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The Risks from State and Local Government Employee Pension Plans: A Stochastic Simulation Analysis

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The Risks from State and Local Government Employee Pension Plans: A Stochastic Simulation Analysis

June 6, 2024

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Abstract

There is a large professional literature on the correct measurement of the funded status of and indicated employer contributions to government employee pension plans. But static measures do not provide a quantification of the risk that plans could represent in the future in various possible investment environments. This is better done through stochastic simulation projections. Using a 2022 data base of 187 large pension plans, basic plan features and conditions, actuarial relationships, simple economic projections, and varied bond and stock investment returns based on past ten-year historical periods in the US and the current asset allocation of the plans, I create a risk model. This risk assessment is denominated as the range of reasonably possible future actuarial funded ratios and amounts of indicated employer contributions across plans, when investment performance is poor but within historical experience. Several plans would be at or near insolvency, about 11 percent of plans would see very large drops in funded status, while employer contributions would, on average, double, and for about one in seven plans, triple.

Highlights

- At the median of historical investment experience, the mean plan funded ratio is projected to increase from about 75 percent in 2022 to around 92 percent in 2032. But at the 25th and 10th percentile simulations, the average plan funded ratio is 72 and 61 percent, respectively, in 2032.
- At the fiftieth percentile, employer contributions decline by \$53 billion in aggregate from 2022 to 2032 or 42 percent. But if investment conditions do not turn out so well, at the 75th percentile (the obverse of the 25th percentile for funded ratios), aggregate contributions increase by \$43 billion, or 34 percent, and at the 90th percentile, in a rough investment (and presumably economic) environment, aggregate contributions nearly double, increasing by \$103 billion.
- Another measure of risk – the ratio of the standard deviation to the mean of indicated contributions projected in 2032 – is high, at 0.96, for the median plan, and above 1.12 for about a quarter of the plans.

Keywords and JEL Codes

Public pension plans, funding, costs, investment risk, stochastic projections

G17, G23, H75, J32

Introduction

There is a large professional literature on the correct measurement of the funded status of or indicated employer contributions to defined benefit plans, both in the private and public sectors. This is natural because these are good measures of the exposure of corporate investors (for private plans) and municipal investors and taxpayers (for public plans) as well of plan participants and government guarantee agencies to unfunded benefit obligations. But the static measures do not provide a quantification of the risk that plans could represent in the future, either through the funded status or employer contributions to the plans, in various possible investment and economic environments. This is better done through stochastic simulation projections, as explained and performed in this paper.

Here I update, revise, and greatly expand the application of a simple ten-year stochastic methodology that I first introduced in Warshawsky (2022) for three Connecticut public pension plans. It starts with the most recent actuarial valuation for each plan, taken from a large plan date base, does a basic economic projection on the future benefit and compensation variables for each plan, and, most importantly, varies the future bond and stock investment returns based on past historical periods in the last hundred years in the US and the current asset allocation of the plan. Using basic actuarial relationships and plan features and conditions, this information is combined into a risk assessment of the plan, in terms of the range of reasonably possible future funded ratios and amounts of employer contributions, when investment performance is variously below the median of past periods. I report this in the aggregate for most large and many medium-size plans in the public sector, in distribution analysis, and by naming the specific plans with the highest risk measures.

The rest of this paper is organized as follows. The next section reviews briefly the recent literature on the funding and cost of government pension plans. Then the unique stochastic methodology of this paper is described, followed by an illustration of its results for two large New Jersey state and local government employee plans, contrasting deterministic actuarial and stochastic projections of future funded ratios and employer contributions. The main section then gives the risk results for nearly 200 large and medium-size state and local plans, based on the most recent available actuarial reports in 2022. The final section concludes the paper.

Different Measures of the Security and Cost of Government Employee Pension Plans

Most state and local governments provide defined benefit (DB) pension retirement plans to their employees. The private sector never fully adopted and has more recently moved away from DB plans. According to the Bureau of Labor Statistics (BLS) the percentage of workers in the private sector with access to a DB plan dropped from 20 percent in 2010 to 15 percent in 2023, and many of these plans are frozen or closed, moving in decided favor of defined contribution, mainly 401(k), plans. By contrast, state and local governments still predominately use DB plans to provide retirement coverage for their workers – according to the BLS, an increase in access from 84 to 86 percent over the period.

In a typical DB plan, the sponsor promises employees an annual lifetime pension payment upon retirement whose amount is dependent on the employee's tenure with the organization, salary near retirement or at time of departure from employment, age of retirement, and the plan's benefit factor. DB plans in the private sector are subject to strict federal rules that require the relatively fast and full funding by the sponsor of these promised benefits in order to

secure the retirement benefits, should the sponsor go bankrupt, and also strict reporting of the pension liabilities and assets on the sponsor's balance sheet, to disclose them to creditors and investors, to reveal the true costs of the benefit provisions. By contrast, government plans have no federal funding requirements and their disclosure rules (both for financial accounting and actuarial valuations) are not as strict. Nonetheless, nearly all governments do fund their plans, owing to state laws, to a greater or lesser extent, and are subject to both actuarial and financial accounting disclosure rules, on different but uniformly relaxed bases, compared to the private sector.

The most significant difference between the two funding and disclosure regimes is that private sector plans use a standard high-grade corporate bond rate (in 2021, for example, 3 percent) to value their liabilities, regardless of the risk and return nature of the assets held by the plan, whereas state and local governments use a much higher expected return on assets (around 7 percent in 2021) as the valuation rate, which tends to increase somewhat with the risk characteristics of the assets. The higher the discount rate, the lower the measured liability and plan cost. Also the market value of assets is used in the private sector, whereas an actuarially smoothed value of assets is generally employed by the governments for actuarial funding and disclosure. These differences have caused many analysts to restate government pension liabilities and assets to a more economically valid basis. The Bureau of Economic Analysis and the Federal Reserve Board use a corporate bond valuation rate for state and local government pension liabilities and the market value of assets, and academics, such as Stanford Professor Joshua Rauh, use the generally lower Treasury bond yield as the liability valuation rate, to reflect the view that government pension promises to workers are low risk, akin to Treasury bonds. Also, the amortization of gains and losses resulting from realizations differing from actuarial assumptions is much faster in private sector plans (7 to 15 years) than in the public sector (up to 30 years or even longer).

A traditional measure of the funded status and hence the security of a pension plan is its funded ratio, that is, the ratio of assets to liability. Tabulating the results found in the annual statements of 220 of the largest state and local government employee pension plans, Aubry and Yin (2023) report on funded status from 1990 through 2022 according to the loosest government actuarial valuation standards. They find that the aggregate funded ratio of these plans was about 80 percent in the early 1990s, increased to just over 100 percent in the booming stock market year of 2000, then fell significantly and continually to a low of 72 percent in 2016 before recovering somewhat to 76 percent in 2022. Based on incomplete data, they estimate it increased further in 2023 to 78 percent. This aggregate ratio is a type of average and therefore covers up the wide range of funded ratios for individual plans. According to Aubry and Yin, grouping plans by their most recent funded status into three groups – bottom, middle and top – the average funded ratio of the bottom group of plans dropped from 92 percent in 2001 to 56 percent in 2022, for the middle, from 100 to 77 percent, and for the top, from 110 to 89 percent. So there has been an increasing dispersion of plan security levels (the spread widened from 18 to 33 percentage points), with bottom plans performing particularly poorly.

When funding declines, actuarially determined or indicated employer contributions increase. Indeed, another important measure for DB pension plans is their cost to their sponsor. Aubry and Yin collected the actuarially determined contribution rates – the rate required to take the plan to full funding on an actuarial basis over a period of time if all assumptions are realized and plan features are not changed. Across all plans, the average required contribution rate

increased from 13 percent of payroll in 2001 to 28 percent in 2022. The rate needed to pay for the accrual of newly earned benefits in the year (“normal cost” also called “service cost”) increased from 13 to about 15 percent, while the remainder of the rise in the actuarially determined contribution rate is needed to fill in the growing funding hole. Aubry and Yin also calculated that the actual investment performance of government plans from 2001 to present was a 6 percent annual rate of return rather than the 7 percent assumed. If the 6 percent rate was used instead along with another technical strengthening factor, the indicated required contribution rate would be about 35 percent of payroll.

It is worth noting that although the actuarially determined contribution rate is the recommended contribution rate, government sponsors do not always contribute as much, especially when times are tough, given the looseness of funding requirements. For example, in 2012, only 81 percent of suggested contributions were made, with some states paying even less.

As mentioned above, the Federal Reserve Board’s Financial Accounts report state and local government pension assets at market and liabilities valued using a corporate bond rate. At year-end 2021, it stated that the aggregate funded ratio of these plans was 62 percent, significantly lower than the ratios reported in government financial and actuarial valuation statements. At the end of the third quarter 2023, the Fed’s ratio was also 62 percent. The interim rise in interest rates had reduced liabilities, but market asset values were then lower than the highs experienced at the end of 2021. So unlike Aubry and Yin, the Federal Reserve did not see any improvement in the security of state and local government pension plans in the last couple of years.

Giesecke and Rauh (2023) applied their stricter market-based valuation standards (including a discount rate of about 1.6 percent in 2021), now common in academic articles, to a large set of state and local government plans (nearly 650) through 2021. They report an aggregate funding ratio of 44 percent in 2021, up from 34 percent in 2020 when Treasury rates were pushed down by unprecedented Federal Reserve monetary policy, but essentially unchanged from about 42 percent in 2014. Looking at the cross-section of states in 2021, Giesecke and Rauh find a large variation, from funding ratios as low as 27 percent for Hawaii, New Jersey, Connecticut, Kentucky and Illinois, to as high as 62 percent for Wisconsin, Delaware, Washington, South Dakota and New York.

Market valuation also raises the service cost, from a reported actuarial rate of 13 percent of payroll to almost 27 percent, in 2021. Thus, according to Giesecke and Rauh, the actual contributions made barely cover the service cost of accruing benefits, and do not address the existing unfunded liability at all. Giesecke and Rauh alternatively express pension cost as the required contributions needed to maintain the current market value of the unfunded pension liability, that is the service and the interest cost, but not to amortize, that is, eventually eliminate the unfunded liability, as best practice would suggest. They calculate that this alternative pension cost is about two and half times the actuarially determined contribution rate. So, across many measures, Giesecke and Rauh believe that the security of government pension plans is much lower and their cost much higher than the plans themselves disclose and even compared to the Federal Reserve’s statistics.

Another Approach

As in Warshawsky (2022)'s analysis for three Connecticut state plans, I take yet another alternative approach here to evaluate the security and cost of state and local government pension plans. I start with the reported assets, liabilities and costs of the 220 plans used in Aubry and Yin's study, based on actuarial valuation reports, but remove some for missing data and then perform stochastic simulations of possible investment returns for the next 10 years, through 2032, to gauge the financial and cost risk inherent in the plans, at least as it arises from volatility in asset performance. In particular, I apply the range of historical stock and bond return experience to current financial status of the plans, as reported in their 2022 actuarial reports, and project forward, including expectations of plan conditions in the future based on recent trends in plan operations. I create a fairly simple "macro" model for each plan, assuming optimistically that there are no actuarial losses or gains from assumption or method changes or realizations different from assumed, such as future salary increases, retirement rates, or mortality, and so on, other than what is produced by the different periods of stochastic annual historical investment returns, and that no actuarial assumptions or methods are changed. Recent experience for each plan was used to extrapolate rates of increase in payroll and benefit payments for the next 10 years. As in Warshawsky (2022), I fold all the various benefit tiers together for each plan, which represents an approximation of the future operation of the plan as a whole. It is true that the impact of different tiers and changing demographics is probably not well projected over long time periods with this method, but over a short horizon of 10 years, it seems reasonable, and moreover, 10 years is the traditional budget window for public policymakers.

I assume for each plan that the normal cost and employee contribution rates are constant, at the most recent percent of payroll, and that payroll and benefit payments grow with recent trends. I use actuarial asset valuations and amortizations of new unfunded actuarial liabilities, based on the valuation discount rate, and assume that all actuarially determined employer contributions (ADECs) are made, although sometimes sponsors make extra contributions and, as indicated above, sometimes do not even make the amount actuarially determined. This is all done from the 2022 base of plan assets (market and actuarial values), actuarial plan liabilities, and the most recent amortization amount. The plan liability grows with assumed interest and normal cost, less benefit payments assumed to be made in the middle of the year. Assets grow with contributions and investment returns, less benefit payments. Employer contributions are the normal cost, less employee contributions, plus the amortization of unfunded liability to full funding (assumed to be a 100 percent funded ratio although in reality a few plans have only a 90 percent funded goal, and some (such as Cook County, Illinois) ignore their actuary's calculation and base contributions on statutory formulas), based on the plan's reported average amortization schedule denominated in number of years (often in the mid-20s, sometimes shorter and occasionally longer, particularly when the plan is significantly underfunded).

Note that if the amortization period is too long, depending on other factors, contributions will not even cover normal cost and interest on the pension liability, and the plan funding will worsen over time with high probability. Note also that there are some differences among government plans in choice of actuarial cost and funding methods with relevance to whether contributions are somewhat front- or back-loaded (front-loaded most common), as well as whether the amortization schedule is denominated in dollar terms or as a percent of pay (percent of pay is most common, but we assume, conservatively, dollar terms) and is closed or open (we assume closed, as most common, although in actual experience, it is sometimes open,

considering phase-ins, resets and other changes) and the use of various actuarial asset value smoothing techniques for assets (most are five-year moving averages within a corridor of 80 to 120 percent of market value, as we assume). A few plans have the level of benefits (especially through discretionary cost of living adjustments) somewhat sensitive to asset and plan performance, but I ignore those features, as well as any payments on outstanding pension obligation bonds. Similarly, I ignore the possibility, within state law in some states, for ad hoc benefit adjustments when funding is particularly low. Over a ten-year horizon, I assert that the investment return variables are by far more significant to the funding and cost outcomes, than other demographic and plan feature details. In particular, beyond the investment return, the initial amortization amount implicitly contains much information about the actuarial methods and assumptions used in the plan funding policy.¹ I also assume that all actuarial assumptions for each plan except the investment return are reasonable and correctly reflect expected experience, which as mentioned above is optimistic, given that actuarial losses are more common than gains, even putting investment returns aside.

Data on plans used in this analysis comes from the Boston College Retirement Research Center Public Plans data base as of spring 2024, that is, for the 2022 plan year. I hand-collect the liability amortization amounts from 2022 actuarial valuation reports. The ADEC is constrained to be non-negative, that is, the sponsor cannot take assets out of the plan, although in reality, when plans become overfunded, unions demand and government employers agree to increase benefits, which will make ADECs positive again. In the opposite direction, assets are constrained to be non-negative, that is, if assets drop to zero, the plan is declared insolvent. In this scenario, the plan would likely be reorganized, closed to new entrants, perhaps bailed out, and, workers and even retirees would probably see some cuts in benefits; we assume though that the ADEC amount is maintained to pay benefits.

I drop the few plans that use unusual funding methods, such as pay-as-you-go and aggregate, with no amortization bases, or if the plan is closed. I also drop municipal systems which have hundreds of small individual plans, and plans with missing significant data in 2022 and earlier years, including two plans that do not perform annual valuations. In a few instances, some missing variable measures are filled in from 2021 reports or with sample averages. I split a few plans into their component parts when they are funded separately but still of significant size in their own right. In total, there are 187 plans in this analysis, including nearly all large and some medium-size state and local government plans in the US, excluding the insolvent and now closed Puerto Rico plans, which have been missing from the Boston College data set entirely.

The stochastic analysis is based on 94 historical rolling 10-year periods, from 1919 to 2023. I assume that current broad asset allocation of each of the plans' trust fund is kept fixed over the projection period. I simulate how a repeat of the annual investment performance during each successive 10-year period since 1919 would affect funded ratios and required contributions for the 187 plans. In particular, for simulated projected plan years 2023 through 2032, I calculate the effects if, instead of the assumed fixed actuarial discount rate/ expected investment return, asset returns followed the various historical patterns, including the Great Depression, the post-war boom, the malaise of the 1970s, the dot.com boom and bust, the Great Recession, and the pandemic and stock market rise. Those returns are estimated on the basis of annually rebalanced portfolios consisting of holdings in the S&P stock index and 10-year Treasury bonds, with a

¹ I include those few plans which use market value of assets in their funding policy.

modest 20 basis point investment management fee for bonds and a 120 basis point fee for equity. Although many plans have significant holdings of higher-risk-and-return assets than these, such as alternative investments, real estate and so on, the long historical record on these asset classes is not available, and besides, I implicitly assume that the still higher investment fees actually charged for these specialized funds net out the higher expected returns.

The investment model here of stochastic historical nominal annual after-fees returns is an update and new version of those used in Warshawsky (2022, 2016). The equity return data come from Robert Shiller's public access database; the geometric mean over the 103-year period was 8.97 percent. The bond returns are based on the then current yield on 10-year constant-maturity Treasury bonds in the year and the change over the year in bond yields, calculated by formula; the geometric mean here is 4.68 percent. The resulting realized equity premium, at 4.3 percent, is somewhat lower than found in the literature but is higher than the current projections of investment professionals, and the bond return is in line with current Treasury yields.

Although simple, the investment return model lets the data speak for themselves, that is, it has the advantage of being free of an assumed functional form, particular econometric techniques, inflation assumptions, and so on. The approach is easy to understand but substantive – the 94 historical 10-year periods of returns (1919 – 1928, 1920 – 1929, ... , 2013 – 2022) contain substantial variability, covariance, and serial correlation, and represent a wide range of economic and financial conditions and government policies.

Illustration for New Jersey PERS

To illustrate our approach more completely, we initially focus on two separate segments from the state and local government employee pension plan of the state of New Jersey, respectively, which are funded separately but administered and whose assets are invested together. The Public Employees' Retirement System (PERS) is the largest retirement entity in New Jersey by number of participants and assets, although the teachers' plan has a larger liability. Some background information – the recent financial accounting history (which has some differences from the actuarial reports) and other facts – about the two segments of the PERS of New Jersey is given in Exhibit 1 for 2018 and 2022. Both segments are aging, with the number of active members declining while the number of deferred and retirement members increasing. This is significant because in an underfunded plan, an aging demographic increases the cash outflow of benefit payments, evident here, and raises the cost and its volatility, and reduces the security of the plan. The state portion of PERS is quite poorly funded in 2022, with a funded ratio – market value of assets divided by pension liability, liberally measured, at only 23 percent, and the local portion has a funding ratio, 63 percent, less than the national average. Counter to national trends, New Jersey raised the discount rate it is using to measure its financial accounting liability for pensions from 5.66 percent in 2018 to 7.0 percent in 2022, so in a sense its plans' funded ratios are overstated.

The cost of the plan has increased dramatically, as the ratio of employer contributions to payroll for the state portion ballooned from 16 to 42 percent – the actuarially required contributions increased, in line with increases in the liability, and the state upped the percentage of those contributions it actually was making after years of paying less than the required contribution, owing to robust dedicated lottery revenues and perhaps owing to large federal grants coming out of pandemic stimulus payments to state governments in 2021 and 2022. Retirement benefits from this plan are generous, accruing at almost 2 percent per year of final-

three-year average salary unreduced at retirement age of 60 or after 25 years of service, paid as a life annuity with employee contributions refunded with interest to the extent benefits paid have not covered those amounts, with modest reductions for earlier retirement. There have been, however, small downward adjustments in accruing benefits for workers who started employment after 2010 and 2011, reflected in different benefit tiers within the system. The asset allocation of the plan was a 76/24 stock/bond split.

Exhibit 1. New Jersey Public Employees’ Retirement System (PERS) Plans: Recent Financial Accounting History

		State		Local	
		2018	2022	2018	2022
Membership	Active	77,838	74,808	176,942	165,094
	Deferred	176	369	413	1,413
	Retired	57,262	61,535	117,642	125,837
Funding (billions \$)	Market Value of Assets	6.730	6.758	22.742	25.81
	Pension Liability	30.435	29.145	42.432	41.030
	Unfunded Liability	23.704	22.387	19.690	15.219
	Benefit Payments	1.728	2.012	2.208	2.606
	Total Contributions	0.998	2.202	1.511	1.871
Statistics	Funded Ratio (%)	22.1	23.2	53.6	62.9
	Employee Contributions to Payroll (%)	15.8	41.5	13.5	16.1
	Discount Rate (%)	5.66	7.00	5.66	7.00
	Amortization Period	30	29	30	29
	Normal Retirement Age and Service	60/25	60/25	60/25	60/25

Source: New Jersey PERS GASB 67 Reports as of June 30, 2018 and June 30, 2022.

Exhibit 2 shows the actuarial and stochastic projected simulation results for these two plan segments, according to my macro model. It should be noted at the outset that the actuarial valuation report for New Jersey PERS, in contrast to the financial accounting report, counts discounted receivable contributions and future lottery proceeds as assets; this unusual arrangement obviously inflates the funded ratio and reduces ADECs. There are also various, generally small, differences in the assumptions and methods used in the computation of pension liability, so that the 2022 base in Exhibit 2 (actuarial) is not entirely consistent with Exhibit 1 (government financial accounting). Nonetheless, the actuarial approach is what is relevant for future contribution flows and therefore future asset levels and funded ratios.

In the first panel, A, the funded ratios and ADECs for each of the two plan segments are projected on the presumption that all actuarial assumptions, including the investment return/discount rate, at 7 percent, are exactly and consistently realized. Note that these are quite

liberal presumptions, even outside of investment returns, because in the last ten years, realizations of the liability and actuarial method and assumption changes for New Jersey PERS have predominately produced losses, which in turn calls into question the reasonableness of the actuary's process and the lack of bias in his judgements. But we put those issues aside. As would be expected, the funded ratios rise slowly, because the unfunded liability is amortized over many years. Still, the funded ratio for NJ PERS State does not break 40 percent. Somewhat more surprisingly, the ADECs decline somewhat. This is due to a small increase in employee contributions rising with payroll, and some past paid-off amortization bases drop off, and because the pension liabilities eventually start to decline, as the plan populations age, and growing retirement benefit amounts are paid out.

Exhibit 2. New Jersey PERS: Actuarial Projected and Stochastic Funded Ratios and Actuarially Determined Employer Contributions (ADECs), 2022 and 2032

Panel A. Using Current Actuarial Discount Rate

	Funded Ratio (%)		ADEC (\$ thousands)	
	2022	2032	2022	2032
NJ PERS State	33.2	39.1	1,718,462	1,482,433
NJ PERS Local	67.9	79.3	1,167,822	941,487

Panel B. 2032 Stochastic Funded Ratios (%) Distribution

	10%	25%	Mean	Median	75%	90%	St. dev
NJ PERS State	24.60	30.56	43.32	41.42	55.01	64.76	15.63
NJ PERS Local	53.31	64.29	87.28	82.89	107.61	126.03	28.64

Panel C. 2032 Stochastic ADECs (\$ thousands) Distribution

	10%	25%	Mean	Median	75%	90%	St. dev
NJ PERS State	985,270	1,146,318	1,415,510	1,443,118	1,659,644	1,810,209	310,400
NJ PERS Local	0	0	847,176	801,630	1,433,506	1,858,844	733,607

Source: PERS Actuarial Valuation Report as of July 1, 2022 for 2022 Actuals; Author's calculations for 2032 actuarial and stochastic projections.

Note: Includes discounted receivables of state appropriations and expected lottery revenue in the market and actuarial values of assets used in funded ratio and ADEC calculations.

The stochastic results are shown in Panels B (funded ratios) and C (ADECs), demonstrating the range of possible outcomes through 2032 under various historical investment scenarios. At the median, the funded ratios do show improvement from the current ratios. Similarly, at the median, the ADECs decline. These projections are broadly similar to the deterministic actuarial projection.

At the 25th percentile for the funded ratios, where investment returns are somewhat lower than the median, but still in the thick of historical experience, the ratios decline somewhat to 30.6 percent and 64.3 percent for the state and local segments, respectively. For the same experience for ADECs (75th percentile), required employer contributions decline at the state level, but are above the actuarial projection, and increase at the local level. Local contributions are more

sensitive than State contributions to investment returns outside of median experience. This is caused by the funded status at the beginning of the stochastic projection period. The state plan segment is less well funded and, as a result, has less to gain or lose from positive or negative investment experience.

Moving to the outer bounds of experience, but still quite possible, at the 10th (90th) percentile, by 2032, funded ratios fall – for State, closing in on an insolvency approach with a funded ratio of 24.6 percent – and ADECs increase, even assuming all other actuarial assumptions, like termination and retirement rates, remain unchanged and realized. It is clear from these simulations how much risk the New Jersey taxpayer bears from these underfunded DB pension plans for state and local government employees. The high risk is also demonstrated by the large standard deviations in dollar terms, shown in Exhibit 2. Indeed, the ratio of the standard deviation to the projected mean, as measure of risk, is about 22 percent for the State plan and 87 percent for the Local plan.

These stochastic results show a realistic view of the costs and risk that taxpayers bear when governments continue to operate DB pension plans for employees. Focus on the downside is appropriate because experience shows that the upside of investment returns is of no real benefit to taxpayers. When plans become fully funded, as they did in the late 1990s, benefits increases are demanded by employee unions and granted by legislatures and governors, wiping out any surpluses and putting the plans back into a risky position for the next downturn in markets and the economy, as has occurred in the last twenty years, when employer contributions massively increased.

Full Sample Results

Exhibit 3 gives basic variable statistics for the full sample of plans. There are nearly 21 million participants in these plans, and nearly 8 million beneficiaries, mainly including retirees, but also surviving spouses, disabled workers, and so on. The market value of plans’ assets is almost \$3.4 trillion (the actuarial value a bit higher) and the plans’ liabilities are over \$4.6 trillion, so the weighted average funded ratio is about 72 percent. Payroll for workers covered by these plans totals \$625 billion, benefits paid are \$256 billion, and reported employee and employer contributions come to \$143 billion. The average plan in the sample is quite large, with nearly \$18 billion in assets, and 120 thousand participants. The mean normal cost, that is the average cost of accruing benefits without consideration of the plan funding, is 16 percent of payroll, quite generous compared to the private sector’s typical employee contribution and employer’s matching contributions to a 401(k) plan of 11.3 percent, according to Vanguard.

Relevant to the mechanics of funding the plans, the average discount rate was 6.9 percent, within a fairly tight range, and the average amortization period was 22 years, although here the range was quite wide, from 5 to 35 years. Also of relevance to our stochastic simulations, the weighted average fund allocation, not shown, was 79/21 equity/bond in 2022, with equities including public and private stock, hedge funds, real estate, and other investments. The average plan is expecting a relatively high investment return while taking significant investment risk.

Exhibit 3. Sample Statistics for State and Local Government Employee Pension Plans, 2022

Variable	N	Mean	SD	Min	25th	75th	Max	Sum	Unit
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Market Value of Assets	187	17.93	33.88	0.03	1.79	20.56	300.06	3352.45	Billions USD
Actuarial Value of Assets	187	18.26	32.86	0.03	1.79	21.00	257.54	3414.92	Billions USD
Actuarial Value of Liabilities	187	24.80	42.62	0.06	2.63	28.01	346.09	4638.32	Billions USD
Payroll	187	3.34	6.05	0.01	0.28	4.25	54.20	625.47	Billions USD
Benefits Paid	187	1.37	2.28	0.00	0.17	1.64	17.17	255.81	Billions USD
Employee Contribution	187	0.26	0.51	0.00	0.02	0.31	4.21	48.71	Billions USD
Employer Contribution	167	0.56	0.97	0.00	0.06	0.65	6.52	94.04	Billions USD
Normal Cost Rate	187	16.0	6.7	1.9	11.0	19.0	54.0	--	Percent
Amortization Period	187	22	6.2	5	17	27	35	--	Years
Discount Rate	187	6.9	0.6	4.1	6.8	7.2	7.50	--	Percent
Total Beneficiaries	173	45.79	73.42	0.09	4.37	60.17	475.95	7921.25	Thousands
Total Members	173	119.78	212.53	0.25	10.01	141.83	1529.33	20721.59	Thousands

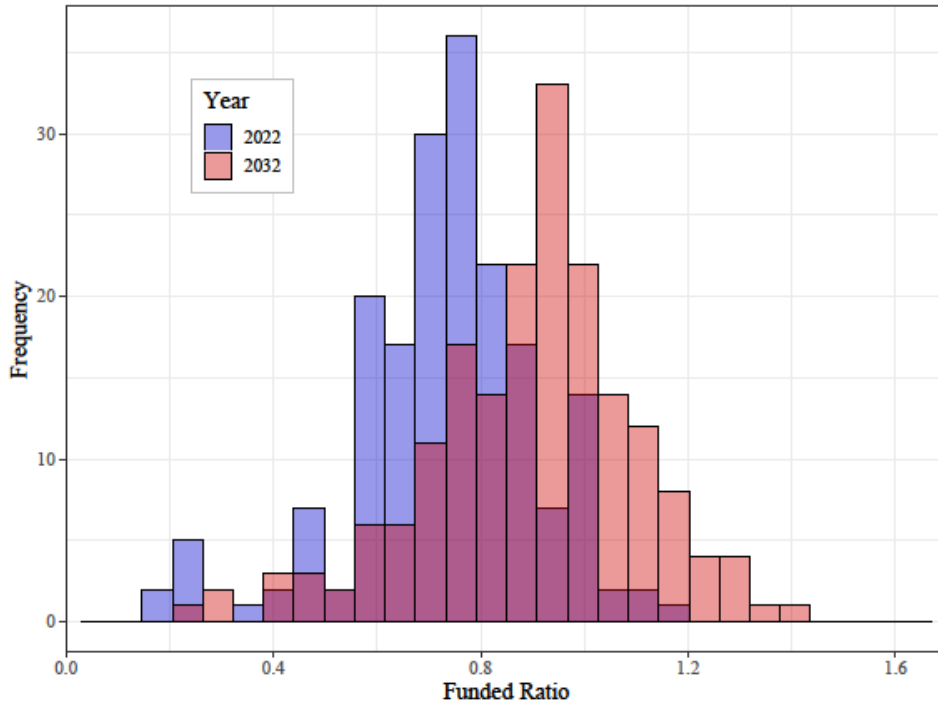
Note: Means are unweighted.

Source: Boston College Center for Retirement Research Public Plans Database; Author's Calculations

Now let's examine some basic results from the stochastic simulation projections, starting with the funded ratio, before moving to ADECs. As shown in Exhibit 4, and consistent with the simulations that we saw for the New Jersey plans, in the median simulations, the funded ratios is projected to improve, on average across plans, as investment performance is good, and amortizations also pay off the prior underfunding. For example, from 2022 to 2032, at the median stochastic asset return simulation, the liability-weighted average funded ratio increases from about 74 percent to 92 percent. At the 75th percentile (not shown), full funding is reached by about 2028 for the average plan.

Now consider the shifting distribution of projected funded ratios across plans in the simulations. As seen in Exhibit 4, the modal funded ratio in 2022 is at about 75 percent (the liability-weighted mean is 74 percent), with several fully funded plans, but also a small bump of quite poorly funded plans, below 25 percent. At the median projected simulation for 2032, this distribution is smoothed out, flattened somewhat, widened, and shifted to the right, as funding improves; the mode is at around 90 percent, the liability-weighted mean is 92 percent, more plans are fully and overfunded, but still a handful are at funded ratios below 50 percent. By contrast, at the 25th and 10th percentile simulations, shown in the next exhibits, the average plan funded ratio declines to 72 and 61 percent, respectively, by 2032.

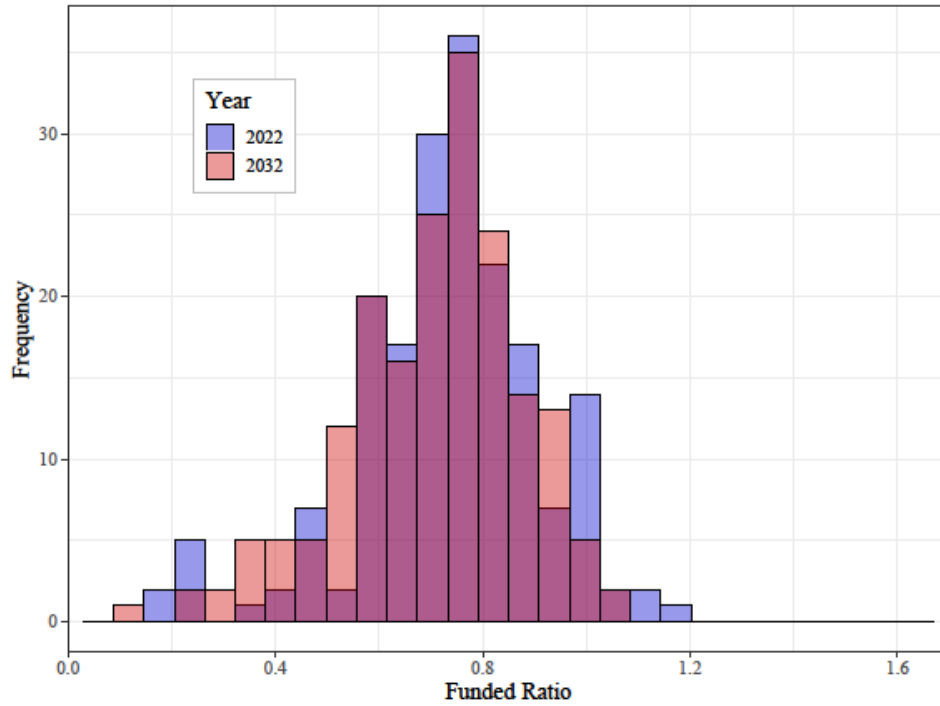
Exhibit 4. Actual 2022 vs Median Projected Funded Ratios in 2032



Source: Boston College Center for Retirement Research Public Plans Database; Author’s Calculations

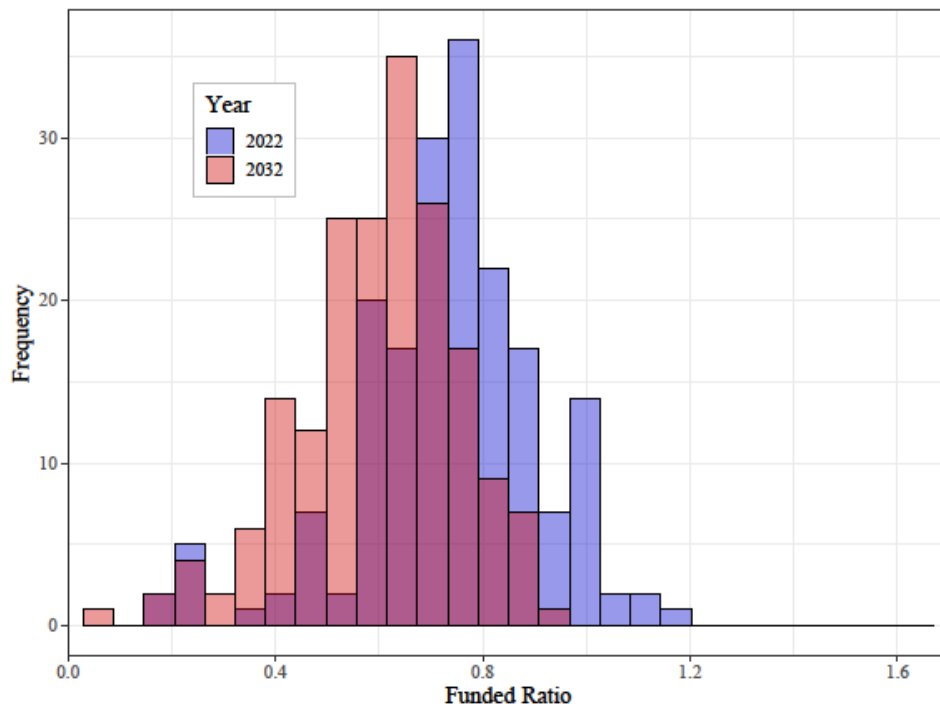
At the 25th percentile, shown in Exhibit 5, the modal projected funded ratio around 75 percent, the liability-weighted mean is 72 percent, few plans are fully funded, and a substantial segment is below 50 percent funding, with a few showing severely worsening funded ratios. At the 10th percentile, in Exhibit 6, the distribution shifts further to the left, with the modal plan having a funded ratio of 65 percent, the liability-weighted mean at 61 percent, and a few plans are in bad shape, with funded ratios below 30 percent.

Exhibit 5. Actual 2022 vs 25th Percentile Projected Funded Ratios in 2032



Source: Boston College Center for Retirement Research Public Plans Database; Author's Calculations

Exhibit 6. Actual 2022 vs 10th Percentile Projected Funded Ratios in 2032



Source: Boston College Center for Retirement Research Public Plans Database; Author's Calculations

In particular, two plans have funded ratios of less than 10% in some simulation, namely Atlanta ERS and Charleston (WV) Firemen. At the 20% funded ratio and below threshold, there are twelve plans, or about 6 percent of plans, in some simulation, listed below:

- Alaska PERS
- Arkansas Police and Fire
- Atlanta ERS
- Charleston (WV) Firemen
- Charleston (WV) Police
- Chicago Fire
- Chicago Municipal
- Chicago Police
- Kentucky ERS Retirement Non-hazardous occupations
- Missouri State Employees
- New Jersey PERS State
- Providence ERS

Note that this assessment of risk may be considered optimistic because it only considers investment performance. Often, however, when asset markets are weak, so is the economy, with fewer workers, lower wages, more retirees, lower tax revenues, and so on. This will mean deeper losses to plans precisely at a time when governments are hurting, making it difficult to increase contributions, further risking a death spiral for some plans, and therefore actual pension losses to government retirees and workers, as has occurred in the past decade.

Yet another way to evaluate downside risk is to count the number of plans who see declines of various percentage point amounts in their 2032 projected funded ratios at the 10th percentile of stochastic investment simulated outcomes. Of the 187 plans, 42 plans, or 22 percent, experience declines of 20 percentage points or more at the 10th percentile. Increasing this threshold to 30 percentage points in funded ratio loss, there are nine plans: Alaska PERS, Arkansas Police and Fire, Atlanta ERS, Austin Fire, Colorado Municipal, DC Police and Fire, Detroit Police and Fire, Missouri State Employees, and Montana PERS.

Now let's consider the other side of the coin for plan sponsor responsibility – ADECs, that is, actuarially determined employer contributions. As seen in Exhibit 7, at the fiftieth percentile, employer contributions decline by \$53 billion in aggregate from 2022 to 2032 or 42 percent, as many plans achieve full funding over ten years with steady investment returns. At the liability-weighted mean, the lessening of the burden is even greater, as larger plans are more leveraged in investment return than smaller plans – the mean reduction in employer contributions is 1.7 billion dollars or 60 percent. But if investment conditions do not turn out so well, at the 75th percentile (the obverse of the 25th percentile for funded ratios), aggregate contributions increase by \$43 billion, or 34 percent, and at the mean, they increase by half a billion dollars (the increase is proportionally smaller at the weighted mean because large plans have longer amortization periods). At the 90th percentile, in a rough investment (and presumably economic) environment, aggregate contributions would increase by \$103 billion, or 81 percent; at the mean, there would be a \$1.9 billion increase. Because actuarially determined contributions are not required by federal, and in many case, state, law, the actual contributions could be less, but then the risk of

the plan to participants and future taxpayers would be even greater, again ignoring other non-investment actuarial losses.

Exhibit 7. 2022 ADEC vs Median, 75th and 90th Percentile Projected ADEC

		Sum of ADECs	Mean ADEC
Actual 2022	ADEC	126.96	2.84
	Difference (\$)	--	--
	Difference (%)	--	--
Median 2032 Projection	ADEC	73.50	1.14
	Difference (\$)	-53.46	-1.70
	Difference (%)	-42.1%	-59.9%
75th Percentile 2032 Projection	ADEC	169.98	3.36
	Difference (\$)	43.02	0.52
	Difference (%)	33.9%	18.3%
90th Percentile 2032 Projection	ADEC	229.76	4.69
	Difference (\$)	102.80	1.85
	Difference (%)	81.0%	65.1%

Source: Boston College Center for Retirement Research Public Plans Database; Author's Calculations

Note: All dollar values are billions of 2022 dollars. Means are weighted by 2022 liabilities.

At the 75th percentile of investment returns, 65 plans experience ADEC increases of 50 percent or more, with 33 plans seeing increases of at least 75 percent, 19 plans with increases of 100 percent or higher, and nine plans experiencing ADEC increases of 150 percent or more.

The effects become even more pronounced at the 90th percentile of investment returns. In this scenario, 126 plans face ADEC increases of 50 percent or more, 100 plans with increases of 75 percent or higher, 75 plans with increases of 100 percent or more, 31 plans, or about 17 percent of plans, with increases of 150 percent or more, and 17 plans, or about 9 percent of plans, would experience ADEC increases of 200 percent or higher. The plans which experience an ADEC increase of 200 percent or more are Bismarck Employees' Pension Plan, Bismarck Police Plan, Delaware County and Municipal Employees, Maine Local, Milwaukee City ERS, Milwaukee County ERS, Minnesota State Employees, Montgomery County (MD) ERS, Nebraska Schools, Ohio Teachers, Oklahoma City ERS, Oklahoma PERS, Oklahoma Police, South Dakota RS, St. Louis Firemen, Wichita ERS, and Wichita Police and Fire.

It is interesting to note that the overlap between this measure of sponsor responsibility is only partial with the measures based on funded ratios because some of these plans may now be relatively well funded but would demand big increases in contributions if investment returns were poor.

Finally, Exhibit 8 gives the distribution of the summary risk factor, that is, the standard deviation of ADECs divided by mean projected ADEC, across all plans. The mean and median risk factor, about 0.95, are quite high. Even at the 25th percentile, the risk factor is 0.76 and at the 75th percentile, it is 1.13. These estimates of the risk measure show that pension plans are quite volatile to their plan sponsors, and ultimately quite risky to taxpayers, and even to plan

participants in terms of actual benefits being paid compared to those illustrated and promised when conditions are tough.

Exhibit 8. Distribution of Summary Risk Factor across All Plans

	Min	25th	Median	Mean	75th	Max
Risk Factor	0.1128	0.7616	0.9578	0.9327	1.1252	1.7047

Source: Author’s calculations

Note: Risk factor is computed for each plan as the ratio of the standard deviation of projected ADECs in 2032 to the mean ADEC in 2032.

Conclusion

I have quantified, through a stochastic simulation methodology, based on actual plan and asset allocation features and economic conditions of a large sample of state and local government pension plans, that considerable risk exists in the next ten years to municipal investors and taxpayers from variable investment returns, modeled from historical experience, even under generally optimistic assumptions. These risk measures include projected future funded ratios, indicated employer contributions and a summary risk factor. At the edge of poor investment, the risk extends to plan participants themselves, through benefit cuts and even plan insolvency.

This risk has been recognized in the private sector, as corporate pension plans are closed and frozen and no new ones started, and retirement benefits are now given to workers through 401(k) plans. Similarly, in the union multiemployer sector, the federal government has had to undertake a large bailout in 2021. It is therefore concerning that the risk is seemingly being ignored in the government sector, as pension plans continue to be sponsored and high allocations made to risky investments, even when there is no competitive need to do so in the labor market. Although at the median and better investment performance, funded status of government plans will improve and indicated contributions will decline, if investment returns turn out less than expected, which is likely, based on historical experience, funded ratios will again turn down, and employer contributions rise significantly, with some large plans at the edge of insolvency, at the same time general tax revenues would decline and government expenditures increase, enhancing the risk to state and local governments and taxpayers.

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