An Analysis of Connecticut's Public Employee Retirement Plans

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Andrew G. Biggs and Tracy C. Miller. "An Analysis of Connecticut's Public Employee Retirement Plans." Mercatus Research, Mercatus Center at George Mason University, Arlington, VA, July 2020.

ABSTRACT

The state of Connecticut runs six defined benefit pension funds for its employees, which in the aggregate are among the most poorly funded retirement plans in the country and place increasing fiscal burdens on the state budget. We use a computer model to simulate the finances of these plans, demonstrating how sensitive the plans' funded ratios and unfunded liabilities are to changes in assumed future investment returns. Future investment returns that are well within the reasonable distribution of outcomes could produce substantially greater unfunded liabilities than even those that currently are reported. This exercise demonstrates the need for greater attention to uncertain investment returns in government analyses and financial disclosures regarding public employee pensions plans.

JEL codes: H76, H71, G23, H55, H75, J32

Keywords: state and local budget and expenditures, retirement, state and local government, health, education, welfare, public pensions

This paper can be accessed at https://www.mercatus.org/publications/government-spending/analysis-connecticut-public-employee-retirement-plans

The state of Connecticut faces a significant fiscal challenge driven by unfunded public employee pension benefits. The state operates six retirement plans for its employees.[1] According to actuarial reports, five of these plans—the State Employees Retirement System (SERS), the Teachers' Retirement System (TRS), the Municipal Employees Retirement System (MERS), the Probate Judges and Employees Retirement System (PJERS), and the Judges, Family Support Magistrates, and Compensation Commissioners Retirement System (JFSMCCRS)—faced a total funding gap of $39 billion in 2018, such that all five plans together were less than 47 percent funded.

Growing pension liabilities funded with increasingly risky investments present a fiscal and budgetary risk to the state, now and in the future. They also pose a risk of benefit reductions to employees should a plan become insolvent. Calls to consistently fund retirement plans present the state with budgetary tradeoffs and the potential for future tax increases, which pose risks for a state whose revenues depend so heavily on a small number of potentially mobile workers employed in finance and related fields.

Connecticut pension funds are seriously underfunded and current contributions are too low to assure benefit security in the future. Underfunding results from a combination of factors. First, reserves are insufficient, even if liabilities are calculated using the inappropriately high discount rates favored by government pensions in computing target reserves.[2] What might have been a reasonable rate of return in the past, 6.9 percent, is too high for current pension planning when yields on safe investments have dropped so much. Second, defined benefit pensions are a bond-like promise that the state should take as inviolable; that means that the correct interest rate for discounting state and

1. The sixth plan, which is not discussed here, is the State's Attorney's Retirement Fund. It does not publish actuarial reports, so we were unable to determine the fiscal condition of this plan.
2. We are grateful to an anonymous reviewer for suggesting this approach to discussing pension underfunding, which is different from the approach we used in the first draft.

local government pension liabilities should be drawn from investments such as government bonds—investments that have similar risk to pension benefits. Even if the state has chosen to invest part of its portfolio in risky assets by holding a mixed stock and bond portfolio, the appropriate discount rate for guaranteed pension liabilities is far lower than the expected portfolio returns to compensate for the risk the state is assuming.

The purpose of this paper is to encourage state policymakers to consider ways to improve the funding of Connecticut's various pensions. Policymakers can achieve this improvement by providing better information than they currently provide about pension obligations, assumed rates of return, and the risk that current pension promises and planned funding formulas pose to taxpayers and state employees.

We have constructed a model that allows us to test the effect of varying core assumptions that influence the measurement of plan liabilities and allows us to assess the risks of funding gaps emerging in five of Connecticut's pension plans. We begin with an overview of the plans and basic funding and participation statistics, including recent reforms that have been implemented. In section 2 we discuss the major actuarial assumptions that are used to value plan liabilities, the choice of discount rates, and the investment risks facing the state's pension plans. In section 3 we explore how well Connecticut is doing in funding its pension plans, focusing on what our simulation results reveal. We use the model to estimate how plan liabilities, normal costs, and annual required contributions (ARCs) vary with expected rates of return and to simulate the effect on funding costs of a market downturn similar to the Great Recession. We conclude by suggesting ways to reduce risk and better analyze and disclose pension risks to stakeholders.

1. CONNECTICUT'S PENSION PLANS

We focus on the five major defined benefit retirement plans listed earlier that the state of Connecticut operates for its employees (SERS, TRS, MERS, PJERS, and JFSMCCRS). An employer that operates a defined benefit pension plan commits to pay a specified benefit to an employee during each year of retirement, usually calculated as a function of the employee's final salary and years of service under the plan. In most cases, benefits increase during retirement with changes in the cost of living, according to a specified formula. Defined benefit pension plans are funded by annual contributions from employers and employees and by investment returns earned on reserves held by the pension plan. While employees generally contribute a fixed percentage of their earnings, the amounts contributed

TABLE 1. CONNECTICUT PENSION DATA BY PLAN, 2018

Plan	Active employees	Retirees	Liabilities ($ millions)	Actuarial value of assets ($ millions)	Unfunded actuarial accrued liability ($ millions)	Funded ratio
State Employees Retirement System	49,153	50,441	$34,214	$12,990	$21,224	38.0%
Teachers' Retirement System	50,594	37,446	$34,712	$17,952	$16,760	51.7%
Municipal Employees Retirement System	10,096	7,448	$3,623	$2,780	$843	76.7%
Probate Judges and Employees Retirement System	329	379	$118	$103	$15	87.1%
Judges, Family Support Magistrates, and Compensation Commissioners Retirement System	209	284	$443	$232	$211	52.3%
Total	110,381	95,998	$73,110	$34,057	$39,053	46.6%

Sources: Cavanaugh Macdonald Consulting, *Connecticut State Employees Retirement System: Report of the Actuary on the Valuation*, June 30, 2018, rev. June 18, 2019, 1, 15, https://www.osc.ct.gov/rbsd/reports/pdfs/06-20-19CTSERS6-30-2018ValuationFINALReport.pdf; Cavanaugh Macdonald Consulting, *Connecticut Judges, Family Support Magistrates, and Compensation Commissioners Retirement System: Report of the Actuary on the Valuation*, June 30, 2018, 1, 3, https://www.osc.ct.gov/rbsd/reports/pdfs/Report%20CT%20JFSMCCRS%206-30-2018%20Valuation.pdf; Cavanaugh Macdonald Consulting, *Connecticut Probate Judges and Employees Retirement System: Report of the Actuary on the Valuation*, December 31, 2018, 1, 3, https://www.osc.ct.gov/rbsd/reports/pdfs/06-20-19%20CT%20PJERS%2012-31-2018%20FINAL%20Valuation.pdf; Cavanaugh Macdonald Consulting, *Connecticut Municipal Employees Retirement System: Report of the Actuary on the Valuation*, June 30, 2018, 1, 3, https://www.osc.ct.gov/rbsd/reports/pdfs/06-20-19%20CMERS%202018%20Valuation%20FINAL%20Report.pdf; Cavanaugh Macdonald Consulting, *Connecticut State Teachers' Retirement System: Actuarial Valuation*, June 30, 2018, rev. June 18, 2019, 1, 12, https://portal.ct.gov/-/media/TRB/Content/StatisticsResearch/SR_ACTVAL18.pdf?la=en.

by the employer depend on the funding status of the plan and the assumed rate of return on the plan's investments.

Regardless of its assets, a pension fund is contractually obligated to pay benefits. This implies that, unless otherwise specified in the pension's benefit or funding formula, the government (and therefore the taxpayers) sponsoring the plan bears the risk that pension investments will produce returns falling short of the rate that had been assumed at the time contributions were made.

These plans covered 110,381 active employees and 95,998 retirees in 2018 (see table 1). In fiscal year (FY) 2018, unfunded liabilities reported for the five plans totaled $39 billion, which was more than 50 percent of the value of plan assets under Governmental Accounting Standards Board (GASB) accounting standards, which allow guaranteed pension liabilities to be discounted using the assumed rate of return on a risky portfolio of investments. Liabilities exceeded assets in all five plans, with the state's largest plan, SERS, funded at only 38

percent using GASB standards. These unfunded liabilities are in addition to the unfunded liabilities for other postemployment benefits, principally retiree health benefits, which were just under $22 billion for all Connecticut pension plans in 2016.[3]

Table 1 provides basic information on the number of participants and funded condition of each plan, published in the actuarial valuation reports from FY 2018.

2. ACTUARIAL ASSUMPTIONS AND RISK

The reasons for the underfunding of Connecticut's pension plans are well documented. These include a failure of the government to consistently make its full annual pension contributions, investment performance that fell short of the assumptions set by the retirement plans, and a reliance on accounting and actuarial methods that encourage plans to undervalue the guaranteed benefits promised by public employee plans and to undercontribute toward funding these benefit liabilities.

The approach that public pension plans use to value liabilities has received a great deal of scrutiny in the policy and academic literature. Under the accounting standards promulgated by GASB, state and local government pensions calculate the value of the plan's liabilities on an "expected-cost basis," which implies that future benefit liabilities are discounted to the present at the rate of return that the plan assumes it will receive on a portfolio of risky assets. For Connecticut, these assumed returns were recently reduced to 6.9 percent, with the year of the change depending on the specific plan. But for many years Connecticut plans assumed 8.5 percent annual returns over a period in which actual returns turned out to be substantially lower.

This expected-cost approach to pension liability valuation differs from how most other defined benefit plans value their liabilities, as well as from economic theory. Corporate defined benefit plans in the United States are required by federal law to discount liabilities using an interest rate derived from high-quality corporate bonds, which currently yield less than 3 percent.[4] Likewise, a Dutch central bank study of pension benefit liabilities shows that as of 2012, US

3. Eileen Norcross and Olivia Gonzalez, "Ranking the States by Fiscal Condition," 2018 ed. (Mercatus Research, Mercatus Center at George Mason University, Arlington, VA, October 2018).
4. Moody's seasoned Aaa corporate bond yield was 2.43 percent as of April 2020. Federal Reserve Bank of St. Louis, "Moody's Seasoned Aaa Corporate Bond Yield (AAA)," accessed June 15, 2020, https://fred.stlouisfed.org/series/AAA.

state and local pension plans utilized discount rates that were at least 1.5 percentage points higher than the rates that overseas public plans apply to qualitatively similar liabilities.[5]

Economic theory suggests that the discount rate applied to a liability should be derived from the risk of the liability itself, not the risk of any assets used to fund that liability.[6] The reason for this is that a discount rate matched to the risk of the liability captures the value of the sponsor's obligation to make future catch-up payments if the plan's investments fail to yield their assumed rate of return.[7] A lower discount rate will increase the present value of a pension's liabilities, thereby reducing the plan's funded ratio and increasing the unfunded liabilities that the plan sponsor must seek to pay down. With the exception of US "multiemployer pensions"—which are, if anything, even more poorly funded than state and local plans—the rest of the pension world calculates most liability figures using a lower discount rate, generally one based on bond yields.

In a classic paper, economists Robert Novy-Marx and Joshua Rauh apply a risk-adjusted discount rate to state and local government pension liabilities.[8] Rauh provides updated figures, using a 2.77 percent discount rate derived from US Treasury yields, and finds nationwide unfunded public pension liabilities that exceed $3.8 trillion.[9] Rather than being 72 percent funded, as calculated using a 7.6 percent discount rate under GASB methodology, US state and local government pensions are only 48 percent funded, as calculated using Treasury yields to estimate the market value of liabilities. In the United States, the official accounts of the US economy—the Bureau of Economic Analysis's National Income and Product Accounts and the Federal Reserve's Financial Accounts of the United States—measure pension liabilities using a discount rate derived from the yield on corporate bonds. In the most recent data available from the Bureau of Economic Analysis and the Fed, a 4.0 percent discount rate is used.[10] Using this

5. Dirk van der Wal, "The Measurement of International Pension Obligations—Have We Harmonized Enough?" (DNB Working Paper no. 424, De Nederlandsche Bank NV, Amsterdam, May 2014).
6. Jeffrey R. Brown and David W. Wilcox, "Discounting State and Local Pension Liabilities," *American Economic Review* 99, no. 2 (2009): 538–42.
7. Andrew G. Biggs, "An Options Pricing Method for Calculating the Market Price of Public Sector Pension Liabilities," *Public Budgeting and Finance* 3, no. 31 (2011): 94–118.
8. Robert Novy-Marx and Joshua D. Rauh, "The Liabilities and Risks of State-Sponsored Pension Plans," *Journal of Economic Perspectives* 23 (2009): 191–210.
9. Joshua D. Rauh, "Hidden Debt, Hidden Deficits: How Pension Promises Are Consuming State and Local Budgets" (essay, Hoover Institution, Washington, DC, 2017).
10. Additional details are available at the Federal Reserve's website: "EFA: State Pensions," Board of Governors of the Federal Reserve System, accessed December 20, 2019, https://www.federalreserve.gov/releases/z1/dataviz/pension/.

methodology, the Fed finds that Connecticut's pensions were only 34 percent funded in 2016 and unfunded benefit liabilities were approximately $80 billion, equal to about 30 percent of Connecticut's GDP.[11] As of March 2020, the Mercer Pension Discount Yield Curve recommended a discount rate of 3.03 percent for US corporate pension plans of average maturity, which would imply even lower levels of funding health for Connecticut pensions.[12]

The reason for using bond interest rates is that pension payments are very "bond like" and so should be valued in a manner similar to the way bonds are priced. For instance, a given government might promise a bondholder a given stream of payments at some future date, which a potential purchaser of that bond would assign a price to by discounting those future payments back to the present using a low interest rate to reflect the low risk of default. Likewise, the same government might promise a retired public employee a similar stream of payments beginning at some future date. Those promised pension benefits are at least as safe as the payments offered to bondholders, and so should be discounted using a similar low interest rate. The fact that those pension benefits are financed using investments with a higher expected return than corporate bonds does not reduce the value of the benefits being offered or the liability to the government offering them. The reason is that a pension investment portfolio offering higher returns does so by taking greater investment risk, and that risk exists even over long time periods. If the pension's investment returns fall short, the government must make additional contributions to make up the difference. The fact that nearly all pension plans have ARCs well above the normal cost of newly accruing benefits reflects the costs of making good on those implicit guarantees. It can be shown mathematically using "options pricing" techniques that once the cost of such guarantees is accounted for, a pension plan does not reduce its liabilities by investing in riskier but higher-returning assets. It merely trades a lower contribution today for the risk of a (much) higher contribution in the future.[13]

In analyzing pension benefits from an employee compensation point of view, analysts focus on the normal cost of newly accruing pension benefits, since amortization costs of past unfunded liabilities are not part of current-year compensation. In such analysis, the Congressional Budget Office and the Bureau of

11. This estimate includes additional state and local pension funds that are not included in our dataset.
12. For the most recent figures available, see "Pension Discount Yield Curve and Index Rates in US," Mercer, June 3, 2020, https://www.mercer.us/our-thinking/wealth/mercer-pension-discount-yield-curve-and-index-rates-in-us.html.
13. Andrew G. Biggs, "An Options Pricing Method for Calculating the Market Price of Public Sector Pension Liabilities," *Public Budgeting and Finance* 3, no. 31 (2011): 94–118.

Economic Analysis calculate the normal cost of accruing pension benefits using a low discount rate to capture the fact that these benefits are guaranteed against market risk while defined contribution plans such as 401(k)s offer no such guarantee.[14] The Congressional Budget Office, in its analyses of federal employee compensation paid via pensions, discounts future benefit liabilities at a Treasury bond yield. The Bureau of Economic Analysis uses the corporate bond yield in its analysis of aggregate pension liabilities. Put another way, the dollar increase in pension liabilities that occurs as a result of employees working an additional year is counted as compensation to those employees and added to measures of household wealth.

There is widespread agreement among experts that public employee pensions such as Connecticut's should at the least supplement the expected-cost measures produced under GASB rules with liabilities measured using a lower discount rate to better reflect the financial risks facing states as they guarantee pension participants' benefits against low investment returns.[15] In 2014, the Society of Actuaries' Blue Ribbon Panel on Public Pension Plan Funding, of which one author of this paper was a member, recommended that state and local pensions report both plan liabilities and the normal cost of newly accruing benefits as valued using the yield on riskless securities such as US Treasury bonds.[16] Similarly, in 2016 the Actuarial Standards Board's Pension Task Force concluded that "a market-based alternative liability measurement should be calculated and disclosed for all valuations of pension plans for funding purposes."[17] A 2012 exposure draft of the board's Actuarial Standards of Practice would require that such a calculation be made by pension actuaries.[18]

Discussions among economists and actuaries have resulted in some minor changes to government accounting standards, but these are far from sufficient. While the debate on how to value public sector pensions is not settled, the effect

14. Congressional Budget Office, *Accounting for Federal Retirement and Veterans' Benefits: Cash and Accrual Measures*, September 2019.
15. John A. Turner et al., *Determining Discount Rates Required to Fund Defined Benefit Plans* (Shaumberg, IL: Society of Actuaries, January 2017).
16. Bob Stein et al., *Report of the Blue Ribbon Panel on Public Pension Plan Funding* (Shaumberg, IL: Society of Actuaries, February 2014).
17. "Report of the Pension Task Force of the Actuarial Standards Board," Actuarial Standards Board, February 29, 2016, www.actuarialstandardsboard.org/wp-content/uploads/2016/06/Pension TaskForceReport.pdf.
18. Pension Committee of the Actuarial Standards Board, *Proposed Revision of Actuarial Standard of Practice No. 4: Measuring Pension Obligations and Determining Pension Plan Costs or Contributions*, December 2012, http://www.actuarialstandardsboard.org/wp-content/uploads/2014/03/asop4_2nd_exposure-draft_dec_2012.pdf.

on plan funding policy and on the fiscal burdens placed on governments from pension assumptions that may overstate investment returns and ignore investment risk continues to be a major concern, as it exposes plans to sudden funding gaps because of the volatility of plan assets.

2.1. Accounting for Pension Risk

One way to describe the investment risk facing Connecticut's public employee pensions is to estimate the range of potential long-run investment returns. Connecticut currently assumes an expected investment return of 6.9 percent on its investment portfolio and uses that assumption to value its liabilities.[19] However, the portfolios of investments for Connecticut pension plans consist of roughly three-quarters risky assets. In SERS's case, this includes 48 percent in equities, 10 percent in private equity, 8 percent in hedge funds, and 7 percent in real estate.[20] Such a portfolio carries significant investment risk in both the short and the long terms.

Connecticut assumes a standard deviation of annual investment returns of 11 percentage points. This implies that a plan's investment returns can vary significantly from the assumed mean from one year to the next. But, more importantly, a risky portfolio remains risky even over long holding periods. Over a 25-year period, for instance, the 11-percentage-point single-year standard deviation of Connecticut's portfolio falls to 2.2 percentage points.[21]

Many interpret this decline as indicating that risk falls for long-term investments. That is not the case. Over a 25-year period, an investor who received a return one standard deviation below the 6.9 percent assumed mean return would end up with less than 60 percent of the earnings of an investor who received the assumed mean return. And since there is a roughly 16 percent chance of receiving a long-term return at least one standard deviation below the mean, responsible pension managers cannot ignore such risks.

The reason investment risk does not decline over long holding periods is that, while a relatively "low" return over a long period is not as low as what might occur over a single year, that low long-term return is compounded over

19. This is based on the average rate of return of 6.9 percent earned by public pension plans between 2007 and 2017. Adam Millsap, "State Pensions Plans Are in Bad Shape but Reforms Can Help," *Forbes*, March 27, 2019.
20. Cavanaugh Macdonald Consulting, *GASB Statement No. 67 Report for the Connecticut State Employees' Retirement System*, June 30, 2017.
21. The standard deviation of annual returns over a given holding period is equal to the single-year standard deviation divided by the square root of the holding period.

an increasing number of years.[22] The compounding effect is stronger than the decline in annualized risk, such that the distribution of long-term investment outcomes is substantially wider than what might occur over a single year and thus the potential costs to the pension sponsor grow larger.

Besides the risk of below-average rates of return, there is uncertainty about what is the correct average rate of return to assume over the long run. Between 2001 and 2018, the TRS pension earned an average rate of return of 6.1 percent.[23] Morningstar surveyed a number of investment experts regarding their expectations of stock market returns over the next decade.[24] These annual return predictions ranged from a negative return on the low end to a high of 7 percent. In light of the low level of market interest rates over the past 10 years and their very low level now, the 6.9 percent rate of return assumed by Connecticut pension plans seems too high, even ignoring investment risk. Connecticut's pension plans might answer that their investment return assumptions cover a period of decades, not merely the next 10 years. However, returns in the early years form the foundation of later asset accumulation. Were Connecticut's retirement plans to receive portfolio returns in the 3 to 5 percent range over the next decade, returns in following decades must be substantially higher than the assumed rate in order to keep the plan financially whole.

2.2. How States Respond to Underfunded Pensions

The more underfunded pension plans become, the more state governments will need to spend to make sure that they have enough to cover promised benefits. Besides setting aside funding to cover the additional benefits that current workers earn for each additional year that they work (referred to as the "normal cost" of the pensions), Connecticut and other state governments spend to pay down unfunded actuarially accrued liabilities.

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22. For a crude-but-understandable illustration, if the assumed mean annual return is 6.9 percent and the standard deviation of annual returns is 11 percent, an investor receiving a single-year return one standard deviation below the mean falls short of the mean return by 11 percentage points. Over 25 years, the standard deviation of annualized investment returns falls to 2.2 percentage points. But that 2.2 percentage point shortfall is received 25 times, producing an approximate shortfall relative to assumed mean return of 25 × 2.2 = 55 percent. In reality the shortfall is slightly larger than this, but this simple illustration may more intuitively explain the logic of why risky investments do not become less risky over long holding periods.
23. "Teachers' Retirement System (TRS)," School + State Finance Project, accessed June 20, 2019, http://ctstatefinance.org/pensions/trs.
24. Christine Benz, "Experts Forecast Long-Term Stock and Bond Returns: 2019 Edition," *Morningstar*, January 10, 2019.

How quickly pension sponsors pay down unfunded liabilities matters for current state budgets and future state budgets. Setting aside additional money now to cover the cost of future benefits makes it harder for states to fund current programs such as education, healthcare, infrastructure, and public safety. The less government sets aside from the current budget for pensions, the more it will need to spend on pension benefits in the future. In a worst-case scenario, such as has struck the government of Puerto Rico, a pension fund could reach the point where it has exhausted all prior contributions, meaning benefits must be funded on a pay-as-you-go basis (with all current pension benefits paid for by current tax revenue).

Some have argued that funding pensions on a pay-as-you-go basis would not pose a significant problem.[25] Indeed, pay-as-you-go funding would ease cost burdens in the short term, because plans could draw down remaining assets, reducing the need for current contributions. However, for nearly all public employee plans, the pay-as-you-go cost would be substantially higher than the current cost of prefunding benefits calculated under GASB accounting rules. Connecticut has been contributing a substantial amount each year to reduce its unfunded liabilities. Thus, for 2018, Connecticut's SERS required employer contribution under GASB rules was about 42 percent of annual employee payroll.[26] This was less than the cost of funding 2018 benefit payments on a pay-as-you-go basis, which would have been about 56 percent of payroll. The number of retirees is growing faster than the number of covered workers, so the cost of pay-as-you-go funding is expected to rise as a percentage of payroll, while the cost of prefunding benefits should decline as the unfunded liability is amortized. Also, with pay-as-you-go funding, a state could be forced to make drastic cuts in other spending to be able to afford to make pension payments during recession years when state tax revenues drop—a consideration that is particularly significant as Connecticut's tax revenues drop owing to the COVID-19 economic downturn. By contrast, a state with substantial reserves accumulated can afford to temporarily reduce its pension contributions during a severe recession when tax revenues plummet. If reserves declined to zero and the state were forced to pay pension benefits out of current revenues, this would restrict the government's ability to fund its other priorities.

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25. Tom Sgouros, *Funding Public Pensions: Is Fully Funding Public Pensions a Worthy Goal* (Berkeley, CA: Haas Institute for a Fair and Inclusive Society, 2017), 8.
26. Cavanaugh Macdonald Consulting, *Connecticut State Employees Retirement System: Report of the Actuary on the Valuation*, June 30, 2018, rev. June 18, 2019, 1, 13, https://www.osc.ct.gov/rbsd/reports/pdfs/06-20-19CTSERS6-30-2018ValuationFINALReport.pdf.

3. HOW IS CONNECTICUT DOING IN FUNDING ITS PENSIONS?

Connecticut's bonds have been downgraded by the three major ratings agencies several times since 2016, acknowledging the increasingly precarious state of the government's finances as pensions compete with other priorities for resources. Connecticut's general obligation bond rating was dropped from Aa3 to A1 by Moody's Investors Service in 2017. Fitch Ratings downgraded Connecticut's general obligation bonds from AA– to A+ in 2017. S&P Global Ratings downgraded the state's general obligation bonds from AA– to A+ in 2017 and then downgraded them again, to A, in 2018.[27]

Connecticut, like many other states, has sought to address the problem of underfunded pensions. To address its large unfunded pension liabilities, Connecticut has held back on employee wage increases, increased employee contribution rates, and reduced annual cost-of-living increases. Pensions were adjusted in agreements with the State Employees Bargaining Agent Coalition in 2011 and 2016. In December 2016, the Connecticut governor and the coalition agreed to reduce the actuarial rate of return from 8.0 percent to 6.9 percent for the SERS and the JFSMCCRS funds, a step that would bring the assumed investment return much closer to mainstream estimates but that also increased required employer contributions. The actuarially assumed rate of return was also subsequently reduced to 6.9 percent for the TRS, MERS, and PJERS funds.

For each Connecticut public pension fund, the state government has a formula for how it intends to eliminate unfunded accrued actuarial liabilities. This formula determines the ARC for the fund for each year. In paying down unfunded liabilities, SERS had taken the approach of making such payments in terms of a constant percentage of payroll every year, with the intention of fully funding its pension plans by 2031.[28] But in 2016, the State Employees Bargaining Agent Coalition and the governor agreed that this required too large a contribution from the state budget over the next 15 years, so they changed the state's approach to funding SERS, agreeing to pay a flat dollar annual amortization payment beginning in 2021 and continuing until 2042.[29] This increased the state's contribution in the first few years, but reduced it in the years from 2025 to

27. "CT Bond Ratings," School + State Finance Project, accessed June 18, 2020, http://ctstatefinance.org/bonding/bondratings.
28. Cavanaugh Macdonald Consulting, *Connecticut State Employees Retirement System: Report of the Actuary on the Valuation*, June 30, 2014, https://www.osc.ct.gov/rbsd/reports/pdfs/Report%20%20CT%20SERS%206-30-2014%20Valuation%20-%20FINAL.pdf.
29. Kevin Lembo, *An Evidence-Based Approach to Pension Funding Reform* (Hartford, CT: Office of the State Comptroller, January 14, 2016).

2030, as compared to the old formula.[30] If the assumed 6.9 percent rate of return is earned, the unfunded accrued liability would decline steadily until it reaches zero in 2046. Different approaches are used to derive the annual required employer contributions of the other funds.[31]

For the past few years, Connecticut has carefully adhered to a plan to pay down the unfunded liability of each pension plan, with annual payments equaling the ARC each year. The result has been that pension contributions are occupying an increasing share of the state budget, with contributions for TRS and SERS requiring more than 13 percent of the state general fund budget in FY 2018.[32] This approach might not succeed in achieving full funding as soon as planned, for two reasons. First, average annual investment returns may turn out to be less than anticipated, particularly given financial market performance so far in 2020. Second, even if average returns are high enough, a period of below-average returns in the next few years could result in the pension fund spending some of its capital, thus having less principal on which to earn future returns. A period of below-average returns would require either increasing the ARC or delaying the date when pensions are fully funded.

3.1. Data and Simulation Results

To estimate the ARC that will be necessary in order for a plan to eventually be fully funded, we obtained data from the actuarial reports for each Connecticut pension plan. Actuarial reports for 2016 and 2018 were available for each plan except PJERS. We used the actuarial report from June 2016 as the source of data on the members of the JFSMCCRS, TRS, SERS, and MERS plans and on benefits to be

30. For details, see the projected amortization payments in the 2016 report compared to the 2014 report. Cavanaugh Macdonald Consulting, *Connecticut State Employees Retirement System: Report of the Actuary on the Valuation*, June 30, 2016, https://www.osc.ct.gov/rbsd/reports/pdfs/6-05-17CTSERS6-30-2016ValuationReport-Revised-FINAL.PDF; Cavanaugh Macdonald Consulting, *Connecticut State Employees Retirement System: Report of the Actuary on the Valuation*, June 30, 2014, https://www.osc.ct.gov/rbsd/reports/pdfs/Report%20%20CT%20SERS%206-30-2014%20Valuation%20-%20FINAL.pdf.

31. For the JFSMCCRS fund, according to the 2019 actuarial valuation report, the annual contribution was set to rise by 3.5 percent a year so that the unfunded accrued liability is expected to fall to zero by 2031. In 2016, the unfunded liabilities of the TRS pension plan were amortized over a 17.6-year period so that contributions were to be a constant percentage of payroll. This was changed to a 30-year amortization period with constant annual contributions beginning in 2020. The unfunded liabilities of MERS are amortized over 23 years and those of PJERS over 20 years based on a constant annual payment.

32. Authors' calculation using the SERS and TRS actuarial reports and Connecticut budget data from Office of the State Comptroller (website), accessed June 15, 2020, https://openbudget.ct.gov/#!/year/2018/revenue/0/fund_type.

paid to those members, on plan assets, and on annual required contributions. We used the 2015 actuarial report as the source of data on members of the PJERS plan. For details on the data collected and the methodology used, see the appendix.

We have constructed the future cash flows required under two actuarial liability concepts—the actuarial accrued liability and the normal cost. The actuarial accrued liability is a measure of the present value of expected future payments that are owed to current workers and retirees. It only accounts for liabilities associated with current workers and current retirees. For current workers, it only includes benefits accrued up to and including the current year. The normal cost is the expected present value of additional benefits earned as the result of working one more year. Since we calculate normal cost for the current year, it applies only to those presently employed.

In addition to estimating actuarial accrued liability, ARCs, and normal costs for 2016 under different long-run expected rates of return, the model is used to simulate what would happen to the ARC over a four-year period if the economy were to experience a downturn similar to the Great Recession. The ARC exceeds the normal cost if the plan is not fully funded. The ARC represents the payment needed in each year to fully fund a pension by a specified future date, assuming that all the underlying assumptions used to calculate the ARC payment prove to be accurate. To estimate the ARC going forward and how it may change in response to differing assumptions about the short-run and long-run values of financial variables, we pair the cash flow projections with information on plan assets and assumptions about asset returns. In simulating liabilities going forward, we include only current retirees and workers who were employed in 2016; we did not account for those who were hired after that.

To simulate the cost of funding Connecticut pensions under various scenarios, we start with what is a prudent rate of return to expect for the long run and then account for risk by calculating the 10th, 25th, 75th, and 90th percentiles of returns over a 25-year period. Following the recommendations of the Society of Actuaries' Blue Ribbon Panel on Public Pension Plan Funding, we assume a long-run return of 4.1 percent, which is approximately equal to the 10-year safe Treasury yield plus a 3 percent premium for taking additional investment risk.[33]

33. If pension plans invest in a portfolio of 60 percent stocks and 40 percent corporate bonds, they can expect to earn about 3 percentage points more than the interest rate on 10-year Treasury bonds, assuming that the difference in expected returns between Treasury bonds, corporate bonds, and stocks is equal to the long-term average values estimated by the Society of Actuaries. The current rate of return on 10-year Treasury bonds is around 0.6 percent, which suggests an expected portfolio return of 3.6 percent. In order to use 6.9 percent as the estimated 90th percentile over a 25-year hold-

TABLE 2. ESTIMATED DISTRIBUTION OF THE CONNECTICUT STATE EMPLOYEES RETIREMENT SYSTEM'S ANNUALIZED RETURNS, OVER 25-YEAR PERIOD BEGINNING IN 2020

Rate of return percentile	10th	25th	50th	75th	90th
Return	1.28%	2.62%	4.1%	5.58%	6.9%

Source: Authors' calculations.

TABLE 3. SENSITIVITY OF NORMAL COSTS (NCS) AND ANNUAL REQUIRED CONTRIBUTIONS (ARCS) TO ASSUMED INVESTMENT RETURNS IN CONNECTICUT PENSION PLANS, FISCAL YEAR 2016

Category		10th percentile	25th percentile	Median	75th percentile	90th percentile
Expected return (25-yr. avg)		1.28%	2.62%	4.10%	5.58%	6.90%
State Employees Retirement System	NC rate	33.79%	23.07%	16.12%	10.41%	7.35%
	ARC rate	83.56%	67.57%	55.76%	45.89%	39.50%
Weighted avg. of five plans	NC rate	33.59%	22.34%	14.57%	9.40%	6.37%
	ARC rate	90.1%	69.82%	53.80%	42.53%	34.53%

Note: The five Connecticut pension plans considered are the State Employees Retirement System, the Teachers' Retirement System, the Municipal Employees Retirement System, the Probate Judges and Employees Retirement System, and the Judges, Family Support Magistrates, and Compensation Commissioners Retirement System.

Source: Authors' calculations using model developed for the Mercatus Center at George Mason University.

Table 2 shows the estimated distribution of long-run annualized returns, assuming a mean return of 4.1 percent, a standard deviation of annual returns of 11.0 percent, and a 25-year holding period. As table 2 shows, even over the long run there is a substantial risk that returns will be well below or well above the assumed average. As will be explained below, pension financing is extremely sensitive to changes in the long-run average return, which implies that so long as Connecticut pension plans continue to take substantial investment risk, Connecticut taxpayers and other budgetary stakeholders must shoulder that risk and expect the annual contributions required for the state's pension plans to be volatile.

Table 3 shows how values for the normal cost of new accruing benefits and the ARC that includes amortization costs of unfunded liabilities change as the discount rate changes from the baseline. The figures shown are averages for the SERS plan and weighted averages for all five Connecticut plans on which this study focuses; however, the relative effects of changing discount rates on normal costs and annual contributions will be similar for other plans. The averages for all five plans are close to the averages for the SERS plan.

ing period, we use 4.1 percent as our best estimate of the median portfolio return, since we are assuming a standard deviation of the average rate of return over 25 years of 2.2 percent.

By using 4.1 percent as the assumed median investment return, we are suggesting that there is a probability greater than 50 percent that the state will fail to meet its funding goals if it sets ARCs on the basis of an assumed 6.9 percent rate of return. Table 3 shows the sensitivity of plan financing as measured by the ARC and normal cost to plausible changes in the long-run investment return. If the long-run average rate of return turns out to be 4.1 percent instead of 6.9 percent, the weighted average normal cost of the Connecticut plans rises from 6.37 percent to 14.57 percent of employee payroll—a 78 percent increase in the cash cost to the state. The ARC increases from 34.53 to 53.80 percent—a 44 percent increase.

The ARC is less sensitive than the normal cost to changes in the discount rate because the duration of already-accrued benefits is shorter than that of newly accruing benefits. If the mean long-run expected rate of return is close to 4.1 percent and the standard deviation over a 25-year period is 2.2 percent, then there is a considerable probability that for a given 25-year period the normal cost will be more than 20 percent and the ARC will be more than 60 percent of payroll. Even if the long-run rate of return over 25 years is 4.1 percent, if it averages below that for the first 10 years, the normal cost and the ARC will need to be higher than if the rate of return did not deviate much below or above 4.1 percent for an extended period of time. Although the normal cost and ARC for SERS are a little higher than the average for all five Connecticut plans, the average normal cost and ARC increase by similar amounts as the SERS normal cost and ARC if the long-run expected returns are 4.1 percent instead of 6.9 percent. The qualitative conclusion from table 3 is that Connecticut's government and taxpayers face considerable uncertainty regarding the costs of funding public employees' retirement benefits.

This range of possible outcomes is helpful in illustrating the risks facing Connecticut taxpayers and Connecticut residents who may depend on public programs that could be squeezed out by rising pension costs. If we are correct in arguing that the long-run expected rate of return may be closer to 4.1 percent than 6.9 percent, the current ARCs are too low and will need to be increased to prevent a substantial long-run decline in the plans' funded ratios. This is particularly true for those plans that started with a relatively low funded ratio, but less of a problem for MERS and PJERS, whose funding ratios, calculated at a 6.9 percent discount rate, are above 75 percent.

Since current ARCs are such a large share of the budget that Connecticut currently has difficulty meeting its annual contributions, the state may need to consider additional reforms that increase employee contributions or reduce promised benefits going forward. This may be better than risking the substantial decline in assets that would occur if the state experiences an extended period

TABLE 4. SENSITIVITY OF CONNECTICUT PENSION PLAN LIABILITIES IN 2016 TO ASSUMED INVESTMENT RETURNS

10th percentile	25th percentile	Median	75th percentile	90th percentile
1.28%	2.62%	4.10%	5.58%	6.90%
$159 billion	$124 billion	$97 billion	$79 billion	$67 billion

Source: Authors' calculations using model developed for the Mercatus Center at George Mason University.

with average rates of return well below 6.9 percent, an outcome that has a probability of 50 percent or more.

It is better to recognize that there is a range of possible returns for Connecticut pensions, even in the long run. If pension sponsors must use the expected return to discount future liabilities, it should be lower than 6.9 percent, though there is room for reasonable differences of opinion about how much lower it should be.

When we focus only on the dollar value of plan liabilities, we see a similar sensitivity to the discount rate as shown above using normal costs and ARCs. The relation between the discount rate and liabilities for all plans combined is shown in table 4. At each plan's chosen discount rate, total Connecticut liabilities come to more than $67 billion. But this figure could be more than $100 billion if long-term rates of return are less than 4.1 percent.

Again, the question arises: Which figures are the most appropriate? And yet here the answer is clearer, because the value of a "liability" does not depend on whether the assets used to fund it achieve some given rate of return. Rather, the liability to pay benefits exists regardless of the return on the pension's assets. That is why defined benefit pensions must record their liabilities, while defined contribution plans need not. And the appropriate interest rate at which to calculate the present value of a future liability is one that accounts for the legal obligation to pay benefits come what may. If that obligation is absolute, or if the pension sponsor intends it to be, then the appropriate discount rate is one associated with very low-risk investments. In today's interest-rate environment, the appropriate risk-adjusted discount rate should probably be around 3 percent, although some analysts would go even lower and discount public pension obligations using the yield on guaranteed US Treasury securities. It is worth noting that the Ontario Teachers' Pension Plan in Canada, which offers defined benefits very similar to those paid by Connecticut's various state plans, valued pension benefit liabilities using a 4.8 percent discount rate even before the COVID-19 downturn hit.[34]

34. Ontario Teachers' Pension Plan, *2018 Annual Report: All the Right Elements*, 2019.

3.2. Simulating the Short-Term Effect of a Market Downturn

The preceding discussion considers how average annual Connecticut pension contributions would change if the plans' long-run rate of investment return differed from the assumptions currently made by the plan trustees. A separate issue is how required contributions would change from year to year owing to the volatility of investment returns. Given the heavy weighting of Connecticut pension portfolios toward risky investments such as stocks, real estate, and alternatives, investment return volatility is virtually guaranteed even if the average long-term investment return meets the plan trustees' assumptions.

State and local government pensions use a variety of actuarial techniques in attempts to maintain the stability of required contributions from year to year, which is intended to reduce the disruptive effects of pensions on annual budget planning. For instance, when unfunded liabilities increase because the observed rate of return is less than the assumed rate, Connecticut plans adjust contributions to address that shortfall over a period of up to 30 years in order to reduce the amount of additional contributions required in a given year. Likewise, Connecticut plans base contributions on the level of actuarially smoothed assets, a concept that incorporates annual fluctuations in asset values over a five-year period. In this way, a market loss in a given year is not fully incorporated into required annual contributions until the fifth year following that event.

Nevertheless, as shown in an earlier study by one of us, when a retirement system takes significant investment risk, even these actuarial smoothing techniques cannot eliminate volatility of annual required contributions.[35] The reasons are twofold: First, risky investments remain risky even over long periods of time, so a retirement plan cannot guarantee that an investment loss in one year will soon be recouped in following years. Second, even if public-sector retirement plans are intended to operate in perpetuity, they do not have forever to address unfunded liabilities. Most private-sector pensions must address unfunded liabilities within seven years, and the 30-year amortization period used by some Connecticut plans is on the high end even for public-sector retirement systems.

The required increase in annual employer contributions is exacerbated because employee contributions are fixed as a percentage of their wages. For instance, if contributions were currently evenly split between employer and employee but, because of a market decline, the total required contribution

35. Andrew G. Biggs, "The Public Pension Quadrilemma: The Intersection of Investment Risk and Contribution Risk," *Journal of Retirement* 2, no. 1 (2014): 115–27.

increased by one-quarter, the employer would bear all that additional cost and thus must increase its own contribution by one-half. A 50 percent increase in total pension costs would cause the employer contribution to double. Put another way, in such circumstances the sponsor's financial obligation is about twice as risky as that of the plan's investment portfolio, because the sponsor bears both its own investment risk and that of the employees.

In this subsection, we simulate how a repeat of the investment performance during the Great Recession could impact required contributions for Connecticut public-sector retirement plans. We simulate the effects on contributions for the JFSMCCRS, TRS, SERS, MERS, and PJERS. For plan years 2017 through 2020, we simulate the effect on annual required contributions if, instead of a steady 6.9 percent nominal investment return, returns instead followed the pattern of the years 2008 through 2011. We estimate those returns on the basis of a portfolio consisting of 75 percent holdings in the S&P 500 index and 25 percent holdings in the Barclays Aggregate US Bond Index. This produces annual returns from 2017 through 2020 of −26.4 percent, 21.3 percent, 12.9 percent, and 3.5 percent, respectively.[36] On a compound return basis, the four-year return produces an annualized gain of 1.1 percent per year versus an assumed gain of 6.9 percent. While seemingly modest, over four years this would leave retirement plans' assets approximately 20 percent lower than they would have been had markets produced the assumed 6.9 percent return.

Using actuarial smoothing techniques and measuring over only a four-year period from the beginning of the recession, the effects on plan contributions are noticeable by the final year. Under the baseline 6.9 percent assumed return, the weighted average contribution for the five plans analyzed rises from 34.53 percent of employee wages in 2016 to 39.36 percent in 2020 (as shown in table 5). Assuming a repeat of 2008–2011 investment returns, beginning in 2017, the average required contribution in the fourth year after the recession (2020) rises from 39.36 percent to 46.50 percent—an increase of more than 18 percent in the dollar value of required employer contributions. All of this points to the need for greater analysis of how the increasingly risky investments that Connecticut pensions depend on can increase the volatility of annual government pension costs and create instability in the statewide budget-making process.

36. Our results assuming the recession begins in 2017 should be relatively close to the results of simulating the effect of a recession beginning in 2020, since the numbers of retirees and covered workers, assets, liabilities, and unfunded liabilities have not changed very much in the latest report available for each plan, as compared to 2016.

TABLE 5. EFFECT OF GREAT RECESSION–STYLE RETURNS ON ANNUAL REQUIRED EMPLOYER CONTRIBUTIONS (ARCS) FOR CONNECTICUT PENSION PLANS

		2016	2017	2018	2019	2020
6.9% steady return—ARC		34.53%	34.55%	37.18%	35.79%	39.36%
Great Recession repeat	Annual rate of return	6.9%	−26.4%	21.3%	12.9%	3.5%
	ARC	34.53%	38.75%	41.94%	40.63%	46.50%
Relative difference in contributions		0.00%	12.16%	12.78%	13.54%	18.14%

Source: Authors' calculations using model developed for the Mercatus Center at George Mason University.

4. CONCLUSION: REDUCING RISK AND IMPROVING TRANSPARENCY

The modeling of Connecticut's various public employee retirement systems generates a common conclusion: policymakers in Connecticut must pay increasing attention to the financial risks posed by public employee pensions. Despite reductions in the assumed return on plan investments, Connecticut plans continue to invest in assets whose values can fluctuate significantly from year to year and whose returns, even over the long term, remain uncertain. The design of a defined benefit pension is that the plan sponsor—which in this case effectively means Connecticut's taxpayers and other stakeholders of the state and local budgets—must bear that risk.

In light of those risks, it is important that Connecticut calculate and report its liabilities using a risk-adjusted discount rate, even if it combines that disclosure with a more optimistic estimate based on a rate of return that anticipates the receipt of an investment risk premium. Responsible stewardship of Connecticut's public employee retirement programs means going above and beyond mandated disclosures to provide policymakers, plan participants, and members of the public with the most information possible regarding the financial stakes involved. Plans should acknowledge the possibility of lower rates of return than the chosen expected rate of return and then list the consequences of lower returns for the future of the pension fund.

In light of a more realistic assessment of the contributions necessary to fully fund Connecticut pension plans, policymakers may consider provisions that share risk with employees or retirees, such as variable contributions, benefit accrual rates, or postretirement cost-of-living adjustments. For example, certain Nevada public employee plans split the ARC payment evenly between employees and the government, thereby sharing risk. Likewise, the Wisconsin Retirement

System adjusts postretirement cost-of-living adjustments according to the funded status of the plan. But unless risk is considered explicitly, policymakers and participants cannot know what such provisions might entail and how much they would accomplish in the effort to stabilize retirement plan financing both from year to year and over the long term.

The core conclusion is that Connecticut's policymakers cannot manage pension costs and risks unless they first understand them. Better analysis and disclosure is an important first step in that direction, and in improving policymakers' accountability to taxpayers and state employees.

APPENDIX: CONSTRUCTING THE SIMULATION MODEL

For each plan, we collected the following data for the 2016 plan year: the age and years-of-service distribution of current employed members; average salaries by age and service for the currently employed members; the age distribution of current beneficiaries; the distribution of average benefits for current beneficiaries by age; mortality assumptions by age and plan; wage growth assumptions by age, service, and plan; termination rates by age and service; and retirement rates by age, service, and tier. We also used information on vesting requirements, the method of salary averaging, and cost-of-living adjustments from the actuarial reports for each plan. In the case of SERS, we collected this information for each plan "tier," since each tier has different parameters for employees, which usually depend on the date of hire.

The methodology used to build the model included several stages. In the first stage we collected the data, inputs, and actuarial assumptions discussed earlier for each plan and used them to calculate the expected future annual benefit cash flows for current workers and retirees. Using the assumed discount rate for each plan, the model estimates the present value of these cash flows. We calibrated the estimated average age of retirement to bring the simulated value of liabilities close to the stated values of those liabilities in the relevant actuarial reports.

Using the simulated benefit cash flows for each plan, the model calculates liabilities as the present value of liabilities at different discount rates, which are based on an estimate of the distribution of long-run average rates of return.

Normal Cost Calculations

The normal cost represents the annual cost of new benefits accruing to active employees in that year based on their participation in the plan. If the experience of the plan matches its assumptions, a contribution equal to the normal cost will be sufficient to pay all benefits accrued in that year. The normal cost factor is often represented as a percentage of employee wages, and is calculated as the present value of the sum of expected additional benefits resulting from each active worker working one more year divided by current compensation.

Each pension plan calculates its normal cost rate using a smoothed method that expresses the normal cost as a constant percentage of payroll over an employee's working lifetime that will raise enough to fund expected future benefits. For instance, a given employee's normal cost is not zero in years before he or she vests in his or her benefits, but it is a constant percentage of the employee's

compensation as long as he or she is employed. Actual benefits owed at retirement are a function of the average salary over the last three or five years before retirement, depending on the plan. The formula used in this paper's model, since it divides the present value of expected benefits by current salary, does not account for salary increases during working years, but does account for cost-of-living adjustments to benefits after retirement. The simulated value using that formula closely approximates the baseline value reported by each plan.

Annual Required Contribution

The annual required contribution is the normal cost contribution plus a payment to amortize the unfunded actuarially accrued liability over a specified length of time. For JFSMCCRS, TRS, and SERS, the amortization payment is calculated as a constant percentage of payroll, which means that the payment begins smaller but then increases at the rate that total employee payroll rises.[37] For MERS and PJERS, the amortization payment is calculated using the level dollar method, which implies a constant payment in nominal terms over time. The ARC is the annual payment that, if all plan assumptions are satisfied, will be sufficient to reduce unfunded actuarial liabilities to zero at the end of a specified amortization period. Beginning in 2016, the amortization period was 15 years for JFSMCCRS, 25 years for SERS, 23 years for MERS, and 20 years for PJERS. For TRS, the weighted average amortization period was 17.6 years.

37. As noted earlier, the method of calculating the amortization payment to reduce unfunded liability for TRS and SERS changed to the level dollar method in 2020 and 2021, respectively.

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ACKNOWLEDGMENTS

The authors would like to thank Ryan Van Dusen and Justin Leventhal for their crucial and timely research assistance, as well as Paul Wroblewski of the First Actuarial Consulting Team for providing advice that helped the authors improve the model that was used to get their simulation results.

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