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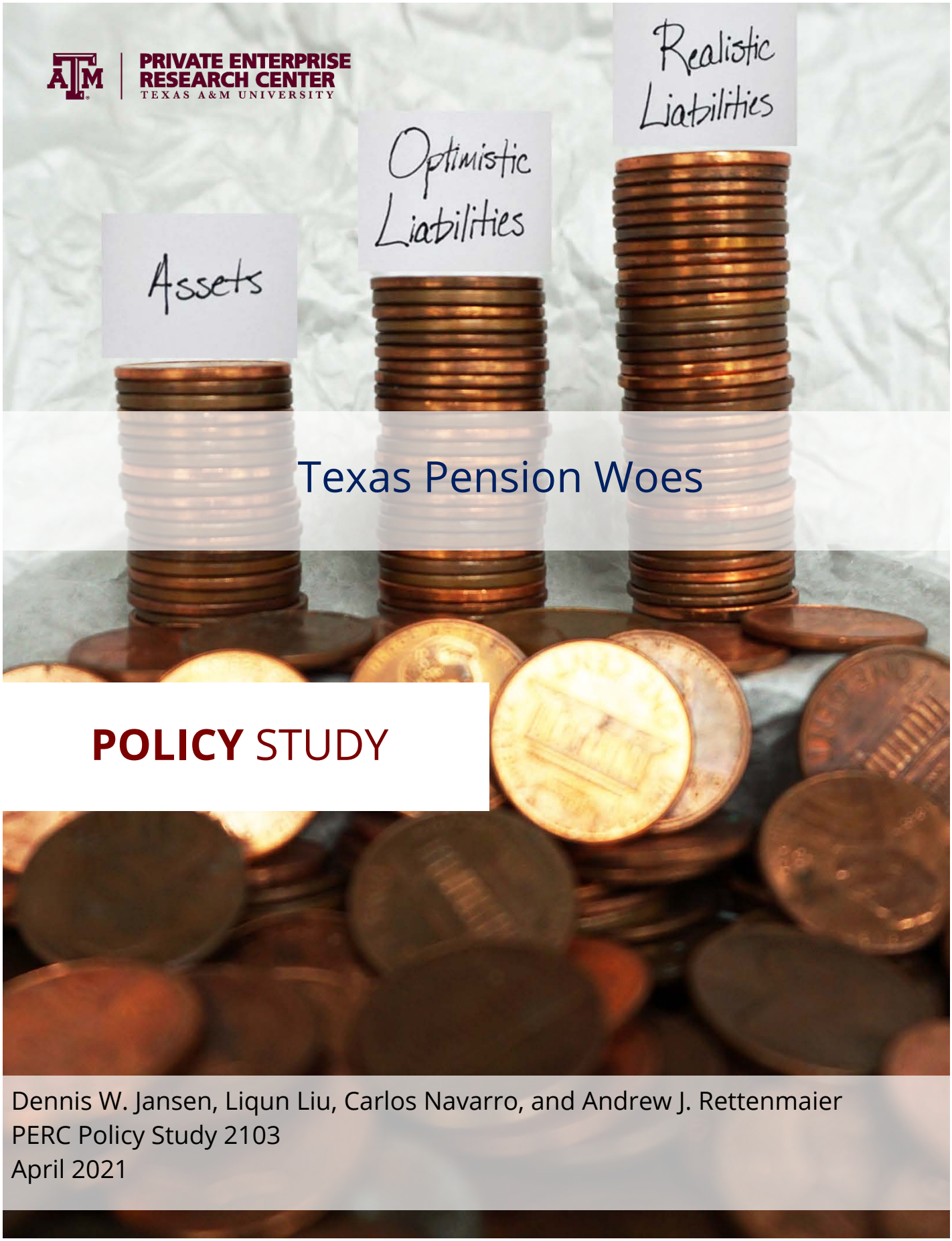


# Texas Pension Woes

**POLICY** STUDY

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# SUMMARY

State and local pension plans in Texas are underfunded. Their assets were less than their liabilities by $86 billion in 2019 and the funding ratio of their assets to liabilities was 77%. The situation in Texas is not unique; nationally the funding ratio in 2018 was 71%.

While an unfunded state and local pension liability of $86 billion in Texas is concern enough, it is based on optimistic accounting of each pension plan's liabilities. Currently, when state and local pensions calculate the present value of the future benefit payments they will pay out to current and future retirees, they can discount those future payments using the ***expected*** rate of return on the assets they hold. While this practice is consistent with government accounting standards, it produces estimated liabilities that are much too low. This is due to the expected rate of return on a pension plan's assets being estimated at too high a rate for discounting future benefit payouts.

Pension benefits promised to state and local government retirees are essentially risk-free payments each month. Pensioners expect to receive those benefits with near certainty and taxpayers ultimately underwrite the receipt of the monthly payments. For this type of liability, the appropriate, or realistic, discount rate is the ***risk-free*** rate on a government bond. Lower discount rates produce higher estimates of the plans' liabilities.

For example, the largest pension plan in Texas, the Teacher Retirement System, had a stated unfunded liability of $52 billion in 2019. However, when a more realistic discount rate is used to calculate the present value of promised future benefits, the unfunded liability rises to $122 billion, and the funding ratio drops from 75% to 56%.

Statewide, there were 81 plans with sufficient data to calculate funding ratios from 2015 to 2018, and the aggregate unfunded liability in 2018 was officially $96 billion, and according to our corrected estimates was $170 billion.

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For the 18 plans that had data through 2019 (including TRS), the aggregate unfunded liability was officially $91 billion, and according to our corrected estimates was $161 billion.

Unfunded liabilities have snowballed over time, and have recently reached unprecedented levels. From 2014 to 2019, TRS's official unfunded liability has grown from $27 billion to $52 billion, and the corrected measure of unfunded liability has grown from $81 billion to $122 billion. For the 18 plans with data through 2019, unfunded liabilities have grown, officially, from $58 billion in 2015 to $91 billion in 2019, and the corrected measures have increased from $130 billion in 2015 to $161 billion in 2019.

Estimating pension liabilities using both discount rate assumptions reveals that the already underfunded pensions are more underfunded than they first appear. Further, the discussion of the appropriate discount rate raises the issue of who ultimately bears the risk of insuring rising public sector pension benefits. Relatedly, the continued prevalence of defined benefit pensions in the public sector results from the accepted accounting procedures that mask the full cost of the pension liabilities and the value of the implied risk protection provided by taxpayers.

Potential state and local pension reforms include the following:

- Update accounting standards to include estimates of the present value of the pension liabilities using both rate of return on the pension assets and the risk-free rate. This will give policy makers and the public a better understanding of the magnitude of the problem and the value of the implied insurance provided by taxpayers.
- Institute funding reforms that up the contribution rates to fully fund the pensions based on the broader accounting of the pension liabilities.
- Develop options to defined benefit pensions for new hires including defined contribution plans and cash-balance plans.

State and local unfunded pension liabilities in Texas are large and are growing based on current accounting standards. However, these standards understate the magnitude of the problem. The size of the problem and the role of taxpayers in insuring rising pension costs requires a serious and thoughtful rethinking of why defined benefit pensions remain a staple in the public sector but have become a scare commodity in the private sector. Private sector employers have largely adopted defined contribution plans for their employees and this alternative, along with hybrid or cash balance plans, are viable reform options.

# TEXAS PENSION WOES

## INTRODUCTION

Most full-time workers in the United States have access to an employer-sponsored retirement plan, either a defined contribution plan and/or a defined benefit plan. These include 401K and 403B plans. Defined contribution plans typically involve contributions by workers with matches from their employers, contributions that are a specific percentage of a worker's salary. These contributions are deposited in an approved set of mutual funds or other investment vehicles, with workers choosing the investments within the employer-defined set. At retirement, workers can begin making withdrawals from their accumulated savings. Neither the accumulations nor the rate of return on the contributions are guaranteed.

Defined benefit plans are also funded by employer and employee contributions; however, the investments are managed by the pension plan, and the defined benefits paid during retirement are typically based on a benefit formula related to the earning experience of the worker, the length of service to the particular employer, and a conversion factor. The ratio of the resulting monthly benefit to a worker's pre-retirement income is known as the replacement rate. The pension plans' sponsors – the employers – are responsible for paying a monthly benefit throughout the length of the worker's retirement. In this way, the plan sponsor takes on the risk of guaranteeing the stability of retirees' benefits and in ensuring there are sufficient resources to fund the benefits of current plan participants.

In 2018, about 26% of all full-time civilian workers participated in a traditional defined benefit pension plan. However, this does not tell the entire story, as private sector workers are overwhelmingly offered defined contribution plans, while among public sector workers – full time state and local government workers – 83% participated in traditional defined benefit pensions. For full time private sector workers, only 16% participated in a defined benefit pension plan.[1]

Over time, defined contribution plans have replaced defined benefit plans in the private sector as firms responded to the funding and regulatory requirements of the Employee Retirement Income Security Act (ERISA) of 1974, as unionization declined, and as workers have sought more portable retirement planning vehicles. However, the huge decline in the share of private sector workers covered by traditional defined benefit pension plans has not been realized to anywhere near that extent in the public sector.

State and local pension plans are underfunded; their assets are less than their liabilities. Their liabilities are the value of the promises made to current retirees and current workers. The state and local pension plans in the state of Texas, the focus of this study, were in aggregate underfunded by $86 billion in 2019. The ratio of assets to liabilities in 2019, the funding ratio, in Texas was 77%. Nationally, the funding ratio in 2018 was 71% for state pension plans.[2] These funding ratios are a cause for concern

[1] See "Worker Participation in Employer-Sponsored Pensions: A Fact Sheet," Congressional Research Services, April 30, 2019.

[2] See "The State Pension Funding Gap:2018," The PEW Charitable Trusts, June 2020.

because taxpayers and plan participants are ultimately responsible for filling these gaps through higher compensation expenses.

Although defined benefit plans specify contributions from the employer and employees based on employees' salaries, retirement benefits are not directly related to these contributions. In contrast, defined contribution plans only specify contributions from the employer and each employee. Each employee in a defined contribution plan is responsible for managing his/her own account, and the employee's retirement benefits depend on the performance of the account. Both forms of plans face investment risk -- the risk that the stock market and bond market, and other investments, may underperform relative to expectations. The difference is that much of the investment risk is borne by the employer, and ultimately the taxpayers, in the case of state and local government employees' defined benefit plans. For defined contribution plans, this risk is borne by each individual employee.

Like wages, pension promises are part of the workers' total compensation. Thus, there is a tradeoff between wages and pension promises. Some argue that risk averse individuals gravitate toward public sector employment and are willing to accept lower wages if their employer offers a defined benefit retirement plan instead of a riskier defined contribution plan. Alternatively, less risk averse individuals are more likely to take jobs in the private sector than in the public sector. However, as pointed out by Gittleman and Pierce (2012), public sector wages, after controlling for observable skills, are comparable if not higher than private sector wages. They also find higher total compensation for public sector workers when total compensation, including pensions and health care, is included in the comparison.

The popularity of defined benefit plans over defined contribution plans in the public sector can be attributed to the fact the market risk in the public plans is ultimately borne by the taxpayers. There is a principal-agent problem here, an economic phrase for a situation in which the ultimate responsible party, the principals (here the taxpayers) are represented by an agent (here, elected politicians), and the principal and the agent have incentives that are not perfectly aligned. Politicians are interested in votes and reelection, and the tradeoff is then the impact of tax increases versus the impact of pension promise reductions on votes and the probability of reelection. The option of tax increases often wins because required tax increases can be delayed, and future taxpayers do not get to express their opinions in a current election.

Any principal-agent issue is strengthened by the lack of transparency in pension accounting. Interestingly, the private sector and the public sector rules that apply to pension accounting (specifically defined benefit pension accounting) are different in significant ways, and the public sector rules are looser and allow state and local employers to exaggerate the financial position of their defined benefit pension plans. Under current government accounting standards, public pension plans are allowed to calculate the present value of their liabilities using the expected rate of return on their assets. However, given that these pension liabilities are implicitly if not explicitly guaranteed, the appropriate discount rate is closer to the significantly lower "risk-free" government borrowing rate. As we discuss below, there are a range of possible discount rates that can be used to recalculate the state and local pensions liabilities, but each rate results in (much) higher total liability estimates and, consequently, lower funding ratios.

This project provides an overview of the state of public sector pensions in Texas, as well as other post-employment benefits such as retiree health insurance. We discuss the pros and cons of public sector defined benefit and defined contribution pension plans and discuss an alternative middle-of-the-road cash balance plan. We pay particular attention to issues of equity in these pensions, and issues that impact the taxpayer, especially the risk sharing structure embedded in each plan.

We start with an overview of the Texas Pension plans registered with the Texas Pension Review Board. We then identify how the current practice of using the expected return on a plan's assets results in pension liability estimates that are too low. The point of this exercise is to emphasize that funding a defined benefit pension involves financial and longevity risks that must be quantified. These are the same risks that private sector defined benefit pensions must manage, but in contrast to the public sector pensions, they are required to invest more conservatively, and account for their liabilities using much lower discount rates.

We next discuss how other post-employment benefits also add significantly to the state's and the local government's unfunded liabilities. The aggregate amount of pension and other post-employment benefit liabilities reflect obligations that will be borne by current and future taxpayers and are a form of debt that can be imposed on future government budgets.

Next, we discuss public pension plan reform options in light of the plans' unfunded liabilities. Reforms include accounting reforms, financing reforms and structural reforms. The principal accounting reform would require pensions to report their liabilities using the government borrowing rate to discount their liabilities to the present. Funding reforms would require significant increases in contribution rates from employers and employees. These reforms would recognize that public pensions are already underfunded with the current discount rate assumptions and are critically underfunded when their liabilities are calculated using the government borrowing rate. The structural reform discussion compares the situation of private sector and public sector workers and points out the relative inequity in their pension plan promises and pension plan funding. We discuss the within-public sector worker inequities between workers who work their entire career in public sector jobs covered by a defined benefit pension versus the treatment of public sector workers who move to public sector jobs in other states or to private sector jobs. The role of the taxpayer in insuring public sector pensions is also discussed. Finally, we conclude with a discussion of ways to reform Texas pension plans.

## AN OVERVIEW OF TEXAS PUBLIC PENSIONS

Our project focuses on the state and local defined benefit pension plans in Texas. Based on data from the Texas Comptroller on 99 pension plans, total membership across all plans topped 2.8 million in 2019.[3] There are statewide plans, local plans, plans tailored for firefighters and police, and plans for special purpose districts. The actuarial value of the pension plans' assets was $289.5 billion in 2019, while the actuarial accrued liabilities totaled $375.4 billion. Thus, the resulting aggregate unfunded actuarial accrued liability was $86.1 billion and the funding ratio of assets to liabilities was 77.1%. The

[3]Texas Comptroller, https://comptroller.texas.gov/application.php/pension/search

Texas Pension Review Board (TPRB) reported that in 2014, the aggregate funding ratio was 80.6% and it has declined each subsequent year.

While there are 99 state and local government pension plans in the state, four statewide plans account for the bulk of the plans' total membership, assets, and liabilities. Membership in the Teacher Retirement System (TRS), the Employees Retirement System (ERS), Texas County and District Retirement System (TCDRS), and Texas Municipal Retirement System (TMRS) account for 89% of total membership in all Texas state and local pension plans. These four plans accounted for 85.7% of the assets and 84.6% of the liabilities of all Texas plans and their collective funding ratio was 78.1%. Table 1 summarizes the distribution and shares of assets, liabilities, unfunded liabilities, and the funding ratio for these large statewide plans, and for the other state and local plans in the state as of 2019.

Table 1. Summary of Texas Pension Plans in 2019

| Category | Plans | Members | Assets | Liabilities | Unfunded Liabilities | Funding Ratio |
|---|---|---|---|---|---|---|
| Big 4 Statewide | 4 | 2,558,311 | $248.2 | $317.8 | $69.6 | 78.1 |
| Other Statewide | 3 | 82,909 | $1.6 | $2.2 | $0.6 | 72.0 |
| Firefighters and Police | 52 | 53,565 | $20.4 | $27.6 | $7.2 | 73.9 |
| Municipalities | 11 | 95,741 | $12.7 | $19.4 | $6.6 | 65.8 |
| Special Districts | 29 | 68,497 | $6.6 | $8.7 | $2.1 | 76.2 |
| Total | 99 | 2,859,023 | $289.5 | $375.5 | $86.1 | 77.1 |

| | Shares | | | | |
|---|---|---|---|---|---|
| Category | Plans | Members | Assets | Liabilities | Unfunded Liabilities |
| Big 4 Statewide | 4.0 | 89.5 | 85.7 | 84.6 | 80.8 |
| Other Statewide | 3.0 | 2.9 | 0.5 | 0.6 | 0.7 |
| Firefighters and Police | 52.5 | 1.9 | 7.0 | 7.3 | 8.4 |
| Municipalities | 11.1 | 3.3 | 4.4 | 5.2 | 7.7 |
| Special Districts | 29.3 | 2.4 | 2.3 | 2.3 | 2.4 |
| Total | 100 | 100 | 100 | 100 | 100 |

Data from Texas Comptroller https://comptroller.texas.gov/application.php/pension/search. Dollar values are in billions.

TRS and ERS are conventional defined benefit plans with a formula that combines years of work, a conversion factor, and earnings averaged over several years to determine members' retirement benefits. In contrast, while TCDRS and TMRS are defined benefit plans in that workers receive a monthly benefit in retirement, the benefit or annuity payment is determined by the "cash balance" in the workers' accounts at retirement. The cash balances in workers' accounts are based on their contributions during their working years combined with their employers' contributions and a target accumulation rate. We will return to the TCDRS and the TMRS in our discussion of pension reforms. These systems are good examples of hybrid retirement systems that fall between traditional defined

benefit plans and defined contribution plans. However, the accounting applied to the liabilities of these plans still allows for discounting at the expected rate of return on the plans' assets.

There are several other smaller statewide pension plans: the Judicial Retirement System of Texas - Plan Two, the Law Enforcement and Custodial Officer Supplemental Retirement Plan and the Texas Emergency Services Retirement System Plan. These plans had 82,909 members and their collective funding ratio is 72%.

The 52 firefighter and/or police plans account for the largest number of plans and have 53,565 members. Their collective funding ratio was 73.9% and their unfunded liabilities accounted for 8.4% of all unfunded liabilities in the state. The pension liability per member is a measure of the size of the plans' commitment per member. In the case of firefighters and police, this was $514,907 in 2019, which was more than four times the liability per member among the four largest statewide plans. This liability is a result of the anticipated longer pension payout period, differences in the benefit structures and earnings.

Municipalities account for 3.3% of members and 7.7% of total unfunded liabilities, and a funding ratio of 65.8%. These municipal plans are in the larger cities in Texas.[4] The smaller cities participate in the statewide Texas Municipal Retirement System. Special district pension plans for transit workers, hospitals, and other districts have 68,497 members and account for 2.4% of all members and the same percent of statewide unfunded liabilities.

The remainder of our empirical analysis is based on available data available from the TPRB.[5] The TPRB provides data on each pension plan's actuarial assets and liabilities, the market value of the plan's assets, the net pension liabilities under three alternative discount rate assumptions, the contribution rates by employees and employers, discount rate assumptions, and total annual contributions and distributions, among other variables.

Central to our analysis is estimating each pension plan's total liability using lower discount rates that better align with the nature of pension liabilities. As discussed below, our estimates can be derived from the discount rate sensitivity analysis required by the Government Accounting Standard Board's (GASB) statement 67. GASB 67 was approved in 2012 and pension plans were required to implement its guidelines for the fiscal years beginning mid-year 2013. The net pension liability estimates under the alternative discount rate assumptions for most of the pension plans are available for the years 2015-2018 and for a subset that includes the large statewide pension plans for the years 2015-2019.

## ALTERNATIVE DISCOUNT RATE ASSUMPTIONS IN CALCULATING PENSION LIABILITIES

Until 2013, government accounting standards allowed pensions to discount their future pension obligations using the expected rate of return on their pension assets – often a nominal rate between 7%

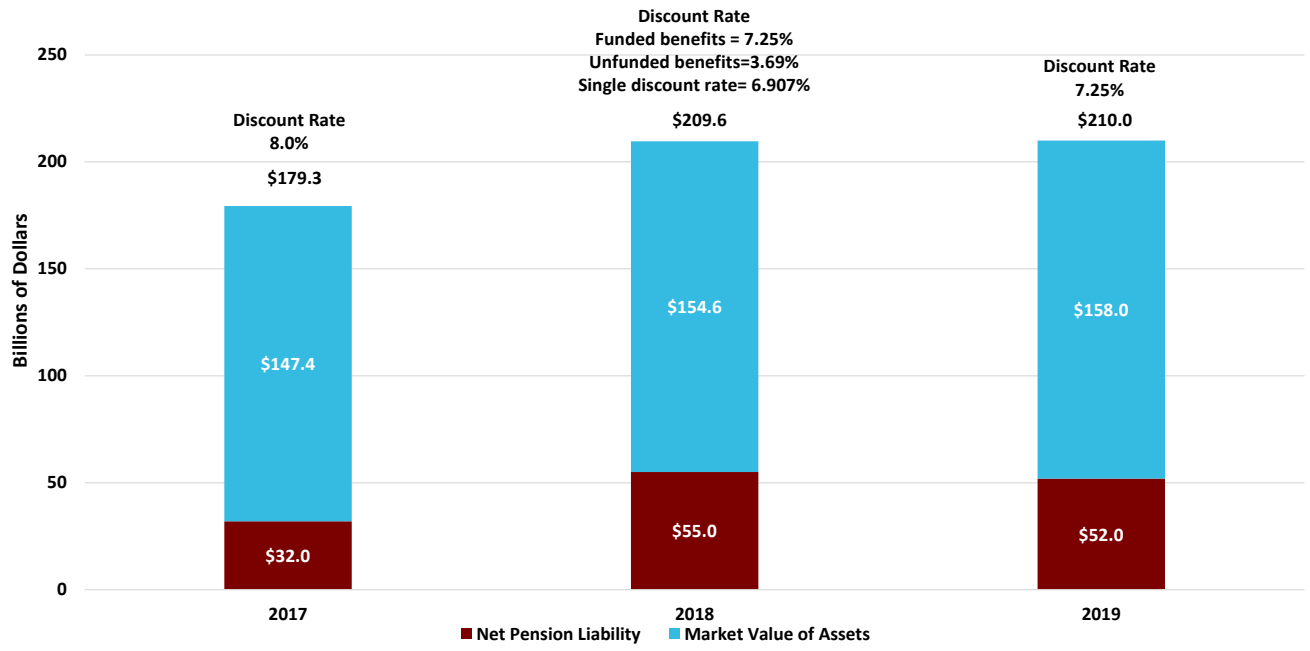
[4]The municipal plans in this category are in Arlington, Austin, Dallas, El Paso, Fort Worth, Galveston, Houston, Irving, and Plano.

[5] The Texas Pension Review Board's data on each pension plan is available at: https://data.prb.texas.gov/.

and 8%. The Government Accounting Standard Board (GASB) issued new guidelines with GASB No. 67 and GASB No. 68 on the discount rate used by pension plans in estimating pension liabilities. (The new guidelines for pension plans are specified in GASB No. 67. The guidelines for governments providing pension benefits are specified in GASB No. 68.) In some cases, the new guidelines result in applying a lower discount rate to future benefit payments than a pension's expected return on its assets. In those cases, the new guidelines produce a weighted discount rate that falls between the rate of return on pension assets and the government borrowing rate, which is represented by the municipal bond rate. A pension plan can discount the funded portion of its liability at the expected rate of return on the pension plan's assets and if any of the projected benefits are deemed to be unfunded those projected benefits are discounted at the municipal bond rate.

An example based on the experience of the Teacher Retirement System (TRS) illustrates how the new discount rate guidelines come into play. In 2018, the actuaries working on behalf of TRS determined that future benefit payments were funded through the first 52 years of the projection period and were unfunded through the remainder of the 100-year projection period. By the 18th year of the projection period, the expected benefit payments were greater than the combination of contributions from current employees, employer contributions on behalf of employees, and the investment returns on the pension assets. Between the 18th year of the projection period and the 52nd year, the pension assets were drawn down to such a degree that they were depleted by the 52nd year. Given the results of this projection, the annual funded benefits payments for the first 52 years were discounted to the present at the long-term expected return on pension assets, 7.25%, and over the remaining years they were discounted to the present at the municipal bond rate of 3.69%. The "single" discount rate that produces the same present value of the total pension liability was 6.907%.

**Figure 1.** How the Discount Rate Assumption Affects Total Liability Estimates – Teacher's Retirement System Example




Source: Texas Pension Review Board.

This single discount rate produced a total pension liability of $209.6 billion in 2018. The market value of the pension's assets that year was $154.6 billion. This resulted in a net pension liability, the difference between the total pension liability and market value of the pension's assets, of $55.0 billion in 2018. These amounts are depicted in the figure above. The plan's assets as a percent of its liabilities were 73.7%.

It should be noted that in 2017, the plan's total liability was estimated to be $179.3 billion or over 14% lower than in 2018. The higher liability in 2018 was largely due to the change in the discount rate assumption from 8% in 2017 to the single rate of 6.907% in 2018. The net pension liability in 2017 was $32 billion or almost 42% lower than in 2018. In 2019, the Teacher Retirement System instituted several changes in projected funding that ensured future annual revenues would exceed future benefit payouts. Future non-member contributions were assumed to increase to 8.5% of payroll in 2020, up from the 7.76% assumption used for the 2018 report. Over the next several years, these employer contributions are assumed to grow to 9.55% of payroll. With these increased funding assumptions, the 7.25% long-term expected return could be used to discount all expected future benefit payments to the present. The resulting present value of total liabilities were about the same as estimated in 2018.

However, it can be argued that the discount rates, either the expected return on assets or the single blended rate, when it is required, are too high, and consequently the resulting liability measures are too low. The rationale for using a lower discount rate is that pension liabilities are a form of deferred compensation that former employees expect with near certainty. That is, former state and local workers who become pensioners expect stable benefits that do not move up and down with market conditions, and court cases indicate that pensioners have a legal claim to their benefits. The appropriate discount rate for this kind of liability is more in line with a government borrowing rate – the municipal bond rate for example, or possibly an even lower rate.

## ESTIMATING PENSION LIABILITIES FROM GASB REPORTING VARIABLES

The reporting requirements in the new GASB standards provide a way to estimate the size of a pension's liabilities under alternative discount rate assumptions. Under the new standards, pensions are required to report their net pension liability based on discounting future benefit payments using a single discount rate, $r$. They are also required to report their net pension liability when the single discount rate is increased by 1 percentage point, $r$+1% and when it is decreased by 1 percentage point, $r$-1%. The single discount rate is either the expected rate of return on their assets when their revenues (contributions from existing employees, contributions from the employer that are not dedicated to new employees, and the return on the pension's assets) exceed their benefit payments in all years of their forecast or the blended rate when their revenues fall short of their benefit payments over their forecast period. With the three estimates of a pension's net pension liability and the pension's market value of its pension assets we have three estimates of the pension's total liability.

From these three estimates of a pension plan's net liability and the market value of the pension plan's assets, three estimates of the total liability are available. Rauh (2017) and McCaulay (2013) illustrate how the duration of a pension plan's liability and its convexity can be calculated using these values

using different discount rate assumptions. See the Appendix for a detailed discussion of estimating a pension plan's duration and convexity.

The duration of a plan's total pension liability is identified as follows:

$$\text{Duration} = (TPL_{r-0.01} - TPL_{r+0.01}) / (2TPL_{r} \times (.01)),$$

where TPL is the plan's total pension liability. The duration is the difference between the pension plan's total liability based on the discount rates $r$-0.01 and $r$+0.01 divided by the liability based on the base discount rate $r$ times the change in the interest rate.

The convexity of the plan's total liability is:

$$\text{Convexity} = (TPL_{r-0.01} + TPL_{r+0.01} - 2TPL_{r}) / (2TPL_{r} \times (.01)^2)$$

Together duration and convexity can be used to estimate the total plan liability under other discount rates $r^*$ based on the following:

$$TPL_{r^*} = ((1+(-\text{duration}^*\Delta r + 0.5^*\text{convexity} \times \Delta r^2))) \times TPL_{r}$$

where $\Delta r = r^* - r$.

## CALCULATING THE TEACHER RETIREMENT SYSTEM'S PENSION LIABILITY UNDER DIFFERENT DISCOUNT RATE ASSUMPTIONS

The data from the Texas Pension Review Board for each pension allow for the derivation of unfunded pension liabilities under alternative – lower – discount rates that better match the nature of the liabilities. Again, we use information from the Teacher Retirement System's actuarial reports to identify estimates of the plan's total and net pension liabilities under alternative discount rate assumptions.

Table 2 summarizes the pension's reported total and net liabilities and funding ratios based on the single discount rate, $r$ of 7.25%, $r$-1% of 6.25% and $r$+1% of 8.25%. The table also presents estimates based on two alternative discount rates. The first alternative is 4.8%, which combines the long run real discount rate used by the Social Security Administration in its 2019 Trustees Report of 2.5% with the Teacher Retirement System's assumed inflation rate of 2.3%. The second alternative is the tax adjusted municipal bond rate. The municipal bond rate reported in the System's GASB 67 Reporting and Disclosure statement was 2.63%. However, because municipal bonds are tax free, the discount rate is adjusted upwards, following Novy-Marx and Rauh (2011), to reflect an estimated tax rate of 25%. This results in a tax adjusted municipal bond rate of 3.51% [0.0263/(1-0.25)].

The baseline TRS total pension liability in 2019 calculated using the expected return on the plan's assets of 7.25% was $210.0 billion. The baseline funding ratio was 75.24%. With a one percentage point higher discount rate of 8.25%, the liability falls to $187.3 billion and the funding ratio rises to 84.33%. The total liability rises to $237.9 billion when the discount rate is lowered to 6.25% and the funding ratio drops to 66.41%. Based on these estimates, the duration of the TRS pension liability is 12 years and the convexity is 126.2.

Table 2. Teacher Retirement System Total Pension Liability Estimates in 2019
Dollar amounts in Millions

| | Discount rate Assumption | | | | |
|---|---|---|---|---|---|
| | *r*-1 | *r* | *r*+1 | Social Security Rate + Inflation Rate | Tax Adjusted Municipal Bond Rate |
| Rate | 6.25% | 7.25% | 8.25% | 4.80% | 3.51% |
| Net pension liability | $79,906 | $51,983 | $29,361 | $121,854 | $165,153 |
| Market Value of Pension Assets | $157,978 | $157,978 | $157,978 | $157,978 | $157,978 |
| Total Pension Liability | $237,884 | $209,961 | $187,339 | $279,832 | $323,131 |
| Funding ratio | 66.41% | 75.24% | 84.33% | 56.45% | 48.89% |
| Duration | 12.0 | | | | |
| Convexity | 126.2 | | | | |

When the lower discount rates are used in the formula above, we have higher total pension liability estimates and lower funding ratios. The 4.8% discount rate assumption produces a total pension liability of $279.8 billion and a funding ratio of 56.45%. The 3.51% discount rate results in a total liability of $323.1 billion and a funding ratio of 48.89%.

So, how do we interpret these results and what is the alternative discount rate one should use if an alternative rate is appropriate at all? The logic behind using the *expected* rate on pension assets as the applicable discount rate is as follows. The expected rate of return on assets is appropriate because the earnings on these assets reduce the contribution required by the employer. However, the key point here is that the expected rate of return is just that, it is ***expected***, but there is variance around that expectation. The results in Table 2 allow us to see the difference between the baseline liability and the estimated liabilities based on two often-used government borrowing rates. These differences represent estimates of the degree to which the total liability increases when accounting for investment risk. These risks are imposed on current employees and employers through changing contribution rates. Ultimately, taxpayers bear the expense of the necessary employer contribution rate increases and default risks.

The Report of the Blue Ribbon Panel on Public Pension Plan Funding issued by an independent panel and commissioned by the Society of Actuaries issues several sets of recommendations related to pension plan governance, the role of the actuary, risk measures, and disclosures.[6] In particular, the panel recommended that the reporting of the expected standard deviation of the plans' asset portfolios

[6] Report of the Blue Ribbon Panel on Public Pension Plan Funding, February 2014.

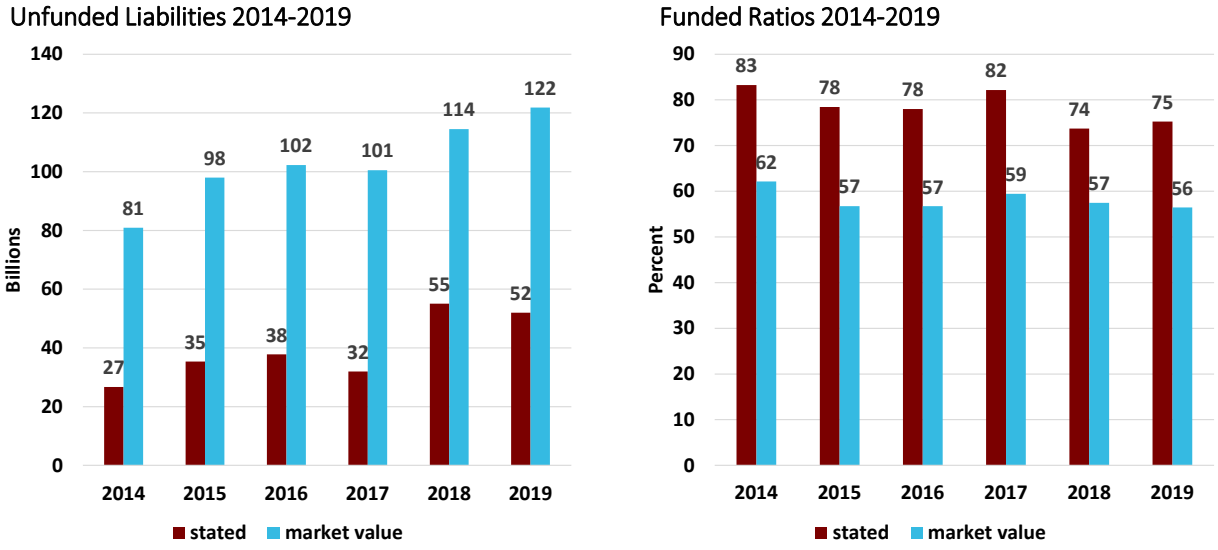
and that the calculation of the liability and the normal cost using the risk-free rate. Reporting pension plans' total liability using the risk-free rate will be discussed further in the section on reform options.

## THE TEACHER RETIREMENT SYSTEM'S PENSION UNFUNDED LIABILITY THROUGH TIME

We next consider how the Texas pension plans' unfunded liabilities and funding ratios have changed over time. Again using the Teacher Retirement System as an example, the graph on the left in Figure 2 presents the plan's 2014-2019 stated unfunded liabilities using the single discount rate and the liabilities calculated using the discount rate that combines the real rate of 2.5% with the plan's inflation rate assumption in each year.[7]

As seen in the figure, the stated unfunded liability based on the single discount rate was $27 in 2014 and rose to $55 billion in 2018 and then declined to $52 billion in 2019. Recall that the rise between 2017 and 2018 was due to a reduction in the discount rate from 8% in 2017 to 6.907% in 2018. The unfunded liabilities with the lower discount rate, labeled the market value, were substantially higher each year. In 2014, the market value of the unfunded liability was three times the stated unfunded liability and in 2019 it was 2.3 times the stated unfunded liability.

**Figure 2.** Unfunded Liabilities and Funded Ratios for the Teacher Retirement System 2014-2019




Source: Texas Pension Review Board. Market value based on setting *r* to 2.5%+the plan's inflation rate assumptions.

The graph on the right of Figure 2 indicates that both sets of funded ratios have declined and the market value funded ratio is lower than the stated ratio. In 2019 the stated funding ratio was 75% and the market value funded ratio is only 56%.

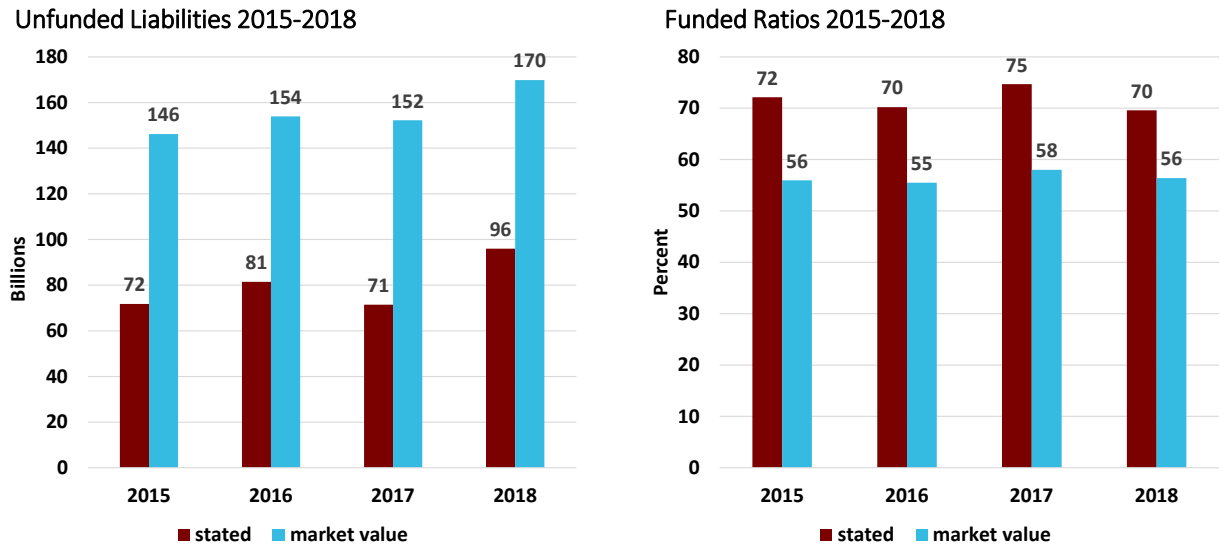
[7] For TRS, this discount rate changed through time with changes in the inflation rate assumption. In 2014 the rate was 5.5%, from 2015 to 2017 it was 5.0% and in 2018 and 2019 it was 4.8%. The discount rate used to calculate the stated liability was 8% in 2014-2017, was 6.907% in 2018 and 7.25% in 2019.

## TEXAS PENSION PLANS' AGGREGATE UNFUNDED LIABILITY 2015-2018

The time trend of rising unfunded pension liabilities is also evident when we expanded the set of pensions beyond the Teacher Retirement system. The unfunded liabilities and funded ratios for the years 2015 to 2018 for 81 pensions for which we have all the net pension liabilities and discount rate assumptions in each year are presented in Figure 3. The final year in the figure is 2018 because some of these data elements are missing for 2019 for some pensions. This is due to the timing of the close of their fiscal years and their reporting to the Texas Pension Review Board.

Two of the largest pension systems, the Texas County and District Retirement System and the Texas Municipal Retirement System, are not included in the set of pension plans aggregated in Figure 3. As noted earlier these two plans, while offering defined benefits to their retired participants, are not traditional defined benefit plans. Their participants' defined benefits are not based on a formula related to years of service, a conversion factor, and the average of a participant's highest earnings years. Rather, the defined benefits in these two plans are based on an annuity tied to the "cash balances" in the participants' accounts at retirement. Because the counties and municipalities have different contribution rates and benefit options, the system-wide sensitivity of alternative discount rates is not available for these two plans.

**Figure 3.** Unfunded Liabilities and Funded Ratios for Texas Pensions 2015-2018
(Set of 81 plans with sufficient data in each year 2015-2018)




Source: Texas Pension Review Board. 81 plans with discount rate, net pension liability, and total asset data for all years 2015-2018. Market value based on setting *r* to 2.5%+the individual plan's inflation rate assumptions.

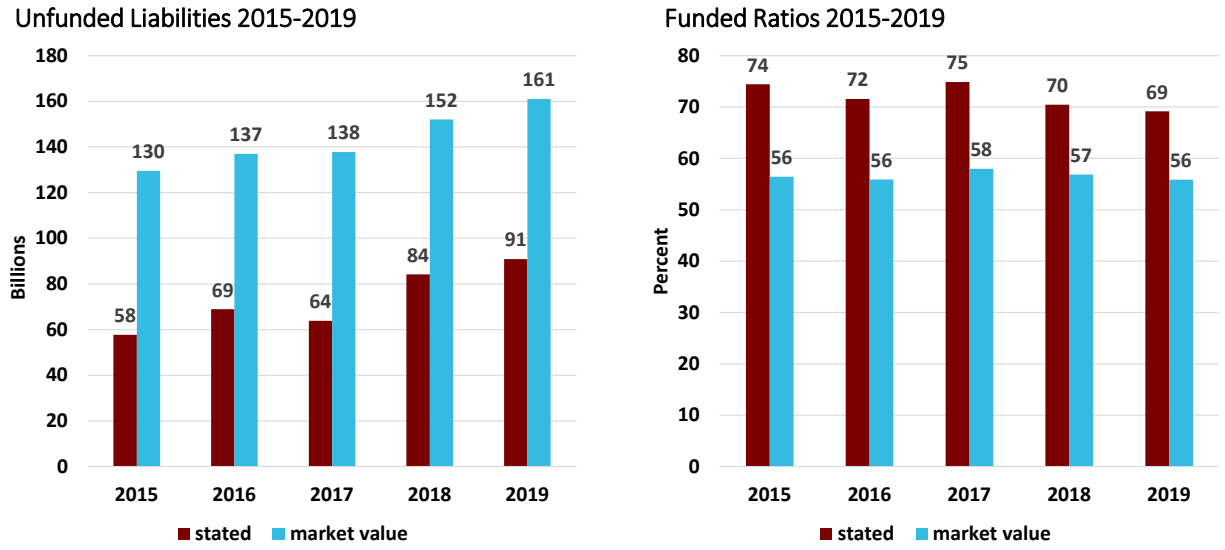
The stated net pension liability in each year is the total value of net liabilities across all 81 pensions as presented in the TPRB data. The market value of the net pension liability begins with calculating the total pension liability for each plan using a market discount rate defined as the real interest rate assumption of 2.5% added to the plan's inflation rate assumption in each year. The market value of the plan's assets is subtracted from the market value of the plan's total liability to arrive at the market value of the net pension liability. The total value of these net pension liabilities across the 81 pensions are reported as the market value.

The stated unfunded net liabilities in 2018 totaled $96 billion across the 81 plans and increased 77% to $170 billion when the lower discount rate was applied. The average of the single discount rates in 2018, weighted by the market values of the pensions' assets was 6.7%. In 2015, the average of the single discount rates, again weighted by the market values of the pensions' assets, was a full percentage point higher at 7.7%. So, some of the rise in the stated unfunded net liabilities over time is due to the lower discount rate assumptions plans adopted or were required to use in compliance with GASB 67. The average of the market value discount rates was 4.9% in 2018. The stated funding ratios ranged from 75% in 2017 to 70% in 2018. The decline from 2017 to 2018 in the stated funding ratio and the rise in the unfunded net liabilities between those years are largely due to the changes in these series for TRS between 2017 and 2018. The market value funded ratios were relatively stable and ranged from 55% to 58%. The weighted average market discount rate assumptions ranged from a high or 5.2% in 2015 to 4.9% in 2018 as the pension plans lowered their inflation rate assumptions.

## SUBSET OF TEXAS PENSION PLANS' AGGREGATE UNFUNDED LIABILITY 2015-2019

Figure 4 presents the unfunded liabilities and funded ratios for the years 2015 to 2019 for 18 pensions for which we have all the net pension liabilities and discount rate assumptions in each year. Again, the number of plans in this series is governed by the timing of the close of their fiscal years for the pension plans and when they report their data to the Texas Pension Review Board. As evident by the magnitudes of the unfunded liabilities with respect to the liabilities in Figure 3, the pensions in Figure 4 are some of the largest in the state.

**Figure 4.** Unfunded Liabilities and Funded Ratios for Texas Pensions 2015-2019
(Set of 18 plans with sufficient data in each year 2015-2019)




Source: Texas Pension Review Board. 18 plans with discount rate, net pension liability, and total asset data for all years 2015-2019. Market value based on setting r to 2.5%+the individual plan's inflation rate assumptions.

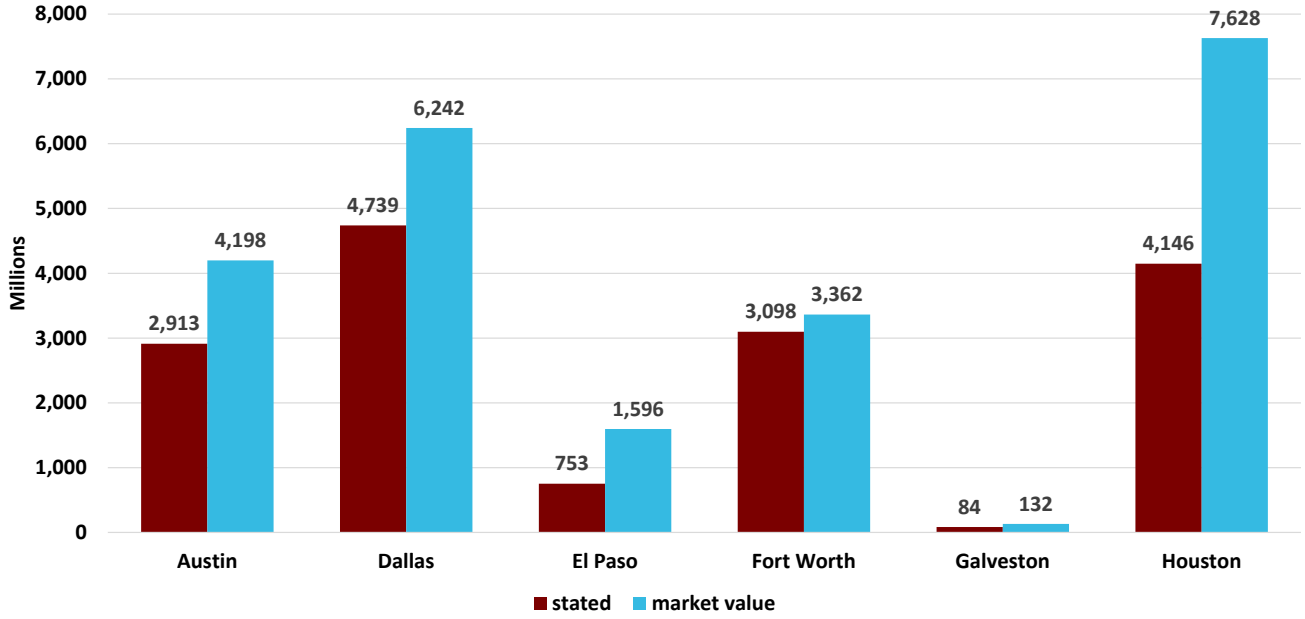
Similar to the series from Figure 3, the stated and market value unfunded liabilities have risen while the stated funded ratios have generally declined over time. The market value funded ratios are more stable over time than are the stated funding ratios given that the only variation in the market discount rate is due to changing inflation rate assumptions by the pensions. For these pensions, the average market discount rate weighted by the pensions' assets ranged from 5.2% in 2015 to 4.9% in 2019. In

contrast, the average single discount rate used in calculating the stated liabilities, weighted by the pensions' assets, ranged from 7.8% in 2015 to 6.7% in 2018. This average rose to 6.9% in 2019.

## TEXAS CITIES

Some Texas cities have their own municipal employee retirement plan and retirement plans for firefighters and police. Figure 5 presents the 2018 unfunded liabilities for cities that have municipal employee plans, a firefighter and a police plan or a combination plan that covers multiple employee groups.[8] Dallas and Houston have the largest stated and market value unfunded pension liabilities. The stated Dallas unfunded liability is $4.7 billion, and the market value rises to $6.2. This 32% increase in the unfunded liability is much less than the 84% increase from the stated to the market value of the net pension liabilities in Houston.

**Figure 5.** Unfunded Liabilities for Texas Cities in 2018



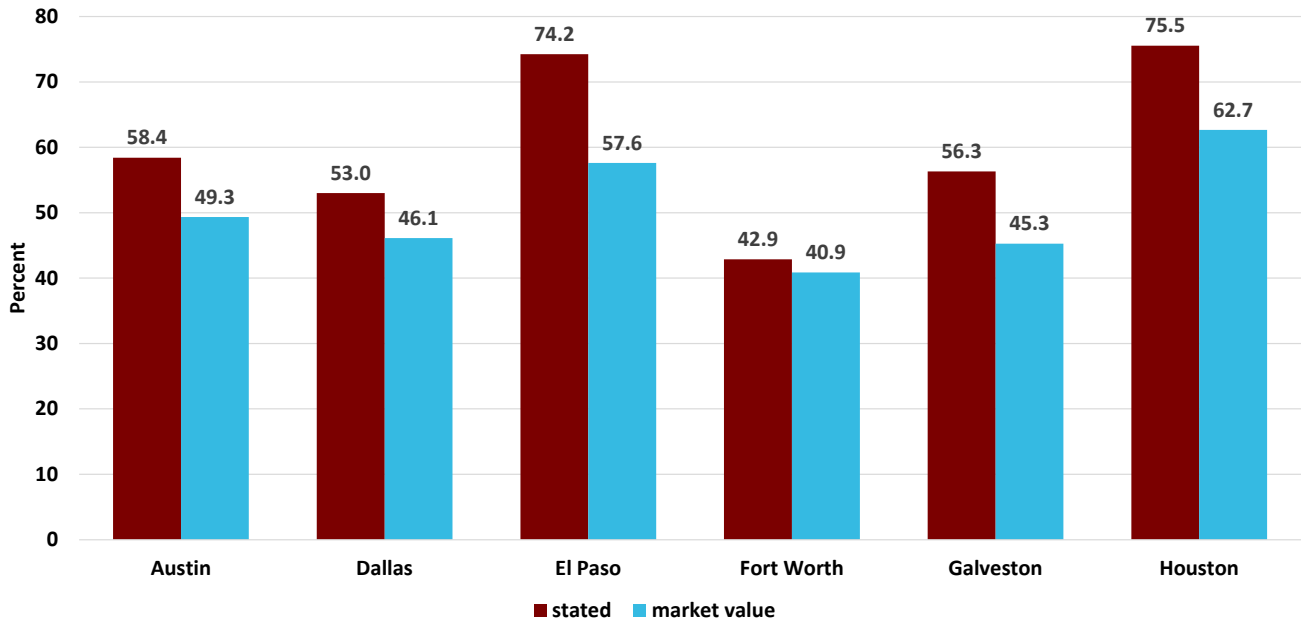

Source: Texas Pension Review Board. Market value based on setting *r* to 2.5%+the individual plan's inflation rate assumptions.

The reason the two unfunded liability estimates in Dallas are closer is due to the similarity of the discount rates underlying the two calculations for the Dallas Employees' Retirement Fund's liability valuation in 2018. This pension had to use a single discount rate of 5.98% in 2018 rather than the expected return on the plan's assets of 7.75% because the actuarial valuation in that year determined that the plan's assets would be depleted during the 100- year forward forecast. The discount rate used to calculate the market valuation of this plan was 5.25% in 2018. Across all three Dallas plans, including the Dallas Police and Fire System's combined and supplement plans, the asset weighted average single discount rate was 6.47% in 2018 and the market discount rate was 5.25%. In Houston, the asset weighted average single discount rate was 7.08% in 2018 and the market discount rate was 5.21%. None of the Houston pension plans were required to use a blended rate in 2018.

[8] See the appendix for the plans represented in each city's total.

Austin's Police Retirement System and Fort Worth's Employees' Retirement System were also required to use a blended rate in 2018 due to the plans' assets depletion during the 100-year forward forecast. In Austin, the total stated unfunded liability of its three plans was $2.9 billion in 2018. This liability rises 44% to $4.2 billion based on the market discount rate. The Fort Worth Employees' Retirement System includes both firefighters and the police. The system's stated and market valued unfunded liabilities are $3.1 billion and $3.4 billion, respectively. The single discount rate for this plan was 5.35% and the market rate was 5.0%.

**Figure 6.** Funded Ratios for Texas Cities in 2018




Source: Texas Pension Review Board. Market value based on setting *r* to 2.5%+the individual plan's inflation rate assumptions.

As we have noted, pension funds that are in poorer financing positions are required to use a blended single discount rate that combines the rate of return on assets and the municipal borrowing rate. This single rate moves the discount rate towards the market rate, producing more unfunded liability calculations and similar funded ratios as seen in Figure 6. Houston has the highest stated and market value funded ratios at 75.5% and 62.7%, respectively. El Paso has the second highest funded ratios. Fort Worth has the lowest funded ratios with both at less than 50%.

## OTHER POST-EMPLOYMENT BENEFITS

State and local government employees are also often eligible for certain health care benefits once they retire from their jobs. These benefits may include health insurance coverage between the time workers retire until they reach 65 years of age and are eligible for Medicare. The benefits may also include insurance that covers the gaps in Medicare's coverage once the worker is eligible for Medicare. The Governmental Accounting Standards Board, Statement No. 74, establishes the accounting standards used in reporting on post-employment benefit plans other than pension plans. This standard was promulgated in June 2015 and the reporting of these Other Post-Employment Benefits (OPEBS) have significantly increased the liabilities on state and local government's balance sheets.

GASB 74 specifies that the appropriate discount rate used to calculate the present value of expected OPEB benefits is a tax-exempt, high quality municipal bond rate in the case of unfunded plans that have no dedicated OPEB plan investment assets. This is the same discount rate specified in GASB 67 for the unfunded portions of pension liabilities. Like GASB 67, the standard also requires sensitivity analysis with the estimation of the net OPEB liability using the municipal bond rate plus and minus one percentage point. This standard also requires further sensitivity analysis with the estimation of the net OPEB liability based on a set of healthcare cost growth rates and varying those rates plus and minus one percentage point.

There are four OPEB plans reported in the State of Texas Comprehensive Annual Financial Report (TCAFR). The first plan is the State Retiree Health Plan (SRHP), which is administered by the Employees Retirement System of Texas. The Teacher Retirement System of Texas administers the second plan, the Texas Public School Retired Employees Group Insurance Program (TRS-Care). The Texas A&M University System administers the third plan, the Texas A&M University System Retiree Group Insurance Program (A&M Plan), and the University of Texas System administers the fourth plan, the University of Texas System Employee Group Insurance Program (UT Plan).

Figure 7 presents the unfunded OPEB liabilities of these four statewide plans in 2017 and 2018. The amounts shown for each plan in the figure represent the plan's total unfunded liabilities. The TCAFR reports the state shares of the liabilities for each plan. Because the state share encompasses the total OPEB liabilities for the two university systems' plans, the values in the figure for these plans are from the TCAFR. However, the state's share in the TCAFR reflects a portion of the total liabilities for the SRHP and for TRS-Care. The total unfunded liabilities for SRHP and TRS-Care are from the plans' respective actuarial reports.[9] As the figure illustrates, the reported OPEB liabilities for TRS-Care are almost $50 billion in 2018. The OPEB liability for the SRHP in 2018 was almost $30 billion. The unfunded liabilities for the UT and A&M Plans were $13.1 and $3.4 billion respectively. Together these four statewide plans' total unfunded liabilities were $96 billion in 2018.

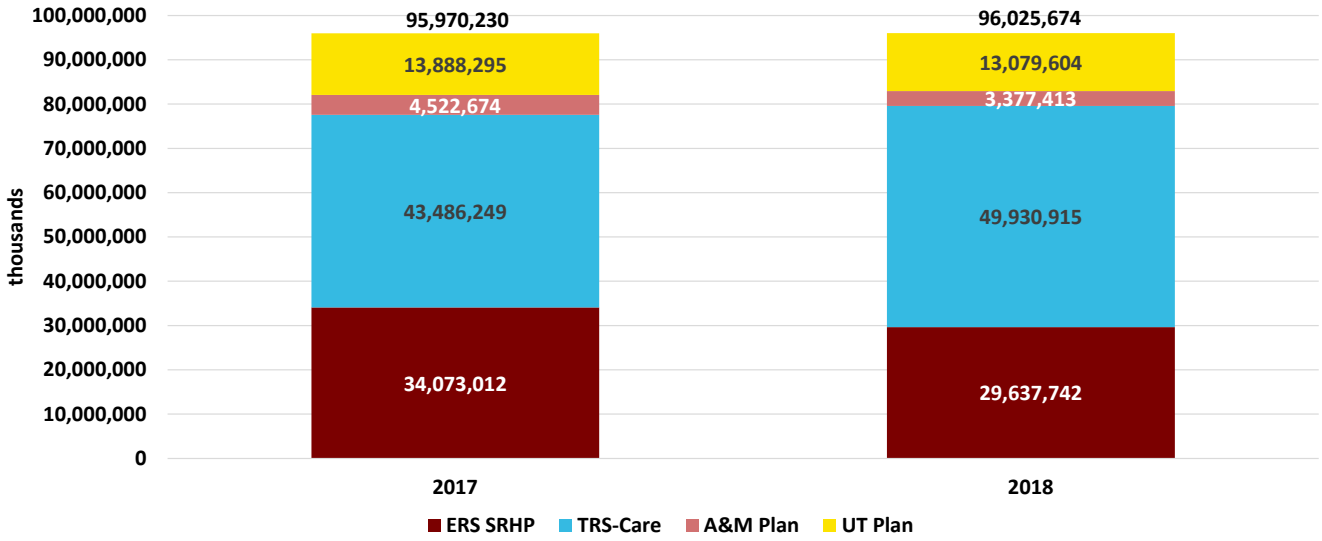
In Figure 8 the net pension liabilities for ERS and TRS and the OPEB unfunded liabilities in 2018 are presented side-by-side. Two net pension liabilities are presented for each plan: the stated and the market value. The unfunded liability of the OPEB plan administered by ERS of $29.6 billion was larger than the stated net pension liability of $20.2 billion and also higher than the market value of the pension's net liability of $24.4 billion.

Of note is the fact that the stated and the market value of the ERS pension liability are similar in size. This results from the similarity of the single discount rate of 5.69% used to calculate the plan's stated net liability and the ERS plan's market discount rate of 5.0% As mentioned earlier, the market value of a pension's liability is calculated using a discount rate equal to 2.5% plus the pension plan's assumed

[9] For the Employee Retirement System's SRHP see https://ers.texas.gov/About-ERS/Reports-and-Studies/ERS-Actuarial-Valuation-Reports/2018-ERS-OPEB-Valuation-Report-December-2018.pdf and for TRS-Care see https://www.trs.texas.gov/TRS%20Documents/actuarial_valuation_trscare_2018.pdf. Note that the GASB 74 statements are available for both of these plans through 2020, but the valuations from the TCAFR are only available up to 2018.

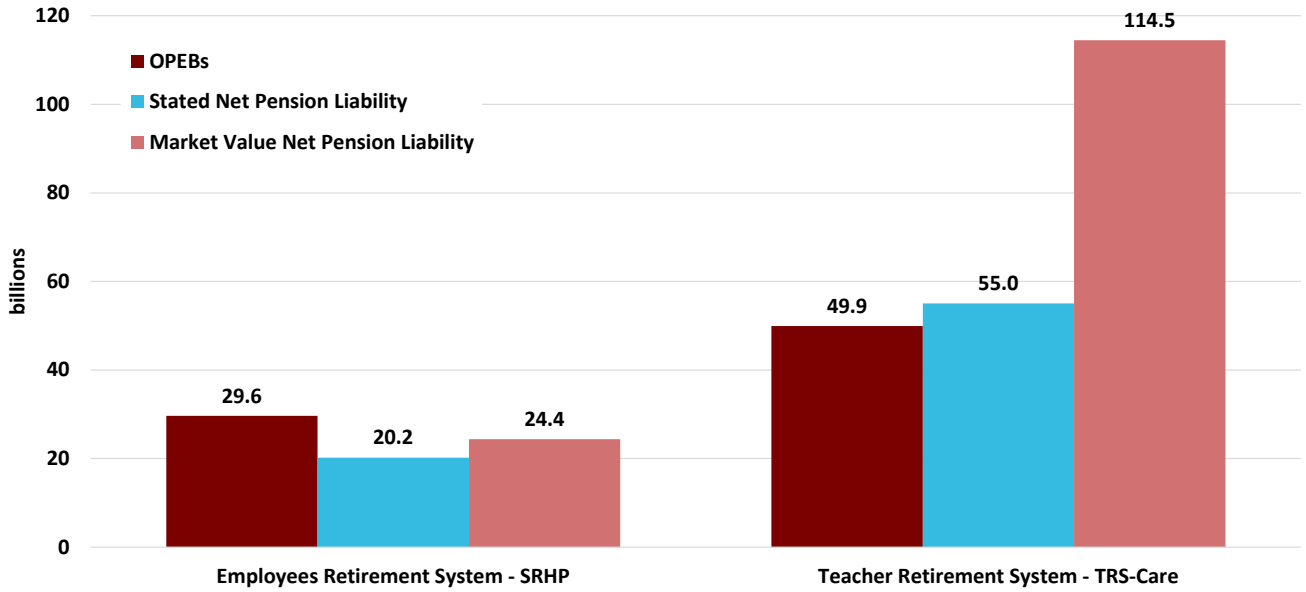
inflation rate. In 2018, the ERS assumed inflation rate was 2.5%, which combined with the 2.5% real discount rate assumption yields 5.0%.

**Figure 7.** Unfunded OPEB Liabilities for Four Plans in State of Texas Comprehensive Annual Financial Report, 2017 and 2018




Sources: State of Texas Comprehensive Annual Financial Reports, TRS-Care Retiree Health Care Plan Teacher Retirement System of Texas, GASB Statement No. 74, Employees Retirement System of Texas, Actuarial Valuation of Other Post-Employment Benefits, Annual Financial Report of the Texas A&M University System, and The University of Texas Consolidated Financial Statements.

**Figure 8.** Teacher Retirement System and Employees Retirement System OPEB and Pension Liabilities in 2018




Sources: State of Texas Comprehensive Annual Financial Reports, TRS-Care Retiree Health Care Plan Teacher Retirement System of Texas, GASB Statement No. 74, Employees Retirement System of Texas, Actuarial Valuation of Other Post-Employment Benefits, Annual Financial Report of the Texas A&M University System, and The University of Texas Consolidated Financial Statements. Texas Pension Review Board. Market value based on setting *r* to 2.5%+the individual plan's interest rate assumptions.

Why did the ERS have such a low single discount rate? The 2018 actuarial analysis of the plan's future expenses and revenues indicated that the plan's assets would be exhausted by 2049. In this case, the present value of expected future benefit payments for the years up to 2048 were discounted to the present using the expected return on investment assets of 7.5%, but the future benefit payments beginning in 2049 and thereafter were discounted to the present at the municipal bond rate 3.69%. The single discount rate that produces the same present value as the present value based on those two discount rates over the two periods was 5.69%.

The TRS-Care's OPEB liability of $49.9 billion in 2018 was 91% the size of the stated net pension liability of $55 billion and was 44% of the market value of the pension liability of $114.5 billion.

This brief summary of state-level OPEB unfunded liabilities indicates that their size rivals the size of the state-level stated unfunded liabilities. This is due to the low discount rate - the municipal bond rate - used to calculate the present value of the expected future benefits. The GASB notes that there is concern by some state and local governments that OPEB benefits are not like pension benefits in that OPEB benefits can be changed because they are not always legal obligations. In these cases, a higher discount rate would be justified. The GASB, however, justifies the current accounting, reporting, and the low municipal bond rate in the case of plans with no offsetting assets because the obligation exists at the date of the financial statements.

Municipalities also have significant OPEB liabilities. The City of Austin reported a $2.40 billion OPEB liability for 2018.[10] The OPEB liability for the City of Dallas in 2019 was $565 million. This plan is limited to city employees hired before January 1, 2010. Employees hired after this date are not eligible for post-employment health care benefits through this plan.[11] The City of Houston reported an OPEB liability of $2.25 billion for 2018.[12] The City of San Antonio has several separate OPEB plans. The city's primary government plan had an unfunded liability of $394 million in 2018. The Fire and Police Retiree Health Care Fund had a net OPEB liability of $627 million. This plan has assets set aside, and the liability was calculated using a 7.25% discount rate. The San Antonio Water System's net OPEB liability was $88 million, and it too had an asset position. The assumed discount rate for this plan's liability valuation was 6.5%.[13]

Like unfunded pension liabilities, these municipal OPEB obligations are calls on future tax revenues. Unlike pension liabilities, the municipalities have more flexibility in lowering these obligations through changing the terms of the arrangement they have made with their former employees and for new hires. The changes include higher contributions at the expense of the health insurance provided, discontinuing eligibility for the plan for new hires, and changing the vesting rules, among other options. Reporting the OPEB liabilities does provide the public a clearer picture of the size of the

[10] *Comprehensive Annual Financial Report, City of Austin, TX, September 30, 2019*, pp. 96.

[11] *City of Dallas Texas, Comprehensive Annual Financial Report, for Fiscal Year Ended September 30,2019, p.102 and p. 104.*

[12] *City of Houston Texas, Annual Financial Report, for the Fiscal Year Ended June 30, 2019*, p. 119.

[13] *City of San Antonio, Comprehensive Annual Financial Report, Fiscal Year Ended September 30, 2019,* pp.172, 178, 190.

commitments, however flexible they may be, and how they affect the municipalities' future expected expenditures.

The prior section makes clear the nature of the pension problem facing Texas and Texas taxpayers. Texas state and local pensions are hugely underfunded, with liabilities -- correctly measured -- far exceeding assets. The cost of providing pensions to state and local government workers, as a percent of wages and salaries, is increasing. What is to be done to address this issue?

## PUBLIC PENSION REFORMS

There are several related avenues to reforming public pensions. These include accounting reforms, funding reforms and structural reforms. Accounting reforms include the aforementioned valuation of pension liabilities using an appropriate risk-adjusted discount rate that reflects the durability of the pension benefits retirees are currently receiving and workers expect to receive. Funding reforms include requiring the state and municipal employers and employees to increase contribution rates so that the pension plans are fully funded. This would require substantial increases for many pensions even under current accounting standards but the use of the appropriate risk-adjusted discount rate in assessing the liability would lead to even higher required contribution rate increases. Discussion of structural reforms naturally follow once the implications of accounting reforms and the funding reforms are fully appreciated. Structural reforms include moving away from defined benefit pension plans with their obscured costs due to the current accounting standards, and with the funding risks they impose on taxpayers. Instead, a move toward the type of retirement plans that are widely enjoyed by the private sector, defined contribution plans, would solve the accounting problem and eliminate the funding risk that defined benefit plans impose on the taxpayer. An alternative partial solution would be to move to a cash-balance plan, where the accounting is more transparent. These cash-balance plans also make more transparent just who bears the risks inherent in retirement planning and how it is shared between taxpayers and pension participants.

### Accounting Reforms

Accounting reforms set the stage for evaluating all of the remaining reforms. One way to recast the current accounting methods is to think of the pension fund liabilities from the perspective of a retiree who receives a monthly benefit payment. From the vantage point of a retiree, the present value of this stream of benefits is an asset. The value of the pension fund's liability is exactly the same as the value of the participants' (retirees and workers) pension asset, as they are two sides of the same coin and should be exactly the same number. If we were to value the retiree's wealth embodied in that stream of future benefits, we would discount those mortality-adjusted benefits back to the present using the same discount rate that a private annuity provider would use. The revised rate would be a relatively low rate, reflecting the low risk to pension participants of receiving promised payments. Currently, pension funds report the aggregate value of their pension liabilities much lower than the aggregate value of participant's pension assets. This accounting mismatch violates fundamental principles of financial economics and should be addressed immediately.

Basic principles of financial economics require that the discount rate used to value an asset or a liability should match the risk of that asset or liability. For pension benefits, the risk is low, and the discount rate used to calculate the asset value to pension participants should be the same as the discount rate used to calculate the equal liability value to pension funds. Actuaries are finally coming around to acknowledge this fact. The Society of Actuaries' Report of the Blue Ribbon Panel on Public Pension Plan Funding also recommended using the risk-free rate to calculate pension liabilities to assess the investment risk associated with the investment earnings assumption.

Accounting reforms could further improve the public's understanding of the size of pension liabilities and the inherent risks associated with the current valuation. GASB 67 already requires pension plans to report how sensitive their net pension liability is to one percentage point increases and decreases in their single discount rate. A natural and meaningful extension of the sensitivity analysis would require pension plans to report their net pension liability based on a discount rate tied to closely to what are considered to be risk-free rates.

## Funding Reforms

Higher unfunded pension liabilities based on the risk-free rate reveal that pensions are even more underfunded than under current accounting standards. This means that necessary increase in contribution rates, when a plan is underfunded based on current account standards, would have to increase further to achieve the full funding when the liability is estimated using the risk-free rate.

The Teachers' and State Employees' Retirement System (TSERS) in North Carolina provides an example of a step in the direction of allowing the risk-free discount rate to help guide funding policy. In 2016, the TSERS's Board of Trustees established the Employer Contribution Rate Policy to make recommendations about the size of employer contributions to the pension system for fiscal years 2018-2022. Under this policy, the Board estimates an employer contribution that is at least 0.35 percentage points higher than the previous year's contribution rate. The employer contribution rate is bounded such that the contributions are not less than the contribution rate based on the assumed discount rate and not greater than the contribution rate based on risk-free rate. Here, the risk-free rate is used to set the upper bound on the contribution rate for the TSERS.

Achieving full funding when the liability is calculated using the risk-free rate will require significantly higher contribution rates for many pensions. Reporting these higher necessary contribution rates would be a large step in the direction of greater transparency and accuracy in reporting pension expenses to taxpayers and public officials.

## Structural Pension Reforms

The chronic underfunding problem of defined benefit pension plans, and their growing expense, has led to calls for structural reforms. In particular, these new reforms move away from the current defined benefit form and toward either a defined contribution type plan or to a hybrid plan such as a cash balance plan.

What are the structural issues with current defined benefit plans? They are chronically underfunded, because of investment performance below expectations, because of retiree longevity that exceeds expectations, and because governments are slow to increase funding as needed to make up for these two issues.

In addition to these funding issues, defined benefit plans raise a host of inequities. They are structured to reward workers who work a lifetime for the state or for a local government, providing them with generous retirement benefits. But two state workers beginning work at 21, one of whom works for the state for the next 40 years and the other works for the state for ten years and then joins the private sector, will receive vastly different outcomes from their defined benefit plan. The defined benefit plan actually counts on the existence of a large number of workers who will depart state service early in their careers and therefore have contributed to the state pension but who do not get much in return. Instead, those funds go to subsidize the benefit payments to the long-time state workers. According to Ingersoll (2001), the annual teacher turnover rate is between 13% to 15% with about half due to teacher migration (i.e., moving to other schools) and the other half due to teacher attrition (i.e., leaving the profession). The turnover rate for younger teachers is higher than older teachers. Nationally, nearly a third of teachers leave the profession within the first few years of their careers (Headden 2014, Hanna and Pennington 2015). Texas's Teacher Retirement System (TRS) reports that the probability of termination within the first three years of service is 38% for males and 41% for females.

Moreover, there is the inequity between state and local government workers and private sector workers regarding risk sharing. Private sector workers who are enrolled in defined contribution retirement plans have both the risk of investment performance and longevity risk, and they bear it all. They also have the additional risk of taxes levied to pay for the guarantees offered to public sector workers. Meanwhile, public sector workers are insured against investment risk, against longevity risk, and bear only the risk of higher taxes and possibly higher pension contribution rates to pay for the guarantees they receive.

## The Case for Transitioning Defined Benefit Plans to Defined Contribution or Hybrid Plans

As detailed above, traditional defined benefit plans are underfunded when the present value of pension liabilities are calculated, incorrectly, using the expected return on their pension assets. The actual degree to which they are underfunded is even higher when the future pension promises are discounted to the present at the more appropriate risk-free rate. Using the expected asset return as the discount rate for future pension liabilities fails to account for the risk associated with asset investment, thereby under-estimating the size of the future pension liabilities.

While currently acceptable accounting practices indicate that pensions require additional funding through higher contributions from employees, employers and ultimately taxpayers, the additional funding requirements are even greater if the full risk of the pension liability is accounted for appropriately. Although defined contribution plans also face such a risk, they do not cause unfunded liabilities for employers -- and ultimately taxpayers -- because the consequences of the risk are borne by the individual employees under defined contribution plans.

Jansen et al. (2018) argue that the problem of underfunding in defined benefit public pension plans is partly rooted in politics. Unfunded public pension liabilities are another form of government debt, and politicians have an incentive to resort to debt financing in order to please current voters (public sector employees in particular) with benefit hikes and contribution cuts while shifting the financing costs to future generations who cannot express their opinions in a current election. After a period of good years with superb fund investment performance, an otherwise adequately funded pension plan would appear overfunded, triggering benefit hikes and/or contribution cuts. However, the stochastic nature of investment returns suggests that a period of bad years will occur sooner or later, revealing the unfunded liabilities caused by the earlier premature benefit hikes and/or contribution cuts.

Reporting pension liabilities using both the current asset return and the risk-free rate allows taxpayers to realize that they must eventually shoulder the burden of financing the retirement benefits to public sector employees. Why should taxpayers with private sector jobs and defined contribution plans agree to provide generous guaranteed returns to public sector workers? When market returns are down and private sector workers are getting negative realizations of returns, these same workers are seeing higher taxes (or lower government benefits) so that public sector workers can receive their guaranteed high returns. As mentioned above, this is a bad deal for taxpayers who work in the private sector. While government employees enjoy their guaranteed benefits, private sector workers see their taxes rise to pay those benefits while those same private sector workers face a decline in their own defined contribution pension balances.

It is not surprising that government attempts to shore up defined benefit plans with explicit debts have become increasingly more difficult to secure public support. As an example, to deal with Chicago's $28 billion unfunded liabilities in the city's four public pension funds at the end of 2017, Chicago's then leaders considered issuing $10 billion in pension obligation bonds. This plan did not materialize because of strong objections from residents outside the public sector. Such a plan was undertaken to a lesser degree in Houston. In order to reduce the unfunded liabilities in Houston's three public pension funds, the city completed a pension reform in 2017 that includes issuing $1 billion in pension obligation bonds. This bond issuance occurred in conjunction with higher employee contributions and a range of benefit reductions affecting all plan participants.

One way to get out of public pensions' recurring financing crises and to remove taxpayers from the role of pension underwriters is to transition defined benefit plans to defined contribution plans, following the trend that has already taken place in the private sector. How do employees compare these two types of retirement plans?

## Defined Benefit Plans vs Defined Contribution Plans from the Perspective of Employees

To a public sector employee, a defined contribution plan has both certain advantages and certain disadvantages, compared to an equal-cost defined benefit plan.

**Portability** – The first main advantage of the defined contribution plan is portability. Upon termination of employment, an employee with a defined contribution plan may either retain the vendor funds until retirement or request a direct rollover of the defined contribution retirement account to a qualified

plan. Either way, the employee does not lose any retirement benefits from past employee and employer contributions. In contrast, defined benefit plans usually do not have this portability from one job to another. Typical defined benefit plans are designed to reward long periods of service to a single public employer. As a result, an employee who leaves a job with a defined benefit plan would lose some amount of retirement benefits.

The Teacher Retirement System (TRS) of Texas provides a good example. Several provisions in TRS work against an employee who wants to leave for another job or wants to retire early. TRS requires a 5-year period of participation to be vested in the program. Vested employees can receive a defined benefit in retirement and they also have an accumulated value in the event of a withdrawal, or refund, that is higher than that of a non-vested employee. Thus, the vesting period favors workers who stay with the employer for at least 5 years.

The second attribute of TRS that favors longer-term employment is the limited value of the refund or rollover available to plan participants in the event of moving to a new job. The refund for non-vested employees is equal to their own contributions to TRS accumulated at 2%. These contributions can accumulate at the 2% rate for up to 5 years, but after that there is no further interest accruals. For vested enrollees, the refunded amount is also equal to their own contributions accumulated at 2%. Interest of 2% continues to accrue to the vested employees account as long as the employee leaves the balance with TRS. Note, however, that employees who leave TRS-covered employment and roll over their account balances into another form of deferred tax accounts do not receive any of the employer contributions made on their behalf. These contributions remain with the TRS Pension Fund.

The third attribute of TRS that favors long-term employees is the benefit formula that is directly proportional to the average a worker's 3 (or 5 for newer hires) highest yearly wages, which tend to occur in later years of employment. The TRS benefit formula is thus biased against employees who leave early.

Lastly, there is the "Rule of 80", which allows TRS members to retire with full benefits promised by the TRS benefit formula when they achieve the combination of age and years of service equal to 80. If the number of employment years is not long enough to satisfy the "Rule of 80," one must wait to retire at the normal retirement age of 65 or later to qualify for the TRS benefit formula.

Recognizing the portability advantage of defined contribution plans helps one see the fallacy of an often-made comparison of an individual in a particular defined contribution plan (say Texas's 'Optional Retirement Program' or ORP) and a particular defined benefit plan (say TRS itself) that is based on an employment history completely with a single employer. Because typical employees do in fact switch jobs, an employee with a defined benefit plan would lose a (potentially large) part of her retirement benefits each time she switches jobs, whereas an employee with a defined contribution plan would keep all of her and her employer's contributions. Employees with an uncertain planned tenure at a job or an uncertain career path would be more likely to choose a defined contribution plan.

McGee and Winters (2013, 2014) emphasize the importance of taking into account the risk that entering public school teachers face under traditional, heavily back-loaded defined benefit plans, due to the fact

that most teachers are uncertain about how long they would/could stay with their employers. Comparing a traditional defined benefit plan with a cost-equivalent, less back-loaded (i.e. more portable) defined benefit plan, they show that even though teachers who stay in the same job until retirement fare better in the former plan than in the latter plan, all entering teachers as a group, with unknown future tenure on the job, fare better in the latter plan than in the former plan as long as they are risk averse.

The attractiveness of defined contribution plans' portability is reflected in employee plan choices. The State University of New York (SUNY) and the City University of New York (CUNY) systems offer faculty members the choice between a defined contribution plan and a defined benefit plan, and nearly 75% of the faculty in both systems have opted into the defined contribution plan (Hunt 2020). In addition, according to a poll of New York State public school teachers (Empire Center for Public Policy 2012), a total of 83% of the teachers polled would opt into either a defined contribution plan or a hybrid plan consisting of both a (smaller) defined benefit plan and a defined contribution plan, if they were offered the respective option. Data from Texas A&M University for 1,402 new employees hired from January 2018 to March 2021 indicate that 356 (25%) chose the defined-benefit TRS retirement plan and 1046 (75%) chose the defined-contribution Optional Retirement Plan (or ORP). (See Appendix Table 1.)

**Inheritability** – Defined-contribution plans are inheritable. This is an absolute. However, some defined benefit plans provide generous benefits to employees' heirs in the event of death. TRS for example, offers what seems a generous menu of death benefits to the heirs of workers who die during a school year in which they worked. The options include: (1) 2 times the worker's annual compensation, up to $80,000, (2) 60 monthly payments equal to the standard annuity; or (3) a lifetime joint life annuity. Death benefits are also available to the heirs of members who did not work during the year of their death but were eligible to retire or were absent from service due to illness or accident.

The heirs of participants who are vested but are no longer employed in TRS-covered employment receive the accumulated value of the participant's own contributions. In this case, the worker's heirs would almost certainly have received a larger amount had the worker originally been in a defined contribution plan.

**Investment Risk** – The first main disadvantage of defined contribution plans is the investment risk. There are two types of investment risk associated with a defined contribution plan. First, an individual directing his or her defined contribution retirement account will get different returns than the market average, and different returns than his or her peers. Second, the market average return will vary over time and impact cohorts differently. As a result, an employee with a defined contribution plan may find upon retirement that the wealth balance in his or her retirement account is considerably above or below expectations. In contrast, while defined benefit plans also face the same investment risk, the risk is borne by taxpayers as a whole rather than by individual employees. From the perspective of employees with a defined benefit plan, their post-retirement benefits are largely predetermined, and the investment performance of the fund has little or nothing to do with what they will receive after retirement.

On the other hand, a defined contribution plan allows an employee to choose a level of risk that they are comfortable with in terms of investing. A defined benefit plan with central investment management is one size fits all. (Of course, with the generous current defined benefit plans, with taxpayer insurance of risk, this one size fits all constraint is much less of an issue.)

**Longevity Risk** – The second main potential disadvantage of defined contribution plans is longevity risk. In the case of defined benefit plans, the plan's sponsor insures the longevity risks, but in the case of defined contribution plans, the individual takes on that risk. The individual in a defined contribution plan can choose to purchase longevity insurance by using accumulated funds to purchase a lifetime annuity, but this is not automatic. At the same time, the defined contribution plan does allow the individual to decide this issue.

Again using TRS as an example, the system offers six different annuity options: (1) standard single (own) life annuity (2) 100% joint life annuity, (3) a 50% joint life annuity, (4) payments guaranteed for 60 months from retirement date, (5) payments guaranteed for 120 months from retirement date, and (6) a 75% joint life annuity. TRS employees can also take a partial lump sum in exchange for lower annuity payments. Employees can opt for a partial lump sum equal to 12, 24, or 36 months of the standard annuity.

Defined contribution workers have greater choice; they can annuitize with or without a death benefit, or not annuitize at all. They can choose almost any pattern of lump sum payouts or withdrawals. However, if they choose to annuitize, they may receive a smaller annuity than in the case of a pension plan with pooled longevity risks. The defined contribution plan is set up to provide an unspecified lump sum at retirement. The retiree can either keep the accumulated value in equities and bonds and draw down the wealth as he or she goes through retirement or use all or part of the accumulated value to purchase an annuity in the private annuity market.

These retirees can take periodic withdrawals, even irregular amounts, and can pass on any remainder to their heirs. Defined benefit plan participants face much tighter constraints on how they can receive the value in their account at retirement, and inheritability is contingent on the choice they make among possible options they have at retirement.

Of course, employees with a defined contribution plan can decide if they want to insure against longevity risk. In a defined benefit plan, the employee will be insured against longevity risk even if he or she prefers not to be. Nevertheless, the defined contribution plan has a disadvantage in dealing with longevity risk in that life annuities in the private annuity market tend to be very costly to annuity buyers. Poterba and Warshawsky (1999) estimated that about 10% of the initial premium of a life annuity in the private annuity market is used to cover the so-called "adverse selection."

"Adverse selection" in the annuity market occurs because insurers (in this case annuity providers) do not know specific information on the expected longevity of annuity purchasers. Meanwhile, annuity purchasers do have specific, if imperfect, information on their expected longevity. Therefore, those potential purchasers who expect to live longest are most willing to purchase an annuity, while those potential purchasers who expect to live less than the average lifespan are less willing to purchase

annuities. This means that annuity providers are not facing a random selection of individuals when they sell annuities, but instead are facing a group that has a higher-than-average life expectancy. To deal with this, annuity providers must set the premiums high to break even. This means that for the average individual, annuity prices seem high. Defined benefit pension providers do not have this issue, because they basically annuitize pension benefits for everyone, those with both long and short expected lifespans.

So, exactly what can be said about the relative desirability of the defined contribution and the defined benefit plans to workers? Defined contribution plans typically are superior in the dimensions of portability, flexibility, and inheritability, and treat workers the same in terms of future promised retirement benefits throughout their working career. Defined benefit plans typically provide workers with better insurance against both investment risk and longevity risk.

Apparently, given the choice between defined benefit and defined contribution plans employees have diverse preferences. For example, there is some evidence that young employees are more likely to enroll in a defined contribution plan than older employees, and it is considered a consequence of the fact that workers are more likely to change jobs when young, and hence value portability of a pension plan more (Clark et al. 2006, and Toutkoushian 2019).

## Defined Benefit Plans vs Defined Contribution Plans from the Perspective of Taxpayers

Taxpayers ultimately provide the funds for public sector employment. Taxpayers bear the investment risk and the longevity risk that defined benefit pensions provide. In contrast, with a defined contribution plan, taxpayers do not bear this risk; it is borne by the employees.

There is always risk associated with investment, regardless of whether investment occurs within a defined benefit plan or a defined contribution plan. The difference is that a defined benefit plan guarantees a return, a guarantee paid for by taxpayers.

Importantly, those taxpayers working in the private sector are providing a guarantee that they themselves do not share with public sector workers. Taxpayers in the private sector overwhelmingly have defined contribution retirement program options, and thus these taxpayers may find themselves both bearing unfavorable investment outcomes in their own portfolio while seeing tax increases (or government services cuts) to hold public sector workers harmless against those same unfavorable investment outcomes.

The chronic unfunded liabilities problem of defined benefit plans is the direct consequence of two accounting practices regarding public defined benefit plans. First, if defined benefit plans use a discount rate to evaluate plan liabilities that is too high, that reflects the risk of plan *assets* instead of plan *liabilities.* As a result, employee plus employer contributions are too low for the promised guaranteed benefits. Or, alternatively, the promised guaranteed benefits are too high for the employee plus employer contributions. Second, the amortization periods set by government guidelines to repay unfunded liabilities -- to restore full funding levels -- tend to be too long, perpetuating the problem of pension debts.

To make things even worse, the burden of the investment risk in the defined benefit plan is not equitably distributed among taxpayers. Public sector employees, as taxpayers, pay for only a part of the costs associated with the investment risk incurred in their pension plan; private sector employees and taxpayers are passively committed to paying higher taxes for the benefits they will not receive and often before they even have a chance to express their objection to it.

## Implementing a Transition Away from a Defined Benefit Plan

Many government employers are seriously considering moving their traditional defined benefit plans to either a defined contribution plan or a hybrid plan (discussed below) as a long-term solution to the repeated problem of public pension debts. Public defined benefit pensions are chronically underfunded and represent a large and growing cost to state and local governments and, eventually, to taxpayers. The private sector has moved away from defined benefit pensions to avoid the high and uncertain cost of these pensions, and their relatively high administration cost compared to defined contribution plans. Pension reforms in the past have revealed that a considerable share of employees, when given the choice, would choose a defined contribution plan or a hybrid plan over a traditional defined benefit plan.

For example, Goldhaber and Grout (2013) study the choice by Washington State public school teachers between enrolling in a traditional defined benefit plan and enrolling in a hybrid plan with both a defined benefit and a defined contribution components during 2007-2009, and find that 52% of active choosers choose the hybrid plan over the defined benefit plan. Clark et al. (2015) examine the choice by new hires covered by the Utah Retirement Systems following the state's public sector pension reform in 2010. New hires chose between a defined contribution plan and a hybrid plan with both a defined benefit and a defined contribution component. About 50% actively chose the defined contribution plan over the hybrid plan. These experiences suggest that replacing a defined benefit plan with a defined contribution plan or a hybrid plan will receive support from many employees, and that many employees find these alternative plans attractive. At the same time, such a move mitigates the problem of unfunded pension liabilities.

A transition from a defined benefit plan to an alternative retirement plan can start with enrolling new hires into the new plan. Current enrollees can be given the option of remaining in the defined benefit plan or making the move to the new plan with a specified amount related to past participation rolled over into the new plan. Note that this transition would not immediately reduce the costs to the public employer, but, importantly, this operation would also not increase the employer costs.

It is true that when new members are placed in a new defined contribution plan, the employee and employer contributions for those members no longer flow into the original pension trust, but absent a positive unfunded liability, trust fund assets and both employer and employee contributions for current employees should be able to cover (future) pension benefits to current retirees and employees. However, in the more realistic and relevant case when there is an unfunded liability, this unfunded liability will remain and is not affected by moving new members to a defined contribution plan. It is possible that pension obligation bonds could be issued to close the gap in financing the unfunded liability portion of the defined benefit plan during its phase-out stage. This still obligates the employer,

and ultimately the taxpayer, to pay the unfunded liability. There is no avoiding the realization of this debt. This necessity reveals the degree to which the pension is underfunded and the employer's hidden debt.

The transition to a defined contribution plan delivers portability and flexibility to the worker. Moreover, although moving new hires to a defined contribution plan would not reduce any existing unfunded liabilities, it does prevent unfunded liabilities in the future, and it removes the taxpayer from the role of underwriting the pension plans's risks in the future. Again, the taxpayer is still on the hook for the current unfunded liabilities, but future unfunded liabilities will not accrue.

## Hybrid Plans

Sitting between pure defined benefit and pure defined contribution retirement plans are hybrid plans. In a hybrid plan, employees share some downside risk with the taxpayers in the case equity investment fails to produce the expected returns. At the same time, the hybrid plan continues to provide longevity risk insurance that is not available in a defined contribution plan.

There are two popular forms of hybrid plans. One is simply a combination of a defined benefit plan and a defined contribution plan, known as the "defined benefit + defined contribution plan", and the other one is the so-called "cash balance" plan (NASRA 2020). In a typical cash balance plan, a guaranteed rate of return (set by statute) – usually between 4% and 7% – is credited to members' retirement accounts annually. When actual returns are above the guaranteed return, the excess amounts are distributed, either according to a formula or by the decision of a board, to pay down unfunded liabilities, to members' retirement accounts, and to a reserve to help offset future investment losses. In addition, a cash balance plan preserves the advantage of providing lifetime benefits associated with the traditional defined benefit plan.

However, the lifetime benefits offered by a cash balance plan, instead of being determined by a formula that is biased against shorter employment periods, are based on the final balance in an employee's account, adjusted by any employee-elected partial lump-sum payment and employer matched funds. In a cash balance plan, therefore, the investment risk is shared between the employer and the employees. As a result, the problem of unfunded liabilities in the traditional defined benefit plan is mitigated (but not eliminated). To employees, the cash balance plan has more investment risk than the defined benefit plan but less investment risk than the defined contribution plan. The cash balance plan continues to provide longevity insurance available in the traditional defined benefit plan and increases portability. A drawback with the cash balance plan is that unfunded liabilities can continue to exist when contribution rates and investment returns are insufficient to meet the rate of return target.

Consideration of transitioning TRS to a defined contribution plan or a cash balance plan should recognize that, in Texas, 78% of all TRS participants and 96% of teachers do not participate in Social Security. This means that the system's retirement benefits are the sole source of longevity insurance for its participants. Thus, robust annuity options should be part of the offerings of a reformed system.

Some may argue that teachers choose the teaching profession in part because they like the benefit/pay package, and replacing the existing defined benefit plan with a defined contribution plan may reduce the attractiveness of the retirement benefits offered and, as a result, lower the quality of the future teachers. Based on some existing evidence (Goldhaber and Grout 2013, and Clark et al. 2015), however, about half of teachers chose the defined contribution plan while the other half chose the defined benefit plan when they were given the choice. This suggests that a transition from a defined benefit plan to a defined contribution plan or a hybrid plan does not necessarily reduce the competitiveness of public schools as the employer. Both the defined benefit + defined contribution plan and the cash balance plan have already been adopted by public employers in many states (NASRA 2018, NASRA 2020). Here are some examples.

*Utah Retirement Systems (URS)* – URS is the sole public retirement system in the state covering almost all public employees. Public employees in Utah participate in Social Security. In the wake of the Great Recession of 2008-2009, the state raised employer contribution rate and gave the new hires a choice between a defined benefit + defined contribution hybrid plan and a defined contribution plan. The hybrid plan is the default option in the case a new employee does not make a choice during the first year of employment. As of 2015, about 80% of new employees have opted for the hybrid plan; 60% by default, and 20% by active choice (Clark et al. 2015).

*Texas County and District Retirement System (TCDRS) and Texas Municipal Retirement System (TMRS)* – TCDRS covers public employees from nearly 800 counties and special districts in Texas, whereas TMRS covers public employees from about 890 cities in Texas. These two long-running Texas public retirement systems can be characterized as cash balance hybrid plans mainly because (1) a guaranteed rate of return – 7% for TCDRS and 5% for TMRS – is credited to employees' retirement accounts each year and any upside gains or downside losses go to the government employer; and (2) lifetime annuity is based on the actual final balance in each employee's retirement account, rather than a preset formula as in a typical defined benefit plan (TCDRS 2020 and TMRS 2020).

Transitioning the current heavily back-loaded TRS defined benefit plan to a cash balance plan for new hires and for current workers who voluntarily opt into the plan is a reform worth considering. With the cash balance plan an employee's account is annually credited with a guaranteed rate of return and the employee's annuity options are based on the final balance in his or her account, as well as on the age of retirement. This reform would considerably improve portability by equalizing the treatments of short-term and long-term teachers and could also allow for enhanced inheritability since the annuitized life benefit is derived from accumulated balance in an employee's account. In addition, it maintains insurance against longevity risk that is provided under the current defined benefit plan.

To facilitate meaningful risk sharing between an employer and its employees with respect to investment returns, the guaranteed rate in a cash balance plan should be between the government long-term borrowing rate and the market average return, or between 3% and 7%-8%. Since the motivation behind such a reform is to remove taxpayers from the role of underwriting rate of return guarantees, the guaranteed rate during the accumulation phase of a worker's years in the labor force would need to be set such that the return can be achieved with a high probability. Furthermore, the rate of return used to determine the annuity amount should be related to high-grade bond returns.

One criticism of transitioning from a defined benefit plan to a cash balance plan might be that the guaranteed return in the cash balance plan, say 5% or 6%, is much lower than the current defined benefit plan's guaranteed return embodied in the benefit formula. But this criticism is only valid for lifetime employees. The benefit formula in the current defined benefit plan does not necessarily translate into a high rate of return on the employee and employer contributions for an entering employee, who may or may not remain in his or her current job. The current TRS defined benefit pension has a highly backloaded benefit structure, in that longer-term employees benefit from the plan at the expense of shorter-term employees. Currently, TRS requires a 5-year vesting period, but nearly a third of teachers leave the profession within the first five years of their careers (Headden 2014, Hanna and Pennington 2015). For those who leave early, the rate of return from their plan participation is negative. As another example, the retirement benefits in TRS are directly proportional to the average of 5 highest yearly wages, which tend to occur right before retirement. Again, this provision in the TRS benefit structure is biased against shorter-term employees.

From the perspective of an entering employee, the expected return under the defined benefit plan and the cash balance plan should be the same, except for the difference in the costs to taxpayers. That is, only in the sense of receiving a smaller amount of taxpayer subsidy would the cash balance plan produce a lower expected return than the defined benefit plan. The investment risk in the defined benefit plan is entirely borne by taxpayers, whereas it is shared between employees and taxpayers in the cash balance plan. On the other hand, the cash balance plan treats short-term and long-term employees much more equally, greatly reducing the risk associated with uncertain job tenure with a particular employer.

## CONCLUSION

Texas has a large and growing pension funding problem. State and local pensions are significantly underfunded, and the problem is worse than has been officially acknowledged by governments using flawed but accounting standards-blessed discount rates. The problem is growing, as payments for employee pensions are a larger and larger share of employee compensation. Moreover, the issue is caused by risk, risk of increasing longevity and risk of investment underperformance, risks that are covered by taxpayers. Thus, Texas taxpayers at the state and at the local level are facing rising taxes (or reduced government services) to cover these risks. This is combined with chronic underfunding as state and local governments are making contributions based on flawed actuarial assumptions.

The private sector has long moved to defined contribution pension programs to avoid these problems. However, the public sector issues are increasingly rearing an ugly head, with large and growing unfunded liabilities, and rising cost of providing pension benefits. Perhaps it is time to seriously consider putting public sector workers on a level playing field with their private sector colleagues and transitioning to defined-contribution plans. If that is too big a step at present, transitioning to a cash-balance plan or other hybrid plan could at least allow taxpayers to share the risk more transparently, and more equitably, than the current situation in Texas.

## REFERENCES


Clark, Robert L., Linda S. Ghent, and Ann A. McDermed, 2006. "Pension Plan Choice among University Faculty," *Southern Economic Journal* 72, 560-577.

Clark, Robert L. Emma Hanson and Olivia S. Mitchell, 2015. "Lessons for Public Pensions from Utah's Move to Pension Choice," *NRER Working Paper* 21385, July 2015.

Congressional Research Services. 2019. "Worker Participation in Employer-Sponsored Pensions: A Fact Sheet," April 30, 2019.

Empire Center for Public Policy, "Poll: NY Teachers Want Retirement Choice," Press Release, March 14, 2012. https://www.empirecenter.org/publications/poll-ny-teachers-want-retirement-choice/

Gittlemen, Maury and Brooks Pierce. 2012. "Compensation of State and Local Government Workers," *Journal of Economic Perspectives*, 26(1): 2017-242.

Goldhaber, Dan, and Cyrus Grout, 2013. "Which Plan to Choose? The Determinants of Pension System Choice for Public School Teachers," Center for Education Data & Research Working Paper 2013-1, University of Washington Bothell.

Hanna, Robert, and Kaitlin Pennington, 2015. "Despite Reports to the Contrary, New Teachers Are Staying in Their Jobs Longer," Center for American Progress, January 2015, https://www.americanprogress.org/issues/education/news/2015/01/08/103421/despite-reports-tothe-contrary-new-teachers-are-staying-in-their-jobs-longer/.

Headden, Susan, 2014. *Beginners in the Classroom: What the Changing Demographics of Teaching Mean for Schools, Students, and Society*, Carnegie Foundation for the Advancement of Teaching.

Hunt, John. 2020. "Reforming New York City's Public Retirement System," Manhattan Institute Report, October 15, 2020. https://www.manhattan-institute.org/reforming-new-york-city-public-retirement-system

Ingersoll, Richard, 2001. "Teacher Turnover and Teacher Shortages: An Organizational Analysis," *American Educational Research Journal* 38, 499-534.

Jansen, Dennis W. Liqun Liu, and Andrew J. Rettenmaier. 2018. "Pensions Rescued by Borrowing: What Could Go Wrong with That?" https://perc.tamu.edu/PERC-Blog/PERC-Blog/Pensions-Rescued-by-Borrowing-What-Could-Go-Wrong

Lucas, Deborah J. and Stephen P. Zeldes, 2009. "How Should Public Pension Plans Invest?" *American Economic Review Papers and Proceedings*, 99 (2), 572-532.

Lusardi, Annamaria, and Olivia S Mitchell, 2011. "Financial Literacy around the World: an Overview," NBER Working Paper 17107, June 2011.

McCaulay, Martin. 2013. "Duration and Convexity for Pension Liabilities," *Pension Section News*, Issue 81 (September 2013), pages 18-21, Society of Actuaries.

McGee, Josh and Marcus A. Winters, 2013, *Better Pay, Fairer Pensions: Reforming Teacher Compensation*, Manhattan Institute Civic Report No. 79, September 2013.

McGee, Josh and Marcus A. Winters, 2014, *Better Pay, Fairer Pensions II: Modeling Preferences between Defined-Benefit Teacher Compensation Plans*, Manhattan Institute Civic Report No. 90, June 2014.

National Association of State Retirement Administrators (NASRA), *In-depth: Risk Sharing in Public Retirement Plans*. December 2018.

National Association of State Retirement Administrators (NASRA), *NASRA Issue Brief: State Hybrid Retirement Plans.* June 2020.

Mitchell, Olivia S James M Poterba, Mark J Warshawsky, Jeffrey R Brown, 1999, "New evidence on the money's worth of individual annuities," *American economic review* 89 (5), 1299-1318.

Novy-Marx, Robert and Joshua Rauh. 2009. "The Liabilities and Risks of State-Sponsored Pension Plans?" *Journal of Economic Perspectives,* 23(4): 191-210.

Novy-Marx, Robert and Joshua Rauh. 2011. "Public Pension Promises: How Big Are They and What Are They Worth?" *Journal of Finance,* 66(4): 1211-1249.

Peskin, Michael. 2001. "Asset/Liability Management in the Public Sector." In *Pensions in the Public Sector*, ed. Olivia S. Mitchell and Edwin C. Hustead, University of Pennsylvania Press, 195-217.

Poterba, James and Mark J. Warshawsky, 1999, "The Costs of Annuitizing Retirement Payouts from Individual Accounts," NBER Working Paper 6918.

Rauh, Joshua D. 2017. "Hidden Debt, Hidden Deficits: 2017 Edition," A Hoover Institution Essay.

Office of the State Controller. 2020. *State of North Carolina Comprehensive Annual Financial Report, Fiscal Year Ending June 30, 2020.*

Teacher Retirement System of Texas. 2019. *Pension Benefit Design Study*, December 2018.

Teacher Retirement System. 2019. *Requesting a Refund*. https://www.trs.texas.gov/TRS%20Documents/request_refund.pdf

Teacher Retirement System of Texas, 2020. Comprehensive Annual Financial Report for Fiscal Year Ended August 31, 2020. https://www.trs.texas.gov/TRS%20Documents/cafr_2020.pdf

Texas County & District Retirement System (TCDRS), *Comprehensive Annual Financial Report for the Years Ended December 31, 2019 & 2018*. June 5, 2020.

Texas Municipal Retirement System (TMRS), *Actuarial Valuation Report as of December 31, 2019*. May 28, 2020. https://www.tmrs.com/down/Actuarial_Valuations/2019_Actuarial_Valuation.pdf

Texas Pension Review Board, 2021. (Online Information from) Texas Public Pension Data Center. https://data.prb.texas.gov/index.html

The PEW Charitable Trusts, 2020, "The State Pension Funding Gap:2018," June 2020.

Toutkoushian, Robert K., 2019. "What affects the Choice of Retirement Plan among Faculty: Evidence from the University System of Georgia," Journal of the Professoriate 10, 101-123.

Society of Actuaries. 2014. Report of the Blue Ribbon Panel on Public Pension Plan Funding. https://www.soa.org/globalassets/assets/files/newsroom/brp-report.pdf

## APPENDIX

### The Impact of Interest rates on Bond Prices and on Liability Values: Duration and Convexity

Calculating the impact of a change in interest rates on the price of a bond begins with the familiar Taylor series expansion. As a reminder, a function *f(x)* can be represented by a Taylor series expansion, and the following presents the terms necessary for a second order Taylor series approximation to *f(x)*:

$$f(x) = f(x_0) + f'(x_0) \cdot (x - x_0) + .5 \cdot f''(x_0) \cdot (x - x_0)^2 + \ldots$$

The price of a bond is simply the summation of the present value of the cash flows that accrue to the bond holder. That is, the price of a bond is a function of *y*, *P(y)*, and can be written as:

$$P(y) = \sum_{t=1}^{T} \frac{CF_t}{(1+y)^t}$$

Here *CF* is cash flow at time *t*, and *y* is the yield to maturity.

We want to know the change in *P* for a small change in the yield *y*. So, for our problem, our notation has *P(y)* instead of *f(x)*. Also, the change in P due to a change in *y*, $P(y) - P(y_0)$, is our version of $f(x) - f(x_0)$.

$$dP = P(y) - P(y_0)$$

In our Taylor series, we need the first and second derivate of *f(x)*, or in our case, the first and second derivative of *P(y)*. The first derivative:

$$P'(y_0) = \sum_{t=1}^{T} \frac{(-t) \cdot CF_t}{(1+y_0)^{t+1}}$$

And the second derivative:

$$P''(y_0) = \sum_{t=1}^{T} \frac{t \cdot (t+1) \cdot CF_t}{(1+y_0)^{t+2}}$$

Using these expressions in our Taylor series approximation, we have:

$$dP = \sum_{t=1}^{T} \frac{(-t) \cdot CF_t}{(1+y_0)^{t+1}} d(1+y) + .5 \cdot \sum_{t=1}^{T} \frac{t \cdot (t+1) \cdot CF_t}{(1+y_0)^{t+2}} \cdot d^2(1+y)$$

Or, equivalently

$$dP = \sum_{t=1}^{T} \frac{(-t) \cdot CF_t}{(1+y_0)^{t+1}} d(y) + .5 \cdot \sum_{t=1}^{T} \frac{t \cdot (t+1) \cdot CF_t}{(1+y_0)^{t+2}} \cdot d^2(y)$$

This expression is commonly written as the percentage change in price, or:

$$\frac{dP}{P_0} = \sum_{t=1}^{T} \frac{(-t) \cdot CF_t}{P_0 \cdot (1+y_0)^{t+1}} d(y) + .5 \cdot \sum_{t=1}^{T} \frac{t \cdot (t+1) \cdot CF_t}{P_0 \cdot (1+y_0)^{t+2}} \cdot d^2(y)$$

Now, Duration (*D*) and Modified Duration (*D**) are defined as:

$$D = \sum_{t=1}^{T} \frac{(t) \cdot CF_t}{P_0 \cdot (1+y_0)^{t+1}}$$

$$D* = D/(1+y) = \sum_{t=1}^{T} \frac{(t) \cdot CF_t}{P_0 \cdot (1+y_0)^{t}}$$

Note that while *P'(y)* is negative, Duration has been defined as a positive quantity, so that the derivative is *-D* not *D*, and this must be recognized in the Taylor series approximation when using Duration in the formula.

*Convexity* is defined as:

$$Convexity = \sum_{t=1}^{T} \frac{t \cdot (t+1) \cdot CF_t}{P_0 \cdot (1+y_0)^{t+2}} = \sum_{t=1}^{T} \frac{t \cdot (t+1) \cdot CF_t}{P_0 \cdot (1+y_0)^{2} \cdot (1+y_0)^{t}}$$

Then, using *Modified Duration* and *Convexity*, we can calculate the impact on bond prices of a change in yield as:

$$\begin{aligned} \frac{dP}{P_0} &= -D^* \cdot d(y) + .5 \cdot Convexity \cdot d^2(y) \\ &= -D^* \cdot (y - y_0) + .5 \cdot Convexity \cdot (y - y_0)^2 \end{aligned}$$

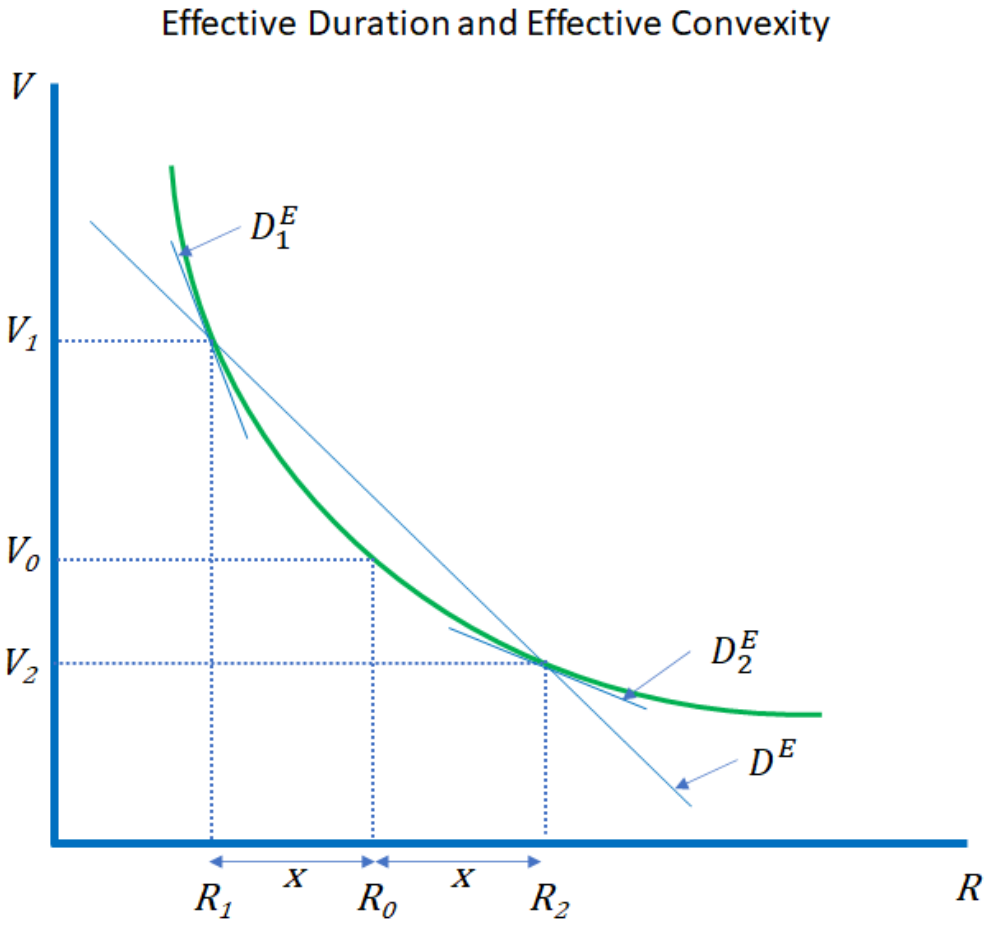
This is the formula that is used to calculate the impact on bond prices of a change in bond yield to maturity.

**Effective Duration**

For certain financial assets (callable bonds and portfolios such as pension fund liabilities) it may be difficult or nearly impossible to calculate duration and convexity as outlined above, where we use formulas involving known cash flows. Instead of using cash flows, there are empirical definitions of duration and convexity that can be used to calculate the impact of a change in bond yields on the value of pension liabilities. The source of these measures of what is called Effective Duration and of what we will call Effective Convexity can be illustrated graphically.

Consider the following graph, which has the value of pension fund liabilities V on the vertical axis, and the interest rate on the horizontal axis. Note that in the prior discussion of Duration and Convexity, the interest rate that impacted bond prices was the yield to maturity on the bond, labeled y. In the current

discussion the interest rate is a measure of the market interest rate, ideally a measure of the level of the term structure. We will label this market interest rate *R*.




The relationship between the value of pension fund liabilities, V, and the interest rate R, is convex, as shown in the graph. Pension funds report the value of liabilities, labeled $V_0$, for a stated interest rate, labeled $R_0$. They also report the value of liabilities of the stated interest rate plus 1%, represented by $V_1$ and $R_1$, and the value of liabilities of the stated interest rate minus 1%, represented by $V_2$ and $R_2$. Given these three data points, we can calculate Effective Duration and Effective Convexity.

Effective Duration is defined as the average slope between points $V_1$, $R_1$ and $V_2$,$R_2$. This is an empirical measure of the first derivative, of

$$D^E = -\frac{\frac{\Delta V}{V}}{\Delta R} = -\frac{\left[\frac{(V_1 - V_2)}{V_0}\right]}{(R_1 - R_2)} = \frac{\left[\frac{(V_1 - V_2)}{V_0}\right]}{(2x)}$$

In this formula, there is a negative sign to define Effective Duration as a positive quantity. Also, in the numerator we employ a midpoint adjustment similar to what is done in calculating elasticity in principles of economics texts. Finally, the change in interest rates is two times the deviation of each rate from the midpoint, hence 2x. Pension funds reporting has x=.01, a one percentage point change.

For Effective Convexity, the calculation involves calculating Effective Duration at point 1 and at point 2, and then calculating how Effective Duration changes with changes in the interest rate. This works by

calculating Effective Duration for a change between point 1 and point 0, and again for a change between point 0 and point 2.

So, Effective Duration for a change between point 1 and point 0 is calculated as:

$$D_1^E = -\frac{\left[\frac{(V_1 - V_0)}{V_0}\right]}{(R_1 - R_0)} = \frac{\left[\frac{(V_1 - V_0)}{V_0}\right]}{x} = \frac{(V_1 - V_0)}{xV_0}$$

Effective Duration for a change between point 0 and point 1 is calculated as:

$$D_2^E = -\frac{\left[\frac{(V_0 - V_2)}{V_0}\right]}{(R_0 - R_2)} = \frac{\left[\frac{(V_0 - V_2)}{V_0}\right]}{x} = \frac{(V_0 - V_2)}{xV_0}$$

Effective Convexity is then the change in Effective Duration as market interest rates change, calculated as follows:

$$C^E = -\frac{\left[\frac{(V_1 - V_0)}{xV_0} - \frac{(V_0 - V_2)}{xV_0}\right]}{(R_1 - R_2)} = \frac{\left[\frac{(V_1 + V_2 - 2V_0)}{xV_0}\right]}{2x} = \frac{(V_1 + V_2 - 2V_0)}{2x^2V_0}$$

With these measures of Effective Duration and Effective Convexity, the impact of a change in market interest rates on the value of pension fund liabilities can be calculated as:

$$\begin{aligned}\frac{dV}{V_0} &= -D^E \cdot (\Delta R) + .5 \cdot C^E \cdot (\Delta R)^2 \\ &= -D^* \cdot (y - y_0) + .5 \cdot Convexity \cdot (y - y_0)^2\end{aligned}$$

## Formula for determining the lifetime annuity in a cash balance plan

Suppose that an employee retiring at age $a$ has an accumulated balance of $V$ in his or her account. Then the employee's actuarially fair lifetime annuity is

$$V = A \cdot \sum_{t=1}^{120-a} \frac{P_{a,j}}{(1+r)^j}$$

where

$$P_{a,j} = (1 - q_{a,1}) \ldots (1 - q_{a,j-1})$$

is the probability of an individual of age $a$ being still alive $j$th year from now (the time of retirement), $q_{a,k}$ is the probability of an individual of age $a$ dying between $(k\text{-}1)$th year and $k$th year from now, and $r$ is the discount rate. According to the convention in annuity analysis and consistent with the risk-free nature of annuity payments, $r$ is set to equal the long-term government borrowing rate.

**Appendix Table 1. Choices by ORP-eligible new hires between TRS and ORP at TAMU (2018 - March 2021)**

| Employment Category | Declined ORP | Enrolled in ORP | Grand Total | % Enrolled in ORP |
|---|---|---|---|---|
| **2018 Total** | **103** | **389** | **492** | **79** |
| Athletic Coaches and Executive Administrative (Chancellors, Presidents) | 7 | 23 | 30 | 77 |
| Faculty Administrator (Deans, Department Heads) | 2 | 8 | 10 | 80 |
| Faculty Member | 90 | 347 | 437 | 79 |
| Other Key Administrators and Professional (Lawyers, Engineers, Physicians) | 4 | 11 | 15 | 73 |
| **2019 Total** | **140** | **341** | **481** | **71** |
| Athletic Coaches and Executive Administrative (Chancellors, Presidents) | 7 | 8 | 15 | 53 |
| Faculty Administrator (Deans, Department Heads) | 2 | 8 | 10 | 80 |
| Faculty Member | 122 | 319 | 441 | 72 |
| Other Key Administrators and Professional (Lawyers, Engineers, Physicians) | 9 | 6 | 15 | 40 |
| **2020 Total** | **107** | **261** | **368** | **71** |
| Athletic Coaches and Executive Administrative (Chancellors, Presidents) | 4 | 6 | 10 | 60 |
| Faculty Administrator (Deans, Department Heads) | 1 | 4 | 5 | 80 |
| Faculty Member | 97 | 247 | 344 | 72 |
| Other Key Administrators and Professional (Lawyers, Engineers, Physicians) | 5 | 4 | 9 | 44 |
| **2021 Total** | **6** | **55** | **61** | **90** |
| Athletic Coaches, Faculty Members and Other Key Administrators | 6 | 55 | 61 | 90 |
| **Grand Total** | **356** | **1,046** | **1,402** | **75** |

Source: We thank Wes Wynn of Texas A&M University's Division of Human Resources and Organizational Effectiveness for providing this information. The faculty member category includes ORP-eligible professional staff.