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Traditional vs. Cash Balance Pension Plans: The Case of Kansas, the 1st Teacher CB Plan

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TRADITIONAL VS. CASH BALANCE PENSION PLANS: THE CASE OF KANSAS, THE 1ST TEACHER CB 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 the level and distribution of benefits and system costs, 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.

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1. INTRODUCTION AND SUMMARY

Two key sets of issues with teacher pension plans are: (1) cost and funding; and (2) distribution of benefits. While these issues are logically distinct (both low- and high-cost systems can distribute benefits equitably or inequitably) they are practically related in a few ways. First, the cost of career teachers' pensions are defrayed in part by cross-subsidies from the contributions made by or for short-termers (Costrell and McGee, 2019). Second, the costs that remain unfunded provide the main motive for reform of plan design. It has long been argued that one such plan design, a cash balance (CB) plan, offers a more equitable distribution of benefits than traditional, final-average-salary (FAS) plans (Costrell and Podgursky, 2008, 2009, 2010a, 2010b). That is because formula-based FAS plans are highly back-loaded, while CB plans tie benefits to contributions. But it has also been understood that the impetus for reform would come from fiscal distress, rather than a direct concern for equity. That is, the funding crisis provided an opportunity to adopt CB plans.

In this paper I examine how the nation's first CB plan for teachers, enacted under such conditions in Kansas, has played out for the level and distribution of benefits and system costs, compared to the FAS plan it replaced. As other states now also consider proposed CB plans for teachers,[1] the lessons from Kansas would appear to be two-fold: (1) the impetus to cut costs can lead states to adopt CB plans that provide lower employer-funded benefits than meet the eye; and (2) the value of the pension guarantee, which is off-the-books, can be much reduced from FAS.

[1] Kentucky enacted such a plan, but it was struck down judicially on grounds of legislative procedure. New Jersey legislators have proposed a hybrid, including a cash balance component.

In both respects, benefits are more equitably distributed under Kansas' CB plan, but at lower levels. In the case of Kansas, the reduction in the employer's implicit cost of risk (point (2) above) was more substantial than the cut in employer contributions for currently accruing benefits (point (1)), since the latter had already been reduced to minimal levels under the preceding FAS plan. However, the *surface* appearance of relatively generous employer-funded benefits may have eased the political difficulty of enacting the cuts that were actually entailed.

Specifically, using the metric of individual normal cost rates developed in Costrell and McGee, 2019, I find the distribution of benefits is more even under CB than FAS, as expected, but the employer-funded component is notably lower than the stated (albeit notional) employer match. The reasons for the marked difference between the stated and actual match lie in actuarial details that are not widely understood. Unlike FAS plans which depress contributions by assuming a high rate of return, CB plans do so by virtue of the *spread* between the plan's assumed return and its embedded interest rates, both prior to retirement and, less well known, *after* retirement. In these respects, the actual CB plan adopted for Kansas teachers differs from idealized[2] CB plans discussed in prior literature that would be cost-neutral. These and other actuarial details reduce employer costs, even as the stated features may seem modestly generous.

These employer cost results pertain only to the cost of benefits that is on-the-books for determining contributions under standard actuarial accounting. This cost was already low under Kansas' FAS plan, so there was not much left to cut by adopting the CB plan. More significant was the change in the value of the pension guarantee (the risk borne by the employer) – a benefit (and cost) that is off-the-books. The market value of the FAS plan's risk-free benefits is found to be quite substantial and highly concentrated among career teachers in Kansas' plan, as in other

[2] I do not mean to imply the idealized form is optimal, only that it provides the simplest comparison.

such plans. This benefit is much reduced in the CB plan that was adopted, but still dwarfs the benefit that is on-the-books. It is also more broadly distributed. The overall reduction in the risk borne by the employer may form the strongest case for replacing FAS plans with CB. However, it remains the case that this cost is off-the-books under current actuarial standards, and does not correspond to employer contributions.

The plan of the paper is to first briefly explain the concept of annualized value of individual benefits (i.e. the individual "normal cost"), and the system of cross-subsidies engendered by the wide variation in benefits, by age of entry and exit, under traditional FAS plans. Then I will apply this concept to the FAS plan for Kansas teachers hired before 2015, to show the level and wide distribution of individual normal cost rates. In the next section, I derive and portray the array of individual cost rates under the CB plan that Kansas implemented for teachers hired since 2015. I will compare this system of benefits with the FAS system it replaced. I will also compare it with the more generous – and more costly – system of benefits that the stated plan features may seem to imply. Specifically, I will closely examine the features of the actual CB plan that reduce the costs. I will then turn to the issue of risk, by depicting the distribution of individual values of the pension guarantee under Kansas' FAS plan (using the method of Costrell, 2018b), which is highly concentrated (as in other states). I find a very different distribution of the value of the guarantee under the CB plan. It is much lower and less concentrated, but still notably enhances the benefits covered by actual contributions. Concluding remarks will summarize my findings and consider the potential policy implications.

2. INDIVIDUAL NORMAL COST RATES AND CROSS-SUBSIDIES[3]

Pension benefits are funded by a uniform fringe benefit rate. For example, the annual contribution to the pension fund (employer and employee contributions taken together) may be 15 percent of each teacher's salary. These "normal cost" contributions are designed to fund the future retirement benefits as they are earned,[4] 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 pay 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. In this paper, I present these patterns of *individual* normal cost rates and associated cross-subsidies for school employees under the Kansas Public Employees Retirement System (KPERS), for the traditional FAS plan that applies to teachers hired before January 1, 2015 and the CB plan for those hired afterwards. By examining the level and distribution of these cost rates, we can see the equity implications of the move to CB, and also the cost-cutting results to be explored further below.

Pension plans calculate the normal cost rate at the aggregate level, to fund a cohort's benefits as they accrue. Individual cost rates, based on age of entry and exit are implicitly embedded within the calculation (Costrell and McGee, 2019, Appendix), but they are not publicly reported. Specifically, consider an individual of type *(e,s)*, where *e* is the age of entry

[3] This section is based on Costrell and McGee, 2019.

[4] 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 (alluded to briefly below), but is not the main subject of this paper.

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. This is the measure I will use to examine the level and distribution of benefits. Expressed as a percent of annual salary, the normal cost rates are comparable to contribution rates to 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.

It can be readily shown that 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) $n_{es} = B_{es}/W_{es}$.

This is the rate that, applied to the individual's annual earnings over her career, would prefund her benefits. It represents the value of her benefits earned annually, as a percent of earnings – an *individual* fringe benefit rate for pensions. If we compare individuals with different entry and exit ages, *(e,s)*, we find their cost rates, n_{es}, vary widely. In the simple example above, n_{es} was 5 percent for early leavers and 25 percent for career teachers. The actual results for the full array of entry and exit ages will be shown below for teachers under Kansas' FAS and CB plans.

The joint contribution rate (employee plus employer), *n**, is *uniform* (independent of the individual's normal cost), and is calculated to fund the benefits of the whole entering cohort. This rate is a weighted average of individual costs.[5] The deviations $(n_{es} - n^*)$ are positive and negative, as the cost of funding an individual's benefit exceeds or falls short of the uniform contribution rate, *n**, comprising a system of cross-subsidies. By the nature of averages, the weighted sum of cross-subsidies $(n_{es} - n^*)$ is zero: the negative cross-subsidies provided by the

[5] 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).

losers fund the positive cross-subsidies enjoyed by winners. To continue with the simple example above, $n^* = 15$ percent, and $(n_{es} - n^*) = -/+ 10$ percent for early leavers and career teachers, respectively: contributions equal to 10 percent of pay are redistributed. The full array of cross-subsidies embedded within Kansas' FAS and CB plans will be shown below.

3. Individual Normal Cost Rates in Kansas' Traditional Teacher Plan

I now apply these concepts to Kansas' FAS plan for teachers hired in the years preceding the CB plan – KPERS Tier 2.[6] I estimate the individual normal cost rates, $n_{es} = B_{es}/W_{es}$, 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 Tier 2 benefit formula.[7]

Benefits can be in the form of a pension or refund of employee contributions.[8] 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.

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[6] Teachers hired between July 1, 2009 and December 31, 2014 are in Tier 2. Those hired earlier are in Tier 1 (also an FAS plan, with different benefit parameters), and those hired later are in the CB plan – Tier 3.

[7] The actuarial assumptions cover wage growth, investment returns, exit rates, and mortality rates. These assumptions are drawn from the 2017 annual valuation report (KPERS 2018), based on the most recent 3-year experience study (KPERS 2016). The benefit formula is delineated in the valuation report and elsewhere. This includes the retirement eligibility conditions, multiplier, employee contribution rate, and interest rate on refunds.

[8] I leave aside death and disability benefits, as well as administrative expenses, which total 0.40 percentage point, about 5 percent of school normal cost under KPERS.

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.[9] The annual pension payments equal the multiplier 1.85% × years of service $(s - e)$ × final average salary (FAS, last 5 years). There is no COLA, since it was eliminated in 2012. Under Tier 2, teachers are eligible for "normal retirement" at age 65, after 5-year vesting, or age 60 with 30 years of service.[10] Thus, for example, a 25-year-old entrant working to 65 retires with a pension of 40 × 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), 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} – 6.00 %).

3.1 Variation in Normal Cost Rates By Age of 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 dashed 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.

[9] The assumed return was cut from 8.00 percent as of the 2016 valuation. It had been 8.00 since 1986.
[10] 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.

The contribution rate needed to cover the refund falls as this difference accumulates. The gap represents the arbitrage profits the plan assumes it will earn on employee contributions.

[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 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.[11] 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 for 25-year-old entrants.

3.2 Variation in Normal Cost Rates By Age of Entry and Age of Exit

The normal cost rate also varies with age of entry. In general, the normal cost rate can rise or fall with later entry under traditional FAS plans, and we can see this for Kansas.[12] Figure

[11] I calculate the average normal cost rate for the cohort of 25-year-old entrants to be 6.9 percent.

[12] Later entrants with the same exit age have shorter service, so their pension is lower, reducing B_{es}, but the stream of earnings is shorter, reducing W_{es}. Thus, the ratio, $n_{es} = B_{es}/W_{es}$, can rise or fall with e, over different ranges of s, discount rates r, and benefit formulas. Another way of seeing the ambiguity is to note that the normal cost rate equals the product of: (i) the annuity factor at the given exit age s; (ii) starting pension/FAS; and (iii) FAS/W_{es}. For older entrants, with shorter service, the starting pension is a lower percent of FAS, which reduces normal cost. But their FAS is higher relative to cumulative earnings (since it is a shorter stream), which raises normal cost.

2 depicts the range of normal cost rates for selected entry ages. Thus, for 30-year-old entrants, the normal cost rate is below that of 25-year-old entrants for exit ages 55 – 59 (since they must still defer the pension to age 65), and is higher for exit ages beyond 60. The highest normal cost rates of all those depicted are for 45-year-old entrants who exit at age 65. These (and other) late entrants expand the upper range of normal cost rates beyond the 25-year-old entrants' maximum of 9.3 percent up to a maximum of 12.4 percent.

[Figure 2 about here]

The variation in normal cost rates, from 3.7 to 12.4 percent, generates a range of cross-subsidies. The overall normal cost rate is about 7.4 percent, by my rough estimate.[13] Thus, the cross-subsidies range from about -3.7 percent to + 5.0 percent. These cross-subsidies are built into the funding plan. For those individuals below the dotted line in Figure 2, depicting the overall normal cost rate, the plan is counting on using some or all of the employer contributions – plus, for many (those below the dashed line), part of the assumed earnings on employee 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).[14]

Advocates of traditional FAS pension systems defend the apparent inequities as a rational human resource policy to reward longevity.[15] As we see in Figure 2, Kansas' FAS plan does reward longevity for any given entry age, by awarding benefits at a higher annual rate, as the exit

[13] KPERS calculates the overall normal cost rate for school employees (all tiers) at 7.76 percent (net of death and disability payments and administrative expense).

[14] Rhee and Fornia (2016, 2017) and Rhee and Joyner (2019) argue that those individuals who would fall below the line 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 results in "survivorship bias" toward the beneficiaries of the cross-subsidies. 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.

[15] See, for example, Rhee and Fornia (2016, 2017), Rhee and Joyner (2019) and Weingarten (2017).

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.[16] But the variation across entry ages, for any given exit age (i.e. the vertical spread in Figure 2) 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 that costs much less annually 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.

To summarize, Kansas' FAS plan, like others, generates wide variation in the cost of individual benefits, and an elaborate implicit system of cross-subsidies. These inequities, although significant, are less dramatic than some other states' FAS plans.[17] Moreover, the costs are lower than some other states. Since the overall cost rate for Kansas' FAS benefits is about 7.4 percent, of which the employees pay 6.0 percent, the employer-funded portion is only 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.[18] 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.

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[16] 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).

[17] I have previously calculated the 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 2 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.

[18] 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.

4. Individual Normal Cost Rates in Kansas' Cash Balance Plan

4.1 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 make direct payments to the fund to help cover amortization payments. 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 (as Tier 3), effective for all new hires as of January 1, 2015.

4.2 What is a Cash Balance Plan?

A CB plan is a defined benefit plan, in which benefits are tied to contributions, similar to a DC plan, and unlike FAS formulas. 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, CB plans can be designed such that the plan bears the risk or the risk is shared. The elements of a CB plan are these:

- Employee contributions. These accumulate in an individual retirement account.
- Employer contribution credits. These are bookkeeping entries that also accumulate in one's retirement account, but are not actual contributions. The employer credits are defined in the plan, but the employer contributions are calculated to fund the benefit, 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.
- Annuitization. The accumulated balance is converted to an annuity upon retirement.[19] This is the defined benefit that employers are required to fund.

As a benchmark case, consider an idealized plan where the interest credit equals the plan's assumed return, the annuity is determined using the same rate, and vesting is immediate. 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 dotted line in Figure 2. In practice, all CB plans deviate from such a benchmark, as the Kansas plan will illustrate rather strikingly.

[19] The plan often includes a partial lump sum option, up to 30 percent in the case of Kansas.

4.3 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 3 depicts the normal cost rates implied by these retirement credits, under the otherwise idealized assumptions discussed above. For each entry age, the 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 Tier 2's average of about 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 3 about here]

4.4 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 2) 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. The vesting requirement reduces the overall normal cost rate a bit, by 0.5 percent.

The second feature, which depresses the employer 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.[20] This upside-risk-sharing provision leads KPERS to assume that the interest credit will average 6.25 percent.[21] Although this has proven to be a conservatively high cost assumption, to date,[22] 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 interest credit and the return on the fund, up to the point of retirement.[23] It is the *spread* between the two rates, not their levels,

[20] 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 credit was reduced to 4.0 percent and formula-based dividends were introduced in 2014 legislation, prior to the implementation of the plan in 2015.
[21] This was reduced from 6.50 percent in the 2016 valuation, when the assumed return was cut by 0.25 percent.
[22] For the first three years of the plan, 2015 – 2017, the dividends were 0.0, 0.0, and 1.1 percent, so the interest credits came to only 4.0, 4.0, and 5.1 percent, for a compound average of 4.37 percent.
[23] For those who take the refund, the spread is with the 4.0 percent refund rate, as under the FAS plan.

which matters most for the actuarially determined contribution. The period during 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.[24] 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. The spread reduces the normal cost by over 2 percentage points.

The final feature is the annuity factor. Under a somewhat obscure provision,[25] the interest rate embedded in the annuity, upon retirement, is 2.0 percentage points below the assumed return.[26] 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.[27] This reduces the normal cost rate by almost 1 percentage point.

Taking the benefit provisions given above and the actuarial assumptions reported in the valuation,[28] I estimate the individual normal cost rates for Kansas' CB plan, depicted in Figure 4.

[24] 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.

[25] It is not mentioned in the Tier 3 benefit guide, but can be found in the most current (2017) valuation report. It seems to have last been mentioned in the 2013 valuation, released in 2014, where that year's legislation modifying the provision was reported. It is found in statute, subsection 74-49, 313(a).

[26] 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.

[27] This reduction does not appear to apply to the portion of the account balance which is claimed as a lump sum. KPERS assumes that all members of the CB plan take the full 30 percent lump sum allowed, so the reduction implied above is only assumed to apply to the 70 percent of the balance that is annuitized.

[28] 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.

As one can see, these cost rates are significantly lower than the "sticker prices," depicted in Figure 3. 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 4 about here]

The plan features that are assumed to 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 would only raise the overall normal cost by 0.4 percent.[29]

Finally, we compare the CB normal cost rates with the FAS rates, in Figure 2. 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 much compressed. 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.

[29] This pertains to both the no-spread case of Figure 3 and the two-spread case of Figure 4.

5. 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.[30] Defenders claim the actuarial cost *is* the full cost; there is a free lunch, so to speak, for public plans to invest in risky-assets, since they can diversity 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 or even possible insolvency (Boyd and Yin, 2018). Public plans and the taxpayers that stand behind them may, in effect, self-insure, but that does not eliminate the costs of funding risk-free benefits by investing in risky assets, even if these costs are unreported.[31] For the purposes of this paper, we take as uncontroversial

[30] For a short distillation of the points of agreement and disagreement over the discount rate, see Costrell, 2018b.
[31] 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.

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. My analysis suggested that the concentration of individual values of the pension guarantee magnifies that of conventionally calculated normal cost rates. Thus, the value of the pension guarantee is much more concentrated under FAS plans, with their wide distribution of normal cost rates, than under CB plans with a narrower distribution.[32]

Figures 5 and 6 illustrate for Kansas' FAS plan. Figure 5 gives the full cost of each individual's benefit, evaluated using a discount rate of 4.0 percent. Figure 6 depicts the difference between the corresponding points in Figures 5 and 2. 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 2), but 26.1 percent when discounted at 4.00 percent (Figure 5). The difference is 16.8 percent, the value of the pension guarantee depicted in Figure 6. As the diagram illustrates, the overall value of the pension guarantee is substantial, averaging 11.4 percent, and highly concentrated among teachers who stay beyond their mid-50s. The cost of

[32] The illustration of this point in Costrell, 2018b with the case of Kansas' CB plan, while qualitatively accurate, is superseded quantitatively by this paper's analysis, given below.

this 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.

[Figures 5 and 6 about here]

6. 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 annuity is based on the retirement balance primarily accrued at the guaranteed 4.00 percent interest credit.[33] As with the risk-free FAS benefits, I estimate the full value of the guaranteed CB annuity using a discount rate of 4.00 percent.[34] Figure 7 depicts the result. The overall normal cost rate is 9.1 percent, somewhat higher than the 6.6 percent actuarial cost (Figure 4), but not as high as the overall sticker price of 10.0 percent (Figure 3). Essentially, evaluating the guaranteed CB benefit at the risk-free rate eliminates the spread between the interest and discount rates, prior to retirement.

[Figures 7 and 8 about here]

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 4), 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.

[33] As noted above, additional dividends based on plan performance have been uncommon in the plan's first years.
[34] The annuity factor is calculated as given in the plan, with a 5.75 percent interest, discounted to retirement at 7.75 percent. The results are similar (overall normal cost about 0.3 points lower) using a discount rate of 4.00 percent for the annuity and annuity interest of 2 points lower. Again, it is the spread that counts.

Compared with the FAS plan, the total employer-provided benefits are much reduced from an overall average of 12.8 percent to 3.1 percent. In both plans, the vast majority of the employer-provided benefit is the value of the guarantees, which is off-the-books. The value of the guarantee is cut from 11.4 percent under the FAS plan to 2.5 percent under the CB plan.

Thus, the primary gain for Kansas' fiscally distressed system of moving from the FAS plan to the CB plan was arguably to reduce the system's unreported cost of risk, rather than the actuarially calculated normal cost (and the corresponding employer contribution), which was already so low there was little left to cut. Of course, on the other side of the coin, this also means the unreported benefits of the guarantee were cut overall – and substantially so for career teachers – but are more broadly distributed.

7. CONCLUSION

Cash balance pension plans have been recommended for some years as an alternative to traditional final-average-salary plans, to ameliorate the inequities generated by the back-loaded benefit structure of such plans. Those inequities are particularly salient for teachers, since they have high turnover in their early years. And yet, as benefits have been reformed over the last decade, only one state has adopted a CB structure. Upon reflection, it is not hard to speculate on the reasons for this. On the beneficiary side, 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. 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). As Kansas is the sole exception thus far, it is worth asking what, if anything, the state had to gain by moving to CB.

My analysis suggests a somewhat subtle answer. First, since Kansas had been facing fiscal distress for some time, there was actually little left to cut in employer-funded benefits. The CB plan adopted did manage to cut a bit further, and, moreover, it did so despite offering the surface appearance of somewhat generous employer matches. As Kansas shows, CB plans offer the opportunity to reduce 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 use these *spreads* to achieve that end.

The second, more important gain for the state was the reduction in costs that are off-the-books. 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 the difference between the market value of guaranteed benefits, discounted at the risk-free rate, and the contributions calculated 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 risk-free rate. This is much higher in a traditional FAS plan than a CB plan because the back-loading of FAS benefits provides 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 well be that the most compelling reason for legislatures to shift to CB is not so much the improvement to equity in funded benefits – as noble as that would be, and as strongly as I and others have argued this case – but rather the reduction in the cost of risk, which also 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.

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REFERENCES

Backes, Ben, Dan Goldhaber, Cyrus Grout, Cory Koedel, Shawn Ni, Michael Podgursky, P. Brett Xiang and Zeyu Xu, 2016. "Benefit or Burden? On the Intergenerational Inequity of Teacher Pension Plans," *Educational Researcher*, August/September 2016 (Vol. 45, No. 6), 367-377.

Biggs, Andrew, 2011. "An Options Pricing Method for Calculating the Market Price of Public Sector Pension Liabilities," *Public Budgeting & Finance*, Fall 2011, pp. 94-118.

Boyd, Don and Yimeng Yin, 2018. "Investment Risk and its Potential Consequences for Teacher Retirement Systems and School Districts," RAND Education Working Paper 1250.

Brown, Jeffrey, and David Wilcox, 2009. "Discounting State and Local Pension Liabilities," *American Economic Review*, 99(2), 538-42.

Costrell, Robert M., 2018a. "Distribution of Teacher Pension Benefits in California: A Vast System of Cross-Subsidies," University of Arkansas.

Costrell, Robert M., 2018b. "Cross-Subsidization of Teacher Pension Benefits: The Impact of the Discount Rate," *Journal of Pension Economics and Finance*, version of record online November 5, 2018; print forthcoming.

Costrell, Robert M. 2018c. "Arkansas Teacher Retirement Plan: Risks, Redistribution, and Remedies," presentation to the Arkansas Legislature, Joint Committee on Retirement.

Costrell, Robert M., 2018d. "Accounting for the Rise in Unfunded Public Pension Liabilities: Faulty Counterfactuals and the Allure of Simple Gain/Loss Summations," *Journal of Pension Economics and Finance*, Vol. 17, no. 1: 23-45.

Costrell, Robert M., 2018e. "The 80 Percent Pension Funding Target, High Assumed Returns, and Generational Inequity," *Contemporary Economic Policy*, Vol. 36, no. 3: 493 – 504.

Costrell, Robert M. and Dillon Fuchsman, 2018. "Distribution of Teacher Pension Benefits in Massachusetts: An Idiosyncratic System of Cross-Subsidies," University of Arkansas.

Costrell, Robert M. and Josh McGee, 2019. "Cross-Subsidization of Teacher Pension Costs: The Case of California," *Education Finance and Policy*, Spring 2019 (Vol. 14, no. 2), pp. 327-354. Early access version, 16 November, 2017.

Costrell, Robert M. and Michael Podgursky, 2008. "Peaks, Cliffs, and Valleys," *EducationNext*, Winter 2008 (Vol. 8, no. 1), pp. 22-28.

Costrell, Robert M. and Michael Podgursky, 2009. "Peaks, Cliffs and Valleys: The Peculiar Incentives in Teacher Retirement Systems and their Consequences for School Staffing," *Education Finance and Policy*, Spring 2009 (Vol. 4, No. 2), 175-211.

Costrell, Robert M. and Michael Podgursky, 2010a. "Distribution of Benefits in Teacher Retirement Systems and their Implications for Mobility," *Education Finance and Policy*, Fall 2010 (Vol. 5, no. 4), 519-557.

Costrell, Robert M. and Michael Podgursky, 2010b. "Golden Handcuffs: Teachers who change jobs or move pay a high price," *Education Next*, Winter 2010 (Vol. 10, no. 1), pp. 60-66.

Kansas Public Employees Retirement System, 2016. "Triennial Experience Study Study Period: Calendar Years 2013 through 2015," Cavanaugh Macdonald, November 18.

Kansas Public Employees Retirement System, 2018. "Valuation Report as of December 31, 2017," Cavanaugh Macdonald, July 10.

Koedel, C. and M. Podgursky, 2016. "Teacher Pensions," Chapter 6 in Hanushek, Machin, and Woessmann (eds.), *Handbook of the Economics of Education*, vol. 5, North-Holland Elsevier, Amsterdam, pp. 281-303.

McGee, Josh and Marcus A. Winters, 2016. "Better Pay, Fairer Pensions III. The Impact of Cash-Balance Pensions on Teacher Retention and Quality: Results of a Simulation," Report 15 (June), Manhattan Institute, New York.

Ni, Shawn and Michael Podgursky, 2016. "How Teachers Respond to Pension System Incentives: New Estimates and Policy Applications," *Journal of Labor Economics*, October, 2016 (Vol. 34, no. 4), pp. 1075-1104.

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

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.

Rhee, Nari and William B. Fornia, 2017. "How Do California Teachers Fare under CalSTRS? Applying Workforce Tenure Analysis and Counterfactual Benefit Modeling to Retirement Benefit Evaluation," *The Journal of Retirement*, Fall 2017 (Vol. 5, no. 2), pp. 42-65.

Rhee, Nari and Leon F. Joyner, 2019. "Teacher Pensions vs. 401(k)s in Six States," UC Berkeley Center for Labor Research and Education and National Institute on Retirement Security.

Richwine, Jason, and Andrew G. Biggs, 2011. "Assessing the Compensation of Public-School Teachers," Heritage Center for Data Analysis, November 1, 2011, Washington, D.C.

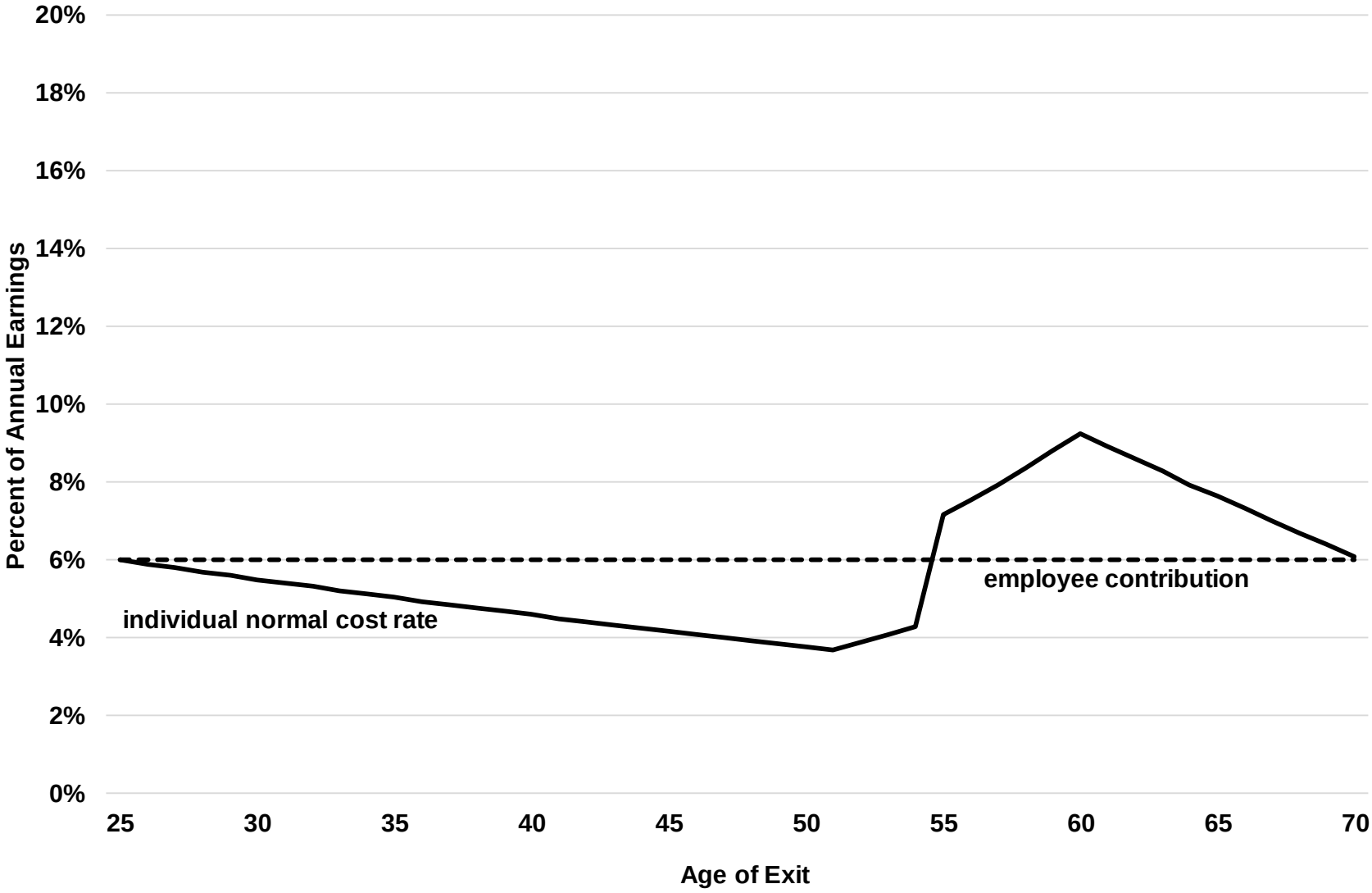
Roth, Jonathan, 2017. "Union Reform and Teacher Turnover: Evidence from Wisconsin's Act 10," Harvard Kennedy School, Program on Education Policy and Governance Working Paper Series, PEPG 17-02.

Samuelson, Paul A., 1963. "Risk and Uncertainty: A Fallacy of Large Numbers," Scientia (April/May), pp. 1-6.

Weingarten, Randi, 2017. "Flawed Bellwether Education Report on Teacher Pensions," American Federation of Teachers Memorandum, May 22.

Figure 1. Normal Cost Rates, Kansas FAS Plan, by Age of Exit, Entry Age 25

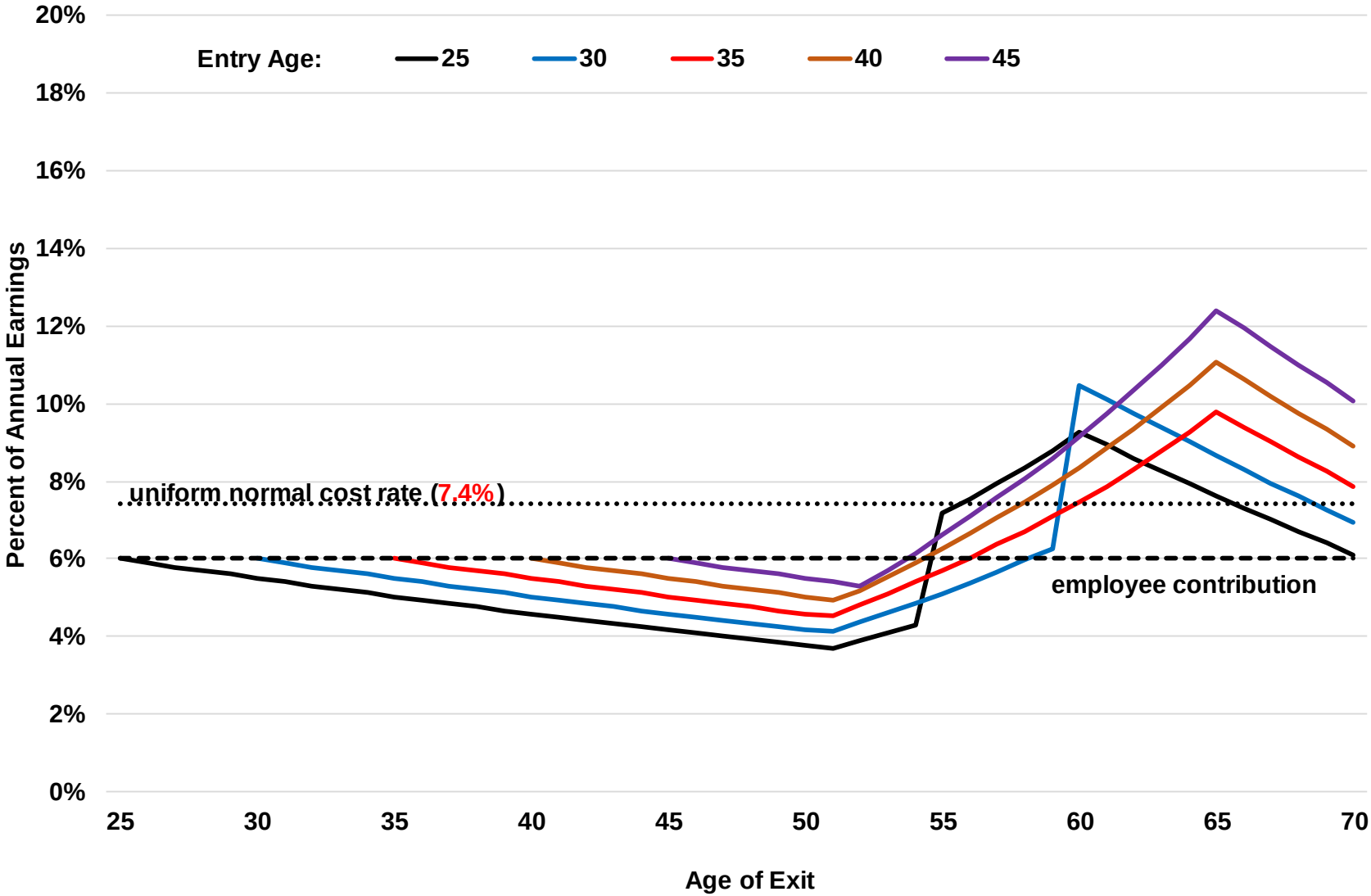
Estimated using 2017 KPERS 2 assumptions and benefit formula, r = 7.75%



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*.

Figure 2. Normal Cost Rates, Kansas FAS Plan, by Age of Entry and Exit

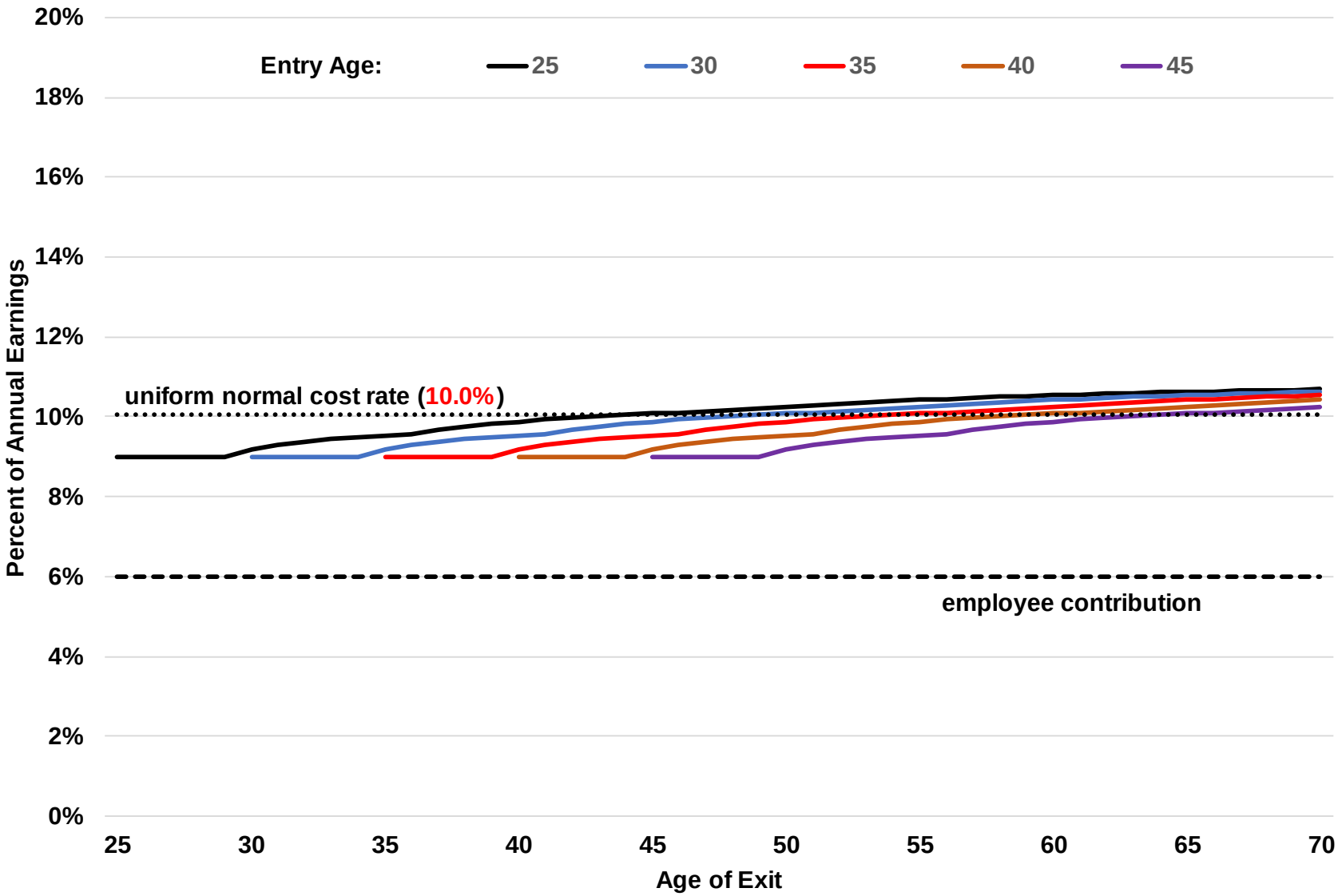
Estimated using 2017 KPERS 2 assumptions and benefit formula, r = 7.75%



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 3. Normal Cost Rates, Kansas CB Plan: Sticker Price

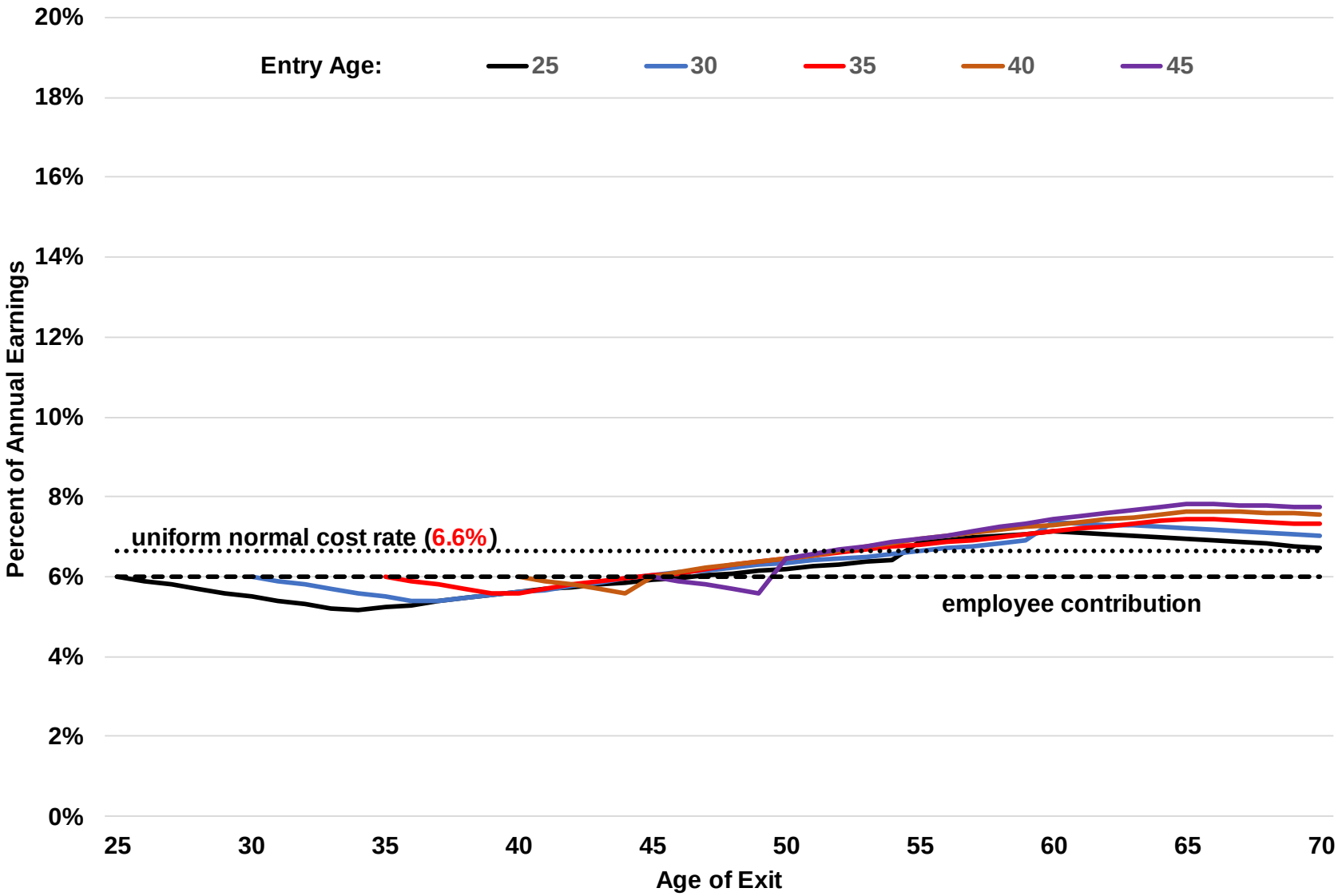
Employer credits = 3 - 6%. Immediate vesting. discount = interest = annuity rate = 7.75%



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 4. Normal Cost Rates, Kansas CB Plan: As Implemented

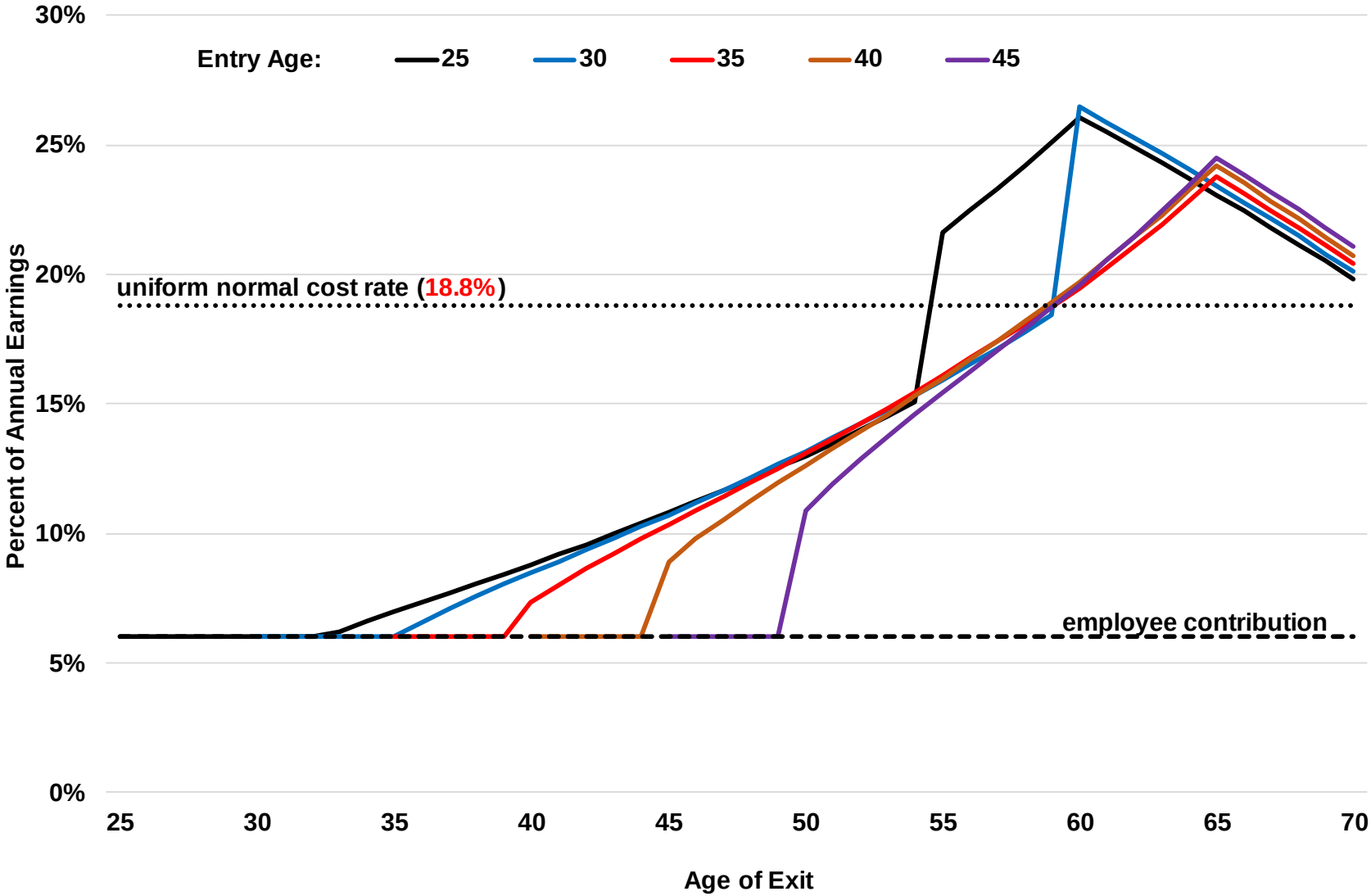
Employer credits = 3 - 6%. 5-year vesting. annuity interest = 5.75%, interest credit = 6.25%, discount rate = 7.75%



The curves depict n_{es}, the annual contribution rate required to fund benefits of an individual entering at age e and exiting at age s.

Figure 5. Full Cost of Risk-Free Benefits, Kansas FAS Plan

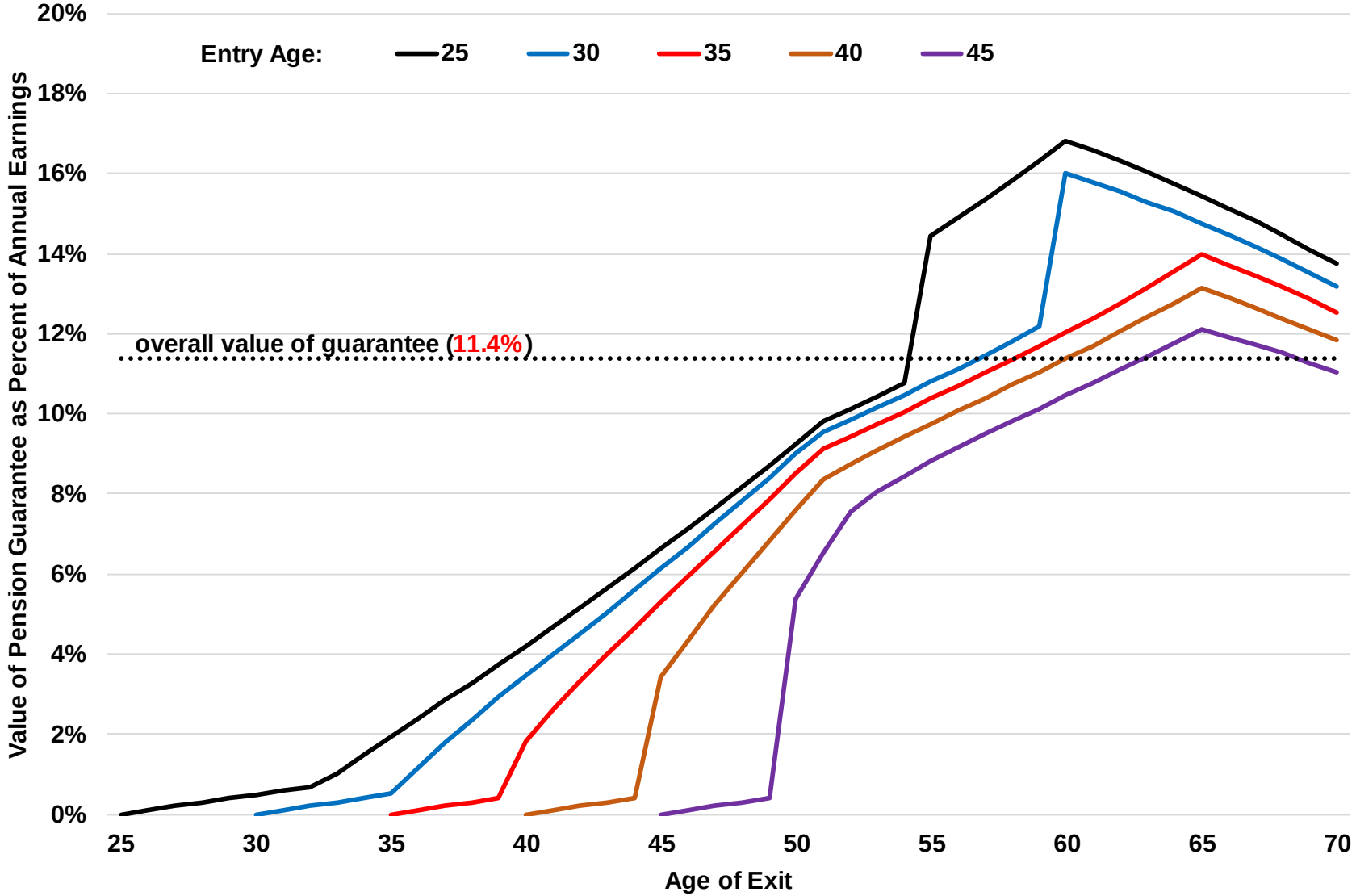
Estimated using 2017 KPERS 2 assumptions and benefit formula, r = 4.00%



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 6. Value of Pension Guarantee, Kansas FAS Plan

Difference between value of individual normal cost evaluated at 4.0% and 7.75% for KPERS-2 teachers



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

Figure 7. Full Cost of Risk-Free Benefits, Kansas CB Plan

KPERS 3 benefits & assumptions, except discount = interest = 4.00%.

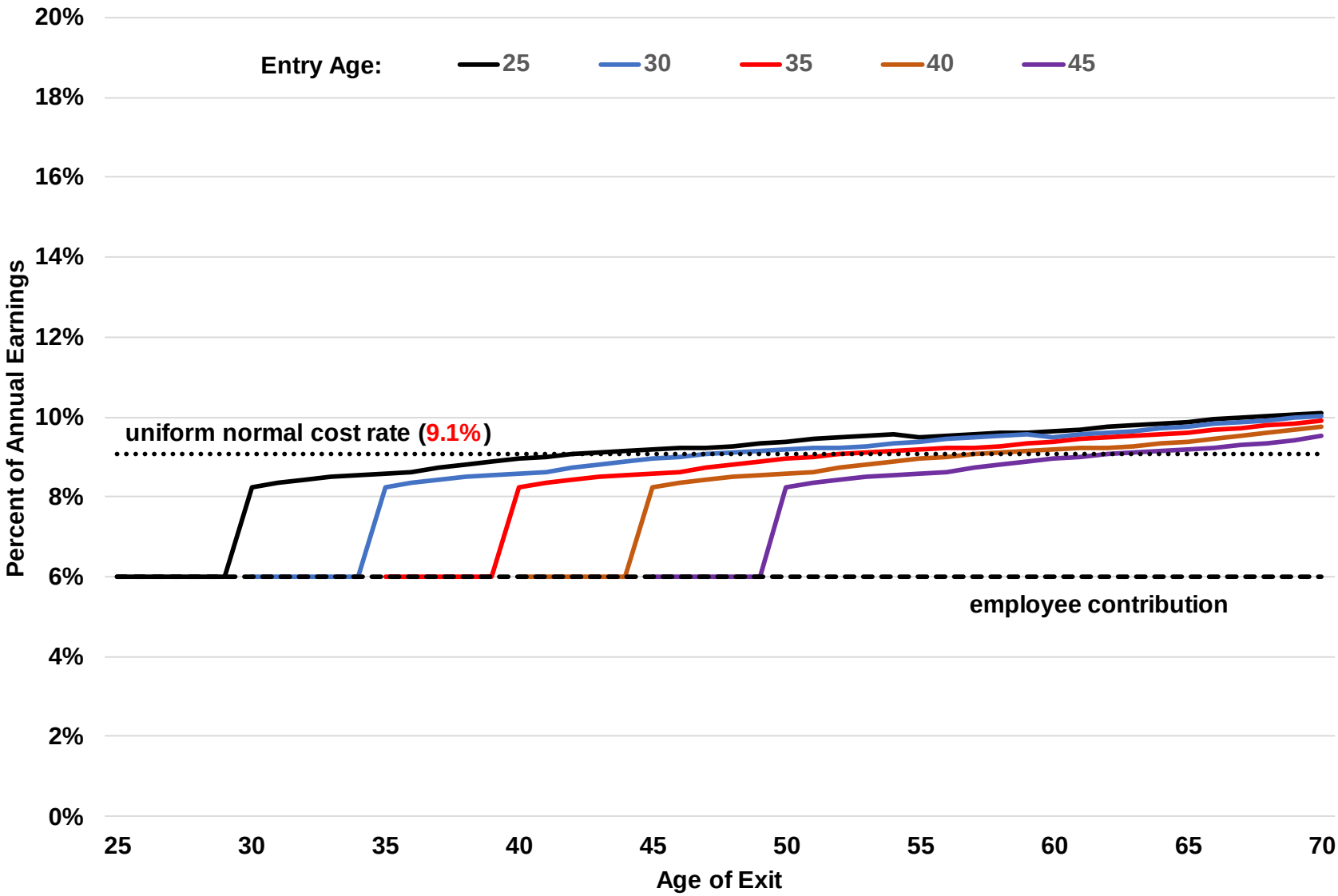


Figure 8. Value of Pension Guarantee, Kansas CB Plan

Difference between full value of guaranteed benefit and actuarial normal cost.

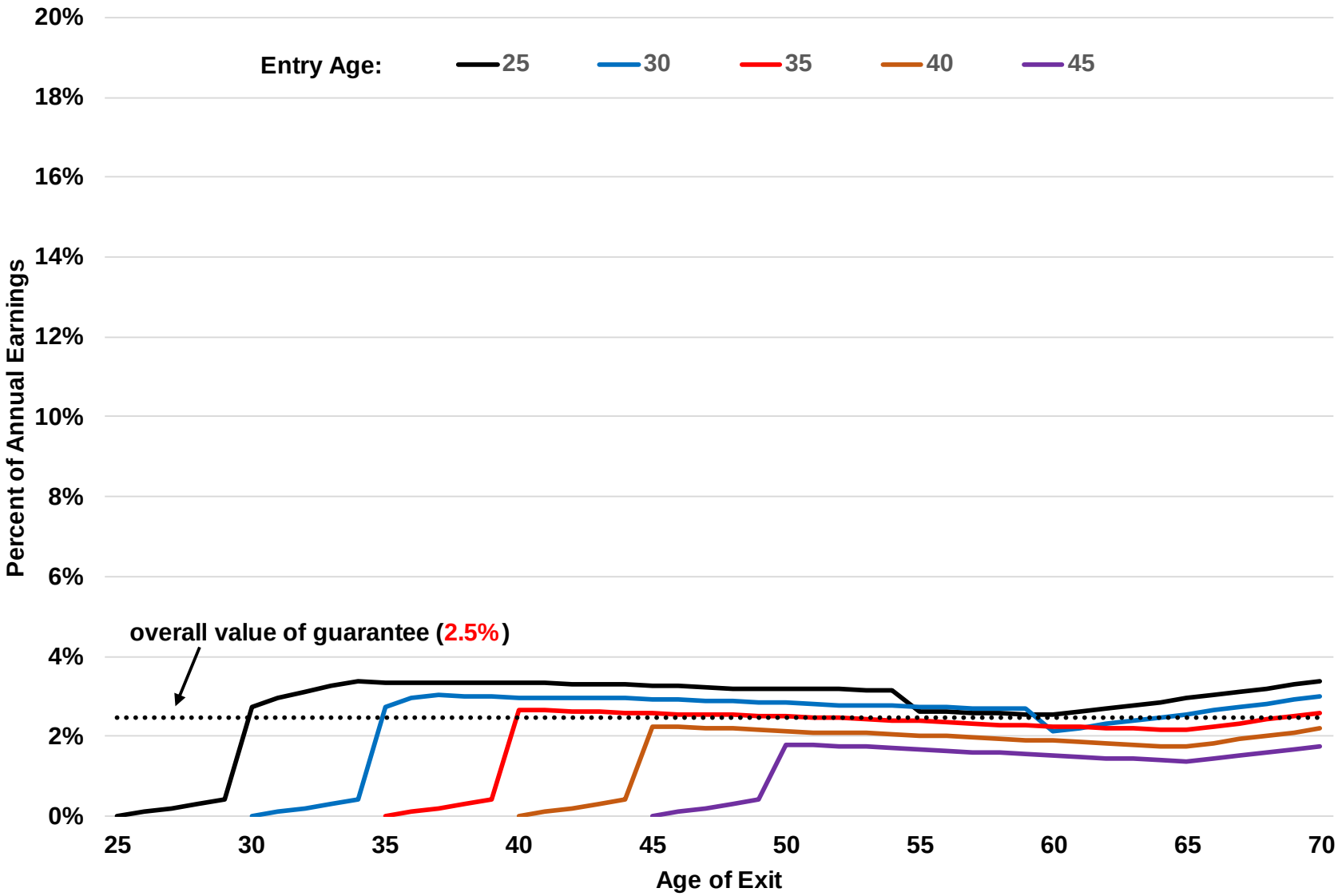
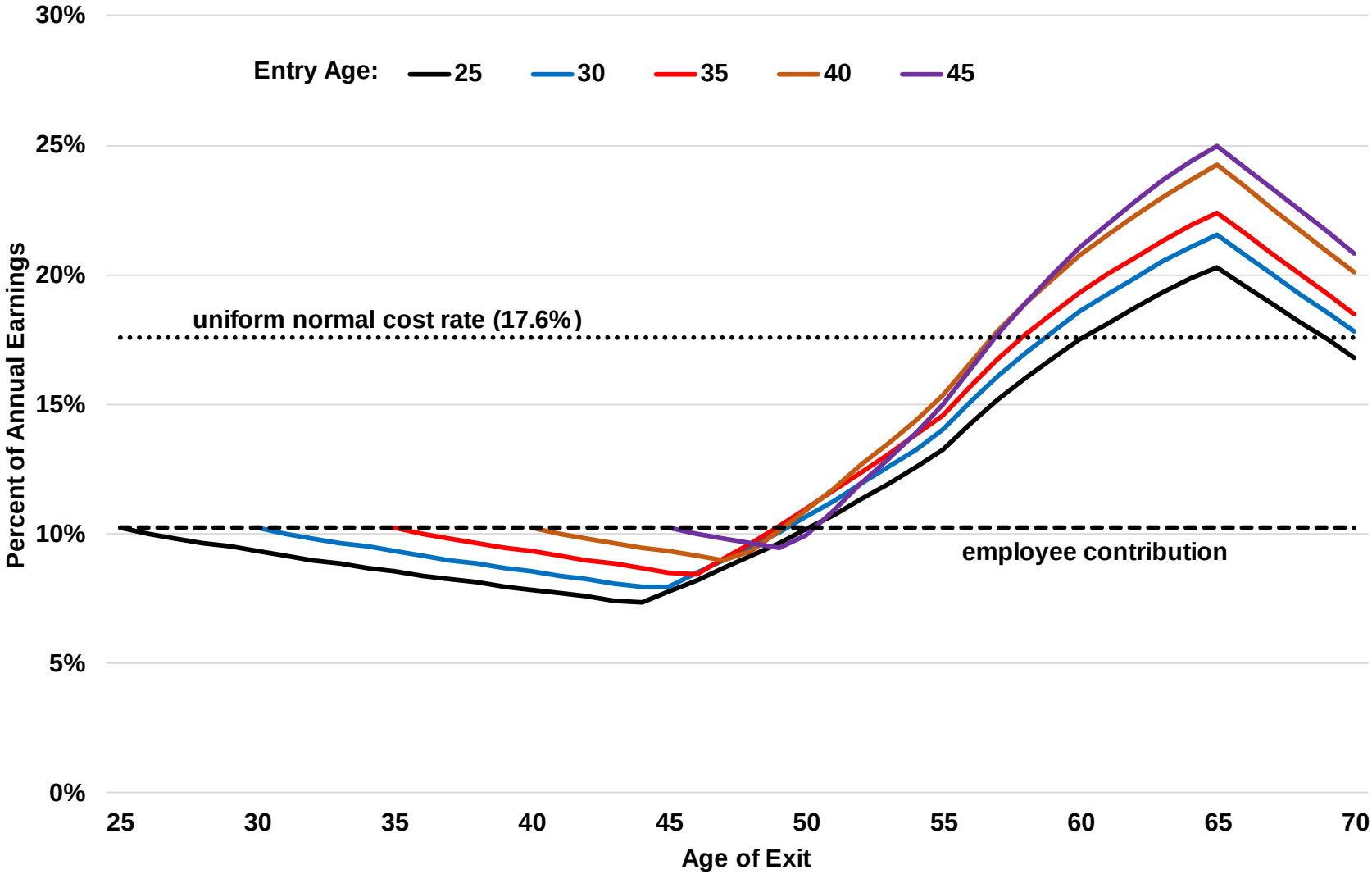


Figure A1. Normal Cost Rates, California, by Age of Entry and Exit

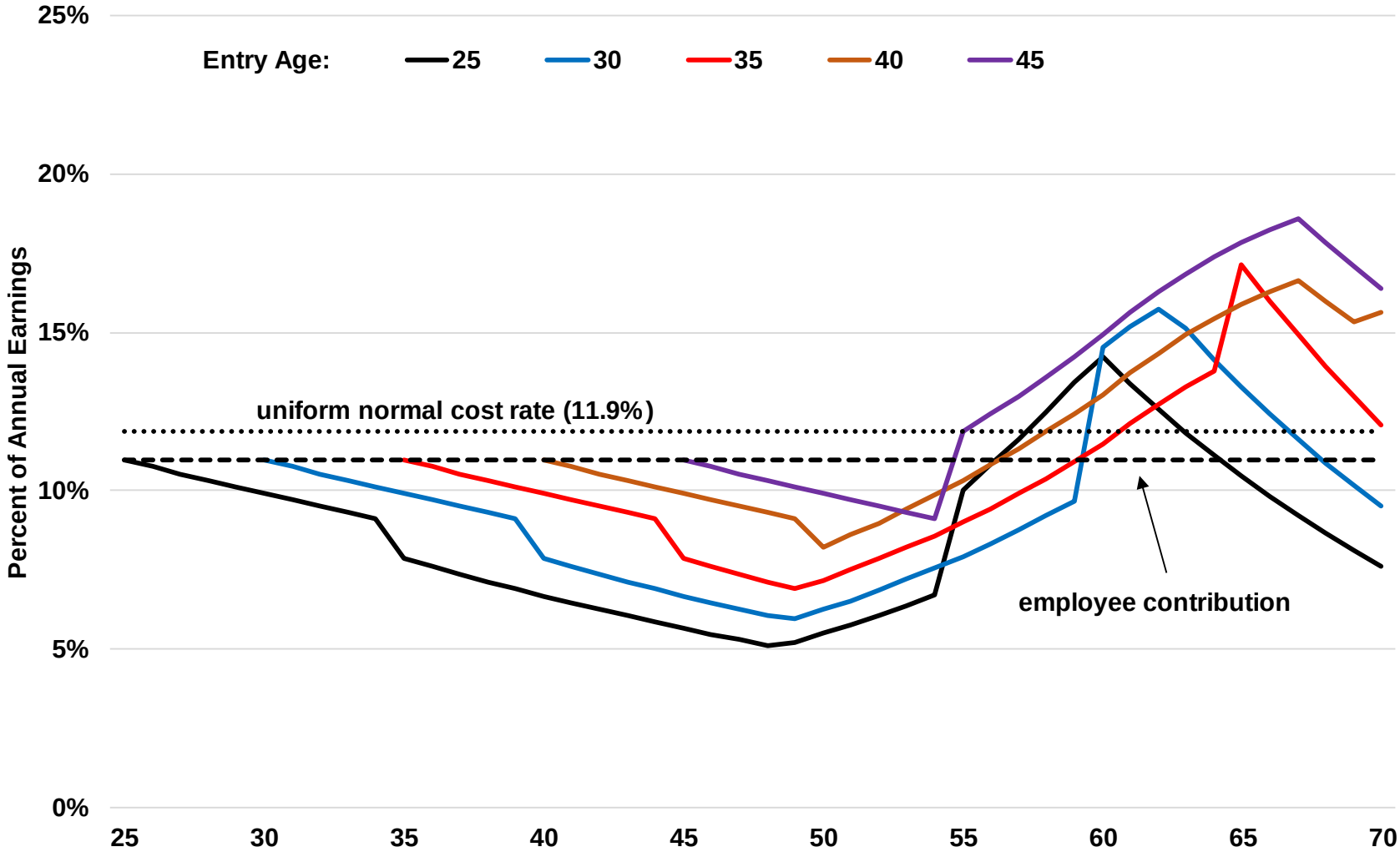
Source: Costrell, 2018a, based on 2016 CalSTRS assumptions and benefits for new hires



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

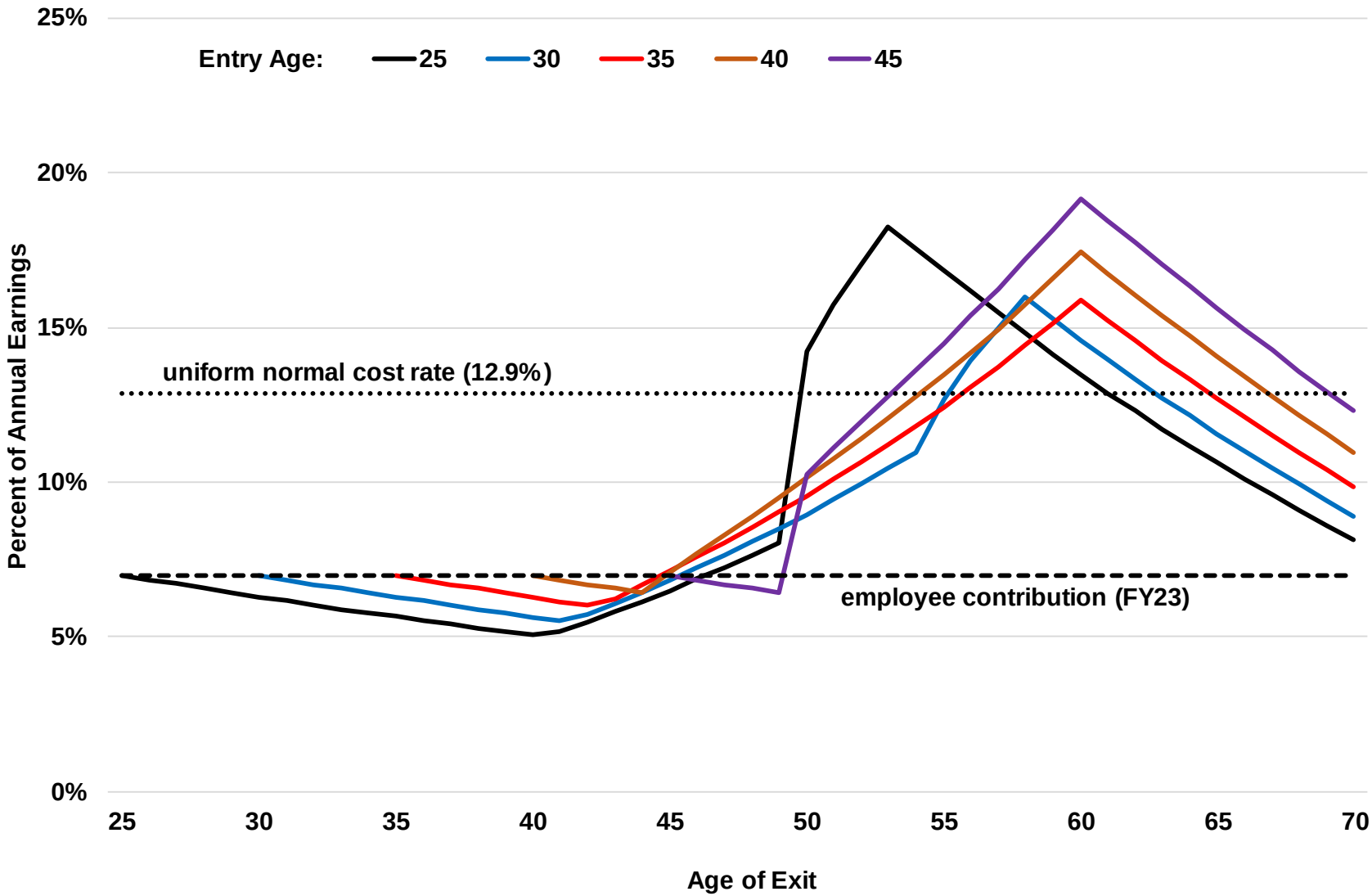
Source: Costrell and Fuchsman, 2018, based on 2016 MTRS assumptions and benefits for new hires



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 A3. Normal Cost Rates, Arkansas, by Age of Entry and Exit

Source: Costrell, 2018c, based on 2017 ATRS assumptions and benefits for new hires.



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.