.8 %**

**Based on December CPI-U67 index.*

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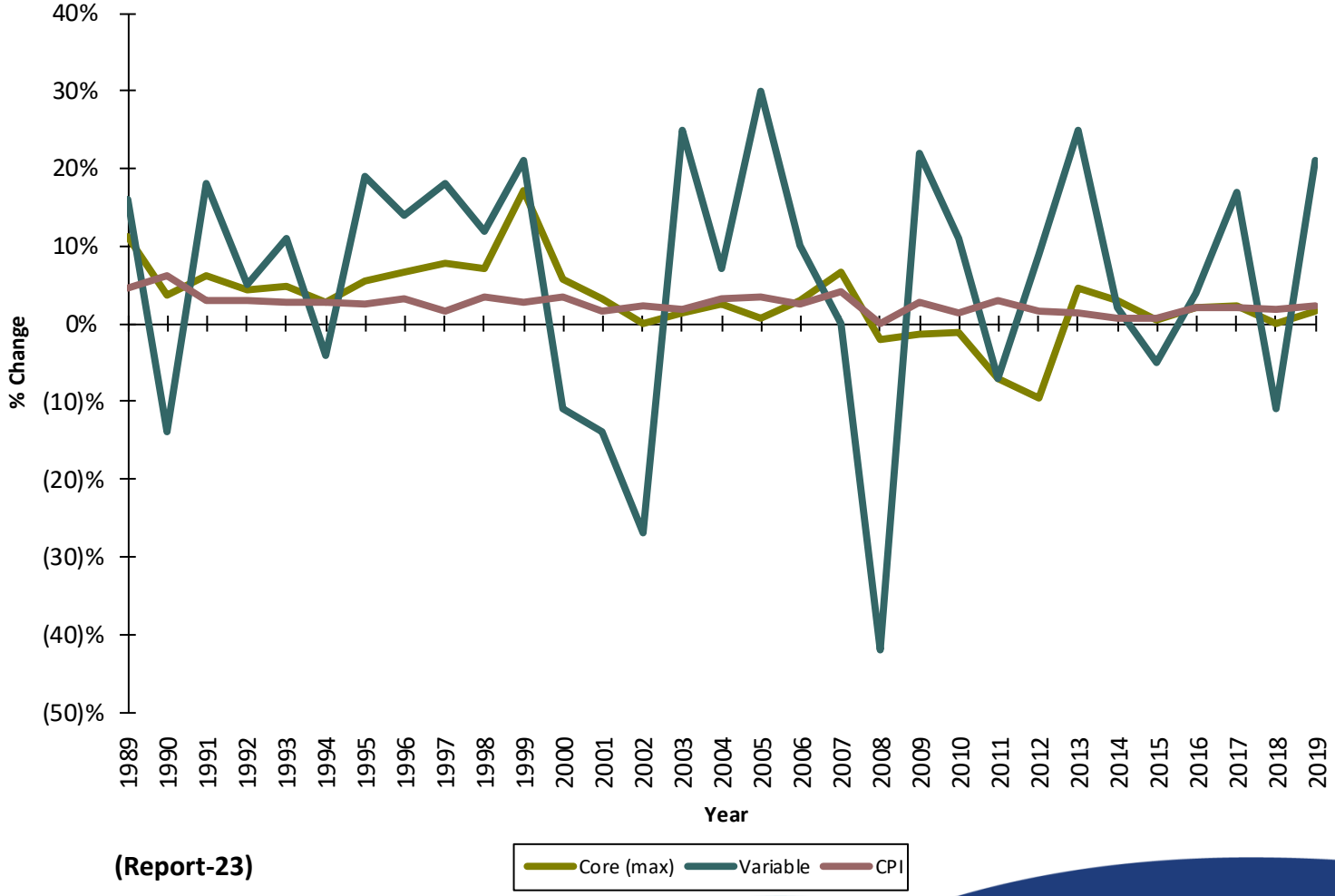
History of % Dividend Changes



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Looking Ahead

- As of the December 31, 2019 valuation, there are about $5.7 billion in unrecognized asset gains in the Core fund
  - About half of this will be applied to annuitant reserve
  - Will be recognized over the next four years
  - Will put upward pressure on dividends
- A few more years of positive dividends for all annuitants is needed to decrease the probability of dividend depletion

WRS STRESS TESTING

Objectives of the Study

- Investigate
  - Relationship of Investment Return to Success Measures
  - Effects of bad outcomes
- Evaluate several points along the Asset Allocation spectrum against the measures of success
- Find the “Sweet Spot” if it exists

Key Changes from 2017 Study

- 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

WRS Accounts and Reserves

- **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

- 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.

WRS STRESS TESTING

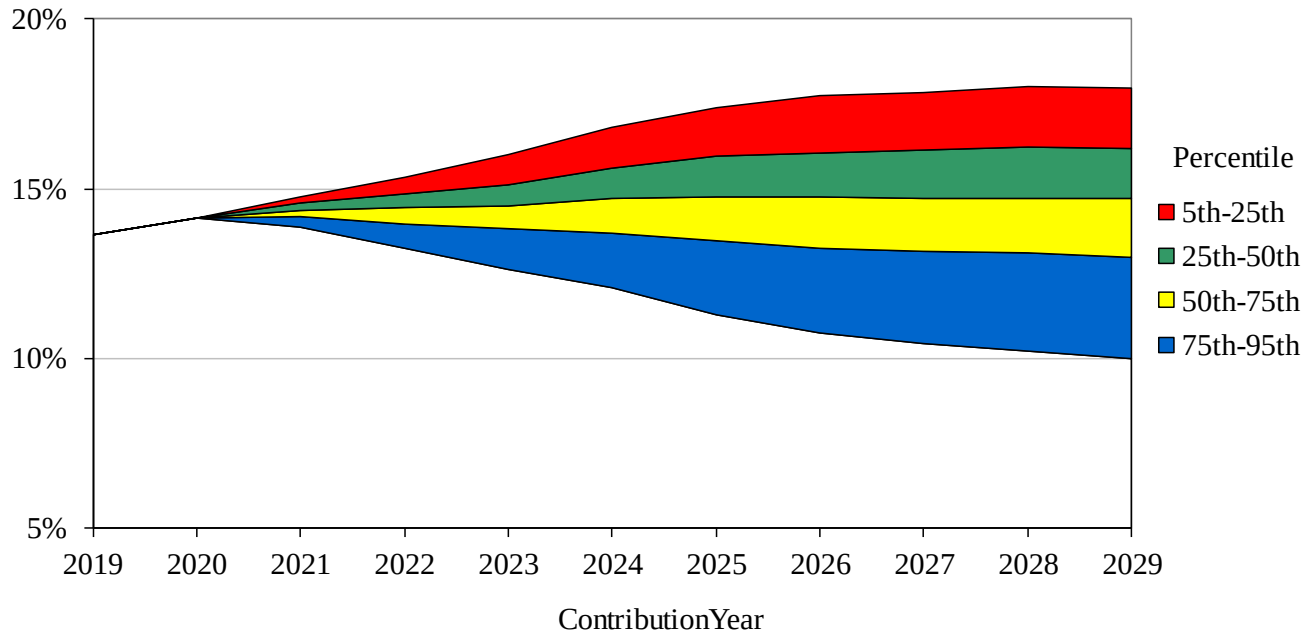
Monte Carlo Simulations

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

Actuarial Rate →

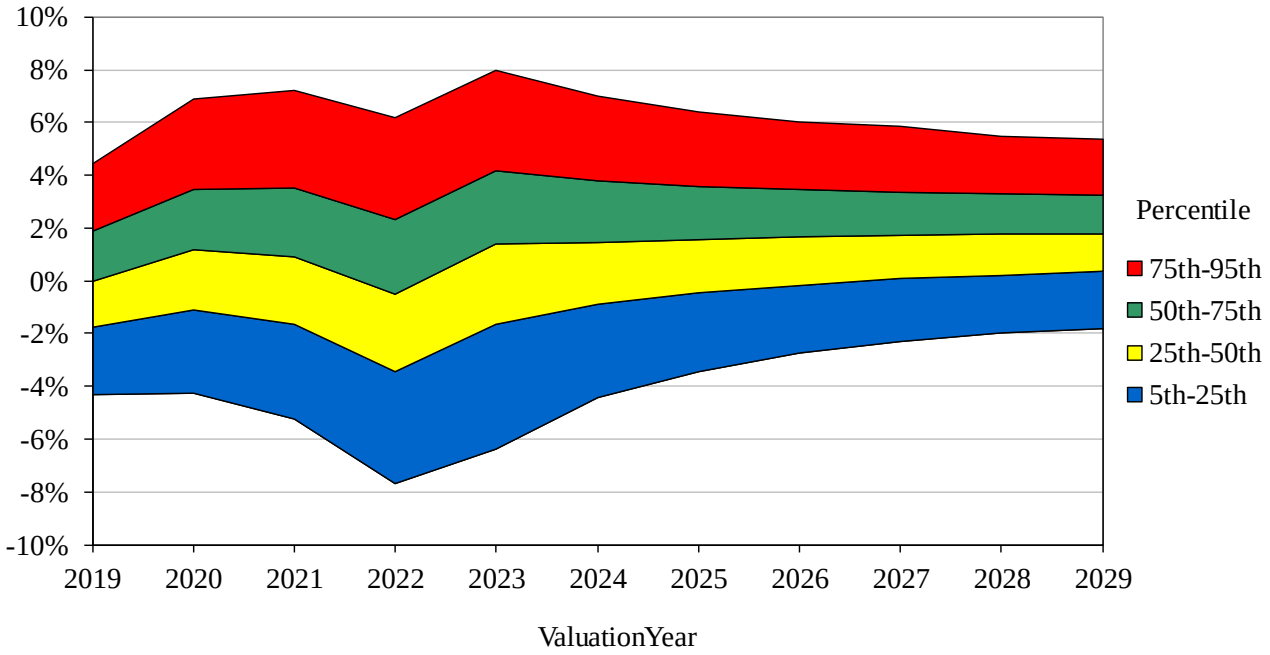
	Expected Return		Standard
	Geometric	Arithmetic	Deviation
Scenario 1	4.0%	4.1%	4.3%
Scenario 2	5.0%	5.2%	7.4%
Scenario 3	6.0%	6.4%	10.7%
Scenario 4	7.0%	7.8%	14.7%
Scenario 5	8.0%	9.3%	19.0%
Scenario 6	9.0%	11.1%	24.1%
Scenario 7	10.0%	13.1%	29.9%

Contribution as a % of Payroll
Scenario 1 – 7.0%ER,14.7%Volatility



5th Percentile	13.6%	14.1%	14.8%	15.3%	16.0%	16.8%	17.4%	17.8%	17.8%	18.0%	18.0%
25th Percentile	13.6%	14.1%	14.6%	14.8%	15.1%	15.6%	16.0%	16.1%	16.1%	16.2%	16.2%
Median	13.6%	14.1%	14.4%	14.4%	14.5%	14.7%	14.8%	14.8%	14.7%	14.7%	14.7%
75th Percentile	13.6%	14.1%	14.2%	13.9%	13.8%	13.7%	13.5%	13.3%	13.1%	13.1%	13.0%
95th Percentile	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 1 – 7.0%ER,14.7%Volatility



5th Percentile	-4.3%	-4.3%	-5.2%	-7.7%	-6.4%	-4.4%	-3.4%	-2.7%	-2.3%	-2.0%	-1.8%
25th Percentile	-1.8%	-1.1%	-1.6%	-3.4%	-1.7%	-0.9%	-0.5%	-0.2%	0.1%	0.2%	0.3%
Median	0.0%	1.2%	0.9%	-0.5%	1.4%	1.5%	1.6%	1.7%	1.7%	1.8%	1.8%
75th Percentile	1.9%	3.5%	3.5%	2.3%	4.2%	3.8%	3.6%	3.5%	3.4%	3.3%	3.3%
95th Percentile	4.4%	6.9%	7.2%	6.2%	8.0%	7.0%	6.4%	6.0%	5.9%	5.5%	5.4%

Dividend Stress Test

Probability That Dividend Reserve Will Be Depleted in Year

	Expected ROR	Standard Deviation	Year 1	Year 5	Year 10	Year 20	Year 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 →

Dividend Stress Test

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

	Expected ROR	Standard Deviation	Year 1	Year 5	Year 10	Year 20	Year 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 Cumulative Dividend Percent (% of Floor Benefit That Is Funded)

Actuarial Rate	Expected ROR	Standard Deviation	Year 1	Year 5	Year 10	Year 20	Year 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%

Actuarial Rate →

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

Dividend Stress Test Observations

- 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						
			Contribution Rates			Dividend Rates			Retiree FS/Year occurred
	ROR	StdDev	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
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

Actuarial Rate →

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 3 and 4 represent potential “Goldilocks Zone”

2019 Observations

- 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

Disclaimers

- This presentation shall not be construed to provide tax advice, legal advice or investment advice.
- This presentation is intended to be used in conjunction with the actuarial valuation report for retired lives issued on February 28, 2020. This presentation should not be relied on for any purpose other than the purpose described in the valuation report.
- Readers are cautioned to examine original source materials and to consult with subject matter experts before making decisions related to the subject matter of this presentation.
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