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ABSTRACT

This paper describes a method of projecting inflation-adjusted (real) retirement benefit replacement ratios for defined contribution retirement plans such as TIAA-CREF (Teachers Insurance and Annuity Association--College Retirement Equities Fund). The illustrated ratios are comparable to the ratios in defined benefit plans that result automatically from the defined benefit formula. The article points out that real defined-contribution replacement percentages take into account the plan contribution rate, salary growth rates, and length and rates of investment return over the preretirement period. The article emphasizes that these factors can vary and shows a range of possible ratios, allowing for different assumptions about relative rates of salary growth and investment return over periods of different length. The method automatically results in figures which reflect the inflation factor. Other factors affecting defined contribution plan benefits discussed include the annuity income option selected, applicable annuitant mortality rates, total investment return credited during the annuity income payout period, and expenses associated with the plan's operation. Tables show estimated retirement income replacement percentages and past experience of salary, interest, and investment return rates of growth for TIAA-CREF accounts. The paper concludes that a career replacement goal of approximately two-thirds of salary during the last few years of employment with continuing purchasing power protection after retirement is a desirable goal for a pension plan. (CK)

TIAA CREF

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Replacement Ratio Projections in Defined Contribution Retirement Plans: Time, Salary Growth, Investment Return, and Real Income

This issue of Research Dialogues *describes a method of projecting inflation-adjusted (real) retirement benefit replacement ratios—benefits as a percentage of final salary—for defined contribution retirement plans. It revises and updates our October 1989 report on this subject. The illustrated ratios are comparable to the ratios in defined benefit plans that result automatically from the defined benefit formula.*

Real defined-contribution replacement percentages take into account the plan contribution rate, salary growth rates, and rates of investment return over the preretirement period. Because these factors can be expected to vary, we show a range of possible ratios, allowing for different assumptions about relative rates of salary growth and investment return over periods of different length. With a choice of assumptions available, administrators can use them in plan evaluation and as a means of testing and maintaining replacement ratio objectives. The ratio table we present avoids the process of projecting benefits for defined contribution plans in nominal dollars and then discounting for inflation.

Factors Affecting Defined Contribution Plan Benefits

Under defined contribution retirement plans—such as TIAA-CREF—eight major factors determine the actual amount of pension income:

- Plan contribution rate
- Length of plan participation
- Participant's salary growth rate over the period of plan participation
- Rate of interest or total investment return credited during the accumulation period
- Annuity income option selected (such as continuing income for a second annuitant)
- Applicable annuitant mortality rates—determined by the age at which the participant starts the annuity benefit (and the age of a second annuitant, if any)
- Rate of interest or total investment return credited during the annuity income payout period
- Expenses associated with the operation of the plan

Because of the numerous factors involved—along with inflation—the projection of real replacement ratios in defined contribution plans is a definite challenge. In the approach described here, the effects of inflation on the key factors involved are automatically accounted for in the basic calculation method. Benefit replacement results can thus be stated very much like the simple formula percentages in defined benefit plans. (A defined benefit formula generally has three components—an accrual percentage, years of credited service, and "final" or "final average" salary. Multiplied together, they automatically express the benefit in real terms.)

Replacement Ratios in Defined Contribution Plans

Table 1 presents a range of possible ratio outcomes under defined contribution plans. With these ratio choices, benefit administrators can apply their own assumptions about the major pension variables: plan contribution rate, length of participation, and expected rates of salary growth and investment return. (*Replacement ratio* and *replacement percentage* are generally given the same meaning in this report.)

Table 1 also fulfills the practical need in defined contribution plans for a "what if" approach in evaluating potential pension plan results, since it can accommodate different views on appropriate growth-rate assumptions for the long term for both pension investments and employee salaries. Each cell in Table 1 represents an estimated replacement percentage based on specific assumptions.

Method of the Replacement Ratio Table

The method of developing the range of inflation-adjusted defined contribution replacement percentages is based on the relation over time between the average rate of salary growth and the average rate of pension investment return. Holding other elements constant (contribution rate, accumulation period, age at retirement, etc.), the resulting ratios will vary according to whether the salary and investment return rates are assumed to be the same or different, and by how much in either direction. Both of these rates affect the ultimate annuity benefit (the numerator of the ratio) and its relation to final salary (the denominator):

$$\text{Replacement ratio} = \frac{\text{Annuity benefit}}{\text{Final salary}}$$

The Inflation Element

Inflation affects lifetime salary growth as well as interest and investment return on accumulating annuity funds. Although it may affect salary

Table 1

Estimated Retirement Income Replacement Percentages

Yearly Annuity Benefit as a Percentage of Final Year's Salary
Contribution Rate: 10% of Salary
Retirement Ages: 65 and 70
Retirement Benefit Based on a One-Life Annuity with Ten-Year Guarantee

Retirement Age and Entry Age	Annuity Payout Interest or Investment Rate of Return	Benefit Replacement Percentage at Retirement according to Expected Difference between Salary Growth Rate and Credited Interest or Investment Rate of Return during Accumulation Period: Interest or Investment Rate Exceeds Salary Growth Rate by 3%	2%	1%	Interest or Investment Rate and Salary Growth Rate the Same	Salary Growth Rate Exceeds Interest or Investment Rate by 1%	2%
Age-65 Retirement							
Entry-Age 30	4%	42.3%	34.9%	29.1%	24.6%	21.0%	18.1%
	6%	50.8	42.1	35.3	29.9	25.6	22.1
	8%	59.7	49.7	41.8	35.5	30.5	26.4
	10%	68.8	57.5	48.5	41.4	35.6	31.0
Entry-Age 35	4%	33.3%	28.3%	24.3%	21.1%	18.4%	16.2%
	6%	40.1	34.2	29.5	25.6	22.4	19.8
	8%	47.2	40.4	34.9	30.4	26.7	23.6
	10%	54.5	46.9	40.6	35.5	31.2	27.7
Age-70 Retirement							
Entry-Age 30	4%	58.8%	47.0%	38.2%	31.4%	26.2%	22.2%
	6%	69.0	55.4	45.2	37.3	31.3	26.5
	8%	79.5	64.2	52.5	43.5	36.6	31.1
	10%	90.2	73.2	60.1	50.0	42.2	36.0
Entry-Age 35	4%	47.2%	39.0%	32.5%	27.5%	23.5%	20.3%
	6%	55.5	46.0	38.5	32.7	28.0	24.2
	8%	64.0	53.3	44.8	38.1	32.7	28.4
	10%	72.8	60.8	51.3	43.8	37.7	32.8

Mortality Table: 1983 Table A (Merged-Gender Mod 1) set back 2.5 years.

Note: The benefit replacement percentages are based on the average difference between salary growth and investment growth. For any particular difference, the replacement percentage will be approximately the same (with a 1% difference between the two, for example) whether the preretirement investment and salary growth rates are 5% and 4%, respectively, or are 10% and 9%, etc.

and investment growth rates differently at different times, the inflation factor is automatically reflected in the ultimate replacement value, since it affects both the numerator and the denominator of the replacement ratio.

The calculation of the real replacement ratio is based on the critical difference—positive, negative, or none at all—between the average interest or investment growth rate and the average salary growth rate over the periods considered. Relative to the salary increase rate, the higher the interest or investment rate of return on the accumulating annuity funds, the higher will be the real replacement value.

It may seem novel to link a measure of inflation-adjusted benefit adequacy in a defined contribution plan so closely to the relation between salary, on the one hand, and interest and investment growth rates on the other. But the relationship is definitive.

Imagine, for example, a situation in which average salary growth rates have been strong but investment growth rates have lagged. (This was the case for employees who retired in the years just following World War II.) At the time of retirement—since the annuity benefit is the numerator in the replacement ratio formula and the final salary the denominator—a lower numerator (the annuity benefit) and a higher denominator (salary) will result in a lower replacement percentage. On the other hand, if investment growth rates over the participation period have exceeded salary growth rates (as shown in the historical illustrations in Table 2 and Chart 1), the ratio will be affected accordingly, and will be higher.

The benefit replacement percentages shown in Table 1 are based on an actuarial formula. The formula takes into account plan entry age; retirement age; plan contribution rate; assumed salary increase rate; assumed rate of interest or total investment return from entry age to retirement age; an annuity mortality table—1983 Table A (Merged-Gender Mod 1) set back 2.5 years; and an assumed payout rate of interest or rate of total investment return. Within any period, of course, investment rates of return will fluctuate over time. The assumptions used are indicated in the table. (A copy of the actuarial formula can be obtained on request from the Corporate Research division, TIAA-CREF.)

Analyzing the Range of Replacement Percentages

Table 1 shows plan entry ages at 30 and 35, and retirement ages at 65 and

and 47.2% for entry-age 35. (The difference between 59.7% and 47.2%—one is 26% higher than the other— illustrates the leverage on benefits from joining a plan as early as possible, in this case just five years earlier.)

For an age-70 retirement with a 4% assumed annuity payout rate and an assumption of an average 3% excess rate of investment growth over salary during the accumulation period, we see a replacement percentage of 58.8% for entry-age 30, and 47.2% for entry-age 35. Assuming an 8% annuity payout rate at retirement would give a replacement ratio for retirement at age 70 a boost to 79.5% with entry-age 30, and to 64.0% for entry-age 35.

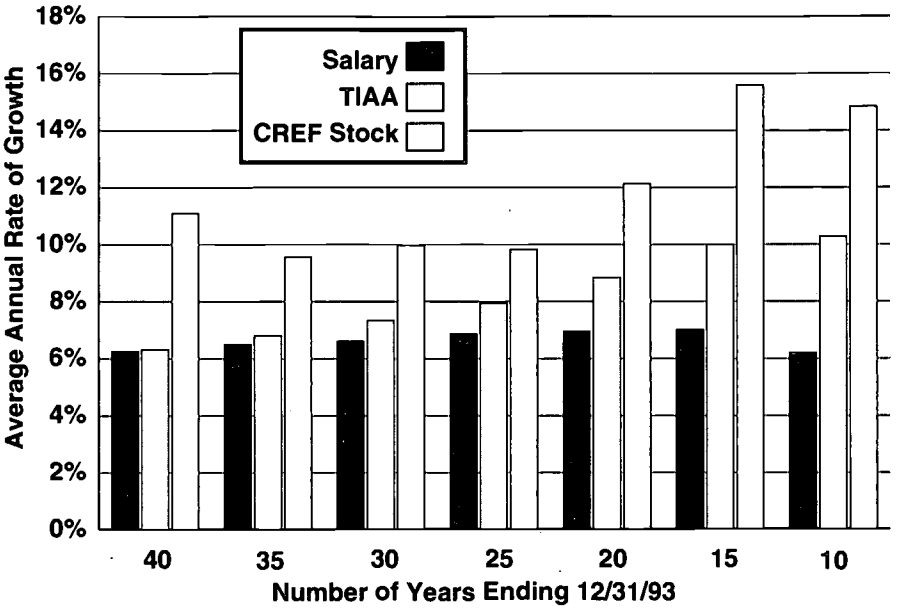
Historical Experience of Relative Growth Rates How much have salary and interest or investment growth rates actually differed over various lengths of time? What "excess" assumptions are reasonable?

Table 2 and Chart 1, "Past Experience of Salary, Interest, and Investment Return Rates of Growth," compare average rates of faculty salary growth and interest or investment growth for TIAA and the CREF Stock Account over seven periods, starting with the forty-year period 1954-1993. (The oldest of the CREF accounts, the CREF Stock Account began in July 1952.) The figures in Table 2 and Chart 1 illustrate how the rates have differed over various lengths of time, all ending December 31, 1993; but remember that past performance is no guarantee of future results. (For the rates of return of the CREF Stock Account through the one-, five-, and ten-year periods ending June 30, 1994, see the CREF Stock Account performance figures on page 6, or, for updated information available after September 30, 1994, the CREF Performance Highlights card accompanying later distributions of this *Research Dialogues* issue.)

The TIAA interest rates and CREF Stock Account rates of return shown in Table 2 and Chart 1 are based on premiums applied at the beginning of each period. A participant's actual rates of return will reflect his or her own history of periodic premium applications.

Chart 1
Past Experience of Salary, Interest, and Investment Return Rates of Growth

Average Annual Growth Rates for Periods Shown, Ending 12/31/93



Choosing Assumptions The figures in Table 2 are historical data and therefore don't illustrate possible future experience. When we choose long-term assumptions about salary and interest or investment growth rates, past experience can provide a useful perspective, but the past does not predict the future. Many developments can directly or indirectly affect the relative growth rates of salaries and pension investment earnings. They include government actions designed to influence the economy, changes in employment levels, domestic and international events, consumer and investor psychology, financial market conditions, and changing demands for goods and services, including education.

Investment returns achieved by plan participants will also reflect differing individual decisions about allocating pension contributions to various investment choices. When plans provide participants with a variety of investment choices, there is no way of knowing which accounts participants will choose, exactly how those funds will perform, or how participants during their working years will decide to reallocate, cash out, or transfer annuity premiums and accumulations among accounts. As a result of variations in individual choices and actions, ultimate annuity results may range widely among otherwise equally situated participants in the same pension plan. Participants' personal decisions will play a definite part in determining ultimate replacement values.

Extent of Growth-Rate Differences Taking the three longest periods shown in Table 2 and Chart 1—forty years (1954-1993), thirty-five years (1959-1993), and thirty years (1964-1993)—periods typical of career participation in a portable defined contribution retirement system—we see that average annual TIAA interest growth rates were always at least slightly higher than average salary growth rates. In the forty-year period, they exceeded salary growth by 0.06%; in the thirty-five year period, by 0.30%; and in the thirty-year period, by 0.72%. Average annual CREF Stock investment growth rates over the same three periods were significantly higher

than average salary growth rates—4.83% higher for the forty-year period; 3.06% and 3.34% higher, respectively, for the periods of thirty-five and thirty years.

Over the somewhat shorter and later periods, the average annual growth rates for TIAA interest and CREF Stock returns continued to exceed average salary growth rates. In the twenty-five year 1969-1993 period, for example, TIAA's interest rates averaged 1.07% higher than salary growth rates; CREF Stock's returns, 2.96% higher. In the twenty-year 1974-1993 period, average interest growth rates of TIAA topped salary growth rates by 1.89%; CREF Stock investment growth rates by 5.18%. And over the last periods of fifteen years (1979-1993) and ten years (1984-1993), TIAA's interest growth rates were higher than salary growth rates by 2.97% and 4.09%, respectively, while CREF Stock's returns were higher by 8.58% and 8.64%, respectively.

For all the periods shown, it is important to reemphasize that past investment results don't guarantee future results. Also, it should be noted that all the periods shown end at one point—December 31, 1993. Particularly for the shorter ten- and fifteen-year periods, "endpoint sensitivity" may be especially pronounced. The shorter, later periods display differences between salary and investment growth rates at a level that may not be sustained in the future. Averages over longer periods are likely to be a more conservative base on which to make assumptions for long-term projections.

The salary increase data in Table 2 and Chart 1 are based on the annual rates of faculty salary growth for the academic years 1953-54 through 1992-93 reported by the salary surveys of the American Association of University Professors.[1]

Income after the First Year

The replacement ratios in Table 1 apply only in the first year of retirement, as do most replacement illustrations. But unless income continues to increase in the following years, postretirement inflation will reduce initial purchasing power. This is a matter of deep concern to retirees.

Under defined contribution plans, after annuity income is started, later changes (up or down) in annuity income amounts will depend on the types of annuity investment accounts selected by the plan participant and on the investment experience of the accounts.

As noted, benefits from CREF accounts in the first year of retirement are based on a 4% assumed rate of investment return. This rate is just a start. If a CREF annuity account's actual total rate of return in the first year is 10%, for example, instead of the 4% initial assumption, CREF benefits for the second year will increase by the ratio of 1.10 to 1.04, or about 5.8%. This would represent an inflation adjustment; it would be a full adjustment provided the inflation rate was equal to or less than the benefit increase. Or the second year's benefits could be significantly more than inflation adjusted, or less. The CREF method of benefit recalculation continues similarly once each year; benefits change accordingly—up or down—depending on actual rates of total return versus 4%.

Benefits from TIAA annuities can also be expected to change up or down in retirement, depending on the interest rate payable, either under the Standard Payment Method or under the Graded Payment Method, which, like CREF, pays its first-year benefits based on a 4% assumed interest rate. Thereafter, benefits under the Graded Payment Method may increase each year to the extent that the guaranteed interest rate plus the declared dividend rate exceeds the 4% assumption.

Social Security

Although Social Security benefits are an important part of most institutions' retirement plans, they are not included in the replacement estimates in Table 1. For the *total* replacement ratios of a retirement plan at various final salary levels, Social Security replacement values should also be taken into account.

Because Social Security benefits are heavily weighted in favor of earnings at the lower ranges, their value as replacement percentages will vary by level of final salary. For employees who have a work history at the maximum taxable wage base and above, the Social Security Primary Insurance Amount replacement percentage at age 65 may be as low as 20% or even less. For those with final pay in the mid-ranges of the wage base, Social Security replacement may be in the 30% range; for lower-wage earners, it may be 40% or more.[2]

Retirement Income Objectives

Benefit replacement ratios at retirement are—or should be—a reasonable reflection of a pension plan's goal for a career of service. Table 1 can be used in considering policy goals. A recommended pension income objective (including Social Security) for educational institutions is presented in the joint Statement of Principles on Academic Retirement and Insurance Plans of the American Association of University Professors and the Association of American Colleges (AAUP-AAC).

The AAUP-AAC goal for those retiring at age 65 who have participated in a plan for at least thirty-five years is a recommended "continuing after-tax income equivalent in purchasing power to approximately two-thirds of the yearly disposable salary (after taxes and other mandatory deductions) during the last few years of full-time employment."[3] Another benefit goal statement was made by the Committee on Mandatory Retirement of the National Research Council in its recent report to the Congress. The committee noted that colleges and universities cannot meet the goal of providing for their retired faculty without protecting pensions against inflation. The committee called for a level of retirement income for a career of service that "continues to be equal to 67 to 100 percent of preretirement income in real terms."[4]

Conclusion

A pension plan's benefit replacement ratio at retirement measures the percent-

70. Earlier retirements or later entry ages would result in lower replacement ratios. Longer plan participation and retirements at later ages would produce higher ratios because of longer-continuing contributions, a larger accumulation base for continuing investment growth, and a shorter average life expectancy due to a later annuity-starting date.

The plan contribution rate in Table 1 is assumed to be 10% of salary for all table cells. For institutions having higher contribution rates, replacement ratios can be figured simply by multiplying the figure in a cell by the ratio of the specific contribution rate to 10%. For a replacement ratio projection assuming a 15% contribution rate, for example, a ratio figure in Table 1 is simply increased by 1.5. For a 20% contribution rate, a percentage in the table would be doubled. (For step-rate plans, replacement projections would involve separate determinations by step according to the contribution rate for each step interval.)

Annuity Payout Rate Each row of replacement ratios in Table 1, expressed as percentages, is set opposite a column headed "Annuity Payout Interest or Investment Rate of Return." This column shows four alternative assumptions for interest or investment return during the annuity payout period: 4%, 6%, 8%, and 10%. Four percent is included because it is the assumed investment return (AIR) for the first year of benefits from income-paying CREF accounts and is the assumed interest rate for the first year of benefits under the TIAA Graded Payment Method. Currently, TIAA retirement annuity payout interest rates applicable to participants retiring in 1994 (contractually guaranteed interest rates plus dividends) range from 6.0% to 8.5%, depending on when the underlying funds were received by TIAA. All the replacement ratios in Table 1 reflect the mortality rates underlying TIAA's 1994 payout annuity rates (including dividends) and the one-life annuity with a ten-year guaranteed period.

The Growth-Rate "Difference" Columns Table 1 shows six possible replacement ratio columns according to six different assumptions about the relationship between interest or investment returns and salary growth rates. On the left, in the first three columns, growth rates of interest or investment return exceed the salary growth rates by 3%, 2%, and 1%, respectively. On that side of the table, the replacement ratios are relatively high. In the two right-hand columns, the salary growth rates exceed the interest or investment growth rates by 1% and 2%, respectively. On the right, the replacement ratios are therefore lower. In the center is a zero-difference column; this column shows the resulting replacement ratios when the salary and interest or investment growth rates are assumed to be exactly the same.

Let us look, for example, at an age-65 retirement with a 4% annuity payout rate and an assumption of an average 3% excess rate of investment growth over salary growth during the accumulation period. Under a plan with a 10% contribution rate, the replacement figure is 42.3% for entry-age 30 and 33.3% for entry-age 35. (A 4% annuity payout assumption for investment return would be appropriate for first-year benefits from CREF Stock, as noted, or for TIAA under the Graded Payment Method.) A higher payout level, assuming an 8% annuity payout rate at retirement (again in the 3% excess column), would give a replacement percentage of 59.7% for retirement at age 65 with entry-age 30,

Table 2

Past Experience of Salary, Interest, and Investment Return Rates of Growth

Comparison of Average Annual Growth Rates—Faculty Salaries and Credited Rates of TIAA Interest and CREF Stock Total Investment Return

	Period of Plan Participation and Average Annual Growth Rate						
Growth-Rate Item	**1954-1993 40 Years**	**1959-1993 35 Years**	**1964-1993 30 Years**	**1969-1993 25 Years**	**1974-1993 20 Years**	**1979-1993 15 Years**	**1984-1993 10 Years**
Salary[a]	6.25%	6.49%	6.60%	6.85%	6.93%	6.99%	6.17%
TIAA[b]	6.31%	6.79%	7.32%	7.92%	8.82%	9.96%	10.26%
CREF Stock[c]	11.08%	9.55%	9.94%	9.81%	12.11%	15.57%	14.81%
Excess of Interest or Investment Growth Rate over Salary Growth Rate							
TIAA[b]	0.06%	0.30%	0.72%	1.07%	1.89%	2.97%	4.09%
CREF Stock[c]	4.83%	3.06%	3.34%	2.96%	5.18%	8.58%	8.64%

[a]Average annual increase in faculty salaries based on data from Howard R. Bowen, *Academic Compensation* (New York: TIAA-CREF, 1978), 64-69, and *Academe* (March-April 1993): 9, Table 1, "Percentage Increases in Average Monetary and Real Salaries for Institutions Reporting Comparable Data for Adjacent One-Year Periods, and Percentage Change in the Consumer Price Index, 1971-72 through 1992-93" (continuing faculty).

[b]Average annual growth rate of a TIAA premium through 12/31/93.

[c]Average annual total return of the CREF Stock Account through 12/31/93.

age of salary just prior to retirement that will be replaced by the plan. Generally recommended for educational institutions is a career replacement goal of two-thirds or more of salary during the last few years of employment (including Social Security), with continuing purchasing power protection after retirement.

In defined benefit plans, a simple formula is used to express the future inflation-adjusted benefit replacement ratio at retirement. Under defined contribution plans, a simple formula is not available, since there are numerous factors that can affect ultimate plan benefits. However, a range of estimated replacement ratios for various retirement ages and career lengths can be developed for defined contribution plans through the use of an actuarial formula.

A range of estimated ratios enables plan administrators and participants to consider replacement values based on alternative assumptions for salary growth on the one hand, and interest or investment rates of growth on the other. Since both salary and investment growth rates are affected by inflation (even though in different ways at different times), the ultimate benefit, when related to final salary as a ratio instead of simply stated as a dollar amount, automatically incorporates the inflation factor.

Table 1 of this report presents a range of replacement ratios and choices for underlying assumptions. As shown, replacement ratios will generally be at the higher end of the spectrum to the degree that interest or investment growth rates exceed salary growth rates over the accumulation period. Where salary growth and interest or investment growth rates are the same, the replacement percentages will be lower, as they will also be when salary growth exceeds interest or investment growth. The table of replacement percentages allows administrators and participants in defined contribution plans to estimate inflation-adjusted replacement values according to a variety of assumptions for future salary, interest, and investment growth. *(This report for* Research Dialogues *was prepared by Michael Heller and Francis P. King.)* □

Endnotes

[1] See Howard R. Bowen, *Academic Compensation* (New York: TIAA-CREF, 1978), 64-69; *Academe* (March-April 1993): 9, Table 1 (continuing faculty).

[2] For a discussion of the replacement ratios needed at retirement to maintain the full salary-based preretirement standard of living—including pensions, personal savings, and Social Security benefits—see *Research Dialogues*, no. 37 (July 1993), "Planning for Retirement: Using Income Replacement Ratios in Setting Retirement Income Objectives."

[3] American Association of University Professors, *Policy Documents & Reports* (Washington, D.C.: American Association of University Professors, 1990), 174.

[4] P. Brett Hammond and Harriet P. Morgan, eds., *Ending Mandatory Retirement for Tenured Faculty*, Committee on Mandatory Retirement in Higher Education, Commission on Behavioral and Social Sciences and Education, National Research Council (Washington, D.C.: National Academy Press, 1991), 69.

CREF Stock Account Performance Highlights

Performance information for the CREF Stock Account reflects past investment results. Total return may rise or fall. As a result, CREF Stock Account accumulation units may at any particular time be worth more or less than their original price. The CREF Stock Account makes no deductions of any kind from premiums. There are no front- or back-end loads. Returns are quoted after all expense charges have been deducted. These charges generally average under 4/10 of 1% of annuity assets each year.

AVERAGE ANNUAL CREF STOCK ACCOUNT COMPOUND RATES OF TOTAL RETURN

(Periods Ending June 30, 1994)

One year	4.42%
Five years	10.17%
Ten years*	15.13%

*Effective April 1, 1988, a registration statement for CREF variable annuities became effective under the rules and regulations of the Securities and Exchange Commission, but CREF's management and its investment objectives did not change.

For average annual compound rates of CREF Stock Account total return for quarters ending later than June 30, 1994, see the CREF Performance Highlights card accompanying later distributions of *Research Dialogues* issue no. 41.

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