

**DISTRIBUTION OF TEACHER PENSION BENEFITS IN CALIFORNIA:
A VAST SYSTEM OF CROSS-SUBSIDIES**

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ABSTRACT: The value of pension benefits varies widely, by a teacher’s age of entry and exit, e.g. between early leavers and those who retire at the “sweet spot.” This variation is masked by the uniform rate of annual contributions, as a percent of pay, to fund benefits for all – the “normal cost rate.” To unmask that variation I calculate annual cost rates at the *individual* level. In California, I find that the cost of a teacher’s benefits ranges from about 7 to 27 percent of pay, and exhibits some idiosyncratic patterns, as is endemic to traditional pension plans. The variation in individual cost rates generates an extensive, but hidden array of cross-subsidies, as winners receive benefits worth more than the uniform contribution rate, and losers receive less. One-fifth of annual contributions are redistributed in this fashion, comprising almost half of the employer’s contribution. My main policy conclusion is that cash balance plans can rationalize or eliminate the current system of cross-subsidies and provide the transparency lacking in traditional plans.

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I. INTRODUCTION AND SUMMARY

The funding plans for traditional teacher pension systems are built upon a highly uneven set of benefits, varying widely in value by age of entry and exit.¹ These inequities are masked by a *uniform* fringe benefit rate for pensions. 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,² 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 those who retire at the "sweet spot" 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. In this brief, I present these patterns of *individual* normal cost rates and associated cross-subsidies under the California State Teachers Retirement System (CalSTRS). My goal is greater transparency and deeper understanding of the system of winners and losers embedded in the funding plans of traditional teacher pension systems. By bringing the *individual* cost rates out into the open, individual teachers may learn how they are affected by the redistribution of contributions that pension systems build into their funding plan.

¹ This line of research dates to [Costrell and Podgursky \(2008, 2009, 2010a, 2010b\)](#).

² In addition, the employer makes payments for the unfunded liability – benefits earned in the past, but not funded. This is a very large problem, but is not the subject of this brief. 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 \(2016a,b\)](#)). In this brief, we take the assumptions as given to analyze the cross-subsidies within generations that are *built into the system's funding plan*, as distinct from the cross-subsidies between generations when the assumptions fail. For analyses that incorporate cross-subsidies across generations that arise from the failure to meet assumed investment returns, see [Costrell and McGee \(2017b\)](#).

The cross-subsidies embedded in the CalSTRS plan are widespread, substantial, and somewhat arbitrary. Individual annual cost rates vary from about 7 percent of pay (for those who enter and leave early) to 27 percent (for those who enter late and leave at 65). Three-fifths of entrants are losers: their benefits are worth less than their contributions and those of their employers. The cross-subsidies they provide to the winners are not small: for almost half of entrants, the entire employer contribution and some of the investment returns on their own contributions goes to fund others' benefits. As a result, the winners receive benefits of substantially greater value than the contributions made by or for them.

II. INDIVIDUAL NORMAL COST RATES AND CROSS-SUBSIDIZATION

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 \(2017a\), Appendix](#)), but they are not publicly reported. Specifically, 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. It can readily be 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):

$$(1) \quad n_{es} = B_{es}/W_{es}.$$

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 CalSTRS.

Traditional pension plans levy a joint (employee plus employer) contribution rate, n^* , that is *uniform* (independent of the individual's normal cost), calculated to fund the benefits of the whole entering cohort.³ This rate is a weighted average of individual costs.⁴ 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 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 CalSTRS' funding plan will be shown below.

III. INDIVIDUAL NORMAL COST RATES FOR CALSTRS

I now apply these concepts specifically to the California State Teacher Retirement System plan. I estimate the individual normal cost rates, $n_{es} = B_{es}/W_{es}$, for all entry and exit ages, $e, s = 20, \dots, 75$. I base the calculations on the CalSTRS actuarial assumptions (slightly modified, as explained below) and benefit formula.⁵

³ It can be shown that n^* applies not simply to a single entering cohort, but to any cohort, past or present, or the full set of such cohorts working their way over time through the workforce, under a given benefit formula and set of actuarial assumptions ([Costrell and McGee \(2017a\)](#)).

⁴ 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 \(2017a\)](#), [Appendix](#)).

⁵ The actuarial assumptions cover wage growth, investment returns, exit rates, and mortality rates. These assumptions are drawn from the 2016 annual valuation report ([CalSTRS, 2017](#)), based on the most recent 5-year experience study ([CalSTRS, 2016](#)). (The actuarial assumptions used in [Costrell and McGee \(2017a\)](#) were drawn from the 2015 valuation report, based on the prior 5-year experience study.) The benefit formula is delineated in the valuation report and the member handbook ([CalSTRS, 2018](#)). This includes the retirement eligibility conditions, age-specific multipliers, cost of living adjustments (COLA), employee contribution rate, and interest rate on refunds.

Benefits can be in the form of a pension or refund of employee contributions.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 CalSTRS. Teachers who leave before vesting, without the expectation of returning and becoming eligible 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. Finally, teachers who leave service and are eligible for an immediate pension, may still choose the refund, although it is generally not financially prudent to do so. I assume that teachers choose the refund or pension to maximize the PV of their benefits.⁷

If a teacher takes the pension, B_{es} is the PV of the stream of pension payments, weighted by her survival probabilities, discounted to entry. The payments begin with a starting pension equal to an age-specific multiplier \times years of service $(s - e) \times$ final average salary (FAS, last 3 years), augmented annually with a 2.0 percent simple COLA. Specifically, I consider the “2% at 62” program for new hires (since 2013), with multipliers ranging from 1.16 percent at age 55 to 2.0 percent at 62 and 2.4 percent at 65, after 5-year vesting.⁸ For example, a 25-year-old entrant working to 65 retires with a starting pension of $40 \times 2.4 = 96$ percent of FAS. This formula, together with CalSTRS mortality assumptions, allows us to calculate the PV of benefits, relative to the PV of wages, $n_{es} = B_{es}/W_{es}$, the annual contribution rate required to fund the benefits of an individual entering at age e and exiting at age s .

⁶ I leave aside death and disability benefits, which comprise about 5 percent of normal cost, less than 1 point.

⁷ CalSTRS assigns probabilities of taking the refund which may not maximize PV. Our modified assumption eliminates a precipitous drop in the individual normal cost rate upon vesting, due to suboptimal cash-outs.

⁸ Vested employees who withdraw before age 55 but do not cash out must defer the pension to at least age 55. CalSTRS assumes they defer to age 62, so we adopt that assumption. The results are similar for deferral only to 55.

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 10.2 percent:⁹ 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 3 percent is below the fund's assumed return, 7 percent.¹⁰ The contribution rate needed to cover the refund falls as this difference accumulates.

At a certain point, the pension becomes more attractive than the refund. A 25-year-old entrant reaches that point at age 45; at this age the pension would still be deferred, but exceeds in PV the value of the employee refunds. Beyond that point, the normal cost rate rises as the deferral becomes shorter, and then, beyond age 55, there is no deferral, but the normal cost rate continues to rise as the age-specific multiplier grows. Each year of delayed retirement beyond 55 is a year of forgone pension payments, but prior to age 65, the growth in the multiplier outweighs this effect. After age 65 the multiplier stops growing, and the normal cost declines, due to the decreasing number of years the pension will be paid. Overall, there is a wide variation in the normal cost rate, ranging from 7.3 to 20.3 percent of pay per year. This is a manifestation of the well-known back-loading of benefits that favors long-termers under traditional FAS formulas ([Costrell and Podgursky \(2008, 2009, 2010a, 2010b\)](#)).

⁹ The rate has been 9.2 percent, but is expected to rise one percent, effective July 1, 2018 ([CalSTRS, 2018](#), p. 5).

¹⁰ The assumed return has been cut from 7.5 percent through the 2015 valuation (the valuation used in [Costrell and McGee \(2017a\)](#)) to 7.25 percent for the 2016 valuation and 7.00 percent thereafter. At the same time, the interest credit has been reduced from 4.5 percent.

Variation in Normal Cost Rates By Age of Entry, Age of Exit, and Years of Service

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,¹¹ but for CalSTRS the predominant pattern is for a higher normal cost rate with later entry, at any given exit age. Figure 2 depicts this pattern for the normal cost curves of selected entry ages. Thus, in addition to the variation *within* entry-age cohorts, Figure 2 also depicts the (vertical) variation *across* entry ages, for the same exit age. For example, the annual cost to fund retirement at age 65 varies from 20.3 percent per year over the career of a 25-year-old entrant to 24.9 percent for a teacher who enters late, at age 45. Consequently, the overall variation in normal cost rates depicted, within and across entry ages, is rather wide, ranging from 7.3 to 24.9 percent of pay per year; the full range, for entry ages not shown, is 6.8 to 27.1 percent.¹²

Advocates of traditional FAS pension systems often defend the apparent inequities as a rational human resource policy to reward longevity.¹³ As we have seen, in Figures 1 and 2, CalSTRS does reward longevity for any given entry age, by awarding benefits at a higher annual rate, as the exit age rises from age 45 or so, up through 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.¹⁴ But the variation across entry ages, for any given exit age (i.e. the vertical spread in Figure 2) generally goes in the opposite direction: *shorter* tenures are

¹¹ 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, over different ranges of s , discount rates, and benefit formulas. Another way of seeing the ambiguity is to note that for any given exit age, the normal cost rate varies with (i) the starting pension as a percent of FAS; and (ii) FAS relative to cumulative earnings. 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.

¹² The higher rates are for unusual entry ages, later than 45.

¹³ See, for example, [Rhee and Fornia \(2016, 2017\)](#) and [Weingarten \(2017\)](#).

¹⁴ For a good summary of the research, see [Koedel and Podgursky \(2016\)](#), as well as the recent papers by [Ni and Podgursky \(2016\)](#), [McGee and Winters \(2016\)](#), and [Roth \(2017\)](#).

rewarded.¹⁵ 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.

Figure 3 depicts the relationship between normal cost rates and years of service, for the same selected ages of entry as Figure 2. We can see in this diagram the point made above, that the normal cost rate generally declines with years of service, *when the variation is due to age of entry*. For example, the 65-year-old retirees are those at the peak of the curves depicted, and their normal cost, at those peaks, declines with years of service. This is perhaps difficult to reconcile with the usual defense of traditional pension systems, based on rewarding longevity.

Figure 3 also shows – looking vertically across curves – that the normal cost rate varies widely for the *same* years of service, and, moreover, the patterns are highly idiosyncratic. For 20 years of service, the normal cost rate rises with age of entry,¹⁶ but for 25, 30, or 35 years of service, the normal cost rate rises and then falls, and for 40 years of service, it simply falls with age of entry. One may well wonder if there is any human resource rationale for these patterns.

IV. CROSS-SUBSIDY RATES AND THE DEGREE OF REDISTRIBUTION

The wide variation among individual cost rates contrasts with the uniform contribution rate, n^* . That is the weighted average of the individual cost rates, n_{es} , where the weights are the shares of the cohort's lifetime earnings for entrants of type (e,s) . These weights generate the normal cost rate that will fund the benefits of each cohort, past and present, taken as a whole, under the current benefit formula and actuarial assumptions. I calculate n^* to be 17.6 percent of

¹⁵ This is not a universal relationship across state plans, or even within CalSTRS, as can be seen in Figure 2 by comparing the normal cost for exits around age 50, between 45-year-old entrants and those of age 35 or 40.

¹⁶ This is due to the plan's eligibility conditions, as the pension for younger entrants, exiting before age 55, is deferred, while the pension for older entrants, exiting with the same years of service, is immediate.

pay, depicted in Figure 2 as the solid horizontal line.¹⁷ The deviations of individual cost rates from n^* represent the cross-subsidy rates, $(n_{es} - n^*)$. Those above the line receive cross-subsidies from those below the line. For example, the extreme points depicted for n_{es} , of 7.3 and 24.9 percent, represent cross-subsidies of -10.3 and $+7.4$ percent of pay. These cross-subsidies are built into the funding plan. For those individuals below the solid line, 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.

Those who provide the cross-subsidies comprise 61 percent of entrants¹⁸ and account for 36 percent of their lifetime earnings;¹⁹ those who receive the cross-subsidies are the remainder. How large are the cross-subsidies? Taken together, the losers provide cross-subsidies that total -4.8 percent of their lifetime earnings. That is the average cross-subsidy rate for those below the solid line in Figure 2 (weighted by shares of lifetime earnings). The winners receive cross-subsidies that average $+2.7$ percent. One can readily verify the zero-sum result: $0.64 \times 2.7\% - 0.36 \times 4.8\% = 0.0\%$. Thus, in all, taking absolute values of the cross-subsidies, 3.4 percent of total income is redistributed ($0.64 \times 2.7\% + 0.36 \times 4.8\%$), about one-fifth of the total normal cost, and almost half the employer contribution. While the uniform employer contribution rate is 7.4 percent, the losers receive, on average, employer funded benefits worth only 2.6 percent, while those of the winners' are worth 10.1 percent.

¹⁷ This is slightly higher than CalSTRS' 2016 calculation of the normal cost rate for new hires, after netting out death and disability benefits, consistent with my assumption that there are no sub-optimal cashouts.

¹⁸ [Rhee and Fornia \(2016, 2017\)](#) argue that prior entrants who are no longer in the workforce should be excluded when counting winners and losers. But as explained in [Costrell and McGee \(2017a\)](#), this results in “survivorship bias” toward winners. As a result, the losses left behind by prior leavers are excluded, such that the cross-subsidies do not sum to zero. In other words, the funding math simply does not add up.

¹⁹ Those with lower normal cost rates (negative cross-subsidies) tend to be early leavers with shorter earnings streams, so smaller shares of the cohort's PV of earnings.

V. CONCLUSION

The distinguishing characteristic of traditional FAS pension plans, such as CalSTRS, is that the benefit is delinked from contributions, unlike cash balance or other account-based plans (discussed below). Some individuals receive benefits that cost more than the contributions made by or for them, and some receive less. This creates a system of hidden cross-subsidies, varying by age of entry and exit. In this brief, I have measured the value of individual benefits as the annual contributions required to fund them, as a percent of pay. The wide variation in these individual cost rates – ranging from 7 percent to 27 percent – contrasts with the uniformity in the contribution rate actually levied, clearly revealing the system of cross-subsidies. In effect, many entrants help fund the benefits of others through some or all of their employer contribution and even some of the earnings on their own contribution. I estimate that this redistribution represents almost half the employer contribution. Without these cross-subsidies, the employer and/or employee would have to contribute much more to fund the benefits of career teachers.

My analysis covers the full range of entry and exit ages, illuminating additional patterns of cross-subsidies to those previously identified between short-termers and career teachers. Benefits not only vary by age of exit, but also by age of entry. Older entrants are often strongly subsidized by younger entrants leaving with the same years of service. Indeed, older entrants are generally subsidized by younger entrants leaving at the same age, even though the older entrants have fewer years of service. These patterns are difficult to reconcile with the usual claim that traditional FAS systems rationally reward *longer* years of service.

What are the policy implications of this analysis? At the very least, any good policy should be transparent. Where traditional FAS plans are employed, the system of hidden cross-subsidies should be laid bare. The uniform contribution rate, designed for funding purposes,

masks the wide variation in individual cost rates. These rates can be readily calculated, by age of entry and exit, as a byproduct of the annual actuarial valuations, and should be made publicly available, so that members can better understand how their plan may affect them.

There is reason to go further, by reducing the actual variation in cost rates. One of the reasons employers offer retirement plans is to help workers save enough across their careers to reach a secure retirement. The low savings rates effectively offered to workers who leave early (in order to help fund those with high normal costs) have the potential to endanger this goal, placing them at a big retirement savings deficit. The most efficient way of reducing the variation in cost rates is through an account-based system, such as a cash balance (CB) plan.

A CB plan is a defined benefit plan, in which each individual's benefit is directly tied to a retirement account balance (to be annuitized or drawn down). That balance is equal to the cumulative value of employee contributions and employer contribution credits (a bookkeeping entry), plus accumulated interest credits. The employer contribution credit, with interest, is the employer-funded benefit, transparent to all. If the credit is uniform, so are the rewards – there are no cross-subsidies; benefits accrue smoothly in tandem with contributions.

If human resource goals are to include rewarding longevity, CB plans can do so more efficiently. As we have seen, FAS systems do not reward longevity consistently. CB systems can reward longevity far more rationally, by designing employer contributions to rise smoothly, gently, and non-idiosyncratically, with years of service. For example, under Kansas' Tier 3 CB plan ([Schmitz, 2016](#); [KPERs, 2017](#)) – the nation's first such plan covering teachers – the employer match (to the employee's contribution of 6 percent) rises from 3 percent of pay for years 1-4 of service to 6 percent of pay for years 24 and beyond.²⁰ Such a gently varying system

²⁰ Typical of other CB plans, the employers' actual contribution rate is less than the notional contribution credit, because the plan's assumed return exceeds the interest credit. The individual employer normal cost rate, averaged

of employer matches, readily understood by teachers, may enhance the efficiency of the embedded incentives and accommodate teacher heterogeneity. In short, a CB or other account-based system, tying benefits directly to contributions, offers a more effective and equitable vehicle for delivering transparent and deliberate rewards to meet the goals of teachers and employers than the seemingly arbitrary system of cross-subsidies that are embedded in traditional FAS plans, such as CalSTRS.

over one's years of service, for providing these credits would range from 3.0% to 4.7%, with interest credits equal to the assumed return of 7.75%. Under the assumed interest credit of 6.25%, the range in individual employer normal cost rates is only 3.0% to 3.7%. Either way, the range is much narrower than under FAS systems, as we have seen.

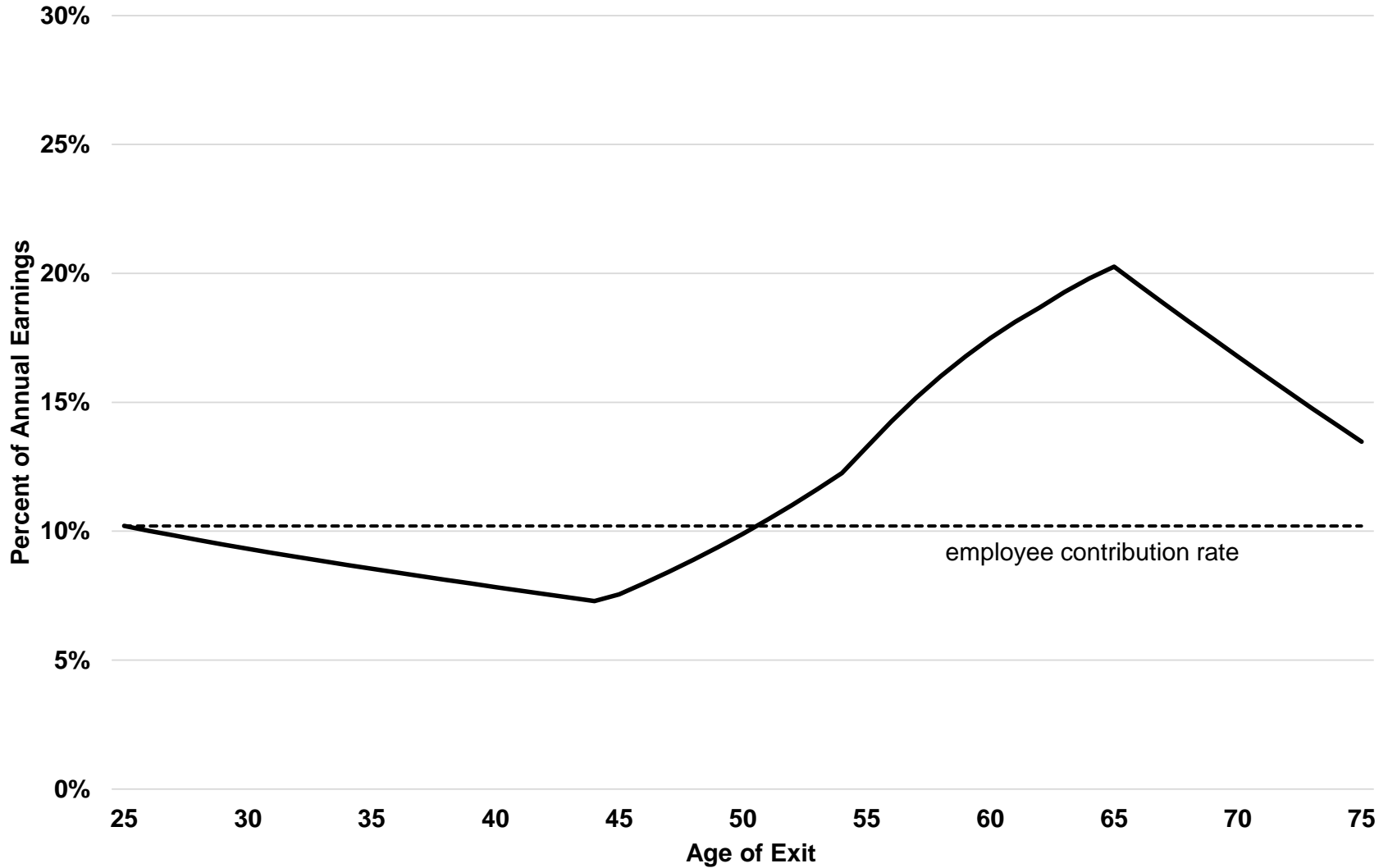
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Figure 1. Normal Cost Rate, Entry Age 25

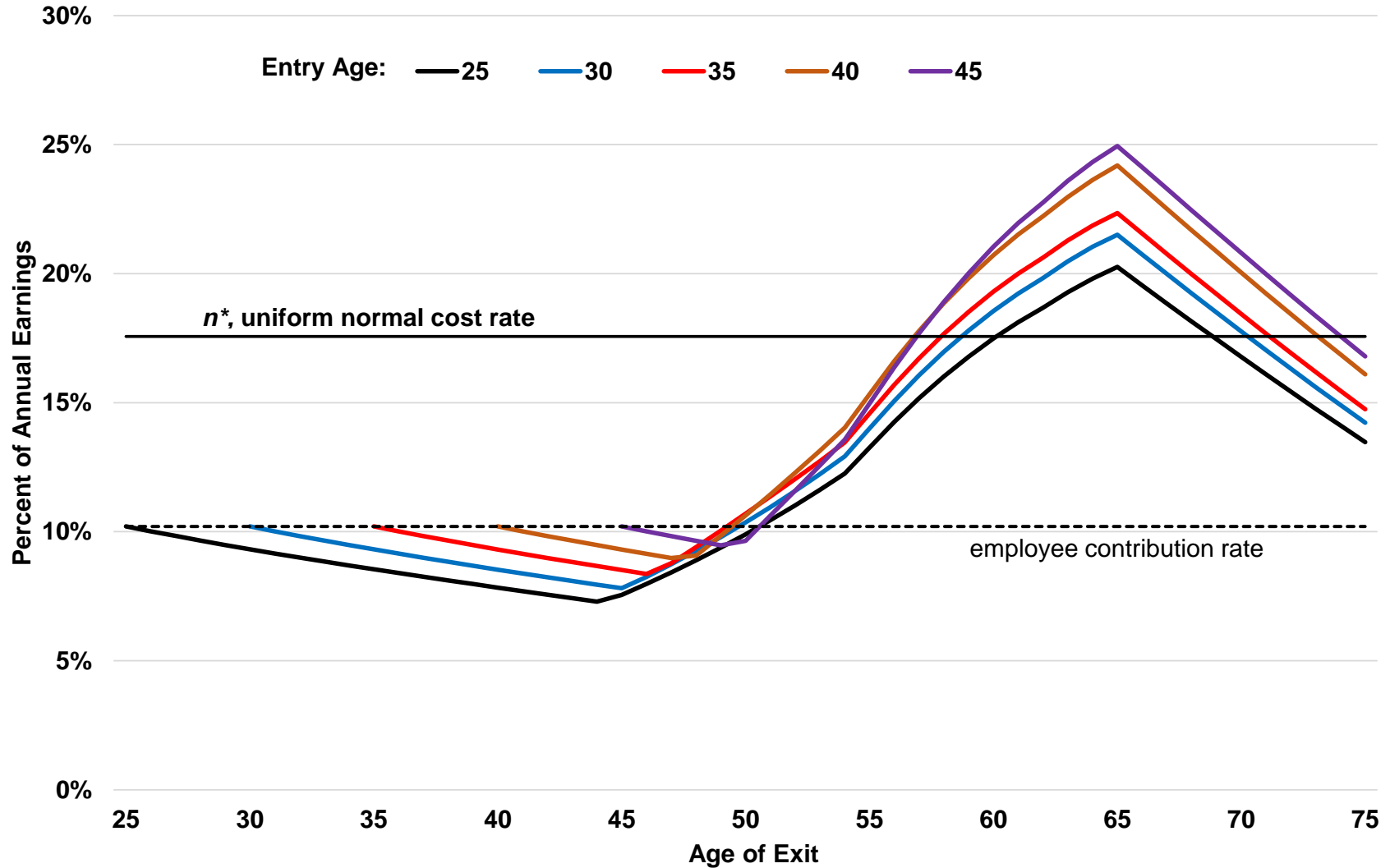
Estimated using 2015 CalSTRS assumptions and benefit formula for new hires, slightly modified



The curve depicts $n_{25,s}$, the annual contribution rate required to fund benefits of an individual entering at age 25 and exiting at age s .

Figure 2. Normal Cost Rate, by Entry Age and Age of Exit

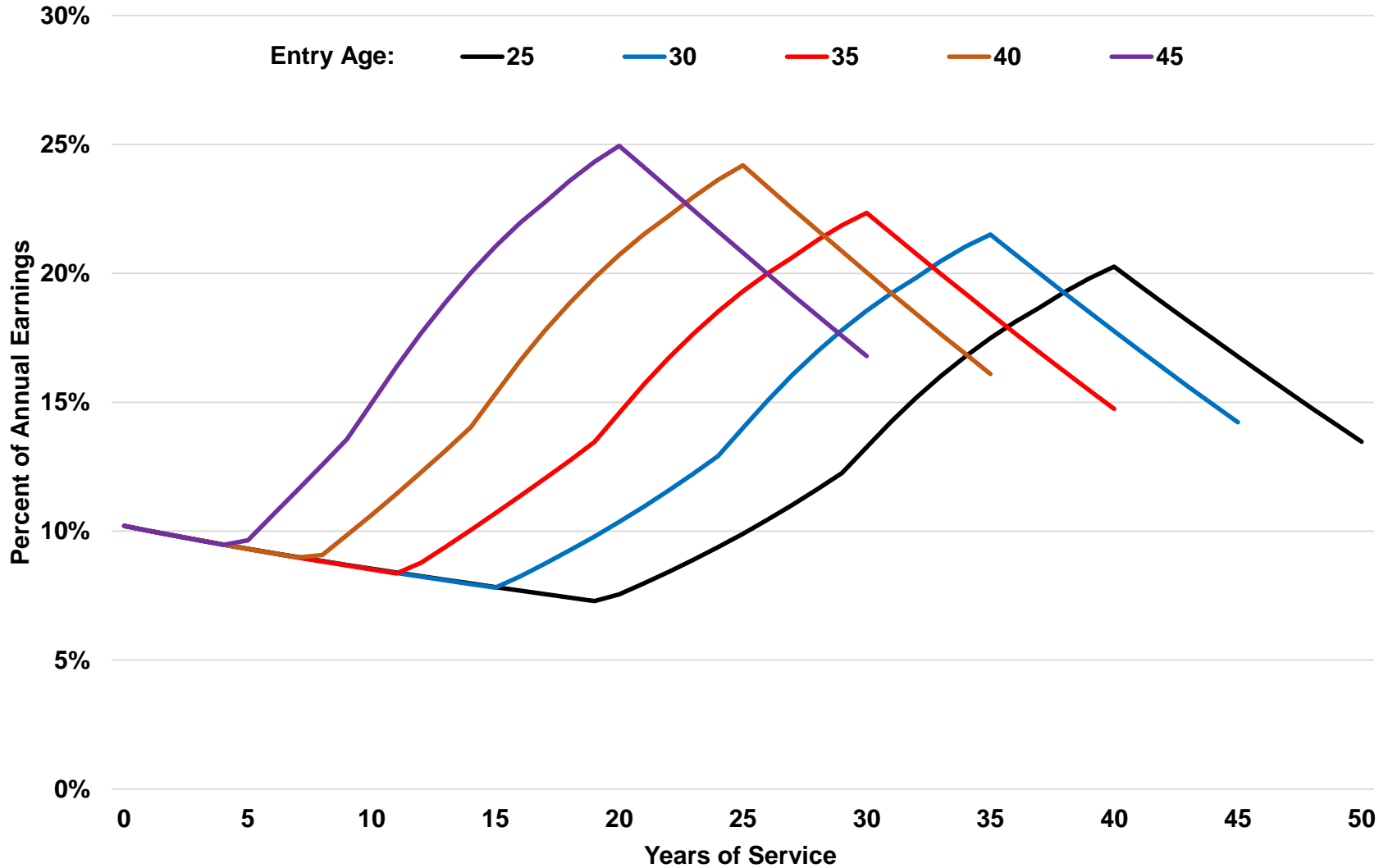
Estimated using 2015 CalSTRS assumptions and benefit formula for new hires, slightly modified



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 Rate, by Entry Age and Years of Service

Estimated using 2015 CalSTRS assumptions and benefit formula for new hires



The curves depict n_{es} , the annual contribution rate required to fund benefits of an individual entering at age e and serving $(s-e)$ years. Variation in cost by years of service is shown along each curve; variation by age of entry is shown across curves.