Ohio Public Pension System: Traditional Funding Ratios Are Not Enough for Pension Funds

Erick M. Elder and David Mitchell

MERCATUS CENTER
George Mason University

3434 Washington Blvd., 4th Floor, Arlington, Virginia 22201
www.mercatus.org

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ABSTRACT

Ohio's public pension system comprises five state-level plans that have actuarial funding ratios ranging between 67 and 84 percent. Pension plan funding levels are a proxy for the ability of a pension plan to fund its promised benefit payments without additional resources. Volatile and uncertain investment returns mean that even a fully funded pension plan has less than a 50 percent chance of having sufficient assets to fund all accrued future benefit payments, so the likelihood that Ohio's pension plans can meet their obligations is even less. In this study, we determine the likelihood that Ohio's major public pension plans will be able to make their accrued, promised future payments using only each plan's current stock of assets—without future contributions, which are intended to fund benefits that accrue later. Furthermore, we calculate the amount of assets the pension plans would need to increase the likelihood of being able to fund future benefit payments and the effect this has for potential "overfunding." Overall, we show that traditional funding ratios may be a misleading indicator of a pension plan's ability to use current assets to pay future benefits.

JEL codes: H5, H6, H7

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A State Budget Solutions report on the nation's public pension plans warns that most are severely underfunded, and Ohio's five state-level public pension plans are not exceptions.[1] Ohio ranks behind only Mississippi in terms of its level of unfunded liabilities relative to the size of the state's income. Additionally, despite having assets of more than $150 billion, Ohio's five plans may be underfunded by as much as $289 billion, according to the report. This high level of underfunding is due to the current stock of assets in the Ohio plans, which, even when considering future investment returns, is grossly insufficient to pay the retirement benefits that have already been earned. A Morningstar report on state public pensions maintains that from 2008 to 2012, average funding ratios for state pension plans nationwide declined from 84 to 72 percent and that the funding ratio for Ohio's largest public pension plan declined from 96.1 to 77.2 percent.[2] This decline in funding ratios was due in large part to poor investment returns on assets held during the Great Recession.

In this study, we analyze the structure and funding history of Ohio's five state public pension plans and provide a probability for each fund's ability to meet its obligations. To do this, we examine pensions' ability to create cash flow from currently accrued future benefits. We analyze pensions that are funded at various levels, including levels corresponding to the present situation in Ohio as well as ratios of 80 percent, 100 percent, and 120 percent. It is important to note that Ohio's 2012 pension reforms only influence the analysis presented in this study to the extent that the reforms affect the pensions' funding ratios. Only a significant change in these pensions' investment portfolios would affect our conclusions concerning their ability to create cash flow and deliver their promised benefits.

1. Joe Luppino-Esposito, "Promises Made, Promises Broken 2014: Unfunded Liabilities Hit 4.7 Trillion," American Legislative Exchange Council, November 12, 2014.
2. Rachel Barkley, "The State of State Pension Plans 2013: A Deep Dive into Shortfalls and Surpluses" (Morningstar, September 16, 2013).

"Traditional proxies of a pension plan's financial health, specifically funding ratios, may be a misleading indicator of a plan's ability to use its current assets to pay promised future benefits."

Background

The level of pension plan funding is often used as the main proxy for the ability of a pension fund to pay all its promised future benefits. In this study, we show that there is a clear and positive relationship between the current level of funding and the ability of a plan to pay its future liabilities. Further, we show that there is still a substantial probability that a "fully funded" pension plan will not be able to pay all its future promised payments without the need for additional resources. We supplement the traditional accounting or actuarial "level of funding" or "funding ratio" with a simple additional metric for gauging the likelihood that a pension plan will be able to make its future promised benefit payments without recourse to additional resources from future taxpayers. We demonstrate that even a fully funded plan has less than a fifty-fifty chance of being able to pay all future liabilities without an additional infusion of funds, such as an increase in taxes or contribution rates, or without using funds designed to fund future accrued benefits. For pension plans that are less than fully funded, such as Ohio's largest public pension plans, the problem is even more severe. Therefore, we believe that traditional proxies of a pension plan's financial health, specifically funding ratios, may be a misleading indicator of a plan's ability to use its current assets to pay promised future benefits. We believe another measure that we develop, showing the year-by-year probability of being able to pay benefits using only current assets, may be a useful additional measure of a pension plan's financial health.

Nationwide, 38 percent of state and local pension plans have funding ratios over 80 percent, and 20 percent have funding ratios below 60 percent.[3] The five state-operated public pension plans in Ohio have *actuarial* funding ratios between 66 and 83 percent. Given the

3. Alicia H. Munnell and Jean-Pierre Aubry, "The Funding of State and Local Pensions: 2015–2020" (Issue Brief, Center for State and Local Government Excellence, Washington, DC, June 2016).

2014 funding ratios and asset allocations for Ohio's five public pension plans, we calculate the probability that the plans will be able to pay their promised benefits at various time horizons on the basis of the return characteristics of their portfolio allocations. Because each of the pension plans is currently underfunded, there is only a small likelihood that any will be able to pay all future promised obligations without increases in employee or employer contributions or changes in benefits or without tapping into future contributions intended to fund future benefits. Tapping into future contributions intended to fund future accrued benefits causes problems by further increasing the underfunding problem in the long term, hence violating the general notion that benefits should be paid for at the time they are accrued and not passed onto future generations. Current funding ratios and an assumed distribution of asset returns indicate that Ohio's plans have sufficient assets to pay benefits with complete certainty for only the next five years.[4] After that the probability that the plans will be able to make their obligated payments falls precipitously. By 2037, Ohio's largest public pension, the Ohio Public Employees Retirement System, has only a 50 percent chance of being able to meets its obligations, and the Ohio Police and Fire Pension Fund has less than a 25 percent chance. We estimate that to significantly increase the probability of meeting future obligations using the stock of assets these pension plans currently hold, the plans would need two and a half times more than their current assets.[5]

Furthermore, to demonstrate and emphasize that traditional funding ratios are not necessarily a good measure of the solvency of a public pension plan, we calculate the probability that a pension plan that is fully funded, as well as 20 percent overfunded, will be able to make its future promised payments at various time horizons. Although this method does increase the probability that Ohio's pension plans will able to pay their future liabilities, the probabilities remain far short of 100 percent. The results, therefore, cast significant doubt on the use of the accounting practices behind simple traditional funding ratios as a metric for evaluating pension plans and the way in which plans assets are invested.

4. The results presented in this paper are similar to those of Alicia H. Munnell et al., "Can State and Local Pensions Muddle Through?" (State and Local Pension Plans Brief 15, Center for Retirement Research at Boston College, Boston, March 2011).

5. As table 3 shows, to increase the probability of meeting all future obligations to 90 percent, the pension plans would need a funding ratio (discussed later) of 190 percent. Currently, Ohio's five major plans have funding ratios of approximately 70–85 percent.

The Appropriate Discount Rate

Popular press reporting tends to focus on the lack of assets in public pension plans, but recent research demonstrates that the rate used to discount future liabilities may be equally important. In particular, pension liabilities are improperly measured. Finance professors and pension experts Robert Novy-Marx (of the University of Rochester) and Joshua D. Rauh (of Stanford University) argue that pension liabilities should be discounted by a (nearly) risk-free rate because finance theory suggests that the rate at which liabilities are discounted should match the riskiness of the liabilities themselves.[6] Discounting liabilities by a lower rate substantially increases their present value and substantially lowers the reported funding ratio. For example, as Alicia H. Munnell and Jean-Pierre Aubry of the Center for Retirement Research at Boston College show, discounting aggregate state and local pension liabilities by a rate of 7.6 percent values the liabilities at $4.3 trillion, whereas using a 4 percent discount rate values the liabilities at $7.1 trillion.[7]

The chosen discount rate affects the valuation of liabilities, but the discount rate does not change the ability of a pension plan to fund its sequence of expected liabilities (or benefits) given a certain amount of current assets. We first estimate the likelihood that each of the Ohio pension plans examined will be able to pay its future benefits given each plan's 2014 stock of assets and portfolio allocation. We also estimate the likelihood that each pension plan will be able to pay its future liabilities over various time periods if fully funded in the Novy-Marx and Rauh sense, such that the plan's assets are equal to the present value of its liabilities discounted by a sequence of risk-free rates but still assigned to retirees based on the current allocation.[8]

Regardless of how a plan's liabilities are calculated, as the likelihood increases that a plan has sufficient assets to pay promised benefits, so does the likelihood that a plan will ultimately have a surplus of assets. A surplus can lead to significant political pressure to raise pension benefits, which could exacerbate future funding problems.[9] A surplus invites political pressure to increase benefits

6. Robert Novy-Marx and Joshua D. Rauh, "The Liabilities and Risks of State-Sponsored Pension Plans," *Journal of Economic Perspectives* 23, no. 4 (2009): 191–210; Robert Novy-Marx and Joshua D. Rauh, "Public Pension Promises: How Big Are They and What Are They Worth?," *Journal of Finance* 66, no. 4 (2011): 1211–49.

7. Munnell and Aubrey, "Funding of State and Local Pensions."

8. If a pension plan is fully funded in the Novy-Marx and Rauh sense and is invested in risk-free assets, there is virtually no chance of over- or underaccumulation.

9. Erick M. Elder and Gary Wagner, "Political Effects on Pension Underfunding," *Economics & Politics* 27, no. 1 (2015).

not only for current beneficiaries, but also for future beneficiaries. But increasing benefits for future beneficiaries means the plan will need additional funds for later retirees as well. For example, as a result of strong investment returns in the late 1990s, Pennsylvania's two largest public pensions had funding ratios in excess of 120 percent, and subsequently benefit formulas were made more generous in 2001 and 2002. Therefore, although state governments should not want their public pension plans to be underfunded, they should also be wary of overfunding them.

The next section of this paper discusses the financial health of the four largest public pension plans in Ohio and discusses the importance of investment returns to their financial health. Another section analyzes the financial health of the plans. This analysis does four things. First, it looks at the likelihood that each plan can fund its promised future benefits using only the assets it accumulated as of the end of 2014. Second, the analysis looks at the level of assets that would be necessary under a Novy-Marx and Rauh discounting of liabilities by a risk-free rate. Next, we look at the level of assets that would be necessary to have a certain amount of confidence that all future benefits will be paid while the current allocation of assets is maintained. Lastly, because a relationship exists between the likelihood of having a sufficient amount of assets to make all future payments and the likelihood of having "too many" assets, we look at the distribution of wealth under various scenarios. Not surprisingly, if pension plans discount their liabilities by a risk-free rate and aim to be fully funded, there are numerous implications. First, if the allocation of assets does not change, the accumulation of assets is enormous and, with almost complete certainty, will lead to a gross overaccumulation that results from an unnecessary burden on employees, employers, and taxpayers. Alternatively, if pension plans discount by the risk-free rate and invest in risk-free assets, the cost of funding those liabilities significantly increases.

INVESTMENT RETURNS AND THE FINANCIAL HEALTH OF PENSION PLANS

Ohio's public pension system comprises five plans: Ohio Public Employees Retirement System (OPERS), Ohio School Employees Retirement System (SERS), Ohio State Teachers Retirement System (STRS), Ohio Police and Fire Pension Fund (OP&F), and the State Highway Patrol system (SHP, formally known as the Ohio Highway Patrol Retirement System, or HPRS). Table 1 reports characteristics of the plans, including membership, assets, and accrued

TABLE 1. DESCRIPTIVE STATISTICS FOR OHIO'S PUBLIC PENSION PLANS

	OPERS	STRS	SERS	OP&F	SHP	Total
Active members	328,341	169,295	121,251	27,605	1,622	648,114
Retirees and beneficiaries	208,859	152,208	72,605	27,703	1,567	462,942
Assets ($ billions)	$76.6	$72.1	$12.6	$13.4	$0.74	$175.4
Liabilities ($ billions)	$89.0	$96.2	$17.5	$18.6	$1.01	$222.3
Funding ratio	86.1%	75.0%	72.0%	72.0%	73.3%	78.9%
Assumed rate of return	8%	7.75%	7.75%	8.25%	8.0%	

Note: OPERS = Ohio Public Employees Retirement System; STRS = State Teachers Retirement System; SERS = School Employees Retirement System; OP&F = Ohio Police and Fire Pension Fund; SHP = State Highway Patrol (now Highway Patrol Retirement System, or HPRS).

Sources: 2014 comprehensive annual financial reports for each pension plan are available at https://www.opers.org/financial/reports.shtml (OPERS); https://www.strsoh.org/publications/annual-reports.html (STRS); http://www.ohsers.org/publications (SERS); https://www.op-f.org/Information/Reports.aspx (OP&F); and https://www.ohprs.org/ohprs/annualReport.jsp (SHP [HPRS]).

liabilities. In terms of assets, OPERS and STRS are the two largest plans, with $76.6 billion and $72.1 billion, respectively, and SERS and OP&F had $12.6 billion and $13.4 billion, respectively.[10]

Although several of Ohio's plans have a defined contribution component, the four largest plans discussed in this study are predominantly defined benefit plans. Thus each beneficiary receives a predefined monthly payment at retirement that is guaranteed for the duration of his or her life or the life of his or her surviving spouse. The retirement benefit depends on the employee's number of years of service, final average salary, and a multiplier. For example, for an individual with an OPERS, STRS, or SERS plan who has 30 years of service, his or her final average salary is determined by using either the last 3 or 5 years of service and a multiplier, which is generally 2.2 percent. For an employee retiring after 30 years with a final average salary of $60,000 and a multiplier of 2.2 percent, the fixed retirement benefit would be equal to $39,600 per year or $3,300 per month ($0.022 \times 30 \times \$60{,}000 = \$39{,}600$).[11]

While defined benefit retirement plans are the norm for public-sector employees around the nation, private-sector employees with employer-sponsored

10. Unless otherwise noted, all financial and institutional information for Ohio's public pension plans is from the 2014 comprehensive annual financial report for each plan. As mentioned, Ohio's State Highway Patrol employees have their own pension plan, but because it is relatively small, we do not consider it in many of our calculations.

11. The basic pension formulas can be obtained from documents on each of the pension plan's websites. The benefit formula for OP&F is slightly more complicated.

retirement plans are overwhelmingly enrolled in defined contribution plans, the most common of which are 401(k) and 403(b) plans. Defined contribution plans are individual-based retirement plans wherein annual contributions are often shared between employee and employer. Benefit levels are uncertain and depend on the performance of the portfolio of assets and the ultimate accumulation of assets. The funds are invested, and employees receive the balance of their account on retirement rather than a fixed retirement benefit. One key difference between a defined benefit plan and a defined contribution plan is that individual employees bear the full risk of accumulating retirement funds in a defined contribution plan, but taxpayers ultimately bear the burden of financing the retirement funds for workers in a government-sponsored defined benefit plan (additionally, future employees may bear some of the burden if a defined benefit plan raises future contribution rates).[12]

Public pension plans are generally funded through a combination of employee and employer contributions and investment returns on accumulated assets. For the four largest public pension plans in Ohio, the distribution of funding sources varies, but generally employee and employer contributions account for 25–40 percent of annual income, and investment earnings account for the remaining 60–75 percent. This particular distribution of funding sources is typical for established pension systems. The contribution rates of employees vary by plan, hire date, and other factors, but typically employees contribute 10–14 percent of their annual salary and employers contribute 14 percent. These funding sources tend to be very stable because they are based on the total value of the salaries of active plan participants.

The income to pension plans from employee and employer contributions tends to be stable; in contrast, investment returns tend to be unpredictable and unstable. All Ohio's four largest pension plans hold similar portfolios

"The income to pension plans from employee and employer contributions tends to be stable; in contrast, investment returns tend to be unpredictable and unstable."

12. It is not unprecedented for municipalities to default on their defined benefit pension obligations.

and as such have generally experienced similar average investment returns in the recent past. For example, over the past 10 years, OPERS, STRS, SERS, and OP&F all had average returns of 6.0–7.8 percent. In addition, these portfolios have tended to experience similar investment return volatility. In just the past 10 years, OPERS, STRS, and SERS have had investment returns ranging from −21 percent to +20 percent. Over the past 30 years, SERS has had 10 years in which its portfolio earned a return greater than 15 percent and 4 years in which the return was negative. The impact of such volatility on the income to a pension plan can be significant. According to the 2009 comprehensive annual financial report for OPERS, the net income from investments in 2008 was −$22.8 billion. (At the end of 2007, OPERS had $83.6 billion in assets.) In 2009, OPERS had a net investment income of $15.8 billion, a difference of $38.6 billion.

Both the Rate and Investment Volatility Influence Plan Health

Variations in investment returns clearly affect the valuation of the assets each pension plan accumulates and as such affect the reported financial health of each plan. Furthermore, although individual plan assumptions vary, each plan's liabilities are calculated based on several known factors, such as the demographics of plan members, their work experience, and their salaries. The estimate of each plan's liabilities also depends on actuarial assumptions concerning several factors, such as work and life expectancy, expected performance of the plan's financial investments, and other economic and noneconomic assumptions. Of course, any or all actuarial assumptions involve uncertainty, but special attention needs to be paid to the uncertainty surrounding investment returns because they are critical to the financial health of pension plans, accounting for a majority of the plans' annual income.

Following convention, to value the future liabilities of Ohio's public pension plans, we calculate the present value of the benefits expected to be paid out in the future by discounting expected liabilities by the expected return on assets that each plan holds. Later, we will discuss the controversy regarding which discount rate to use in detail. A pension plan's liabilities are a sequence of future benefits promised to retirees. The payments are converted into a present value based on the size of the payments, the timing of the payments, and the interest rate used to "discount" the stream of payments to their present value. The present value of some future amount is the amount of money needed today, which if invested so as to earn a constant return equal to the discount rate, will yield the prespecified amount of money in the future. If the discount

rate is r, the present value of $\$X$ in t years is $X \div (1 + r)^t$. For example, if the discount rate is 5 percent, to have $100 next year, $95.24 is needed now; so $95.24 is the present value of $100 next year.

One measure of the financial health of a pension plan is the plan's net liability. Also known as the unfunded liability, this number is the difference between the stock of assets that the pension plan has accumulated and the present value of future benefits (which are liabilities to the pension plan) that the plan expects to pay. Table 1 shows the expected returns of Ohio's five state-operated public pension plans. The expected returns vary across the plans but are all between 7.75 and 8.25 percent.[13] Changes in expected investment returns can have a substantial impact on the reported financial health of a pension plan. The assets that OPERS had as of 2014 were valued at $76.6 billion; using a discount rate of 8 percent to calculate the value of future liabilities, the plan has $89 billion in future liabilities. Therefore, the unfunded liabilities of OPERS are about $12 billion. If a 9 percent discount rate is used instead, the value of future liabilities would decrease by about $8.5 billion, and OPERS would have only $3.5 billion in unfunded liabilities. Alternatively, if a 7 percent discount rate is used, the value of the plan's future liabilities would increase by $10 billion, resulting in unfunded liabilities of more than $22 billion.

Although the net pension liability is the *difference* between the assets of a pension plan and the present value of expected future liabilities, another common measure of the financial health of a pension plan is its level of funding, which is the ratio of the plan's assets to its liabilities. Not surprisingly, the funding ratio is affected by the uncertainty of investment returns. The ratio is sometimes a more meaningful measure of the financial health of a pension plan than net liability is because a pension plan with assets of $100 billion and a net liability of $15 billion is vastly different from a plan with $20 billion in assets and a net liability of $15 billion in terms of its ability to make future benefit payments without the need for additional resources.

According to the most recent actuarial reports at the end of 2014, Ohio's four largest public pension plans have actuarial funding ratios of 66.7–83.8 percent.[14]

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13. The median investment return assumption was 7.75 percent. Public Fund Survey, "Summary of Findings for FY 2013," January 2015.

14. There is a distinction between a plan's actuarial value of assets and the valuation of the plan's assets based on fair market value. The fair market value of a plan's assets is based on the current market value of the assets in the plan's portfolio. The actuarial value of a plan's assets may differ from this value because the actuarial value smoothes the investment returns over a number of years. The percentages in table 1 for "funding ratio" were computed as the ratio of the market value of assets to actuarial liabilities and thus differ slightly from the actuarial definition of funding.

Generally, the terms "fully funded," "underfunded," and "overfunded" refer to pensions that have assets equal to, less than, and more than 100 percent, respectively, of the present value of their projected future benefits. Because Ohio's four largest public pension plans have funding ratios of less than 100 percent, they are considered underfunded.[15] These funding ratios have declined, in large part, because of below-average returns on assets during the Great Recession. For example, in 2007, before the Great Recession, OPERS had a funding ratio of 97 percent. The decline in funding is certainly not unique to Ohio's public pension plans. Public pension funding has generally been declining nationwide since 2001, when the funding level for the 126 public pensions surveyed was 100.8 percent; in 2013, the same public pensions had a funding ratio of 71.8 percent.[16]

A public pension plan's funding ratio is really only a proxy for what should truly matter to workers and voters—the probability that a plan will be able to make its promised future benefit payments and the potential size of a possible shortfall. A plan's funding ratio and the probability of maintaining solvency are positively related, but they are not the same. The volatility and uncertainty associated with investment returns are associated with this issue. When calculating the funding ratio for a pension plan, a constant discount rate is used, and the discount rate is often the assumed return on the pension plan's portfolio. Unfortunately, investment returns are not constant, and this variability has implications concerning the ability of a plan to use its current stock of assets to fund future benefit payments.

Consider a simple example in which a pension plan has a single $100 payment due next year. The current stock of assets is invested in a risky asset, so there is some uncertainty concerning the actual investment return. Even though the exact return cannot be known, suppose three returns are possible and equally likely for the risky asset: 2 percent, 7 percent, and 12 percent (so the distribution of returns for the risky asset is known). The average, or expected, return on the risky asset is 7 percent. If the pension plan discounts its future liabilities by the expected return, the present value of its liability is 100 ÷ 1.07 = $93.46. The pension plan may be classified as being fully funded if the market value of the current stock of assets is $93.46, underfunded if the value of the current stock

15. Alternatively, according to the National Association of State Retirement Administrators, funding ratios below 80 percent have historically been considered underfunded, and ratios in excess of 100 percent have been considered overfunded. Ken Brainard and Paul Zorn, "The 80-Percent Threshold: Its Source as a Healthy or Minimum Funding Level for Public Pension Plans" (National Association of State Retirement Administrators, Lexington, KY, January 2012).
16. Public Fund Survey, "Summary Findings for FY 2013."

of assets is less than $93.46, and overfunded if the value of the current stock of assets is greater than $93.46.

If the pension plan is fully funded and has $93.46 in assets, and the return on the risky asset turns out to be 7 percent, the pension plan will have $100 next year (93.46 × 1.07 = 100)—or exactly enough money to make its payment. However, if the return on the risky asset turns out to be 12 percent, the $93.46 worth of assets this year will grow to be $104.68, and the pension plan will again have a sufficient amount of assets to make the $100 payment (with $4.68 left over). If the return on the risky asset turns out to be only 2 percent, however, the current stock of assets will grow to only $95.33, and the plan will not be able to pay the full $100 worth of promised pension payments. Hence, even though the pension plan is fully funded with exactly $93.46 in assets, under the scenario, the plan has a two out of three chance of having a sufficient amount of assets next year to make its promised pension payment of $100. This finding is important because the general connotation of a fully funded pension plan is that a sufficient amount of assets is available to fund the promised benefits without the need for additional contributions to the plan. In this example, however, an additional contribution of funds from the state would be necessary in one of three cases, and those funds would likely have to come from a reappropriation of funds originally designated for another purpose or from an increase in taxes.

In a more realistic example, in which the distribution of returns for risky assets is more complete and continuous, if a pension plan uses the average return on its assets to discount future liabilities, a fully funded pension plan actually has less than a 50 percent chance of being able to pay all its expected future liabilities. This is because 50 percent of the return sequences will average *below* the assumed average return, so a pension plan that experiences those sequences of returns will have insufficient initial assets to pay all benefits that are due. Additionally, even in the 50 percent of sequences in which the realized return sequences average the assumed return or higher, a pension plan may not be able to pay all benefits because of the possibility that a sequence of early poor returns has exhausted the plan's assets before all benefits can be paid.

Over a relatively short time horizon, even a severely underfunded pension plan has a very high probability of being able to pay all its future liabilities. At more distant time horizons, the likelihood that a severely underfunded pension plan will have a sufficient amount of assets to be able to pay its liabilities decreases dramatically as a result of the relatively limited amount of initial assets of the plan.

"When pension funds assume high expected returns, fund managers are forced to try to earn those returns. Yet the actions taken to try to achieve higher returns are going to be more risky."

The Discount Rate and the Expected Return Should Not Be the Same

An additional issue associated with the measurement of a pension plan's liabilities is that the discount rate often used to calculate the present value of liabilities does not reflect the riskiness of future liabilities. A sequence of payments should be discounted by a rate that reflects the riskiness of those cash flows, not the expected returns of the assets dedicated to finance the cash flows.[17] The underlying logic is quite simple: any level of assets could theoretically be sufficient to finance any level of future payments if the initial portfolio is invested in risky enough assets and the risk pays off.

When pension funds assume high expected returns, fund managers are forced to try to earn those returns. Yet the actions taken to try to achieve higher returns are going to be more risky. Investments have higher expected returns when they are risky. This principle exacerbates the problem by increasing the volatility of returns and therefore the volatility of plan funding and employer contributions.[18]

An alternative way to explain why the discount rate should not be the expected return on assets is that, for a given sequence of future liabilities, the present value of those liabilities could be lowered simply by investing the fund backing them in riskier assets. The fund is likely to earn more over time, but the higher rate of return reflects the higher degree of risk the plan is assuming. That option would lower the present value of future liabilities

17. Franco Modigliani and Merton H. Miller, "The Cost of Capital, Corporation Finance, and the Theory of Investment," *American Economic Review* 48, no. 3 (1958): 261–97.
18. Some evidence suggests that funds are then pushed toward expensive hedge funds. Andrew G. Biggs, "The Public Pension Funding Trap: To Make Up for Shortfalls in Contributions, Plans Take Extraordinary Risks to Earn Higher Returns," *Wall Street Journal*, May 31, 2015; Eric Pianin and David Francis, "Mismanaged State Pensions Bill Taxpayers for Shortfall," *Fiscal Times*, March 22, 2013; Chris Arnold, "Some Public Pension Funds Making Big Bets on Hedge Funds," NPR, August 1, 2014; and Matt Taibbi, "Looting the Pension Funds: All across America, Wall Street Is Grabbing Money Meant for Public Workers," *Rolling Stone*, September 26, 2013.

even though the actual sequence of expected future payments would remain unchanged. In other words, discounting a pension plan's future liabilities with a higher discount rate will improve the plan's actuarial funding ratio even though the plan's future payments are unchanged. The value of a liability is distinct from the investment strategy used to fund the liability.

As a result, Novy-Marx and Rauh suggest discounting future benefits by a risk-free rate, given that numerous examples suggest that pension benefits are virtually guaranteed by law, by legal precedent, or by state constitutions.[19] Using risk-free Treasury rates to discount future liabilities and actuarial figures from 2009, Novy-Marx and Rauh estimate that Ohio's public pension plans had liabilities that were nearly 42 percent larger than the self-reported values, which resulted in unfunded liabilities for the plans of more than $166 billion.[20]

If a pension plan's portfolio is invested in a risk-free asset that matches the duration of liabilities (instead of a risky asset such as equities), and if the pension has an amount of assets equal to the present value of future liabilities and then discounted its liabilities using a risk-free rate, there would be a 100 percent chance of being able to pay the liabilities at any time horizon. Alternatively, and much more realistically, if a pension plan's portfolio is invested in a risky asset, then there is still some small positive probability that the plan will not have a sufficient amount of assets to pay future liabilities.

An Example Using the Risk-Free Rate

If the risk-free return is 5 percent, then using the simple one-period example presented earlier, the present value of a pension plan's single $100 payment, discounted by the risk-free rate, is 100 ÷ 1.05 = $95.24. Therefore, even if a pension plan has $95.24 in assets today, if those assets are invested in the (simple) risky asset described earlier, there is still a one-third probability that the risky asset's return will be 2 percent, in which case the plan will not have a sufficient amount of assets to meet its promised payments.

If a pension plan has a stock of current assets equal to its future liabilities discounted using risk-free rates and the portfolio is invested in a risk-free asset, only then will the plan be able to pay future liabilities with certainty. Investing the portfolio in a risky asset produces some probability that the plan will not be able to pay all future liabilities. Conversely, if the probability is very low

19. Novy-Marx and Rauh, "Liabilities and Risks"; see also Novy-Marx and Rauh, "Public Pension Promises."
20. Novy-Marx and Rauh, "Public Pension Promises."

that a pension plan will not be able to pay expected future liabilities, then the probability is very high that the plan will have sufficient assets to pay all future liabilities. One major concern, which has largely been ignored in the research on pension funding, involves possible overfunding of pensions. When a public pension plan has sufficient assets to pay all future liabilities, it is highly probable that the plan will have too much in assets, an outcome that can lead to political pressure for increases in benefits. As previously mentioned, this is what occurred in Pennsylvania.

Using the previous example, if a pension plan has current assets equal to a future $100 payment discounted by the risk-free rate of 5 percent (i.e., the plan currently has $95.24 worth of assets) and that portfolio is invested in a risky asset, the plan will have $101.91 next year if the return on the risky asset is 7 percent. If the return on the risky asset is 12 percent, the plan will have $106.67 next year. Although the plan will have sufficient funds in either case, in both cases the system generates an excess of funds and creates a different set of problems.

Assuming that the pension plan is going to maintain its investment in risky assets, an alternative is to increase the level of pension funding such that the probability of not being able to pay future liabilities is still effectively zero. Continuing with our example, if the pension plan has assets of $98.04 (the $100 required payment discounted by the low return of 2 percent), the plan will have a sufficient amount of assets to make its promised payments with certainty regardless of the investment in the risky asset. The obvious problem with this solution is that the plan might end up with an even greater excess of funds than in the previous cases.

Clearly, a tradeoff exists between the probability of being able to pay a pension plan's liabilities and the probability of having too many assets unless the assets are invested in risk-free, low-return investments that require a higher level of contributions. In addition to political pressure for additional benefits if and when a pension plan becomes overfunded, a system that generates too many assets also risks the implication that the system has imposed an unnecessarily large cost on the plan's sponsor, employees, or both in terms of excessive current contributions. Alternatively, not having a sufficient amount of assets to pay future liabilities imposes an obvious cost on future generations, new employees, or both in the form of increased employee contributions, reduced retirement benefits, or both.

The following analysis first looks at the likelihood that Ohio's public pension plans can fund their promised future benefits using only the assets

currently accumulated. Second, we look at the level of assets that would be necessary under a Novy-Marx and Rauh approach to the discounting of liabilities by a risk-free rate. Next, we analyze the level of assets that would be necessary to have a certain amount of confidence that all future benefits will be paid. Last, because of the relationship between the likelihood of having a sufficient amount of assets to make all future payments and the likelihood of having too many assets, we look at the distribution of wealth under these various scenarios. Not surprisingly, if Ohio's pension plans, like any other pension plans, discount their liabilities by a risk-free rate and aim for fully funded plans, the accumulation of assets will be enormous and, with almost complete certainty, will lead to a gross overaccumulation of assets, resulting in an unnecessary burden on employees, employers, and taxpayers.[21]

WILL OHIO'S PUBLIC PENSIONS BE ABLE TO MAKE THEIR PROMISED PAYMENTS WITHOUT CONTRIBUTION INCREASES?

To calculate the likelihood that Ohio's four largest public pension plans will be able to pay their future liabilities and to examine each plan's level of assets at the end of our time horizons, we first generated a single sequence of 63 returns for each plan. The returns are drawn from an assumed distribution of asset returns that are based on the asset allocation for each plan. Given this sequence of annual returns, each plan's current level of assets, and the year-by-year expected liabilities of each plan, it is possible to model the evolution of each plan's assets over time and to calculate the probability that each plan will have assets sufficient to cover liabilities.[22] The pattern of liabilities is assumed to follow that reported for OP&F by Buck Consultants.[23] The process of generating a sequence of returns is repeated 100,000 times. The repetition allows the calculation, for each period, of the likelihood that a plan will be able to pay its liabilities as well as of the distribution of the level of assets the pension plan will have at the end of the time horizon. The major Ohio public pension plans all hold a variety of assets, including domestic and foreign

21. An enormous overaccumulation of assets is likely *unless* the pension plans change their asset allocations to completely risk-free assets.
22. In our calculations, we assume that the pension plan enters the period with a given amount of assets, makes the required payments to beneficiaries, and then earns a return on the remaining assets, which are carried over to the following period.
23. The pattern of liabilities reported for OPERS is nearly identical to that reported for OP&F. Buck Consultants, "Ohio Police and Fire Pension Fund: Information Required under Governmental Accounting Standards Board Statements Nos. 67 and 68 as of Dec. 31, 2014," 2014.

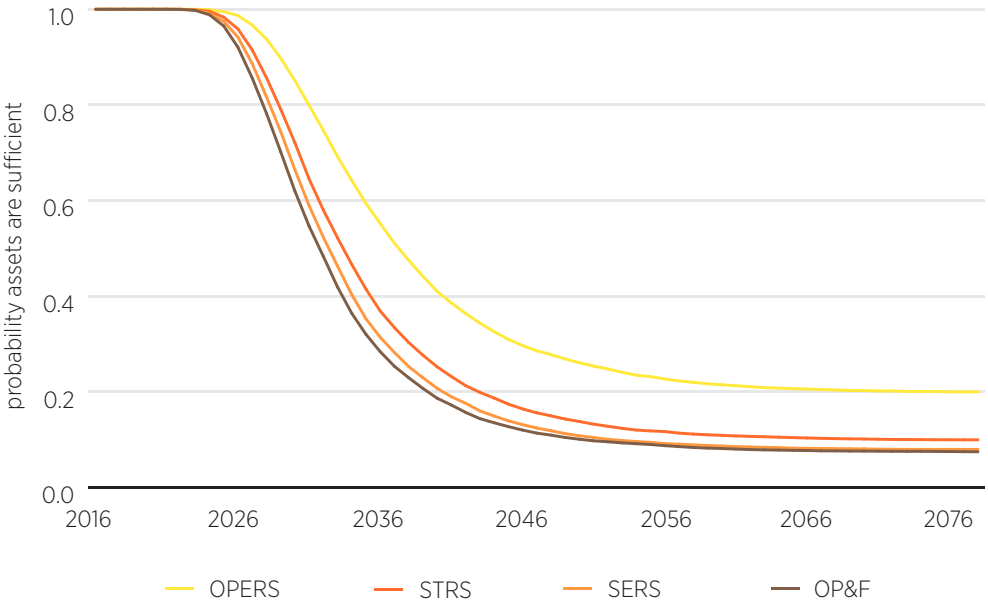
equity, short- and long-term bonds, and real estate.[24] The standard deviation of returns for each plan is assumed to be 13.4 percent, which is the average expected standard deviation of the portfolio reported by OPERS in its investment plans for 2013–2015.[25] The average return, unless otherwise noted, is based on the expected return for each plan as shown in table 1.

As previously noted, as of 2014 the OPERS plan has a funding ratio of 86.1 percent, STRS has a funding ratio of 75 percent, and SERS and OP&F have funding ratios of 72 percent. The market values of the assets the plans hold are $76.6 billion, $72.1 billion, $12.6 billion, and $13.4 billion, respectively. Given the current level of funding, current asset allocation, and the assumed distribution of asset returns (as previously discussed), figure 1 shows the probability that OPERS, STRS, SERS, and OP&F will be able to pay their expected future liabilities.

Not surprisingly, because OPERS has the highest ratio of market value of assets to present value of future liabilities, it generally has a slightly higher probability of solvency at each time horizon than the other three plans do beyond 10 years, although none of the plans perform very well at more distant horizons. Comparatively, OP&F and SERS have lower asset-to-liability ratios and correspondingly lower probabilities of solvency at each time horizon. Because of their low funding ratios and the volatility of returns, OPERS, STRS, SERS, and OP&F all have nearly a 100 percent probability of making future payments for only the next 8–10 years. After that point, the likelihood of meeting promised obligations falls rapidly. For example, although OPERS has an 85 percent likelihood of making all pension payments through 2030, the corresponding likelihood for OP&F is only 62 percent. These figures fall to just 60 percent and 32 percent, respectively, by 2035. In one generation—30 years—the likelihood of being able to make all pension payments falls to 31 percent and 13 percent,

24. The average allocation was 50 percent to equities, 24 percent to fixed income, 7 percent to real estate, and 4 percent held as cash, with the remaining assets held in other investments, such as private equity and hedge funds. Public Fund Survey, "Summary Findings."
25. Specifically, the standard deviation was 12.75 percent in 2013, 13.15 percent in 2014, and 14.10 percent in 2015. Ohio Public Employees Retirement System, *Comprehensive Annual Financial Report*, multiple years, available at https://www.opers.org/financial/reports.shtml. This is slightly lower than the estimated standard deviation of 14.6 percent from STRS's fiscal year 2016 investment plan. Ohio Public Employees Retirement System, Investment Plans for multiple years, available at https://www.opers.org/investments/inv-plans.shtml. See State Teachers Retirement System of Ohio, "Fiscal 2016 Investment Plan," 2015, 8. It is slightly higher than the 12.5 percent estimated standard deviation for state pension plans reported by Wilshire Consulting. See Julia K. Bonafede et al., "2015 Report on State Retirement Systems: Funding Levels and Asset Allocation," Wilshire Consulting, February 25, 2015, 17. Furthermore, it is slightly higher than the standard deviation of returns that OPERS has experienced over the past 20 years, but relatively small changes in the assumed standard deviation do not appreciably alter the results.

FIGURE 1. PROBABILITY THAT OHIO PENSION FUNDS WILL HAVE SUFFICIENT ASSETS TO PAY EXPECTED LIABILITIES, 2016–2078



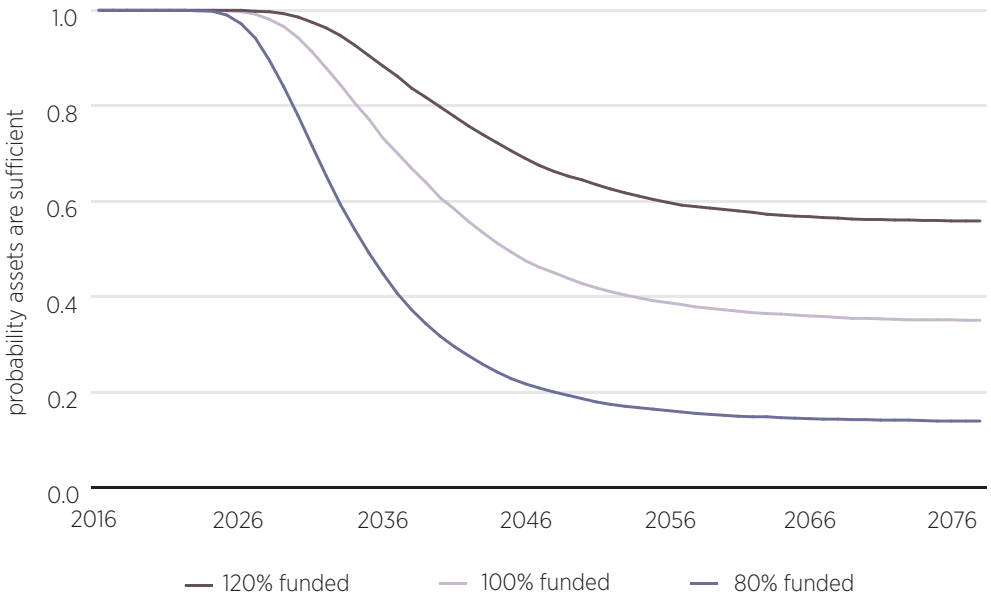
Note: OPERS = Ohio Public Employees Retirement System; STRS = State Teachers Retirement System; SERS = School Employees Retirement System; OP&F = Ohio Police and Fire Pension Fund.

Source: Authors' calculations using Gauss software.

respectively, for OPERS and OP&F. Looking out at the next two generations, or 60 years, OPERS and OP&F have less than a 20.0 percent and 7.5 percent chance, respectively, of being able to finance all their promised benefit payments without additional contributions or benefit reductions.

Furthermore, even if the four pension plans were funded at levels that exceeded 2014 levels, they would not be ensured to have sufficient assets to pay all expected future liabilities. Figure 2 shows the likelihood that a pension plan could pay its future liabilities at various funding levels of 80 percent, 100 percent, and 120 percent, respectively. As illustrated, funding a pension plan at a greater extent increases the likelihood that a plan has a sufficient amount of assets to pay future liabilities. However, greater funding alone does not guarantee that a plan will have sufficient assets. In fact, a current funding ratio of 100 percent or 120 percent will guarantee sufficient funds to meet future obligations for only roughly the next decade. If the pension plans were funded at 100 percent (or were funded at that level in the future), meaning each plan would have assets on hand that would equal the present value of its future liabilities, there would

FIGURE 2. PROBABILITY THAT A PENSION FUND WILL HAVE SUFFICIENT ASSETS UNDER HYPOTHETICAL FUNDING RATIOS, 2016–2078



Note: The results presented in this figure are based on an expected return of 8.0 percent. Assuming an expected return of 7.75 or 8.25 percent does not materially affect the results.

Source: Authors' calculations using Gauss software.

still be only a 50 percent probability of being able to pay all promised benefits through the year 2045 and only a 35 percent probability of being able to make all currently promised benefits over the next 63 years.[26] As the level of funding increases, the probability also increases that a pension plan will be able to pay all promised liabilities. For an overfunded plan, one with 20 percent more assets on hand than the expected value of its future liabilities, the probability of being able to pay all promised liabilities is only 70 percent in 2045, and overall the probability is only 56 percent of making all future promised payments.

The effect that volatility of asset returns has on the ability of pension plans to have sufficient assets to pay promised benefits can be seen by comparing the probabilities in figure 1 or figure 2 to the likelihood of paying benefits if there was no uncertainty in asset returns. With no uncertainty in asset returns, a

26. The 35 percent figure is consistent with that estimated by Andrew G. Biggs, "An Options Pricing Method for Calculating the Market Price of Public Sector Pension Liabilities" (AEI Working Paper 164, American Enterprise Institute, Washington, DC, February 2010).

TABLE 2. NUMBER OF YEARS BEFORE ASSETS ARE EXHAUSTED

	Discount rate/asset return		
Level of funding	Years at 7%	Years at 8%	Years at 9%
60%	16	15	13
70%	20	18	17
80%	25	23	21
90%	32	30	28

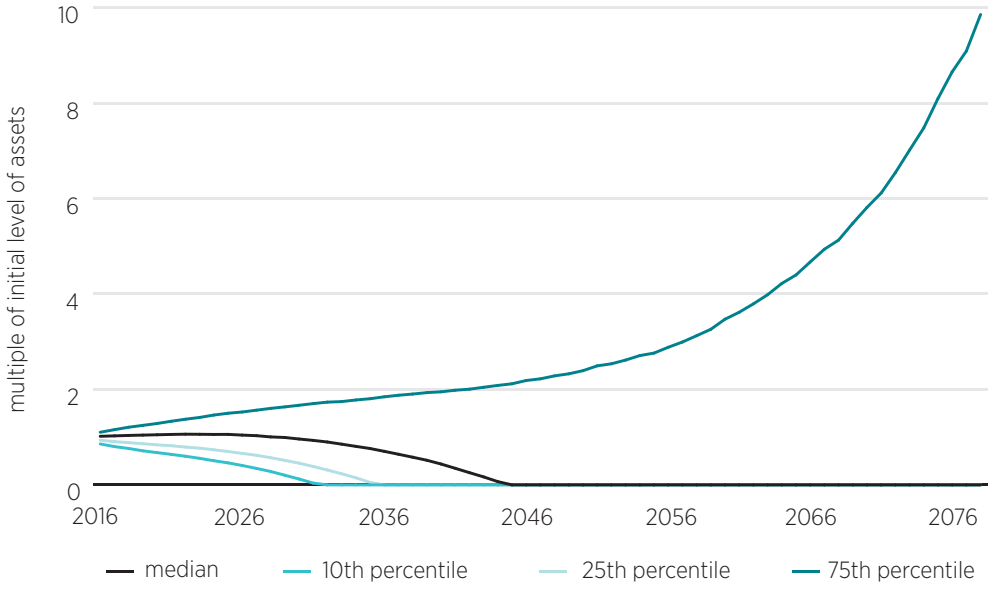
Source: Authors' calculations from net present value formula.

fully funded pension plan would have exactly the correct amount of assets to be able to pay all promised benefits and in the end have $0 in assets. Therefore, a pension plan that is underfunded, if asset returns are constant and known, would not have a sufficient amount of accumulated assets to pay all promised benefits. For example, if a pension plan discounts its liabilities by 8 percent, earns an 8 percent return on its assets each period, and is 70 percent funded, it will run out of assets in 18 years. If that same pension plan is 80 percent funded, its assets will be sufficient to pay all benefits for 23 years. Table 2 shows the number of periods until a pension plan depletes its assets for various combinations of expected returns and funding levels. If the return on a plan's assets is constant and does not exhibit volatility, the pension will be able to pay benefits, with certainty, for the number of years shown.

By contrast, figure 2 shows the evolution of the probabilities of having sufficient assets to pay benefits for a pension plan that is 80 percent funded. For a plan not experiencing any volatility in asset returns, the probability is equal to 1 that assets are sufficient for the first 23 years, after which the probability is equal to 0. For a plan that experiences asset return volatility, the probability of having a sufficient amount of assets is equal to 1 for the first 10 years and then declines. By the year 22, the probability is down to 40 percent, which is 60 percent lower than the probability if a pension plan did not experience asset return volatility. Therefore, one way to think about the cost of having asset volatility is to think in terms of the decrease in the probability of being able to pay promised benefits. After year 23, though, there is a benefit to asset volatility—the nonzero probability of being able to pay the promised benefits.

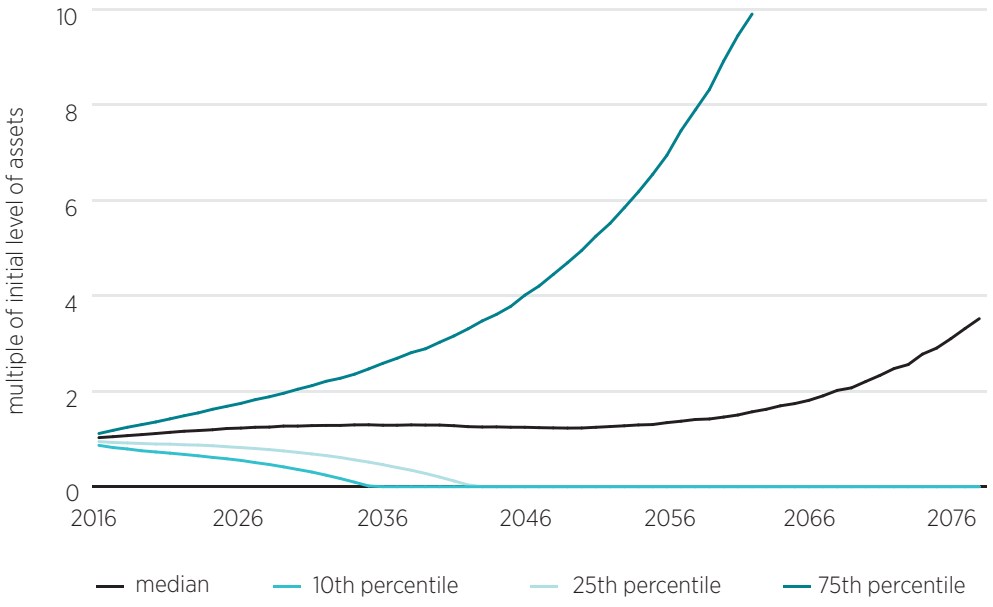
Assuming that the actual benefits closely reflect the forecast level of benefits, examining the evolution of a plan's assets yields interesting insights into the funding probabilities previously discussed. Figures 3 and 4 show the evolution of the median level of assets, along with the distribution of assets over 63

FIGURE 3. EVOLUTION OF ASSETS FOR A FULLY FUNDED PENSION PLAN, 2016–2078



Source: Authors' calculations using Gauss software.

FIGURE 4. EVOLUTION OF ASSETS FOR AN OVERFUNDED PENSION PLAN, 2016–2078



Source: Authors' calculations using Gauss software.

years under various hypothetical current funding levels. Specifically, the figures show the evolution of the median level of assets, along with the 10th, 25th, and 75th percentiles. At the 10th percentile asset level, the level of assets is less than that level 10 percent of the time; alternatively, the level of assets will be greater than that level 90 percent of the time.

Figure 3 applies to a fully funded pension plan. The median level of assets goes to zero by 2045 (or 29 years from now), suggesting a fifty-fifty chance that assets will not be sufficient in year 30 and beyond to pay promised benefits. Even for a fully funded plan, in which liabilities are discounted by the expected return, assets will be sufficient to make all future payments less than half the time. The possibility of a sequence of early, lower-than-expected returns would exhaust the assets. The 25th percentile level of assets goes to zero by 2036, meaning there is a 25 percent chance that the pension plan will have insufficient assets to pay its liabilities beyond 20 years and will run out of assets by year 21. Alternatively, it is equally likely that the plan will end the year 2078 with assets of almost 10 times the amount that the fully funded plan started with. For OPERS, which as of 2015 had a present value of $89 billion in future liabilities, this translates to more than $875 billion worth of assets. That is, if OPERS were currently fully funded as traditionally defined, there is a 25 percent chance that it would not have sufficient assets to pay promised benefits within 21 years and a 25 percent chance that its current stock of assets would be sufficient to pay all promised benefits over the next 63 years and still have more than $875 billion worth of assets. This example again highlights the relationship between having a stock of assets that is sufficient to pay promised benefits and actually having too many assets.

If a pension plan is more than fully funded (e.g., the plan has a funding ratio of 120 percent), then the probability of being able to pay future benefits increases but so does the probability of a possible future overaccumulation of assets. Figure 4 shows the distribution of assets for a pension plan

"If a pension plan is more than fully funded . . . , then the probability of being able to pay future benefits increases but so does the probability of a possible future overaccumulation of assets."

that is initially funded at the 120 percent level. Even if the plan, as of 2016, is funded at that level, the 25th percentile wealth level goes to zero in 28 years, suggesting there is a 25 percent chance that assets will be insufficient to pay promised benefits after 2043. The median level of assets in 62 years (2078) is 3.5 times the pension plan's starting level. Again, for OPERS, this translates into a median level of ending assets of more than $375 billion.[27] Although not shown in the figure, the 75th percentile asset level in 2078 is almost 29 times the initial level of assets! Not surprisingly, as the level of current funding increases, so does the expected ending distribution of assets.

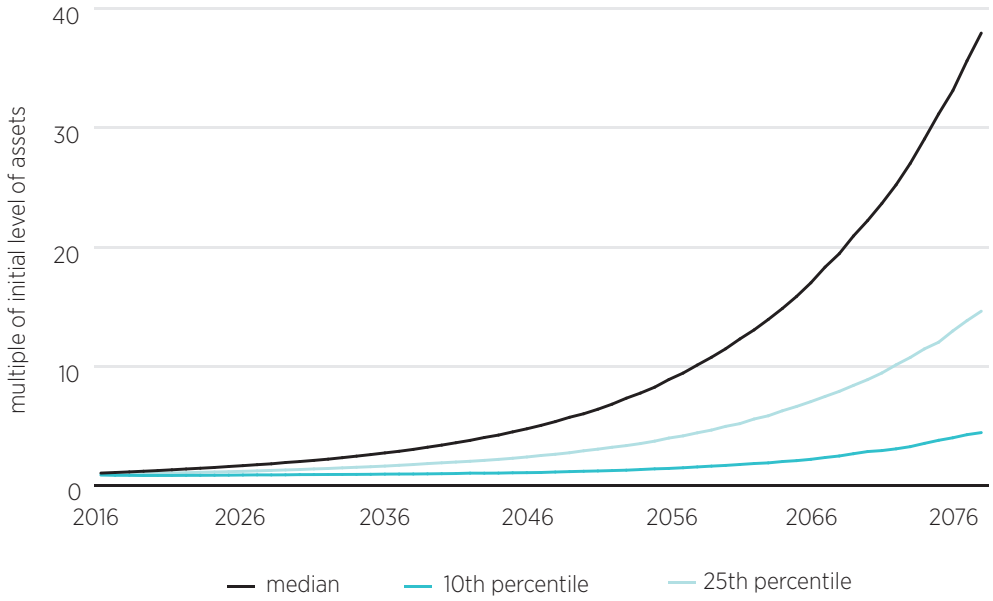
Because public pension liabilities are virtually guaranteed, future liabilities should be discounted by risk-free interest rates instead of the assumed rate of return on the portfolio the pension plan is holding (which is 7.75–8.25 percent for Ohio's four major public pension plans[28]). As then–vice chairman of the Federal Reserve Donald Kohn said, "The only appropriate way to calculate the present value of a very-low-risk liability is to use a very-low-risk discount rate."[29] Discounting by a risk-free rate instead of a higher rate significantly increases the present value of the plan's future liabilities. Using the Treasury yield curve to discount the year-by-year liabilities, the present value of the sequence of 65 annual payments is 2.29 times greater than the present value of the sequence discounted using an interest rate of 8.0 percent.[30] For OPERS, approximately $200 billion worth of additional assets would be needed.

Even if the pension plans were funded at this level, as long as their portfolios included risky assets, there is still some chance, albeit a very small one, that the plans would not be able to pay all promised future liabilities because of randomness in asset returns. In fact, for the year 2078 (or 62 years from now), there is only an about 4 percent chance that assets will be insufficient to pay promised benefits. Figure 5 shows the distribution of assets assuming a pension plan is fully funded in the Novy-Marx and Rauh sense.

The median ending asset value is equal to almost 38 times the initial level of assets when the pension plan should ideally have zero assets. In fact, the 10th percentile asset level in 2078 is 4.5 times the initial level of assets, meaning that

27. If fully funded, OPERS would have $89 billion in assets, so if OPERS were funded at 120 percent and the final stock of assets in 2078 were 3.52 times the initial stock of assets, $89 billion × 1.2 × 3.52 = $375.9 billion.
28. Novy-Marx and Rauh, "Liabilities and Risks"; see also Novy-Marx and Rauh, "Public Pension Promises."
29. Donald L. Kohn, "The Economic Outlook," speech to the National Conference on Public Employee Retirement Systems annual conference, New Orleans, LA, May 20, 2008.
30. Yields as of December 15, 2015.

FIGURE 5. EVOLUTION OF ASSETS FOR A NOVY-MARX AND RAUH FULLY FUNDED PENSION PLAN, 2016–2078



Source: Authors' calculations using Gauss software.

the plan has a very high probability of ending up with a very large stock of assets over time.

As these figures demonstrate, being fully funded (on the basis of discounting liabilities by the expected return) does not guarantee a pension fund a sufficient amount of assets to pay all promised future liabilities. Therefore, to the extent that a pension plan's level of funding is used as a proxy for the solvency or ability of the fund to pay future benefits, the pension funding level is incomplete because the ability to make future payments depends on the amount of the plan's assets as well as on the performance of the portfolio of the assets the pension plan holds. Thus, a key question should be this: given the portfolio of the pension plan, how many assets would the plan need so it can have a certain level of confidence that it will be able to pay all promised benefits? For a given portfolio of assets, table 3 shows the amount of assets that a pension plan must have to achieve a certain degree of confidence regarding its ability to pay all future benefits. Specifically, the table shows the minimum level of assets a pension plan would need to be 80 percent, 90 percent, 95 percent, and 99 percent confident that its assets are sufficient to pay all future benefits.

TABLE 3. CONFIDENCE LEVELS AND PENSION FUNDING LEVELS

Confidence level (%)	Failure rate (%)	Initial pension funding level (%)
80	20	159
90	10	190
95	5	224
99	1	310

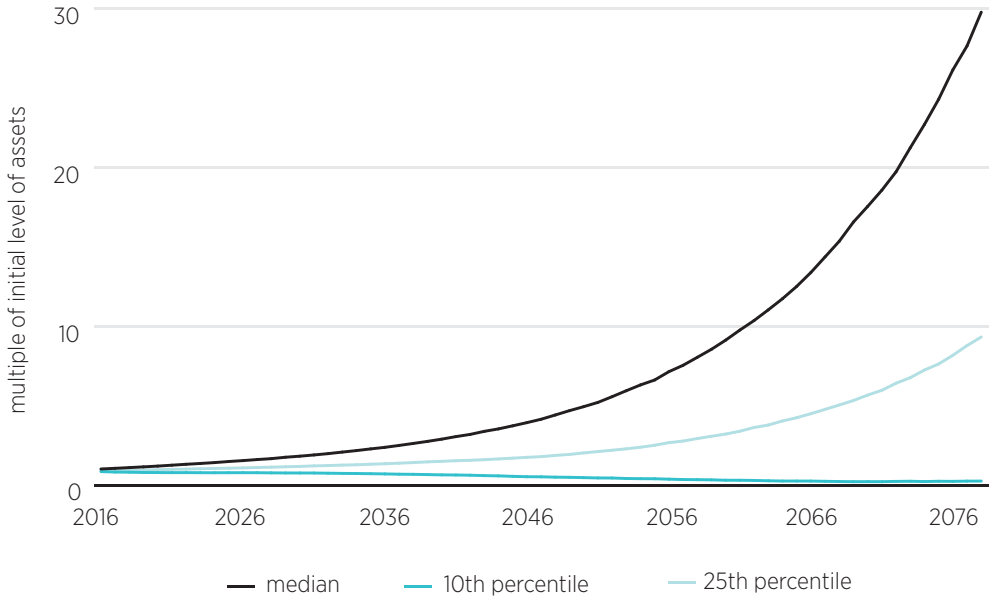
Note: Percentages derived by assuming the return of a pension plan's portfolio is normally distributed with a mean of 8.0 percent and a standard deviation of 13.4 percent and that the liabilities are discounted at 8.0 percent.

Source: Author's simulations applying Aaron Meder and Renato Staub's methodology and using Ohio Police and Fire Pension Fund's pattern of benefits and 8 percent discount rate. Aaron Meder and Renato Staub, "Linking Pension Liabilities to Assets" (Global Asset Management Working Paper, UBS, 2006).

If a pension plan's portfolio allocation remains the same, for the plan to have a 10 percent chance of failing to have sufficient assets to pay all its future liabilities (or a 90 percent chance of success), the fund would need assets equal to 190 percent of the present value of its currently accrued liabilities. To achieve an 80 percent confidence level, the pension would need to be funded at 159 percent. Higher confidence levels, such as 95 percent or 99 percent, are associated with funding ratios that explode to 224 percent and 310 percent, respectively. Increasing the confidence level from 80 to 90 percent requires an additional increase in the funding level of 31 percent (for OPERS, this is an additional $27 billion worth of assets). Increasing the confidence level to 95 percent requires 34 percent of additional funding (for OPERS, an additional $30 billion). Increasing the confidence level to 99 percent would require increasing the funding level by 86 additional percentage points; for OPERS, this would mean an additional $76 billion, for total assets of $275 billion, which is $199 billion or more than 3.5 times the amount of assets.

Thus, it is not surprising that if a pension plan had these funding levels, the amount of assets the plan ultimately ended up with is likely to be astronomically high. For example, if the pension plan administrators wanted to have only a 5 percent chance of not having sufficient assets to pay all the plan's liabilities, the plan would have a 95 chance of having an excess of assets at the end of the 63-year sample period. The evolution of assets for a 95 percent confidence level looks very similar to the evolution that would occur if liabilities were discounted with a risk-free rate of return based on traditional actuarial tables. This is not surprising considering that the Novy-Marx and Rauh level of assets yielded a 96 percent chance of having a sufficient amount of assets. Figure 6 shows the evolution of the distribution of assets (the median, 10th, and 25th percentiles) for the 90 percent confidence level (which is a 10 percent failure rate).

FIGURE 6. EVOLUTION OF ASSETS WITH A 95 PERCENT CONFIDENCE LEVEL, 2016–2078



Source: Authors' calculations using Gauss software.

For a failure rate of 10 percent, the 10th percentile asset level in the final period is approximately half the initial assets of a fully funded system; thus the pension plan has a 90 percent chance of ending up with this amount of assets or more. As expected, the situation is even more extreme for a 1 percent or 5 percent failure rate. Although possibly appealing to future beneficiaries, a target confidence level of a mere 1 percent failure rate for a pension plan will nearly always lead to extreme levels of overfunding and an accumulation of an unnecessarily large amount of assets (assuming the portfolio allocations do not change). Given the political pressure likely to be associated with gross pension overfunding, such a scenario should be a very real concern for the citizens of a state.

CONCLUSION

Ohio's four largest public pension plans—OPERS, STRS, SERS, and OP&F—are severely underfunded according to traditional metrics and are guaranteed to be able to finance their promised obligations for only about the next decade without additional taxpayer contributions. The funding ratio metric is only a proxy for

the probability that the plans will be able to pay their future liabilities. In fact, even if the four plans were fully funded today, such that they had assets on hand that were equal to the present value of their promised benefit payments (discounted at the expected return of each plan's portfolio), the four pension plans would have a roughly fifty-fifty chance of being able to fulfill their promises in the year 2045. Finally, it may be useful to include calculations similar to those provided here into each pension plan's comprehensive annual financial report so that plan participants and other constituents might better understand the likelihood of potential changes to Ohio's public pension system.

ABOUT THE AUTHORS

Erick M. Elder joined University of Arkansas at Little Rock in 1996. His areas of specialization are statistics, macroeconomics, and international economics. He has published articles in a variety of high-quality economics and finance journals and has refereed for several others. Elder has earned national recognition for research on the appropriate size of state government rainy-day funds and has published research on public pensions in high-quality academic journals. He has served as a judge for several local and regional economic competitions, and helped coach the Central High School Fed Challenge team that won the national competition in 2007 and 2008.

David Mitchell is an associate professor of economics at the University of Central Arkansas. He is also the director of the Arkansas Center for Research in Economics. His peer-reviewed publications include articles in the *Journal of Small Business Management,* the *Cato Journal,* and the *Southern Economic Journal*. His research focuses on state policy and taxes.

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