Assessing the Risk of Fiscal Distress for Public Pensions: State Stress Test Analysis

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This paper summarizes the results of a stress test simulation analysis on the largest government pension plans in 10 states under different economic scenarios and assumptions for policymaker behavior. The simulation model applies both deterministic and stochastic methods. The model also uses state-specific actuarial projections and revenue forecasts, as well as a common set of capital market assumptions. Results are calculated for a variety of actuarial and financial measures over 30 years, with particular attention to downside economic scenarios and different assumptions on how officials are likely to respond to resulting increases in pension costs based on past behavior. We find that poorly funded plans face the risk of unfunded liabilities and high costs, and in some cases, insolvency under scenarios where returns are lower than expected. Conversely, we find that states with well-funded pension systems have achieved this result through a combination of fiscal discipline and adherence to policies specifically designed to manage the impact of market volatility in low-return scenarios. Finally, stochastic analysis of the state plans reveals that contribution policy — in addition to the timing of investment returns — is a significant factor influencing cost variability. We conclude that stress testing is not just an academic exercise, and recommend that it be a standard reporting practice for all public-sector retirement systems.

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I. Overview

State and local governments reported total unfunded pension liabilities of $1.6 trillion at the end of fiscal year 2017 — a larger deficit in both absolute terms and as a percentage of U.S. gross domestic product (GDP) than at any time before the Great Recession.[1] This funding gap is the result of lower-than-expected investment returns, shortfalls in making actuarially required contributions, and for some jurisdictions, unfunded benefit increases that were negotiated when systems were prospering. Pension deficits matter because the cost of paying for underfunded retirement obligations can constrain spending for other essential government programs and services, including education and transportation.

Indeed, state pension costs have nearly doubled as a percentage of available state revenue since fiscal year 2000, when the pension deficit reported by state and local governments in aggregate was approximately zero.[2] During that same time frame, measures of investment risk for pension portfolios have more than tripled, as has the use of higher-cost alternative investments, including real estate, private equity, and hedge funds. From a financial accounting perspective, cash flow measures show increasing outflows to pay for benefits increasing significantly as the aging public workforce moves into retirement. This places further pressure on plans to maintain asset levels and leaves state funds less able to absorb unexpected costs and investment shortfalls. Looking forward, most funds are lowering their outlook for investment returns based on the expectation of reduced economic growth and continued low interest rates.

These factors indicate that public pension systems may be more vulnerable to an economic downturn than they have ever been. However, there has been limited analysis of the consequences of risky investment strategies combined with low funding levels on state budgets. Ultimately, benefits must be paid to retirees, meaning that state budgets could be strained with increased costs potentially extending across decades.

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[1] The United States Federal Reserve (2018) "Financial Accounts of the United States;" data and graphics illustrating the historical growth and status of the pension funding gap and growing vulnerability state pension plans have experienced since the Great Recession can be found appended to the conclusion of this analysis.

[2] The Pew Charitable Trusts. (2018). *The State Pension Funding Gap: 2016*. http://www.pewtrusts.org/en/research-and-analysis/issue-briefs/2018/04/the-state-pension-funding-gap-2016 for reported contributions by states; own source revenue information from the U.S. Census Bureau's Annual Survey of State Government Finances or the Annual Survey of State & Local Government Finance.

This paper examines the impact of lower investment returns and market volatility on state pension systems and budgets through the application of a rigorous stress test analysis. To assess the sustainability of pension plans, we included 10 states of varying fiscal health in our analysis: Colorado, Connecticut, Kentucky, New Jersey, North Carolina, Ohio, Pennsylvania, South Carolina, Virginia, and Wisconsin.[3] The results of our analysis indicate that:

- States with both low funded levels and low contribution rates face the real prospect of pension system insolvency — the complete depletion of pension plan assets — under downside economic scenarios. The pension systems in New Jersey and Kentucky have the greatest exposure to system insolvency in our study.
- States with low funded levels that have already increased contributions are unlikely to face insolvency, but may struggle to improve funding levels and reduce costs if target investment returns are not met. The risk of permanent high costs is most acute in Pennsylvania and Connecticut.
- States with funding policies that are not designed to respond to market downturns are also at risk of fiscal distress. Colorado faces the greatest level of uncertainty due to an inflexible pension funding policy that does not automatically adjusted to offset lower-than-expected investment returns. Ohio also follows a fixed rate funding policy, but recent increases in contributions and cuts to benefits have mitigated the immediate risk of insolvency for the state's pension plans.
- In certain cases, states' actuarial funding policies are not fit for managing costs in an affordable and sustainable manner in the face of market volatility. This finding is informed by stochastic simulation analysis of two states that follow actuarial funding policies, but have very different results — Virginia and South Carolina.
- Current reporting on public pensions is not adequate to assess these risks.

Our findings also reveal positive results. North Carolina and Wisconsin both demonstrate how strong funding policies can help to ensure that public pension systems are sustainable and secure. In addition, there has been some initial progress on states' implementation of stress test analysis, both as part of regular reporting and to evaluate proposed reforms. For example, in 2017, acting on recommendations made by a legislative commission, Virginia adopted legislation requiring annual comprehensive stress testing of its state-sponsored retirement plans. This will ensure policymakers in Virginia are able to continually monitor the fiscal health of the retirement system and plan for potential unexpected costs if investments underperform over the long term.

Following in Virginia's steps, New Jersey enacted legislation requiring annual stress test reporting for its largest pension plans in January of this year. This is a significant step toward transparency for a state that has ranked among the worst funded pension systems in the nation, and will help New Jersey better plan for and manage the fiscal health of its pension funds going forward.

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[3] The analysis examines 18 pension plans across the 10 states and is limited to state worker and teacher plans in every case. For Connecticut, Ohio, Pennsylvania, and Wisconsin, the plans we cover represent virtually all of what is managed and reported at the state level. A full list of the plans is noted in the methodology section and appended to this analysis.

Connecticut has also adopted policies mandating annual stress testing of its public plans, while Pennsylvania is currently considering similar legislation. Overall, the number of states that have adopted mandatory stress test reporting has more than doubled to seven in a little over a year.[4]

We expect this trend to continue, particularly in light of a growing consensus among the professional standards boards in the field. In September of 2017, the Actuarial Standards Board adopted a new standard of practice for pension plan actuaries and administrators to disclose in their annual valuations the amount of risk — in terms of both cost and funding status — to which public pension plans are exposed.[5] The newly adopted guidelines, effective in November of 2018, follow recommendations made in a Blue Ribbon Panel Report commissioned by the Society of Actuaries in 2014, and build upon changes in reporting requirements for state and local public pension funds mandated by the Governmental Accounting Standards Board (GASB) that same year.[6]

The methodology, analytic framework, and resulting simulation model applied in this paper build on these recommendations and reporting requirements and provide the most comprehensive approach to stress testing for public pensions that has been developed to date.

This is not an academic exercise. For example, reforms passed in 2017 in Pennsylvania were guided in part by stress test analysis provided by the state's independent fiscal office. And at the time of this writing, the Colorado legislature had just passed much-needed reforms informed by the results of a stress test analysis conducted by an independent consultant, as required by state law. That analysis matches closely with our examination of the Colorado, and bolsters the case for requiring publicly reported stress testing analysis in other jurisdictions, based on the findings of this report.

Our core recommendation is for the adoption of standard stress test reporting to better inform policymakers about the costs and risks associated with funding pension promises. At its most basic, these analyses can quantify the estimated impact of lower investment returns. However, we believe that comprehensive stress testing will not only help policymakers understand the volatility surrounding pension systems' investments, but also how decisions related to plan funding can affect the overall health of the pension system, the state budget, and ultimately, the ability to pay promised benefits.

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[4] California and Washington state have established reporting practices. Colorado published a comprehensive stress testing report in 2015, 2016 and legislation waiting for gubernatorial signature would continue that practice on an annual basis. Virginia, Hawaii, New Jersey, and Connecticut recently adopted legislation or policies requiring regular stress test reporting, while policymakers in Minnesota and Pennsylvania have proposed legislation or policies as of 2018.

[5] See the Actuarial Standards Board, *Actuarial Standard of Practice No. 51: Assessment and Disclosure of Risk Associated with Measuring Pension Obligations and Determining Pension Plan Contributions*. Adopted September 2017 and available at http://www.actuarialstandardsboard.org/asops/assessment-disclosure-risk-associated-measuring-pension-obligations-determining-pension-plan-contributions-3/

[6] Society of Actuaries. (2014). Report of the Blue Ribbon Panel on Public Pension Plan Funding. Available at https://www.soa.org/Files/Newsroom/brp-report.pdf; and Governmental Accounting Standards Board (2014). Summary of Statement No. 67: *Financial Reporting for Pension Plans — An Amendment of GASB Statement No. 25.* This revised previously existing guidance in Statement No. 25.

II. Methodology

Stress testing is a simulation technique used on asset and liability portfolios to determine the impact of downside economic scenarios. It is a valuable method for determining how financial balance sheets will fare during a financial crisis or a period of low economic growth.

One of the most notable examples of stress testing comes from the Dodd-Frank Wall Street Reform and Consumer Protection Act. This legislation was passed in 2010 in response to the 2008 financial crisis, and requires the Federal Reserve to conduct annual evaluations of financial institutions' ability to maintain solvency under hypothetical adverse economic conditions. The scenarios presented in this paper apply similar principles to examine pension funds by assessing the impact of a recession, stock market losses, slower economic growth, and lower-than-expected investment returns on pension fund balance sheets and government budgets.

In the context of public pensions, research related to stress testing has primarily been focused on investment performance, with specific attention to the probability and potential impact of lower-than-expected returns on actuarially required contribution. Financial economists have also cautioned against the attendant risks associated with current reporting practices, and have argued extensively for measuring pension liabilities and costs using more conservative assumptions.[7] To that end, bond rating agencies now regularly analyze pension liabilities using lower assumed rates of return.[8] And Pew's own research to date has reported on the diverse fiscal health of pension systems across the states using more precise measures to assess pension contribution adequacy.[9]

Other studies include simulations to evaluate the affordability of state pension plans based on the interaction of uncertain investment performance and pension funding contribution policies for typical state plans.[10] More recently, analyses have emerged that include more extensive simulations to assess the volatility of investment returns based on current data for select state examples.[11] Recognizing of the benefits of such analyses, the Society of Actuaries' Blue Ribbon Panel recommended in 2014 that stress testing be included in plans' annual financial reporting.[12]

[7] Rauh, J.D. (2016). *Hidden Debt, Hidden Deficits: How Pension Promises Are Consuming State and Local Budgets*. Hoover Institution: Stanford*, CA*; and
Novy-Marx, R, & Rauh, J.D. (2013). The Revenue Demands of Public Employee Pension Promises. *American Economic Journal: Economic Policy,* 6(1): 193-229.

[8] Moody's Investor Service. (2016). *Fiscal Stress Test: Ability to Withstand Next Recession Depends on Reserves, Flexibility*

[9] See discussion on net amortization introduced in The Pew Charitable Trusts (2016). *The State Pension Funding Gap: 2014* http://www.pewtrusts.org/en/research-and-analysis/issue-briefs/2016/08/the-state-pension-funding-gap-2014; and current rankings in the (2018) *State Pension Funding Gap: 2016* http://www.pewtrusts.org/en/research-and-analysis/issue-briefs/2018/04/the-state-pension-funding-gap-2016

[10] See, for example, Biggs, A. G. (2014) The public pension quadrilemma: the intersection of investment risk and contribution risk. *The Journal of Retirement* 2(1): 115-127.

[11] Boyd, D.J., & Yin, Y. (2017). *How Public Pension Plan Investment Risk Affects Funding and Contribution Risk*, Rockefeller Institute of Government; and
Farrell, J., & Shoag, D. (2016). *Risky Choices: Simulating Public Pension Funding Stress with Realistic Shocks.* Harvard Kennedy School of Government.

[12] Society of Actuaries. (2014). *Report of the Blue Ribbon Panel on Public Pension Plan Funding.* Available at https://www.soa.org/Files/Newsroom/brp-report.pdf

However, risk management for public pension plans needs to extend well beyond return scenarios, to include assessments of the risks associated with benefit funding policies, policymaker behavior in making required contributions, and the broader economic environment. In addition, these assessments should address the potential costs associated with these risks, in terms of impact to government budgets. The stress test simulation model presented here was constructed to account for these risk factors and their potential impact on both pension system health and resources to pay for other core government services.

Model Foundation

All stress test models are grounded on a foundation, or structure, which includes the inputs, the simulation itself, and the outputs. Our stress test simulation model follows this approach and comprises these three basic elements and their component parts:

1. **Model Inputs**. Inputs include actuarial projections, a complete suite of capital market and asset allocation assumptions, and state revenue forecasts.
2. **Model Simulator**. Simulations are conducted using both deterministic and stochastic methods.
3. **Model Outputs**. The model produces a set of custom outputs that includes actuarial, financial, and economic measures to assess plan fiscal health and compare projected pension costs to available resources.

Figure 1
Stress Testing Simulation Model Foundation Structure
Pew's simulation tool incorporates state financials as inputs, simulates economic conditions, and produces projections and metrics
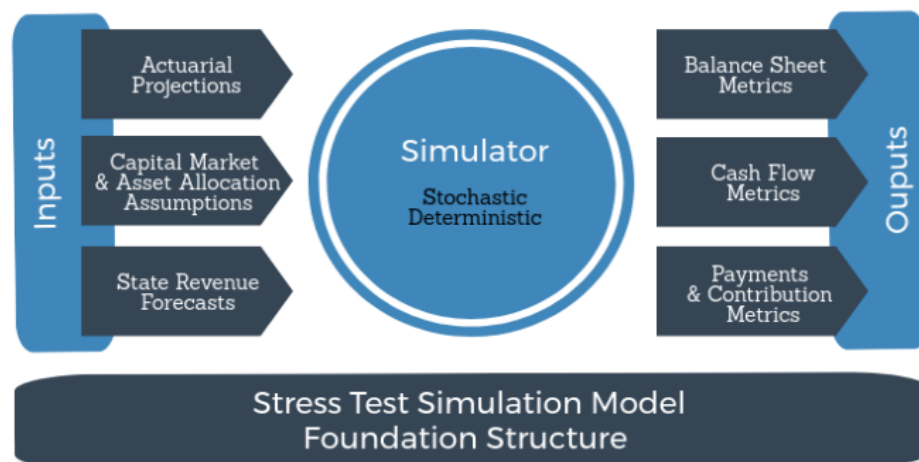
Source: The Pew Charitable Trusts.

Inputs

The model inputs were selected to allow for both actuarial and financial analysis of state pension plans in the context of a state's ability to pay for the associated fluctuating costs. We compiled three major classes of inputs:

- **Actuarial Projections:** To provide a starting point for stress test simulations, actuarial projections establish a 30-year outlook for pension benefits, costs, and liabilities based on each plan's assumptions, including the assumed rate of return on investments.
- **Capital Market and Asset Allocation Assumptions:** Capital market assumptions, which incorporate forecasts of economic growth and inflation, as well as expected returns and volatility by asset class, were developed for a 30-year, forward-looking time horizon. Asset allocations are based on the investment policy and target allocation for each state.
- **State Revenue Forecast:** A unique feature of the model is its ability to frame pension costs and debt in relation to budget capacity over the 30-year forecast period. This required the use of a consistent budget metric and application of a standard methodology to projected revenue growth for each of the 10 states.

Actuarial Projections

Actuarial projections establish a 30-year outlook for pension benefits, costs, and liabilities. These projections, developed by The Terry Group, depend upon an accurate starting point for financial measures and demographics. The projections also utilize forward-looking assumptions around workforce and salary growth, rates of inflation, turnover, and retirement, as well as long-term mortality expectations.

Actuarial projections are included for a total of 18 pension plans across the 10 states.[13] Because the organization of pension plans varies across states, we included state worker and teacher plans in every case, as these are typically the largest retirement plans in terms of total pension liability. For several states, these two plans also represent the sum of what is managed and reported at the state level. In others, we also included plans for local employees where the management and reporting for these plans prevented separation, and were deemed to have an immaterial impact on the results in any event.

The actuarial forecast component of the simulation model is also designed to facilitate projections under different economic scenarios and assumptions about the behavior of policymakers in making required contributions. The methodology for the actuarial projections is included in Appendix I. The appendix also includes discussion of how certain economic

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[13] The 18 plans in our study comprise the Colorado Public Employees' Retirement Association — State and School Divisions; Connecticut State Employees' Retirement System and Teachers' Retirement System; Kentucky Employees Retirement System: Hazardous and Non-Hazardous, and Teachers Retirement System; New Jersey Public Employees Retirement System (excluding local contributions) and Teachers' Pension and Annuity Fund; North Carolina Teachers' and State Employees' Retirement Program; Ohio Public Employees Retirement System and State Teachers Retirement System; Pennsylvania State Employees' Retirement System and Public School Employees' Retirement System; South Carolina Retirement System; Virginia Retirement System — State Employees and Teachers; and the Wisconsin Retirement System.

assumptions, including inflation, are applied in a consistent manner across the different components of the simulation model. They are applied for purposes of stochastic simulation analysis and to supplement scenarios based on each state's return assumptions, which are also included in our study.

Capital Market and Asset Allocation Assumptions

The capital market and asset allocation assumptions provide an independent estimate of the expected return for stocks, bonds, and other investments based on the investment policy and target allocation for each state. These assumptions were developed after reviewing the forecasts of major business, academic, and government institutions.[14]

Our capital market assumptions contain projections for a variety of financial, economic, and investment variables over time. Some of these variables pertain to the broad outlook for the U.S. economy, such as real gross domestic product (GDP) and inflation. The remaining indicators measure the performance and expected volatility for each asset class, including public equity (both U.S. and non-U.S.), bonds, real estate, and private equity. These factors are then applied to develop a 30-year, forward-looking estimate of performance for each state's pension funds under both deterministic and stochastic simulation models.

In total, we developed return and risks assumptions for six asset classes: U.S. equity, non-U.S. equity, core bonds, private equity, real estate, and cash. Due to methodological constraints, we evenly distributed fund allocations to hedge funds across all asset classes and remapped commodities to real estate for pension plan portfolios containing these alternative investments.[15]

To better understand the expected returns and risk across the plans, we also applied our capital market model to a plan portfolio that is representative of the asset allocation for pension systems across the 10 states in our analysis. Typical pension funds in these states are invested 51 percent in stocks; 27 percent in fixed income and cash; and 22 percent in real estate and private equity. The resulting asset allocation has a projected median return of 6.4 percent over 20 years.

Although this is almost a full percentage point below the weighted average expected return of 7.2 percent among the plans modeled, most of the differences can be attributed to assumed rates of inflation. The stress test simulation model assumes annual inflation of 2 percent, based on projections of the Congressional Budget Office (CBO), while the average inflation assumption across the 10 states in our study, weighted by liability, is 2.5 percent. If plan return assumptions

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[14] Sources used in developing the capital market assumptions include the Federal Reserve, the Bureau of Economic Analysis, the Congressional Budget Office, and a variety of private sector and academic market researchers. See "Capital Market Assumptions 2017 Methodology" in Appendix I for further detail.

[15] A more detailed overview of the methodology behind our capital market assumptions and deterministic scenarios can be found in Appendix I.

were adjusted downward to match the CBO estimate, the difference in expected returns between the capital market and pension plan assumptions is minimal, as illustrated in **Figure 2**.[16]

Weighted State Average Assumed Rate of Return with and without Inflation
Most states assume inflation in the long term will be closer to 2.5 than 2 percent
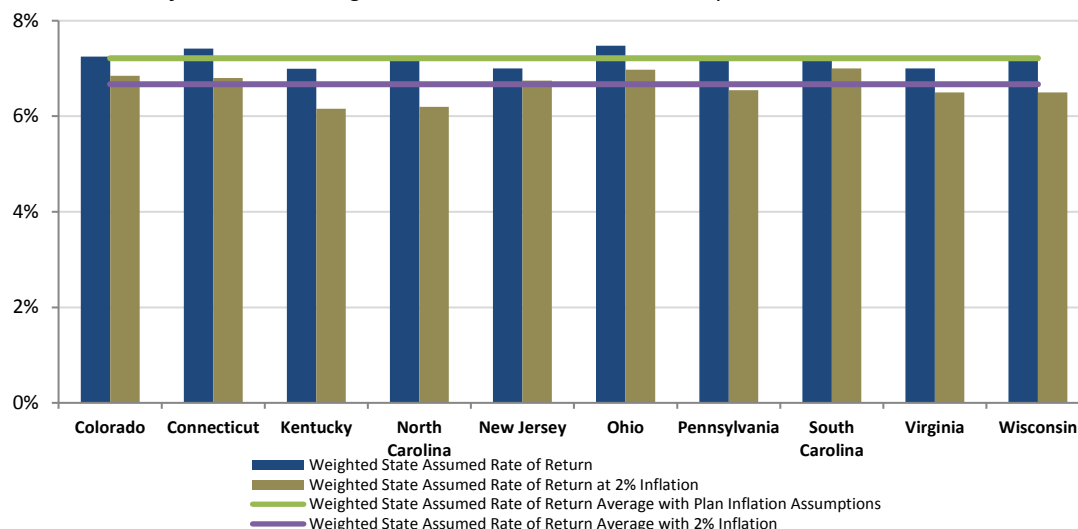
Notes: State average assumed rate of return at 2 percent inflation is equal to the states' average assumed rate of return less the difference between plans' assumed inflation plus 2 percent; Assumed rate of return data is based on plans' most recently published valuations (2016-2017), and weighted by 2016 total pension liability. **Sources:** Comprehensive Annual Financial Reports (CAFRs), actuarial reports and valuations, or other public documents, or as provided by plan officials.

The distribution of returns under our capital market assumptions shows that 20-year returns have the potential to vary from 3.3 percent (a 10th percentile scenario, meaning returns are expected to exceed that level 90 percent of the time) to 9.6 percent (a 90th percentile scenario). In other words, in a scenario where returns over 20 years are expected to be 6.4 percent, the analysis indicates that there is an 80 percent chance they will fall between 3.3 and 9.6 percent (see **Figure 6** or Appendix I for the full distribution).

The distribution of returns for the average portfolio was also used to inform an economic scenario used throughout our analysis that assumes returns of 5 percent over the long term. Specifically, this scenario was constructed to reflect expected returns for the average portfolio at approximately the 25th percentile. At this level of probability, the capital market assumptions for the average portfolio produce an estimated return of 4.8 percent over 20 years and 5.0 percent over 30 years. Capital market assumptions and asset allocation are the primary inputs needed to simulate investment return volatility, and include broader economic assumptions that also apply to the forecast of state revenue.

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[16] This analysis is not intended to be a critique of actuarial assumptions. Differences between inflation assumptions used for actuarial purposes and those for investment forecasting are not uncommon — even within one state's own retirement system. This analysis does, however, provide additional information to suggest that the lower expected rate of return is reasonable.

State Revenue Forecast

The model utilizes states' own source revenue (OSR) from the U.S. Census Bureau Survey of State Government Finance as a consistent measure of resources against which to compare pension costs over time and under different scenarios.[17] Because state revenues are not typically forecasted over the 30-year analysis period, we performed a simple evaluation of the historical relationship between gross state product (GSP) and own source revenue. We then applied the projected rate of growth in GSP as a proxy for state revenue growth to create a baseline projection starting with fiscal year 2017.[18]

Over the past 20 years, state revenue and GSP have been highly correlated, suggesting that GSP growth can reasonably be used as a proxy for state revenue growth. This approach has the added benefit of allowing for a clean integration with the forecast methods for our economic and capital market assumptions. Specifically, different projections for state GSP and OSR across scenarios are based on the underlying capital market assumptions for U.S. GDP and inflation, which are used to forecast investment returns.

There are some limitations to the use of own source revenue as a measure of states' resources. For example, other researchers have noted that OSR includes some revenue sources that states are unlikely to use to pay for pension liabilities, such as tuition fees at state universities.[19] Further, states may be facing "revenue hills"— diminishing or even negative marginal returns from increased tax rates — which may constrain policymakers' ability to further raise taxes.[20] Both issues result in estimates of revenue growth that may be slightly optimistic and therefore may inflate a state's ability to afford required increases in pension contributions

Although OSR growth provides a useful metric for evaluating the impact of pension costs on individual state budgets over time, it cannot be used for precise comparisons across states. This is because state-run pension plans vary in whether they include local government or school district employees and in the proportion of pension costs for those workers that is paid from the state budget. For example, some states fund teacher pensions entirely out of the state general fund, whereas in others much of costs for teacher retirement benefits are paid from school district or municipal budgets.[21] Yet, on balance, the use of own source revenue provides a consistent point of reference against which to measure pension liabilities for an individual state

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[17] State general own source revenue includes all state revenue sources, except for intergovernmental revenues, state-owned liquor stores receipts, utility revenues, and social insurance trust revenues. U.S. Census Bureau, 2016 Annual Survey of State Government Finances, https://www.census.gov/programs-surveys/state.html.

[18] GSP growth data from Moody's Analytics www.economy.com.

[19] Rauh, J.D. (2017). *Hidden Debt, Hidden Deficits: How Pension Promises are Consuming State and Local Budgets*. The Hoover Institution. http://www.hoover.org/research/hidden-debt-hidden-deficits-2017-edition.

[20] See Haughwout, A., Inman, R., Craig, S., & Luce, T. (2004). Local Revenue Hills: Evidence from Four U.S. Cities. *Review of Economics and Statistics, Volume 86(2)*, 570-585.

[21] For example, for the Pennsylvania Public School Employees Retirement System (PSERS), employer contributions to the plan are split between state, which pays for approximately 55 percent of the contribution, and local municipalities that are responsible for approximately 45 percent of the contribution, based on Pew calculations from PA Department of Education data: http://www.education.pa.gov/teachers%20-%20administrators/school%20finances/pages/default.aspx.

over time that grows at a rate that is highly consistent with state-level GSP growth. See Appendix I for further details.

Ratio of State Own Source Revenue to Nominal Gross State Product (GSP)
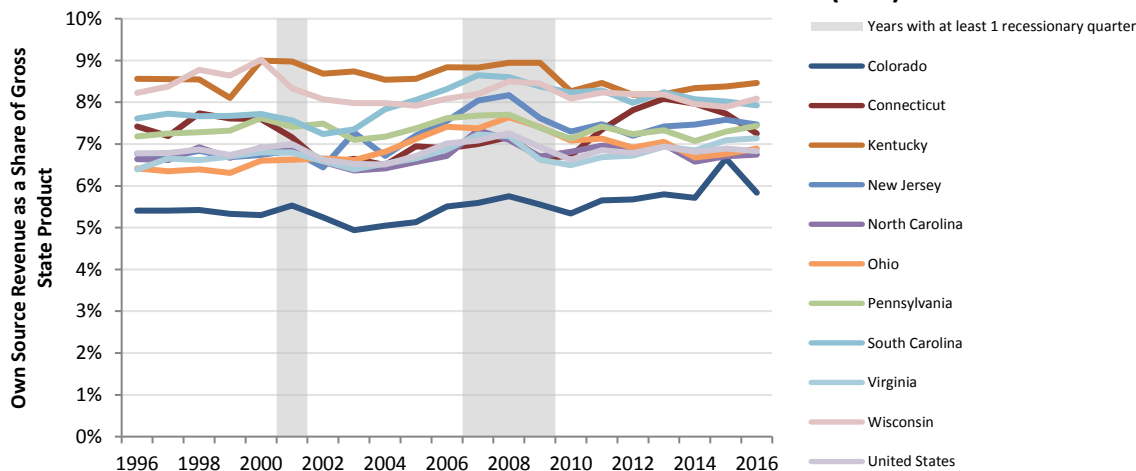
Note: United States uses national gross domestic product; there is a discontinuity in gross state product between 1996 and the rest of the time series due to a change from SIC industry definitions to NAICS industry definitions. Years highlighted in gray above include any year in which at least one quarter was in recession, according to the U.S. Federal Reserve. **Sources:** U.S. Census Bureau; Bureau of Economic Analysis; Moody's Analytics.

Simulator

The model is constructed to perform two basic types of stress testing: deterministic simulations and stochastic simulations.

- **Deterministic simulations** are used to test how portfolios perform under precise circumstances of our own design, typically by performing a single trial run for each year in the forecast. Each run strictly adheres to the same user-specified assumptions on investment returns and economic metrics.
- **Stochastic simulations** are used to model the probabilities of various financial outcomes given specified means and standard deviations of economic variables and market returns. Our stress test model generates 10,000 runs for each simulation.

The hundreds of thousands of trials provide a rich body of data with which to assess the fiscal health of public pension funds under a broad range of scenarios. Because the volume of data is exhaustive, we developed a standard set of fiscal metrics to succinctly and effectively summarize relevant impacts and outcomes.

Outputs

We project pension assets and liabilities under different scenarios, along with estimates of the resources available to pay for benefits, to provide a full range of financial projections across all the scenarios applied in the model. The stress test simulation model summarizes results using a

comprehensive set of actuarial, economic, and financial accounting metrics. These include standard balance sheet, payment, contribution, and cash-flow metrics that assess fiscal health over time and provide forward-looking indicators of future fiscal challenges.

A brief discussion of each type of metric is provided below. Complete fiscal metrics results for each state can be found in Appendix II.

- **Balance Sheet Metrics:** These metrics include the level and change in pension assets on a market value basis, and the funded ratio of assets to actuarial liabilities at the plan's assumed rate of return. The ratio of pension debt to own source revenue, calculated using a lower discount rate for plan liabilities, is also included to reflect an approximate average long-term borrowing rate for state government bonds. These measures provide an indication of fiscal position for each forecast year and the foundation for assessment of solvency.

- **Payment and Contribution Metrics:** These metrics include annual measures of employer and employee contributions, normal cost, and payroll, as well as net amortization, to assess contribution sufficiency.[22] Ratios of contributions to both own source revenue and payroll provide measures to assess pension costs as a share of state budget and workforce compensation, respectively. Payment and contribution measures are the building blocks for assessing the long-term cost to taxpayers of promised pension benefits.

- **Cash Flow Metrics:** These metrics are based on the difference between contributions and benefits (operating cash flow) and are applied mainly as an early indicator of long-term fiscal solvency for poorly funded plans. A primary example used throughout our analysis is the ratio of operating cash flow to assets. The calculation:

    [(Total Contributions — Benefit Payments) / Plan Assets at the Beginning of the Year]

    Most public pension funds exhibit negative operating cash flow, and this ratio provides a benchmark for the rate of return required to ensure that asset balances do not decline.

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[22] The Pew Charitable Trusts. (2016). *The State Pension Funding Gap: 2014*. http://www.pewtrusts.org/en/research-and-analysis/issue-briefs/2016/08/the-state-pension-funding-gap-2014.

Research Questions

The stress test simulation model provides an analytic engine to rigorously study a range of uncertain outcomes related to the fiscal health of state pension systems and potential impacts to government budgets. To apply the model in a focused manner, given that the number of potential simulations is limitless, the output is based on a framework designed to address three key research questions (RQ):

RQ 1: How do we assess fiscal distress and which states are at risk?

RQ 2: How might lower investment returns affect pension costs and therefore state budgets in the long term?

RQ 3: What is the impact of economic volatility on pension fiscal health, given states' high exposure to stocks and other risky asset classes?

RQ1: Assessing the Risk of Fiscal Distress

Researchers grapple with how to identify the characteristics of a plan at risk of fiscal distress. Here, we use the stress test simulation model to evaluate the likelihood that a state's pension plan will become insolvent and/or payments will become unaffordable, based on three criteria:

- Declining asset levels, due to negative operating cash flows, that exceed the offsetting impact of annual investment earnings assuming a 5 percent rate of return;
- A high probability that system assets will be depleted within 20 years, requiring a transition from pre-funding pension benefits to pay-as-you-go (pay-go); and
- The resulting transition to pay-go would require the state to dramatically increase contributions over a short time period.

A transition to pay-go is problematic because the state is forced to fund benefit payments entirely through current employee and employer contributions, which may ultimately require dramatic budget cuts, a substantial increase in new tax revenue, or some combination of both.

States with a negative cash flow ratio in excess of 5 percent will have a high likelihood of reductions in assets in any given year. As **Figure 4** shows, declining assets can generate even less in investment returns in subsequent years, further accelerating this drawdown. This can lead to an increased risk of insolvency followed by a transition to pay-go funding.

Figure 4

Sample Plan Asset Losses in a Scenario with Accelerating Negative Operating Cash Flow

Funded status and operating cash flow can significantly affect a plan's long-term fiscal health

Funding Ratio 50%, Outflow 7.0%

— Plan Assets   ‑ ‑ Cash Outflow as Share of Assets
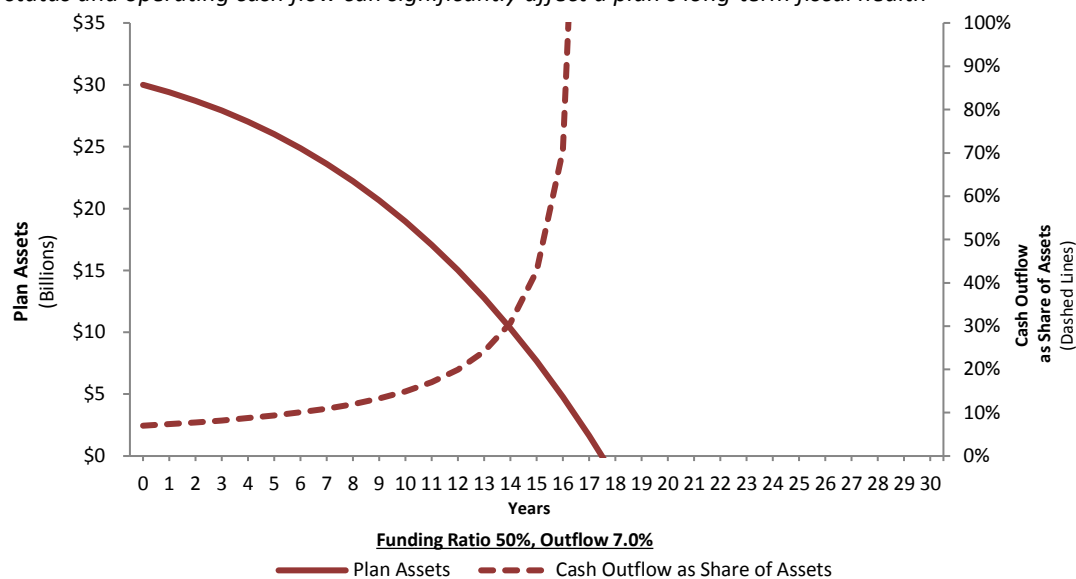
Source: The Pew Charitable Trusts.

RQ2: Measuring Estimated Long-Term Costs

Even in the absence of fiscal distress, lower-than-projected returns will have long-term cost implications for state retirement systems, because pension plans rely on investment earnings to pay for a substantial portion of benefits over time.[23] Lower returns translate into reduced asset levels and require more from the budget to pay for promised benefits. And, because governments may be constrained in their ability to channel more money into pension plans, it also means that states may not be able to achieve their goals of full funding going forward. In effect, lower or more volatile investment returns could mean that current high contribution rates become essentially fixed long-term costs.

We measure long-term costs by evaluating two ratios: total contributions to payroll and employer contributions as a percentage of own source revenue. Permanent high-cost plans are defined as those with total contributions projected to exceed 25 percent of payroll beyond the 30-year forecast period. The 25 percent benchmark represents twice the estimated actuarial cost of benefits for a typical state defined benefit plan.

The ratio of contributions to own source revenue is applied to determine whether states have the capacity to further increase pension payments. Affordable payments are calculated based on

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[23] National Association of State Retirement Administrators. (2017). *Public Fund Survey: Summary of Findings for FY 2015*. Accessed August 13, 2017, at http://www.nasra.org/publicfundsurvey.

past behavior and defined as no more than a 50 percent increase in employer contributions as a percentage of own source revenue over the course of a decade.

RQ 3: Evaluating the Impact of Financial Market Volatility

Deterministic simulations allow us to chart the effects on state pension systems of specific fixed rates of return and simplistic assumed models of policymaker behavior. However, stochastic simulations provide a more complete picture of the fiscal impact of market volatility and the effect of policy choices on managing that risk.

We use stochastic simulation methods to investigate the effects of volatility from two primary sources: the sequence of returns over the forecast period; and each state's pension contribution policy in response to the associated volatility. The model simulates 10,000 different trials per year, shedding light on minimum and maximum levels of fiscal health as well as cost over the measurement period.

Analytic Framework

To answer these questions, we applied a two-part analytic framework to the stress test model foundation. First, we designed two economic scenarios that focus on the downside risk associated with lower-than-expected returns, including the effect of an economic recession. Second, we adopted two behavioral assumptions to model how policymakers respond to lower returns. These assumptions are based on a range of likely outcomes for pension funding and account for current plan funding policies, affordability, and past behavior.

Figure 5
Pew's Analytic Framework
Two-part lens that helps generate a broad range of likely outcomes
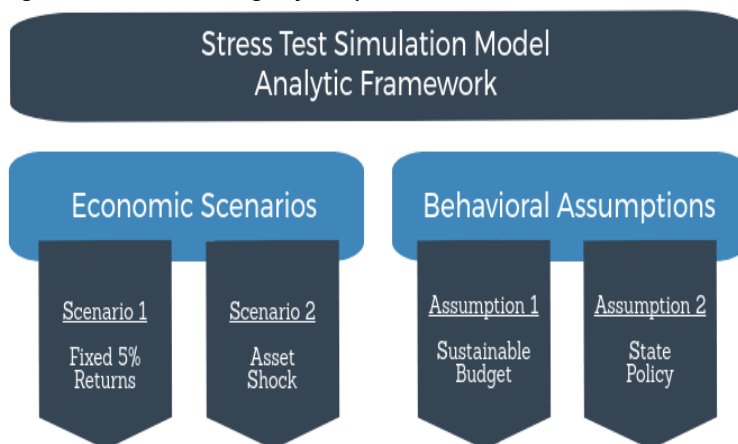
Source: The Pew Charitable Trusts.

Economic Scenarios

Shortfalls in investment performance, relative to expected returns, explain approximately 50 percent of the increase in unfunded pension liabilities reported by states in 2016.[24] As a result, examination of downside investment risk is at the heart of stress test analysis of public pensions. The analytic framework applied in our model includes two downside investment return scenarios: a fixed 5 percent return scenario and a scenario that accounts for an asset shock — a steep decline in asset values, as typically occurs during the onset of a recession — followed by low returns.[25] By conducting a deterministic simulation using these two scenarios, we were able to examine plan solvency (RQ1) and the potential cost of downside risk (RQ2).

Scenario 1: Fixed 5 Percent Returns

In the first economic scenario, which we call the *fixed 5 percent return scenario*, a single low rate of return is applied to the model for each year in the forecast period. The purpose of this scenario is to assess how plans perform when investment returns are lower than expected over the long term. Although most financial experts do not project returns this low in the coming years, they do expect investments to perform below historical averages.[26]

We selected 5 percent for this scenario for two reasons. First, given public plans trend toward 7 percent assumed rates of return, a low return scenario of 2 percentage points below that falls between the low return investment scenario required by the GASB (1 percentage point below the plan assumption) and the recommendation of the Society of Actuaries Blue Ribbon Panel (3 percentage points below the plan assumption).[27] Second, 5 percent is in line with the stochastic analysis of our capital market assumptions, which generate a 25th percentile return of about 5 percent over 30 years. In other words, there is a 50 percent chance, based on these assumptions, that long-term returns will be between 4.8 and 8.1 percent — a range that includes the 5 percent low return scenario.[28]

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[24]The Pew Charitable Trusts. (2018). *The State Pension Funding Gap: 2016.* http://www.pewtrusts.org/en/research-and-analysis/issue-briefs/2018/04/the-state-pension-funding-gap-2016

[25] Appendix I contains the market and economic assumptions for each scenario described here.

[26] Wilshire Consulting. (2017*). Asset Allocation Return and Risk Assumptions*.

[27] Society of Actuaries. (2014). *Report of the Blue Ribbon Panel on Public Pension Plan Funding.* https://www.soa.org/Files/Newsroom/brp-report.pdf pg. 27-28

[28] For more on inflation assumptions, see also Congressional Budget Office (2017). *The Budget and Economic Outlook 2017 to 2027*; J.P. Morgan Asset Management. (2017). *Long-Term Capital Market Assumption*. 21st Annual Edition; and Foresti, S. and Rush, M. (2017). *Asset Allocation Return and Risk Assumptions*. Wilshire Consulting.

Figure 6

Distribution of Stochastic 20-Year Returns for a Typical Portfolio

Typical portfolio has expected return of 6.4 percent at the median
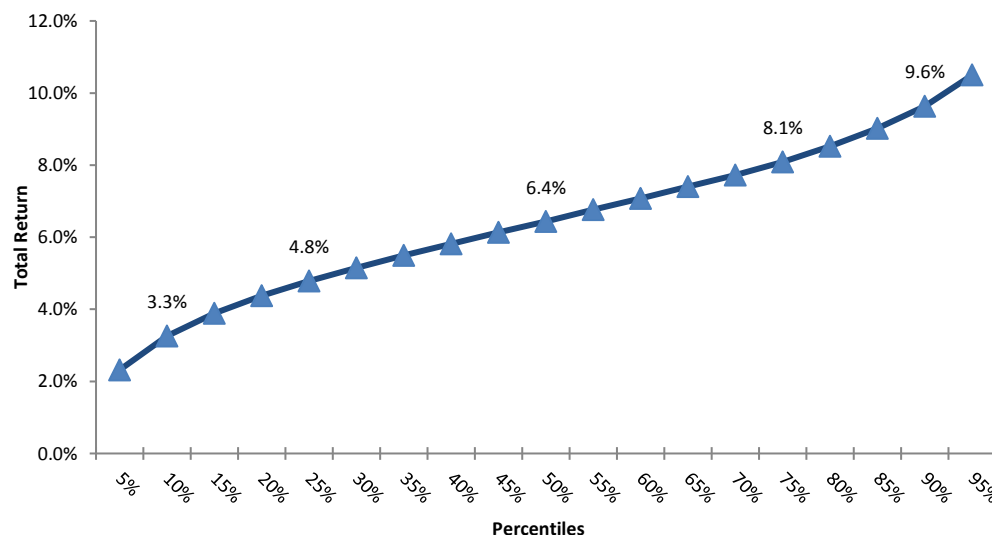
Notes: Labels are for returns at the 10th, 25th, 50th, 75th, and 90th percentile. Typical portfolio has 51 percent stocks, 27 percent fixed income/cash, and 22 percent in alternatives (i.e. private equity and real estate). **Sources:** The Terry Group and The Pew Charitable Trusts.

Scenario 2: Asset Shock

In our second economic scenario, which we refer to as the *asset shock scenario*, we incorporated an initial decline in the stock market and loss in pension asset values followed by low returns over the long term. The scenario is based on the Federal Reserve's "2017 Supervisory Scenarios for Annual Stress Tests Required under the Dodd-Frank Act Stress Testing Rules."[29]

The asset shock scenario assumes an approximate 20 percent loss in asset value in year one, followed by three years of recovery. The trajectory here is similar to that seen after the start of the Great Recession. For 2018 to 2021, we based our assumptions of real GDP growth, inflation, interest rates, and public equity performance on those specified by the Federal Reserve under Dodd-Frank.[30] In addition, we modified the scenario to also include a persistent low rate of return of 5 percent for equities from year five to year 30.

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[29] See Table 3A at https://www.federalreserve.gov/newsevents/pressreleases/files/bcreg20170203a5.pdf and Appendix I.
[30]Ibid.

Investment Returns in Hypothetical Asset Shock Versus Great Recession

Asset losses larger and market rebound gains smaller in asset shock scenario
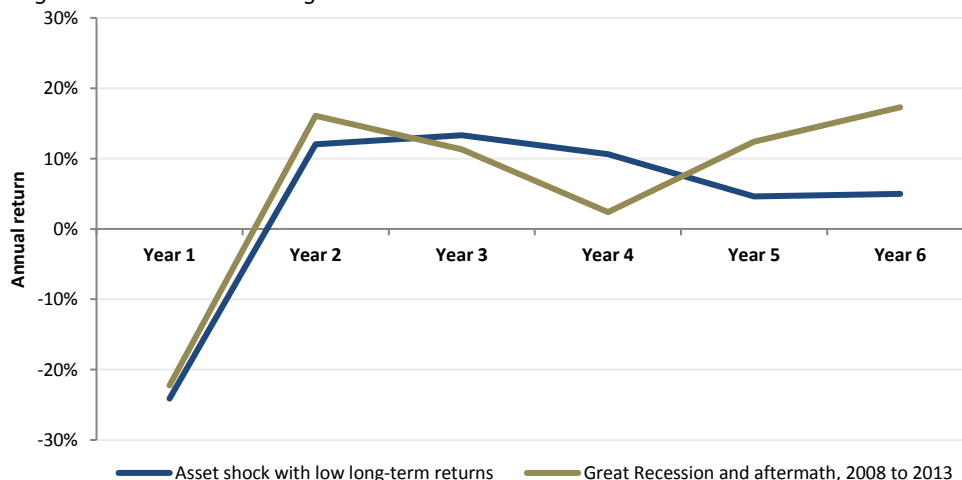
Note: See Appendix I for description of adverse shock scenario. **Sources:** The Pew Charitable Trusts, The Terry Group, and FactSet Research Systems Inc.

Behavioral Assumptions

Although modeling market downturns is at the heart of stress testing, policymakers' responses to investment losses are a source of equal risk to plans' fiscal health, and therefore should be accounted for as part of a comprehensive stress test analysis. Our model examines two behavioral assumptions: first, that states increase funding to offset losses based on written state policy; and second, that policymakers limit increases to mitigate spending cuts in other areas of the budget.

Most states have formal fixed or actuarial funding policies written in statute. When investment returns are lower than expected, most policies call for increased payments to offset the impact and ensure the state remains on target for 100 percent actuarial funding by a preset date. Historical data indicate that state and local governments generally do respond to rising unfunded liabilities by increasing pension contributions, to some degree, as a share of government budgets. At the same time, policymakers also tend to modify funding policies — usually by stretching out the full funding date — to limit the size of the increase in pension costs in any given year.

For example, between 2003 and 2013, state pension contributions as a percentage of own source revenue increased from 4 to over 6 percent, while the amount needed to meet actuarial funding requirements went from 4 to 8 percent. Despite the increase in contributions, the average payment schedule for paying down unfunded liabilities (amortization period) during this time was essentially unchanged, meaning states continued to have long amortization periods that allowed little progress in paying down their pension debts (see **Figures 8** and **9**).

Figure 8

50 State Analysis: Actual Contribution as a Share of Own Source Revenue, 2001 to 2016

Overall, contributions nearly doubled over this time
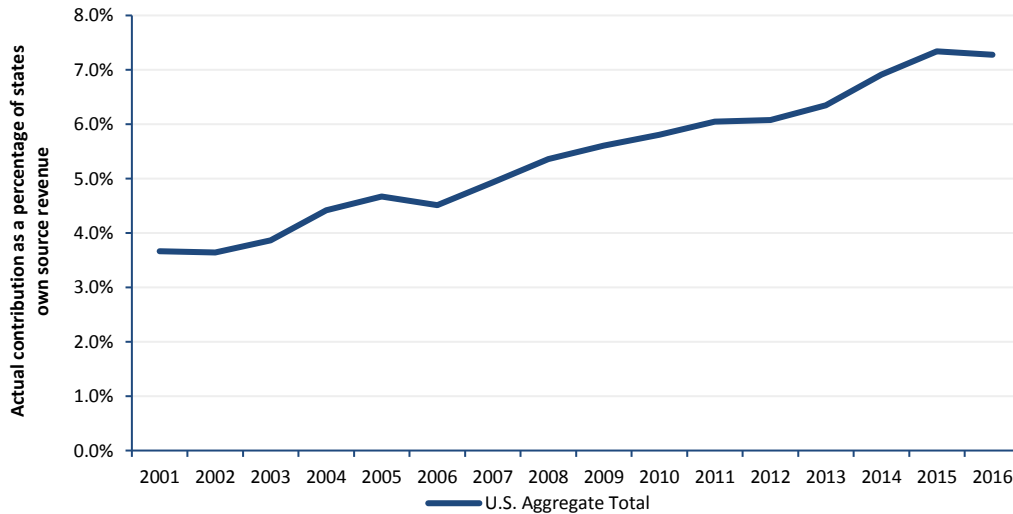
Sources: Public Plan Comprehensive Annual Financial Reports, 2003-2013, and the U.S. Census Bureau's Annual Survey of State Government Finances.

Figure 9

50 State Analysis: Average Amortization Period for Open and Closed State Plans that are Level Percent of Pay, 2001-2016

Amortization periods increased in the early 2000s and after the Great Recession
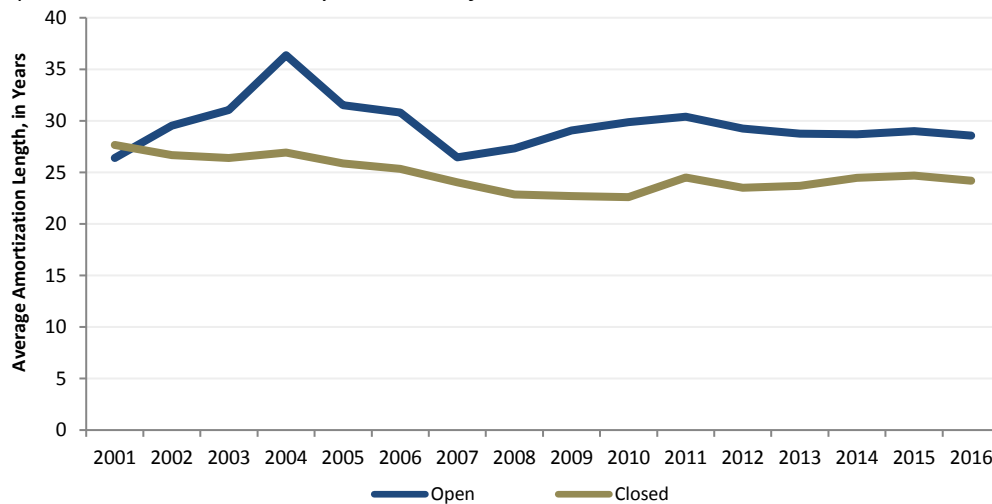
Note: Includes 87 state and teacher plans. Observations of plans with an aggregate actuarial cost method are excluded. **Source:** Boston College Public Plans Database.

The analytic framework applied to our model accounts for the growth in pension contributions and the stagnation of amortization periods by including two behavioral assumptions: a *sustainable budget assumption* and a *state policy assumption*.

Assumption 1: Sustainable Budget

In the *sustainable budget assumption*, contributions are set at a fixed percentage of state revenue. The assumption tracks closely with what states currently expect to contribute to their pension systems, if all plan assumptions are met. The sustainable budget assumption implicitly sets a limit on what is affordable to avoid additional strain on the state's budget at a time when other state obligations may also require increases in funding.

Assumption 2: State Policy

In contrast to the sustainable budget assumption, the *state policy assumption* assumes strict adherence to current actuarial funding requirements based on states' written contribution policies. The best-case result from the perspective of pension funding is a rapid increase in contributions, to fully offset lower investment returns. Because this increase occurs at the worst possible time for the rest of the state budget, we also calculate a benchmark for fiscal capacity, called tolerance for payment.

The tolerance for payment metric, which is based on past behavior, assumes that policymakers are willing to increase payments over a 10-year period by the same amount as payments have increased, over the previous 10 years, measured as a percentage of state revenue. Based on five-year rolling averages, the 10 states in our study have increased contributions based on this tolerance for payment measure by approximately 3 percentage points. A further increase of 3 percentage points would translate, on average, to approximately a 50 percent increase in payments over 10 years relative to available budget resources. The tolerance for payment metric is used as a benchmark to assess whether increases in required contributions from the simulation model output are likely to be affordable.

Figure 10

50-State Analysis: Tolerance for Payment, Five-Year Rolling Average of Employer Contributions as a Share of Own Source Revenue for 2016 Compared with 2006

Historical increases about 50 percent at the median
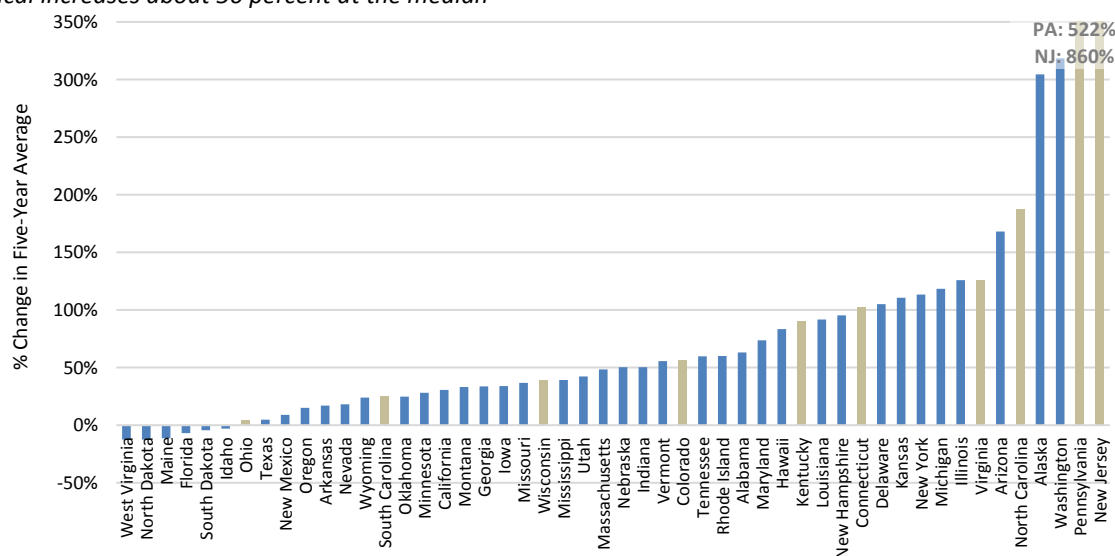
Note: 10 states in Pew's analysis are highlighted in gold above. **Sources:** Public plan comprehensive annual financial reports, 2000-2016, and the U.S. Census Bureau's Annual Survey of State Government Finances.

The two assumptions for contribution behavior — sustainable budget and state policy — provide a range of likely funding levels for different investment return scenarios. In our simulations, the sustainable budget assumption, in which scarce state resources are appropriated evenly across pensions and other budgetary priorities, becomes the lower bound for projecting contributions. The state policy assumption, in which pension contributions are determined per written policy, serves as the upper bound. Based on past performance, we project future behavior to fall somewhere in between these two assumptions. In circumstances where the state policy calls for increases that may be especially difficult to reach, we also analyze results based on the tolerance for payment limit.

Data Sources

We used a variety of sources to construct baseline and scenario assumptions, including the Federal Reserve, the Bureau of Labor Statistics, and the Congressional Budget Office.[31] The investment and actuarial data sources used for this analysis are primarily from Pew's stress test simulation model, which employs data collected from comprehensive annual financial reports, as well as actuarial reports and valuations. State revenue assumptions were developed using historical data from the U.S. Census Bureau's Annual Survey of State Government Finances. For

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[31] We consulted the Board of Governors of the Federal Reserve Systems. (2017). *Supervisory Scenarios for Annual Stress Tests Required Under the Dodd-Frank Act Stress Testing Rules and the Capital Plan Rule*. Accessed on June 29, 2017 https://www.federalreserve.gov/newsevents/pressreleases/files/bcreg20170203a5.pdf For interest rate projections, we drew from the Congressional Budget Office. (2017). *The Budget and Economic Outlook 2017 to 2027*. Accessed on June 12, 2017 at https://www.cbo.gov/publication/52370. We relied on the U.S. Bureau of Labor Statistics for data on historical inflation, accessed at https://data.bls.gov/timeseries/CUUR0000SA0L1E?output_view=pct_12mths.

gross state product, historical data came from the Bureau of Economic Analysis and projections from Moody's Analytics starting in 2017. We also constructed deterministic scenarios using sources from the Federal Reserve, the Bureau of Labor Statistics, and the Congressional Budget Office. Data sources for the development of capital market assumptions include the Congressional Budget Office, the Federal Reserve, the NCREIF National Property Index, FACTSET, and the Cambridge Associates LLC U.S. Private Equity Index.

Contribution policy assumptions for each pension plan come from comprehensive annual financial reports, actuarial reports and valuations, and other public documents or information as provided by plan officials. Contribution policy behavior was also informed by data from Boston College's Public Plans Database. A detailed table of each plan's assumptions — including contribution policies — can be found in Appendix II.

III. Results and Findings

The states we chose to evaluate — Colorado, Connecticut, Kentucky, New Jersey, North Carolina, Ohio, Pennsylvania, South Carolina, Virginia, and Wisconsin — represent a range of fiscal positions and policies. The differences among these states allow us to use the stress test simulation model to demonstrate how market volatility and economic uncertainty can affect pension costs depending on a state's current financial status and contribution rules.

Kentucky and New Jersey: The state-sponsored pension plans in Kentucky and New Jersey were selected to assess their potential for insolvency as outlined in Research Question 1 (RQ1). Both states rank worst in the nation across a range of fiscal metrics, each reporting only 31 percent of assets on hand to pay for promised benefits, the lowest funded ratios in the country. We conclude that both states face the risk of pension system insolvency under the fixed 5 percent return scenario, if public officials fail to raise state contributions as required under recently adopted reforms.

Pennsylvania and Connecticut: Connecticut and Pennsylvania also rank near the bottom on pension funding alongside Kentucky and New Jersey but have stabilized system financing by following through on policies that increase employer contributions and reduce pension liabilities. As such, Connecticut and Pennsylvania were selected to assess Research Question 2 (RQ2), by determining whether these policies will be sufficient to achieve full funding, and reduce budget costs, even in the case of lower investment returns. We conclude that, for both states, increases in required contributions under these conditions may be unaffordable, and that public officials may potentially modify state policy and stretch out high pension costs beyond the 30-year forecast period.

Colorado and Ohio: Although not as fiscally challenged as Kentucky or New Jersey, neither Colorado nor Ohio has policies in place that respond to economic downturns, as both states set contributions as a statutorily fixed percentage of pay. We conclude that without policy intervention, Colorado faces the risk of pension system insolvency in a low-return environment. The outlook in Ohio is less dire, in large part because the state has implemented significant benefit reductions in years past, but policymakers may be forced to revisit a narrowing set of policy options when there is another economic recession.

Virginia and South Carolina: South Carolina's fiscal metrics place the state in the bottom 10 in the nation — about the same as Colorado — while Virginia tracks closely to the national average. We selected South Carolina and Virginia because they have more traditional actuarial funding policies, which allows us to assess Research Question 3 (RQ3), regarding the impact of financial market volatility on pension costs and the role state funding policies play in addressing this risk. We conclude that for poorly funded states like South Carolina, policymakers need to evaluate whether pension system finances can absorb an extreme one-time shock in the stock market, based on the Federal Reserve scenario. Separately, results in Virginia using stochastic analysis reveal substantial volatility in pension costs, even at expected rates of return, and point to the need to better calibrate actuarial funding policies to avoid such a level of budget uncertainty.

North Carolina and Wisconsin: Finally, we chose North Carolina and Wisconsin to evaluate how two of the best-funded systems in the country are expected to weather the next economic downturn, with particular focus on their fundamentally different policies. North Carolina has a robust contribution policy, and the state can be counted on to pay every bill in full, each year, regardless of market fluctuations. Wisconsin is equally diligent when it comes to maintaining contribution levels, but the state's defined benefit plan is also designed to share the risk of unexpected costs between employees and employers.

Our key findings for the 10 states are discussed below, and detailed tables of fiscal metrics for each state are provided in Appendix II. The results reflect the impact of pension reforms and other policy changes enacted through March 2018. For example, in Connecticut and Pennsylvania, the adoption of risk-managed hybrid plans for new workers is factored into our analysis, which projects substantial cost containment under low return scenarios. We also include reference to the most recent reforms passed in Kentucky and Colorado, in April and May respectively. However, the financial impact of these two reforms were not included in our analysis.

New Jersey and Kentucky: *Risk of Retirement System Insolvency*

Based on the results of our stress test simulations, New Jersey and Kentucky are most at risk of pension system insolvency. The public pension systems in both states have seen reported funded levels decline from over 100 percent in fiscal year 2000 to 31 percent as of 2016. New Jersey and Kentucky are now the two lowest-funded state pension systems in the country, and have the lowest operating cash flow to assets ratios (see **Figure 11**). In both cases, our analysis demonstrates the real risk that plan assets could be fully depleted in a scenario where investment returns are lower than expected, unless the states firmly adhere to recent reforms to strengthen pension finances.

Figure 11

50-State Analysis — Funded Ratio (FY 2016) and Operating Cash Flow to Assets Ratio (Average FY 2014 - 2016)

New Jersey and Kentucky rank worst among the 50 states
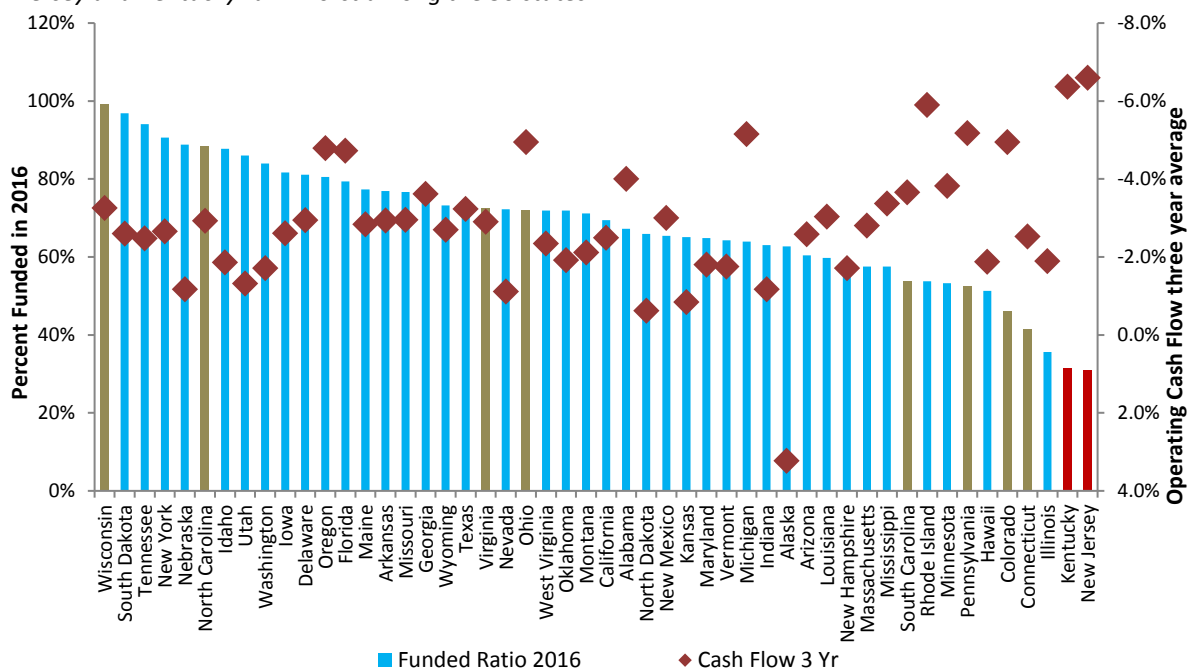
Notes: The eight other states in Pew's analysis are highlighted in gold above. **Sources:** Comprehensive annual financial reports, actuarial reports and valuations, or other public documents, or as provided by plan officials.

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New Jersey

The results for New Jersey demonstrate the potential effect of pension system insolvency on the state budget. A simulation using the fixed 5 percent return scenario and assuming sustainable budget contributions — i.e., without adjusting for recently adopted plans to triple pension contributions over the next five years — shows the state's pension fund assets would decline at an accelerated rate until reaching zero by the end of 2029 (see **Figure 12**).[32] Once insolvent, future benefit payments for the plans would be directly paid out of employee contributions, the lottery revenues newly dedicated towards the pension funds, and the state's budget. This would increase the state's annual cost from about $5 billion in 2029 to almost $7 billion in 2030, the first year of projected insolvency (or $6 billion to $8.5 billion including employee contributions, as illustrated in **Figure 13**). Furthermore, from 2018 to 2028 alone, reported pension debt in this scenario would balloon from $56 billion to $101 billion.[33]

Figure 12

New Jersey's Projected Assets and Operating Cash Flow

Under fixed 5 percent returns scenario and applying the sustainable budget contribution assumption
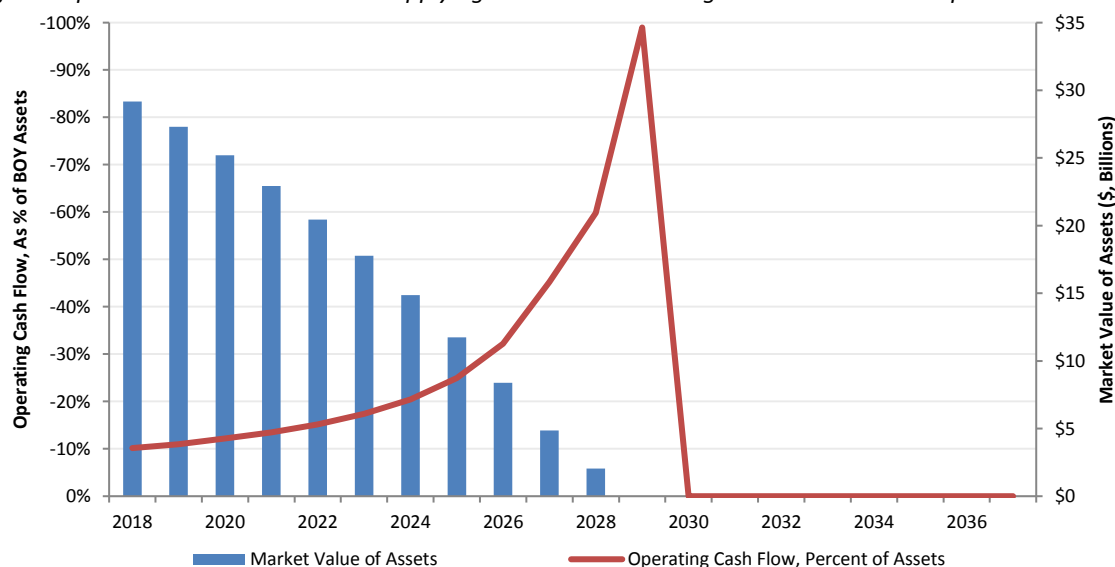
Note: Assumes actual investment returns of 5 percent and employer contributions are fixed as a percentage of own source revenue (sustainable budget).
Sources: The Pew Charitable Trust and The Terry Group, based on publicly available comprehensive annual financial reports, actuarial reports and valuations, or other public documents, or as provided by plan officials.

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[32] In 2017 the state adopted an initiative to increase contributions over the next five years, with the goal to ramp up to making 100 percent of actuarial required contributions (ARC) by 2023; In July of 2017, to help ease this planned increase in state contributions towards the pension funds, New Jersey adopted legislation to transfer revenues from state lottery sales to the three largest state pension funds; finally, in January of 2018 the Governor and Legislature in New Jersey adopted P.L. 2017, Chapter 277 Assembly Bill No. 4704 requiring comprehensive annual stress testing of the five largest pension funds in the state. The legislation requires the results from the yearly analysis to be publicly reported, along with information on investment performance and disclosures of fees paid to outside investment managers.
[33] Calculations of pension debt do not account for the future expected value of lottery revenues.

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Figure 13

New Jersey's Projected Contributions and Benefit Payments

Under fixed 5 percent returns scenario and applying the sustainable budget assumption
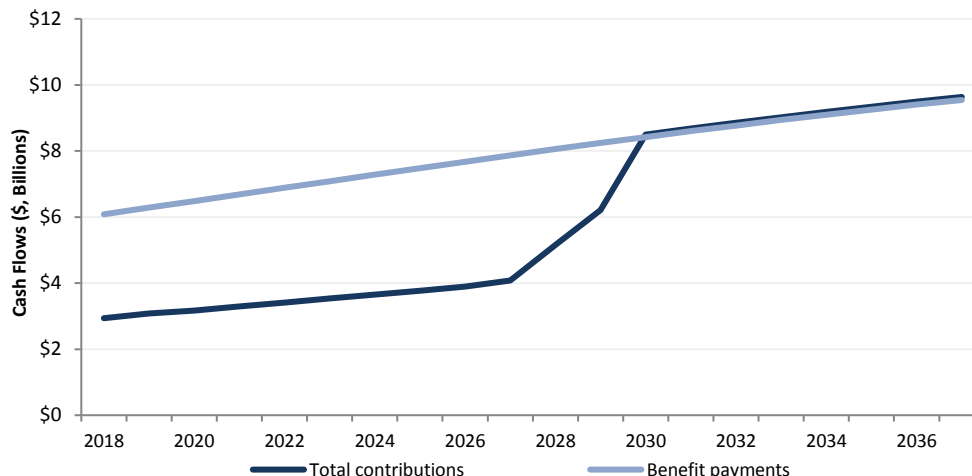
Note: Assumes actual investment returns of 5 percent and employer contributions are fixed as a percentage of own source revenue (sustainable budget). **Sources:** The Pew Charitable Trust and The Terry Group, based on publicly available comprehensive annual financial reports, actuarial reports and valuations, or other public documents, or as provided by plan officials.

To avoid fiscal distress and protect the state employee and teacher pension plans from insolvency, New Jersey will need to rigidly adhere to the newly adopted funding policies (see **Figure 14**). We anticipate this to be a challenge. The lottery revenue accounts for only about one quarter of total required contributions over the next five years, and Pennsylvania is the only state to date that has successfully raised contributions this rapidly over such a limited time frame. In addition, New Jersey's track record for making annual required contributions is weak — our research places the state last among the 50 states in making actuarial required contributions since fiscal year 2000.

Figure 14

New Jersey's Annual Required Contributions (ARC) Compared with Actual Contributions

Ramp-up calls for going from paying 30 percent of ARC in 2016 to full payment in 2023 — a $5 billion increase annually.
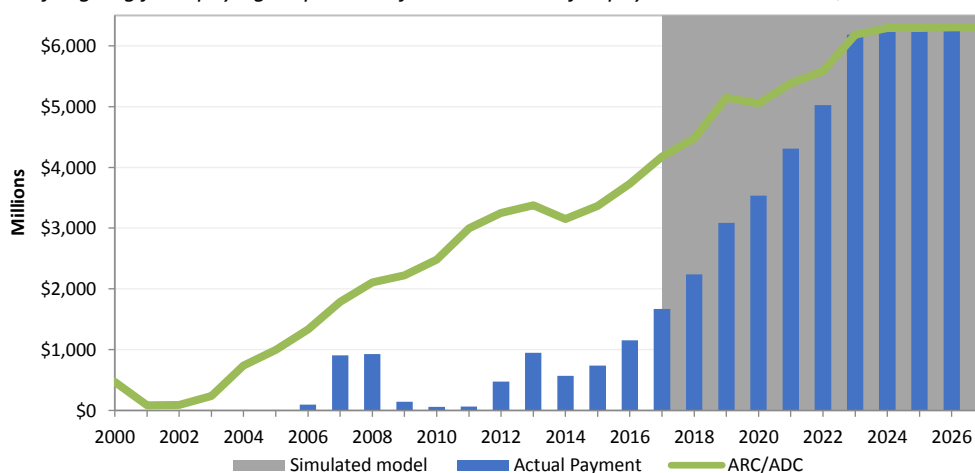
Note: Data for the New Jersey PERS and TPAF plans, state portion only; does not include contributions by local employers. Simulated model figures represent the ramp up contribution policy. **Sources:** The Pew Charitable Trust and The Terry Group (2017-2027), based on publicly available comprehensive annual financial reports, actuarial reports and valuations, or other public documents (2000-2016).

Kentucky's fiscal condition is less dire than New Jersey's, assuming policymakers abide by recent changes to funding policies; however, our results for Kentucky's state and teacher plans vary, with the state's largest plan facing a significant risk of fiscal distress during the forecast period.

Specifically, projections for the Kentucky Employee Retirement System (KERS) reveal that a $500 million increase in annual funding committed by the state in 2017 has altered the fiscal trajectory for the plan and placed it on more solid financial footing. Separately, analysis of the Kentucky Teachers Retirement System (KTRS) — completed before April 2018 pension reforms were signed into law, projects that the teachers' plan would reach insolvency by 2036 under a fixed 5 percent return scenario and the sustainable budget assumption (**Figure 15**).[34] Given the relative size of KTRS, such an outcome would result in significant fiscal distress for the statewide system overall under these conditions.[35]

However, the April 2018 reforms may provide some fiscal relief for Kentucky's pension systems. At the time of this writing, the state had just adopted additional reforms — most significantly, an actuarial funding policy for KTRS. Because these changes occurred after our analysis, and are currently being challenged in the courts, they were not included in our simulations.[36] However, if the state adheres to this stronger funding policy, its risk of insolvency will largely be constrained, though like Pennsylvania and Connecticut, Kentucky may face high and potentially volatile costs indefinitely.

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[34] Our projections include a one-time funding increase of nearly $1 billion in fiscal years 2017 and 2018 for KTRS; but do not include the better-funded County Employee Retirement System (CERS). The reforms in 2013 also made changes to both KERS and CERS, which included a commitment to actuarial funding, a restriction on unfunded COLAs, and a cash balance plan design for future hires that shares risk between employers and employee.

[35] KTRS had total liabilities of $33 billion in 2017 at the start of the projection period, while KERS liabilities were $17 billion for the hazardous and nonhazardous plans combined.

[36] The state's attorney general filed a suit challenging the reforms shortly after they were signed into law, claiming they breach an inviolable contract, as well as alleging procedural problems with how the pension reforms were passed. The complaint is available at https://ag.ky.gov/pdf_news/20160411_complaint.pdf.

Figure 15

Kentucky's Projected Assets and Operating Cash Flow — May 2018 Analysis

Under the fixed 5 percent returns scenario and the sustainable budget assumption
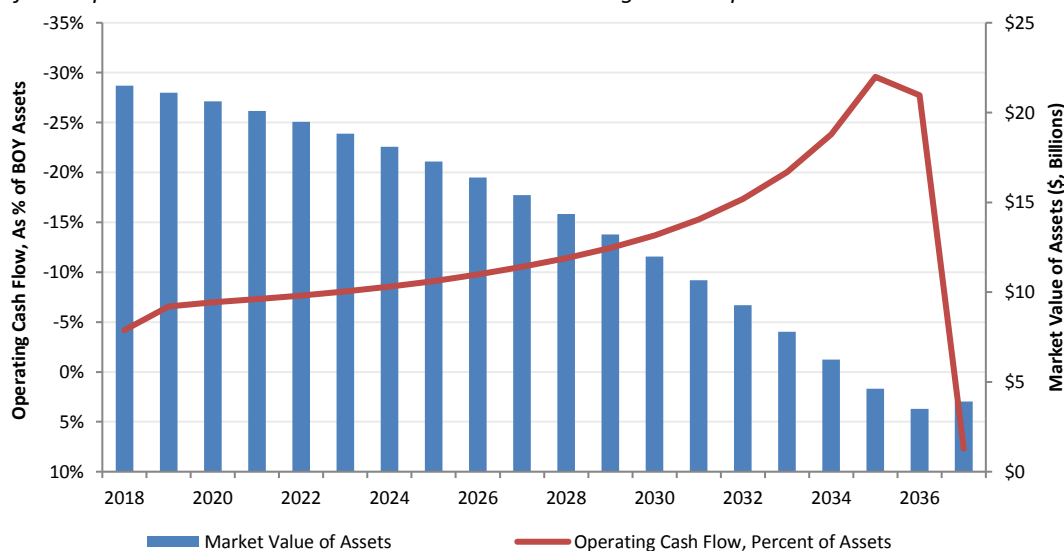
Note: Assumes actual investment returns of 5 percent and employer contributions are fixed as a percentage of own source revenue (sustainable budget). **Sources:** The Pew Charitable Trust and The Terry Group, based on publicly available comprehensive annual financial reports, actuarial reports and valuations, or other public documents, or as provided by plan officials.

Figure 16

Kentucky's Projected Employer Contributions and Pension Debt

Under fixed 5 percent total returns and state policy assumption
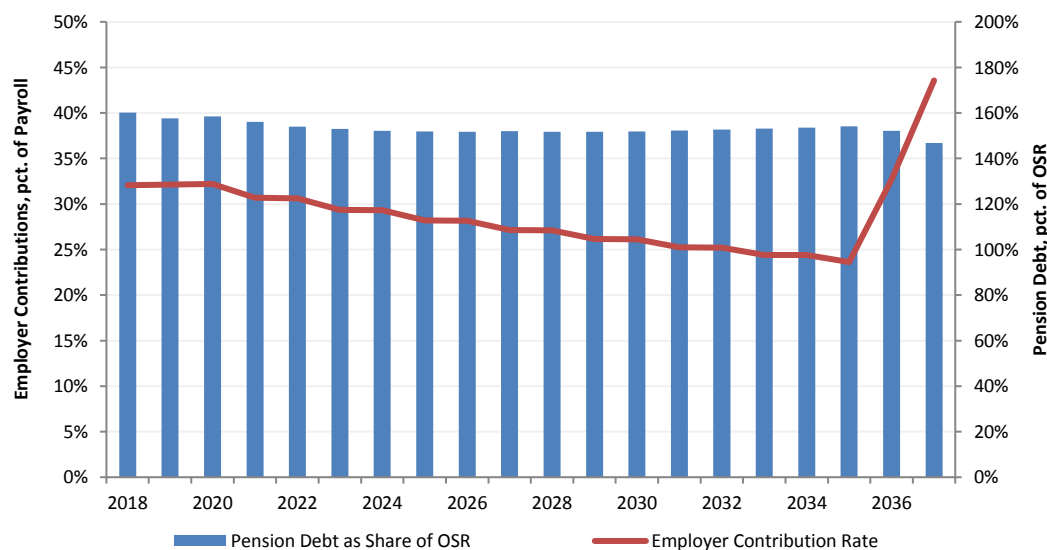
Note: Assumes actual investment returns of 5 percent and that state adheres to current funding policies or statutes as written (state policy). **Sources:** The Pew Charitable Trust and The Terry Group, based on publicly available comprehensive annual financial reports, actuarial reports and valuations, or other public documents, or as provided by plan officials.

Pennsylvania and Connecticut: *Risk of Permanent High Costs*

Along with New Jersey and Kentucky, the pension plans in Pennsylvania and Connecticut have funded ratios that rank among the lowest in the nation. But, in contrast, Pennsylvania and Connecticut are in nominally better shape, thanks to recent reforms in which both states increased contribution rates to more than 30 percent of payroll (see **Figure 17**). That said, our stress test simulations found that both states are likely to see these current high levels of cost persist for as long as 50 years if returns fall short of expectations.

Figure 17

Employer Contribution Rates for Pennsylvania and Connecticut Over Time

Under current plan assumptions for both states
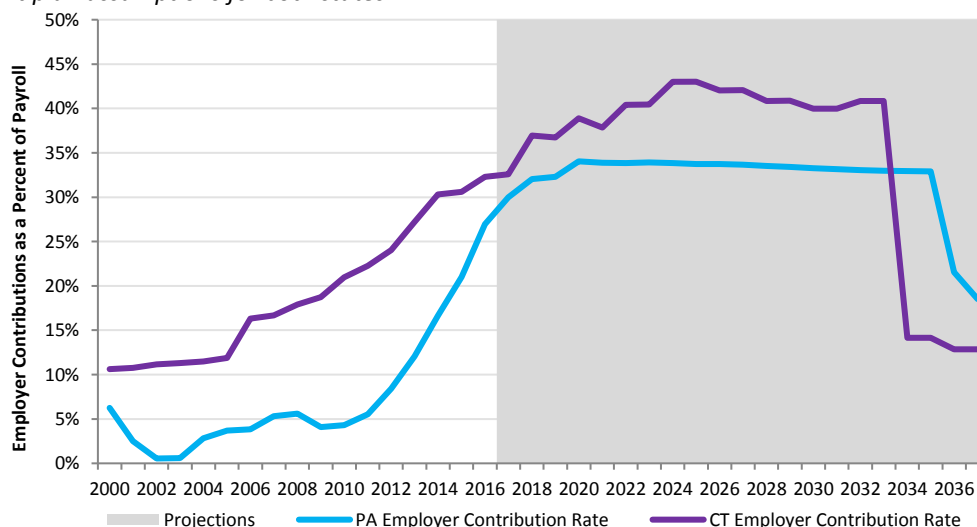
Sources: The Pew Charitable Trust and The Terry Group, based on publicly available comprehensive annual financial reports, actuarial reports and valuations, other public documents, or as provided by plan officials.

We reached this conclusion by conducting a deterministic simulation and using the same fixed 5 percent return scenario used to evaluate New Jersey and Kentucky. If Pennsylvania and Connecticut follow their state policy assumptions, both would face substantial increases in cost that could further limit budget capacity for other state spending. As a result, there is a significant risk that state officials will modify current policy to mitigate further spikes in pension costs by extending amortization schedules. Should that occur, costs and unfunded liabilities could remain at, or around, current levels until well beyond the 30-year forecast period.

Pennsylvania

From 2000 to 2016, Pennsylvania's pension systems went from a $16 billion *surplus* to a $69 billion *deficit*. This $85 billion deterioration in fiscal position was caused by persistent underfunding, lower-than-expected investment returns, and one of the largest unfunded benefit

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increase that any state has implemented.[37] In response, the state has enacted two rounds of reform since the financial crisis, dramatically ramping up employer contributions to stabilize pension financing and shifting new workers to a risk-managed hybrid plan to lower taxpayer risk.[38]

We estimate that current levels of high cost are likely to persist for decades in a scenario with significantly lower returns, because further increases in required state contributions may be unaffordable. Specifically, if returns are lower under the fixed 5 percent return scenario, we estimate that contributions would increase from 32 percent to 41 percent within the forecast period. This increase is equivalent to approximately 8 percent of state revenue (see **Figure 18**).

Figure 18

Pennsylvania's Projected Employer Contributions and Pension Debt

Under the fixed 5 percent returns scenario and the state policy assumption
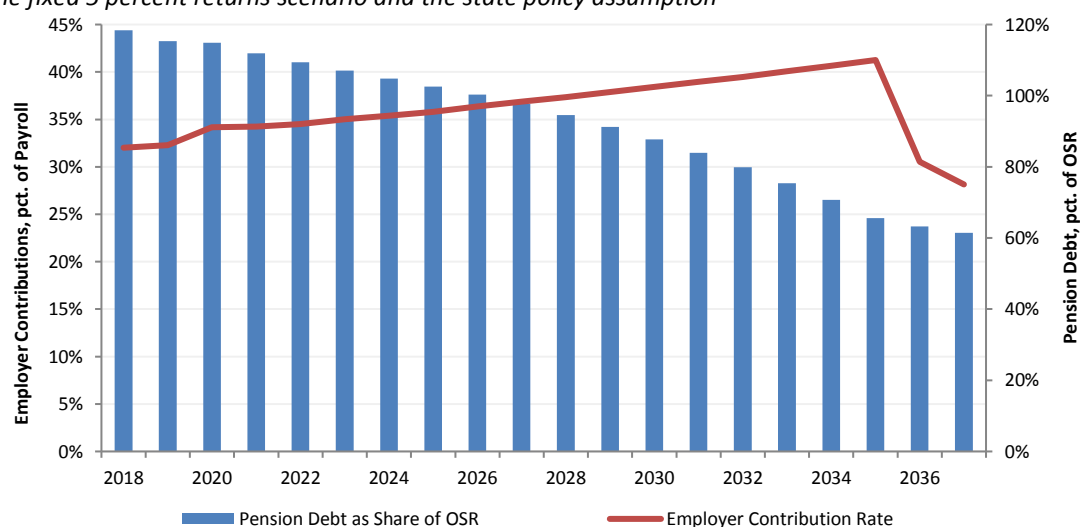
Note: Assumes actual investment returns of 5 percent and applying the assumption that the state adheres to current funding policies or statute as written (state policy). **Sources:** The Pew Charitable Trust and The Terry Group, based on publicly available comprehensive annual financial reports, actuarial reports and valuations, other public documents, or as provided by plan officials.

The additional increases in funding required by Pennsylvania's current policy under a 5 percent return scenario may prove difficult. The rapid escalation in funding over the past five years is already the largest any state has implemented over that time frame, and, in the absence of increased resources, has displaced approximately $10 billion in other government spending.[39] As such, the legislature's willingness to further increase spending on pensions is likely to be limited if it were to crowd out spending for other core government services.

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[37] See Act 9 in 2001 and Act 38 in 2002 of the Pennsylvania General Assembly contained significant retirement benefit enhancements for workers in the Public School Employees Retirement System (PSERS) and the State Employees Retirement System (SERS) plans.

[38] Act 120 in 2010 reduced benefit levels for SERS and PSERS new workers starting on or after July 1, 2011; and shared risk by requiring additional contributions if investment returns targets are not met. Act 5 in 2017 introduced two new hybrid retirement plans for all new SERS and PSERS workers hired on and after January 1, 2019.

[39] Estimate based on Pew's analysis of employer costs for the state and teacher plans as reported in the actuarial valuations from 2012 to 2016.

Because of this, we project that higher unfunded liabilities and payments well above the 25 percent of payroll benchmark identified in the Methodology section, will continue beyond the current forecast period. This result provides a direct and sobering response to research question number two on the impact of investment shortfalls on pension costs. For states like Pennsylvania with low funded levels that may already be at budget capacity for funding pensions, it may be difficult for their retirement systems to achieve fully funded status and the attendant reduction in costs within a 30-year time horizon if returns fall short of current targets. As a result, the state's continued attention to managing unfunded liabilities, including a current study to lower investment fees and to adopt regular stress test reporting, is essential.

Connecticut

The root cause of Connecticut's 41 percent funded ratio, among the lowest across the 50 states, was a considerable delay in adopting sufficient actuarial pre-funding policies for its state employee and teacher pension plans.[40] Like Pennsylvania, Connecticut improved funding practices in recent years — making 100 percent of ARC payments for over a decade — and also adopted a hybrid plan for state workers in 2017.[41]

The stress test results for Connecticut's retirement systems highlight the positive effect of higher contribution rates in staving off the risk of insolvency. Under the fixed 5 percent return scenario with sustainable budget contributions, for example, asset levels still increase over time. However, like Pennsylvania, projected outcomes under the state policy assumptions also highlight the risk of high long-term costs.

If Connecticut were to follow its current state funding policy under the fixed 5 percent return scenario, the required contribution rate is projected to reach over 80 percent of payroll during the 20-year forecast period (**Figure 19**). This spike would push pension contributions from 14 percent to over 20 percent of annual revenue, consuming more than $1 billion of addition available revenue on an annual basis. Adherence to such a substantial schedule of payments is highly unlikely. Indeed, our analysis found required contributions closely mirror or exceed the state's tolerance for payment — as defined in the Methodology section of this analysis — throughout much of the forecast period under this scenario.[42]

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[40] Aubry, J., & Munnell, A. (2015). *Final Report on Connecticut's State Employees Retirement System and Teachers' Retirement System*. Center for Retirement Research at Boston College.

[41] Projections Report of the Actuary on the 2017 SEBAC Agreement posted by the Office of the Governor of Connecticut, available here: http://portal.ct.gov/-/media/Office-of-the-Governor/Press-Room/20170606-SEBAC-2017-Projections-Report-of-the-Actuary.pdf?la=en.

[42] This finding reflects the combined result for the Connecticut's State Employees Retirement System (SERS) and Teachers Retirement System (TRS) which now follow significantly different funding policies.

Figure 19
Connecticut's Projected Employer Contributions and Pension Debt
Under the fixed 5 percent returns scenario and applying the state policy contribution assumption
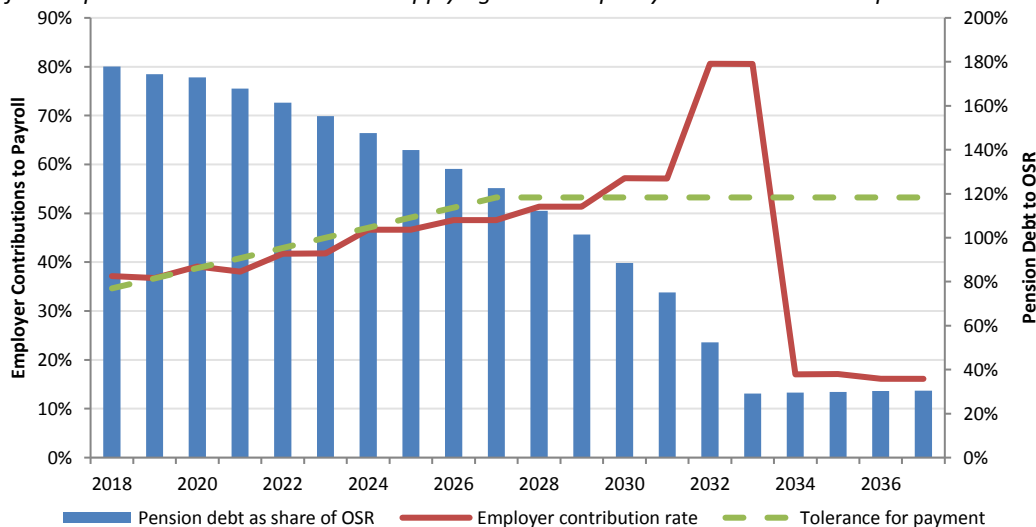
Note: Assumes actual investment returns of 5 percent and that the state adheres to the current funding policies or statutes as written (state policy). The tolerance for payment assumes that over 10 years payments as a share of payroll cannot grow by more than 50 percent of OSR.
Sources: The Pew Charitable Trust and The Terry Group, based on publicly available comprehensive annual financial reports, actuarial reports and valuations, or other public documents, or as provided by plan officials.

The clear finding for Connecticut is that market downturns could increase that cost beyond the state's capacity to pay under the current funding policy. As a result, current high costs are likely to persist for decades under scenarios where investments underperform.

Colorado and Ohio: *Greatest Uncertainty*

What sets Colorado and Ohio apart from the other eight states analyzed here is their fixed-rate funding policies, which are based on a set percentage of covered payroll and do not provide a mechanism for increasing state contributions to offset the effect of market downturns. This contrasts with other states that employ actuarial funding methods that respond to increases in unfunded liabilities by prescribing higher contributions.

The consequence of this inflexible approach to funding pension obligations is reflected in historical results and reinforced through the stress test results for both states. In Colorado, persistent underfunding explains most of the rapid decline in fiscal position between 2000, when the state reported a funded ratio of more than 100 percent, to the 2016 reported figure of only 52 percent. Pension finances in Ohio are more stable, as their primary response to growing unfunded liabilities was the enactment, following the Great Recession, of one of the largest reductions in pension benefits any state has implemented.

Looking forward, both states' fixed-rate funding policies cause heightened uncertainty around how policymakers will address unfunded pension liabilities if future investment returns are lower than expected. Of the 10 states studied here, Colorado and Ohio face the greatest fiscal uncertainty over the next 20 or 30 years, with Colorado facing a significant risk of fiscal distress.

To reach this conclusion, we conducted a deterministic analysis using the fixed 5 percent return scenario and kept contributions at budget sustainable levels. The output from the stress test model forecasts a 51 percent reduction in pension fund assets over 20 years for Colorado, which is a clear early indicator of fiscal distress (see **Figure 20**). Although recent policy changes in Ohio prevent the state's pensions from similar projected insolvency, the funded ratio for Ohio would drop to just 54 percent and operating cash flow would approach -6 percent over the same period. These findings are based on the same sustainable budget framework used for previous states, which assumes contributions remain fixed as a percentage of revenue.[43]

Figure 20

Colorado's Projected Assets and Operating Cash Flow

Under fixed 5 percent return scenario and applying the sustainable budget contribution assumption
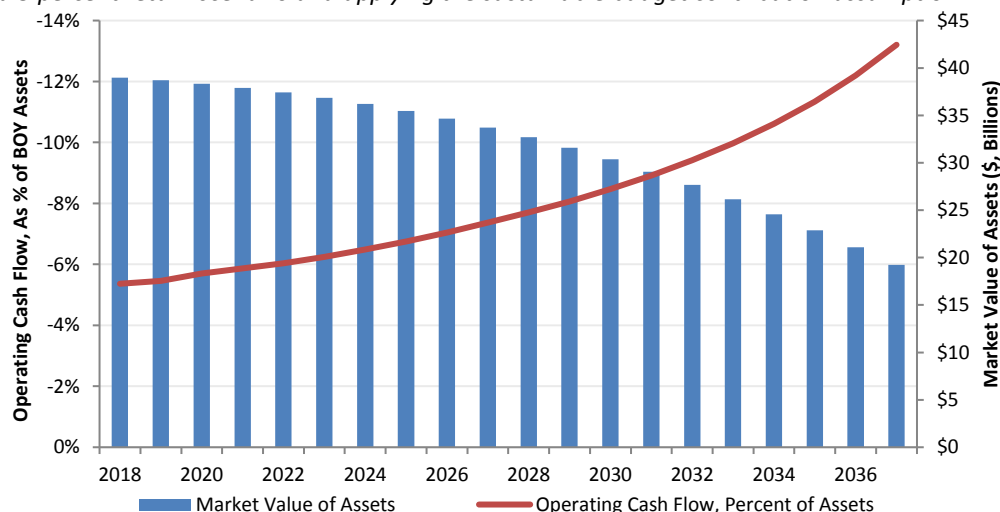
Note: Assumes actual investment returns of 5 percent and employer contributions are fixed as a percentage of own source revenue (sustainable budget). **Sources:** The Pew Charitable Trust and The Terry Group, based on publicly available Comprehensive Annual Financial Reports (CAFRs), actuarial reports and valuations, or other public documents, or as provided by plan officials.

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[43] Because the fixed rate funding policies for both Colorado and Ohio are tied to payroll (which is projected to grow slower than revenue) the results based on the budget sustainable scenarios reflect a more optimistic outlook for employer contributions and slightly better results than under the state policy scenario, based on existing fixed rate funding policies. See Appendix I for a full description of the contribution scenarios and Appendix I.

Colorado

There is clear evidence that Colorado's fixed-rate funding policy, which sets employer contributions at 19.13 percent of payroll for the state and school divisions, has contributed to Colorado's deteriorating fiscal position.[44] Between 2000 and 2016, the state's funded ratio fell from over 100 percent to 46 percent, causing the state to drop from 15th to 46th in pension funding across the 50 states. In response to the system's funding crisis, Colorado policymakers adopted legislation in 2010 with the goal of putting these systems on a path to full funding within 30 years.[45] However, in 2015, an independent consultant hired by the state conducted a stress test analysis on the impacts of the 2010 reforms which projected about a one-in-four chance that, without additional policy intervention, at least two of the PERA plans could face technical insolvency.[46]

The results of our stress test analysis are consistent with this finding as well as a more recent estimate of insolvency risk published by PERA plan actuaries: an estimated 20 percent to 23 percent probability of technical insolvency under current policy for the state and school divisions.[47] In fact, plan actuaries forecast insolvency for Colorado PERA state and school divisions by 2041 assuming a 5.75 percent return or less, while our projections at a 5 percent rate of return with similar contribution policy assumptions result in asset depletion by 2042.[48]

The consistent result is not surprising. The estimates of the real return on assets in our capital market assumption model track closely to those supplied by consultants hired by the state (**Figure 21**). The differences in return distribution between our typical portfolio and Colorado's are driven by asset allocation, a longer projection horizon, and slight differences in expected investment performance and volatility for individual asset classes.

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[44] The total employer contribution rate of 19.13 percent includes 9.13 percent in the base employer contribution rate for pensions, plus a total of 10.00 percent for the Amortization Equalization Disbursement (AED) and the Supplemental Amortization Equalization Disbursement (SAED).

[45] The reforms increased the age of retirement for some employees, required higher contributions from workers and employers, and reduced post-retirement cost-of-living adjustments (COLAs) for retirees. The 2010 reforms saved the state an estimated $15 billion over the five years after passage. See Colorado PERA's Senate Bill 10-001 Report from December 2015 for details on the 2010 legislative reforms and impacts.

[46] Eason, B. "*Lower PERA benefits, higher taxpayer and worker contributions proposed to close Colorado pension system's $32 billion gap" The Denver Post*, Sept. 22, 2017, http://www.denverpost.com/2017/09/22/colorado-pension-system-32-billion-gap/

[47] See the 2015 Actuarial Valuation and pages 40-41 from the August 22, 2016 Cavanaugh Macdonald presentation to the Colorado Legislative Audit Committee on the valuation results; Technical insolvency is defined as less than 20 percent funded.

[48] Estimates based on projections provided by plan officials to Pew from the 2016 actuarial valuation for PERA which forecasts insolvency for Colorado PERA state and school divisions by 2041 assuming a 5.75 percent return or less. Similarly, our projections using fixed 5 percent rate of return with the state contribution policy assumption applied results in asset depletion by 2042. It should be noted that at the time of this writing, Colorado had not published audited 2017 investment return figures, but the state's returns have tracked closely with the Wilshire TUCS median return over the last several years. As such, we used this value as a proxy for 2017.

Figure 21

Colorado's Distribution of Returns Compared with Typical Portfolio under Stochastic Simulation

Typical portfolio has expected return of 6.4 percent compared with Colorado's 7.1 percent
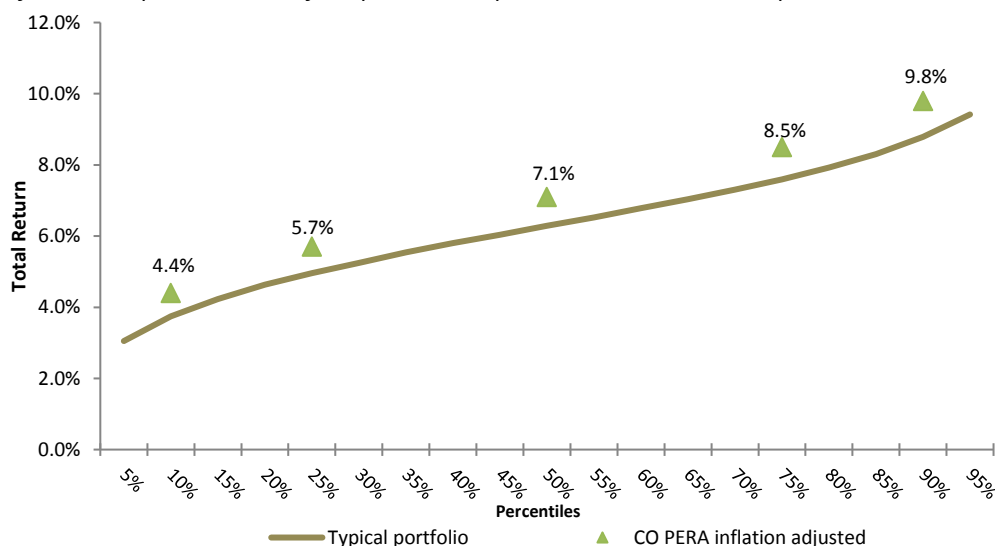
Notes: Labels are for returns at the 10th, 25th, 50th, 75th, and 90th percentile. Colorado shows distribution of returns over 40 years with inflation adjusted to 2 percent. Typical portfolio has 51 percent stocks, 27 percent fixed income/cash, and 22 percent in alternatives (i.e. private equity and real estate) and distribution is over 30 years. **Sources:** The Pew Charitable Trusts, The Terry Group, and Pension Trustee Advisors (October 2015).

Given these results, the state is currently considering additional reforms that would require increased employee and employer contributions as well as cuts to benefits for current employees and retirees. At the time of this writing, a reform bill that includes these changes — as well as a requirement that stress test be performed on a regular basis — is awaiting signature by the Governor.[49] We estimate that the reform would largely address the insolvency risk issues first identified by the state via stress test analysis.

In fact, Colorado's reform experience over the last decade represents the strongest example to date of applying stress testing simulation to inform pension reform discussions, and validates the findings and central recommendation of this paper.

Ohio

Like Colorado, Ohio state statute establishes a flat maximum employer contribution rate toward retirement benefits of 14 percent of payroll. However, in contrast to Colorado, the state's current fiscal position is representative of the national average with a 2016 funded ratio of 72 percent. The state's more favorable position compared with Colorado's is largely the result of reforms implemented in 2012 that reduced benefits for both future and current workers — a result of a

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[49] Continued monitoring to ensure that reform requirements are being followed is especially important in Colorado because of a constitutional amendment known as the Taxpayers' Bill of Rights (TABOR). TABOR severely limits the state's budget capacity and makes it much more difficult for Colorado, in comparison with nearly any other state, to raise pension contributions without a direct and corresponding cut to other lines in the state budget.

pension legal framework that provides weaker legal protections for worker benefits than other states.[50] In the year following the reform, Ohio's reported liability fell by over $9 billion, the second-largest year-over-year decrease experienced by any state since 2000.[51]

However, in the face of another economic downturn, these reforms may not be adequate to protect Ohio's retirement system. The results under a fixed 5 percent return, sustainable budget scenario show Ohio's funding levels and plan assets declining over time. Indeed, the Ohio Public Employees Retirement System (OPERS) would hit insolvency in 2056 under this scenario, and the Ohio State Teacher Retirement System (STRS) would see funding levels drop from 75 percent funded to 56 percent funded.

Ohio's Projected Assets and Operating Cash Flow
Under the fixed 5 percent return scenario and applying the sustainable budget contribution assumption
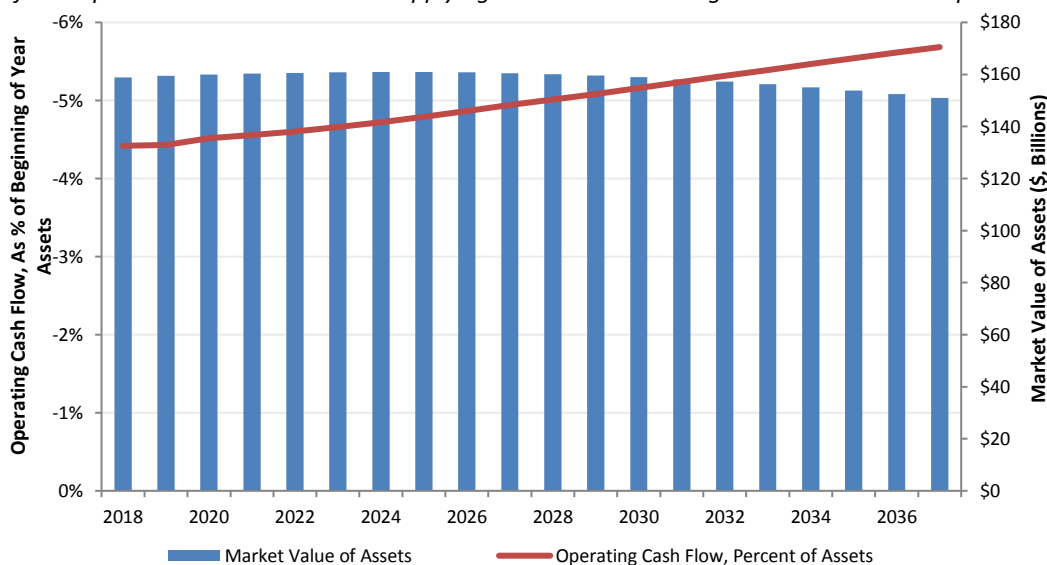
Note: Assumes actual investment returns of 5 percent and employer contributions are fixed as a percentage of own source revenue (sustainable budget). **Sources:** The Pew Charitable Trust and The Terry Group, based on publicly available Comprehensive Annual Financial Reports (CAFRs), actuarial reports and valuations, or other public documents, or as provided by plan officials.

Both Colorado and Ohio have taken measures to address eroding fiscal health; however, neither state has built-in policies to adjust to market downturns or react to changing economic circumstances. If investments fall short in the future, both states could once again face potential insolvency. As demonstrated below with Virginia and South Carolina, adequate actuarial funding policies can be instrumental in maintaining funding in uncertain and volatile investment climates.

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[50] In 2012, Ohio modified current state worker and teacher benefits by lowering the multiplier awarded at later years of service, reducing COLAs, and tightening retirement eligibility (for state workers the retirement age was raised from age 65 with 5 years of service to age 67 with 10 years of service (YOS) and for teachers it was modified to ultimately reach age 60 with 30 YOS and age 65 with 5 YOS. In addition, the reform gradually increased contribution rates for teachers from 10 to 14 percent of pay.
[51] Based on Pew's database of state and local public retirement systems.

Virginia and South Carolina: *Impact of Volatility on Costs*

In contrast to Colorado and Ohio, Virginia and South Carolina follow actuarial funding policies crafted with the goal of achieving a 100 percent funded ratio by a targeted date, a practice that is typical across most states. This is a primary reason that Virginia and South Carolina face limited risk of fiscal distress over our forecast period under the fixed 5 percent return scenario. However, the results diverge under the asset shock economic scenario, and even more so when more sophisticated stochastic simulation methods are applied.

South Carolina is more at risk of fiscal distress than Virginia given its weaker fiscal position — the state has a funded ratio of only 52 percent, ranking 41st among states. Under an asset shock scenario, this creates a heightened risk of insolvency.

In comparison, Virginia tracks more closely to the national average with a 72 percent funded ratio. As a result, stress test results under both the fixed 5 percent return and asset shock scenarios do not indicate fiscal distress. However, stochastic simulation reveals that Virginia's funding policy could result in significantly higher volatility in required contributions over time.

Virginia
In Virginia, we see the impact of recent contribution increases in the form of fiscal stability over a range of scenarios, even under the fixed 5 percent return scenario in which the state makes only sustainable budget contributions. Though the state's fiscal position worsens considerably under these conditions — with the funded ratio declining to 62 percent in 2037 — fiscal distress is not evident over the forecast period (**Figure 23**).[52] In addition, benefit reforms enacted in 2014, which place new workers in a hybrid retirement plan, mitigate a portion of the increase in employer contributions that would otherwise occur, and will help to make pension costs somewhat more predictable for the state over time.

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[52] The projections for Virginia include the state portions of the state and teachers plans and do not include the political subdivision plans. Cities and towns are required by state law to make full actuarial payments, even in years in which the state is underfunding the main state pension plans, and, in the case of Virginia, including local employers had relatively immaterial impacts on the results or projections presented in this analysis.

Figure 23

Virginia's Projected Unfunded Liability and Funding Levels

Under fixed 5 percent returns scenario and applying the sustainable budget contribution assumption
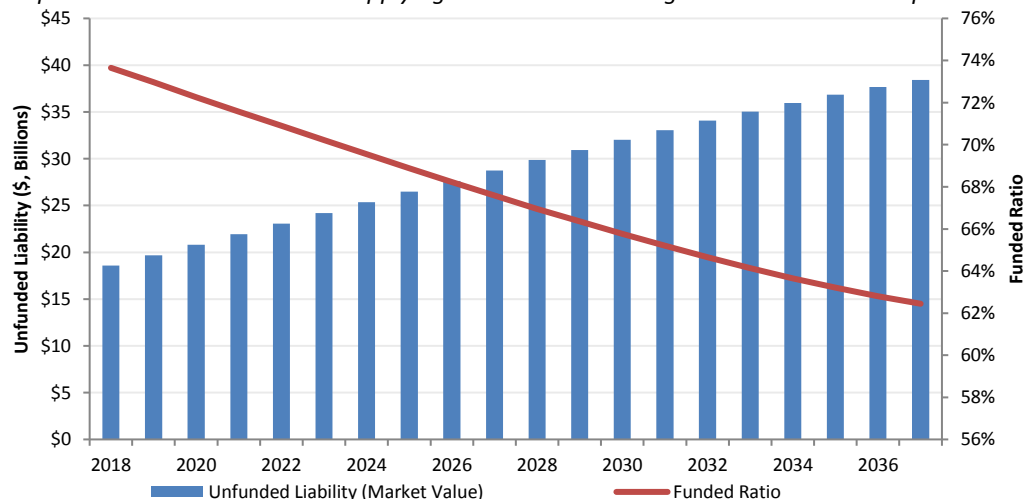
Note: Assumes actual investment returns of 5 percent and employer contributions are fixed as a percentage of own source revenue (sustainable budget). **Sources:** The Pew Charitable Trust and The Terry Group, based on publicly available comprehensive annual financial reports, actuarial reports and valuations, other public documents, or as provided by plan officials.

South Carolina

Results for South Carolina are similar to those of Virginia, except when we introduce the asset shock scenario. Under these conditions, we forecast fiscal distress within 20 years — with assets plummeting by more than two-thirds and the operating cash flow ratio dropping to negative 40 percent (**Figure 24**). It is important to reinforce that this analysis assumes the state keeps employer contributions stable as a share of own source revenue, which leaves out scheduled increases in contributions based on legislation passed in 2017.[53] Simulations using the state policy contribution assumption — which includes these increases — are provided in Appendix II, and result in higher asset balances and improved funded ratios relative to those in **Figure 24**. The results for South Carolina provide another example of how forward-looking stress test analysis can help to ensure that policymakers develop and stick to well-designed funding policies in each annual budget.

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[53] The 2017 reforms package included provisions to lower the assumed rate of return for the pension plans from 7.5 to 7.25 percent, increases to employee contributions capped at 9 percent, and a schedule to increase employer contributions by two percentage points to 13.56 percent, then one percentage point each year after until reaching 18.56 percent in 2022. Our analysis includes required employer contributions toward the defined benefit for each worker, regardless of whether the employee elects to participate in the voluntary defined contribution plan or not.

Figure 24

South Carolina Projected Assets and Operating Cash Flow

Under asset shock scenario and sustainable budget contribution assumption
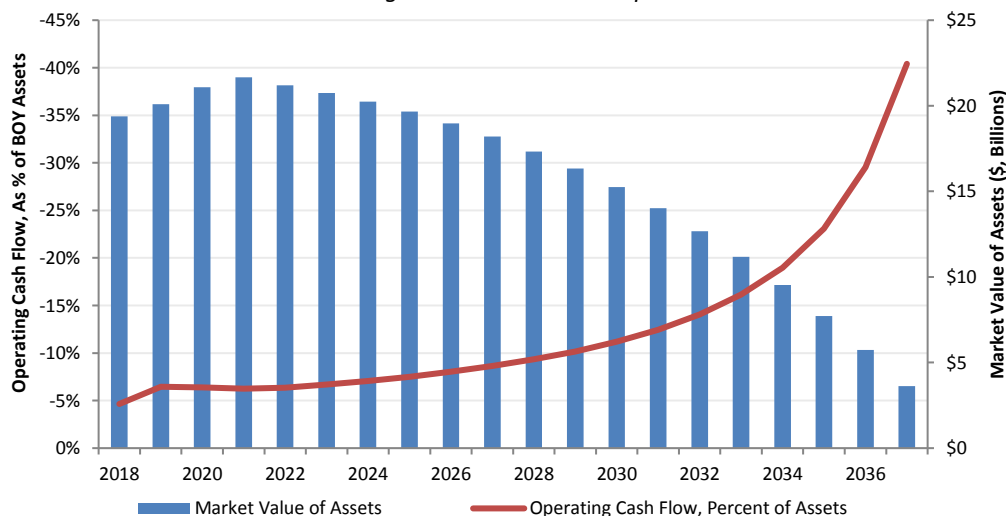
Note: Assumed asset shock scenario and employer contributions are fixed as a percentage of own source revenue (sustainable budget). **Sources:** The Pew Charitable Trust and The Terry Group, based on publicly available comprehensive annual financial reports, actuarial reports and valuations, other public documents, or as provided by plan officials.

Introducing Stochastic Analysis

The results above for Virginia and South Carolina are based on deterministic simulations that provide a wealth of information with which to assess the likelihood of fiscal distress (RQ1) and the impact of lower returns (RQ2). However, we must be attentive to the fact that the world does not behave in a deterministic fashion and that swings in the financial markets can also lead to volatility in pension costs. There are two reasons for this: the magnitude and timing of investment shortfalls; and the design of states' contribution policies.

Stochastic modeling allows us to examine both of these factors by simulating thousands of trials that forecast the variations of possible returns on assets and asset classes over time. **Figure 25** illustrates the variation in returns in Virginia from three such trials. Each trial has a 20-year return of 6.4 percent (our median capital market assumptions return) but differ in how they get to that point, with gains and losses reflecting the volatility of investment markets.

Figure 25

Stochastic Projection of Investment Returns for Virginia over a 20-Year Period

Trials averaging 6.4 percent over 20 years show volatility of returns over time
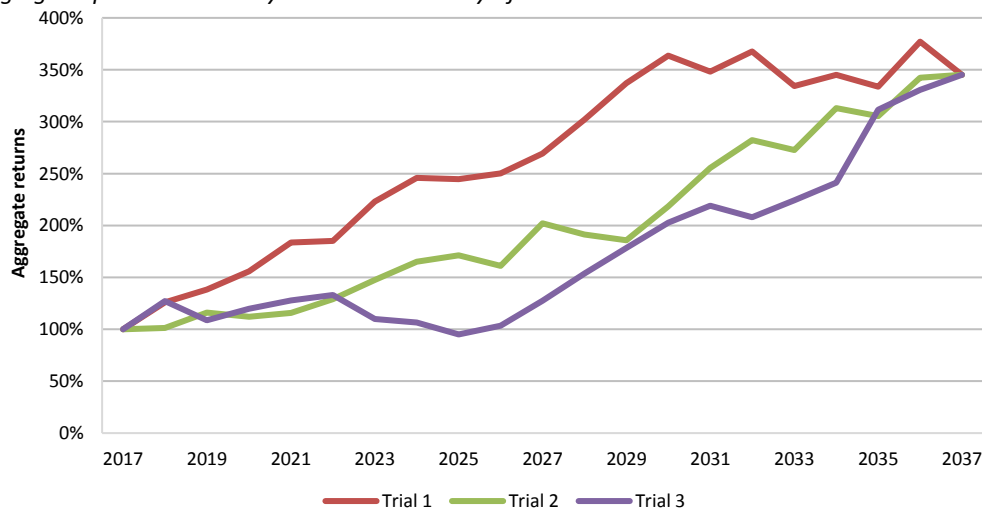
Note: Each line shows the total growth of a dollar in plan assets from investments. By 2036, in all three of the trials, that dollar value is projected to grow by 345 percent for an annual growth rate of 6.4 percent. **Sources:** The Pew Charitable Trust and The Terry Group, based on publicly available comprehensive annual financial reports, actuarial reports and valuations, other public documents, or as provided by plan officials.

The different paths towards 20-year returns of 6.4 percent provide an illustrative example of financial market volatility based on a consistent set of capital market assumptions, as discussed in the Methodology section. This variation can result in significant swings in annual required contributions, depending on the state's specific funding policy. This variability in cost can best be illustrated by comparing outputs for stochastic and deterministic simulations for the same rate of long-term returns.

For Virginia, we evaluated results based on both rates of return suggested by our capital markets analysis for the state, as well as the plan's assumed rate of 7 percent. Over the next 20 years, total employer contributions for Virginia pension plans are expected to equal 12.4 percent of payroll, if returns are precisely 7 percent (the plan's assumption) each year. In contrast, examining 10 stochastic simulations where investment performance varies each year, shows total contributions over the projection period ranging from 9.1 percent to 18.7 percent of payroll. In other words, costs can increase by as much as 50 percent over the expected 12.4 percent employer contribution rate, under a scenario in which the 20-year assumed rate of return is met, but rates fluctuate year-over-year. Results assuming a 6.4 percent return (50th percentile using common capital market assumptions) and 4.9 percent (25th percentile) indicate similar levels of contribution volatility for Virginia.

Figure 26

Projected Impact of Volatility of Cost for Virginia Compared with South Carolina

Funding policy has significant impact on range of required contributions
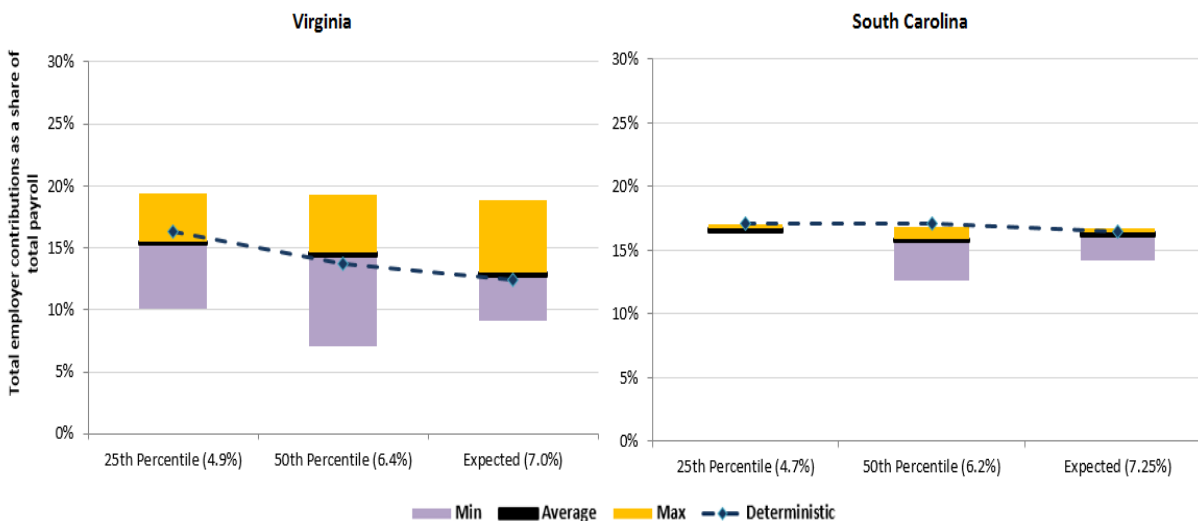
Note: 20-year projected contributions at different returns. **Sources:** The Pew Charitable Trust and The Terry Group, based on publicly available comprehensive annual financial reports, actuarial reports and valuations, other public documents, or as provided by plan officials.

Stochastic analysis for South Carolina yields a strikingly different result than that for Virginia: the range of possible costs clusters tightly around the employer contribution rate estimated in the deterministic simulation (**Figure 26**). The primary factor limiting cost volatility in South Carolina is its funding policy. Unlike Virginia, which sets contributions based on the latest actuarial valuation and allows for required payments to either increase or decrease to offset return volatility, South Carolina sets a contribution floor, but otherwise keeps the contribution rate relatively stable. Specifically, the state's funding policy does not automatically adjust contributions downward to account for investment gains unless the plan is fully funded; nor does it adjust them upward to offset investment losses, unless the new funding level falls below the contribution floor. In other words, contribution rates and total contribution amounts are *designed* to be less volatile.

A key finding of the stochastic analysis is that well-designed funding policy can mitigate much of the cost volatility caused by the amount or timing of investment shortfalls. We conclude that states can, in fact, solve for a fair amount of uncertainty with well-drafted contribution policies. Like South Carolina, states can construct funding policies that explicitly maintain adequate funding levels during good economic times to create a cushion, or surplus, to protect against contribution shortfalls during economic downturns.

North Carolina and Wisconsin: *Policies to Manage Cost and Volatility*

Retirement systems in North Carolina and Wisconsin have consistently ranked among the best-funded public pensions in the U.S., with 2016 reported funded ratios of 88 percent and 99 percent, respectively.[54] For this reason, North Carolina and Wisconsin are at a minimal risk of fiscal distress. Both have maintained a commitment to fiscal discipline and have enacted policies that strengthen the financial position of their public plans. However, the two states have achieved fiscal health through different paths, which are reflected in different projected results under stochastic analysis.

North Carolina

North Carolina has maintained its full-funded status through strict adherence to an actuarial funding policy that is much more robust than that of a typical state pension plan. The policy requires that the state increase contributions to offset – or amortize - any increase in the unfunded liability over 12 years using level payments. This compares favorably with the average state amortization period of 25 years or more, and the less restrictive percent of payroll model utilized by other states. More recently, North Carolina also adopted a policy that would steadily increase contributions as a share of payroll for the next 20 or more years, even if investments meet their targets.[55] Collectively, these policies are projected to result in annual increases in state contributions averaging 4.9 percent over 20 years. If state policymakers follow this policy and the state achieves the target rate of return, North Carolina could expect a surplus of about $61 billion by 2037, making the state particularly well suited to withstand economic downturns.

Even in the absence of adherence to these strict contribution policies, under the sustainable budget assumption — in which contributions are projected to only increase at the same rate as revenues — North Carolina would not be at risk of insolvency under a fixed 5 percent return scenario. Under these conditions, we project that the state's funded ratio would drop to approximately 70 percent over 20 years, with unfunded liabilities increasing by $30 billion over that time frame. Yet, such an outcome would very likely still place North Carolina among the best-funded states under that scenario. This result provides further evidence that setting and following a well-designed contribution policy is one of a state's best protections against fiscal distress and cost volatility in the future.

However, the potential for unaffordable increases under the state policy contribution assumption is more pronounced relative to that of other states we've examined, as demonstrated by the results of stochastic simulation. For example, looking at 10 trials with returns that average over 20 years to the plan's expected return of 7.2 percent, North Carolina's costs range from 14 to 19 percent of payroll, with an average contribution rate of 16 percent. The results when assuming 6 percent returns (50th percentile using North Carolina's asset

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[54] The Pew Charitable Trusts (2018). *The State Pension Funding Gap: 2016.*

[55] As described in the 2016 actuarial valuation for NC TSERS, the Employer Contribution Rate Stabilization Policy requires increases in the contribution rate of 0.35 percentage points each year, with the rate never going below the actuarially determined contribution rate and never going higher than the actuarially determined rate calculated using discount rate equal to the long-term Treasury bond yield.

allocation and our capital market assumptions), and at a lower return of 4.6 percent (25th percentile), show an even broader range of outcomes than those based on deterministic projections (**Figure 27**).

Projected Impact of Volatility of Cost for North Carolina Compared with Wisconsin
Risk-sharing provisions limit cost volatility for Wisconsin
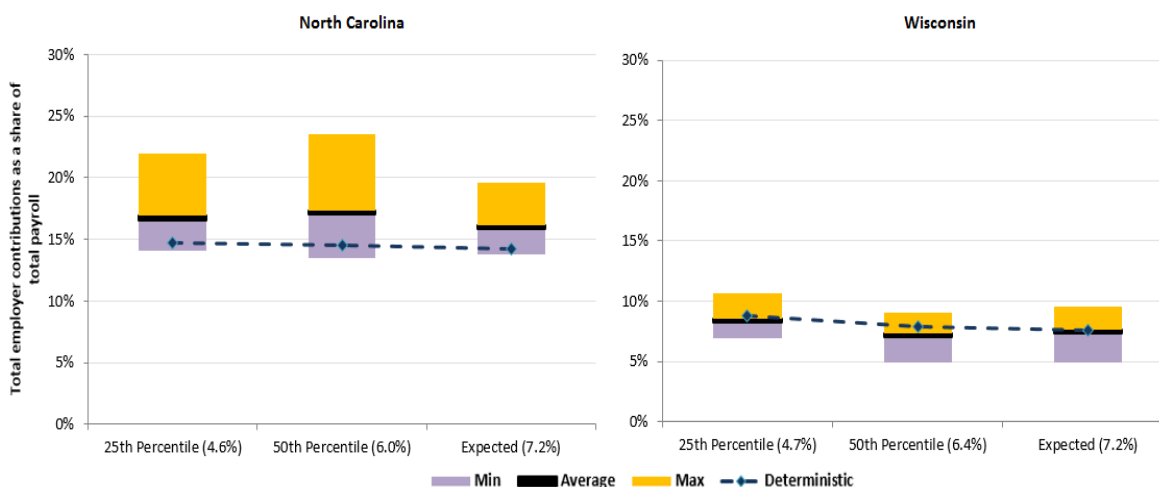
Note: 20-year projected contributions at different returns. **Sources:** The Pew Charitable Trust and The Terry Group, based on publicly available comprehensive annual financial reports, actuarial reports and valuations, other public documents, or as provided by plan officials.

For policymakers in North Carolina, the challenge is how to address the potential for unaffordable spikes in cost resulting from market volatility. In all 10 of the stochastic simulation trials at the 50th percentile, and in most of the trials at the 25th percentile, North Carolina's pension plan reaches full funding under the state's current funding policy. However, employer contributions could rise to more than 20 percent of payroll, nearly double the state's current contribution rate of 10 percent.

Wisconsin
Wisconsin has also demonstrated a commitment to making full actuarial contributions by following a funding policy that calls for addressing unfunded liabilities more quickly than most states.[56] In addition, the state's unique risk-managed defined benefit plan mitigates most of taxpayers' exposure to market fluctuations. Specifically, the plan adjusts employee contributions to account for unplanned costs, as well as sharing gains if investments outperform. The plan also increases and decreases its post-retirement annuity benefits based on returns and funding status.[57]

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[56] Wisconsin calculates pension contributions using a funding method that amortizes unfunded liabilities over the future payroll of active employees, which effectively results in paying off pension debt faster than the 25- to 30-year amortization periods typically used among public pension plans.

[57] The Pew Charitable Trusts. (2017). *Cost-Sharing Features of State Defined Benefit Pension Plans: Distributing risk can help preserve plans' fiscal health*. Available at http://www.pewtrusts.org/en/research-and-analysis/reports/2017/01/cost-sharing-features-of-state-defined-benefit-pension-plan.

Under a fixed 5 percent scenario, we estimate that approximately 75 percent of costs associated with lower investment returns are accounted for through this innovative plan design. Given these risk-sharing provisions, cost uncertainty for Wisconsin's state budget is muted in relation to North Carolina. Additionally, even after 20 years of fixed 5 percent returns and the sustainable budget assumption, Wisconsin remains relatively well funded at over 85 percent.

Stochastic analysis further illuminates this divergence. Wisconsin is expected to have both lower costs and volatility of costs over the next 20 years when compared with North Carolina (**Figure 27**). Across the trials shown, employer costs for Wisconsin can vary by as much as 4.7 percent of payroll over the 20-year projection. In contrast, North Carolina taxpayers could face contribution requirements that vary by almost 10 percent of payroll – or approximately 3.2 percent of state revenue - depending on the timing and volatility of returns. North Carolina shows that a strong contribution policy can ensure the plan is well funded, while Wisconsin shows that cost-sharing policies designed to mitigate risk can make costs more predictable.

The efficacy of risk-management policies in Wisconsin are further reflected in the detailed results for all simulations included in Appendix II. The state's results across our metrics are striking. For example, the employer contribution rate does not exceed 25 percent of payroll in virtually any year under any simulation; and the funding level drops below 80 percent in any forecasted year in less than half of the simulations. Additionally, the largest year-over-year increase in contribution rates across any of the 10,000 simulations we modeled under state policy was less than 4 percent of payroll. However, Wisconsin's policy does result in more variable outcomes for workers — employee contributions will rise or fall depending on plan funding, and investment performance will determine the size of COLAs provided to retirees, or whether COLAs are provided at all.

Although pension funds in aggregate face a tougher challenge now than ever before, North Carolina and Wisconsin demonstrate how, through different policies, states can maintain affordable pension systems with more predictable costs. The results for North Carolina also demonstrate how stress testing can aid policymakers in states with well-funded pension plans by identifying the risks associated with financial market volatility and potential improvements to even the strongest pension funding policies.

IV. Conclusion and Recommendations

The current fiscal position and outlook for state pension systems warrant careful attention. Our analysis demonstrates how vulnerable many state pension systems are to an economic downturn or extended period of low investment returns.

We conclude that states like New Jersey and Kentucky, which are severely underfunded, are at high risk of insolvency. Meanwhile, Connecticut, Pennsylvania, and other states that have undergone pension reforms are better protected against total insolvency, but are likely to experience high fixed costs over the long term. States without adequate funding policies, like Colorado and Ohio, are also at risk of fiscal distress and face the greatest uncertainty around how they will manage volatile financial markets given their fixed-rate funding policies. In effect, these states do not have a plan in place to manage through an economic downturn.

Conversely, states like Virginia and South Carolina, which have actuarial funding policies that adjust in response to lower- or higher-than-expected investment returns, may fare better during periods of market distress, but only if they meet their contribution targets each year. Even for well-funded states with robust policies, like North Carolina, it is unclear if they can fully adhere to those policies during particularly difficult economic periods. Finally, Wisconsin — by designing its pension plan with significant risk-sharing elements in addition to a strong funding policy — serves as an exemplar for managing cost volatility under virtually any scenario.

Traditionally, researchers pointed to aggregate measures such as total unfunded liabilities as a means of assessing the fiscal health of U.S. public pensions, and debate centered on the proper set of assumptions, including discount rates, to accurately calculate this figure. However, we find cash-flow-driven metrics to be more useful as indicators of potential fiscal distress, and that stress test simulation based on comprehensive assumptions to be a more appropriate assessment method.

In contrast with current reporting practices, stress testing allows states to better assess the likelihood of fiscal distress, the potential for permanent high costs, and the effects of market volatility and contribution policies. We find stress test results that are evaluated in relation to state revenues or payroll provide an intuitive benchmark with which to assess costs. In addition, we demonstrate that an analytic framework that includes only the risk of investment shortfalls is inadequate without also simulating a range of contribution behaviors.

We find three key benefits to stress testing, generally:

- First, stress testing can aid administrators and policymakers in planning for the next downturn, as well as protect state plans against the worst possible outcome: insolvency.
- Second, stress testing provides a fuller understanding of the impacts caused by market fluctuations and can inform good funding policies and practices to better manage volatility and ultimately lower costs.

- Finally, stress testing can provide a useful tool for considering a range of possible economic scenarios when scoring proposed reforms.

The lessons learned in this analysis also apply to the 40 states not examined here. As described at the outset, we selected 10 states from across the country to provide a realistic distribution of policies and fiscal positions. Although this allows us to highlight a myriad of different causes and potential solutions to the fiscal challenges state systems face, it also drives home a much simpler and universal conclusion from our research: **Stress testing should be a standard reporting practice for all public retirement systems**.

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Historical Background: Public Pensions Vulnerable to Next Economic Downturn

In aggregate, state and local pension systems have never been more exposed to market volatility, based on fiscal measures and economic outlook

- State and local governments report a larger total pension debt in both absolute terms and as a share of U.S. GDP than any time before the Great Recession (Figure A).
- Pension costs have nearly doubled as a percentage of available state revenue since 2001, when the pension deficit reported by state and local governments in aggregate was approximately zero (Figure B).
- Since the early 1990s, measures of investment risk for pension portfolios have more than tripled, as has the use of higher cost alternative investments, including real estate, private equity, and hedge funds (Figure C).
- As the population ages, and larger shares of public pension plan participants move into retirement, benefit payments will take up a growing share of plan assets and states funds will be less able to absorb unexpected costs and investment shortfalls (Figure D).

Figure A: State and Local Pension Debt as a Share of Gross Domestic Product
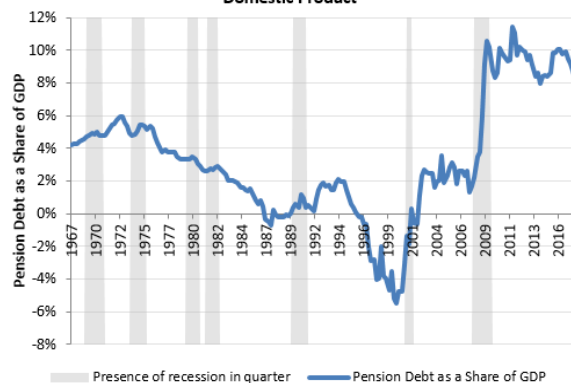
Figure B: Contributions as a Share of Own Source Revenue
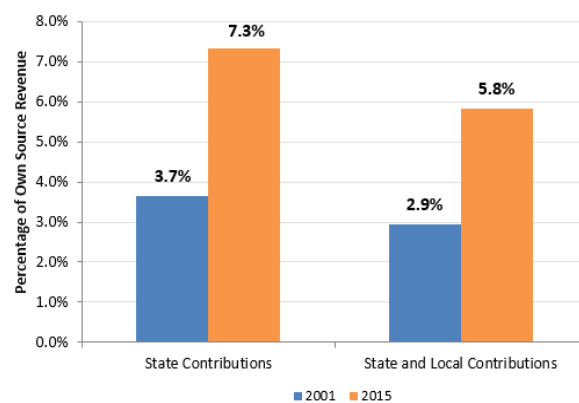
Figure C: Investment Risk: Target Return vs. 30-Year Treasury
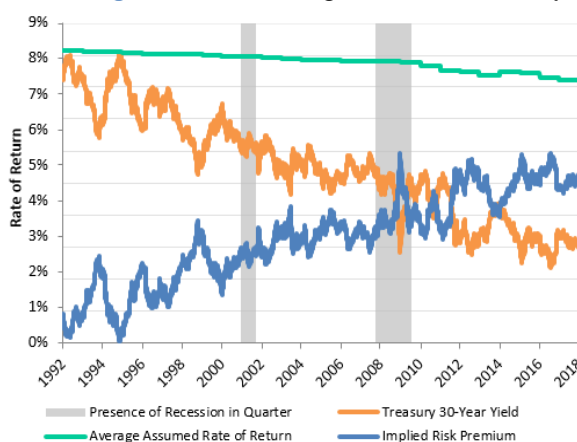
Figure D: Benefits, Contributions and Assets as a Share of Benefits for State and Local Plans
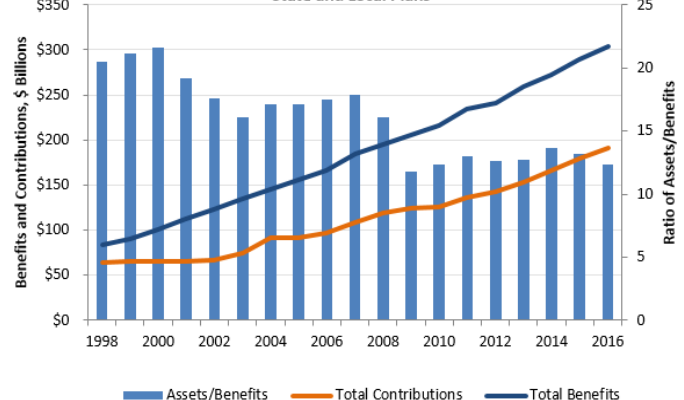
Sources: The Pew Charitable Trusts, based on Comprehensive Annual Financial Reports, actuarial valuations, and related reports from states; U.S. Treasury data; and Center for Retirement Research at Boston College, Center for State and Local Government Excellence, and National Association of State Retirement Administrators, Public Plans Data; the United States Federal Reserves (2018), "Financial Accounts of the United States"; the U.S. Census Bureau's Annual Survey of Public Pensions; and the U.S. Census Bureau's Annual Survey of State Government.

Listing of Public Sector Pension Plans Examined in the Analysis

Colorado Public Employees' Retirement Association — State

Colorado Public Employees' Retirement Association — School

Connecticut State Employees' Retirement System

Connecticut Teachers' Retirement System

Kentucky Employees Retirement System — Hazardous

Kentucky Employees Retirement System — Non-hazardous

Kentucky Teachers Retirement System

New Jersey Public Employees Retirement System — State

New Jersey Teachers' Pension and Annuity Fund

North Carolina Teachers' and State Employees' Retirement Program

Ohio Public Employees Retirement System

Ohio State Teachers Retirement System

Pennsylvania State Employees' Retirement System

Pennsylvania Public School Employees' Retirement System

South Carolina Retirement System

Virginia Retirement System — State

Virginia Retirement System — Teachers

Wisconsin Retirement System

Definitions and Terms

Actuarial required contribution or annual required contribution (ARC): Using plans' own economic and demographic assumptions, the ARC calculation includes the expected cost of benefits earned for the current year and an amount to reduce some of the unfunded liability. Under prior rules, the ARC calculation included in governmental financial statements had to conform to the Governmental Accounting Standards Board's (GASB) regulations, but it is no longer a required disclosure.

Actuarially determined contribution (ADC): A contribution requirement for plan sponsors set by each plan based on actuarial methods and practices. The ADC does not have to comply with the minimum standards used in calculating the actuarially required contribution as defined by the Government Accounting Standards Board (GASB).

Alternative investments: Although there is no fixed definition for alternative investments, they are generally agreed to include private equity, hedge funds, real estate, and some commodities. These investments typically lack an established public exchange, have low liquidity, and can be more difficult to value. Alternative investments usually carry higher fees and can be used to diversify investment portfolios or to achieve higher rates of return, although often at higher levels of risk.

Amortization policy: Rules for how actuaries calculate the amortization period when computing the ARC. Key parameters are how long the employer must pay off the debt (often 30 years), when payments are level or back-loaded (level dollar or level percentage of payroll), and whether the amortization period shrinks each year or resets annually (closed versus open).

Amortize: Make scheduled payments to eliminate pension liabilities over specific period.

Asset allocation: The distribution of assets under management and typically invested by designated asset classes, such as equities, fixed income, or alternatives (which include private equity, real estate, and other complex financial instruments).

Assets: Money on hand to fund benefits. Assets build up over time, generally from three sources: employee contributions, employer contributions, and investment returns. Some plans use actuarial smoothing to acknowledge only unexpected investment gains and losses over a given period — usually five years. Those plans present an actuarial value of assets as opposed to a market value of assets.

Asset shock scenario: Economic scenario used in Pew's stress test analysis that incorporates an initial adverse shock followed by low returns over the long term. The scenario is based on the Federal Reserve's scenarios for stress testing under the Dodd-Frank Act.

Assumed rate of return: The assumed, or expected, rate of return is the investment return target and the result that a pension plan estimates its investment allocation mix will deliver.

Basis point: A commonly used unit of measure (one one-hundredth of one percentage point) of the change in the value of a financial instrument.

Bonds: An instrument of indebtedness of the bond issuer to the holders. It is a debt security, under which the issuer owes the holders a debt and, depending on the terms of the bond, is obliged to pay them interest (the coupon) and/or to repay the principal at a later date, termed the maturity date.

Cash equivalents and short-term investments: Financial investments of relatively short duration that generally present low risk and lower returns but are more liquid than other investments. For pension plans, these can be notes or certificates of deposit.

Cash flow (measures): Metrics used specifically in this analysis, based on the difference between contributions and benefits (operating cash flow) and applied mainly as an early indicator of long-term fiscal solvency. For most public plans, this number will be negative, highlighting how actuarial funding and the maturity of plan demographics leave pension funds dependent on investment returns to maintain asset levels.

Cost-of-living adjustment (COLA): Annual increases to retirees' benefits to help mitigate the effects of inflation. COLAs were historically provided in many public-sector DB plans. They can be fixed increases or based on the consumer price index (CPI) to keep pace with inflation.

Defined benefit (DB) plan: A plan in which the employer promises a specific amount of monthly retirement income based on a formula that typically considers the employee's salary, years of service, and age.

Defined contribution (DC) plan: A plan that provides employees with an individual retirement account that grows through investment of accumulated employer and employee contributions. Annual returns are generally based on investment performance and are not typically guaranteed. DC plans can provide workers with access to annuities upon retirement.

Deterministic simulation: Simulation used in Pew's stress test analysis to illustrate how portfolios perform under precise circumstances of our own design, typically by performing a single trial run for each year in the forecast that strictly adheres to the same user-specified assumptions on investment returns and economic metrics.

Equities: Stocks held by investors that represent ownership in a piece of a company. They can be domestic or international. Equities do not guarantee a specific rate of return and thus are generally riskier than fixed-income investments. But equities also have the potential for higher returns, and shareholders' investments may grow rapidly with the market.

Fixed 5 percent returns scenario: Scenario applied to Pew's stress test analysis that uses a low rate of return over an entire forecast period. The purpose of this scenario is to assess how plans perform when investment returns are lower than expected over the long term.

Fixed income: Investments in which returns are predictable and paid at designated times. These can include domestic or international bonds. Because fixed-income investments generate predictable streams of income, they are generally considered low risk.

Funded ratio: The level of assets at market value in proportion to accrued pension liability. This is an annual point-in-time measure, as of the valuation date.

Gross domestic product (GDP): The total value of goods produced and services provided in a country during one year. GDP is usually calculated on an annual basis.

Gross state product (GSP): The total annual value of a state's output.

Hedge fund: A relatively unregulated private investment fund or pool that trades and invests in various risky assets such as securities, commodities, currency, and derivatives. Available only to sophisticated investors with

significant assets, hedge funds employ several different strategies to earn high returns (either in an absolute sense or over a specified market benchmark) for investors and may be used to diversify a portfolio.

Hybrid retirement plan: A plan that combines a defined benefit based on the employee's final average salary with a separate defined contribution savings account.

Investment fees: Any fees that a pension plan pays to professionals to allocate its assets. These can be administrative or money management fees. Generally, more traditional investment types have lower investment fees than more complex investments.

Liabilities: Total value of pension benefits owed to current and retired employees or dependents based on past years of service; sometimes referred to as the Actuarial Accrued Liability (AAL).

Net amortization: Measures whether total contributions to a public retirement system would have been sufficient to reduce unfunded liabilities if all actuarial assumptions — primarily investment expectations — had been met for that year. The calculation uses the plan's own reported numbers and assumptions about investment returns. Plans that consistently fall short of this benchmark can expect to see the gap between the liability for promised benefits and available funds grow over time.

Net pension liability: Current-year pension debt calculated as the difference between the total value of pension benefits owed to current and retired employees or dependents and the plan assets on hand. Pension plans with assets greater than accrued liabilities show a surplus.

Normal cost: The cost of benefits earned by employees in any given year. Also called service cost.

Own source revenue (OSR): Revenues raised directly by state and local governments, generally excluding funds from the federal government.

Pay-as-you-go: Contributions pay for benefits as they come due, rather than pre-funding benefits as they are earned.

Pension debt/unfunded liabilities: The difference between the total value of pension benefits owed to current and retired employees or dependents and the plan assets on hand. This is an unfunded obligation for past service. The data reflect the GASB standards in effect at the time. Before 2014, the data represent the unfunded actuarial accrued liability. In 2014 and after, this is reported as the net pension liability. Pension plans with assets greater than accrued liabilities show a surplus.

Private equity: An asset class consisting of equity securities and debt in operating companies that are not publicly traded on a stock exchange.

Real assets: Physical or tangible assets, such as precious metals, commodities, or oil, as opposed to financial assets.

Risk premium: The amount the return on a risky asset is expected to exceed the risk-free rate. This premium can be thought of as compensation for the investor taking on risk.

Sensitivity analysis: A method for measuring the impact of differing assumptions, particularly around investments, on key pension funding measures. Sensitivity analysis showing an investment return assumption 1 percentage point higher or lower than the base assumption is included in the GASB disclosures.

State policy (behavioral) assumption: Condition applied to Pew's stress test analysis that assumes strict adherence to current actuarial funding requirements based on states' written contribution policy.

Stochastic simulations: Simulations used in Pew's stress test analysis that model the probabilities of various financial outcomes given specified means and standard deviations of economic variables and market returns. Our stress test model generates 10,000 runs for each simulation, which yields a distribution of investment returns for each year.

Sustainable budget (behavioral) assumption: Condition applied to Pew's stress test analysis that assumes contributions are set at a fixed percentage of state revenue. The assumption tracks closely with what states currently expect to contribute to their pension systems, if all plan assumptions are met. The sustainable budget assumption implicitly sets a limit on what is affordable so as not to place strain on the budget at a time when other state obligations may also require increases in funding.

Tolerance for payment: Measure used in Pew's stress test analysis that assumes that policymakers will be willing to increase payments over a 10-year period, measured as a percentage of revenue, by the same amount as payments have increased since the year 2000.

Unfunded actuarial accrued liability (UAAL): See *Pension debt.*

Volatility: Investment volatility measures how much the value of a particular asset class or a portfolio in total moves up and down with financial markets and the economy. It is the standard measure of risk based on historical results and is also used as a forward-looking indicator of risk. A higher volatility indicates the potential for larger fluctuations in value or price.

Yield: The return on an investment. In securities, it is the dividends or interest received, usually expressed as an annual percentage of either the current market value or the cost of the investment.

Appendices

This technical appendix is divided into two sections. **Appendix I** contains supporting detail for the methodology applied to develop model inputs for actuarial assumptions, own source revenue, and capital market assumptions. **Appendix II** includes comprehensive financial outputs from the model for each state in our study, including: balance sheet, payment/contribution, and cash flow metrics. These financial outputs are provided for years 5, 10, and 20 for each economic scenario in our model. Additionally, 30-year baseline projections, using the plans' own assumptions, are also included in Appendix II.

Specifically, the **model inputs** detailed in **Appendix I** include:
- **Actuarial assumptions**: This first section of Appendix I describes how the plans' actuarial assumptions are used by the stress test simulation model to forecast pension benefits, costs, and liabilities. This approach was designed to reflect the most detailed information available from experts in each state, and to create a baseline that closely aligns with each state's forecast.
- **Own source revenue**: The methodology for forecasting own source revenue, based on expected growth in gross state product, is explained in section three and makes note of certain limitations for comparing this measure of budget capacity across states. We note here that each state has reported revenues for fiscal years 2016 and 2017 that are more current than the inputs used in the stress test simulation model and, in most cases, publish short-term to medium-term annual estimates of state revenue growth. The inputs to the simulation model are based on the most current information available from the U.S. Census Bureau and are designed to provide a long-term benchmark for budget capacity, as opposed to a precise estimate of tax revenue for any given state.
- **Capital market assumptions**: Section two describes our investment return assumptions, which align closely with expected rates of return recently developed by market experts. On average, pension funds have posted 5-, 10-, and 20-year returns, gross of fees, of 7.11, 5.98, and 7.34 percent, respectively.[58] Although the fixed 5 percent return scenario used in the model is lower than plans' current assumptions as well as these historical rates, we wanted to use the best forward-looking information available and to demonstrate lower return scenarios consistent with the primary purpose of stress test analysis. The output for each state does include results at assumed rates of return, as well as higher returns, including a fixed 9 percent scenario.

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The **model outputs** are grouped together for each state in **Appendix II** and include:

- **Baseline projections for each state:** These 30-year baseline projections provide a combined forecast for the plans in each state we examined, based on the plans' own assumptions and expected returns. The projections include long-term outlooks for the same fiscal metrics provided by the model output at years 5, 10, and 20.
- **Plan assumptions:** These tables detail each individual plan's actuarial assumptions, as reported in annual reports, actuarial valuations, or documents provided by plan administrators.
- **Fiscal metrics:** The stress test simulation model summarizes results using a comprehensive set of actuarial, economic, and financial accounting metrics. These include standard balance sheet, payment and contribution, and cash flow metrics that assess fiscal health over time and provide indicators of future fiscal challenges under a variety of economic and behavioral scenarios.
- **State analysis graphics:** A standard suite of four graphics is provided for each state and summarizes key results for deterministic simulation under the fixed 5 percent return scenario and, where applicable, the asset shock scenario.

A note on supplemental analysis: The discussion of Pennsylvania and Connecticut refers to projections beyond the 30-year forecast period, as well as the impact of recent reforms on our forecast. In both cases, we project that under the fixed 5 percent return scenario, unfunded liabilities will persist well beyond a 30-year time horizon — as long as 50 years in total — when also including historical results. For both states, we also estimate lower costs that can be attributed to recent reforms that establish a hybrid plan for new workers. The details of these analyses, although not included in the appendix, are available upon request.

All pension plan projections and other analysis herein are based on the best information available. In certain cases, this may include updated assumptions or other information published or provided by the individual pension plans that are included in our study.

Actuarial Assumptions

MuniSage is a software application that can forecast municipal, county, and state budgets, populations, revenues, and demographics. Below is documentation from The Terry Group for the actuarial assumptions applied to the stress test simulation model using MuniSage.

Basic notations and variables

Normal cost at time t: NC_t
Payroll at time t: P_t
Benefit payment at time t: BP_t
Actuarial accrued liability at time t: AAL_t
Actual inflation at time t: $ActInf_t$
Expected inflation: $ExpInf$
Discount rate (interest rate): i
Survival from time t-1 to time t: S_t
Expected COLA: $ExpCOLA$
Actual COLA at time t: $ActCOLA_t$

Relationship between payroll, normal costs, benefit payments, and liabilities

The main method MuniSage uses to project payroll is to increase payroll each year with a payroll growth rate:

$$P_t = P_{t-1} \cdot g_t$$

where g_t is the payroll growth rate.

Normal costs are usually expressed as a normal cost rate times payroll:

$$NC_t = NCRate_t \cdot P_t$$

where $NCRate_t$ is the normal cost rate at time t.

The actuarial accrued liability AAL is projected via the roll-forward formula:

$$AAL_t = AAL_{t-1} \cdot (1 + i) + NC_{t-1} \cdot (1 + i)^{0.5} - BP_t \cdot (1 + i)^{0.5}$$

Normal costs and benefit payments are assumed to occur at the middle of the year.

How payroll projection is affected by inflation

MuniSage models the effect of actual inflation on payroll by adjusting the payroll growth rate by a portion of unexpected inflation. Because the payroll growth rate has an expected inflation component

built in, the adjustment due to actual inflation is based on the difference between actual inflation and expected inflation, not based on the actual inflation itself.

Payroll growth typically does not respond to actual inflation immediately. To reflect the "stickiness" of payroll growth to actual inflation, MuniSage uses the following parameters to model how quickly payroll growth responds to inflation.

Lag : a variable that specifies the lag between actual inflation and payroll growth rate

$AvgPeriod$: the averaging period for inflation, i.e., actual inflation from multiple prior periods are averaged for determining the effect of actual inflation on payroll growth

$InfSens$: an inflation sensitivity factor that takes into account the percentage of unexpected inflation that is reflected in the payroll growth. A factor of less than 100% reflects the belief that the employers and employees do not believe the unexpected inflation to continue into the future

$StaPeriod$: the stability period where inflation adjustment is assumed to stay the same.

A typical application of these parameters will be a three-year bargaining cycle. In this case the average inflation over the prior three years will be used in the payroll growth of the next three years. The parameters can be set as Lag = 1, AvgPeriod = 3, InfSens = 100%, and StaPeriod = 3. If it is desired to reflect inflation on payroll growth immediately, the parameters can be set as Lag = 1, AvgPeriod = 1, InfSens = 100%, and StaPeriod = 1.

We define average inflation as the actual inflation averaged over prior periods:

$$AvgInf_t = \frac{1}{AvgPeriod} \sum_{j=0}^{AvgPeriod\ -1} ActInf_{t-Lag\ -j}$$

Then inflation adjustment is defined as

$$InflationAdj_t = (AvgInf_t - ExpInf) \cdot InfSen + 1$$

The projection of payroll will be modified as

$$P_t = P_{t-1} \cdot g_t \cdot InflationAdj_t$$

How normal cost is affected by inflation

Normal costs are affected by actual inflation via payroll. Thus, the equation

$$NC_t = NCRate_t \cdot P_t$$

is the same, but the normal costs will change if payroll reflects actual inflation.

Note that the normal cost rate is not changed. The normal cost rate will change if the valuation assumptions change, i.e., if the expected inflation change. MuniSage reflects the effect of actual

inflation on payroll, but it does not model changing valuation assumptions and changing inflation expectations.

How AAL is affected by inflation

Actual inflation affects actuarial accrued liabilities via its effect on normal costs and the roll-forward formula.

Additionally, the actual payroll growth being different from the expected payroll growth will create liability gains and losses. MuniSage models these liability gains or losses by multiplying the active portion of the actuarial accrued liability by the payroll inflation adjustment factor.

$ActPercent$: Percentage of the actuarial accrued liability that is assumed to be active, an input to MuniSage

$InflationAdj_t$: Payroll inflation adjustment factor, defined in the payroll section above

Then the actuarial accrued liability is projected using the following formula

$$AAL_t = [AAL_{t-1} \cdot (1+i) + NC_{t-1} \cdot (1+i)^{0.5} - BP_t \cdot (1+i)^{0.5}] \cdot$$

$$[1 + (InflationAdj_t - 1) \cdot ActPercent]$$

How MuniSage models COLA policy

A typical COLA policy responds to inflation with a minimum COLA, a maximum COLA, and a transition between the minimum and the maximum. See the chart below. The minimum COLA can be 0% if the COLA policy does not have a minimum. The maximum COLA can also be set to be a large number if the maximum COLA does not apply.
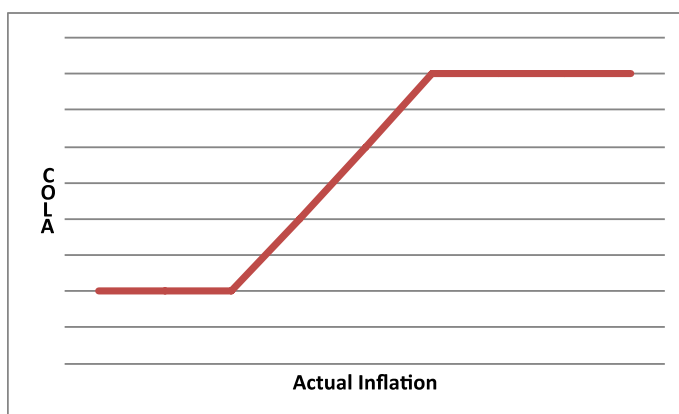
MuniSage uses four parameters to specify a COLA policy:

$MinCOLA$: minimum COLA

$MaxCOLA$: COLA cap

$ExcessPoint$: the point from which the COLA transitions from minimum to maximum

$PercentInf$: the percentage of actual inflation reflected in the COLA, i.e., the slope of the transition line in the chart above

Then actual annual COLA is modeled as

$$ActCOLA_t = \min(MaxCOLA, MinCOLA + \max(0, ActInf_{t-1} - ExcessPoint) \cdot PercentInf)$$

How inflation affect benefit payments

MuniSage models the impact of inflation on benefit payments through the realized COLA. If there is no COLA, then the benefit payment is not affected by COLA.

First, benefit payments are split into separate payment streams based on payment year ("benefit payment triangle"). Let $BP_{t,d}$ denote the benefit payment stream starting in time t, after d years. The first-year benefit payment for the payment stream that begins in year t is calculated as the total benefit payment at time t minus the payment streams from prior years.

$$BP_{t,1} = BP_t - \sum_{j=1} BP_{t-j,j+1}$$

The payment stream starting in time t includes lump sums and refunds that would not continue to the second year and, therefore, would not be subject to COLA. So the payment in the second year for the benefit payment stream starting in year t should be reduced by a factor that represents lump sums and refunds. Additionally, the benefit payment will be reduced by mortality, and increased by COLA built into the valuation assumption. Thus, we calculate the second-year benefit payment for the benefit payment stream starting in time t by

$$BP_{t,2} = (BP_{t,1} - (1 - PercentCOLA) \cdot BP_t) \cdot S_{t+1} \cdot (1 + ExpCOLA)$$

$PercentCOLA$ is an input to MuniSage and specifies the percent of the total benefit payment in year t that is subject to COLA. So $(1 - PercentCOLA) \cdot BP_t$ represents lump sums and refunds that will not continue to the second year. The survival probability S_t used in MuniSage is based on RP2000 50/50 male/female without pre-55 mortality. $ExpCOLA$ is an input to MuniSage and represents the expected COLA in the actuarial assumption.

After the second year, the benefit payment is given by

$$BP_{t,d} = BP_{t,d-1} \cdot S_{t+d-1} \cdot (1 + ExpCOLA)$$

Finally, after the benefit payments are split into a benefit payment triangle, the benefit payments are adjusted by actual COLA as they are realized. We back out the expected COLA and replace it with actual COLA.

$$BP_{t-j,k} = \frac{BP_{t-j,k}}{1 + ExpCOLA} * (1 + ActCOLA_t), j \geq 1, k \geq j + 1$$

$$BP_t = \sum_{j=1} BP_{t-j,j+1}$$

The impact of COLA on actuarial accrued liability

When the benefit payments change with actual COLA, there will be liability gains and losses when the actual COLA differs from expected COLA. MuniSage calculates the present value of benefit payments before and after COLA adjustment and adds the difference to AAL as liability gains/losses.

Modeling employer's contribution policy

MuniSage models employer contributions with the following steps:

1. A "funding valuation" is performed at the end of each year. The funding valuation produces two employer contribution components:

   a. Regular employer contributions, usually based on the actuarial determined employer contributions (ADEC). If the system does not have an actuarial funding policy, then the funding valuation will calculate according to the funding policy, for example, a statutory contribution rate.

   b. Other employer contributions, such as special contribution rates under a certain funded ratio.

2. For each year of the forecast, MuniSage first looks for contribution overrides. If contribution override exists for that year, MuniSage will use the override amount as the employer contribution and skip the rest of the calculations.

3. If there is no contribution override for the year, MuniSage first calculates the employer contributions (regular and other) taking into account the lag between the timing of funding valuations and actual contributions.

Own Source Revenue

We statistically imputed a stream of projected own source revenue using state GSP forecasts obtained from Moody's Economy.com for each state and a simple linear time series model. We tested several model specifications, including using state personal income (SPI) instead of GSP, but we find that growth in own source revenues is best projected using the simple state-specific model:

$$\ln(OSR_i) = \alpha + \beta_1 \ln(GSP_i) + \beta_2 \text{unemployment-rate}_i + \varepsilon_i$$

where the ln(OSR) is the natural log of state own source revenue. The independent variables are the natural log of nominal state GSP (ln(GSP)), and unemployment rate, all by year.

Data on own source revenue come from the Census' Annual Survey of State Government Finance. Own source revenue is a standard benchmark for state budget capacity. General own source revenue excludes intergovernmental transfers (all dollars received from federal and local governments as grants, shared taxes, or loans) as well as revenues from state-operated liquor stores, utilities, and social insurance trusts (including pension system trusts). A limitation of own source revenue is that it includes some revenue sources that states are unlikely to use to pay for pension liabilities, such as tuition fees at state universities.[59] As a result, our model may slightly understate pension costs relative to state resources. We use data from 1996-2016, as those are the years for which data are available for all variables. State GDP, or gross state product (GSP), is a measurement of the economic output of a state. It is measured by the sum of all value added by industries within the state. It is produced by the Bureau of Economic Analysis and was compiled by Moody's Analytics for its data subscribers. In addition to historical GSP, Moody's projected these data forward to 2047. As with revenue, we used the natural log transformation of GSP in the regression model.

The OSR growth rate for 2015 and 2016, highlighted in green, represent actual year-over-year changes as reported from the U.S. Census Bureau's Survey of State Government Finance. Model estimates are used to project OSR for three years (2017-2019) and are highlighted in orange. After 2019, we assume OSR will grow at the same rate as GSP (highlighted in purple).

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[59] Joshua D. Rauh, "Hidden Debt, Hidden Deficits: How Pension Promises are Consuming State and Local Budgets," Hoover Institution (May 2017), http://www.hoover.org/research/hidden-debt-hidden-deficits-2017-edition.

Table 1. Nominal Year-over-Year Growth in Own Source Revenue, 2015-2046

	CO	CT	KY	NJ	NC	OH	PA	SC	VA	WI
2015	20.1%	1.3%	3.7%	5.3%	7.6%	4.1%	6.6%	5.3%	8.6%	3.7%
2016	-10.2%	-4.5%	3.5%	0.8%	4.6%	4.4%	3.5%	2.3%	3.1%	5.4%
2017	6.4%	1.1%	4.0%	3.2%	4.4%	4.9%	4.0%	4.9%	4.4%	3.4%
2018	6.6%	4.7%	4.7%	6.2%	6.3%	6.7%	5.4%	5.9%	5.6%	4.9%
2019	6.9%	4.1%	4.6%	6.2%	6.3%	6.0%	5.2%	5.9%	5.8%	4.9%
2020	3.3%	2.2%	2.4%	2.5%	3.6%	2.6%	2.4%	3.2%	3.0%	2.6%
2021	5.5%	4.5%	4.7%	4.6%	5.8%	4.6%	4.5%	5.5%	4.6%	4.7%
2022	5.4%	4.4%	4.6%	4.4%	5.7%	4.3%	4.2%	5.3%	4.5%	4.5%
2023	4.8%	4.0%	4.0%	3.9%	5.1%	3.8%	3.8%	4.7%	3.9%	4.0%
2024	4.5%	3.8%	3.9%	3.7%	4.8%	3.7%	3.5%	4.5%	4.0%	3.8%
2025	4.2%	3.5%	3.7%	3.5%	4.6%	3.4%	3.2%	4.2%	4.0%	3.5%
2026	4.1%	3.4%	3.5%	3.3%	4.4%	3.2%	3.1%	4.0%	3.8%	3.4%
2027	4.0%	3.3%	3.5%	3.2%	4.3%	3.1%	3.0%	3.9%	3.7%	3.3%
2028	4.3%	3.6%	3.8%	3.5%	4.7%	3.4%	3.3%	4.2%	4.0%	3.6%
2029	4.3%	3.6%	3.7%	3.5%	4.7%	3.3%	3.2%	4.1%	4.0%	3.6%
2030	4.1%	3.4%	3.5%	3.4%	4.5%	3.1%	3.0%	3.9%	3.8%	3.4%
2031	4.0%	3.4%	3.5%	3.5%	4.5%	3.1%	2.9%	4.0%	3.7%	3.4%
2032	4.0%	3.5%	3.5%	3.6%	4.5%	3.1%	2.9%	4.0%	3.7%	3.4%
2033	4.0%	3.4%	3.6%	3.6%	4.5%	3.0%	2.9%	4.0%	3.7%	3.4%
2034	4.0%	3.4%	3.6%	3.5%	4.6%	3.0%	2.8%	4.0%	3.7%	3.3%
2035	4.0%	3.4%	3.6%	3.4%	4.6%	3.0%	2.8%	4.0%	3.7%	3.4%
2036	3.9%	3.3%	3.5%	3.3%	4.6%	2.9%	2.7%	4.0%	3.6%	3.3%
2037	3.9%	3.4%	3.5%	3.3%	4.7%	3.0%	2.7%	4.1%	3.7%	3.4%
2038	4.0%	3.5%	3.5%	3.3%	4.8%	3.0%	2.8%	4.1%	3.8%	3.4%
2039	4.0%	3.5%	3.5%	3.3%	4.7%	3.0%	2.9%	4.2%	3.8%	3.4%
2040	4.0%	3.4%	3.5%	3.3%	4.7%	3.0%	2.9%	4.2%	3.8%	3.4%
2041	3.9%	3.2%	3.5%	3.3%	4.6%	2.8%	2.8%	4.1%	3.7%	3.3%
2042	3.8%	3.1%	3.4%	3.2%	4.5%	2.7%	2.7%	4.0%	3.6%	3.2%
2043	3.8%	3.1%	3.4%	3.2%	4.5%	2.7%	2.8%	4.1%	3.6%	3.2%
2044	3.8%	3.1%	3.4%	3.1%	4.4%	2.7%	2.7%	4.1%	3.5%	3.2%
2045	3.8%	3.0%	3.3%	3.0%	4.3%	2.7%	2.7%	4.1%	3.5%	3.2%
2046	3.7%	3.0%	3.3%	3.0%	4.3%	2.7%	2.7%	4.0%	3.5%	3.2%
2047	3.7%	2.9%	3.2%	2.8%	4.2%	2.6%	2.6%	4.0%	3.4%	3.1%
Compound Annual Growth in OSR	3.85%	3.13%	3.66%	3.48%	4.71%	3.43%	3.20%	4.23%	3.87%	3.59%
Compound Annual Growth in GSP	4.19%	3.36%	3.62%	3.43%	4.67%	3.30%	3.13%	4.22%	3.80%	3.53%

Capital Market Assumptions

Our capital market assumptions contain projections for a variety of financial and economic variables over time. Some of these variables pertain to the broad state of U.S. economic development, such as real GDP and inflation. The rest of the indicators measure the performance of various asset classes, including public equity (both U.S. and non-U.S.), real estate, and private equity returns. Returns are compounded and presented in nominal terms.

Based on our review of various sources of inflation expectation data and the 30-year time horizon of these assumptions, we selected an inflation expectation of 2.0%. The growth of the real gross domestic product (GDP) is a key economic indicator. In its most recent forecast, the CBO projects real GDP growth to average 1.9% over the next 10 years. Growth in 2017 is projected to be 2.3%, followed by two years at 1.6%, then reverting to the ultimate expectation of 1.9%.[60] We assume an average of 2.0% for growth of real GDP.

The CBO forecasts the ultimate expected rate for 3-month Treasury bills to be 2.8% and 10-year Treasury notes to be 3.6% by 2023. We follow expectations built into the CBO forecasts, developing expected returns for fixed income asset classes in a manner consistent with our assumption on the rising rates environment and appropriate durations. For each class, we started with the current yield (as of December 31, 2016) and assumed a five-year transition to the long-term equilibrium yield, with the returns being made up of "coupon" or income return and "price change" (due to the movements in yields).
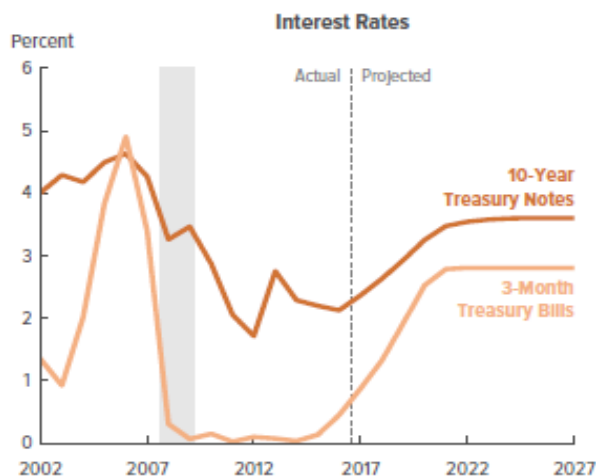
Source: 2017 CBO Report.

We developed our expected returns for the broad equity asset classes by utilizing a variety of models, as well as reviewing information from actuarial and investment firms. We benchmark this class to the S&P 500 Index and factor in results from the multistage dividend discount model (DDM). We selected a geometric expected return for U.S. equity class at 6.7%. The historical record, going back to 1970, is supportive of the view that there is no expectation of non-U.S. equity outperforming U.S. equity in the long term. We expect the geometric return for the non-U.S. equity broad asset class will be the same as that for the U.S. equity class.

For Private Equity, we set an illiquidity premium assumption at 1.9%. This is supported by capital asset pricing model (CAPM) regression analysis we performed relating the private equity quarterly historical

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[60] Data for CBO 2017 Report www.cbo.gov/publication/52370/

return time series to the analogous public equity returns. To correct for the inherent smoothness within the PE historical returns time series, we regressed PE returns against public equity returns time series with lags of 0, 1, 2, 3, and 4 quarters. Regression was done on excess returns over the Long-Term Government Bond returns (which we used as a proxy for the long-term "risk-free" rate). We used the same model to calculate the standard deviation for the PE class at 21.1%, assuming a 16.4% standard deviation for public equity and 0.7 correlation between private and public equities (calculated based on historical analysis).

For real estate, we employ a forward-looking cash flow discount model, much like in the case of U.S. equity. Over a long-term holding horizon, RE returns are primarily driven by dividend yields and NOI growth.[61] We selected an expected return of 6.0% for the RE asset class. For this class, the estimate of the risk (e.g. standard deviation) does not rely on historical analysis but rather on a target Sharpe ratio of about 0.36.

For most classes, we utilize monthly and quarterly data to estimate standard deviations and correlations, with an exception of the real estate and the private equity classes, for which only quarterly data are available. We develop the correlation matrix directly from the quarterly or annual data, as appropriate for the most recent 27 years, since 1990, with slight modifications to reflect common sense and consensus among investment firms. Modifications were made to the cash and core bond classes, reflecting correlation for longer periods or other adjustments. The resulting correlation matrix is shown below in Table 2.

Table 2

	Expected Geometric Return	Standard Deviation	U.S. Equity	non-U.S. Equity	Cash	Core	Long Gov't	RE	PE
U.S. Equity	6.70%	16.4%	1.00	0.83	0.02	0.14	-0.31	0.13	0.72
non-U.S. Equity	6.70%	18.5%	0.83	1.00	0.03	0.14	-0.28	0.12	0.66
Cash	1.70%	0.8%	0.02	0.03	1.00	0.07	0.05	0.01	0.09
Core	3.60%	4.1%	0.14	0.14	0.07	1.00	0.84	0.05	0.03
Long Gov't	3.40%	11.0%	-0.31	-0.28	0.05	0.84	1.00	-0.04	-0.30
RE	6.00%	12.5%	0.13	0.12	0.01	0.05	-0.04	1.00	0.35
PE	8.60%	21.1%	0.72	0.66	0.09	0.03	-0.30	0.35	1.00

The capital market assumptions were modified slightly for the deterministic scenarios. In the fixed 5 percent return scenario (called the "Low Return" scenario in Appendix II), all asset classes are set to return 5 percent for the entire projected period. Similarly, the "High Return" scenario applied a fixed 9 percent return for all asset classes, and the "Current Plan Assumptions" scenario assumed that returns would equal the plan's assumed rate of return for all years.

The "**low-for-long**" and "**asset shock**" scenarios applied 12 economic, asset price, and interest rate variables uniformly across all plans. They varied by year for years 1-5, 6-10, and 11-20 of the projection. The specific assumptions for each scenario are outlined in the tables below.

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[61] Blackrock, "Long-Term Income Opportunities in U.S. Real Estate," June 2013.

Table 3

Low-for-Long Scenario

	Variables	Y1	Y2	Y3	Y4	Y5	Y6-10	Y11-20
Economic Variables	Real GDP growth	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
	Inflation	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Asset Price Variables	U.S. Equity returns	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
	non-U.S. Equity returns	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
	Real estate returns	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%
	Private equity returns	6.90%	6.90%	6.90%	6.90%	6.90%	6.90%	6.90%
	Core Bond Returns	1.25%	1.55%	1.85%	2.15%	2.45%	3.95%	3.95%
	Cash	0.62%	0.84%	1.05%	1.27%	1.48%	1.70%	1.70%
Interest Rate Variables	1-year Treasury rate	0.85%	1.10%	1.35%	1.60%	1.85%	2.10%	2.10%
	10-year Treasury rate	2.45%	2.68%	2.91%	3.14%	3.37%	3.60%	3.60%
	30-year Treasury rate	3.06%	3.27%	3.48%	3.68%	3.89%	4.10%	4.10%
	Core Bond yield	2.61%	2.88%	3.15%	3.41%	3.68%	3.95%	3.95%

Table 4

"Asset Shock" Scenario

	Variables	Y1	Y2	Y3	Y4	Y5	Y6-10	Y11-20
Economic Variables	Real GDP growth	-1.95%	1.12%	2.90%	3.00%	2.00%	2.00%	2.00%
	Inflation	1.80%	1.97%	2.00%	1.80%	2.00%	2.00%	2.00%
Asset Price Variables	U.S. Equity returns	-39.00%	18.75%	20.60%	16.24%	5.00%	5.00%	5.00%
	non-U.S. Equity returns	-39.00%	18.75%	20.60%	16.24%	5.00%	5.00%	5.00%
	Real estate returns	-2.00%	-2.00%	-2.00%	-2.00%	6.00%	6.00%	6.00%
	Private equity returns	-39.00%	18.75%	20.60%	16.24%	6.90%	6.90%	6.90%
	Core Bond returns	1.15%	2.45%	3.05%	3.05%	2.45%	3.95%	3.95%
	Cash	0.10%	0.10%	0.10%	0.10%	1.48%	1.70%	1.70%
Interest Rate Variables	1-year Treasury rate	0.10%	0.10%	0.10%	0.10%	1.85%	2.10%	2.10%
	10-year Treasury rate	2.30%	2.60%	2.70%	2.70%	3.37%	3.60%	3.60%
	30-year Treasury rate	2.80%	3.10%	3.20%	3.20%	3.89%	4.10%	4.10%
	Core Bond yield	2.65%	2.95%	3.05%	3.05%	3.68%	3.95%	3.95%

Appendix II
Model Outputs

Colorado Retirement System 30 Year Projections

Plans included: Public Employees' Retirement Association - State, Public Employees' Retirement Association - School
State contribution policy at assumed rate of return (7.25%)

$MMs

Fiscal Year	Pension Liability (Actuarial Accrued Liability)						Pension Assets (Market Value)					Change in Pension Debt			% Funded	Cash Flow	Employer Contribution		
	Payroll	Beginning of Period	Service Cost	Interest	Benefit Payments	End of Period	Beginning of Period	Total Contribution	Interest	Benefit Payments	End of Period	Debt	$	% of Payroll	% Funded	% of Assets	$	% Change	% Payroll
2018	7,563	68,583	829	4,855	(4,130)	70,137	39,187	2,009	2,733	(4,130)	39,799	30,338	942	12%	57%	-5%	1,403	N/A	19%
2019	7,828	70,137	859	4,963	(4,276)	71,683	39,799	2,087	2,773	(4,276)	40,383	31,300	961	12%	56%	-5%	1,459	4%	19%
2020	8,101	71,683	889	5,071	(4,425)	73,218	40,383	2,160	2,812	(4,425)	40,931	32,288	988	12%	56%	-6%	1,511	4%	19%
2021	8,385	73,218	920	5,178	(4,576)	74,740	40,931	2,233	2,847	(4,576)	41,435	33,305	1,017	12%	55%	-6%	1,561	3%	19%
2022	8,679	74,740	952	5,284	(4,730)	76,246	41,435	2,308	2,880	(4,730)	41,894	34,353	1,048	12%	55%	-6%	1,612	3%	19%
2023	8,982	76,246	985	5,389	(4,886)	77,734	41,894	2,385	2,909	(4,886)	42,302	35,432	1,080	12%	54%	-6%	1,665	3%	19%
2024	9,297	77,734	1,020	5,492	(5,045)	79,201	42,302	2,465	2,934	(5,045)	42,656	36,544	1,112	12%	54%	-6%	1,720	3%	18%
2025	9,622	79,201	1,055	5,594	(5,207)	80,644	42,656	2,548	2,956	(5,207)	42,954	37,690	1,145	12%	53%	-6%	1,777	3%	18%
2026	9,959	80,644	1,092	5,694	(5,370)	82,060	42,954	2,634	2,973	(5,370)	43,191	38,869	1,179	12%	53%	-6%	1,835	3%	18%
2027	10,307	82,060	1,130	5,793	(5,534)	83,449	43,191	2,726	2,986	(5,534)	43,370	40,079	1,210	12%	52%	-7%	1,900	4%	18%
2028	10,668	83,449	1,170	5,889	(5,699)	84,809	43,370	2,822	2,995	(5,699)	43,488	41,321	1,242	12%	51%	-7%	1,966	3%	18%
2029	11,041	84,809	1,211	5,983	(5,863)	86,140	43,488	2,920	3,000	(5,863)	43,545	42,595	1,274	12%	51%	-7%	2,035	3%	18%
2030	11,428	86,140	1,253	6,075	(6,028)	87,441	43,545	3,023	3,000	(6,028)	43,540	43,900	1,306	11%	50%	-7%	2,106	4%	18%
2031	11,828	87,441	1,297	6,165	(6,192)	88,711	43,540	3,128	2,996	(6,192)	43,473	45,238	1,338	11%	49%	-7%	2,180	3%	18%
2032	12,242	88,711	1,343	6,253	(6,355)	89,952	43,473	3,238	2,987	(6,355)	43,343	46,609	1,370	11%	48%	-7%	2,256	4%	18%
2033	12,670	89,952	1,390	6,339	(6,518)	91,163	43,343	3,351	2,974	(6,518)	43,151	48,012	1,403	11%	47%	-7%	2,335	4%	18%
2034	13,114	91,163	1,438	6,423	(6,679)	92,345	43,151	3,469	2,957	(6,679)	42,898	49,447	1,435	11%	46%	-7%	2,417	3%	18%
2035	13,573	92,345	1,489	6,504	(6,839)	93,499	42,898	3,590	2,935	(6,839)	42,583	50,915	1,468	11%	46%	-8%	2,502	3%	18%
2036	14,048	93,499	1,541	6,584	(6,998)	94,626	42,583	3,716	2,909	(6,998)	42,210	52,416	1,500	11%	45%	-8%	2,589	4%	18%
2037	14,540	94,626	1,595	6,662	(7,155)	95,728	42,210	3,846	2,879	(7,155)	41,780	53,948	1,532	11%	44%	-8%	2,680	3%	18%
2038	15,048	95,728	1,650	6,739	(7,300)	96,817	41,780	3,980	2,845	(7,300)	41,306	55,512	1,564	10%	43%	-8%	2,774	3%	18%
2039	15,575	96,817	1,708	6,815	(7,431)	97,910	41,306	4,120	2,809	(7,431)	40,803	57,107	1,595	10%	42%	-8%	2,871	4%	18%
2040	16,120	97,910	1,768	6,893	(7,548)	99,024	40,803	4,264	2,771	(7,548)	40,290	58,733	1,626	10%	41%	-8%	2,971	4%	18%
2041	16,684	99,024	1,830	6,972	(7,649)	100,176	40,290	4,413	2,733	(7,649)	39,787	60,389	1,656	10%	40%	-8%	3,075	4%	18%
2042	17,268	100,176	1,894	7,055	(7,735)	101,390	39,787	4,567	2,696	(7,735)	39,316	62,074	1,685	10%	39%	-8%	3,183	3%	18%
2043	17,873	101,390	1,960	7,143	(7,804)	102,690	39,316	4,727	2,663	(7,804)	38,903	63,787	1,713	10%	38%	-8%	3,294	4%	18%
2044	18,498	102,690	2,029	7,238	(7,855)	104,101	38,903	4,893	2,634	(7,855)	38,575	65,526	1,739	9%	37%	-8%	3,409	3%	18%
2045	19,146	104,101	2,100	7,341	(7,889)	105,653	38,575	5,064	2,613	(7,889)	38,363	67,291	1,764	9%	36%	-7%	3,529	3%	18%
2046	19,816	105,653	2,173	7,456	(7,905)	107,377	38,363	5,241	2,600	(7,905)	38,299	69,078	1,788	9%	36%	-7%	3,652	3%	18%
2047	20,509	107,377	2,249	7,584	(7,903)	109,308	38,299	5,425	2,599	(7,903)	38,420	70,888	1,809	9%	35%	-6%	3,780	4%	18%

Source: Analysis by The Pew Charitable Trusts and The Terry Group based on data from Retirement System actuarial valuations and annual reports

Model Assumptions		
State	Colorado	
Plan	Public Employees' Retirement Association - State	
Actuarial Valuation Used	12/31/2016	
Employer Contribution Policy		
Description	Statutory	
Applies to	Non-Troopers	Troopers
Base Rate	9.13%	11.83%
AED	5.00%	5.00%
SAED	5.00%	5.00%
Total Contribution	19.13%	21.83%
Additional Contribution Rules	Total Contributions reduced by 1% for AIR on employees hired after 1/1/2007	
Employee Contribution Rate		
Applies to	Non-Troopers	Troopers
Rate	8.00%	10.00%
Employee Contribution Cost-Sharing	No	No
Actuarial Assumptions		
Plan Assumed Rate of Return	7.25%	
Inflation Assumption	2.40%	
Payroll Growth Assumption	3.50%	
COLA		
Applies to	Pre-1/1/2007 hires	
Description	2%	
Assumed Effective COLA	2%	
COLA Adjustment for Plan Funding and Investment Experience	No	

Model Assumptions	
State	Colorado
Plan	Public Employees' Retirement Association - School
Actuarial Valuation Used	12/31/2016
Employer Contribution Policy	
Description	Statutory
Applies to	All
Base Rate	9.13%
AED	4.50%
SAED	5.50%
Total Contribution	19.13%
Additional Contribution Rules	Total Contributions reduced by 1% for AIR on employees hired after 1/1/2007
Employee Contribution Rate	
Applies to	All
Rate	8.00%
Employee Contribution Cost-Sharing	No
Actuarial Assumptions	
Plan Assumed Rate of Return	7.25%
Inflation Assumption	2.40%
Payroll Growth Assumption	3.50%
COLA	
Applies to	Pre-1/1/2007 hires
Description	2%
Assumed Effective COLA	2%
COLA Adjustment for Plan Funding and Investment Experience	No

Fiscal Metrics
Model Output

State

Colorado

Plans Included

Public Employees' Retirement Association - State

Public Employees' Retirement Association - School

	State Policy (Current Contribution Policy)									Sustainable Budget (Fixed % of OSR)								
	Deterministic 7.25%			Deterministic 5%			Deterministic 9%			Deterministic 7.25%			Deterministic 5%			Deterministic 9%		
	Current Plan Assumptions			Low Return			High Return			Current Plan Assumptions			Low Return			High Return		
Metrics	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures																		
Market Value of Assets (MVA)	41,894	43,370	41,780	37,023	32,023	11,502	45,994	53,999	78,039	42,308	45,203	51,003	37,421	33,715	19,241	46,422	55,952	88,668
Actuarial Accrued Liability (AAL)	76,246	83,449	95,728	76,246	83,449	95,728	76,246	83,449	95,728	76,246	83,449	95,728	76,246	83,449	95,728	76,246	83,449	95,728
Accrued Liability at 4% Discount Rate (DR)	115,389	126,290	144,872	115,389	126,290	144,872	115,389	126,290	144,872	115,389	126,290	144,872	115,389	126,290	144,872	115,389	126,290	144,872
Unfunded Actuarial Accrued Liability (UAAL)	34,353	40,079	53,948	39,223	51,426	84,226	30,252	29,450	17,688	33,938	38,246	44,725	38,825	49,734	76,487	29,824	27,497	7,059
Unfunded Liability at 4% DR	73,496	82,920	103,092	78,367	94,267	133,370	69,395	72,291	66,833	73,081	81,087	93,869	77,968	92,575	125,631	68,968	70,338	56,204
Funded Ratio	54.9%	52.0%	43.6%	48.6%	38.4%	12.0%	60.3%	64.7%	81.5%	55.5%	54.2%	53.3%	49.1%	40.4%	20.1%	60.9%	67.0%	92.6%
Funded Ratio at 4% Discount Rate	36.3%	34.3%	28.8%	32.1%	25.4%	7.9%	39.9%	42.8%	53.9%	36.7%	35.8%	35.2%	32.4%	26.7%	13.3%	40.2%	44.3%	61.2%
AAL Compound Annual Growth Rate	2.1%	2.0%	1.7%	2.1%	2.0%	1.7%	2.1%	2.0%	1.7%	2.1%	2.0%	1.7%	2.1%	2.0%	1.7%	2.1%	2.0%	1.7%
Change in AAL from Prior Year (%)	2.0%	1.7%	1.2%	2.0%	1.7%	1.2%	2.0%	1.7%	1.2%	2.0%	1.7%	1.2%	2.0%	1.7%	1.2%	2.0%	1.7%	1.2%
Unfunded Liability / Own Source Revenue at 4% DR	280%	256%	214%	299%	291%	277%	265%	223%	139%	279%	251%	195%	297%	286%	261%	263%	217%	117%
Cash Flow Measures																		
Benefit Payments	4,730	5,534	7,155	4,730	5,534	7,155	4,730	5,534	7,155	4,730	5,534	7,155	4,730	5,534	7,155	4,730	5,534	7,155
Total Contributions	2,308	2,726	3,846	2,308	2,726	3,846	2,308	2,726	3,846	2,440	2,980	4,368	2,440	2,980	4,368	2,440	2,980	4,368
Negative Operating Cash Flow	2,422	2,808	3,309	2,422	2,808	3,309	2,422	2,808	3,309	2,290	2,554	2,787	2,290	2,554	2,787	2,290	2,554	2,787
Benefit Payments / Beginning of Period MVA	11.4%	12.8%	17.0%	12.6%	16.6%	50.2%	10.6%	10.6%	9.6%	11.3%	12.4%	14.2%	12.5%	16.0%	33.9%	10.6%	10.3%	8.5%
Operating Cash Flow to Assets Ratio	-5.8%	-6.5%	-7.8%	-6.4%	-8.4%	-23.2%	-5.4%	-5.4%	-4.4%	-5.5%	-5.7%	-5.5%	-6.0%	-7.4%	-13.2%	-5.1%	-4.7%	-3.3%
Change in MVA from Prior Year (%)	1.1%	0.4%	-1.0%	-1.7%	-3.8%	-19.2%	3.2%	3.3%	4.3%	1.5%	1.2%	1.4%	-1.3%	-2.7%	-8.8%	3.6%	4.0%	5.5%
Own Source Revenue (OSR)	26,209	32,356	48,112	26,209	32,356	48,112	26,209	32,356	48,112	26,209	32,356	48,112	26,209	32,356	48,112	26,209	32,356	48,112
OSR Compound Annual Growth Rate	5.5%	4.9%	4.5%	5.5%	4.9%	4.5%	5.5%	4.9%	4.5%	5.5%	4.9%	4.5%	5.5%	4.9%	4.5%	5.5%	4.9%	4.5%
Change in OSR from Prior Year (%)	5.4%	4.0%	3.9%	5.4%	4.0%	3.9%	5.4%	4.0%	3.9%	5.4%	4.0%	3.9%	5.4%	4.0%	3.9%	5.4%	4.0%	3.9%
Employer Contributions / OSR	6.2%	5.9%	5.6%	6.2%	5.9%	5.6%	6.2%	5.9%	5.6%	6.7%	6.7%	6.7%	6.7%	6.7%	6.7%	6.7%	6.7%	6.7%
Total Contributions / OSR	8.8%	8.4%	8.0%	8.8%	8.4%	8.0%	8.8%	8.4%	8.0%	9.3%	9.2%	9.1%	9.3%	9.2%	9.1%	9.3%	9.2%	9.1%
Payment and Contribution Measures																		
Employer Contributions (ERC)	1,612	1,900	2,680	1,612	1,900	2,680	1,612	1,900	2,680	1,744	2,154	3,202	1,744	2,154	3,202	1,744	2,154	3,202
Change in ERC from Prior Year (%)	3.3%	3.5%	3.5%	3.3%	3.5%	3.5%	3.3%	3.5%	3.5%	5.4%	4.0%	3.9%	5.4%	4.0%	3.9%	5.4%	4.0%	3.9%
Employee Contributions (EEC)	696	827	1,166	696	827	1,166	696	827	1,166	696	827	1,166	696	827	1,166	696	827	1,166
Payroll	8,679	10,307	14,540	8,679	10,307	14,540	8,679	10,307	14,540	8,679	10,307	14,540	8,679	10,307	14,540	8,679	10,307	14,540
Employer Contribution / Payroll	18.6%	18.4%	18.4%	18.6%	18.4%	18.4%	18.6%	18.4%	18.4%	20.1%	20.9%	22.0%	20.1%	20.9%	22.0%	20.1%	20.9%	22.0%
Employee Contribution / Payroll	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
Total Contributions / Payroll	26.6%	26.4%	26.5%	26.6%	26.4%	26.5%	26.6%	26.4%	26.5%	28.1%	28.9%	30.0%	28.1%	28.9%	30.0%	28.1%	28.9%	30.0%
Normal Cost	952	1,130	1,595	952	1,130	1,595	952	1,130	1,595	952	1,130	1,595	952	1,130	1,595	952	1,130	1,595
Normal Cost (4% DR)	1,902	2,259	3,187	1,902	2,259	3,187	1,902	2,259	3,187	1,902	2,259	3,187	1,902	2,259	3,187	1,902	2,259	3,187
Net amortization $	(1,010)	(1,165)	(1,469)	(1,284)	(1,884)	(3,496)	(784)	(507)	896	(854)	(796)	(341)	(1,129)	(1,522)	(2,458)	(628)	(132)	2,107
Net amortization $ (4% DR)	(2,453)	(2,764)	(3,368)	(2,604)	(3,160)	(4,487)	(2,328)	(2,401)	(2,064)	(2,308)	(2,446)	(2,512)	(2,459)	(2,847)	(3,680)	(2,183)	(2,080)	(1,161)
Net amortization $ / Payroll	-11.6%	-11.3%	-10.1%	-14.8%	-18.3%	-24.0%	-9.0%	-4.9%	6.2%	-9.8%	-7.7%	-2.3%	-13.0%	-14.8%	-16.9%	-7.2%	-1.3%	14.5%
Net amortization $ / Payroll (4% DR)	-28.3%	-26.8%	-23.2%	-30.0%	-30.7%	-30.9%	-26.8%	-23.3%	-14.2%	-26.6%	-23.7%	-17.3%	-28.3%	-27.6%	-25.3%	-25.2%	-20.2%	-8.0%
Investment Performance																		
Compounded Annual Growth - From Start Date	7.25%	7.25%	7.25%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%	7.25%	7.25%	7.25%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%
Compounded Annual Growth - Segments	7.25%	7.25%	7.25%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%	7.25%	7.25%	7.25%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%

Note: Dollar Figures in Millions

Fiscal Metrics
Model Output

State

Colorado

Plans Included

Public Employees' Retirement Association - State

Public Employees' Retirement Association - School

	State Policy (Current Contribution Policy)									Sustainable Budget (Fixed % of OSR)								
	Stochastic Run - Baseline CMA									Stochastic Run - Baseline CMA								
	25th Percentile			50th Percentile			75th Percentile			25th Percentile			50th Percentile			75th Percentile		
Metrics	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures																		
Market Value of Assets (MVA)	32,670	26,711	7,084	40,038	38,886	24,136	48,444	53,370	53,688	33,049	28,492	13,439	40,452	40,874	34,365	48,869	55,525	65,987
Actuarial Accrued Liability (AAL)	76,134	82,814	93,402	76,158	83,006	93,472	76,136	83,012	93,719	76,134	82,814	93,402	76,158	83,006	93,472	76,136	83,012	93,719
Accrued Liability at 4% Discount Rate (DR)	115,219	125,329	141,353	115,255	125,620	141,458	115,222	125,629	141,833	115,219	125,329	141,353	115,255	125,620	141,458	115,222	125,629	141,833
Unfunded Actuarial Accrued Liability (UAAL)	43,464	56,104	86,318	36,120	44,120	69,336	27,692	29,642	40,032	43,085	54,322	79,964	35,706	42,133	59,107	27,267	27,488	27,732
Unfunded Liability at 4% DR	82,549	98,619	134,269	75,218	86,733	117,322	66,778	72,259	88,145	82,170	96,837	127,914	74,804	84,746	107,093	66,353	70,105	75,846
Funded Ratio	42.9%	32.3%	7.6%	52.6%	46.8%	25.8%	63.6%	64.3%	57.3%	43.4%	34.4%	14.4%	53.1%	49.2%	36.8%	64.2%	66.9%	70.4%
Funded Ratio at 4% Discount Rate	28.4%	21.3%	5.0%	34.7%	31.0%	17.1%	42.0%	42.5%	37.9%	28.7%	22.7%	9.5%	35.1%	32.5%	24.3%	42.4%	44.2%	46.5%
AAL Compound Annual Growth Rate	2.1%	1.9%	1.6%	2.1%	1.9%	1.6%	2.1%	1.9%	1.6%	2.1%	1.9%	1.6%	2.1%	1.9%	1.6%	2.1%	1.9%	1.6%
Change in AAL from Prior Year (%)	1.9%	1.6%	0.9%	2.0%	1.6%	0.9%	1.9%	1.6%	0.9%	1.9%	1.6%	0.9%	2.0%	1.6%	0.9%	1.9%	1.6%	0.9%
Unfunded Liability / Own Source Revenue at 4% DR	317%	310%	281%	288%	269%	246%	257%	223%	183%	316%	304%	268%	286%	263%	224%	255%	217%	157%
Cash Flow Measures																		
Benefit Payments	4,730	5,534	7,155	4,730	5,534	7,155	4,730	5,534	7,155	4,730	5,534	7,155	4,730	5,534	7,155	4,730	5,534	7,155
Total Contributions	2,279	2,606	4,808	2,285	2,640	3,842	2,279	2,646	3,608	2,419	2,911	4,753	2,428	2,944	4,278	2,420	2,955	4,308
Negative Operating Cash Flow	2,451	2,928	2,347	2,445	2,894	3,313	2,451	2,888	3,547	2,311	2,624	2,402	2,302	2,591	2,877	2,310	2,579	2,847
Benefit Payments / Beginning of Period MVA	13.9%	19.4%	76.3%	11.7%	13.8%	27.0%	10.2%	10.6%	13.2%	13.8%	18.5%	45.8%	11.6%	13.3%	20.1%	10.1%	10.2%	11.1%
Operating Cash Flow to Assets Ratio	-7.2%	-10.3%	-25.0%	-6.1%	-7.2%	-12.5%	-5.3%	-5.5%	-6.6%	-6.7%	-8.8%	-15.4%	-5.7%	-6.2%	-8.1%	-4.9%	-4.8%	-4.4%
Change in MVA from Prior Year (%)	-4.2%	-6.2%	-24.5%	-0.9%	-2.8%	-8.9%	4.3%	1.9%	-0.7%	-3.7%	-4.6%	-14.0%	-0.5%	-1.7%	-3.7%	4.6%	2.8%	1.9%
Own Source Revenue (OSR)	26,026	31,859	47,731	26,132	32,200	47,725	26,032	32,348	48,237	26,026	31,859	47,731	26,132	32,200	47,725	26,032	32,348	48,237
OSR Compound Annual Growth Rate	5.4%	4.7%	4.4%	5.5%	4.9%	4.4%	5.4%	4.9%	4.5%	5.4%	4.7%	4.4%	5.5%	4.9%	4.4%	5.4%	4.9%	4.5%
Change in OSR from Prior Year (%)	5.4%	4.0%	3.9%	5.4%	3.9%	3.9%	5.4%	4.1%	4.0%	5.4%	4.0%	3.9%	5.4%	3.9%	3.9%	5.4%	4.1%	4.0%
Employer Contributions / OSR	6.1%	5.7%	7.8%	6.1%	5.7%	5.8%	6.1%	5.7%	5.2%	6.7%	6.7%	7.7%	6.7%	6.7%	6.7%	6.7%	6.7%	6.7%
Total Contributions / OSR	8.8%	8.2%	10.1%	8.7%	8.2%	8.0%	8.8%	8.2%	7.5%	9.3%	9.1%	10.0%	9.3%	9.1%	9.0%	9.3%	9.1%	8.9%
Payment and Contribution Measures																		
Employer Contributions (ERC)	1,592	1,816	3,726	1,596	1,840	2,761	1,592	1,844	2,517	1,732	2,120	3,671	1,739	2,143	3,198	1,733	2,153	3,217
Change in ERC from Prior Year (%)	2.7%	3.1%	10.7%	2.8%	3.0%	8.5%	2.7%	3.1%	3.8%	5.4%	4.0%	7.5%	5.4%	3.9%	4.3%	5.4%	4.1%	4.2%
Employee Contributions (EEC)	687	790	1,082	689	800	1,080	687	802	1,091	687	790	1,082	689	800	1,080	687	802	1,091
Payroll	8,567	9,853	13,487	8,591	9,981	13,472	8,570	10,006	13,605	8,567	9,853	13,487	8,591	9,981	13,472	8,570	10,006	13,605
Employer Contribution / Payroll	18.6%	18.4%	27.6%	18.6%	18.4%	20.5%	18.6%	18.4%	18.5%	20.2%	21.5%	27.2%	20.2%	21.5%	23.7%	20.2%	21.5%	23.6%
Employee Contribution / Payroll	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
Total Contributions / Payroll	26.6%	26.4%	35.6%	26.6%	26.4%	28.5%	26.6%	26.4%	26.5%	28.2%	29.5%	35.2%	28.3%	29.5%	31.8%	28.2%	29.5%	31.7%
Normal Cost	946	1,084	1,486	947	1,100	1,483	946	1,101	1,497	946	1,084	1,486	947	1,100	1,483	946	1,101	1,497
Normal Cost (4% DR)	1,890	2,167	2,971	1,893	2,198	2,964	1,890	2,201	2,992	1,890	2,167	2,971	1,893	2,198	2,964	1,890	2,201	2,992
Net amortization $	(1,562)	(2,272)	(2,592)	(1,101)	(1,428)	(2,352)	(666)	(528)	(625)	(1,400)	(1,856)	(2,196)	(935)	(999)	(1,234)	(502)	(86)	873
Net amortization $ (4% DR)	(2,761)	(3,350)	(3,355)	(2,506)	(2,895)	(3,652)	(2,266)	(2,398)	(2,830)	(2,609)	(2,984)	(3,161)	(2,350)	(2,522)	(2,840)	(2,113)	(2,015)	(1,689)
Net amortization $ / Payroll	-18.2%	-23.1%	-19.2%	-12.8%	-14.3%	-17.5%	-7.8%	-5.3%	-4.6%	-16.3%	-18.8%	-16.3%	-10.9%	-10.0%	-9.2%	-5.9%	-0.9%	6.4%
Net amortization $ / Payroll (4% DR)	-32.2%	-34.0%	-24.9%	-29.2%	-29.0%	-27.1%	-26.4%	-24.0%	-20.8%	-30.4%	-30.3%	-23.4%	-27.4%	-25.3%	-21.1%	-24.7%	-20.1%	-12.4%
Investment Performance																		
Compounded Annual Growth - From Start Date	2.9%	4.0%	4.7%	6.4%	6.5%	6.5%	10.0%	8.9%	8.2%	2.9%	4.0%	4.7%	6.4%	6.5%	6.5%	10.0%	8.9%	8.2%
Compounded Annual Growth - Segments	2.9%	5.0%	5.5%	6.4%	6.5%	6.4%	10.0%	7.9%	7.4%	2.9%	5.0%	5.5%	6.4%	6.5%	6.4%	10.0%	7.9%	7.4%

Note: Dollar Figures in Millions

Fiscal Metrics
Model Output

State

Colorado

Plans Included

Public Employees' Retirement Association - State

Public Employees' Retirement Association - School

	State Policy (Current Contribution Policy)						Sustainable Budget (Fixed % of OSR)					
	Deterministic			Deterministic			Deterministic			Deterministic		
	"Low-for-long" Economic Scenario			"Asset Shock" Economic Scenario			"Low-for-long" Economic Scenario			"Asset Shock" Economic Scenario		
Metrics	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures												
Market Value of Assets (MVA)	35,850	30,192	6,439	29,754	22,374	-	36,265	32,101	15,932	29,415	22,279	-
Actuarial Accrued Liability (AAL)	76,176	83,076	93,839	76,163	83,014	93,634	76,176	83,076	93,839	76,163	83,014	93,634
Accrued Liability at 4% Discount Rate (DR)	115,283	125,726	142,014	115,263	125,631	141,704	115,283	125,726	142,014	115,263	125,631	141,704
Unfunded Actuarial Accrued Liability (UAAL)	40,327	52,884	87,400	46,409	60,640	93,634	39,911	50,975	77,907	46,748	60,734	93,634
Unfunded Liability at 4% DR	79,434	95,534	135,575	85,510	103,257	141,704	79,019	93,625	126,082	85,848	103,352	141,704
Funded Ratio	47.1%	36.3%	6.9%	39.1%	27.0%	0.0%	47.6%	38.6%	17.0%	38.6%	26.8%	0.0%
Funded Ratio at 4% Discount Rate	31.1%	24.0%	4.5%	25.8%	17.8%	0.0%	31.5%	25.5%	11.2%	25.5%	17.7%	0.0%
AAL Compound Annual Growth Rate	2.1%	1.9%	1.6%	2.1%	1.9%	1.6%	2.1%	1.9%	1.6%	2.1%	1.9%	1.6%
Change in AAL from Prior Year (%)	2.0%	1.6%	0.9%	2.0%	1.6%	0.9%	2.0%	1.6%	0.9%	2.0%	1.6%	0.9%
Unfunded Liability / Own Source Revenue at 4% DR	303%	295%	282%	361%	353%	326%	301%	289%	262%	362%	353%	326%
Cash Flow Measures												
Benefit Payments	4,730	5,534	7,155	4,730	5,534	7,155	4,730	5,534	7,155	4,730	5,534	7,155
Total Contributions	2,290	2,651	3,592	2,286	2,639	7,086	2,435	2,957	4,291	2,266	2,747	6,058
Negative Operating Cash Flow	2,440	2,883	3,563	2,444	2,895	69	2,295	2,577	2,864	2,464	2,787	1,097
Benefit Payments / Beginning of Period MVA	12.9%	17.5%	74.0%	15.3%	22.9%	N/A	12.8%	16.7%	39.7%	15.5%	23.1%	N/A
Operating Cash Flow to Assets Ratio	-6.6%	-9.1%	-36.9%	-7.9%	-12.0%	N/A	-6.2%	-7.8%	-15.9%	-8.1%	-11.6%	N/A
Change in MVA from Prior Year (%)	-2.3%	-4.5%	-33.4%	-3.6%	-7.5%	N/A	-1.9%	-3.1%	-11.6%	-3.8%	-7.1%	N/A
Own Source Revenue (OSR)	26,209	32,356	48,112	23,691	29,248	43,490	26,209	32,356	48,112	23,691	29,248	43,490
OSR Compound Annual Growth Rate	5.5%	4.9%	4.5%	3.4%	3.9%	4.0%	5.5%	4.9%	4.5%	3.4%	3.9%	4.0%
Change in OSR from Prior Year (%)	5.4%	4.0%	3.9%	3.8%	4.0%	3.9%	5.4%	4.0%	3.9%	3.8%	4.0%	3.9%
Employer Contributions / OSR	6.1%	5.7%	5.2%	6.7%	6.3%	13.8%	6.7%	6.7%	6.7%	6.7%	6.7%	11.4%
Total Contributions / OSR	8.7%	8.2%	7.5%	9.7%	9.0%	16.3%	9.3%	9.1%	8.9%	9.6%	9.4%	13.9%
Payment and Contribution Measures												
Employer Contributions (ERC)	1,599	1,847	2,503	1,597	1,839	6,002	1,744	2,154	3,202	1,577	1,947	4,974
Change in ERC from Prior Year (%)	2.9%	3.1%	3.1%	2.8%	3.1%	63.4%	5.4%	4.0%	3.9%	3.8%	4.0%	28.4%
Employee Contributions (EEC)	690	804	1,089	689	800	1,084	690	804	1,089	689	800	1,084
Payroll	8,609	10,022	13,582	8,596	9,979	13,523	8,609	10,022	13,582	8,596	9,979	13,523
Employer Contribution / Payroll	18.6%	18.4%	18.4%	18.6%	18.4%	44.4%	20.3%	21.5%	23.6%	18.3%	19.5%	36.8%
Employee Contribution / Payroll	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
Total Contributions / Payroll	26.6%	26.4%	26.4%	26.6%	26.5%	52.4%	28.3%	29.5%	31.6%	26.4%	27.5%	44.8%
Normal Cost	948	1,104	1,496	947	1,099	1,489	948	1,104	1,496	947	1,099	1,489
Normal Cost (4% DR)	1,895	2,206	2,989	1,893	2,196	2,976	1,895	2,206	2,989	1,893	2,196	2,976
Net amortization $	(1,366)	(2,033)	(3,868)	(1,791)	(2,576)	(921)	(1,198)	(1,606)	(2,538)	(1,834)	(2,478)	(1,913)
Net amortization $ (4% DR)	(2,652)	(3,231)	(4,626)	(2,887)	(3,527)	(1,420)	(2,494)	(2,858)	(3,579)	(2,919)	(3,425)	(2,429)
Net amortization $ / Payroll	-15.9%	-20.3%	-28.5%	-20.8%	-25.8%	-6.8%	-13.9%	-16.0%	-18.7%	-21.3%	-24.8%	-14.1%
Net amortization $ / Payroll (4% DR)	-30.8%	-32.2%	-34.1%	-33.6%	-35.3%	-10.5%	-29.0%	-28.5%	-26.3%	-34.0%	-34.3%	-18.0%
Investment Performance												
Compounded Annual Growth - From Start Date	4.4%	4.7%	4.8%	2.2%	3.6%	4.3%	4.4%	4.7%	4.8%	2.2%	3.6%	4.3%
Compounded Annual Growth - Segments	4.4%	5.0%	5.0%	2.2%	5.0%	5.0%	4.4%	5.0%	5.0%	2.2%	5.0%	5.0%

Note: Dollar Figures in Millions

Colorado
Fixed 5% Economic Scenario
Public Employees' Retirement Association - State and School

Assets vs. Cash Flow
Assuming 5% returns and contributions fixed as % of OSR

Market Value of Assets — Operating Cash Flow, Percent of Assets

Total Contributions vs. Benefit Payments
Assuming 5% returns and contributions fixed as % of OSR

Total contributions — Benefit payments

Unfunded Liability vs. Funding Levels
Assuming 5% returns and contributions fixed as % of OSR

Unfunded Liability (Market Value) — Funded Ratio

Employer Contributions vs. Pension Debt
Assuming 5% returns and plans' statutory contribution policy

Pension Debt as Share of OSR — Employer Contribution Rate

Colorado
Asset Shock Economic Scenario
Public Employees' Retirement Association - State and School

Assets vs. Cash Flow
Assuming asset shock and contributions fixed as % of OSR

Legend: Market Value of Assets · Operating Cash Flow, Percent of Assets

Total Contributions vs. Benefit Payments
Assuming asset shock and contributions fixed as % of OSR

Legend: Total contributions · Benefit payments

Unfunded Liability vs. Funding Levels
Assuming asset shock and contributions fixed as % of OSR

Legend: Unfunded Liability (Market Value) · Funded Ratio
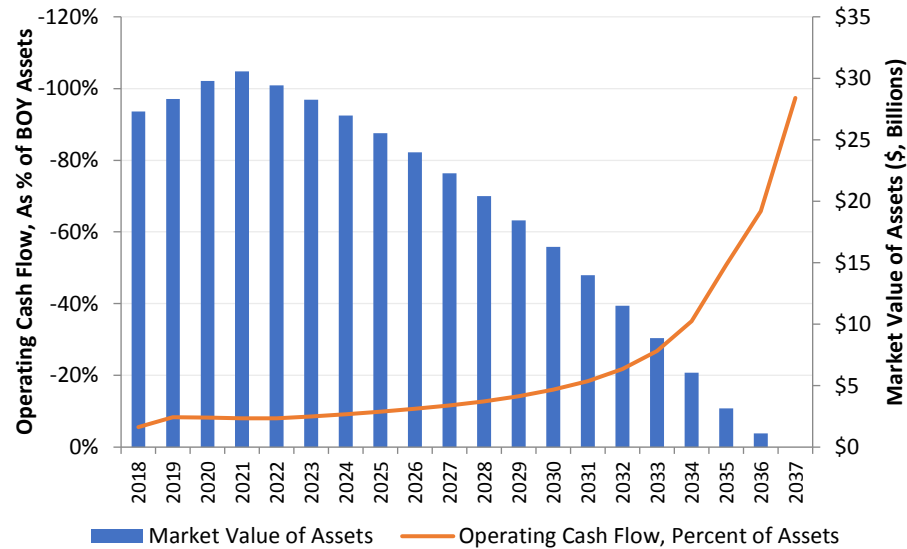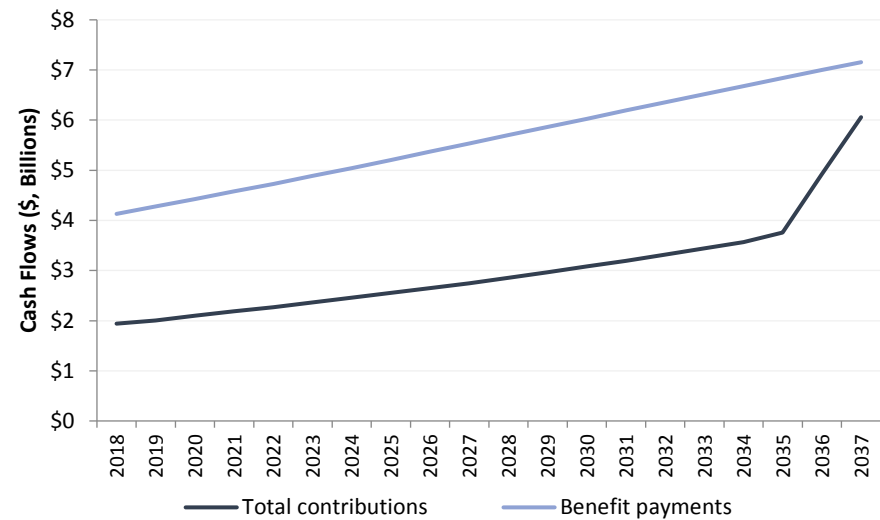
Employer Contributions vs. Pension Debt
Assuming asset shock and plans' statutory contribution policy

Legend: Pension Debt as Share of OSR · Employer Contribution Rate
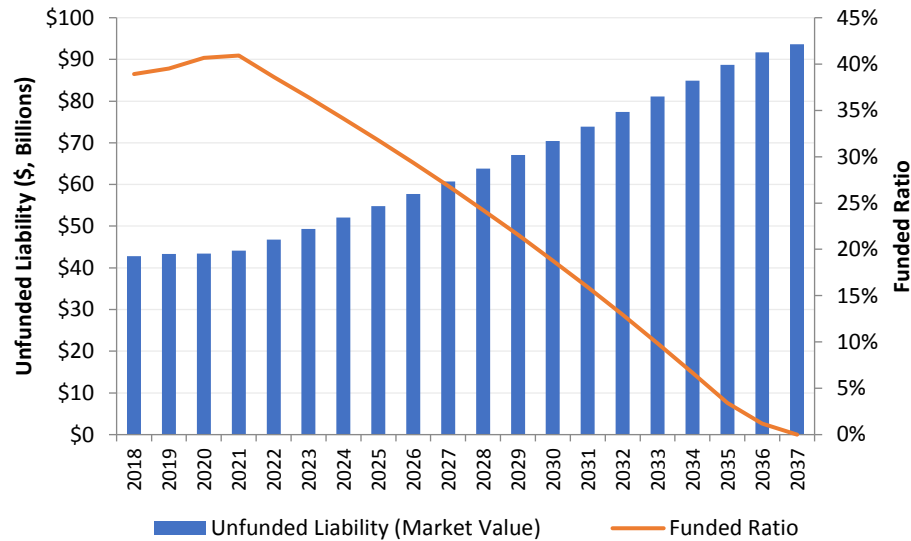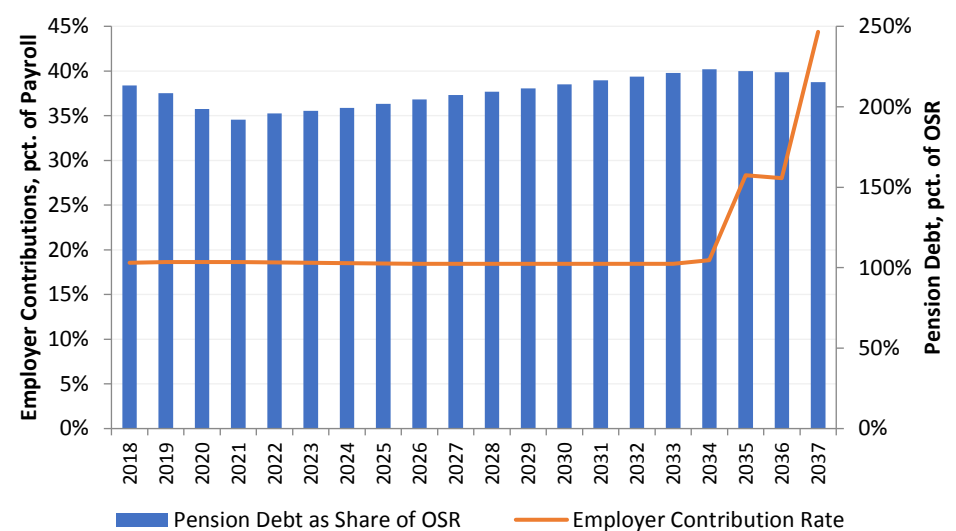
Connecticut Retirement System 30 Year Projections

Plans included: State Employees' Retirement System, Teachers' Retirement System
State contribution policy at assumed rate of return (7.43%)

$MMs

| Fiscal Year | Pension Liability (Actuarial Accrued Liability) | | | | | | Pension Assets (Market Value) | | | | | Change in Pension Debt | | | % Funded | Cash Flow | Employer Contribution | | |
	Payroll	Beginning of Period	Service Cost	Interest	Benefit Payments	End of Period	Beginning of Period	Total Contribution	Interest	Benefit Payments	End of Period	Debt	$	% of Payroll		% of Assets	$	% Change	% Payroll
2018	7,821	63,734	826	4,618	(3,990)	65,188	28,947	3,321	2,154	(3,990)	30,432	34,756	(31)	0%	47%	-2%	2,907	N/A	37%
2019	7,904	65,188	830	4,721	(4,160)	66,579	30,432	3,366	2,261	(4,160)	31,900	34,680	(76)	-1%	48%	-3%	2,904	0%	37%
2020	8,169	66,579	835	4,819	(4,330)	67,903	31,900	3,660	2,376	(4,330)	33,605	34,298	(382)	-5%	49%	-2%	3,178	9%	39%
2021	8,444	67,903	857	4,913	(4,503)	69,169	33,605	3,702	2,499	(4,503)	35,304	33,866	(432)	-5%	51%	-2%	3,197	1%	38%
2022	8,728	69,169	879	5,002	(4,675)	70,375	35,304	4,050	2,633	(4,675)	37,311	33,064	(802)	-9%	53%	-2%	3,527	10%	40%
2023	9,021	70,375	902	5,088	(4,849)	71,516	37,311	4,191	2,782	(4,849)	39,436	32,081	(983)	-11%	55%	-2%	3,647	3%	40%
2024	9,325	71,516	926	5,168	(5,022)	72,589	39,436	4,576	2,949	(5,022)	41,938	30,651	(1,430)	-15%	58%	-1%	4,010	10%	43%
2025	9,638	72,589	951	5,244	(5,194)	73,591	41,938	4,734	3,136	(5,194)	44,615	28,976	(1,675)	-17%	61%	-1%	4,146	3%	43%
2026	9,963	73,591	977	5,315	(5,366)	74,517	44,615	4,801	3,334	(5,366)	47,384	27,134	(1,842)	-18%	64%	-1%	4,188	1%	42%
2027	10,298	74,517	1,004	5,380	(5,535)	75,367	47,384	4,967	3,543	(5,535)	50,358	25,009	(2,125)	-21%	67%	-1%	4,330	3%	42%
2028	10,644	75,367	1,032	5,441	(5,703)	76,136	50,358	5,010	3,764	(5,703)	53,429	22,707	(2,302)	-22%	70%	-1%	4,348	0%	41%
2029	11,002	76,136	1,061	5,495	(5,869)	76,824	53,429	5,183	3,999	(5,869)	56,743	20,081	(2,625)	-24%	74%	-1%	4,495	3%	41%
2030	11,372	76,824	1,091	5,544	(6,035)	77,424	56,743	5,262	4,249	(6,035)	60,218	17,206	(2,876)	-25%	78%	-1%	4,547	1%	40%
2031	11,755	77,424	1,122	5,587	(6,203)	77,929	60,218	5,443	4,516	(6,203)	63,974	13,956	(3,250)	-28%	82%	-1%	4,700	3%	40%
2032	12,150	77,929	1,154	5,623	(6,365)	78,342	63,974	5,735	4,810	(6,365)	68,154	10,188	(3,767)	-31%	87%	-1%	4,963	6%	41%
2033	12,559	78,342	1,188	5,653	(6,519)	78,664	68,154	5,931	5,135	(6,519)	72,701	5,963	(4,225)	-34%	92%	-1%	5,130	3%	41%
2034	12,982	78,664	1,222	5,677	(6,665)	78,897	72,701	2,666	5,356	(6,665)	74,058	4,839	(1,124)	-9%	94%	-6%	1,835	-64%	14%
2035	13,418	78,897	1,258	5,694	(6,803)	79,047	74,058	2,761	5,458	(6,803)	75,474	3,573	(1,266)	-9%	95%	-5%	1,898	3%	14%
2036	13,870	79,047	1,296	5,706	(6,932)	79,116	75,474	2,677	5,557	(6,932)	76,777	2,340	(1,233)	-9%	97%	-6%	1,782	-6%	13%
2037	14,337	79,116	1,334	5,712	(7,051)	79,112	76,777	2,772	5,656	(7,051)	78,154	958	(1,381)	-10%	99%	-6%	1,844	3%	13%
2038	14,819	79,112	1,374	5,713	(7,161)	79,039	78,154	2,740	5,755	(7,161)	79,489	(450)	(1,408)	-10%	101%	-6%	1,778	-4%	12%
2039	15,318	79,039	1,416	5,710	(7,261)	78,904	79,489	2,837	5,857	(7,261)	80,922	(2,018)	(1,568)	-10%	103%	-6%	1,839	3%	12%
2040	15,833	78,904	1,459	5,702	(7,351)	78,714	80,922	2,814	5,961	(7,351)	82,347	(3,632)	(1,614)	-10%	105%	-6%	1,780	-3%	11%
2041	16,366	78,714	1,504	5,689	(7,431)	78,477	82,347	2,913	6,069	(7,431)	83,898	(5,421)	(1,789)	-11%	107%	-5%	1,842	3%	11%
2042	16,917	78,477	1,551	5,674	(7,502)	78,200	83,898	2,895	6,182	(7,502)	85,473	(7,273)	(1,852)	-11%	109%	-5%	1,784	-3%	11%
2043	17,487	78,200	1,599	5,655	(7,564)	77,890	85,473	2,996	6,302	(7,564)	87,206	(9,316)	(2,043)	-12%	112%	-5%	1,846	3%	11%
2044	18,075	77,890	1,650	5,634	(7,618)	77,556	87,206	2,703	6,417	(7,618)	88,709	(11,153)	(1,837)	-10%	114%	-6%	1,513	-18%	8%
2045	18,684	77,556	1,702	5,610	(7,663)	77,204	88,709	2,798	6,527	(7,663)	90,371	(13,166)	(2,014)	-11%	117%	-5%	1,566	3%	8%
2046	19,313	77,204	1,756	5,584	(7,702)	76,842	90,371	2,673	6,640	(7,702)	91,982	(15,140)	(1,974)	-10%	120%	-6%	1,476	-6%	8%
2047	19,963	76,842	1,812	5,557	(7,734)	76,477	91,982	2,766	6,757	(7,734)	93,771	(17,294)	(2,154)	-11%	123%	-5%	1,527	4%	8%

Source: Analysis by The Pew Charitable Trusts and The Terry Group based on data from Retirement System actuarial valuations and annual reports

Model Assumptions			
State	Connecticut		
Plan	State Employees' Retirement System		
Actuarial Valuation Used	6/30/2016		
Employer Contribution Policy			
Description	Actuarial		
Applies to	Ongoing Policy	1984 Statutory Base	2016 Base
Amortization Period	25	15	30
Amortization Method Type	Level Dollar (phased in from level percent to level dollar over 5 years)	Level Dollar (phased in from level percent to level dollar over 5 years)	Level Dollar (phased in from level percent to level dollar over 5 years)
Open or closed	Closed	Closed	Closed
Layered or Single Amortization	Layered	Single	Single
Amortization Payment Growth Rate	0% (phased in from 3.5%)	0% (phased in from 3.5%)	0% (phased in from 3.5%)
Additional Contribution Rules			
Employee Contribution Rate			
Applies to	Tier 1	Tier 2	Tier 3
Rate	2.25%, 3.75% (2017, 2018), 4.25% thereafter	3.15%, 4.65% (2017, 2018), 5.15% thereafter	5.60%
Employee Contribution Cost-Sharing	No	No	Yes - up to 2%
Model Assumptions			
Plan Assumed Rate of Return	6.90%		
Inflation Assumption	2.50%		
Payroll Growth Assumption	3.50%		

COLA				
Applies to	Retired < 7/1/1980	7/1/1980 - 6/30/1997	7/1/1997 - 10/1/2011	Retired >= 10/2/2011
Description	Up to 5%, assumed 3.25%	3.00%	60% of increase in CPI up to 6% and 75% of the increase in CPI over 6%. Current 2.60%	60% of increase in CPI up to 6% and 75% of the increase in CPI over 6%. Current 2.25%
Assumed Effective COLA	COLA is assumed to be a minimum of 2% and will increase based on 60% of the COLA in excess of the break point 3.33% with a maximum of 7.5%			
COLA Adjusts for Plan Funding and Investment Experience	No			

Model Assumptions			
State	Connecticut		
Plan	Teachers' Retirement System		
Actuarial Valuation Used	6/30/2016		
Employer Contribution Policy			
Description	Actuarial		
Applies to	Ongoing Policy	Outstanding Layers	
Amortization Period	15	1, 6, 11, and 21 years	
Amortization Method Type	Level Percent	Level Percent	
Open or closed	Closed	Closed	
Layered or Single Amortization	Single	Layered	
Amortization Payment Growth Rate	3.25%	3.25%	
Additional Contribution Rules			
Employee Contribution Rate			
Applies to	All		
Rate	6%, 7% effective in 2018		
Employee Contribution Cost-Sharing	No		
Model Assumptions			
Plan Assumed Rate of Return	8.00%		
Inflation Assumption	2.75%		
Payroll Growth Assumption	3.25%		
COLA			
Applies to	Retired < 9/1/1992	Retired >= 9/1/1992, hired < 7/1/2007	Hired >= 7/1/2007
Description	Equal to CPI with a min of 3% and a max of 5%	Equal to Soc. Sec. COLA with a max of 1.5% if returns <8.5% and a max of 6% if returns >=8.5%	Equal to Soc. Sec. COLA with a max of 1.0% if returns <8.5%, a max of 3% if returns are between 8.5% and 11.5% and a max of 5% if returns >=11.5%
Assumed Effective COLA	COLA is assumed to be a minimum of 1% and will increase based on 80% of the Social Security COLA in excess of the break point of 1.5% with a maximum COLA of 6%		
COLA Adjustment for Plan Funding and Investment Experience	No	No	Yes

Fiscal Metrics
Model Output

State

Connecticut

Plans Included

State Employees' Retirement System

Teachers' Retirement System

	State Policy (Current Contribution Policy)									Sustainable Budget (Fixed % of OSR)								
	Deterministic 7.43%			Deterministic 5%			Deterministic 9%			Deterministic 7.43%			Deterministic 5%			Deterministic 9%		
	Current Plan Assumptions			Low Return			High Return			Current Plan Assumptions			Low Return			High Return		
Metrics	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures																		
Market Value of Assets (MVA)	37,311	50,358	78,154	33,041	41,503	67,325	39,945	56,665	89,796	35,507	43,850	72,233	31,196	33,142	38,584	38,180	51,264	101,523
Actuarial Accrued Liability (AAL)	70,375	75,367	79,112	70,375	75,367	79,112	70,375	75,367	79,112	70,375	75,367	79,112	70,375	75,367	79,112	70,375	75,367	79,112
Accrued Liability at 4% Discount Rate (DR)	103,886	111,254	116,783	103,886	111,254	116,783	103,886	111,254	116,783	103,886	111,254	116,783	103,886	111,254	116,783	103,886	111,254	116,783
Unfunded Actuarial Accrued Liability (UAAL)	33,064	25,009	958	37,334	33,863	11,787	30,430	18,702	(10,684)	34,868	31,517	6,879	39,179	42,225	40,528	32,195	24,103	(22,412)
Unfunded Liability at 4% DR	66,575	60,896	38,629	70,845	69,751	49,458	63,941	54,589	26,987	68,379	67,404	44,550	72,690	78,112	78,199	65,706	59,990	15,259
Funded Ratio	53.0%	66.8%	98.8%	46.9%	55.1%	85.1%	56.8%	75.2%	113.5%	50.5%	58.2%	91.3%	44.3%	44.0%	48.8%	54.3%	68.0%	128.3%
Funded Ratio at 4% Discount Rate	35.9%	45.3%	66.9%	31.8%	37.3%	57.6%	38.5%	50.9%	76.9%	34.2%	39.4%	61.9%	30.0%	29.8%	33.0%	36.8%	46.1%	86.9%
AAL Compound Annual Growth Rate	2.0%	1.7%	1.1%	2.0%	1.7%	1.1%	2.0%	1.7%	1.1%	2.0%	1.7%	1.1%	2.0%	1.7%	1.1%	2.0%	1.7%	1.1%
Change in AAL from Prior Year (%)	1.7%	1.1%	0.0%	1.7%	1.1%	0.0%	1.7%	1.1%	0.0%	1.7%	1.1%	0.0%	1.7%	1.1%	0.0%	1.7%	1.1%	0.0%
Unfunded Liability / Own Source Revenue at 4% DR	288%	221%	100%	306%	253%	128%	276%	198%	70%	296%	244%	115%	314%	283%	202%	284%	217%	39%
Cash Flow Measures																		
Benefit Payments	4,675	5,535	7,051	4,675	5,535	7,051	4,675	5,535	7,051	4,675	5,535	7,051	4,675	5,535	7,051	4,675	5,535	7,051
Total Contributions	4,050	4,967	2,772	4,171	5,661	3,291	3,983	4,598	2,042	3,585	4,292	6,051	3,589	4,302	6,075	3,577	4,273	6,003
Negative Operating Cash Flow	625	569	4,279	504	(126)	3,760	692	938	5,009	1,091	1,243	1,000	1,087	1,234	976	1,099	1,262	1,048
Benefit Payments / Beginning of Period MVA	13.2%	11.7%	9.2%	14.6%	14.0%	10.4%	12.5%	10.5%	8.1%	13.7%	13.2%	10.3%	15.2%	16.9%	18.7%	13.0%	11.5%	7.5%
Operating Cash Flow to Assets Ratio	-1.8%	-1.2%	-5.6%	-1.6%	0.3%	-5.5%	-1.9%	-1.8%	-5.7%	-3.2%	-3.0%	-1.5%	-3.5%	-3.8%	-2.6%	-3.0%	-2.6%	-1.1%
Change in MVA from Prior Year (%)	5.7%	6.3%	1.8%	3.4%	5.3%	-0.7%	7.0%	7.1%	3.0%	4.2%	4.4%	5.9%	1.4%	1.1%	2.3%	5.8%	6.3%	7.8%
Own Source Revenue (OSR)	23,136	27,616	38,702	23,136	27,616	38,702	23,136	27,616	38,702	23,136	27,616	38,702	23,136	27,616	38,702	23,136	27,616	38,702
OSR Compound Annual Growth Rate	4.0%	3.8%	3.6%	4.0%	3.8%	3.6%	4.0%	3.8%	3.6%	4.0%	3.8%	3.6%	4.0%	3.8%	3.6%	4.0%	3.8%	3.6%
Change in OSR from Prior Year (%)	4.4%	3.3%	3.4%	4.4%	3.3%	3.4%	4.4%	3.3%	3.4%	4.4%	3.3%	3.4%	4.4%	3.3%	3.4%	4.4%	3.3%	3.4%
Employer Contributions / OSR	15.2%	15.7%	4.8%	15.8%	18.1%	6.0%	15.0%	14.4%	3.0%	13.2%	13.2%	13.2%	13.2%	13.2%	13.2%	13.2%	13.2%	13.2%
Total Contributions / OSR	17.5%	18.0%	7.2%	18.0%	20.5%	8.5%	17.2%	16.6%	5.3%	15.5%	15.5%	15.6%	15.5%	15.6%	15.7%	15.5%	15.5%	15.5%
Payment and Contribution Measures																		
Employer Contributions (ERC)	3,527	4,330	1,844	3,645	5,006	2,315	3,469	3,980	1,161	3,062	3,655	5,123	3,062	3,655	5,123	3,062	3,655	5,123
Change in ERC from Prior Year (%)	10.3%	3.4%	3.5%	13.4%	3.4%	3.5%	8.8%	3.4%	3.4%	4.4%	3.3%	3.4%	4.4%	3.3%	3.4%	4.4%	3.3%	3.4%
Employee Contributions (EEC)	522	637	928	526	656	976	514	618	881	522	637	928	526	646	952	514	618	881
Payroll	8,728	10,298	14,337	8,728	10,298	14,337	8,728	10,298	14,337	8,728	10,298	14,337	8,728	10,298	14,337	8,728	10,298	14,337
Employer Contribution / Payroll	40.4%	42.0%	12.9%	41.8%	48.6%	16.1%	39.7%	38.6%	8.1%	35.1%	35.5%	35.7%	35.1%	35.5%	35.7%	35.1%	35.5%	35.7%
Employee Contribution / Payroll	6.0%	6.2%	6.5%	6.0%	6.4%	6.8%	5.9%	6.0%	6.1%	6.0%	6.2%	6.5%	6.0%	6.3%	6.6%	5.9%	6.0%	6.1%
Total Contributions / Payroll	46.4%	48.2%	19.3%	47.8%	55.0%	23.0%	45.6%	44.6%	14.2%	41.1%	41.7%	42.2%	41.1%	41.8%	42.4%	41.0%	41.5%	41.9%
Normal Cost	879	1,004	1,334	879	1,004	1,334	879	1,004	1,334	879	1,004	1,334	879	1,004	1,334	879	1,004	1,334
Normal Cost (4% DR)	1,696	1,938	2,574	1,696	1,938	2,574	1,696	1,938	2,574	1,696	1,938	2,574	1,696	1,938	2,574	1,696	1,938	2,574
Net amortization $	807	2,131	1,390	647	2,214	1,182	850	2,115	1,338	226	1,008	4,035	(45)	311	1,816	337	1,433	5,966
Net amortization $ (4% DR)	(271)	584	(1,399)	(281)	974	(1,229)	(259)	428	(1,727)	(795)	(319)	1,602	(923)	(678)	407	(723)	(88)	2,591
Net amortization $ / Payroll	9.2%	20.7%	9.7%	7.4%	21.5%	8.2%	9.7%	20.5%	9.3%	2.6%	9.8%	28.1%	-0.5%	3.0%	12.7%	3.9%	13.9%	41.6%
Net amortization $ / Payroll (4% DR)	-3.1%	5.7%	-9.8%	-3.2%	9.5%	-8.6%	-3.0%	4.2%	-12.0%	-9.1%	-3.1%	11.2%	-10.6%	-6.6%	2.8%	-8.3%	-0.9%	18.1%
Investment Performance																		
Compounded Annual Growth - From Start Date	7.43%	7.43%	7.43%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%	7.43%	7.43%	7.43%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%
Compounded Annual Growth - Segments	7.43%	7.43%	7.43%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%	7.43%	7.43%	7.43%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%

Note: Dollar Figures in Millions

Fiscal Metrics
Model Output

State

Connecticut

Plans Included

State Employees' Retirement System

Teachers' Retirement System

	State Policy (Current Contribution Policy)									Sustainable Budget (Fixed % of OSR)								
	Stochastic Run - Baseline CMA									Stochastic Run - Baseline CMA								
	25th Percentile			50th Percentile			75th Percentile			25th Percentile			50th Percentile			75th Percentile		
Metrics	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures																		
Market Value of Assets (MVA)	29,821	38,128	66,327	35,274	45,366	76,702	41,571	55,452	85,515	27,849	29,065	35,738	33,522	39,141	56,060	39,760	50,484	83,802
Actuarial Accrued Liability (AAL)	69,633	73,458	73,254	69,749	73,538	73,113	69,685	73,601	73,543	69,636	73,451	73,199	69,749	73,561	73,145	69,685	73,601	73,581
Accrued Liability at 4% Discount Rate (DR)	102,790	108,436	108,135	102,962	108,554	107,928	102,867	108,648	108,562	102,794	108,426	108,055	102,962	108,588	107,975	102,867	108,648	108,619
Unfunded Actuarial Accrued Liability (UAAL)	39,811	35,330	6,927	34,475	28,172	(3,588)	28,114	18,149	(11,972)	41,786	44,385	37,462	36,227	34,420	17,086	29,925	23,117	(10,221)
Unfunded Liability at 4% DR	72,968	70,308	41,808	67,688	63,188	31,226	61,296	53,196	23,048	74,945	79,361	72,317	69,440	69,447	51,916	63,107	58,164	24,816
Funded Ratio	42.8%	51.9%	90.5%	50.6%	61.7%	104.9%	59.7%	75.3%	116.3%	40.0%	39.6%	48.8%	48.1%	53.2%	76.6%	57.1%	68.6%	113.9%
Funded Ratio at 4% Discount Rate	29.0%	35.2%	61.3%	34.3%	41.8%	71.1%	40.4%	51.0%	78.8%	27.1%	26.8%	33.1%	32.6%	36.0%	51.9%	38.7%	46.5%	77.2%
AAL Compound Annual Growth Rate	1.8%	1.4%	0.7%	1.8%	1.4%	0.7%	1.8%	1.4%	0.7%	1.8%	1.4%	0.7%	1.8%	1.4%	0.7%	1.8%	1.4%	0.7%
Change in AAL from Prior Year (%)	1.4%	0.8%	-0.8%	1.5%	0.8%	-0.8%	1.5%	0.8%	-0.7%	1.4%	0.8%	-0.8%	1.5%	0.8%	-0.8%	1.5%	0.8%	-0.7%
Unfunded Liability / Own Source Revenue at 4% DR	318%	257%	108%	293%	230%	81%	266%	193%	59%	327%	290%	188%	301%	253%	135%	274%	211%	64%
Cash Flow Measures																		
Benefit Payments	4,606	5,397	6,813	4,615	5,395	6,799	4,610	5,402	6,815	4,606	5,397	6,811	4,615	5,396	6,802	4,610	5,402	6,815
Total Contributions	4,204	5,662	3,616	4,017	4,916	3,384	3,909	4,383	2,524	3,550	4,231	5,914	3,568	4,227	5,875	3,553	4,234	5,932
Negative Operating Cash Flow	402	(265)	3,196	599	480	3,415	701	1,019	4,291	1,056	1,166	897	1,047	1,169	926	1,057	1,168	883
Benefit Payments / Beginning of Period MVA	15.8%	15.0%	10.2%	13.6%	12.2%	9.1%	12.2%	10.4%	8.3%	16.5%	18.8%	19.2%	14.1%	13.8%	12.6%	12.6%	11.3%	8.8%
Operating Cash Flow to Assets Ratio	-1.4%	0.7%	-4.8%	-1.8%	-1.1%	-4.5%	-1.9%	-2.0%	-5.2%	-3.8%	-4.1%	-2.5%	-3.2%	-3.0%	-1.7%	-2.9%	-2.5%	-1.1%
Change in MVA from Prior Year (%)	2.3%	6.3%	-0.5%	3.9%	2.8%	2.2%	9.8%	6.7%	4.3%	-0.1%	1.1%	0.6%	2.4%	0.4%	3.5%	8.9%	5.9%	7.9%
Own Source Revenue (OSR)	22,920	27,399	38,592	23,091	27,415	38,396	23,012	27,517	38,799	22,924	27,382	38,545	23,091	27,424	38,409	23,011	27,517	38,846
OSR Compound Annual Growth Rate	3.8%	3.7%	3.6%	3.9%	3.7%	3.6%	3.8%	3.7%	3.6%	3.8%	3.7%	3.6%	3.9%	3.7%	3.6%	3.8%	3.7%	3.6%
Change in OSR from Prior Year (%)	4.2%	3.4%	3.4%	4.4%	3.1%	3.2%	4.4%	3.3%	3.4%	4.2%	3.4%	3.5%	4.4%	3.0%	3.2%	4.4%	3.3%	3.5%
Employer Contributions / OSR	16.1%	18.5%	7.3%	15.2%	15.8%	6.8%	14.8%	13.8%	4.5%	13.2%	13.2%	13.2%	13.2%	13.2%	13.2%	13.2%	13.2%	13.2%
Total Contributions / OSR	18.3%	20.7%	9.4%	17.4%	17.9%	8.8%	17.0%	15.9%	6.5%	15.5%	15.5%	15.3%	15.5%	15.4%	15.3%	15.4%	15.4%	15.3%
Payment and Contribution Measures																		
Employer Contributions (ERC)	3,691	5,057	2,814	3,506	4,322	2,596	3,402	3,793	1,733	3,034	3,624	5,102	3,056	3,630	5,084	3,046	3,642	5,142
Change in ERC from Prior Year (%)	14.6%	2.7%	2.9%	10.0%	2.7%	2.9%	7.2%	2.7%	3.0%	4.2%	3.4%	3.5%	4.4%	3.0%	3.2%	4.4%	3.3%	3.5%
Employee Contributions (EEC)	513	604	803	511	594	788	507	590	791	515	607	812	512	597	792	508	591	790
Payroll	8,570	9,756	12,812	8,602	9,800	12,785	8,584	9,808	12,882	8,571	9,753	12,789	8,602	9,808	12,786	8,584	9,808	12,889
Employer Contribution / Payroll	43.1%	51.8%	22.0%	40.8%	44.1%	20.3%	39.6%	38.7%	13.5%	35.4%	37.2%	39.9%	35.5%	37.0%	39.8%	35.5%	37.1%	39.9%
Employee Contribution / Payroll	6.0%	6.2%	6.3%	5.9%	6.1%	6.2%	5.9%	6.0%	6.1%	6.0%	6.2%	6.3%	5.9%	6.1%	6.2%	5.9%	6.0%	6.1%
Total Contributions / Payroll	49.1%	58.0%	28.2%	46.7%	50.2%	26.5%	45.5%	44.7%	19.6%	41.4%	43.4%	46.2%	41.5%	43.1%	46.0%	41.4%	43.2%	46.0%
Normal Cost	871	957	1,197	873	963	1,196	872	962	1,204	871	957	1,195	873	964	1,195	872	962	1,204
Normal Cost (4% DR)	1,680	1,846	2,310	1,684	1,858	2,307	1,682	1,857	2,322	1,680	1,846	2,305	1,684	1,860	2,306	1,682	1,857	2,323
Net amortization $	519	2,127	1,971	673	1,951	2,368	857	1,980	1,961	(255)	115	2,034	118	852	3,386	389	1,506	5,165
Net amortization $ (4% DR)	(314)	1,025	(361)	(322)	574	(253)	(270)	344	(889)	(1,033)	(718)	746	(827)	(337)	1,451	(686)	20	2,410
Net amortization $ / Payroll	6.1%	21.8%	15.4%	7.8%	19.9%	18.5%	10.0%	20.2%	15.2%	-3.0%	1.2%	15.9%	1.4%	8.7%	26.5%	4.5%	15.4%	40.1%
Net amortization $ / Payroll (4% DR)	-3.7%	10.5%	-2.8%	-3.7%	5.9%	-2.0%	-3.1%	3.5%	-6.9%	-12.1%	-7.4%	5.8%	-9.6%	-3.4%	11.3%	-8.0%	0.2%	18.7%
Investment Performance																		
Compounded Annual Growth - From Start Date	2.9%	3.9%	4.6%	6.3%	6.4%	6.3%	9.8%	8.8%	8.0%	2.9%	3.9%	4.7%	6.3%	6.4%	6.3%	9.8%	8.8%	8.0%
Compounded Annual Growth - Segments	2.9%	4.9%	5.4%	6.3%	6.4%	6.3%	9.8%	7.7%	7.3%	2.9%	4.9%	5.4%	6.3%	6.4%	6.3%	9.8%	7.7%	7.3%

Note: Dollar Figures in Millions

Fiscal Metrics
Model Output

State

Connecticut

Plans Included

State Employees' Retirement System

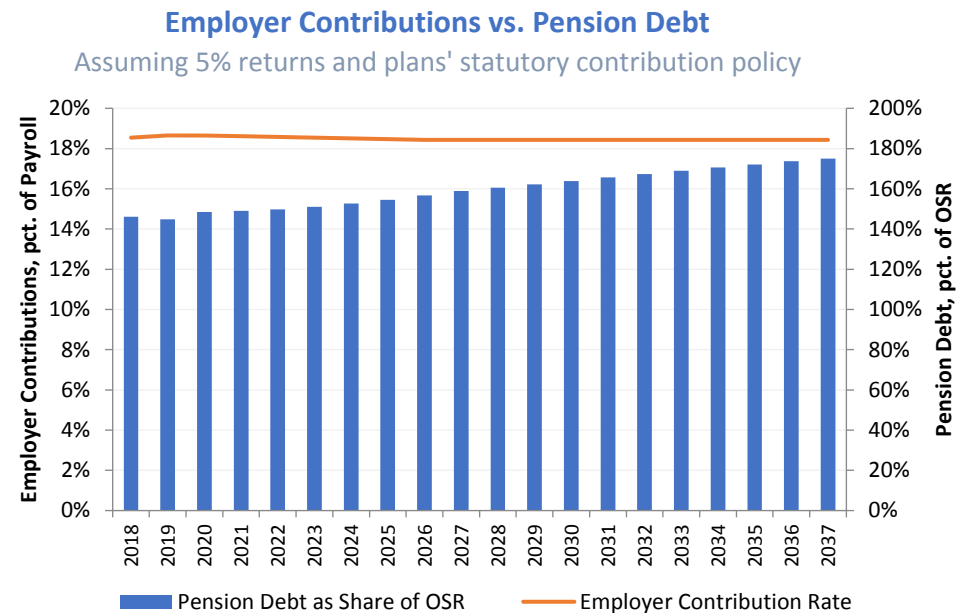Teachers' Retirement System

	State Policy (Current Contribution Policy)						Sustainable Budget (Fixed % of OSR)					
	Deterministic			Deterministic			Deterministic			Deterministic		
	"Low-for-long" Economic Scenario			"Asset Shock" Economic Scenario			"Low-for-long" Economic Scenario			"Asset Shock" Economic Scenario		
Metrics	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures												
Market Value of Assets (MVA)	32,117	40,252	62,848	29,331	39,176	62,638	30,323	32,422	39,338	25,653	25,838	26,543
Actuarial Accrued Liability (AAL)	69,704	73,527	73,423	69,634	73,411	73,188	69,704	73,527	73,423	69,634	73,411	73,188
Accrued Liability at 4% Discount Rate (DR)	102,895	108,539	108,386	102,792	108,367	108,038	102,895	108,539	108,386	102,792	108,367	108,038
Unfunded Actuarial Accrued Liability (UAAL)	37,587	33,275	10,575	40,303	34,235	10,550	39,381	41,106	34,086	43,981	47,573	46,645
Unfunded Liability at 4% DR	70,778	68,287	45,537	73,460	69,191	45,400	72,572	76,118	69,048	77,138	82,529	81,495
Funded Ratio	46.1%	54.7%	85.6%	42.1%	53.4%	85.6%	43.5%	44.1%	53.6%	36.8%	35.2%	36.3%
Funded Ratio at 4% Discount Rate	31.2%	37.1%	58.0%	28.5%	36.2%	58.0%	29.5%	29.9%	36.3%	25.0%	23.8%	24.6%
AAL Compound Annual Growth Rate	1.8%	1.4%	0.7%	1.8%	1.4%	0.7%	1.8%	1.4%	0.7%	1.8%	1.4%	0.7%
Change in AAL from Prior Year (%)	1.5%	0.8%	-0.7%	1.4%	0.8%	-0.8%	1.5%	0.8%	-0.7%	1.4%	0.8%	-0.8%
Unfunded Liability / Own Source Revenue at 4% DR	306%	247%	118%	328%	259%	121%	314%	276%	178%	345%	309%	218%
Cash Flow Measures												
Benefit Payments	4,606	5,376	6,749	4,599	5,370	6,746	4,606	5,376	6,749	4,599	5,370	6,746
Total Contributions	4,140	5,520	3,066	4,616	5,815	3,102	3,586	4,282	5,998	3,485	4,141	5,783
Negative Operating Cash Flow	466	(144)	3,683	(17)	(446)	3,644	1,020	1,094	751	1,114	1,228	963
Benefit Payments / Beginning of Period MVA	14.8%	14.1%	10.6%	16.4%	14.5%	10.7%	15.3%	16.8%	17.6%	17.9%	20.8%	25.7%
Operating Cash Flow to Assets Ratio	-1.5%	0.4%	-5.8%	0.1%	1.2%	-5.8%	-3.4%	-3.4%	-2.0%	-4.3%	-4.8%	-3.7%
Change in MVA from Prior Year (%)	3.0%	5.2%	-1.1%	4.6%	6.1%	-1.0%	1.0%	1.3%	2.8%	0.0%	0.0%	1.1%
Own Source Revenue (OSR)	23,136	27,616	38,702	22,379	26,712	37,435	23,136	27,616	38,702	22,379	26,712	37,435
OSR Compound Annual Growth Rate	4.0%	3.8%	3.6%	3.3%	3.4%	3.4%	4.0%	3.8%	3.6%	3.3%	3.4%	3.4%
Change in OSR from Prior Year (%)	4.4%	3.3%	3.4%	3.8%	3.3%	3.4%	4.4%	3.3%	3.4%	3.8%	3.3%	3.4%
Employer Contributions / OSR	15.7%	17.7%	5.7%	18.3%	19.5%	6.1%	13.2%	13.2%	13.2%	13.2%	13.2%	13.2%
Total Contributions / OSR	17.9%	20.0%	7.9%	20.6%	21.8%	8.3%	15.5%	15.5%	15.5%	15.6%	15.5%	15.4%
Payment and Contribution Measures												
Employer Contributions (ERC)	3,621	4,894	2,190	4,097	5,210	2,274	3,062	3,655	5,123	2,962	3,536	4,955
Change in ERC from Prior Year (%)	12.9%	2.7%	2.9%	18.1%	2.7%	2.9%	4.4%	3.3%	3.4%	3.8%	3.3%	3.4%
Employee Contributions (EEC)	520	626	876	519	606	828	524	626	876	523	606	828
Payroll	8,617	9,848	12,868	8,604	9,805	12,813	8,617	9,848	12,868	8,604	9,805	12,813
Employer Contribution / Payroll	42.0%	49.7%	17.0%	47.6%	53.1%	17.7%	35.5%	37.1%	39.8%	34.4%	36.1%	38.7%
Employee Contribution / Payroll	6.0%	6.4%	6.8%	6.0%	6.2%	6.5%	6.1%	6.4%	6.8%	6.1%	6.2%	6.5%
Total Contributions / Payroll	48.0%	56.1%	23.8%	53.7%	59.3%	24.2%	41.6%	43.5%	46.6%	40.5%	42.2%	45.1%
Normal Cost	873	966	1,204	873	962	1,198	873	966	1,204	873	962	1,198
Normal Cost (4% DR)	1,685	1,865	2,322	1,684	1,857	2,312	1,685	1,865	2,322	1,684	1,857	2,312
Net amortization $	599	2,140	1,151	862	2,361	1,192	(64)	391	2,301	(490)	(199)	1,203
Net amortization $ (4% DR)	(305)	951	(1,068)	58	1,214	(1,017)	(918)	(562)	911	(1,192)	(936)	235
Net amortization $ / Payroll	6.9%	21.7%	8.9%	10.0%	24.1%	9.3%	-0.7%	4.0%	17.9%	-5.7%	-2.0%	9.4%
Net amortization $ / Payroll (4% DR)	-3.5%	9.7%	-8.3%	0.7%	12.4%	-7.9%	-10.6%	-5.7%	7.1%	-13.9%	-9.5%	1.8%
Investment Performance												
Compounded Annual Growth - From Start Date	4.3%	4.6%	4.7%	2.2%	3.5%	4.2%	4.3%	4.6%	4.7%	2.2%	3.5%	4.2%
Compounded Annual Growth - Segments	4.3%	4.9%	4.9%	2.2%	4.9%	4.9%	4.3%	4.9%	4.9%	2.2%	4.9%	4.9%

Note: Dollar Figures in Millions

Connecticut
Fixed 5% Economic Scenario
State Employees' Retirement System and Teachers' Retirement System

Assets vs. Cash Flow
Assuming 5% returns and contributions fixed as % of OSR

Legend: Market Value of Assets — Operating Cash Flow, Percent of Assets

Total Contributions vs. Benefit Payments
Assuming 5% returns and contributions fixed as % of OSR

Legend: Total contributions — Benefit payments

Unfunded Liability vs. Funding Levels
Assuming 5% returns and contributions fixed as % of OSR

Legend: Unfunded Liability (Market Value) — Funded Ratio

Employer Contributions vs. Pension Debt
Assuming 5% returns and plans' statutory contribution policy

Legend: Pension Debt as Share of OSR — Employer Contribution Rate

Kentucky Retirement System 30 Year Projections

Plans included: Employees Retirement System - Hazardous, Employees Retirement System - Non-hazardous, Teachers Retirement System
State contribution policy at assumed rate of return (about 6.77%)

$MMs

Fiscal Year	Pension Liability (Actuarial Accrued Liability)						Pension Assets (Market Value)					Change in Pension Debt			% Funded	Cash Flow	Employer Contribution		
	Payroll	Beginning of Period	Service Cost	Interest	Benefit Payments	End of Period	Beginning of Period	Total Contribution	Interest	Benefit Payments	End of Period	Debt	$	% of Payroll		% of Assets	$	% Change	% Payroll
2018	5,434	49,533	764	3,278	(3,060)	50,515	21,366	2,168	1,495	(3,060)	21,969	28,546	379	7%	43%	-4%	1,743	N/A	32%
2019	5,616	50,515	786	3,348	(3,168)	51,481	21,969	2,243	1,535	(3,168)	22,580	28,902	356	6%	44%	-4%	1,804	3%	32%
2020	5,805	51,481	810	3,416	(3,277)	52,430	22,580	2,323	1,570	(3,277)	23,195	29,235	333	6%	44%	-4%	1,868	4%	32%
2021	6,000	52,430	834	3,483	(3,389)	53,358	23,195	2,310	1,602	(3,389)	23,718	29,640	405	7%	44%	-5%	1,840	-1%	31%
2022	6,201	53,358	859	3,549	(3,503)	54,265	23,718	2,383	1,630	(3,503)	24,229	30,036	395	6%	45%	-5%	1,898	3%	31%
2023	6,409	54,265	886	3,614	(3,617)	55,146	24,229	2,381	1,654	(3,617)	24,647	30,500	464	7%	45%	-5%	1,879	-1%	29%
2024	6,624	55,146	913	3,677	(3,733)	56,002	24,647	2,458	1,674	(3,733)	25,045	30,957	458	7%	45%	-5%	1,939	3%	29%
2025	6,847	56,002	941	3,738	(3,850)	56,831	25,045	2,461	1,690	(3,850)	25,346	31,485	528	8%	45%	-6%	1,925	-1%	28%
2026	7,077	56,831	970	3,797	(3,968)	57,630	25,346	2,541	1,700	(3,968)	25,620	32,011	526	7%	44%	-6%	1,986	3%	28%
2027	7,314	57,630	1,001	3,854	(4,086)	58,400	25,620	2,548	1,706	(4,086)	25,789	32,611	600	8%	44%	-6%	1,975	-1%	27%
2028	7,560	58,400	1,032	3,910	(4,203)	59,138	25,789	2,631	1,707	(4,203)	25,923	33,215	604	8%	44%	-6%	2,038	3%	27%
2029	7,814	59,138	1,065	3,963	(4,321)	59,846	25,923	2,642	1,702	(4,321)	25,947	33,899	684	9%	43%	-6%	2,029	0%	26%
2030	8,077	59,846	1,099	4,015	(4,438)	60,522	25,947	2,728	1,692	(4,438)	25,929	34,593	694	9%	43%	-7%	2,094	3%	26%
2031	8,348	60,522	1,134	4,064	(4,554)	61,166	25,929	2,742	1,676	(4,554)	25,794	35,373	780	9%	42%	-7%	2,087	0%	25%
2032	8,629	61,166	1,171	4,112	(4,668)	61,780	25,794	2,832	1,653	(4,668)	25,610	36,170	798	9%	41%	-7%	2,154	3%	25%
2033	8,919	61,780	1,208	4,158	(4,778)	62,369	25,610	2,850	1,624	(4,778)	25,306	37,062	892	10%	41%	-8%	2,148	0%	24%
2034	9,219	62,369	1,248	4,202	(4,882)	62,936	25,306	2,943	1,589	(4,882)	24,956	37,980	918	10%	40%	-8%	2,218	3%	24%
2035	9,528	62,936	1,288	4,245	(4,981)	63,488	24,956	2,964	1,548	(4,981)	24,486	39,002	1,022	11%	39%	-8%	2,214	0%	23%
2036	9,849	63,488	1,330	4,288	(5,073)	64,033	24,486	3,061	1,500	(5,073)	23,974	40,060	1,058	11%	37%	-8%	2,285	3%	23%
2037	10,180	64,033	1,374	4,330	(5,159)	64,578	23,974	3,084	1,445	(5,159)	23,345	41,234	1,174	12%	36%	-9%	2,283	0%	22%
2038	10,522	64,578	1,419	4,372	(5,238)	65,132	23,345	3,186	1,385	(5,238)	22,677	42,454	1,221	12%	35%	-9%	2,357	3%	22%
2039	10,876	65,132	1,466	4,415	(5,311)	65,702	22,677	3,211	1,318	(5,311)	21,895	43,807	1,352	12%	33%	-9%	2,354	0%	22%
2040	11,242	65,702	1,514	4,459	(5,377)	66,298	21,895	3,317	1,244	(5,377)	21,079	45,220	1,413	13%	32%	-9%	2,430	3%	22%
2041	11,621	66,298	1,564	4,506	(5,436)	66,932	21,079	3,338	1,165	(5,436)	20,146	46,787	1,567	13%	30%	-10%	2,421	0%	21%
2042	12,012	66,932	1,616	4,555	(5,487)	67,616	20,146	3,448	1,079	(5,487)	19,185	48,431	1,644	14%	28%	-10%	2,500	3%	21%
2043	12,416	67,616	1,670	4,607	(5,531)	68,362	19,185	3,446	986	(5,531)	18,087	50,275	1,845	15%	26%	-11%	2,466	-1%	20%
2044	12,834	68,362	1,726	4,663	(5,576)	69,175	18,087	3,707	892	(5,576)	17,109	52,066	1,791	14%	25%	-10%	2,693	9%	21%
2045	13,266	69,175	1,783	4,724	(5,615)	70,067	17,109	4,875	847	(5,615)	17,216	52,851	785	6%	25%	-4%	3,827	42%	29%
2046	13,712	70,067	1,843	4,791	(5,648)	71,053	17,216	4,937	852	(5,648)	17,357	53,696	845	6%	24%	-4%	3,853	1%	28%
2047	14,174	71,053	1,904	4,864	(5,675)	72,146	17,357	4,992	859	(5,675)	17,533	54,613	918	6%	24%	-4%	3,872	0%	27%

Source: Analysis by The Pew Charitable Trusts and The Terry Group based on data from Retirement System actuarial valuations and annual reports

Model Assumptions	
State	Kentucky
Plan	Employees Retirement System - Hazardous
Actuarial Valuation Used	6/30/2017
Employer Contribution Policy	
Description	Actuarial
Applies to	All
Amortization Period	30 Years in 2013
Amortization Method Type	Level Percent
Open or closed	Closed
Layered or Single Amortization	Single
Amortization Payment Growth Rate	0.0%
Additional Contribution Rules	
Employee Contribution Rate	
Applies to	All
Rate	8.00%
Employee Contribution Cost-Sharing	No
Model Assumptions	
Plan Assumed Rate of Return	6.25%
Inflation Assumption	2.30%
Payroll Growth Assumption	3.05% to project future payroll
COLA	
Applies to	All
Description	No COLA
Assumed effective COLA	N/A
COLA Adjustment for Plan Funding and Investment Experience	N/A

Model Assumptions	
State	Kentucky
Plan	Employees Retirement System - Non-hazardous
Actuarial Valuation Used	6/30/2017
Employer Contribution Policy	
Description	Actuarial
Applies to	All
Amortization Period	30 Years in 2013
Amortization Method Type	Level Percent
Open or closed	Closed
Layered or Single Amortization	Single
Amortization Payment Growth Rate	0.0%
Additional Contribution Rules	
Employee Contribution Rate	
Applies to	All
Rate	5.00%
Employee Contribution Cost-Sharing	No
Model Assumptions	
Plan Assumed Rate of Return	5.25%
Inflation Assumption	2.30%
Payroll Growth Assumption	3.05% to project future payroll
COLA	
Applies to	All
Description	No COLA
Assumed effective COLA	N/A
COLA Adjustment for Plan Funding and Investment Experience	N/A

Model Assumptions			
State	Kentucky		
Plan	Teachers' Retirement System		
Actuarial Valuation Used	6/30/2017		
Employer Contribution Policy			
Description	Statutory		
Applies to	University	Non-University	
Rate	Pre-08: 13.65% minus 0.05% (Life) and 2.775% (Med) Post-08: 13.65% minus 0.05% (Life) and 1.775% (Med)	Pre-08: 16.105% minus 0.05% (Life) and 3.75% (Med) Post-08: 16.105% minus 0.05% (Life) and 2.75% (Med)	
Additional contribution rules	Additional State Special Appropriation of 3.0%	Additional State Special Appropriation of 3.0%	
Employee Contribution Rate			
Applies to	University	Non-University	Blended
Rate	7.625%	9.105%	Approximately 9.0% over time
Employee Contribution Cost-Sharing	No		
Actuarial Assumptions			
Plan Assumed Rate of Return	7.50%		
Inflation Assumption	3.00%		
Payroll Growth Assumption	3.50%		
COLA			
Applies to	All		
Description	1.50%		
Assumed effective COLA	Flat 1.5% COLA modeled		
COLA Adjustment for Plan Funding and Investment Experience	No		

State

Kentucky

Plans Included

Employees Retirement System - Hazardous

Employees Retirement System - Non-hazardous

Teachers Retirement System

Metrics	State Policy (Current Contribution Policy)									Sustainable Budget (Fixed % of OSR)								
	Deterministic 6.77%			Deterministic 5%			Deterministic 9%			Deterministic 6.77%			Deterministic 5%			Deterministic 9%		
	Current Plan Assumptions			Low Return			High Return			Current Plan Assumptions			Low Return			High Return		
	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures																		
Market Value of Assets (MVA)	24,229	25,789	23,345	21,540	19,633	11,327	26,566	31,946	42,390	22,167	21,534	16,494	19,488	15,405	3,916	24,354	27,030	34,505
Actuarial Accrued Liability (AAL)	54,265	58,400	64,578	54,265	58,401	64,592	54,264	58,389	64,459	54,265	58,400	64,578	54,265	58,401	64,592	54,264	58,389	64,459
Accrued Liability at 4% Discount Rate (DR)	75,309	81,047	89,622	75,309	81,049	89,641	75,307	81,032	89,457	75,309	81,047	89,622	75,309	81,049	89,641	75,307	81,032	89,457
Unfunded Actuarial Accrued Liability (UAAL)	30,036	32,611	41,234	32,724	38,768	53,265	27,698	26,443	22,069	32,098	36,866	48,084	34,777	42,996	60,676	29,910	31,359	29,955
Unfunded Liability at 4% DR	51,080	55,259	66,277	53,768	61,416	78,314	48,742	49,086	47,067	53,142	59,514	73,128	55,821	65,645	85,725	50,954	54,002	54,952
Funded Ratio	44.6%	44.2%	36.1%	39.7%	33.6%	17.5%	49.0%	54.7%	65.8%	40.8%	36.9%	25.5%	35.9%	26.4%	6.1%	44.9%	46.3%	53.5%
Funded Ratio at 4% Discount Rate	32.2%	31.8%	26.0%	28.6%	24.2%	12.6%	35.3%	39.4%	47.4%	29.4%	26.6%	18.4%	25.9%	19.0%	4.4%	32.3%	33.4%	38.6%
AAL Compound Annual Growth Rate	1.8%	1.7%	1.3%	1.8%	1.7%	1.3%	1.8%	1.7%	1.3%	1.8%	1.7%	1.3%	1.8%	1.7%	1.3%	1.8%	1.7%	1.3%
Change in AAL from Prior Year (%)	1.7%	1.3%	0.9%	1.7%	1.3%	0.9%	1.7%	1.3%	0.8%	1.7%	1.3%	0.9%	1.7%	1.3%	0.9%	1.7%	1.3%	0.8%
Unfunded Liability / Own Source Revenue at 4% DR	240%	217%	183%	253%	241%	216%	229%	192%	130%	250%	233%	202%	263%	257%	236%	240%	212%	151%
Cash Flow Measures																		
Benefit Payments	3,503	4,086	5,159	3,502	4,085	5,157	3,503	4,088	5,172	3,503	4,086	5,159	3,502	4,085	5,157	3,503	4,088	5,172
Total Contributions	2,383	2,548	3,084	2,385	2,558	5,237	2,378	2,469	2,542	1,968	2,360	3,355	1,968	2,360	5,427	1,968	2,360	3,355
Negative Operating Cash Flow	1,119	1,537	2,074	1,118	1,527	(79)	1,125	1,620	2,630	1,535	1,725	1,804	1,534	1,725	(270)	1,535	1,728	1,818
Benefit Payments / Beginning of Period MVA	14.8%	15.9%	21.5%	16.2%	20.2%	48.0%	13.8%	13.2%	12.5%	15.8%	18.8%	30.0%	17.4%	24.9%	147.1%	14.7%	15.4%	15.5%
Operating Cash Flow to Assets Ratio	-4.7%	-6.0%	-8.7%	-5.2%	-7.6%	0.7%	-4.4%	-5.2%	-6.3%	-6.9%	-7.9%	-10.5%	-7.6%	-10.5%	7.7%	-6.4%	-6.5%	-5.4%
Change in MVA from Prior Year (%)	2.2%	0.7%	-2.6%	-0.4%	-2.9%	5.4%	4.3%	3.4%	2.3%	0.0%	-1.0%	-4.1%	-3.0%	-6.0%	11.7%	2.2%	2.1%	3.2%
Own Source Revenue (OSR)	21,255	25,512	36,274	21,255	25,512	36,274	21,255	25,512	36,274	21,255	25,512	36,274	21,255	25,512	36,274	21,255	25,512	36,274
OSR Compound Annual Growth Rate	4.2%	4.0%	3.8%	4.2%	4.0%	3.8%	4.2%	4.0%	3.8%	4.2%	4.0%	3.8%	4.2%	4.0%	3.8%	4.2%	4.0%	3.8%
Change in OSR from Prior Year (%)	4.6%	3.5%	3.5%	4.6%	3.5%	3.5%	4.6%	3.5%	3.5%	4.6%	3.5%	3.5%	4.6%	3.5%	3.5%	4.6%	3.5%	3.5%
Employer Contributions / OSR	8.9%	7.7%	6.3%	8.9%	7.8%	12.2%	8.9%	7.4%	4.8%	7.0%	7.0%	7.0%	7.0%	7.0%	12.8%	7.0%	7.0%	7.0%
Total Contributions / OSR	11.2%	10.0%	8.5%	11.2%	10.0%	14.4%	11.2%	9.7%	7.0%	9.3%	9.3%	9.2%	9.3%	9.3%	15.0%	9.3%	9.3%	9.2%
Payment and Contribution Measures																		
Employer Contributions (ERC)	1,898	1,975	2,283	1,899	1,984	4,435	1,892	1,895	1,740	1,482	1,787	2,553	1,482	1,787	4,625	1,482	1,787	2,553
Change in ERC from Prior Year (%)	3.1%	-0.6%	-0.1%	3.2%	-0.4%	37.6%	3.1%	-2.3%	-7.6%	4.7%	3.5%	3.5%	4.7%	3.5%	53.5%	4.7%	3.5%	3.5%
Employee Contributions (EEC)	486	574	802	486	574	802	486	574	802	486	574	802	486	574	802	486	574	802
Payroll	6,201	7,314	10,180	6,201	7,314	10,180	6,201	7,314	10,180	6,201	7,314	10,180	6,201	7,314	10,180	6,201	7,314	10,180
Employer Contribution / Payroll	30.6%	27.0%	22.4%	30.6%	27.1%	43.6%	30.5%	25.9%	17.1%	23.9%	24.4%	25.1%	23.9%	24.4%	45.4%	23.9%	24.4%	25.1%
Employee Contribution / Payroll	7.8%	7.8%	7.9%	7.8%	7.8%	7.9%	7.8%	7.8%	7.9%	7.8%	7.8%	7.9%	7.8%	7.8%	7.9%	7.8%	7.8%	7.9%
Total Contributions / Payroll	38.4%	34.8%	30.3%	38.5%	35.0%	51.4%	38.3%	33.8%	25.0%	31.7%	32.3%	33.0%	31.7%	32.3%	53.3%	31.7%	32.3%	33.0%
Normal Cost	859	1,001	1,374	859	1,001	1,374	859	1,001	1,374	859	1,001	1,374	859	1,001	1,374	859	1,001	1,374
Normal Cost (4% DR)	1,516	1,765	2,424	1,516	1,765	2,424	1,516	1,765	2,424	1,516	1,765	2,424	1,516	1,765	2,424	1,516	1,765	2,424
Net amortization $	(364)	(564)	(1,124)	(584)	(956)	291	(329)	(316)	(355)	(872)	(959)	(1,194)	(1,120)	(1,423)	(15)	(864)	(730)	(72)
Net amortization $ (4% DR)	(1,129)	(1,376)	(1,922)	(1,211)	(1,582)	(257)	(1,064)	(1,246)	(1,771)	(1,615)	(1,722)	(1,917)	(1,698)	(1,937)	(352)	(1,548)	(1,533)	(1,262)
Net amortization $ / Payroll	-5.9%	-7.7%	-11.0%	-9.4%	-13.1%	2.9%	-5.3%	-4.3%	-3.5%	-14.1%	-13.1%	-11.7%	-18.1%	-19.5%	-0.2%	-13.9%	-10.0%	-0.7%
Net amortization $ / Payroll (4% DR)	-18.2%	-18.8%	-18.9%	-19.5%	-21.6%	-2.5%	-17.2%	-17.0%	-17.4%	-26.0%	-23.5%	-18.8%	-27.4%	-26.5%	-3.5%	-25.0%	-21.0%	-12.4%
Investment Performance																		
Compounded Annual Growth - From Start Date	6.77%	6.77%	6.77%	5.00%	5.00%	5.00%	9.00%	9.00%	9.01%	6.77%	6.77%	6.77%	5.00%	5.00%	5.00%	9.01%	9.01%	9.01%
Compounded Annual Growth - Segments	6.77%	6.77%	6.77%	5.00%	5.00%	5.00%	9.00%	9.01%	9.01%	6.77%	6.77%	6.77%	5.00%	5.00%	5.01%	9.01%	9.01%	9.01%

Note: Dollar Figures in Millions

State

Kentucky

Plans Included

Employees Retirement System - Hazardous

Employees Retirement System - Non-hazardous

Teachers Retirement System

Metrics	State Policy (Current Contribution Policy) Stochastic Run - Baseline CMA									Sustainable Budget (Fixed % of OSR) Stochastic Run - Baseline CMA								
	25th Percentile			50th Percentile			75th Percentile			25th Percentile			50th Percentile			75th Percentile		
	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures																		
Market Value of Assets (MVA)	19,099	16,224	11,527	23,371	23,155	16,219	28,283	31,805	30,903	17,145	12,179	4,269	21,212	18,832	10,374	26,057	26,899	25,852
Actuarial Accrued Liability (AAL)	54,051	57,280	60,004	54,064	57,424	60,062	54,053	57,524	60,333	54,044	57,307	59,888	54,039	57,332	59,760	54,066	57,412	60,280
Accrued Liability at 4% Discount Rate (DR)	75,012	79,494	83,274	75,030	79,693	83,355	75,014	79,832	83,730	75,002	79,531	83,113	74,995	79,565	82,935	75,034	79,677	83,657
Unfunded Actuarial Accrued Liability (UAAL)	34,952	41,056	48,477	30,693	34,269	43,844	25,770	25,720	29,430	36,899	45,128	55,619	32,827	38,500	49,386	28,009	30,513	34,428
Unfunded Liability at 4% DR	55,914	63,270	71,747	51,659	56,538	67,136	46,732	48,028	52,827	57,857	67,352	78,844	53,784	60,733	72,561	48,976	52,777	57,805
Funded Ratio	35.3%	28.3%	19.2%	43.2%	40.3%	27.0%	52.3%	55.3%	51.2%	31.7%	21.3%	7.1%	39.3%	32.8%	17.4%	48.2%	46.9%	42.9%
Funded Ratio at 4% Discount Rate	25.5%	20.4%	13.8%	31.1%	29.1%	19.5%	37.7%	39.8%	36.9%	22.9%	15.3%	5.1%	28.3%	23.7%	12.5%	34.7%	33.8%	30.9%
AAL Compound Annual Growth Rate	1.8%	1.5%	1.0%	1.8%	1.5%	1.0%	1.8%	1.5%	1.0%	1.8%	1.5%	1.0%	1.8%	1.5%	0.9%	1.8%	1.5%	1.0%
Change in AAL from Prior Year (%)	1.5%	1.0%	0.0%	1.5%	1.0%	0.0%	1.5%	1.0%	0.1%	1.5%	1.0%	-0.1%	1.5%	1.0%	-0.1%	1.5%	1.0%	0.0%
Unfunded Liability / Own Source Revenue at 4% DR	265%	251%	198%	245%	224%	184%	222%	188%	145%	275%	267%	218%	256%	241%	202%	232%	209%	158%
Cash Flow Measures																		
Benefit Payments	3,502	4,083	5,151	3,502	4,085	5,155	3,503	4,086	5,160	3,502	4,083	5,152	3,502	4,084	5,155	3,503	4,086	5,160
Total Contributions	2,347	2,452	4,868	2,345	2,419	3,811	2,338	2,390	2,595	1,943	2,302	5,021	1,940	2,297	3,902	1,946	2,302	3,286
Negative Operating Cash Flow	1,156	1,632	283	1,158	1,665	1,344	1,165	1,697	2,566	1,559	1,781	131	1,563	1,788	1,253	1,556	1,784	1,874
Benefit Payments / Beginning of Period MVA	17.5%	23.6%	45.8%	15.2%	17.1%	30.5%	13.1%	13.2%	16.3%	18.9%	30.4%	120.3%	16.4%	20.7%	44.6%	13.9%	15.5%	20.0%
Operating Cash Flow to Assets Ratio	-5.8%	-9.4%	-2.5%	-5.0%	-7.0%	-8.0%	-4.4%	-5.5%	-8.1%	-8.4%	-13.2%	-3.1%	-7.3%	-9.0%	-10.8%	-6.2%	-6.7%	-7.3%
Change in MVA from Prior Year (%)	-4.5%	-6.3%	2.5%	1.1%	-3.3%	-4.0%	6.1%	3.1%	-2.5%	-7.7%	-9.5%	-0.3%	-0.5%	-4.8%	-10.3%	3.6%	1.7%	0.4%
Own Source Revenue (OSR)	21,090	25,214	36,287	21,091	25,248	36,502	21,016	25,483	36,516	21,056	25,232	36,191	21,010	25,159	35,871	21,093	25,221	36,577
OSR Compound Annual Growth Rate	4.0%	3.8%	3.8%	4.0%	3.8%	3.8%	4.0%	3.9%	3.8%	4.0%	3.8%	3.8%	4.0%	3.8%	3.7%	4.0%	3.8%	3.8%
Change in OSR from Prior Year (%)	4.5%	3.6%	3.4%	4.4%	3.2%	3.5%	4.3%	3.5%	3.5%	4.5%	3.6%	3.5%	4.4%	3.4%	3.5%	4.5%	3.4%	3.6%
Employer Contributions / OSR	8.9%	7.6%	11.5%	8.9%	7.5%	8.5%	8.9%	7.3%	5.2%	7.0%	7.0%	12.0%	7.0%	7.0%	9.0%	7.0%	7.0%	7.1%
Total Contributions / OSR	11.1%	9.7%	13.4%	11.1%	9.6%	10.4%	11.1%	9.4%	7.1%	9.2%	9.1%	13.9%	9.2%	9.1%	10.9%	9.2%	9.1%	9.0%
Payment and Contribution Measures																		
Employer Contributions (ERC)	1,872	1,918	4,173	1,869	1,883	3,114	1,863	1,850	1,897	1,469	1,768	4,329	1,466	1,763	3,218	1,471	1,767	2,589
Change in ERC from Prior Year (%)	2.5%	-0.4%	5.3%	2.5%	-1.6%	5.1%	2.4%	-2.3%	-2.1%	4.6%	3.6%	7.7%	4.5%	3.5%	6.3%	4.6%	3.5%	4.1%
Employee Contributions (EEC)	475	533	695	475	536	696	474	539	698	475	534	692	474	534	685	475	535	697
Payroll	6,075	6,831	8,933	6,079	6,873	8,953	6,067	6,909	8,970	6,070	6,842	8,895	6,064	6,837	8,802	6,076	6,854	8,963
Employer Contribution / Payroll	30.8%	28.1%	46.7%	30.8%	27.4%	34.8%	30.7%	26.8%	21.1%	24.2%	25.8%	48.7%	24.2%	25.8%	36.6%	24.2%	25.8%	28.9%
Employee Contribution / Payroll	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%
Total Contributions / Payroll	38.6%	35.9%	54.5%	38.6%	35.2%	42.6%	38.5%	34.6%	28.9%	32.0%	33.6%	56.4%	32.0%	33.6%	44.3%	32.0%	33.6%	36.7%
Normal Cost	850	939	1,208	851	947	1,208	850	950	1,211	850	941	1,202	850	942	1,188	850	944	1,208
Normal Cost (4% DR)	1,500	1,657	2,130	1,501	1,671	2,130	1,499	1,676	2,136	1,499	1,660	2,121	1,499	1,661	2,096	1,500	1,665	2,131
Net amortization $	(718)	(1,137)	406	(509)	(735)	(296)	(273)	(299)	(549)	(1,231)	(1,560)	95	(1,048)	(1,135)	(533)	(782)	(678)	(240)
Net amortization $ (4% DR)	(1,293)	(1,645)	(90)	(1,172)	(1,436)	(943)	(1,035)	(1,199)	(1,612)	(1,760)	(1,957)	(198)	(1,654)	(1,712)	(1,015)	(1,496)	(1,448)	(1,137)
Net amortization $ / Payroll	-11.8%	-16.6%	4.5%	-8.4%	-10.7%	-3.3%	-4.5%	-4.3%	-6.1%	-20.3%	-22.8%	1.1%	-17.3%	-16.6%	-6.1%	-12.9%	-9.9%	-2.7%
Net amortization $ / Payroll (4% DR)	-21.3%	-24.1%	-1.0%	-19.3%	-20.9%	-10.5%	-17.1%	-17.3%	-18.0%	-29.0%	-28.6%	-2.2%	-27.3%	-25.0%	-11.5%	-24.6%	-21.1%	-12.7%
Investment Performance																		
Compounded Annual Growth - From Start Date	2.8%	3.9%	4.6%	6.6%	6.5%	6.4%	10.3%	9.1%	8.2%	2.8%	3.9%	4.6%	6.6%	6.6%	6.4%	10.3%	9.2%	8.3%
Compounded Annual Growth - Segments	2.8%	5.0%	5.4%	6.6%	6.5%	6.3%	10.3%	8.0%	7.3%	2.8%	5.0%	5.4%	6.6%	6.6%	6.3%	10.3%	8.1%	7.4%

Note: Dollar Figures in Millions

Fiscal Metrics
Model Output

State

Kentucky

Plans Included

Employees Retirement System - Hazardous

Employees Retirement System - Non-hazardous

Teachers Retirement System

Metrics	State Policy (Current Contribution Policy)						Sustainable Budget (Fixed % of OSR)					
	Deterministic			Deterministic			Deterministic			Deterministic		
	"Low-for-long" Economic Scenario			"Asset Shock" Economic Scenario			"Low-for-long" Economic Scenario			"Asset Shock" Economic Scenario		
	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures												
Market Value of Assets (MVA)	20,992	18,550	10,826	17,374	14,043	10,734	18,991	14,628	3,716	14,879	8,984	1,527
Actuarial Accrued Liability (AAL)	54,098	57,506	59,966	54,077	57,455	59,783	54,098	57,506	59,966	54,077	57,455	59,783
Accrued Liability at 4% Discount Rate (DR)	75,077	79,807	83,221	75,049	79,737	82,967	75,077	79,807	83,221	75,049	79,737	82,967
Unfunded Actuarial Accrued Liability (UAAL)	33,106	38,955	49,141	36,704	43,412	49,049	35,108	42,878	56,251	39,198	48,471	58,256
Unfunded Liability at 4% DR	54,085	61,256	72,396	57,675	65,693	72,233	56,087	65,178	79,506	60,170	70,752	81,441
Funded Ratio	38.8%	32.3%	18.1%	32.1%	24.4%	18.0%	35.1%	25.4%	6.2%	27.5%	15.6%	2.6%
Funded Ratio at 4% Discount Rate	28.0%	23.2%	13.0%	23.1%	17.6%	12.9%	25.3%	18.3%	4.5%	19.8%	11.3%	1.8%
AAL Compound Annual Growth Rate	1.8%	1.5%	1.0%	1.8%	1.5%	0.9%	1.8%	1.5%	1.0%	1.8%	1.5%	0.9%
Change in AAL from Prior Year (%)	1.5%	1.0%	0.0%	1.5%	1.0%	-0.1%	1.5%	1.0%	0.0%	1.5%	1.0%	-0.1%
Unfunded Liability / Own Source Revenue at 4% DR	254%	240%	200%	283%	269%	208%	264%	255%	219%	295%	289%	234%
Cash Flow Measures												
Benefit Payments	3,502	4,083	5,147	3,502	4,084	5,147	3,502	4,083	5,147	3,502	4,084	5,147
Total Contributions	2,359	2,468	5,200	2,375	2,477	5,211	1,960	2,328	5,416	1,897	2,251	5,357
Negative Operating Cash Flow	1,143	1,615	(53)	1,127	1,606	(64)	1,542	1,755	(269)	1,605	1,833	(210)
Benefit Payments / Beginning of Period MVA	16.5%	21.2%	50.0%	19.8%	27.3%	50.5%	17.8%	26.0%	155.3%	22.2%	39.4%	400.6%
Operating Cash Flow to Assets Ratio	-5.4%	-8.4%	0.5%	-6.4%	-10.7%	0.6%	-7.8%	-11.2%	8.1%	-10.2%	-17.7%	16.4%
Change in MVA from Prior Year (%)	-1.0%	-3.8%	5.1%	-2.0%	-6.2%	5.2%	-3.5%	-6.7%	12.1%	-5.9%	-13.4%	18.8%
Own Source Revenue (OSR)	21,255	25,512	36,274	20,371	24,451	34,766	21,255	25,512	36,274	20,371	24,451	34,766
OSR Compound Annual Growth Rate	4.2%	4.0%	3.8%	3.3%	3.5%	3.5%	4.2%	4.0%	3.8%	3.3%	3.5%	3.5%
Change in OSR from Prior Year (%)	4.6%	3.5%	3.5%	3.8%	3.5%	3.5%	4.6%	3.5%	3.5%	3.8%	3.5%	3.5%
Employer Contributions / OSR	8.9%	7.6%	12.4%	9.3%	7.9%	13.0%	7.0%	7.0%	13.0%	7.0%	7.0%	13.4%
Total Contributions / OSR	11.1%	9.7%	14.3%	11.7%	10.1%	15.0%	9.2%	9.1%	14.9%	9.3%	9.2%	15.4%
Payment and Contribution Measures												
Employer Contributions (ERC)	1,882	1,928	4,506	1,898	1,939	4,521	1,483	1,788	4,722	1,420	1,713	4,667
Change in ERC from Prior Year (%)	2.7%	-0.8%	0.8%	2.6%	-1.1%	0.8%	4.7%	3.5%	2.6%	3.9%	3.5%	2.6%
Employee Contributions (EEC)	477	541	693	477	538	690	477	541	693	477	538	690
Payroll	6,105	6,925	8,913	6,095	6,895	8,874	6,105	6,925	8,913	6,095	6,895	8,874
Employer Contribution / Payroll	30.8%	27.8%	50.6%	31.1%	28.1%	50.9%	24.3%	25.8%	53.0%	23.3%	24.8%	52.6%
Employee Contribution / Payroll	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%
Total Contributions / Payroll	38.6%	35.6%	58.3%	39.0%	35.9%	58.7%	32.1%	33.6%	60.8%	31.1%	32.6%	60.4%
Normal Cost	852	953	1,204	852	949	1,199	852	953	1,204	852	949	1,199
Normal Cost (4% DR)	1,504	1,681	2,124	1,503	1,674	2,115	1,504	1,681	2,124	1,503	1,674	2,115
Net amortization $	(627)	(1,014)	687	(846)	(1,292)	709	(1,143)	(1,405)	427	(1,470)	(1,841)	243
Net amortization $ (4% DR)	(1,237)	(1,586)	218	(1,359)	(1,739)	244	(1,705)	(1,873)	159	(1,923)	(2,154)	36
Net amortization $ / Payroll	-10.3%	-14.6%	7.7%	-13.9%	-18.7%	8.0%	-18.7%	-20.3%	4.8%	-24.1%	-26.7%	2.7%
Net amortization $ / Payroll (4% DR)	-20.3%	-22.9%	2.4%	-22.3%	-25.2%	2.7%	-27.9%	-27.0%	1.8%	-31.5%	-31.2%	0.4%
Investment Performance												
Compounded Annual Growth - From Start Date	4.6%	4.8%	4.9%	2.0%	3.5%	4.2%	4.6%	4.8%	4.9%	2.1%	3.5%	4.2%
Compounded Annual Growth - Segments	4.6%	5.0%	5.0%	2.0%	5.0%	5.0%	4.6%	5.0%	5.0%	2.1%	5.0%	5.0%

Note: Dollar Figures in Millions

Kentucky
Fixed 5% Economic Scenario
Employees Retirement System - Hazardous / Non-hazardous and Teachers Retirement System

Assets vs. Cash Flow
Assuming 5% returns and contributions fixed as % of OSR
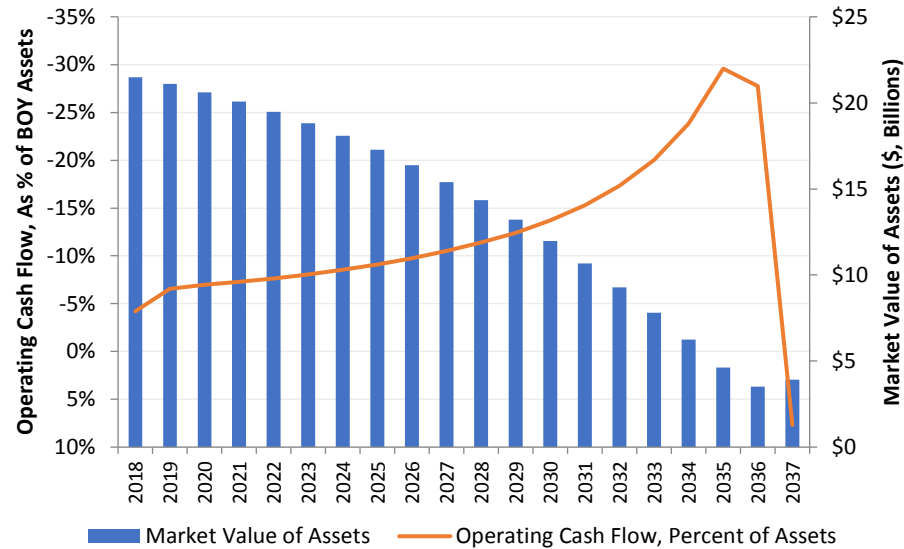
Total Contributions vs. Benefit Payments
Assuming 5% returns and contributions fixed as % of OSR
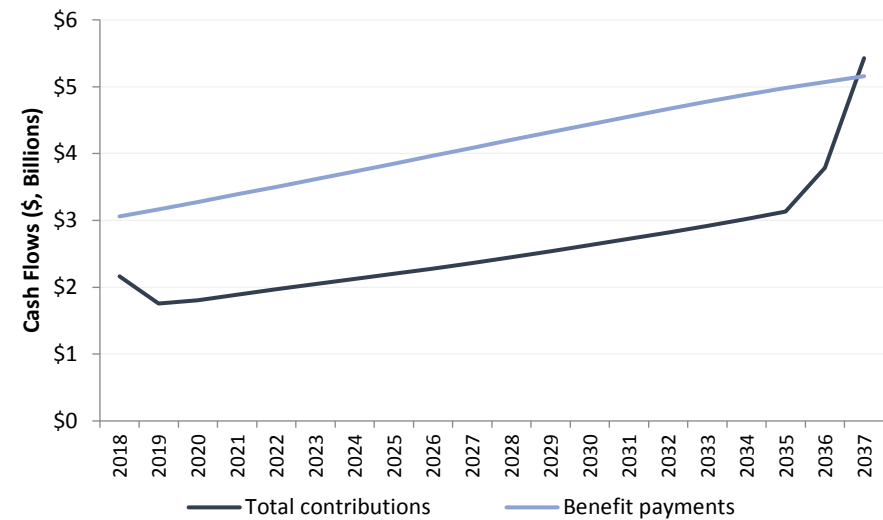
Unfunded Liability vs. Funding Levels
Assuming 5% returns and contributions fixed as % of OSR
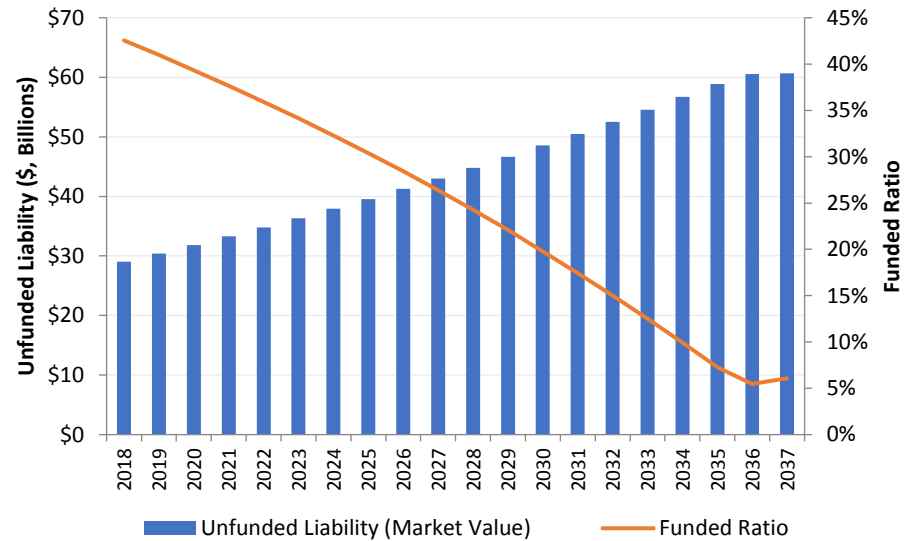
Employer Contributions vs. Pension Debt
Assuming 5% returns and plans' statutory contribution policy
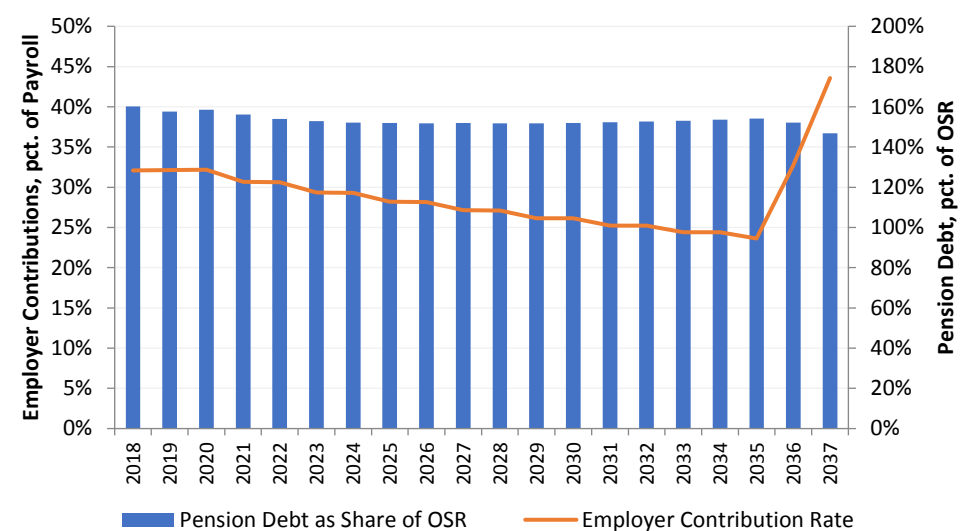
New Jersey Retirement System 30 Year Projections

Plans included: Public Employees Retirement System - State, Teachers Pension and Annuity Fund
State contribution policy at assumed rate of return (7.5% / 7.3% / 7.0%)

$MMs

Fiscal Year	Pension Liability (Actuarial Accrued Liability)						Pension Assets (Market Value)						Change in Pension Debt			% Funded	Cash Flow	Employer Contribution		
	Payroll	Beginning of Period	Service Cost	Interest	Benefit Payments	End of Period	Beginning of Period	Total Contribution	Interest	Benefit Payments	End of Period	Debt	$	% of Payroll			% of Assets	$	% Change	% Payroll
2018	15,381	83,240	1,620	6,079	(6,083)	84,855	30,900	3,401	2,128	(6,083)	30,346	54,510	2,170	14%	36%	-9%	2,239	N/A	15%
2019	15,811	84,855	1,646	7,997	(6,284)	88,214	30,346	4,289	2,106	(6,284)	30,456	57,758	3,248	21%	35%	-7%	3,088	38%	20%
2020	16,254	88,214	1,759	6,270	(6,485)	89,758	30,456	4,771	2,044	(6,485)	30,785	58,973	1,215	7%	34%	-6%	3,536	15%	22%
2021	16,709	89,758	1,808	8,567	(6,686)	93,446	30,785	5,575	2,086	(6,686)	31,759	61,687	2,714	16%	34%	-4%	4,306	22%	26%
2022	17,177	93,446	1,970	6,372	(6,887)	94,902	31,759	6,328	2,086	(6,887)	33,286	61,615	(72)	0%	35%	-2%	5,023	17%	29%
2023	17,658	94,902	2,025	6,469	(7,087)	96,309	33,286	7,522	2,222	(7,087)	35,944	60,365	(1,250)	-7%	37%	1%	6,181	23%	35%
2024	18,152	96,309	2,082	6,563	(7,285)	97,668	35,944	7,670	2,404	(7,285)	38,732	58,936	(1,429)	-8%	40%	1%	6,291	2%	35%
2025	18,661	97,668	2,140	6,653	(7,482)	98,980	38,732	7,709	2,591	(7,482)	41,550	57,429	(1,507)	-8%	42%	1%	6,292	0%	34%
2026	19,258	98,980	2,200	6,740	(7,676)	100,243	41,550	7,765	2,781	(7,676)	44,419	55,824	(1,605)	-8%	44%	0%	6,302	0%	33%
2027	19,874	100,243	2,262	6,824	(7,868)	101,462	44,419	7,818	2,971	(7,868)	47,341	54,121	(1,703)	-9%	47%	0%	6,309	0%	32%
2028	20,510	101,462	2,327	6,905	(8,057)	102,637	47,341	7,839	3,166	(8,057)	50,289	52,349	(1,773)	-9%	49%	0%	6,281	0%	31%
2029	21,166	102,637	2,394	6,983	(8,242)	103,773	50,289	7,866	3,365	(8,242)	53,277	50,495	(1,853)	-9%	51%	-1%	6,258	0%	30%
2030	21,844	103,773	2,464	7,059	(8,424)	104,872	53,277	7,895	3,566	(8,424)	56,314	48,557	(1,938)	-9%	54%	-1%	6,236	0%	29%
2031	22,543	104,872	2,535	7,132	(8,601)	105,939	56,314	7,840	3,767	(8,601)	59,321	46,618	(1,940)	-9%	56%	-1%	6,128	-2%	27%
2032	23,264	105,939	2,610	7,204	(8,773)	106,980	59,321	7,743	3,965	(8,773)	62,257	44,723	(1,895)	-8%	58%	-2%	5,976	-2%	26%
2033	24,009	106,980	2,687	7,273	(8,939)	108,000	62,257	7,647	4,159	(8,939)	65,122	42,878	(1,845)	-8%	60%	-2%	5,823	-3%	24%
2034	24,777	108,000	2,766	7,342	(9,100)	109,009	65,122	7,557	4,347	(9,100)	67,926	41,083	(1,795)	-7%	62%	-2%	5,675	-3%	23%
2035	25,570	109,009	2,849	7,410	(9,255)	110,013	67,926	7,474	4,532	(9,255)	70,677	39,336	(1,747)	-7%	64%	-3%	5,532	-3%	22%
2036	26,388	110,013	2,934	7,478	(9,403)	111,022	70,677	7,401	4,713	(9,403)	73,387	37,634	(1,702)	-6%	66%	-3%	5,396	-2%	20%
2037	27,232	111,022	3,022	7,547	(9,544)	112,047	73,387	7,335	4,892	(9,544)	76,070	35,976	(1,658)	-6%	68%	-3%	5,266	-2%	19%
2038	28,104	112,047	3,113	7,617	(9,678)	113,099	76,070	7,272	5,069	(9,678)	78,734	34,365	(1,611)	-6%	70%	-3%	5,138	-2%	18%
2039	29,003	113,099	3,207	7,690	(9,803)	114,193	78,734	7,220	5,246	(9,803)	81,397	32,796	(1,569)	-5%	71%	-3%	5,017	-2%	17%
2040	29,931	114,193	3,304	7,766	(9,921)	115,342	81,397	7,176	5,422	(9,921)	84,074	31,268	(1,528)	-5%	73%	-3%	4,903	-2%	16%
2041	30,889	115,342	3,405	7,846	(10,030)	116,563	84,074	7,139	5,601	(10,030)	86,784	29,779	(1,489)	-5%	74%	-3%	4,793	-2%	16%
2042	31,877	116,563	3,509	7,932	(10,130)	117,873	86,784	7,109	5,782	(10,130)	89,543	28,329	(1,450)	-5%	76%	-3%	4,687	-2%	15%
2043	32,898	117,873	3,617	8,024	(10,222)	119,292	89,543	7,084	5,967	(10,222)	92,372	26,919	(1,410)	-4%	77%	-4%	4,585	-2%	14%
2044	33,950	119,292	3,728	8,124	(10,303)	120,840	92,372	7,071	6,157	(10,303)	95,296	25,544	(1,376)	-4%	79%	-3%	4,492	-2%	13%
2045	35,037	120,840	3,843	8,234	(10,376)	122,541	95,296	7,063	6,354	(10,376)	98,338	24,203	(1,341)	-4%	80%	-3%	4,402	-2%	13%
2046	36,158	122,541	3,961	8,355	(10,438)	124,420	98,338	7,060	6,560	(10,438)	101,521	22,899	(1,304)	-4%	82%	-3%	4,314	-2%	12%
2047	37,315	124,420	4,084	8,489	(10,490)	126,502	101,521	7,068	5,404	(10,490)	103,502	23,001	102	0%	82%	-3%	4,233	-2%	11%

Source: Analysis by The Pew Charitable Trusts and The Terry Group based on data from Retirement System actuarial valuations and annual reports

Model Assumptions			
State	New Jersey		
Plan	Public Employees Retirement System - State		
Actuarial Valuation Used	6/30/2017		
Employer Contribution Policy			
Description	Actuarial		
Applies to	Through 6/30/2019	7/2/2019 through 6/30/2029	7/1/2029 and onward
Amortization Period	30 Years	30 Years	20 Years
Amortization Method Type	Level Dollar	Level Dollar	Level Dollar
Open or closed	Open	Open	Open
Layered or Single Amortization	Single	Single	Single
Amortization Payment Growth Rate		Declining period from 30 years to 20 years	
Additional Contribution Rules	Phase-in of ARC: 10% increase in % of ARC paid each year from 30% in FY 2016 to 100% in FY 2023		
	NJ Lottery: The present value of the lottery proceeds were used to adjust the actuarial contribution rate. For a given year, the expected lottery revenue for the subsequent year was discounted back one year and counted as a receivable. The State plan is being credited with 21.02% of the lottery assets. The lottery was not added to reported assets.		
Employee Contribution Rate			
Applies to	as of 6/30/2011	Starting 7/1/2011	
Rate	6.50%	Increase 1/7th of 1% each year until reaching 7.50% in FY 2019	
Employee Contribution Cost-Sharing	No	No	
Actuarial Assumptions			
Plan Assumed Rate of Return	2017 - 2018: 7.5% 2019 - 2020: 7.3% 2021 and beyond: 7.0%		
Inflation Assumption	2.25%		
Payroll Growth Assumption	Select and ultimate. Approximate estimates: FY 2016-FY 2025: 2.8% FY 2026+: 3.2%		
COLA			
Applies to	All		
Description	No COLA		
Assumed effective COLA	N/A		
COLA Adjustment for Plan Funding and Investment Experience	N/A		

Model Assumptions			
State	New Jersey		
Plan	Teachers Pension and Annuity Fund		
Actuarial Valuation Used	6/30/2017		
Employer Contribution Policy			
Description	Actuarial		
Applies to	Through 6/30/2018	7/2/2018 through 6/30/2028	7/1/2028 and onward
Amortization Period	30 Years	30 Years	20 Years
Amortization Method Type	Level Dollar	Level Dollar	Level Dollar
Open or closed	Open	Open	Open
Layered or Single Amortization	Single	Single	Single
Amortization Payment Growth Rate		Declining period from 30 years to 20 years	
Additional Contribution Rules	Phase-in of ARC: 10% increase in % of ARC paid each year from 30% in FY 2016 to 100% in FY 2023		
	NJ Lottery: The present value of the lottery proceeds were used to adjust the actuarial contribution rate. For a given year, the expected lottery revenue for the subsequent year was discounted back one year and counted as a receivable. The Teachers plan is being credited with 77.78% of the lottery assets. The lottery was not added to reported assets.		
Employee Contribution Rate			
Applies to	as of 10/1/2011	Starting 7/1/2012	
Rate	6.50%	Increase 1/7th of 1% each year until reaching 7.50% in FY 2018, and 7.50% going forward.	
Employee Contribution Cost-Sharing	No	No	
Actuarial Assumptions			
Plan Assumed Rate of Return	2017 - 2018: 7.5% 2019 - 2020: 7.3% 2021 and beyond: 7.0%		
Inflation Assumption	2.25%		
Payroll Growth Assumption	Select and ultimate. Approximate estimates: FY 2016-FY 2025: 2.8% FY 2026+: 3.2%		
COLA			
Applies to	All		
Description	60% of the percentage change in the average CPI for the 12-month period of the retirement year and 8/31 preceding the February adjustment, paid subsequent February. Effective 7/1/2011: Eliminated COLA unless Target Funded Ratio is met as of valuation date, and each of next 30 years on projected basis. 25 month wait period, paid subsequent February		
Assumed effective COLA	No COLA modeled		
COLA Adjustment for Plan Funding and Investment Experience	No		

Fiscal Metrics
Model Output

State

New Jersey

Plans Included

Public Employees Retirement System - State

Teachers Pension and Annuity Fund

	State Policy (Current Contribution Policy)									Sustainable Budget (Fixed % of OSR)								
	Deterministic 7.5% / 7.3% / 7.0%			Deterministic 5%			Deterministic 9%			Deterministic 7.5% / 7.3% / 7.0%			Deterministic 5%			Deterministic 9%		
	Current Plan Assumptions			Low Return			High Return			Current Plan Assumptions			Low Return			High Return		
Metrics	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures																		
Market Value of Assets (MVA)	33,286	47,341	76,070	29,659	39,755	58,150	36,104	55,137	100,329	23,952	11,224	-	20,450	4,850	-	26,631	17,496	-
Actuarial Accrued Liability (AAL)	94,902	101,462	112,047	94,902	101,462	112,047	94,902	101,462	112,047	94,902	101,462	112,047	94,902	101,462	112,047	94,902	101,462	112,047
Accrued Liability at 4% Discount Rate (DR)	133,946	143,205	158,145	133,946	143,205	158,145	133,946	143,205	158,145	133,946	143,205	158,145	133,946	143,205	158,145	133,946	143,205	158,145
Unfunded Actuarial Accrued Liability (UAAL)	61,615	54,121	35,976	65,243	61,707	53,896	58,797	46,325	11,717	70,950	90,238	112,047	74,452	96,612	112,047	68,271	83,966	112,047
Unfunded Liability at 4% DR	100,659	95,865	82,074	104,287	103,450	99,994	97,841	88,068	57,815	109,994	131,981	158,145	113,496	138,356	158,145	107,315	125,709	158,145
Funded Ratio	35.1%	46.7%	67.9%	31.3%	39.2%	51.9%	38.0%	54.3%	89.5%	25.2%	11.1%	0.0%	21.5%	4.8%	0.0%	28.1%	17.2%	0.0%
Funded Ratio at 4% Discount Rate	24.9%	33.1%	48.1%	22.1%	27.8%	36.8%	27.0%	38.5%	63.4%	17.9%	7.8%	0.0%	15.3%	3.4%	0.0%	19.9%	12.2%	0.0%
AAL Compound Annual Growth Rate	2.7%	2.0%	1.5%	2.7%	2.0%	1.5%	2.7%	2.0%	1.5%	2.7%	2.0%	1.5%	2.7%	2.0%	1.5%	2.7%	2.0%	1.5%
Change in AAL from Prior Year (%)	1.6%	1.2%	0.9%	1.6%	1.2%	0.9%	1.6%	1.2%	0.9%	1.6%	1.2%	0.9%	1.6%	1.2%	0.9%	1.6%	1.2%	0.9%
Unfunded Liability / Own Source Revenue at 4% DR	180%	144%	88%	186%	155%	107%	175%	132%	62%	196%	198%	169%	203%	208%	169%	192%	189%	169%
Cash Flow Measures																		
Benefit Payments	6,887	7,868	9,544	6,887	7,868	9,544	6,887	7,868	9,544	6,887	7,868	9,544	6,887	7,868	9,544	6,887	7,868	9,544
Total Contributions	6,328	7,818	7,335	6,388	8,149	8,424	6,289	7,535	5,996	3,414	4,017	9,636	3,414	4,074	9,636	3,414	4,017	9,636
Negative Operating Cash Flow	559	50	2,209	499	(281)	1,120	598	334	3,548	3,473	3,852	(92)	3,473	3,794	(92)	3,473	3,852	(92)
Benefit Payments / Beginning of Period MVA	21.7%	17.7%	13.0%	23.9%	20.9%	16.9%	20.4%	15.4%	10.0%	26.7%	55.1%	N/A	30.0%	93.8%	N/A	24.8%	39.7%	N/A
Operating Cash Flow to Assets Ratio	-1.8%	-0.1%	-3.0%	-1.7%	0.7%	-2.0%	-1.8%	-0.7%	-3.7%	-13.5%	-27.0%	N/A	-15.2%	-45.2%	N/A	-12.5%	-19.4%	N/A
Change in MVA from Prior Year (%)	4.8%	6.6%	3.7%	2.9%	5.5%	2.7%	6.7%	8.0%	4.9%	-7.2%	-21.4%	N/A	-10.8%	-42.2%	N/A	-4.3%	-11.7%	N/A
Own Source Revenue (OSR)	55,986	66,557	93,475	55,986	66,557	93,475	55,986	66,557	93,475	55,986	66,557	93,475	55,986	66,557	93,475	55,986	66,557	93,475
OSR Compound Annual Growth Rate	4.8%	4.1%	3.8%	4.8%	4.1%	3.8%	4.8%	4.1%	3.8%	4.8%	4.1%	3.8%	4.8%	4.1%	3.8%	4.8%	4.1%	3.8%
Change in OSR from Prior Year (%)	4.4%	3.2%	3.3%	4.4%	3.2%	3.3%	4.4%	3.2%	3.3%	4.4%	3.2%	3.3%	4.4%	3.2%	3.3%	4.4%	3.2%	3.3%
Employer Contributions / OSR	9.0%	9.5%	5.6%	9.1%	10.0%	6.8%	8.9%	9.1%	4.2%	3.8%	3.8%	8.1%	3.8%	3.9%	8.1%	3.8%	3.8%	8.1%
Total Contributions / OSR	11.3%	11.7%	7.8%	11.4%	12.2%	9.0%	11.2%	11.3%	6.4%	6.1%	6.0%	10.3%	6.1%	6.1%	10.3%	6.1%	6.0%	10.3%
Payment and Contribution Measures																		
Employer Contributions (ERC)	5,023	6,309	5,266	5,083	6,640	6,356	4,984	6,025	3,927	2,109	2,507	7,568	2,109	2,564	7,568	2,109	2,507	7,568
Change in ERC from Prior Year (%)	16.7%	0.1%	-2.4%	17.3%	1.1%	-0.7%	16.2%	-1.0%	-6.4%	4.4%	3.2%	1.1%	4.4%	5.6%	1.1%	4.4%	3.2%	1.1%
Employee Contributions (EEC)	1,305	1,510	2,068	1,305	1,510	2,068	1,305	1,510	2,068	1,305	1,510	2,068	1,305	1,510	2,068	1,305	1,510	2,068
Payroll	17,177	19,874	27,232	17,177	19,874	27,232	17,177	19,874	27,232	17,177	19,874	27,232	17,177	19,874	27,232	17,177	19,874	27,232
Employer Contribution / Payroll	29.2%	31.7%	19.3%	29.6%	33.4%	23.3%	29.0%	30.3%	14.4%	12.3%	12.6%	27.8%	12.3%	12.9%	27.8%	12.3%	12.6%	27.8%
Employee Contribution / Payroll	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%
Total Contributions / Payroll	36.8%	39.3%	26.9%	37.2%	41.0%	30.9%	36.6%	37.9%	22.0%	19.9%	20.2%	35.4%	19.9%	20.5%	35.4%	19.9%	20.2%	35.4%
Normal Cost	1,970	2,262	3,022	1,970	2,262	3,022	1,970	2,262	3,022	1,970	2,262	3,022	1,970	2,262	3,022	1,970	2,262	3,022
Normal Cost (4% DR)	3,540	4,066	5,431	3,540	4,066	5,431	3,540	4,066	5,431	3,540	4,066	5,431	3,540	4,066	5,431	3,540	4,066	5,431
Net amortization $	190	1,839	1,827	46	1,711	1,780	294	2,010	1,998	(3,242)	(4,203)	(930)	(3,443)	(4,556)	(930)	(3,101)	(3,816)	(930)
Net amortization $ (4% DR)	(1,162)	(56)	(1,391)	(1,219)	12	(951)	(1,120)	(80)	(1,867)	(4,373)	(5,139)	(1,979)	(4,488)	(5,316)	(1,979)	(4,292)	(4,918)	(1,979)
Net amortization $ / Payroll	1.1%	9.3%	6.7%	0.3%	8.6%	6.5%	1.7%	10.1%	7.3%	-18.9%	-21.1%	-3.4%	-20.0%	-22.9%	-3.4%	-18.1%	-19.2%	-3.4%
Net amortization $ / Payroll (4% DR)	-6.8%	-0.3%	-5.1%	-7.1%	0.1%	-3.5%	-6.5%	-0.4%	-6.9%	-25.5%	-25.9%	-7.3%	-26.1%	-26.7%	-7.3%	-25.0%	-24.7%	-7.3%
Investment Performance																		
Compounded Annual Growth - From Start Date	7.32%	7.16%	7.08%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%	7.32%	7.16%	7.08%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%
Compounded Annual Growth - Segments	7.32%	7.00%	7.00%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%	7.32%	7.00%	7.00%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%

Note: Dollar Figures in Millions

State

New Jersey

Plans Included

Public Employees Retirement System - State

Teachers Pension and Annuity Fund

	State Policy (Current Contribution Policy)									Sustainable Budget (Fixed % of OSR)								
	Stochastic Run - Baseline CMA									Stochastic Run - Baseline CMA								
	25th Percentile			50th Percentile			75th Percentile			25th Percentile			50th Percentile			75th Percentile		
Metrics	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures																		
Market Value of Assets (MVA)	26,674	35,880	54,158	31,591	43,771	66,118	37,133	52,952	83,975	17,675	2,578	-	22,383	8,075	-	27,645	15,878	257
Actuarial Accrued Liability (AAL)	94,732	100,490	108,382	94,687	100,822	107,856	94,730	100,694	109,041	94,697	100,490	108,382	94,687	100,822	107,856	94,730	100,694	109,041
Accrued Liability at 4% Discount Rate (DR)	133,706	141,833	152,972	133,643	142,302	152,230	133,704	142,122	153,903	133,656	141,833	152,972	133,643	142,302	152,230	133,704	142,122	153,903
Unfunded Actuarial Accrued Liability (UAAL)	68,058	64,609	54,224	63,096	57,051	41,738	57,597	47,743	25,066	77,022	97,911	108,382	72,304	92,747	107,856	67,085	84,816	108,784
Unfunded Liability at 4% DR	107,032	105,952	98,814	102,052	98,531	86,112	96,571	89,170	69,928	115,982	139,255	152,972	111,260	134,227	152,230	106,059	126,244	153,645
Funded Ratio	28.2%	35.7%	50.0%	33.4%	43.4%	61.3%	39.2%	52.6%	77.0%	18.7%	2.6%	0.0%	23.6%	8.0%	0.0%	29.2%	15.8%	0.2%
Funded Ratio at 4% Discount Rate	19.9%	25.3%	35.4%	23.6%	30.8%	43.4%	27.8%	37.3%	54.6%	13.2%	1.8%	0.0%	16.7%	5.7%	0.0%	20.7%	11.2%	0.2%
AAL Compound Annual Growth Rate	2.6%	1.9%	1.3%	2.6%	1.9%	1.3%	2.6%	1.9%	1.4%	2.6%	1.9%	1.3%	2.6%	1.9%	1.3%	2.6%	1.9%	1.4%
Change in AAL from Prior Year (%)	1.5%	1.1%	0.5%	1.4%	1.1%	0.5%	1.5%	1.1%	0.7%	1.5%	1.1%	0.5%	1.4%	1.1%	0.5%	1.5%	1.1%	0.7%
Unfunded Liability / Own Source Revenue at 4% DR	193%	162%	107%	184%	149%	94%	174%	135%	74%	209%	212%	166%	201%	202%	166%	191%	191%	163%
Cash Flow Measures																		
Benefit Payments	6,887	7,868	9,544	6,887	7,868	9,544	6,887	7,868	9,544	6,887	7,868	9,544	6,887	7,868	9,544	6,887	7,868	9,544
Total Contributions	6,360	8,174	8,237	6,262	7,863	7,502	6,205	7,461	6,588	3,387	4,973	9,631	3,375	4,150	9,626	3,386	4,008	9,418
Negative Operating Cash Flow	527	(306)	1,307	625	5	2,042	682	407	2,956	3,500	2,895	(87)	3,512	3,718	(82)	3,501	3,860	126
Benefit Payments / Beginning of Period MVA	25.7%	22.6%	18.0%	22.3%	19.1%	15.0%	19.7%	16.0%	11.9%	32.9%	141.9%	N/A	27.7%	69.2%	N/A	23.8%	42.3%	1925.3%
Operating Cash Flow to Assets Ratio	-2.0%	0.9%	-2.5%	-2.0%	0.0%	-3.2%	-1.9%	-0.8%	-3.7%	-16.7%	-52.2%	N/A	-14.1%	-32.7%	N/A	-12.1%	-20.7%	-25.3%
Change in MVA from Prior Year (%)	-0.4%	3.3%	1.9%	2.5%	6.1%	3.7%	6.0%	7.4%	4.9%	-15.6%	-53.5%	N/A	-10.1%	-29.0%	N/A	-4.6%	-14.7%	-48.1%
Own Source Revenue (OSR)	55,600	65,600	92,193	55,353	66,298	91,718	55,586	66,175	94,097	55,600	65,600	92,193	55,353	66,298	91,718	55,586	66,175	94,097
OSR Compound Annual Growth Rate	4.6%	4.0%	3.7%	4.5%	4.1%	3.7%	4.6%	4.1%	3.8%	4.6%	4.0%	3.7%	4.5%	4.1%	3.7%	4.6%	4.1%	3.8%
Change in OSR from Prior Year (%)	4.3%	3.2%	3.4%	4.2%	3.2%	3.3%	4.3%	3.3%	3.4%	4.3%	3.2%	3.4%	4.2%	3.2%	3.3%	4.3%	3.3%	3.4%
Employer Contributions / OSR	9.1%	10.2%	6.8%	9.0%	9.6%	6.1%	8.8%	9.0%	4.9%	3.8%	5.4%	8.3%	3.8%	4.0%	8.4%	3.8%	3.8%	7.9%
Total Contributions / OSR	11.4%	12.5%	8.9%	11.3%	11.9%	8.2%	11.2%	11.3%	7.0%	6.1%	7.6%	10.4%	6.1%	6.3%	10.5%	6.1%	6.1%	10.0%
Payment and Contribution Measures																		
Employer Contributions (ERC)	5,067	6,712	6,283	4,972	6,385	5,557	4,912	5,988	4,598	2,094	3,511	7,677	2,085	2,672	7,681	2,094	2,536	7,429
Change in ERC from Prior Year (%)	17.1%	1.5%	-0.8%	16.1%	0.5%	-2.2%	15.4%	-0.5%	-3.6%	4.3%	29.1%	1.2%	4.2%	9.0%	1.7%	4.3%	5.1%	3.0%
Employee Contributions (EEC)	1,293	1,462	1,954	1,290	1,478	1,945	1,293	1,472	1,990	1,293	1,462	1,954	1,290	1,478	1,945	1,293	1,472	1,990
Payroll	17,020	19,250	25,729	16,979	19,461	25,608	17,018	19,385	26,196	17,020	19,250	25,729	16,979	19,461	25,608	17,018	19,385	26,196
Employer Contribution / Payroll	29.8%	34.9%	24.4%	29.3%	32.8%	21.7%	28.9%	30.9%	17.6%	12.3%	18.2%	29.8%	12.3%	13.7%	30.0%	12.3%	13.1%	28.4%
Employee Contribution / Payroll	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%
Total Contributions / Payroll	37.4%	42.5%	32.0%	36.9%	40.4%	29.3%	36.5%	38.5%	25.1%	19.9%	25.8%	37.4%	19.9%	21.3%	37.6%	19.9%	20.7%	36.0%
Normal Cost	1,961	2,198	2,865	1,958	2,222	2,849	1,961	2,211	2,909	1,960	2,198	2,865	1,958	2,222	2,849	1,961	2,211	2,909
Normal Cost (4% DR)	3,524	3,949	5,149	3,520	3,993	5,121	3,524	3,973	5,228	3,522	3,949	5,149	3,520	3,993	5,121	3,524	3,973	5,228
Net amortization $	(111)	1,653	1,731	75	1,741	1,762	307	1,909	1,825	(3,595)	(3,702)	(548)	(3,327)	(4,190)	(502)	(3,032)	(3,810)	(815)
Net amortization $ (4% DR)	(1,308)	84	(811)	(1,240)	(34)	(1,081)	(1,135)	(95)	(1,528)	(4,569)	(4,349)	(1,516)	(4,423)	(5,015)	(1,464)	(4,252)	(4,843)	(1,823)
Net amortization $ / Payroll	-0.7%	8.6%	6.7%	0.4%	8.9%	6.9%	1.8%	9.8%	7.0%	-21.1%	-19.2%	-2.1%	-19.6%	-21.5%	-2.0%	-17.8%	-19.7%	-3.1%
Net amortization $ / Payroll (4% DR)	-7.7%	0.4%	-3.2%	-7.3%	-0.2%	-4.2%	-6.7%	-0.5%	-5.8%	-26.8%	-22.6%	-5.9%	-26.0%	-25.8%	-5.7%	-25.0%	-25.0%	-7.0%
Investment Performance																		
Compounded Annual Growth - From Start Date	3.0%	4.0%	4.7%	6.3%	6.3%	6.3%	9.6%	8.7%	8.0%	3.0%	4.0%	4.7%	6.3%	6.3%	6.3%	9.6%	8.7%	8.0%
Compounded Annual Growth - Segments	3.0%	5.0%	5.4%	6.3%	6.3%	6.3%	9.6%	7.7%	7.2%	3.0%	5.0%	5.4%	6.3%	6.3%	6.3%	9.6%	7.7%	7.2%

Note: Dollar Figures in Millions

State

New Jersey

Plans Included

Public Employees Retirement System - State

Teachers Pension and Annuity Fund

Metrics	State Policy (Current Contribution Policy)						Sustainable Budget (Fixed % of OSR)					
	Deterministic			Deterministic			Deterministic			Deterministic		
	"Low-for-long" Economic Scenario			"Asset Shock" Economic Scenario			"Low-for-long" Economic Scenario			"Asset Shock" Economic Scenario		
	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures												
Market Value of Assets (MVA)	28,711	38,308	54,737	24,589	35,032	52,790	19,563	3,839	-	13,461	-	-
Actuarial Accrued Liability (AAL)	94,809	100,957	109,373	94,781	100,823	108,956	94,809	100,957	109,373	94,781	100,823	108,956
Accrued Liability at 4% Discount Rate (DR)	133,816	142,492	154,370	133,776	142,304	153,782	133,816	142,492	154,370	133,776	142,304	153,782
Unfunded Actuarial Accrued Liability (UAAL)	66,099	62,649	54,636	70,192	65,791	56,165	75,247	97,118	109,373	81,320	100,823	108,956
Unfunded Liability at 4% DR	105,105	104,184	99,634	109,187	107,272	100,992	114,253	138,653	154,370	120,314	142,304	153,782
Funded Ratio	30.3%	37.9%	50.0%	25.9%	34.7%	48.5%	20.6%	3.8%	0.0%	14.2%	0.0%	0.0%
Funded Ratio at 4% Discount Rate	21.5%	26.9%	35.5%	18.4%	24.6%	34.3%	14.6%	2.7%	0.0%	10.1%	0.0%	0.0%
AAL Compound Annual Growth Rate	2.6%	1.9%	1.4%	2.6%	1.9%	1.4%	2.6%	1.9%	1.4%	2.6%	1.9%	1.4%
Change in AAL from Prior Year (%)	1.5%	1.1%	0.6%	1.5%	1.1%	0.6%	1.5%	1.1%	0.6%	1.5%	1.1%	0.6%
Unfunded Liability / Own Source Revenue at 4% DR	188%	157%	107%	208%	172%	115%	204%	208%	165%	229%	228%	175%
Cash Flow Measures												
Benefit Payments	6,887	7,868	9,544	6,887	7,868	9,544	6,887	7,868	9,544	6,887	7,868	9,544
Total Contributions	6,373	8,144	8,342	6,627	8,461	8,526	3,407	4,331	9,632	3,278	7,376	9,632
Negative Operating Cash Flow	514	(275)	1,202	260	(593)	1,018	3,480	3,537	(88)	3,609	492	(88)
Benefit Payments / Beginning of Period MVA	24.6%	21.6%	17.8%	28.9%	23.9%	18.5%	31.1%	109.6%	N/A	41.8%	N/A	N/A
Operating Cash Flow to Assets Ratio	-1.8%	0.8%	-2.2%	-1.1%	1.8%	-2.0%	-15.7%	-49.3%	N/A	-21.9%	N/A	N/A
Change in MVA from Prior Year (%)	2.3%	5.4%	2.3%	3.1%	6.4%	2.6%	-11.8%	-46.5%	N/A	-18.2%	N/A	N/A
Own Source Revenue (OSR)	55,986	66,557	93,475	52,602	62,533	87,824	55,986	66,557	93,475	52,602	62,533	87,824
OSR Compound Annual Growth Rate	4.8%	4.1%	3.8%	3.5%	3.5%	3.5%	4.8%	4.1%	3.8%	3.5%	3.5%	3.5%
Change in OSR from Prior Year (%)	4.4%	3.2%	3.3%	3.8%	3.2%	3.3%	4.4%	3.2%	3.3%	3.8%	3.2%	3.3%
Employer Contributions / OSR	9.1%	10.0%	6.8%	10.1%	11.2%	7.5%	3.8%	4.3%	8.2%	3.8%	9.4%	8.7%
Total Contributions / OSR	11.4%	12.2%	8.9%	12.6%	13.5%	9.7%	6.1%	6.5%	10.3%	6.2%	11.8%	11.0%
Payment and Contribution Measures												
Employer Contributions (ERC)	5,075	6,660	6,359	5,331	6,984	6,552	2,109	2,848	7,650	1,981	5,899	7,658
Change in ERC from Prior Year (%)	17.2%	1.1%	-0.7%	18.1%	1.1%	-0.9%	4.4%	17.2%	1.1%	3.8%	78.1%	1.2%
Employee Contributions (EEC)	1,298	1,483	1,982	1,296	1,477	1,974	1,298	1,483	1,982	1,296	1,477	1,974
Payroll	17,091	19,529	26,098	17,065	19,445	25,986	17,091	19,529	26,098	17,065	19,445	25,986
Employer Contribution / Payroll	29.7%	34.1%	24.4%	31.2%	35.9%	25.2%	12.3%	14.6%	29.3%	11.6%	30.3%	29.5%
Employee Contribution / Payroll	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%
Total Contributions / Payroll	37.3%	41.7%	32.0%	38.8%	43.5%	32.8%	19.9%	22.2%	36.9%	19.2%	37.9%	37.1%
Normal Cost	1,965	2,229	2,903	1,963	2,219	2,891	1,965	2,229	2,903	1,963	2,219	2,891
Normal Cost (4% DR)	3,531	4,005	5,217	3,529	3,988	5,195	3,531	4,005	5,217	3,529	3,988	5,195
Net amortization $	(15)	1,674	1,762	(44)	1,780	1,850	(3,495)	(4,312)	(647)	(4,026)	(1,609)	(608)
Net amortization $ (4% DR)	(1,254)	38	(810)	(1,159)	248	(659)	(4,513)	(5,018)	(1,634)	(4,870)	(2,154)	(1,590)
Net amortization $ / Payroll	-0.1%	8.6%	6.8%	-0.3%	9.2%	7.1%	-20.4%	-22.1%	-2.5%	-23.6%	-8.3%	-2.3%
Net amortization $ / Payroll (4% DR)	-7.3%	0.2%	-3.1%	-6.8%	1.3%	-2.5%	-26.4%	-25.7%	-6.3%	-28.5%	-11.1%	-6.1%
Investment Performance												
Compounded Annual Growth - From Start Date	4.4%	4.6%	4.8%	2.1%	3.5%	4.2%	4.4%	4.6%	4.8%	2.1%	3.5%	4.2%
Compounded Annual Growth - Segments	4.4%	4.9%	4.9%	2.1%	4.9%	4.9%	4.4%	4.9%	4.9%	2.1%	4.9%	4.9%

Note: Dollar Figures in Millions

New Jersey
Fixed 5% Economic Scenario
Public Employees Retirement System - State and Teachers Pension and Annuity Fund

Assets vs. Cash Flow
Assuming 5% returns and contributions fixed as % of OSR

Legend: Market Value of Assets | Operating Cash Flow, Percent of Assets

Total Contributions vs. Benefit Payments
Assuming 5% returns and contributions fixed as % of OSR

Legend: Total contributions | Benefit payments

Unfunded Liability vs. Funding Levels
Assuming 5% returns and contributions fixed as % of OSR

Legend: Unfunded Liability (Market Value) | Funded Ratio

Employer Contributions vs. Pension Debt
Assuming 5% returns and plans' statutory contribution policy

Legend: Pension Debt as Share of OSR | Employer Contribution Rate

North Carolina Retirement System 30 Year Projections

Plans included: Teachers' and State Employees' Retirement System
State contribution policy at assumed rate of return (7.2%)

$MMs

Fiscal Year	Pension Liability (Actuarial Accrued Liability)						Pension Assets (Market Value)					Change in Pension Debt			Cash Flow	Employer Contribution		
	Payroll	Beginning of Period	Service Cost	Interest	Benefit Payments	End of Period	Beginning of Period	Total Contribution	Interest	Benefit Payments	End of Period	Debt	$	% of Payroll	% Funded	% of Assets	$	% Change	% Payroll
2018	15,299	76,717	1,604	5,439	(4,846)	78,914	70,481	2,567	4,994	(4,846)	73,196	5,717	(519)	-3%	93%	-3%	1,649	N/A	11%
2019	15,835	78,914	1,660	5,593	(5,031)	81,136	73,196	2,847	5,193	(5,031)	76,206	4,931	(787)	-5%	94%	-3%	1,897	15%	12%
2020	16,389	81,136	1,718	5,750	(5,220)	83,384	76,206	3,050	5,410	(5,220)	79,446	3,938	(992)	-6%	95%	-3%	2,067	9%	13%
2021	16,963	83,384	1,778	5,908	(5,413)	85,657	79,446	3,216	5,642	(5,413)	82,891	2,766	(1,172)	-7%	97%	-3%	2,198	6%	13%
2022	17,556	85,657	1,841	6,068	(5,612)	87,954	82,891	3,390	5,890	(5,612)	86,559	1,395	(1,371)	-8%	98%	-3%	2,337	6%	13%
2023	18,171	87,954	1,905	6,229	(5,815)	90,274	86,559	3,572	6,153	(5,815)	90,470	(196)	(1,591)	-9%	100%	-3%	2,482	6%	14%
2024	18,807	90,274	1,972	6,393	(6,022)	92,616	90,470	3,763	6,434	(6,022)	94,644	(2,029)	(1,833)	-10%	102%	-2%	2,635	6%	14%
2025	19,465	92,616	2,041	6,558	(6,234)	94,980	94,644	3,963	6,734	(6,234)	99,107	(4,128)	(2,099)	-11%	104%	-2%	2,795	6%	14%
2026	20,146	94,980	2,112	6,724	(6,451)	97,365	99,107	4,172	7,055	(6,451)	103,884	(6,519)	(2,391)	-12%	107%	-2%	2,964	6%	15%
2027	20,851	97,365	2,186	6,892	(6,672)	99,772	103,884	4,391	7,399	(6,672)	109,003	(9,231)	(2,712)	-13%	109%	-2%	3,140	6%	15%
2028	21,581	99,772	2,263	7,061	(6,897)	102,199	109,003	4,621	7,768	(6,897)	114,495	(12,296)	(3,064)	-14%	112%	-2%	3,326	6%	15%
2029	22,337	102,199	2,342	7,232	(7,126)	104,646	114,495	4,860	8,163	(7,126)	120,392	(15,746)	(3,450)	-15%	115%	-2%	3,520	6%	16%
2030	23,118	104,646	2,424	7,405	(7,360)	107,115	120,392	5,111	8,589	(7,360)	126,732	(19,618)	(3,872)	-17%	118%	-2%	3,724	6%	16%
2031	23,927	107,115	2,509	7,578	(7,598)	109,604	126,732	5,374	9,046	(7,598)	133,555	(23,951)	(4,333)	-18%	122%	-2%	3,938	6%	16%
2032	24,765	109,604	2,596	7,754	(7,840)	112,114	133,555	5,649	9,538	(7,840)	140,902	(28,788)	(4,837)	-20%	126%	-2%	4,163	6%	17%
2033	25,632	112,114	2,687	7,931	(8,086)	114,647	140,902	5,936	10,069	(8,086)	148,822	(34,175)	(5,387)	-21%	130%	-2%	4,398	6%	17%
2034	26,529	114,647	2,781	8,109	(8,335)	117,202	148,822	6,237	10,641	(8,335)	157,364	(40,162)	(5,987)	-23%	134%	-1%	4,645	6%	18%
2035	27,457	117,202	2,879	8,290	(8,589)	119,781	157,364	6,551	11,258	(8,589)	166,585	(46,804)	(6,641)	-24%	139%	-1%	4,904	6%	18%
2036	28,418	119,781	2,979	8,472	(8,846)	122,386	166,585	6,880	11,925	(8,846)	176,544	(54,158)	(7,354)	-26%	144%	-1%	5,175	6%	18%
2037	29,413	122,386	3,084	8,656	(9,106)	125,020	176,544	5,617	12,588	(9,106)	185,643	(60,623)	(6,466)	-22%	148%	-2%	3,853	-26%	13%
2038	30,442	125,020	3,192	8,842	(9,370)	127,683	185,643	5,814	13,241	(9,370)	195,328	(67,645)	(7,021)	-23%	153%	-2%	3,987	4%	13%
2039	31,508	127,683	3,303	9,030	(9,637)	130,379	195,328	6,017	13,936	(9,637)	205,644	(75,265)	(7,620)	-24%	158%	-2%	4,127	3%	13%
2040	32,611	130,379	3,419	9,221	(9,907)	133,113	205,644	6,228	14,676	(9,907)	216,642	(83,529)	(8,265)	-25%	163%	-2%	4,271	4%	13%
2041	33,752	133,113	3,538	9,415	(10,174)	135,891	216,642	6,446	15,466	(10,174)	228,380	(92,489)	(8,959)	-27%	168%	-2%	4,421	3%	13%
2042	34,933	135,891	3,662	9,612	(10,439)	138,727	228,380	6,672	16,310	(10,439)	240,923	(102,196)	(9,707)	-28%	174%	-2%	4,576	3%	13%
2043	36,156	138,727	3,791	9,814	(10,701)	141,630	240,923	6,905	17,212	(10,701)	254,339	(112,709)	(10,513)	-29%	180%	-2%	4,736	3%	13%
2044	37,422	141,630	3,923	10,021	(10,958)	144,616	254,339	7,147	18,178	(10,958)	268,705	(124,090)	(11,380)	-30%	186%	-1%	4,902	4%	13%
2045	38,731	144,616	4,061	10,234	(11,212)	147,699	268,705	7,397	19,212	(11,212)	284,103	(136,404)	(12,314)	-32%	192%	-1%	5,073	3%	13%
2046	40,087	147,699	4,203	10,455	(11,460)	150,897	284,103	7,656	20,321	(11,460)	300,620	(149,723)	(13,319)	-33%	199%	-1%	5,251	4%	13%
2047	41,490	150,897	4,350	10,685	(11,702)	154,230	300,620	7,924	21,511	(11,702)	318,353	(164,123)	(14,400)	-35%	206%	-1%	5,434	4%	13%

Source: Analysis by The Pew Charitable Trusts and The Terry Group based on data from Retirement System actuarial valuations and annual reports

Model Assumptions		
State	North Carolina	
Plan	Teachers' and State Employees' Retirement System	
Actuarial Valuation Used	12/31/2016	
Employer Contribution Policy		
Description	Appropriated contribution rate from prior year, plus 0.35%, but not less than the ARC and not more than a contribution based on the long-term Treasury bond yield	
Applies to	All bases, subject to above	
Amortization Period	12 year	
Amortization Method Type	Level dollar	
Open or closed	Closed	
Layered or Single Amortization	Layered	
Amortization Payment Growth Rate	Level dollar	
Additional Contribution Rules		
Employee Contribution Rate		
Applies to	All	
Rate	6.00%	
Employee Contribution Cost-Sharing	No	
Model Assumptions		
Actuarial Assumptions	7.20%	
Inflation Assumption	3.00%	
Payroll Growth Assumption	3.50%	
COLA		
Applies to	All	
Description	Discretionary	
Assumed Effective COLA	None assumed	
COLA Adjustment for Plan Funding and Investment Experience	No	

Fiscal Metrics
Model Output

State

North Carolina

Plans Included

Teachers' and State Employees' Retirement System

	State Policy (Current Contribution Policy)									Sustainable Budget (Fixed % of OSR)								
	Deterministic 7.2%			Deterministic 5%			Deterministic 9%			Deterministic 7.2%			Deterministic 5%			Deterministic 9%		
	Current Plan Assumptions			Low Return			High Return			Current Plan Assumptions			Low Return			High Return		
Metrics	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures																		
Market Value of Assets (MVA)	86,559	109,003	185,643	77,577	86,493	114,067	94,506	131,018	264,621	84,897	103,225	159,125	75,840	80,708	88,718	92,901	125,225	244,110
Actuarial Accrued Liability (AAL)	87,954	99,772	125,020	87,954	99,772	125,020	87,954	99,772	125,020	87,954	99,772	125,020	87,954	99,772	125,020	87,954	99,772	125,020
Accrued Liability at 4% Discount Rate (DR)	126,570	143,577	179,910	126,570	143,577	179,910	126,570	143,577	179,910	126,570	143,577	179,910	126,570	143,577	179,910	126,570	143,577	179,910
Unfunded Actuarial Accrued Liability (UAAL)	1,395	(9,231)	(60,623)	10,376	13,279	10,952	(6,552)	(31,246)	(139,601)	3,057	(3,453)	(34,106)	12,114	19,064	36,302	(4,948)	(25,453)	(119,091)
Unfunded Liability at 4% DR	40,011	34,574	(5,733)	48,993	57,084	65,843	32,064	12,559	(84,711)	41,673	40,352	20,784	50,730	62,869	91,192	33,669	18,352	(64,201)
Funded Ratio	98.4%	109.3%	148.5%	88.2%	86.7%	91.2%	107.4%	131.3%	211.7%	96.5%	103.5%	127.3%	86.2%	80.9%	71.0%	105.6%	125.5%	195.3%
Funded Ratio at 4% Discount Rate	68.4%	75.9%	103.2%	61.3%	60.2%	63.4%	74.7%	91.3%	147.1%	67.1%	71.9%	88.4%	59.9%	56.2%	49.3%	73.4%	87.2%	135.7%
AAL Compound Annual Growth Rate	2.8%	2.7%	2.5%	2.8%	2.7%	2.5%	2.8%	2.7%	2.5%	2.8%	2.7%	2.5%	2.8%	2.7%	2.5%	2.8%	2.7%	2.5%
Change in AAL from Prior Year (%)	2.7%	2.5%	2.2%	2.7%	2.5%	2.2%	2.7%	2.5%	2.2%	2.7%	2.5%	2.2%	2.7%	2.5%	2.2%	2.7%	2.5%	2.2%
Unfunded Liability / Own Source Revenue at 4% DR	83%	57%	-6%	102%	95%	70%	67%	21%	-90%	87%	67%	22%	105%	104%	96%	70%	30%	-68%
Cash Flow Measures																		
Benefit Payments	5,612	6,672	9,106	5,612	6,672	9,106	5,612	6,672	9,106	5,612	6,672	9,106	5,612	6,672	9,106	5,612	6,672	9,106
Total Contributions	3,390	4,391	5,617	3,439	4,450	7,306	3,355	4,350	5,617	2,981	3,669	5,554	2,981	3,669	5,554	2,981	3,669	5,554
Negative Operating Cash Flow	2,222	2,280	3,489	2,173	2,222	1,800	2,257	2,322	3,489	2,631	3,002	3,553	2,631	3,002	3,553	2,631	3,002	3,553
Benefit Payments / Beginning of Period MVA	6.8%	6.4%	5.2%	7.4%	7.9%	8.2%	6.3%	5.4%	3.7%	6.9%	6.7%	6.0%	7.5%	8.4%	10.4%	6.4%	5.7%	4.0%
Operating Cash Flow to Assets Ratio	-2.7%	-2.2%	-2.0%	-2.9%	-2.6%	-1.6%	-2.5%	-1.9%	-1.4%	-3.2%	-3.0%	-2.3%	-3.5%	-3.8%	-4.0%	-3.0%	-2.5%	-1.6%
Change in MVA from Prior Year (%)	4.4%	4.9%	5.2%	2.1%	2.3%	3.3%	6.3%	7.0%	7.5%	3.9%	4.1%	4.8%	1.4%	1.1%	0.9%	5.9%	6.3%	7.4%
Own Source Revenue (OSR)	48,114	60,371	94,586	48,114	60,371	94,586	48,114	60,371	94,586	48,114	60,371	94,586	48,114	60,371	94,586	48,114	60,371	94,586
OSR Compound Annual Growth Rate	5.5%	5.1%	4.8%	5.5%	5.1%	4.8%	5.5%	5.1%	4.8%	5.5%	5.1%	4.8%	5.5%	5.1%	4.8%	5.5%	5.1%	4.8%
Change in OSR from Prior Year (%)	5.7%	4.3%	4.7%	5.7%	4.3%	4.7%	5.7%	4.3%	4.7%	5.7%	4.3%	4.7%	5.7%	4.3%	4.7%	5.7%	4.3%	4.7%
Employer Contributions / OSR	4.9%	5.2%	4.1%	5.0%	5.3%	5.9%	4.8%	5.1%	4.1%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%
Total Contributions / OSR	7.0%	7.3%	5.9%	7.1%	7.4%	7.7%	7.0%	7.2%	5.9%	6.2%	6.1%	5.9%	6.2%	6.1%	5.9%	6.2%	6.1%	5.9%
Payment and Contribution Measures																		
Employer Contributions (ERC)	2,337	3,140	3,853	2,386	3,199	5,541	2,302	3,099	3,853	1,927	2,418	3,789	1,927	2,418	3,789	1,927	2,418	3,789
Change in ERC from Prior Year (%)	6.3%	6.0%	-25.6%	6.2%	5.9%	5.5%	6.3%	6.0%	3.5%	5.7%	4.3%	4.7%	5.7%	4.3%	4.7%	5.7%	4.3%	4.7%
Employee Contributions (EEC)	1,053	1,251	1,765	1,053	1,251	1,765	1,053	1,251	1,765	1,053	1,251	1,765	1,053	1,251	1,765	1,053	1,251	1,765
Payroll	17,556	20,851	29,413	17,556	20,851	29,413	17,556	20,851	29,413	17,556	20,851	29,413	17,556	20,851	29,413	17,556	20,851	29,413
Employer Contribution / Payroll	13.3%	15.1%	13.1%	13.6%	15.3%	18.8%	13.1%	14.9%	13.1%	11.0%	11.6%	12.9%	11.0%	11.6%	12.9%	11.0%	11.6%	12.9%
Employee Contribution / Payroll	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
Total Contributions / Payroll	19.3%	21.1%	19.1%	19.6%	21.3%	24.8%	19.1%	20.9%	19.1%	17.0%	17.6%	18.9%	17.0%	17.6%	18.9%	17.0%	17.6%	18.9%
Normal Cost	1,841	2,186	3,084	1,841	2,186	3,084	1,841	2,186	3,084	1,841	2,186	3,084	1,841	2,186	3,084	1,841	2,186	3,084
Normal Cost (4% DR)	3,420	4,062	5,729	3,420	4,062	5,729	3,420	4,062	5,729	3,420	4,062	5,729	3,420	4,062	5,729	3,420	4,062	5,729
Net amortization $	1,405	2,753	6,523	960	1,420	3,508	1,799	4,044	11,532	898	1,667	4,680	398	271	79	1,331	3,004	10,115
Net amortization $ (4% DR)	(1,645)	(1,113)	(97)	(1,871)	(1,827)	(1,021)	(1,442)	(414)	2,686	(2,109)	(2,037)	(1,149)	(2,387)	(2,813)	(3,706)	(1,868)	(1,294)	1,870
Net amortization $ / Payroll	8.0%	13.2%	22.2%	5.5%	6.8%	11.9%	10.2%	19.4%	39.2%	5.1%	8.0%	15.9%	2.3%	1.3%	0.3%	7.6%	14.4%	34.4%
Net amortization $ / Payroll (4% DR)	-9.4%	-5.3%	-0.3%	-10.7%	-8.8%	-3.5%	-8.2%	-2.0%	9.1%	-12.0%	-9.8%	-3.9%	-13.6%	-13.5%	-12.6%	-10.6%	-6.2%	6.4%
Investment Performance																		
Compounded Annual Growth - From Start Date	7.20%	7.20%	7.20%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%	7.20%	7.20%	7.20%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%
Compounded Annual Growth - Segments	7.20%	7.20%	7.20%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%	7.20%	7.20%	7.20%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%

Note: Dollar Figures in Millions

Fiscal Metrics
Model Output

State
North Carolina
Plans Included
Teachers' and State Employees' Retirement System

Metrics	State Policy (Current Contribution Policy)									Sustainable Budget (Fixed % of OSR)								
	Stochastic Run - Baseline CMA									Stochastic Run - Baseline CMA								
	25th Percentile			50th Percentile			75th Percentile			25th Percentile			50th Percentile			75th Percentile		
	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures																		
Market Value of Assets (MVA)	70,517	79,750	112,232	81,476	96,662	143,138	93,825	118,392	191,823	68,229	69,821	72,504	79,691	89,663	110,247	92,044	112,371	158,729
Actuarial Accrued Liability (AAL)	87,503	97,293	112,210	87,521	97,472	113,302	87,532	97,649	113,641	87,503	97,293	112,210	87,521	97,472	113,302	87,532	97,649	113,641
Accrued Liability at 4% Discount Rate (DR)	125,922	140,010	161,477	125,947	140,268	163,048	125,964	140,522	163,536	125,922	140,010	161,477	125,947	140,268	163,048	125,964	140,522	163,536
Unfunded Actuarial Accrued Liability (UAAL)	16,986	17,543	(22)	6,045	810	(29,836)	(6,292)	(20,743)	(78,181)	19,274	27,472	39,706	7,829	7,809	3,055	(4,512)	(14,722)	(45,088)
Unfunded Liability at 4% DR	55,405	60,260	49,244	44,471	43,606	19,910	32,139	22,130	(28,286)	57,693	70,189	88,973	46,256	50,604	52,801	33,920	28,151	4,807
Funded Ratio	80.6%	82.0%	100.0%	93.1%	99.2%	126.3%	107.2%	121.2%	168.8%	78.0%	71.8%	64.6%	91.1%	92.0%	97.3%	105.2%	115.1%	139.7%
Funded Ratio at 4% Discount Rate	56.0%	57.0%	69.5%	64.7%	68.9%	87.8%	74.5%	84.3%	117.3%	54.2%	49.9%	44.9%	63.3%	63.9%	67.6%	73.1%	80.0%	97.1%
AAL Compound Annual Growth Rate	2.7%	2.4%	1.9%	2.7%	2.4%	2.0%	2.7%	2.4%	2.0%	2.7%	2.4%	1.9%	2.7%	2.4%	2.0%	2.7%	2.4%	2.0%
Change in AAL from Prior Year (%)	2.4%	2.0%	1.0%	2.4%	2.0%	1.1%	2.4%	2.1%	1.1%	2.4%	2.0%	1.0%	2.4%	2.0%	1.1%	2.4%	2.1%	1.1%
Unfunded Liability / Own Source Revenue at 4% DR	116%	101%	53%	93%	73%	21%	67%	37%	-30%	121%	117%	96%	97%	85%	56%	71%	47%	5%
Cash Flow Measures																		
Benefit Payments	5,612	6,672	9,106	5,612	6,672	9,106	5,612	6,672	9,106	5,612	6,672	9,106	5,612	6,672	9,106	5,612	6,672	9,106
Total Contributions	3,683	4,945	7,313	3,405	4,391	6,425	3,353	4,197	5,709	2,940	3,545	5,177	2,944	3,554	5,246	2,946	3,581	5,270
Negative Operating Cash Flow	1,929	1,726	1,793	2,207	2,280	2,681	2,259	2,474	3,397	2,672	3,127	3,929	2,667	3,117	3,860	2,666	3,091	3,836
Benefit Payments / Beginning of Period MVA	8.0%	8.5%	8.4%	7.1%	7.0%	6.7%	6.4%	5.9%	5.1%	8.2%	9.5%	12.4%	7.2%	7.5%	8.5%	6.5%	6.2%	6.1%
Operating Cash Flow to Assets Ratio	-2.8%	-2.2%	-1.7%	-2.8%	-2.4%	-2.0%	-2.6%	-2.2%	-1.9%	-3.9%	-4.5%	-5.4%	-3.4%	-3.5%	-3.6%	-3.1%	-2.9%	-2.6%
Change in MVA from Prior Year (%)	1.1%	2.1%	3.6%	2.5%	2.0%	4.7%	7.0%	4.7%	6.4%	-0.1%	-0.4%	-1.1%	1.9%	0.8%	2.5%	6.5%	3.9%	5.7%
Own Source Revenue (OSR)	47,742	59,757	92,818	47,830	59,873	94,077	47,842	60,335	94,475	47,742	59,757	92,818	47,830	59,873	94,077	47,842	60,335	94,475
OSR Compound Annual Growth Rate	5.4%	5.0%	4.7%	5.4%	5.0%	4.8%	5.4%	5.1%	4.8%	5.4%	5.0%	4.7%	5.4%	5.0%	4.8%	5.4%	5.1%	4.8%
Change in OSR from Prior Year (%)	5.6%	4.5%	4.7%	5.7%	4.3%	4.8%	5.6%	4.4%	4.6%	5.6%	4.5%	4.7%	5.7%	4.3%	4.8%	5.6%	4.4%	4.6%
Employer Contributions / OSR	5.6%	6.3%	6.3%	5.0%	5.4%	5.3%	4.9%	5.0%	4.5%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%
Total Contributions / OSR	7.7%	8.3%	7.9%	7.1%	7.3%	6.8%	7.0%	7.0%	6.0%	6.2%	5.9%	5.6%	6.2%	5.9%	5.6%	6.2%	5.9%	5.6%
Payment and Contribution Measures																		
Employer Contributions (ERC)	2,656	3,794	5,854	2,377	3,235	4,947	2,324	3,033	4,223	1,912	2,394	3,718	1,916	2,398	3,768	1,916	2,417	3,784
Change in ERC from Prior Year (%)	10.0%	6.0%	1.7%	5.8%	5.1%	-0.4%	5.2%	4.9%	-0.8%	5.6%	4.5%	4.7%	5.7%	4.3%	4.8%	5.6%	4.4%	4.6%
Employee Contributions (EEC)	1,027	1,151	1,459	1,028	1,156	1,478	1,029	1,164	1,486	1,027	1,151	1,459	1,028	1,156	1,478	1,029	1,164	1,486
Payroll	17,124	19,183	24,323	17,141	19,266	24,632	17,152	19,402	24,768	17,124	19,183	24,323	17,141	19,266	24,632	17,152	19,402	24,768
Employer Contribution / Payroll	15.5%	19.8%	24.1%	13.9%	16.8%	20.1%	13.5%	15.6%	17.1%	11.2%	12.5%	15.3%	11.2%	12.4%	15.3%	11.2%	12.5%	15.3%
Employee Contribution / Payroll	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
Total Contributions / Payroll	21.5%	25.8%	30.1%	19.9%	22.8%	26.1%	19.5%	21.6%	23.1%	17.2%	18.5%	21.3%	17.2%	18.4%	21.3%	17.2%	18.5%	21.3%
Normal Cost	1,818	2,029	2,575	1,819	2,040	2,608	1,819	2,054	2,621	1,818	2,029	2,575	1,819	2,040	2,608	1,819	2,054	2,621
Normal Cost (4% DR)	3,377	3,770	4,785	3,379	3,790	4,845	3,380	3,816	4,870	3,377	3,770	4,785	3,379	3,790	4,845	3,380	3,816	4,870
Net amortization $	801	1,775	4,704	1,212	2,378	5,724	1,748	3,476	8,080	(72)	(250)	(29)	645	1,092	2,402	1,238	2,479	5,463
Net amortization $ (4% DR)	(1,817)	(1,167)	515	(1,714)	(1,096)	627	(1,440)	(593)	1,594	(2,632)	(2,915)	(3,065)	(2,233)	(2,183)	(1,743)	(1,904)	(1,421)	(55)
Net amortization $ / Payroll	4.7%	9.3%	19.3%	7.1%	12.3%	23.2%	10.2%	17.9%	32.6%	-0.4%	-1.3%	-0.1%	3.8%	5.7%	9.8%	7.2%	12.8%	22.1%
Net amortization $ / Payroll (4% DR)	-10.6%	-6.1%	2.1%	-10.0%	-5.7%	2.5%	-8.4%	-3.1%	6.4%	-15.4%	-15.2%	-12.6%	-13.0%	-11.3%	-7.1%	-11.1%	-7.3%	-0.2%
Investment Performance																		
Compounded Annual Growth - From Start Date	3.0%	3.9%	4.6%	5.9%	6.0%	6.0%	8.8%	8.0%	7.4%	3.0%	3.9%	4.6%	5.9%	6.0%	6.0%	8.8%	8.0%	7.4%
Compounded Annual Growth - Segments	3.0%	4.8%	5.2%	5.9%	6.0%	6.0%	8.8%	7.2%	6.8%	3.0%	4.8%	5.2%	5.9%	6.0%	6.0%	8.8%	7.2%	6.8%

Note: Dollar Figures in Millions

State

North Carolina

Plans Included

Teachers' and State Employees' Retirement System

Metrics	State Policy (Current Contribution Policy)						Sustainable Budget (Fixed % of OSR)					
	Deterministic			Deterministic			Deterministic			Deterministic		
	"Low-for-long" Economic Scenario			"Asset Shock" Economic Scenario			"Low-for-long" Economic Scenario			"Asset Shock" Economic Scenario		
	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures												
Market Value of Assets (MVA)	73,699	80,349	97,877	69,667	82,825	119,476	71,885	74,487	74,346	63,702	62,885	51,860
Actuarial Accrued Liability (AAL)	87,591	97,745	114,048	87,563	97,613	113,642	87,591	97,745	114,048	87,563	97,613	113,642
Accrued Liability at 4% Discount Rate (DR)	126,048	140,660	164,122	126,008	140,470	163,538	126,048	140,660	164,122	126,008	140,470	163,538
Unfunded Actuarial Accrued Liability (UAAL)	13,891	17,396	16,171	17,896	14,788	(5,834)	15,705	23,257	39,702	23,861	34,728	61,783
Unfunded Liability at 4% DR	52,348	60,311	66,244	56,341	57,645	44,061	54,162	66,173	89,775	62,306	77,585	111,678
Funded Ratio	84.1%	82.2%	85.8%	79.6%	84.9%	105.1%	82.1%	76.2%	65.2%	72.7%	64.4%	45.6%
Funded Ratio at 4% Discount Rate	58.5%	57.1%	59.6%	55.3%	59.0%	73.1%	57.0%	53.0%	45.3%	50.6%	44.8%	31.7%
AAL Compound Annual Growth Rate	2.7%	2.5%	2.0%	2.7%	2.4%	2.0%	2.7%	2.5%	2.0%	2.7%	2.4%	2.0%
Change in AAL from Prior Year (%)	2.5%	2.1%	1.1%	2.4%	2.0%	1.1%	2.5%	2.1%	1.1%	2.4%	2.0%	1.1%
Unfunded Liability / Own Source Revenue at 4% DR	109%	100%	70%	130%	106%	52%	113%	110%	95%	144%	143%	131%
Cash Flow Measures												
Benefit Payments	5,612	6,672	9,106	5,612	6,672	9,106	5,612	6,672	9,106	5,612	6,672	9,106
Total Contributions	3,445	4,385	6,590	4,623	5,707	8,144	2,960	3,584	5,276	2,766	3,338	4,892
Negative Operating Cash Flow	2,167	2,287	2,516	989	965	962	2,652	3,087	3,830	2,846	3,333	4,214
Benefit Payments / Beginning of Period MVA	7.7%	8.5%	9.5%	8.3%	8.3%	7.9%	7.8%	9.0%	12.2%	8.8%	10.5%	17.0%
Operating Cash Flow to Assets Ratio	-3.0%	-2.9%	-2.6%	-1.5%	-1.2%	-0.8%	-3.7%	-4.2%	-5.1%	-4.5%	-5.3%	-7.9%
Change in MVA from Prior Year (%)	1.2%	1.8%	2.1%	2.7%	3.5%	3.9%	0.4%	0.5%	-0.5%	-0.3%	-0.6%	-3.3%
Own Source Revenue (OSR)	48,114	60,371	94,586	43,316	54,351	85,153	48,114	60,371	94,586	43,316	54,351	85,153
OSR Compound Annual Growth Rate	5.5%	5.1%	4.8%	3.3%	4.0%	4.3%	5.5%	5.1%	4.8%	3.3%	4.0%	4.3%
Change in OSR from Prior Year (%)	5.7%	4.3%	4.7%	3.8%	4.3%	4.7%	5.7%	4.3%	4.7%	3.8%	4.3%	4.7%
Employer Contributions / OSR	5.0%	5.3%	5.4%	8.3%	8.4%	7.8%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%
Total Contributions / OSR	7.2%	7.3%	7.0%	10.7%	10.5%	9.6%	6.2%	5.9%	5.6%	6.4%	6.1%	5.7%
Payment and Contribution Measures												
Employer Contributions (ERC)	2,412	3,218	5,102	3,592	4,545	6,663	1,927	2,418	3,789	1,735	2,177	3,411
Change in ERC from Prior Year (%)	5.1%	8.4%	4.2%	11.4%	4.0%	3.8%	5.7%	4.3%	4.7%	3.8%	4.3%	4.7%
Employee Contributions (EEC)	1,032	1,166	1,488	1,031	1,161	1,481	1,032	1,166	1,488	1,031	1,161	1,481
Payroll	17,207	19,435	24,793	17,180	19,351	24,686	17,207	19,435	24,793	17,180	19,351	24,686
Employer Contribution / Payroll	14.0%	16.6%	20.6%	20.9%	23.5%	27.0%	11.2%	12.4%	15.3%	10.1%	11.3%	13.8%
Employee Contribution / Payroll	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
Total Contributions / Payroll	20.0%	22.6%	26.6%	26.9%	29.5%	33.0%	17.2%	18.4%	21.3%	16.1%	17.3%	19.8%
Normal Cost	1,822	2,058	2,626	1,821	2,049	2,614	1,822	2,058	2,626	1,821	2,049	2,614
Normal Cost (4% DR)	3,386	3,824	4,878	3,383	3,807	4,857	3,386	3,824	4,878	3,383	3,807	4,857
Net amortization $	769	1,195	2,885	1,630	2,658	5,907	175	20	1	(575)	(998)	(1,877)
Net amortization $ (4% DR)	(1,947)	(1,785)	(913)	(943)	(370)	1,478	(2,493)	(2,793)	(3,100)	(2,993)	(3,454)	(4,292)
Net amortization $ / Payroll	4.5%	6.1%	11.6%	9.5%	13.7%	23.9%	1.0%	0.1%	0.0%	-3.3%	-5.2%	-7.6%
Net amortization $ / Payroll (4% DR)	-11.3%	-9.2%	-3.7%	-5.5%	-1.9%	6.0%	-14.5%	-14.4%	-12.5%	-17.4%	-17.8%	-17.4%
Investment Performance												
Compounded Annual Growth - From Start Date	4.0%	4.4%	4.6%	2.4%	3.6%	4.2%	4.0%	4.4%	4.6%	2.4%	3.6%	4.2%
Compounded Annual Growth - Segments	4.0%	4.8%	4.8%	2.4%	4.8%	4.8%	4.0%	4.8%	4.8%	2.4%	4.8%	4.8%

Note: Dollar Figures in Millions

North Carolina
Fixed 5% Economic Scenario
Teachers' and State Employees' Retirement System

Assets vs. Cash Flow
Assuming 5% returns and contributions fixed as % of OSR
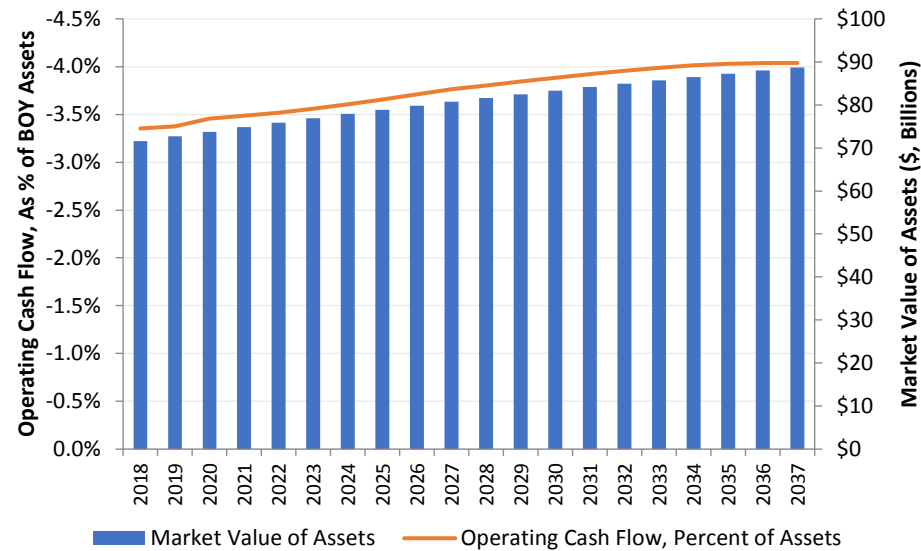
Total Contributions vs. Benefit Payments
Assuming 5% returns and contributions fixed as % of OSR
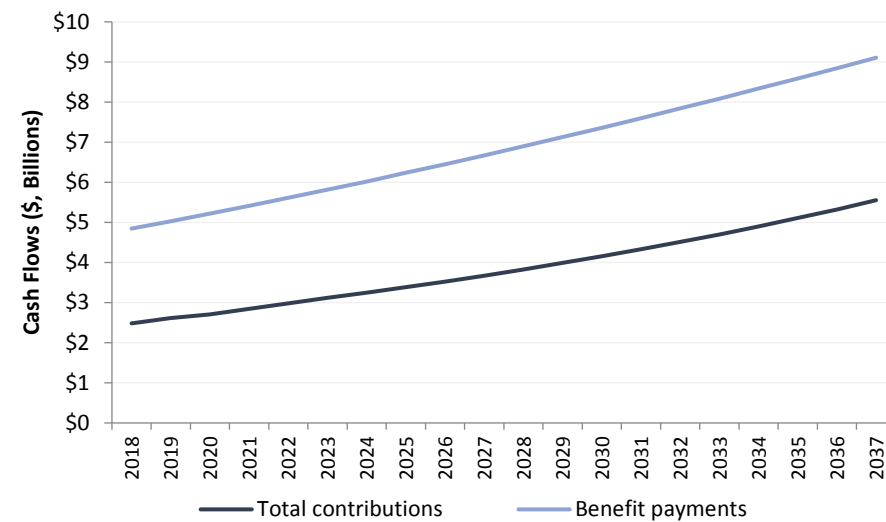
Unfunded Liability vs. Funding Levels
Assuming 5% returns and contributions fixed as % of OSR
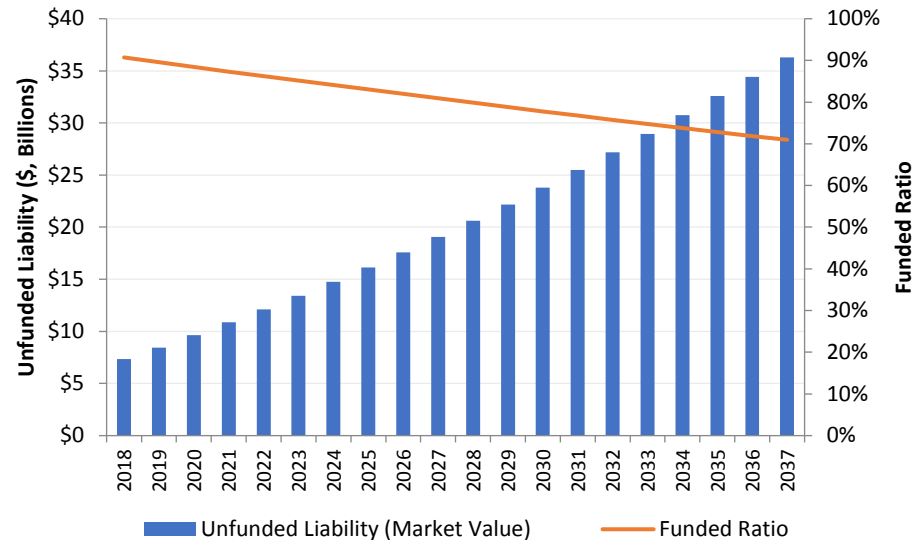
Employer Contributions vs. Pension Debt
Assuming 5% returns and plans' statutory contribution policy

North Carolina
Asset Shock Economic Scenario
Teachers' and State Employees' Retirement System

Assets vs. Cash Flow
Assuming asset shock and contributions fixed as % of OSR

Market Value of Assets   Operating Cash Flow, Percent of Assets

Total Contributions vs. Benefit Payments
Assuming asset shock and contributions fixed as % of OSR

Total contributions   Benefit payments

Unfunded Liability vs. Funding Levels
Assuming asset shock and contributions fixed as % of OSR

Unfunded Liability (Market Value)   Funded Ratio
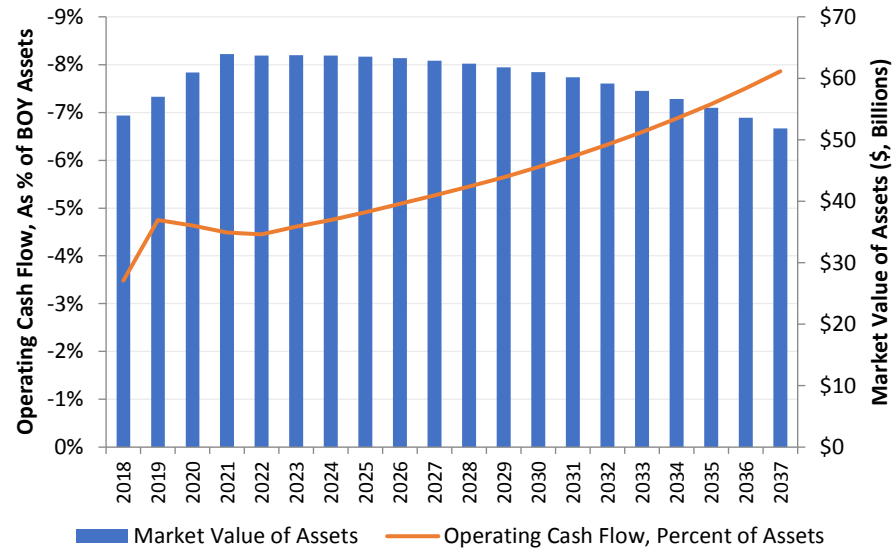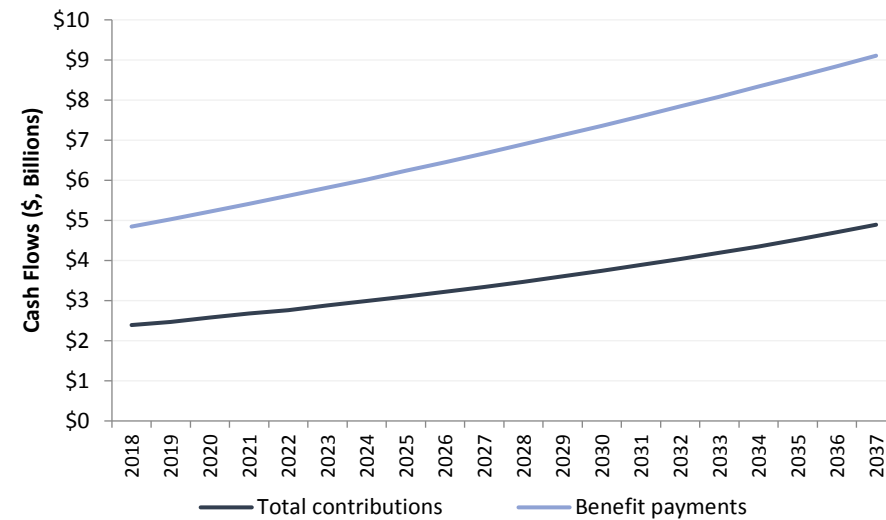
Employer Contributions vs. Pension Debt
Assuming asset shock and plans' statutory contribution policy
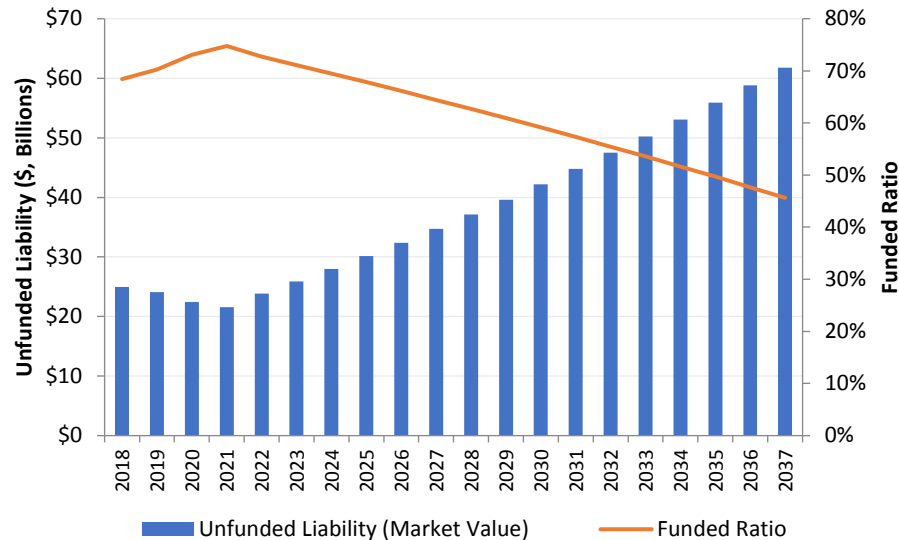
Pension Debt as Share of OSR   Employer Contribution Rate
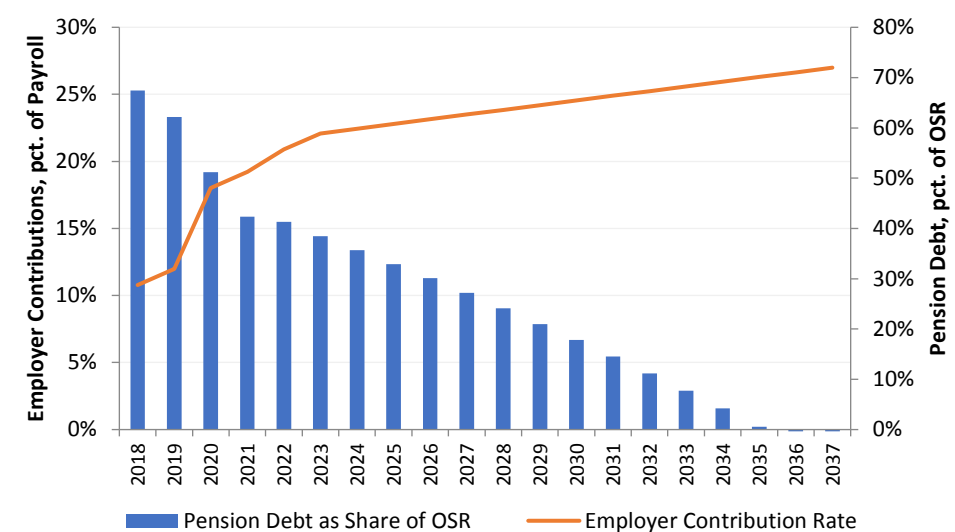
Ohio Retirement System 30 Year Projections

Plans included: Public Employees Retirement System, State Teachers Retirement System
State contribution policy at assumed rate of return (7.48%)

$MMs

Fiscal Year	Payroll	Pension Liability (Actuarial Accrued Liability)					Pension Assets (Market Value)					Debt	Change in Pension Debt		% Funded	Cash Flow % of Assets	Employer Contribution		
		Beginning of Period	Service Cost	Interest	Benefit Payments	End of Period	Beginning of Period	Total Contribution	Interest	Benefit Payments	End of Period		$	% of Payroll			$	% Change	% Payroll
2018	26,365	198,059	3,217	14,428	(13,548)	202,156	158,279	6,680	11,450	(13,548)	162,861	39,294	(486)	-2%	81%	-4%	3,675	N/A	14%
2019	27,191	202,156	3,244	14,723	(13,901)	206,222	162,861	6,889	11,784	(13,901)	167,634	38,588	(706)	-3%	81%	-4%	3,790	3%	14%
2020	28,043	206,222	3,317	15,017	(14,259)	210,296	167,634	7,105	12,131	(14,259)	172,610	37,686	(902)	-3%	82%	-4%	3,909	3%	14%
2021	28,922	210,296	3,393	15,311	(14,623)	214,377	172,610	7,327	12,494	(14,623)	177,808	36,569	(1,117)	-4%	83%	-4%	4,032	3%	14%
2022	29,829	214,377	3,472	15,606	(14,992)	218,463	177,808	7,556	12,873	(14,992)	183,245	35,218	(1,351)	-5%	84%	-4%	4,158	3%	14%
2023	30,763	218,463	3,554	15,901	(15,366)	222,552	183,245	7,792	13,270	(15,366)	188,941	33,611	(1,607)	-5%	85%	-4%	4,289	3%	14%
2024	31,727	222,552	3,640	16,196	(15,745)	226,644	188,941	8,036	13,687	(15,745)	194,919	31,725	(1,886)	-6%	86%	-4%	4,423	3%	14%
2025	32,722	226,644	3,729	16,492	(16,127)	230,738	194,919	8,287	14,124	(16,127)	201,203	29,535	(2,190)	-7%	87%	-4%	4,562	3%	14%
2026	33,747	230,738	3,822	16,787	(16,513)	234,834	201,203	8,546	14,584	(16,513)	207,821	27,013	(2,521)	-7%	88%	-4%	4,705	3%	14%
2027	34,805	234,834	3,918	17,083	(16,901)	238,934	207,821	8,813	15,069	(16,901)	214,802	24,132	(2,882)	-8%	90%	-4%	4,852	3%	14%
2028	35,896	238,934	4,018	17,379	(17,292)	243,039	214,802	9,089	15,582	(17,292)	222,181	20,858	(3,274)	-9%	91%	-4%	5,005	3%	14%
2029	37,022	243,039	4,122	17,675	(17,685)	247,152	222,181	9,373	16,124	(17,685)	229,994	17,158	(3,700)	-10%	93%	-4%	5,162	3%	14%
2030	38,182	247,152	4,229	17,973	(18,078)	251,275	229,994	9,666	16,699	(18,078)	238,281	12,995	(4,163)	-11%	95%	-4%	5,324	3%	14%
2031	39,379	251,275	4,341	18,271	(18,473)	255,415	238,281	9,969	17,309	(18,473)	247,086	8,329	(4,666)	-12%	97%	-4%	5,491	3%	14%
2032	40,614	255,415	4,457	18,570	(18,867)	259,575	247,086	10,281	17,958	(18,867)	256,457	3,118	(5,211)	-13%	99%	-3%	5,663	3%	14%
2033	41,887	259,575	4,578	18,871	(19,260)	263,763	256,457	10,602	18,649	(19,260)	266,449	(2,686)	(5,803)	-14%	101%	-3%	5,841	3%	14%
2034	43,201	263,763	4,702	19,174	(19,652)	267,988	266,449	10,934	19,388	(19,652)	277,119	(9,131)	(6,445)	-15%	103%	-3%	6,024	3%	14%
2035	44,555	267,988	4,831	19,480	(20,041)	272,258	277,119	11,340	20,179	(20,041)	288,596	(16,338)	(7,207)	-16%	106%	-3%	6,276	4%	14%
2036	45,953	272,258	4,965	19,790	(20,428)	276,586	288,596	11,694	21,028	(20,428)	300,891	(24,305)	(7,967)	-17%	109%	-3%	6,473	3%	14%
2037	47,394	276,586	5,104	20,104	(20,811)	280,983	300,891	12,060	21,939	(20,811)	314,079	(33,096)	(8,791)	-19%	112%	-3%	6,676	3%	14%
2038	48,880	280,983	5,247	20,424	(21,190)	285,465	314,079	12,437	22,917	(21,190)	328,244	(42,779)	(9,683)	-20%	115%	-3%	6,886	3%	14%
2039	50,413	285,465	5,396	20,751	(21,563)	290,049	328,244	12,827	23,969	(21,563)	343,477	(53,428)	(10,648)	-21%	118%	-3%	7,102	3%	14%
2040	51,994	290,049	5,550	21,085	(21,931)	294,753	343,477	13,228	25,100	(21,931)	359,874	(65,120)	(11,693)	-22%	122%	-3%	7,325	3%	14%
2041	53,625	294,753	5,709	21,429	(22,292)	299,599	359,874	13,642	26,319	(22,292)	377,542	(77,943)	(12,823)	-24%	126%	-2%	7,554	3%	14%
2042	55,307	299,599	5,874	21,784	(22,647)	304,611	377,542	14,069	27,634	(22,647)	396,598	(91,987)	(14,044)	-25%	130%	-2%	7,791	3%	14%
2043	57,042	304,611	6,045	22,152	(22,993)	309,814	396,598	14,509	29,052	(22,993)	417,167	(107,352)	(15,365)	-27%	135%	-2%	8,036	3%	14%
2044	58,831	309,814	6,221	22,534	(23,330)	315,239	417,167	14,963	30,585	(23,330)	439,384	(124,144)	(16,792)	-29%	139%	-2%	8,288	3%	14%
2045	60,677	315,239	6,404	22,933	(23,659)	320,918	439,384	15,431	32,240	(23,659)	463,396	(142,478)	(18,334)	-30%	144%	-2%	8,548	3%	14%
2046	62,581	320,918	6,592	23,352	(23,977)	326,886	463,396	15,914	34,031	(23,977)	489,365	(162,479)	(20,000)	-32%	150%	-2%	8,816	3%	14%
2047	64,544	326,886	6,787	23,794	(24,285)	333,182	489,365	16,412	35,968	(24,285)	517,460	(184,278)	(21,799)	-34%	155%	-2%	9,093	3%	14%

Source: Analysis by The Pew Charitable Trusts and The Terry Group based on data from Retirement System actuarial valuations and annual reports

Model Assumptions			
State	Ohio		
Plan	Public Employees Retirement System		
Actuarial Valuation Used	12/31/2016		
Employer Contribution Policy			
Description	Statutory rate		
Applies to	All		
Rate	14.00% for General employees, 18.10% for Law = 14.16% on average		
Employee Contribution Rate			
Applies to	All		
Rate	9.63% for General employees, 13.00% for Law Enforcement = 9.82% on average		
Employee Contribution Cost-Sharing	No		
Model Assumptions			
Actuarial Assumptions	7.50%		
Inflation Assumption	2.50%		
Payroll Growth Assumption	3.25%		
COLA			
Applies to	Retired after 1/7/2013 or Eligible to retire on or before 1/7/2018 (transition group A)	Current retirees - retired on or before 1/7/2013	Everyone else
Description	3% up until 12/31/2018. After 12/31/2018, annual percentage change in CPI. Max 3%	Flat 3%	Annual percent change in CPI, max 3%
Assumed Effective COLA	Simple 3% through 2018, 2.8% thereafter. Modeled as: COLA is assumed to be a minimum of 1.75% and will increase based on 100% of the COLA in excess of the break point 1.75% with a maximum COLA of 2.75%	Simple 3%. Modeled as: COLA is assumed to be a minimum of 1.75% and will increase based on 100% of the COLA in excess of the break point 1.75% with a maximum COLA of 2.75%	Simple 2.8%. Modeled as: COLA is assumed to be a minimum of 1.75% and will increase based on 100% of the COLA in excess of the break point 1.75% with a maximum COLA of 2.75%
COLA Adjustment for Plan Funding and Investment Experience	No		

Model Assumptions		
State	Ohio	
Plan	State Teachers Retirement System	
Actuarial Valuation Used	7/1/2017	
Employer Contribution Policy		
Description	Statutory rate	
Applies to	DB Participants	DC Participants
Rate	14.00%	9.53% to the DC plan 4.47% to the DB plan
Employee Contribution Rate		
Applies to	Tier 1 (DB Plan)	Tier 2 (Combined Plan)
Rate	14.00%	2.00% to DB portion 12.00% to DC portion
Employee Contribution Cost-Sharing	No	No
Model Assumptions		
Actuarial Assumptions	7.45%	
Inflation Assumption	2.50%	
Payroll Growth Assumption	3.00%	
COLA		
Applies to	All	
Description	No COLA	
Assumed Effective COLA	N/A	
COLA Adjustment for Plan Funding and Investment Experience	N/A	

State

Ohio

Plans Included

Public Employees Retirement System

State Teachers Retirement System

Metrics	State Policy (Current Contribution Policy)									Sustainable Budget (Fixed % of OSR)								
	Deterministic 7.48%			Deterministic 5%			Deterministic 9%			Deterministic 7.48%			Deterministic 5%			Deterministic 9%		
	Current Plan Assumptions			Low Return			High Return			Current Plan Assumptions			Low Return			High Return		
	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures																		
Market Value of Assets (MVA)	183,245	214,802	314,079	160,812	160,047	147,948	198,139	255,050	466,210	183,044	215,242	317,512	160,633	160,508	150,926	197,923	255,472	470,070
Actuarial Accrued Liability (AAL)	218,463	238,934	280,983	218,463	238,934	280,983	218,463	238,934	280,983	218,463	238,934	280,983	218,463	238,934	280,983	218,463	238,934	280,983
Accrued Liability at 4% Discount Rate (DR)	328,853	359,667	422,964	328,853	359,667	422,964	328,853	359,667	422,964	328,853	359,667	422,964	328,853	359,667	422,964	328,853	359,667	422,964
Unfunded Actuarial Accrued Liability (UAAL)	35,218	24,132	(33,096)	57,651	78,887	133,035	20,324	(16,116)	(185,227)	35,420	23,692	(36,529)	57,830	78,426	130,057	20,540	(16,538)	(189,087)
Unfunded Liability at 4% DR	145,607	144,865	108,884	168,040	199,621	275,016	130,714	104,617	(43,246)	145,809	144,425	105,452	168,220	199,159	272,038	130,930	104,195	(47,106)
Funded Ratio	83.9%	89.9%	111.8%	73.6%	67.0%	52.7%	90.7%	106.7%	165.9%	83.8%	90.1%	113.0%	73.5%	67.2%	53.7%	90.6%	106.9%	167.3%
Funded Ratio at 4% Discount Rate	55.7%	59.7%	74.3%	48.9%	44.5%	35.0%	60.3%	70.9%	110.2%	55.7%	59.8%	75.1%	48.8%	44.6%	35.7%	60.2%	71.0%	111.1%
AAL Compound Annual Growth Rate	2.0%	1.9%	1.8%	2.0%	1.9%	1.8%	2.0%	1.9%	1.8%	2.0%	1.9%	1.8%	2.0%	1.9%	1.8%	2.0%	1.9%	1.8%
Change in AAL from Prior Year (%)	1.9%	1.7%	1.6%	1.9%	1.7%	1.6%	1.9%	1.7%	1.6%	1.9%	1.7%	1.6%	1.9%	1.7%	1.6%	1.9%	1.7%	1.6%
Unfunded Liability / Own Source Revenue at 4% DR	254%	213%	118%	293%	293%	299%	228%	154%	-47%	254%	212%	114%	293%	293%	295%	228%	153%	-51%
Cash Flow Measures																		
Benefit Payments	14,992	16,901	20,811	14,992	16,901	20,811	14,992	16,901	20,811	14,992	16,901	20,811	14,992	16,901	20,811	14,992	16,901	20,811
Total Contributions	7,556	8,813	12,060	7,556	8,813	11,993	7,556	8,813	12,060	7,611	8,956	12,215	7,611	8,956	12,147	7,611	8,956	12,215
Negative Operating Cash Flow	7,436	8,088	8,751	7,436	8,088	8,818	7,436	8,088	8,751	7,381	7,945	8,596	7,381	7,945	8,664	7,381	7,945	8,596
Benefit Payments / Beginning of Period MVA	8.4%	8.1%	6.9%	9.3%	10.5%	13.9%	7.9%	7.0%	4.8%	8.4%	8.1%	6.8%	9.4%	10.5%	13.7%	7.9%	7.0%	4.7%
Operating Cash Flow to Assets Ratio	-4.2%	-3.9%	-2.9%	-4.6%	-5.0%	-5.9%	-3.9%	-3.3%	-2.0%	-4.2%	-3.8%	-2.8%	-4.6%	-4.9%	-5.7%	-3.9%	-3.3%	-2.0%
Change in MVA from Prior Year (%)	3.1%	3.4%	4.4%	0.2%	-0.3%	-1.2%	4.8%	5.4%	6.9%	3.1%	3.4%	4.5%	0.2%	-0.2%	-1.0%	4.8%	5.5%	6.9%
Own Source Revenue (OSR)	57,415	68,050	92,130	57,415	68,050	92,130	57,415	68,050	92,130	57,415	68,050	92,130	57,415	68,050	92,130	57,415	68,050	92,130
OSR Compound Annual Growth Rate	4.8%	4.1%	3.6%	4.8%	4.1%	3.6%	4.8%	4.1%	3.6%	4.8%	4.1%	3.6%	4.8%	4.1%	3.6%	4.8%	4.1%	3.6%
Change in OSR from Prior Year (%)	4.3%	3.1%	3.0%	4.3%	3.1%	3.0%	4.3%	3.1%	3.0%	4.3%	3.1%	3.0%	4.3%	3.1%	3.0%	4.3%	3.1%	3.0%
Employer Contributions / OSR	7.2%	7.1%	7.2%	7.2%	7.1%	7.2%	7.2%	7.1%	7.2%	7.3%	7.3%	7.4%	7.3%	7.3%	7.3%	7.3%	7.3%	7.4%
Total Contributions / OSR	13.2%	13.0%	13.1%	13.2%	13.0%	13.0%	13.2%	13.0%	13.1%	13.3%	13.2%	13.3%	13.3%	13.2%	13.2%	13.3%	13.2%	13.3%
Payment and Contribution Measures																		
Employer Contributions (ERC)	4,158	4,852	6,676	4,158	4,852	6,609	4,158	4,852	6,676	4,214	4,995	6,831	4,214	4,995	6,764	4,214	4,995	6,831
Change in ERC from Prior Year (%)	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%	4.3%	3.1%	3.0%	4.3%	3.1%	2.9%	4.3%	3.1%	3.0%
Employee Contributions (EEC)	3,398	3,961	5,384	3,398	3,961	5,384	3,398	3,961	5,384	3,398	3,961	5,384	3,398	3,961	5,384	3,398	3,961	5,384
Payroll	29,829	34,805	47,394	29,829	34,805	47,394	29,829	34,805	47,394	29,829	34,805	47,394	29,829	34,805	47,394	29,829	34,805	47,394
Employer Contribution / Payroll	13.9%	13.9%	14.1%	13.9%	13.9%	13.9%	13.9%	13.9%	14.1%	14.1%	14.4%	14.4%	14.1%	14.4%	14.3%	14.1%	14.4%	14.4%
Employee Contribution / Payroll	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%
Total Contributions / Payroll	25.3%	25.3%	25.4%	25.3%	25.3%	25.3%	25.3%	25.3%	25.4%	25.5%	25.7%	25.8%	25.5%	25.7%	25.6%	25.5%	25.7%	25.8%
Normal Cost	3,472	3,918	5,104	3,472	3,918	5,104	3,472	3,918	5,104	3,472	3,918	5,104	3,472	3,918	5,104	3,472	3,918	5,104
Normal Cost (4% DR)	6,928	7,818	10,184	6,928	7,818	10,184	6,928	7,818	10,184	6,928	7,818	10,184	6,928	7,818	10,184	6,928	7,818	10,184
Net amortization $	1,502	3,058	9,030	209	(484)	(2,344)	2,339	5,603	19,155	1,542	3,226	9,417	250	(314)	(1,982)	2,378	5,770	19,570
Net amortization $ (4% DR)	(5,156)	(4,812)	(2,705)	(5,846)	(6,705)	(8,821)	(4,706)	(3,449)	2,712	(5,109)	(4,655)	(2,426)	(5,798)	(6,548)	(8,555)	(4,660)	(3,293)	3,005
Net amortization $ / Payroll	5.0%	8.8%	19.1%	0.7%	-1.4%	-4.9%	7.8%	16.1%	40.4%	5.2%	9.3%	19.9%	0.8%	-0.9%	-4.2%	8.0%	16.6%	41.3%
Net amortization $ / Payroll (4% DR)	-17.3%	-13.8%	-5.7%	-19.6%	-19.3%	-18.6%	-15.8%	-9.9%	5.7%	-17.1%	-13.4%	-5.1%	-19.4%	-18.8%	-18.1%	-15.6%	-9.5%	6.3%
Investment Performance																		
Compounded Annual Growth - From Start Date	7.48%	7.48%	7.48%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%	7.48%	7.48%	7.48%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%
Compounded Annual Growth - Segments	7.48%	7.48%	7.48%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%	7.48%	7.48%	7.48%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%

Note: Dollar Figures in Millions

Fiscal Metrics
Model Output

State

Ohio

Plans Included

Public Employees Retirement System

State Teachers Retirement System

Metrics	State Policy (Current Contribution Policy)									Sustainable Budget (Fixed % of OSR)								
	Stochastic Run - Baseline CMA									Stochastic Run - Baseline CMA								
	25th Percentile			50th Percentile			75th Percentile			25th Percentile			50th Percentile			75th Percentile		
	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures																		
Market Value of Assets (MVA)	144,324	142,051	123,633	173,464	187,509	220,371	205,523	247,259	350,283	144,149	143,017	132,111	173,251	188,623	229,557	205,290	248,206	360,261
Actuarial Accrued Liability (AAL)	217,589	235,781	269,017	217,549	235,504	268,012	217,605	235,956	269,371	217,589	235,741	269,136	217,549	235,578	268,183	217,605	235,928	269,125
Accrued Liability at 4% Discount Rate (DR)	327,536	354,921	404,951	327,476	354,503	403,438	327,560	355,185	405,484	327,536	354,861	405,130	327,476	354,615	403,696	327,560	355,143	405,114
Unfunded Actuarial Accrued Liability (UAAL)	73,265	93,730	145,384	44,085	47,994	47,640	12,082	(11,303)	(80,912)	73,440	92,724	137,025	44,297	46,955	38,626	12,314	(12,278)	(91,136)
Unfunded Liability at 4% DR	183,212	212,870	281,318	154,012	166,994	183,067	122,037	107,926	55,201	183,387	211,844	273,019	154,225	165,992	174,138	122,270	106,937	44,853
Funded Ratio	66.3%	60.2%	46.0%	79.7%	79.6%	82.2%	94.4%	104.8%	130.0%	66.2%	60.7%	49.1%	79.6%	80.1%	85.6%	94.3%	105.2%	133.9%
Funded Ratio at 4% Discount Rate	44.1%	40.0%	30.5%	53.0%	52.9%	54.6%	62.7%	69.6%	86.4%	44.0%	40.3%	32.6%	52.9%	53.2%	56.9%	62.7%	69.9%	88.9%
AAL Compound Annual Growth Rate	1.9%	1.8%	1.5%	1.9%	1.7%	1.5%	1.9%	1.8%	1.5%	1.9%	1.8%	1.5%	1.9%	1.7%	1.5%	1.9%	1.8%	1.5%
Change in AAL from Prior Year (%)	1.8%	1.5%	1.1%	1.7%	1.5%	1.1%	1.7%	1.6%	1.2%	1.8%	1.5%	1.1%	1.7%	1.5%	1.1%	1.7%	1.6%	1.1%
Unfunded Liability / Own Source Revenue at 4% DR	322%	317%	306%	270%	249%	200%	214%	160%	60%	322%	315%	297%	271%	247%	190%	215%	158%	49%
Cash Flow Measures																		
Benefit Payments	14,946	16,822	20,711	14,943	16,799	20,698	14,947	16,829	20,733	14,946	16,821	20,711	14,943	16,801	20,700	14,947	16,828	20,728
Total Contributions	7,444	8,415	10,982	7,441	8,398	10,914	7,447	8,455	11,086	7,529	8,715	11,693	7,525	8,711	11,639	7,532	8,764	11,773
Negative Operating Cash Flow	7,502	8,407	9,729	7,501	8,401	9,784	7,499	8,373	9,647	7,417	8,106	9,018	7,418	8,090	9,061	7,415	8,063	8,955
Benefit Payments / Beginning of Period MVA	10.1%	11.5%	16.0%	8.7%	9.1%	9.5%	7.8%	7.2%	6.2%	10.2%	11.4%	15.2%	8.7%	9.0%	9.2%	7.8%	7.2%	6.1%
Operating Cash Flow to Assets Ratio	-5.1%	-5.7%	-7.5%	-4.4%	-4.5%	-4.5%	-3.9%	-3.6%	-2.9%	-5.0%	-5.5%	-6.6%	-4.3%	-4.4%	-4.0%	-3.9%	-3.4%	-2.6%
Change in MVA from Prior Year (%)	-2.1%	-2.9%	-4.4%	0.7%	1.3%	1.6%	6.6%	5.7%	5.1%	-2.0%	-2.8%	-3.4%	0.8%	1.5%	2.0%	6.7%	6.0%	5.3%
Own Source Revenue (OSR)	56,974	67,247	91,965	56,939	67,100	91,353	56,998	67,520	92,417	56,974	67,211	92,006	56,939	67,161	91,485	56,998	67,495	92,211
OSR Compound Annual Growth Rate	4.7%	4.0%	3.6%	4.7%	4.0%	3.6%	4.7%	4.1%	3.6%	4.7%	4.0%	3.6%	4.7%	4.0%	3.6%	4.7%	4.1%	3.6%
Change in OSR from Prior Year (%)	4.3%	3.1%	3.1%	4.3%	3.1%	3.0%	4.2%	3.2%	3.0%	4.3%	3.1%	3.1%	4.3%	3.1%	3.0%	4.2%	3.2%	2.9%
Employer Contributions / OSR	7.2%	6.9%	6.6%	7.2%	6.9%	6.6%	7.2%	6.9%	6.6%	7.3%	7.3%	7.3%	7.3%	7.3%	7.4%	7.3%	7.4%	7.4%
Total Contributions / OSR	13.1%	12.5%	11.9%	13.1%	12.5%	11.9%	13.1%	12.5%	12.0%	13.2%	13.0%	12.7%	13.2%	13.0%	12.7%	13.2%	13.0%	12.8%
Payment and Contribution Measures																		
Employer Contributions (ERC)	4,097	4,633	6,052	4,095	4,625	6,020	4,099	4,663	6,132	4,182	4,936	6,760	4,179	4,934	6,739	4,183	4,973	6,829
Change in ERC from Prior Year (%)	2.4%	2.6%	2.6%	2.4%	2.6%	2.7%	2.4%	2.7%	2.8%	4.3%	3.1%	3.1%	4.3%	3.1%	3.1%	4.3%	3.3%	3.0%
Employee Contributions (EEC)	3,348	3,782	4,930	3,346	3,773	4,894	3,349	3,792	4,954	3,348	3,780	4,933	3,346	3,777	4,900	3,349	3,791	4,944
Payroll	29,389	33,232	43,400	29,377	33,154	43,078	29,401	33,325	43,612	29,389	33,212	43,426	29,377	33,188	43,138	29,401	33,312	43,521
Employer Contribution / Payroll	13.9%	13.9%	13.9%	13.9%	13.9%	14.0%	13.9%	14.0%	14.1%	14.2%	14.9%	15.6%	14.2%	14.9%	15.6%	14.2%	14.9%	15.7%
Employee Contribution / Payroll	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%
Total Contributions / Payroll	25.3%	25.3%	25.3%	25.3%	25.3%	25.3%	25.3%	25.4%	25.4%	25.6%	26.2%	26.9%	25.6%	26.2%	27.0%	25.6%	26.3%	27.1%
Normal Cost	3,446	3,761	4,698	3,446	3,753	4,658	3,447	3,770	4,714	3,446	3,759	4,702	3,446	3,757	4,665	3,446	3,768	4,704
Normal Cost (4% DR)	6,877	7,506	9,375	6,875	7,488	9,295	6,878	7,522	9,406	6,877	7,501	9,382	6,875	7,496	9,308	6,878	7,519	9,387
Net amortization $	(824)	(1,601)	(3,705)	1,029	1,306	2,890	2,570	4,981	11,621	(755)	(1,227)	(2,428)	1,095	1,678	4,230	2,636	5,317	13,007
Net amortization $ (4% DR)	(6,401)	(7,204)	(9,205)	(5,410)	(5,638)	(5,630)	(4,586)	(3,678)	(986)	(6,325)	(6,860)	(8,197)	(5,336)	(5,301)	(4,588)	(4,511)	(3,352)	93
Net amortization $ / Payroll	-2.8%	-4.8%	-8.5%	3.5%	3.9%	6.7%	8.7%	14.9%	26.6%	-2.6%	-3.7%	-5.6%	3.7%	5.1%	9.8%	9.0%	16.0%	29.9%
Net amortization $ / Payroll (4% DR)	-21.8%	-21.7%	-21.2%	-18.4%	-17.0%	-13.1%	-15.6%	-11.0%	-2.3%	-21.5%	-20.7%	-18.9%	-18.2%	-16.0%	-10.6%	-15.3%	-10.1%	0.2%
Investment Performance																		
Compounded Annual Growth - From Start Date	3.1%	4.1%	4.8%	6.4%	6.5%	6.5%	9.8%	8.8%	8.1%	3.1%	4.1%	4.8%	6.4%	6.5%	6.5%	9.8%	8.8%	8.1%
Compounded Annual Growth - Segments	3.1%	5.1%	5.6%	6.4%	6.5%	6.5%	9.8%	7.9%	7.4%	3.1%	5.1%	5.6%	6.4%	6.5%	6.5%	9.8%	7.9%	7.4%

Note: Dollar Figures in Millions

Fiscal Metrics
Model Output

State

Ohio

Plans Included

Public Employees Retirement System

State Teachers Retirement System

Metrics	State Policy (Current Contribution Policy)						Sustainable Budget (Fixed % of OSR)					
	Deterministic			Deterministic			Deterministic			Deterministic		
	"Low-for-long" Economic Scenario			"Asset Shock" Economic Scenario			"Low-for-long" Economic Scenario			"Asset Shock" Economic Scenario		
	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures												
Market Value of Assets (MVA)	156,311	153,954	133,352	132,723	123,811	83,881	156,201	155,143	141,967	130,972	121,197	81,456
Actuarial Accrued Liability (AAL)	217,641	236,033	269,034	217,388	235,645	268,250	217,641	236,033	269,034	217,388	235,645	268,250
Accrued Liability at 4% Discount Rate (DR)	327,614	355,300	404,976	327,234	354,717	403,797	327,614	355,300	404,976	327,234	354,717	403,797
Unfunded Actuarial Accrued Liability (UAAL)	61,330	82,078	135,682	84,665	111,835	184,369	61,440	80,890	127,066	86,416	114,448	186,795
Unfunded Liability at 4% DR	171,303	201,346	271,625	194,512	230,906	319,916	171,414	200,157	263,009	196,262	233,520	322,341
Funded Ratio	71.8%	65.2%	49.6%	61.1%	52.5%	31.3%	71.8%	65.7%	52.8%	60.2%	51.4%	30.4%
Funded Ratio at 4% Discount Rate	47.7%	43.3%	32.9%	40.6%	34.9%	20.8%	47.7%	43.7%	35.1%	40.0%	34.2%	20.2%
AAL Compound Annual Growth Rate	1.9%	1.8%	1.5%	1.9%	1.8%	1.5%	1.9%	1.8%	1.5%	1.9%	1.8%	1.5%
Change in AAL from Prior Year (%)	1.8%	1.5%	1.1%	1.7%	1.5%	1.1%	1.8%	1.5%	1.1%	1.7%	1.5%	1.1%
Unfunded Liability / Own Source Revenue at 4% DR	298%	296%	295%	363%	364%	372%	299%	294%	285%	366%	368%	375%
Cash Flow Measures												
Benefit Payments	14,931	16,757	20,527	14,905	16,734	20,515	14,931	16,757	20,527	14,905	16,734	20,515
Total Contributions	7,480	8,509	11,013	7,469	8,473	10,965	7,578	8,821	11,713	7,287	8,466	11,233
Negative Operating Cash Flow	7,450	8,248	9,514	7,436	8,261	9,550	7,353	7,936	8,814	7,618	8,267	9,282
Benefit Payments / Beginning of Period MVA	9.5%	10.8%	15.0%	11.1%	13.3%	22.9%	9.5%	10.8%	14.3%	11.2%	13.5%	23.6%
Operating Cash Flow to Assets Ratio	-4.8%	-5.3%	-7.0%	-5.5%	-6.6%	-10.7%	-4.7%	-5.1%	-6.1%	-5.7%	-6.7%	-10.7%
Change in MVA from Prior Year (%)	-0.3%	-0.5%	-2.3%	-1.1%	-1.8%	-6.2%	-0.3%	-0.3%	-1.4%	-1.3%	-2.0%	-6.2%
Own Source Revenue (OSR)	57,415	68,050	92,130	53,560	63,480	85,943	57,415	68,050	92,130	53,560	63,480	85,943
OSR Compound Annual Growth Rate	4.8%	4.1%	3.6%	3.4%	3.4%	3.3%	4.8%	4.1%	3.6%	3.4%	3.4%	3.3%
Change in OSR from Prior Year (%)	4.3%	3.1%	3.0%	3.8%	3.1%	3.0%	4.3%	3.1%	3.0%	3.8%	3.1%	3.0%
Employer Contributions / OSR	7.2%	6.9%	6.6%	7.7%	7.3%	7.0%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%
Total Contributions / OSR	13.0%	12.5%	12.0%	13.9%	13.3%	12.8%	13.2%	13.0%	12.7%	13.6%	13.3%	13.1%
Payment and Contribution Measures												
Employer Contributions (ERC)	4,117	4,685	6,069	4,110	4,665	6,043	4,214	4,997	6,769	3,928	4,659	6,311
Change in ERC from Prior Year (%)	2.6%	2.6%	2.6%	2.5%	2.6%	2.6%	4.4%	3.1%	3.0%	3.8%	3.1%	3.0%
Employee Contributions (EEC)	3,364	3,824	4,944	3,358	3,808	4,923	3,364	3,824	4,944	3,358	3,808	4,923
Payroll	29,531	33,605	43,522	29,485	33,460	43,335	29,531	33,605	43,522	29,485	33,460	43,335
Employer Contribution / Payroll	13.9%	13.9%	13.9%	13.9%	13.9%	13.9%	14.3%	14.9%	15.6%	13.3%	13.9%	14.6%
Employee Contribution / Payroll	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%
Total Contributions / Payroll	25.3%	25.3%	25.3%	25.3%	25.3%	25.3%	25.7%	26.3%	26.9%	24.7%	25.3%	25.9%
Normal Cost	3,455	3,802	4,711	3,452	3,785	4,690	3,455	3,802	4,711	3,452	3,785	4,690
Normal Cost (4% DR)	6,893	7,586	9,400	6,888	7,554	9,359	6,893	7,586	9,400	6,888	7,554	9,359
Net amortization $	(91)	(924)	(3,151)	(1,778)	(3,063)	(6,645)	(5)	(539)	(1,863)	(2,078)	(3,255)	(6,559)
Net amortization $ (4% DR)	(6,006)	(6,862)	(8,912)	(6,907)	(7,991)	(10,758)	(5,914)	(6,511)	(7,897)	(7,152)	(8,097)	(10,588)
Net amortization $ / Payroll	-0.3%	-2.8%	-7.2%	-6.0%	-9.2%	-15.3%	0.0%	-1.6%	-4.3%	-7.0%	-9.7%	-15.1%
Net amortization $ / Payroll (4% DR)	-20.3%	-20.4%	-20.5%	-23.4%	-23.9%	-24.8%	-20.0%	-19.4%	-18.1%	-24.3%	-24.2%	-24.4%
Investment Performance												
Compounded Annual Growth - From Start Date	4.5%	4.7%	4.9%	2.2%	3.6%	4.3%	4.5%	4.7%	4.9%	2.2%	3.6%	4.3%
Compounded Annual Growth - Segments	4.5%	5.0%	5.0%	2.2%	5.0%	5.0%	4.5%	5.0%	5.0%	2.2%	5.0%	5.0%

Note: Dollar Figures in Millions

Ohio
Fixed 5% Economic Scenario
Public Employees Retirement System and State Teachers Retirement System

Assets vs. Cash Flow
Assuming 5% returns and contributions fixed as % of OSR

Market Value of Assets — Operating Cash Flow, Percent of Assets

Total Contributions vs. Benefit Payments
Assuming 5% returns and contributions fixed as % of OSR

Total contributions — Benefit payments

Unfunded Liability vs. Funding Levels
Assuming 5% returns and contributions fixed as % of OSR

Unfunded Liability (Market Value) — Funded Ratio

Employer Contributions vs. Pension Debt
Assuming 5% returns and plans' statutory contribution policy

Pension Debt as Share of OSR — Employer Contribution Rate

Pennsylvania Retirement System 30 Year Projections

Plans included: State Employees' Retirement System, Public School Employees' Retirement System
State contribution policy at assumed rate of return (7.25%)

$MMs

Fiscal Year	Pension Liability (Actuarial Accrued Liability)						Pension Assets (Market Value)					Debt	Change in Pension Debt		% Funded	Cash Flow	Employer Contribution		
	Payroll	Beginning of Period	Service Cost	Interest	Benefit Payments	End of Period	Beginning of Period	Total Contribution	Interest	Benefit Payments	End of Period		$	% of Payroll		% of Assets	$	% Change	% Payroll
2018	19,545	150,187	2,745	10,725	(10,195)	153,463	82,514	7,633	5,891	(10,195)	85,843	67,619	(54)	0%	56%	-3%	6,260	N/A	32%
2019	19,983	153,463	2,788	10,957	(10,476)	156,732	85,843	7,843	6,130	(10,476)	89,340	67,392	(228)	-1%	57%	-3%	6,450	3%	32%
2020	20,431	156,732	2,808	11,187	(10,764)	159,964	89,340	8,359	6,392	(10,764)	93,327	66,636	(755)	-4%	58%	-3%	6,954	8%	34%
2021	20,890	159,964	2,796	11,413	(11,060)	163,113	93,327	8,500	6,675	(11,060)	97,443	65,671	(966)	-5%	60%	-3%	7,077	2%	34%
2022	21,359	163,113	2,971	11,639	(11,364)	166,360	97,443	8,668	6,969	(11,364)	101,716	64,644	(1,026)	-5%	61%	-3%	7,226	2%	34%
2023	21,839	166,360	2,976	11,866	(11,676)	169,526	101,716	8,855	7,274	(11,676)	106,169	63,357	(1,287)	-6%	63%	-3%	7,408	3%	34%
2024	22,331	169,526	2,979	12,087	(11,997)	172,595	106,169	9,016	7,591	(11,997)	110,779	61,816	(1,541)	-7%	64%	-3%	7,554	2%	34%
2025	22,834	172,595	2,981	12,301	(12,327)	175,549	110,779	9,180	7,919	(12,327)	115,551	59,998	(1,818)	-8%	66%	-3%	7,702	2%	34%
2026	23,349	175,549	2,981	12,505	(12,666)	178,369	115,551	9,351	8,259	(12,666)	120,495	57,874	(2,124)	-9%	68%	-3%	7,877	2%	34%
2027	23,876	178,369	2,978	12,700	(13,015)	181,032	120,495	9,503	8,611	(13,015)	125,594	55,438	(2,436)	-10%	69%	-3%	8,039	2%	34%
2028	24,415	181,032	2,974	12,882	(13,373)	183,515	125,594	9,655	8,973	(13,373)	130,850	52,666	(2,772)	-11%	71%	-3%	8,183	2%	34%
2029	24,967	183,515	2,966	13,051	(13,740)	185,793	130,850	9,815	9,347	(13,740)	136,271	49,522	(3,144)	-13%	73%	-3%	8,338	2%	33%
2030	25,532	185,793	2,957	13,205	(14,118)	187,837	136,271	9,977	9,732	(14,118)	141,862	45,975	(3,547)	-14%	76%	-3%	8,495	2%	33%
2031	26,111	187,837	2,945	13,342	(14,487)	189,636	141,862	10,142	10,130	(14,487)	147,647	41,989	(3,986)	-15%	78%	-3%	8,658	2%	33%
2032	26,703	189,636	2,931	13,461	(14,847)	191,181	147,647	10,312	10,543	(14,847)	153,655	37,526	(4,463)	-17%	80%	-3%	8,826	2%	33%
2033	27,308	191,181	2,914	13,562	(15,176)	192,482	153,655	10,494	10,973	(15,176)	159,947	32,535	(4,991)	-18%	83%	-3%	9,009	2%	33%
2034	27,929	192,482	2,896	13,647	(15,472)	193,553	159,947	10,684	11,426	(15,472)	166,584	26,969	(5,566)	-20%	86%	-3%	9,200	2%	33%
2035	28,564	193,553	2,876	13,716	(15,734)	194,412	166,584	10,878	11,904	(15,734)	173,633	20,778	(6,191)	-22%	89%	-3%	9,396	2%	33%
2036	29,214	194,412	2,854	13,771	(15,958)	195,079	173,633	7,770	12,297	(15,958)	177,742	17,337	(3,441)	-12%	91%	-5%	6,291	-33%	22%
2037	29,879	195,079	2,832	13,814	(16,145)	195,580	177,742	7,003	12,561	(16,145)	181,161	14,419	(2,918)	-10%	93%	-5%	5,528	-12%	19%
2038	30,560	195,580	2,809	13,845	(16,292)	195,941	181,161	6,684	12,792	(16,292)	184,344	11,597	(2,821)	-9%	94%	-5%	5,213	-6%	17%
2039	31,258	195,941	2,786	13,868	(16,399)	196,196	184,344	6,301	13,005	(16,399)	187,251	8,944	(2,653)	-8%	95%	-5%	4,836	-7%	15%
2040	31,972	196,196	2,764	13,884	(16,466)	196,377	187,251	5,995	13,203	(16,466)	189,983	6,394	(2,551)	-8%	97%	-6%	4,534	-6%	14%
2041	32,703	196,377	2,742	13,896	(16,492)	196,523	189,983	5,565	13,385	(16,492)	192,440	4,082	(2,312)	-7%	98%	-6%	4,108	-9%	13%
2042	33,451	196,523	2,722	13,907	(16,478)	196,673	192,440	4,440	13,523	(16,478)	193,925	2,748	(1,334)	-4%	99%	-6%	2,987	-27%	9%
2043	34,217	196,673	2,703	13,920	(16,424)	196,873	193,925	3,772	13,609	(16,424)	194,883	1,990	(758)	-2%	99%	-7%	2,322	-22%	7%
2044	35,002	196,873	2,687	13,938	(16,330)	197,168	194,883	3,141	13,659	(16,330)	195,353	1,815	(175)	-1%	99%	-7%	1,693	-27%	5%
2045	35,805	197,168	2,673	13,964	(16,199)	197,606	195,353	2,863	13,688	(16,199)	195,704	1,901	87	0%	99%	-7%	1,416	-16%	4%
2046	36,627	197,606	2,662	14,002	(16,032)	198,238	195,704	2,783	13,717	(16,032)	196,172	2,066	165	0%	99%	-7%	1,336	-6%	4%
2047	37,469	198,238	2,654	14,056	(15,829)	199,119	196,172	2,792	13,758	(15,829)	196,893	2,225	159	0%	99%	-7%	1,343	1%	4%

Source: Analysis by The Pew Charitable Trusts and The Terry Group based on data from Retirement System actuarial valuations and annual reports

Model Assumptions			
State	Pennsylvania		
Plan	State Employees' Retirement System		
Actuarial Valuation Used	12/31/2016		
Employer Contribution Policy			
Description	Actuarial		
Applies to	All		
Amortization Period	30		
Amortization Method Type	Level Dollar		
Open or closed	Closed		
Layered or Single Amortization	Layered		
Amortization Payment Growth Rate	0.0%		
Additional Contribution Rules	Maximum contribution rate equal to prior year rate plus 4.5% until full actuarial contribution is made.		
Employee Contribution Rate			
Applies to	Old Tier	New Tier	
Rate	6.25%	3.50%	
Employee Contribution Cost-Sharing	Yes	Yes	
Model Assumptions			
Actuarial Assumptions	7.25%		
Inflation Assumption	2.60%		
Payroll Growth Assumption	2.90%		
COLA			
Applies to	All		
Description	No COLA		
Assumed effective COLA	N/A		
COLA Adjustment for Plan Funding and Investment Experience	N/A		

Model Assumptions		
State	Pennsylvania	
Plan	Public School Employees' Retirement System	
Actuarial Valuation Used	6/30/2017	
Employer Contribution Policy		
Description		
Applies to	All	
Amortization Period	24	
Amortization Method Type	Level Percent of Pay	
Open or closed	Closed	
Layered or Single Amortization	Layered	
Amortization Payment Growth Rate	3.5%	
Additional Contribution Rules	Maximum contribution rate equal to prior year rate plus 4.5% until full actuarial contribution is made.	
Employee Contribution Rate		
Applies to	Old Tier	New Tier
Rate	7.50%	5.00%
Employee Contribution Cost-Sharing	Yes	Yes
Model Assumptions		
Actuarial Assumptions	7.25%	
Inflation Assumption	2.75%	
Payroll Growth Assumption	1.93%, to align with aggregate payroll projections from IFO reports	
COLA		
Applies to	All	
Description	No COLA	
Assumed effective COLA	N/A	
COLA Adjustment for Plan Funding and Investment Experience	N/A	

Fiscal Metrics
Model Output

State

Pennsylvania

Plans Included

State Employees' Retirement System

Public School Employees' Retirement System

Metrics	State Policy (Current Contribution Policy) Deterministic 7.25% Current Plan Assumptions 2022	2027	2037	Deterministic 5% Low Return 2022	2027	2037	Deterministic 9% High Return 2022	2027	2037	Sustainable Budget (Fixed % of OSR) Deterministic 7.25% Current Plan Assumptions 2022	2027	2037	Deterministic 5% Low Return 2022	2027	2037	Deterministic 9% High Return 2022	2027	2037
Balance Sheet Measures																		
Market Value of Assets (MVA)	101,716	125,594	181,161	91,115	101,878	129,156	110,670	148,076	239,088	100,332	124,404	199,212	89,535	97,987	119,697	109,455	149,495	295,327
Actuarial Accrued Liability (AAL)	166,360	181,032	195,580	166,360	181,032	195,580	166,360	181,032	195,580	166,360	181,032	195,580	166,360	181,032	195,580	166,360	181,032	195,580
Accrued Liability at 4% Discount Rate (DR)	237,941	258,927	279,734	237,941	258,927	279,734	237,941	258,927	279,734	237,941	258,927	279,734	237,941	258,927	279,734	237,941	258,927	279,734
Unfunded Actuarial Accrued Liability (UAAL)	64,644	55,438	14,419	75,244	79,154	66,423	55,690	32,956	(43,509)	66,027	56,628	(3,633)	76,825	83,045	75,883	56,905	31,537	(99,747)
Unfunded Liability at 4% DR	136,226	133,333	98,573	146,826	157,049	150,577	127,271	110,850	40,645	137,609	134,522	80,521	148,406	160,939	160,037	128,487	109,432	(15,593)
Funded Ratio	61.1%	69.4%	92.6%	54.8%	56.3%	66.0%	66.5%	81.8%	122.2%	60.3%	68.7%	101.9%	53.8%	54.1%	61.2%	65.8%	82.6%	151.0%
Funded Ratio at 4% Discount Rate	42.7%	48.5%	64.8%	38.3%	39.3%	46.2%	46.5%	57.2%	85.5%	42.2%	48.0%	71.2%	37.6%	37.8%	42.8%	46.0%	57.7%	105.6%
AAL Compound Annual Growth Rate	2.1%	1.9%	1.3%	2.1%	1.9%	1.3%	2.1%	1.9%	1.3%	2.1%	1.9%	1.3%	2.1%	1.9%	1.3%	2.1%	1.9%	1.3%
Change in AAL from Prior Year (%)	2.0%	1.5%	0.3%	2.0%	1.5%	0.3%	2.0%	1.5%	0.3%	2.0%	1.5%	0.3%	2.0%	1.5%	0.3%	2.0%	1.5%	0.3%
Unfunded Liability / Own Source Revenue at 4% DR	198%	165%	91%	213%	194%	139%	185%	137%	38%	200%	166%	75%	216%	199%	148%	187%	135%	-14%
Cash Flow Measures																		
Benefit Payments	11,364	13,015	16,145	11,364	13,015	16,145	11,364	13,015	16,145	11,364	13,015	16,145	11,364	13,015	16,145	11,364	13,015	16,145
Total Contributions	8,668	9,503	7,003	8,849	10,488	10,477	8,543	8,779	2,392	8,531	9,813	12,605	8,569	10,061	13,258	8,523	9,770	12,328
Negative Operating Cash Flow	2,696	3,511	9,142	2,514	2,527	5,668	2,821	4,235	13,753	2,832	3,202	3,540	2,795	2,954	2,887	2,840	3,245	3,817
Benefit Payments / Beginning of Period MVA	11.7%	10.8%	9.1%	12.7%	13.1%	12.6%	10.9%	9.3%	6.9%	11.8%	10.9%	8.5%	12.9%	13.5%	13.8%	11.0%	9.3%	5.9%
Operating Cash Flow to Assets Ratio	-2.8%	-2.9%	-5.1%	-2.8%	-2.5%	-4.4%	-2.7%	-3.0%	-5.9%	-2.9%	-2.7%	-1.9%	-3.2%	-3.1%	-2.5%	-2.8%	-2.3%	-1.4%
Change in MVA from Prior Year (%)	4.4%	4.2%	1.9%	2.1%	2.4%	0.5%	6.2%	5.8%	2.8%	4.2%	4.5%	5.3%	1.7%	1.9%	2.5%	6.1%	6.6%	7.5%
Own Source Revenue (OSR)	68,808	81,023	108,023	68,808	81,023	108,023	68,808	81,023	108,023	68,808	81,023	108,023	68,808	81,023	108,023	68,808	81,023	108,023
OSR Compound Annual Growth Rate	4.3%	3.8%	3.4%	4.3%	3.8%	3.4%	4.3%	3.8%	3.4%	4.3%	3.8%	3.4%	4.3%	3.8%	3.4%	4.3%	3.8%	3.4%
Change in OSR from Prior Year (%)	4.2%	3.0%	2.7%	4.2%	3.0%	2.7%	4.2%	3.0%	2.7%	4.2%	3.0%	2.7%	4.2%	3.0%	2.7%	4.2%	3.0%	2.7%
Employer Contributions / OSR	10.5%	9.9%	5.1%	10.7%	10.9%	7.8%	10.3%	9.1%	1.1%	10.3%	10.3%	10.3%	10.3%	10.3%	10.3%	10.3%	10.3%	10.3%
Total Contributions / OSR	12.6%	11.7%	6.5%	12.9%	12.9%	9.7%	12.4%	10.8%	2.2%	12.4%	12.1%	11.7%	12.5%	12.4%	12.3%	12.4%	12.1%	11.4%
Payment and Contribution Measures																		
Employer Contributions (ERC)	7,226	8,039	5,528	7,371	8,806	8,410	7,110	7,358	1,194	7,090	8,349	11,131	7,090	8,349	11,131	7,090	8,349	11,131
Change in ERC from Prior Year (%)	2.1%	2.1%	-12.1%	3.0%	3.7%	-5.7%	1.3%	0.2%	-1.9%	4.2%	3.0%	2.7%	4.2%	3.0%	2.7%	4.2%	3.0%	2.7%
Employee Contributions (EEC)	1,442	1,464	1,475	1,479	1,681	2,067	1,433	1,421	1,198	1,442	1,464	1,475	1,479	1,712	2,127	1,433	1,421	1,198
Payroll	21,359	23,876	29,879	21,359	23,876	29,879	21,359	23,876	29,879	21,359	23,876	29,879	21,359	23,876	29,879	21,359	23,876	29,879
Employer Contribution / Payroll	33.8%	33.7%	18.5%	34.5%	36.9%	28.1%	33.3%	30.8%	4.0%	33.2%	35.0%	37.3%	33.2%	35.0%	37.3%	33.2%	35.0%	37.3%
Employee Contribution / Payroll	6.7%	6.1%	4.9%	6.9%	7.0%	6.9%	6.7%	6.0%	4.0%	6.7%	6.1%	4.9%	6.9%	7.2%	7.1%	6.7%	6.0%	4.0%
Total Contributions / Payroll	40.6%	39.8%	23.4%	41.4%	43.9%	35.1%	40.0%	36.8%	8.0%	39.9%	41.1%	42.2%	40.1%	42.1%	44.4%	39.9%	40.9%	41.3%
Normal Cost	2,971	2,978	2,832	2,971	2,978	2,832	2,971	2,978	2,832	2,971	2,978	2,832	2,971	2,978	2,832	2,971	2,978	2,832
Normal Cost (4% DR)	5,490	5,504	5,234	5,490	5,504	5,234	5,490	5,504	5,234	5,490	5,504	5,234	5,490	5,504	5,234	5,490	5,504	5,234
Net amortization $	1,139	2,562	3,063	731	2,058	3,093	1,502	3,219	2,259	914	2,780	9,693	351	1,378	5,123	1,402	4,270	15,600
Net amortization $ (4% DR)	(2,194)	(1,306)	(2,246)	(2,337)	(1,143)	(672)	(2,049)	(1,268)	(4,758)	(2,379)	(1,047)	3,924	(2,673)	(1,709)	1,695	(2,113)	(244)	7,059
Net amortization $ / Payroll	5.3%	10.7%	10.3%	3.4%	8.6%	10.4%	7.0%	13.5%	7.6%	4.3%	11.6%	32.4%	1.6%	5.8%	17.1%	6.6%	17.9%	52.2%
Net amortization $ / Payroll (4% DR)	-10.3%	-5.5%	-7.5%	-10.9%	-4.8%	-2.2%	-9.6%	-5.3%	-15.9%	-11.1%	-4.4%	13.1%	-12.5%	-7.2%	5.7%	-9.9%	-1.0%	23.6%
Investment Performance																		
Compounded Annual Growth - From Start Date	7.25%	7.25%	7.25%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%	7.25%	7.25%	7.25%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%
Compounded Annual Growth - Segments	7.25%	7.25%	7.25%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%	7.25%	7.25%	7.25%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%

Note: Dollar Figures in Millions

Fiscal Metrics
Model Output

State

Pennsylvania

Plans Included

State Employees' Retirement System

Public School Employees' Retirement System

	State Policy (Current Contribution Policy)									Sustainable Budget (Fixed % of OSR)								
	Stochastic Run - Baseline CMA									Stochastic Run - Baseline CMA								
	25th Percentile			50th Percentile			75th Percentile			25th Percentile			50th Percentile			75th Percentile		
Metrics	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures																		
Market Value of Assets (MVA)	83,182	92,610	117,303	97,644	115,169	149,051	113,939	142,178	192,287	81,495	88,272	108,970	96,245	113,485	163,361	112,936	144,628	233,548
Actuarial Accrued Liability (AAL)	165,612	177,639	180,802	165,536	177,919	182,148	165,687	177,382	181,282	165,629	177,652	180,828	165,559	177,719	182,292	165,704	177,664	181,779
Accrued Liability at 4% Discount Rate (DR)	236,871	254,074	258,597	236,763	254,474	260,522	236,979	253,706	259,285	236,896	254,092	258,634	236,795	254,188	260,728	237,003	254,110	259,996
Unfunded Actuarial Accrued Liability (UAAL)	82,430	85,029	63,499	67,892	62,750	33,097	51,748	35,204	(11,005)	84,134	89,379	71,857	69,314	64,234	18,930	52,768	33,036	(51,768)
Unfunded Liability at 4% DR	153,689	161,464	141,295	139,119	139,305	111,471	123,040	111,528	66,997	155,401	165,819	149,664	140,551	140,703	97,367	124,067	109,482	26,448
Funded Ratio	50.2%	52.1%	64.9%	59.0%	64.7%	81.8%	68.8%	80.2%	106.1%	49.2%	49.7%	60.3%	58.1%	63.9%	89.6%	68.2%	81.4%	128.5%
Funded Ratio at 4% Discount Rate	35.1%	36.4%	45.4%	41.2%	45.3%	57.2%	48.1%	56.0%	74.2%	34.4%	34.7%	42.1%	40.6%	44.6%	62.7%	47.7%	56.9%	89.8%
AAL Compound Annual Growth Rate	2.0%	1.7%	0.9%	2.0%	1.7%	1.0%	2.0%	1.7%	0.9%	2.0%	1.7%	0.9%	2.0%	1.7%	1.0%	2.0%	1.7%	1.0%
Change in AAL from Prior Year (%)	1.7%	1.2%	-0.6%	1.7%	1.2%	-0.5%	1.8%	1.1%	-0.6%	1.8%	1.2%	-0.6%	1.7%	1.2%	-0.5%	1.8%	1.1%	-0.5%
Unfunded Liability / Own Source Revenue at 4% DR	226%	201%	133%	205%	172%	104%	180%	140%	63%	228%	207%	141%	207%	175%	90%	181%	137%	25%
Cash Flow Measures																		
Benefit Payments	11,364	13,015	16,145	11,364	13,015	16,145	11,364	13,015	16,145	11,364	13,015	16,145	11,364	13,015	16,145	11,364	13,015	16,145
Total Contributions	8,769	10,340	9,762	8,520	9,534	7,066	8,298	8,412	4,210	8,471	9,844	12,704	8,437	9,777	12,578	8,480	9,630	12,350
Negative Operating Cash Flow	2,595	2,674	6,383	2,843	3,481	9,079	3,066	4,603	11,935	2,893	3,170	3,441	2,926	3,237	3,566	2,883	3,385	3,795
Benefit Payments / Beginning of Period MVA	13.6%	14.2%	13.6%	12.0%	11.7%	10.6%	10.5%	9.6%	8.4%	13.9%	14.7%	14.9%	12.1%	11.8%	10.0%	10.6%	9.5%	7.2%
Operating Cash Flow to Assets Ratio	-3.1%	-2.9%	-5.4%	-3.0%	-3.1%	-6.0%	-2.8%	-3.4%	-6.2%	-3.5%	-3.6%	-3.2%	-3.1%	-2.9%	-2.2%	-2.7%	-2.5%	-1.7%
Change in MVA from Prior Year (%)	-0.4%	0.8%	-1.5%	2.8%	3.2%	-2.0%	4.8%	4.5%	0.3%	-0.6%	-0.1%	0.6%	2.7%	2.9%	1.3%	5.2%	5.6%	4.4%
Own Source Revenue (OSR)	68,101	80,203	106,432	67,974	80,841	107,289	68,493	79,681	106,785	68,166	80,261	106,465	68,057	80,555	107,588	68,541	80,040	107,560
OSR Compound Annual Growth Rate	4.1%	3.7%	3.3%	4.1%	3.8%	3.3%	4.2%	3.7%	3.3%	4.1%	3.7%	3.3%	4.1%	3.8%	3.4%	4.3%	3.7%	3.4%
Change in OSR from Prior Year (%)	4.0%	3.0%	2.8%	4.1%	3.1%	2.6%	4.3%	2.9%	2.7%	4.0%	3.1%	2.7%	4.1%	3.1%	2.6%	4.3%	2.9%	2.8%
Employer Contributions / OSR	10.8%	10.9%	7.5%	10.4%	10.0%	5.2%	10.0%	8.8%	2.8%	10.3%	10.3%	10.3%	10.3%	10.3%	10.3%	10.3%	10.3%	10.3%
Total Contributions / OSR	12.9%	12.9%	9.2%	12.5%	11.8%	6.6%	12.1%	10.6%	3.9%	12.4%	12.3%	11.9%	12.4%	12.1%	11.7%	12.4%	12.0%	11.5%
Payment and Contribution Measures																		
Employer Contributions (ERC)	7,323	8,776	8,034	7,096	8,049	5,604	6,881	7,036	2,980	7,024	8,270	10,970	7,013	8,300	11,086	7,062	8,247	11,083
Change in ERC from Prior Year (%)	2.7%	4.2%	-5.9%	1.3%	2.3%	-11.9%	-0.3%	-0.1%	-24.3%	4.0%	3.1%	2.7%	4.1%	3.1%	2.6%	4.3%	2.9%	2.8%
Employee Contributions (EEC)	1,446	1,564	1,728	1,425	1,484	1,462	1,417	1,376	1,230	1,447	1,574	1,734	1,425	1,477	1,493	1,418	1,382	1,267
Payroll	20,945	22,510	26,133	20,903	22,633	26,398	20,987	22,399	26,255	20,954	22,516	26,180	20,916	22,554	26,467	20,996	22,506	26,397
Employer Contribution / Payroll	35.0%	39.0%	30.7%	33.9%	35.6%	21.2%	32.8%	31.4%	11.4%	33.5%	36.7%	41.9%	33.5%	36.8%	41.9%	33.6%	36.6%	42.0%
Employee Contribution / Payroll	6.9%	6.9%	6.6%	6.8%	6.6%	5.5%	6.8%	6.1%	4.7%	6.9%	7.0%	6.6%	6.8%	6.5%	5.6%	6.8%	6.1%	4.8%
Total Contributions / Payroll	41.9%	45.9%	37.4%	40.8%	42.1%	26.8%	39.5%	37.6%	16.0%	40.4%	43.7%	48.5%	40.3%	43.4%	47.5%	40.4%	42.8%	46.8%
Normal Cost	2,942	2,828	2,493	2,939	2,839	2,519	2,945	2,816	2,505	2,942	2,828	2,498	2,940	2,830	2,525	2,945	2,830	2,516
Normal Cost (4% DR)	5,436	5,226	4,608	5,431	5,247	4,655	5,442	5,204	4,630	5,438	5,226	4,617	5,433	5,229	4,666	5,443	5,230	4,650
Net amortization $	287	1,706	2,976	872	2,277	2,461	1,620	2,937	2,451	(131)	943	5,229	691	2,454	8,815	1,713	4,237	13,160
Net amortization $ (4% DR)	(2,574)	(1,158)	(386)	(2,358)	(1,224)	(1,934)	(2,054)	(1,325)	(3,189)	(2,940)	(1,802)	2,169	(2,497)	(1,000)	4,034	(1,922)	(84)	6,349
Net amortization $ / Payroll	1.4%	7.6%	11.4%	4.2%	10.1%	9.3%	7.7%	13.1%	9.3%	-0.6%	4.2%	20.0%	3.3%	10.9%	33.3%	8.2%	18.8%	49.9%
Net amortization $ / Payroll (4% DR)	-12.3%	-5.1%	-1.5%	-11.3%	-5.4%	-7.3%	-9.8%	-5.9%	-12.1%	-14.0%	-8.0%	8.3%	-11.9%	-4.4%	15.2%	-9.2%	-0.4%	24.1%
Investment Performance																		
Compounded Annual Growth - From Start Date	3.3%	4.2%	4.9%	6.5%	6.5%	6.5%	9.7%	8.8%	8.0%	3.3%	4.2%	4.9%	6.5%	6.5%	6.5%	9.7%	8.8%	8.1%
Compounded Annual Growth - Segments	3.3%	5.2%	5.6%	6.5%	6.5%	6.5%	9.7%	7.9%	7.3%	3.3%	5.2%	5.6%	6.5%	6.5%	6.5%	9.7%	7.9%	7.4%

Note: Dollar Figures in Millions

Fiscal Metrics
Model Output

State

Pennsylvania

Plans Included

State Employees' Retirement System

Public School Employees' Retirement System

Metrics	State Policy (Current Contribution Policy)						Sustainable Budget (Fixed % of OSR)					
	Deterministic			Deterministic			Deterministic			Deterministic		
	"Low-for-long" Economic Scenario			"Asset Shock" Economic Scenario			"Low-for-long" Economic Scenario			"Asset Shock" Economic Scenario		
	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures												
Market Value of Assets (MVA)	89,106	98,931	120,565	78,358	89,778	117,146	87,647	95,772	116,313	72,809	74,904	76,376
Actuarial Accrued Liability (AAL)	165,822	178,265	182,926	165,764	178,010	182,249	165,822	178,265	182,926	165,764	178,010	182,249
Accrued Liability at 4% Discount Rate (DR)	237,172	254,969	261,636	237,089	254,604	260,667	237,172	254,969	261,636	237,089	254,604	260,667
Unfunded Actuarial Accrued Liability (UAAL)	76,716	79,334	62,362	87,406	88,232	65,103	78,175	82,493	66,613	92,955	103,106	105,873
Unfunded Liability at 4% DR	148,066	156,038	141,071	158,731	164,826	143,521	149,525	159,196	145,323	164,280	179,700	184,292
Funded Ratio	53.7%	55.5%	65.9%	47.3%	50.4%	64.3%	52.9%	53.7%	63.6%	43.9%	42.1%	41.9%
Funded Ratio at 4% Discount Rate	37.6%	38.8%	46.1%	33.1%	35.3%	44.9%	37.0%	37.6%	44.5%	30.7%	29.4%	29.3%
AAL Compound Annual Growth Rate	2.0%	1.7%	1.0%	2.0%	1.7%	1.0%	2.0%	1.7%	1.0%	2.0%	1.7%	1.0%
Change in AAL from Prior Year (%)	1.8%	1.2%	-0.5%	1.8%	1.2%	-0.5%	1.8%	1.2%	-0.5%	1.8%	1.2%	-0.5%
Unfunded Liability / Own Source Revenue at 4% DR	215%	193%	131%	242%	213%	139%	217%	196%	135%	251%	233%	179%
Cash Flow Measures												
Benefit Payments	11,364	13,015	16,145	11,364	13,015	16,145	11,364	13,015	16,145	11,364	13,015	16,145
Total Contributions	8,756	10,272	9,887	9,404	11,121	10,779	8,548	9,978	13,176	8,230	9,637	12,645
Negative Operating Cash Flow	2,608	2,743	6,258	1,959	1,894	5,365	2,816	3,037	2,968	3,133	3,377	3,500
Benefit Payments / Beginning of Period MVA	13.0%	13.4%	13.4%	14.8%	14.9%	13.8%	13.1%	13.8%	14.2%	15.7%	17.5%	21.2%
Operating Cash Flow to Assets Ratio	-3.0%	-2.8%	-5.2%	-2.6%	-2.2%	-4.6%	-3.3%	-3.2%	-2.6%	-4.3%	-4.5%	-4.6%
Change in MVA from Prior Year (%)	1.7%	2.2%	-0.2%	2.1%	2.9%	0.4%	1.4%	1.8%	2.4%	0.3%	0.5%	0.4%
Own Source Revenue (OSR)	68,808	81,023	108,023	65,575	77,215	102,947	68,808	81,023	108,023	65,575	77,215	102,947
OSR Compound Annual Growth Rate	4.3%	3.8%	3.4%	3.3%	3.3%	3.1%	4.3%	3.8%	3.4%	3.3%	3.3%	3.1%
Change in OSR from Prior Year (%)	4.2%	3.0%	2.7%	3.8%	3.0%	2.7%	4.2%	3.0%	2.7%	3.8%	3.0%	2.7%
Employer Contributions / OSR	10.6%	10.7%	7.5%	12.1%	12.3%	8.6%	10.3%	10.3%	10.3%	10.3%	10.3%	10.3%
Total Contributions / OSR	12.7%	12.7%	9.2%	14.3%	14.4%	10.5%	12.4%	12.3%	12.2%	12.6%	12.5%	12.3%
Payment and Contribution Measures												
Employer Contributions (ERC)	7,298	8,673	8,056	7,931	9,469	8,849	7,090	8,349	11,131	6,757	7,956	10,608
Change in ERC from Prior Year (%)	2.6%	3.6%	-6.2%	3.5%	3.7%	-5.7%	4.2%	3.0%	2.7%	3.8%	3.0%	2.7%
Employee Contributions (EEC)	1,458	1,599	1,831	1,474	1,652	1,930	1,458	1,629	2,046	1,474	1,681	2,037
Payroll	21,061	22,732	26,536	21,028	22,634	26,422	21,061	22,732	26,536	21,028	22,634	26,422
Employer Contribution / Payroll	34.7%	38.2%	30.4%	37.7%	41.8%	33.5%	33.7%	36.7%	41.9%	32.1%	35.2%	40.1%
Employee Contribution / Payroll	6.9%	7.0%	6.9%	7.0%	7.3%	7.3%	6.9%	7.2%	7.7%	7.0%	7.4%	7.7%
Total Contributions / Payroll	41.6%	45.2%	37.3%	44.7%	49.1%	40.8%	40.6%	43.9%	49.7%	39.1%	42.6%	47.9%
Normal Cost	2,950	2,854	2,531	2,948	2,842	2,521	2,950	2,854	2,531	2,948	2,842	2,521
Normal Cost (4% DR)	5,452	5,275	4,678	5,447	5,252	4,658	5,452	5,275	4,678	5,447	5,252	4,658
Net amortization $	557	1,928	3,048	443	2,145	3,729	255	1,426	5,929	(1,074)	(312)	2,717
Net amortization $ (4% DR)	(2,444)	(1,111)	(374)	(2,212)	(590)	428	(2,703)	(1,520)	2,691	(3,575)	(2,611)	706
Net amortization $ / Payroll	2.6%	8.5%	11.5%	2.1%	9.5%	14.1%	1.2%	6.3%	22.3%	-5.1%	-1.4%	10.3%
Net amortization $ / Payroll (4% DR)	-11.6%	-4.9%	-1.4%	-10.5%	-2.6%	1.6%	-12.8%	-6.7%	10.1%	-17.0%	-11.5%	2.7%
Investment Performance												
Compounded Annual Growth - From Start Date	4.6%	4.9%	5.0%	2.1%	3.6%	4.3%	4.6%	4.9%	5.0%	2.1%	3.6%	4.3%
Compounded Annual Growth - Segments	4.6%	5.1%	5.1%	2.1%	5.1%	5.1%	4.6%	5.1%	5.1%	2.1%	5.1%	5.1%

Note: Dollar Figures in Millions

Pennsylvania
Fixed 5% Economic Scenario
State Employees' Retirement System and Public School Employees' Retirement System

Assets vs. Cash Flow
Assuming 5% returns and contributions fixed as % of OSR

Total Contributions vs. Benefit Payments
Assuming 5% returns and contributions fixed as % of OSR

Unfunded Liability vs. Funding Levels
Assuming 5% returns and contributions fixed as % of OSR

Employer Contributions vs. Pension Debt
Assuming 5% returns and plans' statutory contribution policy

South Carolina Retirement System 30 Year Projections

Plans included: Retirement System
State contribution policy at assumed rate of return (7.25%)

$MMs

Fiscal Year	Pension Liability (Actuarial Accrued Liability)						Pension Assets (Market Value)					Debt	Change in Pension Debt		% Funded	Cash Flow	Employer Contribution		
	Payroll	Beginning of Period	Service Cost	Interest	Benefit Payments	End of Period	Beginning of Period	Total Contribution	Interest	Benefit Payments	End of Period		$	% of Payroll		% of Assets	$	% Change	% Payroll
2018	10,893	48,375	975	3,430	(3,147)	49,632	25,733	2,258	1,820	(3,147)	26,665	22,967	326	3%	54%	-3%	1,406	N/A	13%
2019	11,220	49,632	995	3,518	(3,261)	50,884	26,665	2,438	1,890	(3,261)	27,732	23,152	185	2%	54%	-3%	1,560	11%	14%
2020	11,557	50,884	1,018	3,605	(3,380)	52,127	27,732	2,627	1,969	(3,380)	28,949	23,178	26	0%	56%	-3%	1,723	10%	15%
2021	11,903	52,127	1,041	3,692	(3,502)	53,357	28,949	2,825	2,060	(3,502)	30,331	23,026	(152)	-1%	57%	-2%	1,894	10%	16%
2022	12,260	53,357	1,065	3,777	(3,629)	54,571	30,331	3,032	2,163	(3,629)	31,897	22,674	(352)	-3%	58%	-2%	2,073	9%	17%
2023	12,628	54,571	1,091	3,861	(3,761)	55,762	31,897	3,250	2,279	(3,761)	33,665	22,098	(576)	-5%	60%	-2%	2,261	9%	18%
2024	13,007	55,762	1,117	3,944	(3,897)	56,926	33,665	3,347	2,405	(3,897)	35,519	21,406	(691)	-5%	62%	-2%	2,329	3%	18%
2025	13,397	56,926	1,144	4,024	(4,038)	58,056	35,519	3,447	2,537	(4,038)	37,466	20,590	(816)	-6%	65%	-2%	2,399	3%	18%
2026	13,799	58,056	1,173	4,102	(4,185)	59,146	37,466	3,551	2,677	(4,185)	39,509	19,637	(953)	-7%	67%	-2%	2,471	3%	18%
2027	14,213	59,146	1,203	4,176	(4,337)	60,189	39,509	3,657	2,823	(4,337)	41,652	18,536	(1,101)	-8%	69%	-2%	2,545	3%	18%
2028	14,640	60,189	1,233	4,248	(4,494)	61,176	41,652	3,767	2,976	(4,494)	43,901	17,274	(1,262)	-9%	72%	-2%	2,622	3%	18%
2029	15,079	61,176	1,265	4,314	(4,657)	62,099	43,901	3,880	3,136	(4,657)	46,261	15,837	(1,437)	-10%	74%	-2%	2,700	3%	18%
2030	15,531	62,099	1,298	4,377	(4,826)	62,948	46,261	3,997	3,305	(4,826)	48,737	14,210	(1,627)	-10%	77%	-2%	2,781	3%	18%
2031	15,997	62,948	1,333	4,433	(5,001)	63,713	48,737	4,116	3,482	(5,001)	51,335	12,378	(1,833)	-11%	81%	-2%	2,865	3%	18%
2032	16,477	63,713	1,368	4,483	(5,182)	64,383	51,335	4,240	3,668	(5,182)	54,061	10,321	(2,056)	-12%	84%	-2%	2,951	3%	18%
2033	16,971	64,383	1,405	4,527	(5,370)	64,944	54,061	4,367	3,863	(5,370)	56,921	8,023	(2,298)	-14%	88%	-2%	3,039	3%	18%
2034	17,481	64,944	1,443	4,562	(5,564)	65,385	56,921	4,498	4,067	(5,564)	59,922	5,462	(2,561)	-15%	92%	-2%	3,130	3%	18%
2035	18,005	65,385	1,483	4,588	(5,766)	65,689	59,922	4,633	4,282	(5,766)	63,071	2,618	(2,844)	-16%	96%	-2%	3,224	3%	18%
2036	18,545	65,689	1,523	4,604	(5,975)	65,841	63,071	4,772	4,507	(5,975)	66,374	(534)	(3,152)	-17%	101%	-2%	3,321	3%	18%
2037	19,101	65,841	1,566	4,610	(6,147)	65,870	66,374	4,225	4,720	(6,147)	69,173	(3,303)	(2,769)	-14%	105%	-3%	3,421	3%	18%
2038	19,674	65,870	1,609	4,609	(6,276)	65,812	69,173	1,681	4,827	(6,276)	69,404	(3,592)	(289)	-1%	105%	-7%	854	-75%	4%
2039	20,265	65,812	1,655	4,604	(6,361)	65,709	69,404	1,730	4,842	(6,361)	69,615	(3,906)	(313)	-2%	106%	-7%	879	3%	4%
2040	20,873	65,709	1,701	4,597	(6,399)	65,608	69,615	1,779	4,857	(6,399)	69,851	(4,243)	(337)	-2%	106%	-7%	904	3%	4%
2041	21,499	65,608	1,750	4,591	(6,389)	65,560	69,851	1,829	4,875	(6,389)	70,165	(4,606)	(363)	-2%	107%	-7%	929	3%	4%
2042	22,144	65,560	1,800	4,592	(6,330)	65,621	70,165	1,880	4,901	(6,330)	70,616	(4,995)	(390)	-2%	108%	-6%	954	3%	4%
2043	22,808	65,621	1,851	4,602	(6,224)	65,849	70,616	1,933	4,938	(6,224)	71,263	(5,414)	(419)	-2%	108%	-6%	981	3%	4%
2044	23,492	65,849	1,904	4,626	(6,073)	66,307	71,263	1,990	4,992	(6,073)	72,172	(5,866)	(452)	-2%	109%	-6%	1,010	3%	4%
2045	24,197	66,307	1,959	4,668	(5,879)	67,055	72,172	2,048	5,066	(5,879)	73,408	(6,353)	(488)	-2%	109%	-5%	1,040	3%	4%
2046	24,923	67,055	2,016	4,732	(5,647)	68,156	73,408	2,106	5,165	(5,647)	75,033	(6,877)	(523)	-2%	110%	-5%	1,069	3%	4%
2047	25,671	68,156	2,075	4,824	(5,381)	69,673	75,033	2,166	5,293	(5,381)	77,111	(7,438)	(562)	-2%	111%	-4%	1,099	3%	4%

Source: Analysis by The Pew Charitable Trusts and The Terry Group based on data from Retirement System actuarial valuations and annual reports

<table>
<tr><td colspan="3" align="center">Model Assumptions</td></tr>
<tr><td align="right">State
Plan
Actuarial Valuation Used</td><td colspan="2" align="center">South Carolina
Retirement System
7/1/2017</td></tr>
<tr><td align="center">Employer Contribution Policy</td><td colspan="2"></td></tr>
<tr><td align="center">Description</td><td colspan="2" align="center">Scheduled ramp up in employer contribution rate to 18.56% in 2023.
Contribution rate floor set at the rate needed to amortize UAAL within a set timeframe:
30 years in 2017 and counting down to 20 year amortization in 2027. Stays at 20 year amortization in subsequent years.
Employer contribution rate cannot be lowered until 85% funded.
Employee contribution set at 9%, can be lowered if employer contribution rate goes down.</td></tr>
<tr><td align="center">If actuarial contribution policy</td><td colspan="2"></td></tr>
<tr><td align="center">Applies to</td><td align="center">Prior to July 1, 2027</td><td align="center">After June 30, 2027</td></tr>
<tr><td align="center">Amortization Period</td><td align="center">30</td><td align="center">20</td></tr>
<tr><td align="center">Amortization Method Type</td><td></td><td></td></tr>
<tr><td align="center">Open or closed</td><td align="center">Closed</td><td align="center">Open</td></tr>
<tr><td align="center">Layered or Single Amortization</td><td align="center">Single</td><td align="center">Single</td></tr>
<tr><td align="center">Amortization Payment Growth Rate</td><td align="center">3.00%</td><td align="center">3.00%</td></tr>
<tr><td align="center">Additional Contribution Rules</td><td align="center">Yes</td><td align="center">Yes</td></tr>
<tr><td align="center">If statutory rate</td><td colspan="2"></td></tr>
<tr><td align="center">Applies to</td><td align="center">Prior to July 1, 2027</td><td align="center">After June 30, 2027</td></tr>
<tr><td align="center">Rate</td><td align="center">Employer contribution increases 1% per year until reaches 18.56% in 2023. Employer contributions will stay at 18.56% unless that falls below the minimum actuarial rate.</td><td align="center">After July 1, 2027 the board may raise the employer contribution rate by half a percentage point annually or, if the plan is at least 85 percent funded, lower it.</td></tr>
<tr><td align="center">Employee Contribution Rate</td><td colspan="2"></td></tr>
<tr><td align="center">Applies to</td><td align="center">All</td><td></td></tr>
<tr><td align="center">Rate</td><td align="center">Employees pay 9%</td><td></td></tr>
<tr><td align="center">Employee Contribution Cost-Sharing</td><td align="center">Yes, if funding levels improve sufficiently employee contributions will lower though will be at least half of the normal cost. Employee contribution rates can subsequently rise again if funding levels decline, with a cap of 9%.</td><td></td></tr>
<tr><td align="center">Actuarial Assumptions</td><td colspan="2"></td></tr>
<tr><td align="center">Plan Assumed Rate of Return</td><td colspan="2" align="center">7.25%</td></tr>
<tr><td align="center">Inflation Assumption</td><td colspan="2" align="center">2.25%</td></tr>
<tr><td align="center">Payroll Growth Assumption</td><td colspan="2" align="center">3.00%</td></tr>
<tr><td align="center">COLA</td><td colspan="2"></td></tr>
<tr><td align="center">Applies to</td><td align="center">All</td><td></td></tr>
<tr><td align="center">Description</td><td align="center">Minimum of 1% or $500/year ($500 not indexed). Wait period of 1 year. For early retirements, must wait until 2nd year following attainment of age 60 or 28 years of service if not retired</td><td></td></tr>
<tr><td align="center">Assumed Effective COLA</td><td align="center">Minimum of 1% or $500/year ($500 not indexed). Flat 1% COLA modeled</td><td></td></tr>
<tr><td align="center">COLA Adjustment for Plan Funding and Investment Experience</td><td align="center">No</td><td></td></tr>
</table>

State

South Carolina

Plans Included

Retirement System

Metrics	State Policy (Current Contribution Policy)									Sustainable Budget (Fixed % of OSR)								
	Deterministic 7.25%			Deterministic 5%			Deterministic 9%			Deterministic 7.25%			Deterministic 5%			Deterministic 9%		
	Current Plan Assumptions			Low Return			High Return			Current Plan Assumptions			Low Return			High Return		
	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures																		
Market Value of Assets (MVA)	31,897	41,652	69,173	28,491	32,937	41,073	34,758	49,719	82,374	29,353	33,398	41,707	26,059	25,439	18,567	32,122	40,817	68,769
Actuarial Accrued Liability (AAL)	54,571	60,189	65,870	54,571	60,189	65,870	54,571	60,189	65,870	54,571	60,189	65,870	54,571	60,189	65,870	54,571	60,189	65,870
Accrued Liability at 4% Discount Rate (DR)	80,380	88,655	97,024	80,380	88,655	97,024	80,380	88,655	97,024	80,380	88,655	97,024	80,380	88,655	97,024	80,380	88,655	97,024
Unfunded Actuarial Accrued Liability (UAAL)	22,674	18,536	(3,303)	26,080	27,252	24,797	19,813	10,470	(16,504)	25,218	26,791	24,163	28,512	34,749	47,303	22,448	19,372	(2,899)
Unfunded Liability at 4% DR	48,483	47,003	27,851	51,890	55,718	55,951	45,623	38,937	14,649	51,028	55,258	55,317	54,321	63,216	78,457	48,258	47,838	28,255
Funded Ratio	58.5%	69.2%	105.0%	52.2%	54.7%	62.4%	63.7%	82.6%	125.1%	53.8%	55.5%	63.3%	47.8%	42.3%	28.2%	58.9%	67.8%	104.4%
Funded Ratio at 4% Discount Rate	39.7%	47.0%	71.3%	35.4%	37.2%	42.3%	43.2%	56.1%	84.9%	36.5%	37.7%	43.0%	32.4%	28.7%	19.1%	40.0%	46.0%	70.9%
AAL Compound Annual Growth Rate	2.4%	2.2%	1.6%	2.4%	2.2%	1.6%	2.4%	2.2%	1.6%	2.4%	2.2%	1.6%	2.4%	2.2%	1.6%	2.4%	2.2%	1.6%
Change in AAL from Prior Year (%)	2.3%	1.8%	0.0%	2.3%	1.8%	0.0%	2.3%	1.8%	0.0%	2.3%	1.8%	0.0%	2.3%	1.8%	0.0%	2.3%	1.8%	0.0%
Unfunded Liability / Own Source Revenue at 4% DR	216%	170%	68%	231%	202%	136%	203%	141%	36%	227%	200%	135%	242%	229%	191%	215%	173%	69%
Cash Flow Measures																		
Benefit Payments	3,629	4,337	6,147	3,629	4,337	6,147	3,629	4,337	6,147	3,629	4,337	6,147	3,629	4,337	6,147	3,629	4,337	6,147
Total Contributions	3,032	3,657	4,225	3,032	3,657	4,915	3,032	3,657	1,636	2,383	2,870	4,119	2,383	2,870	4,119	2,383	2,870	4,119
Negative Operating Cash Flow	597	679	1,921	597	679	1,231	597	679	4,511	1,246	1,467	2,028	1,246	1,467	2,028	1,246	1,467	2,028
Benefit Payments / Beginning of Period MVA	12.0%	11.0%	9.3%	13.1%	13.5%	15.2%	11.2%	9.4%	7.7%	12.7%	13.3%	15.0%	13.9%	16.9%	31.2%	11.8%	11.2%	9.4%
Operating Cash Flow to Assets Ratio	-2.0%	-1.7%	-2.9%	-2.2%	-2.1%	-3.1%	-1.8%	-1.5%	-5.6%	-4.4%	-4.5%	-5.0%	-4.8%	-5.7%	-10.3%	-4.1%	-3.8%	-3.1%
Change in MVA from Prior Year (%)	5.2%	5.4%	4.2%	2.7%	2.8%	1.8%	7.0%	7.4%	3.1%	2.7%	2.5%	2.1%	0.0%	-0.9%	-5.7%	4.7%	5.0%	5.7%
Own Source Revenue (OSR)	22,443	27,617	41,026	22,443	27,617	41,026	22,443	27,617	41,026	22,443	27,617	41,026	22,443	27,617	41,026	22,443	27,617	41,026
OSR Compound Annual Growth Rate	5.2%	4.7%	4.4%	5.2%	4.7%	4.4%	5.2%	4.7%	4.4%	5.2%	4.7%	4.4%	5.2%	4.7%	4.4%	5.2%	4.7%	4.4%
Change in OSR from Prior Year (%)	5.3%	3.9%	4.1%	5.3%	3.9%	4.1%	5.3%	3.9%	4.1%	5.3%	3.9%	4.1%	5.3%	3.9%	4.1%	5.3%	3.9%	4.1%
Employer Contributions / OSR	9.2%	9.2%	8.3%	9.2%	9.2%	8.3%	9.2%	9.2%	2.0%	6.3%	6.4%	6.4%	6.3%	6.4%	6.4%	6.3%	6.4%	6.4%
Total Contributions / OSR	13.5%	13.2%	10.3%	13.5%	13.2%	12.0%	13.5%	13.2%	4.0%	10.6%	10.4%	10.0%	10.6%	10.4%	10.0%	10.6%	10.4%	10.0%
Payment and Contribution Measures																		
Employer Contributions (ERC)	2,073	2,545	3,421	2,073	2,545	3,421	2,073	2,545	831	1,424	1,757	2,624	1,424	1,757	2,624	1,424	1,757	2,624
Change in ERC from Prior Year (%)	9.5%	3.0%	3.0%	9.5%	3.0%	3.0%	9.5%	3.0%	2.8%	5.4%	3.9%	4.1%	5.4%	3.9%	4.1%	5.4%	3.9%	4.1%
Employee Contributions (EEC)	959	1,112	805	959	1,112	1,495	959	1,112	805	959	1,112	1,495	959	1,112	1,495	959	1,112	1,495
Payroll	12,260	14,213	19,101	12,260	14,213	19,101	12,260	14,213	19,101	12,260	14,213	19,101	12,260	14,213	19,101	12,260	14,213	19,101
Employer Contribution / Payroll	16.9%	17.9%	17.9%	16.9%	17.9%	17.9%	16.9%	17.9%	4.4%	11.6%	12.4%	13.7%	11.6%	12.4%	13.7%	11.6%	12.4%	13.7%
Employee Contribution / Payroll	7.8%	7.8%	4.2%	7.8%	7.8%	7.8%	7.8%	7.8%	4.2%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%
Total Contributions / Payroll	24.7%	25.7%	22.1%	24.7%	25.7%	25.7%	24.7%	25.7%	8.6%	19.4%	20.2%	21.6%	19.4%	20.2%	21.6%	19.4%	20.2%	21.6%
Normal Cost	1,065	1,203	1,566	1,065	1,203	1,566	1,065	1,203	1,566	1,065	1,203	1,566	1,065	1,203	1,566	1,065	1,203	1,566
Normal Cost (4% DR)	2,052	2,316	3,015	2,052	2,316	3,015	2,052	2,316	3,015	2,052	2,316	3,015	2,052	2,316	3,015	2,052	2,316	3,015
Net amortization $	368	1,119	2,793	179	578	1,620	523	1,610	1,093	(431)	(200)	833	(615)	(700)	(703)	(280)	256	2,587
Net amortization $ (4% DR)	(930)	(536)	10	(1,034)	(835)	(328)	(845)	(265)	(2,089)	(1,663)	(1,617)	(1,119)	(1,764)	(1,893)	(1,967)	(1,579)	(1,365)	(152)
Net amortization $ / Payroll	3.0%	7.9%	14.6%	1.5%	4.1%	8.5%	4.3%	11.3%	5.7%	-3.5%	-1.4%	4.4%	-5.0%	-4.9%	-3.7%	-2.3%	1.8%	13.5%
Net amortization $ / Payroll (4% DR)	-7.6%	-3.8%	0.1%	-8.4%	-5.9%	-1.7%	-6.9%	-1.9%	-10.9%	-13.6%	-11.4%	-5.9%	-14.4%	-13.3%	-10.3%	-12.9%	-9.6%	-0.8%
Investment Performance																		
Compounded Annual Growth - From Start Date	7.25%	7.25%	7.25%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%	7.25%	7.25%	7.25%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%
Compounded Annual Growth - Segments	7.25%	7.25%	7.25%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%	7.25%	7.25%	7.25%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%

Note: Dollar Figures in Millions

Fiscal Metrics
Model Output

State
South Carolina
Plans Included
Retirement System

Metrics	State Policy (Current Contribution Policy) Stochastic Run - Baseline CMA									Sustainable Budget (Fixed % of OSR) Stochastic Run - Baseline CMA								
	25th Percentile			50th Percentile			75th Percentile			25th Percentile			50th Percentile			75th Percentile		
	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures																		
Market Value of Assets (MVA)	25,788	29,037	34,430	30,107	36,689	49,276	34,796	45,442	64,177	23,432	21,957	13,455	27,625	29,034	27,375	32,133	36,907	43,764
Actuarial Accrued Liability (AAL)	54,446	59,648	63,608	54,490	59,737	63,841	54,471	59,769	64,105	54,446	59,648	63,608	54,490	59,737	63,841	54,471	59,769	64,105
Accrued Liability at 4% Discount Rate (DR)	80,197	87,859	93,692	80,262	87,990	94,036	80,234	88,037	94,423	80,197	87,859	93,692	80,262	87,990	94,036	80,234	88,037	94,423
Unfunded Actuarial Accrued Liability (UAAL)	28,658	30,611	29,178	24,383	23,048	14,566	19,676	14,326	(73)	31,014	37,691	50,152	26,865	30,703	36,466	22,339	22,862	20,341
Unfunded Liability at 4% DR	54,409	58,822	59,262	50,155	51,301	44,760	45,438	42,595	30,246	56,765	65,902	80,236	52,637	58,956	66,661	48,101	51,130	50,660
Funded Ratio	47.4%	48.7%	54.1%	55.3%	61.4%	77.2%	63.9%	76.0%	100.1%	43.0%	36.8%	21.2%	50.7%	48.6%	42.9%	59.0%	61.7%	68.3%
Funded Ratio at 4% Discount Rate	32.2%	33.0%	36.7%	37.5%	41.7%	52.4%	43.4%	51.6%	68.0%	29.2%	25.0%	14.4%	34.4%	33.0%	29.1%	40.0%	41.9%	46.3%
AAL Compound Annual Growth Rate	2.4%	2.1%	1.4%	2.4%	2.1%	1.4%	2.4%	2.1%	1.4%	2.4%	2.1%	1.4%	2.4%	2.1%	1.4%	2.4%	2.1%	1.4%
Change in AAL from Prior Year (%)	2.1%	1.6%	-0.4%	2.2%	1.6%	-0.3%	2.2%	1.6%	-0.3%	2.1%	1.6%	-0.4%	2.2%	1.6%	-0.3%	2.2%	1.6%	-0.3%
Unfunded Liability / Own Source Revenue at 4% DR	245%	216%	146%	225%	187%	110%	204%	155%	74%	256%	242%	198%	236%	215%	164%	216%	186%	124%
Cash Flow Measures																		
Benefit Payments	3,629	4,337	6,147	3,629	4,337	6,147	3,629	4,337	6,147	3,629	4,337	6,147	3,629	4,337	6,147	3,629	4,337	6,147
Total Contributions	2,996	3,551	4,635	3,009	3,563	4,384	3,003	3,571	2,827	2,355	2,811	4,101	2,368	2,828	4,007	2,363	2,832	4,031
Negative Operating Cash Flow	633	785	1,512	620	774	1,763	626	765	3,320	1,274	1,525	2,046	1,261	1,508	2,139	1,266	1,504	2,116
Benefit Payments / Beginning of Period MVA	14.1%	15.2%	17.8%	12.5%	12.1%	12.6%	11.2%	10.2%	9.8%	15.1%	19.3%	40.9%	13.3%	14.8%	21.6%	11.8%	12.3%	14.3%
Operating Cash Flow to Assets Ratio	-2.5%	-2.8%	-4.4%	-2.1%	-2.2%	-3.6%	-1.9%	-1.8%	-5.3%	-5.3%	-6.8%	-13.6%	-4.6%	-5.1%	-7.5%	-4.1%	-4.2%	-4.9%
Change in MVA from Prior Year (%)	0.5%	1.8%	-0.4%	3.7%	2.2%	1.1%	7.1%	6.9%	2.1%	-2.5%	-2.4%	-10.4%	1.1%	-1.0%	-3.7%	4.7%	4.3%	1.7%
Own Source Revenue (OSR)	22,180	27,211	40,509	22,323	27,395	40,636	22,272	27,417	40,957	22,180	27,211	40,509	22,323	27,395	40,636	22,272	27,417	40,957
OSR Compound Annual Growth Rate	4.9%	4.5%	4.3%	5.0%	4.6%	4.3%	5.0%	4.6%	4.4%	4.9%	4.5%	4.3%	5.0%	4.6%	4.3%	5.0%	4.6%	4.4%
Change in OSR from Prior Year (%)	5.1%	3.9%	4.2%	5.1%	3.9%	4.1%	5.2%	3.9%	4.1%	5.1%	3.9%	4.2%	5.1%	3.9%	4.1%	5.2%	3.9%	4.1%
Employer Contributions / OSR	9.2%	9.1%	8.0%	9.2%	9.1%	7.5%	9.2%	9.1%	4.6%	6.3%	6.4%	6.6%	6.3%	6.4%	6.4%	6.3%	6.4%	6.4%
Total Contributions / OSR	13.5%	13.1%	11.4%	13.5%	13.0%	10.8%	13.5%	13.0%	6.9%	10.6%	10.3%	10.1%	10.6%	10.3%	9.9%	10.6%	10.3%	9.8%
Payment and Contribution Measures																		
Employer Contributions (ERC)	2,048	2,473	3,227	2,057	2,479	3,028	2,053	2,485	1,867	1,407	1,733	2,688	1,416	1,745	2,607	1,413	1,746	2,629
Change in ERC from Prior Year (%)	8.8%	2.8%	2.8%	9.1%	2.8%	2.4%	9.0%	2.7%	-11.0%	5.3%	4.0%	6.5%	5.3%	4.0%	4.1%	5.3%	3.9%	4.2%
Employee Contributions (EEC)	948	1,078	1,408	952	1,083	1,355	950	1,086	959	948	1,078	1,413	952	1,083	1,400	950	1,086	1,402
Payroll	12,114	13,776	18,054	12,165	13,846	18,139	12,143	13,878	18,268	12,114	13,776	18,054	12,165	13,846	18,139	12,143	13,878	18,268
Employer Contribution / Payroll	16.9%	18.0%	17.9%	16.9%	17.9%	16.7%	16.9%	17.9%	10.2%	11.6%	12.6%	14.9%	11.6%	12.6%	14.4%	11.6%	12.6%	14.4%
Employee Contribution / Payroll	7.8%	7.8%	7.8%	7.8%	7.8%	7.5%	7.8%	7.8%	5.3%	7.8%	7.8%	7.8%	7.8%	7.8%	7.7%	7.8%	7.8%	7.7%
Total Contributions / Payroll	24.7%	25.8%	25.7%	24.7%	25.7%	24.2%	24.7%	25.7%	15.5%	19.4%	20.4%	22.7%	19.5%	20.4%	22.1%	19.5%	20.4%	22.1%
Normal Cost	1,059	1,169	1,483	1,061	1,174	1,491	1,060	1,178	1,501	1,059	1,169	1,483	1,061	1,174	1,491	1,060	1,178	1,501
Normal Cost (4% DR)	2,039	2,252	2,856	2,044	2,261	2,871	2,042	2,268	2,891	2,039	2,252	2,856	2,044	2,261	2,871	2,042	2,268	2,891
Net amortization $	3	278	1,141	256	815	1,886	503	1,297	1,271	(781)	(924)	(828)	(531)	(423)	22	(292)	16	1,077
Net amortization $ (4% DR)	(1,138)	(993)	(565)	(996)	(700)	(282)	(861)	(436)	(1,338)	(1,858)	(1,988)	(1,890)	(1,718)	(1,712)	(1,478)	(1,586)	(1,474)	(905)
Net amortization $ / Payroll	0.0%	2.0%	6.3%	2.1%	5.9%	10.4%	4.1%	9.3%	7.0%	-6.4%	-6.7%	-4.6%	-4.4%	-3.1%	0.1%	-2.4%	0.1%	5.9%
Net amortization $ / Payroll (4% DR)	-9.4%	-7.2%	-3.1%	-8.2%	-5.1%	-1.6%	-7.1%	-3.1%	-7.3%	-15.3%	-14.4%	-10.5%	-14.1%	-12.4%	-8.2%	-13.1%	-10.6%	-5.0%
Investment Performance																		
Compounded Annual Growth - From Start Date	3.1%	4.0%	4.7%	6.1%	6.1%	6.2%	9.1%	8.2%	7.6%	3.1%	4.0%	4.7%	6.1%	6.1%	6.2%	9.1%	8.2%	7.6%
Compounded Annual Growth - Segments	3.1%	4.9%	5.4%	6.1%	6.2%	6.2%	9.1%	7.4%	7.0%	3.1%	4.9%	5.4%	6.1%	6.2%	6.2%	9.1%	7.4%	7.0%

Note: Dollar Figures in Millions

Fiscal Metrics
Model Output

State
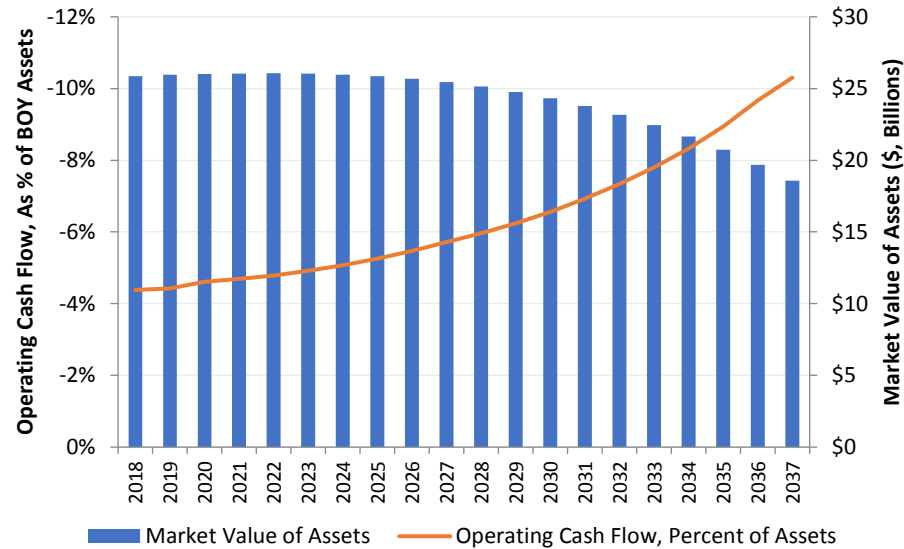
South Carolina

Plans Included

Retirement System

Metrics	State Policy (Current Contribution Policy)						Sustainable Budget (Fixed % of OSR)					
	Deterministic			Deterministic			Deterministic			Deterministic		
	"Low-for-long" Economic Scenario			"Asset Shock" Economic Scenario			"Low-for-long" Economic Scenario			"Asset Shock" Economic Scenario		
	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures												
Market Value of Assets (MVA)	27,241	30,897	35,545	24,282	27,078	29,175	24,862	23,672	14,899	21,205	18,225	3,675
Actuarial Accrued Liability (AAL)	54,519	59,903	64,363	54,503	59,828	64,130	54,519	59,903	64,363	54,503	59,828	64,130
Accrued Liability at 4% Discount Rate (DR)	80,304	88,234	94,804	80,281	88,124	94,460	80,304	88,234	94,804	80,281	88,124	94,460
Unfunded Actuarial Accrued Liability (UAAL)	27,278	29,006	28,818	30,221	32,750	34,955	29,657	36,231	49,464	33,298	41,603	60,454
Unfunded Liability at 4% DR	53,064	57,338	59,259	55,999	61,046	65,285	55,443	64,562	79,905	59,076	69,899	90,785
Funded Ratio	50.0%	51.6%	55.2%	44.6%	45.3%	45.5%	45.6%	39.5%	23.1%	38.9%	30.5%	5.7%
Funded Ratio at 4% Discount Rate	33.9%	35.0%	37.5%	30.2%	30.7%	30.9%	31.0%	26.8%	15.7%	26.4%	20.7%	3.9%
AAL Compound Annual Growth Rate	2.4%	2.2%	1.4%	2.4%	2.1%	1.4%	2.4%	2.2%	1.4%	2.4%	2.1%	1.4%
Change in AAL from Prior Year (%)	2.2%	1.7%	-0.2%	2.2%	1.7%	-0.3%	2.2%	1.7%	-0.2%	2.2%	1.7%	-0.3%
Unfunded Liability / Own Source Revenue at 4% DR	236%	208%	144%	272%	241%	173%	247%	234%	195%	287%	276%	241%
Cash Flow Measures												
Benefit Payments	3,629	4,337	6,147	3,629	4,337	6,147	3,629	4,337	6,147	3,629	4,337	6,147
Total Contributions	3,017	3,594	4,711	3,013	3,578	4,690	2,379	2,852	4,061	2,254	2,696	3,830
Negative Operating Cash Flow	612	743	1,436	617	758	1,456	1,251	1,485	2,085	1,375	1,641	2,317
Benefit Payments / Beginning of Period MVA	13.6%	14.4%	17.4%	15.2%	16.3%	21.0%	14.5%	18.0%	37.8%	16.7%	22.8%	106.2%
Operating Cash Flow to Assets Ratio	-2.3%	-2.5%	-4.1%	-2.6%	-2.9%	-5.0%	-5.0%	-6.2%	-12.8%	-6.3%	-8.6%	-40.0%
Change in MVA from Prior Year (%)	2.0%	2.3%	0.6%	1.7%	1.9%	-0.3%	-0.8%	-1.5%	-8.4%	-2.2%	-4.1%	-36.5%
Own Source Revenue (OSR)	22,443	27,617	41,026	20,599	25,347	37,655	22,443	27,617	41,026	20,599	25,347	37,655
OSR Compound Annual Growth Rate	5.2%	4.7%	4.4%	3.4%	3.8%	3.9%	5.2%	4.7%	4.4%	3.4%	3.8%	3.9%
Change in OSR from Prior Year (%)	5.3%	3.9%	4.1%	3.8%	3.9%	4.1%	5.3%	3.9%	4.1%	3.8%	3.9%	4.1%
Employer Contributions / OSR	9.2%	9.1%	8.0%	10.0%	9.8%	8.7%	6.3%	6.4%	6.4%	6.3%	6.3%	6.4%
Total Contributions / OSR	13.4%	13.0%	11.5%	14.6%	14.1%	12.5%	10.6%	10.3%	9.9%	10.9%	10.6%	10.2%
Payment and Contribution Measures												
Employer Contributions (ERC)	2,063	2,501	3,278	2,059	2,490	3,264	1,424	1,759	2,629	1,300	1,607	2,404
Change in ERC from Prior Year (%)	9.2%	2.7%	2.7%	9.1%	2.7%	2.7%	5.4%	4.0%	4.1%	3.9%	4.0%	4.1%
Employee Contributions (EEC)	955	1,093	1,432	953	1,088	1,426	955	1,093	1,432	953	1,088	1,426
Payroll	12,199	13,966	18,306	12,181	13,906	18,227	12,199	13,966	18,306	12,181	13,906	18,227
Employer Contribution / Payroll	16.9%	17.9%	17.9%	16.9%	17.9%	17.9%	11.7%	12.6%	14.4%	10.7%	11.6%	13.2%
Employee Contribution / Payroll	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%
Total Contributions / Payroll	24.7%	25.7%	25.7%	24.7%	25.7%	25.7%	19.5%	20.4%	22.2%	18.5%	19.4%	21.0%
Normal Cost	1,063	1,185	1,504	1,062	1,180	1,498	1,063	1,185	1,504	1,062	1,180	1,498
Normal Cost (4% DR)	2,047	2,281	2,897	2,045	2,271	2,884	2,047	2,281	2,897	2,045	2,271	2,884
Net amortization $	94	413	1,203	(114)	144	765	(687)	(802)	(850)	(1,060)	(1,320)	(1,828)
Net amortization $ (4% DR)	(1,084)	(925)	(539)	(1,200)	(1,072)	(777)	(1,801)	(1,928)	(1,963)	(2,062)	(2,275)	(2,593)
Net amortization $ / Payroll	0.8%	3.0%	6.6%	-0.9%	1.0%	4.2%	-5.6%	-5.7%	-4.6%	-8.7%	-9.5%	-10.0%
Net amortization $ / Payroll (4% DR)	-8.9%	-6.6%	-2.9%	-9.9%	-7.7%	-4.3%	-14.8%	-13.8%	-10.7%	-16.9%	-16.4%	-14.2%
Investment Performance												
Compounded Annual Growth - From Start Date	4.1%	4.5%	4.7%	2.3%	3.6%	4.2%	4.1%	4.5%	4.7%	2.3%	3.6%	4.2%
Compounded Annual Growth - Segments	4.1%	4.9%	4.9%	2.3%	4.9%	4.9%	4.1%	4.9%	4.9%	2.3%	4.9%	4.9%

Note: Dollar Figures in Millions

South Carolina
Fixed 5% Economic Scenario
Retirement System

Assets vs. Cash Flow
Assuming 5% returns and contributions fixed as % of OSR

Legend: Market Value of Assets | Operating Cash Flow, Percent of Assets

Total Contributions vs. Benefit Payments
Assuming 5% returns and contributions fixed as % of OSR

Legend: Total contributions | Benefit payments

Unfunded Liability vs. Funding Levels
Assuming 5% returns and contributions fixed as % of OSR

Legend: Unfunded Liability (Market Value) | Funded Ratio

Employer Contributions vs. Pension Debt
Assuming 5% returns and plans' statutory contribution policy

Legend: Pension Debt as Share of OSR | Employer Contribution Rate

South Carolina
Asset Shock Economic Scenario
Retirement System

Assets vs. Cash Flow
Assuming asset shock and contributions fixed as % of OSR

Legend: Market Value of Assets | Operating Cash Flow, Percent of Assets

Total Contributions vs. Benefit Payments
Assuming asset shock and contributions fixed as % of OSR

Legend: Total contributions | Benefit payments

Unfunded Liability vs. Funding Levels
Assuming asset shock and contributions fixed as % of OSR

Legend: Unfunded Liability (Market Value) | Funded Ratio

Employer Contributions vs. Pension Debt
Assuming asset shock and plans' statutory contribution policy

Legend: Pension Debt as Share of OSR | Employer Contribution Rate

Virginia Retirement System 30 Year Projections

Plans included: Retirement System - State, Retirement System - Teachers
State contribution policy at assumed rate of return (7.00%)

$MMs

Fiscal Year	Pension Liability (Actuarial Accrued Liability)						Pension Assets (Market Value)					Change in Pension Debt			% Funded	Cash Flow	Employer Contribution		
	Payroll	Beginning of Period	Service Cost	Interest	Benefit Payments	End of Period	Beginning of Period	Total Contribution	Interest	Benefit Payments	End of Period	Debt	$	% of Payroll		% of Assets	$	% Change	% Payroll
2018	12,315	68,318	1,218	4,792	(3,815)	70,512	50,909	2,491	3,483	(3,815)	53,068	17,444	36	0%	75%	-3%	1,894	N/A	15%
2019	12,685	70,512	1,161	4,946	(3,832)	72,786	53,068	2,415	3,636	(3,832)	55,286	17,500	56	0%	76%	-3%	1,808	-5%	14%
2020	13,065	72,786	1,161	5,101	(4,048)	75,000	55,286	2,480	3,785	(4,048)	57,503	17,497	(3)	0%	77%	-3%	1,862	3%	14%
2021	13,457	75,000	1,162	5,252	(4,259)	77,155	57,503	2,424	3,930	(4,259)	59,598	17,557	60	0%	77%	-3%	1,794	-4%	13%
2022	13,861	77,155	1,165	5,399	(4,464)	79,254	59,598	2,490	4,071	(4,464)	61,695	17,559	3	0%	78%	-3%	1,847	3%	13%
2023	14,277	79,254	1,168	5,541	(4,698)	81,265	61,695	2,385	4,205	(4,698)	63,587	17,678	119	1%	78%	-4%	1,730	-6%	12%
2024	14,705	81,265	1,173	5,678	(4,911)	83,206	63,587	2,451	4,331	(4,911)	65,458	17,747	69	0%	79%	-4%	1,782	3%	12%
2025	15,146	83,206	1,178	5,811	(5,093)	85,102	65,458	2,460	4,455	(5,093)	67,281	17,821	74	0%	79%	-4%	1,777	0%	12%
2026	15,601	85,102	1,185	5,941	(5,305)	86,923	67,281	2,528	4,577	(5,305)	69,081	17,842	21	0%	79%	-4%	1,830	3%	12%
2027	16,069	86,923	1,193	6,065	(5,505)	88,676	69,081	2,554	4,696	(5,505)	70,825	17,850	8	0%	80%	-4%	1,841	1%	11%
2028	16,551	88,676	1,202	6,185	(5,713)	90,350	70,825	2,626	4,812	(5,713)	72,550	17,800	(50)	0%	80%	-4%	1,896	3%	11%
2029	17,047	90,350	1,213	6,301	(5,888)	91,975	72,550	2,662	4,927	(5,888)	74,250	17,724	(75)	0%	81%	-4%	1,915	1%	11%
2030	17,559	91,975	1,225	6,412	(6,101)	93,510	74,250	2,737	5,040	(6,101)	75,926	17,584	(140)	-1%	81%	-5%	1,973	3%	11%
2031	18,085	93,510	1,238	6,518	(6,282)	94,984	75,926	2,779	5,151	(6,282)	77,574	17,410	(174)	-1%	82%	-5%	1,996	1%	11%
2032	18,628	94,984	1,253	6,619	(6,476)	96,380	77,574	2,858	5,261	(6,476)	79,217	17,162	(247)	-1%	82%	-5%	2,056	3%	11%
2033	19,187	96,380	1,269	6,715	(6,660)	97,703	79,217	2,911	5,370	(6,660)	80,838	16,865	(297)	-2%	83%	-5%	2,089	2%	11%
2034	19,762	97,703	1,286	6,808	(6,821)	98,976	80,838	2,994	5,480	(6,821)	82,491	16,485	(380)	-2%	83%	-5%	2,152	3%	11%
2035	20,355	98,976	1,305	6,896	(7,014)	100,163	82,491	3,055	5,589	(7,014)	84,121	16,042	(443)	-2%	84%	-5%	2,191	2%	11%
2036	20,966	100,163	1,326	6,979	(7,175)	101,292	84,121	3,143	5,700	(7,175)	85,789	15,504	(538)	-3%	85%	-5%	2,257	3%	11%
2037	21,595	101,292	1,348	7,058	(7,348)	102,350	85,789	3,661	5,827	(7,348)	87,928	14,422	(1,082)	-5%	86%	-4%	2,751	22%	13%
2038	22,243	102,350	1,372	7,132	(7,502)	103,352	87,928	3,767	5,973	(7,502)	90,167	13,185	(1,237)	-6%	87%	-4%	2,834	3%	13%
2039	22,910	103,352	1,397	7,204	(7,639)	104,314	90,167	4,125	6,136	(7,639)	92,789	11,525	(1,660)	-7%	89%	-4%	3,166	12%	14%
2040	23,597	104,314	1,424	7,274	(7,756)	105,257	92,789	4,246	6,318	(7,756)	95,597	9,659	(1,866)	-8%	91%	-4%	3,261	3%	14%
2041	24,305	105,257	1,453	7,343	(7,849)	106,203	95,597	4,448	6,517	(7,849)	98,713	7,490	(2,169)	-9%	93%	-4%	3,437	5%	14%
2042	25,034	106,203	1,483	7,414	(7,913)	107,187	98,713	4,579	6,735	(7,913)	102,114	5,073	(2,417)	-10%	95%	-3%	3,540	3%	14%
2043	25,785	107,187	1,515	7,487	(7,997)	108,193	102,114	4,791	6,976	(7,997)	105,884	2,308	(2,765)	-11%	98%	-3%	3,723	5%	14%
2044	26,559	108,193	1,548	7,562	(8,096)	109,206	105,884	4,932	7,239	(8,096)	109,960	(753)	(3,062)	-12%	101%	-3%	3,834	3%	14%
2045	27,356	109,206	1,584	7,638	(8,152)	110,276	109,960	1,938	7,418	(8,152)	111,163	(887)	(134)	0%	101%	-6%	809	-79%	3%
2046	28,176	110,276	1,621	7,718	(8,231)	111,384	111,163	1,994	7,499	(8,231)	112,425	(1,041)	(154)	-1%	101%	-6%	833	3%	3%
2047	29,022	111,384	1,660	7,802	(8,291)	112,555	112,425	1,866	7,579	(8,291)	113,580	(1,024)	16	0%	101%	-6%	673	-19%	2%

Source: Analysis by The Pew Charitable Trusts and The Terry Group based on data from Retirement System actuarial valuations and annual reports

Model Assumptions			
State	Virginia		
Plan	Retirement System - State		
Actuarial Valuation Used	6/30/2017		
Employer Contribution Policy			
Description	Actuarial		
Applies to	All		
Amortization Period	20 Years Outstanding Bases: 2011: 10 Yr. Payback of Contribution Deficit 2013: 30 2014: 20 2015: 20 2016: 20 2017: 20		
Amortization Method Type	Level Percent		
Open or closed	Closed		
Layered or Single Amortization	Layered		
Amortization Payment Growth Rate	3.00%		
Additional Contribution Rules			
Employee Contribution Rate			
Applies to	Tier 1 - Plan 1 & 2	Tier 2 - Hybrid	
Rate	5.00%	4.00%	
Employee Contribution Cost-Sharing	No	No	
Actuarial Assumptions			
Plan Assumed Rate of Return	7.00%		
Inflation Assumption	2.50%		
Payroll Growth Assumption	3.00%		
COLA			
Applies to	All	Plan 1	Plan 2 & Hybrid
Description	COLA is deferred for one full calendar year after member reaches unreduced retirement age. Does not apply to members with 20 or more years of service, or to members who were within 5 years of full eligibility on 1/1/2013	First 3% of the increase in CPI plus 1/2 of each percentage increase from 3% to 7%. Applies 7/1 of second calendar year after retirement	First 2% of the increase in CPI plus 1/2 of each percent from 2% to 4%, max 3%
Assumed Effective COLA	COLA is assumed to be a minimum of 0% and will increase based on 90% of the COLA in excess of the break point 0% with a maximum COLA of 3%	2.50% for current retirees or vested actives at 1/1/2013, 2.25% for all others. Modeled as: minimum of 0% and will increase based on 90% of the COLA in excess of the break point 0% with a maximum COLA of 3%	2.25%. Modeled as: minimum of 0% and will increase based on 90% of the COLA in excess of the break point 0% with a maximum COLA of 3%
COLA Adjustment for Plan Funding and Investment Experience	No		

Model Assumptions				
State	Virginia			
Plan	Retirement System - Teachers			
Actuarial Valuation Used	6/30/2017			
Employer Contribution Policy				
Description	Actuarial			
Applies to	All			
Amortization Period	20 Years Outstanding Bases: 2011: 10 Yr. Payback of Contribution Deficit 2013: 30 2014: 20 2015: 20 2016: 20 2017: 20			
Amortization Method Type	Level Percent			
Open or closed	Closed			
Layered or Single Amortization	Layered			
Amortization Payment Growth Rate	3.00%			
Additional Contribution Rules				
Employee Contribution Rate				
Applies to	Tier 1 - Plan 1 & 2	Tier 2 - Hybrid		
Rate	5.00%	4.00%		
Employee Contribution Cost-Sharing	No	NO		
Actuarial Assumptions				
Plan Assumed Rate of Return	7.00%			
Inflation Assumption	2.50%			
Payroll Growth Assumption	3.00%			
COLA				
Applies to	All	Plan 1	Plan 2 & Hybrid	
Description	COLA is deferred for one full calendar year after member reaches unreduced retirement age. Does not apply to members with 20 or more years of service, or to members who were within 5 years of full eligibility on 1/1/2013	First 3% of the increase in CPI plus 1/2 of each percentage increase from 3% to 7%. Applies 7/1 of second calendar year after retirement	First 2% of the increase in CPI plus 1/2 of each percent from 2% to 4%, max 3%	
Assumed Effective COLA	COLA is assumed to be a minimum of 0% and will increase based on 90% of the COLA in excess of the break point 0% with a maximum COLA of 3%	2.50% for current retirees or vested actives at 1/1/2013, 2.25% for all others. Modeled as: minimum of 0% and will increase based on 90% of the COLA in excess of the break point 0% with a maximum COLA of 3%	2.25%. Modeled as: minimum of 0% and will increase based on 90% of the COLA in excess of the break point 0% with a maximum COLA of 3%	
COLA Adjustment for Plan Funding and Investment Experience	No			

Fiscal Metrics
Model Output

State

Virginia

Plans Included

Retirement System - State

Retirement System - Teachers

Metrics	State Policy (Current Contribution Policy)									Sustainable Budget (Fixed % of OSR)								
	Deterministic 7%			Deterministic 5%			Deterministic 9%			Deterministic 7%			Deterministic 5%			Deterministic 9%		
	Current Plan Assumptions			Low Return			High Return			Current Plan Assumptions			Low Return			High Return		
	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures																		
Market Value of Assets (MVA)	61,695	70,825	87,928	55,810	58,328	65,489	68,054	85,836	124,679	62,189	74,872	110,012	56,188	59,935	63,914	68,670	92,706	178,222
Actuarial Accrued Liability (AAL)	79,254	88,676	102,350	79,254	88,676	102,350	79,254	88,676	102,350	79,254	88,676	102,350	79,254	88,676	102,350	79,254	88,676	102,350
Accrued Liability at 4% Discount Rate (DR)	116,559	130,415	150,526	116,559	130,415	150,526	116,559	130,415	150,526	116,559	130,415	150,526	116,559	130,415	150,526	116,559	130,415	150,526
Unfunded Actuarial Accrued Liability (UAAL)	17,559	17,850	14,422	23,444	30,347	36,861	11,201	2,840	(22,329)	17,065	13,804	(7,662)	23,066	28,741	38,436	10,584	(4,031)	(75,872)
Unfunded Liability at 4% DR	54,864	59,589	62,598	60,749	72,087	85,037	48,505	44,579	25,847	54,370	55,543	40,515	60,371	70,480	86,612	47,889	37,709	(27,696)
Funded Ratio	77.8%	79.9%	85.9%	70.4%	65.8%	64.0%	85.9%	96.8%	121.8%	78.5%	84.4%	107.5%	70.9%	67.6%	62.4%	86.6%	104.5%	174.1%
Funded Ratio at 4% Discount Rate	52.9%	54.3%	58.4%	47.9%	44.7%	43.5%	58.4%	65.8%	82.8%	53.4%	57.4%	73.1%	48.2%	46.0%	42.5%	58.9%	71.1%	118.4%
AAL Compound Annual Growth Rate	3.0%	2.6%	2.0%	3.0%	2.6%	2.0%	3.0%	2.6%	2.0%	3.0%	2.6%	2.0%	3.0%	2.6%	2.0%	3.0%	2.6%	2.0%
Change in AAL from Prior Year (%)	2.7%	2.0%	1.0%	2.7%	2.0%	1.0%	2.7%	2.0%	1.0%	2.7%	2.0%	1.0%	2.7%	2.0%	1.0%	2.7%	2.0%	1.0%
Unfunded Liability / Own Source Revenue at 4% DR	119%	107%	78%	131%	129%	105%	105%	80%	32%	118%	99%	50%	131%	126%	107%	104%	68%	-34%
Cash Flow Measures																		
Benefit Payments	4,464	5,505	7,348	4,464	5,505	7,348	4,464	5,505	7,348	4,464	5,505	7,348	4,464	5,505	7,348	4,464	5,505	7,348
Total Contributions	2,490	2,554	3,661	2,544	3,210	5,813	2,435	1,826	1,427	2,747	3,257	4,587	2,747	3,257	4,587	2,747	3,257	4,587
Negative Operating Cash Flow	1,974	2,951	3,687	1,919	2,295	1,535	2,029	3,679	5,921	1,717	2,249	2,761	1,717	2,249	2,761	1,717	2,249	2,761
Benefit Payments / Beginning of Period MVA	7.5%	8.0%	8.6%	8.1%	9.5%	11.5%	6.9%	6.7%	6.1%	7.5%	7.6%	7.0%	8.1%	9.3%	11.6%	6.9%	6.3%	4.4%
Operating Cash Flow to Assets Ratio	-3.3%	-4.3%	-4.3%	-3.5%	-4.0%	-2.4%	-3.1%	-4.5%	-4.9%	-2.9%	-3.1%	-2.6%	-3.1%	-3.8%	-4.3%	-2.7%	-2.6%	-1.7%
Change in MVA from Prior Year (%)	3.5%	2.5%	2.5%	1.4%	0.9%	2.5%	5.7%	4.3%	3.8%	4.0%	3.7%	4.2%	1.8%	1.1%	0.5%	6.2%	6.3%	7.2%
Own Source Revenue (OSR)	46,202	55,832	80,735	46,202	55,832	80,735	46,202	55,832	80,735	46,202	55,832	80,735	46,202	55,832	80,735	46,202	55,832	80,735
OSR Compound Annual Growth Rate	4.7%	4.3%	4.0%	4.7%	4.3%	4.0%	4.7%	4.3%	4.0%	4.7%	4.3%	4.0%	4.7%	4.3%	4.0%	4.7%	4.3%	4.0%
Change in OSR from Prior Year (%)	4.5%	3.7%	3.7%	4.5%	3.7%	3.7%	4.5%	3.7%	3.7%	4.5%	3.7%	3.7%	4.5%	3.7%	3.7%	4.5%	3.7%	3.7%
Employer Contributions / OSR	4.0%	3.3%	3.4%	4.1%	4.5%	6.1%	3.9%	2.0%	0.6%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%
Total Contributions / OSR	5.4%	4.6%	4.5%	5.5%	5.8%	7.2%	5.3%	3.3%	1.8%	5.9%	5.8%	5.7%	5.9%	5.8%	5.7%	5.9%	5.8%	5.7%
Payment and Contribution Measures																		
Employer Contributions (ERC)	1,847	1,841	2,751	1,902	2,497	4,904	1,792	1,112	517	2,104	2,543	3,677	2,104	2,543	3,677	2,104	2,543	3,677
Change in ERC from Prior Year (%)	3.0%	0.6%	21.9%	3.0%	10.7%	18.9%	3.0%	-19.0%	-3.0%	4.5%	3.7%	3.7%	4.5%	3.7%	3.7%	4.5%	3.7%	3.7%
Employee Contributions (EEC)	643	714	910	643	714	910	643	714	910	643	714	910	643	714	910	643	714	910
Payroll	13,861	16,069	21,595	13,861	16,069	21,595	13,861	16,069	21,595	13,861	16,069	21,595	13,861	16,069	21,595	13,861	16,069	21,595
Employer Contribution / Payroll	13.3%	11.5%	12.7%	13.7%	15.5%	22.7%	12.9%	6.9%	2.4%	15.2%	15.8%	17.0%	15.2%	15.8%	17.0%	15.2%	15.8%	17.0%
Employee Contribution / Payroll	4.6%	4.4%	4.2%	4.6%	4.4%	4.2%	4.6%	4.4%	4.2%	4.6%	4.4%	4.2%	4.6%	4.4%	4.2%	4.6%	4.4%	4.2%
Total Contributions / Payroll	18.0%	15.9%	17.0%	18.4%	20.0%	26.9%	17.6%	11.4%	6.6%	19.8%	20.3%	21.2%	19.8%	20.3%	21.2%	19.8%	20.3%	21.2%
Normal Cost	1,165	1,193	1,348	1,165	1,193	1,348	1,165	1,193	1,348	1,165	1,193	1,348	1,165	1,193	1,348	1,165	1,193	1,348
Normal Cost (4% DR)	2,261	2,315	2,617	2,261	2,315	2,617	2,261	2,315	2,617	2,261	2,315	2,617	2,261	2,315	2,617	2,261	2,315	2,617
Net amortization $	142	159	1,307	(120)	50	2,003	422	332	1,398	423	1,103	3,647	101	202	713	763	2,157	7,894
Net amortization $ (4% DR)	(1,921)	(2,107)	(1,462)	(2,047)	(1,888)	(142)	(1,785)	(2,320)	(2,368)	(1,650)	(1,266)	272	(1,834)	(1,781)	(1,405)	(1,456)	(664)	2,698
Net amortization $ / Payroll	1.0%	1.0%	6.1%	-0.9%	0.3%	9.3%	3.0%	2.1%	6.5%	3.0%	6.9%	16.9%	0.7%	1.3%	3.3%	5.5%	13.4%	36.6%
Net amortization $ / Payroll (4% DR)	-13.9%	-13.1%	-6.8%	-14.8%	-11.7%	-0.7%	-12.9%	-14.4%	-11.0%	-11.9%	-7.9%	1.3%	-13.2%	-11.1%	-6.5%	-10.5%	-4.1%	12.5%
Investment Performance																		
Compounded Annual Growth - From Start Date	7.00%	7.00%	7.00%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%	7.00%	7.00%	7.00%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%
Compounded Annual Growth - Segments	7.00%	7.00%	7.00%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%	7.00%	7.00%	7.00%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%

Note: Dollar Figures in Millions

State

Virginia

Plans Included

Retirement System - State

Retirement System - Teachers

Metrics	State Policy (Current Contribution Policy)									Sustainable Budget (Fixed % of OSR)								
	Stochastic Run - Baseline CMA									Stochastic Run - Baseline CMA								
	25th Percentile			50th Percentile			75th Percentile			25th Percentile			50th Percentile			75th Percentile		
	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures																		
Market Value of Assets (MVA)	51,172	54,147	62,263	59,823	66,565	80,105	69,601	82,208	103,998	51,425	54,761	64,090	60,281	70,876	96,899	70,245	89,269	141,411
Actuarial Accrued Liability (AAL)	78,075	86,007	94,764	78,240	85,829	95,404	78,143	86,279	95,288	78,075	86,007	94,764	78,240	85,829	95,404	78,143	86,279	95,288
Accrued Liability at 4% Discount Rate (DR)	114,825	126,490	139,369	115,067	126,228	140,310	114,925	126,890	140,140	114,825	126,490	139,369	115,067	126,228	140,310	114,925	126,890	140,140
Unfunded Actuarial Accrued Liability (UAAL)	26,903	31,860	32,501	18,417	19,264	15,299	8,542	4,070	(8,710)	26,650	31,246	30,673	17,959	14,952	(1,495)	7,898	(2,991)	(46,122)
Unfunded Liability at 4% DR	63,653	72,343	77,106	55,244	59,663	60,205	45,324	44,682	36,142	63,399	71,730	75,279	54,786	55,352	43,411	44,680	37,620	(1,270)
Funded Ratio	65.5%	63.0%	65.7%	76.5%	77.6%	84.0%	89.1%	95.3%	109.1%	65.9%	63.7%	67.6%	77.0%	82.6%	101.6%	89.9%	103.5%	148.4%
Funded Ratio at 4% Discount Rate	44.6%	42.8%	44.7%	52.0%	52.7%	57.1%	60.6%	64.8%	74.2%	44.8%	43.3%	46.0%	52.4%	56.1%	69.1%	61.1%	70.4%	100.9%
AAL Compound Annual Growth Rate	2.7%	2.3%	1.6%	2.7%	2.3%	1.7%	2.7%	2.4%	1.7%	2.7%	2.3%	1.6%	2.7%	2.3%	1.7%	2.7%	2.4%	1.7%
Change in AAL from Prior Year (%)	2.3%	1.7%	0.5%	2.3%	1.7%	0.5%	2.3%	1.7%	0.4%	2.3%	1.7%	0.5%	2.3%	1.7%	0.5%	2.3%	1.7%	0.4%
Unfunded Liability / Own Source Revenue at 4% DR	139%	131%	97%	120%	109%	75%	99%	81%	45%	139%	130%	95%	119%	101%	54%	98%	68%	-2%
Cash Flow Measures																		
Benefit Payments	4,355	5,300	6,965	4,369	5,287	6,999	4,361	5,319	6,973	4,355	5,300	6,965	4,369	5,287	6,999	4,361	5,319	6,973
Total Contributions	2,545	3,257	5,107	2,464	2,411	3,478	2,370	1,786	1,864	2,710	3,192	4,431	2,722	3,180	4,478	2,714	3,212	4,464
Negative Operating Cash Flow	1,810	2,043	1,858	1,905	2,877	3,521	1,992	3,533	5,110	1,645	2,109	2,533	1,647	2,107	2,521	1,647	2,106	2,509
Benefit Payments / Beginning of Period MVA	8.5%	9.8%	11.3%	7.5%	8.0%	9.0%	6.6%	6.7%	6.9%	8.5%	9.6%	10.8%	7.5%	7.6%	7.5%	6.6%	6.3%	5.2%
Operating Cash Flow to Assets Ratio	-3.5%	-3.8%	-3.0%	-3.3%	-4.3%	-4.5%	-3.0%	-4.5%	-5.0%	-3.2%	-3.8%	-3.9%	-2.8%	-3.0%	-2.7%	-2.5%	-2.5%	-1.9%
Change in MVA from Prior Year (%)	0.3%	-0.4%	0.8%	2.7%	0.1%	2.5%	5.9%	3.7%	2.3%	0.6%	-0.6%	-0.5%	3.2%	1.4%	3.8%	6.4%	5.7%	5.4%
Own Source Revenue (OSR)	45,629	55,137	79,302	45,854	54,937	80,126	45,705	55,499	79,843	45,629	55,137	79,302	45,854	54,937	80,126	45,705	55,499	79,843
OSR Compound Annual Growth Rate	4.4%	4.1%	3.9%	4.5%	4.1%	4.0%	4.5%	4.2%	4.0%	4.4%	4.1%	3.9%	4.5%	4.1%	4.0%	4.5%	4.2%	4.0%
Change in OSR from Prior Year (%)	4.3%	3.7%	3.8%	4.3%	3.6%	3.7%	4.3%	3.7%	3.6%	4.3%	3.7%	3.8%	4.3%	3.6%	3.7%	4.3%	3.7%	3.6%
Employer Contributions / OSR	4.2%	4.7%	5.4%	4.0%	3.2%	3.3%	3.8%	2.0%	1.3%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%
Total Contributions / OSR	5.6%	5.9%	6.4%	5.4%	4.4%	4.3%	5.2%	3.2%	2.3%	5.9%	5.8%	5.6%	5.9%	5.8%	5.6%	5.9%	5.8%	5.6%
Payment and Contribution Measures																		
Employer Contributions (ERC)	1,913	2,577	4,287	1,830	1,733	2,650	1,738	1,101	1,036	2,078	2,511	3,612	2,089	2,502	3,650	2,082	2,528	3,637
Change in ERC from Prior Year (%)	2.1%	10.4%	18.4%	2.3%	1.5%	13.7%	2.2%	-13.1%	-11.3%	4.3%	3.7%	3.8%	4.3%	3.6%	3.7%	4.3%	3.7%	3.6%
Employee Contributions (EEC)	631	680	819	633	678	828	632	684	827	631	680	819	633	678	828	632	684	827
Payroll	13,621	15,312	19,454	13,664	15,263	19,663	13,636	15,409	19,640	13,621	15,312	19,454	13,664	15,263	19,663	13,636	15,409	19,640
Employer Contribution / Payroll	14.0%	16.8%	22.0%	13.4%	11.4%	13.5%	12.7%	7.1%	5.3%	15.3%	16.4%	18.6%	15.3%	16.4%	18.6%	15.3%	16.4%	18.5%
Employee Contribution / Payroll	4.6%	4.4%	4.2%	4.6%	4.4%	4.2%	4.6%	4.4%	4.2%	4.6%	4.4%	4.2%	4.6%	4.4%	4.2%	4.6%	4.4%	4.2%
Total Contributions / Payroll	18.7%	21.3%	26.3%	18.0%	15.8%	17.7%	17.4%	11.6%	9.5%	19.9%	20.8%	22.8%	19.9%	20.8%	22.8%	19.9%	20.8%	22.7%
Normal Cost	1,155	1,142	1,221	1,156	1,139	1,233	1,155	1,149	1,233	1,155	1,142	1,221	1,156	1,139	1,233	1,155	1,149	1,233
Normal Cost (4% DR)	2,241	2,217	2,369	2,244	2,211	2,393	2,242	2,231	2,393	2,241	2,217	2,369	2,244	2,211	2,393	2,242	2,231	2,393
Net amortization $	(332)	72	1,743	79	61	1,147	513	270	1,126	(154)	55	1,229	359	1,095	3,247	888	2,109	6,090
Net amortization $ (4% DR)	(2,138)	(1,740)	(285)	(1,944)	(2,102)	(1,353)	(1,732)	(2,273)	(2,056)	(1,966)	(1,778)	(868)	(1,673)	(1,181)	276	(1,371)	(610)	1,896
Net amortization $ / Payroll	-2.4%	0.5%	9.0%	0.6%	0.4%	5.8%	3.8%	1.8%	5.7%	-1.1%	0.4%	6.3%	2.6%	7.2%	16.5%	6.5%	13.7%	31.0%
Net amortization $ / Payroll (4% DR)	-15.7%	-11.4%	-1.5%	-14.2%	-13.8%	-6.9%	-12.7%	-14.8%	-10.5%	-14.4%	-11.6%	-4.5%	-12.2%	-7.7%	1.4%	-10.1%	-4.0%	9.7%
Investment Performance																		
Compounded Annual Growth - From Start Date	3.2%	4.2%	4.9%	6.3%	6.4%	6.4%	9.4%	8.5%	7.9%	3.2%	4.2%	4.9%	6.3%	6.4%	6.4%	9.4%	8.5%	7.9%
Compounded Annual Growth - Segments	3.2%	5.1%	5.6%	6.3%	6.4%	6.4%	9.4%	7.6%	7.2%	3.2%	5.1%	5.6%	6.3%	6.4%	6.4%	9.4%	7.6%	7.2%

Note: Dollar Figures in Millions

Fiscal Metrics
Model Output

State

Virginia

Plans Included

Retirement System - State

Retirement System - Teachers

Metrics	State Policy (Current Contribution Policy)						Sustainable Budget (Fixed % of OSR)					
	Deterministic			Deterministic			Deterministic			Deterministic		
	"Low-for-long" Economic Scenario			"Asset Shock" Economic Scenario			"Low-for-long" Economic Scenario			"Asset Shock" Economic Scenario		
	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures												
Market Value of Assets (MVA)	54,278	57,030	63,800	48,378	53,290	64,969	54,670	58,728	64,930	47,165	48,379	45,652
Actuarial Accrued Liability (AAL)	78,534	86,644	96,190	78,390	86,448	95,881	78,534	86,644	96,190	78,390	86,448	95,881
Accrued Liability at 4% Discount Rate (DR)	115,500	127,427	141,466	115,288	127,140	141,012	115,500	127,427	141,466	115,288	127,140	141,012
Unfunded Actuarial Accrued Liability (UAAL)	24,257	29,614	32,390	30,012	33,159	30,912	23,865	27,916	31,260	31,225	38,070	50,229
Unfunded Liability at 4% DR	61,223	70,398	77,666	66,909	73,850	76,043	60,831	68,699	76,536	68,123	78,761	95,361
Funded Ratio	69.1%	65.8%	66.3%	61.7%	61.6%	67.8%	69.6%	67.8%	67.5%	60.2%	56.0%	47.6%
Funded Ratio at 4% Discount Rate	47.0%	44.8%	45.1%	42.0%	41.9%	46.1%	47.3%	46.1%	45.9%	40.9%	38.1%	32.4%
AAL Compound Annual Growth Rate	2.8%	2.4%	1.7%	2.8%	2.4%	1.7%	2.8%	2.4%	1.7%	2.8%	2.4%	1.7%
Change in AAL from Prior Year (%)	2.4%	1.7%	0.5%	2.4%	1.7%	0.5%	2.4%	1.7%	0.5%	2.4%	1.7%	0.5%
Unfunded Liability / Own Source Revenue at 4% DR	133%	126%	96%	154%	141%	100%	132%	123%	95%	157%	150%	126%
Cash Flow Measures												
Benefit Payments	4,396	5,344	7,021	4,382	5,331	7,014	4,396	5,344	7,021	4,382	5,331	7,014
Total Contributions	2,527	3,153	5,332	2,966	3,677	5,935	2,741	3,232	4,513	2,611	3,074	4,284
Negative Operating Cash Flow	1,870	2,191	1,688	1,416	1,654	1,079	1,656	2,112	2,508	1,771	2,257	2,730
Benefit Payments / Beginning of Period MVA	8.2%	9.5%	11.2%	9.2%	10.2%	11.1%	8.2%	9.2%	10.9%	9.4%	11.0%	15.2%
Operating Cash Flow to Assets Ratio	-3.5%	-3.9%	-2.7%	-3.0%	-3.2%	-1.7%	-3.1%	-3.6%	-3.9%	-3.8%	-4.7%	-5.9%
Change in MVA from Prior Year (%)	1.0%	1.0%	2.2%	1.5%	1.7%	3.2%	1.4%	1.2%	1.0%	0.7%	0.2%	-1.1%
Own Source Revenue (OSR)	46,202	55,832	80,735	43,376	52,418	75,798	46,202	55,832	80,735	43,376	52,418	75,798
OSR Compound Annual Growth Rate	4.7%	4.3%	4.0%	3.4%	3.6%	3.7%	4.7%	4.3%	4.0%	3.4%	3.6%	3.7%
Change in OSR from Prior Year (%)	4.5%	3.7%	3.7%	3.8%	3.7%	3.7%	4.5%	3.7%	3.7%	3.8%	3.7%	3.7%
Employer Contributions / OSR	4.1%	4.4%	5.6%	5.4%	5.7%	6.7%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%
Total Contributions / OSR	5.5%	5.6%	6.6%	6.8%	7.0%	7.8%	5.9%	5.8%	5.6%	6.0%	5.9%	5.7%
Payment and Contribution Measures												
Employer Contributions (ERC)	1,890	2,464	4,497	2,330	2,990	5,103	2,104	2,543	3,677	1,976	2,388	3,453
Change in ERC from Prior Year (%)	2.5%	9.9%	18.9%	2.4%	2.6%	16.6%	4.5%	3.7%	3.7%	3.8%	3.7%	3.7%
Employee Contributions (EEC)	636	689	835	635	686	832	636	689	835	635	686	832
Payroll	13,723	15,515	19,831	13,701	15,448	19,745	13,723	15,515	19,831	13,701	15,448	19,745
Employer Contribution / Payroll	13.8%	15.9%	22.7%	17.0%	19.4%	25.8%	15.3%	16.4%	18.5%	14.4%	15.5%	17.5%
Employee Contribution / Payroll	4.6%	4.4%	4.2%	4.6%	4.4%	4.2%	4.6%	4.4%	4.2%	4.6%	4.4%	4.2%
Total Contributions / Payroll	18.4%	20.3%	26.9%	21.6%	23.8%	30.1%	20.0%	20.8%	22.8%	19.1%	19.9%	21.7%
Normal Cost	1,159	1,158	1,244	1,158	1,153	1,239	1,159	1,158	1,244	1,158	1,153	1,239
Normal Cost (4% DR)	2,249	2,247	2,415	2,248	2,237	2,405	2,249	2,247	2,415	2,248	2,237	2,405
Net amortization $	(189)	54	1,901	(154)	328	2,586	44	244	1,184	(578)	(582)	(296)
Net amortization $ (4% DR)	(2,077)	(1,828)	(157)	(1,866)	(1,437)	506	(1,852)	(1,686)	(918)	(2,261)	(2,215)	(1,849)
Net amortization $ / Payroll	-1.4%	0.3%	9.6%	-1.1%	2.1%	13.1%	0.3%	1.6%	6.0%	-4.2%	-3.8%	-1.5%
Net amortization $ / Payroll (4% DR)	-15.1%	-11.8%	-0.8%	-13.6%	-9.3%	2.6%	-13.5%	-10.9%	-4.6%	-16.5%	-14.3%	-9.4%
Investment Performance												
Compounded Annual Growth - From Start Date	4.4%	4.7%	4.9%	2.2%	3.6%	4.3%	4.4%	4.7%	4.9%	2.2%	3.6%	4.3%
Compounded Annual Growth - Segments	4.4%	5.0%	5.0%	2.2%	5.0%	5.0%	4.4%	5.0%	5.0%	2.2%	5.0%	5.0%

Note: Dollar Figures in Millions

Virginia
Fixed 5% Economic Scenario
Retirement System - State and Teachers

Assets vs. Cash Flow
Assuming 5% returns and contributions fixed as % of OSR
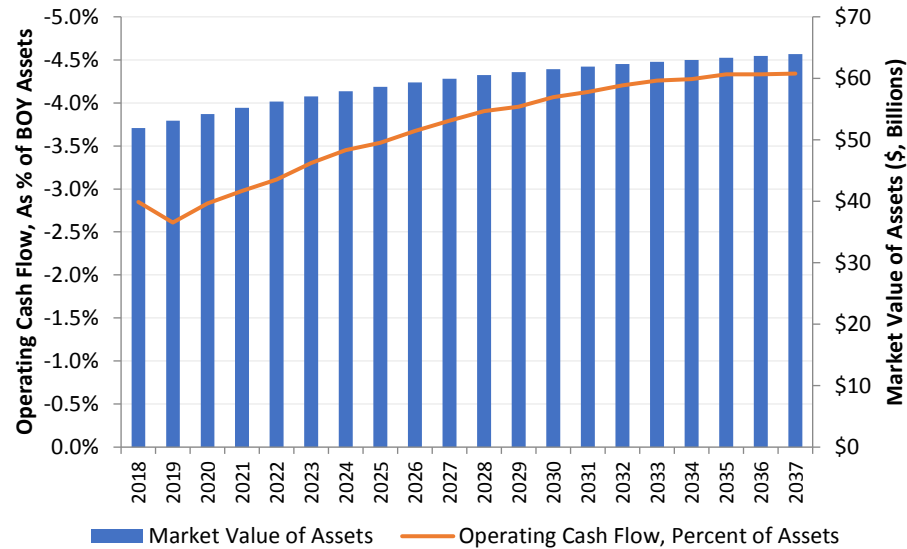
Total Contributions vs. Benefit Payments
Assuming 5% returns and contributions fixed as % of OSR
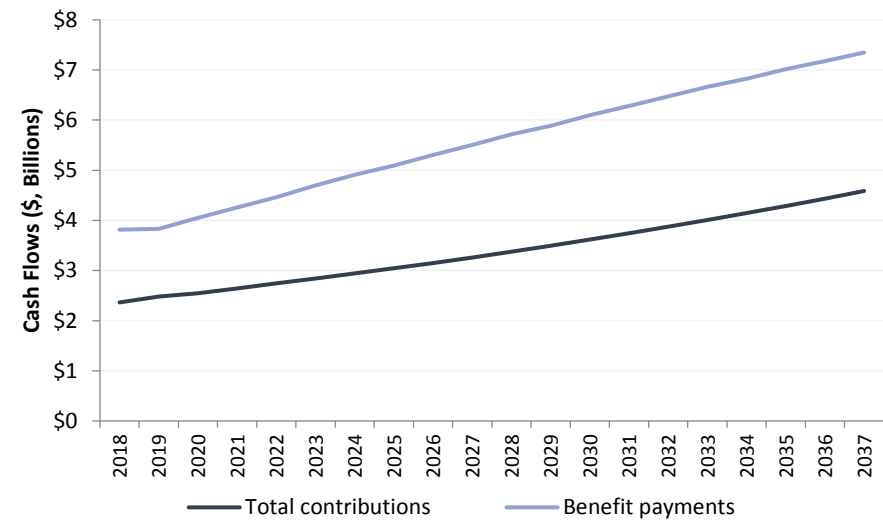
Unfunded Liability vs. Funding Levels
Assuming 5% returns and contributions fixed as % of OSR
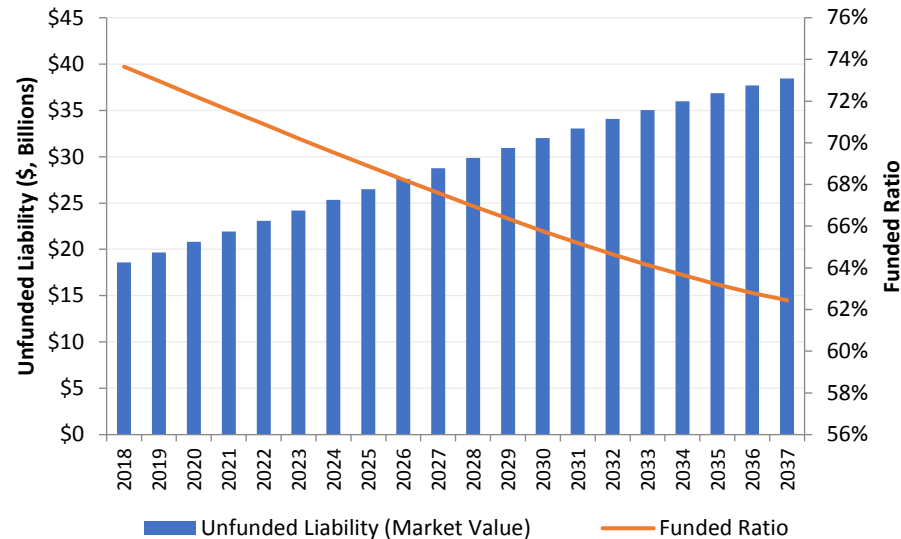
Employer Contributions vs. Pension Debt
Assuming 5% returns and plans' statutory contribution policy
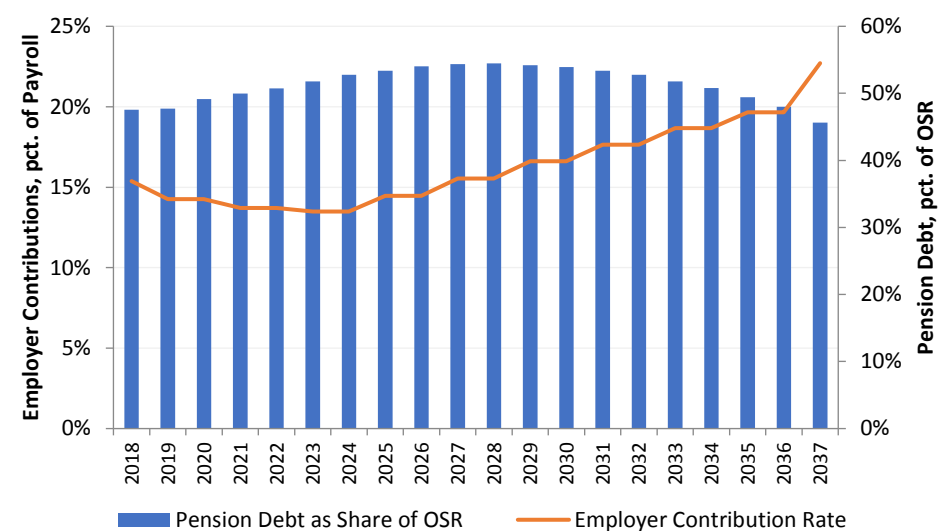
Virginia
Asset Shock Economic Scenario
Retirement System - State and Teachers

Assets vs. Cash Flow
Assuming asset shock and contributions fixed as % of OSR

Market Value of Assets   Operating Cash Flow, Percent of Assets

Total Contributions vs. Benefit Payments
Assuming asset shock and contributions fixed as % of OSR

Total contributions   Benefit payments

Unfunded Liability vs. Funding Levels
Assuming asset shock and contributions fixed as % of OSR

Unfunded Liability (Market Value)   Funded Ratio

Employer Contributions vs. Pension Debt
Assuming asset shock and plans' statutory contribution policy

Pension Debt as Share of OSR   Employer Contribution Rate

Wisconsin Retirement System 30 Year Projections

Plans included: Retirement System
State contribution policy at assumed rate of return (7.2%)

$MMs

Fiscal Year	Pension Liability (Actuarial Accrued Liability)						Pension Assets (Market Value)					Change in Pension Debt			% Funded	Cash Flow	Employer Contribution		
	Payroll	Beginning of Period	Service Cost	Interest	Benefit Payments	End of Period	Beginning of Period	Total Contribution	Interest	Benefit Payments	End of Period	Debt	$	% of Payroll		% of Assets	$	% Change	% Payroll
2018	14,363	100,701	1,865	7,174	(5,511)	104,229	104,220	1,913	7,377	(5,511)	107,998	(3,769)	(250)	-2%	104%	-3%	992	N/A	7%
2019	14,823	104,229	1,925	7,547	(5,784)	107,917	107,998	1,968	7,641	(5,784)	111,824	(3,907)	(138)	-1%	104%	-4%	1,021	3%	7%
2020	15,297	107,917	1,986	8,664	(6,071)	112,496	111,824	2,018	7,908	(6,071)	115,678	(3,182)	725	5%	103%	-4%	1,047	3%	7%
2021	15,786	112,496	2,050	8,976	(6,440)	117,082	115,678	2,027	8,173	(6,440)	119,438	(2,356)	827	5%	102%	-4%	1,053	1%	7%
2022	16,292	117,082	2,115	8,340	(6,811)	120,726	119,438	2,043	8,431	(6,811)	123,100	(2,374)	(18)	0%	102%	-4%	1,062	1%	7%
2023	16,813	120,726	2,183	8,661	(7,098)	124,473	123,100	2,105	8,687	(7,098)	126,794	(2,322)	52	0%	102%	-4%	1,095	3%	7%
2024	17,351	124,473	2,253	8,757	(7,390)	128,092	126,794	2,169	8,944	(7,390)	130,517	(2,425)	(103)	-1%	102%	-4%	1,128	3%	6%
2025	17,906	128,092	2,325	9,118	(7,667)	131,868	130,517	2,235	9,205	(7,667)	134,290	(2,422)	3	0%	102%	-4%	1,162	3%	6%
2026	18,479	131,868	2,399	9,312	(7,952)	135,628	134,290	2,306	9,469	(7,952)	138,114	(2,486)	(63)	0%	102%	-4%	1,199	3%	6%
2027	19,070	135,628	2,476	9,612	(8,228)	139,489	138,114	2,380	9,737	(8,228)	142,003	(2,514)	(29)	0%	102%	-4%	1,238	3%	6%
2028	19,681	139,489	2,555	9,842	(8,505)	143,381	142,003	2,458	10,010	(8,505)	145,967	(2,585)	(71)	0%	102%	-4%	1,278	3%	6%
2029	20,310	143,381	2,637	10,082	(8,770)	147,330	145,967	2,537	10,289	(8,770)	150,022	(2,692)	(106)	-1%	102%	-4%	1,319	3%	6%
2030	20,960	147,330	2,722	10,396	(9,025)	151,423	150,022	2,618	10,575	(9,025)	154,189	(2,767)	(75)	0%	102%	-4%	1,361	3%	6%
2031	21,631	151,423	2,809	10,719	(9,277)	155,674	154,189	2,704	10,869	(9,277)	158,485	(2,812)	(45)	0%	102%	-4%	1,406	3%	6%
2032	22,323	155,674	2,899	10,981	(9,524)	160,030	158,485	2,790	11,173	(9,524)	162,925	(2,895)	(83)	0%	102%	-4%	1,451	3%	7%
2033	23,038	160,030	2,991	11,259	(9,754)	164,525	162,925	2,882	11,487	(9,754)	167,540	(3,015)	(119)	-1%	102%	-4%	1,499	3%	7%
2034	23,775	164,525	3,087	11,646	(9,969)	169,289	167,540	2,974	11,815	(9,969)	172,360	(3,071)	(56)	0%	102%	-4%	1,547	3%	7%
2035	24,536	169,289	3,186	11,918	(10,181)	174,212	172,360	3,069	12,158	(10,181)	177,407	(3,195)	(124)	-1%	102%	-4%	1,596	3%	7%
2036	25,321	174,212	3,288	12,303	(10,369)	179,433	177,407	3,168	12,519	(10,369)	182,724	(3,291)	(95)	0%	102%	-4%	1,647	3%	7%
2037	26,131	179,433	3,393	12,677	(10,553)	184,950	182,724	3,272	12,899	(10,553)	188,341	(3,391)	(100)	0%	102%	-4%	1,701	3%	7%
2038	26,967	184,950	3,502	13,072	(10,728)	190,796	188,341	3,376	13,301	(10,728)	194,290	(3,494)	(103)	0%	102%	-4%	1,756	3%	7%
2039	27,830	190,796	3,614	13,492	(10,895)	197,006	194,290	3,484	13,727	(10,895)	200,606	(3,600)	(106)	0%	102%	-4%	1,812	3%	7%
2040	28,721	197,006	3,729	13,938	(11,056)	203,617	200,606	3,599	14,180	(11,056)	207,329	(3,712)	(112)	0%	102%	-4%	1,871	3%	7%
2041	29,640	203,617	3,849	14,512	(11,213)	210,765	207,329	3,714	14,662	(11,213)	214,492	(3,727)	(16)	0%	102%	-4%	1,931	3%	7%
2042	30,588	210,765	3,972	14,927	(11,377)	218,286	214,492	3,833	15,177	(11,377)	222,125	(3,838)	(111)	0%	102%	-4%	1,993	3%	7%
2043	31,567	218,286	4,099	15,468	(11,529)	226,324	222,125	3,955	15,725	(11,529)	230,276	(3,952)	(114)	0%	102%	-3%	2,057	3%	7%
2044	32,577	226,324	4,230	16,046	(11,681)	234,919	230,276	4,082	16,311	(11,681)	238,988	(4,070)	(117)	0%	102%	-3%	2,122	3%	7%
2045	33,620	234,919	4,365	16,664	(11,833)	244,115	238,988	4,216	16,938	(11,833)	248,309	(4,194)	(124)	0%	102%	-3%	2,192	3%	7%
2046	34,696	244,115	4,505	17,325	(11,987)	253,958	248,309	4,351	17,608	(11,987)	258,281	(4,323)	(129)	0%	102%	-3%	2,262	3%	7%
2047	35,806	253,958	4,649	18,077	(11,513)	265,171	258,281	4,490	18,348	(11,513)	269,605	(4,435)	(112)	0%	102%	-3%	2,335	3%	7%

Source: Analysis by The Pew Charitable Trusts and The Terry Group based on data from Retirement System actuarial valuations and annual reports

Model Assumptions	
State	Wisconsin
Plan	Retirement System
Actuarial Valuation Used	12/31/2016
Employer Contribution Policy	
Description	Actuarial
If actuarial contribution policy	
Applies to	All
Amortization Period	Active plan: 20 years (the average future working lifetime)
Amortization Method Type	Level Percent
Open or closed	Closed from date of participation in WRS
Layered or Single Amortization	Single
Amortization Payment Growth Rate	3.20%
Additional Contribution Rules	Yes
If statutory rate	
Applies to	
Rate	
Employee Contribution Rate	
Applies to	After July 1, 2011
Rate	One-half of the actuarially determined rate for General participants and Executive and Elected Officials. Participant contributions for Protective participants are set equal to the participant contribution for General members
Employee Contribution Cost-Sharing	
Actuarial Assumptions	
Plan Assumed Rate of Return	7.20%
Inflation Assumption	2.70%
Payroll Growth Assumption	3.20%
COLA	
Applies to	All
Description	Actuarially determined by WI rules to balance retirees' assets and liabilities
Assumed Effective COLA	The COLA is funded by actual returns exceeding the 5% discount rate used to calculate retiree liabilities. If actual returns match the assumed rate of return of 7.2%, the implied COLA would be 2.1%.
COLA Adjustment for Plan Funding and Investment Experience	Yes

Fiscal Metrics
Model Output

State
Wisconsin
Plans Included
Retirement System

Metrics	State Policy (Current Contribution Policy)									Sustainable Budget (Fixed % of OSR)								
	Deterministic 7.2%			Deterministic 5%			Deterministic 9%			Deterministic 7.2%			Deterministic 5%			Deterministic 9%		
	Current Plan Assumptions			Low Return			High Return			Current Plan Assumptions			Low Return			High Return		
	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures																		
Market Value of Assets (MVA)	123,100	142,003	188,341	110,658	116,410	136,876	134,105	166,998	248,022	124,316	146,317	205,608	111,530	118,003	135,737	135,642	173,980	288,065
Actuarial Accrued Liability (AAL)	120,726	139,489	184,950	115,956	127,289	158,275	124,752	151,245	215,194	120,765	139,651	185,681	115,998	127,443	158,727	124,862	151,422	216,143
Accrued Liability at 4% Discount Rate (DR)	149,367	172,580	228,827	143,465	157,486	195,824	154,347	187,126	266,246	149,414	172,781	229,731	143,517	157,677	196,383	154,484	187,345	267,420
Unfunded Actuarial Accrued Liability (UAAL)	(2,374)	(2,514)	(3,391)	5,298	10,879	21,400	(9,353)	(15,752)	(32,828)	(3,551)	(6,666)	(19,927)	4,468	9,440	22,990	(10,780)	(22,557)	(71,923)
Unfunded Liability at 4% DR	26,267	30,577	40,486	32,807	41,077	58,948	20,243	20,129	18,224	25,098	26,464	24,123	31,987	39,674	60,646	18,842	13,365	(20,646)
Funded Ratio	102.0%	101.8%	101.8%	95.4%	91.5%	86.5%	107.5%	110.4%	115.3%	102.9%	104.8%	110.7%	96.1%	92.6%	85.5%	108.6%	114.9%	133.3%
Funded Ratio at 4% Discount Rate	82.4%	82.3%	82.3%	77.1%	73.9%	69.9%	86.9%	89.2%	93.2%	83.2%	84.7%	89.5%	77.7%	74.8%	69.1%	87.8%	92.9%	107.7%
AAL Compound Annual Growth Rate	3.7%	3.3%	3.1%	2.9%	2.4%	2.3%	4.4%	4.2%	3.9%	3.7%	3.3%	3.1%	2.9%	2.4%	2.3%	4.4%	4.2%	3.9%
Change in AAL from Prior Year (%)	3.1%	2.8%	3.1%	1.8%	1.9%	2.7%	4.1%	3.7%	3.6%	3.1%	2.9%	3.1%	1.9%	2.0%	2.7%	4.2%	3.8%	3.7%
Unfunded Liability / Own Source Revenue at 4% DR	81%	79%	75%	101%	106%	109%	63%	52%	34%	78%	69%	45%	99%	103%	113%	58%	35%	-38%
Cash Flow Measures																		
Benefit Payments	6,811	8,228	10,553	6,548	7,256	8,213	7,030	9,149	13,220	6,811	8,228	10,552	6,548	7,256	8,198	7,030	9,149	13,218
Total Contributions	2,043	2,380	3,272	2,185	2,885	4,536	1,924	1,915	1,850	2,395	2,858	3,994	2,395	2,858	3,994	2,395	2,858	3,994
Negative Operating Cash Flow	4,768	5,848	7,281	4,364	4,370	3,677	5,106	7,234	11,370	4,416	5,370	6,559	4,153	4,398	4,204	4,635	6,291	9,225
Benefit Payments / Beginning of Period MVA	5.7%	6.0%	5.8%	6.0%	6.3%	6.1%	5.5%	5.7%	5.5%	5.7%	5.8%	5.3%	5.9%	6.2%	6.1%	5.5%	5.5%	4.8%
Operating Cash Flow to Assets Ratio	-4.0%	-4.2%	-4.0%	-4.0%	-3.8%	-2.7%	-4.0%	-4.5%	-4.8%	-3.7%	-3.8%	-3.3%	-3.8%	-3.8%	-3.2%	-3.6%	-3.8%	-3.4%
Change in MVA from Prior Year (%)	3.1%	2.8%	3.1%	0.9%	1.1%	2.2%	4.8%	4.3%	4.0%	3.4%	3.3%	3.8%	1.1%	1.1%	1.8%	5.2%	5.0%	5.5%
Own Source Revenue (OSR)	32,363	38,588	53,894	32,363	38,588	53,894	32,363	38,588	53,894	32,363	38,588	53,894	32,363	38,588	53,894	32,363	38,588	53,894
OSR Compound Annual Growth Rate	4.3%	4.0%	3.7%	4.3%	4.0%	3.7%	4.3%	4.0%	3.7%	4.3%	4.0%	3.7%	4.3%	4.0%	3.7%	4.3%	4.0%	3.7%
Change in OSR from Prior Year (%)	4.5%	3.3%	3.4%	4.5%	3.3%	3.4%	4.5%	3.3%	3.4%	4.5%	3.3%	3.4%	4.5%	3.3%	3.4%	4.5%	3.3%	3.4%
Employer Contributions / OSR	3.3%	3.2%	3.2%	3.5%	3.9%	4.3%	3.1%	2.6%	1.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%
Total Contributions / OSR	6.3%	6.2%	6.1%	6.8%	7.5%	8.4%	5.9%	5.0%	3.4%	7.4%	7.4%	7.4%	7.4%	7.4%	7.4%	7.4%	7.4%	7.4%
Payment and Contribution Measures																		
Employer Contributions (ERC)	1,062	1,238	1,701	1,133	1,490	2,334	1,003	1,005	990	1,238	1,476	2,062	1,238	1,476	2,062	1,238	1,476	2,062
Change in ERC from Prior Year (%)	0.9%	3.2%	3.3%	3.4%	5.4%	4.1%	-1.4%	0.0%	-0.3%	4.5%	3.3%	3.4%	4.5%	3.3%	3.4%	4.5%	3.3%	3.4%
Employee Contributions (EEC)	981	1,142	1,570	1,052	1,395	2,203	921	910	860	1,157	1,381	1,931	1,157	1,381	1,931	1,157	1,381	1,931
Payroll	16,292	19,070	26,131	16,292	19,070	26,131	16,292	19,070	26,131	16,292	19,070	26,131	16,292	19,070	26,131	16,292	19,070	26,131
Employer Contribution / Payroll	6.5%	6.5%	6.5%	7.0%	7.8%	8.9%	6.2%	5.3%	3.8%	7.6%	7.7%	7.9%	7.6%	7.7%	7.9%	7.6%	7.7%	7.9%
Employee Contribution / Payroll	6.0%	6.0%	6.0%	6.5%	7.3%	8.4%	5.7%	4.8%	3.3%	7.1%	7.2%	7.4%	7.1%	7.2%	7.4%	7.1%	7.2%	7.4%
Total Contributions / Payroll	12.5%	12.5%	12.5%	13.4%	15.1%	17.4%	11.8%	10.0%	7.1%	14.7%	15.0%	15.3%	14.7%	15.0%	15.3%	14.7%	15.0%	15.3%
Normal Cost	2,115	2,476	3,393	2,115	2,476	3,393	2,115	2,476	3,393	2,115	2,476	3,393	2,115	2,476	3,393	2,115	2,476	3,393
Normal Cost (4% DR)	3,620	4,237	5,806	3,620	4,237	5,806	3,620	4,237	5,806	3,620	4,237	5,806	3,620	4,237	5,806	3,620	4,237	5,806
Net amortization $	95	79	111	(232)	(278)	(269)	388	452	617	515	821	1,922	29	(205)	(899)	943	1,814	5,281
Net amortization $ (4% DR)	(2,625)	(3,082)	(4,156)	(2,713)	(2,954)	(3,565)	(2,540)	(3,178)	(4,775)	(2,235)	(2,459)	(2,835)	(2,475)	(2,927)	(4,160)	(2,023)	(2,003)	(1,238)
Net amortization $ / Payroll	0.6%	0.4%	0.4%	-1.4%	-1.5%	-1.0%	2.4%	2.4%	2.4%	3.2%	4.3%	7.4%	0.2%	-1.1%	-3.4%	5.8%	9.5%	20.2%
Net amortization $ / Payroll (4% DR)	-16.1%	-16.2%	-15.9%	-16.7%	-15.5%	-13.6%	-15.6%	-16.7%	-18.3%	-13.7%	-12.9%	-10.9%	-15.2%	-15.3%	-15.9%	-12.4%	-10.5%	-4.7%
Investment Performance																		
Compounded Annual Growth - From Start Date	7.20%	7.20%	7.20%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%	7.20%	7.20%	7.20%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%
Compounded Annual Growth - Segments	7.20%	7.20%	7.20%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%	7.20%	7.20%	7.20%	5.00%	5.00%	5.00%	9.00%	9.00%	9.00%

Note: Dollar Figures in Millions

Fiscal Metrics
Model Output

State
Wisconsin
Plans Included
Retirement System

Metrics	State Policy (Current Contribution Policy)									Sustainable Budget (Fixed % of OSR)								
	Stochastic Run - Baseline CMA									Stochastic Run - Baseline CMA								
	25th Percentile			50th Percentile			75th Percentile			25th Percentile			50th Percentile			75th Percentile		
	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures																		
Market Value of Assets (MVA)	99,536	103,595	123,077	117,865	130,495	156,273	138,758	162,148	209,010	100,148	104,967	123,642	119,060	134,454	173,571	140,481	169,503	240,353
Actuarial Accrued Liability (AAL)	111,231	117,901	139,290	119,164	131,848	159,510	127,088	147,553	191,088	111,267	118,069	140,363	119,252	132,136	160,351	127,165	147,748	191,404
Accrued Liability at 4% Discount Rate (DR)	137,619	145,872	172,335	147,433	163,126	197,351	157,238	182,558	236,420	137,663	146,080	173,662	147,542	163,483	198,392	157,333	182,799	236,812
Unfunded Actuarial Accrued Liability (UAAL)	11,695	14,306	16,213	1,298	1,353	3,237	(11,670)	(14,596)	(17,922)	11,118	13,102	16,721	192	(2,318)	(13,221)	(13,316)	(21,755)	(48,948)
Unfunded Liability at 4% DR	38,083	42,277	49,257	29,568	32,632	41,078	18,480	20,409	27,411	37,514	41,113	50,020	28,482	29,029	24,820	16,852	13,296	(3,540)
Funded Ratio	89.5%	87.9%	88.4%	98.9%	99.0%	98.0%	109.2%	109.9%	109.4%	90.0%	88.9%	88.1%	99.8%	101.8%	108.2%	110.5%	114.7%	125.6%
Funded Ratio at 4% Discount Rate	72.3%	71.0%	71.4%	79.9%	80.0%	79.2%	88.2%	88.8%	88.4%	72.7%	71.9%	71.2%	80.7%	82.2%	87.5%	89.3%	92.7%	101.5%
AAL Compound Annual Growth Rate	2.0%	1.6%	1.6%	3.4%	2.7%	2.3%	4.8%	3.9%	3.3%	2.0%	1.6%	1.7%	3.4%	2.8%	2.4%	4.8%	3.9%	3.3%
Change in AAL from Prior Year (%)	0.4%	0.7%	1.3%	2.1%	2.0%	2.0%	4.4%	3.1%	3.0%	0.4%	0.7%	1.5%	2.1%	2.0%	2.1%	4.4%	3.1%	3.0%
Unfunded Liability / Own Source Revenue at 4% DR	118%	111%	93%	92%	84%	76%	57%	53%	51%	117%	108%	94%	89%	75%	46%	52%	35%	-7%
Cash Flow Measures																		
Benefit Payments	6,345	6,900	8,045	6,801	7,844	9,488	7,185	9,034	11,811	6,346	6,900	8,032	6,808	7,853	9,489	7,190	9,043	11,771
Total Contributions	2,232	2,802	3,844	1,998	2,352	3,068	1,811	1,749	1,989	2,381	2,823	4,004	2,381	2,868	3,986	2,382	2,833	4,002
Negative Operating Cash Flow	4,114	4,099	4,201	4,803	5,492	6,420	5,374	7,285	9,822	3,964	4,077	4,028	4,426	4,985	5,502	4,808	6,210	7,768
Benefit Payments / Beginning of Period MVA	6.3%	6.7%	6.6%	5.8%	6.1%	6.2%	5.5%	5.7%	5.8%	6.3%	6.6%	6.6%	5.8%	6.0%	5.6%	5.5%	5.6%	5.1%
Operating Cash Flow to Assets Ratio	-4.1%	-4.0%	-3.5%	-4.1%	-4.3%	-4.2%	-4.1%	-4.6%	-4.9%	-3.9%	-3.9%	-3.3%	-3.7%	-3.8%	-3.3%	-3.6%	-3.8%	-3.4%
Change in MVA from Prior Year (%)	-1.4%	0.0%	1.2%	0.7%	1.4%	2.2%	6.2%	3.1%	3.4%	-1.3%	-0.1%	1.5%	0.7%	1.9%	3.1%	6.6%	4.1%	5.0%
Own Source Revenue (OSR)	32,177	38,034	53,160	32,165	38,669	53,875	32,194	38,237	54,103	32,164	38,064	53,341	32,164	38,672	53,598	32,172	38,197	53,810
OSR Compound Annual Growth Rate	4.2%	3.8%	3.6%	4.2%	4.0%	3.7%	4.2%	3.9%	3.7%	4.2%	3.8%	3.6%	4.2%	4.0%	3.6%	4.2%	3.8%	3.7%
Change in OSR from Prior Year (%)	4.5%	3.4%	3.4%	4.4%	3.2%	3.5%	4.5%	3.2%	3.5%	4.5%	3.4%	3.3%	4.5%	3.2%	3.5%	4.4%	3.2%	3.4%
Employer Contributions / OSR	3.6%	3.8%	3.7%	3.2%	3.2%	3.0%	2.9%	2.4%	1.9%	3.8%	3.8%	3.9%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%
Total Contributions / OSR	6.9%	7.4%	7.2%	6.2%	6.1%	5.7%	5.6%	4.6%	3.7%	7.4%	7.4%	7.5%	7.4%	7.4%	7.4%	7.4%	7.4%	7.4%
Payment and Contribution Measures																		
Employer Contributions (ERC)	1,156	1,446	1,979	1,039	1,222	1,592	945	919	1,051	1,231	1,456	2,078	1,231	1,480	2,051	1,231	1,461	2,059
Change in ERC from Prior Year (%)	3.6%	5.9%	2.3%	-0.5%	3.0%	3.3%	-4.1%	-0.9%	1.5%	4.5%	3.4%	3.1%	4.5%	3.2%	3.5%	4.4%	3.2%	3.4%
Employee Contributions (EEC)	1,076	1,356	1,865	959	1,131	1,476	865	830	938	1,151	1,367	1,926	1,151	1,389	1,936	1,151	1,372	1,943
Payroll	16,007	17,878	22,857	16,005	18,176	23,157	16,013	18,015	23,224	16,003	17,884	22,957	16,004	18,174	23,036	16,007	17,995	23,118
Employer Contribution / Payroll	7.2%	8.1%	8.7%	6.5%	6.7%	6.9%	5.9%	5.1%	4.5%	7.7%	8.1%	9.1%	7.7%	8.1%	8.9%	7.7%	8.1%	8.9%
Employee Contribution / Payroll	6.7%	7.6%	8.2%	6.0%	6.2%	6.4%	5.4%	4.6%	4.0%	7.2%	7.6%	8.4%	7.2%	7.6%	8.4%	7.2%	7.6%	8.4%
Total Contributions / Payroll	13.9%	15.7%	16.8%	12.5%	12.9%	13.2%	11.3%	9.7%	8.6%	14.9%	15.8%	17.4%	14.9%	15.8%	17.3%	14.9%	15.7%	17.3%
Normal Cost	2,097	2,337	2,988	2,097	2,375	3,027	2,097	2,358	3,032	2,097	2,337	3,002	2,097	2,375	3,012	2,097	2,355	3,020
Normal Cost (4% DR)	3,588	3,999	5,114	3,588	4,065	5,180	3,589	4,035	5,189	3,588	4,000	5,137	3,588	4,064	5,154	3,588	4,030	5,168
Net amortization $	(567)	(494)	(254)	(77)	(64)	(209)	350	392	121	(378)	(376)	(153)	395	685	1,819	1,018	1,909	4,122
Net amortization $ (4% DR)	(2,827)	(2,874)	(3,233)	(2,715)	(2,995)	(3,779)	(2,609)	(3,121)	(4,356)	(2,656)	(2,801)	(3,129)	(2,283)	(2,352)	(2,232)	(1,984)	(1,795)	(1,227)
Net amortization $ / Payroll	-3.5%	-2.8%	-1.1%	-0.5%	-0.4%	-0.9%	2.2%	2.2%	0.5%	-2.4%	-2.1%	-0.7%	2.5%	3.8%	7.9%	6.4%	10.6%	17.8%
Net amortization $ / Payroll (4% DR)	-17.7%	-16.1%	-14.1%	-17.0%	-16.5%	-16.3%	-16.3%	-17.3%	-18.8%	-16.6%	-15.7%	-13.6%	-14.3%	-12.9%	-9.7%	-12.4%	-10.0%	-5.3%
Investment Performance																		
Compounded Annual Growth - From Start Date	2.9%	3.9%	4.7%	6.3%	6.4%	6.4%	9.8%	8.8%	8.1%	2.9%	3.9%	4.7%	6.3%	6.4%	6.4%	9.8%	8.8%	8.1%
Compounded Annual Growth - Segments	2.9%	4.9%	5.4%	6.3%	6.4%	6.4%	9.8%	7.8%	7.4%	2.9%	4.9%	5.5%	6.3%	6.4%	6.4%	9.8%	7.8%	7.4%

Note: Dollar Figures in Millions

State

Wisconsin

Plans Included

Retirement System

	State Policy (Current Contribution Policy)						Sustainable Budget (Fixed % of OSR)					
	Deterministic			Deterministic			Deterministic			Deterministic		
	"Low-for-long" Economic Scenario			"Asset Shock" Economic Scenario			"Low-for-long" Economic Scenario			"Asset Shock" Economic Scenario		
Metrics	2022	2027	2037	2022	2027	2037	2022	2027	2037	2022	2027	2037
Balance Sheet Measures												
Market Value of Assets (MVA)	106,936	111,752	125,846	97,328	104,867	121,013	107,751	113,633	130,251	95,975	101,442	112,301
Actuarial Accrued Liability (AAL)	114,131	122,186	142,757	104,062	117,827	140,227	114,118	122,380	143,944	104,035	117,875	140,794
Accrued Liability at 4% Discount Rate (DR)	141,206	151,173	176,624	128,749	145,780	173,494	141,191	151,413	178,092	128,716	145,839	174,195
Unfunded Actuarial Accrued Liability (UAAL)	7,195	10,434	16,912	6,734	12,960	19,214	6,367	8,747	13,692	8,060	16,433	28,492
Unfunded Liability at 4% DR	34,270	39,421	50,779	31,421	40,913	52,481	33,440	37,780	47,841	32,741	44,397	61,894
Funded Ratio	93.7%	91.5%	88.2%	93.5%	89.0%	86.3%	94.4%	92.9%	90.5%	92.3%	86.1%	79.8%
Funded Ratio at 4% Discount Rate	75.7%	73.9%	71.3%	75.6%	71.9%	69.8%	76.3%	75.0%	73.1%	74.6%	69.6%	64.5%
AAL Compound Annual Growth Rate	2.5%	2.0%	1.8%	0.7%	1.6%	1.7%	2.5%	2.0%	1.8%	0.7%	1.6%	1.7%
Change in AAL from Prior Year (%)	1.3%	1.6%	1.5%	0.6%	1.8%	2.0%	1.2%	1.6%	2.0%	0.5%	1.8%	2.0%
Unfunded Liability / Own Source Revenue at 4% DR	106%	102%	94%	102%	111%	102%	103%	98%	89%	106%	121%	121%
Cash Flow Measures												
Benefit Payments	6,467	7,033	8,050	5,662	6,616	7,834	6,467	7,032	8,014	5,667	6,615	7,833
Total Contributions	2,186	2,751	3,880	2,611	2,970	4,027	2,396	2,862	4,008	2,275	2,718	3,806
Negative Operating Cash Flow	4,280	4,283	4,170	3,051	3,646	3,808	4,070	4,170	4,006	3,392	3,898	4,027
Benefit Payments / Beginning of Period MVA	6.1%	6.4%	6.5%	5.9%	6.4%	6.6%	6.0%	6.3%	6.3%	6.0%	6.6%	7.1%
Operating Cash Flow to Assets Ratio	-4.0%	-3.9%	-3.4%	-3.2%	-3.5%	-3.2%	-3.8%	-3.7%	-3.1%	-3.6%	-3.9%	-3.6%
Change in MVA from Prior Year (%)	0.4%	1.0%	1.5%	1.2%	1.3%	1.6%	0.6%	1.1%	1.7%	0.8%	0.9%	1.2%
Own Source Revenue (OSR)	32,363	38,588	53,894	30,775	36,693	51,248	32,363	38,588	53,894	30,775	36,693	51,248
OSR Compound Annual Growth Rate	4.3%	4.0%	3.7%	3.3%	3.4%	3.4%	4.3%	4.0%	3.7%	3.3%	3.4%	3.4%
Change in OSR from Prior Year (%)	4.5%	3.3%	3.4%	3.8%	3.3%	3.4%	4.5%	3.3%	3.4%	3.8%	3.3%	3.4%
Employer Contributions / OSR	3.5%	3.7%	3.7%	4.4%	4.2%	4.0%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%
Total Contributions / OSR	6.8%	7.1%	7.2%	8.5%	8.1%	7.9%	7.4%	7.4%	7.4%	7.4%	7.4%	7.4%
Payment and Contribution Measures												
Employer Contributions (ERC)	1,133	1,421	1,998	1,346	1,530	2,071	1,238	1,476	2,062	1,177	1,404	1,961
Change in ERC from Prior Year (%)	2.6%	4.1%	3.1%	3.8%	3.3%	2.8%	4.5%	3.3%	3.4%	3.8%	3.3%	3.4%
Employee Contributions (EEC)	1,053	1,330	1,882	1,266	1,440	1,956	1,158	1,386	1,946	1,097	1,314	1,845
Payroll	16,064	18,155	23,190	16,039	18,077	23,089	16,064	18,155	23,190	16,039	18,077	23,089
Employer Contribution / Payroll	7.1%	7.8%	8.6%	8.4%	8.5%	9.0%	7.7%	8.1%	8.9%	7.3%	7.8%	8.5%
Employee Contribution / Payroll	6.6%	7.3%	8.1%	7.9%	8.0%	8.5%	7.2%	7.6%	8.4%	6.8%	7.3%	8.0%
Total Contributions / Payroll	13.6%	15.2%	16.7%	16.3%	16.4%	17.4%	14.9%	15.8%	17.3%	14.2%	15.0%	16.5%
Normal Cost	2,101	2,374	3,032	2,099	2,364	3,019	2,101	2,374	3,032	2,099	2,364	3,019
Normal Cost (4% DR)	3,595	4,063	5,189	3,592	4,045	5,167	3,595	4,063	5,189	3,592	4,045	5,167
Net amortization $	(355)	(299)	(317)	4	(251)	(287)	(98)	(73)	68	(416)	(732)	(1,132)
Net amortization $ (4% DR)	(2,752)	(2,862)	(3,333)	(2,274)	(2,682)	(3,206)	(2,516)	(2,688)	(3,067)	(2,657)	(3,062)	(3,779)
Net amortization $ / Payroll	-2.2%	-1.6%	-1.4%	0.0%	-1.4%	-1.2%	-0.6%	-0.4%	0.3%	-2.6%	-4.0%	-4.9%
Net amortization $ / Payroll (4% DR)	-17.1%	-15.8%	-14.4%	-14.2%	-14.8%	-13.9%	-15.7%	-14.8%	-13.2%	-16.6%	-16.9%	-16.4%
Investment Performance												
Compounded Annual Growth - From Start Date	4.3%	4.6%	4.8%	2.3%	3.6%	4.3%	4.3%	4.6%	4.8%	2.3%	3.6%	4.3%
Compounded Annual Growth - Segments	4.3%	4.9%	4.9%	2.3%	4.9%	4.9%	4.3%	4.9%	4.9%	2.3%	4.9%	4.9%

Note: Dollar Figures in Millions

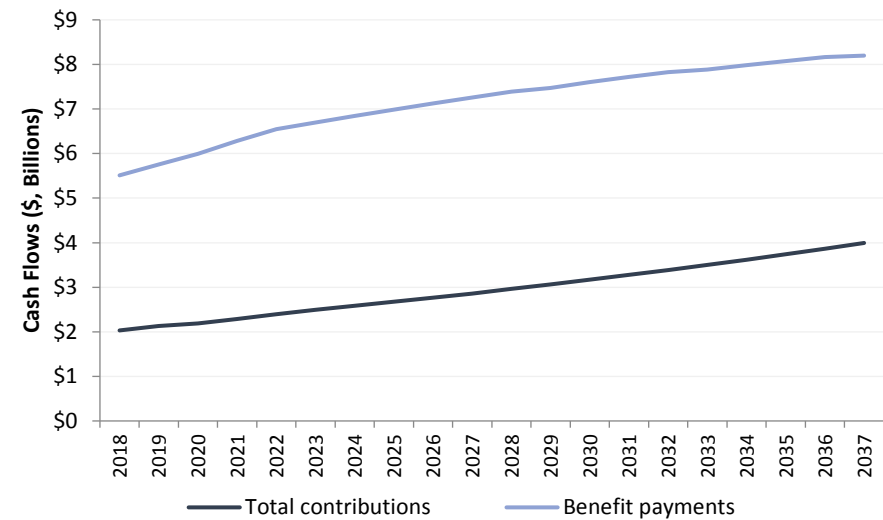# Wisconsin
Fixed 5% Economic Scenario
Retirement System

Assets vs. Cash Flow
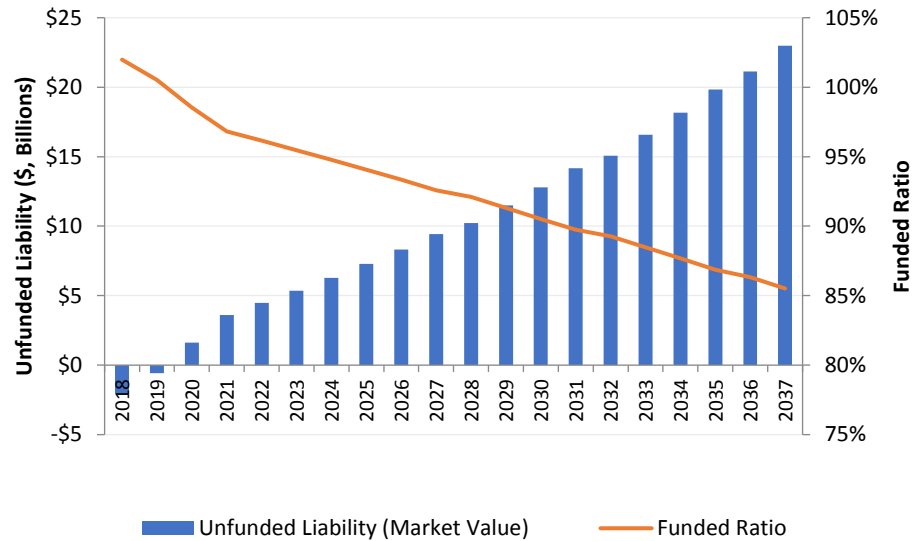Assuming 5% returns and contributions fixed as % of OSR

Market Value of Assets — Operating Cash Flow, Percent of Assets

Total Contributions vs. Benefit Payments
Assuming 5% returns and contributions fixed as % of OSR

Total contributions — Benefit payments

Unfunded Liability vs. Funding Levels
Assuming 5% returns and contributions fixed as % of OSR

Unfunded Liability (Market Value) — Funded Ratio

Employer Contributions vs. Pension Debt
Assuming 5% returns and plans' statutory contribution policy

Pension Debt as Share of OSR — Employer Contribution Rate