



LEGACY PENSION DEBT REPORT: OHIO STATE TEACHERS RETIREMENT SYSTEM

Center for Retirement Research at Boston College

SPECIAL REPORT
June 2022

Center for Retirement Research at Boston College
Hovey House
140 Commonwealth Avenue
Chestnut Hill, MA 02467
<https://crr.bc.edu>

The Center for Retirement Research gratefully acknowledges the Laura and John Arnold Foundation for its support of this research. The findings and conclusions expressed do not represent the opinions or policy of the Laura and John Arnold Foundation or Boston College.

© 2022, Center for Retirement Research at Boston College. All rights reserved. Short sections of text, not to exceed two paragraphs, may be quoted without explicit permission provided that full credit, including © notice, is given to the source.

About the Center for Retirement Research

The mission of the Center for Retirement Research at Boston College is to produce first-class research and educational tools and forge a strong link between the academic community and decision-makers in the public and private sectors around an issue of critical importance to the nation's future. To achieve this mission, the Center conducts a wide variety of research projects, transmits new findings to a broad audience, trains new scholars, and broadens access to valuable data sources. Since its inception in 1998, the Center has established a reputation as an authoritative source of information on all major aspects of the retirement income debate.

Center for Retirement Research at Boston College
Hovey House
140 Commonwealth Ave
Chestnut Hill, MA 02467
Tel: 617-552-1762 Fax: 617-552-0191
<https://crr.bc.edu/>

Affiliated Institutions:
The Brookings Institution
Mathematica – Center for Studying Disability Policy
Syracuse University
Urban Institute

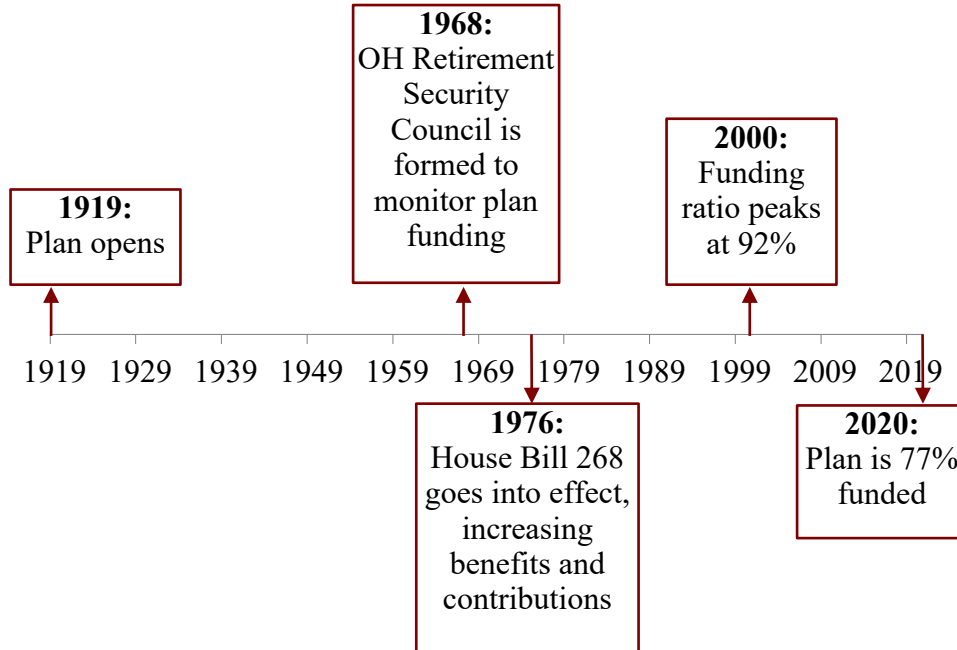
Legacy Pension Debt Report: Ohio State Teachers Retirement System

This goal of this report on the Ohio State Teachers Retirement System is twofold. The first is to highlight the extent to which the plan's current unfunded actuarial liability reflects unfunded liabilities that existed before modern actuarial funding practices were adopted. The second goal is to present a new funding approach that separates the funding of these legacy liabilities from other pension liabilities while valuing liabilities in a manner more consistent with modern accounting and finance. The hope is that separating historical pension debt from ongoing pension liabilities provides a clearer way forward for government employers, employees, and taxpayers.

I. A Brief Overview of the Funding History

The Ohio State Teachers Retirement System (OH STRS) was established in 1919 and has always set contribution policies based on actuarial funding principals. However, it wasn't until 1968 that the Ohio Retirement Study Council (ORSC) was established to provide stronger oversight of actuarial methods and funding practices for the five state retirement systems in Ohio. At that point, OH STRS already had \$0.5 billion in unfunded liabilities – a legacy debt stemming from funding practices before the ORSC that is still a burden on OH STRS today.

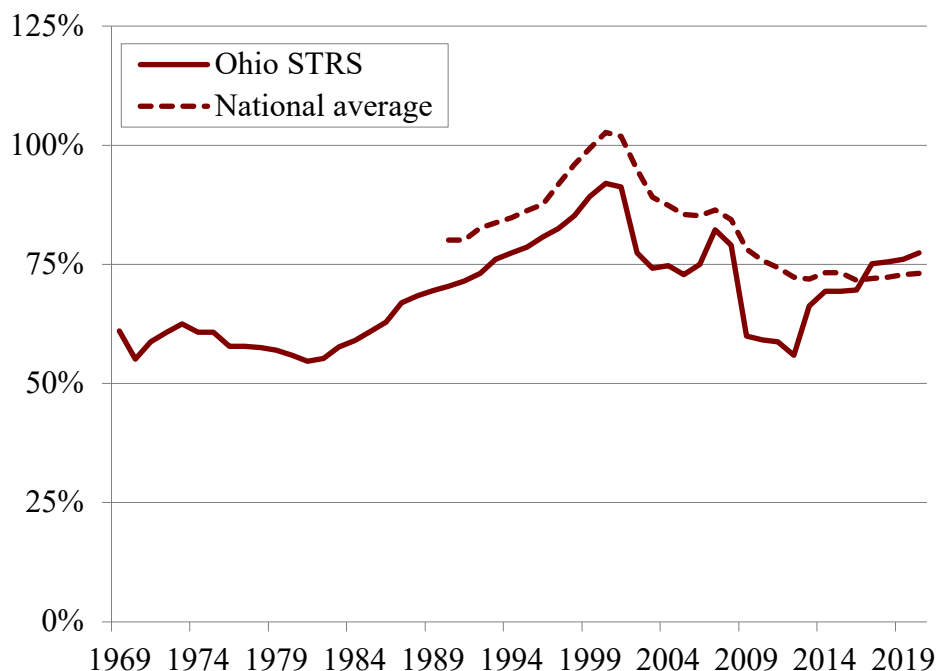
Figure 1. *Timeline of Key Funding Events for OH STRS, 1919-2020*



Sources: CRR calculations based on various financial reports for OH STRS.

Currently, about \$9.4 billion – or about 42 percent of OH STRS’s total unfunded liability – is due to legacy debt.¹ Partly due to the initial legacy debt, the historical funded status of OH STRS has slightly lagged that of average state and local pension plan (see Figure 2). However, due to significant benefit cuts made in the wake of the Global Financial Crisis (GFC), OH STRS’s funded status currently exceeds that of the average state and local pension plan.

Figure 2. *Funded Ratio of OH STRS Compared to the National Average, 1969-2020*



Note: Missing data points estimated using straight-line interpolation between actual data points.

Sources: CRR calculations based on various financial reports for OH STRS; Zorn (1990-2000); and the *Public Plans Database* (2001-2020).

II. Sources of the Current Unfunded Liabilities

The increase in OH STRS’s total unfunded actuarial accrued liability (UAAL) since 1968 is due to a number of factors shown in Figure 3.

¹ See Aubry (2022) for a complete description of how Legacy Debt is calculated. Technically, the calculation is as follows. First, the initial debt in the legacy system is rolled forward each year using a standard formula for tracking growth in unfunded liabilities: $\text{legacy liability (t)} = \text{legacy liability(t-1)} + \text{interest on legacy liability(t-1)} - \text{apportioned amortization payment (t)} + \text{apportioned actuarial gains and losses on the accrued liability (t)}$. Then, the annual accrued liability for the ongoing system equals the retirement system’s reported accrued liability in the year minus the estimated legacy liability. The amortization payment apportioned to legacy debt in each year is based on the relative sizes of the prior year’s: 1) legacy liability; and 2) the additional unfunded accrued liability in the ongoing system. The gains and losses apportioned to the legacy debt each year are based on the relative sizes of the prior year’s: 1) legacy liability; and 2) the additional accrued liability in the ongoing system. In general, this approach results in legacy liabilities growth that is similar to the growth in total unfunded liabilities over time (minus the impact of investment performance).

Figure 3. Sources of Change to UAAL for OH STRS, 1968-2020



Sources: CRR calculations based on various financial reports for OH STRS.

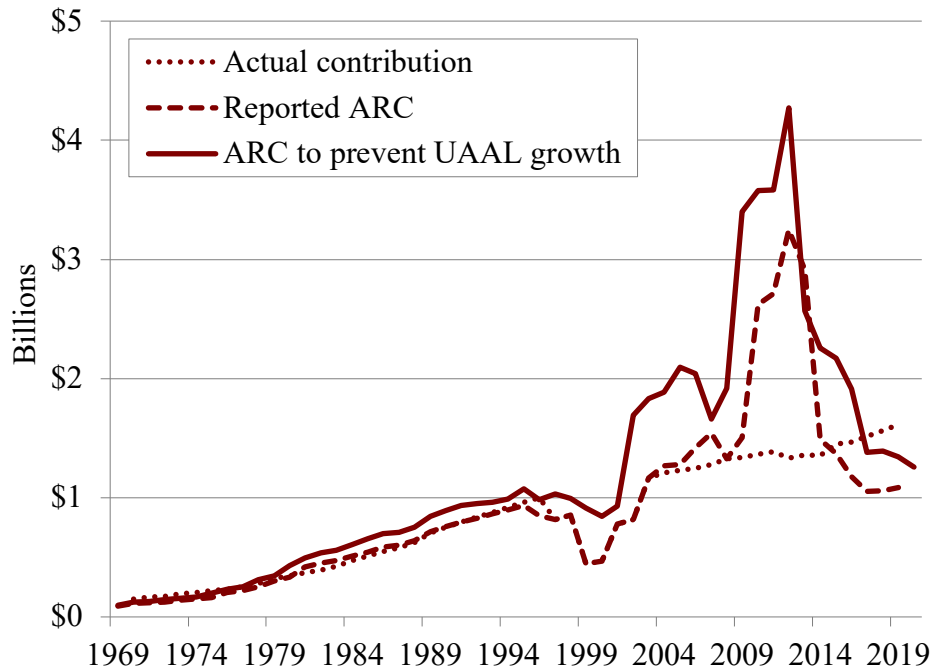
Inadequate Contributions. Paying down unfunded liabilities is a two-step process. First, the amortization payment calculated by the actuary must truly reduce the unfunded liability. Second, the sponsor (Ohio school districts) must actually make the full payment. Since 1968, failures in both areas have resulted in a combined \$20.6 billion increase in OH STRS’s unfunded liabilities.

Figure 4 presents three contribution amounts for OH STRS from 1969 to the present: 1) actual employer contributions; 2) the calculated actuarially required contributions (ARC); and 3) the minimum contributions required to keep the unfunded liability from growing in dollar terms.²

Somewhat uniquely, the required pension contributions for OH STRS are set statutorily and are periodically assessed to ensure that they are sufficient to meet long-term funding goals. Under this paradigm, pension contributions rarely change with the year-to-year changes in OH STRS’s financial status. Instead, changes are made only after enough convincing evidence can be gathered to show that OH STRS cannot meet its long-term funding goals with the existing contribution rates. As a result, OH STRS has often received less than what is required to keep the UAAL from growing each year.

² See Munnell, Aubry, Hurwitz (2013) for details on the various amortization methods used by state and local retirement systems and their impact on funding and contributions.

Figure 4. ARC, Contribution to prevent UAAL growth, and Actual Contributions for OH STRS, 1969-2021



Sources: CRR calculations based on various financial reports for OH STRS.

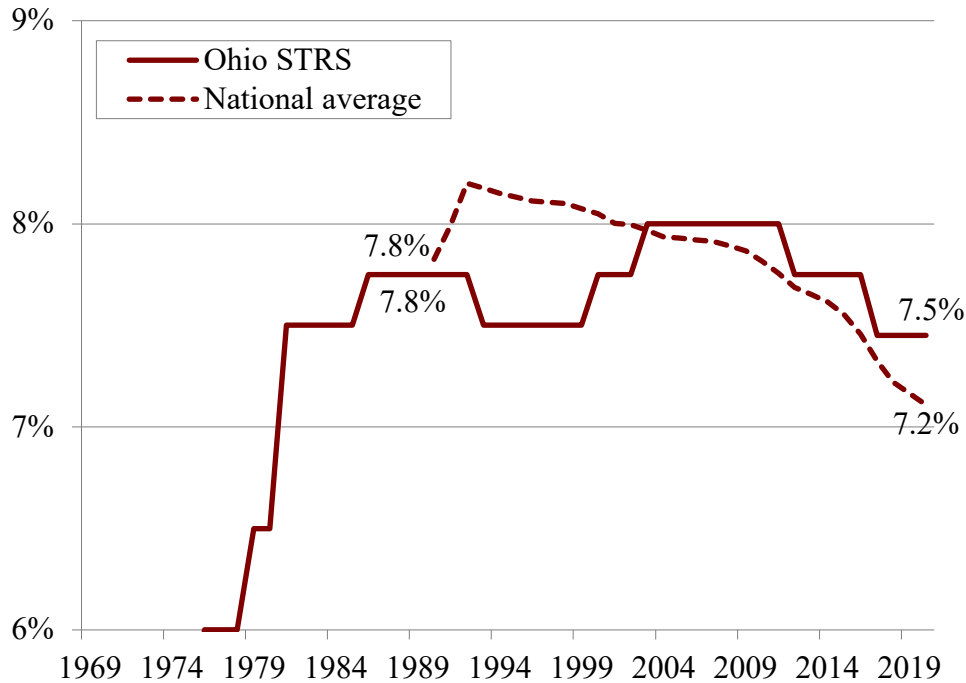
Assumed and Actual Investment Returns. One of the more impactful and contentious actuarial assumptions for public pensions is the rate used to discount promised benefits. For virtually all public plans, this rate is the long-term investment return.³ A lower assumed return produces higher reported liabilities and required contributions, while higher assumed returns produce the opposite. But, when actual returns fall short of expectations, additional unfunded liabilities (requiring higher contributions) result.

To date, the general path of the assumed return for OH STRS has been similar to that of most retirement systems (see Figure 5). OH STRS experienced an initial period of rising assumed rates of return in the 1970s and 1980s as the pension fund shifted from an investment portfolio consisting of predominantly bonds to one allocated toward equities. Assumed returns were then adjusted incrementally in 1990s and 2000s, with incremental rate reductions since the GFC.⁴ On net, the various adjustments to the assumed return have increased OH STRS’s liabilities by \$1.2 billion since 1969.

³ Single-employer plans in the private sector use the interest rate on investment-grade corporate bonds to value future benefits because, it is presumed, the risk of default on corporate bond payments is similar to the risk of default on payment of corporate pension benefits. Unlike these private sector plans, public pensions use the actuarially assumed rate of return on their investments as the discount rate to value liabilities. Thus, investing in riskier assets that increase the expected return for the investment portfolio also reduces the reported value of benefits and, consequently, the actuarially required contribution.

⁴ See Aubry and Wandrei (2019) for details on how, for many state and local government retirement systems, a decline in their assumed return masks an increase in the assumed *real* (i.e., net of inflation) return, which lowers costs.

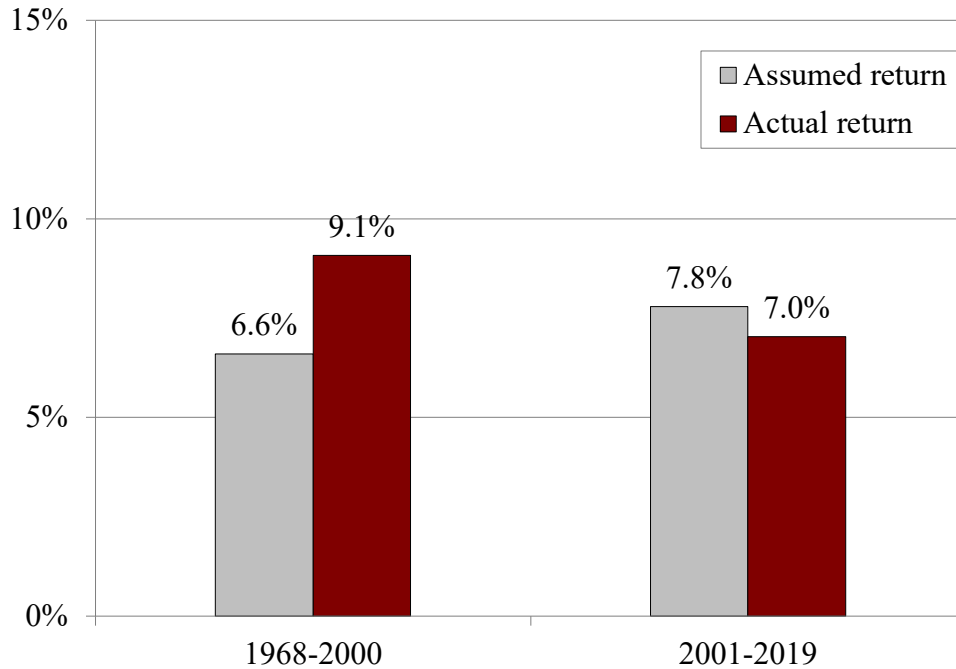
Figure 5. Assumed Return for OH STRS Compared to the National Average, 1969-2020



Sources: CRR calculations based on various financial reports for OH STRS; PENDAT (1990-2000); and *Public Plans Database* (2001-2020).

Looking back, the historical investment return for OH STRS has also been similar to that of most public retirement systems – returns generally exceeded assumptions prior to 2000 and fell short afterward (Figure 6). The differences between the actual and assumed returns have reduced unfunded liabilities by \$6.7 billion since 1968.

Figure 6. *Annualized Returns for OH STRS, 1968-2000 and 2001-2019*

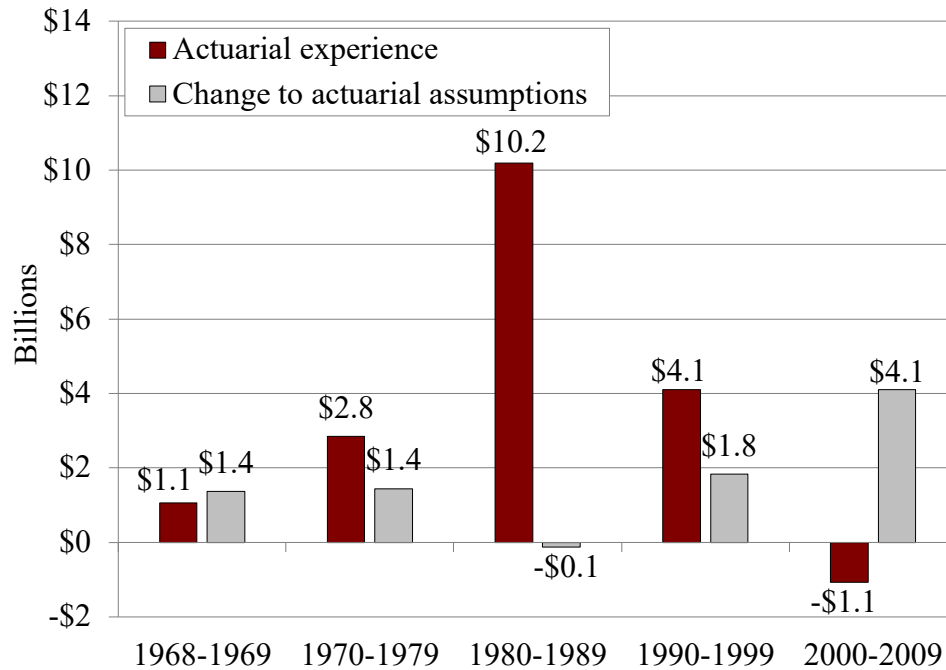


Sources: CRR calculations based on various financial reports for OH STRS; PENDAT (1990-2000); and *Public Plans Database* (2001-2020).

Demographic Assumptions and Actual Experience. In addition to the assumed return, the value of liabilities depends on a series of assumptions about plan members' future pay, tenure, retirement age, and mortality. To the extent that the experience of plan members deviates from these assumptions in ways that increase future benefits (e.g., retirees living longer than assumed), unfunded liabilities will arise.

The data show that, prior to the GFC, the actual activity of plan members relative to assumptions tended to produce unfunded liabilities (see Figure 7). But OH STRS has regularly adjusted its assumptions to expect higher liabilities and, following the benefit reductions implemented in the wake of the GFC, the actual activity of members has resulted in lower liabilities.

Figure 7. Change in UAAL for OH STRS from Actuarial Experience and Assumptions, 1970-2020



Sources: CRR calculations based on various financial reports for OH STRS.

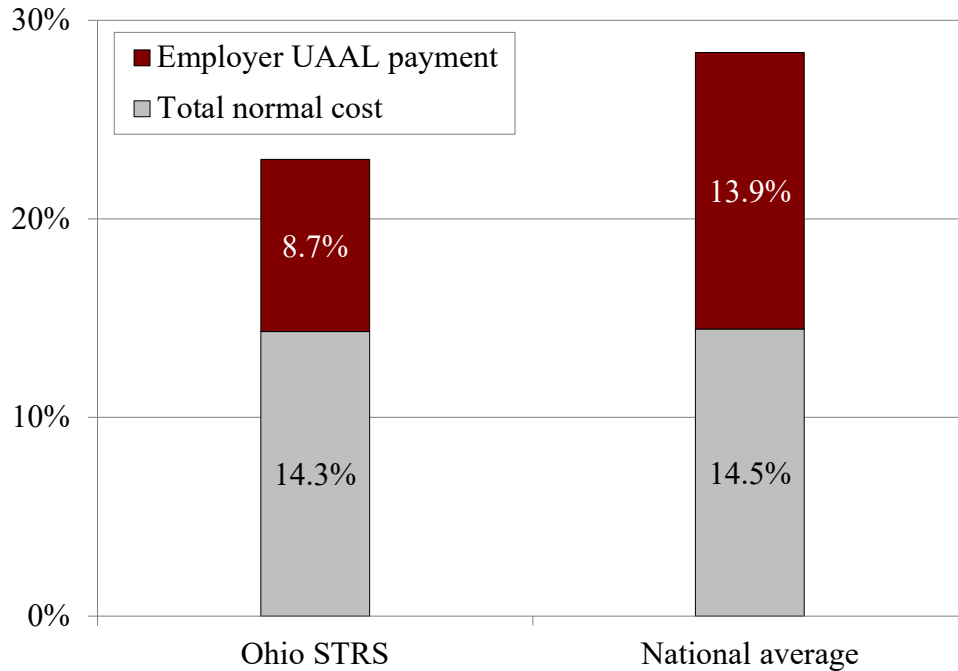
Benefit Changes. Like most other state and local government retirement systems across the U.S., the benefits provided by the Retirement System were mostly expanded throughout its history leading up to the GFC. However, in the wake of the GFC, benefits were significantly reduced, and some of the reductions affected current members. As result, the net impact of benefit changes over time has been to decrease the unfunded liability by about \$21.1 billion.⁵

Even if historical benefit increases had contributed to unfunded liabilities, the cost of the benefits earned by OH STRS members – the normal cost – was about average prior to the recent benefit cuts (see Figure 8).⁶ Government agencies that cut benefits to control costs without carefully assessing the competitiveness of public sector compensation risk under-compensating workers, which eventually leads to understaffing or a lower quality workforce.

⁵ Due to data limitations, this amount reflects only the effect of benefits changes made since 1982.

⁶ Members of OH STRS are among the roughly 25 percent of state and local workers nationwide who are not covered by Social Security. For more on the retirement benefits of state and local workers who are not covered by Social Security see Aubry et al (2022).

Figure 8. *Actuarial Costs for OH STRS Compared to the National Average, 2009*



Note: The actuarial costs for OH STRS are based on a 8.5-percent discount rate, while the average for PPD plans is 8.2-percent.

Sources: CRR calculations based on the *Public Plans Database*; and various financial reports for OH STRS.

The bottom line, however, is that a \$0.7 billion liability inherited from before modern actuarial funding was adopted has grown to \$9.4 billion since then. This raises questions about how these liabilities should be managed going forward. The next section proposes a new approach that separates the funding of legacy liabilities from other pension liabilities, while valuing liabilities in a manner more consistent with modern accounting and finance. Hopefully, it provides a clearer way forward for government employers, employees, and taxpayers.

III. A New Approach

The current approach for managing pension liabilities suffers from three problems:

1. *It does not recognize the unique aspect of legacy liabilities.* The current approach to actuarial funding allocates the costs of pension benefits to the period when the benefit was promised and earned, which limits the spillover costs from one generation to the next.⁷ Legacy liabilities do not fit this framework. Choosing any single future generation

⁷ Each year, government workers earn a higher promised retirement benefit because of increases in both their salaries (on which benefit payouts are based) and their years of tenure in government (which determine the percentage of salary they receive as a benefit payout). Each year's normal cost represents the current value of that increase in promised future benefits to workers. In theory, paying the normal cost would result in each generation paying for promised benefits as they are earned. In practice, however, the value of future benefits is impossible to determine precisely, and additional contributions are typically required in later periods to ensure the cost of benefits earned in prior periods does not spill too far into other generations.

to bear the full cost of legacy liabilities is arbitrary because no future generation is more responsible for the legacy debt than any other.

2. *It attributes the costs associated with historical liabilities to current workers.* Actuarially required pension contributions consist of two parts: 1) the cost of benefits earned due to continued employment (the normal cost); and 2) the cost of unfunded benefits from the past (the amortization payment). The normal cost is variable; the amortization payment is fixed. To improve resource allocation and decision making, managerial accounting differentiates between fixed and variable costs. However, government managers often view both the fixed and variable components of pension costs as a single variable cost.
3. *It uses assumed investment returns to value future benefits.* Using the assumed return to value benefits understates their cost and likely pushes some of that cost onto future generations.⁸ Modern finance theory maintains that the value of a government's promise to pay future benefits should resemble the value of other similar government promises of future payments.⁹ The obvious candidate is municipal bonds which require the issuing government to promise to make payments to bondholders.¹⁰

To address these issues, this *brief* suggests a new approach that:

1. adopts modern finance techniques by using the average yield on investment-grade municipal bonds (after adjusting for tax exemption) to calculate liabilities and required contributions;¹¹
2. treats unfunded liabilities and normal costs as fixed and variable costs, respectively; and
3. separates legacy unfunded liabilities and spreads the costs over multiple generations.

At a high level, the new approach presents a trade-off. On the one hand, it increases annual pension costs by appropriately valuing promised benefits to limit unintended generational spillover. On the other hand, it reduces the annual costs of legacy liabilities by spreading them over multiple generations. So, while the new approach involves a more rational allocation of costs, it is not obvious how it will affect annual costs overall. Figure 9, which compares the new approach with the required contributions for a more typical actuarial approach, reveals that

⁸ For more details, see Bronner, et al. (2008); Bader and Gold (2003); Gold and Latter (2008); Novy-Marx and Rauh (2009a); and Arnott (2005).

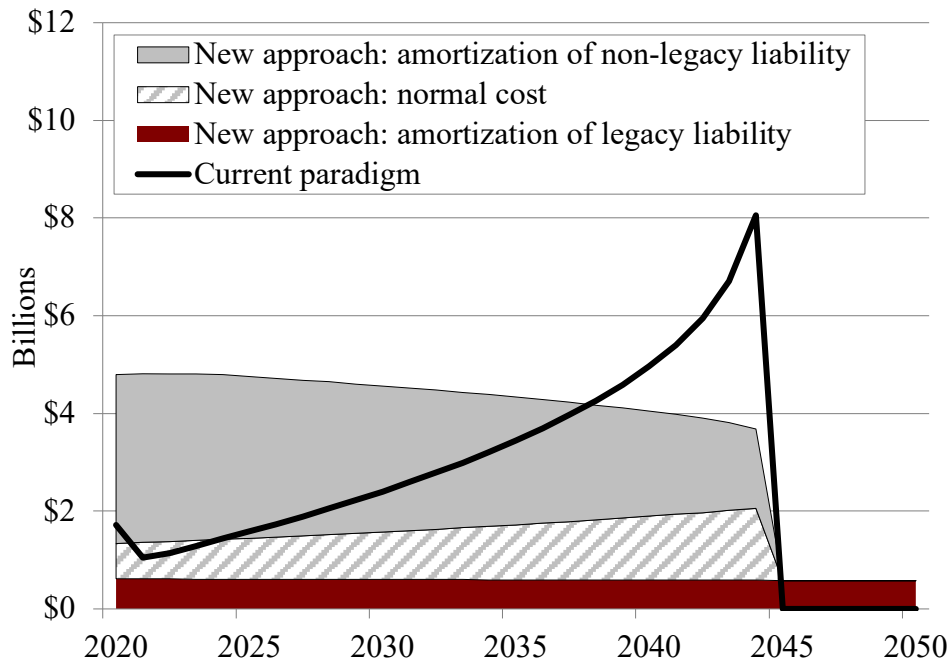
⁹ In economics and finance, the analysis of choice under uncertainty identifies the discount rate for riskless payoffs with the riskless rate of interest. See Gollier (2001) and Luenberger (1997). This correspondence underlies much of the current theory and practice for the pricing of risky assets and liabilities, and the setting of risk premiums. See Sharpe, Alexander, and Bailey (2003); Bodie, Merton, and Cheeton (2008); and Benninga (2008).

¹⁰ Ideally, the discount rate would reflect the risk of the liabilities themselves, would be based on fully taxable securities (because pension benefit payments are, generally, subject to individual federal income tax), and would not have a premium for liquidity (because promised pension payouts cannot be easily traded on the open market).

¹¹ Novy-Marx and Rauh (2009b) employ a *state specific* taxable municipal bond rate based on the zero-coupon municipal bond curve. Their rationale is that states are equally likely to default on their pension obligations as on their other debt.

contributions under the new approach are initially higher but ultimately lower and much more consistent.¹²

Figure 9. *Projected Contributions for OH STRS, by Approach, 2020-2050*



Source: CRR calculations.

Separating fixed historical costs from ongoing variable costs also has important implications for how government agencies and the public view the cost of government workers. To illustrate, Figure 10 presents the perceived variable retirement costs for members of OH STRS under the current paradigm and under the new approach. Even though the cost of accruing retirement benefits (the normal cost) is higher under the new approach, excluding fixed amortization costs

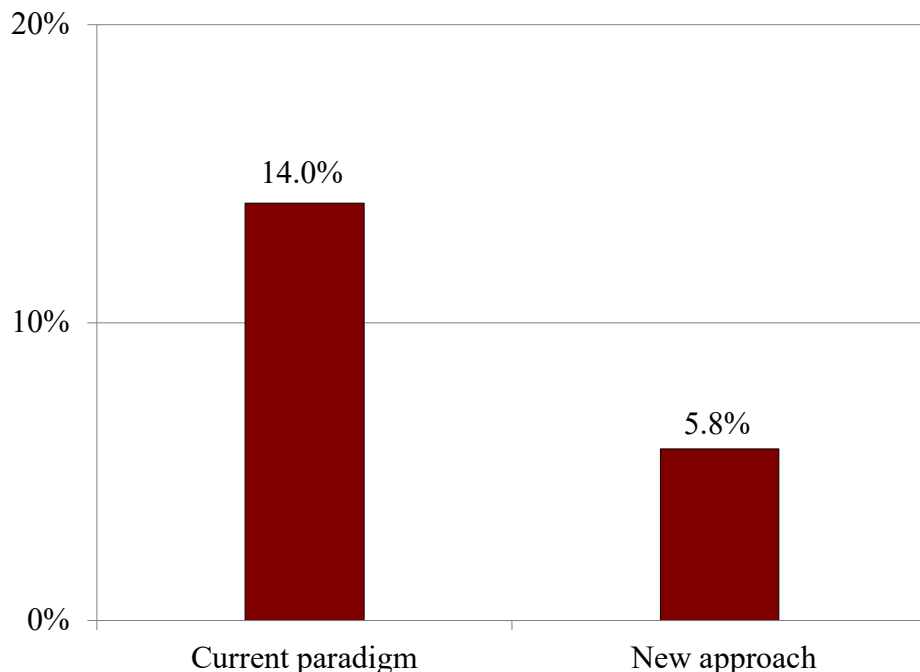
¹² Under the typical actuarial approach, contributions are based on pension benefits valued using the actuarially assumed return. Amortization payments reflect a 25-year level-percent-of-payroll approach (assuming 2-percent payroll growth) that is closed initially and rolling afterward.

Under the new approach, contributions are based on pension benefits valued at a 4.5-percent discount rate (using an actuarial rule of thumb that every 1-percent reduction in the discount rate increases liabilities by 12.5 percent and normal costs by 22.5 percent). Amortization payments reflect a 4.51-percent interest payment on legacy liabilities (to pay a tiny fraction of the principal on the legacy debt each period), a closed 25-year level-dollar amortization of current non-legacy liabilities, and a 10-year level-dollar amortization of any new non-legacy liabilities.

In terms of investment performance, realized investment returns are assumed to be 5.5 percent annually. A higher return would lower costs under both the typical and new approaches but would not materially change the cost difference between the two. Importantly, the average annualized return for public plans since 2001 has been roughly 6 percent. Additionally, Aubry and Crawford (2019) suggests that some of the investment risk taken by public pensions is related to the fact that actuarial contributions are based on the expected return to the portfolio. Under the new approach that uses bond yields to value benefits, public pension asset allocation would likely be more similar to the average allocation of large active private sector pension plans. Based on a 2019 CAPM produced by Pension Consulting Alliance, such an allocation produces an average expected return and standard deviation of 5.5 percent and 7 percent, respectively.

appropriately reduces the retirement cost associated with the ongoing employment of government workers.

Figure 10. *Perceived Variable Retirement Cost for OH STRS, by Approach*



Notes: Retirement cost under the current paradigm is equal to the employer normal cost plus UAAL valued using the assumed return. Retirement cost under the new approach is equal to the total normal cost valued using a 4.5-percent discount rate, less employee contributions.

Source: CRR calculations.

Implementing the New Approach in Practice

As noted in the prior section, a key feature of the new framework is making a clear distinction between the fixed legacy cost from benefits earned in a much earlier era and the costs stemming from benefits earned by more recent cohorts. Structurally, the best way would be to break the existing retirement system into two separate entities – the Legacy System and the Pension System.¹³

¹³ The Legacy System would begin with no assets and all the legacy liability while the Pension System would begin with all the retirement system assets and all the non-legacy liability. To pay down the legacy liability over as many generations as possible, government employers would make payments to the Legacy System that are only slightly greater than the annual interest accruing on the legacy liability. To fund non-legacy liabilities, normal costs plus amortization of non-legacy liabilities would be contributed to the Pension System. The current non-legacy liability could be amortized within roughly a generation's time – say, 25 years. (The average amortization period in the Public Plans Database is about 23 years.) Any future unfunded liabilities could be amortized over the average work life of plan members – currently, about 10 years. Finally, annual benefits to current retirees would be paid from the government contributions to the Legacy System first and then from Pension System assets. Importantly, most of the management of the original retirement system – e.g., the retirement board, actuarial staff, investment staff, member services staff, etc. – would transfer to the Pension System. The main purpose of the Legacy System's board and

Creating a totally separate government entity for managing the legacy liability would reduce the distorting effect that these liabilities have on the policy discourse around benefit generosity and the Pension System's management. Specifically, it would free the Pension System from constantly answering for a relatively intractable portion of the unfunded liability, allowing it to focus on the best way to manage ongoing liabilities. Second, two separate systems would make the distinction between fixed and variable costs clearer to government employers because they would be charged fixed legacy debt payments from one entity – the Legacy System – and a per-employee retirement cost from another entity – the Pension System.

Of course, the new approach presents a relatively dramatic shift in pension funding policy that would raise concerns for some. For example, the use of bond yields to value liabilities will increase reported liabilities, which some may take as an indication of worsening plan finances. In reality, little about the retirement system's finances will have changed – asset levels, the promised benefit payouts, and the contractual obligation to fulfill promised benefits are the same.¹⁴ Another concern might be that the use of bond yields may suggest that retirement systems should invest only in bonds.¹⁵ But, public pensions could still take risks in their investment portfolios under the new approach.¹⁶ Even among the largest private sector pension plans, which are required to use corporate bond rates to calculate liabilities and required contributions, equities still make up over half of the average investment portfolio.¹⁷

Finally, some may simply dislike the notion of deliberately lengthening the pay down of some pension liabilities. But, given that promised benefits must be paid – and it is unrealistic to think unfunded liabilities can be paid down more quickly – this new approach provides a practical way forward. It relies on a rational allocation of costs that recognizes the full cost of promised pension benefits while presenting a credible plan for managing the cost. Although the new approach would increase costs somewhat, it would improve intergenerational fairness, produce better resource allocation by government, and ultimately enhance public credibility.

IV. Conclusion

This *Report* takes a historical look at public pension underfunding to motivate a more transparent funding policy going forward. It hinges on a key finding – that OH STRS is still burdened by unfunded liabilities accumulated before modern actuarial funding began. This legacy debt poses

staff would be to charge the government for legacy liability payments and then disburse those payments to pay annual retiree benefits.

¹⁴ At the same time, using bond yields may discourage the use of pension obligation bonds for so-called investment arbitrage.

¹⁵ The problem with this argument is that it assumes an extreme degree of risk aversion. If sponsors of public plans were averse to all risk, they would require the pension funds to hold only Treasury securities. But, if sponsors are willing to take at least as much risk as the average investor, the premiums on stocks and bonds cover their cost of holding these investments. See Munnell et al (2010) and Bader and Gold (2007) for further discussion on the implications that modern finance valuations have on investment decisions.

¹⁶ Assets in the pension system trust fund would likely be invested more like those of a large private sector plan, while the assets in the Legacy Fund would be held in cash or invested in short-term liquidity so that they could be used immediately to pay benefits.

¹⁷ Following modern finance theory, the discount rate used to value the liabilities of private sector pension plans is based on the yield for investment-grade corporate bonds. See Andonov, Bauer, and Cremers (2017) and Rauh (2009) for prior analyses on pension asset allocation and liability discount rates.

a different policy challenge than other sources of unfunded liability, because legacy debt reflects the cost from an older way of managing promised retirement benefits. And, because it stems from a much earlier era, it does not fit within a modern actuarial framework that is designed to allocate costs to the period when benefits are earned.

Given the challenges that legacy debt poses to current funding policy, this *Report* presents a new approach that separates the funding of legacy liabilities from other pension liabilities, while valuing liabilities in a manner more consistent with modern accounting and finance. Ultimately, the new approach presents a trade-off. It increases annual pension costs by appropriately valuing the government's promise to pay future benefits in retirement. At the same time, though, it reduces the annual costs of legacy liabilities by appropriately spreading them over multiple generations. So, while the new approach will increase costs somewhat, it involves a more rational allocation of costs that results in improved intergenerational fairness, better resource allocation by government, and – ultimately – greater public credibility.

References

- Andonov, Aleksandar, Rob Bauer, and Martijn Cremers. 2017. "Pension Fund Asset Allocation and Liability Discount Rates." *Review of Financial Studies* 30(8): 2555-2595.
- Arnott, Robert D. 2005. "The Pension Problem: On Demographic Time Bombs and Odious Debt." *The Financial Analysts Journal* November/December: 12-17
- Aubry, Jean-Pierre. 2022. "Forensic Analysis of Pension Funding: A Tool for Policymakers." *State and Local Plans Issue in Brief* 83. Chestnut Hill, MA: Center for Retirement Research at Boston College.
- Aubry, Jean-Pierre, Alicia H. Munnell, Laura D. Quinby, and Glenn Springstead. 2022. "How Many Public Workers without Social Security Could Fall Short?" *State and Local Plans Issue in Brief* 82. Chestnut Hill, MA: Center for Retirement Research at Boston College.
- Aubry, Jean-Pierre and Caroline Crawford. 2019. "Impact of Public Sector Assumed Returns on Investment Choices." *State and Local Plans Issue in Brief* 63. Chestnut Hill, MA: Center for Retirement Research at Boston College.
- Aubry, Jean-Pierre, and Kevin Wandrei. 2019. "How Has the Decline in Assumed Returns Affected Plan Costs?" *State and Local Plans Issue in Brief* 66. Chestnut Hill, MA: Center for Retirement Research at Boston College.
- Bader, Lawrence N. and Jeremy Gold. 2003. "Reinventing Pension Actuarial Science." *Pension Forum* January: 1-13.
- Bader, Lawrence and Jeremy Gold. 2007. "The Case Against Stock in Public Pension Funds." *Financial Analysts Journal* 63(1): 55-62.
- Benninga, Simon. 2008. *Financial Modeling*. Cambridge MA: MIT Press
- Bodie, Zvi, Robert Merton, and David Cheeton. 2008. *Financial Economics*. Upper Saddle River, NJ: Prentice Hall, Inc.
- Bronner, David, et al. 2008. "Letter in Response to ASB Request for Comments." Submitted to the Actuarial Standards Board on Behalf of 72 State and Local Retirement Systems. Available at: http://www.actuarialstandardsboard.org/wp-content/uploads/2014/06/comment_9-2.pdf
- Ohio State Teachers' Retirement System. 1982-2020. *Actuarial Valuation Reports*. Columbus, OH.
- Gold, Jeremy and Gordon Latter. 2008. "Marking Public Pension Plan Liabilities to Market." Pension Finance Institute Working Paper.

- Gollier, Christian. 2001. *The Economics of Risk and Time*. Cambridge, MA: MIT Press.
- Luenberger, David G. 1997. *Investment Science*. Oxford, UK: Oxford University Press.
- Munnell, Alicia H., Jean-Pierre Aubry, and Josh Hurwitz. 2013. “How Sensitive Is Public Pension Funding to Investment Returns?” *State and Local Plans Issue in Brief* 34. Chestnut Hill, MA: Center for Retirement Research at Boston College.
- Munnell, Alicia H., Richard W. Kopcke, Jean-Pierre Aubry, and Laura Quinby. 2010. “Valuing Liabilities in State and Local Plans.” *State and Local Plans Issue in Brief* 11. Chestnut Hill, MA: Center for Retirement Research at Boston College.
- Novy-Marx, Robert and Joshua D. Rauh. 2009a. “The Liabilities and Risks of State-Sponsored Pension Plans.” *Journal of Economic Perspectives* (23)4: 191-210.
- Novy-Marx, Robert and Joshua D. Rauh. 2009b. “Public Pension Promises: How Big Are They and What Are They Worth?” Working Paper. Evanston, IL: Northwestern University, Kellogg School of Management. Available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1352608
- Public Plans Database*. 2001-2020. Center for Retirement Research at Boston College, MissionSquare Research Institute, National Association of State Retirement Administrators, and the Government Finance Officers Association.
- Rauh, Joshua D. 2009. “Risk Shifting Versus Risk Management: Investment Policy in Corporate Pension Plans.” *Review of Financial Studies* 22(7): 2687-2733.
- Sharpe, William, Gordon J. Alexander, and Jeffrey W. Bailey. 2003. *Investments*. Upper Saddle River, NJ: Prentice Hall, Inc.
- U.S. Census Bureau. 1983-2020. *State and Local Government Employee-OH STRS Survey*. Washington, DC.
- Zorn, Paul. 1990-2000. *Survey of State and Local Government OH STRSs: Survey Report for Members of the Public Pension Coordinating Council [PENDAT]*. Chicago, IL: Government Finance Officers Association.