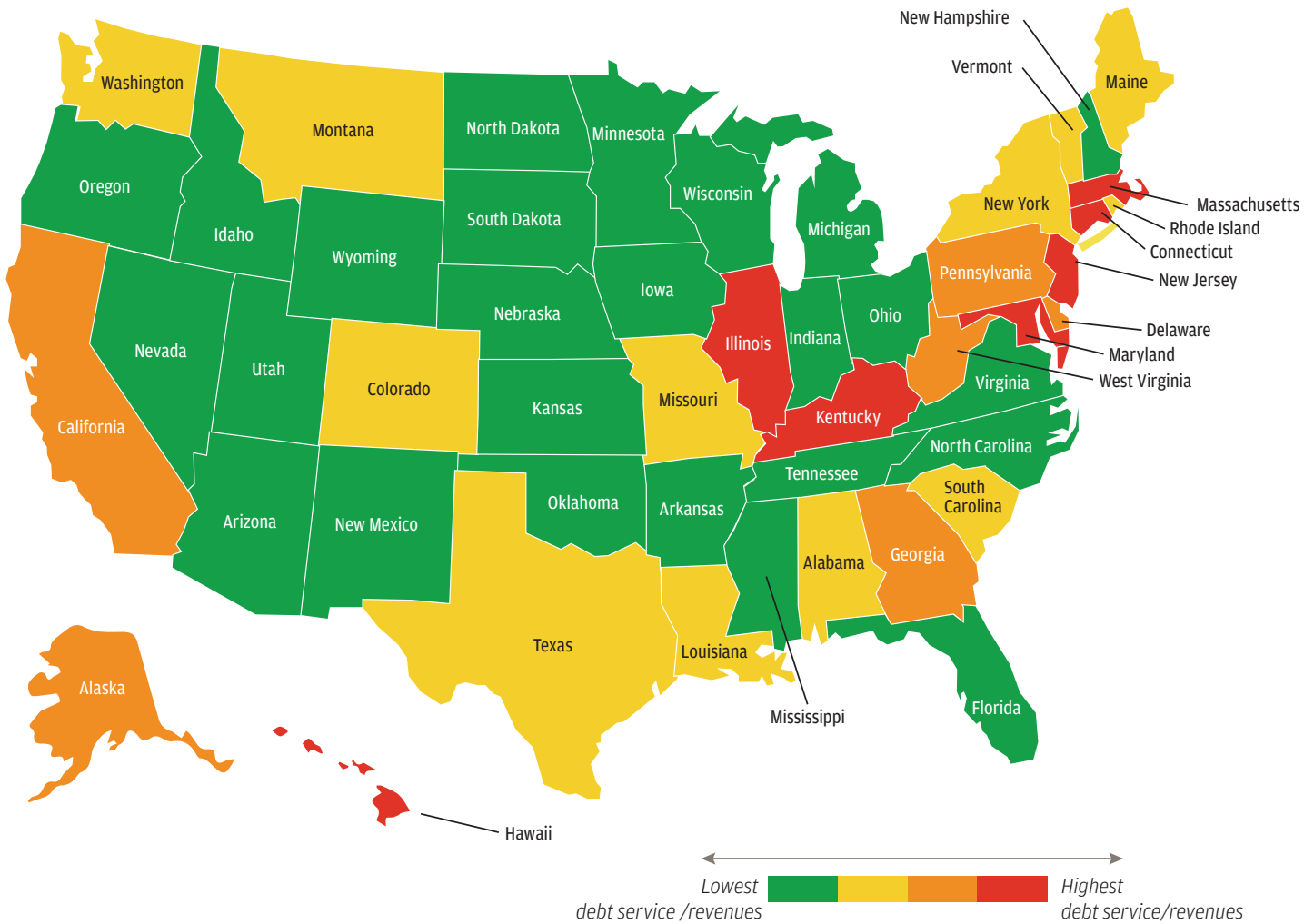


The ARC and the Covenants 4.0

The State of the States, 2018

J.P. MORGAN PRIVATE BANK



The “ARC and the Covenants 4.0” is our latest analysis of fiscal stress facing US states. We define stress as the percentage of state revenues needed to pay interest on general obligation debt, and meet all future pension and retiree healthcare obligations. Most states have burdens that are manageable (which we define as 15% or less). However, there are a few states whose burdens are so large as to require tax increases or spending cuts that may not be politically or economically feasible. I participated in a seminar at Harvard’s Kennedy School last year, and there was a sense that the US should use the Promesa legislation for Puerto Rico as a dry run for creating state-level bankruptcy rules, just in case. Based on the trajectory of funding ratios in a couple of states, I understand why some public policy analysts advocate the expansion of Chapter 9 legislation to states as well.

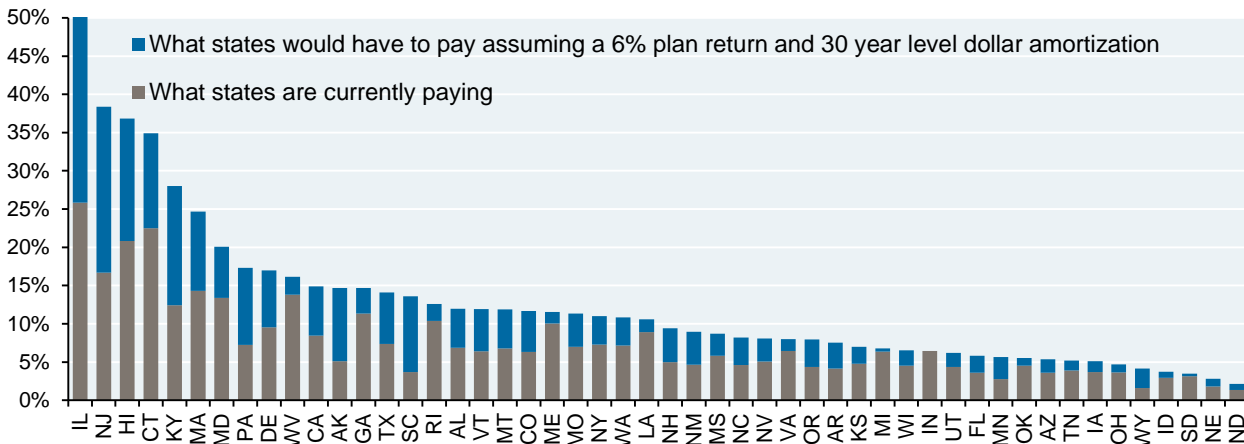
The ARC and the Covenants: The State of the States, 2018

A few years ago, we launched a project to assess the fiscal stress that US states, cities and counties face due to unfunded pension and retiree healthcare obligations. While these obligations are not explicitly cross-defaulted with municipal bonds, recent precedent suggests that we pay close attention anyway: when public sector employees suffer writedowns to pensions or retiree healthcare, bondholder losses are usually worse¹. As managers of \$75 billion in municipal bonds on behalf of our clients (Q3 2018), the issue of unfunded obligations is of paramount concern.

We named this project “The ARC and the Covenants”. ARC stands for “Annual Required Contribution”, and refers to the amount municipalities would have to pay each year to fully meet unfunded obligations over time, based on certain assumptions. We divide ARC payments by municipal revenue to get a sense for how large the burden is. The chart shows the results from our latest analysis on US states, for which we reviewed over 300 single and multi-employer pension, defined contribution and retiree healthcare plans. **The bottom line: many states have ratios that are manageable (which we define as 15% or less). However, there are a few states with severe problems.** I participated in a seminar at Harvard’s Kennedy School last year, and there was a sense that the US should use the Promesa legislation for Puerto Rico as a dry run for creating state-level bankruptcy rules, just in case. I think the expansion of Chapter 9 legislation for states makes sense, and I’m not the only one².

The cost of unfunded pensions and retiree healthcare as a % of state revenues

% of state revenues required to pay the sum of interest on net direct debt, the state's share of unfunded pension and retiree healthcare liabilities, and defined contribution plan payments



Source: J.P. Morgan Asset Management, State Annual Financial Reports, Moody's. FY 2017.

¹ Examples include Central Falls (RI), Vallejo (CA), San Bernadino (CA), Stockton (CA) and Detroit (MI), which we discussed in Exhibit SM7 of our 2017 ARC and the Covenants piece on cities and counties.

² "The city of Chicago and the state of Illinois should act now to restructure their liabilities and put the fiscal mess behind them. This can be accomplished by utilizing Chapter 9 and other tools Congress just gave Puerto Rico. The process would entail about two years of unpleasant headlines, but the city and the state will rebound far sooner and less painfully than if they stay on their current paths", former FDIC Chairman William M. Isaac, 2016.

We refer to our ratio as an “IPOD” ratio, since it measures Interest, Pension, OPEB (retiree healthcare) and Defined Contribution payments as a percentage of state revenues. In our analysis, we amortize unfunded balances over 30 years, and assume a 6% return on pension and OPEB plan assets.

To understand the stress a few states are under, look at Table 1. The current IPOD ratio indicates how much states now pay as a % of revenues, and the revised IPOD ratio is what they would need to pay to fully meet unfunded obligations over time. The middle section shows the primary ways the gap could be filled: tax hikes, increased worker contributions or higher investment returns. Illinois and New Jersey come closest in my view to deteriorations in pension finances that are practically irreversible.

- **Increase tax revenues.** To be clear, this tax hike would have to be in place for 30 years, and be used *solely* for contributions to underfunded plans. It’s unclear if such tax increases are politically viable when considering that state public sector workers generally represent 3%-7% of all workers in the state. If spending cuts were chosen instead of tax hikes, they would be similar in magnitude³.
- **Increase public sector worker contributions.** Require active public sector workers to shoulder the burden on their own, with no help from taxpayers⁴. The increases are 4x or more in some cases.
- **Achieve massive investment returns on plan assets.** First thing to notice: there are no solutions for some plans given how underfunded they are, or if states are dealing with them on a “pay-go” basis and not prefunding them at all. Second: even when required investment returns can be computed, I consider any investment return in double digits to be practically unachievable⁵.

Table 1

Largest revised IPOD ratios			Who funds the gap, every year for 30 years (mutually exclusive)							
State	Current IPOD ratio	Revised IPOD ratio	TAXPAYERS		PUBL SEC WORKERS		STATE FUND MANAGERS			
			Increase in tax revenues		Increased contributions		Req. pension inv return	and	Req. OPEB inv return	
IL	26%	→ 51%	25%	or	689%	or	11.5%	and	No solution	
NJ	17%	→ 38%	22%	or	521%	or	No solution	and	No solution	
HI	21%	→ 37%	16%	or	117091%	or	11.3%	and	18.2%	
CT	22%	→ 35%	12%	or	408%	or	10.5%	and	No solution	
KY	12%	→ 28%	16%	or	427%	or	No solution	and	No solution	
MA	14%	→ 25%	10%	or	237%	or	10.2%	and	No solution	
MD	13%	→ 20%	7%	or	216%	or	8.1%	and	No solution	
PA	7%	→ 17%	10%	or	532%	or	13.0%	and	No solution	
DE	10%	→ 17%	7%	or	614%	or	7.6%	and	No solution	
WV	14%	→ 16%	2%	or	116%	or	6.1%	and	17.5%	
CA	8%	→ 15%	6%	or	387%	or	8.6%	and	No solution	

Source: J.P. Morgan Asset Management, State Annual Financial Reports, Moody’s. FY 2017.

³ Most states run balanced budgets so the figures are similar, but **spending cuts** would need to be a bit larger since cuts would have to be made to non-pension spending (and not overall spending).

⁴ In **Hawaii**, public employees are required to contribute between 6% and 8% of pay to the retirement system. However, employers end up paying most of these contributions on their behalf. As a result, baseline amounts of actual worker contributions paid are small, and would have to increase astronomically to close the funding gap.

⁵ The 90th percentile of all 30-year real returns on a 70/30 stock bond portfolio since 1956 is 7.1%. Assuming 2.5% future inflation, the 90th percentile nominal return since 1956 would be 9.6%. As a result, any breakeven return above 9.6% would require returns in the top decile of historical performance.

Why do some states have such large unfunded obligations relative to revenues? Some enacted benefit increases before a market decline, which resulted in a large funding gap. Some contributed well below recommended levels for many years, worsening funding ratios further. And in some cases, the size of the pension/OPEB system is large relative to the state’s economy and tax base.

Table 2 summarizes key statistics on pension and OPEB plans for the weaker states:

- *Funding ratios*⁶. The reported versions indicate what states disclose for their pension and OPEB plans. The revised versions are what we *estimate* them to be, using a 6% discount rate.
 - The projected 10-year pension funding ratio represents our rough estimate assuming the state continues its contribution pattern, and earns a 6% return on assets. Most projected ratios are not substantially different from current ones, suggesting that depletion risks are not imminent.
 - However, this assumes that states like IL, CT and HI continue to allocate 20%-25% of state revenues to underfunded plans; this may not be feasible forever, given competing needs related to public services, infrastructure and education⁷. There’s also the risk of market volatility that depresses funding ratios, which would raise ARC payments further. **In other words, these are rough estimates that are sensitive to a variety of investment and political outcomes.**
 - Most states do not prefund OPEB plans, and use a pay-as-you-go approach
- *Contributions to underfunded plans*. “Actual vs reported ARC” shows what the state paid in FY 2017 relative to its reported ARC. The revised version shows the state contribution relative to our recomputed ARC, using both different return and amortization assumptions. “Level dollar” vs “level percent” amortization makes a big difference, and is explained in the supplementary materials.
- *Pension vs OPEB shares*. The last 2 columns show the pension and OPEB shares of the combined revised state ARC. Bottom line: **unfunded pensions are generally the larger problem.**

Table 2

State	PENSIONS					OPEB				Unfunded ARC	
	Reported funding ratio	Revised funding ratio	Projected 10-year pension funding ratio	Actual vs reported ARC	Actual vs revised ARC	Reported funding ratio	Revised funding ratio	Actual vs reported ARC	Actual vs revised ARC	Pension share	OPEB share
IL	38%	34%	52%	95%	53%	0%	0%	17%	11%	78%	22%
NJ	36%	40%	27%	49%	35%	0%	0%	30%	36%	58%	42%
HI	55%	48%	65%	100%	41%	9%	7%	89%	61%	56%	44%
CT	41%	35%	53%	99%	62%	3%	4%	57%	42%	71%	29%
KY	34%	40%	40%	72%	36%	33%	29%	138%	43%	77%	23%
MA	60%	50%	64%	100%	45%	5%	7%	29%	36%	78%	22%
MD	69%	56%	71%	99%	61%	3%	4%	63%	63%	79%	21%
PA	55%	48%	61%	102%	28%	1%	2%	55%	47%	75%	25%
DE	82%	74%	82%	99%	58%	4%	6%	43%	45%	39%	61%
WV	79%	67%	76%	100%	93%	25%	22%	69%	53%	71%	29%
CA	68%	57%	72%	100%	53%	1%	1%	53%	36%	68%	32%

Source: J.P. Morgan Asset Management, State Annual Financial Reports, Moody’s. FY 2017.

⁶ For context, the average **corporate** pension funding ratio was 86% in 2017, according to the Milliman 100 Index. Corporate plans also use lower discount rates (3.6% avg) than public plans (7.1% avg) use to discount liabilities.

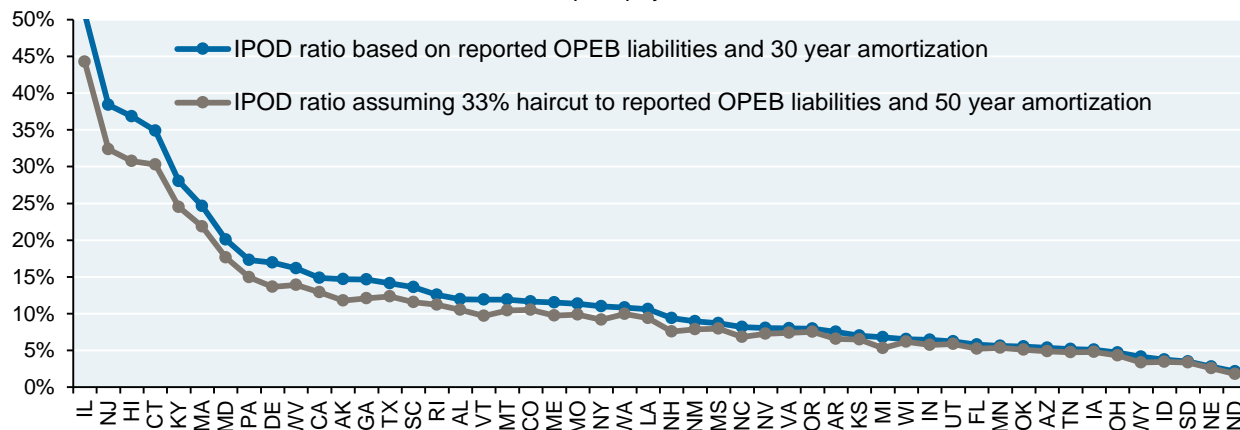
⁷ A 2017 paper from UC Berkeley found evidence that **rising pension expenditures are crowding out public services**. Major finding: a 10% increase in per-employee pension expenditures is associated with a 0.73% drop in city employment the following year, as well as declines in spending on construction and equipment.

Other than tax increases, spending cuts and increased worker contributions, is there anything else states can do to solve this problem? Once pension obligations have been accrued, they cannot be altered; case law has confirmed this. The only exception: states can reduce cost of living adjustments, but most have already done that. Retiree healthcare (OPEB) obligations, on the other hand, can be altered at the state’s discretion; the most common changes are increased retiree premium contributions, co-payments and deductibles. Since our last state analysis two years ago, some states enacted changes that substantially reduced projected OPEB liabilities: Iowa (-38%), Kansas (-100%), Louisiana (-34%), Minnesota (-69%), Nevada (-73%), North Carolina (-37%), Texas (-38%) and Virginia (-28%). In other states, they rose compared to last time. And as stated on the prior page, unfunded OPEB obligations are usually smaller than unfunded pensions.

To see how sensitive IPOD ratios are to OPEB restructuring, we ran an alternative scenario that makes an arbitrary **33% reduction to all retiree healthcare liabilities**, and that amortizes unfunded pension and OPEB obligations over **50 years** instead of 30 when computing ARC payments⁸. Both assumptions lower the IPOD ratios, but not by enough to change our assessment of risk for the weaker states on the left hand side of the chart.

What if states make large cuts to retiree healthcare and use a much longer amortization period?

% of state revenues required to pay the sum of interest on net direct debt, the state's share of unfunded pension and retiree healthcare liabilities, and defined contribution plan payments



Source: J.P. Morgan Asset Management, State Annual Financial Reports, Moody's. FY 2017.

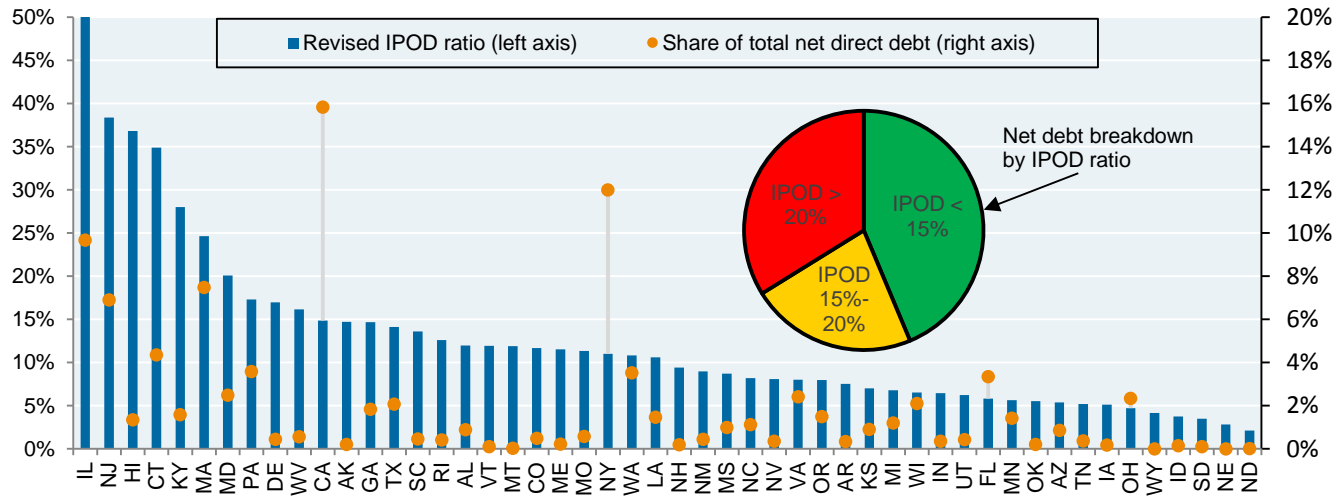
Some states make payments on behalf of local municipalities, referred to as **Special Funding** situations. For example, Illinois, New Jersey and Connecticut IPOD ratios would fall substantially if local municipalities started making these payments instead. However, our sense is that most local entities are not financially sound enough, or politically willing, to do so. See SM2 in the Supplementary Materials for more information on Special Funding.

Since we’re just a few weeks away from one of the most widely anticipated midterm elections in years, here’s some history on the **local politics of underfunded pensions**. The weaker states are generally “blue” ones: of the 11 states with IPOD ratios over 15%, 7 have state legislatures that were controlled by Democrats for the last 20 years; 2 state legislatures were mixed (Kentucky and Delaware); and 2 state legislatures were controlled by the GOP (Alaska and Pennsylvania).

⁸ This effectively allows states to maintain funding ratios from 60%-70% for many years while they wait for compounding benefits to kick in.

While a lot of states have low, healthy IPOD ratios, they are generally not the ones issuing all the debt. The next chart shows each state's IPOD ratio alongside its proportion of all general obligation debt. **Over 50% of general obligation debt outstanding corresponds to states with IPOD ratios over 15%.** For these reasons, our asset managers are generally cautious about general obligation exposures to weaker states. When they do invest there, they consider what (if any) exposure a particular issuer may have directly or indirectly to a state retirement system. In the \$3.7 trillion municipal bond market, many issuers have no exposure, such as the Northwestern Memorial Healthcare in Illinois, or Princeton University in New Jersey. Other issuers, such as local public utilities, may also be separate legal entities, and enjoy segregated revenues and participate in a better-funded local pension.

Plenty of states have low IPOD ratios, but states with high IPOD ratios issue the most state debt



Source: J.P. Morgan Asset Management, State Annual Financial Reports, Moody's. FY 2017.

Before concluding, I want to be clear about something. Public sector workers form a critical part of our civil society. They risk their lives to protect us when we're in danger; they make our lives safer, cleaner and more efficient; they educate our children; they enforce the rule of law and provide remedies when laws are broken; they ensure access to clean air, water and food; and they heal us when we're sick. The legal, medical, environmental and educational problems sometimes found in other countries are a reminder of what life might be like without them. They have earned the benefits they accrued and which were granted by state legislatures, and have the right to expect them to be paid.

The **supplementary materials** review the debate around public plan discount rates, the risks around the timing of market returns, Special Funding situations, the pace of asset depletion in underfunded plans, the history of public plan funding ratios since 2000, some history on New Jersey, descriptions of our methodology and data sources, and full results tables for all 50 states.

Michael Cembalest
JP Morgan Asset & Wealth Management

The ARC and the Covenants: The State of the States, 2018 Supplementary Materials

These exhibits are the supporting documents for our 2018 *ARC and the Covenants* analysis on the US States, which assesses the risks related to unfunded pension and retiree healthcare obligations.

SM1: The 6% investment return assumption, and the risk of cash flow timing

SM2: The impact of special funding situations on state IPOD ratios

SM3: Some history on state and local pension funding ratios

SM4: How did New Jersey end up in such bad shape?

SM5: IPOD ratio methodology

SM6: Definitions and data sources

SM7: Amortization methods for unfunded obligations using level dollar and level percent

SM8: How long might it take for a deeply underfunded pension plan to run out of money?

SM9: Results by state (IPOD ratios, required tax increases, required worker contributions, required return on plans assets)

SM10: Pension statistics by state (reported funding ratio, revised funding ratio based on our assumptions, actual payment vs reported ARC, actual payment vs revised ARC, pension share of total pension + OPEB ARC payments, discount rate, plan duration and projected funding ratios in 10 years assuming both level dollar and level percent ARCs)

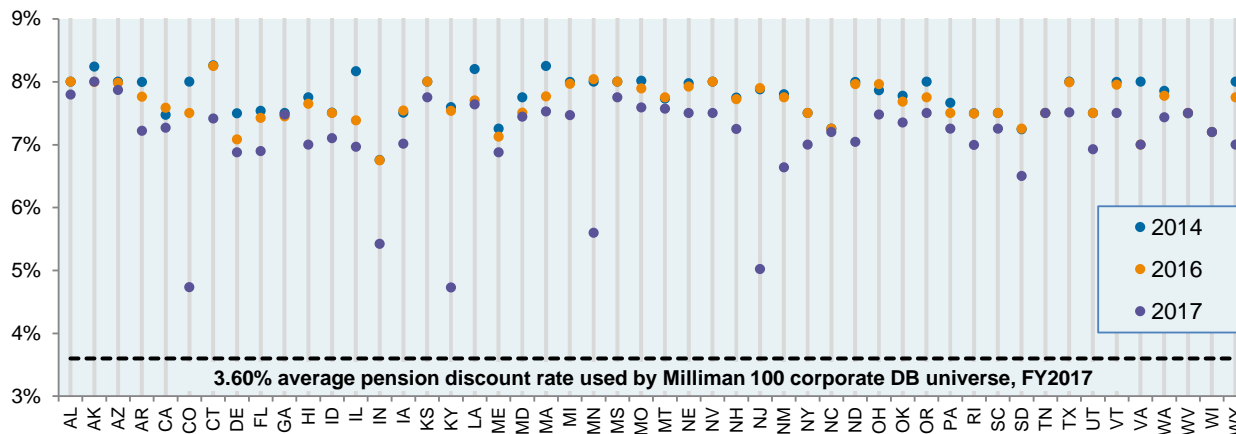
SM11: OPEB statistics by state (same categories as in SM10)

SM12: List of reviewed pension and OPEB plans by state

SM1: The 6% investment return assumption, and the risk of cash flow timing

The first chart shows pension plan return assumptions by state⁹. Many states have lowered their forward-looking return assumptions in recent years, but most are still above the 6% level we used in our analysis, and well above the 3.60% used by the average corporate defined benefit plan.

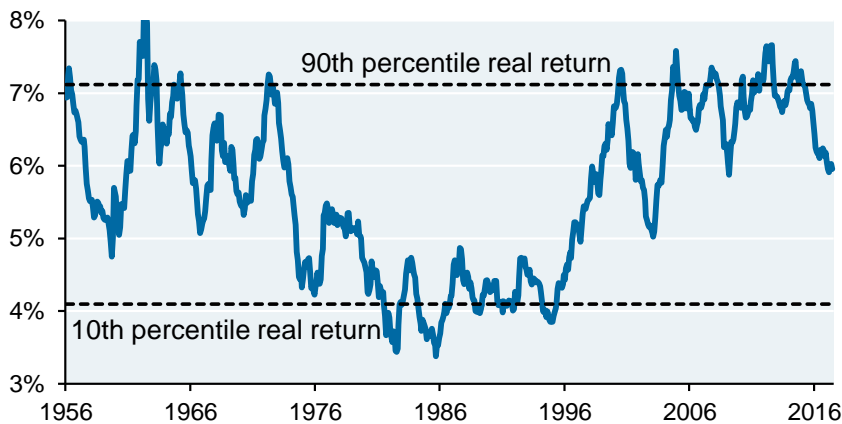
Downward migration of state pension plan discount rates



Source: J.P. Morgan Asset Management, State Annual Financial Reports, Milliman. FY 2014, 2016, 2017.

Discount rates are a widely debated topic in pension finance. **We believe 6% is conservative as a return assumption, since it implies a forward-looking 4% real return plus 2% inflation.** The next chart shows real returns on a simplified stock/bond portfolio since 1956. A 4% real return would rank close to the lowest real 30-year compound investment returns of the post-war era.

Historical real returns for hypothetical 70% stock, 30% bond portfolio, 30-year rolling real return



Source: JPMAM, Shiller, Ibbotson. June 2017. Past performance is not indicative of future results.

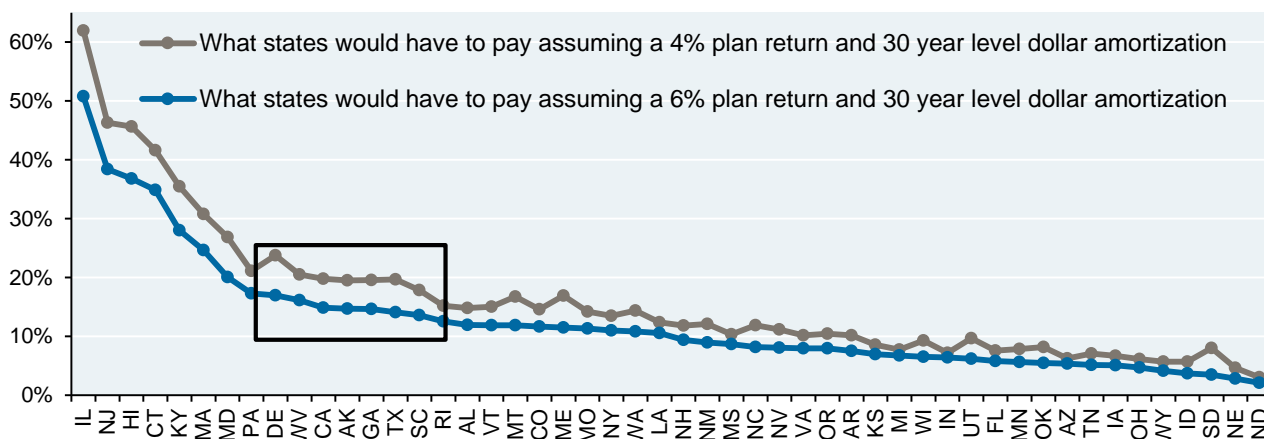
⁹ The average **OPEB** discount rate used by the states is lower: 4.5%, with a standard deviation of 1.4%.

That said, there are reasons to consider alternative rate scenarios as well. An independent Blue Ribbon panel commissioned in 2014 by the US Society of Actuaries looked at the question of public pension discount rates and historical returns. Their conclusion: “return experience does not readily suggest that return assumptions currently in use have been inconsistent with prior experience”¹⁰. However, the panel also concluded that while historical returns can be a useful reference point, return assumptions should ideally be based on a risk-free rate plus forward-looking risk premia. As a separate risk measure, the panel also recommended disclosure of plan liabilities using the risk-free rate.

The complex issue of the timing of market returns. It’s important to understand that not all 6% compound return scenarios are the same, since plans make ongoing distributions to retirees as time passes. The **timing** of investment returns matters a lot; scenarios with low returns earlier in the time horizon can result in substantial asset shortfalls even if the compound return over the entire period meets the expected 6% rate. This is a topic which has drawn increasing attention, and which researchers at Harvard and Pew Charitable Trusts have analyzed in detail¹¹. As a very rough proxy for such a scenario, we recomputed the IPOD ratios using a 4% return assumption¹². The results of this scenario show substantial incremental cash flow burdens on weaker states and also on states in the box, whose IPOD ratios reach 20%. Most well-funded states are not materially affected.

What if compound returns over 30 years are 6%, but returns in early years are lower?

% of state revenues required to pay the sum of interest on net direct debt, the state's share of unfunded pension and retiree healthcare liabilities, and defined contribution plan payments



Source: J.P. Morgan Asset Management, State Annual Financial Reports, Moody's. FY 2017.

¹⁰ “Report of the Blue Ribbon Panel on Public Pension Plan Funding”, An Independent Panel Commissioned by the Society of Actuaries, February 2014

¹¹ “Risky Choices: Simulating Public Pension Funding Stress with Realistic Shocks”, Shoag (Harvard) and Farrell (Univ of S. Florida), September 2016; and “Assessing the Risk of Fiscal Distress for Public Pensions: State Stress Test Analysis”, Mennis, Banta and Draine, Pew Charitable Trusts, May 2018.

¹² **Why 4%?** We looked at several 6% return scenarios where early year returns were lower than later year returns. To avoid asset depletion, the state would had to have planned for a 4% return instead. This is not meant to be a lower bound; there are 6% scenarios that could turn out even worse, depending on the timing of low returns.

SM2: The impact of special funding situations on state IPOD ratios

Many states make payments on behalf of cities and counties in one or more multi-employer plans (particularly Teacher plans), referred to as “**special funding**”. These situations can be temporary or permanent, but since states disclose them as permanent, our state IPOD ratios include the cost of assisting local entities. In this appendix, we examine two scenarios: first, what if special funding went away (local entities pick up their share of the obligations); and second, the extreme case that states take on responsibility for 100% of the obligations in all multi-employer pension and OPEB plans (i.e., every constituent municipality requires a special funding arrangement).

What if special funding disappeared and local municipalities paid their own shares

Most of these states disclose their plan shares *without* the special funding situations as well (i.e., if local entities were making their pro-rata contributions with no help from the state). In the table, we show both IPOD ratios for states that disclosed this information. In some cases the impact is minimal, while in other cases, the impact is large. Note the substantial decline in IPOD ratios in Connecticut, Illinois, Kentucky, New Jersey and Texas when excluding special funding obligations. **We do not gain too much comfort from these lower ratios**, however, since our sense is that in most cases, the cities and counties involved are either unwilling or unable to re-assume the obligations the state is paying on their behalf. Note: Indiana and Pennsylvania also have special funding situations in some plans, but did not disclose what their state shares would have been without them.

State	Revised IPOD	Revised IPOD when excluding special funding situations
AK	15%	12%
CT	35%	26%
GA	14%	13%
IL	50%	25%
KS	7%	6%
KY	29%	15%
MD	20%	12%
MA	22%	21%
MT	12%	8%
NE	3%	2%
NJ	38%	25%
NM	9%	9%
NC	8%	8%
RI	13%	10%
TN	5%	5%
TX	13%	7%
VT	12%	6%
WA	11%	10%
WV	16%	10%

IPOD ratio is the % of state revenues required to pay the sum of interest on net direct debt, the state's share of unfunded pension and retiree healthcare liabilities, and defined contribution plan payments.

Source: J.P. Morgan Asset Management, State Annual Financial Reports, Moody's. FY 2017.

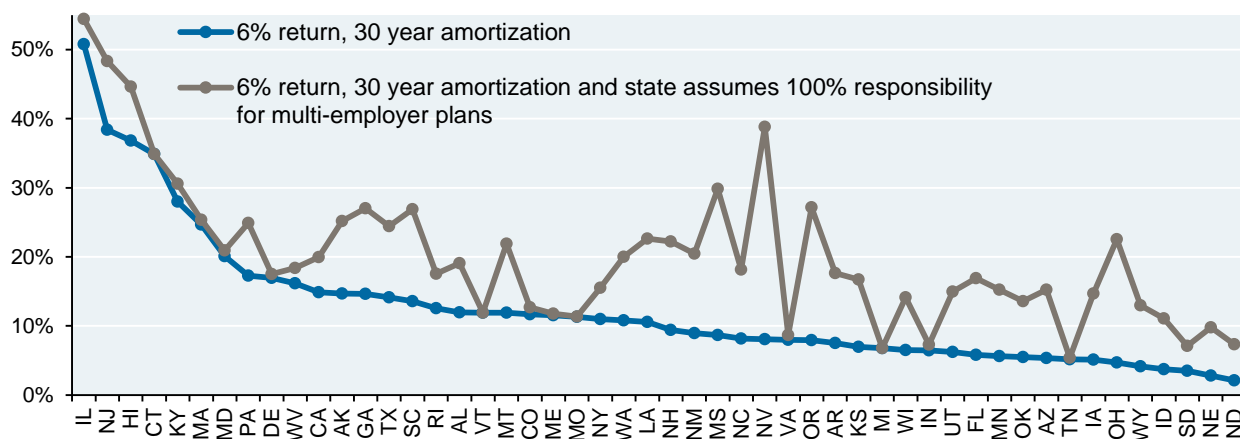
What if every local municipality required a special funding arrangement?

In this case, each state ends up responsible for 100% of the shortfalls in all multi-employer pension and OPEB plans they administer, without any contributions from local municipalities. In some of the weaker states, there's not that much of a change since this is case already for the large teacher plans. In other cases, the increase in the IPOD ratio is large, since most states have small shares of teacher plans in which local employees dominate. Here are some sample state shares for teacher or public employee plans that were increased to 100% in this scenario: Georgia (17%), Texas (67%), Nevada (16%), Oregon (21%), Louisiana (4%), Florida (18%) and Ohio (19%).

While we consider this scenario to be unlikely, state assumption of most plan liabilities has taken place in some states, and goes a long way in explaining why their ratios are so high. Illinois, for example, is responsible for 97% of the Illinois Teacher Retirement System, a \$125 billion multi-employer plan that is only 40% funded. Similar dynamics exist in New Jersey, Massachusetts and Connecticut, where the state is responsible for 100% of multi-employer Teacher plans. We have not been able to fully discern what legislative process led to these outcomes, but the consequence is clearly laid out in state financial reports.

What if states had to assume 100% responsibility for all multi-employer plans?

% of state revenues required to pay the sum of interest on net direct debt, the state's share of unfunded pension and retiree healthcare liabilities, and defined contribution plan payments

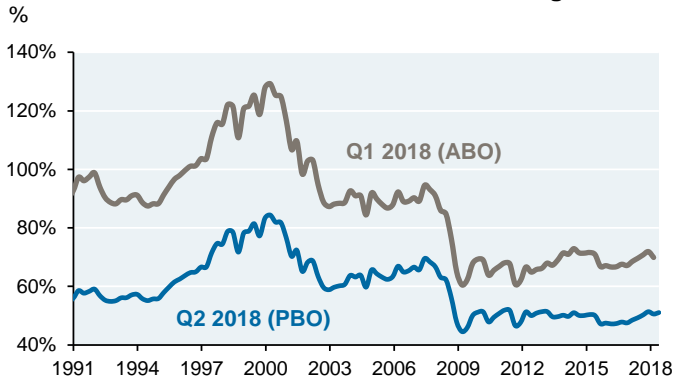


Source: J.P. Morgan Asset Management, State Annual Financial Reports, Moody's. FY 2017.

SM3: Some history on state and local pension funding ratios

When you see a chart on aggregate national pension funding ratios, the source is usually the Fed's Flow-of-Funds report. The Fed makes changes to its assumptions over time, some large and some small. In Q2 2018, they made a very big one: they switched from using **Accumulated Benefit Obligation** methodology to **Projected Benefit Obligation** methodology; the latter results in higher projected liabilities since PBO also includes estimates of future salary growth. As a result of this restatement, the entire history of funding ratios as computed with Fed Flow-of-Funds data declined relative to where it used to be. Even so, there are some inferences we can draw from the chart.

State and Local Government Pensions Funding Ratio



Source: Federal Reserve Flow of Funds. Q2 2018.

The primary factor driving both series down since 1999: two separate 40%+ stock market declines in the first decade of the 21st century, something that hadn't happened since the 1930's. What's also notable is how little public sector funding ratios have improved since 2009 on an aggregate basis. Based on my experience with public pension plans, I do not think this is a consequence of reduced portfolio risk. To me, this data suggests that other factors are in play:

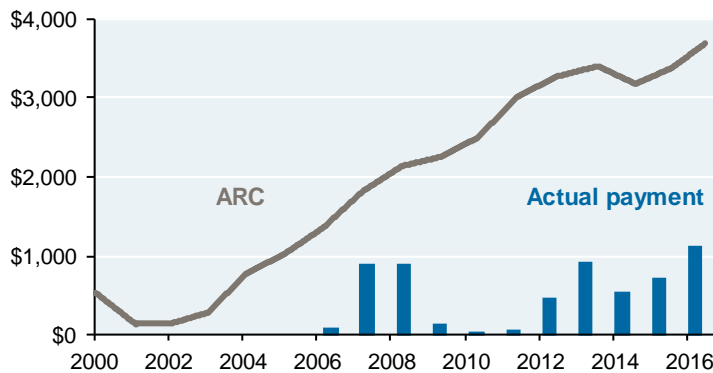
- After equity and risky credit markets declined, states earned high returns but on a smaller base, and continued to pay distributions at contractually promised levels which did not decline
- Some states did not make their full ARC contributions, which are required to gradually drive funding ratios higher
- Some states increased their longevity assumptions. A recent study by PGIM Investments found that if the average life expectancy of a sample plan were to increase by four to five years, liabilities could increase by as much as 15% to 20%
- Financial repression by the Federal Reserve has lowered returns on fixed income. However, public plans tend to hold lower cash and bond allocations than corporate plans, so my sense is that the prior three factors had a greater impact. The average public plan holds fixed income and cash of around 25% vs 45% for the average corporate plan

The current Fed PBO funding ratio of 50% is much lower than the reported national state pension funding ratio of 68%. The primary reason: the Fed uses AAA corporate bond rates to discount liabilities. The current AAA corporate bond rate is 4%, compared to an average 7.1% discount rate used by states.

SM4: How did New Jersey end up in such bad shape?

New Jersey governors and state legislators basically starved the plan. For the last 15 years, actual state contributions were nowhere near the required ARC. As shown, this was a bipartisan effort. A related problem: New Jersey did not adequately disclose problems with its pension plan, which resulted in an SEC enforcement action against the state for \$26 billion in fraudulent municipal bond offerings¹³. While New Jersey was the first state charged with violating federal securities laws in this manner, others were to follow, including Illinois and Kansas¹⁴.

New Jersey's ARC vs actual contributions
US\$ millions

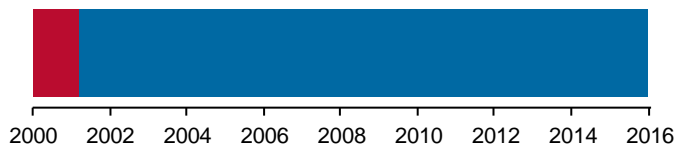


Source: Pew Charitable Trust, New Jersey Annual Reports. 2016.

New Jersey Governor party affiliation



New Jersey General Assembly majority party



¹³ "SEC Charges State of New Jersey for Fraudulent Municipal Bond Offerings", SEC Press Release 2010-152.

¹⁴ See SEC Press Releases 2013-37 (Illinois) and 2014-164 (Kansas).

SM5: IPOD ratio methodology

IPOD ratio = $\frac{I + P + O + D}{R}$ where,

I = interest on net direct debt

P = state share of amortization of unfunded pension liability + pension service cost

O = state share of amortization of unfunded retiree healthcare obligation (OPEB) + OPEB service cost

D = state share of defined contribution payments¹⁵

R = state revenues

Key assumptions:

Interest rate on net direct debt	5%
Investment return on pension plan and OPEB plan assets	6% ¹⁶
Amortization period for unfunded obligations	30 years
Amortization method for unfunded obligations	Level dollar (see SM7)

When normalizing across plans¹⁷:

- First, adjust gross pension or OPEB liability based on the duration of the plan¹⁸, and the difference between the state's assumed return and our assumed return of 6%
- Second, recompute the net pension or OPEB liability (i.e., net of plan assets), which is re-amortized at 6% over 30 years using a level dollar approach
- Third, adjust service costs using the duration of the plan plus an assumed 5 year extension (since service costs apply to active workers only and not current retirees)
- The normalized annual payment for pensions and OPEB is the sum of the recomputed amortization component and the recomputed annual service cost

In many instances, our normalized estimate of pension and OPEB costs was **higher** than what states currently contribute. There are four primary reasons for this:

- Some states do not meet annual required contributions computed by their actuaries. Pension ARC compliance is considerably higher than OPEB ARC compliance (compare column 3 in SM10 vs SM11).
- Some states contribute 100% of their "required" contribution, but this payment is sometimes set by statute (e.g., by the legislature) rather than by actuaries
- We assume a 6% return instead of the generally higher returns assumed by many states on pensions; this increases the size of the gross and net pension liability
- We assume level dollar amortization instead of an approach more commonly used which assumes that ARC payments rise over time ("level percent"); the latter obscures the true cost of unfunded obligations when computing a single accrual-based ratio

¹⁵ While we include **DC plans** in the IPOD ratio, they are infrequently used. Only half of the states use them, and they are generally very small. Aggregate DC payments are ~2% of combined pension and OPEB obligations.

¹⁶ State and local plans generally follow an actuarial funding model and discount future benefits based on the expected return of the assets that will be used to fund the benefits.

¹⁷ We ran scenarios that applied a maximum level of net debt as a % of state revenues, using a 65% threshold. The impacts were small, and primarily affected states that already have the highest IPOD ratios: IL, HI, CT and MA.

¹⁸ While **duration** measures can be used to linearly re-estimate liabilities when small discount rate changes take place (i.e., plus or minus 1%), such measures are less accurate for larger changes in rates, even when convexity measures are used as well. Working with our pension team at JP Morgan Asset Management, we developed a series of prototype pension and OPEB cash flow vectors for different durations. We then used these prototype vectors when re-estimating the value of pension and OPEB liabilities using our 6% discount rate.

SM6: Definitions and data sources

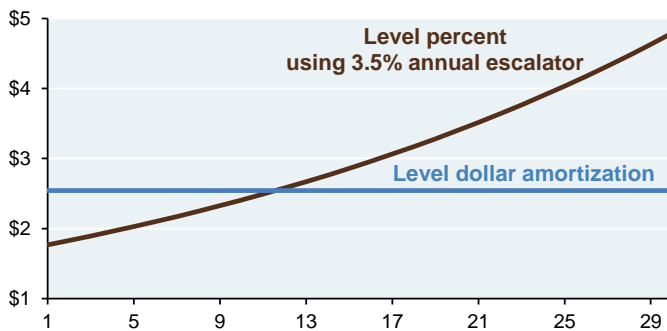
- **Data aggregation.** We sourced data for pensions, OPEB and defined contribution plans from FY2017 reports; we used FY2016 for Alabama since its FY2017 report was not available. All net direct debt and revenue data for FY2017 was sourced from Moody's as of July 31, 2018.
- **Net direct debt** includes bonds, unconditional general fund obligations, capital leases, pension obligation bonds and lease revenue bonds. This concept excludes revenue bonds of state enterprises (e.g., essential service revenue bonds) and self-supporting debt (i.e., if a city issues a general obligation bond but a water utility pays for it or has covered debt service for 3 consecutive years, the debt is excluded). We include negative operational fund balances in "net direct debt" as well.
- **Plan liabilities.** In our model, annual pension and OPEB obligations include the state's share of (a) amortization of unfunded liabilities, and (b) service costs. We derive state service costs by deducting worker contributions from plan-level service costs, and then multiplying by the state share.
- **State revenues** are sourced from the Moody's series entitled "Own Source Revenue". This category includes a) real estate taxes, sales and use taxes, income taxes, and other payments into the General Fund, and b) payments into general debt service funds. According to Moody's, revenues categorized as "non-recurring" are excluded. Own Source Revenues are generally (but not always) similar to Census data on state revenue collections.
- **State shares.** In multi-employer plans, states are often responsible for a *portion* of unfunded obligations (and not the entire amount), based typically on percentage of the plan's workers that are state-level employees; the remainder is owed by local entities whose employees make up the rest of the plan. State shares are usually disclosed, but when they weren't, we estimated them by dividing the state's reported ARC by the plan-level ARC obtained from plan-level financial reports.
- **Special funding situations.** Many states make payments on behalf of local entities in multi-employer plans (particularly Teacher plans), referred to as "special funding". These situations can be temporary or permanent, but since states disclose them as permanent, our state IPOD ratios include the cost of assisting local entities. See SM2 for more details.
- **Missing OPEB data.** Roughly one third of OPEB plans (by liability value) did not disclose duration; in these cases we assumed a Macaulay duration of 15 based on OPEB durations disclosed by other states. Roughly 20% of OPEB plans (by liability value) did not disclose service costs; we estimated them by subtracting our estimated amortization of unfunded liabilities from their reported ARC. **The reason for the missing data:** states are in the process of complying with new GASB rules on OPEB disclosure, and some have not adopted the new rules yet. The latter group includes Arizona, Arkansas, Florida, Illinois, Kansas, Mississippi, Montana and New York.
- **Data uncertainties.** When data in state reports was unclear, we reached out to the state to get confirmation of our interpretations and assumptions; not all of those calls were returned. In our judgment, after reviewing over 300 single and multi-employer plans, most data uncertainties were related to smaller plans which did not materially affect our IPOD results.

SM7: Amortization methods for unfunded obligations using level dollar and level percent

When normalizing across plans, there are 3 primary components: the investment return, the amortization term and the **amortization method**. The latter refers to whether a state assumes level payments over time (“level dollar”), or assumes that amortization payments rise over time (“level percent”). Most plans in our universe use the level percent approach. However, when computing our IPOD ratios, we normalized across plans using the level dollar approach instead, since it’s a better measure to use when comparing states using a single ratio to incorporate the cost of future obligations. The chart compares the ARC under both approaches for a hypothetical plan with a 70% funding ratio.

Level dollar vs. level percent amortization

ARC payment, US\$ millions



Source: J.P. Morgan Asset Management. Assuming 70% funding ratio, \$100mm gross pension liability and 7.5% discount rate.

The table shows how an IPOD ratio would change if a state used both a higher discount rate than our 6% assumption, and if it used the level percent approach with a 3.5% annual escalator. In the base case, the required pension amortization is \$17.7 mm, and the IPOD ratio is 16%. After adjusting for a lower discount rate and the level dollar approach, the IPOD ratio rises to 26%. In this example, the use of level dollar accounts for around half the increase, while the discount rate change explains the rest.

Hypothetical Example	
Pension discount rate	7.5%
Current pension liability, \$mm	1,000
Pension funding ratio	70%
Current pension assets, \$mm	700
Pension duration	12%
Pension amortization term	30
Escalator	3.5%
Net pension liability (\$mm)	300
Pension amortization w/escalator, \$mm	17.7
Pension amortization, no escalator, \$mm	25.4
OPEB Amortization, \$mm	6.4
Interest, \$mm	7.9
Interest + Pension + OPEB, \$mm	32.0
Revenues, \$mm	200
Current IPOD ratio	16%
Pension discount rate	6%
Pension liability, \$mm	1,207
Net pension liability, \$mm	507
Pension amortization, no escalator, \$mm	36.8
Revised IPOD ratio	26%

IPOD ratio is the % of state revenues required to pay the sum of interest on net direct debt, the state's share of unfunded pension and retiree healthcare liabilities, and defined contribution plan payments.

SM8: How long might it take for a deeply underfunded pension plan to run out of money?

This is a complicated question with a variety of potential outcomes. Public sector plans are usually “open”, meaning that new workers, new contributions and new accrued liabilities are added over time. Working with our pension team at JP Morgan Asset Management, we ran a few scenarios that looked at what could happen to a state whose pension plan was 65% funded today.

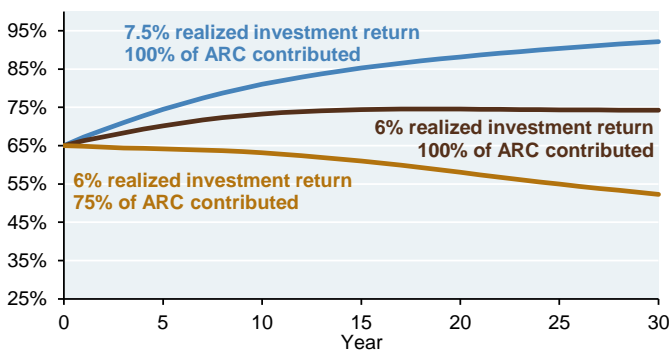
- *Fixed assumptions:* the state’s discount rate is 7.5%; the plan’s service costs are 3% of total pension liabilities; payroll growth rises at 4% per year; the duration of the plan’s liabilities is 13%; and the state uses an “open” amortization approach, meaning that it keeps re-amortizing its net pension liability each year over the subsequent 30 years¹⁹
- *Variable assumptions:* the realized investment return on plan assets; the percentage of the required ARC that the city makes each year; and whether the city uses a level dollar or level percent method when computing its ARC payments

Let’s start with the chart on the left, which assumes **level dollar** amortization. If the state makes its ARC each year and achieves its target return, its funding ratio would rise over time and eventually converge towards 100% (blue line). If the state makes the full ARC but only earns 6% instead of 7.5%, its funding ratio would stay roughly constant (brown line). And if the state falls short on returns and only makes 75% of the ARC, its funding ratio would deteriorate (tan line). The dynamics are worse when a state uses **level percent** amortization (2nd chart), since the state is makes payments that represent the earlier rungs on the rising amortization ladder, and never contributes the larger amounts.

We use both approaches when estimating future 10-year pension funding ratios by state in Exhibit SM10 (see last 2 columns). Both approaches assume a 6% return. Weighted by liabilities, **80% of state plans use level percent**, so that’s the more relevant column to look at.

Pension funded status: level dollar amortization

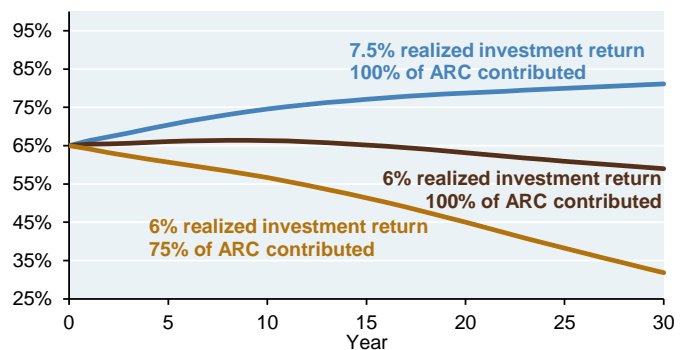
Assets/liabilities, assuming 7.5% discount rate and 30 year term



Source: J.P. Morgan Asset Management. August 2017.

Pension funded status: level percent amortization

Assets/liabilities, assuming 7.5% discount rate and 30 year term



Source: J.P. Morgan Asset Management. August 2017.

¹⁹ In contrast, a “closed” amortization approach would require unfunded liabilities to be fully paid down by a specific fixed date, which could result in sky-rocketing ARC payments if investment shortfalls occurred.

SM9: IPOD results and remediation by state

State	Current IPOD	Revised IPOD	<i>Who funds the gap, every year for 30 years (mutually exclusive)</i>				Required pension and return	Required OPEB return		
			TAXPAYERS		PUBL SEC WORKERS				STATE FUND MANAGERS	
			Increase in tax revenues	or	Increased contributions	or				
IL	26%	51%	25%		689%		11.5%	No solution		
NJ	17%	38%	22%		521%		No solution	No solution		
HI	21%	37%	16%		117091%		11.3%	18.2%		
CT	22%	35%	12%		408%		10.5%	No solution		
KY	12%	28%	16%		427%		No solution	No solution		
MA	14%	25%	10%		237%		10.2%	No solution		
MD	13%	20%	7%		216%		8.1%	No solution		
PA	7%	17%	10%		532%		13.0%	No solution		
DE	10%	17%	7%		614%		7.6%	No solution		
WV	14%	16%	2%		116%		6.1%	17.5%		
CA	8%	15%	6%		387%		8.6%	No solution		
AK	5%	15%	10%		835%		11.3%	8.7%		
GA	11%	15%	3%		473%		7.1%	22.7%		
TX	7%	14%	7%		164%		8.9%	No solution		
SC	4%	14%	10%		263%		11.8%	No solution		
RI	10%	13%	2%		158%		8.2%	6.6%		
AL	7%	12%	5%		216%		9.8%	No solution		
VT	6%	12%	5%		276%		8.7%	No solution		
MT	7%	12%	5%		159%		8.0%	No solution		
CO	6%	12%	5%		305%		11.1%	No solution		
ME	10%	12%	1%		52%		6.6%	7.6%		
MO	7%	11%	4%		358%		9.1%	No solution		
NY	7%	11%	4%		2503%		6.8%	No solution		
WA	7%	11%	4%		312%		7.1%	No solution		
LA	9%	11%	2%		165%		7.5%	No solution		
NH	5%	9%	4%		379%		8.2%	No solution		
NM	5%	9%	4%		151%		9.1%	16.3%		
MS	6%	9%	3%		239%		9.8%	No solution		
NC	5%	8%	4%		503%		6.7%	No solution		
NV	5%	8%	3%		112%		8.3%	4.0%		
VA	6%	8%	2%		153%		7.5%	No solution		
OR	4%	8%	4%		19515%		No solution	-6.2%		
AR	4%	8%	3%		341%		8.3%	No solution		
KS	5%	7%	2%		159%		9.1%	-40.1%		
MI	6%	7%	0%		312%		5.1%	12.9%		
WI	5%	7%	2%		150%		7.2%	No solution		
IN	6%	6%	0%		-1%		6.0%	11.9%		
UT	4%	6%	2%		2515%		7.5%	-13.9%		
FL	4%	6%	2%		351%		8.1%	No solution		
MN	3%	6%	3%		361%		No solution	No solution		
OK	5%	6%	1%		71%		6.6%	No solution		
AZ	4%	5%	2%		104%		9.9%	6.9%		
TN	4%	5%	1%		1519%		7.3%	No solution		
IA	4%	5%	1%		147%		7.5%	No solution		
OH	4%	5%	1%		110%		7.6%	9.4%		
WY	2%	4%	3%		250%		8.0%	No solution		
ID	3%	4%	1%		66%		6.7%	15.9%		
SD	3%	3%	0%		17%		6.1%	No solution		
NE	2%	3%	1%		78%		7.0%	No solution		
ND	1%	2%	1%		63%		8.9%	-10.1%		

Source: J.P. Morgan Asset Management, State Annual Financial Reports, Moody's. FY 2017. IPOD ratio is the % of state revenues required to pay the sum of interest on net direct debt, the state's share of unfunded pension and retiree healthcare liabilities, and defined contribution plan payments.

SM10: Pension statistics by state

Pensions									
State	Reported funding ratio	Revised funding ratio	Actual vs reported ARC	Actual vs revised ARC	Pension share of Pen+OPEB	Liability-weighted discount rate	Liability-weighted duration	Year 10	Year 10
								Projected Funding Ratio Level Dollar	Projected Funding Ratio Level Percent
IL	38%	34%	95%	53%	78%	7.0%	13.6%	63%	52%
NJ	36%	40%	49%	35%	58%	5.0%	13.4%	36%	27%
HI	55%	48%	100%	41%	56%	7.0%	13.6%	73%	65%
CT	41%	35%	99%	62%	71%	7.4%	12.0%	64%	53%
KY	34%	40%	72%	36%	77%	4.7%	13.8%	51%	40%
MA	60%	50%	100%	45%	78%	7.5%	11.4%	72%	64%
MD	69%	56%	99%	61%	79%	7.4%	12.8%	77%	71%
PA	55%	48%	102%	28%	75%	7.3%	10.8%	70%	61%
DE	82%	74%	99%	58%	39%	6.9%	11.8%	86%	82%
WV	79%	67%	100%	93%	71%	7.5%	10.8%	81%	76%
CA	68%	57%	100%	53%	68%	7.3%	13.7%	78%	72%
AK	67%	52%	100%	24%	77%	8.0%	11.4%	74%	67%
GA	79%	65%	100%	72%	43%	7.5%	12.7%	82%	78%
TX	76%	62%	99%	41%	78%	7.5%	12.4%	80%	75%
SC	54%	46%	100%	16%	83%	7.3%	13.5%	72%	64%
RI	53%	47%	100%	74%	88%	7.0%	11.8%	70%	61%
AL	67%	55%	100%	49%	84%	7.8%	10.5%	73%	66%
VT	62%	51%	109%	58%	62%	7.5%	11.6%	77%	69%
MT	73%	60%	100%	59%	88%	7.6%	12.0%	79%	73%
CO	43%	51%	100%	43%	92%	4.7%	13.8%	74%	64%
ME	81%	73%	100%	81%	77%	6.9%	12.3%	86%	82%
MO	64%	53%	102%	57%	86%	7.6%	11.5%	75%	67%
NY	95%	84%	100%	69%	38%	7.0%	11.7%	92%	90%
WA	90%	73%	100%	51%	71%	7.4%	13.7%	87%	85%
LA	66%	55%	101%	81%	73%	7.6%	9.8%	73%	65%
NH	63%	54%	100%	66%	41%	7.2%	11.8%	75%	67%
NM	63%	57%	92%	41%	89%	6.6%	13.3%	75%	68%
MS	62%	49%	100%	46%	90%	7.8%	12.0%	73%	65%
NC	89%	78%	100%	75%	26%	7.2%	11.1%	88%	85%
NV	74%	61%	100%	47%	92%	7.5%	13.1%	80%	75%
VA	75%	66%	100%	66%	78%	7.0%	11.8%	82%	76%
OR	83%	69%	100%	26%	98%	7.5%	11.9%	83%	79%
AR	77%	66%	103%	53%	72%	7.2%	12.5%	83%	78%
KS	68%	55%	75%	46%	99%	7.8%	11.8%	65%	58%
MI	69%	60%	99%	110%	42%	7.5%	9.5%	74%	67%
WI	99%	87%	100%	46%	83%	7.2%	10.7%	93%	92%
IN	61%	65%	100%	100%	97%	5.4%	10.7%	79%	71%
UT	90%	80%	100%	55%	98%	6.9%	13.2%	90%	88%
FL	79%	70%	100%	46%	69%	6.9%	13.1%	85%	81%
MN	61%	64%	93%	25%	96%	5.6%	14.7%	79%	73%
OK	79%	67%	101%	80%	100%	7.4%	11.4%	83%	78%
AZ	67%	57%	100%	55%	97%	7.9%	8.9%	71%	63%
TN	88%	73%	104%	64%	81%	7.5%	11.6%	87%	84%
IA	82%	72%	101%	59%	79%	7.0%	12.2%	86%	82%
OH	80%	67%	100%	56%	90%	7.5%	11.3%	82%	77%
WY	77%	68%	102%	49%	51%	7.0%	12.2%	84%	79%
ID	91%	79%	100%	71%	93%	7.1%	12.3%	89%	87%
SD	100%	93%	100%	85%	100%	6.5%	14.4%	98%	98%
NE	86%	70%	113%	64%	100%	7.5%	13.0%	89%	86%
ND	64%	56%	98%	43%	108%	7.0%	12.9%	76%	69%

Source: J.P. Morgan Asset Management, State Annual Financial Reports, Moody's. FY 2017.

SM11: OPEB statistics by state

OPEB (retiree healthcare)							
State	Reported funding ratio	Revised funding ratio	Actual vs reported ARC	Actual vs revised ARC	OPEB share of Pen+OPEB	Liability-weighted discount rate	Liability-weighted duration
IL	0%	0%	17%	11%	22%	4.1%	20%
NJ	0%	0%	30%	36%	42%	4.5%	na
HI	9%	7%	89%	61%	44%	7.0%	na
CT	3%	4%	57%	42%	29%	3.7%	16%
KY	33%	29%	138%	43%	23%	6.9%	13%
MA	5%	7%	29%	36%	22%	3.6%	20%
MD	3%	4%	63%	63%	21%	3.6%	16%
PA	1%	2%	55%	47%	25%	3.6%	18%
DE	4%	6%	43%	45%	61%	3.6%	19%
WV	25%	22%	69%	53%	29%	7.2%	12%
CA	1%	1%	53%	36%	32%	3.9%	18%
AK	91%	70%	100%	35%	23%	8.0%	12%
GA	10%	12%	102%	72%	57%	4.4%	18%
TX	1%	2%	62%	71%	22%	3.6%	18%
SC	8%	11%	62%	52%	17%	3.6%	16%
RI	26%	31%	100%	108%	12%	4.6%	na
AL	5%	8%	46%	47%	16%	3.6%	19%
VT	0%	0%	53%	37%	38%	3.6%	17%
MT	0%	0%	31%	32%	12%	4.3%	na
CO	15%	15%	48%	46%	8%	6.4%	10%
ME	15%	19%	86%	100%	23%	4.2%	15%
MO	5%	5%	55%	60%	14%	5.1%	15%
NY	0%	0%	43%	36%	62%	3.2%	na
WA	0%	0%	18%	20%	29%	3.8%	13%
LA	0%	0%	65%	72%	27%	4.5%	na
NH	0%	0%	32%	29%	59%	4.5%	19%
NM	11%	16%	50%	65%	11%	3.8%	19%
MS	0%	0%	71%	64%	10%	3.6%	na
NC	5%	7%	100%	36%	74%	3.6%	18%
NV	0%	0%	100%	124%	8%	4.0%	na
VA	35%	32%	55%	76%	22%	6.8%	13%
OR	87%	79%	26%	194%	2%	7.0%	10%
AR	0%	0%	31%	36%	28%	4.5%	na
KS	0%	0%	102%	197%	1%	3.6%	na
MI	18%	16%	96%	79%	58%	7.0%	11%
WI	45%	52%	27%	35%	17%	4.6%	na
IN	24%	36%	95%	109%	3%	3.6%	19%
UT	70%	78%	115%	345%	2%	3.8%	5%
FL	0%	0%	25%	25%	31%	4.0%	na
MN	0%	0%	46%	74%	4%	3.0%	14%
OK	0%	0%	58%	61%	0%	4.5%	na
AZ	104%	85%	100%	70%	3%	8.0%	9%
TN	0%	0%	62%	79%	19%	4.0%	na
IA	0%	0%	34%	34%	21%	4.9%	na
OH	52%	70%	60%	77%	10%	3.9%	16%
WY	0%	0%	29%	26%	49%	5.0%	na
ID	20%	24%	59%	84%	7%	4.3%	na
SD	na	na	na	na	0%	na	na
NE	na	na	na	na	0%	na	na
ND	58%	50%	106%	-181%	-8%	7.4%	10%

Source: J.P. Morgan Asset Management, State Annual Financial Reports, Moody's. FY 2017.

SM12: List of reviewed pension and OPEB plans by state

Alabama Employees Retirement System	Georgia Peace Officers' Annuity and Benefit F	Kentucky Employees' Retirement System, Non-Ha
Alabama Teacher's Retirement System	Georgia Firefighters' Pension Fund	Kentucky Employees' Retirement System, Hazard
Alabama Judicial Retirement Fund	Georgia Public School Employees Retirement Sy	Kentucky Teachers' Retirement System OPEB
Alabama State Employees' Health Insurance Pla	Georgia Judicial Retirement System	
	Georgia State OPEB Fund	Louisiana State Employees' Retirement System
Alaska Public Employees' Retirement System	Georgia School OPEB Fund	Louisiana State Police Retirement System
Alaska Teacher Retirement System	Georgia SEAD-OPEB Plan	Louisiana Teachers' Retirement System
Alaska Judicial Retirement System	Georgia Regents OPEB Plan	Louisiana School Employees' Retirement System
Alaska NGNMRS		Louisiana District Attorneys' Retirement Syst
Alaska Public Employees' Retirement System -	Haw aii ERS	Louisiana Clerks' of Court Retirement and Rel
Alaska Teachers' Retirement System - OPEB	Haw aii EUTF	Louisiana Registrar of Voters Employees' Reti
Alaska Judicial Retirement System - OPEB		Louisiana Office of Group Benefits OPEB Plan
		Louisiana State University System OPEB Plan
Arizona State Retirement System	Idaho Public Employee Retirement System	
Arizona Public Safety Personnel Retirement Sy	Idaho Judges' Retirement Fund	Maine SETP - State Employees
Arizona Correctional Officers Retirement Plan	Idaho Retiree Healthcare OPEB Plan	Maine SETP - Teachers
Arizona Elected Officials Retirement Plan	Idaho Retiree Life Insurance OPEB Plan	Maine Judicial Defined Benefit Plan
Arizona State Retirement System HBS OPEB	Idaho University OPEB Plan	Maine Legislative Defined Benefit Plan
Arizona State Retirement System LTD OPEB	Idaho Long-Term Disability - Healthcare	Maine State Employees OPEB
Arizona Department of Administration OPEB	Idaho Long-Term Disability - Life Insurance	Maine Teacher OPEB
	Idaho Long-Term Disability - Income	Maine First Responders OPEB
		Maine State Group Life OPEB
Arkansas Public Employees' Retirement System	Illinois General Assembly Retirement System	Maine Teachers Group Life OPEB
Arkansas Teacher Retirement System	Illinois Judges' Retirement System	
Arkansas Judicial Retirement System	Illinois State Employees' Retirement System	Maryland State Retirement and Pension System
Arkansas State Police Retirement System	Illinois Teachers' Retirement System	Maryland Transit Administration Pension Plan
Arkansas State Highway Employees Retirement S	Illinois State Universities Retirement System	Maryland State Employee and Retiree Health an
Arkansas State Police Medical and Rx Plan	Illinois State OPEB	Maryland Transit Administration Retiree Healt
Arkansas State Employee Health Plan	Illinois Teacher Health Insurance Security Fu	
	Illinois Community College Health Insurance S	Massachusetts State Employees Retirement Syst
California CALPERS PERF A		Massachusetts Teachers Retirement System
California State Teachers' Retirement Plan	Indiana State Police Retirement Fund	Massachusetts Boston Retirement System - Teac
California Judges' Retirement Fund	Indiana State Police Supplemental Trust Fund	Massachusetts State Retirees' Benefits Trust
California Judges' Retirement Fund II	Indiana State Excise Police, Gaming Agent, Ga	
California Legislators' Retirement Fund	Indiana Prosecuting Attorney's Retirement Fun	Michican State Employees Retirement System
California OPEB	Indiana Legislators' Retirement System	Michigan State Police Retirement System
	Indiana Judges Retirement System	Michigan Legislative Retirement System
Colorado State Division Trust Fund	Indiana Public Employees' Retirement Fund	Michigan Military Retirement System (MRP)
Colorado Judicial Division Trust Fund	Indiana State Teachers' Retirement Fund 1996	Michigan Judges Retirement System
Colorado PERA Health Care Trust Fund OPEB	Indiana State Teachers' Retirement Fund Pre-1	Michican State Employees Retirement System OP
Colorado University Post-Retirement HC & Life	Indiana State Personnel Plan	Michigan State Police Retirement System OPEB
Colorado DCP Refund	Indiana Legislature Plan	Michigan Legislative Retirement System OPEB
Colorado PERA Subsidy	Indiana State Police Plan	Michigan Judges Retirement System - OPEB
Colorado Rx Subsidy	Indiana Conservation and Excise Police Plan	Michigan Life Insurance
Colorado LTD Income Replacement		
Connecticut State Employee Retirement System	low a Public Employees' Retirement System	Minnesota State Employees Retirement Fund
Connecticut Teachers' Retirement System	low a Peace Officers' Retirement, Accident and	Minnesota Correctional Employees Retirement F
Connecticut Judicial Retirement System	low a Judicial Retirement System	Minnesota General Employees Retirement Fund
Connecticut State Employee OPEB Plan	low a State OPEB	Minnesota Judges Retirement Fund
Connecticut Retired Teacher Healthcare Plan	University of low a OPEB	Minnesota Legislators Retirement Fund
	low a State University OPEB	Minnesota State Patrol Retirement Fund
	University of Northern low a OPEB	Minnesota Teachers Retirement Fund
Delaware State Employees' Pension Plan		Minnesota St. Paul Teachers' Retirement Fund
Delaware Special Fund	Kansas Public Employees Retirement System	Minnesota Volunteer Firefighter Retirement Fu
Delaware New State Police Pension Plan	Kansas Police and Firemen's Retirement System	Minnesota Main OPEB plan
Delaware Judiciary Pension Plans	Kansas Retirement System for Judges	Minnesota Metropolitan Council OPEB
Delaware Closed State Police Plan	Kansas Health Care Finance	Minnesota UofM OPEB
Delaware OPEB Fund Trust		
Delaware Transit Corporation (DTC) OPEB Trust	Kentucky Employees' Retirement System, Non-Ha	Mississippi Public Employees' Retirement Syst
	Kentucky Employees' Retirement System, Hazard	Mississippi Highway Safety Patrol Retirement
Florida Retirement System	Kentucky State Police Retirement System	Mississippi Supplemental Legislative Retireme
Florida Retiree Health Insurance Subsidy Prog	Kentucky Judicial Retirement Plan	Mississippi State and School Employees' Life
Florida National Guard Supplemental Retiremen	Kentucky Legislators' Retirement Plan	
Florida State Employees' Health Insurance Pro	Kentucky Teachers' Retirement System	
	Kentucky Judicial Retirement Plan OPEB	Missouri State Employees' Plan
	Kentucky Legislators' Retirement Plan OPEB	Missouri Judicial Plan
Georgia Employees' Retirement System	Kentucky State Police Retirement System OPEB	Missouri Dept of Transportation & Highway Pat
Georgia Teachers Retirement System		



University of Missouri Retirement System	North Dakota Teachers' Fund for Retirement	Texas Teacher Retirement System
Missouri Consolidated Health Care Plan	North Dakota Retiree Health Insurance Credit	Texas Emergency Services Retirement Plan
MoDOT & MSHP Medical and Life Insurance Plan	North Dakota Implicit Subsidy Unfunded OPEB	University of Texas System Employee Group Ins
Conservation Employees' Insurance Plan	North Dakota Retirement Plan for the Employee	Texas A&M University System Group Insurance P
University of Missouri OPEB		Texas State Retiree Health Plan
	Ohio Public Employees Retirement System	Texas TRS-CARE
Montana Public Employees' Retirement System D	Ohio State Teachers Retirement System	
Montana Judges' Retirement System	Ohio State Highway Patrol Retirement System	Utah Public Employees Noncontributory Ret Sys
Montana Highway Patrol Officers' Retirement S	Ohio Public Employees Retirement System - OPE	Utah Public Employees Contributory Ret System
Montana Sheriffs' Retirement System	Ohio State Teachers Retirement System - OPEB	Utah Firefighters Ret System
Montana Game Wardens' and Peace Officers' Ret	Ohio State Highway Patrol Retirement System -	Utah Public Safety Retirement System
Montana Municipal Police Officers' Retirement		Utah Judges Retirement System
Montana Firefighters' Unified Retirement Syst	Oklahoma Firefighters Pension and Retirement	Utah Governors and Legislators Retirement Pla
Montana Volunteer Firefighters' Compensation	Oklahoma Law Enforcement Retirement System	Utah Tier 2 Public Employees System
Montana Teachers' Retirement System	Oklahoma Public Employees Retirement System	Utah Tier 2 Public Safety and Firefighters Sy
State of Montana OPEB	Oklahoma Uniform Retirement System for Justic	Utah State Employee OPEB Plan
Montana University System OPEB	Oklahoma Police Pension and Retirement System	Utah Elected Official OPEB Plan
	Oklahoma Teachers Retirement System	
Nebraska State Employees' Retirement Cash Bal	Oklahoma Wildlife Conservation Retirement Pla	Vermont State Retirement System
Nebraska School Employees' Retirement System	Oklahoma Wildlife Conservation OPEB Plan	Vermont State Teachers' Retirement System
Nebraska Judges Retirement System		Vermont State Postemployment Benefit
Nebraska State Patrol Retirement System	Oregon Public Employee Retirement System	Vermont Retired Teachers' Health and Medical
Nebraska Omaha School Employees' Retirement	Oregon Retirement Health Insurance Account	
Nebraska School Employees' Retirement System	Oregon Retiree Health Insurance Premium Accou	Virginia Retirement System
	Oregon Public Employees Benefit Board	Virginia State Police Officers' Retirement Sy
Nevada Public Employees' Retirement System		Virginia Law Officers' Retirement System
Nevada Legislators' Retirement System	Pennsylvania State Employee Retirement System	Virginia Judicial Retirement System
Nevada Judicial Retirement System	Pennsylvania Public School Employee Retiremen	Virginia Group Life Insurance Fund
Nevada Public Employees' Benefits Program	Pennsylvania Retired Employees Health Program	Virginia Retiree Health Insurance Credit Fund
	Pennsylvania Retired Pennsylvania State Polic	Virginia Disability Insurance Trust Fund
New Hampshire Retirement System		Virginia Line of Duty Death and Disability
New Hampshire Judicial Retirement Plan	Rhode Island Employees' Retirement System - S	Virginia Pre-Medicare Retiree Healthcare
New Hampshire OPEB	Rhode Island Employees' Retirement System - T	
	Rhode Island State Police Retirement Benefits	Washington Public Employees' Retirement Syste
New Jersey Consolidated Police and Firemen's	Rhode Island Judicial Retirement Benefits Tru	Washington Public Employees' Retirement Syste
New Jersey Judicial Retirement System	Rhode Island Judicial Retirement Fund Trust	Washington Teachers' Retirement System 1
New Jersey Police and Firemen's Retirement Sy	Rhode Island State Police Retirement Fund Tru	Washington Teachers' Retirement System 2&3
New Jersey Prison Officers' Pension Fund	Rhode Island Judiciary Non-Contributory Retir	Washington Law Enforcement Officers' and Fire
New Jersey Public Employees' Retirement Syste	Rhode Island State Employee OPEB	Washington Law Enforcement Officers' and Fire
New Jersey State Police Retirement System	Rhode Island Teachers OPEB	Washington Public Safety Employees' Retiremen
New Jersey Teachers' Pension and Annuity Fund	Rhode Island Judicial OPEB	Washington State Patrol Retirement System 1&2
New Jersey State Health Benefit Program Fund	Rhode Island State Police OPEB	Washington Judges' Retirement Fund
	Rhode Island Legislators OPEB	Washington Judicial Retirement System
New Mexico Public Employees Retirement System	Rhode Island Board of Education OPEB	Washington Volunteer Fire Fighters' and Reser
New Mexico Judicial Retirement System		Washington Higher Education Supplemental Defi
New Mexico Magistrate Retirement System	South Carolina Retirement System	Washington Public Employees' Benefits Board
New Mexico Volunteer Firefighter Retirement S	South Carolina Police Officers Retirement Sys	
New Mexico Educational Employees Retirement S	South Carolina Retirement System for General	West Virginia Public Employees Retirement Sy
New Mexico Retiree Health Care Authority	South Carolina Retirement System for Judges	West Virginia Teachers' Retirement System
	South Carolina National Guard Supplemental Re	West Virginia State Police Death, Disability,
New York Employee Retirement System	South Carolina Retiree Health Insurance Trust	West Virginia State Police Retirement System
New York Police and Fire Retirement System	South Carolina Long Term Disability Insurance	West Virginia Judges' Retirement System
New York State Health Insurance Program		West Virginia Retiree Health Benefit Trust
City University of New York	South Dakota Retirement System	
		Wisconsin Retirement System
North Carolina Teachers' and State Employees'	Tennessee CRS - Closed State and Higher Ed Em	Wisconsin State Retiree Health Insurance Fund
North Carolina Firefighters' and Rescue Squad	Tennessee CRS - State and Higher Education E	Wisconsin Duty Disability Fund
North Carolina Consolidated Judicial Retireme	Tennessee Employee Group Plan Total	Wisconsin State Retiree Life Insurance Fund
North Carolina Legislative Retirement System	Tennessee Teacher Group Plan	
North Carolina National Guard Pension Fund	Tennessee Medicare Supplement Plan	Wyoming Public Employees Pension Plan
North Carolina Retiree Health Benefit Fund	Tennessee Local Government Group Plan Compone	Wyoming State Patrol, Game & Fish Warden & Cr
North Carolina Disability Income Plan		Wyoming Judicial Pension Plan
	Texas Employees Retirement System of Texas Pl	Wyoming Law Enforcement Pension Plan
North Dakota Public Employees' Retirement Sys	Texas Law Enforcement and Custodial Officer S	Wyoming Air Guard Firefighters Plan
North Dakota Highway Patrolmen's Retirement S	Texas Judicial Retirement System One	Wyoming State OPEB
North Dakota Retirement Plan for the Employee	Texas Judicial Retirement System Tw o	

IMPORTANT INFORMATION

Purpose of This Material: This material is for information purposes only. The views, opinions, estimates and strategies expressed herein constitutes Michael Cembalest's judgment based on current market conditions and are subject to change without notice, and may differ from those expressed by other areas of J.P. Morgan. **This information in no way constitutes J.P. Morgan Research and should not be treated as such.**

Non-Reliance: We believe the information contained in this material to be reliable and have sought to take reasonable care in its preparation; however, we do not represent or warrant its accuracy, reliability or completeness, or accept any liability for any loss or damage (whether direct or indirect) arising out of the use of all or any part of this material. We do not make any representation or warranty with regard to any computations, graphs, tables, diagrams or commentary in this material which are provided for illustration/reference purposes only. We assume no duty to update any information in this material in the event that such information changes. Any projected results and risks are based solely on hypothetical examples cited, and actual results and risks will vary depending on specific circumstances. Forward looking statements should not be considered as guarantees or predictions of future events. **Investors may get back less than they invested, and past performance is not a reliable indicator of future results.**

Risks, Considerations and Additional information: There may be different or additional factors which are not reflected in this material, but which may impact on a client's portfolio or investment decision. The information contained in this material is intended as general market commentary and should not be relied upon in isolation for the purpose of making an investment decision. Nothing in this document shall be construed as giving rise to any duty of care owed to, or advisory relationship with, you or any third party. Nothing in this document is intended to constitute a representation that any investment strategy or product is suitable for you. You should consider carefully whether any products and strategies discussed are suitable for your needs, and to obtain additional information prior to making an investment decision. Nothing in this document shall be regarded as an offer, solicitation, recommendation or advice (whether financial, accounting, legal, tax or other) given by J.P. Morgan and/or its officers or employees, irrespective of whether or not such communication was given at your request. J.P. Morgan and its affiliates and employees do not provide tax, legal or accounting advice. You should consult your own tax, legal and accounting advisors before engaging in any financial transactions.

Contact your J.P. Morgan representative for additional information concerning your personal investment goals. You should be aware of the general and specific risks relevant to the matters discussed in the material. You will independently, without any reliance on J.P. Morgan, make your own judgment and decision with respect to any investment referenced in this material.

J.P. Morgan may hold a position for itself or our other clients which may not be consistent with the information, opinions, estimates, investment strategies or views expressed in this document. JPMorgan Chase & Co. or its affiliates may hold a position or act as market maker in the financial instruments of any issuer discussed herein or act as an underwriter, placement agent, advisor or lender to such issuer.

References in this report to "J.P. Morgan" are to JPMorgan Chase & Co., its subsidiaries and affiliates worldwide.

Legal Entities and Regulatory Information: In the **United States**, Bank deposit accounts, such as checking, savings and bank lending, may be subject to approval. Deposit products and related services are offered by **JPMorgan Chase Bank, N.A.** Member FDIC.

JPMorgan Chase Bank, N.A. and its affiliates (collectively "**JPMCB**") offer investment products, which may include bank managed accounts and custody, as part of its trust and fiduciary services. Other investment products and services, such as brokerage and advisory accounts, are offered through **J.P. Morgan Securities LLC ("JPMS")**, a member of [FINRA](#) and [SIPC](#). **JPMCB and JPMS** are affiliated companies under the common control of JPMorgan Chase & Co. Products not available in all states.

In the **United Kingdom**, this material is issued by **J.P. Morgan International Bank Limited (JPMIB)** with the registered office located at 25 Bank Street, Canary Wharf, London E14 5JP, registered in England No. 03838766. **JPMIB** is authorised by the Prudential Regulation Authority and regulated by the Financial Conduct Authority and the Prudential Regulation Authority. In addition, this material may be distributed by **JPMorgan Chase Bank, N.A. ("JPMCB"), Paris branch**, which is regulated by the French banking authorities Autorité de Contrôle Prudentiel et de Résolution and Autorité des Marchés Financiers or by **J.P. Morgan (Suisse) SA**, which is regulated in Switzerland by the Swiss Financial Market Supervisory Authority (FINMA).

In **Hong Kong**, this material is distributed by **JPMCB, Hong Kong branch**. JPMCB, Hong Kong branch is regulated by the Hong Kong Monetary Authority and the Securities and Futures Commission of Hong Kong. In Hong Kong, we will cease to use your personal data for our marketing purposes without charge if you so request. In **Singapore**, this material is distributed by **JPMCB, Singapore branch**. JPMCB, Singapore branch is regulated by the Monetary Authority of Singapore. Dealing and advisory services and discretionary investment management services are provided to you by JPMCB, Hong Kong/Singapore branch (as notified to you). Banking and custody services are provided to you by JPMIB and/or JPMCB Singapore Branch. The contents of this document have not been reviewed by any regulatory authority in Hong Kong, Singapore or any other jurisdictions. You are advised to exercise caution in relation to this document. If you are in any doubt about any of the contents of this document, you should obtain independent professional advice.

With respect to countries in **Latin America**, the distribution of this material may be restricted in certain jurisdictions. Receipt of this material does not constitute an offer or solicitation to any person in any jurisdiction in which such offer or solicitation is not authorized or to any person to whom it would be unlawful to make such offer or solicitation. To the extent this content makes reference to a fund, the Fund may not be publicly offered in any Latin American country, without previous registration of such fund's securities in compliance with the laws of the corresponding jurisdiction. Public Offering of any security, including the shares of the Fund, without previous registration at Brazilian Securities and Exchange Commission – CVM is completely prohibited. Some products or services contained in the materials might not be currently provided by the Brazilian and Mexican platforms. This material should not be duplicated or redistributed without our permission.

© 2018 JPMorgan Chase & Co. All rights reserved.