# TECHNICAL APPENDIX

## Sources of Data

The findings in this policy brief were based primarily on publicly available data from the 2012-2013 Comprehensive Annual Financial Reports (CAFR) for California, Illinois, and New Jersey state teacher pension systems. Some additional information was retrieved from state pension websites and from state departments of education when not available in the state's CAFR.

## Explanation of terms used in the pension formula (Figure 1):

- **Final average salary:** Final salary is computed as an average rate as defined in the pension plan – e.g., a one-year average, a three-year average, a four-year average, etc.
- **Multipliers:** Multipliers may be constant or change based on a retiree's years of service or age.
- **Cost of living adjustment (COLA):** The COLA supplements a retiree's pension starting in the second year of retirement at an increasing rate for every year that she receives an allowance. The COLA can vary in percentage terms as well as the financial method by which it is computed (simple interest annually compounded)
- **Years of service:** Only years of service is defined relatively consistently across plans. It's determined by the number of years an educator has worked (and maintained active pension plan membership through annual contributions), as well as credit earned through extra duties, credit from unused sick leave, or purchased credit.

Other factors that can further complicate the pension equation include longevity bonuses for veteran teachers, career factors that affect the multiplier, compensation caps for final average salary used in the retirement formula, and pension modifications for early retirement. For example, in California longevity bonuses are permanently added to the monthly retirement benefit at a set dollar amount of $200-$400 if the teacher earned 30+ years of service credit on or before December 31, 2010 and a career factor of 0.2% is added to the multiplier. In Illinois, cap on creditable earnings that can be used to determine the final average salary is $110,631.

## Assumptions and Adaptation of Data for Analysis

### Overall

For simplicity and accuracy, our analysis focuses on only the costs associated with defined benefit pension allowances. Because this brief is focused on veteran teachers nearing retirement, the average final salary, average years of service, average pension multiplier, and average beginning pension statistics were isolated for teachers retiring with 25 years of experience or more (see Table A1). This includes teachers under the CALSTRS 2% at 60 benefit structure in California, under the Tier I benefit structure in Illinois, and under the Tier I benefit structure in New Jersey.[18]

### California and Illinois

California and Illinois CAFRs publish average beginning pension allowances, final average salary, and retirement by demographic (e.g., age or years of service). These values were used to "back into" each state's pension formula, which allowed us to observe average pension multipliers.

### New Jersey

Because New Jersey's CAFR does not present these statistics by demographic (but does provide overall averages), further data retrieval and modification was necessary to isolate statistics for veteran teachers in the same way. We obtained 2012-2013 teacher salary data published by the Asbury Park Press website to calculate the average salary for all teachers in New Jersey with 25 years of service or more.[19] Then, to determine the average beginning pension for veteran teachers, we modified New Jersey's published average pension for all teachers to represent only those with 25 years of service or more. This was achieved by first determining the ratio of the average pension differential for all retirees vs. those retiring with 25 years of service or more in Illinois and California; we found that on average, the beginning average pension for a veteran teachers is approximately 141% higher that that of the average retiree. Finally, we applied this ratio to the published beginning average pension for all retired teachers in New Jersey (as listed in the state's CAFR).

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[18] "Together We Grow: Comprehensive Annual Financial Report 2012-2013", California State Teachers' Retirement System (CalSTRS), accessed on September 30, 2014 http://www.calstrs.com/sites/main/files/file-attachments/cafr2013.pdf. ; *Comprehensive Annual Financial Report*, 2012-2013, Teachers' Retirement System of the State of Illinois (TRS), accessed on September 30, 2014, https://trs.illinois.gov/pubs/cafr/FY2013/fy13.pdf.; *Comprehensive Annual Financial Report*, 2012-2013, New Jersey Division of Pension & Benefits, accessed on September 30, 204, http://www.state.nj.us/treasury/pensions/annrprts.shtml.

[19] "NJ Public School Teachers, 2012-13," *DataUniverse.* Asbury Park Press, accessed on September 30, 2014, http://php.app.com/edstaff/search.php.

## Cash Flow Discounting

### Future Values

To calculate the value of a future year's pension allowance in a given state, we begin with the state's average beginning pension (for veteran teachers) and applied the respective annual COLA beginning in year two, using the appropriate interest formulas:

**Simple interest:** **FV = Beginning allowance × ( 1+ [ COLA × (Year – 1) ] )**
**Compound interest:** **FV = Beginning allowance × (1+ COLA)$^{(Year - 1)}$**
*Note: We use (Year – 1) to represent time because COLAs begin in the second year of pension payments.*

We then determined the average lump sum of one teacher's total pension allowances over her lifetime by applying actuarial projections of lifespan. Table A2 displays these calculations from our California analysis.

This calculation was based on the state's average teacher retirement age (or minimum retirement age, when averages were not published) and the percentage of veteran retirees expected to live to a given year in the future. This proportion was calculated using unisex mortality rates published in the Internal Revenue Service's Static Mortality Tables for the Year 2014.[20] We then multiplied each year's proportion of retirees still alive (column H) by that year's respective pension allowance (column B), up to a maximum age of 120 years (the highest listed on the IRS mortality tables). Finally, we summed these products to find an overall average of lifetime pension allowances. Table A2 displays the future value calculations for our California analysis.

### Present Values

Next, we used cash flow discounting to translate each future year's pension allowance into an equivalent present day value, using the present value formula (which assumes compounded interest):

**$PV = FV \div (1 + r)^n$**
*Note: PV is Present Value of the annual allowance, FV is Future Value of the annual allowance, r is the discount rate, and n is the number of compounding periods.*

Once again, we multiplied the present value of each year's pension allowance by the proportion of retirees expected to live to the given year, and summed these products to find an overall average. Table A3 displays the present value calculations for our California analysis.

### Discount Rate Assumptions

This cash flow discounting process required that we make assumptions regarding the appropriate discount rate. Two schools of thought exist regarding the valuation of pension debts, each with distinct assumptions about rates of return. Because there is no clear consensus, our analysis illustrates the present value of pension debt under both valuation methods:

- Expected market return valuation, traditionally used by actuaries to analyze pension debt, assumes relatively higher interest rates of 7.5% – 8%. These rates are based on long-term expected returns from a fund's current investment portfolio and incorporate actuarial smoothing to spread risks and gains over a long time horizon (typically 30+ years).
- Fair market valuation is based on a risk-free interest rate, typically 3% – 5%. Financial economists and actuarial experts are increasingly calling for the use of this market-based method, arguing that reliance on a risk-free rate provides a more realistic picture of pension liabilities by accounting for the risk of future inflation and providing greater certainty that today's funds will be sufficient to meet tomorrow's obligations.[21] A commonly cited proxy for the risk-free rate is the current interest rate of a US treasury security, although there is no clear consensus over the appropriate security (e.g., a treasury bill vs. a treasury bond) and time horizon (e.g., short-term vs. long-term) on which to base this proxy.

Our analysis applied a discount rate of 8% under expected market return valuation and a risk-free rate of 3.78% under fair market valuation, which is equivalent to the five-year average forward rates of 10-year treasury bonds.[22]

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[20] "Updated Static Mortality Tables for the Years 2014 and 2015." Interval Revenue Service, accessed on September 30, 2014 http://www.irs.gov/pub/irs-drop/n-13-49.pdf.

[21] "Measuring Pension Obligations" *American Academy of Actuaries Issue Brief* (2013); Andrew G. Biggs, "The Market Value of Public-Sector Pension Deficits," *American Enterprise Institute for Public Policy Research*: Retirement Policy Outlook no. 1 (2010); Eileen Norcross, "Getting an Accurate Picture of State Pension Liabilities," *Mercatus on Policy no. 85* (2010); Ken Smetters and Andrew G. Biggs, "Understanding the argument for market valuation of public pension liabilities," *American Enterprise Institute*, May 29, 2013; *Report of the Blue Ribbon Panel on Public Pension Plan Funding*, Society of Actuaries, February 2014.

[22] *Report of the Blue Ribbon Panel on Public Pension Plan Funding*, Society of Actuaries February 2014, accessed September 30, 2014, http://www.soa.org/blueribbonpanel.

It is worth noting that our overall approach to discounting future cash flows is very similar to the annuity factor method, which can be used to find the present value of a series of annuities.[23]

### Adjustments Under a Late Term Pay Raise Scenario

Our analysis assumes a late-term pay raise that increases the overall final average salary used in a teacher's pension formula by $1,000. To determine the corresponding Average Beginning Pension, we multiplied the new Final Average Salary by its respective pension-salary ratio listed in Table A1. Then, repeating the dollar discounting approach described in the previous section, we again translated future cash flows into present day terms and applied mortality rates to determine an overall lifetime average. Table A3 shows the results from our California Analysis.

Finally, to evaluate the effect of this pay raise, we compared the lump sum present value of a teacher's lifetime pension to that under a late term pay raise scenario. For example, in California a teacher's lifetime pension is worth $1,265,566 today when discounted at 3.78%. After adjusting for a late-term pay raise, her lifetime pension is worth $1,279,457. The difference, $13,891, is the effect of the $1,000 pay raise. Therefore, we can conclude that about $13.90 of new pension obligations are generated by every one dollar added to a teacher's final pay.

## Link to Tables

**Table A1:**

Observed and/or adapted pension terms and statistics for veteran teachers (for use in future and present value calculations) .

**Table A2:**

Future values of annual pension allowances in California.

**Table A3:**

Present values of annual pension allowances in California.

**Table A4:**

Present values of annual pension allowances in California after a late-term pay raise which increases the teacher's final average salary by $1,000.

[23] An annuity factor is applied to the cash flow using the following formulas: Annuity Factor = $1/r \times [1-(1+r)^{-n}]$ ; PV of Annuity = C x Annuity Factor (where r = the discount rate, n = number of payments, PV = present value of the sum of future cash flows, and C = cash flow per period). The IRS publishes annuity factors based on mortality rates for a series of possible interest rates. However, we determined that the annuity factor method is not appropriate for our analysis because it cannot account for the variety of applications of a pension's annual COLA.