Milliman

Economic Assumptions & Actuarial Methods

OREGON PUBLIC EMPLOYEES RETIREMENT SYSTEM

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May 31, 2019

Three-Meeting Process – Assumptions & Methods

- April 1: Background on current key assumptions and methods
  - Assumed rate
  - Amortization period for unfunded actuarial liability (UAL)
  - Contribution rate collaring policy

- **Today: Economic assumptions, system funding methods**
  - **Inflation and system payroll growth**
  - **Assumed rate – data from Treasury's consultant, Milliman's model**
  - **Actuarial methods, including amortization and collaring policy**

- July 26: Demographic assumptions, Board decisions
  - Member-specific assumptions based on study of recent PERS experience
  - Assumptions and methods adopted will be used for:
    - 12/31/2018 actuarial valuation with advisory 2021-2023 contribution rates
    - 12/31/2019 actuarial valuation with 2021-2023 contribution rates proposed for adoption

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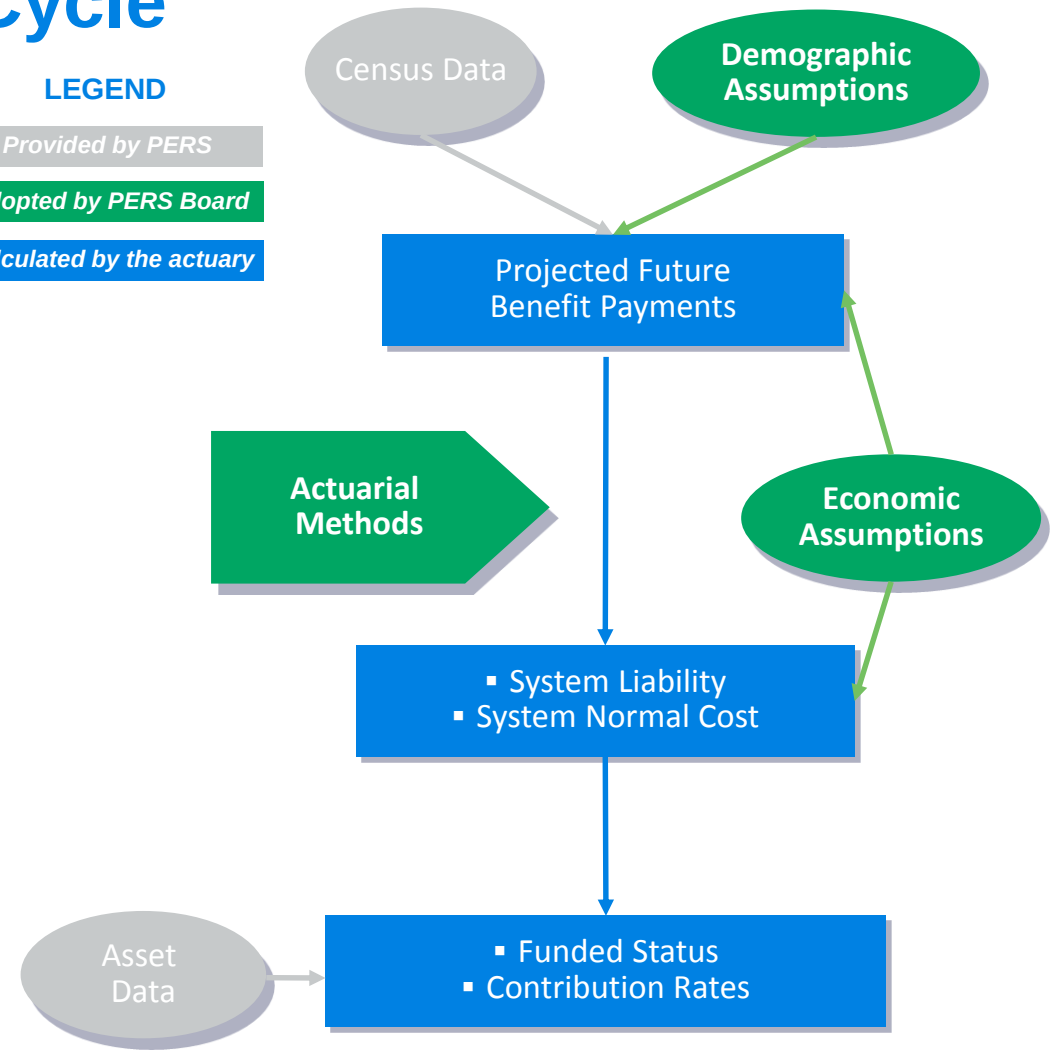
Two-Year Rate-Setting Cycle

- **July 2019: Assumptions & methods adopted by Board in consultation with the actuary**
- October 2019: System-wide 12/31/18 actuarial valuation results
- December 2019: Advisory 2021-2023 employer-specific contribution rates
- July 2020: System-wide 12/31/19 actuarial valuation results
- September 2020: Disclosure & adoption of employer-specific **2021-2023 contribution rates**



Valuation Process and Timeline

- Actuarial valuations are conducted annually
  - Alternate between “rate-setting” and “advisory” valuations
  - The next valuation as of 12/31/2018 will be advisory
- Board adopts contribution rates developed in rate-setting valuations, and those rates go into effect 18 months subsequent to the valuation date

Valuation Date	Employer Contribution Rates
12/31/2015 →	July 2017 – June 2019
12/31/2017 →	July 2019 – June 2021
12/31/2019 →	July 2021 – June 2023

Board Objectives - Methods & Assumptions

- Transparent
- Predictable and stable rates
- Protect funded status
- Equitable across generations
- Actuarially sound
- GASB compliant

Some of the objectives can conflict, particularly in periods with significant volatility in investment return or projected benefit levels. Overall system funding policies should seek an appropriate balance between conflicting objectives.

The Fundamental Cost Equation

- Long-term program costs are the contributions, which are governed by the “fundamental cost equation”:

BENEFITS =

CONTRIBUTIONS +

EARNINGS

Governance Structure

- Benefits:
  - Plan design set by Oregon Legislature
  - Subject to judicial review
- Earnings:
  - Asset allocation set by OIC
  - Actual returns determined by market
- Contributions:
  - Funding, including methods & assumptions, set by PERS Board
  - Since contributions are the balancing item in the fundamental cost equation, PERS Board policies primarily affect the **timing** of contributions
  - Different actuarial methods and assumptions produce different projected future contribution patterns

Review of Non-Investment Economic Assumptions

Assumptions to Be Reviewed

	12/31/2017 Valuation "Current" Assumptions
Inflation	2.5%
Real Wage Growth	1.0%
System Payroll Growth	3.5%
Administrative Expenses:	
- OPSRP	$6.5 million
- Tier 1/ Tier 2	$37.5 million

Economic Assumptions
Inflation

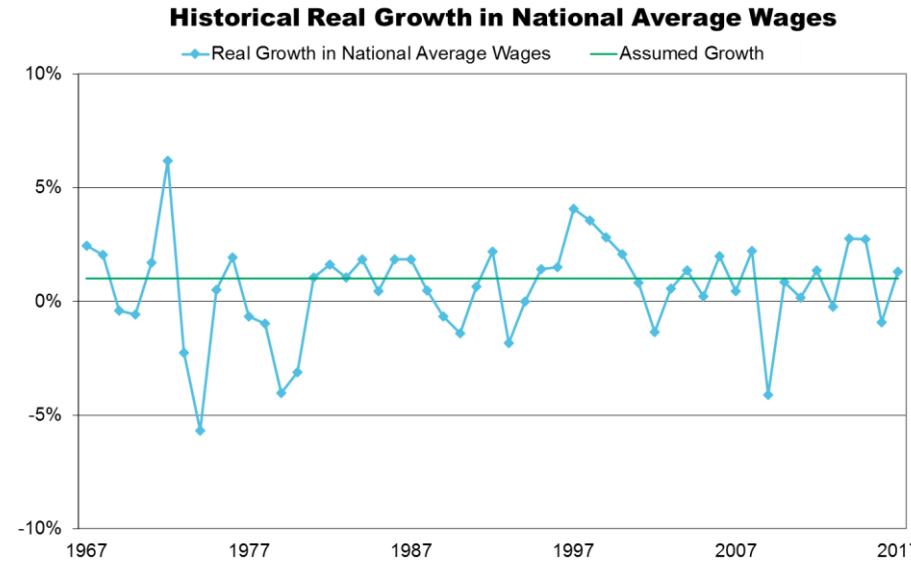
- The inflation assumption affects other assumptions, including system payroll growth, investment return, and health care inflation
- Inflation can vary significantly over time
- One estimate of future inflation can be derived from yields of Treasury securities and Treasury Inflation Protected Securities (TIPS)
- Social Security's current "intermediate cost" 30-year average inflation assumption is **2.58%**
- In our opinion, the current assumption of **2.5%** is reasonable

Period Ending 12/31/2018	Average Inflation
10 years	1.80%
20 years	2.16%
30 years	2.48%
40 years	3.33%

As of 12/31/2018	10 Year	30 Year
Treasury Yield	2.69%	3.02%
TIPS Yield	0.98%	1.21%
"Breakeven" Inflation	**1.71%**	**1.81%**

Economic Assumptions
Real Wage Growth

- An individual member's assumed annual salary increase is composed of:
  - Inflation
  - Real wage growth
  - Individual merit/longevity component
- Real wage growth represents the increase in wages in excess of inflation for the entire group due to improvements in productivity and competitive market pressures
- Social Security's long-term "intermediate cost" real wage growth assumption is 1.2%
- In our opinion, the current assumption of **1.0%** is reasonable



Most Recently Available	Average Real Wage Growth
10 Years	0.59%
20 Years	0.92%
30 Years	0.82%
40 Years	0.65%

Economic Assumptions
System Payroll Growth

- Overall system payroll growth is assumed to equal the sum of:
  - Inflation
  - Real wage growth
- The system payroll growth assumption determines the shape of the curve of payments to amortize the unfunded liability
- Given that in our opinion both an inflation assumption of 2.5% and a real wage growth assumption of 1.0% are reasonable, the current system payroll growth assumption of **3.5%** is also reasonable in our opinion

Trailing Period	Average Annualized Growth in Valuation Payroll
5 Years	3.3%
10 Years	2.7%
14 Years	3.5%

Economic Assumptions
Administrative Expenses

- Actual administrative expenses for recent years are shown below

($ millions)	Tier 1/Tier 2		OPSRP	
Year	Actual Expenses	% of Beginning of Year Assets	Actual Expenses	% of Beginning of Year Assets
2014	$30.1	0.06%	$5.0	0.30%
2015	$31.5	0.06%	$5.7	0.28%
2016	$35.8	0.07%	$5.9	0.25%
2017	$35.1	0.07%	$5.9	0.20%
2018	$29.1	0.05%	$7.6	0.18%

- Overall, 2018 admin expenses were 0.06% of total assets
- Proposed assumed annual expenses for 2019 and 2020:

Tier 1/Tier 2: $32.5 million
OPSRP: $8.0 million

Assumptions to Be Reviewed

	12/31/2017 Valuation Assumptions	12/31/2018 Valuation Proposed* Assumptions
Inflation	2.5%	2.5%
Real Wage Growth	1.0%	1.0%
System Payroll Growth	3.5%	3.5%
Administrative Expenses:		
- OPSRP	$6.5 million	$8.0 million
- Tier 1/Tier 2	$37.5 million	$32.5 million

No explicit assumption is made for investment-related expenses, which are accounted for implicitly in the analysis of the long-term investment return assumption.

*No action is needed on “proposed” assumptions today, since all assumptions and methods will be adopted at the July 2019 Board meeting

Long-Term Investment Return Assumption

Long-Term Investment Return Assumption

- Uses of the investment return assumption
  - As a “discount rate” for establishing the:
    - Actuarial accrued liability, which is a net present value
    - Associated unfunded actuarial liability, also called the UAL or actuarial shortfall
  - Guaranteed crediting level for regular Tier 1 active member account balances
  - Annuitization rate for converting member account balances to lifetime money match monthly benefits

Reflecting expectations for both investment earnings and benefit levels for certain members, the assumption helps set a reasonable and appropriate budgeting glide path for projected employer contribution rates

Use of the Assumed Rate

The PERS Funding Equation

At the end of each calendar year, the PERS actuaries calculate the system's funded status using the following basic equation:

B	=	C	+	E
BENEFITS		CONTRIBUTIONS		EARNINGS
Present value of earned benefits		*Employer funds to pay for pension benefits*		*Future returns on investment funds*
Set by: Oregon Legislature		Set by: PERS Board		Managed by: Oregon Investment Council

Every two years, the PERS Board adjusts contribution rates so that, over time, contributions will be sufficient to fund the benefits earned, if earnings follow assumptions.

- "B" is predictable with a relatively high degree of certainty
- "E" is the unpredictable **actual** future investment return on PERS assets
- "C" is the balancing item --- it must provide to "B" what "E" fails to cover

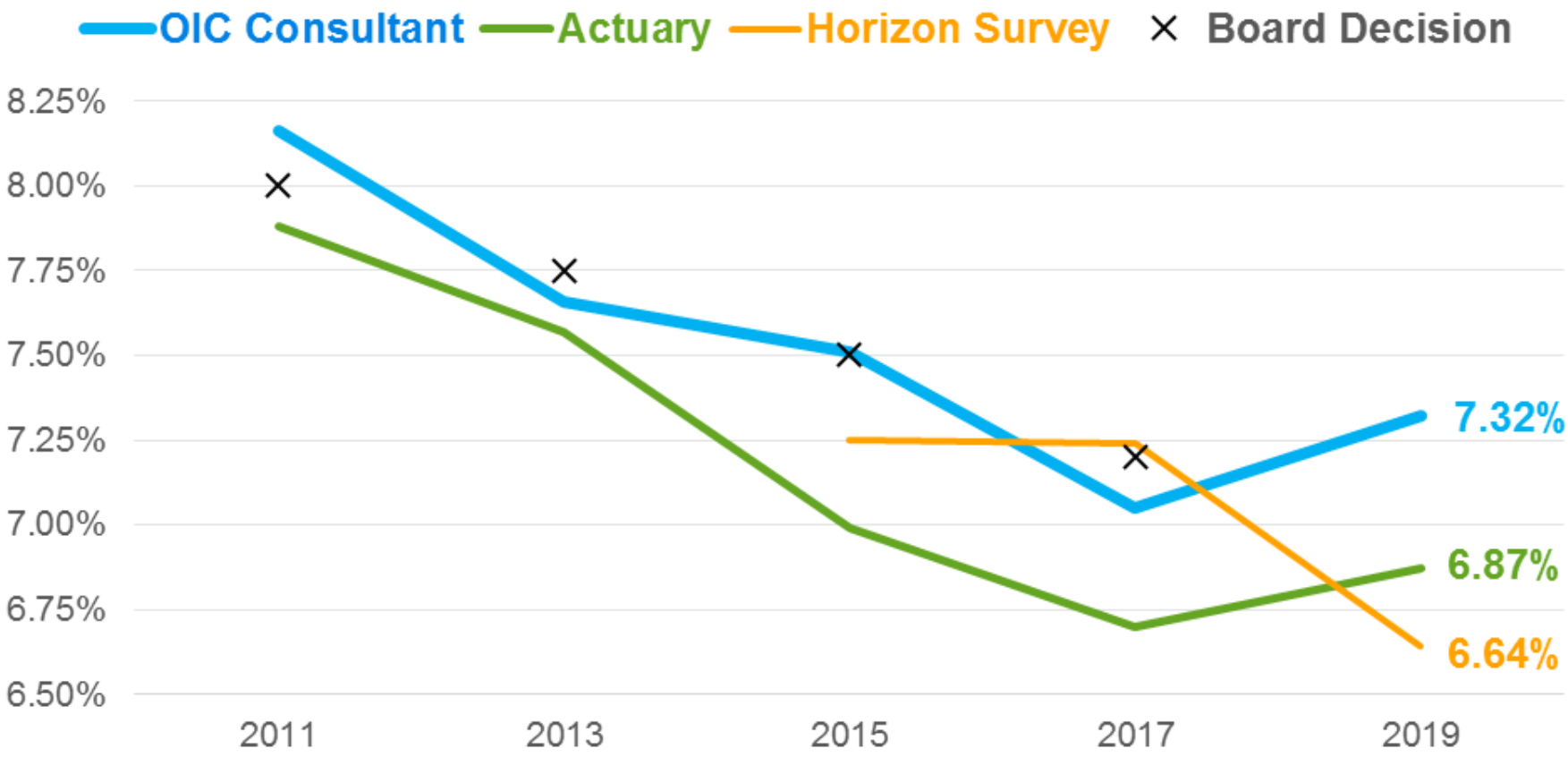
- The **assumed rate** is the Board's estimate of "E" to prudently set "C"
- The Board's decision on "E" does **not** affect actual future earnings

Investment Return 50th Percentile Outlooks

- We applied a standard mean/variance model to calculate 50th percentile return estimates based on capital market outlook assumptions from three sources
  - Milliman
  - Callan – Consultant to OIC
  - 2018 Horizon survey of capital market assumptions (survey of 34 advisors)
- Estimates do not reflect any possible "alpha" due to selected managers potentially outperforming market benchmarks over the long term, net of fees
- Today's speakers are not credentialed investment advisors
  - We are presenting Milliman capital market outlook model results based on assumptions developed by Milliman's credentialed investment professionals

Details on each set of capital market outlook assumptions are in the Appendix

Investment Return 50th Percentile Outlooks



Investment Return 50th Percentile Outlooks

- Estimates are based on OIC's target long-term asset allocation
  - Current actual allocation differs somewhat from the target allocation
- Callan and Horizon estimates are calibrated over a shorter investment timeframe than Milliman's estimates
  - Also reflect lower level of assumed inflation

	Milliman	Callan	Horizon
Median Annualized Return	**6.87%**	**7.32%**	**6.64%**
Assumed Inflation	2.50%	2.25%	2.24%
Timeframe Modeled	20 years	10 years	10 years

The median returns shown above are geometric annualized average returns over the timeframes indicated above for each provided set of capital market assumptions

Investment Return 50th Percentile Outlooks

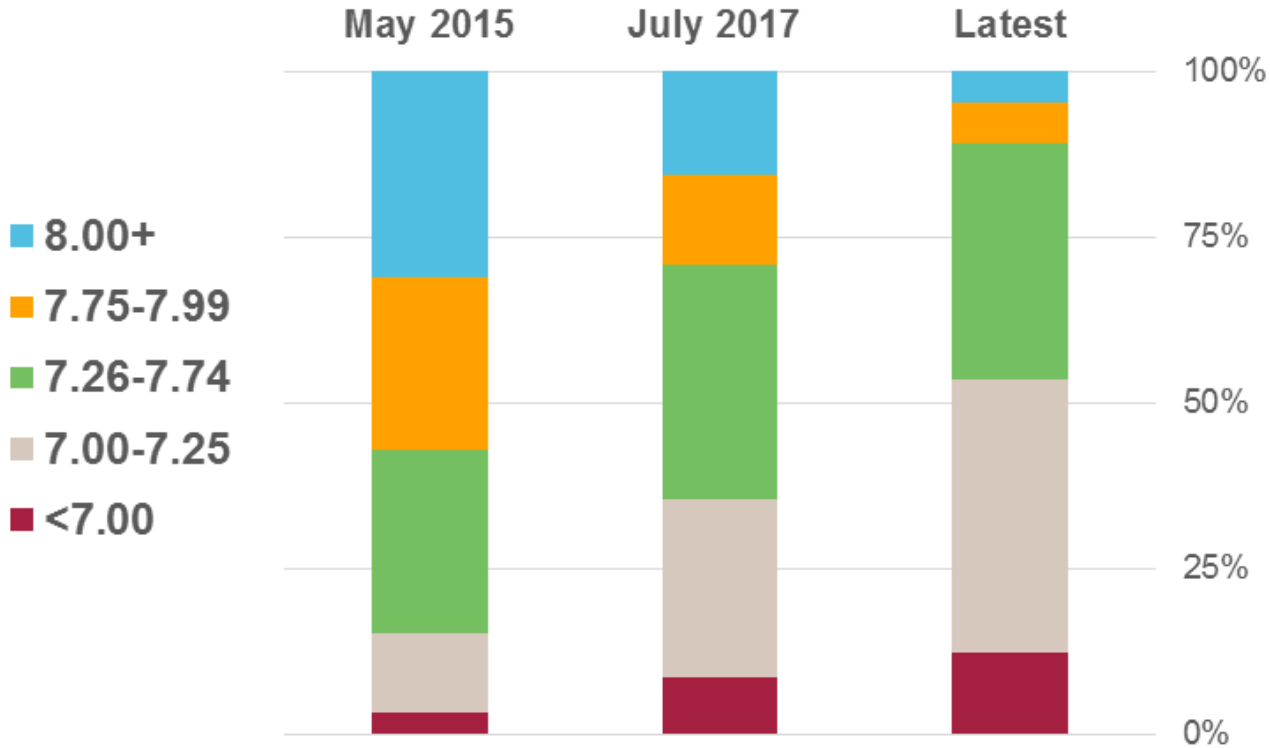
- Capital market outlooks change over time
  - Milliman outlook updated every six months
  - Recent changes and key factors shown below for Milliman model of PERS asset allocation

Milliman 20-year outlook	May 2015	May 2017	May 2019
Median Annualized Return	**6.99%**	**6.70%**	**6.87%**
US Public Equity	6.74%	6.36%	6.36%
Non-US Public Equity	6.89%	6.90%	7.11%
Private Equity	7.97%	7.82%	8.33%
US Core Fixed Income	4.00%	3.49%	4.07%
US Short-term Bonds	3.61%	3.38%	3.68%
Real Estate	5.84%	5.51%	5.55%

Asset category returns shown above are 20-year annualized geometric mean returns

Comparison to Peer Systems

- There is a downward trend in public plan return assumptions, with a current median assumption for large public systems of **7.25%**
- Over 50% of the 129 systems tracked by the NASRA Public Fund Survey reduced their assumption over last 2-3 years



Source: NASRA (April, 2019)

Effects of Lowering the Assumed Return

- A lower investment return assumption would produce higher calculated liabilities and contribution rates
- Liabilities are net present values, as of the valuation date, of a benefit payment projection that stretches far into the future
  - Changing the assumption modifies the projected balance of the fundamental cost equation between future investment earnings and future contributions
    - The actual balance will depend on actual investment earnings, not on the assumed return adopted by the PERS Board
  - The effect of lowering the assumed return to 7.00% is estimated as a 1.7% of payroll increase in the uncollared system average base employer contribution rate
- For PERS, such an assumption change would also lower benefits for future retirements calculated under Money Match

Considerations in Setting the Return Assumption

- In our opinion, the current 7.20% long-term future investment return assumption is reasonable based on current data from the capital market outlook models, the guiding principles, and Actuarial Standards of Practice
- Callan, the primary investment consultant to the OIC, currently estimates a long-term return above the current assumption
  - The PERS Board could still elect to reduce the assumption for conservatism, if desired
  - We would not recommend increasing the return assumption at this time, given the uncertainty in future outlooks and the influence of the point-in-time measurement at year-end 2018
- At the July meeting, we will ask the Board to adopt an assumption for use in the upcoming valuations

Actuarial Methods

Key Actuarial Methods

	12/31/2017 Valuation Methods	12/31/2018 Valuation Proposed* Methods
Cost Allocation Method	Entry Age Normal	No change
Shortfall Amortization Method	Level percent of pay, layered fixed periods: Tier 1/Tier 2: 20 years OPSRP: 16 years RHIA/RHIPA: 10 Years	No change
Rate Collar	Limits change in based contribution rate to larger of 20% of current rate or 3.00% of payroll; Collar widens incrementally when funded status below 70%	No change

*No action is needed on “proposed” methods today, since all assumptions and methods will be adopted at the July 2019 Board meeting

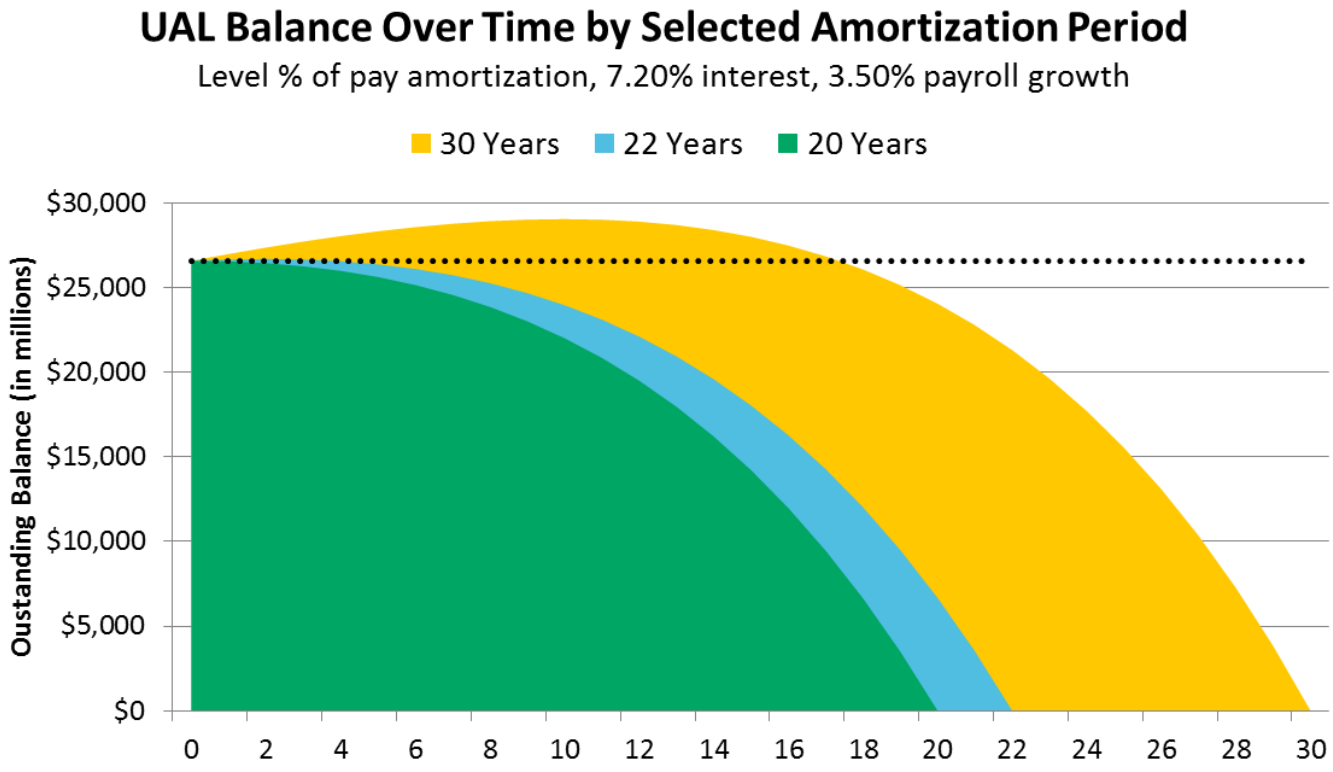
Cost Allocation Method

- Rates are calculated to pre-fund retirement benefits during a member's working career if all assumptions are met
- The present day value of projected future benefits allocated to a particular working year is the Normal Cost
- The present day value of projected future benefits allocated to prior years is the Accrued Liability
- The division between past, current & future service is done through use of an actuarial cost allocation method
- PERS currently uses GASB-compliant cost allocation method of Entry Age Normal (EAN)
  - We recommend no change to the cost allocation method

Shortfall Amortization Periods

- A key part of contribution rate calculations is amortization of Tier 1 / Tier 2 shortfalls over twenty years as a level percentage of payroll
  - As part of changes made in a prior experience study, UAL as of December 31, 2013 was re-amortized over twenty years
  - Subsequent gains or losses, including loss as of December 31, 2015, amortized over twenty years from the rate-setting valuations in which they are recognized
- Twenty years avoids significant negative amortization, where shortfall actually increases in the initial “pay down” years even if assumptions are met and contributions are made
  - The following slide illustrates pay down of a $26.6 billion shortfall over periods of 20, 22 or 30 years at current assumptions

Remaining Balance for 20/22/30 Year Periods



Current policy

- Tier 1 / Tier 2: **20 years**
- OPSRP: **16 years**

- **Why 20 years or less?** If actual experience matches the assumption…
  - with 22 years zero progress is made in decreasing the initial UAL until year 3
  - with 30 years the UAL has increased by about 9% after the first decade, and zero progress is made in decreasing the initial UAL until year 18

Shortfall Amortization and Stress Testing

- Results of updated "stress testing", similar to shown in December financial modeling presentation

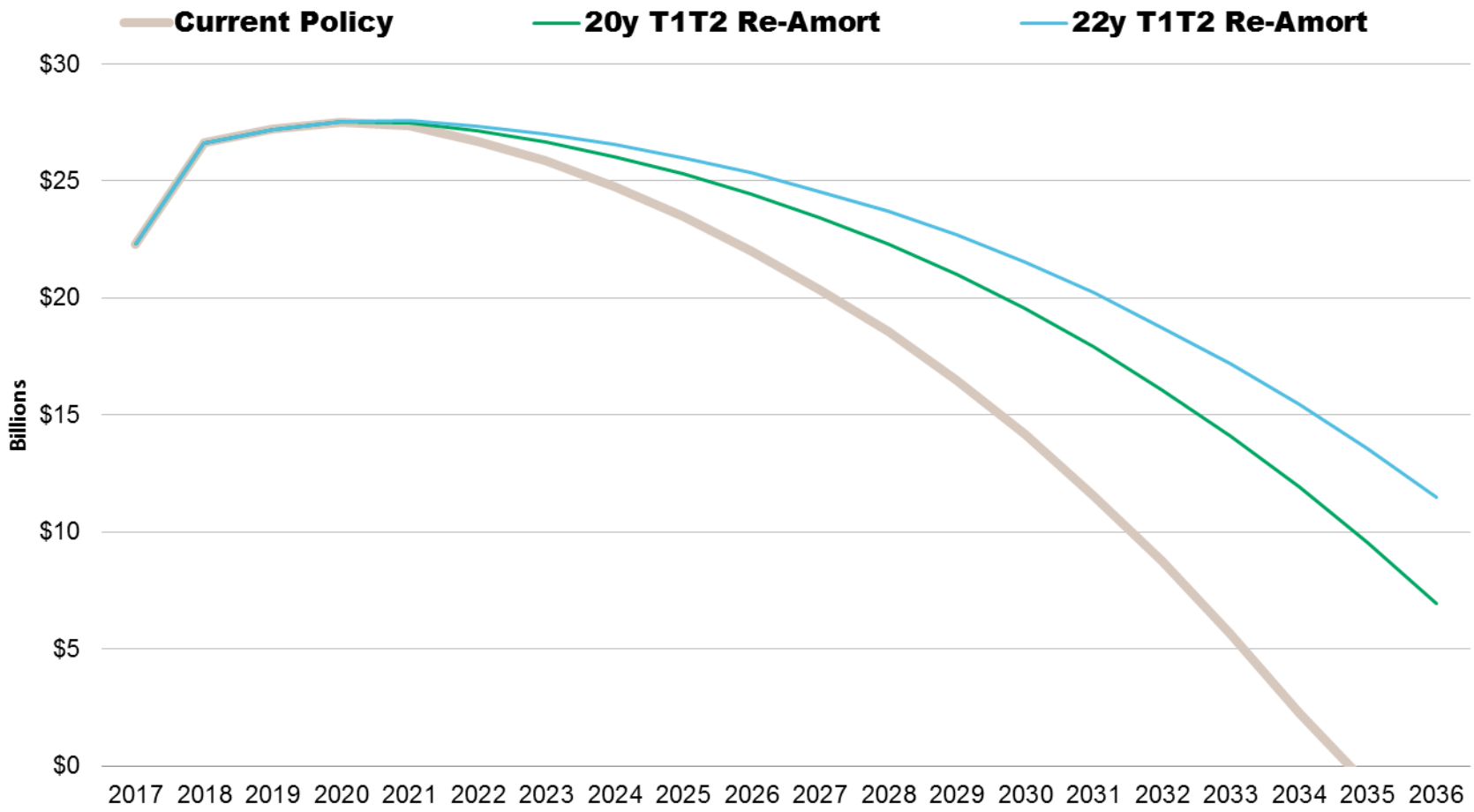
Likelihood of Event Occurring at Some Point in Next 20 Years			
Amortization Policy:	**Baseline**	**20 Year T1T2 Re-Amort**	**22 Year T1T2 Re-Amort**
Funded Status > 100%	64%	55%	52%
Funded Status < 60%	60%	64%	66%
Funded Status < 40%	8%	12%	14%
Base Rate < 10% of Pay	41%	31%	32%
Base Rate > 30% of Pay	87%	80%	76%
Base Rate > 40% of Pay	52%	44%	39%

Funded Status excluding side accounts; Base rate excluding retiree healthcare

Median Year-end 2036 UAL	**$3.1 B**	**$13.5B**	**$17.9B**

Unfunded Actuarial Liability (excl. Side Accounts)

- +7.20% actual annual future return



Unfunded Actuarial Liability (incl. Side Accounts)

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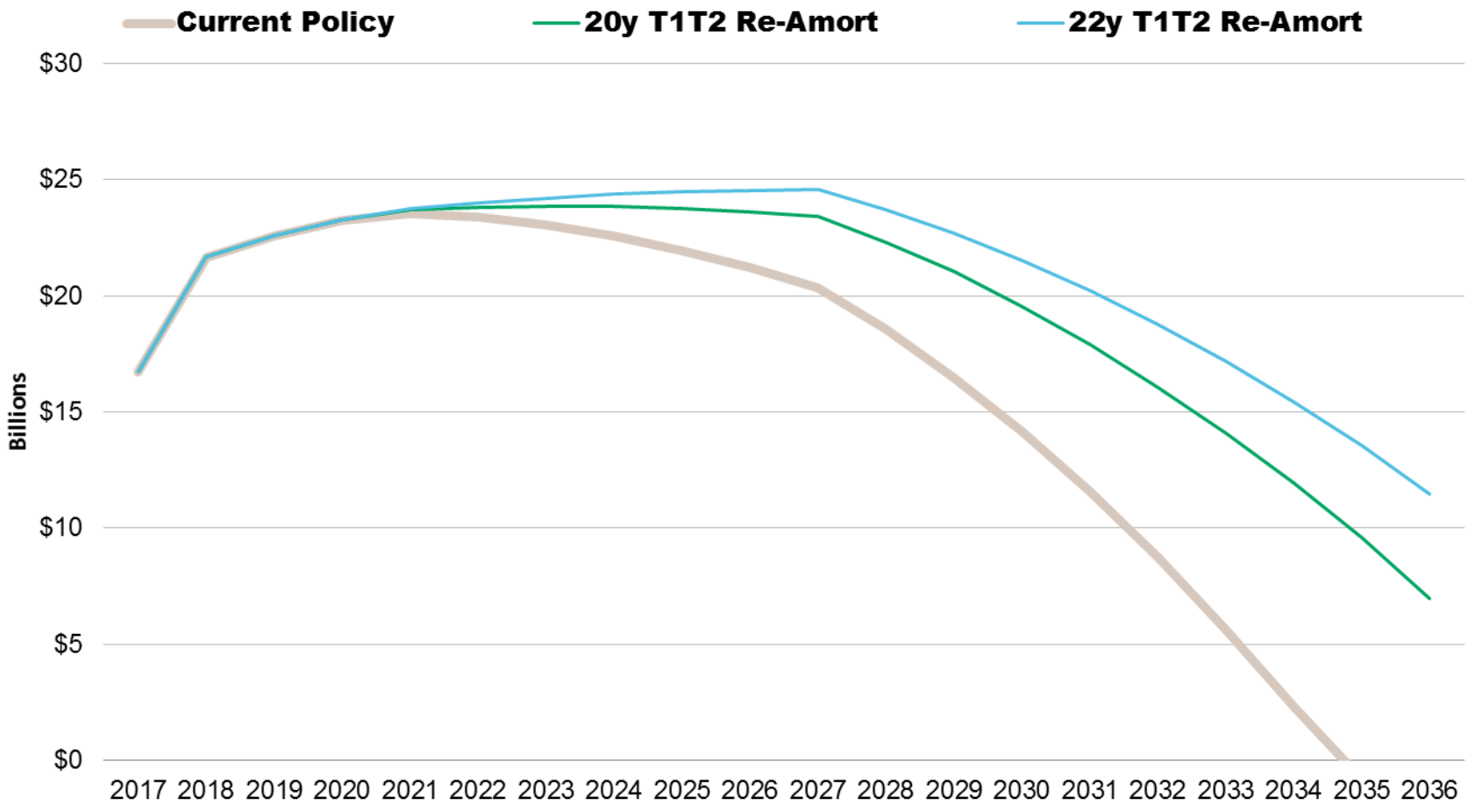


Rate Collar

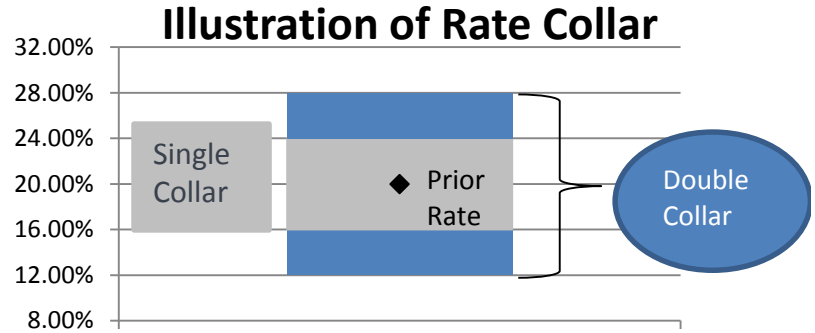
- Rate collar originally established by PERS Board after the 2003 reforms
  - Initially used in the 12/31/04 (advisory) and 12/31/05 (rate-setting) valuations
  - Development process included stochastic (i.e., 10,000 scenario) analysis

High Concept:

- Transparently calculate the actuarially needed **uncollared rate** that would return PERS to 100% funded status over the selected amortization period if future experience matches assumptions
- If uncollared rate is well above the current rate charged, limit the initial rate increase to within a specified range ("collar") of current rate
- The **collared rate** can temporarily be below the uncollared rate
  - New rate charged to employers will be partway toward the uncollared rate
  - Collaring systematically spreads large increases across multiple biennia
- The collar width should be calibrated to balance competing objectives
  - Too wide: same as having no collar, insufficiently stable or predictable
  - Too narrow: harms funded status, generationally inequitable, actuarially unsound

Rate Collar - Current Design

- The maximum change typically permitted by the collar is:
  - 20% of the rate currently in effect (3% of payroll minimum collar width)
- If funded status (w/o side accounts) is 60% or lower, width of collar doubles
  - 40% of rate currently in effect (6% of payroll minimum collar width)
- If the funded status is between 60% and 70%, the collar size is pro-rated between the single collar width and the double collar width



Collars are calculated at a rate pool level and limit the biennium to biennium increase in the UAL Rate for a given rate pool

Additional technical detail regarding the rate collar was provided in our April 1, 2019 presentation

Agenda for July Meeting

- Review demographic assumptions
  - Member-specific assumptions based on study of recent PERS experience
- Adopt all methods and assumptions for use in:
  - 12/31/2018 actuarial valuation with advisory 2021-2023 contribution rates
  - 12/31/2019 actuarial valuation with 2021-2023 contribution rates proposed for adoption

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Appendix

Certification

This presentation discusses actuarial methods and assumptions for use in the valuation of the Oregon Public Employees Retirement System ("PERS" or "the System"). For the most recent complete actuarial valuation results, including cautions regarding the limitations of use of valuation calculations, please refer to our formal Actuarial Valuation Report as of December 31, 2017 ("the Valuation Report") published on September 28, 2018. The Valuation Report, including all supporting information regarding data, assumptions, methods, and provisions, is incorporated by reference into this presentation. The statements of reliance and limitations on the use of this material is reflected in the actuarial report and still apply to this presentation. The Valuation Report, along with prior presentations to the PERS Board, including the December 2018, February 2019, and April 2019 presentations to the PERS Board should be referenced for additional detail on the assumptions, methods, and plan provisions underlying this presentation.

In preparing this presentation, we relied, without audit, on information (some oral and some in writing) supplied by the System's staff as well as capital market expectations provided by Callan and information presented to the Oregon Investment Council. This information includes, but is not limited to, statutory provisions, employee data, and financial information. We found this information to be reasonably consistent and comparable with information used for other purposes. The results depend on the integrity of this information. If any of this information is inaccurate or incomplete our results may be different and our calculations may need to be revised.

Milliman's work product was prepared exclusively for Oregon PERS for a specific and limited purpose. It is a complex, technical analysis that assumes a high level of knowledge concerning PERS' operations, and uses PERS' data, which Milliman has not audited. It is not for the use or benefit of any third party for any purpose. To the extent that Milliman's work is not subject to disclosure under applicable public records laws, Milliman's work may not be provided to third parties without Milliman's prior written consent. Milliman does not intend to benefit or create a legal duty to any third party recipient of its work product. Any third party recipient of Milliman's work product who desires professional guidance should not rely upon Milliman's work product, but should engage qualified professionals for advice appropriate to its own specific needs.

The consultants who worked on this assignment are pension actuaries. Milliman's advice is not intended to be a substitute for qualified legal or accounting counsel. The signing actuaries are independent of the plan sponsors. We are not aware of any relationship that would impair the objectivity of our work.

On the basis of the foregoing, we hereby certify that, to the best of our knowledge and belief, this report is complete and accurate and has been prepared in accordance with generally recognized and accepted actuarial principles and practices. We are members of the American Academy of Actuaries and meet the Qualification Standards to render the actuarial opinion contained herein.

Appendix
Actuarial Basis

Capital Market Assumptions - Milliman

For assessing the expected portfolio return under Milliman's capital market assumptions, we considered the Oregon PERS Fund to be allocated among the model's asset classes as shown below. This allocation is based on the Oregon Investment Council's Statement of Investment Objectives and Policy Framework for the Oregon PERS Fund, as revised April 2018, and changes adopted in April 2019.

	Annual Arithmetic Mean	20-Year Annualized Geometric Mean	Annual Standard Deviation	Policy Allocation
US Large/Mid-Cap Equity	7.35%	6.30%	15.50%	16.17%
US Small Cap Equity	8.35%	6.68%	19.75%	1.35%
US Micro-Cap Equity	8.86%	6.79%	22.10%	1.35%
Non-US Developed Equity	8.30%	6.91%	17.95%	13.47%
Emerging Markets Equity	10.35%	7.69%	25.35%	4.23%
Non-US Small Cap Equity	8.81%	7.25%	19.10%	1.92%
Private Equity	11.95%	8.33%	30.00%	17.50%
US Core Fixed Income	4.14%	4.07%	3.90%	9.60%
US Short-Term Bonds	3.70%	3.68%	2.10%	9.60%
US Bank/Leveraged Loans	5.40%	5.19%	6.85%	3.60%
High Yield Bonds	6.13%	5.74%	9.35%	1.20%
Real Estate	6.19%	5.55%	12.00%	10.00%
Global REITs	8.29%	6.69%	19.30%	2.50%
Timber	6.36%	5.61%	13.00%	1.13%
Farmland	6.87%	6.12%	13.00%	1.13%
Infrastructure	7.51%	6.67%	13.85%	2.25%
Commodities	5.34%	3.79%	18.70%	1.13%
Hedge Fund of Funds - Diversified	4.28%	4.06%	6.90%	1.50%
Hedge Fund Event-Driven	5.89%	5.59%	8.10%	0.37%
US Inflation (CPI-U)		2.50%	1.65%	**N/A**
Fund Total (reflecting asset class correlations)	**7.55%**	**6.91%***	**12.14%**	**100.00%**

* Reflects 0.10% average reduction to model passive investment expenses. The model does not try to assess the actual investment expenses for active management. The model's 20-year annualized geometric median is **6.87%**.

Appendix
Actuarial Basis
Capital Market Assumptions - Callan

For assessing the expected portfolio return under Callan's capital market assumptions, we applied the assumptions shown below provided by Callan.

	10-Year Annualized Geometric Mean	Annual Standard Deviation	Policy Allocation
Broad US Equity	7.15%	17.97%	**16.25%**
Global ex-US Equity	7.25%	21.10%	**16.25%**
OIC Private Equity	9.18%	26.30%	**17.50%**
Private Real Estate	7.03%	12.21%	**12.50%**
US Fixed Income	3.75%	3.75%	**20.00%**
Diversifying Strategies	6.15%	10.97%	**7.50%**
Illiquid Alternatives	7.38%	12.56%	**7.50%**
Risk Parity	6.50%	11.00%	**2.50%**
Inflation	2.25%	1.50%	**N/A**
Fund Total (reflecting asset class correlations)	**7.39%***	**12.49%**	**100.00%**

* 10-year annualized geometric median is **7.32%**.

Appendix
Actuarial Basis

Capital Market Assumptions - Horizon

For assessing the expected portfolio return under an additional set of capital market assumptions, we applied the assumptions from the 2018 Survey of Capital Market Assumptions published by Horizon Actuarial Services, LLC. According to the survey report, the 10-year return assumptions shown below represent an average of the expectations for 34 investment advisors responding to the survey.

	10-Year Annualized Geometric Mean	Annual Standard Deviation	Policy Allocation
US Equity – Large Cap	6.07%	16.39%	**16.17%**
US Equity – Small/Mid Cap	6.57%	20.20%	**5.20%**
Non-US Equity – Developed	6.71%	18.67%	**15.40%**
Non-US Equity – Emerging	7.64%	24.89%	**4.24%**
US Corporate Bonds – Core	3.37%	5.71%	**14.40%**
US Corporate Bonds – High Yield	4.78%	10.24%	**4.80%**
US Treasuries (Cash Equivalents)	2.48%	2.74%	**4.80%**
Real Estate	5.90%	13.86%	**12.25%**
Hedge Funds	4.96%	7.87%	**1.87%**
Commodities	3.97%	17.60%	**1.12%**
Infrastructure	6.56%	14.74%	**2.25%**
Private Equity	8.33%	22.16%	**17.50%**
Inflation	2.24%		**N/A**
Fund Total (reflecting asset class correlations)	**6.70%***		**100.00%**

* 10-year annualized geometric median is **6.64%**.

System-Average Weighted Pension-Only Rates

2009-2011 rates set **prior to economic downturn**

2011-2013 rates first to reflect **-27%** return in 2008

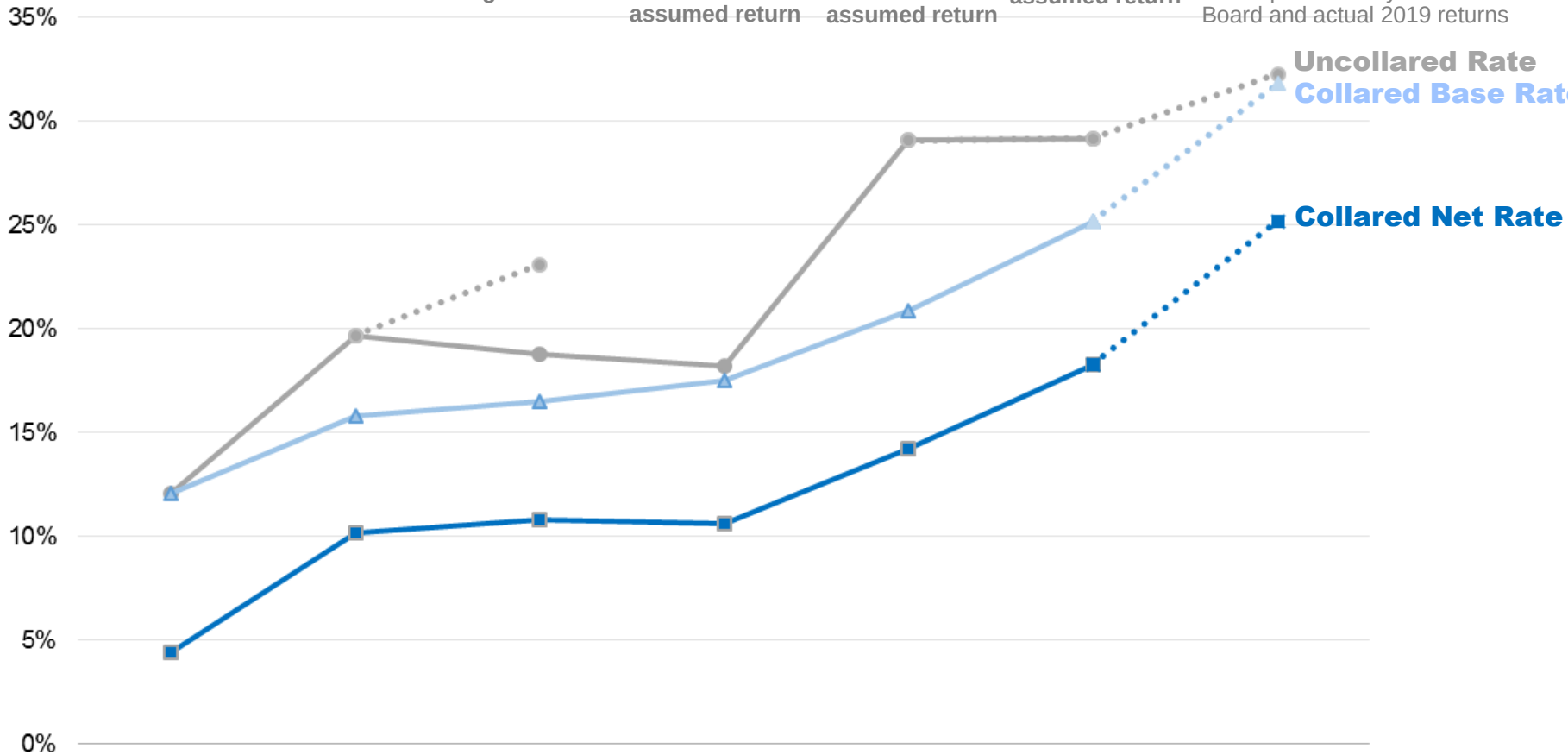
2013-2015 shown before (dotted line) and after (solid line) **legislated changes**

2015-2017 set **pre-*Moro*** reflecting 2012 (**+14.3%**) & 2013 (**+15.6%**) returns, first **decrease in assumed return**

2017-2019 set **post-*Moro***, reflecting 2015 return (**+2.1%**) and second **decrease in assumed return**

2019-2021 reflects **+15.4%** return in 2017 and third **decrease in assumed return**

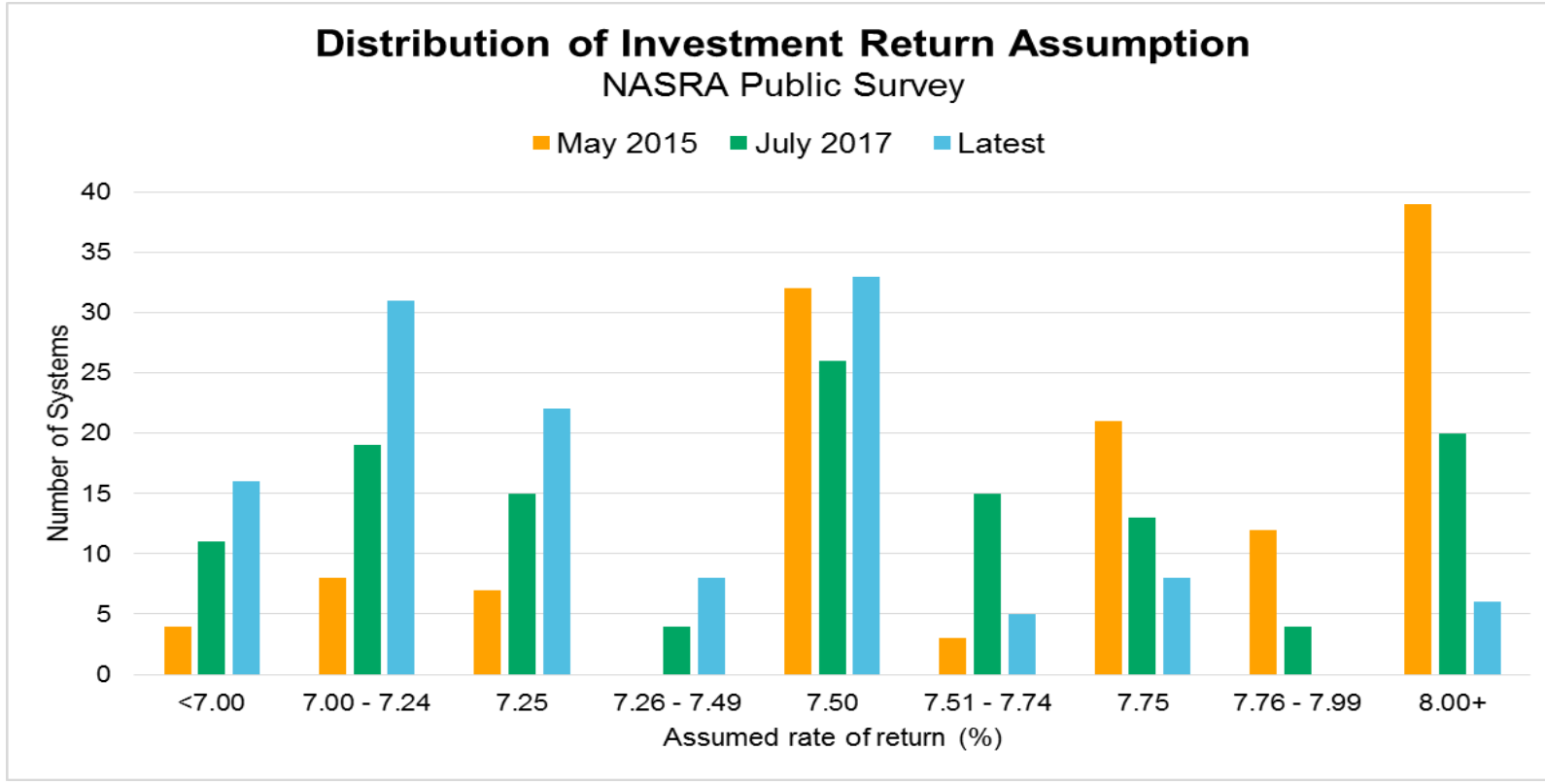
2021-2023 are **preliminary estimates**, based on published 2018 return of **+0.48%** and assumed 2019 return of 7.2%, final rates will depend on assumptions set by PERS Board and actual 2019 returns



Assumed return:	8.00%	8.00%	8.00%	7.75%	7.50%	7.20%	TBD (7.20% illustrated)

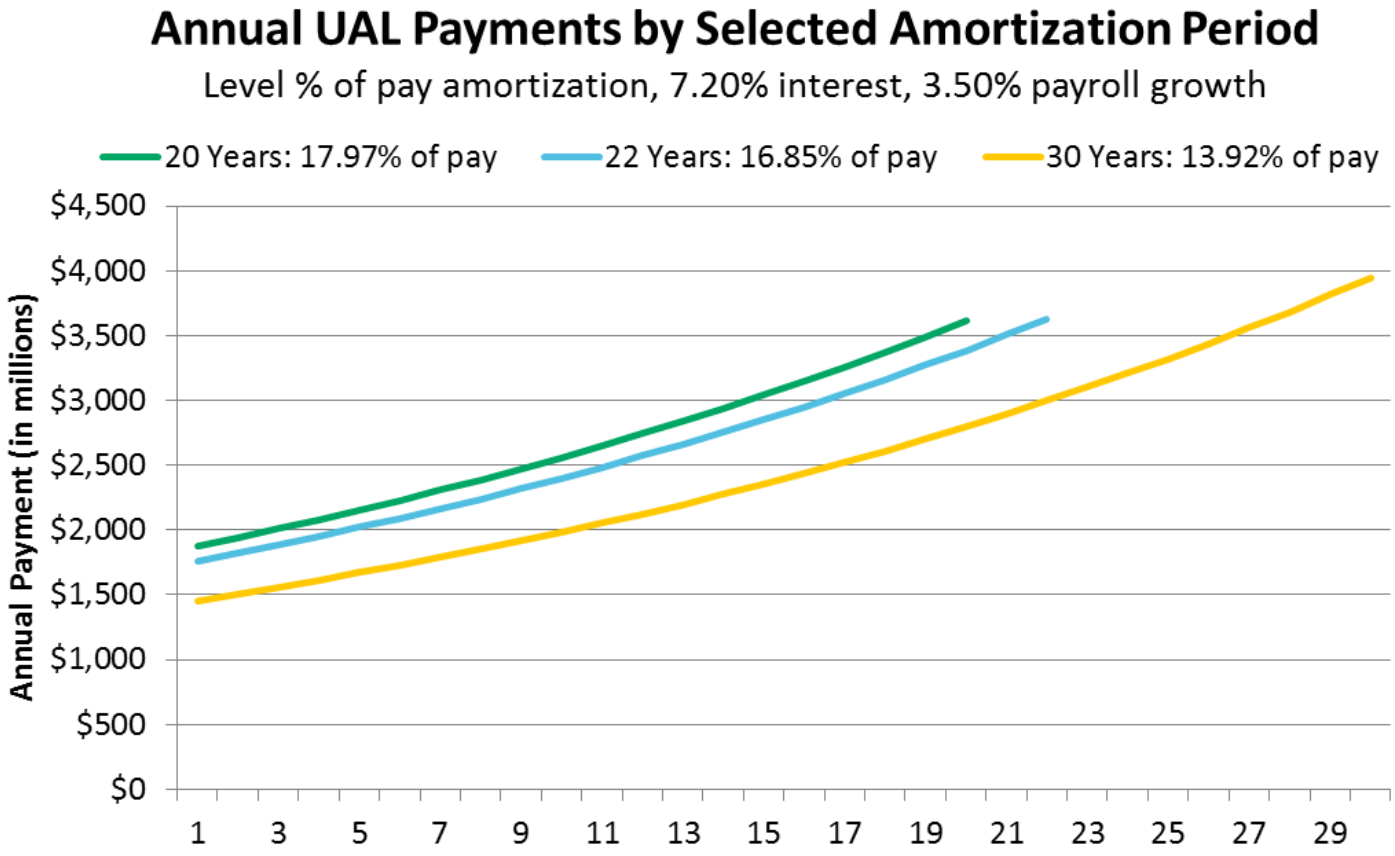
Comparison to Peer Systems

- There is a downward trend in public plan return assumptions, with a current median assumption for large public systems of **7.25%**
- Over 50% of the 129 systems tracked by the NASRA Public Fund Survey reduced their assumption over last 2-3 years



Source: NASRA (April, 2019)

Illustration of UAL Amortization Periods



Current policy

- Tier 1 / Tier 2: **20 years**
- OPSRP: **16 years**

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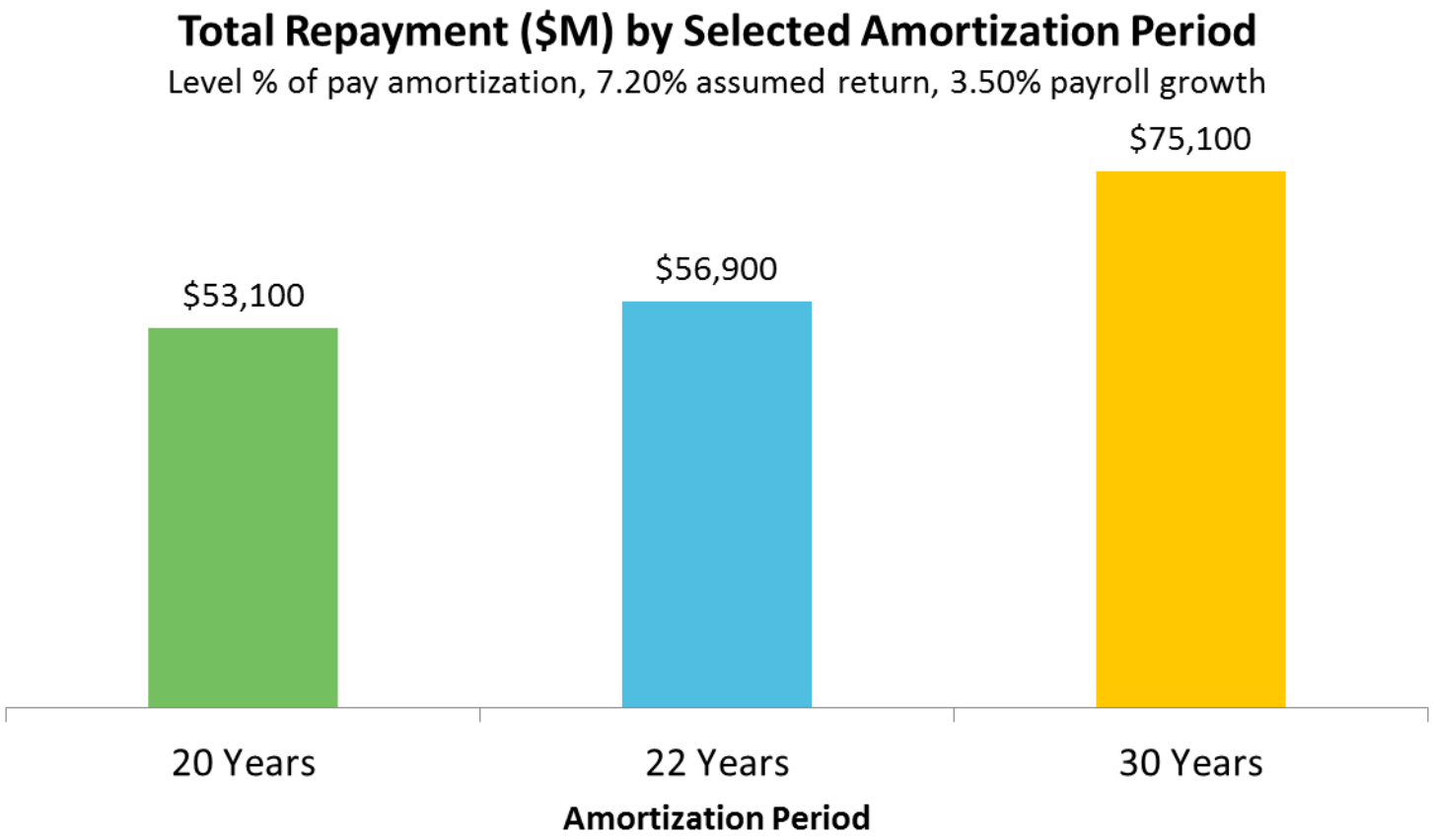

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