THE NEW YORK CITY TEACHERS' RETIREMENT SYSTEM

FISCAL ISSUES AND RISKS

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THE STATE AND LOCAL GOVERNMENT FINANCE PROJECT

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An appendix with further methodological details and additional technical analyses may be found at https://www.albany.edu/slgf/publications.shtml.

CONTENTS

SUMMARY

The New York City Teachers' Retirement System (TRS) is the second-largest of the city's five major defined benefit pension systems measured by assets, and the largest measured by unfunded liability and city contributions. City contributions to TRS were approximately $3.7 billion in 2018, or 6 percent of tax revenue.

Like other defined benefit pension plans, TRS invests assets with the goal of having sufficient funds to make benefit payments when due. Taxpayers and other city stakeholders bear the risk: if investment returns fall short the city will need to increase contributions, and if returns are better than assumed, future city contributions will be lower than otherwise planned. City policymakers should analyze, report, and use appropriate measures to manage these risks, and to help decide whether the risks are acceptable.

Like most other public pension plans, TRS is underfunded: in 2018 its assets could cover only about 74.5 percent of benefits accrued to date, a shortfall of $18.7 billion under the TRS assumption that assets will earn 7 percent annually in the future. Employer contributions increased from 4.3 percent of payroll in 2000 to 27.4 percent in 2008 and 44.1 percent in 2017, primarily driven by investment shortfalls, benefit increases, and changes in actuarial assumptions. The increase from 2008 to 2017 is equivalent to an approximately $1.5 billion increase in annual city contributions, or 2.5 percent of city tax revenue.

TRS has two important characteristics that set it apart from most other public pension plans in the nation. First, like other New York City pension plans, its contribution policy is more conservative than the typical public plan in the sense that city contributions rise relatively rapidly in response to investment shortfalls. This protects the solvency of the pension plan. The trade-off is greater risk to the city budget of sharp contribution increases in short time periods, relative to other commonly used contribution policies.

Second, unlike any other public pension plan we are aware of, in addition to the regular retirement benefit TRS members may contribute to a Tax-Deferred Annuity (TDA) program that offers guaranteed fixed returns backed by the defined benefit pension fund and thus by city taxpayers. The TDA is an optional investment plan available to TRS members, maintained under section 403(b) of the Internal Revenue Code.[1] Employees may make contributions subject to an annual IRS contribution limit that in 2019 generally was $19,000. The guaranteed rate for most members is 7 percent, set by the state legislature. It is well above guaranteed fixed returns that may be purchased in the private market, which are currently around 2 to 2.5 percent or less. The TDA assets are pooled in TRS's pension fund. If the TDA assets earn more than the guarantee, the additional earnings are kept by the pension fund, keeping city contributions lower than they otherwise might be. If it earns less than the guarantee the pension fund must make up the difference to the TDA, increasing costs to the city and its taxpayers. The TDA fixed-return fund had $24 billion in assets in 2018, so a shortfall of 5 percent, for example, would require the defined benefit pension fund to make up approximately $1.2 billion to the TDA. The guarantee provides valuable benefits to plan members but creates special risks to the city. It does not have the constitutional protection that the regular retirement benefit has and therefore is more directly under the control of state and city policymakers.

The TDA guarantee provides valuable benefits to plan members but creates special risks to the city.

The defined benefit pension fund and the TDA both pose large risks to the city, its taxpayers, and other stakeholders. TRS does not publish evaluations of risks related to either. Risk analysis is the primary subject of this report.

We examined risks created by uncertain investment returns using a model that simulates TRS finances and city contributions under alternative scenarios and policies. Our baseline scenario uses the TRS 7 percent long-run investment return assumption but allows variation from year to year by incorporating a 12 percent standard deviation, consistent with other market analyses. While 7 percent is our baseline expected long-run return, returns achieved in any single simulation or any given time period may be higher or lower than 7 percent.

We evaluated risks from three perspectives:

- **Severe underfunding and fiscal and political crisis:** The probability that the TRS-defined benefit plan will become severely underfunded sometime in the next 30 years, using a threshold of 40 percent funding. We use this threshold because in public pension funds elsewhere in the country, funding levels this low have been associated with fiscal and political crises.
- **Long-term fiscal threat:** The probability that city contributions to TRS would have to rise to more than 60 percent of payroll sometime in the next 30 years—an increase of about 50 percent from the current 42 percent, amounting to a sustained increase of nearly $2 billion annually in today's dollars.
- **Near-term budget pressure:** The probability that city contributions to TRS would have to rise sharply in a short time period. Under our measure, this occurs if contributions increase by at least 10 percent of payroll within any five-year period, or by about $1 billion in current dollars.

We found that the conservative TRS contribution policy reduces risks to the plan by about half compared to the far more liberal policies often used elsewhere, but that risks nonetheless are large. A key feature of the TRS contribution policy is that it essentially requires shortfalls to be paid off in equal annual installments over 15 years, while policies in some plans allow repayments to start low and rise over an "open" 30-year period that is constantly extended with each new year. Under the baseline investment return assumptions we found that if TRS used a more liberal 30-year open policy it would face almost a 50 percent chance of severe underfunding sometime in the next 30 years. Its actual 15-year policy reduces that risk to about 28 percent, or slightly more than a 1 in 4 chance. This risk may still seem high to policymakers.

We estimated a roughly 20 percent chance that contributions will rise above 60 percent of payroll sometime in the next 30 years from the current 42 percent.

The current contribution policy results in substantial contribution risks to the city budget. We estimated a roughly 20 percent chance that contributions will rise above 60 percent of payroll sometime in the next 30 years from the current 42 percent, and about a 75 percent chance that city contributions will rise by more than 10 percent of payroll in any five-year period occurring within the next 30 years.

The TDA guarantee makes these risks much higher than they otherwise would be. If TRS did not guarantee the TDA return but maintained its current conservative contribution policy, then under

baseline investment return assumptions the risk of being severely underfunded sometime in the next 30 years would fall from 28 percent to less than 2 percent. The risk that contributions would rise above 60 percent of payroll sometime in the next 30 years would fall from 20 percent to essentially zero, and the risk of a sharp short-term increase in city contributions in a five-year period would fall from 75 percent to about 58 percent.

The body of the report examines alternative scenarios in which investment returns are different than expected, including a sharp asset-shock scenario similar to that used in Dodd-Frank stress tests for banks, and a scenario in which investment returns remain below the TRS assumption for 15 years before rising, on average, to TRS's 7 percent assumption. Under these scenarios, the underfunding and contribution risks are considerably greater than described above. For example, under the low-returns scenario, the risk of severe underfunding in the next 30 years rises from 28 percent to more than 40 percent and the risk of a sharp increase in city contributions in a five-year period rises from 75 percent to about 85 percent. The body of the report also examines alternative assumptions about future participation in the TDA.

Under the low-returns scenario, the risk of severe underfunding in the next 30 years rises from 28 percent to more than 40 percent and the risk of a sharp increase in city contributions in a five-year period rises from 75 percent to about 85 percent.

Whether these risks are appropriate is a question for policymakers. In part, they reflect a choice about how much risk future taxpayers should bear for the costs of services that current taxpayers receive today. Because the TDA guarantee is central to the risk profile of TRS, is well above market rates, and is under the control of state and city legislators, we examined alternative potential policies relating to the TDA.

One alternative would be to recognize that the TDA guarantee is a valuable form of compensation to TRS members, but to ask how much more funding current city taxpayers should provide to avoid pushing risks to future taxpayers. For example, how much higher would contributions have to be to keep the risk of severe underfunding as low as it would be without the guarantee (a 2 percent chance of severe underfunding over the next 30 years)? We estimate that this would require a sustained annual increase in city contributions of 18 percent of payroll, or the equivalent of about $1.6 billion annually. This would reduce the TRS underfunding risk to well below the underfunding risk that other pension plans face because another aspect of TRS—its conservative funding policy—drives risk to the plan down. Alternative contribution increases that fall between the current policy that ignores the risk from the TDA and the 2 percent risk scenario are possible.

Another approach would be to consider alternative TDA guarantees. The TDA fixed-return fund could be treated as an investment option that should be offered to TRS members at near-market rates, rather than as a form of compensation. Lowering the guarantee to 2.5 percent, fairly close to current market rates, would lower the risks of severe underfunding and of contribution increases by about 80 percent. Some downside risk would remain if the funds are invested in the same risky portfolio as TRS, but there would be significant upside to the defined benefit plan if the TRS investment return assumptions are correct, on average—if so, the TRS pension fund would benefit from returns on TDA assets that exceed the expected return on its portfolio. The guarantee could be set somewhere between the current 7 percent and a 2.5 percent near-market rate. For example, a guarantee of 5 percent

would provide a better return to members than they could purchase in the market, but would reduce risks to taxpayers substantially with the risk of severe underfunding in the next 30 years, falling to about 14 percent.

The TDA guarantee also raises questions about whether and how the TDA is considered under standards or regulations promulgated by professional standards organizations and regulatory bodies. We raise several questions in the body of the report.

It is up to city policymakers to decide the extent to which the TDA should be an investment option for teachers, and the extent to which it should be compensation above and beyond salary and the defined benefit pension. Teachers hired recently have far lower defined benefit pensions than teachers hired long ago due to benefit cuts for new teachers enacted in response to past economic downturns. For these teachers, the TDA likely will play a relatively larger role in retirement planning than it will for teachers hired in earlier years.

In any event, the current TDA policy and the current choice of pushing risks from today to the future may be appropriate, but the choice should be made explicitly, with an understanding of its potential implications.

INTRODUCTION

Public pensions are a crucial element of compensation for most state and local governments in the United States. They affect a government's attractiveness as an employer, the retirement security of its workers and retirees, the government's finances, and resources required from taxpayers that might otherwise be available for other governmental purposes. Policymakers must balance many issues in deciding on the level of benefits, how to fund them, and how to manage the pension fund. This is particularly important given that many pension benefits, once set, are constitutionally protected promises that can last 70 years or more for an individual employee.

This project, led by New York University's Marron Institute of Urban Management, is examining important issues related to the New York City Teachers' Retirement System (TRS), the second-largest New York City retirement system by assets under management, and the largest by promised benefits (accrued liabilities). While all pension funds face issues and risks, we are focusing on TRS because its large size, combined with the nature of the Tax-Deferred Annuity (TDA) program discussed here, creates special issues to consider.[2] The TDA is formally a supplementary defined contribution plan, available to TRS members and offering a fixed investment return that is guaranteed by the assets in the TRS-defined benefit fund. In effect, this makes it a guaranteed return program like a cash balance plan funded by the employee. The model we have developed and are using for this analysis is open source and available to anyone upon request.

This report describes our methodology, results, and key conclusions. We describe methodologies in further detail in separate appendices. The project entails far more than an analytic report: the goal is to help major stakeholders understand issues related to TRS and to engage in discussion about them. In May 2019 the Marron Institute held a symposium to examine and discuss our methodology and analysis to date. A second symposium held in December 2019 focused on policy implications.

THE NEW YORK CITY TEACHERS' RETIREMENT SYSTEM

New York City has five major defined benefit pension systems: the New York City Employees' Retirement System (NYCERS), the Teachers' Retirement System (TRS), the Board of Education Retirement System (BERS), and separate police (POLICE) and fire (FIRE) retirement systems.

The Teachers' Retirement System is the second-largest of these systems measured by assets accounting for about 30 percent of total assets, and it is the largest measured by unfunded liability ($18.7 billion, or 33.4 percent of the total). Table 1 shows total pension liability, plan net fiduciary position (essentially the market value of assets), net pension liability (unfunded liability), and the funded ratio as of June 30, 2018, as measured for financial reporting purposes.[3, 4] TRS currently assumes it will earn 7 percent annually on its investments.

New York City contributed an estimated $9.5 billion to its five major pension systems in 2018, or 16 percent of its $58.9 billion of tax revenue.[5] Table 2 shows a breakdown of city contributions to the five major systems. The main components are:

- Entry age normal cost (i.e., cost attributed to an additional year of service by employees);
- Amortization of the unfunded actuarial accrued liability (UAAL) that was determined when the city adopted changed actuarial assumptions and methods in 2012 (amortized over 22 years);
- Amortization of subsequent UAALs such as those arising from unanticipated investment gains or losses; and
- Administrative expenses.

City contributions to TRS are larger than its contributions to any other system, accounting for 40 percent of total contributions, largely because of its size (it accounts for about 40 percent of city-covered employee payroll) and the need to amortize unfunded liabilities.[6]

TABLE 1
NYC pension plan snapshot, GASB measures

Total and Net Pension Liablity For Fiscal Year 2018, Major NYC Plans For Basic Defined Benefits ($ billions)

	NYCERS	TRS	BERS	POLICE	FIRE	Total
Total Pension Liability (TPL)	$ 83.3	$ 73.2	$ 5.2	$ 54.2	$ 22.0	$ 237.9
Plan Fiduciary Net Position (PFNP)	65.7	54.5	4.7	42.8	14.2	181.8
Net Pension Liability (NPL)	17.6	18.7	0.5	11.4	7.8	56.0
Funded ratio for accounting purposes (PFNP as a % of TPL)	78.8%	74.5%	90.3%	79.0%	64.4%	76.4%

Notes: (1) Total pension liability is the measure of liability for financial reporting purposes; (2) Plan Fiduciary Net Position is the measure of assets for accounting purposes; (3) NYCERS, POLICE, and FIRE include Variable Supplement Funds.

Source: Chan, Sherry S. "Fiscal Year 2018 GASB 67/68 Report For The City of New York And The New York City Retirement Systems." Office of the Actuary, New York City, September 28, 2018.

TABLE 2
Estimated contributions by NYC to its major pension plans

New York City Contributions to Retirement Systems Preliminary Estimates for Fiscal Year 2018 ($ millions)

	NYCERS	TRS	BERS	POLICE	FIRE	Total for 5 major plans
Entry age normal cost	$ 836.1	$ 1,102.7	$ 127.6	$ 1,251.2	$ 414.1	$ 3,731.7
Amortization of initial UAAL (based on changed assumptions and methods adopted in 2012)	994.0	1,795.6	117.7	1,185.2	636.6	4,729.1
Amortization of subsequent UAALs	(37.1)	793.1	48.3	(64.2)	149.7	889.8
Administrative expenses	33.4	52.8	14.7	21.2	N/A	122.1
Total	$ 1,826.4	$ 3,744.3	$ 308.2	$ 2,393.4	$ 1,200.4	$ 9,472.7

Source: "Official Statement: The City of New York General Obligation Bonds, Fiscal 2018 Series F." New York City, April 12, 2018.

HOW TRS'S FINANCIAL SITUATION HAS EVOLVED OVER TIME

The funded ratio of the main TRS-defined benefit plan, the Qualified Pension Plan (QPP), increased from a recent low of 47.9 percent in 2010 to 74.5 percent in 2018 on a market-value-of-assets basis. The increase in funded ratio is mostly due to:

- Consistently positive investment returns since 2010, with double-digit returns in five of the years, exceeding the assumed rate of return, on average, over this period;
- An increase in the employer contribution rate from 31.6 percent of payroll in 2010 to 44.1 percent in 2017, as investment losses from 2008–2009 are gradually recognized and funded;
- Full payment by the city of these increased employer contributions; and
- A positive difference between actual and expected experience in 2018 that reduced liabilities by $2.2 billion.[7] TRS does not appear to have explained this change in available experience studies or other public documents.
- In addition, TRS gradually benefits from an increasing share of lower-cost Tier VI members.

Figure 1 shows QPP's funded ratio on a market-value-of-assets basis from 2000 forward. Figure 2 shows QPP's assets and liabilities over the same time period. The gap between the orange line and the blue line in Figure 2 shows the unfunded liabilities. We have annotated the figure with several major events that affected pension assets and liabilities.

Figures 1 and 2 show that TRS's liabilities started to accumulate after 2000, reflecting the 2000 benefit increases, the 2000 recession, and the Great Recession, after unfunded liabilities began to decline.

In 2000, the city's pension funds reset their assets to market value, which increased all funds' reported assets by $17 billion. The increased asset value was used to support significant benefit enhancements that took place in July 2000. One major enhancement was to introduce cost-of-living adjustments (COLAs) broadly for current and future retirees. Under the new provision, retirees who were at least 62 and retired for five years, or were at least 55 and retired for 10 years, were qualified for a CPI-linked COLA. The COLA change was expected to increase TRS's actuarial present value of benefits by $2.3 billion and its recognition was to be phased in over five years. In 2002, the phase-in period was extended to 10 years to mitigate the impact of the benefit increase on city finances. The city also provided additional service credit to Tier I and Tier II members. For Tier III and Tier IV members, member contributions were waived after 10 years of service. A New York City Comptroller's report concluded that the 2000 benefit enhancements were the biggest contributing factor to the NYC pension funds' unfunded liabilities.

In 2000, the city's pension funds reset their assets to market value, which increased all funds' reported assets by $17 billion. The increased asset value was used to support significant benefit enhancements that took place in July 2000.

The early 2000s recession caused significant TRS investment losses. Its primary fund, known as the Pension Fund, experienced a negative 8.2 percent return in 2001.[8] The market continued to decline in 2002 with a negative 8.1 percent rate of return for the Pension Fund. Investment returns bounced back to positive in 2003, but at 4 percent for the Pension Fund they were well below the 8 percent rate of return that TRS then assumed. The

FIGURE 1
QPP's funded ratio on a market-value-of-assets basis

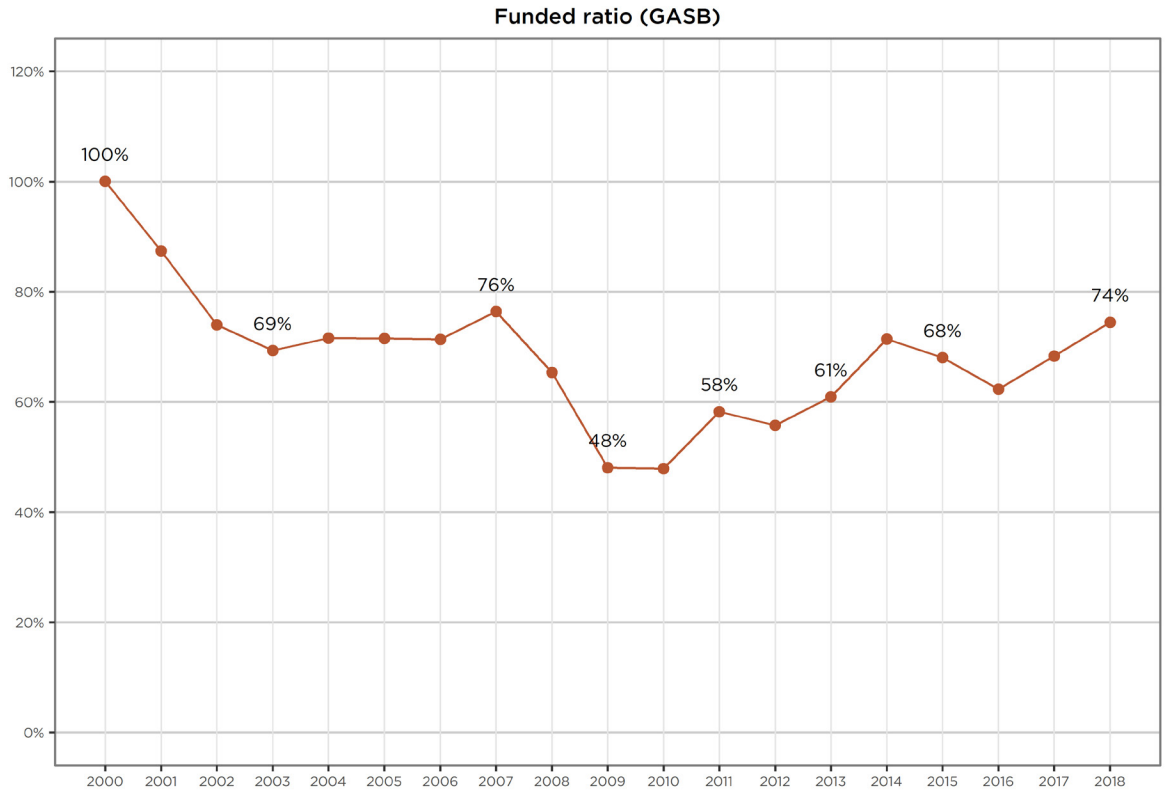
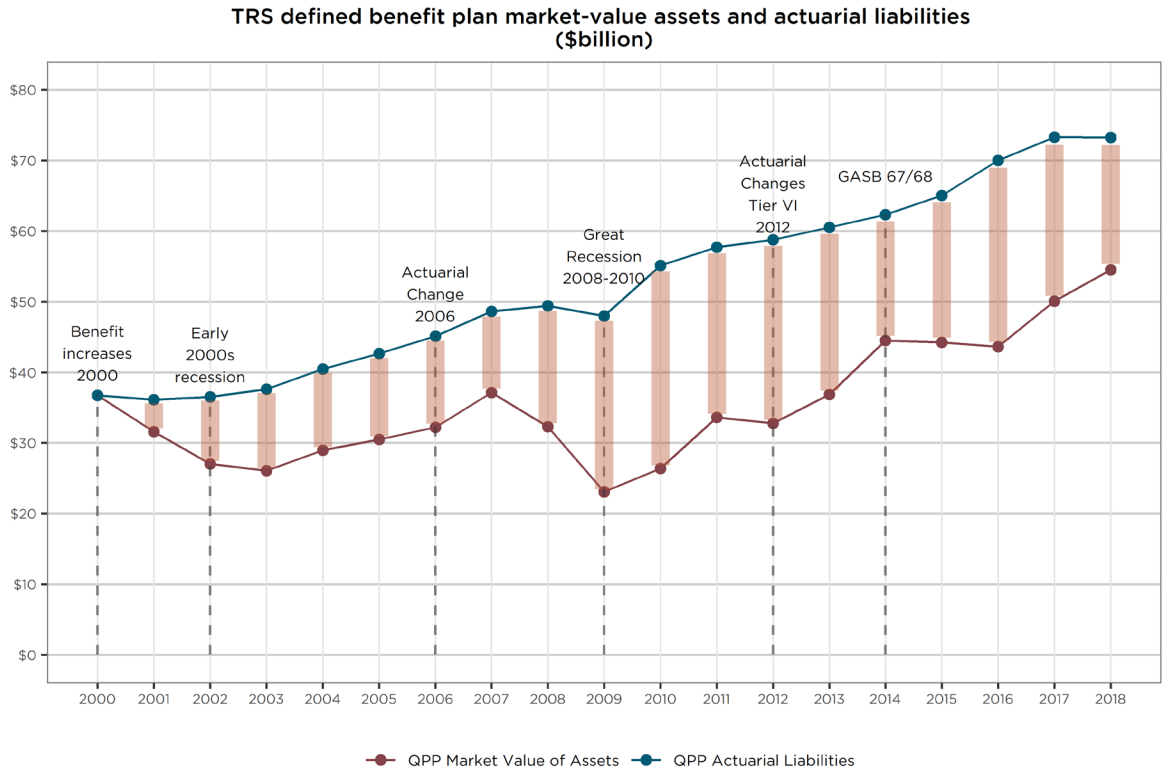


FIGURE 2
QPP assets and liabilities



combined effects of low returns from 2001 to 2003 and benefit enhancements in 2000 resulted in a 30 percentage-point decrease in the actuarial funded ratio from 2000 to 2003.

TRS increased employer contributions after the unfavorable returns from 2001 to 2003. Coupled with four years of strong double-digit investment returns from 2004 through 2007, TRS's funded ratio gradually increased to 76 percent in 2007. With this positive performance, in 2006, the state legislature adopted changes in actuarial assumptions and methods to enhance city pension systems' contribution policy. The changes were based on an experience study by Gabriel, Roeder, Smith & Company, proposed by the actuary, and were summarized in the *Gold Book* in 2005.[9] These changes were adopted by the board and took effect in 2006.

One of the major changes adopted in 2006 was to eliminate the phase-in of liabilities from the 2000 COLA increase so that TRS could begin fully funding the COLAs. TRS also adjusted demographic and merit salary increase assumptions, further increasing employer contributions. The increases in contributions and liabilities were offset by two other changes in the same year. The first was to reset the asset-smoothing period from five years to six years with a "market value restart" as of June 30, 1999. The second was to introduce the One-Year Lag Methodology (OYLM) for determining employer contributions, to bring more certainty to budgeting and to mitigate increases in employer contributions due to actuarial changes.

The 2008–2009 recession had a dramatic impact on TRS's assets. TRS lost $3.2 billion in 2008 and another $7.9 billion in 2009. Its Pension Fund earned negative 6.2 percent and negative 18.1 percent in 2008 and 2009, respectively. TRS's asset decline was comparable to other large pension systems in the country by our calculations. However, the TDA program exacerbated investment losses, requiring guarantees of 4.9 percent of assets in 2008 and 8.8 percent in 2009. Despite these losses, TRS had sufficient income and liquid assets to pay benefits to retirees. Required employer contributions did not increase immediately to make up for the investment losses, because of the six-year asset smoothing and the One-Year Lag Methodology that took effect in 2006.

After the 2008–2009 investment losses, TRS's investment returns started to recover with double-digit returns in 2010 and 2011. In fiscal year 2012, another major change in actuarial methods and assumptions was implemented to enhance the financial integrity of the plan. These actuarial changes were based on experience studies by The Hay Group in 2011 and by The Segal Company in 2006 and were summarized in the *Silver Book*. The major change was to reduce TRS's discount rate from 8 percent to 7 percent, which increased employer contributions in FY 2012 by $390 million. Demographic and salary assumption adjustments increased employer contributions by another $108 million in FY 2012. These increases were offset by the introduction of the Entry Age Actuarial Cost Method (EAACM), which provided for amortization of unfunded liabilities and a reset of assets to market value on June 30, 2011, so that positive investment performance during fiscal year 2011 would be fully recognized.

In 2012, Tier VI was created for members who joined the system on or after April 1, 2012. With this new tier, members were required to contribute 3 percent to 6 percent based on their salary levels. The normal retirement age was increased to 63. Benefits were calculated based on the five-year final average salary. The benefit multiplier was changed. TRS also added a 10-year vesting period. The new tier would decrease the city's FY 2015 contributions to its five pension plans by $49 million and its total impact over the next 30 years was estimated to be a saving of $21 billion (not discounted to reflect the

time value of money). The proportion of members in Tier VI has grown rapidly, from only 0.2 percent in 2012 to 27.6 percent in 2017. (Further details are available in a separate document, *Appendix to Analysis of Teachers' Retirement System*; see inside cover page for further information.)

TRS and the city adopted the new GASB Statement 67 and 68 accounting standards and the city issued its first GASB 67/68 report for the New York City pension systems in FY 2014. As required under the new standards, since 2014 TRS has reported annual changes in net pension liabilities (the accounting term for unfunded liabilities) broken down by the reasons for the changes. Between FY 2014 and 2016, the funded ratio fell by nine percentage points, due to lower-than-expected investment returns in 2015 and 2016 as well as assumption changes in 2016, particularly changes in post-retirement mortality assumptions.[10]

HOW WE MODEL TRS FINANCES

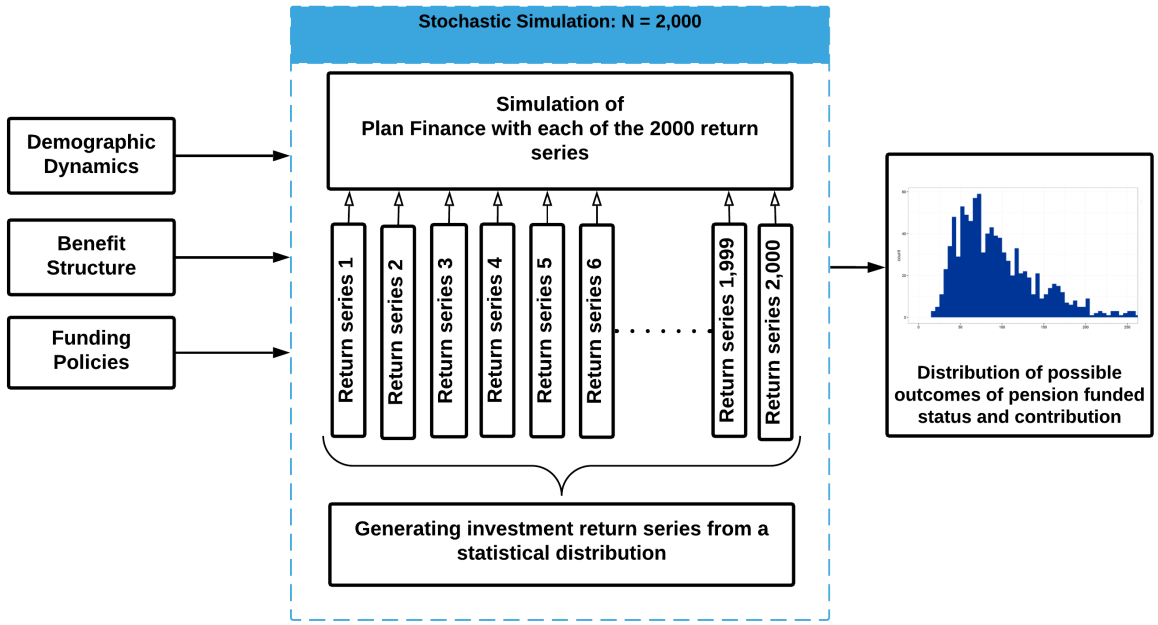
When we model pension funds we specify their characteristics in detail, including benefit policies, the demographic structure of plan participants, actuarial assumptions, plan funding policy, the extent to which contributing governments adhere to funding policy, and plan assets. We simulate the finances of the plan under different investment-return scenarios, funding policies, benefit policies, and other variations in assumptions. We examine outputs from our model, focusing on risks to the plan and its contributing governments that result from the interplay of investment-return risks and plan policies and structure.

In many analyses, we draw investment returns from a probability distribution (i.e., stochastically) such as the normal distribution, allowing us to take investment return variability into account.[11] In these analyses we run 2,000 simulations, each with a different set of annual investment returns (drawn from the same assumed probability distribution), so that we can examine the distribution of results.[12] Each simulation results in different investment earnings, leading to different funded ratios and contribution requirements. By examining the 2,000 different sets of results we can gain insight into the probability of different outcomes.

We simulate the finances of the plan under different investment-return scenarios, funding policies, benefit policies, and other variations in assumptions

The model structure is summarized in Figure 3. We apply this modeling framework to TRS by incorporating data from (1) Comprehensive Annual Financial Reports (CAFRs) for multiple years; (2) the 2018 actuarial valuation report, which includes the 2016 (lag) valuation results; (3) the 2015 experience study, which includes the latest decrement tables and salary scales used in the actuarial valuations;[13] and (4) detailed plan information, including detailed demographics by tier and breakdowns of the present value of benefits, provided by the New York City Office of the Actuary at our request.

FIGURE 3
The structure of our pension simulation model



We focus on risks to the plan and to the city. For example, we examine the probability that the funded ratio will fall below 40 percent anytime during the next 30 years—a rare level of funding met by only 3 to 4 percent of plans in a given year and that often has been associated with crisis in other plans. There is no perfect choice of cutoff, and results using different cutoffs tend to be correlated with each other.[14] We choose 40 percent because it is a good indicator of a deeply troubled pension fund. In a previous analysis, we examined data for 2013 in detail, and only four plans out of 150 in the Public Plans Database had a funded ratio below 40 percent—the Chicago Municipal Employees and Chicago Police plans, the Illinois State Employees Retirement System, and the Kentucky Employees Retirement System.[15, 16] Each plan is widely recognized as being in deep trouble, with the likelihood of either substantial tax increases, service cuts, or benefit cuts yet to come.

THE BASELINE: A STRONG FUNDING POLICY BUT SUBSTANTIAL CONTRIBUTION RISK

TRS has a strong funding policy that the city historically has adhered to. It pays down unfunded liabilities quickly, primarily because it amortizes investment gains and losses over a closed 15-year period in level-dollar amounts, which is a more aggressive approach than most plans use. This means that the plan faces little risk of deep underfunding if the city continues to pay contributions in this manner. The city's strong funding discipline coupled with TRS's conservative amortization method ensures that the TRS-funded status will keep improving if the return assumption is met. However, the tradeoff is that the city faces significant risk that contributions could rise substantially and could be volatile.

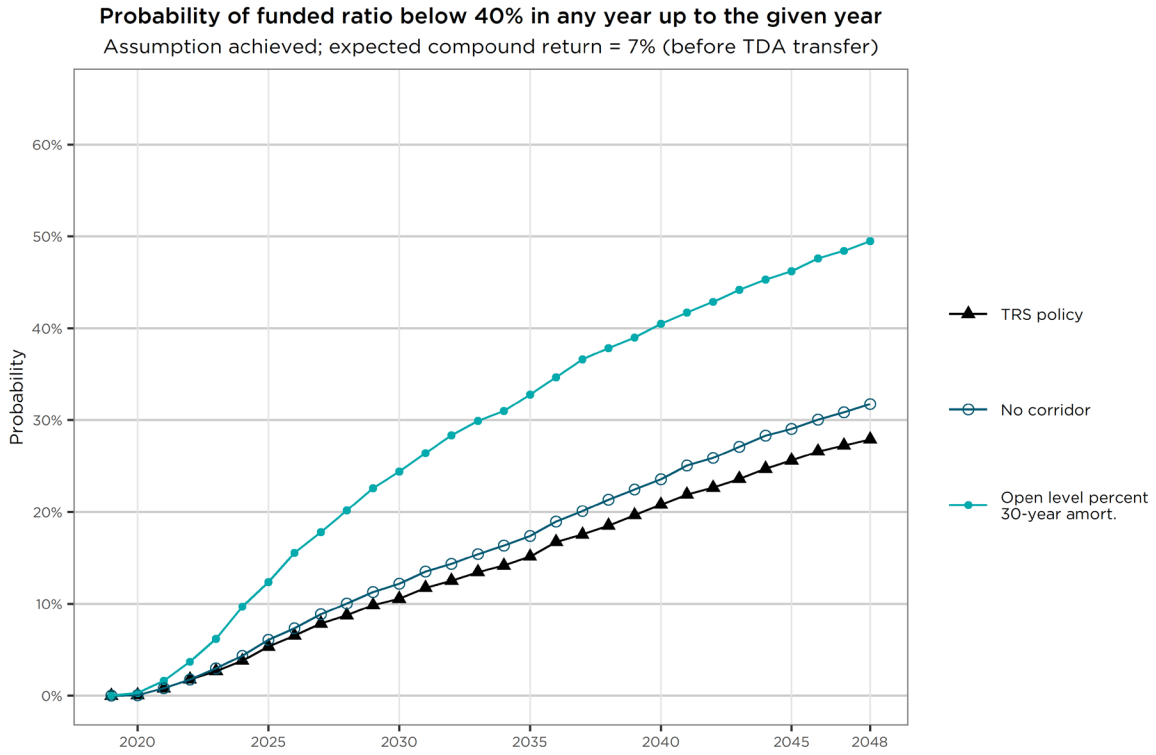
The TRS contribution policy includes some features that delay and smooth the funding of liabilities, and some that reduce unfunded liabilities rapidly, relative to what many other plans commonly use. The main components that delay the funding of liabilities are the One-Year Lag Methodology (OYLM), which uses the information from the preceding year to determine the contribution for the next year, and the six-year asset smoothing with a slow initial start. The main elements that reduce unfunded liabilities quickly are closed 15-year level-dollar amortization of investment gains and losses after the six-year asset smoothing is completed, and the city's commitment, as required under state law, to fully pay the actuarially determined contribution. In addition, the asset-smoothing policy includes a 20 percent corridor designed to prevent the actuarial value of assets from diverging too much from the market value of assets. During a sharp downturn, unless overridden, this corridor would accelerate repayment of unfunded liabilities by forcing actuarial assets to be lower than they otherwise would be, thereby recognizing losses more completely than otherwise. (Many public plans have overridden asset corridors in the past.) The elements that reduce unfunded liabilities rapidly more than make up for those that delay repayment, so that on balance the funding policy protects the finances of TRS more than policies that many other plans use.

These policies can lead to sharp increases in contributions in the face of investment income shortfalls. Employer contributions rose from 4.3 percent of payroll in 2000, before the stock market declines of the early 2000s, to 27.4 percent in 2008, right before the 2008–2009 market declines, to 44.1 percent in 2017. The 16.7 percentage point increase from 2008 to present is the equivalent of approximately $1.5 billion in today's dollars, or 2.5 percent of total city tax revenue.[17] Other measures also show that city contributions respond quickly and substantially to investment shortfalls.[18]

TRS funding policies keep the risk of severe underfunding far lower than it would be under many policies that are in common use among other plans. Figure 4 shows our analysis of the risk that the QPP would become severely underfunded sometime in the next 30 years under the current funding policy and selected alternatives. It is based on our stochastic simulation model, as adapted to TRS. The vertical axis shows the risk that the market-value funded ratio would fall below 40 percent, which we consider to be an indicator of extreme stress, anytime between the present and a given future year. The horizontal axis shows those future years. Each line shows the severe underfunding risk for a different funding policy.

The black line shows the risk under the current TRS policy, in which investment shortfalls, including those related to the Tax-Deferred Annuity, are amortized over a closed 15-year period in level dollar amounts.[19] For example, the black line is approximately 15 percent in 2035, meaning we estimate a

FIGURE 4
TRS funding policy keeps the risk of severe underfunding far lower than it would be under other common policies

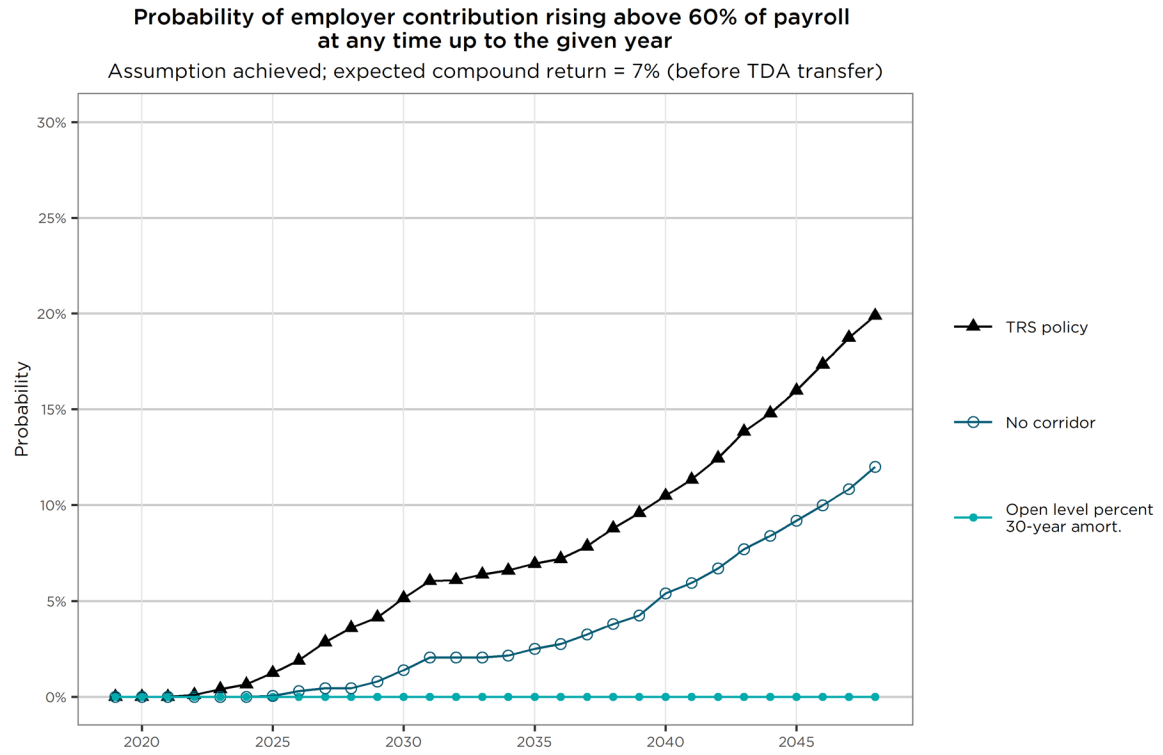


15 percent chance that TRS will fall below 40 percent funding sometime between now and 2035 if the current funding policy is maintained. The line rises to about 28 percent in 2048, meaning we estimate there is about a 1 in 4 chance that TRS will become severely underfunded between now and 2048 under current policy.

The light blue line shows what would happen if the policy were liberalized in three ways, making it similar to policies used by some of the most underfunded plans in the nation: (1) stretching the repayment period to 30 years from 15 years; (2) calculating repayment as a level percentage of payroll rather than as a fixed dollar amount, so that amortization payments start out small and rise as payroll grows; and (3) using an open amortization period in which with each new year the remaining unfunded amount is spread over a new 30-year period, stretching the repayment period indefinitely. Under this policy, the risk of TRS becoming severely underfunded sometime between now and 2035 rises to about 1 in 3 (between 30 and 35 percent on the vertical axis).

The dark blue line shows the current TRS policy but eliminates a New York–specific conservative element of that policy known as the asset corridor. TRS, like most pension plans, smooths asset values when it calculates required city contributions—that is, it does not recognize sharp changes in asset values all at once, instead phasing unexpected changes in over several years. This delays and mutes what might otherwise be sharp increases or decreases in employer contributions. The current asset corridor limits the extent of this smoothing, keeping the measure of assets used for calculating city contributions in a narrow corridor around asset market value. This allows city contributions to change more sharply and quickly in response to investment returns than would a policy with no corridor. Thus the dark blue line, in which the corridor is eliminated, is more liberal than the current TRS policy.

FIGURE 5
The risk of high contributions to TRS under alternative funding policies



More liberal funding policies protect the fund less than conservative policies and lead to greater risks of severe underfunding. The trade-off is that they reduce the risk of rapid contribution increases and the resulting stress on employer finances. Those risks to employers cannot be made to go away in the long run, but in the short term they can be reduced by having more risk borne by the pension plan.

Figure 4 can be looked at from two perspectives. One is that the TRS funding policy is more conservative than policies in use in other pension funds. Another perspective is that even so, there is a 1 in 4 chance that the plan will become deeply underfunded during the next 30 years even if a 7 percent investment return assumption is reasonable. If TRS were to loosen its funding policy, the risks of severe underfunding would become even higher than they are now.

Figure 5 shows the potential consequences of these policies over the longer run for contributions to TRS, measured by the probability that contributions will rise above 60 percent of payroll at sometime in the next 30 years—an approximately 50 percent increase. The current policy, which protects TRS more from severe underfunding than liberal policies such as 30-year open funding, creates a much greater risk that contributions to TRS will rise to high levels in the future: under the current TRS policy (black line) there is about a 20 percent chance that employer contributions will rise above 60 percent of payroll sometime between now and 2048, whereas under the liberal policy (light blue line), which protects the city budget at greater risk to TRS, there is virtually no risk that city contributions will rise above 60 percent of payroll. The no-corridor policy, which is more liberal than the current policy but less liberal than the 30-year level-percent open policy, falls in between.

THE TAX-DEFERRED ANNUITY POSES SUBSTANTIAL ADDITIONAL RISK

The Tax-Deferred Annuity (TDA) program commits the defined benefit plan (the QPP) to guaranteeing returns on defined contributions that employees make to fixed-return accounts, at current rates of 7 percent for UFT members and 8.25 percent for other TDA members. The TDA program does not have the constitutional protection that the QPP has—the program and the guaranteed rate of return may be changed by the state legislature.[20, 21]

The TDA-guaranteed rates are well above market rates for guaranteed returns that can be obtained on guaranteed investment contracts, certificates of deposit, and similar investments. For example, several investment information sources show rates on guaranteed investments in December 2019 that are in the 1.5 to 2.5 percent range for one-year maturities, and are lower if an investor locks funds up for shorter periods.[22] TDA participants can move money between the guaranteed fund and other TDA funds on a quarterly basis and have a more secure guarantee than these other investments, so the TDA guaranteed fund may be more attractive than these options. The program has grown rapidly. Nearly three-quarters of TRS active members now participate, and as of June 30, 2018, the fixed-return portion was $23.7 billion, or 43 percent as large as the $54.5 billion in TRS-defined benefit investible assets.

The guarantee has a leveraging effect that increases the volatility of effective investment returns on QPP assets. The increased volatility also can reduce long-run effective compound investment returns.

Illustrative impact of the TDA guarantee

We can see the volatility impact from the simplified example in Table 3, which uses the numbers for 2018 discussed in the previous section, and assumes a 7 percent guarantee on TDA fixed-return fund assets.[23] In the upper block labeled *Scenario 1* actual returns on pooled funds are 10 percentage points above assumed returns, or 17 percent. The lower block, labeled *Scenario 2*, shows what happens if investment returns are 10 percentage points below assumed returns, or negative 3 percent. We explain the columns in the text below the table.

TABLE 3
The TDA increases the volatility of the effective return on QPP assets

Illustration of how the TDA guarantee affects the effective return on QPP assets

	Amount invested (A)	Amount actually earned on funds invested (B)	Reallocation to ensure TDA receives the 7% guarantee (C)	Net investment earnings credited to account (D)	Effective rate of return on assets (E)
			(Amounts are in $ billions)		
Scenario 1 - actual returns 10% above expected		17%			
QPP defined benefit assets	$ 54.5	$ 9.3	$ 2.4	$ 11.6	21.3%
TDA-Fixed return assets	23.7	4.0	(2.4)	1.7	7.0%
Total invested	$ 78.2	$ 13.3	$ 0.0	$ 13.3	17.0%
Scenario 2 - actual returns 10% below expected		-3%			
QPP defined benefit assets	$ 54.5	($1.6)	($2.4)	($4.0)	-7.3%
TDA-Fixed return assets	23.7	(0.7)	2.4	1.7	7.0%
Total invested	$ 78.2	($2.3)	$ 0.0	($2.3)	-3.0%

As we move from left to right:

- Column A shows the amount invested in QPP and in TDA, in billions of dollars.[24] This is the same in both scenarios. Because the TDA fixed-return account has $23.7 billion invested, the guaranteed amount it must be credited with will be $1.7 billion ($23.7 billion times 7 percent).
- Column B shows the amount earned (or lost), at the respective earnings rates in the two scenarios.
- Column C shows how that investment income must be reallocated between the funds to ensure that TDA gets exactly its guarantee—no more and no less.
    - In the 17 percent return scenario, the TDA funds earned $4 billion, which is $2.4 billion (after rounding) above the $1.7 billion guarantee. That $2.4 billion excess in effect is allocated to the QPP funds, increasing their effective return.
    - In the 3 percent decline scenario, the opposite happens. There is a $0.7 billion loss on the TDA investments, and so $2.4 billion must be allocated away from QPP, toward TDA, to ensure that the TDA fixed funds get their $1.7 billion guaranteed return, worsening the QPP loss.
- Column D shows the net investment earnings credited to QPP and the TDA fixed-return investments. In both scenarios, the QPP must make sure the TDA receives its $1.7 billion guarantee, exactly. In the 17 percent return scenario, when a total of $13.3 billion is earned, TDA receives only $1.7 billion and the remaining $11.6 billion is credited to the QPP—a boon for QPP. But when the portfolio loses 3 percent, TDA must still receive $1.7 billion and the QPP effective loss is thus even greater.
- Column E shows the effective return on assets—i.e., the net investment earnings credited to an account (Column D) as a percentage of the amount invested (Column A). In the 17 percent return scenario, where excess earnings on TDA fixed-return funds are credited to QPP, the effective QPP return is 21.3 percent. In the negative 3 percent scenario, the effective QPP loss is worsened to minus 7.3 percent.

Thus, when actual returns are higher than the TDA guarantee, QPP gains, and when actual returns are below the TDA guarantee, QPP loses. As Table 3 shows, the gain or loss can be quite substantial.

When actual returns are higher than the TDA guarantee, QPP gains, and when actual returns are below the TDA guarantee, QPP loses.

The extent to which the TDA guarantee alters the effective return on QPP depends not just on the level of the guarantee (the higher the guarantee, the larger the guarantee payments), but also on the size of the fixed-return portion of TDA relative to QPP. The greater the relative size, the greater the impact of the guarantee on the effective QPP rate of return. (We provide a derivation of this conclusion in the appendix.)

Table 4 shows this for three different TDA sizes relative to QPP, in the three rightmost columns: 20 percent of QPP, 43 percent (the current size), and 60 percent (which might occur if teachers continue to make substantial contributions to TDA or if QPP investments underperform assumed returns).[25] The leftmost column shows several possible investment returns on the total investment portfolio (QPP plus fixed-return TDA). The cells of the table show effective rates of return for QPP.

TABLE 4
The greater the size of the fixed-return TDA fund relative to QPP, the larger the impact of the guarantee on effective QPP returns

The relative size of TDA vs. QPP and the QPP effective rate of return

	Relative size (TDA / QPP %)		
	20%	43% (current size)	60%
Portfolio rate of return (%)	QPP effective rate of return (%)		
(30.0)	(37.4)	(46.0)	(52.3)
(20.0)	(25.4)	(31.7)	(36.3)
(10.0)	(13.4)	(17.4)	(20.3)
0.0	(1.4)	(3.1)	(4.3)
7.2	7.2	7.2	7.2
10.0	10.6	11.2	11.7
20.0	22.6	25.5	27.7
30.0	34.6	39.8	43.7

Note: Assumes a TDA effective guarantee of 7.2%

Table 4 shows that for any given total portfolio return other than the TDA guaranteed return, the impact of the guarantee on the effective QPP return rises as the relative size of TDA increases. For example, if the total portfolio earns a return of 10 percent (2.8 percentage points higher than the effective TDA guarantee), the QPP effective rate of return will be 10.6 percent if the TDA fixed-return fund is 20 percent of the size of QPP. But at TDA's current 43 percent relative size, the impact on the QPP return is greater, raising it up to 11.2 percent, and if the relative size grows to 60 percent, the effective QPP return rises to 11.7 percent. It works in the other direction for portfolio returns that are below the TDA guaranteed return.

The further the actual portfolio return from the guarantee, the larger the amplifying effect of TDA size. For example, if the total portfolio has a 20 percent loss (the second row of the table), the effective QPP return would be a loss at 37.4 percent if the TDA were 20 percent the size of QPP, a loss of 46 percent at the current TDA relative size, and a loss of 52.3 percent if the relative size were 60 percent of QPP. Thus, the larger the relative size of TDA, the greater the risks to QPP and therefore to the city budget. If the TDA fixed-return fund continues to grow, this will be an increasingly important issue for policymakers.

The TDA guarantee and effective QPP returns

The TRS CAFR reports the return on the total portfolio, but not the effective return on QPP assets taking the TDA guarantee into account—the measure that is most relevant to the funded status of QPP. We have calculated the impact of the TDA guarantee over the last 10 years (Figure 6). The light blue line shows the reported return for QPP assets and the dark blue line shows the effective return on QPP assets. The dashed line shows the TDA guarantee.[26] When reported returns are above the TDA guarantee, the dark blue line is above the light blue line, and when they are below the guarantee, the dark blue line is below the light blue line: QPP effective returns have higher highs and lower lows than QPP reported returns.

Over the time period of the graph, the TDA guarantee increased the standard deviation of effective QPP returns by more than 4 percentage points, from approximately 12 percent to more than 16 percent. In addition, the guarantee pulled down the effective compound return on QPP assets by 29 basis points: over the period shown the compound annual return on the entire portfolio was 5.22 percent, but the effective return for QPP assets taking the guarantee into account was only 4.93 percent.[27] For underlying details, see further information on the relationship between QPP and TDA in the appendix.

FIGURE 6
The impact of the TDA guarantee on effective QPP returns over the last 10 years

The TDA guarantee under alternative investment-return scenarios

We have incorporated the effect of the TDA guarantee into our simulation model. It always increases volatility, but in any given simulation it can increase or decrease effective QPP returns, depending on actual portfolio returns.

An asset-shock scenario

We begin with a severe adverse shock scenario. It is similar to a scenario developed by the Pew Charitable Trusts and is based largely on the Dodd-Frank stress test.[28] It assumes a 24 percent investment loss in 2019 followed by a three-year recovery period with annual returns around 12 percent, after which returns remain persistently low at 5 percent from 2023 to 2049. If the low-interest rate and low expected return environment persists, as this scenario posits, it would pose substantial risks to public pension plans. A growing body of economists and forecasters argues that persistent low interest rates are likely.[29]

The top panel of Figure 7 shows how the TRS-funded status would be affected under the current TRS policy (dark blue line) and under a hypothetical policy without the TDA guarantee (light blue line). The bottom panel shows the impacts on employer contributions as a percentage of payroll. We examine three subperiods.

FIGURE 7, PART 1
Simulated funded ratios and employer contribution rates under the asset-shock scenario

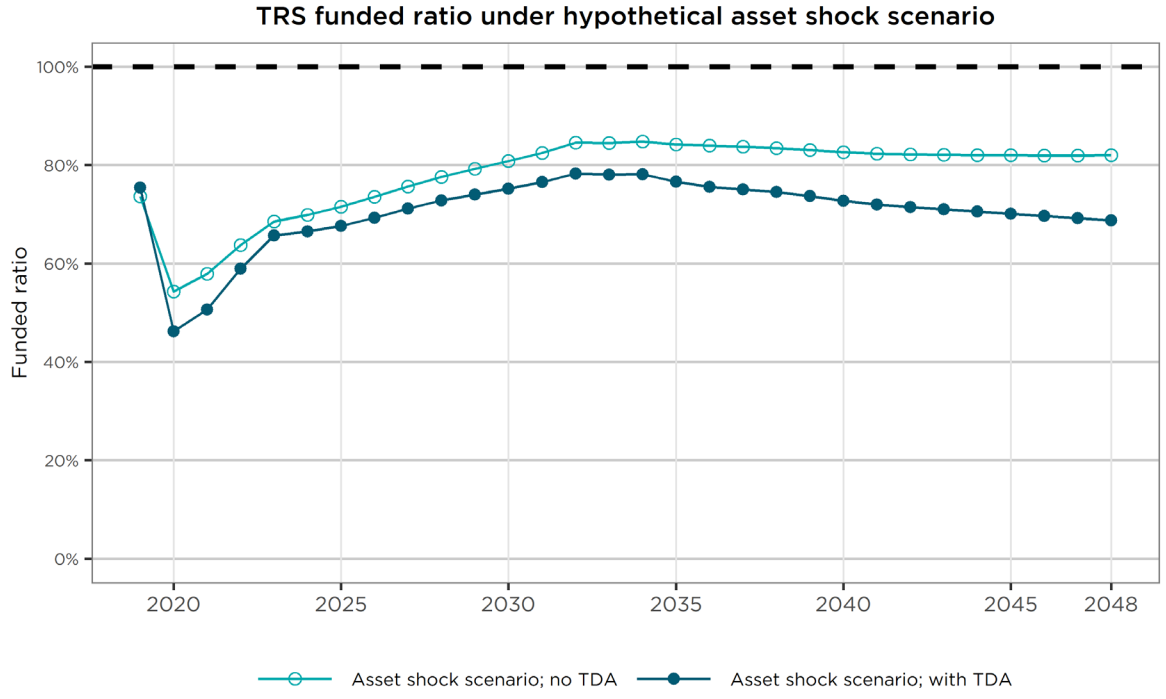
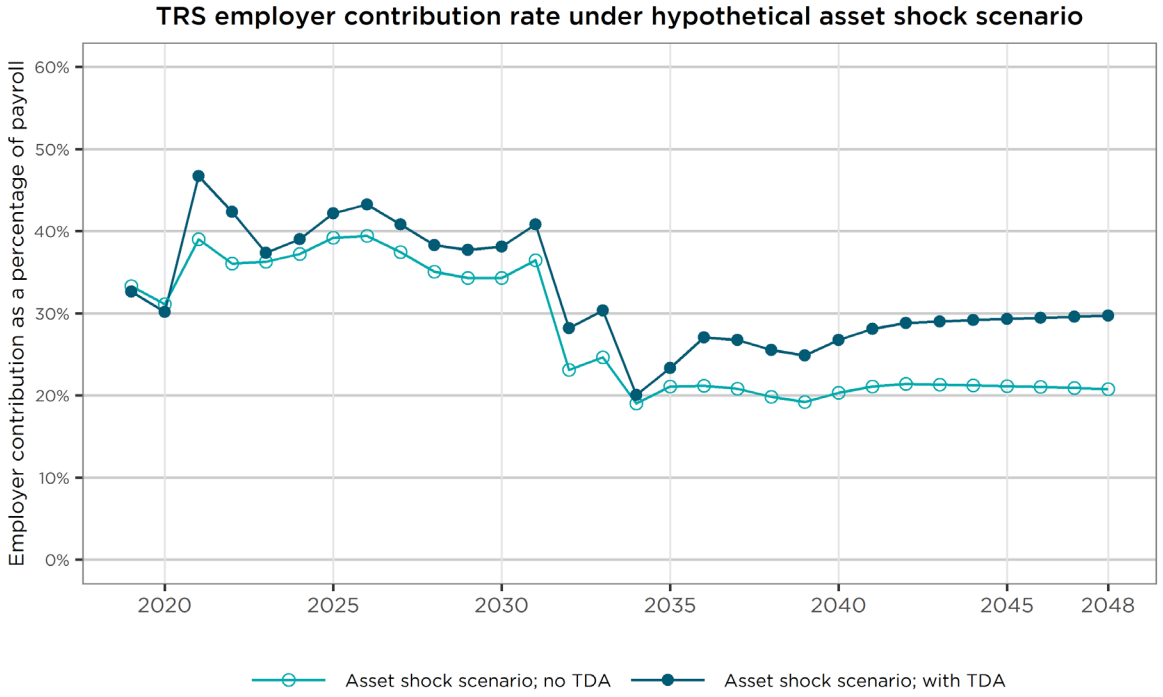


FIGURE 7, PART 2



The immediate post-shock period: The 24 percent investment loss in 2019 would have a significant adverse impact on the funded ratio and on required employer contributions even without a TDA guarantee. The guarantee amplifies the impact.

The asset shock causes the funded ratio to drop from 74 percent to 54 percent even without the TDA guarantee (light blue line in top panel), and the funded ratio would drop further to 46 percent with the TDA guarantee (dark blue line). The employer contribution rate one year after the asset shock would rise by 8 percentage points even without the TDA guarantee (light blue line in part 2) and by 16 percentage points with the guarantee (dark blue line).

The large increase in the employer contribution rate right after the asset shock is partly due to the fact that the corridor constraint on actuarial asset value, which mandates a maximum 20 percent difference between the actuarial asset value and the market asset value, would be triggered by the asset shock and therefore prevent the 24 percent loss from being fully smoothed.

The recovery period: After the initial asset shock and associated contribution spike the contribution rate declines due to higher returns in the three-year recovery period, but contributions remain higher than before the shock. Employer contributions are higher and the funded ratios are lower with the TDA guarantee (dark blue lines) than without it (light blue lines).

The longer-term low-return period: The persistent low-return environment after the recovery would have a larger impact on TRS due to the TDA guarantee. By 2048, the funded ratio would be only 69 percent under the current TRS policy with the TDA guarantee, which is about 13 percentage points lower than that without TDA. The employer contribution rate in 2048 with the TDA guarantee would be almost 9 percentage points higher than that without TDA (30 percent vs. 21 percent). These contribution rates, while high, are lower than current rates because almost 70 percent of current employer contributions are required to pay down unfunded liabilities. After those liabilities are paid down—a result of the strong TRS funding policy—employer contributions will fall even under the asset-shock scenario, although they will be higher than they otherwise would be.

Stochastic simulations and the TDA guarantee

We conducted stochastic simulations assuming an expected 7 percent long-run compound return, and a 12 percent standard deviation. We calculated the standard deviation of investment returns with and without the TDA guarantee and found that the guarantee increased the standard deviation of effective QPP returns in our simulations by approximately 4 to 5 percentage points above our assumed 12 percent standard deviation for the portfolio. We estimate that the TDA guarantee reduced long-run compound returns by approximately 28 basis points (0.28 percentage points), which is quite sizable and is consistent with our analysis of the historical experience.

Illustration of impact under a single simulation

Before summarizing 2,000 simulations, we illustrate the potential impact of the TDA guarantee with a single simulation. Figure 8 shows market investment returns and the effective QPP return, after the TDA guarantee, for one specific simulation run out of 2,000 simulations (simulation number 424). We chose this simulation because it happens to achieve the plan's assumed 7 percent investment return exactly at the end of 30 years, although the path getting there is volatile. The typical simulation will have a higher or lower 30-year return than the expected return, and so results could be even better or worse than seen here.

The light blue line shows the actual market return, and the dark blue line shows the effective return after taking the TDA guarantee into account. As in our historical analysis, we see higher highs and lower lows in the effective returns after the TDA guarantee.

The TDA guarantee also will make employer contributions and the TRS-funded status more volatile. Figure 9 shows how the guarantee could affect employer contributions under two different funding approaches, using simulation 424 from above to illustrate this point. The light blue line shows anticipated employer contributions without the TDA guarantee, the dark blue line shows what happens with the guarantee treated the same way as regular investment income, which is subject to the smoothing and amortization policies of TRS.

FIGURE 8
The TDA guarantee increases the volatility of simulated effective returns

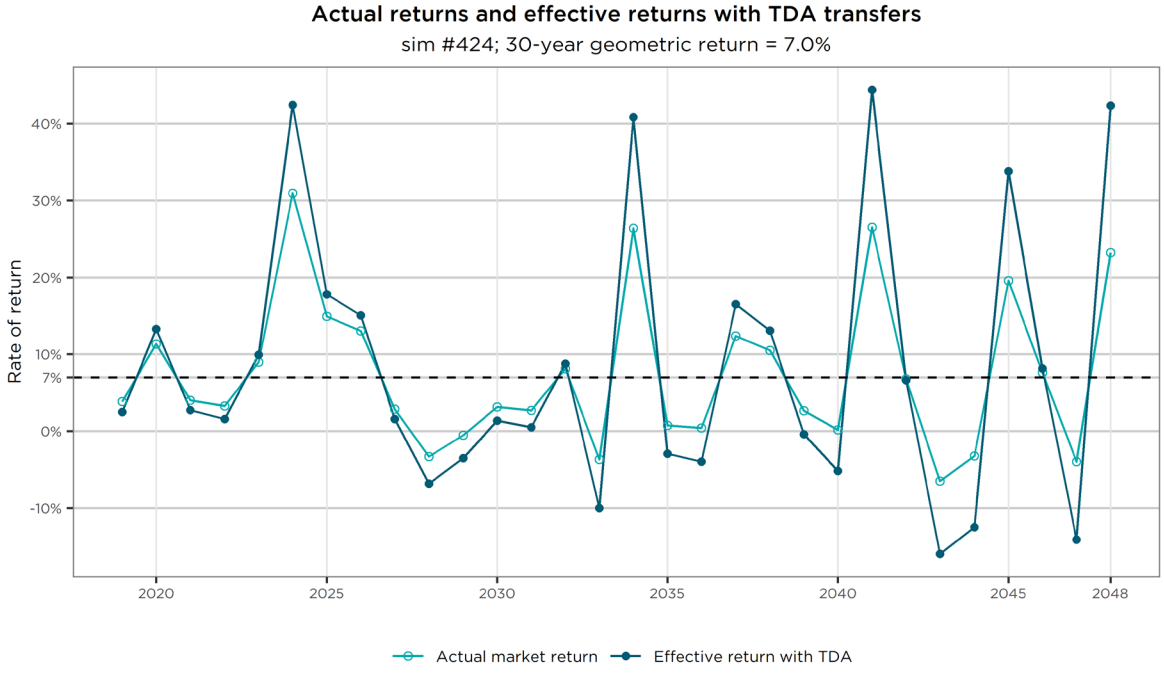
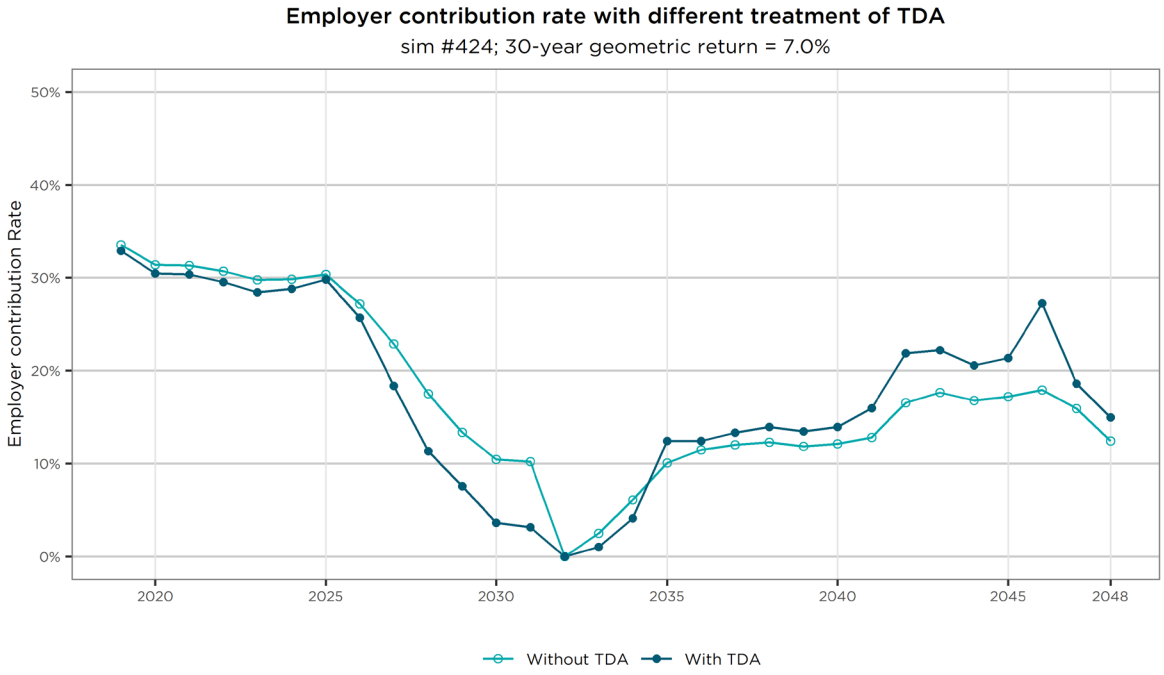


FIGURE 9
How the TDA guarantee could affect contribution volatility under two different funding approaches



The potential impact of the TDA on employer contributions

We summarized the potential impact of the TDA on employer contributions over our 2,000 simulations by constructing probability-based measures for two types of risks:

1. The risk that the employer contribution will become very high relative to payroll (and city tax revenue), causing great fiscal pressure and potentially crowding out public services. We measure this risk by the probability of the employer contribution rising above 60 percent of payroll at any time up to a given simulation year—a nearly 50 percent increase from the 2018 employer contribution rate of 42 percent of payroll.[30]
2. The risk that the employer contribution will increase sharply in a short period of time, causing difficulty in budgeting and short-term fiscal pressure. We measure this risk by the probability that the employer contribution as a percentage of payroll will rise by more than 10 percentage points in any five-year period up to a given simulation year.[31]

Figure 10 and Figure 11 compare these two risk measures under the current TRS policy and a hypothetical scenario in which there is no TDA guarantee—that is, in which the TDA has no impact on the finances of the defined benefit plan. For each risk measure, we run simulations under two investment scenarios:

1. **Baseline:** The expected long-run compound return is equal to the assumed return of 7 percent, with a standard deviation of 12 percent. This scenario is shown in the left panels of the two figures.

FIGURE 10
Comparing the risk of high employer contributions with and without the TDA guarantee under alternative investment-return scenarios

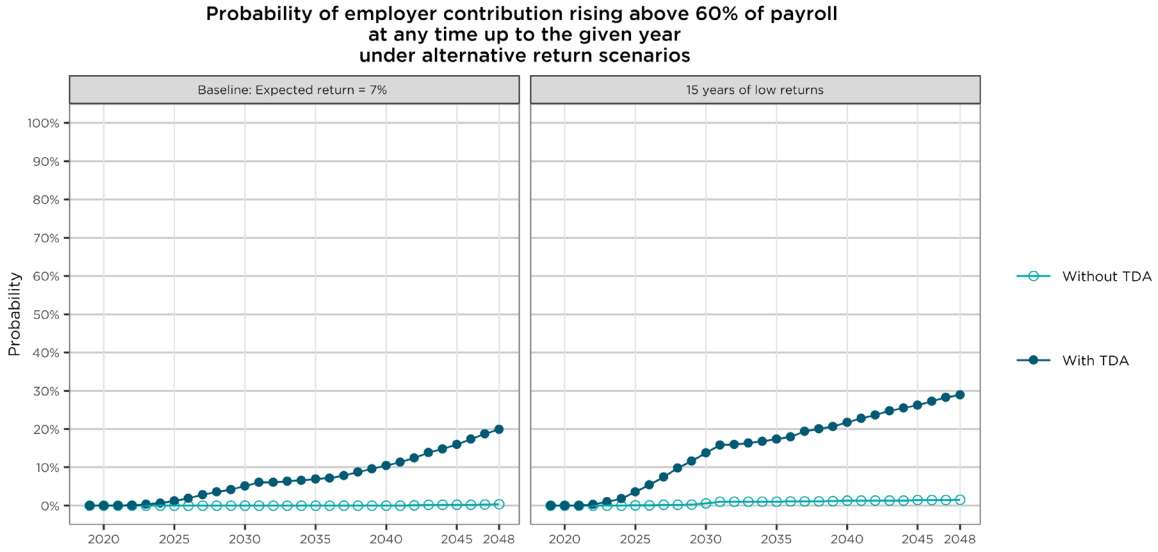
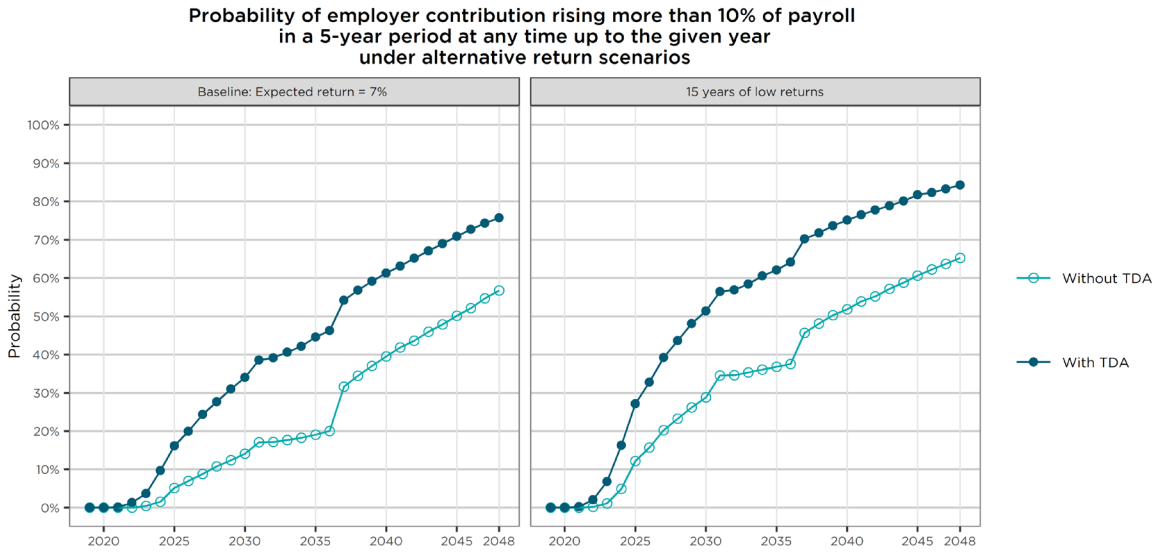


FIGURE 11
Comparing the risk of sharp increases in employer contribution with and without the TDA guarantee under alternative investment-return scenarios



2. **15 years of low returns:** In our alternative scenario, the expected compound return is only 5 percent for 10 years followed by a rise to an expected 6.5 percent compound return for the next five years. After that, the expected long-run compound return rises to the long-run TRS assumption of 7 percent. This is consistent with expectations of some investment analysts who do not expect interest rates to persist for the long run, but rather expect a gradual rise.[32] The standard deviation is 12 percent throughout the simulation period. This scenario is shown in the right panels of the two figures.

The TDA guarantee greatly increases both types of risks to employer contributions, under both investment-return scenarios.

The risk of very high employer contributions is shown in Figure 10. This risk is much higher with the TDA guarantee than when there is no TDA guarantee:

- Under the baseline investment-return scenario (left panel) the risk that employer contributions will rise to 60 percent of payroll sometime in the 30-year period is 20 percent with the TDA guarantee, compared to 0.4 percent without the guarantee. (These are the graph values at year 2048.)
- Under the 15 years of low-returns scenario (right panel), when the low-return period ends in 2033 the risk measure for very high employer contributions is about three times as high as under the baseline scenario—this risk is 19 percent at year 2033 in the right panel, compared to 6 percent in the left panel.

Figure 11 shows the risk of sharp increases in employer contributions in a short time period:

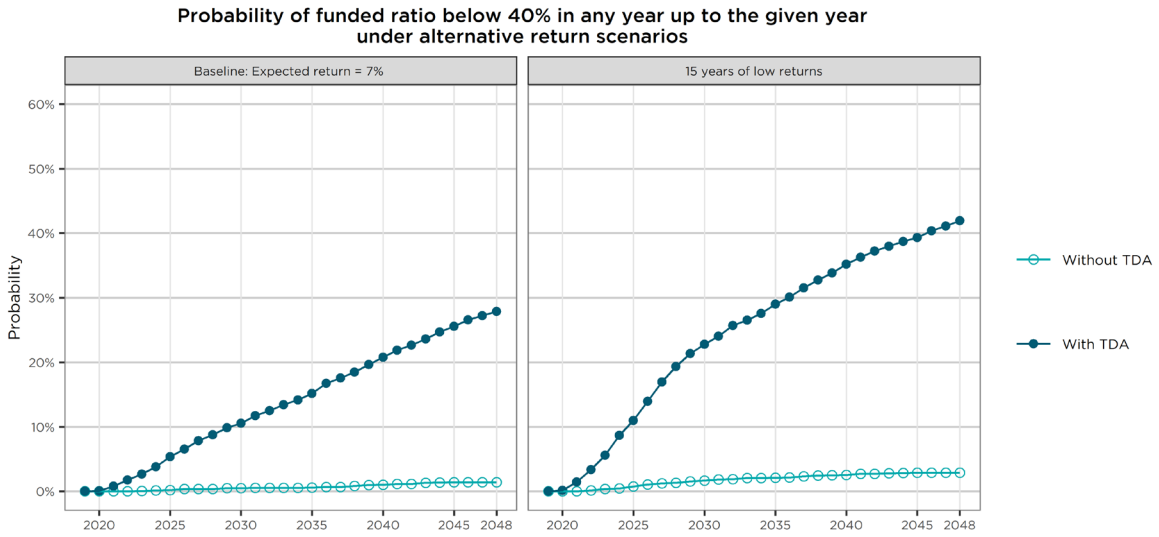
- In the baseline scenario (left panel) this risk is quite high, even without the TDA guarantee. There is about a 57 percent chance that contributions will rise by more than 10 percentage points in a five-year period sometime in our 30-year window (left panel, light blue line, year 2048). The risk of sharp contribution increases is largely due to the strong funding policy of TRS, under which sharp contribution increases following investment shortfalls help restore plan funding. Incorporating the TDA guarantee increases the risk measure by about 19 percentage points, to 76 percent (left panel, dark blue line, year 2048).
- Under the 15 years of low-returns scenario (right panel), the risks of sharp employer contribution increases are greater than in the baseline scenario. Incorporating the TDA guarantee increases the risk measure by slightly more than it does in the baseline scenario.

Under either investment-return scenario, the risk of sharp increases in employer contributions with the TDA guarantee is much greater than without the guarantee.

The potential impact of the TDA guarantee on the plan funded ratio

The increased investment return volatility for QPP caused by the TDA guarantee greatly increases the risk that TRS will become severely underfunded. As Figure 12 shows, the probability that the TRS-funded ratio will fall below 40 percent at some point in the next 30 years is less than 2 percent when the TDA guarantee is excluded, but with the TDA guarantee the risk rises sharply to 28 percent in the baseline scenario (left panel) and to 41 percent in the 15 years of low returns scenario (right panel). This sharp increase in the risk of severe underfunding occurs despite the fact that the strong

FIGURE 12
Comparing the risk of severe underfunding with and without the TDA guarantee under alternative investment-return scenarios



TRS funding policy requires the city to make significantly higher contributions soon after investment return shortfalls.

To further illustrate the impact of TDA, we calculated the amount of additional employer contribution needed to bring the risk of severe underfunding back to the level without TDA. The simulation results show that under the baseline scenario, the employer contribution rate would need to increase by 18 percentage points in every simulation year to reduce the probability of funded ratio falling below 40 percent in any year up to 2048 from 28 percent under the current policy back to below 2 percent. For reference, the median employer contribution rates without the additional contributions for years 2025, 2035, and 2045 in the simulation are 28.3 percent, 8.8 percent, and 4.7 percent respectively. For the entire simulation period from 2019 through 2048, the present value (with 7 percent discount rate) of the total additional employer contribution is amount to 87 percent of the present value of total employer contribution under the current policy.

TDA CONTRIBUTION RISK OUTWEIGHS THE STRONG FUNDING POLICY

Relative to funding policies many other pension plans use, TRS's strong funding policy increases protection for the TRS fund at the risk of higher employer contributions for the city. Meanwhile, the TDA guarantee reduces protection for the fund and increases contribution risk for the city. It is interesting to examine the combined impact of the strong TRS funding policy and the TDA guarantee in comparison to a more liberal funding policy without a TDA guarantee.

Figure 13 shows our measure of the risk of sharp increases in employer contributions within a five-year period. The lowest line, with a transparent circle marker, shows this risk under a liberal 30-year open amortization policy that many funds use, with no TDA guarantee. The middle line with a solid circle marker shows this risk with the strong TRS funding policy with closed amortization and no TDA guarantee. The risk to city contributions is much higher: for example, there is about a 58 percent chance that contributions will increase this much sometime in the 30-year period, compared to about a 9 percent chance under the liberal funding policy (see rightmost point on the middle and bottom lines).

Finally, the top line with the square marker shows the full current TRS policy: the closed amortization plus the TDA guarantee. It shows that the TDA guarantee makes this risk higher still—about a 75 percent chance that city contributions will increase by 10 percent of payroll, or more, in a five-year period sometime in the next 30 years.

Figure 14 shows our measure of the risk of severe underfunding. In this figure the line with the liberal 30-year open amortization policy and no TDA guarantee (transparent marker) is in the middle. It shows about a 16 percent risk of severe underfunding sometime in the 30-year period, under our definition of severe underfunding. Replacing the liberal funding policy with the strong TRS funding policy drives this risk down nearly to zero (the line with the solid black marker, on the bottom). However, adding the TDA guarantee on top of this strong funding policy more than offsets the funding policy, driving the risk of severe underfunding sometime in the next 30 years up to about 27 percent (top line with the square marker).

FIGURE 13
The partially offsetting effects of the TDA and the TRS funding policy on the risk of high New York City contributions

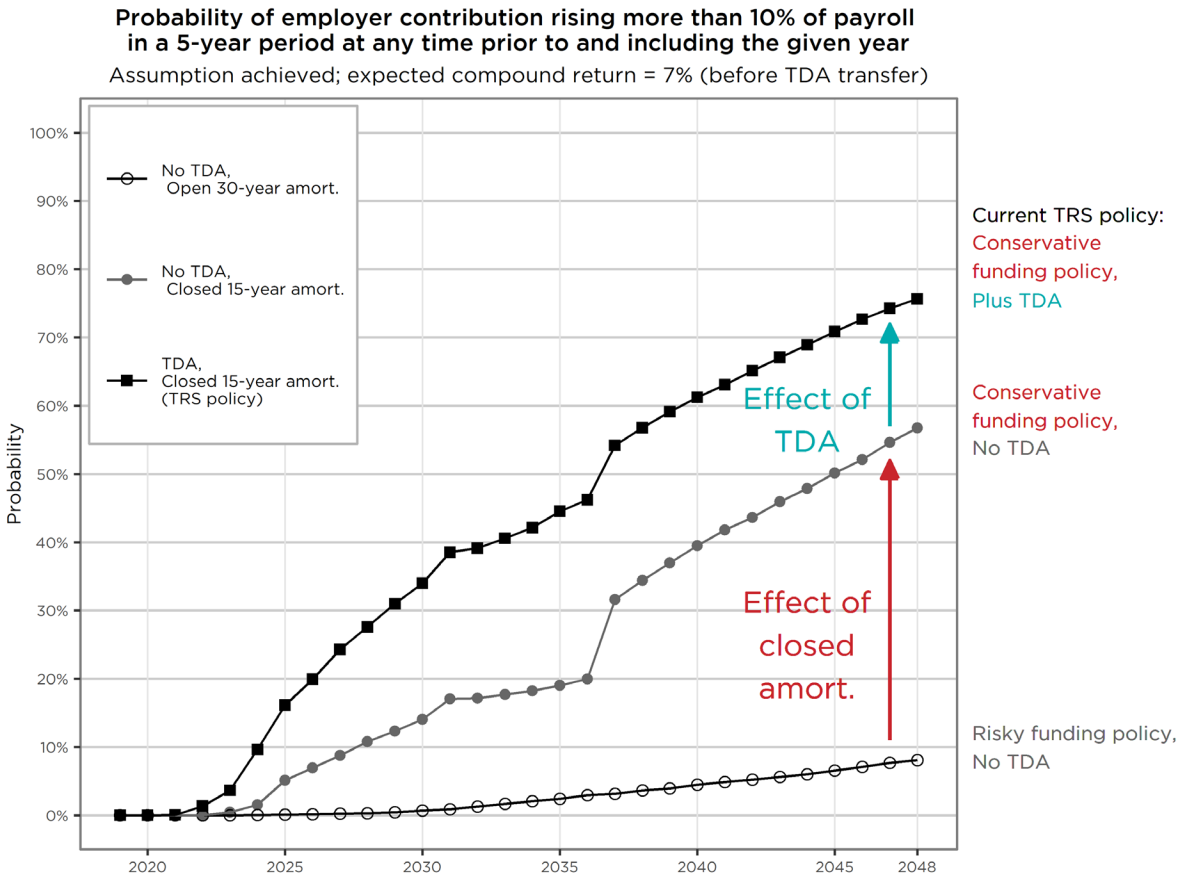
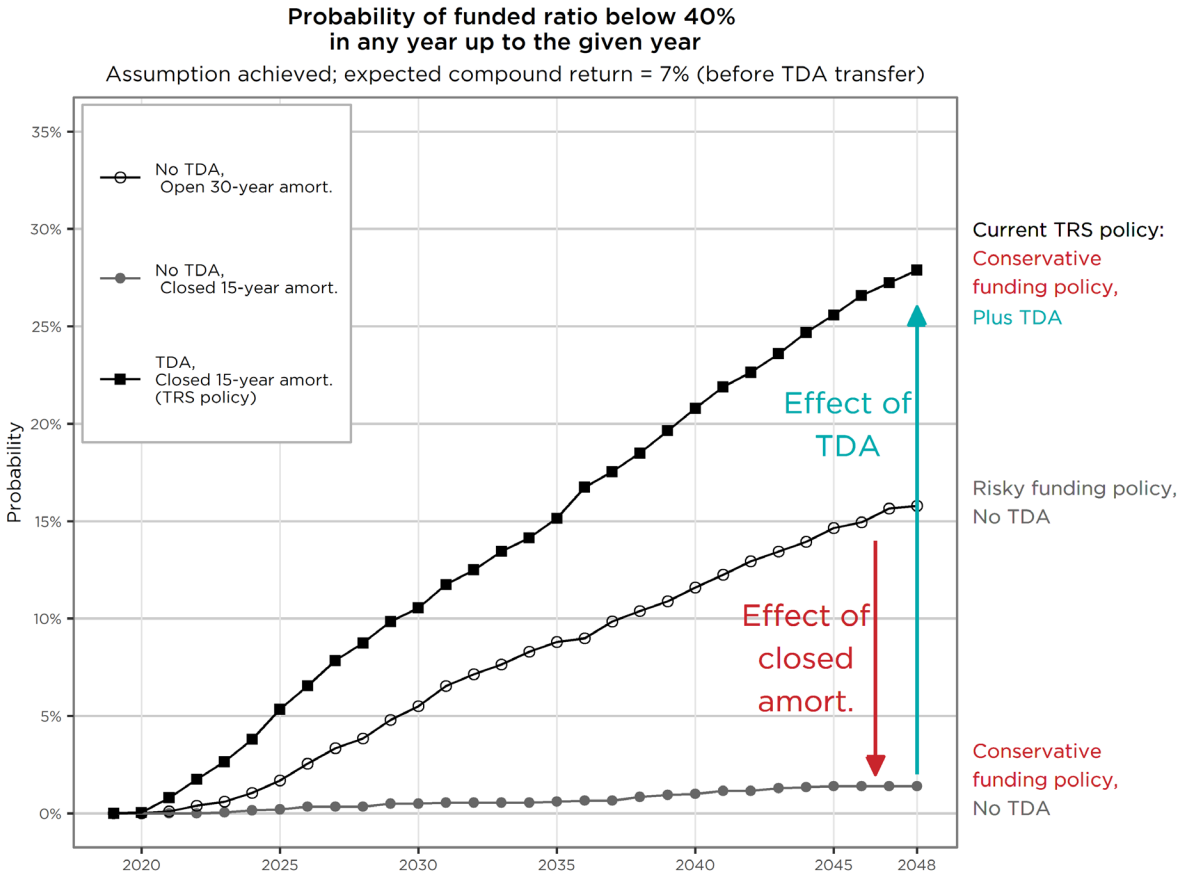


FIGURE 14
The partially offsetting effects of the TDA and the TRS funding policy on the risk of severe underfunding



ALTERNATIVE TDA POLICIES AND GROWTH ASSUMPTIONS

Two major factors determine the impact of the TDA guarantee: the size of the TDA fixed-return fund relative to QPP, and the TDA guaranteed rate of return. In this section, we examine alternative scenarios for these two factors.

Potential growth assumptions for the TDA fixed-return fund

The relative size of the TDA fixed-return fund and QPP will be determined by their respective growth rates.[33] TDA growth depends upon (1) the guaranteed investment earnings of about 7 percent; and (2) its net cash flow, which is total member contributions, plus net transfers from other TDA funds, minus the sum of benefit payouts and withdrawals.

The analysis in previous sections assumed that net cash flow is zero in all simulation years so that guaranteed investment earnings determine growth of the TDA fixed-return fund. Under this assumption, it grows at the guaranteed rate (about 7 percent per year) and its size as a percentage of the QPP rises from 44 percent in 2016 to 46 percent in 2030 and to 82 percent in 2048. This growth leads to increased volatility over time in the effective QPP return.

The future growth of the TDA fixed-return fund is uncertain. During 2015 to 2018, the net cash flow of the TDA fixed-return fund ranged from 1.3 percent to 3.2 percent. The future growth of the TDA fixed fund will be affected by several factors, including plan demographics (for example, increasing retirements may lead to more withdrawals from the fund), changes in the TDA provisions, and the attractiveness of the TDA guarantee relative to other retirement saving options.

The zero net cash flow used in our previous analysis was based on the assumption that the benefit payouts and withdrawals from the TDA fixed-return fund will grow faster than member contributions and transfers as the plan matures, and that net cash flow will be approximately balanced in the long term. The actual growth of the TDA fixed-return fund in the future could be faster or slower than this baseline assumption. To examine the impact of the TDA guarantee on QPP under different TDA fixed-return fund growth assumptions, we ran our simulation model with two alternative scenarios for net cash flow, along with a baseline scenario.

- **7 percent TDA fixed return; baseline net cash flow.** Annual net cash flow of the TDA fixed-return fund is assumed to be zero. This is the assumption we used for simulations discussed in previous sections.
- **7 percent TDA fixed return; high net cash flow.** Annual net cash flow of the TDA fixed-return fund is assumed to be 2 percent of the covered payroll, which is close to the average net cash flow during 2015–2018. That is, the fund has net inflows every year. We consider this to be a high net cash flow scenario—we think the net cash flow is very likely to decline in the long run as the plan matures because withdrawal and benefit payments from the fund may increase rapidly.
- **7 percent TDA fixed return; low net cash flow.** Annual net cash flow of the TDA fixed-return fund is assumed to be minus 2 percent of covered payroll. This scenario could be caused by higher-than-expected benefit payouts and member withdrawals, lower-than-expected member contributions to TDA, transfers out of the fixed-return fund into other TDA funds, or a combination of causes.

Alternative guarantee assumptions

We constructed alternative scenarios to examine the potential impact of a lower TDA guaranteed return. From the perspective of members, the 7 percent guaranteed return is an attractive investment option that generally is not available in other defined contribution programs outside TRS, especially in the low-interest-rate environment after the Great Recession.[34] From the perspective of the QPP fund as an institutional investor, the TDA fixed-return fund, which is pooled with QPP assets, works like a prime loan to QPP with an annual interest rate of 7 percent, which is quite high compared to the benchmark rates in the capital market.[35] How would the impact of the TDA program on QPP change if the TDA guarantee were set to a lower rate? We construct the following policy scenarios:

- **2.5 percent TDA fixed return; baseline net cash flow and 2.5 percent TDA fixed return; low net cash flow.** This scenario drops the TDA guarantee closer to market rates, as discussed above. We couple this with the baseline net cash flow assumption of zero and alternatively with the low net cash flow assumption of minus 2 percent of payroll.
    - **5 percent TDA fixed return; baseline net cash flow.** The current TDA is a valuable form of compensation to TRS members, and no doubt intended as such. A 2.5 percent guarantee would be little different from market rates and would not add much to compensation. Thus, we also examine a guarantee that falls between the current guarantee and a market rate, rounding to 5 percent, which still provides additional compensation to members. We examine this coupled with the baseline net cash flow assumption of zero.[36]
    - **5 percent TDA fixed return; Low net cash flow.** A lower TDA guarantee could make the program less attractive to TRS participants, causing a negative net cash flow from the TDA fixed-return fund in the future. In this scenario we couple the 5 percent guarantee with our low net cash flow assumption, in which the net cash flow is assumed to be minus 2 percent of covered TRS payroll every year.

Results under alternative assumptions

In this section we examine how underfunding and contribution risks are affected by the alternative growth and guarantee assumptions described in the two preceding sections.

Impacts of relative size of the TDA fixed-return fund

Table 5 shows the projected size of the TDA fixed-return fund relative to QPP assets under the three net cash flow scenarios and four lower guarantee scenarios, assuming a constant annual return of 7 percent. Under the zero net cash flow assumption (baseline), the TDA fixed-return fund will become significantly larger relative to QPP in 30 years, growing from 44 percent of QPP assets in 2016 to 87 percent in 2048. Under the high net cash flow (+2 percent of payroll) and low net cash flow (-2 percent of payroll) assumptions the TDA fixed-return fund will be 104 percent and 70 percent of the QPP assets in 2048 respectively. Lowering the TDA guaranteed return from 7 percent to 5 percent or 2.5 percent will greatly limit the size of the TDA fixed-return fund, making the TDA fixed-return fund a lower percentage of QPP assets in 2048 than in 2016.

TABLE 5
TDA fixed-return fund as a percentage of QPP assets under different TDA net cash flow and guaranteed return scenarios

Projected TDA Fixed Return Fun assets as a percentage of projected QPP assets under alternative scenarios of TDA net cash flow and TDA guarantee
(Assuming contsant return of 7% for QPP before TDA transfer)

	7% TDA fixed rate			5% TDA fixed rate		2.5% TDA fixed rate	
Year	Baseline net cash flow	High net cash flow	Low net cash flow	Baseline net cash flow	Low net cash flow	Baseline net cash flow	Low net cash flow
2016	44%	44%	44%	44%	44%	44%	44%
2030	47%	52%	42%	34%	30%	23%	20%
2048	87%	104%	70%	43%	33%	19%	13%

Scenarios for net cash flow. The net cash flow is calculated as the total member contribution to the TDA Fixed Return Fund minus the total value of benefit payouts and withdrawals. In any given simulation year, the amounts of net cash flow of the TDA Fixed Return Funds under the Baseline, High, and Low scenarios are assumed to be 0%, 2%, and -2% of the total covered payroll respectively.
Scenarios for TDA guarantee. The TDA guaranteed returns are 7% for UFT members and 8.25% for non-UFT members under the "7% TDA fixed rate" scenario, which represent the current TDA policy. The TDA guaranteed returns are 5% for UFT members and 6.25% for non-UFT members under the "5% TDA fixed rate" scenario. The TDA guaranteed returns are 2.5% for UFT members and 3.75% for non-UFT members under the "2.5% TDA fixed rate" scenario.

Impacts on risks to employer contributions and to plan funding

We ran simulations under the seven scenarios described above, all with the baseline investment assumption (7 percent expected return and 12 percent standard deviation), and compared across scenarios the risk of a very high employer contribution, the risk of sharp increases in employer contributions, and the risk of severe underfunding. The results for the hypothetical scenario with no TDA guarantee are also presented for comparison.

Impacts of net cash flow on the risk of high employer contributions

Figure 15 shows that the alternative TDA net cash flow assumptions affect the risk of high employer contribution moderately. With the 7 percent TDA guarantee, the probability of the employer contribution rising above 60 percent of payroll sometime during the 30-year simulation period will increase to 23.1 percent under the high net cash flow assumption (+2 percent of payroll) and fall to 16.2 percent under the low net cash flow assumption (-2 percent of payroll), from the 19.9 percent baseline scenario of zero net cash flow.

Impacts of net cash flow on the risk of sharp increases in employer contributions

The impacts of the alternative TDA net cash flow assumptions on the risk of sharp increases in employer contributions are quite limited, as shown in Figure 16. One reason for the limited impact is that the six-year asset-smoothing method provides a strong dampening effect on short-term contribution volatility, so that the modest changes in the size of the TDA fixed fund relative to QPP assets (changes of ±17 percentage points under the two alternative cash flow scenarios from 87 percent under the baseline in 2048) would not greatly change the risk of sharp increases in contribution.

Impacts of net cash flow on the risk of severe underfunding

Figure 17 shows that the impacts of the alternative TDA net cash flow assumptions on the risk of severe underfunding are moderate. With the 7 percent TDA guarantee, the probability of funded ratio falling below 40 percent sometime during the 30-year simulation period is 28 percent under the baseline net cash flow assumption of zero, compared to 31.6 percent under the high net cash flow assumption (+2 percent of payroll) and 24.5 percent under the low net cash flow assumption (-2 percent of payroll).

Impacts of a lower TDA guarantee on the three types of risks

Lowering the TDA guarantee would substantially reduce risks faced by TRS. Comparing the risk measures under the scenarios with the 7 percent TDA guarantee, the scenarios with the 5 percent TDA guarantee and the 2.5 percent guarantee, and the scenario with no TDA guarantee, lowering the TDA guarantee from 7 percent to 5 percent would reduce all three types of risks caused by TDA approximately by half, and lowering the TDA guarantee further to 2.5 percent would reduce the risks by about 80 percent.

With a 5 percent or a 2.5 percent TDA guarantee, the guarantee is lower than the 7 percent expected return assumed in the simulations and therefore the TDA fixed fund will generate excess investment earnings, on average, that are transferred to the QPP funds, bolstering the funded status of QPP and reducing employer contributions.

Overall assessment

In sum, the simulation results show that the funding risks of TRS would not be significantly affected by moderate changes in the future growth of the TDA fixed-return fund as long as the 7 percent guaranteed return is maintained. However, lowering the TDA guaranteed rate of return greatly reduces the funding risks of TRS as doing so will slow the growth of the TDA fixed fund and potentially transfer investment earnings from TDA to QPP.

FIGURE 15
Comparing the risk of high employer contribution under different scenarios of TDA net cash flow and TDA guaranteed return

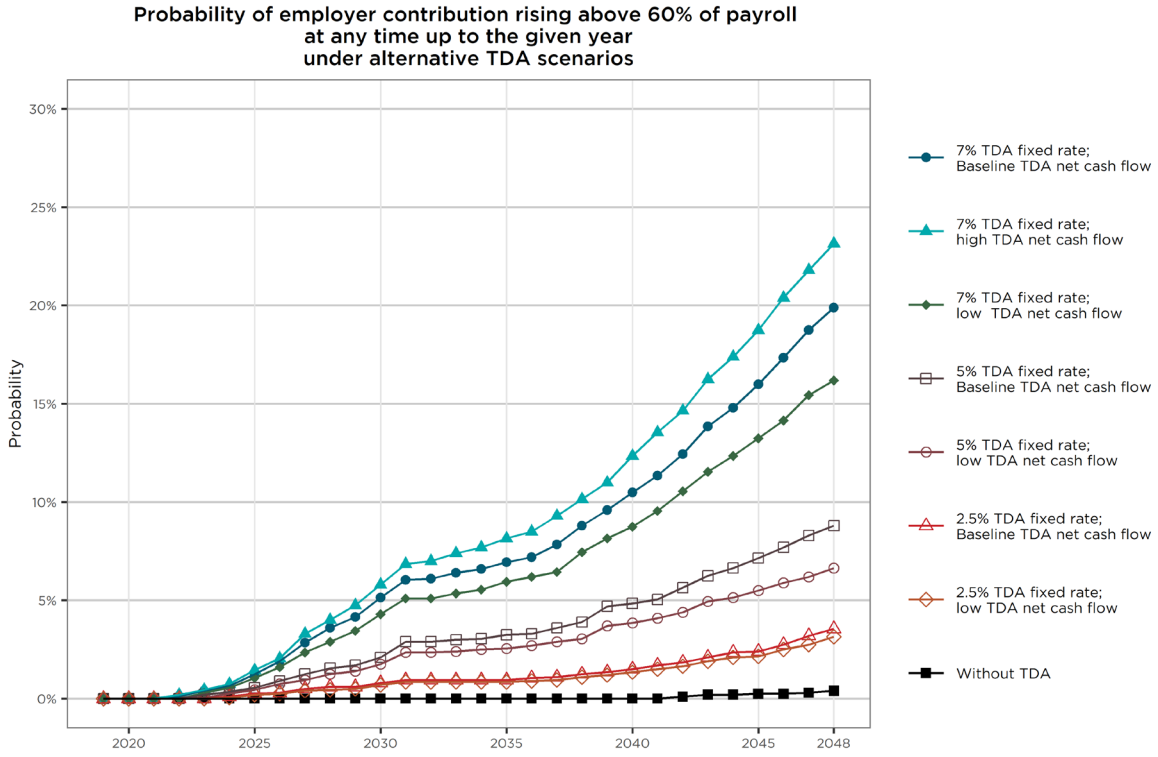
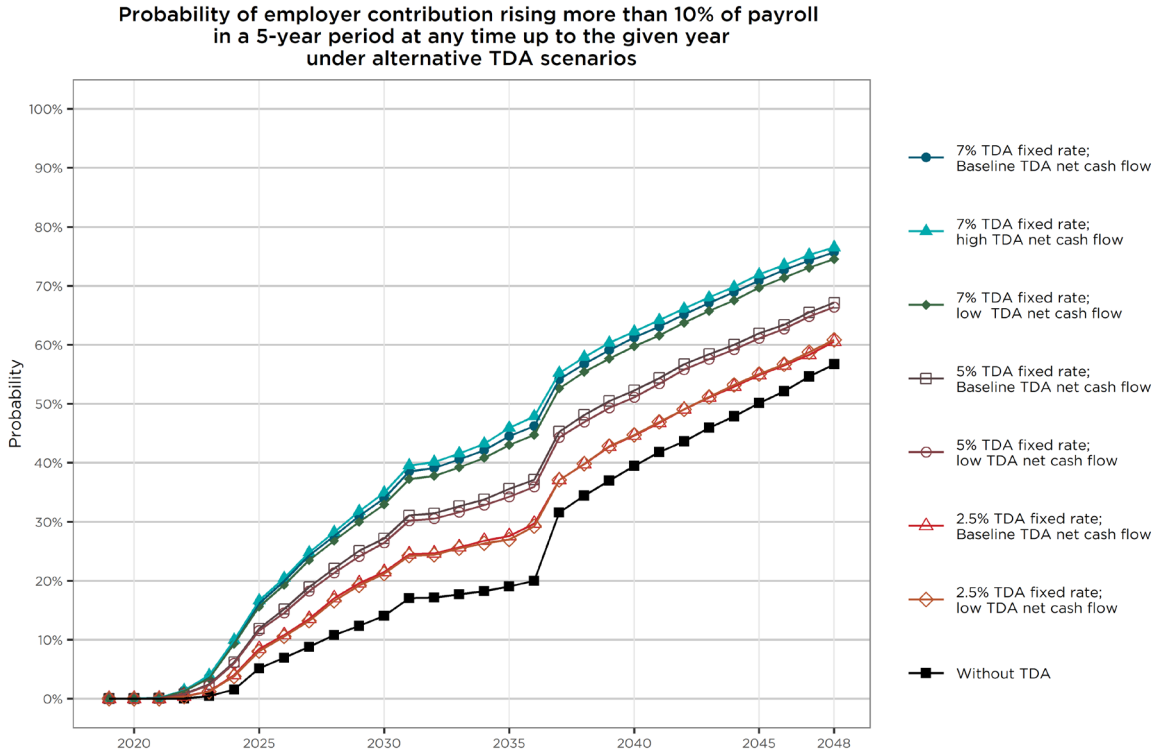


FIGURE 16
Comparing the risk of sharp increases in employer contribution under different scenarios of TDA net



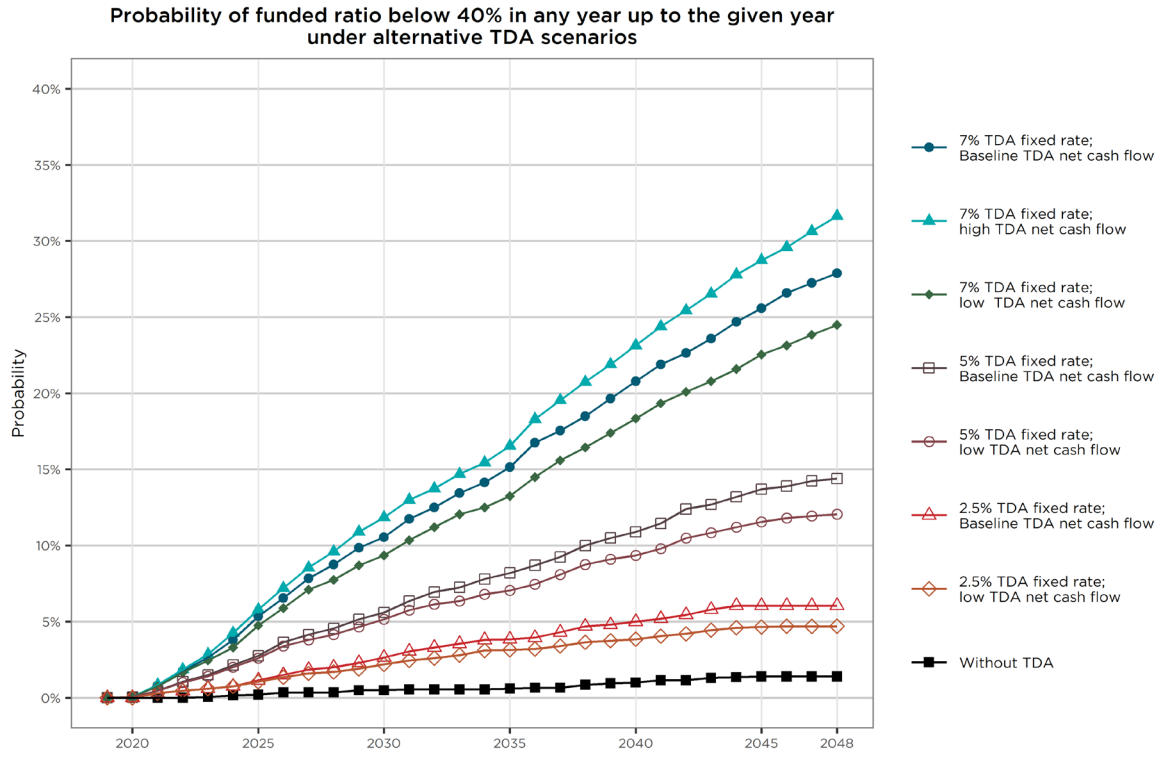
INSTITUTIONAL CONSIDERATIONS RELATED TO THE TAX-DEFERRED ANNUITY

Two characteristics of the TDA guarantee raise questions about whether and how the TDA is considered under standards or regulations promulgated by professional standards organizations and regulatory bodies. The first is that the TDA guarantee increases the volatility of effective investment returns for the Qualified Pension Plan and therefore increases risk to the plan and to the city, and the second is that the above-market guarantee is additional compensation to TDA participants in an economic sense.

First, the Governmental Accounting Standards Board (GASB), which establishes accounting and financial reporting standards for most governments and public pension plans, requires public pension plans to disclose the sensitivity of the plan's net pension liability, a measure of unfunded liability for accounting purposes, to a 1 percentage point change in the plan's investment return assumption. Among other things, this shows how much the reported liability would increase if investment returns were to fall short by one percentage point. It does not take into consideration the fact that if investment returns were to fall short, unfunded liability would increase even further because of the leveraging effect of TDA on plan investment gains and losses. There may be no accounting solution to this problem, but readers of New York City Teachers' Retirement System financial reports need to be made aware of this additional risk to plan underfunding that is not reflected in the sensitivity analysis.

The Actuarial Standards Board, which provides professional guidance to actuaries, adopted Actuarial Standard of Practice (ASOP) No. 51 in 2017, which provides additional guidance to actuaries about assessment and disclosure of risk related to private and public pension plans. Among other things, ASOP 51 notes that the "actuary should identify risks that, in the actuary's professional judgment,

FIGURE 17
Comparing the risk of severe underfunding under different scenarios of TDA net cash flow and TDA guaranteed return



may reasonably be anticipated to significantly affect the plan's future financial condition," including investment risk.[37] ASOP 51 provides guidance to actuaries but does not impose a requirement. The New York City Office of the Actuary's ASOP 51 reporting does not discuss the impact of the TDA.[38]

In addition, some analysts have asked whether the above-market guarantee might raise other institutional or regulatory issues.[39]

CONCLUSIONS

TRS's funding status has improved over time but it remains an important factor in city finances. The city's contributions to TRS of $3.7 billion account for 40 percent of total pension contributions. Unfunded liabilities in TRS of $18.7 billion account for 33.4 percent of total city unfunded pension liabilities.

TRS has a strong funding policy that pays down new unfunded liabilities over a closed 15-year period in level-dollar amounts, and employers have always fully paid their contributions. Our simulations show that TRS's funding policy reduces the risk of the severe underfunding, compared to more liberal policies often used by other plans, at the expense of higher contribution volatility, especially during market downturns.

TRS's voluntary contribution Tax-Deferred Annuity program (TDA) offers a guaranteed rate of return that is well above market rates, guaranteed by the defined benefit Qualified Pension Plan (QPP). The guaranteed rate is 7 percent for the vast majority of participants. TDA participants and assets have grown rapidly in recent years, and the fixed-return fund is now about 43 percent as large as the QPP. The guaranteed returns on the TDA fixed fund create a leveraging effect on TRS, making annual effective returns on the QPP more volatile and reducing long-run compound QPP investment returns. Analysis of TDA historical experience and our stochastic simulation of future years show that the TDA guarantee reduces TRS's long-run compound return by approximately 28–29 basis points.

The increased volatility in QPP effective returns caused by the TDA guarantee increases the risks of higher employer contributions and the risk of severe plan underfunding. Although TRS has a strong funding policy relative to many other plans, the increase in the risk of severe underfunding created by the TDA guarantee more than offsets the reduction in this risk created by the strong TRS funding policy.

We examined several alternative scenarios that entail faster and slower growth in the TDA fixed-return fund, and we also examined a scenario in which the guarantee would be 5 percent for the majority of participants, in isolation and in combination with a low-TDA-growth scenario. The different TDA growth scenarios have relatively little impact on plan funding and employer contribution risks, but the alternative guarantees would have a large impact. Lowering the TDA guarantee from 7 percent to 5 percent would reduce all three major risks we examined caused by TDA by approximately half.

The analysis in this report does not suggest there is any imminent danger to TRS. However, our simulations suggest that the combination of the TDA guarantee and investment-return volatility mean the risk of severe underfunding—a funded ratio below 40 percent in our measure—sometime in the next 30 years is about 28 percent under a 7 percent expected investment return assumption. This risk rises to 41 percent under an investment scenario that includes 15 years of low expected returns before the expected return rises to 7 percent.

Whether these risks are too great or not concerning is for policymakers to decide, but they need to be aware of them and either explicitly affirm the status quo or work to reduce risk.

ENDNOTES

1. TDA Program Summary: Tax-Deferred Annuity Program, Teachers' Retirement System of the City of New York, February 2019, https://www.trsnyc.org/memberportal/WebContent/publications/tdaBook.
2. In its October 2015 actuarial audit of the city retirement systems, Gabriel, Roeder, Smith & Company suggested that Monte Carlo simulation could help assess the extent to which the TDA leverages asset gains and losses. We are conducting these types of simulations in this project.
3. Sherry S. Chan, Fiscal Year 2018 GASB 67/68 Report For The City of New York And The New York City Retirement Systems, Office of the Actuary, New York City, September 28, 2018, https://www1.nyc.gov/assets/actuary/downloads/pdf/GASB_67_68_Report_FY2018.pdf.
4. For this purpose, liabilities are calculated using the plans' earnings assumption of 7 percent. Total liabilities and unfunded liabilities would be far greater if calculated using market discount rates, which could be about 5 percentage points lower depending on the rate used. As shown in Table VIII of the GASB 67/68 disclosure report (cited in previous note), a 1 percent reduction in the discount rate would lead to an increase in reported unfunded liabilities of $8.5 billion for TRS (a 45 percent increase), to $27.3 billion, and an increase of $26.8 billion for city plans as a whole, to $82.8 billion. A reduction in the discount rate of 3 to 4 percentage points would entail much greater increases in reported unfunded liabilities. The calculation is not a simple multiplication, but a 3 percentage point reduction in the discount rate would lead to much more than a tripling of the $8.5 billion TRS increase that results from a 1 percentage point reduction.
5. This only includes contributions directly paid by the city, which are less than the total of all employer contributions. In the case of TRS, more than 90 percent of contributions are paid by the city.
6. These numbers are not identical to other sources, but they are close. Source is Official Statement: The City of New York General Obligation Bonds, Fiscal 2018 Series F, New York City, April 12, 2018, http://nycbonds.org/NYC/pdf/2018/NYC_GO_2018_F.pdf.
7. See Comprehensive Annual Financial Report, Fiscal Years Ended June 30, 2018 and June 30, 2017, Teachers' Retirement System of the City of New York, December 21, 2018, https://www1.nyc.gov/assets/actuary/downloads/pdf/TRS_2018_CAFR.pdf.
8. For details, see *Comprehensive Annual Financial Report, Fiscal Year Ended June 30, 2001, Teachers' Retirement System of the City of New York, December 28, 2001,* https://publicplansdata.org/reports/NY_NYC-TRS_CAFR_2001_77.pdf.
9. See Robert C. North, Proposed Changes in Actuarial Assumptions and Methods for Determining Employer Contributions for Fiscal Years Beginning on and After July 1, 2005 for the New York City Teachers' Retirement System, Office of the Actuary, New York City, August 31, 2005.
10. See *Comprehensive Annual Financial Report*, Fiscal Years Ended June 30, 2016 and June 30, 2015, Teachers' Retirement System of the City of New York, December 22, 2016, https://comptroller.nyc.gov/wp-content/uploads/documents/TRS-CAFR-2016-REVISED.pdf.
11. For some analyses we use more complex investment-return assumptions.

12. Some analysts run many more simulations. The pension simulation model entails many calculations, and we have found that 2,000 simulations are sufficient to yield stable results in a reasonable period of time.
13. The New York City Office of the Actuary proposed changes in actuarial assumptions and methods used in determining employer contributions beginning from fiscal year 2019, and the changes are approved by the Board. The major changes include updating mortality for active members and retirees and the probability of retirement. The Office of Actuary estimates that implementing these changes would decrease the fiscal year 2019 employer contribution to TRS by approximately $70 million, which is a change of less than 2 percent. These changes have not yet been incorporated into our simulation model, but adopting them would not have a substantial impact on our analysis and conclusions, as the impact of these changes on employer contribution is small.
14. By this we mean that if a particular analysis shows, for example, that one funding policy is stronger than another, in terms of protecting the pension plan from downside investment risk, this generally is true regardless of whether the cutoff for severe underfunding is 40 percent, 50 percent, or 60 percent.
15. Donald Boyd and Yiming Yin, *How Public Pension Plan Investment Risk Affects Funding and Contribution Risk*, Rockefeller Institute of Government, January 2017, https://www.albany.edu/slgf/Reports_and_Briefs/2017-01-10-Pension_Investment_Risks.pdf.
16. The Public Plans Data website is maintained through a partnership between the Center for Retirement Research at Boston College and the Center for State and Local Government Excellence. The National Association of State Retirement Administrators supports the partnership by providing review and assistance on the development of data models, validation of data, and development and administration of surveys (see http://publicplansdata.org).
17. TRS city-covered payroll was $8.96 billion in 2018, so 16.7 percent of payroll is $1.497 billion, which is 2.5 percent of the $59.1 billion of 2018 city tax revenue.
18. For example, some plans have contribution policies that do not necessarily pay down unfunded liabilities even if actuarially determined contributions are adhered to and plan assumptions are met. The Pew Charitable Trusts developed a net amortization measure designed to test whether unfunded liabilities would be paid down if plan assumptions are met. We constructed this measure for TRS and found that employer contributions were more than $1 billion higher in each of several recent years than the amount needed to tread water (i.e., the amount needed to keep unfunded liabilities from rising), meaning that the city is making substantial progress in paying down unfunded liabilities. For more, see the separate appendix.
19. There are minor technical differences between the full TRS policy and the policy as we modeled it, due to data limitations.
20. *Official Statement: The City of New York General Obligation Bonds, Fiscal 2018 Series F*, p. 61, New York City, April 12, 2018, http://nycbonds.org/NYC/pdf/2018/NYC_GO_2018_F.pdf.
21. *TDA Program Summary: Tax-Deferred Annuity Program*, Teachers' Retirement System of the City of New York, February 2019, https://www.trsnyc.org/memberportal/WebContent/publications/tdaBook.
22. For example, in early December Barclay's Bank offers a 1-year CD that pays 2.15 percent (https://www.bankrate.com/banking/cds/cd-rates/); Charles Schwab offers 10–18 month CDs with a yield of 1.8 percent (https://client.schwab.com/secure/cc/products/investments/bonds_fixed_income/

certificates_of_deposit); and several Canadian firms offer one-year guaranteed investment certificates in the 2 percent range (https://www.rbcroyalbank.com/investments/gic-rates.html).
23. We estimate the effective guarantee, weighting the portion guaranteed at 7 percent and the portion guaranteed at 8.25 percent, to be approximately 7.2 percent.
24. When we refer to TDA in this section, we mean the fixed-return portion of TDA. TRS members also can invest in variable-return funds, but those funds are not subject to the guarantee.
25. This table can be calculated using the relationship derived in the separate appendix.
26. The line is drawn at the estimated effective guarantee rate of 7.2 percent.
27. The arithmetic mean return for QPP was actually higher as a result of the TDA guarantee, rising from 5.95 percent 6.24 percent, but the compound return is a better indicator of how the guarantee affected pension fund finances.
28. It is based on the 2017 Supervisory Scenarios for Annual Stress Tests Required under the Dodd-Frank Act Stress Testing Rules. See Greg Mennis, Susan Banta, and David Draine, "Assessing the Risk of Fiscal Distress for Public Pensions: State Stress Test Analysis," in Gathering Storm: The Risks of State Pension Underfunding, Harvard Kennedy School of Government, 2017, https://www.hks.harvard.edu/sites/default/files/centers/mrcbg/files/pension/Mennis%20et%20al%2C%20Pew%20Submission%2010.18.17.pdf.
29. For example, (1) the "secular stagnation hypothesis" put forth in Gauti B. Eggertsson, Neil R. Mehrotra, and Jacob A. Robbins, "A Model of Secular Stagnation: Theory and Quantitative Evaluation," *American Economic Journal: Macroeconomics* 11, no. 1, January 2019, https://doi.org/10.1257/mac.20170367, argues that the low rate environment is likely to persist; (2) Rachel and Smith argue similarly in Lukasz Rachel and Thomas Smith, "Secular Drivers of the Global Real Interest Rate," Bank of England Staff Working Paper, December 2015, https://www.bankofengland.co.uk/working-paper/2015/secular-drivers-of-the-global-real-interest-rate, (3) a broad array of economic forecasts suggests interest rates will remain low for an extended period; and (4) forward financial markets also suggest this.
30. If city pension contributions for all plans were to increase by 50 percent, the increase would be about 8 percent of city tax revenue, so this is quite a sizeable increase.
31. As with the asset-shock scenario discussed earlier, the asset corridor can dampen smoothing effects in the asset policy if the market value of assets diverges sufficiently from the actuarial value of assets. See the separate appendix for scenarios in which the asset corridor is removed.
32. We do not present an alternative scenario in which investment returns match the very long-run historical returns of TRS and other pension funds, because those returns were achieved in higher interest-rate and inflation environments.
33. As elsewhere in this report, unless the context clearly indicates otherwise, when we refer to the TDA fund we are referring to the fixed-return portion of the fund guaranteed by the QPP.
34. An example of market rate for an investment option offering a fixed return is the guaranteed investment certificate (GIC) in Canada. The one-year GIC rate was about 2.4 percent in August 2019.
35. The Federal Funds rate, which is the benchmark of the short-term risk-free interest rate, was about 2.25 percent in August 2019. The Wall Street Journal Prime Rate, which is one of the benchmark rates for consumer loan products and includes a risk premium, was 5.25 percent in August 2019. Borrowing costs for institutional investors with good credit should fall between these

two benchmarks. Another potential comparison is to the one-year LIBOR (USD) rate, which was about 2 percent in August 2019.

36. We implement this as a 5 percent guarantee for UFT members and a 6.25 percent guarantee for non-UFT members, maintaining the current spread between these guarantees.

37. Actuarial Standards Board, Actuarial Standard of Practice No. 51: Assessment and Disclosure of Risk Associated with Measuring Pension Obligations and Determining Pension Plan Contributions, September 2017, http://actuarialstandardsboard.org/wp-content/uploads/2017/10/asop051_188.pdf.

38. New York City Office of the Actuary, Fiscal Year 2018 Actuarial Valuation Report for the New York City Teachers' Retirement System, February 5, 2019, http://www1.nyc.gov/assets/actuary/downloads/pdf/TRS_Fiscal_Year_2018_Valuation_Report.pdf.

39. In a symposium we held in relation to a draft of this report, several individuals asked whether the above-market guarantee of the TDA is a form of compensation that is at variance with rules issued by the IRS in relation to 403(b) tax-deferred annuity plans or with regulatory requirements of the New York State Department of Financial Services, which has oversight over New York public pension plans. Both questions are beyond the project scope and our expertise. Our preliminary review of relevant rules and guidance yielded no insights on these questions.