REFORMING TEACHER PENSION PLANS: 
THE CASE OF KANSAS, THE 1ST TEACHER CASH BALANCE PLAN

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ABSTRACT: It has long been argued that cash balance (CB) pension plans offer a more equitable distribution of benefits than traditional final-average-salary (FAS) plans for teachers, particularly between short-termers and career teachers. However, it has also been understood that the impetus for reform would come from fiscal distress, rather than a concern for equity. In this paper I examine how the nation’s first CB plan for teachers, in Kansas, adopted under such conditions, has played out for system costs, and the level and distribution of individual benefits, compared to the FAS plan it replaced. My key findings are: (1) employer-funded benefits were modestly reduced, despite the surface appearance of somewhat generous employer matches; (2) more importantly, the cost of the pension guarantee, which is off-the-books under standard actuarial accounting, was reduced quite substantially. Thus, although much of the distributional benefit originally put forth did materialize, the primary gain for states considering reform may well be the reduction in the cost of risk-bearing. Indeed, I argue that these results are intrinsically linked: it is CB’s near-elimination of back-loading that simultaneously cuts the implicit cost of risk.

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1. INTRODUCTION AND SUMMARY

Two key issues for teacher pension plans are: (1) cost and funding; and (2) distribution of benefits. While logically distinct, these issues are practically related. First, the cost of pre-funding career teachers’ pensions are defrayed in part by cross-subsidies from contributions by or for early leavers (Costrell and McGee, 2019). Second, the costs of unfunded benefits provide the main motive for reform of plan design. That is, the funding crisis provides an opportunity to replace traditional, final-average-salary (FAS) plans with more equitable plan designs. This paper brings out a third link: the adoption of a more equitable plan design – cash balance (CB) – can dramatically reduce the system’s implicit cost of risk.

A CB plan smoothly accumulates contributions in individual retirement balances, so it is more equitable between short- and long-termers than the heavily back-loaded FAS plans.1 The private sector converted hundreds of FAS plans to CB decades ago. Public sector conversions have been less common and came later; teacher plans have been the latest of all.2 In this paper I examine how the nation’s first CB plan covering teachers, enacted under fiscal distress in Kansas (2015), has played out for the level and distribution of benefits and system costs. The lessons may be pertinent for other states considering CB plans for teachers (e.g., New Jersey).

1 Clark and Schieber, 2004; Coronado and Copeland, 2004; Johnson and Uccello, 2004 argue that private sector employers may have been attracted to CB plans to meet employee demand for more portability. Costrell and Podgursky, 2008, 2009, 2010a, 2010b argue that teacher plans should adopt CB to provide more portability. Teachers’ unions, however, typically lobby against replacing FAS with CB plans, as they place highest priority on the benefits of their more active members, the career teachers.

2 Nebraska adopted a CB plan for state employees effective 2003 (discussed further below), and never enacted one for teachers. Kentucky adopted a CB plan for state employees effective 2014, and later, against much resistance, enacted such a plan for teachers in 2018, but it was then struck down judicially on grounds of legislative procedure. Kansas’ CB plan, effective 2015, applies both to teachers and non-corrections state employees. California has a supplemental CB plan for teachers, and Texas has CB plans for local governments. (NASRA, 2019)
First, the case of Kansas illustrates how CB plans include levers that allow states to cut employer contributions for currently earned benefits below the advertised (albeit notional) employer match. In this paper, I explain how this is done, through actuarial details that are not widely understood. Unlike FAS plans, which depress contributions using a high assumed rate of return on investment, CB plans do so by virtue of the spread between the plan’s assumed return and its embedded interest rates. There are two such possible spreads: prior to retirement and, separately, but less well known, after retirement. These and other actuarial details reduce employer costs, even as the stated features may seem modestly generous. To be sure, the employer contribution for currently accruing benefits in Kansas had already been reduced to minimal levels under the preceding FAS plan, so there was not much left to cut by adopting the CB plan. But the surface appearance of a rise, to relatively generous employer-funded benefits, may have eased the political difficulty of enacting the cut that was actually implemented.

This result pertains only to the cost of benefits that is on-the-books for determining contributions under current actuarial practice. Far more significant, I find, was the reduction in the system’s implicit cost of risk. This is the market value of the pension guarantee (the risk borne by the employer) – a benefit (and implicit cost) that is off-the-books. The market value of the FAS plan’s risk-free benefits is substantial and highly concentrated among career teachers in Kansas, as in other such plans. This benefit is much reduced in the CB plan (but still dwarfs the benefit that is on-the-books). It is also more broadly distributed. Indeed, there is a deep connection between the back-loading of FAS plans and their high implicit cost of risk. Both FAS and CB plans promise benefits, to be funded, in part, by returns on risky investments. The assumed return on these investments includes a risk-premium, reflecting the implicit cost of risk borne by the plan. That risk premium compounds far more for an FAS plan’s back-loaded
benefits than for a CB plan’s more uniformly accruing benefits. The reduction in that cost from adopting CB, as illustrated by Kansas, is the most novel point of this paper. Indeed, the overall reduction in the implicit cost of risk borne by the employer may form the strongest case for states considering replacing FAS plans with CB.

The plan of the paper is to first briefly review the concept of individual normal cost rates, developed in Costrell and McGee, 2019, and the associated system of cross-subsidies engendered by their variation, by age of entry and exit. I apply this concept to the FAS plan for Kansas teachers hired before 2015, to show the level and distribution of benefits. In the next section, I derive and portray the distribution of individual cost rates under the CB plan for Kansas teachers hired since 2015, to compare with the FAS system it replaced. I also compare it with the more generous system of benefits that the stated plan features may seem to imply. Specifically, I closely examine the features of the CB plan, as implemented, that reduce the employer contribution. I then turn to the issue of risk, depicting the distribution of individual values of the pension guarantee under Kansas’ FAS plan, using the method of Costrell, 2018b, and compare it with the CB plan. Concluding remarks discuss my findings, briefly contrast Kansas’ CB plan with that of neighboring Nebraska for its state employees, and consider policy implications.

2. INDIVIDUAL NORMAL COST RATES AND CROSS-SUBSIDIES IN KANSAS’ FAS PLAN

Pension benefits are funded by a uniform fringe benefit rate. For example, the annual joint contribution (employer and employee together) to fund newly earned benefits may be 15 percent of each teacher’s salary. These “normal cost” contributions are designed to fund future

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3 In addition, the employer makes payments for the unfunded liability – benefits earned in the past, but not funded. The intergenerational cross-subsidies represented by these payments (Backes, et. al. (2016)) are a consequence of the failure to meet actuarial assumptions, particularly the return on investments (Costrell (2018d,e)). This is a very large problem, and provides the context for reform, as discussed below.
retirement benefits as they are earned, for the system as a whole. However, the annual cost of benefits for individual teachers may deviate widely from this overall average. For example, early leavers may earn benefits worth 5 percent of salary per year while the benefits of career teachers are worth 25 percent. In effect, there is a large cross-subsidy – 10 percent of pay – from the contributions by or for early leavers to help fund the benefits of career teachers. This is a big part of the funding plan. There are also other patterns of cross-subsidies, e.g., from younger to older entrants or vice versa.

More formally, consider an individual of type \((e, s)\), where \(e\) is the age of entry and \(s\) (for separation) is the age of exit. For each type \((e, s)\), one can identify an individual normal cost rate, \(n_{es}\) that generates a stream of contributions sufficient to fund the individual’s future benefits. Expressed as a percent of annual salary, the normal cost rates are comparable to contribution rates for defined contribution (DC) plans. Part of the normal cost is covered by the employee contribution and the remainder is the employer-funded benefit, as with a DC employer match.

As shown in Costrell and McGee, 2019, \(n_{es}\) is the ratio of the present value (PV) of benefits, \(B_{es}\), to the PV of earnings, \(W_{es}\) (both evaluated at entry):

\[
(1) \quad n_{es} = \frac{B_{es}}{W_{es}}.
\]

This is the rate that, applied to the individual’s annual earnings over her career, would prefund her benefits – an individual fringe benefit rate for pensions. In FAS plans, these individual cost rates vary widely by age of entry and exit.

Specifically, I consider the patterns of individual normal cost rates and associated cross-subsidies under the Kansas Public Employees Retirement System (KPERS), for the traditional
FAS plan that applies to teachers hired before January 1, 2015\textsuperscript{4} and (in the next section) the CB plan for those hired afterwards. I estimate the individual normal cost rates, \( n_{es} = \frac{B_{es}}{W_{es}} \), for entry ages, \( e = 25, 30, 35, 40, \) and \( 45 \), and all exit ages, \( s = 25, \ldots, 70 \). I base the calculations on the KPERS actuarial assumptions for school employees and the FAS benefit formula.\textsuperscript{5}

Benefits can be in the form of a pension or refund of employee contributions.\textsuperscript{6} If a teacher takes the refund she forgoes any future pension and receives, instead, the cumulative value of the employee (but not employer) contributions, with accumulated interest at the rate set by KPERS, 4.00 percent. Teachers who leave before vesting, without the expectation of returning and qualifying for a pension, would certainly take the refund because it is the only benefit to which they are entitled. Teachers who leave after vesting, but too young to draw a pension, may either take the refund or leave the money in the fund to draw a pension in the future, upon reaching an eligible age. KPERS assumes that vested teachers choose the refund or the deferred pension to maximize the PV of their benefits. I adopt this assumption, as well.

If a teacher takes the pension, \( B_{es} \) is the PV of the stream of pension payments, weighted by her survival probabilities, and discounted to entry at the assumed return on investment, 7.75 percent. The annual pension payments equal the multiplier \((1.85\%) \times \text{years of service} \times (s - e) \times \text{final average salary (FAS, 5 highest years of salary)}\). There is no Cost of Living Adjustment (COLA), since it was eliminated in 2012. Teachers are eligible for “normal retirement” at age

\textsuperscript{4} The FAS plan I examine is KPERS Tier 2, for teachers hired between July 1, 2009 and December 31, 2014. Those hired earlier are in Tier 1 (also an FAS plan, with different benefit parameters). The CB plan, for those hired starting in 2015, is KPERS Tier 3.

\textsuperscript{5} The actuarial assumptions cover wage growth, investment returns (discussed below), exit rates, and mortality rates. These assumptions are drawn from the 2018 annual valuation report (KPERS 2019), based on the most recent 3-year experience study (KPERS 2016). For example, salary growth assumptions include 3.50\% annual general wage increase, plus 8.00\% in year 1, declining to 2.55\% in year 5 and zero beginning in year 21. The benefit formula includes the retirement eligibility conditions, multiplier, employee contribution rate, and interest rate on refunds.

\textsuperscript{6} I leave aside death and disability benefits, as well as administrative expenses, which total 0.39 percentage point, about 5 percent of school normal cost under KPERS.
65, after 5-year vesting, or age 60 with 30 years of service.\textsuperscript{7} Thus, for example, a 25-year-old entrant working to 65 retires with a pension of $40 \times 1.85 = 74$ percent of FAS. Vested teachers who withdraw before normal retirement but do not cash out are assumed by KPERS to defer the pension to the earliest normal retirement age. This formula, together with KPERS mortality assumptions for school employees (I take the female rate, which tilts the cost up a bit), allows one to calculate the PV of benefits, relative to the PV of wages, $n_{es} = B_{es}/W_{es}$. This is the annual contribution rate required to fund the benefits of an individual entering at age $e$ and exiting at age $s$. The employee contribution is 6.00 percent, so the employer-funded benefit is $n_{es} - 0.06$.

\subsection*{2.1 Variation in Normal Cost Rates By Age of Entry and Exit}

Consider first an entrant of age 25. The normal cost rate for such an entrant is depicted in Figure 1, varying by age of exit. Prior to vesting, and for some years beyond, the benefit is the refund of employee contributions. The normal cost rate, therefore, starts at the employee contribution of 6.00 percent: the curve begins at the horizontal line representing that rate. The cost rate then gently declines, falling slowly below the employee contribution rate. That is because the interest credit of 4.00 percent is below the fund’s assumed return, $r = 7.75$ percent. The gap represents the arbitrage profits the plan assumes it will earn on employee contributions. The contribution rate needed to cover the refund falls as these assumed profits accumulate.

[Figure 1 about here]

At a certain point, the pension becomes more attractive than the refund. A 25-year-old entrant reaches that point at age 52; at this age the pension would still be deferred to age 65, but exceeds in PV the value of the employee refunds. Beyond that point, the normal cost rate rises

\textsuperscript{7} There is a provision for “early retirement” under which the benefit is “reduced actuarially.” For our purposes, that means the normal cost of the benefit is the same as if the pension were deferred until normal retirement age.
as the deferral to 65 becomes shorter. At age 55, she reaches 30 years of service, so she needs only defer the first draw to age 60: the series of benefit payments is extended forward by 5 years. That is why the normal cost rate to fund the benefit jumps at that point. It continues to rise from age 55 to 60, as the deferral to age 60 grows shorter. Beyond age 60, there is no deferral: the first draw is immediate. Each year of further delayed retirement beyond 60 is a year of forgone pension payments. Thus, even though the pension payment continues to grow with additional years of service and higher FAS, the normal cost declines, due to the decreasing number of years the pension will be paid. Overall, the normal cost rate varies from 3.7 percent to 9.3 percent, for a weighted average of 6.9 percent. Since 6.0 percent is paid by the member, the normal cost of the employer-provided benefit ranges from -2.3 percent to +3.3 percent, and an overall rate of 0.9 percent for the cohort of 25-year-old entrants.

The normal cost rate also varies with age of entry. In general, the rate can rise or fall with later entry. Figure 2 illustrates for entrants of age 25 – 45, for a given exit age of 60. The normal cost rate drops off just beyond entry age 30, at which point the first pension draw must be deferred to age 65, due to the 30-year service rule for pension at 60. Otherwise, the normal cost rises with entry age, as shorter service reduces the PV of the earnings stream by more than it reduces that of benefits, so $n_{es} = B_{es}/W_{es}$ rises.

[Figure 2 about here]

Figure 3 presents normal cost rates by age of entry and exit, showing the full range. The highest normal cost rates of all those depicted are for 45-year-old entrants who exit at age 65. These late entrants expand the upper range of normal cost rates up to a maximum of 12.4 percent.
from a minimum of 3.7 percent. The overall normal cost rate, call it $n^*$, is about 7.4 percent, by my rough estimate. Since employees pay 6.0 percent, the employer normal cost is 1.4 percent.

Advocates of traditional FAS pension systems defend the apparent inequities as a rational human resource policy to reward longevity. As we see in Figure 3, Kansas’ FAS plan does reward longevity for any given entry age, by awarding benefits at a higher annual rate, as the exit age rises from age 51 or so, up through ages 60 or 65. One may debate whether the extent of the reward (the steepness of the curves) is effective or goes beyond what is efficient for human resource goals. But the variation across entry ages, for any given exit age (i.e. the vertical spread in Figure 3) often goes in the opposite direction: shorter tenures are rewarded. For example, a 65-year-old retiree who has served 40 years, after entering at 25, receives a pension of much lower normal cost than one who has served only 20 years, after entering at 45. As we shall see, among other potentially attractive features, CB plans offer the opportunity for a more rational system of rewarding longevity.

[Figure 3 about here]

### 2.2 Cross-Subsidies in the FAS Plan

The joint contribution rate for normal costs (employee plus employer) is uniform across employees. It is set to $n^*$, the weighted average of individual costs calculated to fund the benefits of the whole entering cohort. The deviations $(n_{es} - n^*)$ are positive and negative,

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8 KPERS calculates the overall normal cost rate for school employees (all tiers, not just Tier 2) at 7.66 percent (net of death and disability payments and administrative expense), so my estimate is reasonably validated.

9 See, for example, Rhee and Fornia (2016, 2017), Rhee and Joyner (2019) and Weingarten (2017).

10 For a good summary of the research, see Koedel and Podgursky (2016), as well as recent papers by Ni and Podgursky (2016), McGee and Winters (2016), and Roth (2017).

11 The weights for $n_{es}$ are the share of type $(e,s)$ in the cohort’s PV of earnings. These are not the exact weights used in actuarial practice, but are consistent with the approach (see Costrell and McGee, 2019, Appendix).
comprising a system of cross-subsidies, as the cost of funding an individual’s benefit exceeds or falls short of the uniform contribution rate, \(n^*\). By the nature of averages, the weighted sum of cross-subsidies \((n_{es} - n^*)\) is zero: the negative cross-subsidies provided by the losers fund the positive cross-subsidies enjoyed by winners.

For Kansas, the variation in normal cost rates, from 3.7 to 12.4 percent, with \(n^* = 7.4\) percent, generates a range of cross-subsidies from \(-3.7\) percent to + 5.0 percent. These cross-subsidies are built into the funding plan. For those individuals below the uniform normal cost line in Figure 3, the plan is counting on using some or all of the employer contributions to help finance the benefits of others. The beneficiaries of the cross-subsidies (i.e. those whose benefits cost more than the uniform rate assessed for all teachers) are concentrated on those who exit at some age beyond 56 (depending on age of entry). These winners comprise 19.3 percent of entrants, but they account for 52.8 percent of the cohort’s PV of earnings, by virtue of their longer careers.\(^{12}\) Our summary measure of the degree of cross-subsidization is that 1.9 percent of the cohort’s PV of earnings is redistributed from losers to winners.\(^{13}\) Although significant, this degree of redistribution is less dramatic than some other states’ FAS plans.\(^{14}\) However, the amount redistributed exceeds the entirety of the employer-funded benefit of 1.4 percent.\(^{15}\)

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\(^{12}\) As Clark and Schieber, 2004 (p. 287) pointed out long ago, “under a traditional DB plan, a disproportionate share of benefits accrues to a relatively small number of participants, namely those who stay until they retire.” See also Johnson and Uccello, 2004 (p. 321). By contrast, Rhee and Formia (2016, 2017) and Rhee and Joyner (2019) argue that the losers comprise a very small portion of the active workforce, since, for any given snapshot, most of these individuals would have already left. But as explained in Costrell and McGee, 2019 this represents “survivor bias” toward the winners. That is, the losses of prior leavers are excluded, such that the cross-subsidies do not sum to zero, as they must in the funding plan.

\(^{13}\) This represents the weighted sum of the absolute value of cross-subsidies. Winners receive, on average, cross-subsidies of 1.76 percent of earnings from the losers, who lose 1.97 percent. Note that the algebraic sum, weighted by shares of PV of earnings, is \((1.76\% \times 0.528) + (-1.97\% \times 0.472) = 0.00\%\), as it must.

\(^{14}\) I have previously calculated the individual normal cost rates for teachers in California, Massachusetts, and Arkansas. See Appendix Figures A1 – A3 below, drawn from Costrell, 2018a, Costrell and Fuchsman, 2018, and Costrell, 2018c. The comparison with Figure 3 is not quite apples-to-apples, because the assumed rate of return is lower in these states (7.0 percent for California and 7.5 percent for Massachusetts and Arkansas). However, recalculating them with Kansas’ 7.75 percent rate yields the same qualitative comparison.

\(^{15}\) Winners receive employer-funded benefits of 3.2 percent of earnings, while losers receive negative 0.6 percent.
To summarize, Kansas’ FAS plan, like others, generates wide variation in the cost of individual benefits, and an elaborate system of implicit cross-subsidies. The employer-funded benefit is relatively low, at 1.4 percent. This is the result of a series of measures taken in the face of chronic under-funding, which left little more to cut upon adoption of a new plan design.\textsuperscript{16} Nonetheless, Kansas moved to adopt a CB plan for new entrants – the nation’s first such plan for teachers. What did the state have to gain by its adoption? To answer this question, we turn now to examine the level and distribution of the CB plan’s benefits.

3. **Individual Normal Cost Rates in Kansas’ Cash Balance Plan**

3.1 **The Context of Fiscal Duress**

Kansas moved to adopt the new plan under fiscal duress. By 2012, the year its CB plan was authorized, the funded ratio for school employees had dropped to 49 percent, and KPERS as a whole (including state employees and other local plans) was not doing much better. For schools, the employer (i.e. district) contribution rate was actuarially determined to include 13.67 percent for the unfunded liability – over six times the employer normal cost as calculated at that time. A statutory cap on employer contribution hikes deferred a quarter of these payments to the future, and further deferments would be enacted later. In another measure to reduce employer contributions, the state had already issued pension bonds netting $440 million for the fund in 2004 (and would issue an additional $1.0 billion of pension bonds in 2015); this moved unfunded liabilities off the plan’s books, and onto the state, which pays the debt service, instead of the districts. The state would also later begin to periodically appropriate some gaming and other

\textsuperscript{16} New hires as of 2009 were placed in a newly created Tier 2 that was expected to lower employer contributions, by virtue of that tier’s higher employee contributions. As the fiscal situation continued to deteriorate, the Legislature enacted further cost reductions to the FAS plan in 2012, for both Tier 1 and 2.
funds to help cover school contribution requirements. Clearly the system’s funding plan had gone awry under the FAS design. As stated above, further cuts were made to the FAS plan in 2012, but the FAS system itself had, in retrospect, proven to be quite risky. It was in this context that Kansas created a new CB plan, effective for all new hires as of January 1, 2015.

3.2 What is a Cash Balance Plan?

A CB plan is a defined benefit plan, but benefits are tied to contributions, similar to a DC plan. This means benefits accrue more smoothly, providing greater equity between short-termers and career teachers than back-loaded FAS plans. Unlike DC plans, however, where individuals bear all the market risk on investment returns, CB plans can be designed such that the plan bears some or all of the risk. The elements of a CB plan are these:

- **Employee contributions.** These accumulate in an individual retirement account.
- **Employer contribution credits.** These entries also accumulate in one’s retirement account, but need not be actual contributions: they may be bookkeeping entries. If so (as in Kansas), the employer credits are defined in the plan, but the employer contributions calculated to fund the benefit may differ, as discussed further below.
- **Interest credits.** These are applied to both employee contributions and employer contribution credits, according to the plan’s formula. That formula determines the degree of market risk-sharing between the plan and the member.
- **Annuuitization/lump sum distribution.** The accumulated balance can be distributed as a lump sum or converted to an annuity upon retirement, with the split subject to plan rules.\(^\text{17}\) This is the defined benefit that employers are required to fund.

As a benchmark case, consider an idealized\(^\text{18}\) plan where the interest credit equals the plan’s assumed return, the annuity is determined using the same rate, and vesting is immediate.

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\(^{17}\) In private sector CB plans, employers are required to offer retirees the option of annuitization (Clark and Schieber, 2004, p. 273; Johnson and Uccello, 2004, p. 324). By contrast, the Kansas plan requires annuitization of at least 70 percent of the balance, as discussed further below.

\(^{18}\) I do not mean to imply the idealized form is optimal, only that it provides the simplest comparison.
In this simple case, employer contributions will equal the plan’s stated employer credit: that is the employer-funded benefit, just like a DC plan’s employer match. If the credit is uniform, so are the rewards – there are no cross-subsidies, as benefits accrue smoothly in tandem with contributions. Moreover, if the employer contribution credit is set to the same employer normal cost rate as the preceding FAS plan, the new CB plan would be cost-neutral. In the case of Kansas, this would be an employer contribution credit of 1.4 percent, and the normal cost curves for all entry ages would collapse to the flat uniform normal cost line in Figure 3. In practice, CB plans can deviate from such a benchmark, as the Kansas plan will illustrate rather strikingly.

### 3.3 Kansas’ CB Plan: The Sticker Price

We turn now to the actual CB plan implemented by Kansas. The employee contribution is 6.0 percent, the same as for FAS members. The employer contribution credits, referred to as “retirement credits” by KPERS, rise with years of service, to reward longevity, but do so in a more rational, monotonically graduated fashion than the employer normal cost rates of typical FAS plans. Specifically, the retirement credits are:

- 3.0 percent for years 0–4
- 4.0 percent for years 5–11
- 5.0 percent for years 12–23
- 6.0 percent for years 24 and up.

On the surface, this “sticker price” schedule may seem appealing to members as the new plan is introduced – comparable to employer matches in other sectors.

Figure 4 depicts the normal cost rates implied by these retirement credits, under the otherwise idealized assumptions discussed above. For each entry age, the employer cost rises
gently from 3.0 percent to about 4.5 percent, as the higher credits attached to later years accumulate. Overall, the employer normal cost rate would be about 4.0 percent. Thus, it may appear that the CB plan is more costly to the employer than the FAS plan, as it well exceeds that plan’s average of 1.4 percent. Of course, it would be extremely unlikely for a fiscally distressed system to adopt a plan with higher employer costs. Thus, we need to go under the actuarial hood to examine the features of the plan that depress the cost below the sticker price.

[Figure 4 about here]

3.4 Kansas’ CB Plan: Below the Actuarial Hood

The first such feature is vesting. As with FAS plans (and most DC plans), vesting is not immediate: for Kansas’ CB plan, it is five years, the same as its FAS plan. An individual leaving before five years of service (absent an intention to return) withdraws one’s own contributions with interest, but forfeits any benefit from the retirement credits that have accrued during that period. Thus, the individual normal cost curves that we shall see for the CB plan are the same as those under the FAS plan (depicted in Figure 3) prior to vesting: neither of them include any cost for the employer. Upon vesting, the retirement credits that had accrued in years 0 – 4 enter into the retirement balance, along with newly earned credits. I find the vesting requirement reduces the overall normal cost rate by 0.5 percentage points.

The second feature, which depresses the normal cost rate more substantially, is that the interest credit is below the assumed return. Specifically, the interest credit for retirement is 4.0 percent guaranteed, plus a dividend of three-quarters of the actual fund returns that exceed 6.0 percent over a five-year period.19 This upside-risk-sharing provision leads KPERS to assume

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19 The initial plan design, as enacted in 2012, provided a guaranteed interest credit of 5.25 percent, plus additional credits of 0 – 4 percent to be granted at KPERS’ discretion, based on actual returns and funding. The guaranteed
that the interest credit will average 6.25 percent. Although, to date, this has proven to be a conservatively high cost assumption, it still falls short of KPERS’ assumed return of 7.75 percent. Thus, importantly, the fund assumes that part of the cost of funding the retirement credit will be covered by the cumulative difference between the assumed return and interest credit \((7.75 - 6.25\text{ percent})\), up to the point of retirement. It is the spread between the two rates, not their levels, which matters most for the actuarially determined contribution. The interval over which the fund gains from this spread is constrained by the retirement eligibility requirement. This requirement is the same for the CB and FAS plans: age 65, after 5-year vesting, or age 60 with 30 years of service. Thus, an individual leaving service after vesting defers the benefit until that age, and the interest-return spread continues to help cover the cost of the benefit until then. I find the spread reduces the overall normal cost by 2.3 percentage points.

The final feature is the annuity factor. Under a somewhat obscure provision, the interest rate embedded in the annuity, upon retirement, is 2.0 percentage points below the assumed return. That is, upon retirement, the plan rolls the account balance forward at 5.75 percent, while discounting the annual payment back at 7.75 percent. This means the annuity is set with a present value that is substantially less than the account balance at retirement. By my calculation, the reduction is about 15 percent for retirement ages in the range of 60 – 65. This would not

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[20] This was reduced from 6.50 percent in the 2016 valuation, when the assumed return was cut by 0.25 percent.
[21] For the first four years of the plan, 2015 – 2018, the dividends were 0.0, 0.0, 1.1, and 0.0 percent, so the interest credits came to only 4.0, 4.0, 5.1, and 4.0 percent, for a compound average of 4.27 percent.
[22] For those who take the refund, the spread is with the 4.0 percent refund rate, as under the FAS plan.
[23] As with the FAS plan there is a provision for “early retirement” with reduced benefits, but, again, for our purposes, that means the normal cost of the benefit is the same as if the pension were deferred until normal retirement age. KPERS assumes such deferral for inactive vested members.
[24] The initial legislation in 2012 set the annuity interest rate at 6.0 percent, which was 2.0 points below the assumed return at the time. The 2014 legislation tied it to whatever return is assumed. See Article 49, section 74-49, 313(a).
[25] The annuity is set to the retirement balance/the annuity factor at retirement, \(AF\), which is the sum over retirement years of the survival rate times the discount factor. Using an annuity interest rate of 5.75 instead of 7.75 percent shrinks the annuity by \(AF(7.75)/AF(5.75)\), which I calculate at 84-87 percent, for retirement ages 60-70.
matter if the retiree took the account balance as a lump sum distribution instead of annuitizing. In private sector CB plans, retirees have the option of doing so, but Kansas restricts the lump sum distribution to no more than 30 percent (an option that KPERS assumes all members take). Thus, the impact of the annuity interest spread applies only to the 70 percent of the balance that is annuitized. I find that this reduces the normal cost rate by 0.7 percentage points.

Taking the benefit provisions given above and the actuarial assumptions reported in the valuation,\textsuperscript{26} I estimate the individual normal cost rates for Kansas’ CB plan, depicted in Figure 5. As one can see, these cost rates are significantly lower than the “sticker prices,” depicted in Figure 4. That is, although the employer contribution credits are 3 – 6 percent, as advertised, with an overall average of 4.0 percent, the actual employer-funded benefit costs only 0.6 percent.

[Figure 5 about here]

The plan features that defray so much of the employer credits are primarily the two spreads. The spread between the interest credit and the assumed return helps fund the account balance before retirement, and the spread between the annuity interest and the assumed return helps fund the benefit after retirement. It is worth emphasizing that it is the spread, not the level, of these rates that keeps the employer contributions low. This is very different from FAS plans. In FAS plans (as we shall see), a lower discount rate would dramatically raise the normal costs. But in CB plans, that is not the case. For example, reducing the discount rate from 7.75 percent to 4.00 percent, with no change in the spread, would only raise the normal cost by 0.4 percent.\textsuperscript{27}

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\textsuperscript{26} I modify one assumption. KPERS assumes 100 percent of vested CB members leave their contribution with the system. By contrast, KPERS assumes that FAS members “take a refund if it is more valuable than the deferred annuity.” I adopt this latter assumption for my CB estimates as well. This helps facilitate the comparison of the two systems, and also eliminates a discontinuous drop that would otherwise obtain for the CB normal cost rates upon vesting for young entrants. For most members, this assumption makes no difference, so the overall impact is only a slight elevation in the estimated cost rates. It is also worth noting that the plan assumes FAS members compare the refund with the value of the deferred pension “based on 7.75 percent interest,” i.e. the assumed return without any reduction, unlike the annuity interest rate in the CB benefit formula.

\textsuperscript{27} This pertains to both the no-spread case and the two-spread case.
Finally, we compare the CB normal cost rates with the FAS rates, in Figure 3. As one would expect, for a plan adopted under fiscal duress, the overall cost is reduced. There was not much left to cut from the employer cost rate of 1.4 percent, but the CB plan appears to have shaved it down to 0.6 percent (even as the stated employer credits were notably higher). The variation in individual benefits was also reduced, as would be expected from a CB plan. It was not eliminated, as in the idealized CB, but benefits were compressed. While 1.9 percent of the cohort’s PV of earnings is redistributed from losers to winners under the FAS plan, that is reduced to 0.7 percent under the CB plan.28 As we shall argue, however, the most important impact of the move to CB lay in neither of these results, but rather the impact on the plan’s risk burden and, conversely, the value of members’ pension guarantee.

4. FULL COST AND VALUE OF KANSAS’ GUARANTEED FAS BENEFITS

The analysis thus far of the FAS plan is based on conventional actuarial discounting by the assumed rate of return. There are two distinct critiques of this practice. The first is simply that the assumed return is overly optimistic. This keeps contributions low in the short-run, but creates unfunded liabilities and ultimately raises contributions to pay down those liabilities. The second critique is that the expected return on a risky portfolio includes a premium for risk, even though the benefit is risk-free to the member. Thus, the market value of the benefit – the cost of acquiring an equivalent annuity on the open market – discounts at a risk-free (or low-risk) rate. This value far exceeds the actuarially-calculated cost, as both defenders (e.g., Rhee and Fornia (2017)) and critics of FAS plans agree. Where they differ is on the actual cost to the plan.29 Defenders claim the actuarial cost is the full cost; there is a free lunch, so to speak, for public

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28 Winners receive, on average, cross-subsidies of 0.57 percent of earnings from the losers, who lose 0.87 percent.

29 For a summary of the points of agreement and disagreement over the discount rate, see Costrell, 2018b, section 4.
plans to invest in risky-assets, since they can diversify the risk away over time, as immortal entities. However, this claim has been long discredited, as the “fallacy of time diversification” (Samuelson, 1963). Consequently, as the finance economics literature has unequivocally demonstrated (Novy-Marx and Rauh, 2009; Brown and Wilcox, 2009; Biggs, 2011) the full cost of a risk-free benefit is substantially understated when discounted by the expected return. The extra costs may or may not be in the form of higher future contributions, but are nonetheless real costs of bearing risk, e.g., the cost of fluctuating contributions and the higher risk of insolvency (Boyd and Yin, 2018). Public plans and the taxpayers that stand behind them may choose to bear the risk, but that does not eliminate the costs of providing risk-free benefits by investing in risky assets, even if these costs are unreported.\textsuperscript{30} For the purposes of this paper, we take as uncontroversial that the market value of risk-free benefits is based on the risk-free rate, and is equal to the full cost of such benefits, borne by the plan, either as future contributions or as the intangible costs of risk that people would pay to avoid. In either case, the difference between the full cost and the normal cost as calculated on-the-books is real, even though it is off-the-books.

Richwine and Biggs (2011) show how the standard normal cost rate for teachers dramatically understates the overall benefit. Costrell, 2018b analyzes the distribution of the individual values of the pension guarantee under FAS plans. This is done by examining the difference between individual normal cost rates evaluated at the assumed return and the risk-free rate.\textsuperscript{31} This is the market value of the guarantee. My analysis suggested that the concentration of individual values of the pension guarantee magnifies that of conventionally calculated normal

\textsuperscript{30} Biggs (2011) shows that the risk is evaluated in the market by the value of the options that would hedge that risk, and that this is equivalent to the difference between discounting at the expected return and risk-free rate.

\textsuperscript{31} An alternative would be to evaluate the member’s subjective value, using a personal discount rate. That individual discount rate often exceeds the risk-free rate, as suggested by individuals’ general reluctance to buy annuities. Indeed, there is some debate as to whether personal discount rates even exceed the pension fund’s assumed return, in which case members would prefer to receive more of their compensation in salaries and less in pensions (see Goldhaber and Holden, 2018, and Fitzpatrick, 2015).
cost rates. This makes sense: since the value of the guarantee is ascertained by stripping out the risk-premium from the discount rate, the impact will accumulate most substantially for those who enjoy the plan’s back-loaded benefits, far-removed from entry.

Figures 6 illustrates for Kansas’ FAS plan. Each point is calculated as the difference between the individual normal cost evaluated at the assumed return of 7.75 percent (Figure 3) and that evaluated using a low-risk discount rate of 4.0 percent (not shown). Thus, each point in Figure 6 represents the annualized value of an individual’s pension guarantee. For example, individuals entering at 25 and exiting at 60 receive benefits that annually cost 9.3 percent, when discounted at 7.75 percent (Figure 3), but 26.1 percent when discounted at 4.00 percent (not shown). The difference is 16.8 percent, the value of those individuals’ pension guarantee depicted in Figure 6. The overall value of the pension guarantee is substantial, averaging 11.1 percent, which dwarfs the employer-funded benefit of 1.4 percent. The cost of this additional benefit includes future employer contributions to cover unfunded liabilities if the assumed return is overly optimistic, and, in any case, the intangible costs of the risk borne by the plan, as measured by the market price of risk. The value of this benefit is highly concentrated among teachers who stay beyond their mid-50s. My summary measure of the redistribution of this benefit, from those below the line to those above, is 5.1 percent of the cohort’s PV of earnings, on top of the 1.9 percent redistribution discussed above, for benefits that are on-the-books.

[Figure 6 about here]

32 The overall normal cost at \( r = 4.00 \) percent is 18.8 percent. This differs slightly from the sum of the cost at \( r = 7.75 \) percent (7.4 percent) and the value of the guarantee (11.1 percent), due to differences in weighting.

33 Winners (who comprise 20.6 percent of entrants and 66.1 percent of the cohort’s PV of earnings) receive, on average, cross-subsidies of 3.84 percent of earnings from the losers, who lose 7.51 percent.
5. FULL COST AND VALUE OF KANSAS’ GUARANTEED CB BENEFITS

Kansas’ CB plan, like other such plans, is a defined benefit plan. Although there is some upside risk-sharing, the benefits are largely guaranteed. Specifically, the retirement balance is guaranteed to earn 4.00 percent interest, and then annuitized using the plan’s post-retirement spread between 5.75 percent interest and 7.75 percent discount to retirement.34 As with risk-free FAS benefits, I estimate the full value of the guaranteed CB annuity using a discount rate from retirement to entry of 4.00. Figure 7 depicts the result. The overall normal cost rate is 9.1 percent, somewhat higher than the 6.6 percent actuarial cost (Figure 5).

Figure 8 illustrates the value of the guarantee for Kansas’ CB plan. It is estimated as the difference between the normal cost for the guaranteed benefit at the risk-free rate, and the normal cost evaluated at the plan’s assumptions. For example, the same individual as above (entering at 25 and exiting at 60) receives benefits that annually cost 7.1 percent when evaluated at plan assumptions (Figure 5), but 9.6 percent for the guaranteed portion (Figure 7). The difference, 2.5 percent is the annualized value of that guarantee, depicted in Figure 8. The overall value of the guarantee is 2.3 percent, which well exceeds the employer-funded benefit of 0.6 percent.35

[Figures 7 and 8 about here]

Compared with the FAS plan, the overall value of the guarantee is cut dramatically from 11.1 percent to 2.3 percent. This far exceeds the cut in employer-funded benefits, from 1.4 percent to 0.6 percent. Thus, the primary gain for Kansas’ fiscally distressed system of moving from the FAS plan to CB was arguably to reduce the system’s unreported cost of risk, rather than the actuarially calculated contribution. Of course, on the other side of the coin, this means the

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34 The results are similar using post-retirement interest and discount rates of 2.00 and 4.00 percent, respectively. It is the spread that counts. My calculation also maintains the plan’s vesting requirement for employer credits.
35 The 2.3 percent average deviates slightly from the 2.5 percent difference between the full cost, 9.1 percent (at r = 4.00 percent) and the funded cost, 6.6 percent (at r = 7.75 percent), due to differences in weighting.
members’ value of the guarantee was also cut – and substantially so for career teachers. This benefit was, however, more broadly distributed, as seen by comparing Figures 8 and 6. Our summary measure of redistribution is only 0.6 percent of the cohort’s PV of earnings for the CB guarantee, well below the corresponding figure for the FAS guarantee of 5.1 percent.

6. Conclusion

CB pension plans have been recommended for some years as an alternative to traditional FAS plans, to ameliorate the inequities generated by their back-loaded benefit structure. Indeed, the wave of private sector conversions to CB, decades ago, was seen at the time as an employer response to the emergence of a higher-mobility workforce, penalized by traditional plans. Those inequities are particularly salient for teachers, since they have high turnover in their early years. And yet, even as benefits have been reformed over the last decade, only one state has adopted a CB structure for teachers. It is not hard to speculate on the reasons that the equity rationale has failed to gain traction. The political forces for reforms that would benefit young, mobile teachers have inevitably proven weaker than those for preserving the distributional status quo, favoring senior members: the losers under traditional plans are more diffuse – larger numbers, but smaller losses than the highly concentrated gains of more focused and better organized winners.

On the funding side, FAS plans have relied in part on the cross-subsidies from short-termers to career teachers to keep costs low. As benefit reforms since 2000 have been undertaken in the context of fiscal distress, the general pattern has been to tighten benefits within the existing FAS structure, often exacerbating inequities by further back-loading (e.g., raising the retirement age). Switching to CB plans would minimize the cross-subsidy, making it harder to fund the benefits of career teachers. To preserve such benefits for new hires would raise costs;
in the private sector, it has been argued that employers were willing to incur higher costs to tailor their plans for a more mobile workforce (Coronado and Copeland, 2004). This may not be a viable option for fiscally distressed public plans.

The Kansas example shows that public CB plans can be designed to cut contributions for new hires in ways that may not be generally understood. Although I do not recommend such opaque methods, it may be appealing to fiscally distressed legislatures, laboring under the weight of unfunded liabilities bequeathed by FAS plans. To be sure, since Kansas had reduced benefits previously, there was little left to cut in employer-funded benefits. Nonetheless, the CB plan adopted did manage to cut a bit further, and, perhaps importantly, it did so despite offering the surface appearance of somewhat generous employer matches. Specifically, Kansas’ CB plan reduced employer-funded benefits well below the nominal match by virtue of the spreads between the assumed rate of return and (1) the interest credits awarded on accruing retirement balances; and, less well-understood, (2) the interest rate embedded in the annuity awarded upon retirement. Unlike FAS plans, which use high assumed returns to keep contributions low, CB plans can use these spreads to achieve that end, as in Kansas.

It is worth noting the important differences between public and private sector rules that make these moves feasible. First, public sector accounting allows, quite controversially, higher discount rates than private sector rules. As is well-known, this enables public sector FAS plans to keep contributions low by relying on risky investment returns. Less obviously, it also allows public CB plans to offer relatively high interest on account balances, while keeping contributions low. Here, the bet is on the plan earning arbitrage profits between the assumed returns on investment and the promised interest. A second difference concerns annuitization. Private

36 There are cases, notably Illinois, where new plans have cut employer-funded normal costs for new teachers below zero, but their legality can be challenged.
sector plans must offer the option of annuitizing, while Kansas requires annuitizing at least 70 percent of the retirement balance, by capping the lump sum option at 30 percent. This reduces the scope for avoiding the penalty imposed by the annuity spread.

It is also worth noting that although these contribution-minimizing features are available to public sector CB plans, they are not inevitable. The neighboring state of Nebraska offers an instructive comparison. Nebraska has enrolled its state employees in a CB plan since 2003 (Nebraska Public Employees Retirement Systems, 2019). Four features stand out. First, the statutorily-specified employer contributions to the individual retirement accounts are actual (not bookkeeping) dollars, set at 156 percent of the member contribution (7.49 percent and 4.80 percent respectively). Second, the returns credited to the retirement account (interest credits plus dividends) have virtually matched the fund’s assumed return: credits have compounded to 7.8 percent since inception vs. 7.7 percent for the assumed return. Third, the interest rate for annuitization has been statutorily set to match assumed return. Fourth, members can choose to take the full retirement balance as a lump sum. Thus, unlike Kansas’ two-spread system, Nebraska’s system has neither spread; and yet, contributions have sufficed to fully fund the plan, from inception to this day. It is important to note, however, a key difference from Kansas in the plan’s origins. Prior to its adoption in 2003, Nebraska state employees were covered by a defined contribution plan, not an FAS plan. Thus, unlike Kansas, there was no inherited unfunded liability, so no pressure to cut contributions for new hires, which arguably led to

37 The teachers’ plan is FAS.
38 The interest credit has a minimum of 5.0% (or higher, if Federal interest rates warrant), and the dividend provisions, based on fund performance, have resulted in an additional 2.5 percent compounded since inception.
39 Indeed, for 2018 and 2019, it has actually exceeded the assumed return, since that was cut from 7.75 percent to 7.50 percent and the annuitization rate was maintained at 7.75 percent.
40 Nebraska’s assumed interest credit is 6.25 percent, while the assumed return is 7.50 percent. This assumed spread reduces the normal cost rate to 10.48 percent, below the statutory joint contribution of 12.29 percent (7.49 + 4.80). This conservative funding policy allows the plan to distribute dividends as overfull funding accumulates, thereby generating a zero spread between actual credits and assumed return.
Kansas’ two interest rate spreads. In my view, if employer contributions need to be cut, it would be preferable to do so in a more transparent CB plan, setting them statutorily, as in Nebraska, rather than actuarially cutting them below the notional rates advertised.

That said, the more important gain for Kansas from adopting CB was the reduction in the unreported costs that stem from high discount rates. Such costs include both potential underfunding due to optimistic assumed returns (to be made good by future contributions) and the intangible costs of risk-bearing. These costs are measured by the gap between the market value of guaranteed benefits, discounted at a low-risk rate, and the actuarial cost at the assumed rate of return. This is the value of the pension guarantee provided by the employer. It is generated by the market’s risk premium, the gap between the assumed rate of return and the low-risk rate. This cost is much higher in Kansas’ FAS plan than its CB plan, as the back-loading of FAS benefits rests on a much greater cumulative value of the risk premium, borne by the plan.

Finally, the distribution of benefits is, in fact, more equal under Kansas’ CB plan than the FAS plan it replaced. As previously argued, this is true both for the funded benefits (Costrell and McGee, 2019) and for the value of the pension guarantee (Costrell, 2018b). In sum, Kansas’ move to CB reduced the mean value of benefits, as well as the distributions around the mean, both for the funded benefits and the value of the pension guarantee.

The lesson from Kansas may be that the most compelling reason for legislatures to adopt CB is not so much to improve equity – as noble as that would be, and as strongly as I and others have long argued this case – but rather the reduction in the cost of risk, which follows from the reduced back-loading of benefits. That gain is off-the-books, but may be increasingly evident for fiscally stressed plans, in light of previous risks gone bad. Here, too, transparency would be a big help, by putting the market value of the pension guarantee on the books for all to see.
REFERENCES


Rhee, Nari and William B. Fornia, 2016. “Are California Teachers Better off with a Pension or a 401(k)?” UC Berkeley Center for Labor Research and Education.


Figure 1. Normal Cost Rates, Kansas FAS Plan, by Age of Exit, Entry Age 25
Estimated using 2018 KPERS school assumptions and Tier 2 benefit formula; \( r = 7.75\% \)

The curves depict \( n_{25,s} \), the annual contribution rate required to fund benefits of an individual entering at age 25 and exiting at age \( s \).
The curves depict $n_{e,60}$, the annual contribution rate required to fund benefits of an individual entering at age $e$ and exiting at age 60.

Figure 2. Normal Cost Rates, Kansas FAS Plan, by Age of Entry, Exit Age 60
Estimated using 2018 KPERS school assumptions and Tier 2 benefit formula; $r = 7.75\%$
The curves depict $n_{\text{ep}}$, the annual contribution rate required to fund benefits of an individual entering at age $e$ and exiting at age $s$. Variation in cost by age of exit is shown along each curve; variation by age of entry is shown across curves.
Figure 4. Normal Cost Rates, Kansas CB Plan: Sticker Price

Employer credits = 3 - 6%. Immediate vesting. discount = interest = annuity rate = 7.75%

Entry Age: 25 30 35 40 45

The curves depict $n_{es}$, the annual contribution rate required to fund benefits of an individual entering at age $e$ and exiting at age $s$. 
Figure 5. Normal Cost Rates, Kansas CB Plan: As Implemented

Employer credits = 3 - 6%. 5-year vesting. annuity interest = 5.75%, interest credit = 6.25%, discount rate = 7.75%

The curves depict \( n_{\text{est}} \), the annual contribution rate required to fund benefits of an individual entering at age \( e \) and exiting at age \( s \).
Figure 6. Value of Pension Guarantee, Kansas FAS Plan

The curves depict the annualized market value of the pension guarantee for an individual entering at age $e$ and exiting at age $s$.

The difference between the value of individual normal cost evaluated at $r = 4.00\%$ and $7.75\%$ for Tier 2 teachers.

Overall value of guarantee (11.1\%)
Figure 7. Full Cost of Guaranteed Benefit, Kansas CB Plan

discount rate = interest credit = 4.00%. annuity interest = 5.75%; annuity discount = 7.75%

Entry Age: 25 30 35 40 45

uniform normal cost rate (9.1%)
Figure 8. Value of Pension Guarantee, Kansas CB Plan

Difference between full cost of guaranteed benefit at $r = 4.00\%$ and normal cost at $r = 7.75\%$

Entry Age: 25 30 35 40 45

Overall value of guarantee (2.3\%)
Figure A1. Normal Cost Rates, California, by Age of Entry and Exit

Source: Costrell, 2018a, based on 2016 CalSTRS assumptions and benefits for new hires; $r = 7.00\%$

The curves depict $n_{es}$, the annual contribution rate required to fund benefits of an individual entering at age $e$ and exiting at age $s$. Variation in cost by age of exit is shown along each curve; variation by age of entry is shown across curves.
Figure A2. Normal Cost Rates, Massachusetts, by Age of Entry and Exit
Source: Costrell and Fuchsman, 2018, based on 2016 MTRS assumptions and benefits for new hires; $r = 7.50\%$

The curves depict $n_{ret}$, the annual contribution rate required to fund benefits of an individual entering at age $e$ and exiting at age $s$. Variation in cost by age of exit is shown along each curve; variation by age of entry is shown across curves.
The curves depict $n_{ep}$, the annual contribution rate required to fund benefits of an individual entering at age $e$ and exiting at age $s$. Variation in cost by age of exit is shown along each curve; variation by age of entry is shown across curves.