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A Stress Test of Philadelphia's Retirement System

How the city's pension plan would perform under various scenarios

Overview

The Pew Charitable Trusts conducted a stress test analysis of Philadelphia's city retirement plan in late 2018 to help policymakers evaluate how the plan would weather various economic conditions, given recent reforms.

Philadelphia sponsors a retirement plan as part of the compensation package for over 28,000 municipal employees.[1] As of 2017, the most recent year for which data were available for Philadelphia and the other cities cited in this brief—Baltimore, Chicago, Houston, and Pittsburgh—the retirement system was 43 percent funded, a higher percentage than in Chicago but lower than in the other three cities. The annual contribution by city government was over $700 million; the contribution rose to $782 million in 2018.[2] Philadelphia has increased contributions to the pension system substantially since 2014, when they were $553 million, to make up for previous years in which the city's contributions had not kept pace with the system's needs. In addition, reforms that started in 2016 increased employee contributions and established a stacked hybrid structure for new, nonuniformed employees—combining elements of traditional defined benefit plans and 401(k)-style defined contribution plans—to reduce the cost of future pensions.

This brief provides summary results of the stress test analysis for Philadelphia, which Pew conducted in partnership with the actuarial firm The Terry Group. Specifically, the brief assesses whether recent reforms will allow the city's pension promises to be kept in a fiscally sustainable way, whether the plan will more effectively manage the risk of market volatility and underperformance as a result, and how future retirement system costs

will affect Philadelphia's budget.[3] To illustrate the range of outcomes that cities face as a result of their different fiscal situations, plan designs, and funding policies, the brief also presents summary data for the four peer cities cited above.

This research focuses on three key issues: 1) the possibility that investments could not perform as well as expected, 2) the prospect that contributions could fall below the rate required to meet funding objectives, and 3) the impact these risks can have on the plan's fiscal health and the city's budget. The analysis takes as a starting point the plan's own assumptions and actuarial methods—including long-term financial projections released by the Philadelphia city retirement plan each year—before applying risk scenarios. The result is intended to be accessible to all stakeholders and was designed to inform planning and decision-making.[4]

Following are some of the analysis's key findings for Philadelphia:

- If maintained in the years ahead, Philadelphia's current funding policy is projected to sustainably pay down the city's pension debt even if returns fall short of expectations.
- Although market volatility will affect the city government's pension costs, these costs are not projected to be materially higher than they are now—in terms of the percentage of the city's overall revenue to be deposited into the pension system—under any of the scenarios tested.
- The cost to the city is likely to remain high for years to come. This means that contributions to the pension fund will continue to crowd out spending on other budget priorities.
- The stacked hybrid plan design, now in effect for some newly hired workers, will lower the city's exposure to investment risk if its current form is maintained; however, any future increases in the defined benefit portion of the hybrid will add to the cost of benefits.

Philadelphia findings

As part of the stress test analysis, three economic scenarios were simulated for the Philadelphia pension system through 2037. One modeled the baseline projections under current plan policy and actuarial assumptions, in which the plan meets its 7.65 percent expected annual return on investments. Another modeled a likely low-return scenario in which the return on assets is 5 percent, reflecting financial experts' consensus that future returns will perform below historical averages.[5] The third scenario, an asset price shock simulating a recession, showed market returns initially declining by approximately 26 percent in year one, followed by a three-year recovery and then low, 5 percent equity returns over the long term.[6]

The analysis takes into account several changes that have been made to the city's main retirement system in recent years, including the pension board's adoption of a revenue recognition policy that has resulted in increased contributions by city government; the dedication, by state law, of a portion of the local sales tax to the pension system; higher employee contributions; and the hybrid plan for new workers.

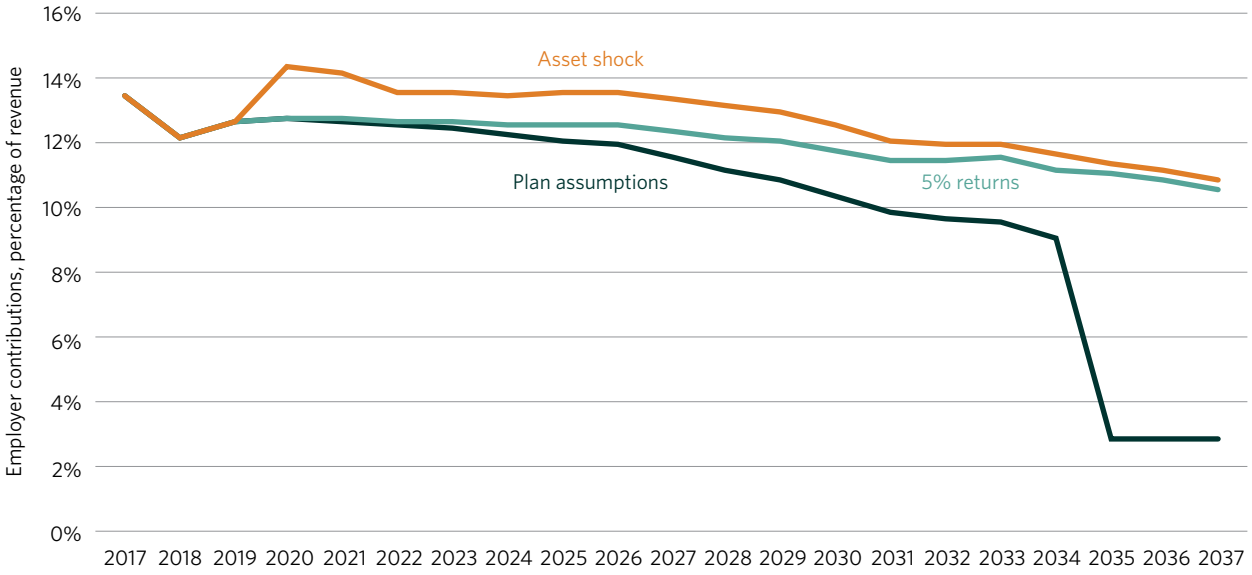
As shown in Figure 1, if the plan meets its 7.65 percent assumed rate of return annually, the government's contributions will drop from 13 percent of revenue in 2017 to about 9 percent in 2034 and then to below 3 percent.[7] Absent the Philadelphia Water Department's and Philadelphia International Airport's funds, which were included in the definition of revenue based on feedback from city budget officials, the 2017 contribution as a share of revenue was 17 percent. Philadelphia's 2017 estimated employer contribution as a share of revenue is currently among the highest of the cities assessed, but it is projected to be the lowest at the end of the forecast period if all assumptions are met.

In a low-return scenario in which the plan earns 5 percent annually, the data project a more gradual decline in employer contributions, which would remain above 10 percent of revenue throughout the forecast period. And in an asset shock scenario, projected contributions based on current policy would rise during the initial market downturn, then start gradually declining in a pattern similar to that projected in the low-return scenario.

Figure 1

Employer Contributions to the Philadelphia City Retirement Plan as a Share of Revenue Under 3 Scenarios

Assuming current city contribution policy is maintained



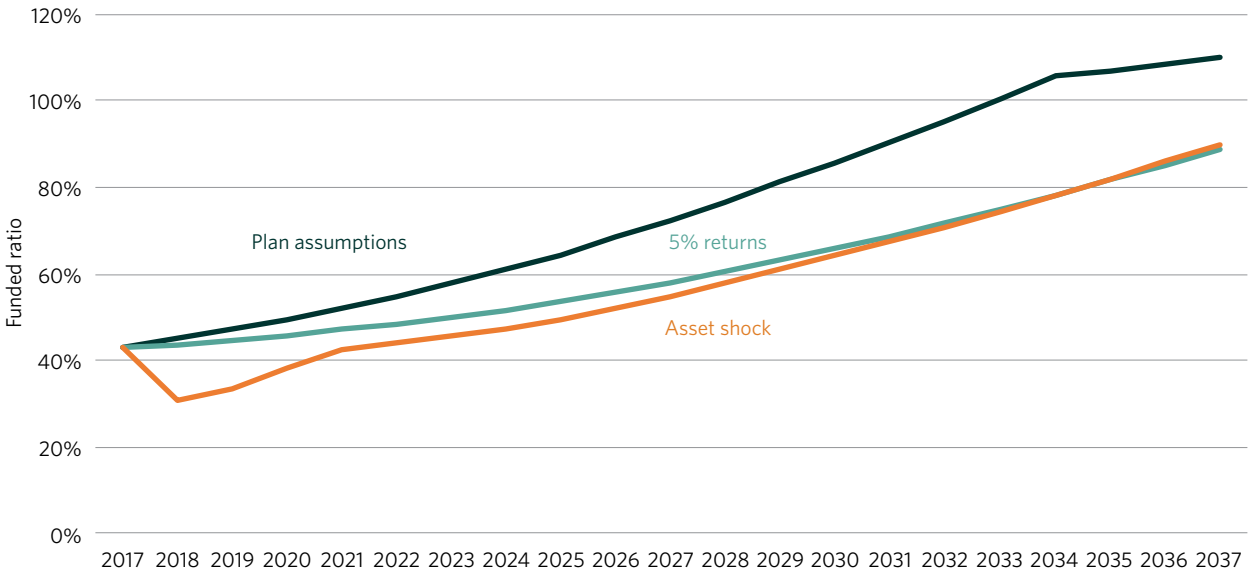
Sources: The Terry Group and The Pew Charitable Trusts

Likewise, in each of these scenarios, the system's funded ratio—the amount of funds on hand divided by benefits owed—is expected to improve, although it would fall initially in the asset shock scenario, as shown in Figure 2. The ratio reaches at least 80 percent by 2035, even under the two lower-return scenarios.

Figure 2

Funded Ratio of the Philadelphia City Retirement Plan Under 3 Scenarios

Assuming current city contribution policy is maintained



Sources: The Terry Group and The Pew Charitable Trusts

These results are largely a function of the recent changes in the system, particularly the relatively high level of current contributions from the city and employees combined—equal to 95 percent of benefit payments in 2017. By way of comparison, the next highest contribution-benefits ratio among the four comparison cities was 68 percent, in Pittsburgh; the highest contribution ratio among state systems in 2017 was 89 percent, in North Dakota. Another contributing factor is the hybrid tier introduced in the 2016 reforms, which will lower plan costs over time by providing some new employees with a defined benefit plan for only a portion of their salaries.

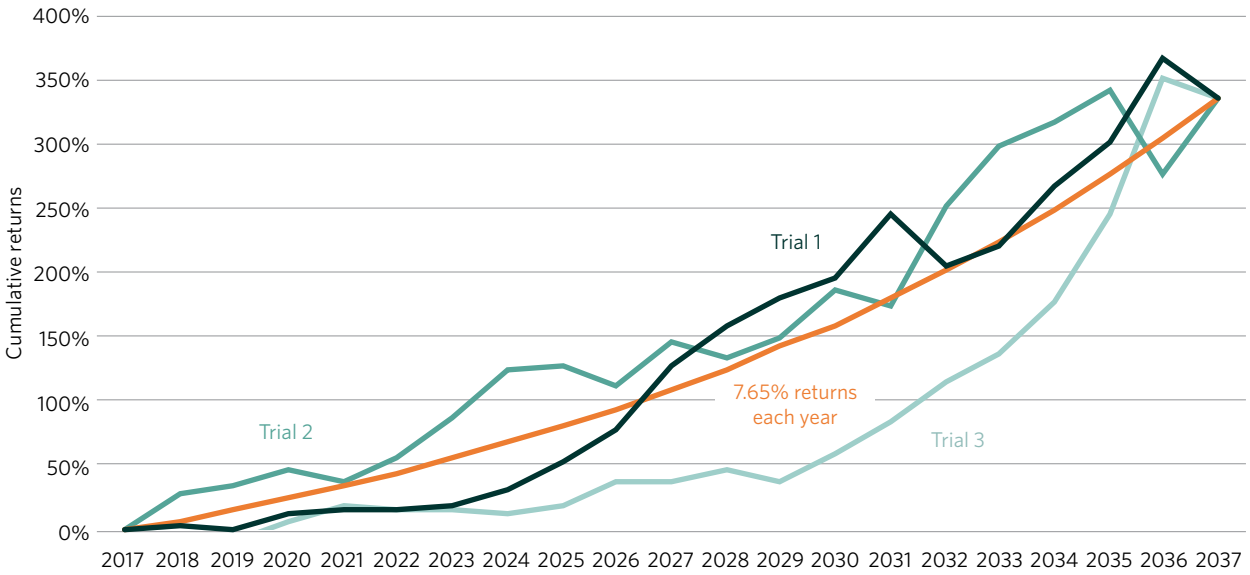
Long-term market underperformance is not the only source of investment risk to retirement systems. Annual fluctuations in market returns can cause volatility in required employer contributions or result in decreased pension plan funding even if returns match plan actuaries' assumptions over the long term. For this reason, the analysis also estimates financial outcomes using stochastic analysis, a simulation tool that generates thousands of possible forward-looking trials to examine the probable impact of market uncertainty on financial outcomes.

The next two graphics illustrate how future market volatility may affect Philadelphia's pension costs. Figure 3 depicts three trial runs with varying sequences of returns that average 7.65 percent over the 20-year forecast period—and compares them with what would happen if the returns were 7.65 percent each year.[8]

Figure 3

Cumulative Investment Returns for the Philadelphia City Retirement Plan

Trials with same overall 20-year performance



Note: Based on trials with 7.65 percent cumulative returns over 20-year period.

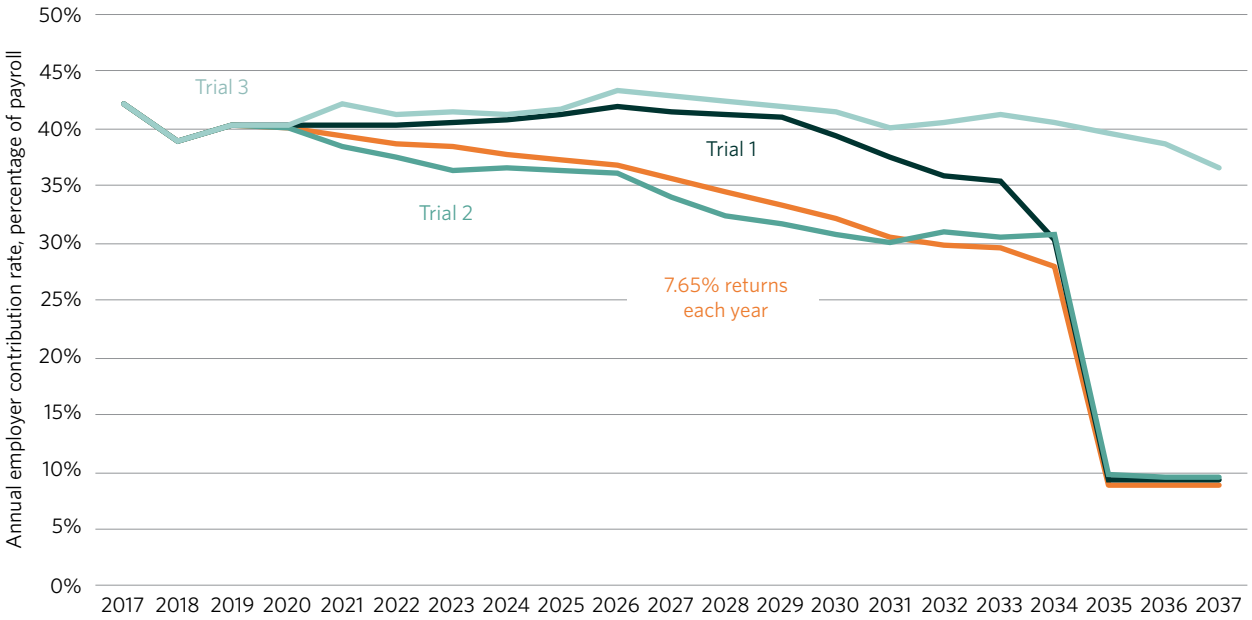
Sources: The Terry Group and The Pew Charitable Trusts

Figure 4 shows the impact of this volatility on employer contributions, with the city's annual contribution to the pension fund—expressed as a percentage of payroll—projected over the forecast period for each of the trials illustrated in Figure 3. The city's contribution in 2017 was 42 percent of payroll; however, the subsequent trajectory of costs depends on the timing of returns in addition to the long-term investment performance. In other words, volatile market returns could potentially lead to longer-term high costs and effectively delay full funding of the system even if long-term plan assumptions are correct, as shown most clearly in Trial 3 of Figure 4.

Figure 4

Annual Employer Contribution Rates for the Philadelphia City Retirement Plan

Trials with same overall 20-year performance



Note: Based on trials with 7.65 percent cumulative returns over 20-year period.

Sources: The Terry Group and The Pew Charitable Trusts

Philadelphia's high contribution rate is a primary driver behind the findings of projected cost stability and funding improvements. In particular, Philadelphia's funding policy pays the full actuarial determined contribution and additionally sets aside a portion of sales tax revenue and employee contributions as pension plan payments above and beyond the actuarial contribution.[9] The adoption of a stacked hybrid plan design for new, nonuniformed city employees also plays a role. The plan provides a defined benefit to all workers based on salaries up to $65,000. Employees with higher salaries may also participate in a defined contribution plan, with employees contributing up to 3 percent of their salaries above $65,000 and employers matching 50 percent of those contributions. Because city funding of the defined contribution portion of the stacked hybrid remains fixed regardless of market performance, this plan reduces Philadelphia's exposure to investment risk.

The benefit design, based on a collective bargaining agreement, does not provide for indexing the $65,000 salary threshold to any measure of inflation. As a result, as salaries rise over time, a declining share of total salary is subject to the defined benefit plan, thereby reducing employer cost and risk. But if the threshold were to increase in future years, it would lessen the reduction of employer cost and risk.

How Philadelphia compares with its peers

Because it can be helpful to compare the fiscal resilience and plan design of one public retirement system with those of similar systems, the researchers performed a stress test analysis on municipal and public safety employees' pension plans in four of Philadelphia's peer cities: Baltimore, Chicago, Houston, and Pittsburgh.

Figure 5, which provides the key fiscal metrics of this comparative analysis, shows that Philadelphia is unique in the level of total contributions it makes to the municipal retirement system—95 percent as a fraction of current benefit payments, which means it had nearly as much coming into the funds as was going out. In essence, annual contributions from government and employees are paying for retiree pension checks, leaving investment returns on the plan's assets to pay down the system's legacy debt. As described above, Philadelphia's high contribution ratio helps to insulate its retirement system and budget from adverse scenarios. However, this is not the case for other cities, highlighting the importance of maintaining the funding commitments that Philadelphia has made in recent reforms, including the revenue recognition policy.

Figure 5

City Pension Plans' Finances in 2017

All 5 cities underfunded, but with very different fiscal positions

2017	Philadelphia	Baltimore	Chicago	Houston	Pittsburgh
Total liability (in billions of dollars)	$11.3	$6.1	$35.0	$15.6	$1.3
Funded ratio	43%	69%	25%	71%	58%
Annual total contributions as a share of benefit payments	95%	65%	66%	50%	68%
Annual employer contributions as a share of payroll	42%	31%	30%	32%	21%
Annual employer contributions as a share of revenue*	13%	12%	16%	16%	9%
Number of participants†	66,321	28,563	94,707	44,969	7,661
Assumed rate of return‡	7.65%	7.28%	7.17%	7.00%	7.25%

* On the advice of Philadelphia pension and budget officials, revenue from the Water Department and airport funds is included in the definition of Philadelphia's revenue, as they are part of the city retirement system. This is not the case with the other cities and, as such, Philadelphia's annual employer contribution as a share of revenue may be understated in relation to those of the comparison cities. Absent the Water Department and airport funds, Philadelphia's 2017 annual employer contribution as a share of revenue is 17 percent.

† Includes active participants, retirees and beneficiaries, and terminated vested employees.

‡ Assumed return is calculated using the liability-weighted average of expected returns for plans in each city.

Note: Data for cities cover the main municipal employee and public safety plans.

Sources: Comprehensive annual financial reports, actuarial valuations, and other plan documents

Projected funded ratios under a 5 percent return scenario using each city's current contribution policy yield striking differences. Philadelphia's funding policy is more robust than those of the comparison cities: It is the sole system to generate significant improvements in funded status even under this low-return scenario. Comparisons of Philadelphia's forward-looking stress test results with those of the other cities will be explored in greater detail in a full report later this year.

Conclusion

Philadelphia's recent reforms demonstrate that improved funding of a municipal pension system is attainable if the city strictly adheres to scheduled contributions. The city's high contribution rate, although challenging from a budgeting perspective, provides protection from future investment underperformance. Even under adverse return scenarios, required contributions are not projected to increase appreciably over time as a percentage of budget resources. And perhaps most significantly, if Philadelphia adheres to its new, higher contribution levels, the pension system's funded ratio will increase gradually and substantially under any economic scenario.

The projected improvement in Philadelphia's retirement system funded level is also due, in part, to the stacked hybrid plan design for new hires, which exposes the city to lower levels of investment risk over time as the stacked hybrid becomes a larger portion of total pension liability.

But even under the best scenarios, high pension costs are likely to persist in Philadelphia for years, making that money unavailable to address other budget priorities. And if policies are changed at a later date—by reducing contributions or increasing benefits without funding them—these findings are likely to change.

Philadelphia's pension reforms have set the city retirement system on a path to sustainably deliver on pension promises as long as policymakers remain committed to their current contribution policy in the years to come. Maintaining those policies will have real costs for taxpayers and those who depend on city services.

Appendix A: Pew Stress Test Foundation and Methodology

What is stress testing?

Stress testing is a type of analysis in which adverse economic scenarios are simulated to assess a financial system's fiscal health and stability. Building on existing projections and reporting practices, comprehensive stress testing can be a powerful tool for determining how balance sheets will fare during a financial crisis, over a period of lower-than-expected growth, or in other downside economic scenarios. It allows government officials and public pension system managers to:

- Assess the impact of lower investment returns or an economic recession on pension costs and liabilities, including the likelihood of retirement system insolvency for poorly funded plans.
- Examine the effects of financial market volatility and contribution policies on governmental budgets.
- Improve funding policies by evaluating the impact of reform proposals under consideration.

In the context of public pensions, stress testing has historically focused on investment returns' impact on balance sheets and funding requirements. To more accurately measure and manage financial risks, these analyses should include assessments of pension funds' specific contribution policies as well as past funding behavior in the context of the impact on the locality's or the state's projected revenue.[10] Pew's stress test simulation model accounts for these risk factors and the potential impact on both pension system health and resources to pay for other core government services. For more detail on the model's methodology and development, please see "Assessing the Risk of Fiscal Distress for Public Pensions: State Stress Test Analysis."[11]

Pew's stress testing model

Pew's simulation tool incorporates a jurisdiction's financials as inputs, simulates different economic conditions, and produces projections and fiscal metrics as outputs. The model uses a distinct, two-part analytic framework that generates a range of likely outcomes in the simulations and includes budget impact measures based on a jurisdiction's specific revenue forecasts.

The framework applies economic scenarios that focus on the risk associated with lower-than-expected investment returns, including the effect of an economic recession. The framework also incorporates behavioral assumptions that model how policymakers may respond to lower returns, accounting for current plan funding policies, affordability, and past behavior.

Actuarial projections

The analysis starts with a baseline roll-forward projection of the actuarial and financial information using the plan's own assumptions and methods. The Terry Group, an independent actuarial firm, developed the underlying model in partnership with Pew. In addition to providing an estimate of budget pressures and plan funding levels if all assumptions are met, the actuarial forecast component of the simulation model is also designed to facilitate projections under different economic scenarios and assumptions about policymakers' behavior in making required contributions.

Capital market assumptions

Pew developed a set of capital market and economic assumptions to provide an independent estimate of the expected return for stocks, bonds, and other investments based on the investment policy and target allocation for each jurisdiction's pension plans. These assumptions were developed after reviewing the forecasts of major business, academic, and government institutions.

The 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 or city's pension fund under both deterministic and stochastic simulation models.

In total, the model developed return and risk assumptions for seven asset classes: U.S. equity, non-U.S. equity, core bonds, long government, private equity, real estate, and cash. Due to methodological constraints, fund allocations to hedge funds were evenly distributed across all other asset classes and commodities were remapped to real estate for pension plan portfolios containing these alternative investments.

A.1

Key Assumptions by Asset Class

	Expected geometric return	Standard deviation	U.S. equity	Non-U.S. equity	Cash	Core bonds	Long government	Real estate	Private equity
U.S. equity	6.7%	16.4%	1	0.83	0.02	0.14	-0.31	0.13	0.72
Non-U.S. equity	6.7%	18.5%	0.83	1	0.03	0.14	-0.28	0.12	0.66
Cash	1.7%	0.8%	0.02	0.03	1	0.07	0.05	0.01	0.09
Core bonds	3.6%	4.1%	0.14	0.14	0.07	1	0.84	0.05	0.03
Long government	3.4%	11.0%	-0.31	-0.28	0.05	0.84	1	-0.04	-0.3
Real estate	6.0%	12.5%	0.13	0.12	0.01	0.05	-0.04	1	0.35
Private equity	8.6%	21.1%	0.72	0.66	0.09	0.03	-0.3	0.35	1

Revenue projections

To understand the budget implications of investment shortfalls or other risks, as well as to model the revenue-constrained contribution assumption (where pension contributions by government are held constant as a percentage of revenue), projected revenue was used for the jurisdictions sponsoring the pension funds covered in this analysis. For Philadelphia, the 2017 base was "own source revenue" (OSR), using data reported in the Statement of Revenues, Expenditures and Changes in Fund Balances of Governmental Funds in the city's Comprehensive Annual Financial Report for the fiscal year ended June 30, 2017.[12] Based on feedback from the city, Philadelphia airport and Water Department funds were included in the 2017 OSR figure. Revenue growth over the next five years was based on projections included in the city's Five Year Financial Plan.[13] In subsequent years, projected revenue was based on the 2017-22 growth rate from the five-year forecast.

Risk scenarios

Pew's stress test analysis focuses primarily on investment risk—the possibility that investments could deviate from expected performance—and contribution risk, the prospect that contributions could fall below the rate required to meet funding objectives. It also takes into account the impact these risks can have on the plan's fiscal health and the city's budget. Scenarios are applied to the baseline actuarial projections to assess how each risk, individually and in conjunction, can affect the plan sponsor's budgetary and fiscal situation as well as the funded level and solvency of the plan itself.

To model investment risk, both deterministic and stochastic analysis are applied to show the impact of different long-term trends and year-over-year volatility. The stochastic analysis applies 10,000 simulations of plan actuarial projections; each year in each of the simulations applies randomly generated returns using the capital market assumptions described above. For the investment portfolio of the typical public plan covered in this analysis, the median return over a 20-year time horizon is 6.4 percent—below the typical assumed return used by the plans.

Two deterministic scenarios are used. In the first, known as 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.

Five percent was selected for this scenario for two reasons. First, because public plans tend to assume returns in the 7 percent range, a low-return scenario of 2 percentage points below that falls between the low-return investment scenario required by the Governmental Accounting Standards Board (1 percentage point below the plan assumption) and the Society of Actuaries Blue Ribbon Panel's recommendation (3 percentage points below the plan assumption). Second, 5 percent is in line with the stochastic analysis of the 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 percent and 8.1 percent (the 75th percentile return)—a range that includes the 5 percent low-return scenario.

The second economic scenario, known as the asset shock scenario, incorporates 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 "adverse scenario" as defined in the Federal Reserve's "2017 Supervisory Scenarios for Annual Stress Tests Required Under the Dodd-Frank Act Stress Testing Rules and the Capital Plan Rule."[14] The economic and financial variables projected over the adverse scenario are applied to the capital market assumptions, and then a long-term impact on investment performance—a 5 percent return on equities after the adverse scenario—is applied. Table A.2 provides the resulting economic and asset price assumptions for the asset shock scenario.

A.2
Asset Shock Indicators

	Variables	Year 1	Year 2	Year 3	Year 4	Year 5	Years 6-10	Years 11-20
Economic variables	Real GDP growth	-1.95%	1.12%	2.90%	3.0%	2.0%	2.0%	2.0%
	Inflation	1.80%	1.97%	2.0%	1.80%	2.0%	2.0%	2.0%
Asset price variables	U.S. equity returns	-39.0%	18.75%	20.6%	16.24%	5.0%	5.0%	5.0%
	Non-U.S. equity returns	-39.0%	18.75%	20.6%	16.24%	5.0%	5.0%	5.0%
	Real estate returns	-2.0%	-2.0%	-2.0%	-2.0%	6.0%	6.0%	6.0%
	Private equity returns	-39.0%	18.75%	20.6%	16.24%	6.9%	6.9%	6.9%
	Core bond returns	1.15%	2.45%	3.05%	3.05%	2.45%	3.95%	3.95%
	Cash	0.1%	0.1%	0.1%	0.1%	1.48%	1.7%	1.7%
Interest rate variables	1-year Treasury rate	0.1%	0.1%	0.1%	0.1%	1.85%	2.1%	2.1%
	10-year Treasury rate	2.3%	2.6%	2.7%	2.7%	3.37%	3.6%	3.6%
	30-year Treasury rate	2.8%	3.1%	3.2%	3.2%	3.89%	4.1%	4.1%
	Core bond yield	2.65%	2.95%	3.05%	3.05%	3.68%	3.95%	3.95%

To model contribution risk, two behavioral scenarios are used, representing different potential paths by policymakers. One scenario applies the stated funding policy, as defined by the plan sponsor, to estimate future contributions to the pension fund. For plans in which the sponsor uses actuarial funding, it is assumed for this scenario that the taxpayer will fund any necessary increase in the event of an investment loss or other downturn. The other scenario is the revenue constrained contribution scenario, in which it is assumed that policymakers face budgetary pressures that result in an unwillingness to dedicate a greater share of state or city revenue to pension funds regardless of the funding level or the actuarial contribution rate. As a result, contributions grow at the same rate as projected revenue regardless of investment performance in a given year.

Endnotes

1 Additionally, Philadelphia sponsors the Gas Works plan, which accounts for 7 percent of the city's total pension liability. Due to its relatively small size, the Gas Works plan was not included in the analysis. This analysis does not include teachers in the School District of Philadelphia, who are part of the statewide Public School Employees' Retirement System (PSERS). Contributions to PSERS are made by the school district and partially reimbursed by the commonwealth. Baseline projections were estimated using the city retirement plan's own assumptions and actuarial information, including an assumed rate of return of 7.65 percent. The plan board has scheduled an additional reduction in the discount rate to 7.6 percent that is not incorporated in this analysis.

2 See Appendix A for methodological details. The 43 percent funded ratio is based on the market value of assets; using the actuarial value of assets, as Philadelphia's Board of Pensions and Retirement does, the funded ratio is 45 percent.

3 The analysis is informed by the Actuarial Standards Board's recent guidance on risk reporting and was created using Pew's stress test methodology as described in Greg Mennis, Susan Banta, and David Draine, "Assessing the Risk of Fiscal Distress for Public Pensions: State Stress Test Analysis," Harvard Kennedy School Mossavar-Rahmani Center for Business and Government Associate Working Paper No. 92 (2018), https://www.hks.harvard.edu/centers/mrcbg/publications/awp/awp92.

4 Stress test analysis can also be used to estimate the impact of longevity risk, mortality risk, changes in workforce behavior, and other actuarial assumptions. These factors are held constant in this analysis to examine investment and contribution risk.

5 Pew's capital market assumptions yield a 50th percentile expected return of 6.4 percent and a 25th percentile return of 4.8 percent when applied to a typical public pension asset allocation. When applied specifically to the Philadelphia city retirement plan's asset mix, they yield 50th and 25th percentile returns of 6.4 percent and 4.7 percent, respectively.

6 Appendix A contains more detail on investment risk scenarios, including additional information on how they were developed. The asset shock scenario is based on the Federal Reserve's "2017 Supervisory Scenarios for Annual Stress Tests Required Under the Dodd-Frank Act Stress Testing Rules and the Capital Plan Rule." Applying the economic and financial data points from that scenario, a drop in equity prices of 39 percent is assumed in the first year of the shock, followed by equity returns of 18.75 percent, 20.6 percent, and 16.24 percent, respectively, in the three years of the subsequent recovery. In addition to the four-year forecast from the Dodd-Frank stress test, an assumption of 5 percent return on equity is applied in years following the recovery.

7 Pew's Philadelphia projections were calculated assuming contribution levels as prescribed in the Revenue Recognition Policy and revenue growth as provided in the City of Philadelphia's FY 2018-22 Five Year Financial Plan. Revenue here is defined as own source revenue, calculated as the city's total revenue from governmental funds, plus revenue from the Water Department and airport funds (which participate in the city retirement system), less revenue from other governments as reported on the city's Statement of Revenues, Expenditures and Changes in Fund Balances. See Appendix A for additional methodological details.

8 See Mennis, Banta, and Draine, "Assessing the Risk," for a more detailed discussion of stochastic methods as they apply to stress testing public pensions. See also Yimeng Yin and Don Boyd, "Analyzing the Interplay Between Public-Pension Finances and Governmental Finances: Lessons From Linking an Economic Model to a Pension Fund Model" (2018), https://www.brookings.edu/wp-content/uploads/2018/04/Boyd-Yin.pdf.

9 Projected cost stability and funding improvements are therefore subject in part to the accuracy of sales tax revenue as forecast and reported in the plan actuarial valuation.

10 Stress test analysis can also be used to estimate the impact of longevity risk, mortality risk, changes in workforce behavior, and other actuarial assumptions.

11 Mennis, Banta, and Draine, "Assessing the Risk."

12 Own source revenue for this report is defined as the city's total revenue from governmental funds, plus revenue from the Water Department and airport funds (which participate in the city retirement system), less revenue from other governments as reported on the city's Statement of Revenues, Expenditures and Changes in Fund Balances in its Comprehensive Annual Financial Report, https://www.phila.gov/finance/pdfs/2017%20Comprehensive%20Annual%20Financial%20Report%20(CAFR).pdf.

13 City of Philadelphia, FY 2018-22 Five Year Financial Plan.

14 Board of Governors of the Federal Reserve System, "2017 Supervisory Scenarios for Annual Stress Tests Required Under the Dodd-Frank Act Stress Testing Rules and the Capital Plan Rule," Table 3A, https://www.federalreserve.gov/newsevents/pressreleases/files/bcreg20170203a5.pdf.

About this brief

This issue brief is a joint project of two programs at The Pew Charitable Trusts: the Philadelphia research initiative and the strengthening public sector retirement systems program. The actuarial analysis at the heart of this publication was performed by The Terry Group using a method developed by Pew for stress testing pension systems. The brief was written by Susan Banta, David Draine, Kate Kemmerer, Chris McIsaac, and Greg Mennis of the strengthening public sector retirement systems program, with input from the Philadelphia research initiative team. It was edited by Larry Eichel, the initiative's project director, along with Erika Compart.

This brief was updated on Sept. 30, 2019, to include the names of two additional members of Pew's public sector retirement systems program who helped write the piece.

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