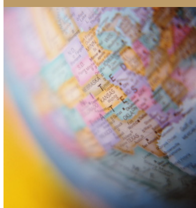

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STATE AND LOCAL PENSION PLANS

NUMBER 34, SEPTEMBER 2013

HOW SENSITIVE IS PUBLIC PENSION FUNDING TO INVESTMENT RETURNS?

*By Alicia H. Munnell, Jean-Pierre Aubry, and Josh Hurwitz**

Introduction

A recent *Issue in Brief* projected that, under the most likely scenario, the aggregate funded ratio for state and local pension plans will increase from 73 percent in 2012 to 81 percent in 2016.[1] The "optimistic" and "pessimistic" scenarios assume higher or lower, but also constant, rates of return. While this type of deterministic analysis is useful, an analysis that takes into account the variability of investment returns from year to year provides a more complete picture of the risks of serious underfunding. Hence, this *brief* builds on the previous analysis by extending the projections of pension funding through 2042, using stochastically generated investment returns to quantify the probability that specific outcomes will occur. This exercise, for illustrative purposes, centers around the average real return adopted by plans themselves.

The discussion proceeds as follows. The first section describes historical investment returns and the assumptions currently used by public plans. A key point is that the real return – the nominal return net of inflation – is the relevant concept for public plans because benefits are generally indexed for inflation both before (through salary increases) and after retirement (through cost-of-living adjustments). The second section presents a stochastic "Monte Carlo" framework and explains why this model is more helpful than a deterministic model that uses constant rates of return. The third section projects pension funding through 2042 (30 years from the most recent plan data) using stochastically generated real investment returns under alternative assumptions regarding how much of the Annual Required Contribution (ARC) plans pay and what amortization methods they

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use. The final section concludes that – even if the median long-run return equals the assumed rate – the potential variability in returns, when combined with paying less than the full ARC and the funding procedures currently used by many plan sponsors, will produce less than full funding over the next 30 years.

Historical Returns and Assumptions

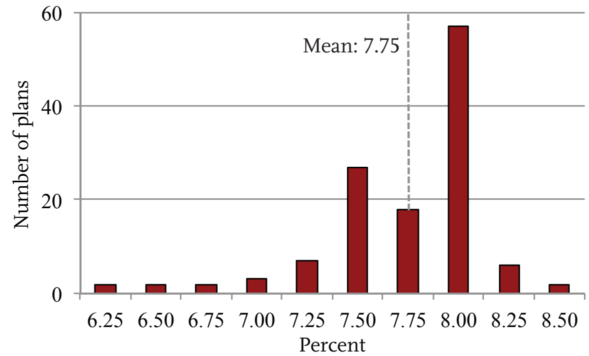
To determine the annual contributions necessary to fund a pension system, plan sponsors make assumptions about mortality, employee turnover, inflation and, most importantly, the expected long-term rate of return on assets.[2] Rates-of-return have always been important, but are even more so today as public plans have matured. In mature plans, investment returns matter immensely because: 1) assets are large relative to the funding base; 2) cash flows are negative; and 3) a significant portion of participants are retired and no longer contributing. Before examining state and local return assumptions, it is first necessary to determine the most relevant measure of return: nominal or real.

Nominal vs. Real Returns

In 2012, the nominal, long-term return assumption used by state and local pension plans averaged 7.75 percent, ranging from 6.25 percent to 8.50 percent (see Figure 1).

While the nominal return assumption typically receives the most scrutiny, the assumed real return – that is, the nominal return minus the assumed rate of inflation – is of primary importance.[3] The real return is key because with fully indexed pension plans – that is, plans where benefits both before and after retirement keep pace with inflation – the inflation assumption has no impact on the required contribution. Yes, higher nominal returns will produce more revenues. But, if these returns are driven by higher inflation, they will also raise initial benefits (through higher wage growth) and the cost-of-living-adjustment (COLA) paid after retirement. So, as long as the same inflation embedded in the nominal rate of return is used to project salary increases and COLAs, the required contribution rate for a plan that assumes a 4.5 percent real return and a 3.5 percent inflation rate (8 percent nominal) is exactly the same as that for a plan that assumes the same real rate of return and an inflation rate of 2 percent (6.5 percent nominal).[4]

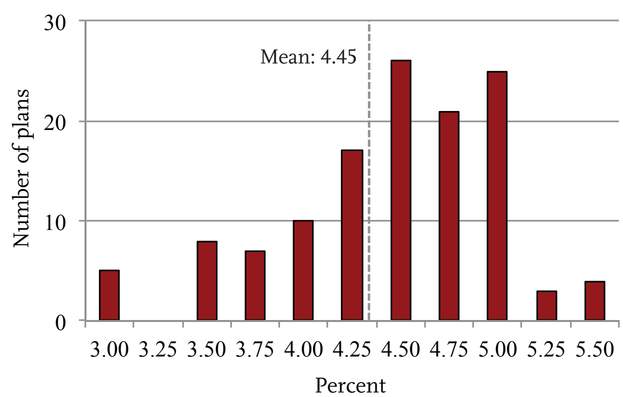
Figure 1. Distribution of Nominal Long-Term Investment Return Assumptions, 2012



Source: Various 2012 actuarial valuation reports.

Thus, when assessing the assumptions used by public plans, the focus should be on the real rate of return. The average inflation assumption in 2012 for plans in the *Public Plans Database* was 3.3 percent, well above the 2.3 percent reported by the Federal Reserve Bank of Philadelphia *Survey of Professional Forecasters* and also much higher than the Federal Reserve's inflation target of 2.0 percent.[5] Deducting each plan's inflation assumption from its assumed nominal return yields real returns ranging from 3.0 percent to 5.5 percent, with an average of 4.45 percent (see Figure 2).

Figure 2. Distribution of Real Long-Term Investment Return Assumptions, 2012



Source: Various 2012 actuarial valuation reports.

Evaluating the Real Return Assumptions

One question is how plans' assumed real return of 4.45 percent stacks up against historical returns. Table 1 shows the compound annualized real returns for broad asset classes over the periods 1926-2012 and 1975-2012.[6] Real returns on equities have exceeded 4.45 percent over the long term, while returns on bonds have been lower. However, since 1975, even bond returns have exceeded the benchmark.

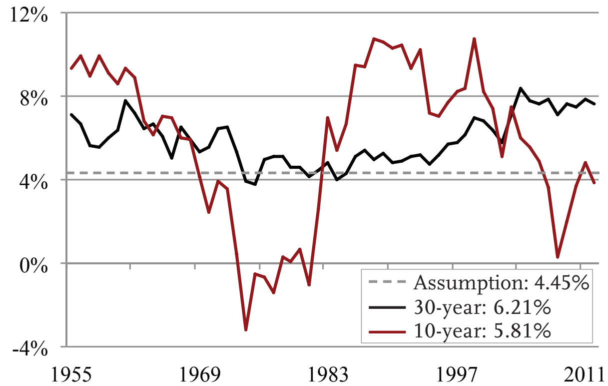
Table 1. Compound Annualized Real Returns on Assets, 1926-2012 and 1975-2012

	1926-2012	1975-2012
Equities:		
Domestic large-cap	6.8%	7.7%
Domestic small-cap	8.8	11.6
International	N/A	6.8
Bonds:		
Long-term corporate	3.2	5.5
Long-term government	2.8	5.3
Intermediate-government	2.5	4.1

Source: Authors' calculations from Morningstar, Inc (2013) and French (2013).

An alternative approach is to calculate the return that a portfolio invested 65 percent in stocks and 35 percent in bonds – roughly the portfolio of today's public plans – would have produced historically.[7] Figure 3 shows rolling 10-year and 30-year geometric real returns for a hypothetical portfolio of 65/35 stocks/bonds from 1955-2012. (That is, for each year, the value shown is the average return on the hypothetical portfolio over the previous 10- or 30-year period, respectively. The straight line in Figure 3 is the average long-term return assumption of 4.45 percent used by public plans.)[8] During the 1955-2012 period, the average rolling 10- and 30-year real returns for the hypothetical portfolio exceeded the long-term return assumption by at least 100 basis points.[9] The rolling 10-year returns fell below the assumed long-term rate in 19 years. About one-quarter of these occurrences

Figure 3. 10-Year and 30-Year Geometric Real Returns for Hypothetical Portfolios of 65 Percent Stocks and 35 Percent Bonds, 1955-2012



Source: Authors' calculations from Morningstar, Inc. (2013) and French (2013).

were during the period that followed the 2008 financial crisis. The rolling 30-year real returns fell below the assumed long-term rate in only three years.

Therefore, it appears that the average long-term real return assumption is quite reasonable *based on history*, particularly over longer periods.[10] But whether future returns will persist at the same levels, particularly in the aftermath of the recent financial crisis, is an open question. Many investment experts suggest that future equity returns could be considerably below historical averages.[11] In addition, returns on bonds are at historically low levels as the Fed has attempted to stimulate the economy in the wake of the financial crisis and the Great Recession. For example, the current nominal rate on a 30-year Treasury bond is 3.6 percent; subtracting inflation of 2.0 percent yields a real return of 1.6 percent, compared to 2.8 percent over the period 1929-2012. Thus, real returns could be considerably lower than the 4.45 percent assumed by plan sponsors.

Selecting the appropriate long-term return, however, is not the focus of this *brief*. Rather, the strategy is to assume that plans' long-term return assumption turns out to equal the long-term average, and then to demonstrate that the substantial volatility around the average exhibited by financial assets creates a significant chance of not achieving funding targets.

A "Monte Carlo" Model

Given the large variation in investment returns, the most appropriate way to project pension finances is with a stochastic model. While deterministic models simplify a complex process by imposing single point estimates, stochastic models project a process with many possible outcomes. More importantly, stochastic models can quantify the probability of any given outcome occurring, such as the likelihood that pension plans will achieve a given funding target.

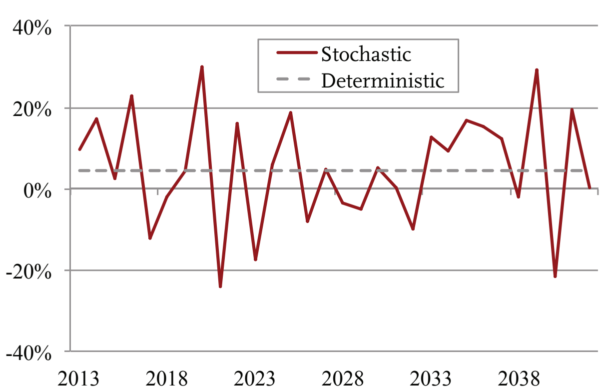
A common stochastic model – the Monte Carlo model – can be used to simulate for each asset class in a portfolio a large number of potential return outcomes that are based on an assumed probability distribution (e.g. normal distribution) and each asset class's average return, deviation from the mean (volatility), and covariance with other asset classes.[12]

Since the Monte Carlo projections are based on historical data, the median return would be more than 100 basis points higher than the 4.45 percent return assumed by public plan sponsors. To focus on the implications of financial volatility, the Monte Carlo projections are assumed to average 4.45 percent rather than the higher historical number or a lower number suggested by many financial experts.

In order to get a sense of the difference between the stochastic and deterministic approaches, Figure 4 compares rates of return in a single 30-year Monte Carlo run to a deterministic projection with the same geometric return (4.45 percent). The figure shows that even if the long-run return matches a plan's assumptions, the volatility in year-to-year returns can create large fluctuations in required contributions and, if poor returns are concentrated in the early years of the period, could have an adverse effect on funding.

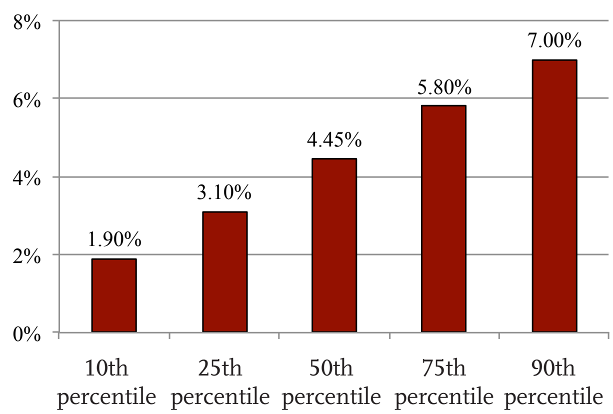
Figure 5 shows how 100,000 computer runs, similar to the single example shown above, can produce a range of possible returns over the 30-year projection period. Mechanically, the exercise involves calculating the 30-year geometric real return for each run, arraying those returns in, say, ascending order, then looking at the 10,000th return (10th percentile), the 25,000th return (25th percentile), the 50,000th return (50th percentile), etc., based on the assumption that the median long-term return is equal to 4.45 percent. At the 25th percentile, the return is 3.10 percent and at the 75th percentile it is equal to 5.80 percent. That is, 25 percent of the 100,000 return outcomes are less than or equal to 3.10 percent and 75 percent of them are less than or equal to 5.80 percent.

Figure 4. Stochastic and Deterministic 30-Year Real Return Projections, 4.45 Percent Long-Term Average



Source: Authors' calculations from Morningstar, Inc. (2013) and French (2013).

Figure 5. 30-Year Compound Annualized Average Real Returns from Monte Carlo Model, by Percentile



Source: Authors' calculations from Morningstar, Inc. (2013) and French (2013).

State and Local Funded Ratios, 2012-2042

The next step is to use the real investment returns from the Monte Carlo model to project pension funding through the year 2042. The asset allocation for the projections is based on the current average state/local portfolio. Salary inflation and COLAs are indexed to the average inflation assumption of 3.3 percent, placing sole importance on the real return. Other important assumptions are as follows:

- *Benefit growth:* Since 2000, growth in pension benefits has averaged about 8 percent. The assumption is that long-term benefit growth will slow gradually to 4.5 percent, reflecting benefit reductions for new employees and suspensions of COLAs.

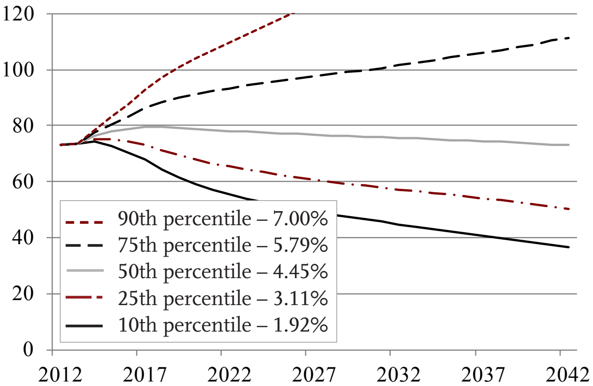
- *Employee contribution rate:* The assumption is that employees will contribute 6 percent of salary, the average for 2012.
- *Employer contributions:* The assumption is that employers will pay 80 percent of their annual required contribution (ARC), the percent paid in 2012.
- *Discount rate/investment return:* The discount rate and nominal investment return assumption of 7.75 percent is equal to the average assumed rate in 2012. As discussed, this figure consists of 3.30 percent inflation and a 4.45 percent real return.
- *Valuation of assets*: Actuarial assets are calculated using a five-year period for smoothing market gains and losses.
- *Amortization:* Amortization payments are calculated as a constant percent of payroll, and the model incorporates an open 30-year amortization schedule – the maximum currently permitted by the Governmental Accounting Standards Board (GASB). In practice, an open 30-year amortization schedule is explicitly used by only a handful of plans (albeit including CalPERS). However, many plans have statutory contribution rates that are set so low that it will take them over 30 years to fund. These two types of plans account for roughly one-third of the plans in the *Public Plans Database*.

For the amortization methods used by each plan in the *Public Plans Database*, see "Amortization Methods for Unfunded Liabilities, 2011-12."

Based on these assumptions, the exercise is to determine funded levels using Monte Carlo projections to simulate 100,000 possible paths of returns and, thereby, funded ratios.

Figure 6 shows projected funded ratios under the baseline assumptions discussed above. To achieve a fully funded status, returns will have to come in higher than assumed. If real returns average 7 percent, plans will be fully funded within the decade. With real returns of 5.79 percent, plans will be fully funded in 20 years. The 50th percentile line indicates that the assumed rate of return will result in a funded ratio between 75 percent and 80 percent. This outcome reflects two factors. First, employers are paying less than the full ARC, so even if assumed returns are realized, plans will not reach full funding. Second, the payments to amortize the unfunded liability are calculated as a percent of future payroll, which combined with an open 30-year amortization period, produces lower contributions than originally scheduled (see Box on the next page).

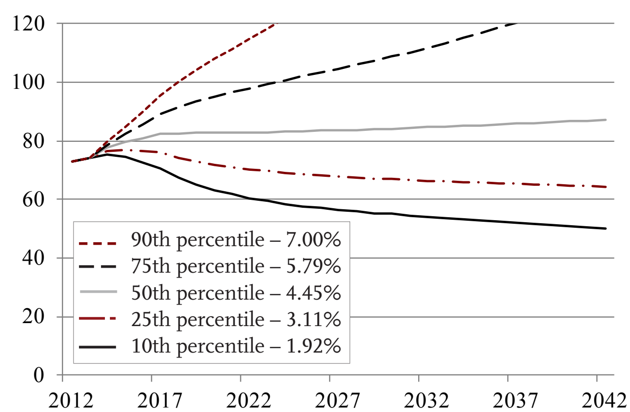
Figure 6. Projected State and Local Funded Ratios When Paying 80 Percent of the ARC, by Percentile



Note: To create the figure, the 100,000 funded ratios were sorted each year and percentiles calculated. The rates of return reflect the 30-year geometric returns for each percentile.
Source: Authors' calculations from Morningstar, Inc. (2013), French (2013), the *Public Plans Database* (2012), and Munnell et al. (2013).

To sort out the relative importance of paying the full ARC, the second scenario continues to calculate the amortization payment as a constant percent of future payroll (with an open 30-year amortization period) but assumes that the employer pays 100 percent of the ARC (see Figure 7). In this case, the 50th-percentile line shows a gradually increasing funded

Figure 7. Projected State and Local Funded Ratios When Paying the Full ARC, by Percentile

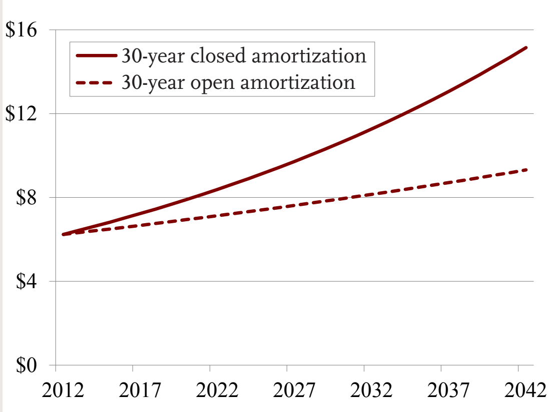


Source: Authors' calculations.

Box: The Impact of an Open 30-year Amortization Period

The combined effect of setting the amortization payment as a fixed percent of future payrolls, and then resetting the amortization payment each year as the 30-year amortization period rolls forward, leads to significantly lower amortization payments than originally scheduled. Assume that, under a constant percent of payroll approach, the amortization payment to fully eliminate the unfunded liability over 30 years is calculated to equal $6 per $100 of payroll. The notion is that payroll will rise about 4 percent each year, so the required payment will rise to 6.24 ($6 x 1.04) in year 2 and then to $6.49 in year 3 and so on. These amounts are shown in the solid rising line in the figure below. But if the amortization period is open rather than closed, the 30-year funding period rolls forward each year. That is, under the open scenario, the amortization payment in year 2 is once again calculated on the basis of paying off the liability in 30 years. With 30 years rather than 29 years to pay off the unfunded liability, the payment in year 2 is lower under the open approach. In year 3, when the funding period rolls forward again, the recalculated payment reflects a 30-year horizon rather than 28 years. Thus, each year as the funding period rolls forward, the gap between the originally scheduled amount and the actual amount (represented by the dashed line) grows wider. Thus, the sponsor will never contribute enough to fully fund the plan within 30 years.

Box Figure. ARC Payments Calculated as a Percent of Payroll: Closed 30-Year Amortization Compared to Open 30-Year Amortization

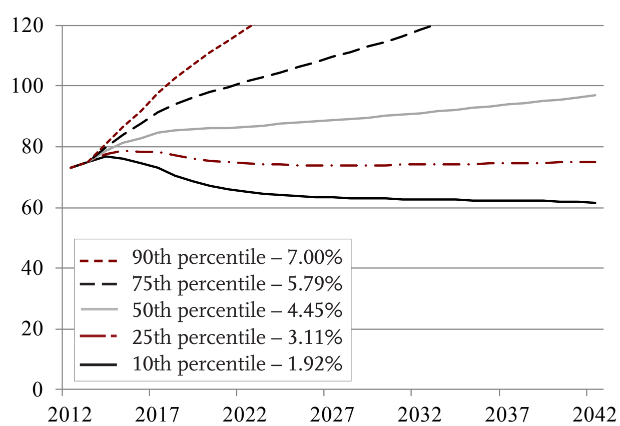


Source: Authors' illustration.

status, but assets amount to only 87 percent of liabilities by the end of the period analyzed. The only way to achieve a fully funded status under this scenario is with higher returns. There is also a 25-percent probability that returns could come in low enough to produce funding levels near 60 percent.

As noted, not paying the full ARC is only one of the impediments to full funding, even when the average return equals the assumed rate. The other is that combining percent of pay with an open 30-year amortization schedule produces amortization payments that are inadequate to fund the system within 30 years. Increasing the payments can be accomplished in numerous ways. One possibility, used by about one-fifth of the plans in our sample, is to shift the amortization payments from percent of pay to level dollar amounts. The impact of using level dollar payments, under an open 30-year period and assuming sponsors pay 100 percent of the required amount, is shown in Figure 8. Because more money is being contributed, funding approaches 100 percent toward the end of the 30-year period if the average return that plans earn equals the assumed 4.45 percent. Of course, if returns are higher, employers will see full funding considerably sooner. In terms of downside risks, at the 25th percentile of possible outcomes, funding skims along a little below 80 percent, as opposed to a little above 60 percent when the amortization payment is calculated as a percent of payroll.

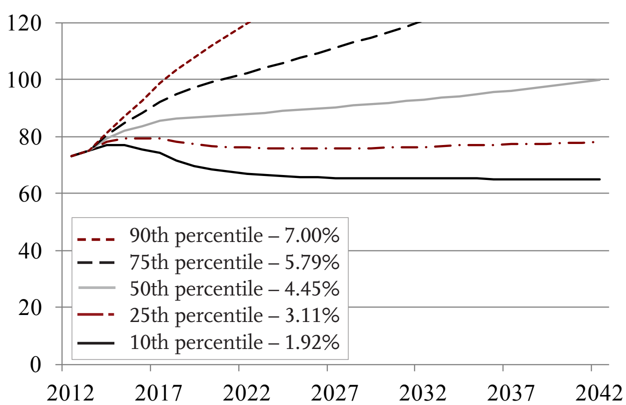
Figure 8. Projected State and Local Funded Ratios When Paying the Full ARC and Calculating the ARC as a Level Dollar Amount, by Percentile



Source: Authors' calculations.

Another alternative, followed by nearly half of the plans in our sample, is to use a *closed* 30-year amortization period. In practice, many of the plans using this approach tend to "start over" periodically by resetting the 30-year period midway through – just as the required payments begin to escalate substantially. While this tendency reduces the effectiveness of using a closed-period method, it is still clearly better than relying on an *open* 30-year amortization period. However, because these mid-course corrections are difficult to predict, our analysis adopts another variant of the percent-of-pay open approach, one that uses a 15-year period rather than the GASB maximum of 30 years. The impact of this scenario is shown in Figure 9. Because sponsors are paying more, the process produces full funding within 30 years if returns average the assumed 4.45 percent. The variability in potential returns produces funding outcomes that are broadly similar to the level dollar method.

Figure 9. Projected State and Local Funded Ratios When Paying the Full ARC and Reducing the Amortization Period to 15 Years, by Percentile



Source: Authors' calculations.

Conclusion

The expected rate of return is the most important assumption required to fund a pension system. While the nominal rate typically receives the most scrutiny, the real rate has the greatest implications for plan funding. For illustrative purposes, this *brief* uses the average real return assumption used by public plans to explore how the variability of returns can affect plan funding.

To account for the uncertain path of future returns, the analysis uses a stochastic model to project pension funding to the year 2042. Under the baseline scenario, the 50th-percentile funded ratio never reaches full funding even if the assumed return materializes, but rather hovers a little below 80 percent. This pattern reflects two problems. First, employers have been paying only 80 percent of the ARC. Rectifying the contribution shortfall improves the picture somewhat, but funding is still only 87 percent after 30 years and the risk of ending up below 60 percent remains substantial. The second problem is the combined effect of calculating the amortization payment as a percent of payrolls with an open 30-year amortization period.

Alternative funding arrangements yield better outcomes. However, plans that follow such approaches still face a significant risk of poor returns, even if the long-run average equals 4.45 percent, leading to less than full funding in 30 years.

Endnotes

1 Munnell et al. (2013).

2 Not only does the rate-of-return assumption directly affect the required contribution to the pension system through its impact on anticipated asset values, it also influences the required contribution indirectly through the liability value, which is calculated using the same rate. While classic finance theory suggests that liabilities be discounted using a rate that reflects their true risk, the Governmental Accounting Standards Board (GASB) currently advocates the use of a discount rate that equals the plan's expected long-term investment rate of return. In 2014, new GASB guidelines will go into effect that call for a blended discount rate reflecting: 1) the expected return for the portion of liabilities that are projected to be covered by plan assets; and 2) the return on high-grade municipal bonds for the portion that are to be covered by other resources.

3 The technical definition for the real rate of return is r = (1+n)/(1+i)-1, where n stands for the nominal rate of return and i stands for inflation. However, public pension plans typically report their rate-of-return assumption using a common approximation of this formula, r = n-i. For example, a plan that assumes an 8.0 percent nominal return and a 3.5 percent inflation rate will report a real return assumption of 4.5 percent, whereas the technically correct real return is 4.35 percent.

4 This relationship applies for a final-pay plan that bases benefits on the final year's salary and provides a COLA. For plans that base benefits on an average of several years' salaries, the equilibrium only holds when those salaries are inflation-adjusted. For plans with no COLAs and that use a nominal final average salary calculation, overestimating actual inflation by 1.5 percent causes a roughly 12-percent underestimate of the required contribution rate. This result has the same annual impact on asset levels as an investment loss of about 40 basis points (0.4 percent).

5 Since 2010, the average nominal rate-of-return assumption for state and local plans has declined by about 25 basis points, from 8.0 percent to 7.73 percent. The majority of this change has come from lowered inflation expectations. For example, in 2011, CalPERS lowered its nominal return assumption from 7.75 percent to 7.5 percent, reflecting a decrease in the assumed inflation rate from 3.0 percent to 2.75 percent.

6 Data on annual returns on international stocks for the period 1975 to 2012 come from French (2013).

7 In order to closely simulate the asset allocation of a typical state/local portfolio, we will first define a $100 investment in "stocks" as $56 in domestic large-cap stocks, $14 in domestic small-cap stocks, and $30 in international stocks. Similarly, we will define a $100 investment in bonds as $30 in long-term corporate bonds, $30 in long-term government bonds, and $40 in intermediate-term government bonds. This estimate is based on the aggregate asset allocation of the plans in the *Public Plans Database*. Given that international stock data are limited prior to 1975, we replace the equity allocation to international stocks with large-cap domestic stocks until that year.

8 Equities (50 percent) and bonds (26.5 percent) account for about 76.5 percent of actual state and local portfolios. The remaining 23.5 percent of portfolios, for which historical data were not available, consists of alternatives (6.75 percent), real estate (6.5 percent), cash (2 percent), and other investments (8.25 percent).

9 In addition to the 65/35 stock/bond portfolio, we also tested two other hypothetical portfolios: a 60/40 portfolio and a 70/30 portfolio. The results for these two alternatives were quite similar to the 65/35 portfolio.

10 Given that public pension plans are generally viewed as perpetual entities, a 30-year investment horizon seems appropriate.

11 For example, financial services firms such as GMO (Montier 2013) and Standard Life Investments (*The Economist* 2013) have projected that real returns on both equities and bonds will fall well short of historical averages for the next several years. However, the debate over prospects for investment returns is far from settled. Two leading academic experts – Jeremy Siegel and Robert Shiller – have expressed strongly opposing views on future stock returns, with Siegel adopting a bullish position (Siegel 2013).

12 We assume constant average returns based on historical data and a normal probability distribution. Kopcke et al. (2013) demonstrate the impact of mean-reversion and "fat tails" on Monte Carlo return projections. All projections in this analysis simulate 100,000 runs.

References

Federal Reserve Bank of Philadelphia. 2013. *Survey of Professional Forecasters*. Philadelphia, PA.

French, Kenneth. 2013. "Index Portfolios formed on B/M, E/P, CE/P, and D/P." Available at: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

Kopcke, Richard W., Anthony Webb, Josh Hurwitz, and Zhenyu Li. 2013. "Rethinking Optimal Wealth Accumulation and Decumulation Strategies in the Wake of the Financial Crisis." Working Paper 2013-1. Chestnut Hill, MA: Center for Retirement Research at Boston College.

Montier, James. 2013. "The Purgatory of Low Returns." GMO Quarterly Letter (July). GMO LLC.

Morningstar, Inc. 2013. *Ibbotson Stocks, Bonds, Bills, and Inflation (SBBI) Classic Yearbook*. Chicago, IL.

Munnell, Alicia H., Jean-Pierre Aubry, Josh Hurwitz, and Madeline Medenica. 2013. "The Funding of State and Local Pensions: 2012-2016." *State and Local Plans Issue in Brief* 32. Chestnut Hill, MA: Center for Retirement Research at Boston College.

Public Plans Database. 2000-2012. Center for Retirement Research at Boston College and Center for State and Local Government Excellence.

Siegel, Jeremy. 2013. "Don't Put Faith in Cape Crusaders." *Financial Times* (August 19).

The Economist. 2013. "Home on the Range." Buttonwood column (January 26).

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