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BETTER PAY, FAIRER PENSIONS II:
Modeling Preferences Between Defined-Benefit Teacher Compensation Plans

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Executive Summary

Most public school teachers in the United States participate in traditional, final-average-salary defined-benefit (FAS-DB) pension plans. A common, but underappreciated, feature of FAS-DB plans is their heavy reliance on backloaded retirement benefits. Under these plans, teachers generally earn relatively meager benefits during their first several years in the classroom and then rapidly accrue far more valuable benefits late in their careers, as they near their plan's retirement eligibility thresholds. At present, the majority of teachers leave—to take teaching jobs in other states or to work in the private sector—before earning substantial benefits.

In a recent paper (Manhattan Institute Civic Report no. 79, "Better Pay, Fairer Pensions: Reforming Teacher Compensation"), we compared the backloaded benefits offered under existing FAS-DB plans, in each of the ten largest U.S. school districts, with a less backloaded, alternative defined-benefit plan that we refer to as a smooth-accrual defined-benefit (SA-DB) plan. Using each pension plan's own assumptions about teacher attrition, we showed that the majority (and sometimes the vast majority) of teachers would be better off under a less backloaded retirement plan.

Nonetheless, teachers' preference between these two DB plans is not immediately clear from basic descriptive comparisons. On the one hand, SA-DB plans ensure that all teachers would leave with meaningful retirement benefits, even if they do so before reaching their plan's retirement age. On the other hand, FAS-DB plans offer larger benefits to teachers who work their entire careers under a single plan.

This paper builds upon our previous work to answer the question: Which of these designs should the rational teacher prefer at entry? For each of the ten largest U.S. public school systems, we use a standard economic model—incorporating variables such as level of financial risk aversion and degree of uncertainty over future career plans—to determine entering teachers' preferences between current backloaded FAS-DB pension plans and our less backloaded SA-DB alternative.

Key findings include:

- When offered a choice between two plans with the same expected retirement benefit, a rational, risk-averse teacher would consistently prefer an SA-DB plan because it offers a smaller difference between potential benefit payouts.

- The magnitude of preference for an SA-DB plan depends both upon the severity of an FAS-DB plan's backloading and the amount of early- and mid-career teacher turnover. Yet in nearly every case, the strength of teacher preference for the less backloaded system (SA-DB) is large, given reasonable, empirically grounded assumptions about risk aversion.

- Indeed, certain FAS-DB plans provide remarkably little retirement security to entering teachers. For instance, a new teacher in Hawaii's school system with a typical level of risk aversion would be wiser to accept a lump-sum payment of merely $279, rather than participate in the system's pension plan (some 77 percent of Hawaii's entering teachers will leave the system before earning $279 in retirement compensation).

- As for teachers who expect to work under the same system for many years—who would, accordingly, experience a higher probability of benefiting from backloading—many would nevertheless benefit from a less backloaded SA-DB system.

- For example, teachers certain to work under the same retirement system for five years would still prefer the alternative SA-DB plan over current FAS-DB plans. Likewise, in six of ten school systems—New York City, Chicago, Philadelphia, Clark County (Nevada), Hawaii, and Houston—a teacher certain to remain for at least ten years would prefer the SA-DB plan. (Teachers certain to work under the same retirement system for 20 years would, however, universally prefer an FAS-DB plan.) In reality, moreover, few can forecast with absolute certainty that they will remain employed under the same retirement plan for the ensuing twenty, ten, or even five, years.

In short, this paper reinforces our earlier findings: reforms to teacher compensation in favor of SA-DB plans would help school districts offer significantly more attractive teacher compensation packages, without the need for higher taxes or reduced services.

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Better Pay, Fairer Pensions II: Modeling Preferences Between Defined-Benefit Teacher Compensation Plans

Josh McGee and
Marcus A. Winters

INTRODUCTION

Since the 2008 financial crisis, public pension reform has gained national attention. Policy discussions around public pensions have, in turn, primarily focused on cost: unfunded liabilities and annual payments tied to such plans have increased substantially in recent years, resulting in difficult fiscal trade-offs in several jurisdictions. Meanwhile, the benefits side of the pension equation has received relatively scant attention. As states and school systems across the nation alter their retirement benefits, now is an ideal time to also consider whether the benefits offered under current systems meet the needs of today's workforce.

Too often, pension reform is characterized as a binary choice between final-average-salary defined-benefit (FAS-DB) plans—whereby workers receive an annuity based on years of service and final average salary—and defined-contribution (DC) plans similar to 401(k) plans common in the private sector. Indeed, numerous previous papers have considered workers' preferences between DB and DC systems and have found each style of plan to be desirable under certain circumstances.[1]

Comparisons between FAS-DB and DC plans are, however, complicated by the large number of different plan features built in to such analyses and, generally, do not consider numerous other available pension structures. What's more, many, if not all, of the assumed plan features are not inherent to one particular model and could instead be incorporated into any retirement savings plan.

One widely known attribute of defined-benefit plans is that they generally provide workers protection from investment risk. As long as the plan is well designed, well managed, and well funded, DB plan benefits do not vary with market returns. All else equal, risk-averse workers would prefer a plan providing investment protection, over the plan that does not.

What is less well understood is that retirement benefits under the dominant public-sector model, FAS-DB, are inherently backloaded—above and beyond accumulated contributions and interest. Backloading, in turn, subjects entering teachers to a different type of risk: attrition. In practice, teachers generally earn relatively meager pension benefits during their first several years in the classroom (often the first 20 years or so) and then rapidly earn much more valuable benefits as they near their plan's retirement eligibility thresholds late in their careers. As a result, employees who exit a system before reaching retirement eligibility often are left with benefits much less valuable than those who work until their plan's retirement eligibility threshold.[2]

In this paper, we isolate one important retirement plan feature—namely, how workers earn benefits across their careers—and consider reforms that would alter this feature strictly within the DB structure. The reforms we model simply shift benefits within teachers' careers, are cost-neutral to taxpayers, and would continue to offer teachers investment protection and lifetime annuities.

In a 2013 study,[3] we compared the pattern of retirement benefit accrual for new teachers in existing FAS-DB plans, in each of the ten largest U.S. school districts, with an actuarially equivalent, but less backloaded, DB plan that we refer to as a smooth-accrual defined-benefit (SA-DB) plan. As its name suggests, under the SA-DB plan, teachers earn benefits equal to a constant percentage of cumulative wages, resulting in a smoothed benefit accrual pattern. Under an SA-DB, the value of teachers' retirement benefits (payable as a lifetime annuity) equals annual contributions, plus guaranteed earnings on those contributions.

Importantly, teachers' preference between these two DB plans is not immediately clear from basic descriptive comparisons. On the one hand, SA-DB plans ensure that all teachers exit with meaningful retirement benefits, even if they exit before the plan's retirement age. On the other hand, current FAS-DB plans generally offer larger benefits to teachers who work a full career under the same plan than do cost-equivalent SA-DB plans. This paper—by estimating the magnitude of entering teachers' preferences between these two plans, given various conditions—expands upon our earlier work.

I. MODELING CURRENT TEACHER PENSION SYSTEMS

The majority of public school teachers in the United States earn retirement benefits under an FAS-DB structure. In such systems, teachers earn a lifetime annuity, which can be accessed once they reach their plan's retirement eligibility thresholds. The starting annuity amount increases as teachers accrue more years of service in the same system and as their salaries increase. The dollar value of an employee's starting annual annuity for a given age at separation a_s and age at retirement a_r is given by equation (1) below.

$$\textbf{(1)}\quad B(a_r|a_s) = YOS_{a_s} * M_{a_r,YOS} * R_{a_r,YOS} * (1 - E_{a_r,YOS}) * FAS_{a_s}$$

In equation (1): B is the starting annual annuity beginning at age a_r, given age of separation a_s; M is the benefit multiplier; R is an indicator for retirement eligibility; E is the percent reduction for early retirement; YOS is the number of years worked for the sponsor; and FAS is final average salary.

The present value of a teacher's retirement benefit, PVB, can be calculated at various ages of separation, a_s, using standard actuarial techniques (see Appendix 2).[4] In principle, PVB is the cash value of the annuity that a teacher has earned to date.[5] Teachers should, in theory, be indifferent as to whether they receive this lump-sum payment or the annuity.

We calculate the present value of teachers' retirement benefits, net of their contributions (i.e., isolating the portion of the benefit funded by the employer). Teachers will be interested in the total benefit provided under the plan; but from a retirement income perspective, netting out the value of their own contributions provides a measurement of the employer-funded benefit, or retirement compensation. Looking at benefits, net of teacher contributions, allows us to better understand how retirement benefits fit into teachers' total compensation package—and to analyze whether teachers might prefer a different pattern of compensation.

II. MODELING THE SMOOTH-ACCRUAL DEFINED-BENEFIT (SA-DB) PLAN

In this paper, our aim is to compare teachers' preference between current retirement savings plans (described in Section I) and less backloaded, cost-equivalent defined-benefit plans. We model a plan in which benefits earned by teachers are a constant percentage of their cumulative earnings. In pension parlance, the constant accrual rate for our SA-DB plans is equal to the normal cost of benefits under the current FAS-DB plans, calculated using the "entry age normal" method.

The SA-DB percentage is calculated by dividing the expected value of future retirement benefits, at age of workforce entry, by expected cumulative wages at entry (see calculations in Appendix 3). The SA-DB system modeled below is equivalent to a cash-balance defined-benefit retirement plan, where employer contributions equal the SA-DB percentage, and annual interest earned on those contributions equals the interest rate used to discount liabilities (5 percent, in our case).

Table I. Constant SA-DB Accrual Rates by School District

	Percent
Chicago	9.56
Dade County, FL	10.55
Broward County, FL	10.55
Hillsborough County, FL	9.30
Clark County, NV	11.77
Hawaii	5.09
Houston	6.95
Los Angeles	18.51
Philadelphia	5.37
New York City	8.91

Source: Authors' calculations

Table 1 shows the calculated SA-DB percentage for the plans currently offered by each of the ten largest U.S. school districts. To produce the SA-DB wealth-accrual patterns, we multiply this constant rate by teachers' cumulative earnings, at each point in their careers.

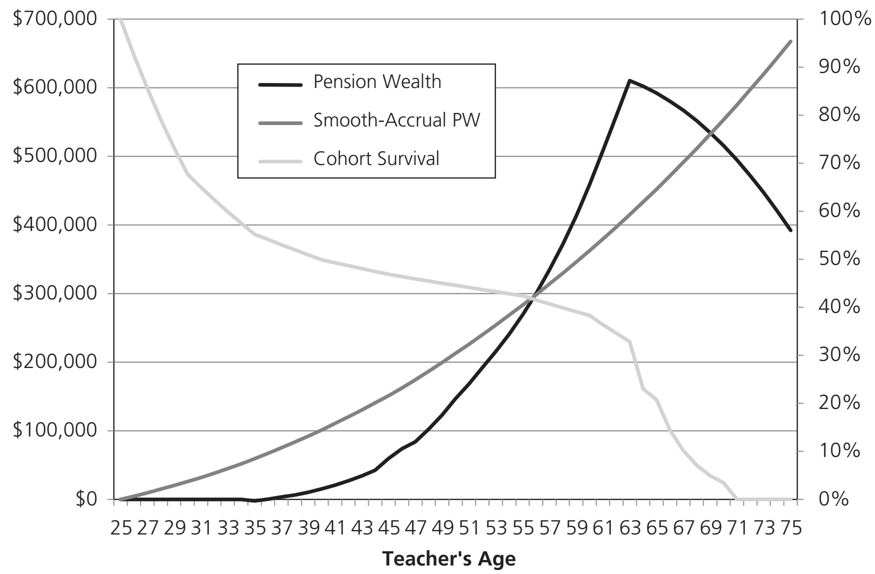
There are meaningful differences in the generosity of pension plans across systems. And though, as we will see, the distribution of benefits across teachers' careers produces substantial differences in the benefits actually earned by individual teachers within each system, most school systems offer a meaningful benefit valued at near 10 percent or more of salary per year. However, two school systems (Hawaii and Philadelphia) offer retirement compensation on average that amounts to only slightly more than 5 percent of salary. Meanwhile, Los Angeles teachers receive retirement compensation that is the equivalent of 18.51 percent of pay.

Importantly, these calculations leave out the value of Social Security, in which six of the ten districts participate. When Social Security contributions are included, teachers in these districts are generally offered average retirement compensation that is more generous than what is commonly offered in the private sector.[6] However, as we will see in the next section, most teachers receive retirement compensation that is far less valuable than the average, while a select few receive retirement packages far in excess of these averages.

III. THE PATTERN OF RETIREMENT BENEFITS ACCRUAL

Under the dominant retirement plan offered to teachers today, retirement compensation is heavily backloaded—far more so than other elements of total compensation. Figure 1 provides an illustration of retirement compensation over the career of

Figure I. Retirement Wealth over Time, Under Alternate Systems, New York, NY



Source: Authors' calculations

a 25-year-old entrant into New York City's public teaching workforce. The figure presents three lines, including: (i) the present value of the total benefit, net of employee contributions (retirement compensation); (ii) cost-equivalent smooth accrual; and (iii) cohort survival, according to the plan's decrement table. (Appendix 1 presents similar figures for each of the nation's ten largest school districts.)

We first consider pension benefits under the current system (black line). Figure 1 clearly illustrates the current backloaded nature of retirement compensation. Teachers earn relatively meager retirement benefits early in their careers. The rate at which they accrue benefits then increases rapidly later in their careers, illustrated by the steepening of the line around age 50. In New York, the actuarial maximum pension benefit is earned at age 65. After 65, teachers' benefits actually lose value each additional year that they remain employed by the school system: each year in the classroom, after reaching retirement eligibility, represents one year fewer of pension payments.

The dark grey line represents pension benefits under the alternative SA-DB plan. Unlike the current FAS-DB, teachers earn benefits at a relatively constant rate throughout their careers. As a result, teachers earn significantly more valuable benefits early in their careers than they would under the existing plan. At the same time, teachers who remain in the system for a long period of time earn less under SA-DB than they would under FAS-DB.

Because we are modeling a cost-equivalent plan, the value of SA-DB benefits, relative to the current FAS-DB, is driven by the rate at which teachers leave the plan in the early and middle portions of their careers. The SA-DB line in Figure 1 can also be viewed as the current pension plan's expected value of employer contributions *and* earnings on those contributions over time. Under the current FAS-DB system, for a portion of teachers' careers, the contributions made by their employer are more valuable than the benefits they have earned. When workers leave the system during this period, contributions made on their behalf in excess of the value of their benefits are used by the plan to pay teachers whose benefits exceed the employer contributions made on the latter's behalf, respectively. In other words, a cost-equivalent SA-DB plan only offers less valuable benefits relative to the FAS-DB plan late in workers' careers—to the extent that the current system relies on teacher turnover to keep total employer cost low. Finally, the light grey line addresses the issue of teacher turnover: the pension plan's own assumption for the percentage of entering teachers expected to remain employed under the retirement plan until a given age. Figure 1 demonstrates that by the time benefits under the two plans are equal—represented by the point at which the FAS-DB and SA-DB lines cross (age 56)—only about 42 percent of teachers who started within this cohort are expected to be still employed by the New York City system. That is, 58 percent of teachers are expected to leave before they would benefit from the backloaded structure of the current plan.

Even in New York City, which has very low teacher turnover for an urban district, the majority of 25-year-old entering teachers are not expected to make it to the point where their retirement compensation is at least as valuable as the employer contributions made on their behalf. Indeed, the issue affects far more teachers in certain other systems that impose more severe backloading and have higher early-career attrition.

Philadelphia is one such example: the city's plan heavily backloads pension benefits late in teachers' careers (Figure 2). Meanwhile, teacher attrition in Philadelphia is very high for early-career teachers. As Figure 2 shows, teachers who would remain in the system until age 50 would benefit from the existing system. However, only about 18 percent of teachers who enter at age 25 are expected to remain employed under the plan until age 50.

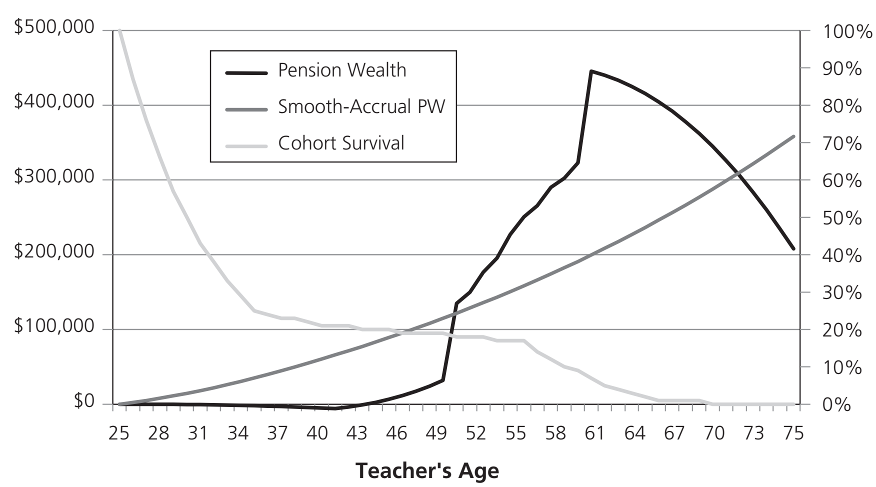
IV. UNCERTAIN TEACHER PREFERENCES BETWEEN PLANS

Thus far, we have discussed how teachers earn retirement benefits under current plans and less backloaded, cost-equivalent plans. Relative to the current FAS-DB plan, the SA-DB plan would provide higher benefits to teachers who separate earlier in their careers—at the expense of lower benefits for teachers who work under a single plan until reaching retirement eligibility.

If a teacher were to know at the beginning of his career the exact number of years he would work under the same retirement plan, his preference between the systems would be obvious. Alas, there is little reason to believe that entering teachers are able to reliably forecast their tenure in a single retirement system.

We consider teacher preferences between plans by treating the issue as a choice under uncertainty.

Figure 2. Retirement Wealth over Time, Under Alternate Systems, Philadelphia, PA



Source: Authors' calculations

Each retirement plan yields a series of discrete payoffs across service that entering teachers can expect to achieve with probability (p). The series of payouts, combined with teachers' uncertainty about their tenure, constitutes a "lottery" for retirement benefits. We examine which pension plan (i.e., which lottery) would be preferred by an entering teacher, given preferences about risk.

Our primary analysis considers the preferences of a hypothetical 25-year-old female entrant to the teaching workforce, one naive about the number of years she will work under her current pension plan. That is, we assume that our entering teacher's probability of exit matches the historical pattern of teacher attrition, within that particular pension system. We use the pension plans' decrement tables—assumed hazard rates across age and service—to calculate the exit probabilities for our hypothetical teacher. Because our exit probabilities are tethered to the plans' expected attrition rates, we argue that this analysis offers the best estimate for an average entering teacher. Later, we consider the preferences of teachers who enter with the knowledge that they are certain to remain in the plan for a minimum number of years (and thus may have different preferences from those of teachers lacking such certainty).[7]

In our model, teachers consider their expected retirement compensation when they enter employment at a school district. When offered a choice between two plans, a risk-neutral entering teacher would prefer the lottery offering the highest expected value, at the point of entry. By design, the SA-DB plans we evaluate have the same expected value as the respective current system with which it is directly compared. Thus, a risk-neutral entering teacher, naive about the number of years she will remain in the classroom, is indifferent as to which plan she wants.

Empirical research, however, suggests that workers are at least somewhat risk-averse.[8] In addition, at least one laboratory experiment finds that teachers are particularly risk-averse.[9] As such, we can meaningfully expand upon our analysis by considering teacher preferences under various assumptions accounting for their aversion to risk.

V. RISK-AVERSE INDIVIDUALS PREFER THE SA-DB PLAN TO CURRENT FAS-DB PLANS

While the SA-DB plans that we model are designed to have the same expected value as current plans, they have smaller variance than do current backloaded plans (see Appendix 3). Table 2 reports the standard deviation for pension benefits accrual under each current, and alternative, SA-DB plan. Together, these facts imply that a risk-averse entering teacher would always prefer the SA-DB plan because less backloaded plans second-order stochastic dominate current plans.[10] The proof derives from the argument regarding mean preserving spreads of distributions. In short, when offered choices between two distributions with the same expected value, a risk-averse teacher will prefer the distribution with smaller variance: the SA-DB plan offers the same expected return, but less difference between potential benefit payouts.

VI. CONSIDERING THE MAGNITUDE OF TEACHER PREFERENCES

Though it is a potentially important finding that risk-averse teachers would prefer a less backloaded plan to their current plan, the analysis thus far does not indicate the magnitude of this preference. This

Table 2. Standard Deviation, Under (Current) FAS-DB and (Alternative) SA-DB Plans

	FAS-DB ($)	SA-DB ($)
Chicago	87,592	75,624
Dade County, FL	75,582	40,479
Broward County, FL	78,813	41,139
Hillsborough County, FL	67,504	36,455
Clark County, NV	88,052	50,826
Hawaii	41,974	21,897
Houston	62,979	29,886
Los Angeles	110,334	93,953
Philadelphia	58,778	29,640
New York City	106,164	76,991

Source: Authors' calculations

is an essential factor to consider, if only because altering the structure of public pension systems is a difficult logistical and political undertaking—and therefore might only be worthwhile (from a policymaker's perspective) if teacher preference for the SA-DB system is substantial.

To estimate the magnitude of teachers' preference for the less backloaded plan, we must specify a utility function. The utility function is a tool commonly used by economists to map an individual's well-being (often thought of as "happiness"), under different states of the world, by formalizing the relationship between changes in a given good (in our case, retirement benefits) on an individual's rate of satisfaction.

Consistent with similar previous research, we assume that teacher utility follows a CRRA isoelastic utility function, taking the form in equation (2) below:

$$(2)\quad U(W)=\frac{W^{1-\eta}}{1-\eta}$$

In equation (2): W represents the present value of retirement benefits accrued at time of separation (as considered by the entering teacher at time of hire) and η represents the coefficient of risk aversion. Where $\eta = 0$, individuals are risk-neutral; as η increases, individuals become more risk-averse. We consider teacher preferences, under various assumptions, for aversion to risk. Previous empirical research in economics suggests that $\eta = 0.71$ offers a good approximation of workers' risk aversion.[11] We might consider this finding, based on research evaluating all workers, to be a lower bound in the case of teachers.

For this analysis, we use previously determined values for the present value of pension benefits, as well as the probability of exiting the retirement plan, to calculate the teacher's expected utility from each plan's lottery (see Appendix 2).

We then convert these utility calculations into the certainty equivalents for each lottery and level of risk aversion. The certainty equivalent is a conventional economic calculation representing the dollar amount that an entering teacher would be willing to accept, in lieu of participating in a respective retirement plan.

Table 3 shows the certainty equivalents for each system, under a variety of assumed levels of risk aversion. The plan that produces the higher certainty equivalent at a given level of risk aversion is preferred by the average teacher entering the system. Intuitively, an entering teacher would require a larger up-front payment to be persuaded to forgo participation in the preferred plan, versus the alternative plan. The third column for each system reports the percentage increase in the certainty equivalent for the SA-DB plan, relative to that of the respective current system. Because the plans, by design, have the same expected value, the plans have the same certainty equivalent for a risk-neutral teacher.[12] As the assumed level of risk aversion is increased, so too does the difference between the certainty equivalents for the plans.

As an example, consider the values for New York City. Under both plans, entering teachers are expected to earn average retirement compensation equal to $98,380—shown by the certainty equivalent for a risk-neutral teacher ($\eta = 0$). An entering teacher, naive about her tenure, should be indifferent as to whether she accepts $98,380 when she is hired or participates in either of the retirement plans. (To counter the risk of exiting the system before earning the equivalent retirement benefits by participating in the plans, the teacher would, in theory, be willing to accept this up-front payment.)

A risk-averse teacher, on the other hand, would be willing to accept a lower amount up front, in lieu of participating in the pension plan, because she is more concerned about the risk that she might leave the system having earned less than the average amount. According to Table 3, a 25-year-old teacher entering the New York City public school system who exhibits risk aversion—such that $\eta = 0.3$—would be indifferent as to whether to accept an up-front payment of $72,847 or participate in the current FAS-DB retirement plan. In comparison, we calculate that the same teacher

Table 3. Certainty Equivalents for Current FAS-DB and SA-DB Plans, Under Various Assumptions for Risk Aversion

	New York			Philadelphia			Dade County, FL		
η	Current ($)	SA-DB ($)	Difference (%)	Current ($)	SA-DB ($)	Difference (%)	Current ($)	SA-DB ($)	Difference (%)
0.0	98,380	98,380	0.0	27,518	27,518	0.0	32,894	32,894	0.0
0.3	72,847	87,077	19.5	13,466	22,994	70.7	16,526	26,912	62.8
0.7	22,211	69,910	214.8	606	17,937	2,861	1,235	20,181	1,534.3
	Clark County, NV			**Houston**			**Hillsborough County, FL**		
η	Current ($)	SA-DB ($)	Difference (%)	Current ($)	SA-DB ($)	Difference (%)	Current ($)	SA-DB ($)	Difference (%)
0.0	57,863	57,863	0.0	27,457	27,457	0.0	29,712	29,712	0.0
0.3	37,148	49,445	33.1	13,306	23,280	75.0	15,090	24,251	60.7
0.7	6,625	38,346	478.8	667	18,140	2,619	1,159	18,074	1,459.2
	Chicago			**Broward County, FL**			**Los Angeles**		
η	Current ($)	SA-DB ($)	Difference (%)	Current ($)	SA-DB ($)	Difference (%)	Current ($)	SA-DB ($)	Difference (%)
0.0	74,968	74,968	0.0	33,760	33,760	0.0	142,609	142,609	0.0
0.3	58,962	61,992	5.1	16,812	27,714	64.8	123,173	129,005	4.7
0.7	37,842	43,731	15.6	1,236	20,878	1,589	89,739	106,129	18.3
	Hawaii								
η	Current ($)	SA-DB ($)	Difference (%)						
0.0	16,288	16,288	0.0						
0.3	7,221	12,559	73.9						
0.7	279	8,674	3,007.8						

Source: Authors' calculations

would require an up-front payment of $87,077, in lieu of participating in the SA-DB plan. Thus, because she would require a higher up-front payment to forgo participating in the SA-DB plan, this suggests that risk-averse teachers would prefer the SA-DB plan over the current FAS-DB plan. Reasoned intuitively, this preference occurs because the SA-DB plan offers a larger benefit early in teachers' careers, thereby reducing the penalty that teachers face for exiting the system prior to retirement eligibility.

Consistent with the previous example, once risk aversion is introduced ($\eta > 0$), the SA-DB plan is preferred over the current plan in each case. Indeed, the preference for the SA-DB plan increases as risk aversion increases.

The magnitude of the preference between a given current system and its SA-DB counterpart differs substantially across systems, depending on the severity of the current plan's backloading and probability of remaining employed under the same plan for a prolonged period of time. For instance, in the heavily backloaded Philadelphia system, even at the relatively low level of risk aversion (where $\eta = 0.3$), we see that the teacher would require a 70.7 percent higher payoff at entry in lieu of participating in the SA-DB plan, than he would require in lieu of participating in the current FAS-DB plan. On the other hand, even at $\eta = 0.7$, the payoff required—for a teacher to choose not to participate in the SA-DB Chicago plan—is only about 15.6 percent higher than she would require not to participate in Chicago's relatively less backloaded FAS-DB system.

In cases where benefits are heavily backloaded, with significant early-career turnover, certainty equivalents for the current system can appear so low, once risk aversion is introduced, that they seem implausible. In Hawaii, for instance, the certainty equivalent for an individual with $\eta = 0.7$ (a level consistent with empirical research) is only $279. In other words, an entering teacher should be willing to accept $279 at the time of hire, rather than participate in the system's pension plan. But when one considers the fact that 77 percent of Hawaii's entering teachers are expected to leave the system before earning $279 in retirement compensation (see Appendix 1), this finding no longer seems so odd.

VII. PREFERENCES OF TEACHERS WITH HIGH EXPECTATIONS FOR LONGEVITY IN SYSTEM

Thus far, we have considered the preferences of teachers who enter a school system with no particular expectation of the amount of time that they will remain employed under the same plan. Since our "naive" teacher's exit probabilities are based on real attrition rates, we argue that, on average, this analysis is the best way to consider the preferences of teachers.

However, we might be especially concerned with the preferences of teachers who expect to remain in a particular school system for a sustained period of time. Schools might wish to attract teachers who expect to remain in the system for their entire careers—or, at least, longer than the average teacher. Retaining, as well as rewarding, employees is a frequent justification for the backloaded nature of current pension plans.[13]

As Appendix 1 makes clear, current plans are quite beneficial for teachers working under the same plan long enough to benefit from the steep benefit accrual earned late in their careers. For this reason, entering teachers anticipating long careers under the same retirement system might prefer current plans to less backloaded ones.

Any given teacher, it is true, might enter a school system with any (among an infinite) number of expectations for his or her tenure. To limit our analysis to a manageable number of alternatives, we therefore consider teachers certain to remain in a particular school system for a fixed number of years: five, ten, or 20 (i.e., we consider the preferences of a hypothetical teacher with a 0 percent chance of exiting the retirement plan within the first five years, and so on). We utilize, as before, information from the respective pension plan's decrement tables for the probability that a teacher exits after any given year of service—but we assign a probability of exit at *earlier* years of service (five, ten, or 20) to be 0.

The certainty equivalents for certain-to-remain teachers with risk-aversion values equal to 0.3 or 0.7 are reported in Table 4. We use boldface type to highlight the preferred plan in each comparison. We focus our discussion on the case where $\eta = 0.7$—the level suggested by previous empirical findings.

In all plans, teachers certain to remain in the same school system for 20 or more years prefer the current FAS-DB plan to the alternative SA-DB plan. At first blush, this might surprise, given that in each of the districts, the SA-DB system is more valuable than the FAS-DB at 20 years of service. However, at this point in a teacher's career, she is relatively close to the maximum benefit offered under these plans, and the probability that she leaves the system sometime over the next ten years is quite low.

Meanwhile, the story is entirely different for teachers with lower levels of certainty about their tenure. For each of the plans in our analysis, teachers only certain to remain in the retirement system for at least five years prefer the SA-DB plan. In addition, in six systems—New York City, Chicago, Philadelphia, Clark County, Hawaii, and Houston—a teacher certain to remain for at least ten years would continue to prefer the SA-DB plan over the existing pension plan.

The results in Table 4 are particularly revealing, given the extreme nature of the test under consideration: few, if any individuals, at the time they are hired, can realistically say with absolute certainty that they will remain employed under the same retirement plan for the ensuing ten years. Our result suggests that even if such an individual did exist, he would prefer, under a conventional assumption for risk aversion, the SA-DB plan to current backloaded FAS-DB plans in the majority of the ten largest American school districts.

Table 4. Certainty Equivalents, for Certain-to-Remain Teachers, for Current FAS-DB and SA-DB Plans, Under Various Assumptions for Risk Aversion

	New York				Chicago			
	$\eta = 0.3$		$\eta = 0.7$		$\eta = 0.3$		$\eta = 0.7$	
Certain Years*	**Current ($)**	**Smoothed ($)**	**Current ($)**	**Smoothed ($)**	**Current ($)**	**Smoothed ($)**	**Current ($)**	**Smoothed ($)**
5	127,132	**133,437**	81,447	**125,401**	119,864	**122,083**	105,823	**114,471**
10	**169,284**	159,193	152,957	**156,059**	**156,611**	153,480	147,836	**150,293**
20	**204,429**	176,503	**201,496**	175,930	**189,355**	174,540	**187,083**	174,079
	Philadelphia				**Los Angeles**			
	$\eta = 0.3$		$\eta = 0.7$		$\eta = 0.3$		$\eta = 0.7$	
Certain Years*	**Current ($)**	**Smoothed ($)**	**Current ($)**	**Smoothed ($)**	**Current ($)**	**Smoothed ($)**	**Current ($)**	**Smoothed ($)**
5	36,413	**44,633**	6,170	**40,763**	**196,340**	195,446	184,343	**190,898**
10	**98,461**	73,652	62,852	**72,354**	**217,122**	210,401	**212,366**	209,074
20	**135,954**	83,102	**130,151**	82,902	**231,007**	218,546	**229,839**	218,320
	Clark County, NV				**Hillsborough County, FL**			
	$\eta = 0.3$		$\eta = 0.7$		$\eta = 0.3$		$\eta = 0.7$	
Certain Years*	**Current ($)**	**Smoothed ($)**	**Current ($)**	**Smoothed ($)**	**Current ($)**	**Smoothed ($)**	**Current ($)**	**Smoothed ($)**
5	86,516	**92,472**	47,633	**88,410**	62,499	**63,393**	31,936	**58,907**
10	**121,438**	110,326	102,591	**109,041**	**107,782**	85,629	**89,090**	83,380
20	**155,720**	121,388	**147,955**	121,194	**165,406**	105,114	**158,176**	104,690
	Dade County, FL				**Broward County, FL**			
	$\eta = 0.3$		$\eta = 0.7$		$\eta = 0.3$		$\eta = 0.7$	
Certain Years*	**Current ($)**	**Smoothed ($)**	**Current ($)**	**Smoothed ($)**	**Current ($)**	**Smoothed ($)**	**Current ($)**	**Smoothed ($)**
5	68,448	**69,721**	34,020	**64,622**	69,633	**71,424**	34,058	**66,375**
10	**118,471**	94,242	**95,771**	91,470	**120,615**	96,112	**95,971**	93,363
20	**185,145**	116,976	**176,913**	116,413	**189,565**	118,803	**179,055**	118,170
	Hawaii				**Houston**			
	$\eta = 0.3$		$\eta = 0.7$		$\eta = 0.3$		$\eta = 0.7$	
Certain Years*	**Current ($)**	**Smoothed ($)**	**Current ($)**	**Smoothed ($)**	**Current ($)**	**Smoothed ($)**	**Current ($)**	**Smoothed ($)**
5	33,787	**38,517**	10,220	**35,749**	41,958	**50,009**	9,729	**46,743**
10	**55,057**	50,172	29,642	**48,768**	**71,812**	64,939	34,091	**62,997**
20	**100,820**	62,734	**93,897**	62,476	**142,678**	83,660	**135,011**	83,067

* Indicates the number of years that the employee is assumed to have zero probability of attrition
Source: Authors' calculations

CONCLUSION

In this paper, we used information from pension plans in the ten largest U.S. school districts to demonstrate that—under a variety of conditions—teachers would prefer less backloaded retirement benefits. We have also demonstrated that—under reasonable assumed levels of risk aversion—teachers' preference for a less backloaded plan is often quite large.

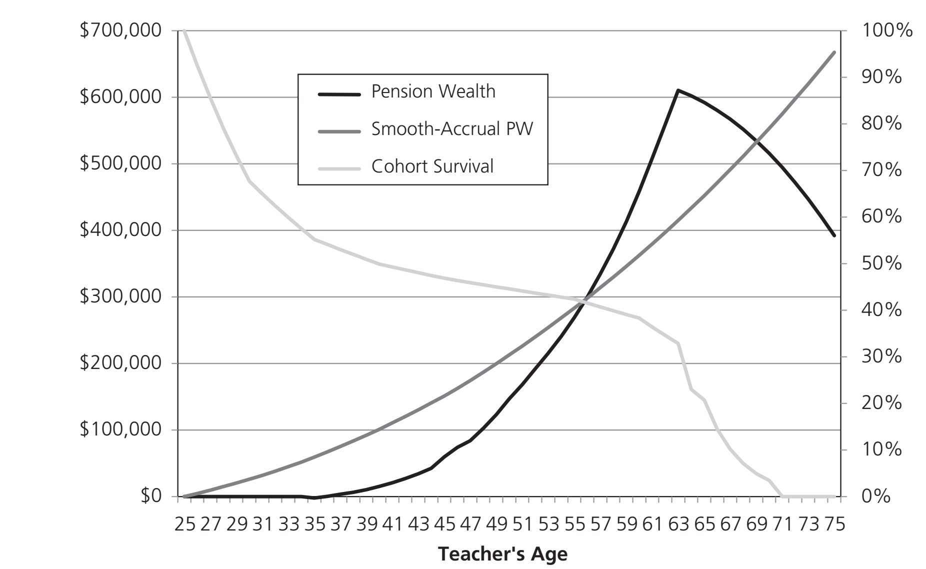
For policymakers, our findings offer several important insights. Most startling, perhaps, is our calculation of just how undesirable many current pension plans are from a teacher's perspective, after accounting for even the slightest amount of risk aversion. Indeed, some current plans are so heavily backloaded—offering entering teachers such little probability of earning meaningful retirement benefits—that risk-averse teachers would be willing to accept relatively small certain amounts at the time of hire, rather than participate in the pension plan. All of this strongly suggests that future teachers might greatly benefit from less backloaded benefits.

In addition, our analysis makes clear some similarities, as well as meaningful differences, between plans offered in districts across the United States. Each of the current systems considered is backloaded and can, in fact, be improved (from the risk-averse teacher's perspective) by adopting a less backloaded plan. However, the magnitude of the preference varies considerably across systems: some current pension plans are severely backloaded, and others less so.

To our knowledge, our paper represents the first formal consideration of teacher preferences between current FAS-DB systems and less backloaded alternative defined-benefit plans. Additional research is, admittedly, needed to ascertain all the effects of a policy change toward the latter. In particular, future research should more formally consider the likely impact of such a change in pension plans on teacher attrition patterns—and, consequently, on the distribution of teacher quality within American public schools.

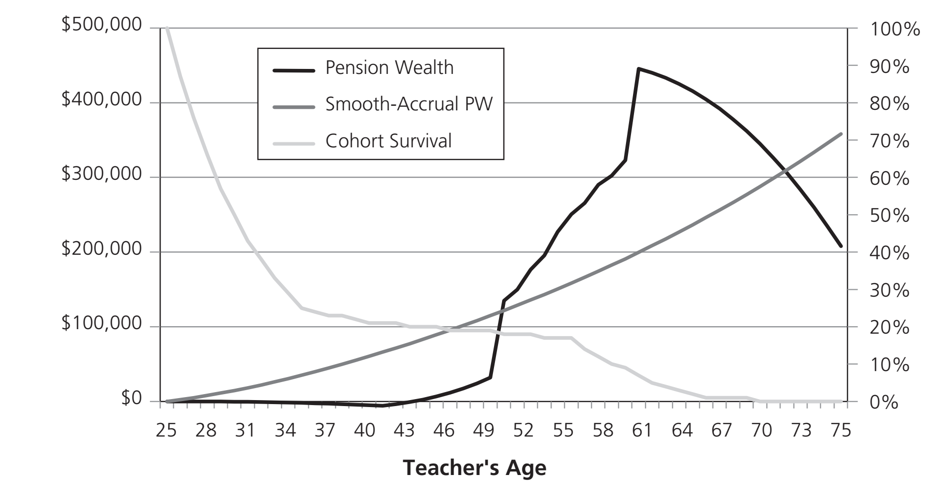
Appendix I. Employer-Sponsored Retirement Wealth over Time, Under Alternative Systems

Figure 1. Retirement Wealth over Time, Under Alternate Systems, New York, NY



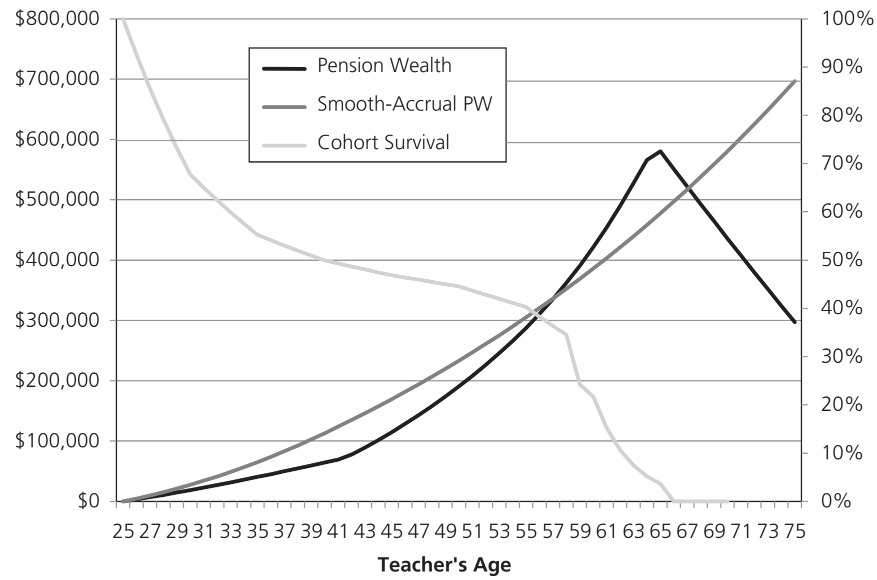
Source: Authors' calculations

Figure 2. Retirement Wealth over Time, Under Alternate Systems, Philadelphia, PA



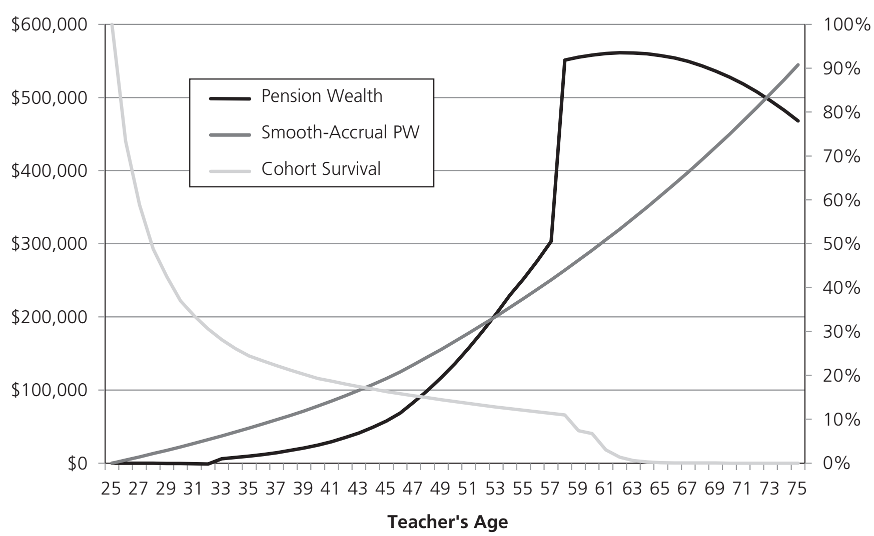
Source: Authors' calculations

Figure 3. Retirement Wealth over Time, Under Alternate Systems, Chicago, IL



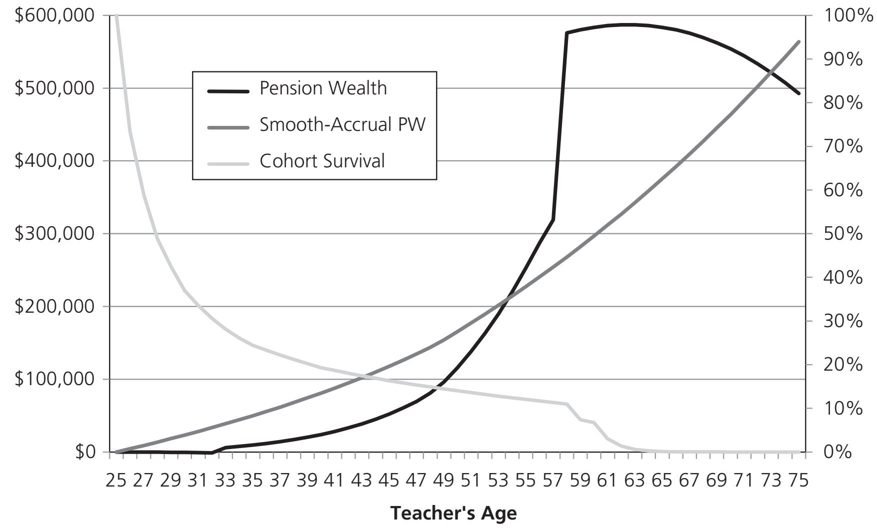
Source: Authors' calculations

Figure 4. Retirement Wealth over Time, Under Alternate Systems, Dade County, FL



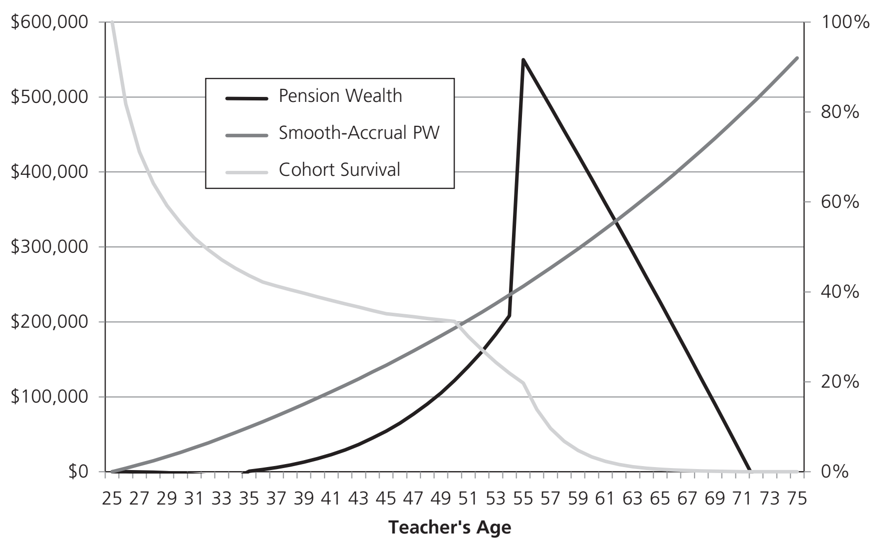
Source: Authors' calculations

Figure 5. Retirement Wealth over Time, Under Alternate Systems, Broward County, FL



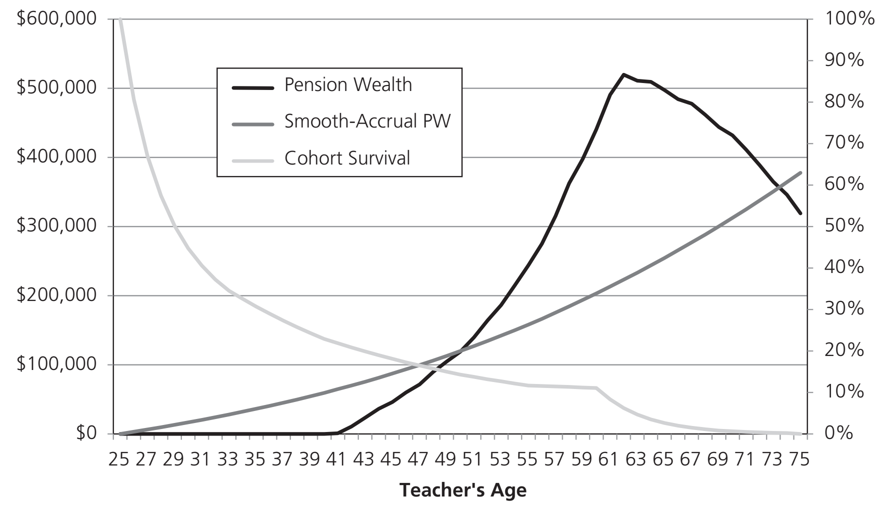
Source: Authors' calculations

Figure 6. Retirement Wealth over Time, Under Alternate Systems, Clark County, NV



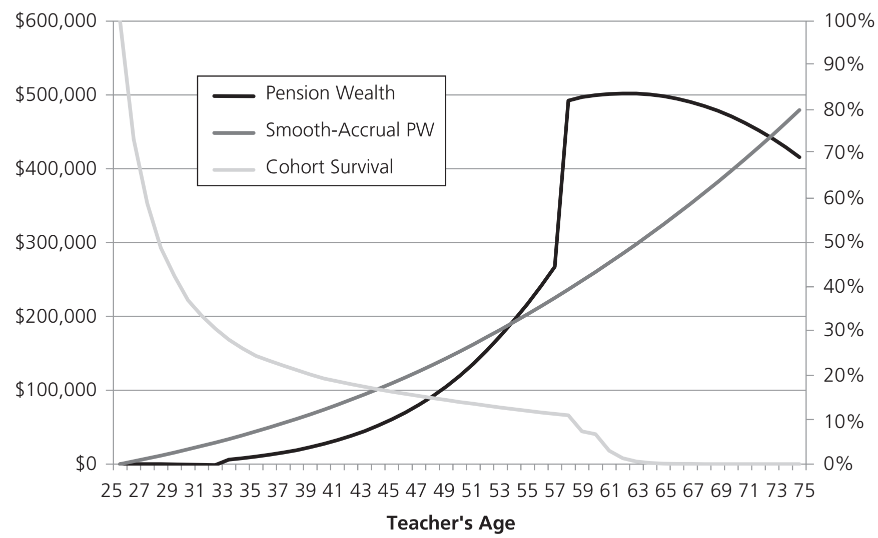
Source: Authors' calculations

Figure 7. Retirement Wealth over Time, Under Alternate Systems, Houston, TX



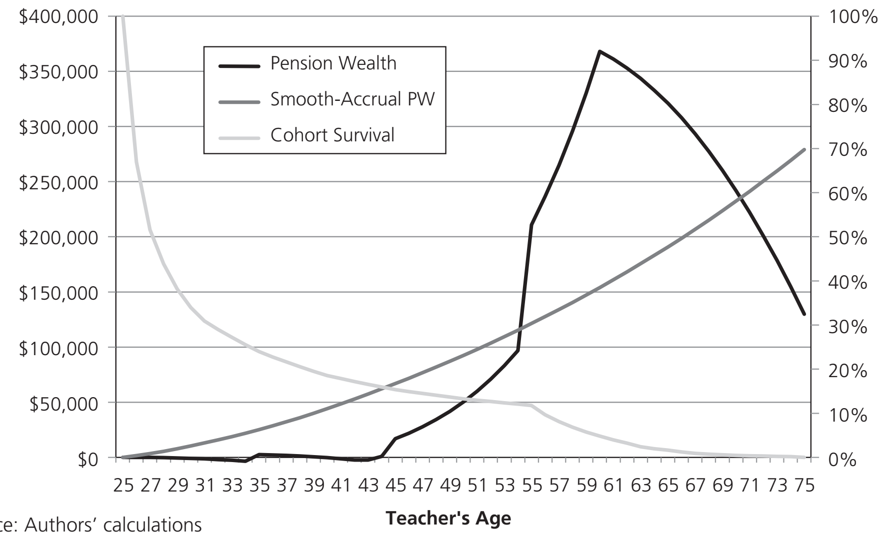
Source: Authors' calculations

Figure 8. Retirement Wealth over Time, Under Alternate Systems, Hillsborough County, FL



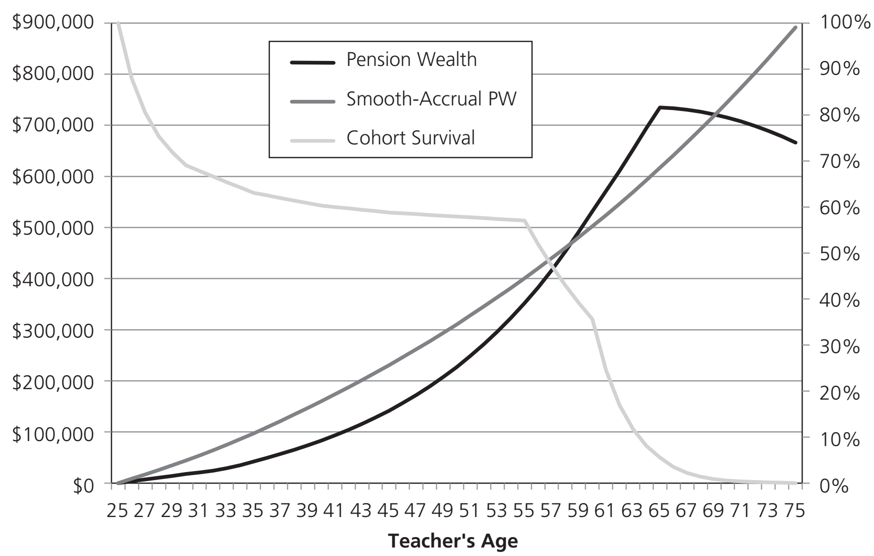
Source: Authors' calculations

Figure 9. Retirement Wealth over Time, Under Alternate Systems, Hawaii



Source: Authors' calculations

Figure 10. Retirement Wealth over Time, Under Alternate Systems, Los Angeles, CA



Source: Authors' calculations

APPENDIX 2. CALCULATING NET PRESENT VALUE OF RETIREMENT WEALTH

The present value of an employee's retirement benefit, *PVB*, can be calculated at various ages of separation, a_s, using standard actuarial techniques.[14] Retirement rules may allow employees to begin receiving an annuity immediately—or may require them to defer until meeting the retirement eligibility thresholds. The present value of the employee's retirement benefit, at any given age, is given by equation (A1) below. The equation calculates the maximum pension benefits that an employee may achieve at each age, a_s.

$$PVB_{a_s} = \max_{\{a_r \in A | a_r \geq a_s\}} [B(a_r|a_s) * AF_{a_r} * f(a_r|a_s) * (1+r)^{-(a_r - a_s)}] \qquad \textbf{(A1)}$$

In equation (1) (see Section I), $B(a_r|a_s)$ is the starting annuity that an employee would begin receiving at the age of a_r, given that the employee separated at age a_s; *AF* is the annuity factor, representing the value of a dollar of annuity, beginning at the age of retirement a_r; $f(a_r|a_s)$ is the conditional probability of survival from a_s to a_r; and *r* is the interest rate used to discount future cash flows.

In principle, PVB_{a_s} represents the cash value of the annuity that an employee has earned at age a_s.[15] An employee should be indifferent as to whether to receive the lump sum PVB_{a_s} or the annuity $B(a_r|a_s)$.

The present value of an employee's retirement benefit can be calculated net of employee contributions (i.e., isolating the portion of the benefit funded by the employer), PVB^{net}, shown in equation (A2) below. *TotCont* represents cumulative employee contributions, up to a specified age. While workers will be interested in the total benefit provided under the plan (from a retirement income perspective), netting out the value of worker contributions provides a measurement of the employer-funded benefit, or retirement compensation. Looking at benefits, net of worker contributions, allows us to better understand how retirement benefits fit into workers' total compensation package— and analyze whether workers might prefer a different pattern of compensation.

$$PVB_{a_s}^{net} = PW_{a_s} - TotCont_{a_s} \qquad \textbf{(A2)}$$

Appendix 3. Calculating the Constant Accrual Rate Under the Smooth-Accrual Defined-Benefit Plan

In this paper, our aim is to compare the current retirement savings system, described in Section I, with a cost-equivalent system featuring a smooth-accrual pattern across a worker's career. (By "smooth," we mean that the benefits earned by teachers are a constant percentage of their cumulative earnings.) In pension parlance, the constant accrual rate in our SA-DB system is equal to the normal cost of benefits calculated using the Entry Age Normal method. The SA-DB percentage is calculated by dividing the expected value of future retirement benefits (at age of workforce entry) by expected cumulative wages at entry. The SA-DB system, modeled below, is equivalent to a cash-balance defined-benefit retirement system, where employer contributions are equal to the SA-DB percentage—and annual interest on those contributions is equal to the interest rate used to discount liabilities (5 percent, in our case).

Equation (A3)—the numerator of the SA-DB percentage formula—calculates the expected value of retirement benefits standing at entry age, a_e, where $g(a_s)$ represents the separation probability distribution for a given entry age.[16] The summation extends to the last possible age at which an employee might separate from employment, a_z.

$$E_{a_e}(PVB^{net})=\sum_{a=a_e}^{a_z} PVB_a^{net}(1+r)^{-(a-a_e)}*g_{a_e}(a_s) \qquad \textbf{(A3)}$$

Equation (A4)—the denominator of the SA-DB percentage formula—calculates expected cumulative wages for an employee entering the pension plan at age a_e.

$$E_{a_e}(CCW_e)=\sum_{a=a_e}^{a_z} CW_a*(1+r)^{-(a-a_e)}*g_{a_e}(a_s) \qquad \textbf{(A4)}$$

Equation (A5) represents the SA-DB percentage, the constant percentage of cumulative wages resulting in a smooth-accrual pattern that is cost-equivalent to the current backloaded FAS-DB accrual pattern. Equation (A5) is simply the quotient of equations (A3) and (A4). Importantly, the smooth-accrual percentage is specific to a particular entry age.

$$SA_{a_e}=E_{a_e}(PVB^{net})/E_{a_e}(CCW_e) \qquad \textbf{(A5)}$$

APPENDIX 4. UTILITY AND CALCULATING THE CERTAINTY EQUIVALENT

For this analysis, we use previously determined values—for the *present* value of pension benefits and probability of exiting the pension system at given years—to calculate the teacher's expected utility from each lottery. The expected utility from a lottery equals the sum of the utility products deriving from the retirement benefits accrued from leaving the system at time period i $(U_i(W_i))$; and the probability (p_i) of exiting after i years of service. Keeping with the decrement tables used by the pension plans, we consider teacher exits at year one through 50. Formally:

$$E(U(W))=\sum_{i=1}^{50} p_i U(W_i)=\sum_{i=1}^{50} p_i \frac{W^{1-\eta}}{1-\eta} \qquad \textbf{(A6)}$$

Each value necessary to calculate equation (A6) is known for each system considered. We can thus directly compare expected utility, resulting from each lottery for a teacher entering the profession, under various assumptions for η.

To better illustrate the magnitude of teacher preferences between systems, we calculate the certainty equivalent for each lottery—for each particular level of risk aversion. The certainty equivalent is the certain amount of benefits that an individual is indifferent about accepting at the time of hire, to avoid participating in a particular pension lottery. Combining equations (A1) and (A6), and performing some algebra, yields for the calculation of the certainty equivalent:

$$W=\left(\sum p_i W_i^{1-\eta}\right)^{\frac{1}{1-\eta}} \qquad \textbf{(A7)}$$

Endnotes

[1] See, e.g., D. McCarthy, *A Lifecycle Analysis of Defined Benefit Pension Plans*, University of Michigan Retirement Research Center, working paper 2003-053 (2003); J. Poterba et al., "Defined Contribution Plans, Defined Benefit Plans, and the Accumulation of Retirement Wealth," Journal of Public Economics 91, no. 10 (2007): 2062–86; and A. Schrager, "The Decline of Defined Benefit Plans and Job Tenure," *Journal of Pension Economics and Finance* 8, no. 3 (2009): 259–90.

[2] Consider a teacher who began working in the New York City public school system at age 25. If she exited the system 38 years later, she would, we calculate, retire with an employer-funded lifetime annuity worth about $635,090—equivalent to about $16,713 in retirement compensation for each year in the classroom. Had that same teacher instead exited the system after 20 years of service—perhaps to take another teaching job in another state—New York City's contribution to her retirement would be a lifetime annuity worth about $70,738—just $3,537 per year of service.

[3] Josh McGee and Marcus A. Winters, "Better Pay, Fairer Pensions: Reforming Teacher Compensation," Manhattan Institute, Civic Report no. 79 (September 2013).

[4] The methods used here follow 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, no 2 (2009): 175–211; and Robert M. Costrell and Josh B. McGee, "Teacher Pension Incentives, Retirement Behavior, and Potential for Reform in Arkansas," *Education Finance and Policy* 5, no. 4 (2010): 492–518.

[5] For all present value calculations, we use a nominal interest rate of 5 percent and an inflation rate of 2.5 percent. We use mortality tables—dictated for use under ERISA—compiled and updated by the IRS. Specifically, we use the 2013 static mortality table based on the RP-2000 Mortality Tables Report, adjusted for mortality improvement using Projection Scale AA, http://www.irs.gov/pub/irs-drop/n-08-85.pdf.

[6] According to the Bureau of Labor Statistics (its latest update of the National Compensation Survey), the average private-sector manager and professional earns 10.6 percent of total earnings in the form of deferred retirement savings. This time series is maintained by Robert Costrell,
http://www.uaedreform.org/downloads/2013/12/quarterly-employer-contribution-chart-update.pdf.

[7] In a related work, we also later consider the fact that adoption of an SA-DB plan might alter teacher incentives to remain in the system—and thereby change attrition patterns. We find that reasonable changes to teacher attrition, due to the adoption of the SA-DB plan, have no significant influence on our overall findings.

[8] See, e.g., R. Chetty, "A New Method of Estimating Risk Aversion," *American Economic Review* 96, no. 5 (2006): 1821–34.

[9] See D. H. Bowen et al., "Risky Business: An Analysis of Teacher Risk Preferences," University of Arkansas Department of Education Reform, working paper 2013-01 (2013).

[10] We do not claim here that the offered SA-DB plan would second-order stochastic dominate all other accrual patterns. One could imagine plans with the same expected value but a smaller variance. As an extreme example, one could imagine a plan in which, after one year of service, all employees were given pension benefits equal to the expected value of the current system. Such a plan would have the same expected value as the offered SA-DB plan but a variance of 0. We argue, however, that the SA plans that we consider offer a plausible alternative to current systems and, thus, are worthy of consideration.

[11] Chetty, "A New Method of Estimating Risk Aversion."

[12] Our calculations consider the net present value of pension wealth in a given year, net of the employee's cumulative contributions. For some plans, there are at least some years early in a teacher's career when the employee's contribution is greater than the present value of pension wealth—in these cases, employees who exit in such a year would have negative net pension wealth. This poses a problem for our utility calculations because the CRRA utility function cannot calculate utility when wealth is negative. In such cases, we adjust the negative benefits value to "0" when calculating the individual's utility. This change slightly alters the expected value under each plan. Nevertheless, the impact on our calculations is insubstantial and does not meaningfully influence our findings. For these cases, we replace the calculated certainty equivalent under the SA-DB plan, for a risk-neutral individual, to be equal to the value under the respective FAS-DB plan. We make this change because equivalent expected value is the definition of risk-neutrality.

[13] Though we do not directly consider the impact of such a change on teacher quality, it is notable that one rationale for backloaded pension plans is to encourage more productive behavior from employees, who otherwise might shirk their responsibilities (Edward P. Lazear, "Incentive Contracts," NBER working paper no. 1917 (1986)). Still, C. Koedel, M. Podgursky, and S. Shi, "Teacher Pension Systems, the Composition of the Teaching Workforce, and Teacher Quality," *Journal of Policy Analysis and Management* 32, no. 3 (2013): 574–96, provide sound empirical evidence suggesting that this argument likely does not hold true in the case of public school teachers.

[14] Methods used follow Costrell and Podgursky, "Peaks, Cliffs, and Valleys; and Costrell and McGee, "Teacher Pension Incentives, Retirement Behavior, and Potential for Reform in Arkansas."

[15] For all present-value calculations, we use a nominal interest rate of 5 percent and an inflation rate of 2.5 percent. We use the mortality tables, dictated for use under ERISA and compiled and updated by the IRS. Specifically, we use the 2013 static mortality table—based on the RP-2000 Mortality Tables Report, adjusted for mortality improvement using Projection Scale AA, http://www.irs.gov/pub/irs-drop/n-08-85.pdf.

[16] The separation probability function, g(), is estimated using the decrement tables reported by each plan in the CAFRs.

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