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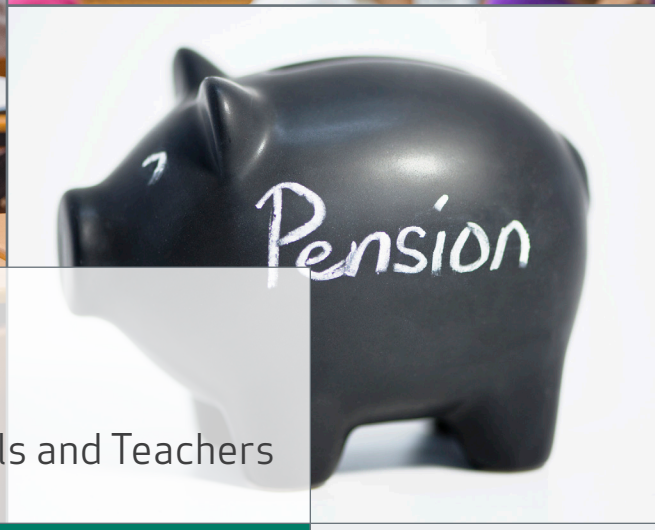

Win-Win:

Pensions Efficiently Serve American Schools and Teachers

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EXECUTIVE SUMMARY

School districts typically offer teachers a defined benefit (DB) pension as part of their compensation. The evidence in this paper shows that DB pension retirement benefits continue to work for both employers and employees. That is, there are good reasons to keep them in place.

DB pensions give employers an effective recruitment and retention tool, due to the way these benefits reward longevity with an employer. The evidence in this report specifically shows that:

- DB pensions create meaningful incentives for effective teachers to stay. DB pensions defer part of an employee's compensation into the future. The longer a teacher stays in their job, the larger the annual retirement benefits they earn becomes. This deferred compensation is an economic incentive for teachers to stay in their jobs. Schools then get the benefit of more experienced and more productive teachers.

DB pensions also offer teachers a real path to retirement security. There are several key aspects of DB pensions that help teachers to accomplish this:

- DB pensions encourage saving for retirement. In particular, DB pensions help all teachers overcome known obstacles to saving for retirement such as putting off saving and saving too little. Every teacher is automatically eligible for benefits, if they meet certain criteria.

- DB pensions boost retirement incomes among lower-income and middle-income teachers. Automatic participation in a DB means that highly unequal tax incentives for retirement savings have only a limited impact on teachers' retirement savings. The data shows that income inequality is less for retirees with DB benefits than for those without DB benefits.

- DB pensions deliver benefits more efficiently than defined contribution (DC) retirement accounts. Each dollar saved in a DB pension provides more retirement income than money invested in an individual savings plan because of lower costs and fewer risks. DB pension benefits thus afford teachers a higher standard of living in retirement than would be the case for the same amount of savings in a DC account.

The public realizes the value that DB pensions offer to employers and employees as they overwhelmingly support these benefits for public sector employees. Continuing to offer DB pensions as a key component of teacher compensation is thus good policy.

INTRODUCTION

School districts typically offer teachers a defined benefit (DB) pension as part of their compensation. As the United States retirement system has changed over time, with many private sector industries moving away from offering DB pensions, some have called for a reevaluation of the efficiency of such retirement benefits in school systems. The evidence in this paper shows that DB pension retirement benefits continue to work for both employers and employees.

DB pensions give employers an effective recruitment and retention tool, due to the way these benefits reward longevity with an employer. Specifically, DB pensions defer part of an employee's compensation into the future. The longer a teacher stays in their job, the larger the annual retirement benefits they earn becomes, relative to their salary. This deferred compensation means that there is an economic incentive for teachers to stay in their jobs. Schools then get the benefit of more productive teachers, as they become better at their jobs with more experience. This has become especially important as wages have eroded more among more experienced teachers than among less experienced ones,[1] which makes it harder for schools to hold onto experienced teachers to begin with.

At the same time, DB pensions offer employees a real path to retirement security. DB pensions help all teachers overcome known obstacles to saving for retirement. Every teacher is automatically eligible for benefits, if they meet certain criteria. DB pensions thus overcome known behavioral obstacles to saving, such as participant inertia. Similarly, automatic participation means that highly unequal tax incentives have only a limited impact on savings. Lower-income teachers likely save more for retirement with a DB pension than in a retirement savings account like a 401(k) plan. Low-income and middle-income teachers end up with more secure retirements in DB pensions because these pensions can overcome well-known and widespread obstacles to more savings for retirement.

DB pensions also deliver benefits to employers and employees more efficiently than other retirement plans, most notably defined contribution (DC) retirement accounts. Each dollar saved in a DB pension provides more retirement income than money invested in an individual savings plan, for two major reasons: lower costs and fewer risks. First, DB pensions pool large amounts of money and invest those amounts over long periods of time. They thus operate with low costs due to the size of the funds, meaning more money goes to investments that eventually generate retirement income instead of fees. Second, DB pensions invest money for long periods of time. They can continuously invest in broadly diversified assets that have greater risk in the short term, but often deliver higher earnings over the long term, for instance, in the stock market. Otherwise, to avoid possible losses that couldn't be made up before they need the money, individual teachers would need to withdraw from the stock market as they near retirement and forego potential earnings and additional retirement income.

Furthermore, DB pensions pay benefits as lifetime streams of income, so that retired teachers will not run out of money in retirement. This means that individual teachers do not have to scrimp during their earlier retirement years to prepare for the—costly—eventuality of living a very long life and running out of money. The pension enables teachers to enjoy higher retirement incomes because a DB pension fund can plan around the average lifetime of teachers, rather than an individual teacher's maximum possible lifetime. Thus, teachers can expect to receive higher retirement benefits for each dollar invested in a DB pension than in a DC retirement savings plan.

The rest of this report is organized as follows. Section II briefly describes the functions of DB pensions and retirement savings accounts from an employers' perspective. This section includes some simulations to illustrate the benefits of DB pensions for employers, discusses the results and backs up the results with the relevant evidence from the literature. Section III then discusses the benefits from DB pensions for teachers, specifically arising from more savings and greater efficiency, using some summary data, illustrative calculations and a review of the relevant literature. Section IV briefly demonstrates that the public understands the value of DB pensions for employers and employees. Finally, section V addresses potential criticisms of DB pensions and concludes.

THE SIGNIFICANCE OF RETIREMENT BENEFITS FOR EMPLOYERS

Retirement benefits are part of teachers' compensation. In large part, schools offer those benefits to achieve labor management goals, such as recruiting and retaining the best people for the job. Having good teachers in schools is a critical component to ensure student success. Teacher retirement benefits are typically DB pensions. Alternatively, employees could receive retirement plans in the form of retirement savings accounts, so-called defined contribution (DC) plans.[2] This section briefly discusses the typical benefit designs and the implications for labor management under DB pensions and DC plans.[3]

Retirement Plan Designs and Annual Benefits

Before going into why DB pensions work for schools as a critical labor management tool, it is first important to see how DB pensions actually work. The typical teacher retirement benefit comes in the form of a DB pension.[4] Teachers receive lifetime benefits upon retirement, based on years of service, age, and their earnings at the end of their teaching careers. They often have to work for at least five or more years before becoming vested, i.e. before they earn any claim to lifetime retirement benefits.[5] Regardless, they are entitled to their own contributions to the plan, if applicable. Since DB pension benefits are tied to teachers' earnings and because teachers, similar to other professionals, have to wait a little while before they fully qualify for benefits, retirement benefits make up a smaller share of total compensation earlier in teachers' careers than in later years.[6]

At the other end of teachers' careers, DB pensions allow an employer to encourage teachers to stay at a particular job longer, but then to retire at an age that is more predictable to the employer (and the teacher) than under DC pensions. One way that DB pensions influence retirement age, making it more predictable, is that they frequently offer early retirement incentives. Teachers, who leave around the early retirement age, a few years before the normal retirement age, will generally get a bump in their lifetime retirement benefits. Although their annual benefits are lower than if they had waited to retire at the normal retirement age, they often receive benefits for a longer retirement than somebody who does not retire early. The annual benefit reduction is smaller—over a teacher's lifetime—than the additional benefits received during those extra years of retirement. Yet, before the early retirement age, teachers earn an extra bump in retirement benefits for each year of service. This encourages them to keep working until at least the early retirement age. This bump, though, disappears after the early retirement age. To be clear, teachers do not lose pension benefits if they choose not to retire early, they just earn smaller additional lifetime benefits after the early retirement age than before.[7] The result is that teachers often maximize their lifetime benefits if they retire at the early retirement age, but end up with the highest annual benefit at the normal retirement age. Assuming that teachers care about the total amount of money they will receive, there is an incentive for them to retire early.

DC retirement accounts constitute an alternative retirement benefit, which sometimes exist as an add-on for teachers, but are rare as primary retirement benefits. With DC plans in the public sector, employees and employers contribute a fixed percentage of earnings each year to a DC plan. Employees also often have to wait until they fully qualify for all employer contributions into a DC plan, although that time period tends to be shorter than in a typical DB pension. Moreover, DC plans typically do not offer normal retirement ages or retirement incentives tied to a specific early retirement age. Teachers by and large receive a flat share of their salary contributed to the plan as retirement benefits, once they are fully qualified, or vested, for all of their benefits. Put differently, teachers receive more compensation with a DC plan earlier in their careers and they receive less compensation later in their careers than under a DB pension.

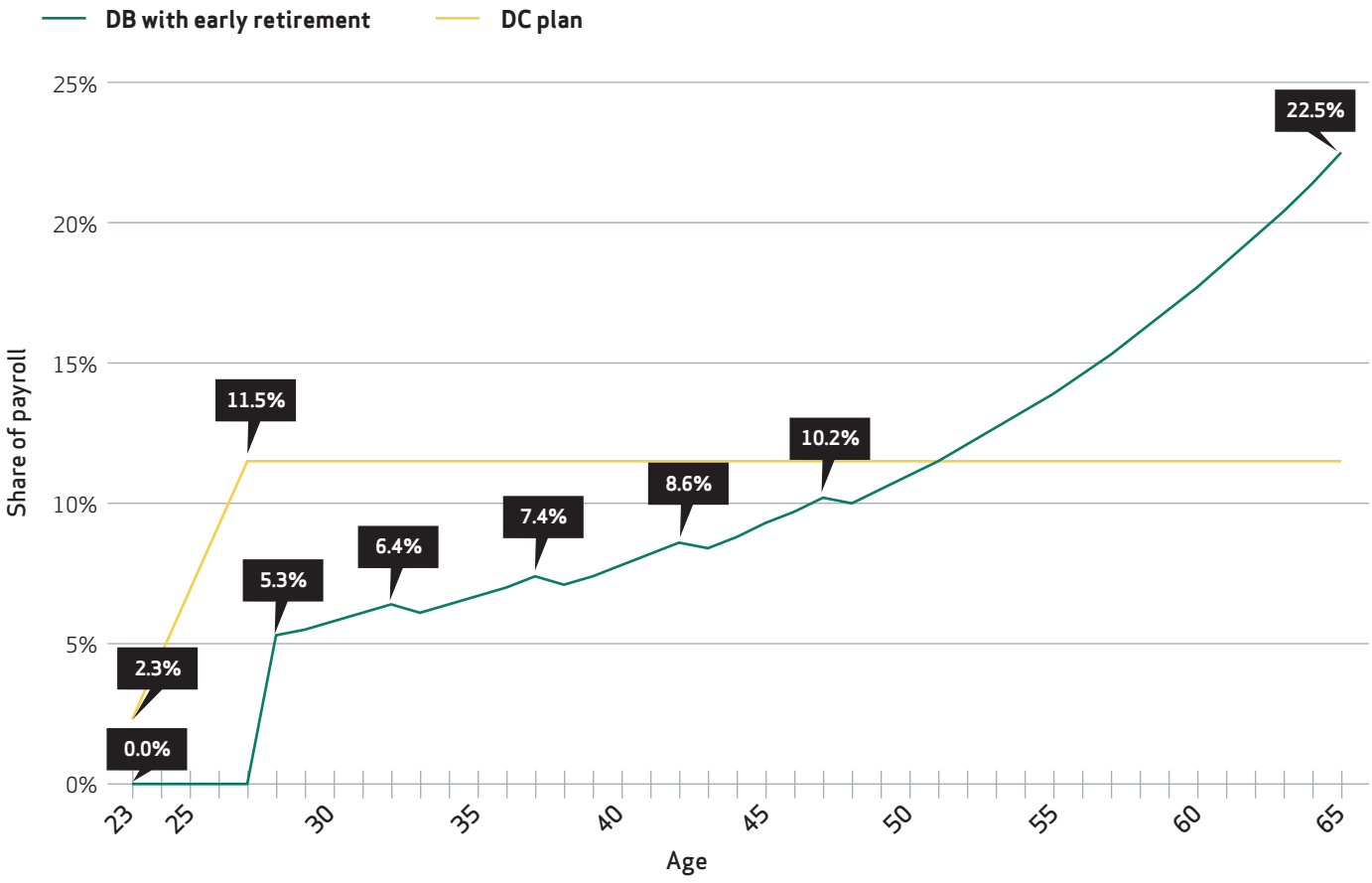
Figure 1 shows illustrative examples of the annual benefit earned by a typical teacher under a DB pension and a DC account.[8] The x-axis shows the teacher's age and the y-axis shows the annual amount of retirement benefits relative to a teacher's salary that she earns with a DB pension and a DC

plan.[9] Teachers earn an increasing amount of retirement benefits relative to their salaries until they become eligible for early retirement, in this example, after 35 years of service. This example assumes that a teacher works for 35 years until age 58 and that she earns 1.5 percent of her final salary each year as a retirement benefit. With a final salary of $60,000, for instance, she would then receive an annual DB pension of $31,500, which is equal to 35 times 1.5 percent times $60,000. She will receive this annual retirement benefit until she dies.

In this example, teachers can still earn additional retirement benefits, if they decide to work past the early retirement age, but the additional annual benefit is, by design, less right after the early retirement age than before this age.

Figure 1 also shows how much a teacher would receive in retirement benefits as a share of their salary in each year of service with a DC plan. The example assumes that teachers have to wait for five years until they are fully qualified or, in pension terms, vested for their benefits. They qualify for an additional one-fifth of their benefits in the first five years, so that they receive the full benefit after five years of teaching. The example further assumes that the total contributions under the DC plan are the same as for the DB pension. The example also implicitly assumes that DC plan participants realize the average rate of return every single year. In other words, employers and teachers do not save more money under either retirement benefit option in this example.

Figure 1: **Annual wealth changes for teacher entering in 2017 relative to earnings, under DB pension and DC plan, constant normal cost**



Notes: All figures are in percent of payroll. See appendix for descriptions of the calculations.

Retirement Plans From A Labor Management Perspective

Because DB pensions offer larger benefits later in a teacher's career than earlier, these retirement benefits offer teachers an incentive to stay in their jobs. DB pensions thus serve as a crucial retention tool.[10] The direct implication for employers is that DB pension plans reduce employee turnover for all employees, not just teachers.[11]

Lower turnover among teachers then translates into, on average, more effective teachers. The literature finds that teachers with just a few years of experience perform much worse than more experienced teachers.[12] Less experienced teachers quickly learn on the job, so that they reach close to their full impact in about ten years of teaching. Recent research even suggests that teachers continue to improve in their effectiveness throughout their careers.[13] Put differently, the effectiveness of teachers throughout their careers follows the path of other professionals. They continuously translate experience into more effective teaching, with the effect being more pronounced early in one's career than later. Employers looking for the best outcomes for their students thus should want to keep dedicated and effective teachers in their jobs as long as possible. DB pensions are a well-worn labor management tool to achieve exactly this outcome. They provide substantially lower turnover among teachers, keeping them in their jobs much longer than more immediate benefits, such as DC plans, do.[14] Even with growing turnover in teachers' early years in the classroom, sizeable percentages of teachers remain in their profession for periods spanning decades.[15]

This doesn't mean that DB pensions have all of the advantages. Compensation shifts to earlier years in teachers' careers with DC plans as compared to DB pensions. This increase in initial compensation would allow schools to attract more effective teachers at the outset. A substantial part of the available literature suggests that, as one would expect, teacher effectiveness increases with teacher pay.[16]

A wholesale switch from a DB pension to a DC plan, as the primary teacher retirement plan, will have two competing effects. It will lower average teacher effectiveness, because it increases turnover, leading a larger number of more experienced—and thus more effective—teachers to be replaced with a greater number of less experienced and less effective teachers. Offsetting this effect, though, is an increase in initial compensation, which allows schools to attract more effective people into the teaching profession. The net effect of these two factors is a priori unclear.

A simple simulation model, based on the existing literature, can help answer which of these factors—turnover or initial pay—will dominate. **Table 1** shows the result of the simulations. With the input assumptions in Table A1, the chance that average teacher effectiveness will increase is only 33.8 percent. There is an almost 2-in-3 chance that average teacher effectiveness will be lower under a DC plan than with a DB pension. On average, teacher effectiveness is 2.5 percent lower with a DC plan than with DB pensions (**Table 1**).

Table 1 also shows several possible alternative scenarios to highlight the limited room for improvement. The first scenario assumes that teacher effectiveness is well above average, in fact, 50 percent higher than the average in the baseline scenario. The chance of improving teacher effectiveness increases to 41.7 percent and the average effectiveness decline is lower with 1.3 percent instead of 2.5 (**Table 1**). That is, even if schools manage to attract extraordinarily effective teachers after a switch to a DC plan, they still are more likely to see average effectiveness decline than increase, relative to a DB pension. Average effectiveness increases, even if initial teacher effectiveness goes up, because more experienced teachers become more likely to leave after the switch to a DC plan.

In the second alternative scenario—Alternative 2—the simulations assume that the initial teacher effectiveness does not go up with the switch to a DC plan. Now, there is only a 20.3 percent chance that average teacher effectiveness increases with an average decline in effectiveness of 3.9 percent, relative to where teacher effectiveness would have been with a DB pension.

Scenarios 3 and 4 show what would happen if turnover increases more than expected or, alternatively, if it does not increase after the switch to a DC plan. The chance that teacher effectiveness goes up exceeds 50 percent only without a turnover change. This is an unlikely outcome, as the literature has repeatedly demonstrated that DB plans increase retention—most recently for teacher plans that offer choices of retirement benefits.[17] Furthermore, a stated goal of switching to a DC plan is to raise turnover among teachers.

Table 1: **Simulation results for teacher effectiveness differences under DC plans compared with DB pensions**

	Probability of improvement relative to DB plan	Average change	Change at 25th percentile	Change at 75th percentile
Baseline: random turnover and effectiveness changes, phased vesting	33.8	-2.5	-5.9	1.4
Alternative 1: random turnover; random, high effectiveness, phased vesting	41.7	-1.3	-5.1	2.5
Alternative 2: random turnover; no effectiveness change; phased vesting	20.3	-3.9	-7.6	-0.7
Alternative 3: random, high turnover; random effectiveness change; phased vesting	23.9	-5.5	-11.1	-0.4
Alternative 4: no turnover change; random effectiveness; phased vesting	84.2	1.8	0.6	3.0

Notes: All figures are in percentages. Changes are relative changes. Based on 1,000 iterations of simulation model described in the appendix.

The five scenarios in **Table 1** hold several important lessons. First, shifting compensation to earlier years holds a very small promise of overall improvements in teachers' effectiveness. The chance that average effectiveness will fall after the switch to a DC plan is substantially greater than the chance that it will increase. The reason for this is both the limited size of the impact of higher pay on teacher effectiveness and the uncertainty surrounding this effect. Second, shifting compensation earlier in teachers' careers could have a positive effect if schools could keep turnover from increasing. But, teacher turnover is a variable that schools can influence only with an effective retention tool, such as deferred compensation through DB pensions. Put differently, turnover will almost certainly increase and thus offset any possible increases in teacher effectiveness from attracting more effective teachers into the profession.

The bottom line is that DB pensions then do exactly what they are supposed to do for schools. They help retain committed teachers for long periods of time, so that schools and students can benefit from teachers' increasing effectiveness. Using DC plans as the primary retirement plan will increase turnover, lower the pool of experienced and effective teachers and thus reduce the average teacher effectiveness.

The simulations likely overstate any possible benefits of DC plans as teacher retirement plans.[18] The simulations, for instance, understate the costs associated with DC plans compared to DB pensions, overstate the impact of retirement benefits on teacher effectiveness and ignore transition costs from DB pensions to DC plans, leave aside continued teacher improvements after the first decade and leave aside the costs associated with higher turnover.

THE IMPORTANCE OF RETIREMENT BENEFITS FOR TEACHERS

DB pensions can help teachers prepare for a decent standard of living in retirement[19] and they can do so more effectively than DC plans can. This is crucial, as Americans generally face a growing retirement crisis. More and more households are unprepared for retirement and will have to make substantial cuts in their standard of living once they retire. The National Retirement Risk Index (NRRI) from the Center for Retirement Research at Boston College (CRR) is one measure of how well working-age Americans are prepared for retirement. The NRRI offers reliable comparisons over time, is based on very detailed wealth and income calculations for each household, and generally errs on the side of overstating retirement preparedness when making methodological decisions. It assumes, for instance, that households will convert all of their savings, including the equity in their houses, into retirement income when they retire. This likely substantially overstates people's actual retirement readiness as most people will not convert their savings into lifetime streams and thus have to plan on their own for the eventuality of running out of money in retirement.

The NRRI shows that the share of working-age adults that are unprepared for retirement has grown over time. While 31 percent of households in 1983 could expect to make cuts in their standard of living in retirement, that share had grown to 52 percent by 2013, the last year for which data are available.[20]

The most recent estimates in the NRRI, based on data from 2013, are below those of other researchers. A report by the National Institute on Retirement Security (NIRS), for instance, finds that 66 percent of households fell short of their savings targets in 2013 using savings levels recommended by the financial service industry and the same data as the NRRI.[21] The NRRI, in comparison, finds that in 2013 only 52 percent of working-age households were at risk of not being able to maintain their standard of living in retirement.[22]

Moreover, the challenge is not just that a lot of Americans are ill prepared for retirement, but that this share has been growing.[23] Even researchers who conclude that lower shares of Americans are ill prepared for retirement, than is the case for the NRRI, generally offer evidence of worsening trends. For instance, a relatively optimistic assessment of retirement income adequacy by researchers at the University of Wisconsin in 2006 found that those born between 1931 and 1941, based on data from the University of Michigan's Health and Retirement Study, had only a 16 percent chance of falling below their optimal savings target.[24] An update of this research, though, in 2009—before the negative effects of the financial and economic crisis of 2007 to 2009 were known—found that 26 percent of households were inadequately prepared for retirement.[25] Moreover, studies that break down retirement preparedness data by age find that younger generations are less prepared for retirement than older cohorts.[26]

The overwhelming evidence suggests that many households are already inadequately prepared for retirement and this problem has been getting worse.

DB Pensions Better Address Obstacles To More Retirement Income Security

The growing retirement crisis follows from several factors. These include low participation in work-based retirement benefits, too few savings in retirement plans, and increasing risks that people need to manage on their own. People are more likely to save for retirement if their employer offers a retirement benefit. Participation in a retirement benefit at work, after all, brings with it a number of important economic benefits such as low costs and tax incentives. Employers also often contribute to their employees' retirement benefits, encouraging saving for retirement. Finally, when people need to manage fewer economic risks on their own, such as large savings amid massive stock market swings during their careers and in retirement, more money will be available to pay the bills in retirement. Put differently, retirement benefits that increase participation, boost contributions, and reduce risks for teachers will ultimately raise retirement income. A review of some of the mechanics and economics of DB pensions shows that they perform better than DC plans on all three dimensions—

participation, contributions and risks. Furthermore, DB plans mitigate retirement income inequality, make it easier to plan when to retire, and may trigger other types of saving.

DB Pensions Increase Participation In Retirement Savings

A lot of employees do not even have access to a retirement plan at work. The latest available data shows that only 51.3 percent of private sector workers had access to a workplace retirement plan in 2013.[27] However, in that same year, 82.4 percent of public sector workers were offered a retirement benefit at work.

Public sector employers, such as schools, are more likely to offer retirement benefits to their employees, than is the case in the private sector for a number of reasons. In a number of states, teachers and other public sector employers are not covered by Social Security, meaning that DB pensions both replace Social Security benefits and add to teachers' long-term economic security. Moreover, public sector employees—which includes teachers, police, firefighters and judges—tend to be more likely to be highly skilled than the workforce as a whole. Given the greater skill demands in the public sector, it is only logical to see more retirement plans being offered there.

But, access to a retirement savings plan is only the first step. Employees also need to participate in a retirement plan to build savings. They need to be enrolled in a DB pension and contribute to DC plans. Only 79.5 percent of private sector workers who had access to a retirement plan participated in it, while 89.3 percent of public sector workers participated.[28] Public sector employees' higher rate of actually participating in retirement plans, when offered, is likely a result of DB pensions being more prevalent in the public sector. In DB pensions, employees are automatically enrolled, as long as they meet certain criteria such as working full time. In comparison, employees typically need to *actively* choose to participate in a DC plan if their employers offer one. This requirement to make a deliberate choice often runs into people's inertia—they delay or forego signing up for this important benefit. DB pensions overcome this well-known behavioral obstacle by automatically signing up every eligible employee. Teachers generally do not have to worry about whether or not to participate in a retirement plan at work.

DB Pensions Boost Retirement Savings Contributions

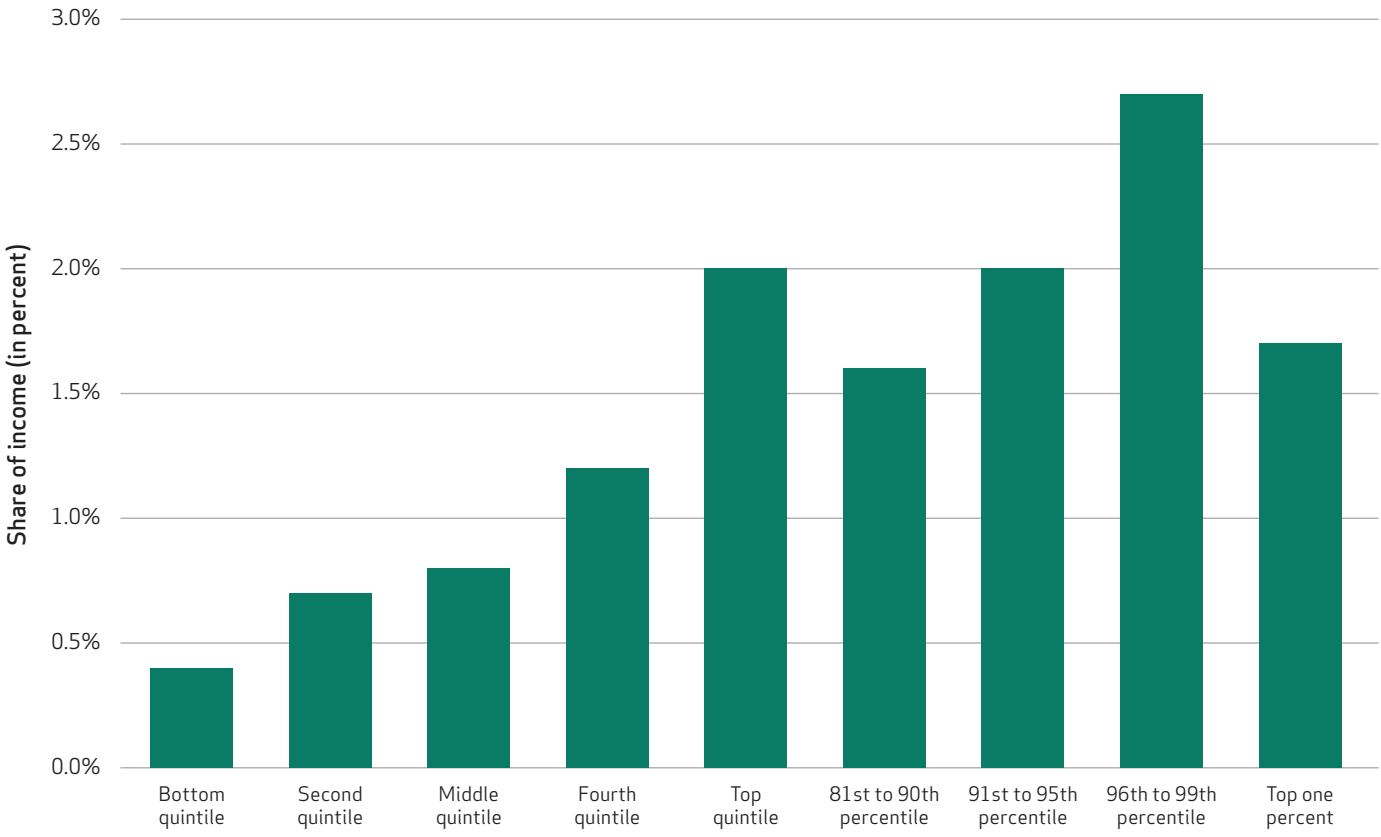
Once people participate, they also need to save enough for their retirement. In DB pensions in the public sector, both employers and employees generally share the cost, with both making contributions towards future benefits.[29] The median employee contribution rate was 6.0 percent in 2015 for state and local government employees who also had Social Security, and 8.1 percent for those who were not covered by Social Security.[30] In comparison, private sector employees typically can choose how much to contribute to a DC plan or they can choose to not contribute at all.

The tax code offers people substantial incentives to contribute to their retirement accounts to make sure that as many people as possible contribute enough for their retirement. These tax incentives come in the form of tax exclusions.[31] Employees who contribute to a 401(k) plan, for instance, do not have to pay income taxes on those contributions, nor are the investment earnings—interest, dividends and capital gains—subject to taxation. Only when people withdraw money from their retirement accounts in the future will they have to pay taxes. Deferring taxes is a substantial economic gain as savings and interest compound tax-free for years and often decades.[32]

These tax incentives, though, provide the most help to people who need it least. The tax incentives are directly tied to people's marginal tax rates—the taxes they pay on the last dollar earned. Higher marginal tax rates mean greater tax incentives to save money. Because income taxes are progressive, marginal tax rates—and thus savings incentives—are higher for higher-income earners than for lower-income earners (**Figure 2**).[33] Middle-income and lower-income earners receive smaller savings incentives and in some cases, if their income is too low, they may not receive any incentives at all.

Finally, teacher pensions make it easier to keep money in a retirement plan for retirement. In most cases, teachers cannot access their retirement benefits before they are retired. Only one state allows teachers to take out their own contributions in a pension plan, but there are limits in doing so to ensure as much money as possible goes towards retirement security.[35] In comparison, people can often access their account balances in a DC plan by taking out a loan from their own DC account and by withdrawing money—and incurring both tax and

Figure 2: **Share of net tax benefits out of income in 2013, by income**



Source: Congressional Budget Office, "The Distribution of Major Tax Expenditures in the Individual Tax System," Table 2, 2013.[34] All figures are in percent of income.

penalties while they are still working for or after they leave their employer. In fact, the U.S. system makes it difficult for people to take DC plan money from one employer to another, thus often unwittingly leading people to deplete their retirement savings when they switch jobs.[36] In contrast, teacher pensions effectively ensure that most of the money meant for retirement will go towards retirement benefits and nearly all teacher retirement systems allow teachers to buy additional service credits that will increase retirement income, for example, based on service in other states.

Most employees face both behavioral obstacles and ill-targeted savings incentives when making a decision to save with a DC plan. In DB pensions, especially in the public sector, teachers do not have to decide on whether and how much they should contribute for their retirement. They are automatically enrolled and thus automatically contribute at the established contribution rate and can make additional retirement savings through other savings vehicles. Behavioral obstacles and inefficient tax incentives matter a lot less in DB pensions than with DC plans.

Retirement savings also go a lot further in terms of creating retirement income in DB pensions than is the case in DC plans. Put differently, DB pensions are more efficient at turning savings into retirement income. One of the primary factors is that DB pensions pool money rather than investing it through a lot of small accounts, as is the case with DC plans.

This pooling of money lowers fees and increases professional management of assets. The resulting difference in retirement income due to lower fees and professional management of assets in DB pensions compared to DC plans is an estimated 27 percent of retirement income.[37]

DB Pensions Manage Risk And Efficiently Convert Savings Into Retirement Income

The other reason DB pensions can more effectively turn savings into retirement income is that they can better manage economic risks than a large number of individual accounts in a DC plan can. These risks are market risk or the risk of a prolonged bear market on Wall Street, idiosyncratic risk or the risk of making unlucky or unwise decisions and thus foregoing higher rates of return, and longevity risk or the risk of outliving one's savings. DB pensions can effectively protect teachers from those risks, while they would need to face them on their own in DC plans.

Consider stock market risks first. The stock market has experienced large up and down swings over the past several decades.[38] Importantly, these stock market cycles follow a pattern. A prolonged bull market of good years is followed by a prolonged bear market of lean returns.[39]

This somewhat regular up and down on the stock market is good news for DB pension plans. They can more or less count on recovering many of the losses from a market downturn in subsequent market upturns. Offsetting bad years with years of good returns, though, only works if DB pension plans can expect to be around for long periods of time. There is no reason to think that DB pension plans for teachers would not be around for extended periods of time given the protections in state law, unlike pension plans in industries that have experienced a secular decline such as coal mining. With a long-term investment horizon, DB pensions can thus smooth the ups and downs of financial markets by investing in riskier assets and generating higher rates of return over long periods of time than is the case for DC plans. **Figure 3** shows the long-term averages on the stock market, based on the Standard and Poor's composite stock index. The line with the larger swings represents inflation-adjusted average earnings over 20-year periods, while the more stable line shows average earnings over 50-year periods. Public sector pensions have a much longer planning horizon than individual DC plans and so the more stable line represents their performance.

DB pensions also save money relative to DC plans due to a related effect. Because individuals with a DC plan face a more or less fixed date of retirement, they will eventually need to withdraw their money from risky investments, particularly in the stock market. But, riskier investments offer on average larger rewards over long periods of time. People thus forego higher returns in exchange for the certainty of having their money available when they retire. DB pensions, though, do not have to leave the stock market as the money paid to retired teachers is replaced with the contributions of newly hired teachers.

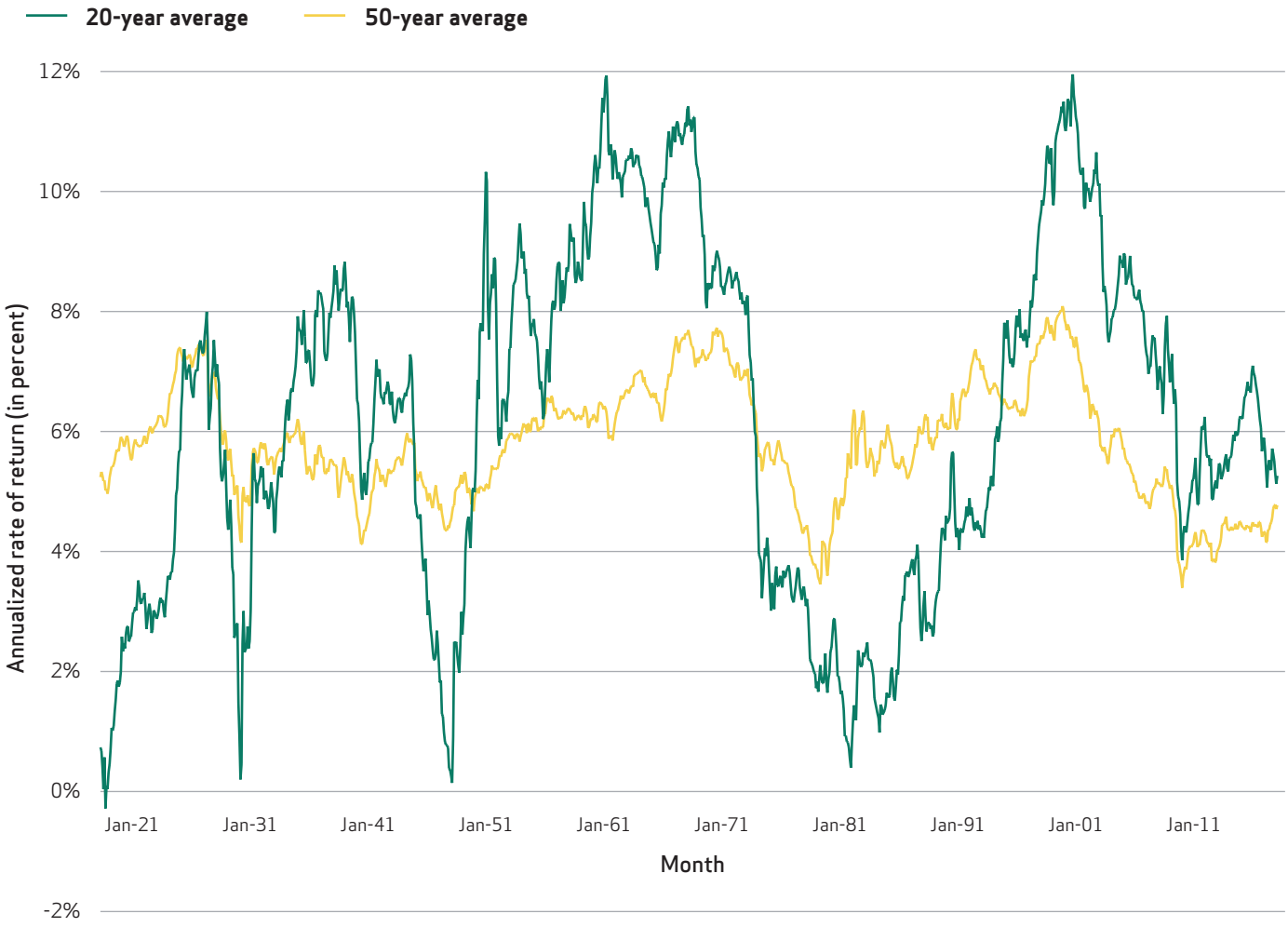
The combination of these two effects means a longer investment horizon for DB pensions than for DC plans, which means they can maintain a steady share of investments in stocks. This difference in investment horizons—short vs long—means that DB pensions save another 11 percent of retirement income relative to individual accounts in DC plans.[41]

The fact that DB pensions have a very long investment horizon provides a third advantage over DC plans. They can pay out lifetime streams of benefits—annuities—from their existing pool of money without changing their overall investment strategies. They can continue to invest in the stock market while paying retirement benefits. After all, they also receive current contributions from active teachers. DB pensions can thus plan on paying annuities for each retired teacher for the average life expectancy and no teacher will outlive their retirement benefits.

Contrast this with the situation in DC plans. Here, each individual needs to plan for the maximum life expectancy to avoid running out of money since they obviously don't know how long they will live.[42] But, the difference between the average life expectancy—the planning horizon of DB pensions—and the maximum life expectancy—the planning horizon of DC plans—is substantial.

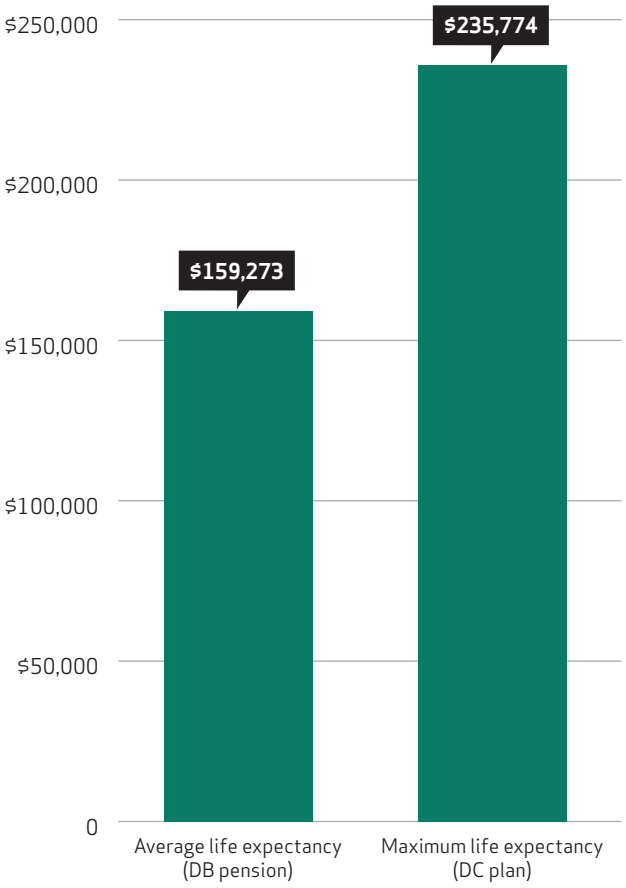
Consider the following illustrative example. The average life expectancy for somebody who reached age 65 in 2012 was 19.3 years.[43] That is, somebody who retired that year at age 65 could expect to live to age 84 on average. But, in that same year, a small percentage of people who reached age 65 could potentially live another 37.3 years, to age 102. Put differently, the maximum life expectancy is about twenty years longer than the average life expectancy.

Figure 3: **20-year and 50-year stock market average real returns**



Notes: Author's calculations based on R.J. Schiller, 2015.[40] Average earnings are the sum of capital gains and dividend payments relative to current prices. Changes are inflation adjusted.

Figure 4: **Wealth necessary for monthly inflation-adjusted retirement income of $1,000 when planning for average and maximum life expectancy**



Notes: Author's calculations based on E. Arias, M. Heron and J. Xu, 2016.[45] The assumed nominal rate of return is 7.0 percent and the assumed inflation rate is 3.0 percent.

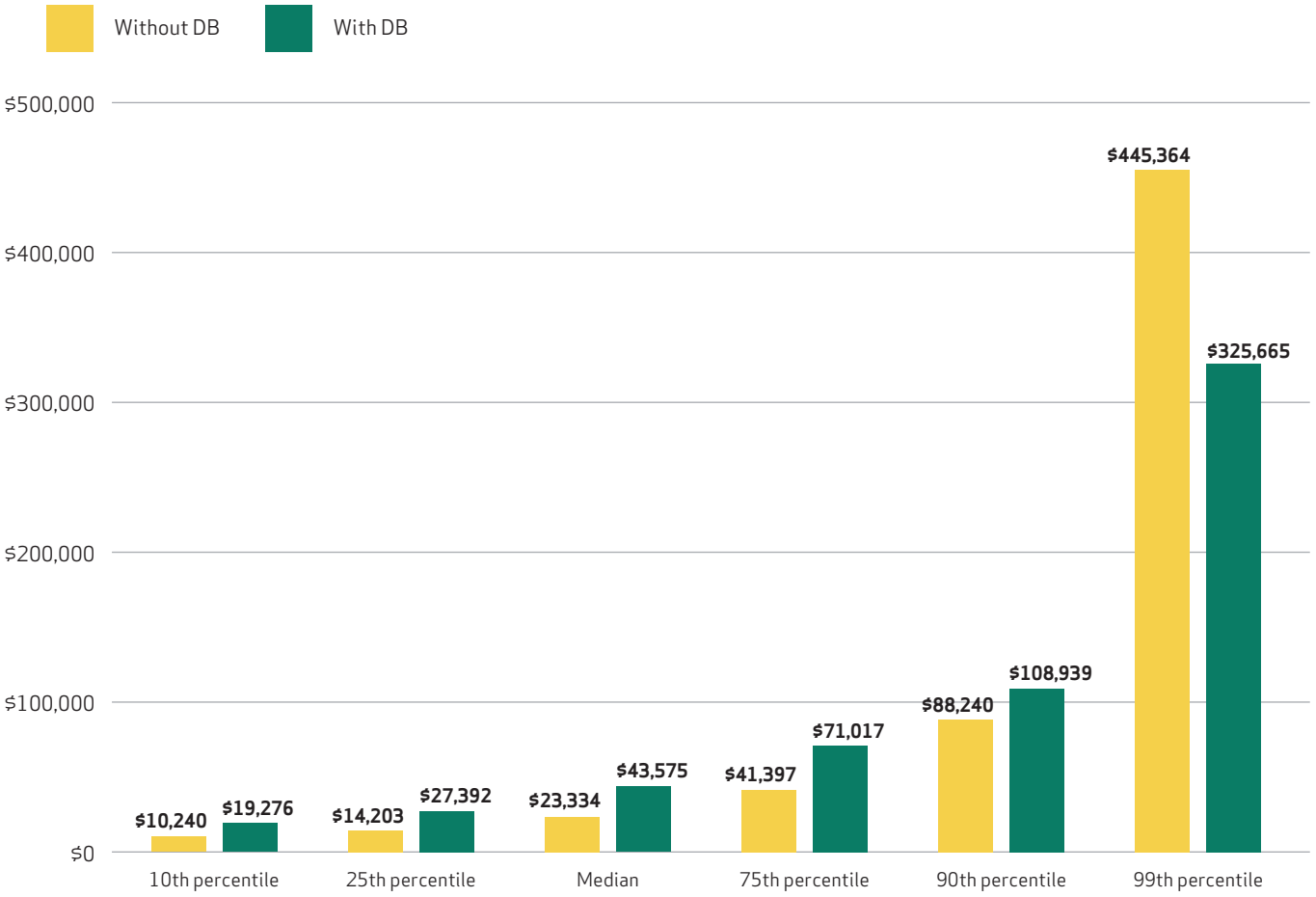
This gap in the life expectancy that teachers would need to plan for—average or maximum—under different retirement plans translates into nontrivial differences in the amount of savings one needs to have. An individual planning for average life expectancy would need to set aside $159,300 to generate a monthly income of $1,000 that increases with annual inflation (**Figure 4**). This is basically the amount the DB pension described earlier would need on hand by the time the individual retires. In comparison, an individual with a DC plan would need to set aside $235,800 to have $1,000 each month until she possibly reaches age 102.3 years.[44]

DB Pensions Lead To More Equity In Retirement

The difference in the way contributions to DB pensions and DC plans are handled is reflected in the distribution of these benefits. Generally, DB pension wealth is more equitably distributed than DC plan assets.[46] Also, people with DB pensions are a lot less likely to experience poverty and economic hardships, such as not being able to pay for medical expenses, than people without DB pensions.[47] Basically, middle-income earners, such as teachers, fare better in terms of savings with a DB pension than with a DC plan.

Figure 5 shows that wealth is more equally distributed among retirees that have a DB pension than among households that do not have a DB pension in retirement. Basically, retirement incomes are higher among lower-income retirees with DB pensions than among low-income retirees without DB pensions. This is true for all income groups up to the top one percent. Only among the top tier retirees are incomes greater for those without DB pensions than for those with DB pensions.

Figure 5: **Inflation-adjusted retiree income at select percentiles from 2010 to 2013**

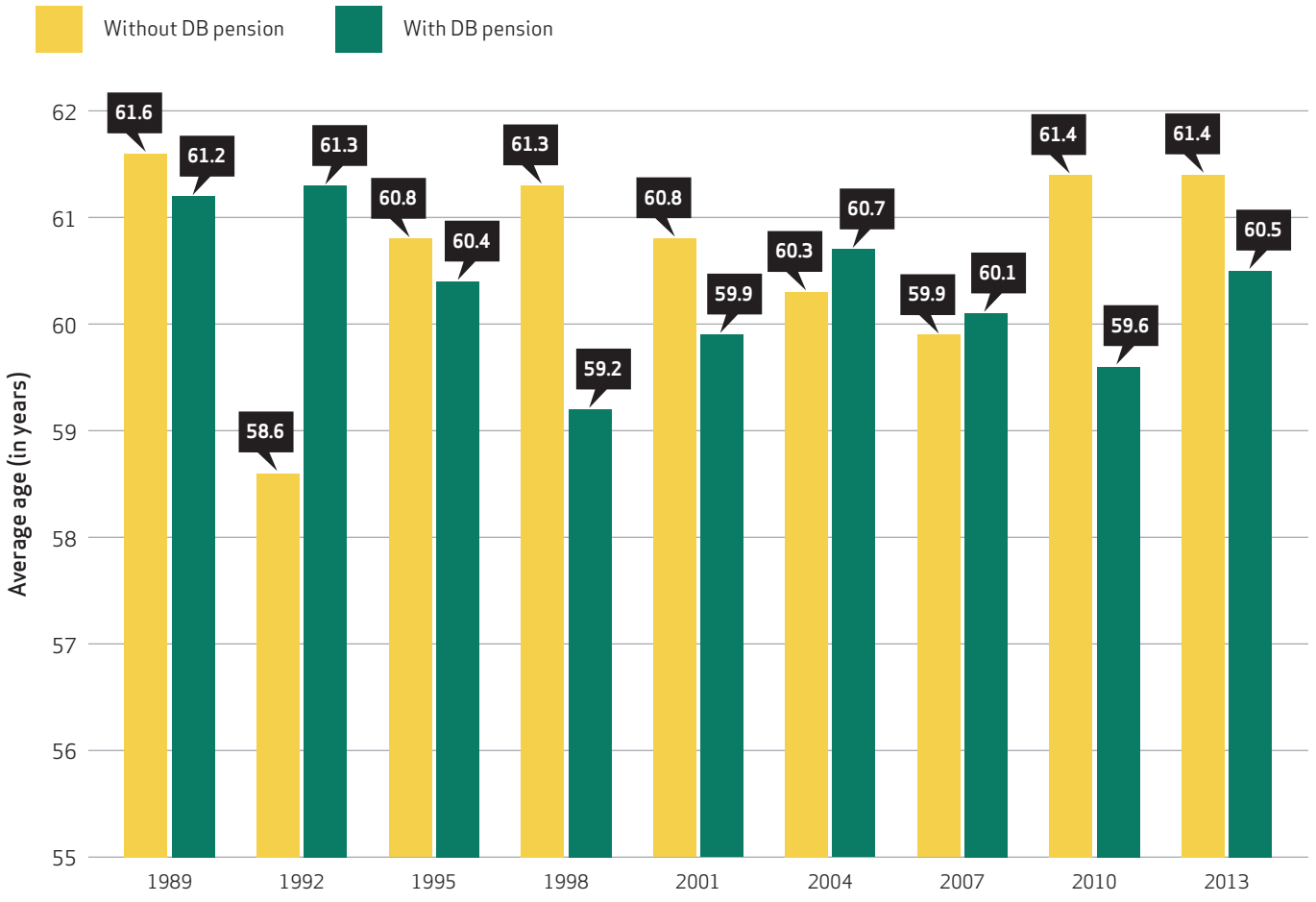


Notes: Author's calculations based on Board of Governors. Federal Reserve System. Various years. Survey of Consumer Finances. Washington, DC: Fed. Data are in 2013 dollars. Numbers deflated by Consumer Price Index for Urban Consumers, Research Series (CPI-U-RX). Sample includes only retired households. DB pension coverage refers to having a DB pension from a prior or current job.

DB Pensions Allow For More Planned Withdrawal From The Labor Market

Another potentially beneficial aspect of DB pensions for teachers lies in the predictable nature of DB benefits. Because teachers can reasonably predict the amount of retirement benefits they will receive upon retirement and during retirement, they can also plan their retirement around other goals, such as volunteering and spending time with family.[50] **Figure 6** shows the average retirement age for people with DB pensions and those without DB pensions in retirement. Generally, people with a DB pension tend to retire somewhat earlier than people who do not have a DB pension (**Figure 6**). And, over time, the retirement age changes less among people with DB pensions than among people without a DB pension.[51] The predictable nature of benefits and the resulting planned pathway into retirement is the flip side for employees of DB pensions as a labor management tool for employers. Schools, like other employers, need to manage their labor force in a predictable fashion, which means fewer worries for teachers about what their retirement income will look like than would be the case with DC plans.

Figure 6: **Retirement age by defined benefit pension coverage**



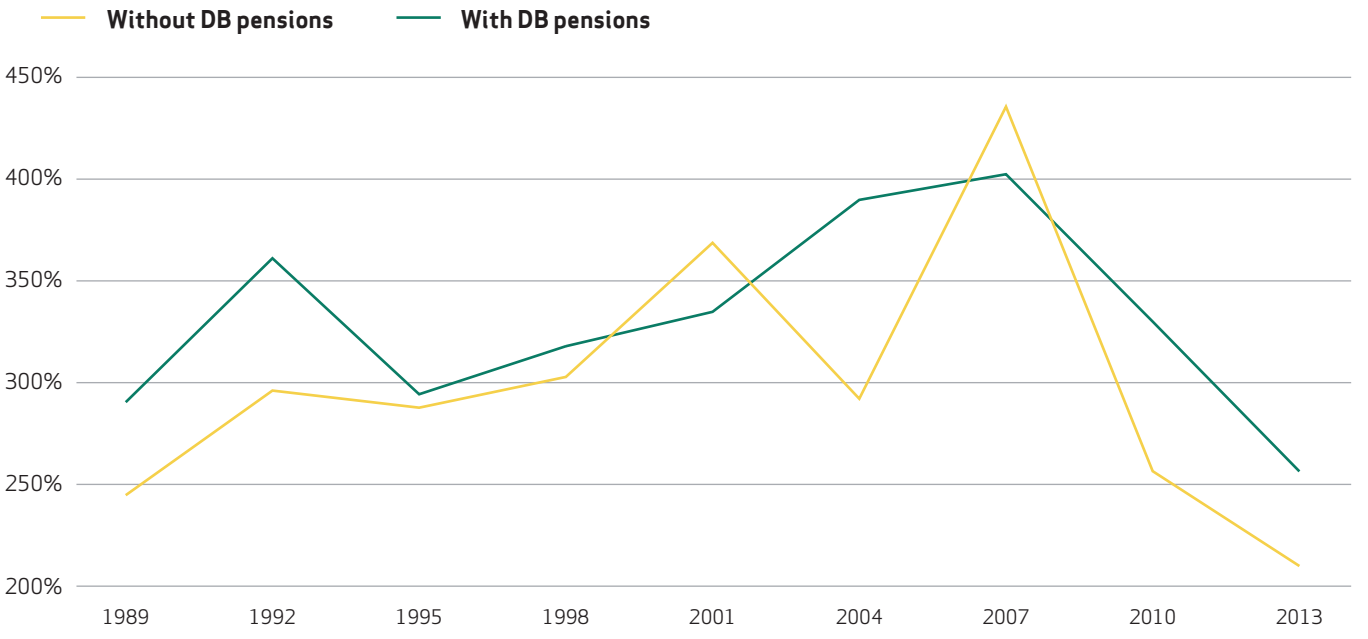
Notes: Retirement refers to full retirement. Retirement age for 1989 and 1992 calculated as the age during the survey year minus the difference between the survey year and the year of retirement. Retirement age for all other years is given by survey respondents. Retirement age refers only to head of households. Author's calculations based on Board of Governors. Federal Reserve System. Various Years. Survey of Consumer Finances. Washington, DC: Fed.

Possible Spillover Effects To More Savings

Households with DB pensions tend to end up with slightly more total marketable wealth—not counting wealth in DB pensions—relative to income in most years as compared to those without DB pensions near retirement, defined here as ages 55 to 64 years (**Figure 7**). This is surprising as households without DB pensions need a lot more wealth to achieve the same level of retirement security as households with DB pensions. Moreover, people with DB pensions also contribute, explicitly and implicitly through lower wages, to their DB pensions, making saving in other forms harder.

But, it is possible that DB pensions give people a sense of economic security that they wouldn't have without this retirement benefit. They can rest more easily, focus more on the long-term and thus save more for the future. People with DB pensions, for instance, had a 14.4 percent chance of having a planning horizon of more than five years in 2013, compared to 11.7 percent for people without a DB pension—a gap of more than 20 percent. And, people with DB pensions also indicated that they save regular or irregular amounts at a rate of 58.5 percent, compared to only 44.3 percent for people without DB pensions.[52] Households with DB pensions, such as those with teachers, not only have access to more effective ways to build retirement security, but they also build as much non-retirement wealth as households without DB pensions, because of the economic security that DB pensions provide.

Figure 7: **Wealth to income ratios for households without and with DB pensions, 1989 to 2013**



Notes: Author's calculations based on Board of Governors. Federal Reserve System. Various Years. Survey of Consumer Finances. Washington, DC: Fed. Marketable wealth is the difference between retirement assets, other financial assets, real estate and business ownerships minus any debt. All dollar figures expressed in 2013 dollars.

PEOPLE UNDERSTAND AND APPRECIATE THE VALUE OF DB PENSIONS

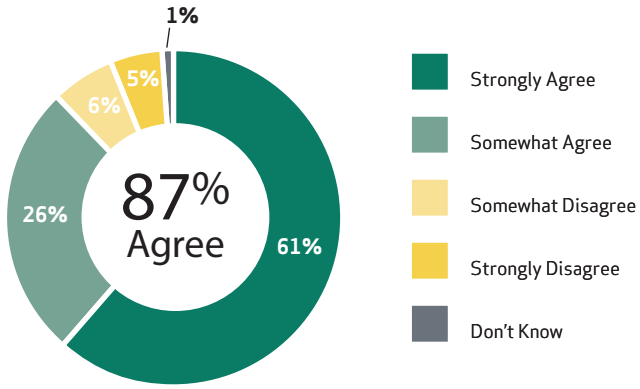
People generally appreciate the role of DB pensions as a key tool to recruit and retain skilled and committed public sector employees, such as teachers. In fact, a stunning 87 percent of Americans indicated in 2015 that they thought DB pensions were a good way to recruit and retain public sector employees, such as teachers, police and firefighters (**Figure 8**). This number is less surprising when considering that 82 percent of respondents had favorable views of DB pensions (**Figure 9**). Respondents valued having retirement benefits at work as much as earning a good salary, with roughly three-quarters of Americans saying both are important to them. Furthermore, 67 percent of respondents in the same survey said that they would be willing to give up part of their salary for guaranteed income in retirement—one of the features of DB pensions most valued by people.[53]

Importantly, people inherently understand the value that DB pensions offer, as compared to DC plans. In 2017, 71 percent of Americans said that DB pensions do more to help people achieve a secure retirement than DC plans, 77 percent said that the disappearance of DB pensions made it harder to achieve the American Dream and 85 percent indicated that all workers should have a pension to be self-reliant in retirement.[54] People favor DB pensions because of professional management and thus presumably lower costs, better managed risks, and higher rates of return. They also value guaranteed streams of income in retirement.[55]

These survey data highlight several key points. First, people inherently understand the role that DB pensions play in the public sector for employers. Second, people think that those benefits are a good example for themselves, suggesting that they also understand the value that DB pensions offer teachers and other public sector employees.

Figure 8: **87% of Americans Say Pensions Are Good Tool to Recruit Teachers, Police, Firefighters**

Are pensions a good way to recruit and retain qualified teachers, police officers and firefighters?



Source: D. Oakley and K. Kenneally, "Retirement Security 2015: Roadmap for Policy Makers—Americans' Views of the Retirement Crisis," NIRS Report, National Institute on Retirement Security, Washington, DC, 2015.

Figure 9: **Americans overwhelmingly maintain a favorable view of pensions.**

How would you describe your overall view of traditional pension plans?

Source: D. Oakley and K. Kenneally, "Retirement Security 2017: Roadmap for Policy Makers—Americans' Views of the Retirement Crisis and Solutions," NIRS Report, National Institute on Retirement Security, Washington, DC, 2017.

DISCUSSION AND CONCLUSION

DB pensions meet important societal goals. They allow schools to recruit and retain teachers, thus reaping the rewards of increasing effectiveness over teachers' careers. This, in extension, provides a benefit to taxpayers because it encourages more effective teachers to remain teaching, which is crucial to positive education outcomes. At the same time, DB pensions help teachers effectively and efficiently build retirement security. Relative to DC plans—such as 403(b) accounts—DB pensions better equip employers and employees to achieve these goals of labor management and retirement security.

None of this is an accident. Public sector DB pensions, including Social Security, have historically emerged out of the confluence of two separate social policy tools.[56] On the one hand, governments created back-loaded benefits, especially for people in the military and public safety, to recruit professionals and ensure a long-term commitment. On the other hand, governments created new social protections, specifically old age assistance programs, as industrialization put an end to multigenerational family units. Today's public pensions have combined these two functions—first, professionalism and long-term commitment to public service and, second, protections against old age poverty—and expanded them to all public sector workers.

Achieving both labor management and retirement security goals simultaneously requires some tradeoffs. Most importantly, employers typically backload pension benefits through vesting requirements and final average pay formulas to achieve their labor management objectives. But, this also means that those teachers with shorter tenure and less long-term commitment to the profession receive relatively fewer benefits than teachers with longer careers.

Replacing DB pensions with DC plans would not change this tradeoff.[57] In fact, many employers in the growing information technology sector offer stock options, where employees have to wait for several years before they receive the full benefits, as a way to recruit and retain skilled workers.[58] If schools replaced DB pensions with DC plans, they could not offer stock options and thus, would have to find another way to backload the DC plans. This can be done, for example, through long vesting requirements. Otherwise, DC plans would weaken schools' ability to recruit and retain effective teachers as employee turnover would go up. For this reason, like DB pensions, DC plans often feature waiting periods and vesting requirements, again creating a tradeoff between encouraging longevity and giving short-term employees the same access to benefits.[59] However, once a teacher is vested, the DC plan provides little incentive to remain in the classroom—especially in mid-career when the loss of an effective teacher could have a substantial impact on average teacher effectiveness. Likewise, the market swings of assets, such as stocks, in DC plans may cause older workers to delay retirement in the face of sudden large losses.

DC plans are also less efficient in achieving retirement income security than is the case with DB pensions. And, the potential adverse effects on teachers' retirement security for those who leave early is limited as teachers can often roll over their own past contributions to other retirement plans. That is, schools would have to substantially increase their contributions to DC plans to achieve the same level of retirement security for all of their employees that DB pensions would provide.

Just because teacher pensions generally work well for both employers and employees doesn't mean that they do not have their problems. Most importantly, public sector pensions have struggled with underfunding—a shortfall of how much money plans have available relative to what they owe to their beneficiaries.[60] Importantly, states and localities have taken steps to address the underfunding and, therefore, it has stabilized in recent years.[61] This includes states contributing more to make up for the shortfalls in recent years.[62] Unfortunately, states have also chosen to address pension underfunding by reducing benefits, for instance, by reducing annual cost-of-living adjustments (COLAs).[63] As a result, while teacher pension benefits have become more stable over time, this stabilization has occurred at somewhat lower benefit levels than were previously available.

States pursue a combination of increased contributions and lower benefits in part because replacing DB pensions with DC plans is not a solution, as much of this report already discussed. First, states still have to fill the funding gap as teachers have already earned those benefits.[64] Second, states would lose an important labor management tool if they replaced DB pensions with DC plans. Third, states would have to contribute more for their employees to achieve the same level of retirement security. In states where DC accounts have been added when DB benefits were reduced, employees have not increased their retirement savings to the level needed to reach the earlier level of retirement security provided by the original DB pension.[65] That is, replacing DB pensions wholesale with DC plans would likely substantially worsen the economics for schools and teachers.

Teacher pensions offer benefits to both schools and teachers and do so more efficiently than alternative retirement benefits, such as DC plans. The long-term challenge is to maintain these crucial benefits on a sustainable basis, for instance by, improving states' pension funding through continued increases in employer contributions.

APPENDIX

A.1 The model of retirement plans and teacher effectiveness

The text shows a few key simulations on the link between retirement plans and teacher effectiveness. Teacher effectiveness in their first year on the job is a function of teacher compensation:

$$p_{i1} = F(s_1(CONT); x_i; y_j) \quad (1)$$

where p_{i1} is the effectiveness of teacher i in her first year. It is positively correlated with initial compensation, s_1, which depends in part on retirement benefits, specifically the amount by which annual retirement wealth increases, denoted here by *CONT*. It also depends on a number of individual characteristics, x_i, and work environment, y_i. The simulations here are akin to a regression, where the effect of benefits on key variables that impact teacher effectiveness is measured, while other factors stay constant. Assuming that individual characteristics are randomly distributed in each teacher cohort, they can be eliminated in the calculation of the average teacher effectiveness, given the associations between teacher attributes and effectiveness.[66] Basically, the simulations ignore teachers' individual characteristics as determinants of average effectiveness. And, the simulations consider effectiveness changes under potentially varying benefits in a given state. The work environment is likely independent of retirement benefit designs and thus is also excluded from the simulations. That is, the key variable that matters is the annual contribution to retirement benefits that each teacher can expect.

Annual Retirement Wealth Increases

Crucial for the simulations are annual retirement wealth increases with DB pensions and with DC plans. Examples of those numbers, relative to a teacher's annual salary, are also shown in **Figure 1** to illustrate the patterns under which teachers receive benefits over their careers.

The simulations first calculate how much employers have to contribute to a DB pension plan for a typical teacher workforce and then calculate what percentage of earnings employers could pay for a DC plan, while holding the total costs for employers constant.

Annual retirement wealth increases under a DB pension for an employee i in any given year t, denoted as $CONT_{it}$, are positively related to her or his tenure, ten_i, and the retirement plan's earnings, ror_t, but negatively related to the plan's costs, $fees_t$, and to employee turnover, to_i:

$$CONT_{it} = NCOST_{it}(ten_i; ror_t; fees_t; to_i) \quad (2)$$

The simulations assume that the annual retirement benefit is equal to the so-called normal cost for the employer. This is the amount that the employer theoretically has to set aside to pay for the promised benefits in the future. The normal costs are denoted by $NCOST_{it}$.

The annual benefit is equal to zero if a teacher is not yet vested, i.e. her tenure is less than the minimum years required, *tmin*:

$$CONT_{it} = 0 \quad \text{if teni<tmin} \quad (2a)$$

The annual benefit or normal cost for vested employees is:[67]

$$CONT_{it} = \frac{a * salary_{it} \prod_{j=t}^{T} (1 + sg_{ij})}{(1 + r_t)^{(T-t)}} * P(\mathrm{Re}\, tAge \mid age_i) * AF \qquad \text{if ten} \geq \text{tmin} \qquad (2a')$$

The benefit is the product of a multiplication factor, *a*. Teachers usually receive a benefit as an additional percentage, for instance 1.5 percent or 2.0 percent, of their final salary per year of service. The total cost also depends on the expected final salary for the teacher, the probability of surviving in the job to the retirement age, *P(RetAge|age)*, the annuity factor, *AF*, and the inverse of the discount factor $(1+r)^{(T-t)}$, to arrive at the present-day value of the future benefit. The final salary is the current salary, $salary_t$, grown to the final year of service, *T*, at the annual salary growth rate, sg_{it}. The salary growth rate is a combination of step increases and future inflation. And, the annuity factor, *AF*, is the amount that a pension plan will need at age 65 to pay one dollar each month to the teacher for the rest of her life.

We assume a typical teacher DB pension.[68] Vesting happens after five years. We also assume a multiplication factor of 2.0%, slightly above the average multiplication factor in teacher pensions.[69] A higher multiplication factor raises a plan's normal cost, making more money available for retirement benefits and leading to greater jumps in initial teacher compensation as a result of changing benefits than a smaller factor would. We further assume that benefits increase with inflation equal to 2.5% annually. A lower inflation rate would decrease the normal cost. We next assume full benefit receipt after working for 35 years as early retirement benefit. We also set a nominal discount rate of 7% per year. A higher discount rate reduces the normal cost. And, we derive the annuity factor for the DB pension from the mortality assumptions in the RP-2014 mortality tables by taking the average of women's and men's mortality rates.[70] We calculate an annuity factor of 13.32 at age 65. Finally, we assume a starting salary of $45,000 in 2011 and a salary schedule following the steps of the North Carolina school system.[71] We assume that the salary steps increase with inflation. Alternative salary schedules have no material effect on our simulations as our estimates depend on initial salary changes following benefit changes, not on the subsequent salary progression.

Annual retirement benefits for DC plans are:

$$CONT_{it} = 0.2 * ten_i * b * salary_{it} \qquad \text{if teni<tmin} \qquad (2b)$$

And

$$CONT_{it} = b * salary_{it} \qquad \text{if teni} \geq \text{tmin} \qquad (2b')$$

The teacher earns a fixed share of her salary, *b*, after vesting and a reduced share before full vesting. The simulations assume that the benefit is linearly phased in over five years.

The simulations also assume that DC plans incur higher fees than DB plans, equal to one percent of assets each year.[72]

Teacher experience

Next, the simulations need to calculate the average teacher effectiveness over all teachers. This requires modeling teacher effectiveness after their first year. A learning curve for teachers captures the impact of teacher experience on their effectiveness:

$$p_{it} = \alpha ten_i + \beta F(x_i; y_i) \qquad \text{if t>1} \qquad (3)$$

The tenure coefficient, α, is defined as follows:

$$\alpha > 0 \qquad \text{if } T>1 \ \& \ T<tmax \tag{3a}$$

$$\alpha \quad \alpha = 0 \qquad \text{if } T \geq tmax \tag{3a'}$$

where *tmax* denotes the first year a teacher reaches her maximum effectiveness, which then stays constant for the remainder of a teacher's career.[73]

The combination of equations (1), (2), and (3) generates a state's average teacher effectiveness:

$$\overline{p} = \frac{\sum_{t=1}^{T} \overline{p}_t N_t}{N} \qquad t=1,\ldots,T \tag{4}$$

where N_t is the number of teachers in a given career year and N is the total number of teachers in a state. The average teacher effectiveness is lower with a steeper learning curve. A larger share of less experienced teachers lowers average effectiveness since a larger number of inexperienced teachers will be multiplied by a lower average teacher effectiveness than if the share of less-experienced teachers is smaller.

Teacher turnover

The calculation of equation (4) requires some definition of teacher turnover to arrive at the number of teachers that are still left in each career year. Each year's level of teacher employment after the first year is the total number of employees divided by the number of teacher cohorts and multiplied by the cumulative turnover for each cohort, to_k:

$$N_t = to_k \frac{N}{(age\max - age\min)} \qquad \text{if (agemax-agemin)>1} \tag{5}$$

And, first-year employment is:

$$N_1 = N - \sum_{t=2}^{T} N_t \tag{5'}$$

All leavers are replaced by new hires into the first-year cohort. Cumulative turnover at any given year is the product of each year's turnover specific to that year of a teacher's career:

$$to_t = \prod_{k=age\min}^{t} to_k \tag{6}$$

And, the annual turnover is positively correlated with future expected compensation:

$$to_k = F(age_t; comp_t; y_j) \tag{6'}$$

where to_t is the cumulative turnover at period t, depending on *age* and future compensation.

Teacher Effectiveness

The simulations normalize average teacher effectiveness. Maximum teacher effectiveness under a DB pension is equal to 100%. The average teacher effectiveness at any year in a career is expressed as share of the maximum effectiveness under a DB pension.

The simulations do not depend on a specific effectiveness measure. The design of retirement benefits may affect average teacher effectiveness, but retirement design does not impact how effectiveness is operationalized.

Benefit Plan Descriptions

The simulations are based on a hypothetical DB pension and DC plan. **Table A1** shows the relevant characteristics of either retirement plan, which determine the total costs together with the assumptions discussed in the next section. The combined contribution rate for the DC plan is set, such that the cost for the employer in the year a switch is made stays constant. The resulting contribution rate amounts to 11.5 percent of pay. This assumes that fees are 0.5 percentage points higher under a DC plan than under a DB pension and that all eligible teachers participate.

Table A1: **Characteristics of modeled retirement benefits – DB pension and DC plan**

	DB Pension	DC Plan
Multiplier	1.5% multiplier of average of final three years of pay	--
Vesting	Five-year cliff vesting	Five-year phased vesting
Full retirement age	65	65
Contribution rate	--	11.5%
Fees (as % of assets)	--	0.5%
Discount rate	7.0%	--

Simulation Input Parameters

The simulations further require input parameters for effectiveness changes following first-year salary increases, turnover changes and the shape of the learning curve—flat or steep—during a teacher's first decade. **Table A2** summarizes these input parameters. A one percent increase in the first-year compensation, for example, results on average in a gain of initial teacher effectiveness equal to 2.6 percent with a standard deviation of 4.2 percent. Turnover is also higher with DC plans than DB pensions since compensation is no longer deferred (**Table A2**). Finally, **Table A2** shows the range of possible learning curves for teachers in the first decade.

Table A2: **Input parameters for simulation**

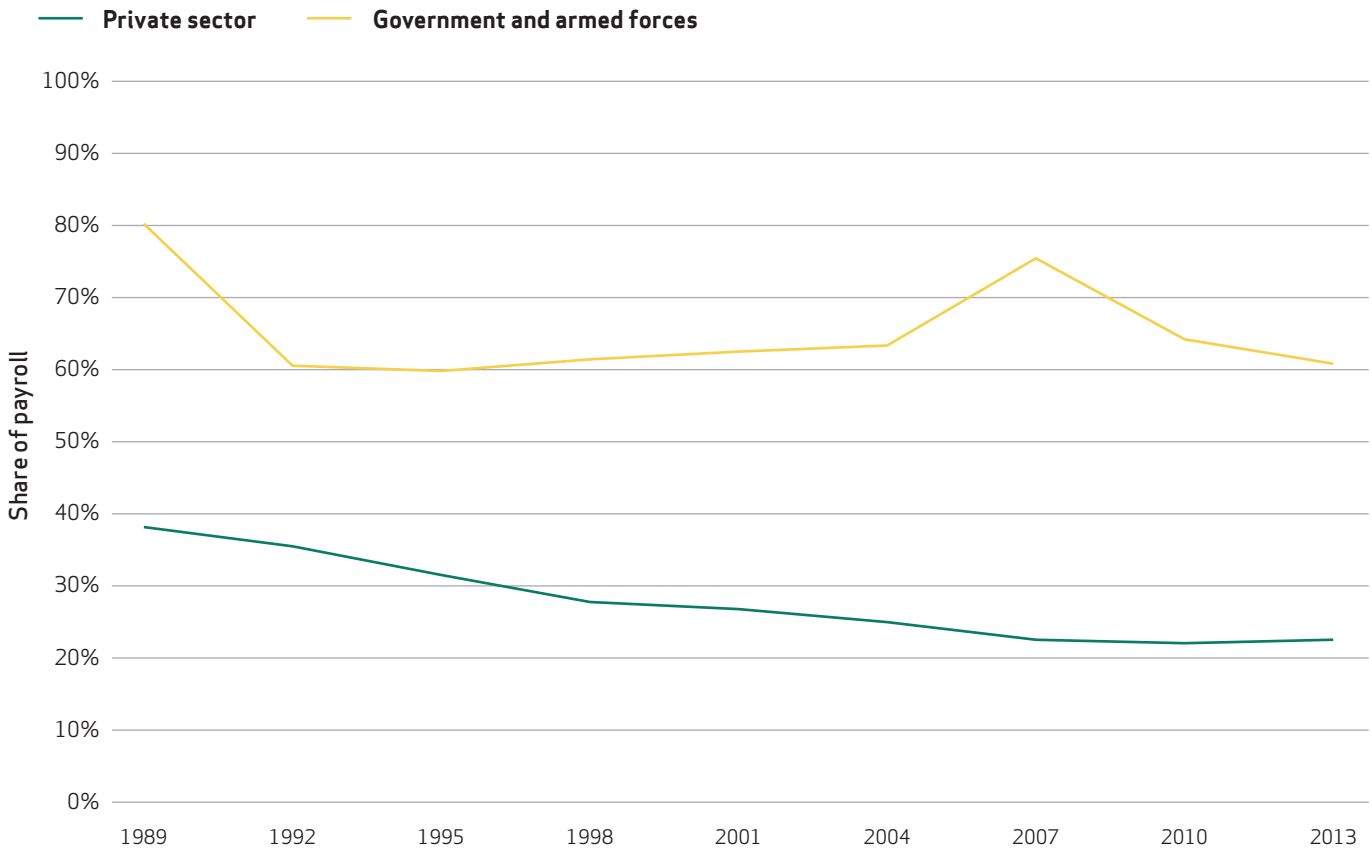
Measure	Range of estimates	Parameter average and standard deviation	Sources
Change in teacher effectiveness relative to 1% change in initial salary	0.1 to 1.0	-5.9	See endnote 74.
Change in turnover for DC plans relative to DB plans	28.0 to 220.0	-5.1	See endnote 75.
Experience – teacher effectiveness level in years 1-10 relative to maximum effectiveness			
Year 1	-48.8 to 0.0	21.5 (16.7)	See endnote 76.
Year 2	-41.4 to 0.0	15.3 (17.6)	- " -
Year 3	-34.0 to 0.0	12.1 (16.3)	- " -
Year 4	-26.6 to 0.0	10.1 (13.7)	- " -
Year 5	-25.0 to 0.0	7.9 (11.1)	- " -
Year 6	-20.0 to 0.0	5.9 (9.3)	- " -
Year 7	-14.0 to 0.0	4.5 (7.1)	- " -
Year 8	-10.0 to 0.0	3.2 (4.9)	- " -
Year 9	-5.0 to 0.0	1.9 (3.0)	- " -
Year 10	-2.0 to 0.0	0.8 (1.4)	- " -

Notes: All numbers are in percent. Our parameter values do not account for sample size in the original estimates since they are often derived from different levels of aggregations, i.e. some are based on school district data, while others are based on state aggregates. The calculations of the averages and standard deviations include statistically insignificant values.

The simulations use the averages and standard errors shown in **Table A2** as inputs for Monte Carlo simulations. They calculate the probability of improving teacher effectiveness and the average change in teacher effectiveness after switching retirement benefits, based on the equations shown earlier. The simulations rely on 5,000 random values for each input parameter. Each iteration multiplies the standard error by a randomly drawn number from a normal distribution with mean zero and standard error one and adds this product to each input's average for each iteration.

A.2 Supplementary figures and tables

Figure A1: **Share of households with DB pensions from 1989 to 2013**



Notes: Author's calculations based on Board of Governors. Federal Reserve System. Various years. Survey of Consumer Finances. Washington, DC: Fed. DB pension coverage refers to having a DB pension from a prior or current job. The Survey of Consumer Finances only reports industry categories at relatively high levels of aggregation. The public sector includes federal, state and local governments as well as people in the armed forces.

ENDNOTES

1 S. Allegretto and L. Mishel, "The Teacher Pay Gap is Wider than Ever," Economic Policy Institute, Washington, DC, 2016.

2 A number of education researchers have asserted that teacher effectiveness would improve if DB pensions were replaced with DC plans or vastly redesigned DB plans. *See* J. Barro and S. Buck, "Underfunded teacher pension plans: It's worse than you think," Civic Report, Manhattan Institute and The Foundation for Educational Choice, New York, NY, 2005; R. Costrell and M. Podgursky, "Peaks, Cliffs, and Valleys: The Peculiar Incentives in Teacher Retirement Systems and Their Consequences for School Staffing," *Education Finance and Policy* 4(2): 175-211, 2009; K.M. Doherty, S. Jacobs, and T.M. Madden, "No One Benefits: How Teacher Pension Systems Are Failing BOTH Teachers and Taxpayers," National Council on Teacher Quality, Washington, DC, 2012; J.S. Hansen, "An introduction to teacher retirement benefits," *Education Finance and Policy* 5(4): 402-437, 2010; J. McGee and M.A. Winters, "Better Pay, Fairer Pensions: Reforming Teacher Compensation," Center for State and Local Leadership, Manhattan Institute, New York, NY, 2013.

3 This section updates the arguments and simulation model developed in C. Weller, "Could Different Retirement Benefits Result in More Effective Teachers?" *Eastern Economic Journal* 39(4): 547-563, 2013.

4 Table A1 shows households with DB pensions with the head of households working in the private sector and the public sector—government and armed forces.

5 National Education Association (NEA), "Characteristics of Large Public Education Pension Plans," NEA, Washington, DC, 2016.

6 K. Cahill and M. Soto, "How Do Cash Balance Plans Affect the Pension Landscape?" (An Issue in Brief No. 14), Center for Retirement Research at Boston College, Boston, MA, 2003; R. Clark and S. Schieber, "An Empirical Analysis of the Transition to Hybrid Pension Plans in the United States," paper presented at the conference on "Public Policies and Private Pensions", sponsored by the Brookings Institution, Stanford Institute for Economic Policy Research, and TIAA-CREF Institute, Washington, DC, 2000; R. Johnson and C. Uccello, "The Potential Effects of Cash Balance Plans on the Distribution of Pension Wealth in Midlife," Final Report to the Pension and Welfare Administration, U.S. Department of Labor, Urban Institute, Washington, DC, 2011.

7 R. Clark and S. Schieber, 2000, op cit.

8 The appendix shows the formulas used for the illustrative examples and the simulations. The calculations hold annual costs constant and assume that DB pensions are not underfunded and thus do not require additional contributions beyond paying for current and future benefits.

9 The profile of annual DB benefits as share of a teacher's salary shows some ups and downs in the early career years. Those result from the underlying step increases in teacher salaries. In some years, when teachers move up a step, their salaries increase faster than their additional DB benefit.

10 L. Friedberg and M.T. Owyang, "Explaining the Evolution of Pension Structure and Job Tenure," Working Paper, Federal Reserve Bank of St. Louis, St. Louis, MO, 2005; A.L. Gustman, O.S. Mitchell, and T.L. Steinmeier, "The role of pensions in the labor market: A survey of the literature," *Industrial and Labor Relations Review* 47(3): 417-438, 1994; B. Nalebluff and R. Zeckhauser, "Pensions and the Retirement Decision" (NBER Working Paper No. 1285), National Bureau of Economic Research, Cambridge, MA, 1984.

11 S.G. Allen, R.L. Clark, A. McDermed, "Pensions, bonding, and lifetime jobs," *Journal of Human Resources* 28(3): 463–481, 1993; W. E. Even and D. MacPherson, "Employer Size and Labor Turnover: The Role of Pensions," *Industrial and Labor Relations Review* 49(1): 707-728, 1996; R.A. Ippolito, *Pension Plans and Employee Performance: Evidence, Analysis, and Policy*, The University of Chicago Press, Chicago, IL, 1997; R. Disney and C. Emmerson, "Choice of Pension Plan and Job Mobility," CPS Discussion Paper No. 04/04, Centre for Pensions and Superannuation, University of New South Wales, Sidney, Australia, 2004; A.H. Munnell, K. Haverstick, and G. Sanzenbacher, "Job Tenure and Pension Coverage" (CRR Working Paper 2006-18), Center for Retirement Research at Boston College, Boston, MA, 2006; S. Nyce, "Behavioral effects of employer-sponsored retirement plans," *Journal of Pension Economics and Finance* 6(3): 251-285, 2007; M. Chingos and M. West, "When Teachers Choose Pension Plans: The Florida Story," Thomas Fordham Institute, Washington, DC, 2013; R. Clark, E. Hanson, and O. Mitchell, "Lessons for Public Pensions from Utah's Move to Pension Choice" (NBER Working Paper No. 21385), National Bureau of Economic Research, Cambridge, MA, 2015.

12 S.G. Rivkin, E.A. Hanushek, and J.F. Kain, "Teachers, Schools, and Academic Achievement," *Econmetrica* 73(2): 417-458, 2005; E.A. Hanushek, J.F. Kain, D.M. O'Brien, and S.G. Rivkin, "The Market for Teacher Quality" (Working Paper No. 11154), National Bureau of Economic Research, Cambridge, MA, 2005; D. Harris and T. Sass, "Teacher training, teacher quality, and student achievement," *Journal of Public Economics* 95(7-8): 798-812, 2011.

13 M. Wiswall, "The dynamics of teacher quality," *Journal of Public Economics* 100: 61–78, 2013; J.P. Papay and M.A. Kraft "Productivity returns to experience in the teacher labor market: Methodological challenges and new evidence on long-term career improvement," *Journal of Public Economics* 130: 105–119, 2015; H.F. Ladd and L.C. Sorensen, "Returns to Teacher Experience: Student Achievement and Motivation in Middle School," *Education Finance and Policy* 12(2): 241–279, 2016.

14 Employee turnover is generally higher in workplaces with DC or CB plans than in those with DB plans. See S.G. Allen, R.L. Clark, A. McDermed, "Pensions, bonding, and lifetime jobs," *Journal of Human Resources* 28(3): 463–481, 1993; W. E. Even and D. MacPherson, "Employer Size and Labor Turnover: The Role of Pensions," *Industrial and Labor Relations Review* 49(1): 707-728, 1996; R.A. Ippolito, *Pension Plans and Employee Performance: Evidence, Analysis, and Policy*, The University of Chicago Press, Chicago, IL, 1997; A.H. Munnell, K. Haverstick, and G. Sanzenbacher, "Job Tenure and Pension Coverage" (CRR Working Paper 2006-18), Center for Retirement Research at Boston College, Boston, MA, 2006; S. Nyce, "Behavioral effects of employer-sponsored retirement plans," *Journal of Pension Economics and Finance* 6(3): 251-285, 2007.

15 N. Rhee and W.B. Fornia, "Are California Teachers Better off with a Pension or a 401(k)?" UC Berkeley Center for Labor Research and Education, Berkeley, CA, 2016.

16 E.A. Hanushek and S.G. Rivkin, "Teacher Quality," In Hanushek, E., and Welch, F., eds., *Handbook of the Economics of Education*, Vol. 2, Chapter 18, Elsevier B.V, Amsterdam, NL, 2006; E. Cohn, "Economies of Scale in Iowa High School Operations," *The Journal of Human Resources* 3(4): 422-434, 1968; L.J. Perl, "Family Background, Secondary School Expenditure, and Student Ability," *The Journal of Human Resources* 8(2): 156-180, 1973; R. Cebula, F. Mixon, and M. Montez, "Teachers' salaries and human capital, and their effects on academic performance: an institution-level analysis of Los Angeles County high schools," *Journal of Economics and Finance Economics Letters* 17: 547-550, 2010; S. Loeb and M. Page, "Examining the Link between Teacher Wages and Student Outcomes: The Importance of Alternative Labor Market Opportunities and Non-Pecuniary Variation," *The Review of Economics and Statistics* 82(3): 393-408, 2000; P. Dolton, O. Marcenaro-Gutierrez, L. Pistaferri, and Y. Algan, "If you pay peanuts do you get monkeys? A cross-country analysis of teacher pay and pupil performance," *Economic Policy* 26(65): 5-55, 2011.

17 M. Chingos and M. West, 2013, op cit; R. Clark, E. Hanson and O. Mitchell, 2015, op cit.

18 The simulations likely overstate any possible benefits of DC plans as teacher retirement plans. The simulations, for instance, assume a fairly small increase in costs—0.5 percentage points of assets—when comparing DC plans to DB pensions. The money in DC plans goes to a number of small accounts, which can incur larger costs than one large pool of money as is the case with DB pensions. Management of many small individual accounts raises costs, such that DC plans tend to have higher fees than DB pensions by about 0.5 percent to 1.0 percent of assets. *See* Council of Institutional Investors (CII), "Protecting the Nest Egg: A Primer on Defined Benefit and Defined Contribution Retirement Plans," CII, Washington, DC, 2006; C. Weller and S. Jenkins, "Building 401(k) Wealth One Percent at a Time: Fees Chip Away at People's Retirement Nest Eggs," Center for American Progress, Washington, DC, 2007.

The simulations also use the estimates of the impact of salary on effectiveness from the literature to the likely effect of benefit changes. Employees, however, value pension benefits less than salaries. *See* E. Montgomery and K. Shaw, "Pensions and Wage Premia" (NBER Working Paper No. 3985), National Bureau of Economic Research, Cambridge, MA, 1992. That is, the effectiveness estimates probably overstate the positive effect of shifting money to earlier in people's careers. Moreover, the simulations do not account for transition costs that would be associated with schools moving from DB pensions to DC plans. Ignoring these costs means that there is more money available for compensation than would be the case in reality. Further, the simulations ignore the fact that teacher effectiveness could continue to improve after the first decade. Ignoring continued increases in effectiveness lowers average effectiveness under a DB pension and understates the potential negative effects of higher turnover under a DC plan, again overstating the likely impact of shifting to a DC plan on teacher effectiveness.

Similarly, the simulations also ignore the administrative costs and other disruptive effects of turnover on schools. *See* E. Watlington, R. Shockley, P. Guglielmo, and R. Felsher, "The High Cost of Leaving: An Analysis of the Cost of Teacher Turnover," *Journal of Education Finance* 36(1): 22-37, 2010; M. Ronfeldt, H. Lankford, S. Loeb, and J. Wyckoff, "How Teacher Turnover Harms Student Achievement" (NBER Working Paper No. 17176), National Bureau of Economic Research, Cambridge, MA, 2011. Leaving out these costs from the simulations means that there is more money available for compensation. And, more compensation translates into higher average effectiveness in the simulations.

19 DB pension income tends to be associated with higher standards of living in retirement. Retired women educators tend to enjoy a more secure retirement than other retired women. *See* J. Brown, N. Rhee, J. Saad-Lessler, and D. Oakley, "Shortchanged in Retirement: Continuing Challenges to Women's Financial Security," NIRS Report, National Institute on Retirement Security, Washington, DC, 2016.

20 A.H. Munnell, W. Hou, and A. Webb, "NRRI Update Shows Half Still Falling Short" (IB#14-20), Center for Retirement Research at Boston College, Boston, MA, 2014.

21 N. Rhee and I. Boivie, "The Continuing Retirement Savings Crisis," National Institute on Retirement Security, Washington, DC, 2015.

22 A.H. Munnell, W. Hou and A. Webb, 2014, op cit.

23 For a discussion of factors that can explain such differences, see C. Weller, *Retirement on the Rocks: Why Americans Can't Get Ahead and How New Savings Policies Could Help*, Palgrave MacMillan, New York, NY, 2016.

24 J. Scholz, A. Seshadri, and S. Khitatakrun, "Are Americans Saving 'Optimally' for Retirement?" *Journal of Political Economy* 114(4): 607–643, 2006.

25 W. Gale, J.K. Scholz, and A. Seshadri, "Are All Americans Saving 'Optimally' for Retirement?" Working Paper, The Brookings Institution and University of Wisconsin-Madison, Washington, DC and Madison, WI, 2009.

26 A.H. Munnell, A. Webb, and F.N. Golub-Sass, "The National Retirement Risk Index: An update" (CRR Issue Brief 12-20), Center for Retirement Research at Boston College, Boston, MA, 2012; N. Rhee, "The Retirement Savings Crisis: Is It Worse than We Think?" National Institute for Retirement Security, Washington, DC, 2013; W. Gale, J.K. Scholz, and A. Seshadri, 2009, op cit; B. Butrica, K. Smith, and H. Iams, "This Is Not Your Parents' Retirement: Comparing Retirement Income across Generations," *Social Security Bulletin* 72(1), 2012; J. Vanderhei, "What Causes EBRI Retirement Readiness Ratings™ to Vary: Results from the 2014 Retirement Security Projection Model" (EBRI Issue Brief No. 396), Employee Benefits Research Institute, Washington, DC, 2014.

27 The underlying data were redesigned for the survey in 2014. For unknown reasons, the retirement benefit data for later years are no longer comparable with earlier years and with other data sources. The 2013 data are in line with earlier years, which also show that only roughly half of all private-sector workers have access to a retirement plan and that fewer than half of all private sector workers participate in a retirement plan at work. *See* C. Copeland, "Employment-Based Retirement Plan Participation: Geographic Differences and Trends" (EBRI Issue Brief No. 405), Employee Benefits Research Institute, Washington, DC, 2014.

28 Copeland, 2014, op cit.

29 NEA, 2016, op cit.

30 K. Brainard and A. Brown, "Employee Contributions to Public Sector Plans," NASRA Issue Brief, National Association of State Retirement Administrators, Washington, DC, 2016.

31 C. Weller and T. Ghilarducci "The Inefficiencies of Existing Retirement Savings Incentives," CAP Report, Center for American Progress, Washington, DC, 2015.

32 An alternative tax benefit is available under so-called "Roth" type savings plans. In those cases, the initial employee contribution is made after taxes have been paid, but all earnings on savings and withdrawals are excluded from taxation.

33 C. Weller and T. Ghilarducci, 2015, op cit; C. Weller, 2016, op cit.

34 Congressional Budget Office, "The Distribution of Major Tax Expenditures in the Individual Tax System," Table 2. CBO, Washington, DC, 2013.

35 D. Oakley and J. Brown, "Preserving Retirement Income Security for Public Sector Employees," National Institute on Retirement Security, Washington, DC, 2016.

36 ERISA Advisory Council, "Participant plan transfers and account consolidation for the advancement of lifetime plan participation," Department of Labor, Washington, DC, 2016.

37 This estimate is likely a lower-bound figure as it only accounts for higher rates of return, but ignores additional differences in fees between DB pensions and DC plans that arise from the fact that DB pensions pool large amounts of money and can thus take advantage of economies of scale. *See* W. Fornia and N. Rhee, "Still a Better Bang for the Buck: An Update on the Economic Efficiencies of Defined Benefit Pensions," NIRS Report, National Institute for Retirement Security, Washington, DC, 2014.

38 D. Baker, J.B. DeLong, and P. Krugman, "Asset returns and economic growth," *Brookings Papers on Economic Activity* 2005(1): 289–330, 2005.

39 J.Y. Campbell and R.J. Shiller, "Valuation Ratios and the Long-Run Stock Market Outlook: An Update" (NBER Working Paper No. 8221), National Bureau of Economic Research, Cambridge, MA, 2001.

40 R.J. Shiller, *Irrational Exuberance*, Princeton University Press, Princeton, NJ, 2015.

41 W. Fornia and M. Rhee, 2014, op cit.

42 Participants in DC plans could also buy annuities from an insurance company if they so desired, but very few do. The overwhelming majority of people with savings in a DC plan manage their own withdrawals. *See* J.R. Brown, A. Kapteyn, E.F.P. Luttmer, and O.S. Mitchell, "Are Cognitive Constraints a Barrier to Annuitization?" Center for Retirement Research at Boston College, Boston, MA, 2015; J. Mulvey and P. Purcell, "Converting Retirement Savings into Income: Annuities and Periodic Withdrawals," Congressional Research Service, Washington, DC, 2008; D. Oakley, "Retirement Security Risks: What Role Can Annuities Play in Easing Risks in Public Pension Plans?" National Institute on Retirement Security, Washington, DC, 2015.

43 E. Arias, M. Heron, and J. Xu, "United States Life Tables, 2012," (National Vital Statistics Report Vol. 65, No. 8), Centers for Disease Control and Prevention, National Center for Health Statistics, U.S. Department of Health and Human Services, Hyattsville, MD, 2016.

44 Note that these wealth amounts show a much larger gap than the cost differences calculated by Fornia and Rhee; *see* W. Fornia and N. Rhee, 2014, op cit. The difference arises from the fact that Fornia and Rhee estimate the annual costs, net of interest earnings that generate a specified retirement amount. The calculations here show the difference in retirement wealth upon reach age 65, which include compounded interest.

45 E. Arias, M. Heron, and J. Xu, 2016, op cit.

46 E. Wolff, "The Transformation of the American Pension System: Was It Beneficial for Workers?" W.E. Upjohn Institute for Employment Research, Kalamazoo, MI, 2011.

47 F. Porell and D. Oakley "The Pension Factor 2012: The Role of Defined Benefit Pensions in Reducing Elder Economic Hardships," National Institute on Retirement Security, Washington, DC, 2012.

48 Figure A2 in the appendix shows the absolute incomes at the relevant percentiles. Generally, incomes for households with DB pensions are higher than for households without DB pensions, except for retirement incomes at the very top. But, the income gap shrinks as income increases. At the 25th percentile, for instance, households with DB pensions have incomes that are 93 percent greater than those of households without DB pensions. At the median, it is 87 percent, at the 75 percentile 72 percent and at the 90th percentile only 23 percent.

49 Public DB pensions play a particular role in helping women narrow the retirement savings gap to men. Women are more likely than men to work in education. And, public sector employees are more covered by DB pensions than private sector employees. Women working in education can thus expect to be financially secure in retirement. Teacher pensions are thus an important step towards reducing the gender wealth gap. *See* Brown et al., 2016, op cit.

50 See A.H. Munnell, R.K. Triest, and N.A. Jivan, "How do Pensions Affect Expected and Actual Retirement Ages" (CRR Working Paper 2004-27), Center for Retirement Research at Boston College, Boston, MA, 2004. Munnell, Triest, and Jivan found that—although they have lower average expected retirement ages—people with DB pension benefits are less likely than those without such benefits to retire earlier than planned, which the researchers attribute to DB pensioners' enhanced ability to plan their exit from the labor force.

51 The standard deviation of the retirement age for people without a DB pension from 1989 to 2013 is 1.0 years, while the standard deviation for people without DB pensions during that time is 0.7 years. Author's calculations based on Board of Governors. Federal Reserve System. Various Years. Survey of Consumer Finances. Washington, DC: Fed.

52 Author's calculations based on Board of Governors. Federal Reserve Board. Various years. Survey of Consumer Finances. Washington, DC: Fed. All numbers refer to non-retirees between the ages of 25 and 64 years.

53 For all survey data in this paragraph, *see* D. Oakley and K. Kenneally, "Retirement Security 2015: Roadmap for Policy Makers—Americans' Views of the Retirement Crisis," NIRS Report, National Institute on Retirement Security, Washington, DC, 2015.

54 For all survey data in this paragraph, see D. Oakley and K. Kenneally, "Retirement Security 2017: Roadmap for Policy Makers—Americans' Views of the Retirement Crisis and Solutions," NIRS Report, National Institute on Retirement Security, Washington, DC, 2017.

55 See D. Oakley and K. Kenneally, 2015, op cit and D. Oakley and K. Kenneally, 2017, op cit for detailed survey responses.

56 For a history of public pensions in the United States, dating back to the Revolutionary War, *see* R. Clark, L. Craig, and J. Sabelhaus, *State and Local Retirement Plans in the United States*. Edward Elgar, Northampton, MA, 2011. For some brief background on public pensions in a number of other industrialized countries, which reflect similar trends, see C. Weller, "The Future of Public Pensions in OECD Countries," *Cambridge Journal of Economics* 28(4): 489-504, 2004.

57 A number of education researchers have asserted that DB pensions have failed because many in the teaching workforce will not qualify for the full retirement benefits; *see* C. Aldeman and A.J. Rotherham, "Friends Without Benefits: How States Systematically Shortchange Teachers' Retirement and Threaten Their Retirement Security," Bellwether Education Partners, Sudbury, MA, 2014. This is at best an overstatement and at worst a fundamental misunderstanding of a key and desired feature of DB pensions. If schools wanted to make sure that all teachers receive something, they could simply not offer retirement (and other) benefits and instead pay higher salaries. Instead, schools, like other employers, offer pensions to achieve labor management and social policy goals that are more difficult to accomplish with just wage payments. Schools can use pensions, as discussed in this report, as effective recruitment and retention tools, as long as they are willing to accept tradeoffs such as delayed vesting and back loaded benefits.

58 J. R. Blasi, R.B. Freeman, C. Mackin, and D.L. Kruse, "Creating a Bigger Pie? The Effects of Employee Ownership, Profit Sharing, and Stock Options on Workplace Performance," *Shared Capitalism at Work: Employee Ownership, Profit and Gain Sharing, and Broad-based Stock Options*, University of Chicago Press, Chicago, IL, 2010; Q. Gong, J. Liang, H. Zhang, and L. Zhou, "Casual Effects of Stock Options on Employee Retention: A Regression Discontinuity Approach," Stanford Center for International Development, Stanford, CA, 2015; C.P. Green and J.S. Heywood, "Profit Sharing, Separation and Training," *British Journal of Industrial Relations* 49(2): 623–42, 2011.

59 Government Accountability Office (GAO), "401(k) Plans: Effects of Eligibility and Vesting Policy on Workers' Retirement Savings," GAO, Washington, DC, 2016.

60 K. Brainard and A. Brown, "Public Fund Survey: Summary Findings for FY 2015," National Association of State Retirement Administrators, Lexington, KY, 2016.

61 K. Brainard and A. Brown, 2016, op cit.

62 W. Gale and A. Krupkin, "Financing State and Local Pension Obligations: Issues and Options," Brookings Working Paper, Brookings Institution, Washington, DC, 2016; A.H. Munnell and J.P. Aubrey, "The Funding of State and Local Pensions: 2014-2018," Center for Retirement Research at Boston College, Boston, MA, 2015; Pew Charitable Trusts, "The Fiscal Health of State Pension Plans," 3-Year Historical Funding Data and Comparison to U.S. Total, Pew, Washington, DC, 2015.

63 A. Petrini, "Recent Reductions in Public Pension COLAs," National Council of State Legislators, Washington, DC, 2015.

64 I. Boivie and B. Almeida, "Look Before You Leap: The Unintended Consequences of Pension Freezes," NIRS Issue Brief, National Institute on Retirement Security, Washington, DC, 2008; I. Boivie and C. Weller, "The Fiscal Crisis, Public Pensions and Labor and Employment Relations," in Daniel Mitchell. Ed. *Public Jobs and Public Agendas: The Public Sector in an Era of Economic Stress*. LERA Research Volume, Cornell University Press, Ithaca, NY, 2012.

65 R. Clark, E. Hanson and O. Mitchell, 2015, op cit.

66 For example, see J.K. Rice, "Teacher quality: Understanding the effectiveness of teacher attributes," Economic Policy Institute, Washington, DC, 2003.

67 The calculations use the prospective unit credit method to calculate normal cost to illustrate additional retirement wealth for teachers in a given year. Public pensions typically use an entry-age normal cost calculation, but this method does not show the additional retirement wealth that each cohort of teachers annually earns. The goal of the simulations, though, is to show the incentives for teachers under a typical DB pension and a typical DC plan. This requires the calculation of the implicit or explicit contributions a teacher receives each year towards retirement.

68 National Education Association (NEA), "Characteristics of Large Public Education Pension Plans," NEA, Washington, DC, 2010.

69 NEA, 2010, op cit.

70 Society of Actuaries, "The RP-2014 Mortality Tables, White Collar, Healthy Annuitants," SOA, Washington, DC, 2014.

71 North Carolina Department of Public Instruction, "Fiscal Year 2015-16 North Carolina Public School Salary Schedules: Bachelor's with NBPTS Certification," Financial and Business Services, Raleigh, NC, 2015.

72 This assumption, while realistic, has no material effect on the simulations.

73 As discussed in the text, there is recent, albeit weak evidence that teacher effectiveness continues to rise even after the first ten years. Assuming that teacher effectiveness stops increasing after some time, though, favors DC plans in the simulations since there will be fewer highly experienced teachers on the job due to higher teacher turnover with DC plans.

74 S.G. Rivkin, E.A. Hanushek, and J.F. Kain, 2005, op cit; E.A. Hanushek, S.G. Rivkin, and L.L. Taylor, "Aggregation and the Estimated Effects of School Resources," *Review of Economics and Statistics* 78(4): 611-627, 1996; R. Cebula, F. Mixon and M. Montez, 2015, op cit; D. Figlio and L. Kenny, "Individual Teacher Incentives and Student Performance" (NBER Working Paper No. 12627), National Bureau of Economic Research, Cambridge, MA, 2006; T. Lin, 2010, op cit; S. Loeb and M. Page, 2010, op cit; P. Dolton et al., 2011, op cit; and L.J. Perl, 1973, op cit.

75 S.G. Allen, R.L. Clark, and A. McDermed, 1993, op cit; A.L. Gustman and T.L. Steinmeier, "Pension Portability and Labor Mobility: Evidence from the Survey of Income and Program Participation" (NBER Working Paper No. 3525), National Bureau of Economic Research, Cambridge, MA, 1990; R. Disney and C. Emmerson, 2004, op cit; G.S. Goda, D. Jones, and C.F. Manchester, "Employee Mobility and Employer Provided Retirement Plans" (CRR Working Paper No. 2012-28), Center for Retirement Research at Boston College, Boston, MA, 2012; W.E. Even and D. MacPherson, 1996, op cit; R.A. Ippolito, 1997, op cit; S. Nyce, 2008, op cit.

76 H.F. Ladd and L.C. Sorensen, 2016, op cit; J.P. Papay and M.A. Kraft, 2015, op cit; D. Harris and T. Sass, 2011, op cit; S.G. Rivkin, E.A. Hanushek, and J.F. Kain, 2005, op cit; M. Wiswall, 2013, op cit.

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