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Buyer Beware

The Risks to Teacher Effectiveness from Changing Retirement Benefits

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Introduction

State and local governments experienced substantial budget shortfalls in the wake of the Great Recession and the U.S. housing crisis. The tough fiscal decisions states had to make amid sharply declining tax revenues focused attention on public employee pensions because underfunded pensions—pensions that had less money than necessary to pay all promised benefits—required additional state contributions in a fiscally constrained budget environment.[1]

Some commentators argue that states should use the crisis as an opportunity to replace so-called defined-benefit pensions for public employees, particularly for teachers, with alternative retirement benefits such as defined-contribution plans, or cash-balance plans, which are a hybrid between defined-benefit and defined-contribution pension plans. Under defined-benefit plans, teachers typically earn monthly retirement benefits for the rest of their lives after deferring part of employees' compensation during their careers. Usually, these plans are structured so that employees earn more retirement benefits relative to their salary later in their careers, creating incentives for employees to stay with one employer.

Alternative retirement benefits such as defined-contribution and cash-balance pension plans do not defer compensation, moving more of public employees' compensation to earlier stages in their careers. Each year employees and employers contribute a share of an employees' salary to these alternative benefits and that share typically stays the same over time. A teacher's retirement income will depend on the performance of her investments for a defined-contribution plan and on the guaranteed interest rate earned on the employer and employee contributions for a cash-balance plan.

By not deferring compensation these types of plans also end incentives for employees to stay with one employer for long periods of time. These alternative-benefit plans, then, would increase turnover among more experienced public employees relative to those

who hold defined-benefit pensions. At the same time, alternative retirement benefits would shift compensation to earlier stages in teachers' careers, which could offer incentives to highly qualified applicants who might not otherwise enter teaching to consider this career. The reason: Their defined-contribution or cash-balance plans would receive new money in a constant proportion to teachers' salaries while the contributions increase relative to a teacher's salary with a defined-benefit pension from a lower level than is the case with defined-contribution and cash-balance plans.

The problem with this set of incentives, though, is that higher turnover and larger initial pay work against each other with respect to average teacher effectiveness reflecting in part their shorter time on the job on average with alternative benefits. More experienced and presumably more effective teachers will become more likely to leave their jobs in search of higher paying or more rewarding work. Less experienced teachers will replace them, lowering the average teacher effectiveness, assuming that there is a difference in effectiveness between experienced and inexperienced teachers because of a learning curve. This drop in average teacher effectiveness, however, could be offset by greater effectiveness among new hires due to higher initial pay.

Whether average teacher effectiveness will fall or rise after switching public employees from deferred compensation under defined-benefit pensions to immediate compensation under defined-contribution or cash-balance plans will depend on the size of each of the following effects:

- The amount of turnover
- The extent of the learning curve
- The reaction to initial compensation changes

The interactions of these three changes in determining the effectiveness of teachers is not easy to predict. Indeed, the economic literature on teacher compensation and on pensions shows a lot of uncertainty related to each of these three factors.[2]

Researchers, however, can use simulation techniques to better understand policy changes when there is uncertainty over the size of relevant factors—as long as there is sufficient evidence to quantify the uncertainty associated with each individual factor. This issue brief summarizes the results of just such a detailed simulation.[3] The simulations calculate the chance that the average effectiveness of teachers will decline and the average change in teacher effectiveness will fall after teachers' pensions are switched from defined-benefit plans to the two alternative retirement plans. The simulations show that:

- **Average teacher effectiveness could decrease.** There is only a 30.2 percent chance that teacher effectiveness will go up with a defined-contribution plan and only a 41.2 percent chance that it will increase with a cash-balance plan compared to the effectiveness under a defined-benefit pension. Average teacher effectiveness could

fall by 4.3 percent with a defined-contribution plan and by 1.2 percent with a cash-balance plan relative to teachers with defined-benefit pensions.

- **The risks for teacher effectiveness could be much greater.** The simulations are biased in favor of alternative retirement benefits, meaning they ignore the costs associated with higher turnover and transition costs that would reduce the money available for actual employee compensation under alternative benefits. The risks for teacher effectiveness highlighted in the first bullet, then, are probably too low because they do not take into account these additional costs.

- **Lowering teacher turnover could lower the risk of declining effectiveness.** The chance of higher teacher effectiveness exceeds 80 percent if turnover does not change with retirement benefit changes. Public employers, however, have few tools available to keep turnover steady, unlike private-sector employers who can offer stock options, for instance, for skilled employees to stay for a desired length of time.

- **Higher initial compensation has a limited impact on the risk of decreasing effectiveness.** The chance of higher teacher effectiveness increases to a little over 50 percent if teachers immediately qualify for their entire alternative-retirement benefits and thus have little incentive to stay for long periods of time.[4] The actual risk is likely much higher since the calculation ignores the employers' costs to hire and train new teachers.

- **There are substantial transition costs in switching retirement benefits.** Transition costs can last about four decades. A switch to a cash-balance plan requires transition costs of an average of 0.7 percent of payroll over the next 40 years, and a switch to defined-contribution plans cost an average of 0.3 percent of payroll over the same period.

My simulations, in short, demonstrate that changing retirement benefits carries large risks and costs with it because average teacher effectiveness could fall after a switch from defined-benefit pensions to alternative retirement benefits. Those interested in raising teacher effectiveness may be better served finding other policy levers than switching retirement benefits.

Let's now turn in more detail to the types of retirement benefits available to teachers, and then explore in more depth the findings of our simulations.

Types of retirement benefits

Teacher retirement benefits are typically defined-benefit pensions. Teachers receive lifetime retirement benefits, based on years of service, age, and final earnings. They often have to work for at least five or more years before they earn any claim to retirement benefits, or become vested in pension parlance.[5] Benefits are financed by employee and employer con-

tributions in addition to investment earnings on accumulated assets. Employee contributions are made at a fixed rate, while employers bear the risk if plans have too few assets to pay all promised benefits and if more employer contributions are necessary.

There are several proposals to use defined-contribution or cash-balance plans instead of defined-benefit plans.[6] In these retirement plans employees and employers contribute a fixed percentage of earnings each year. The money is allocated to an individual account, with employees deciding how the funds are invested and shouldering the risks associated with these decisions.

Cash-balance plans are a hybrid of the first two types of plans. They are still defined-benefit plans but they resemble defined-contribution plans in key aspects. Each worker receives a notional (hypothetical) account, even though all funds are invested as one large pension pool. An employee's notional account is credited with an amount equal to a fixed share of a worker's earnings each year and the account balance increases annually at a pre-determined interest rate, the interest credit. The plan is financed by employer and employee contributions and investment earnings. Employers again bear the risk of too-low assets. Notional account balances can be rolled over into other retirement plans when a teacher switches jobs.[7] Table 1 summarizes the characteristics of each retirement benefit type.

Defined-benefit pensions make up a smaller share of total compensation earlier in employees' careers than later compared to defined-contribution or cash-balance pensions. Figure 1 shows an illustrative example of the annual benefits earned under all three retirement plans. The x-axis shows the years of employment and the y-axis shows the annual amount of retirement benefits relative to a teacher's salary earned with each benefit.

TABLE 1

Types of retirement pension plans

Characteristics of typical pension plans, by plan type

Characteristic	Defined-benefit plan		Defined-contribution plan
Plan type	Traditional	Cash balance	403(b) plans
Participation	Automatic	Automatic	Voluntary
Contribution	Employer and employee	Employer and employee	Employee with occasional employer matches
Investments	Determined by plan	Determined by plan	Typically determined by employee
Withdrawals	Annuity	Annuity or lump sum	Lump sum
Rollovers before age 65	Not permitted	Permitted if lump sum option exists	Permitted
Benefit guarantee	Often constitutionally guaranteed	Often constitutionally guaranteed	None
Early retirement benefits	Common	Uncommon	Unavailable
Vesting	Typically 5-10 years	Typically shorter than in traditional pension plans	Typically immediate for employee contributions and often phased for employer contributions

Notes: Cash balance plans typically do not exist in the public sector. The description thus relies on typical characteristics of private-sector cash balance plans. Also, defined-contribution plans are generally supplemental retirement savings plans in the public sector and thus tend to be voluntary plans.

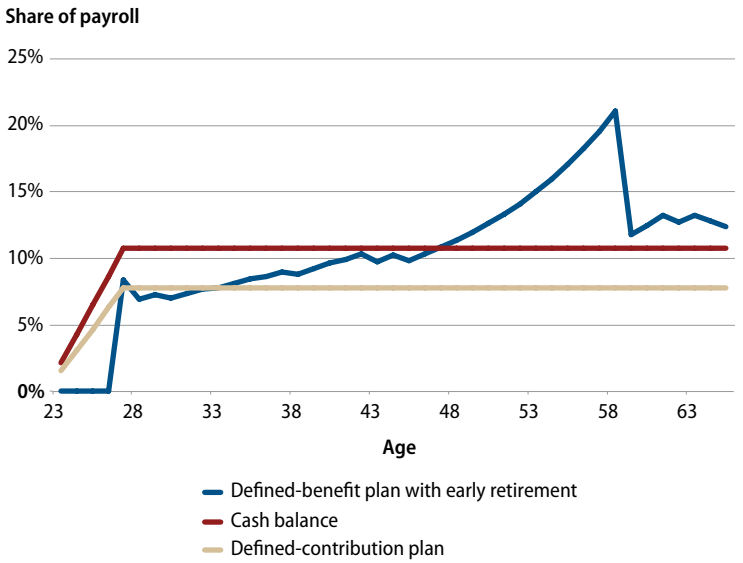
Source: Christian Weller, "What does the literature tell us about the possible effect of changing retirement benefits on public employee effectiveness?" Political Economy Research Institute at the University of Massachusetts Amherst (forthcoming).

With a defined-benefit plan, teachers earn an increasing amount of retirement benefits, relative to earnings, until they reach early retirement (after 35 years of service). A teacher, for instance, may work for 35 years in a school until she reaches age 58, assuming she started when she was 23 years of age, and she may earn 2 percent of her final salary annually as a benefit. With a final salary of $90,000, she would receive an annual defined-benefit pension of $63,000, not adjusted for inflation, (which would be equal to 35 times 2 percent times $90,000), until she dies.[8] Teachers still earn more benefits after the early retirement incentive has expired, but each year's benefit earned is less after the early retirement age than before.

In contrast, the benefits earned with cash-balance or defined-contribution plans equal fixed earnings shares, which are higher earlier in a career and lower later in a career than with defined-benefit pensions. (see Figure 1)

FIGURE 1

Different pensions, different payout over time



Notes: All figures are in percent of payroll.

Source: Christian Weller, 2011, "What does the literature tell us about the possible effect of changing retirement benefits on public employee effectiveness?" PERI Working Paper, (Amherst, MA: Political Economy Research Institute at the University of Massachusetts Amherst, forthcoming).

Retirement benefits and teacher effectiveness

Teacher quality is a critical contributor to student achievement. Teacher effectiveness is typically defined in terms of student outcomes. The issue is then how well teachers can influence student outcomes, measured in a variety of ways, typically by test scores, grades, or graduation rates. The term teacher effectiveness is thus meant to indicate the level to which teachers can influence students' successes.

How effective teachers are in improving student outcomes will depend on a host of input factors. The research literature shows that experience matters to some degree for the effectiveness of teachers, as discussed further below. There are, however, two key caveats to keep in mind about the link between experience and teacher effectiveness.

First, experience is not necessarily the same as longevity. It is reasonable to assume that teachers will eventually reach their maximum effectiveness, as is the case in other professions as well, and that further improvements in teacher effectiveness after that point are more modest than they were before. Experience and longevity are not the same.

Second, teacher experience is only one factor that could determine teacher effectiveness. Other factors may include compensation, credentials, such as certifications and formal degrees, social networks, and professional support from peers and supervisors.

The bottom line: Teacher effectiveness and teacher longevity are two distinct concepts and my simulations focus on teacher effectiveness.

The policy goals, then, are better recruitment and retention of people into the teaching profession who could become effective teachers. Switching retirement benefits from defined benefits to alternative benefits pursues this goal since initial compensation would go up as deferred compensation would go down.

Deferring compensation with defined-benefit pensions provides an incentive for employees to remain with a particular employer. This increases retention and lowers employee turnover, at least until the early retirement age.[9] What's more, these types of pensions offer early retirement incentives to incentivize leaving at a point when average teacher effectiveness may start to decrease toward the end of a teacher's career.

In contrast accruing retirement benefits early in a teaching career no longer defers compensation (as Figure 1 shows), which changes the incentives for employees.[10] Employee retention in particular may decrease and turnover could increase, perhaps substantially. This could lower average teacher effectiveness because less experienced teachers would replace more experienced ones at a higher rate than is currently the case, and there would be, in addition, a learning curve for the new teachers. At the same time, initial pay could increase if compensation is no longer deferred. This could result in schools attracting more people who may become more effective teachers in the future than is the case with defined-pension pensions.

So how would teacher turnover, initial compensation, and experience relate to teacher effectiveness? First of all, effectiveness is negatively correlated with turnover, meaning the more new teachers you have to train the less effective the teacher workforce will be during that high turnover. And alternative retirement benefits may increase turnover by eliminating the incentive to stay on the job, thus lowering average effectiveness since more experienced teachers are replaced with less experienced ones.

Average effectiveness also is positively correlated with initial pay if schools attract people who become more effective teachers in the future. And effectiveness is negatively correlated with the shape of the learning curve. A steeper learning curve lowers the average effectiveness since there is a greater difference between inexperienced and experienced teachers than with a flatter learning curve. Finally, the impact of turnover on average effectiveness is greater if the learning curve is steeper. Less experienced teachers will take longer to reach maximum effectiveness and higher turnover means that there will be more inexperienced teachers, lowering average effectiveness.

The result of switching retirement benefits on average teacher effectiveness is consequently very hard to predict. The net effect on teacher effectiveness of a negative impact of higher turnover and a steep learning curve and of a positive effect of greater initial compensation all will depend on the actual size of each effect in determining average teacher effectiveness.

Retirement benefit costs

Then there is the effect of retirement plan changes on teacher effectiveness that are partially dependent on the additional costs associated with alternative benefits since less money may be available for compensation compared to defined-benefit pensions.

There are several fees that are included in the simulations. First, the defined-contribution plans may have higher fees than defined-benefit pensions. Fees are higher by 0.5 percent to 1 percent of assets for defined-contribution plans than for defined-benefit pensions.[11]

Second, rates of return may be lower with alternative benefit plans compared to defined-benefit pensions. Cash balance plans may need to hold more cash to accommodate withdrawals from teachers leaving more quickly, which lowers the average rate of return. And defined-contribution plans are invested with a fixed retirement date in mind, which means individuals reduce risk toward the end of their career, foregoing potential earnings and lowering their savings by 5 percent after a 40-year career.[12]

Third, the loss of protections from market, idiosyncratic, and longevity risk with a defined-contribution plan compared to a defined-benefit pension lowers benefits by 41 percent after a 40-year career.[13]

The simulations, however, exclude transition costs in the initial model as well as the costs associated with hiring and training new teachers. Transition costs are separately discussed further below, but they have no effect on teacher effectiveness in the simulations. Transition and turnover costs lower the amount of money that is available for teacher compensation. The simulations thus understate the costs and hence the risks of lower average teacher effectiveness associated with switching retirement benefits.

Simulation results

Teacher effectiveness and teacher longevity are two distinct concepts and my simulations focus on teacher effectiveness. This informs my calculation of teacher effectiveness in the simulations. I set the maximum teacher effectiveness under a defined-benefit plan equal to 100 percent, which normalizes teacher effectiveness because every teacher's effectiveness is then expressed relative to the average maximum effectiveness under

such a pension plan. A percentage greater than 100 percent indicates an increase in average effectiveness relative to the average maximum under a defined-benefit pension plan, while a percentage of less than 100 percent says that the teachers are on average less effective than the typical maximum effectiveness under such a pension.

The simulations do not take a position on how student outcomes, which determine teacher effectiveness, are measured because they don't have to. The design of retirement benefits may affect teacher effectiveness, but not exactly according to the measures—by test scores, graduation rates, student grades, or some other indicator. The simulations should register similar measures of changing retirement benefits on teacher effectiveness, regardless of how student outcomes and teacher effectiveness are measured.

There are four steps to the simulation:

- Calculate a typical teacher's defined-benefit pension plan's annual cost, a cash-balance plan's pay credit, and a defined-contribution plan's contribution rate so that the costs under each plan are constant. This calculation shows the differences in initial compensation with alternative benefits, without accounting for potential transition costs.

- Use so-called Monte Carlo simulations—a way to create 1,000 hypothetical scenarios based on the existing evidence for the key parameters—to calculate the probability of improving teacher effectiveness after switching retirement benefits.

- Show the role of experience, effectiveness, and turnover separately in affecting the chance of improving average teacher effectiveness.

- Calculate the transition costs from a defined-benefit pension to alternative retirement benefits.

The annual cost of a typical teacher's defined-benefit pension plan averages 10.25 percent of earnings. This translates into a cash balance plan's pay credit of 10.78 percent of earnings, and a defined-contribution plan's contribution rate of 7.79 percent of payroll, holding total annual cost constant relative to defined-benefit pensions and ignoring transition costs.[14] The simulation model then can calculate the chance of improving teacher effectiveness since the total amount of money available for compensation, which can be moved to different points in teachers' careers, is fixed at 10.25 percent of payroll.

It is important to note that the simulations favor cash-balance plans and defined-contribution plans over defined-benefit pensions because the results show a best-case scenario or upper bound for improving teacher effectiveness. First, the simulations slightly overstate the positive link between initial compensation and teacher effectiveness. Second, the simulations apply the estimates of salaries on teacher effectiveness to nonsalary compensation, even though public employees such as teachers value a dollar in pension

TABLE 2

Gauging teacher effectiveness based on pension compensation

Simulation results for teacher effectiveness changes, with alternative retirement benefits

	Probability of improvement relative to defined-benefit plan	Average change	Change at 25th percentile	Change at 75th percentile
Cash-balance plan, follows defined-benefit plan	41.2	-1.2	-4.8	2.5
Defined-contribution plan, follows defined-benefit plan	30.2	-4.3	-9.4	1.2
Cash-balance plan, follows defined-benefit plan				
Low return to experience, fixed	100	2.3	1.8	2.9
High return to experience, fixed	0.0	-7.0	-7.7	-6.4
No change in turnover	87.4	2.5	1	4
No change in effectiveness	27.3	-3.2	-6.8	0.3
Defined- contribution plan follows defined-benefit plan				
Low return to experience, fixed	100	2.9	2.2	3.5
High return to experience, fixed	0	-11.3	-12.3	-10.2
No change in turnover	83.1	2	0.5	3.4
No change in effectiveness	24.8	-5.1	-10	0.01

Notes: All figures are in percent. Changes are relative changes.

Source: Christian Weller, 2011, "What does the literature tell us about the possible effect of changing retirement benefits on public employee effectiveness?" PERI Working Paper, (Amherst, MA: Political Economy Research Institute at the University of Massachusetts Amherst, forthcoming).

benefits less than a dollar in salary, suggesting that our simulations again overstate the positive link between initial compensation and teacher effectiveness.[15]

Third, the simulations exclude transition costs associated with moving from defined-benefit pensions to alternative benefits, thus making more money available for compensation than would occur in reality. Fourth, the model excludes the administrative costs of teacher turnover, which can be substantive, again making more money for compensation available.[16] And the model ignores any additional incentives that employers (schools) will have to pay to attract new teachers in an environment of higher turnover.

Cash-balance and defined-contribution plans lead to higher effectiveness if the average effectiveness after the switch exceeds 95.4 percent of the maximum teacher effectiveness under a defined-benefit pension. The threshold is less than 100 percent under a defined-benefit pension since there are teachers working at maximum effectiveness (equal to 100 percent) and less experienced teachers due to the existence of a learning curve. This threshold of 95.4 percent of maximum teacher effectiveness under a defined-benefit plan results if the averages for experience, effectiveness, and turnover are inserted into the simulation model discussed in the technical appendix.

The simulations show that there is substantial risk of decreasing average effectiveness due to changes in pension benefits. A change to cash-balance plans may result in higher teacher effectiveness in only 41.2 percent of the cases, and there is only a 30.2 percent chance that a switch to a defined-contribution plan will raise effectiveness. Average

effectiveness decreases by 1.2 percent with a cash-balance plan, and by 4.3 percent with a defined-contribution plan. There is also a 25 percent chance that average effectiveness drops by 4.8 percent with a cash balance plan and by 9.4 percent with a switch to a defined-contribution plan. (see Table 2)

The inputs are turnover, the shape of the learning curve, and the response of teacher effectiveness to initial pay. How does the risk of lower teacher effectiveness change if we hold each input constant and take it out of the model? The answers will give us a sense of which factor, if any, is dominant and if policy could intervene to increase the chance of success.

Holding experience constant means to either use a flat (low-return) or a steep (high-return) learning curve. A steeper-than-average learning curve reduces the average teacher effectiveness by 7 percent under a cash-balance plan and by 11.3 percent under a defined-contribution plan relative to a defined-benefit pension. The chance of improving teacher effectiveness increases with a comparatively flat learning curve, in comparison, and the average improvement increases to about 2 percent. The downside risk of a steeper learning curve exists because a state will have to hire more inexperienced teachers and the experience gap is larger than it would be with a flatter learning curve, thus reducing the average teacher effectiveness.

Next, holding turnover constant substantially reduces the risk of decreasing teacher effectiveness. The chance of higher effectiveness increases to 87.4 percent for cash balance. with an average improvement of 2.5 percent, and to 83.1 percent for defined-contribution plans with an average improvement of 2 percent.

Holding average teacher effectiveness constant increases the risk of lower effectiveness. The chance of improving teacher effectiveness drops below 30 percent for cash-balance plans and below 25 percent for defined-contribution plans. Effectiveness drops on average by 5.1 percent and 3.2 percent, respectively.

All three input factors—turnover, learning curve, and initial pay—play a role in determining teacher effectiveness after switching retirement benefits. Policymakers could focus on lowering turnover, flattening the learning curve, and increasing initial pay to increase the chance of success with changing retirement benefits.

How much money are we really talking here when discussing transition costs? Transition costs exist because promised benefits under the existing plan will have to be paid for until all existing beneficiaries are gone, while the start-up of a new plan will require higher up-front contributions due to the end of deferred compensation. Transition costs initially increase as the concentration of more experienced teachers in the defined-benefit pension and of less experienced teachers in the cash-balance plan or defined-contribution plan grows and start to decline in the third decade after the benefit switch. They exceed on average 1 percent of payroll in the third transition decade.

States and localities could spend this money to reduce the underfunding of public employees' defined-benefit pensions.[17] One of the reasons, of course, that local and state governments are looking at public employees' defined-contribution pension plans as a place to save money is because these governments have largely failed to contribute enough funds over the years to ensure these pensions are fully funded. But if state and local governments shift their teacher employees to cash-balance or defined-contribution plans then the transition costs for the next 30 years could cover between 40 percent and 80 percent of the costs of the estimated underfunding, which is estimated at about 2 percent of payroll per year.[18]

Policy implications and conclusion

The fiscal crisis in the states and localities that occurred during the Great Recession and continues in many parts of the country because of the persistent housing crisis put substantial pressure on governments to consider the efficiency of their spending. Public pensions gained substantial attention due to the need for governments to contribute additional amounts to underfunded defined-benefit pension plans when budgets were already constrained. Some observers have argued that states should take the crisis as a chance to switch retirement benefits from defined-benefit pensions to either defined-contribution or cash-balance plans.

There is a substantial risk of lower teacher effectiveness following a pension benefit switch. There is only a 30.2 percent to 41.2 percent chance that average teacher effectiveness will increase after switching retirement benefits. This risk exists because alternative benefits result in higher turnover, which means that states will have to hire less experienced teachers to replace the more experienced teachers who are leaving. The increase in initial compensation that follows a change in retirement benefits is insufficient to overcome this adverse effect.

There are few additional policy steps that policymakers could take to improve the chances of success, measured as higher teacher effectiveness, following changes in retirement plans.

There is some evidence that public employers would have only limited success in reducing turnover, flattening the learning curve, or raising initial pay to raise the chance of success of greater teacher effectiveness. First, there are few opportunities for public-sector employers to lower turnover. Private-sector employers, who do not offer a defined-benefit pension often rely on stock options or other incentive pay to lower turnover for a desired amount of time. Public-sector employers do not have this opportunity.

Second, flattening the learning curve means increasing the support for skill development for new hires. The evidence from the information technology industry, for instance, suggests that private employers are reluctant to provide key training to their employees

if they feel that the employees will not be around long enough to make full use of the costly new training.[19] So higher turnover following a switch in retirement benefits would decrease public employer's incentives to provide employee training and thus makes it harder to flatten the learning curve.

And finally, public-sector employers could increase initial compensation in a more efficient way than to redesign their retirement benefits. Public employers could design alternative retirement benefits to maximize the increase in initial pay, such as having employees earn retirement benefits immediately. The drawback to this approach is that there are even fewer incentives for employees to remain with their employer, which means turnover could further increase. A reasonable simulation suggests that immediate vesting coupled with higher turnover raises the chance of improving teacher compensation to 51.7 percent.[20] This is just another way of saying that average teacher effectiveness will likely remain unchanged after switching benefits, but this result ignores the administrative costs of turnover and transition costs. A more efficient alternative to immediate vesting with changed benefits would be to dedicate the money for these additional costs to higher initial salaries for teachers without benefit changes.

Indeed, taking this last alternative into account, remember that the results of these simulations are a lower-bound quantification of the risks involved in switching retirement benefits as defined by average teacher effectiveness since the simulations favor alternative benefits over defined-benefit pensions. There would have to be substantial additional benefits from alternative benefits to overcome the substantial risk increases. What's more, the limited potential for success in improving teacher effectiveness by switching from defined-benefit pension to alternative benefits goes along with possibly substantial costs. Transition costs, for instance, can last about four decades, and that a switch to a cash-balance plan requires transition costs of an average of 0.7 percent of payroll, and a switch to defined-contribution plans 0.3 percent of payroll over the next 40 years.

The results—based on a substantial economic and actuarial research related to pensions, teacher compensation, and teacher effectiveness—suggest that states and localities face substantial risks with respect to public-sector productivity when switching from defined-benefit pensions to alternative retirement benefits.

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Technical appendix

The key variable of interest is teacher effectiveness. There is no consensus measure for teacher effectiveness. The simulations thus make a simplifying assumption that the design of retirement benefits may affect teacher effectiveness, but not how teacher effectiveness is measured. We should see similar impacts of changing retirement benefits on teacher effectiveness, regardless of how effectiveness is calculated. This means that the simulations do not have to specify the exact measure of teacher effectiveness but rather design a way of capturing changes in teacher effectiveness under different retirement benefits.

The simulations do this by setting the maximum teacher effectiveness under a defined-benefit plan equal to 100 percent. Less experienced teachers under a defined-benefit pension or alternative retirement benefit are then characterized by a number less than 100 percent, with the reduction in effectiveness determined by how steepness of the learning curve for inexperienced teachers. And more experienced teachers under alternative retirement benefits are indicated by a number greater than 100 percent since the average teacher effectiveness at any year in a career is then expressed as share of the maximum effectiveness under a defined-benefit plan.

There are two more simplifications. First, individual characteristics are assumed to be randomly distributed in each teacher cohort and thus eliminated for the calculation of average teacher effectiveness, given the associations between teacher attributes and effectiveness.[21] This allows us to ignore teachers' individual characteristics as determinants of average effectiveness. Second, the unit of analysis is one state. The work environment—a critical determinant of turnover—is independent of retirement benefits and thus has no bearing on our simulations. Teachers' decisions to leave are frequently due to work-life quality issues, such as sense of support by school leadership, role in decision-making, and school safety or classroom management issues.[22] The simulation is akin to a regression analysis, where the effect of benefits on key variables—experience, compensation, and turnover—that impact teacher effectiveness are measured, while holding other factors constant.

Teacher turnover follows the pattern described by Douglas N. Harris and Scott J. Adams in their 2007 article "Understanding the Level and Causes of Teacher Turnover: A Comparison with Other Professions," published in the *Economics of Education Review* for a defined-benefit pension.[23] Teacher turnover is relatively high when teachers are in their 20s, and reaches its lowest point when they are in their early 40s, before rising again. Lower average turnover to start with would imply higher average teacher effectiveness with defined-benefit pension plans, as discussed further below. We also assume that net in-migration—the difference between new teachers being hired on and existing teachers becoming disabled or dying—equals 2.55 percent of total cohort employment between age 30 and age 60. The resulting average age of teachers in this plan is 41.7 years, or close to the average age of 41.8 years found by Harris and Adams in their 2007 study.[24]

Turnover increases with alternative benefits. A higher turnover means a greater share of younger teachers who earn less than older teachers and who are not fully vested and thus receive fewer benefits. The lack of pensions increases turnover on average by 22 percent at the low end and by 28 percent at the low end in the switch to a defined-contribution plan.[25] Higher turnover rates will reduce average teacher effectiveness.

The model assumes a typical teacher has a defined-benefit pension. Vesting happens after five years. The defined-benefit pension has a multiplication factor of 2 percent, meaning a teacher receives 2 percent of her final pay for each year of service, benefits increase with inflation equal to 2.5 percent annually, and teachers can receive full benefits after working for 35 years. Finally, there is a starting salary of $45,000 in 2011 and a salary schedule following the steps of the New York City school system.[26] The salary steps increase with inflation. Alternative salary schedules have no material effect on the simulations as the results depend on initial salary changes, not on the subsequent salary progression.

For cash-balance plans, the assumption is that the interest credit is equal to the discount rate and that the discount rate reflects the actual long-term rate of return on pension plan assets for a defined-benefit plan. The plan is also assumed to set aside an additional five percent of its assets in cash to accommodate in-service lump sum withdrawals, thus lowering the interest credit by 0.35 percent (a share of 0.05 to correct for the additional cash holdings times 7 percent, the assumed interest rate for the entire portfolio of a cash balance plan) annually. And, the pay credit is linearly phased in over five years, such that teachers receive 20 percent of the pay credit in their first year, 40 percent in the second year, and so on.

Defined-contribution plans are associated with substantially higher costs than a defined-benefit pension due to lower rates of return following the loss of intergenerational smoothing, and lower insurance protections. We specifically assume that there is a cost difference between defined-contribution plans and defined-benefit plans and cash-balance plans equal to 46 percent of the accumulated savings after 40 years, equal to 50 percent of the contribution rate.[27]

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Endnotes

1 This issue brief focuses on the effects of retirement benefits on average teacher effectiveness and not on addressing the funding status of teacher pension plans. The current underfunding resulted from massive stock and real estate market declines. Public pensions were prudently managed before the crisis (see Christian Weller and Jeffrey Wenger, "Prudent Investors: The Asset Allocation of Public Pension Plans," *Journal of Pension Economics and Finance* 8 (4) (2008): 501-525), but many governments did not contribute as much as was necessary to their pensions, making them vulnerable in a crisis. The problems of pensions are more a result of low employer contributions than poor pension management. Governments often avoided paying the full amount of what was necessary to cover benefits earned in a given year. Even in 2011, Gov. Chris Christie (R-NJ) considers the state's contributions to its pension plan an optional expense. Governments, as employers, have exacerbated, and continue to exacerbate, their pension plans' financial challenges. One solution is to make governments pay the necessary amount to their pension plans. States could set a floor under employer pension contributions. The employer contributions could never fall to zero, commonly known as "taking a contribution holiday," and employer contributions could never fall below the "floor" rate. Direct-benefit pensions would receive money more regularly than is currently the case and thus underfunding would become less likely, particularly during a crisis. If they set a floor for employer pension contributions, states would simultaneously have to change the rules that govern pension funding. Strong financial market performance could easily translate into overfunded pensions, which is desirable since it means that direct-benefit pensions are prepared for a rainy day, such as the recent crisis. But, overfunded plans could feed appetites for benefit improvements or contribution cuts, unless the law states that better benefits and lower contributions could only be considered if a direct-benefit pension has a minimum buffer for emergencies. Christian Weller and Dean Baker argue for a buffer of 20 percent of liabilities, which could be even smaller for state direct-benefit pension plans since states cannot go bankrupt (see Christian Weller and Dean Baker, "Smoothing the Waves of Pension Funding: Could Changes in Funding Rules Help Avoid Cyclical Under-funding?" *Journal of Policy Reform* 8(2) (2005): 131-151. See Christian Weller, Mark Price, and David Margolis, "Rewarding Hard Work: Give Pennsylvanians a Shot at Middle Class Retirement" (Washington: Center for American Progress, 2006) for a discussion of regulatory changes that could increase public employer funding of their pension plans.

2 Comprehensive reviews of the relevant literature are included in Christian Weller, "What does the literature tell us about the possible effect of changing retirement benefits on public employee effectiveness?" Political Economy Research Institute at the University of Massachusetts Amherst (forthcoming).

3 The full details are available in Weller, "What does the literature tell us about the possible effect of changing retirement benefits on public employee effectiveness?"

4 This result only follows because the change in initial compensation is limited by the amount of money that is available for compensation and because the existing literature has found only a weak connection between initial compensation and teacher effectiveness within the context of small variations of initial teacher compensation.

5 National Education Association, "Characteristics of Large Public Education Pension Plans" (2010), available at http://www.nea.org/home/30068.htm.

6 Josh Barro and Stuart Buck, "Underfunded teacher pension plans: It's worse than you think" (New York: Manhattan Institute and The Foundation for Educational Choice, 2010); Robert M. Costrell and Michael Podgursky, "Peaks, Cliffs, and Valleys: The Peculiar Incentives in Teacher Retirement Systems and Their Consequences for School Staffing," *Education Finance and Policy* 4 (2) (2009): 175-211; Janet Hansen, "An Introduction to Teacher Retirement Benefits," *Education Finance and Policy 5* (4) (2010): 402-437; Raegen Miller, "Redefining Teacher Pensions: Strategically Defined Benefits for New Teachers and Fiscal Sustainability for All" (Washington: Center for American Progress, 2011).

7 Kevin Cahill and Mauricio Soto, How Do Cash Balance Plans Affect the Pension Landscape? (Chestnut Hill: Center for Retirement Research, 2003); Robert Clark and Sylvester Schieber, "An Empirical Analysis of the Transition to Hybrid Pension Plans in the United States" (Washington: The Brookings Institution, 2000); Richard Johnson and Cori Uccello, "The Potential Effects of Cash Balance on the Distribution of Pension Wealth at Midlife: (Washington: Department of Labor, 2001).

8 Many teachers are not covered by Social Security and their direct-benefit pension is their primary retirement benefit. Many state direct-benefit pensions are not automatically adjusted for inflation, unlike Social Security's benefits.

9 Comprehensive reviews of the relevant literature are included in Weller, "What does the literature tell us about the possible effect of changing retirement benefits on public employee effectiveness?"; Ilana Boivie and Christian Weller, "The Fiscal Crisis, Public Pensions, and Implications for Labor and Employment Relations" in D. Mitchell, ed. *Impact of the Great Recession on Public Sector Employment* (Ithaca: Cornell University Press, forthcoming in 2012).

10 A formalized model of the relationship between the key variables is presented in Christian Weller, "What does the literature tell us about the possible effect of changing retirement benefits on public employee effectiveness?" Political Economy Research Institute at the University of Massachusetts Amherst (forthcoming).

11 See, for example: Council of Institutional Investors, "Protecting the Nest Egg: A Primer on Defined Benefit and Defined Contribution Retirement Plans" (Washington: Council on Institutional Investors, 2006); Christian Weller and Shana Jenkins, "Building 401(k) Wealth One Percent at a Time: Fees Chip Away at People's Retirement Nest Eggs" (Washington: Center for American Progress, 2007).

12 Beth Almeida and William B. Fornia, "A Better Bang for the Buck: The Economic Efficiencies of Pensions" (Washington: National Institute on Retirement Security, 2008) .

13 Ibid.

14 The results are discussed in greater detail in Weller, "What does the literature tell us about the possible effect of changing retirement benefits on public employee effectiveness?"

15 Edward Montgomery and Kathryn Shaw, "Pensions and Wage Premia" (Cambridge: National Bureau of Economic Research, 1992).

16 Eliah Watlington, Robert Shockley, Paul Guglielmino, and Rivka Felsher, "The High Cost of Leaving: An Analysis of the Cost of Teacher Turnover," *Journal of Education Finance* 36 (1) (2010): 22-37.

17 Details taken from Weller, "What does the literature tell us about the possible effect of changing retirement benefits on public employee effectiveness?"

18 Alicia Munnell, Jean-Pierre Aubry, and Laura Quinby, "The Funding of State and Local Pensions: 2009-2013" (Chestnut Hill: Center for Retirement Research, 2010).

19 William Lazonick, "Economic Institutional Change and Employer Pensions." In Teresa Ghilarducci and Christian E. Weller, eds., *Employee Pensions: Policies, Problems, & Possibilities*, Labor and Employment Relations Association Research Series, 2007: 29-68.

20 See Weller, "What does the literature tell us about the possible effect of changing retirement benefits on public employee effectiveness?"

21 Jennifer King Rice, "Teacher Quality: Understanding the Effectiveness of Teacher Attributes" (Washington: Economic Policy Institute, 2003).

22 Susanna Loeb, Linda Darling-Hammond, and John Luczak "How Teaching Conditions Predict Teacher Turnover in California Schools" *Peabody Journal of Education 80*(3) (2005): 44-70; Thomas Smith and Richard Ingersoll "What Are the Effects of Induction and Mentoring on Beginning Teacher Turnover?" *American Educational Research Journal*, *41* (3) (2004): 681-714; Anit Somech, "Participative decision making in schools: A mediating-moderating analytical framework for understanding school and teacher outcomes," *Educational Administration Quarterly* 46 (2) (2010): 174-209.

23 Douglas Harris and Scott Adams, "Understanding the Level and Causes of Teacher Turnover: A Comparison with Other Professions," *Economics of Education Review* 26 (3) (2007): 325-337.

24 Ibid.

25 Steven G. Allen, Robert L. Clark and Ann A. McDermed, "Pensions, bonding, and lifetime jobs," Journal of Human Resources 28 (3) (1993): 463–481; Steven Nyce, "Behavioral effects of employer-sponsored retirement plans," *Journal of Pension Economics and Finance* 6 (3) (2007): 251-285.

26 New York City Department of Education, "New York City Teacher Salary" (2010), available at http://schools.nyc.gov/NR/rdonlyres/EDDB658C-BE7F-4314-85C0-03F5A00B8A0B/0/salary.pdf.

27 Almeida and Fornia, "A Better Bang for the Buck."