2018 Public Pension Funding Study

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Milliman

Introduction

The Milliman Public Pension Funding Study annually explores the funded status of the 100 largest U.S. public pension plans. We report the plan sponsor's own assessment of how well funded a plan is. We also recalibrate the liability for each plan based on our independent assessment of the expected real return on each plan's investments.
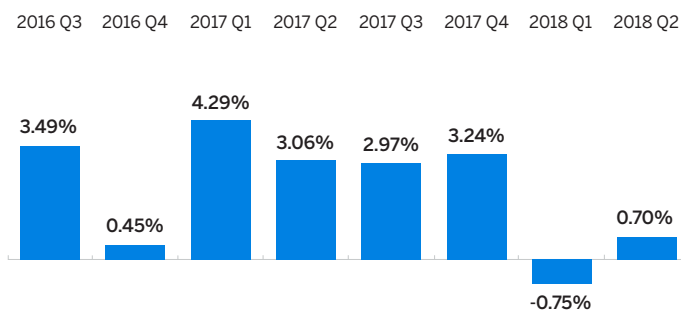
Beginning with our 2016 study, we have utilized the Total Pension Liability figures that are used for financial reporting under the accounting standards that apply to governmental entities, Governmental Accounting Standards Board (GASB) 67/68. GASB 67/68 reporting requirements mandate use of a uniform and consistent liability measurement, so there is more comparability across plans than is the case with the liability figures that the plans use to determine contribution amounts (see the sidebar "Financial Reporting vs. Funding"). GASB 67/68 also requires disclosure of metrics that enable us to project the Total Pension Liability forward beyond the plan sponsor's fiscal year-end. This allows us to estimate how a plan's assets and liabilities, i.e., the plan's funded status, will respond to changing market conditions.

This 2018 report is based on information that was reported by the plan sponsors at their most recent fiscal year-ends—June 30, 2017, is the measurement date for most of the plans in our 2018 study. At that time, plan assets were riding the wave of strong equity returns in the first half of 2017. Total plan assets as of the last fiscal year-ends grew to $3.49 trillion, up from $3.19 trillion as of the prior fiscal year-ends (generally June 30, 2016). Market performance since the last fiscal year-ends has been a mixed bag, with strong performance in the latter half of 2017, relatively flat performance in the first half of 2018, and considerable volatility toward the end of 2018. We estimate that aggregate plan assets rose to $3.67 trillion as of June 30, 2018. We estimate that the plans experienced a median annualized return on assets of 8.29% in the period between their fiscal year-ends and June 30, 2018.

Highlights

- As of June 30, 2018, the aggregate funded ratio is estimated to be 72.1%, with plan assets earning slightly more than anticipated by the plans' interest rate assumptions

- Nearly one-half of the plans reduced the interest rate assumptions they use for determining contribution amounts

- Adoption of more conservative assumptions added $73 billion to reported liabilities; plan changes shaved off $14 billion

FIGURE 1: ESTIMATED QUARTERLY RETURN ON AGGREGATE PLAN ASSETS

2016 Q3	2016 Q4	2017 Q1	2017 Q2	2017 Q3	2017 Q4	2018 Q1	2018 Q2
3.49%	0.45%	4.29%	3.06%	2.97%	3.24%	-0.75%	0.70%

The aggregate Total Pension Liability reported at the last fiscal year-ends was $4.93 trillion, growing from $4.72 trillion as of the prior fiscal year-ends. We estimate that the Total Pension Liability has since passed the $5 trillion mark as of June 30, 2018. The aggregate system-reported underfunding as of the last fiscal year-ends stood at $1.44 trillion, and we estimate that the underfunding has narrowed just slightly to $1.41 trillion as of June 30, 2018. To the extent that systems lowered their interest rate assumptions after the fiscal year-ends reflected in this report, our estimated figures as of June 30, 2018, likely understate the aggregate liability and the aggregate underfunding.

FIGURE 2: AGGREGATE SYSTEM-REPORTED FUNDED STATUS ($ TRILLIONS)
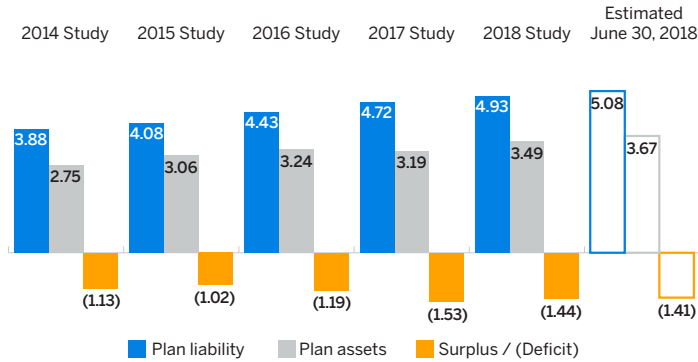
Note: The plan liability amounts from the 2014 and 2015 studies are the accrued liability used for funding purposes; the 2016 through 2018 studies report the GASB 67/68 Total Pension Liability.

Due in large part to the strong equity market performance of early 2017, the aggregate system-reported funded ratio improved to 70.8% as of the most recent fiscal year-ends, and we estimate that it continued this trajectory to settle at 72.1% as of June 30, 2018 (see Figure 3). Look for our funded ratio updates on a quarterly basis. Note that some plan sponsors have recently announced reductions in their discount rates, which will depress funded ratios.

FIGURE 3: AGGREGATE SYSTEM-REPORTED FUNDED RATIO
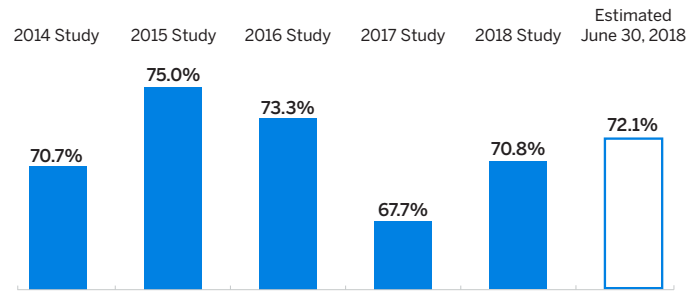
Overall, the 100 plans reported benefit payouts totaling $263 billion in their most recent fiscal years; we project that number will grow to $284 billion in July 2018 to June 2019. Reported contributions totaled $168 billion, with $121 billion and $47 billion provided by employers and members, respectively. Figure 5 summarizes the changes in asset balances reported by the plans in their most recent fiscal years. We project that combined contributions from employers and members will grow to $181 billion in July 2018 to June 2019. With the inclusion of projected administrative expenses of $3 billion, we project a net cash outflow from the plans of $105 billion from July 2018 to June 2019. This cash outflow will be offset (or widened) by investment gains (or losses) on plan assets.

FIGURE 4: SYSTEM-REPORTED FUNDED RATIO AT MOST RECENT FISCAL YEAR-ENDS
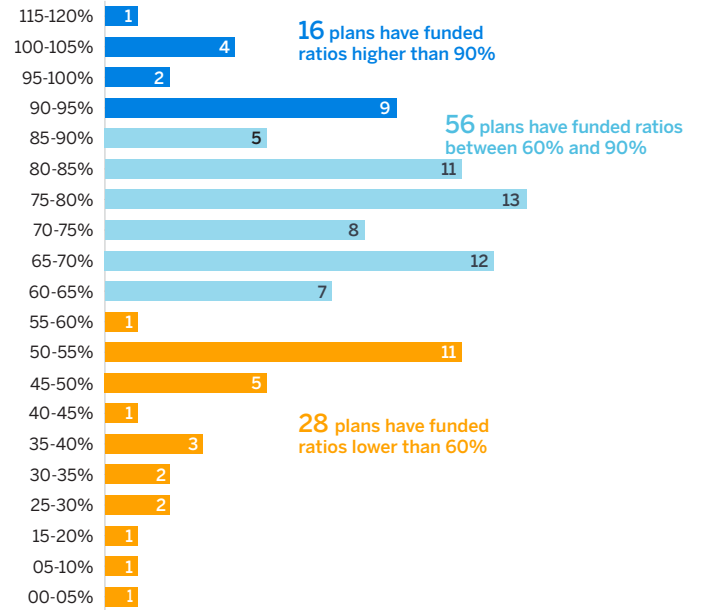

FIGURE 5: REPORTED CHANGES IN ASSETS, MOST RECENT FISCAL YEAR ($ BILLIONS)
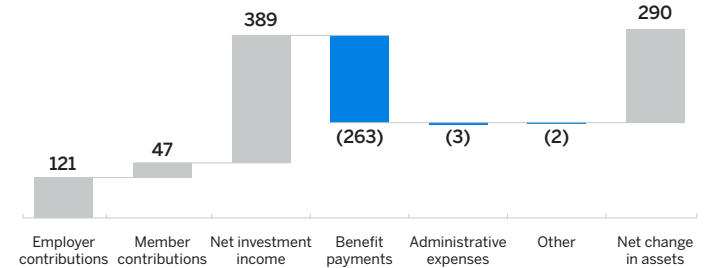
Figure 6 summarizes the changes in Total Pension Liability reported by the plans in their most recent fiscal years. In general, a plan's liability is increased by service cost and interest, and reduced by benefit payments. Changes in assumptions or plan provisions can increase or decrease a plan's liability, depending on the nature of the change. See our analysis of service cost on page 3.

FIGURE 6: REPORTED CHANGES IN TOTAL PENSION LIABILITY, MOST RECENT FISCAL YEAR ($ BILLIONS)
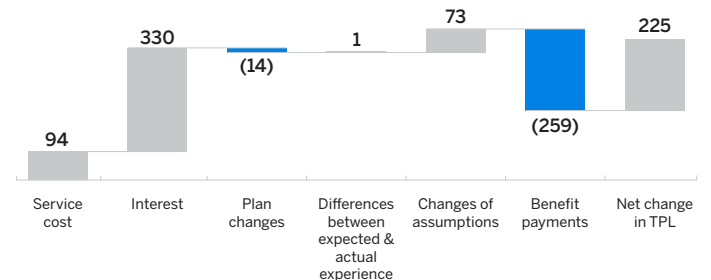
Liabilities

The plans reported aggregate Total Pension Liability of $4.93 trillion for the more than 26 million members covered by the plans in the study. The weighted average liability per member is $190,000. The number of ac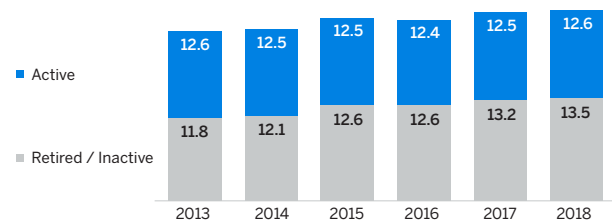tive members has held steady for the past six years, while the number of retired and inactive members has continued to increase.

FIGURE 7: NUMBER OF PLAN MEMBERS (MILLIONS)

The 100 public plans individually range in size of accrued liability from $9 billion to $417 billion. Collectively, the 10 largest plans (ranked by liability) cover 35% of the total members, hold 39% of the aggregate assets, and have 37% of the aggregate liability.

FIGURE 8: PLANS BY SIZE
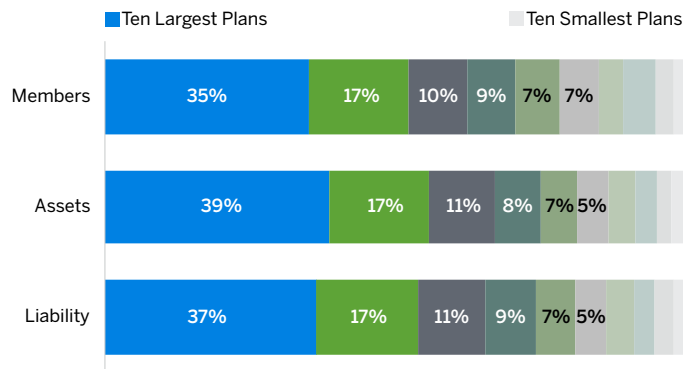
Funded ratio does not vary much by the size of the plan, although it is interesting to note that the 10 smallest plans have a significantly higher aggregate funded ratio than any other decile.

Cost of benefits being earned each year

Service cost is the portion of the actuarial present value of projected benefit payments that is attributable to a given year. In other words, it is the cost to the plan to provide the benefits that active members earn by working one more

year. The plans report the service cost in their GASB 67/68 disclosures as a component of the change in the Total Pension Liability from one reporting date to the next.

In order to determine the relative value of the pension benefits the plans provide annually to their active members, we started with each plan's reported service cost. We then subtracted out the portion of that cost that is paid for with contributions from the active members during the year. And we then divided by each plan's total payroll so that we could adjust for the relative size of the plan. The resulting metric is termed the net employer-paid service cost as a percentage of payroll. It represents the relative richness of the pension benefits that are being paid for by the plan sponsors.

Overall, nearly seven out of 10 plans provide an estimated employer-paid pension benefit in the range of 0% to 10% of payroll; the most common levels of employer-paid pension benefits are 0% to 5% (42 plans) and 5% to 10% (27 plans). There are three plans with negative net service costs, which means that contributions from these plans' active members more than cover the annual cost of their own annual pension accruals. On the flip side, there are 13 plans with a net cost of more than 15% of payroll, indicating relatively costly benefits.

FIGURE 9: EMPLOYER-PAID NET SERVICE COST AS PERCENTAGE OF PAYROLL
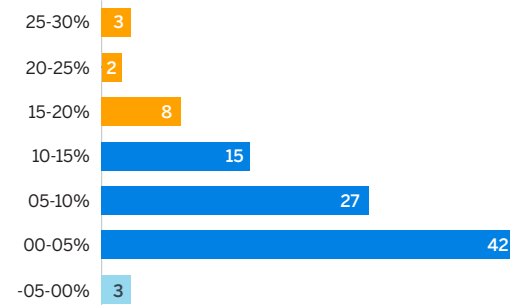
There is very little correlation between the richness of the benefits provided and the funded status of the plan; that is, plans with generous benefits are neither better funded nor more poorly funded than plans with modest benefits.
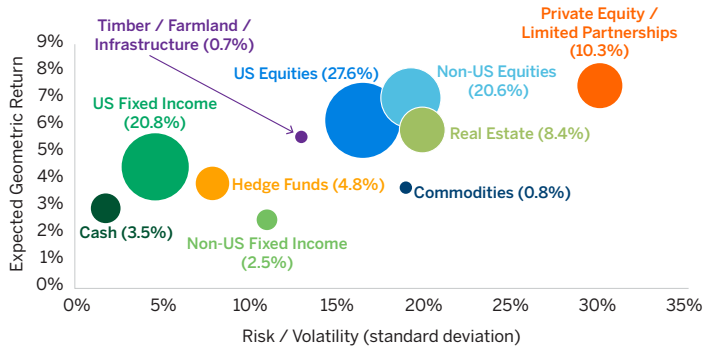
Assets

The plans included in this study are invested in a mix of asset classes with different risk/return characteristics, as illustrated in Figure 10.

Over the past six years there has been very little change in the overall asset allocation of these plans (see Figure 11). While some plans have modified their asset allocation policies over the past five years, in aggregate there has not been a material move toward riskier investments.
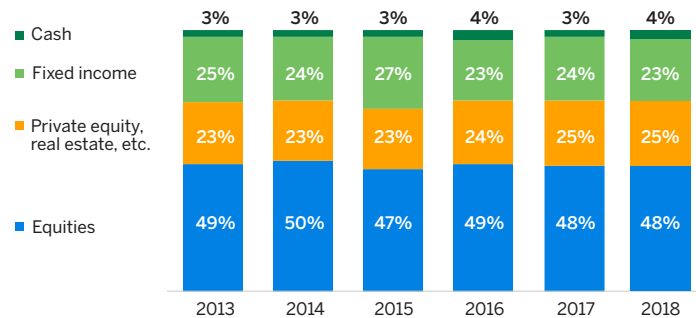
We found little correlation between plans' asset allocations or reported discount rates and whether the plans are well funded or poorly funded (as measured by their funded ratios).

FIGURE 10: INDEPENDENTLY DETERMINED RATE VS. SPONSOR-REPORTED RATE

Note: The expected return and risk/volatility metrics are based on Milliman's December 31, 2017, capital market assumptions.

FIGURE 11: AGGREGATE ASSET ALLOCATIONS OVER TIME

	2013	2014	2015	2016	2017	2018
Cash	3%	3%	3%	4%	3%	4%
Fixed income	25%	24%	27%	23%	24%	23%
Private equity, real estate, etc.	23%	23%	23%	24%	25%	25%
Equities	49%	50%	47%	49%	48%	48%

The market's consensus views on long-term future investment returns have been declining since the turn of the millennium. Figure 12 illustrates this trend by showing the expected long-term future return for a hypothetical asset allocation, based on Milliman's capital market assumptions for each year since 2000. Over this period, the median expected investment return for the illustrated hypothetical asset allocation fell from 8.29% in 2000 to 5.77% in 2017. Where interest rate assumptions of 8.00% were once the norm, 80 of the plans in the study now have assumptions of 7.50% or below (compared to 66 in the 2017 study). Forty-five of the plans lowered their assumption from the 2017 study to the 2018 study; 84 of the plans have lowered their assumption at least once since our inaugural 2012 study.

The terms "interest rate" and "discount rate" are often used interchangeably; both represent the rate used to translate future expected benefit payments into current liabilities. For this study, we use the term "interest rate" to indicate the assumption the plan sponsor has chosen to determine contribution amounts, and we use the term "discount rate" to indicate the
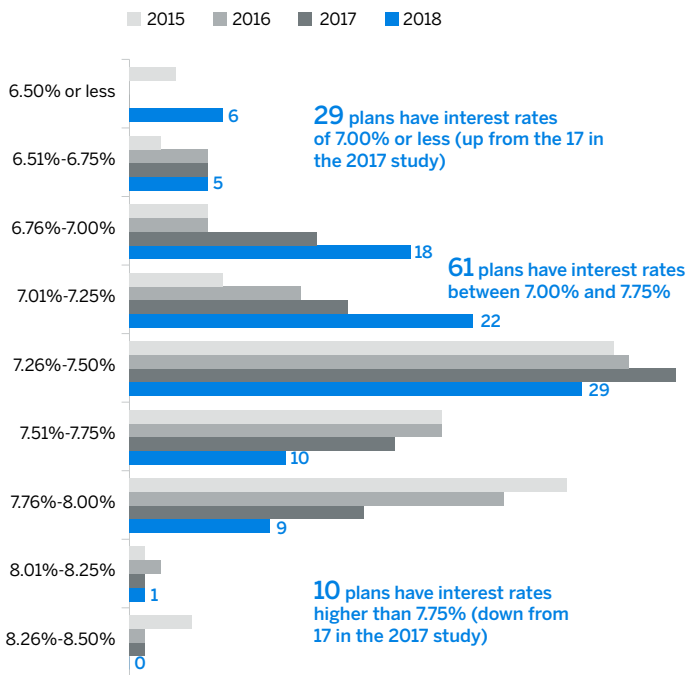
FIGURE 12: EXPECTED RETURN FOR A HYPOTHETICAL ASSET ALLOCATION BASED ON MILLIMAN'S CAPITAL MARKET ASSUMPTIONS
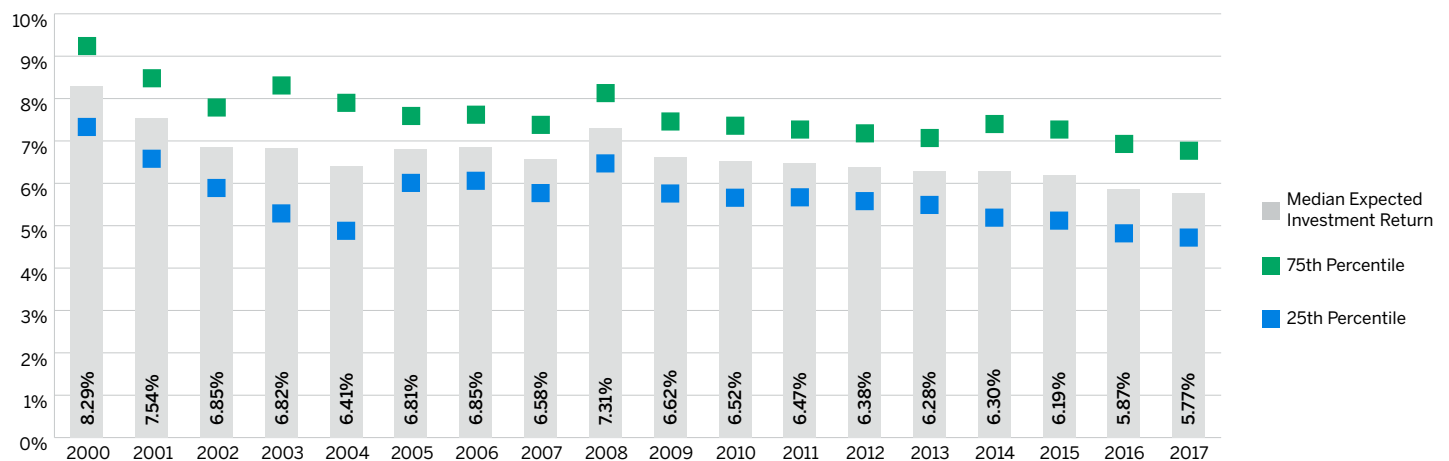
Note: This hypothetical asset allocation consists of 35% broad U.S. equities, 15% developed foreign equities, 25% core fixed income, 5% high-yield bonds, 10% mortgages, 5% real estate, and 5% short-term investments; inflation assumption is fixed at 2.5% for all years.

rate that is used to measure liabilities for GASB 67/68 financial reporting purposes. Interest rates have continued to move lower each year, with a median of 7.25% and ranges from 5.00% to 8.10% (see Figure 13). For most of the plans in this study, the funding interest rate and the financial reporting discount rate are the same. However, GASB 67/68 requires that the discount rate be adjusted downward in situations where the current contribution policy is projected (using the GASB-mandated testing methodology) to result in a plan running out of plan assets at some future date. Such a downward adjustment currently occurs for 11 of the plans in the study.

FIGURE 13: SPONSOR-REPORTED FUNDING INTEREST RATE

2015   2016   2017   2018

6.50% or less	6
	29 plans have interest rates of 7.00% or less (up from the 17 in the 2017 study)
6.51%-6.75%	5
6.76%-7.00%	18
	61 plans have interest rates between 7.00% and 7.75%
7.01%-7.25%	22
7.26%-7.50%	29
7.51%-7.75%	10
7.76%-8.00%	9
8.01%-8.25%	1
	10 plans have interest rates higher than 7.75% (down from 17 in the 2017 study)
8.26%-8.50%	0

Recalibrating the Total Pension Liability

Using each plan's specific asset allocation, we determined the 50th percentile 30-year geometric average annual real rate of return based on Milliman's December 31, 2017, capital market assumptions. We then applied each plan's reported inflation assumption to arrive at our independently determined investment return assumption for that plan. The median of the resulting independently determined investment return assumptions is 6.42%, which is 83 basis points lower than the 7.25% median discount rate used by the plans. All but five of the plans have a lower independently determined rate than the discount rate the plan uses for financial reporting.

Plan sponsors periodically reassess their interest rate assumptions to ensure that they reflect updated market expectations about future investment returns. The frequency of reassessment varies by system, with some systems reassessing annually while others use a two- to five-year review cycle. Because market expectations have been falling continuously since 2000, there has been a persistent lag between the plan sponsor's interest rates and Milliman's independently recalibrated interest rates. While almost half of the plans in the study did lower their interest rate assumptions since the previous study, the gap between the sponsor-reported rates and our recalibrated figures has widened. This indicates that it is likely that coming years will see yet more reductions in interest rates.

We used each plan's independently determined investment return assumption to recalibrate the plan's Total Pension Liability. In aggregate, these plans have a recalibrated Total Pension Liability of $5.30 trillion, compared with a sponsor-reported Total Pension Liability of $4.93 trillion. This year's study found that the gap between the recalibrated accrued liability and the sponsor-reported accrued liability continues to widen.

Financial reporting versus funding
The Governmental Accounting Standards Board (GASB) sets the accounting standards for public entities. Statements Nos. 67 and 68, which became effective in 2014 and 2015, have significantly changed the financial reporting requirements for U.S. public pension plans. Among other changes, these standards require all plans to report a standardized measure of actuarial liability, referred to as the Total Pension Liability. The Total Pension Liability must be calculated using a uniform actuarial cost method (the individual entry age cost method) rather than the actuarial cost method the plan uses to determine contribution amounts, and it must be calculated using a discount rate that under certain circumstances may be lower than the investment return assumption used for funding purposes. Additionally, each plan is required to disclose how sensitive its Total Pension Liability is to changes in the discount rate. For some plans a different liability measurement is used as part of the process of determining amounts that should be contributed to fund the plan.

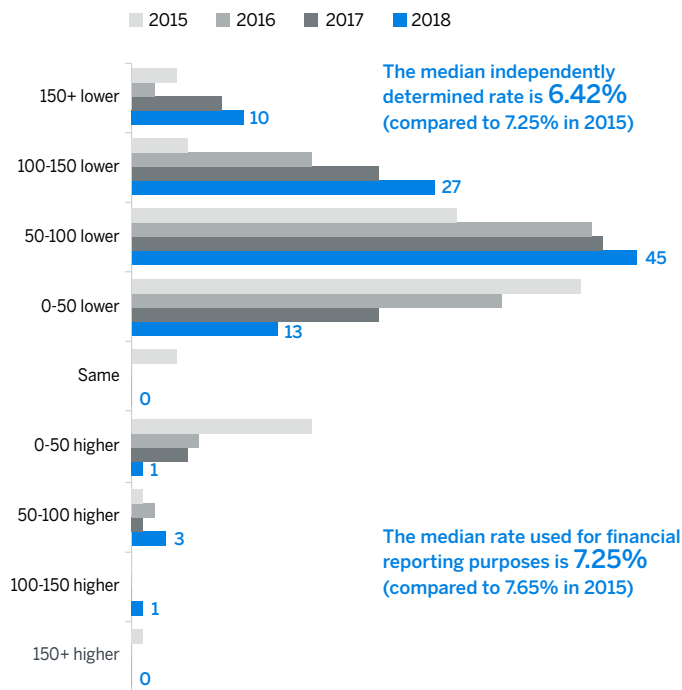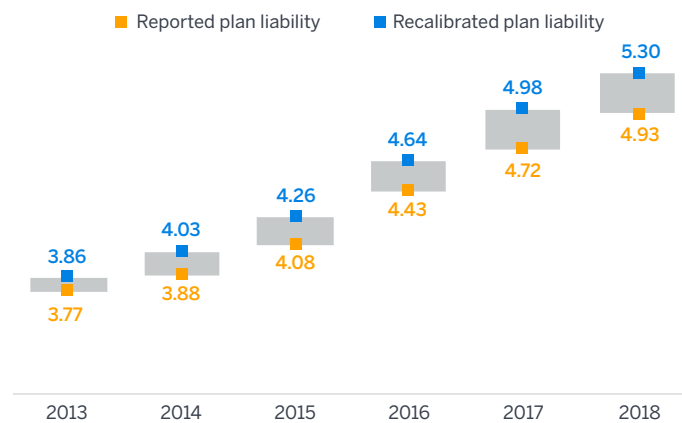**FIGURE 14:** **INDEPENDENTLY DETERMINED RATE VS. SPONSOR–REPORTED RATE**

2015   2016   2017   2018

The median independently determined rate is **6.42%** (compared to 7.25% in 2015)

The median rate used for financial reporting purposes is **7.25%** (compared to 7.65% in 2015)

FIGURE 15: **AGGREGATE RECALIBRATION RESULTS ($ TRILLIONS)**

Reported plan liability   Recalibrated plan liability

As shown in Figure 16, this widening gap in liability mirrors a corresponding widening between the median discount rate reported by the plans in the study and our median independently determined investment return assumption based on Milliman's market outlook expectations.

FIGURE 16: **REPORTED VS. INDEPENDENTLY DETERMINED RATES**

Reported discount rate   Independently determined rate
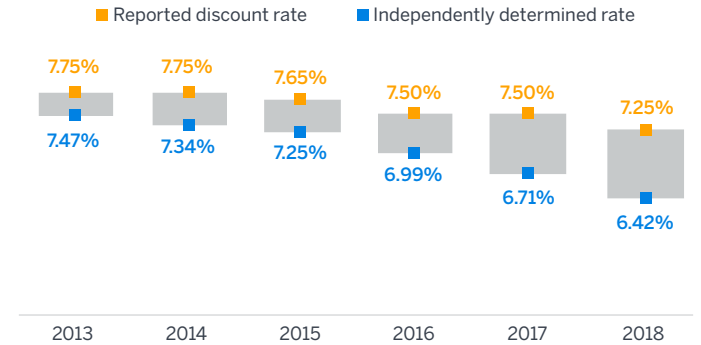
The widening gap suggests that plans should continue to monitor emerging market return expectations and adjust their assumptions as needed, to ensure that liabilities are calculated using assumptions that are based on best-estimate expectations from investment professionals.

Sensitivity analysis

A relatively small change in the discount rate can have a significant impact on the Total Pension Liability. How big that impact is depends on the makeup of the plan's membership: a less "mature" plan with more active members than retirees typically has a higher sensitivity to interest rate changes than a more mature plan with a bigger retiree population. Other factors, such as automatic cost of living features, also come into play in determining a plan's sensitivity. Using a discount rate that is 100 basis points higher or lower than the independently determined investment return assumption moves the aggregate recalibrated Total Pension Liability by anywhere from 8% to 15% (see Figure 17).

FIGURE 17: **EFFECTS OF CHANGING THE DISCOUNT RATE**

Change in Liability from a 1% Decrease in Discount Rate   Change in Liability from a 1% Increase in Discount Rate
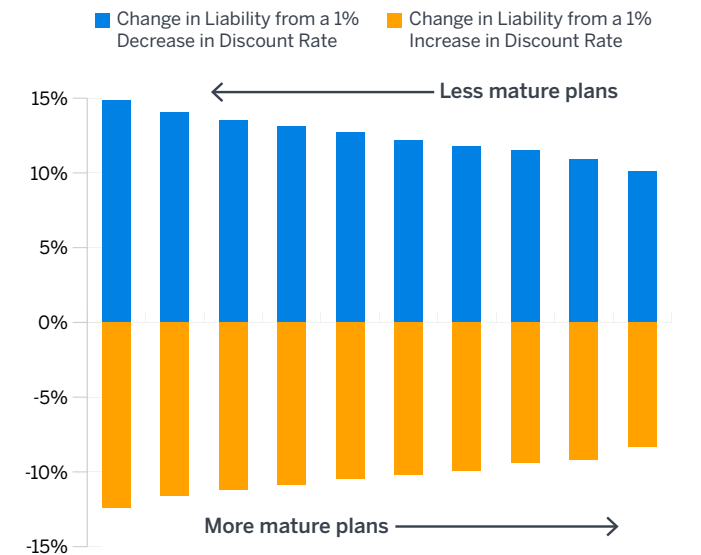
Asset volatility ratio

The **asset volatility ratio** is a metric that helps plan sponsors anticipate the impact of investment volatility on actuarially determined contribution rates. The asset volatility ratio is the ratio of plan assets to the payroll for active members covered by the plan. A lower ratio means that plan assets are relatively small compared with payroll; this implies that a single-year deviation in asset performance may not move the contribution rate much. A higher ratio, on the other hand, signals that a similar single-year deviation in asset performance could translate into a significant shift in the actuarially determined contribution rate. It is unsurprising that, as pension plans have accumulated assets and their member populations have matured over the past several decades, asset volatility ratios have risen. These higher ratios mean that actuarially determined contribution rates are now more sensitive than they once were to investment volatility, despite the use of asset-smoothing methods to help mitigate the impact of market movements.

The median asset volatility ratio for the plans included in this study is 4.8, up slightly from 4.5 in the Milliman 2017 Public Pension Funding Study (see Figure 18). Thirty-nine of the plans have an asset volatility ratio of 5.5 or higher, indicating that their actuarially determined contributions will be more volatile in reaction to future market swings. Four years ago, just 24 of the plans exceeded the 5.5 mark, suggesting that for a significant number of plans the actuarially determined contribution levels are becoming more and more sensitive to market swings.

FIGURE 18: ASSET VOLATILITY RATIO

The 2018 median asset volatility ratio is **4.8%** (compared to 4.5% in 2017)
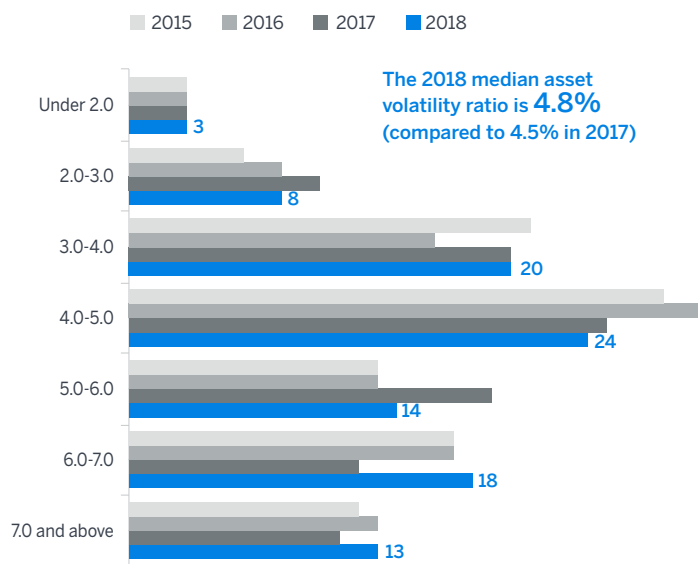
Methodology

This study is based on the most recently available Comprehensive Annual Financial Reports for the 100 largest public pension systems, which reflect measurement dates ranging from June 30, 2015, to December 31, 2017; 91 are from June 30, 2017, or later. For the purposes of this study, the reported asset allocation of each of the plans has been analyzed to determine an independent measure of the expected long-term median real rate of return on plan assets. The sponsor-reported Total Pension Liability for each plan has then been recalibrated to reflect this independently determined investment return assumption. This study therefore adjusts for differences between each plan's reported discount rate and an independently calibrated current market assessment of the expected real return based on actual asset allocations. This study is not intended to price the plans' liabilities for purposes of determining contribution amounts or near-term plan settlement purposes nor to analyze the funding of individual plans.

Public Pension Mortality

The Society of Actuaries (SOA) periodically publishes mortality tables for use in valuing pension liabilities. In August 2018, the SOA issued an exposure draft of mortality tables that are based on experience exclusively from public pension plans. We expect that public plans and their actuaries are reviewing these tables and evaluating whether to eventually adopt these tables.

To the extent that use of a new mortality table projects longer life spans, accrued liabilities will increase and funded ratios will decrease.

Acknowledgements

Appendix

SPONSOR-REPORTED DATA

Plan Name	Measurement Date	GASB 68 Discount Rate	Total Pension Liability ($ millions)	Fiduciary Net Position ($ millions)	Net Pension Liability ($ millions)	Funded Ratio	Count of Active Members	Count of Inactive / Retired Members
Alabama Employees' Retirement System	09/30/17	7.75%	17,391	12,122	5,268	69.7%	84,814	78,376
Alabama Teachers' Retirement System	09/30/17	7.75%	34,480	24,651	9,828	71.5%	136,731	108,344
Alaska Public Employees' Retirement System	06/30/17	8.00%	14,113	8,943	5,169	63.4%	14,956	40,109
Arizona Public Safety Personnel Retirement System	06/30/17							
Arizona State Retirement System	06/30/17	8.00%	51,781	36,203	15,578	69.9%	209,527	376,779
Arkansas Public Employees Retirement System	06/30/17	7.15%	10,613	8,029	2,584	75.7%	46,094	51,133
Arkansas Teacher's Retirement System	06/30/17	7.50%	20,489	16,285	4,204	79.5%	72,148	57,493
California Public Employees' Retirement System	06/30/17							
California State Teachers' Retirement System	06/30/17	7.10%	302,769	210,289	92,480	69.5%	445,935	487,475
Chicago Municipal Employees' Annuity and Benefit Fund	12/31/17	7.00%	16,282	4,554	11,728	28.0%	30,922	27,315
Chicago Public Schools	06/30/17	7.07%	23,176	10,793	12,382	46.6%	28,855	34,501
Colorado Public Employees' Retirement Association	12/31/17	5.00%	103,274	48,677	54,596	47.1%	207,769	146,053
Connecticut State Employees Retirement System	06/30/16	6.90%	33,617	10,654	22,963	31.7%	50,019	49,603
Connecticut State Teachers' Retirement System	06/30/16	8.00%	29,840	15,595	14,245	52.3%	50,877	50,817
Cook County Employees' Annuity and Benefit Fund	12/31/17	7.25%	22,941	10,408	12,533	45.4%	20,349	32,841
Delaware State Employees' Pension Plan	06/30/17	7.00%	9,980	8,514	1,466	85.3%	36,198	30,200
Florida State Retirement System	06/30/17	7.10%	183,633	154,053	29,579	83.9%	518,622	544,855
Georgia Employees' Retirement System	06/30/17	7.50%	17,160	13,098	4,061	76.3%	60,983	106,961
Georgia Teachers' Retirement System	06/30/17	7.50%	89,926	71,341	18,585	79.3%	222,918	224,153
Hawaii State Employees' Retirement System	06/30/17	7.00%	28,649	15,698	12,950	54.8%	65,911	72,650
Idaho Public Employee Retirement System	06/30/17	7.10%	16,869	15,297	1,572	90.7%	70,073	58,137
Illinois Municipal Retirement Fund	12/31/17							
Illinois State Employees' Retirement System	06/30/17	6.78%	49,437	16,530	32,907	33.4%	60,612	96,763
Illinois State Teachers' Retirement System	06/30/17	7.00%	125,774	49,376	76,398	39.3%	160,488	251,963
Illinois State Universities Retirement System	06/30/17	7.09%	43,966	18,485	25,481	42.0%	64,117	145,861
Indiana Public Employees' Retirement Fund	06/30/17	6.75%	19,106	14,645	4,462	76.6%	134,909	166,258
Indiana State Teachers' Retirement Fund	06/30/17	6.75%	23,651	11,070	12,581	46.8%	71,225	65,792
Iowa Public Employees' Retirement System	06/30/17	7.00%	37,440	30,779	6,661	82.2%	169,910	185,721
Kansas Public Employee Retirement System	06/30/17	7.75%	27,762	18,634	9,129	67.1%	144,564	146,239
Kentucky County Employees Retirement System	06/30/17	6.25%	16,996	8,905	8,091	52.4%	91,693	83,369
Kentucky Employees Retirement System	06/30/17	5.32%	16,544	2,658	13,885	16.1%	41,281	60,308
Kentucky Teachers' Retirement System	06/30/17	4.49%	46,967	18,708	28,259	39.8%	72,130	61,590
Los Angeles City Employees' Retirement System	06/30/17	7.25%	18,458	13,181	5,278	71.4%	25,457	21,155
Los Angeles City Water and Power Employees' Retirement Plan	06/30/17	7.25%	12,657	11,314	1,343	89.4%	9,806	10,920
Los Angeles County Employees Retirement Association	06/30/17	7.38%	64,032	52,744	11,288	82.4%	97,221	71,636
Los Angeles Fire and Police Pension Plan	06/30/17	7.25%	20,814	18,997	1,817	91.3%	13,327	13,210
Louisiana State Employees' Retirement System	06/30/17	7.70%	18,792	11,753	7,039	62.5%	39,055	107,566
Louisiana Teachers' Retirement System	06/30/17	7.70%	29,763	19,511	10,252	65.6%	84,228	107,657

Appendix

SPONSOR-REPORTED DATA (CONTINUED)

Plan Name	Measurement Date	GASB 68 Discount Rate	Total Pension Liability ($ millions)	Fiduciary Net Position ($ millions)	Net Pension Liability ($ millions)	Funded Ratio	Count of Active Members	Count of Inactive / Retired Members
Maine Public Employees Retirement System	06/30/17	6.88%	16,613	13,615	2,998	82.0%	51,298	54,689
Maryland State Employees' Combined System	06/30/17	7.50%	24,794	16,541	8,254	66.7%	82,087	103,681
Maryland Teachers	06/30/17	7.50%	41,633	29,731	11,902	71.4%	106,302	101,002
Massachusetts State Board of Retirement System	06/30/17							
Massachusetts Teachers' Retirement System	06/30/17	7.50%	50,024	27,139	22,885	54.3%	92,128	65,036
Michigan Municipal Employees' Retirement System	12/31/17							
Michigan Public School Employee's Retirement System	09/30/17	7.50%	73,501	47,012	26,490	64.0%	203,981	231,993
Michigan State Employees Retirement System	09/30/17	7.50%	17,000	11,807	5,193	69.5%	10,850	63,279
Minnesota Public Employees Retirement Association	06/30/17	7.50%	26,485	20,101	6,384	75.9%	152,867	150,475
Minnesota State Retirement System	06/30/17	5.42%	19,904	12,486	7,418	62.7%	50,578	56,339
Minnesota Teachers Retirement Association	06/30/17	5.12%	41,220	21,258	19,962	51.6%	81,811	112,148
Mississippi Public Employees' Retirement System	06/30/17	7.75%	43,166	26,543	16,623	61.5%	152,382	168,842
Missouri Public School Retirement System	06/30/17	7.60%	44,502	37,280	7,222	83.8%	78,274	68,272
Missouri State Employees' Plan	06/30/17	7.50%	13,152	7,945	5,207	60.4%	48,910	66,138
Nebraska Public Employees Retirement Systems School Retirement System	06/30/17							
Nevada State Public Employees' Retirement System	06/30/17	7.50%	51,986	38,686	13,300	74.4%	105,801	80,798
New Hampshire Retirement System	06/30/17	7.25%	13,172	8,254	4,918	62.7%	47,886	37,975
New Jersey Police and Firemen's Retirement System	06/30/17	6.14%	47,411	25,848	21,563	54.5%	40,789	43,058
New Jersey Public Employees' Retirement System	06/30/17	5.00%	77,388	28,464	48,924	36.8%	254,685	170,774
New Jersey Teachers' Pension and Annuity Fund	06/30/17	4.25%	90,726	23,056	67,670	25.4%	154,858	103,554
New Mexico Educational Retirement Board	06/30/17	5.90%	23,623	12,509	11,113	53.0%	59,495	94,019
New Mexico Public Employees Retirement Association	06/30/17	7.51%	20,068	14,799	5,269	73.7%	48,815	52,479
New York City Employees' Retirement System	06/30/17	7.00%	82,421	61,655	20,766	74.8%	185,758	170,835
New York City Police Pension Fund	06/30/17	7.00%	52,353	39,364	12,989	75.2%	34,325	50,733
New York City Teachers' Retirement System	06/30/17	7.00%	73,323	50,096	23,228	68.3%	114,652	96,259
New York State and Local Employees Retirement System	03/31/17	7.00%	177,401	168,004	9,396	94.7%	496,441	538,201
New York State and Local Police & Fire	03/31/17	7.00%	31,670	29,598	2,073	93.5%	32,332	37,805
New York State Teachers' Retirement System	06/30/17	7.25%	114,708	115,468	(760)	100.7%	256,171	172,408
North Carolina Local Governmental Employees' Retirement System	06/30/17	7.20%	26,231	24,703	1,528	94.2%	126,647	129,612
North Carolina Teachers and State Employees Retirement System	06/30/17	7.20%	75,640	67,705	7,934	89.5%	305,013	360,014
Ohio Police and Fire Pension Fund	12/31/17	8.00%	21,101	14,964	6,137	70.9%	28,175	29,113
Ohio Public Employees Retirement System	12/31/16	7.50%	100,154	77,502	22,653	77.4%	335,482	748,623
Ohio Schools Employees' Retirement System	06/30/17	7.50%	19,588	13,614	5,975	69.5%	157,981	83,892
Ohio State Teachers Retirement System	06/30/17	7.45%	96,126	72,371	23,755	75.3%	168,132	176,442
Oklahoma Public Employees Retirement System	06/30/17	7.00%	9,455	8,914	541	94.3%	38,873	40,530
Oklahoma Teachers' Retirement System	06/30/17	7.50%	21,625	14,990	6,635	69.3%	87,795	74,187

Appendix

SPONSOR-REPORTED DATA (CONTINUED)

Plan Name	Measurement Date	GASB 68 Discount Rate	Total Pension Liability ($ millions)	Fiduciary Net Position ($ millions)	Net Pension Liability ($ millions)	Funded Ratio	Count of Active Members	Count of Inactive / Retired Members
Orange County Employees Retirement System	12/31/17	7.00%	19,754	14,802	4,952	74.9%	21,721	22,750
Oregon Public Employees Retirement System	06/30/17	7.50%	79,852	66,372	13,480	83.1%	172,483	184,104
Pennsylvania Public School Employees' Retirement System	06/30/17	7.25%	102,544	53,155	49,388	51.8%	255,945	254,529
Pennsylvania State Employees' Retirement System	12/31/16	7.25%	45,648	26,388	19,260	57.8%	104,632	134,472
Puerto Rico Government Employees Retirement System	06/30/15	3.80%	32,669	(579)	33,248	-1.8%	119,790	126,742
Puerto Rico Teachers Retirement System	06/30/15	3.82%	16,308	1,313	14,995	8.1%	37,700	42,188
Rhode Island Employees Retirement System	06/30/17	7.00%	11,525	6,122	5,402	53.1%	24,289	28,529
Sacramento County Employees' Retirement System	06/30/17	7.00%	10,681	8,584	2,097	80.4%	12,587	14,821
San Bernardino County Employees' Retirement Association	06/30/17	7.25%	11,924	9,288	2,636	77.9%	21,110	18,266
San Diego County Employees Retirement Association	06/30/17	7.25%	15,084	11,397	3,687	75.6%	17,994	23,906
San Francisco City and County Employees' Retirement System	06/30/17	7.50%	27,404	22,410	4,993	81.8%	33,447	37,541
South Carolina Retirement System	06/30/17	7.25%	48,244	25,733	22,512	53.3%	190,923	307,661
South Dakota Retirement System	06/30/17	6.50%	11,635	11,644	(9)	100.1%	40,452	45,799
Tennessee Consolidated Retirement System	06/30/17	7.50%	22,614	22,895	(281)	101.2%	62,320	80,992
Texas County & District Retirement System	12/31/17							
Texas Employees' Retirement System	08/31/17	5.36%	48,236	26,372	21,865	54.7%	141,629	123,640
Texas Municipal Retirement System	12/31/17							
Texas Teacher Retirement System	08/31/17	8.00%	179,337	147,362	31,975	82.2%	864,233	505,878
University of California Retirement Plan	06/30/17	7.25%	72,827	62,114	10,713	85.3%	129,382	160,047
Utah Retirement Systems	12/31/17	6.95%	35,299	31,879	3,420	90.3%	97,522	120,629
Virginia Employees Retirement System	06/30/17	7.00%	90,599	70,160	20,439	77.4%	330,231	242,328
Washington Public Employees' Retirement System	06/30/17	7.50%	50,717	42,498	8,220	83.8%	159,441	133,318
Washington State Law Enforcement Officer's and Fire Fighters' Plan 1 and 2	06/30/17	7.50%	14,608	17,513	(2,905)	119.9%	17,739	13,287
Washington State Teachers' Retirement System	06/30/17	7.50%	22,229	18,283	3,946	82.2%	74,317	60,878
West Virginia Teachers' Retirement System	06/30/17	7.50%	10,745	7,290	3,455	67.8%	34,459	37,180
Wisconsin Retirement System	12/31/16	7.20%	93,404	92,580	824	99.1%	257,285	364,838

Study technical appendix

METHODOLOGY:
EXPECTED INVESTMENT RETURN

For the purposes of this study, we recalibrated liabilities for included plans to reflect discounting at the expected rate of return on current plan assets. To develop the expected rate of return used in these calculations, we relied on the most recently available asset statements for each plan, particularly on Statements of Plan Net Assets as disclosed in published Comprehensive Annual Financial Reports. We did not make adjustments for potential differences between actual asset allocations and target policy asset allocations.

Our method to calculate the expected rate of return was a "building-block method," using geometric averaging methodology. We used Milliman's December 31, 2017, capital market assumptions to calculate the 50th percentile 30-year real rate of return, and then combined the plan's inflation assumption to arrive at the total expected investment return on plan assets. Where the plan inflation assumption was not available, we used an inflation assumption of 2.50%. We did not make any adjustment to the expected rate of return for plan expenses, nor did we include any assumption for investment alpha (i.e., we did not assume any excess return over market averages resulting from active versus passive management).

METHODOLOGY:
LIABILITY RECALIBRATION

We performed the recalibration of liabilities for pension plans included in the study using the sensitivity information disclosed in published Comprehensive Annual Financial Reports. Where this information was not available, we made adjustments based on available information.

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Milliman is among the world's largest providers of actuarial and related products and services. The firm has consulting practices in life insurance and financial services, property & casualty insurance, healthcare, and employee benefits. Founded in 1947, Milliman is an independent firm with offices in major cities around the globe.

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