Open access • Journal Article • DOI:10.1111/J.1755-053X.2007.TB00088.X

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Institutions: Claremont Graduate University, Claremont McKenna College

Published on: 01 Jul 2007 - Financial Management (Blackwell Publishing Ltd)

Topics: Investment (macroeconomics), Index fund, Investment management, Portfolio and Diversification (marketing strategy)

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Working Paper

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Claremont Colleges Working Papers, No. 2005-05

Provided in Cooperation with:
Department of Economics, Claremont McKenna College

Suggested Citation: Angus, John; Brown, William O.; Smith, Janet Kiholm; Smith, Richard L. (2005) : What's in your 403(b)? Academic retirement plans and the costs of underdiversification, Claremont Colleges Working Papers, No. 2005-05, Claremont McKenna College, Department of Economics, Claremont, CA

This Version is available at:
http://hdl.handle.net/10419/31417

What's in Your 403(b)? Academic Retirement Plans and the Costs of Underdiversification

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Draft: June 1, 2005

Abstract

Many college and university 403(b) plans restrict the menu of investment choices to funds offered by TIAA-CREF, the current manager of over half of all 403(b) contributions. Further, in the face of Internal Revenue Code changes that will take effect in 2006 and will make 403(b) plan ERISA compliance more difficult, some sponsors are dropping their existing alternatives to TIAA-CREF. Using eight years of historical performance data, we study the efficiency of the TIAA-CREF opportunity set relative to a somewhat larger set that includes several standard index funds, and we estimate the lifetime opportunity losses to participants who are constrained to invest only in TIAA-CREF. Based on efficient frontier analysis, and assuming optimal rebalancing by a loss-averse individual as time to retirement approaches, our analysis demonstrates that the opportunity losses are economically significant. Depending on loss-aversion, and diversification constraints, over a forty-year work-life an employee who is restricted to TIAA-CREF would lose approximately half of terminal wealth, compared to investing in the expanded menu that includes index funds. Moreover, limiting the choices to TIAA-CREF does not appear to help even unsophisticated investors. TIAA-CREF equity funds offer little meaningful diversification and are no less risky than the alternative index funds. Even when a naïve diversification strategy of equally-weighting (1/n) all available funds is applied, the expanded menu outperforms the restricted portfolio by about 26 percent over the employee's work-life. The findings have direct implications for the over 6.8 million enrollees in 403(b) plans, who currently make around $27 billion in annual contributions, and indirect implications for the much larger population of 401(k)-type defined contribution plans.

JEL Codes: G11, G23, D14, G28, G18, H24

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What's in Your 403(b)? Academic Retirement Plans and the Costs of Underdiversification

Most faculty members and other employees of non-profit colleges and universities, along with workers at other non-profit organizations, can participate in 403(b) tax deferred retirement plans.[1] Typically, these plans provide for a "mandatory" annual contribution that is specified as a percentage of the employee's base salary, and may also provide for voluntary contributions by the employee, through salary reduction agreements.[2]

Overwhelmingly, 403(b) contributions are invested in vehicles managed by one manager, TIAA-CREF. In fact, it is common for higher-education 403(b) sponsors to limit the choice of investment vehicles to only those offered by TIAA–CREF. Table 1 is a summary of the 403(b) investment manager options that are available at leading colleges and universities. The table is based on the latest information as reported to us by the benefits offices of the various institutions. Schools listed are the top 50 universities and top 50 colleges as ranked by *U.S. News and World Report*.[3]

Of these 100 leading educational institutions, 92 offer TIAA-CREF for both the mandatory employer's contribution and any supplemental employee contributions. The

[1] Non-profit organizations include, for example, hospitals and religious organizations. The use of 403(b) plans is restricted to Internal Revenue Code section 501(c) (3) non-profit organizations and educational organizations of state or political subdivisions.

[2] In some cases, to encourage broad participation, a portion of the employee's contribution is matched by the employer. Broad participation is an IRS requirement and can be met either through the mandatory contribution or through a high level of voluntary contributions. As discussed more fully below, changes in the Internal Revenue Code that take effect after December 31, 2005 have affected the IRS interpretation of what constitutes broad participation, and is affecting how non-profit entities seek to achieve compliance.

[3] *U.S. News and World Report* rankings of national universities and liberal arts colleges for 2005.
http://www.usnews.com/usnews/edu/college/rankings/brief/natudoc/tier1/t1natudoc_brief.php
http://www.usnews.com/usnews/edu/college/rankings/brief/libartco/tier1/t1libartco_brief.php

other eight, including six University of California campuses, offer defined benefit plans.[4] All 50 of the leading liberal arts colleges offer TIAA-CREF. For five universities and 29 colleges, TIAA-CREF is the *only* option for the mandatory contribution. Schools that provide alternatives to TIAA-CREF generally offer one or two different manager choices. Most commonly, these alternatives are mutual funds that are managed by Vanguard, Fidelity, or both. Supplemental contribution options generally offer somewhat more choice--all 100 universities and colleges offer a defined contribution option and the numbers offering Vanguard and/or Fidelity are somewhat higher than for the employer's contribution.

Limiting the investment options to TIAA-CREF is tempting. TIAA-CREF has provided retirement savings investment vehicles to colleges and universities for many years, offers a number of investment options, offers to provide "free" monitoring of its investment vehicles, and offers to assist colleges and universities in meeting newly required 403(b) plan documentation requirements. TIAA-CREF reports that they have more than 3.2 million participants and more than $300 billion of assets under management in 2003.[5] This total represents over 56 percent of all 403(b) assets under management, as estimated by the Investment Company Institute.[6] Even when the choices are not restricted to TIAA-CREF, it appears that many university employees nonetheless select only TIAA-CREF to manage their retirement investments.[7]

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[4] The other public universities generally offer employees a choice between a defined benefit plan and the defined contribution choices noted in Table 1.

[5] TIAA-CREF Annual Report for 2003.

[6] Investment Company Institute, 2004, Mutual funds and the U.S. retirement market in 2003, Fundamentals: Investment Company Institute Research in Brief, 13, Figure 15.

[7] For example, among the colleges that comprise the Claremont Consortium, which offered Vanguard and Fidelity as options for many years for either the employee's contribution or for both, 84 percent of faculty members who were able to select alternatives, nonetheless, invested only through TIAA-CREF. Those who selected other managers tended to be members of the economics faculties who have expertise in finance

In this paper, we examine the wisdom of fiduciary decisions to require employees to concentrate their 403(b) wealth in the ten investment vehicles that are managed by TIAA-CREF. The analysis is timely, as recent mutual fund scandals, and changes in the Internal Revenue Code have caused a number of plan sponsors to re-examine the set of investment options that they make available to participating employees.

Using eight years of historical performance data, we compare the achievable performance of portfolios comprised exclusively of TIAA-CREF variable annuity funds to those that combine TIAA-CREF with a limited menu of index mutual funds. We find that, despite the number of variable annuity funds it offers, the TIAA-CREF menu provides little actual diversification of equity choices, compared to what can be achieved by adding selected index funds. While both the TIAA-CREF menu and the expanded menu are capable of achieving similar levels of total portfolio risk, over the eight years, the expanded portfolio offered substantially higher achievable performance than the TIAA-CREF funds.

Over a typical work-life, our analysis suggests that an employee could achieve roughly twice the level of retirement wealth by using the expanded menu, as compared to the menu limited to TIAA-CREF variable annuity funds. This conclusion is based on optimal rebalancing as time to retirement approaches and holds over a broad range of risk tolerance levels. Finally, we compare the lifetime performance of a naïve diversification strategy of equally-weighting all available investment vehicles and find that, even by this

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and members of the Consortium's central administration. The Claremont Consortium includes Pomona College, Harvey Mudd College, Claremont McKenna College and Scripps College from Table 1 in addition to three other institutions. Only Harvey Mudd has previously restricted investment choices to TIAA-CREF.

approach, the expanded menu outperformed the portfolio limited to TIAA-CREF instruments by a factor of roughly 1.5.

The 403(b) Environment

In 403(b) plans, as with analogous for-profit 401(k) plans, the plan sponsor (the employer) generally offers a menu of vehicles in which retirement savings may be invested. Each employee often is responsible for allocating retirement savings account across the menu of investment vehicles. The menu of permitted investment vehicles can include annuity contracts offered by life insurance companies ("insurance contracts") and variable annuity or non-variable annuity mutual funds ("funds") and can be different for the employer's mandatory contribution than for the employee's voluntary contribution.

The nexus of compliance requirements of the Internal Revenue Code ("IRC") and the Employee Retirement Income Security Act ("ERISA") have given rise to a challenging legal landscape for 403(b) plan sponsors. In addition to compliance issues, sponsors face sources of potential litigation arising in the wake of recent mutual fund scandals and litigation over the Enron retirement plan, among others.

The most imminent concern is the change in the IRC that will take effect after December 31, 2005. In contrast to previous years, where a number of plan sponsors assumed ERISA compliance was not required, under new code the presumption is that non-government-sponsored and non-church-sponsored 403(b) plans must be ERISA compliant. This means that sponsors must develop a formal plan document, provide for universal participation among employees, and provide monitoring of fund performance. The IRC requirement of "universal participation" by employees, rather than the previous requirement of "substantial participation," may be a challenging standard to meet for

some employers. It may mean that relatively less-educated employees, who formerly may have invested in defined benefit plans, now are responsible for making sophisticated decisions concerning how to allocate and diversify their retirement savings portfolios.

Under ERISA, the 403(b) plan sponsor (college administrators and the board of trustees) has fiduciary responsibilities to the participating employees. Under Section 404(c) of ERISA, a sponsor can avoid fiduciary liability by permitting the plan participants to exercise control over their own retirement accounts. However, what constitutes control is unclear. Some aspects of account management, such as the choice of vehicles in which participants are permitted to invest, clearly are beyond the control of the participant.

A commonly expressed view is that, to get 404(c) protection, a sponsor must offer a broad range of investment alternatives that in aggregate enable a participant to achieve a portfolio with aggregate risk and return characteristics that are within the range normally appropriate for the participant. The Preamble to Section 404 states that the fiduciary is responsible for (1) determining the asset classes to be offered, so that participants can create diversified portfolios that balance return and risk, (2) selecting, and (3) making sure that the options continue to be appropriate.[8] Thus, it appears that a sponsor can be subject to fiduciary liability if either the set of available asset classes is too narrow to permit efficient diversification or if the set of specific investment vehicles includes options that are not appropriate because, for example, their fees are not competitive.

One prominent concern of plan sponsors is the potential for class-action liability arising from employer involvement in determining and monitoring the investment

[8]Preamble to Final 404(c) Regulations, 57 F.R. 46906.

choices that are offered to employees.[9] One implication of the new IRC and application of ERISA requirements is that plan sponsors respond by restricting fund choice, perhaps as a way to accommodate the growth in number of participants and to economize on monitoring and related expenses. However, while the employers may reduce out-of-pocket expense with such a response, the opportunity costs for employees may be large.

The employers appear to be caught in a Catch-22: If they offer more choices, they cannot be faulted for failing to offer opportunities for optimal diversification or for implicitly giving investment advice. However, if an employee, who is faced with many choices, concentrates investments in narrow and risky asset classes, the sponsor may be subject to litigation based on the sponsor's failure to withhold investment choices that enable an employee to take excessive risk. Conversely, if the permitted set of investment vehicles is overly restricted, asset classes that are important for achieving good investment performance may be excluded, exposing the sponsor to the potential for litigation based on underperformance.

The ERISA requirement that the sponsor monitor the investment vehicles adds to the challenge of finding the right balance. Monitoring is not costless or perfect. Hence, the larger the number of permitted investment vehicles, the greater is the sponsor's annual cost of monitoring and the greater is the risk of a legal challenge based on the argument that the monitoring effort was defective with regard to a particular investment vehicle.

[9] To date, there has been little litigation over fiduciary responsibility in 403(b) plans, but changes in the IRC elevate concerns with liability under ERISA.

The Economic Significance of Defined Contribution Plan Investing

According to statistics compiled by the Investment Company Institute, as of 2001, 80 percent of all U.S. households participated in defined contribution retirement plans. Included in this total are 60 percent that participated in 401(k) plans and 11 percent that participated in 403(b) plans.[10] Sections 401(k), 403(b), and 457 are substantially parallel sections of the IRC that enable employees to defer the recognition of income that is invested for the purpose of providing post-retirement income. Section 401(k) pertains to employees of for-profit entities, and section 403(b) pertains to employees of non-profit entities, including most private and state and local colleges and universities. Section 457 provides an additional defined contribution option that is limited to a select group of employees, such as only the highest paid employees, and that is not subject to the requirement of broad participation.[11]

All retirement saving plans are of two primary types: defined contribution plans and defined benefit plans. [12] In recent decades, defined contribution plans have largely displaced defined benefit plans as the most widely used vehicle for investing deferred compensation and providing for post retirement income. More specifically, based on Department of Labor survey data, the number of active participants in defined contribution plans increased from 17.5 million in 1979 to 50.3 million in 1998, whereas

[10] Investment Company Institute, *2001 Profile of Mutual Fund Shareholders*, Washington D.C. Reported in *Statistical Abstract of the United States: 2004-2005*, Table 1208, U.S. Census Bureau.

[11] Unlike 401(k) and 403(b), section 457 plans are not funded. Instead, the balances of the retirement accounts are obligations of the plan sponsor.

[12] A defined benefit plan is the traditional vehicle and is similar to an insurance plan. In it, an employee makes contributions of specified amounts over her work-life and is entitled to a specified percentage return that is paid out after retirement. This contractual return is promised by the plan sponsor, not withstanding the return that the sponsor earns by investing the employee's annual contributions. A defined contribution plan fixes the employee's annual contribution, and invests the assets on behalf of the employee. Realized performance on the investments directly affects the employee's post-retirement earnings.

the number in defined benefit plans decreased from 29.4 million to 23.0 million. Annual contributions changed in parallel to the changes in participation. By 1998, annual contributions to defined contribution plans reached $166.9 billion, compared to $35.0 billion for defined benefit plans.[13] Assets under management, of course, change more slowly. The Employee Benefits Research Institute estimates that as of 2001, assets under management in defined contribution plans had reached $2.14 trillion and were rising, whereas assets under management in defined benefit plans were $1.82 trillion and declining.[14]

Within the set of defined contribution plans, 401(k) type plans (including 403(b) and 457 plans) are growing even more rapidly. As of 1998, the Internal Revenue Service reports that there were 37.1 million participants in 401(k) plans, and that annual contributions were $134.7 billion, which is over 80 percent of all contributions to defined contribution plans. The Employee Benefit Research Institute projects that by 2007, the number of participants in 401(k) plans will reach 61.7 million and that assets under management will reach $2.4 trillion.

Statistics for 403(b) and 457 plans are more limited, but participation and contributions can be expected to have grown in parallel to those of 401(k) plans. As an indicator of the economic significance of 403 (b) retirement plans, in 2004, 6.8 million people were enrolled in such plans. With an average annual contribution per participant of approximately $4,000, the volume of economic activity affected is large—around $27

[13] Private Pension Plan Bulletin Abstract for 1998 Form 5500 Annual Reports, U.S. Department of Labor, Pension and Welfare Benefits Administration, Number 11, Winter 2001-2002.

[14] Employee Benefit Research Institute Issue Brief, June 2003. While its estimate of assets in defined benefit plans is similar, that of the Employee Benefits Research Institute, the Investment Company Institute estimates that total funds in defined contribution plans is even higher: $2.70 trillion in 2001 and $2.90 trillion in 1993. Investment Company Institute, 2004, Mutual funds and the U.S. retirement market in 2003, Fundamentals: Investment Company Institute Research in Brief, 13, Figure 6.

billon annually. With $532 billion under management in 2003, 403(b) plans represent 18.4 percent of all defined contribution plan assets. Closely related 457 plans represent roughly an additional two percent.[15]

Over time, for both 401(k) and 403(b) plans, there has been a steady shift in asset allocation, away from insurance contracts and toward variable annuity and non-variable annuity mutual funds. From nine percent of 401(k) assets in 1990, assets held in funds increased to 49 percent by 2003. And from 42 percent of 403(b) assets in 1996, assets held in funds increased to 50 percent by 2003. Essentially all of the percentage growth in allocations of 403(b) assets to funds has been to non-variable annuity funds.[16]

Empirical Analysis

As explained above, the legal climate for 403b plan sponsors is changing, involving potentially much more litigation exposure and greater regulatory compliance costs. The response of institutions of higher education to new IRC and application of ERISA requirements appears to be one of restricting fund choice. The objective of the analysis below is to quantify the impact of such a move by examining the potential economic cost of reduced choice in investment vehicles for 403(b) retirement plans. Our findings bear on the current policy debate regarding the optimal structure of retirements plans generally (how many investment choices to offer, liability exposure of plan sponsors, autonomy of individuals in making investment decisions) and on 403b plans, in particular.

We use the historical performance of the various TIAA-CREF retirement investment funds to estimate the efficient frontier of a retirement plan where participants

[15] Statistics are from: Mutual funds and the U.S. Retirement market in 2003, Fundamentals: Investment Company Institute Research in Brief, 13.
[16] *Ibid*.

are restricted to invest deferred compensation only in funds managed by TIAA-CREF. To assess the opportunity loss of restricting the asset choices in this way, we introduce the possibility to invest in a menu of index funds. We limit the analysis to index funds in order to focus only on the benefits of diversification across asset classes and because index funds are relatively easy to monitor. We selected funds managed by Vanguard because it has the longest history of managing index funds and low expense ratios, and is available in many 403(b) plans.[17] We refer to the opportunity set that is limited to TIAA-CREF as "TIAA-CREF Only;" to an alternative opportunity set that is limited to Vanguard index funds as "Vanguard Only;" and to the combined opportunity set as "TIAA-CREF + Vanguard." Based on the efficient frontiers for TIAA-CREF Only, Vanguard Only, and TIAA-CREF + Vanguard, we estimate expected long-run returns to portfolios that are optimized to maximize expected return subject to risk.

To examine the effects of risk aversion on optimal portfolios, we employ a loss-avoidance value-at-risk ("VAR") methodology that is based on achieving at least the same return as investment in a money market fund. The VAR methodology, in addition to being easier to apply than utility-theory-based risk aversion models, produces results that are intuitive and are broadly consistent with the advice given to individuals by investment management professionals, and with the actual portfolio decisions of individuals. We consider a range of tolerances for VAR and determine how the employee's optimal portfolio composition changes annually as the employee approaches retirement. We then use the annually rebalanced portfolios to estimate the expected value at retirement of a one-dollar per year investment in the optimal portfolio.

[17] Except for expense ratio differences, investing in similar indexes offered by other mangers, such as Fidelity, would not materially affect the results.

Data

TIAA-CREF offers nine retirement investment funds in addition to its annuity insurance product, the TIAA Traditional Annuity. These funds are listed in Table 2, along with information on each fund's date of initiation, investment style, sector focus, and investment objective. Because the TIAA Traditional Annuity is an insurance contract, there is no direct link between investment performance of underlying assets and TIAA-CREF's promised payments to contract holders.[18] Accordingly, we are unable to include the performance of the Traditional Annuity in the analysis. In addition, assets in this account may only be transferred to other accounts over a ten-year period making it difficult for an individual to rebalance to the optimal portfolio over time. Were we able to do so, the addition could affect our conclusions quantitatively, especially for performance of invested assets in the few years shortly before retirement (when purchasing the Traditional Annuity is most likely to be warranted), but would not alter our qualitative conclusions.[19]

California, and possibly some other states, as well as some colleges and universities, do not permit retirement investments in the TIAA Real Estate fund. The TIAA Real Estate portfolio consists primarily of direct investments in real estate. The prospectus for this fund notes that many assets in this fund are not regularly marked to market. For this reason, investors in the TIAA Real Estate Account may only transfer funds out of this account once per calendar. The failure to mark assets to market on a

[18]Measuring performance of the Traditional Annuity is complicated by several attributes: TIAA-CREF does not report investment performance for the Traditional Annuity on a continuous basis; makes occasional adjustments to promised distributions; bears the longevity risks of participating retirees; and charges, but does not specify, expenses associated with performance of its insurance function.

[19] In its 403(b) investment literature to 403(b) participants, TIAA-CREF proposes sample portfolios that include material fractions of retirement assets (from 10 to 60 percent) in the TIAA Traditional Annuity. http://www.mass.edu/hr/includes/retirement/AppTIAA.pdf. Some university websites suggest that investment in the traditional annuity is only appropriate when individuals are approaching retirement age.

timely basis distorts the fund's true risk profile. As a result, we exclude the TIAA Real Estate fund from most of our quantitative analysis. The TIAA-CREF Only portfolio noted throughout the paper excludes both the TIAA Traditional Annuity and TIAA Real Estate fund. When we allow for the inclusion of the TIAA Real Estate account it is specifically noted. However, any results from the inclusion of this account must be interpreted with caution due to the likely bias in our risk estimates.

In addition to the TIAA-CREF funds, Table 2 contains a list of Vanguard's currently available index funds. The 22 listed Vanguard index funds exclude funds that are managed for the purpose of limiting taxes on realized current earnings, as well as various asset allocation funds and blended funds, such as "life-cycle" or "life-style" funds, that target investors with specific profiles.[20]

To base the analysis on a consistent time period, we use the latest origination date of any TIAA-CREF fund as the starting date for our analysis and we exclude all Vanguard funds that were initiated after that date. Thus, the analysis is based on the realized investment performance over the eight years beginning on April 1, 1997 (when the CREF Inflation-Linked Bond fund was launched) and extends through March 31, 2005 (the latest completed month as of the date of our analysis).[21] Sixteen Vanguard index funds were initiated before the April 1, 1997 start date. Because the Vanguard

[20] We also retrieved data on the Vanguard Prime Money Market Fund. We compared the returns on this fund to those of the CREF Money Market fund and found no material differences in realized returns or risk. Accordingly, we include only the CREF fund in our analysis. When we examine the Vanguard Only opportunity set, the CREF Money Market Fund is used as a proxy for the Vanguard Prime Money Market Fund.

[21] In a study of investment choices available to 401(k) plans, Elton, Gruber, and Blake (2004) base their analysis on plans where available funds had at least 5 years of historical data. Because Vanguard added several fund alternatives in the five to eight year range from the time of our study, and generally is quicker than TIAA-CREF to add new funds, our analysis may underestimate the incremental value of including Vanguard index funds among the available asset classes.

REIT index is invested in market assets and is not managed by an insurance company, it is an eligible vehicle for deferred compensation investing.

We retrieved TIAA-CREF fund performance data directly from the TIAA-CREF website and Vanguard fund performance data directly from the Vanguard website. Both companies reported to us that their performance data are net of all expenses. In the case of TIAA-CREF, dividends and other distributions are continuously reinvested and reflected in unit values. In the case of Vanguard, we use unit values that are adjusted for dividends and other distributions.

Figure 1 shows a plot of annualized mean return and annualized standard deviation by investment fund. The annualized standard deviation is based on the assumption that monthly return rates are independently and identically distributed. The annualized expected return rate is derived by compounding the monthly return.[22] The results in the figure are based on monthly returns, which is the interval used throughout the analysis.[23] Although we use the longest feasible consistent sample period, the expected return estimates may not be representative. In particular, as interest rates generally were declining over the period, longer-term bond funds may have realized unexpectedly positive performance. Also, the sample period includes the end of the emerging market rally, the Asian stock market collapse, the end of the dot-com rally, and the effects of 9-11. While these factors probably affected the optimized allocations to specific investment funds, they are less likely to have materially affected allocations across broad asset classes.

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[22] We use return rates computed as: $(p_{i+1} - p_i) / p_i$.

[23] Because some of the assets in certain TIAA-CREF funds are not marked to market daily, possibly resulting in autoregressive error and low estimates of correlation across funds, we compared daily, monthly, and quarterly performance. While there is little evidence that daily data result in biased estimates of variance, there is evidence that correlations across funds are understated by daily data.

It is noteworthy that, based on the results in Figure 1, restricting the set of investment choices to only TIAA-CREF does not appear to limit the ability of employees to take on high risk by investing in only one asset class. The fund in Figure 1 with the highest measured risk over our sample period was the CREF Growth Fund, which also had the second lowest realized return over the eight-year period. As the realized return on this fund was less than the return on the CREF Money Market Fund, the CREF Growth fund had a negative Sharpe Ratio over the sample period.[24]

Figure 2 is a plot of the indexed values of eight representative asset classes over the period of our study. The figure reflects the effects of market-wide phenomena discussed above, and also illustrates that the price movements of a number of the more risky broad asset classes are highly correlated.

Diversification

Table 3 reports correlations across investment funds. TIAA-CREF funds are listed before Vanguard funds. Within a manager's list, the available funds are grouped as: money, debt, domestic equity, foreign equity, and real estate.[25] Correlation coefficients of 0.95 or greater are bolded in the table. TIAA-CREF offers five funds that predominantly are invested in equity (Stock, Equity Index, Social Choice, Growth, and Global). The correlations among all five are always at least 0.93, and frequently much higher. Thus, it appears that the investor's ability to diversify using these five CREF funds is only slightly better than if just one of the five were available. The same five

[24] The ratio was developed by Bill Sharpe to measure risk-adjusted performance. It is calculated by subtracting the risk free rate from the rate of return for a portfolio and dividing the result by the standard deviation of the portfolio returns.

[25] The CREF Social Choice fund and the Vanguard Balanced fund, while they have high correlations with pure equity funds, have lower risk because they combine equity and debt.

funds also are highly correlated with four of the Vanguard funds (Balanced Index, 500 Index, Growth Index and Total Stock Index).

Correlations also are consistently above 0.90 among the four Vanguard bond funds (Total Bond Index, Short-term Bond Index, Intermediate-term Bond Index, and Long-term Bond Index) and with the CREF Bond fund. Based on the correlation evidence in Table 3, Vanguard's foreign equity funds, the CREF Inflation-Protected Bond fund, the real estate funds, and Vanguard Small Cap Index add the most to potential diversification.

Figure 3 provides a graphical presentation of the effects of portfolio diversification based on a variety of naïve strategies that all are based on equally weighting the funds in the portfolio.[26] Bars in the figure show annualized portfolio standard deviations of returns, expressed as percentages of the average standard deviation for the funds comprising the portfolio.[27] The greater the diversification benefit of less than perfect positive correlation across funds, the lower will be the portfolio standard deviation compared to the average for the underlying funds. For this analysis, balanced funds and similar hybrids are classified as equity. The figure demonstrates that, because of the high correlations across TIAA-CREF's five equity funds, the aggregate benefit of diversification, using the naïve equal-weighting strategy, is to reduce portfolio risk by less than five percent. The result is similar for Vanguard's domestic equity index funds, but improves by the addition of international equities. Combining debt and equity funds materially improves diversification, but at the sacrifice of the higher expected returns that

[26] These portfolios are variants of the "1/n Strategy," where n is the number of assets in the portfolio. Benartzi and Thaler (2001) and Liang and Weisbenner (2002) find that investors tend to use the 1/n rule.

[27] These percentages are computed as, (Port. Std. Dev./Avg. Std. Dev.), where (1/n x Avg. Var. + ((n-1)/n) x Ave. Cov.)^.5 is the portfolio standard deviation an n is the number of funds that are equally weighted in the portfolio.

equity historically has afforded.[28] Inclusion of the Vanguard REIT Fund adds still more diversification benefits, but potentially without sacrificing expected return. While the figure shows the greatest diversification benefit when TIAA Real Estate is included, the benefit is likely to be overstated due to lack of regular marking to market of the real estate assets.

Efficient Frontiers

The efficient frontier of a set of risky assets is defined as the maximum expected return for any given level of risk. As a way of assessing the asset allocation choices that are available to plan participants, Elton, Gruber, and Blake (2004) propose that the set of options should enable a person whose only wealth is in the plan to reach the same frontier as if a "reasonable set of alternatives were available." To operationalize the concept of a "reasonable set," they rely on Elton Gruber and Blake (1999), who find the following eleven indexes capture most risk and return differences across funds: six domestic equity indexes (value or growth combined with small, mid, or large capitalization); a general bond index; a mortgage-backed index, a high-yield index; an international bond index; and the MSCI EAFE international stock index. Elton, Gruber, and Blake (2004) do not include real estate because most plans they studied did not offer a real estate fund.

Elton, Gruber, and Blake (2004) assess the adequacy of fund options by comparing the efficient frontiers of the individual funds with the frontier achieved by their set of indices. They conclude that not until 14 asset classes are included, do 401(k) funds reliably span the opportunity set available from the 11 indices. Our approach is conceptually similar. In effect, we assume that the TIAA-CREF + Vanguard menu

[28] Comparisons of portfolios that combine equity with debt and or real estate must be interpreted with caution as the relative proportions of debt and equity vary across the portfolios.

contains a reasonable set of choices and we compare that efficient frontier to the achievable frontiers for TIAA-CREF Only and Vanguard Only. We use the eight years of historical returns, the standard unbiased estimators of covariance, and the optimization routine, "frontcon," of the MATLAB Financial Toolbox to estimate efficient frontiers.[29] In panel (a) of Figure 4, we exclude the TIAA Real Estate fund, but include it in panel (b). The solid curves in the figures show the efficient frontiers that are generated when the investor is constrained to take no short positions (i.e., all fund weights are either positive or zero).

Because the sample period is limited to eight years, the optimization routine may over- or under-weight certain investment instruments based on anomalous performance over the sample period. Also, because investors generally are likely to seek some degree of diversification of their holdings, the dotted lines in the figures show frontiers that are generated with an additional constraint that mandates a degree of diversification. More specifically, except for the CREF Money Market fund (which is unconstrained), we constrain the maximum investment in any one fund to not exceed the greater of 3/n or 30 percent, where n is the number of eligible investment funds other than money. Thus, for TIAA-CREF Only, the maximum is 3/7 or 42.9 percent, whereas for Vanguard Only and TIAA-CREF + Vanguard, the maximum is 30 percent. Because the constraint is applied at the individual fund level, it still is possible for an investor to heavily weight a broad asset class by investing in multiple funds in the same class.

[29] Due to estimation and round-off error, this occasionally leads to a covariance matrix that is not positive semi-definite. To avoid this, we preconditioned the covariance matrix before calling frontcon. To do this, we expressed C as C=VDV' where V is an orthogonal matrix and D is a diagonal matrix with the eigenvalues of C along the diagonal. We then formed the diagonal matrix D*, equal to D except with negative diagonal elements of D replaced by zeros, and replaced C with C*=VD*V'. Although frontcon complained when C was not positive semi-definite, the frontiers it produced in those cases were indistinguishable from those produced with preconditioning.
See http://www.mathworks.com/access/helpdesk/help/toolbox/finance/frontcon.html .

Panel (a) illustrates that, up to an annualized standard deviation of about 4.0 percent, the investment choices available from any of the three sets of investment vehicles perform similarly. This is because the CREF Money Market fund (or its Vanguard equivalent) is available in each, and low risk is achieved by investing heavily in money. Beyond a risk level of 4.0 percent, the reward for bearing additional risk in TIAA-CREF is low. Doubling the annualized standard deviation to 8.0 percent adds only about 0.6 percent to expected return. Adding the Vanguard index funds as additional investment choices, on the other hand, substantially increases achievable expected returns for bearing additional risk. Increasing risk to 8.0 percent increases expected return by about 2.5 percent.

In panel (a), imposing the diversification constraints has a minor effect on the efficient frontier. Also, the panel illustrates the minor difference in achievable performance between the TIAA-CREF + Vanguard and Vanguard Only. At risk levels above 10 percent there is virtually no difference. This is because at high risk levels the optimal portfolios do not include any of the TIAA-CREF funds. Note, however, that even these risk levels are low in relative terms, when compared to single asset classes. As Figure 2 shows, all of the equity-only funds have risk levels during the sample period that are greater than 20 percent.

Panel (b) of Figure 4 tells a somewhat different story. Here, the TIAA Real Estate fund is included as an eligible asset. The result, over our sample period is that low-risk portfolios are invested heavily in this fund. Based on the realized statistics, in TIAA-CREF Only, taking risk levels beyond about 1.5 percent appears to add almost nothing to expected return. The addition of TIAA Real Estate also appears to

dramatically improve the achievable performance of TIAA-CREF + Vanguard. Because the opportunity sets include no close substitutes for the risk-return profile produced by the TIAA Real Estate fund, the diversification constraint does materially reduce the estimate of achievable returns at low risk levels.

Although panel (b) appears to make a compelling case for including TIAA Real Estate in the set of eligible assets, the potential benefit of doing so is overstated by the optimization analysis because of the likely distortions in the risk of this fund noted earlier. Unlike the Vanguard REIT fund, the TIAA Real Estate fund represents mainly direct investments in real estate. Assets in this fund are not marked to market on a regular basis. Thus, reported performance is likely to reflect mainly the realization of cash flows from real estate assets transactions, and not changes in investor sentiment about the long-term prospects for real estate. Also, as is well known, real estate assets generally have performed well over the sample period. The combination of good long-run performance in our sample period and understated volatility causes the optimization routine to heavily weight the TIAA Real Estate fund.

Projected Long-run Relative Performance of Optimized Portfolios

As a step toward assessing the long-run effects of the differences in efficient frontiers, in Figure 5 we compound the expected annual return over investment horizons ranging from ten to forty years. For highly loss-averse investment positions, such as an annual standard deviation of two percent, there is little sensitivity to restrictions on the set of investment choices, even for long investment horizons. However, for any given restricted set of investment choices, the expected terminal value of an initial investment of one dollar increases substantially. At higher risk levels but relatively short investment

horizons, such as a 14 percent annualized standard deviation for ten years, the differences in terminal values across restrictions on investment choices are not large. When the investment horizon is long and the 14 percent annualized standard deviation is selected, the restriction on investment choices can have a substantial effect.

Based on expected annual returns, an employee who worked one year, had $4,000 invested in a deferred compensation plan that was limited to the TIAA-CREF funds other than the CREF Real Estate fund, who limited the maximum investment in any fund to a maximum of 42.9 percent, and who invested with a risk level of 14 percent, would be expected to have an ending value of retirement savings of $87,000. Had the individual invested in TIAA-CREF + Vanguard or in Vanguard Only, with a maximum of 30 percent in any fund, the expected ending value of retirement savings would instead be $250,700, an ending value that is 2.88 times as high as with TIAA-CREF Only.

Asset Allocation by Portfolio Risk Level

Table 4 shows portfolio asset allocations across broad asset classes: money, equity, debt, and real estate.[30] Regardless of the set of available investment vehicles, the lowest level of risk is achieved by investing only in money market funds. Conversely, at risk levels of 4.0 percent or more, the percent of assets invested in the CREF Money Market fund is always zero. Irrespective of which set of investment vehicles is considered and whether allocations to specific funds are constrained or not, at risk levels up to a 6.0 percent annualized standard deviation of returns, the predominant asset class is debt.

[30] Investing in money market funds over long periods is not riskless, but the risk is low and empirical correlations of returns with other asset returns are low.

In our data, at 14.0 percent, the highest risk level we consider, the optimizer selects the Vanguard REIT fund. While unconstrained allocations to the Vanguard REIT fund are very high, the diversification constraint limits this investment to 30 percent of all assets. As discussed above, real estate is excluded from the TIAA-CREF Only portfolios. At intermediate risk levels and high levels of risk, normally 8.0 to 14.0 percent, when investments on real estate are constrained to be no more than either 30 percent or zero, the predominant investment class is equity.

For the TIAA-CREF + Vanguard set of portfolio options, Table 4 also shows the allocation of non-money market investments between TIAA-CREF funds and Vanguard index funds. TIAA-CREF and Vanguard have similar weights at a risk level of 2.0%, TIAA-CREF dominates at 4.0 percent, and Vanguard dominates at 6.0 percent and above. At risk levels above 10.0 percent, the optimizer allocates no funds to TIAA-CREF, even when the allocation to any single fund is constrained to 30 percent or less. The primary reason TIAA-CREF is heavily weighted at the 4.0 percent risk level is inclusion of the CREF Inflation-Protected Bond fund.[31]

The Effects of Risk Aversion and Investment Horizon on Asset Allocation

How much risk should employees accept? The answer depends on a multitude of individual-specific, intangible, and unobservable factors, on time to retirement, and on the marginal effects of greater risk on expected return. Siegel (1994) shows that with longer horizons, mean-variance maximizers would invest more, if not all, in stocks. Benartzi and Thaler (1995) find that a 50-50 allocation between equity and debt is plausible for myopic loss-averse investors. They observe that in consumption-based

[31] Vanguard offers an Inflation-Protected Securities fund with a low expense ratio, but does not classify the fund as an index fund.

asset-pricing models this allocation requires an extremely high level of risk aversion and that with long investment horizons, allocations entirely in equity are plausible.[32] Ballente and Green (2004) and others also note that risk aversion may change with age. These theoretical results are broadly consistent with the rule-of-thumb advice of investment practitioners, that the fraction of an individual's portfolio that is allocated to equity should be around 100 minus the individual's age.

In this subsection we employ a value-at-risk ("VAR") approach to assess the effects of risk aversion that is manifested as loss avoidance and we explicitly take account of the effects of investment horizon on the selected risk level. We then are able to assess how the optimal mix of portfolio weights can be expected to evolve over time as the employee approaches retirement. We also use the analysis to estimate the cumulative value of deferred compensation investments in portfolios that are annually re-weighted to account for the investment horizon.[33]

To make loss avoidance operational, we define VAR as the probability that a risky portfolio will return less than the return from investing in the CREF Money Market fund. Because money market returns normally are only slightly higher than expected inflation, our approach to VAR is essentially a "preservation of principal" criterion that is specified in real terms. The analytical framework we use implies that, at some point, the employee converts the retirement portfolio to a riskless life annuity.[34] The investment

[32] See Jagannathan and Kocherlakota (1996) for a general review of economic theory related to age and horizon effects on asset allocation.

[33] While investment professionals commonly advise reviewing portfolio allocations frequently and adjusting the allocations in response to changes in circumstances, market values, and investment options, Samulson and Zeckhauser (1988) and others document a "status quo bias" of not rebalancing very often, even in response to fluctuating asset values.

[34] Poterba and Wise (1996) note that, in simple life-cycle models, with actuarially fair market values, individuals should annuitize all wealth at retirement, but that under more realistic assumptions the practice may not be optimal.

horizon is defined relative to when this point is expected to occur, which may be at the time of retirement. To the extent that an individual does not elect to convert, our portfolio optimization algorithm would yield an overly conservative portfolio.

While the VAR approach can be challenged as overly simple, because it does not take account of the entire distribution of returns, that concern is mitigated by the fact that the portfolios we focus on all have underlying risk and return properties that are driven by market forces. In addition, in contrast to utility-based models of risk aversion, the VAR approach implies changes in portfolio allocations that are broadly consistent with practice. While Ameriks and Zeldes (2004) find no evidence of gradual reduction in equity as age increases, they do observe a tendency for people to shift completely out of equity around the time of retirement. More specifically, when they examine equity ownership by age, they find that equity ownership profiles are flat over 25 to 55 years of age, and negatively sloped over 56 to70 years. They find that the aggregate trend, rather than being due to smoothing over time, is due to increasing probability of not owning any equity in later years. They conjecture that the pattern they observe is not due to age effects, but to cohort effects. Poterba and Wise (1996) find support for the presence of cohort effects, in that the share of equities in 401(k) plans has increased in recent years. Heaton and Lucas (2000) observe that portfolio holdings could be influenced by non-traded assets. Consistent with this, they find that people who are entrepreneurs (with large holdings of risky illiquid assets) tend to hold financial assets that are more liquid. They also find that equity ownership decreases with age. Bodie and Crane (1997) use TIAA-CREF data and also find that equity percentage declines with age. They interpret their finding as being consistent with the recommendations of practitioners. Finally,

Agnew, Balduzzi, and Sunden (2003) study 401(k) plans and find that age has negative effect on equity holdings of a magnitude that is close to the practitioners' rule of thumb for equity investment.[35]

In the VAR analysis, we consider three critical values, defined in terms of standard deviations from the mean expected return. A critical value of one standard deviation ("1 Sigma") corresponds to a relatively loss-tolerant individual, who, over the investment horizon, is willing to accept a probability of about 16 percent that the investment performance will be less than the performance of investing in the CREF Money Market fund. Factors that could contribute to higher risk tolerance could include holdings of other retirement assets, a two-income family, a reason to anticipate a low level of post-retirement consumption needs, etc. A critical value of two standard deviations ("2 Sigma") corresponds to an individual who is willing to accept a probability of about 2.5 percent that investment performance over the investment horizon will be less that that of the CREF Money Market fund. Finally, a critical value of three standard deviations corresponds to a relatively high level of loss aversion, a willingness to accept a probability of about 0.1 percent that the risky portfolio will underperform the CREF Money Market fund.

To implement the VAR criteria, if the critical value of returns for any risky portfolio is less than the expected return for investing in the CREF Money Market fund, we select the Money Market fund. If any risky portfolio has a critical value that is above the expected return on the Money Market fund, we accept the risky portfolio that has the highest expected return. Generally, consistent with the theoretical argument of Benartzi

[35] See Canner, Mankiw and Weil (1997) for a comparison of professional portfolio advice with the predictions of economic theory.

and Thaler (1995) and the empirical finding of Ameriks and Zeldes (2004), our approach results in selecting either the Money Market fund or the riskiest portfolio. However, there normally is a period of a few years, as the investment horizon approaches zero, over which the transition from high risk to Money Market occurs. The main exception arises when the opportunity set is TIAA-CREF Only. In that set, because the marginal return to bearing risk greater than 4.0 percent is low, the optimal strategy selects relatively low portfolio risk levels, even when the investor is highly loss tolerant and the investment horizon is long.[36]

The effect on the mix of broad asset classes of annually rebalancing the retirement portfolio as the investment horizon approaches zero, is presented in Table 5. Because the results for Vanguard Only are similar to those for TIAA-CREF + Vanguard, we do not report the Vanguard Only results in the table. To illustrate, when TIAA-CREF + Vanguard is available, and the employee is loss tolerant (1 Sigma) and uses our diversification constraint, the riskiest portfolios that we consider, a 14.0 percent standard deviation, is selected until the individual's investment horizon reaches two years. At that point the optimal portfolio has a risk level of 10.0 percent, and at an investment horizon of one year, the optimal portfolio has a risk level of 4.0 percent.

In contrast, the loss-averse employee holds the riskiest portfolio until the investment horizon reaches ten years, then switches to a risk level of 12.0 percent for one year, followed by 10.0 percent for one year, 8.0 percent for one year, and 6.0 percent for

[36] As shown in Table 5, even the most risk tolerant investor never holds more than 46 percent equity (with 54 percent in debt), when constrained to invest only in TIAA-CREF funds. In contrast in TIAA-CREF's printed literature to 403(b) investors who do not have access to the TIAA Real Estate fund, TIAA-CREF presents a sample "Aggressive" portfolio that is invested 75 percent in CREF Stock and 25 percent in debt, and even its "Moderately Conservative" sample portfolio has 50 percent in CREF Stock. It appears that these sample portfolios would have underperformed our optimized allocations over our eight-year sample period. See RA ERISA CA 10/34.3E-703-CA (8/03).

one year. When the investment horizon reaches five years, the loss-averse investor switches to the CREF Money Market fund.

The transitions when the opportunity set is restricted to TIAA-CREF Only follow a similar pattern and timing, except that, as previously noted, the risky portfolio never has a risk level above 6.0 percent. The analysis in Table 5 is based on our discrete categorizations of investment portfolios with respect to risk and on TIAA-CREF funds excluding the TIAA Real Estate fund.

The Effects of Risk Aversion and Investment Horizon on Expected Return

We use annual rebalancing based on loss aversion and investment horizon to compute the expected long-run returns as functions of the opportunity set of investment funds and loss aversion. The results, which are based on the rebalancing changes shown in Table 5, are presented in Table 6. For the loss-tolerant employee, an investment of one dollar per year for 40 years results in an expected terminal amount of $606.10 if the savings are invested optimally in TIAA-CREF + Vanguard and the employee adheres to our diversification limits. In contrast if this investor is restricted to TIAA-CREF Only the expected terminal amount is $317.60.[37] Thus, based on our sample of historical returns and risk, for a loss-tolerant employee, the set of assets that includes Vanguard is capable of producing an ultimate level of retirement savings that is approximately 1.91 times as high as if TIAA-CREF Only is available. The differential is somewhat smaller for a more loss-averse employee. [38]

[37] Alternatively, the comparisons in Table 6 can be viewed as the values, in present purchasing power, of an investment level that begins at $1 per year, and grows each year at the inflation rate. Purchasing power at the time of retirement would be lower due to the cumulative inflationary change in the price level.

[38] These comparisons are not intended to be interpreted as projections of what actually would be realized. Rather, they are presented as illustration of what would be realized if the optimized portfolio were selected *ex ante* and the expected returns from the sample period continued to be realized each year.

Greater risk aversion reduces expected returns. Going from 1 Sigma to 3 Sigma, the expected value of a one dollar per year of constrained investment in TIAA-CREF + Vanguard declines to $431.4, a reduction of 29 percent. The amount of reduction is not as great as might be expected. This is because, even with Vanguard funds included, the achievable risk levels still are quite low relative to what a loss-tolerant employee might desire.

Elton, Gruber, and Blake (2004) perform a similar analysis of the value of lost opportunities for their sample of 401(k) plans and conclude that, for the plans that offered inadequate choices, the cumulative loss of terminal wealth over twenty years would be more than 300 percent. Their approach to estimating terminal wealth is different from ours, in that they rely on the Sharpe Ratio and seek to estimate the expected return that would have been needed to compensate for the level of risk of the plan. Using the Sharpe Ratio of their set of indices as the benchmark, they conclude that the plans would have had to increase expected returns by 3.2 percent. This approach may overstate the loss because it measures all of the plan's underperformance along the expected return dimension, rather than as a combination of both higher risk and lower expected return. Also, their approach is based on application of the 1/n rule, rather than being optimized to an individual.

The Effects of Naïve Investment Strategies

Of course, few employees are likely to examine the results of portfolio optimization routines before investing, and even if they did, the future would not exactly replicate the history they studied. Also, most 403(b) plan sponsors are unwilling to provide investment advice because of concerns that doing so could be interpreted as

taking investment control away from the participant, and increase the sponsor's legal exposure as a fiduciary.

So what happens if investors follow naïve strategies that ignore the historical empirical evidence? One way to examine this is to consider the effect of following an arbitrary rule-of-thumb investment approach. Several studies suggest that when employees are offered n investment choices, they will allocate their investment funds equally across those classes, and that they may not rebalance very often.

Benartzi and Thaler (2001) and Liang and Weisbenner (2002) find that investors tend to use the 1/n rule.[39] As a result, the proportion invested in stocks depends on proportion of stocks in the fund. Generally, they find that the 1/n rule gets close to the frontier, but probably not at the right risk level. Brennan and Torous (1999) find that utility losses associated with being at the wrong place on the frontier can be large, a loss of utility of about 20 percent, based on a relative risk aversion coefficient of 2, a degree of risk aversion that is consistent with empirical findings for a representative investor.

To see the effects of the 1/n behavioral regularity, we computed the realized returns and standard deviations of applying the rule-of-thumb to our sample of funds. Table 7 reports expected annualized returns and standard deviations of the naïve strategy for opportunity sets including and excluding the TIAA Real Estate fund. Based on the historical data, expected return is lower and risk is higher when the TIAA Real Estate fund is not available. The more fundamental comparison shows that the 1/n allocation produces lower expected returns and lower risk when applied to TIAA-CREF Only, compared to the other alternatives. The differences in expected returns across menus are

[39] Huberman and Jiang (2004) find that reliance on the 1/n strategy declines as the number of investment options increases. The median number of funds selected to invest in ranges from 3-4 regardless of the number of funds offered and the strategy tends to be followed once the funds have been selected.

all less than one percent per year. One reason for the lower risk and return of TIAA-CREF Only, is that the relatively small number of funds places more weight on the CREF Money Market fund, which offers low expected returns and low risk.

The Cumulative Expected Returns panel of Table 7 shows expected long-run performance of the naïve strategy. Over time, the lower expected return to TIAA-CREF Only compounds to a substantial difference. Long-run values of the naïve strategy can be compared to projections at comparable risk levels in Figure 4, which are based on optimized weightings. Compared to the results with omniscience, it is no surprise that the naïve strategy yields long-run results that are much lower.

Because application of the naïve strategy to the opportunity sets that include Vanguard indexes yields both higher expected returns and higher risk, we also compare the downside performance of the alternative opportunity sets at one, two, and three standard deviations below the expected return, corresponding to relatively loss-tolerant and relatively loss-averse employees. If the preference for TIAA-CREF Only versus the other alternatives is based on a comparison of values one standard deviation below the mean, as a loss-tolerant investor might do, TIAA-CREF Only is preferred if the investment horizon is one year. Beyond a horizon of one year, either Vanguard Only or TIAA-CREF + Vanguard is preferred. For the most loss-averse employees (by our measures), the TIAA-CREF Only opportunity set is preferred for investment horizons of six years or less. When the TIAA Real Estate fund is added as an additional asset class, subject to our earlier caveats about how returns for this fund are measured, the preference for TIAA-CREF Only extends over somewhat longer investment horizons--up to ten years for the most loss-averse investor.

It is important to recognize that these observations of preferences are based on strict adherence to the 1/n rule of thumb. An employee who had the TIAA-CREF + Vanguard opportunity set could, if desired, duplicate the TIAA-CREF Only profile simply by applying the 1/n rule only to TIAA-CREF funds.

Discussion

Because of recent changes to Section 403(b) of the Internal Revenue Code, colleges and universities that offer qualifying defined contribution retirement plans must make the plans universally available to their employees. Generally, this means that staff, custodians, physical plant workers, etc. will be participating in the same plans as professors who hold PhDs in economics and finance. Because the colleges and universities generally try to limit their fiduciary liability by ensuring that retirement investments are self-directed, the change, which merges people with radically different education backgrounds and expertise, poses serious issues for plan sponsors. Should the sponsor limit the number and risk of available investment options in order to protect unqualified employees from making investment mistakes? Or should the sponsor offer a broad menu of options so that more sophisticated employees will not suffer opportunity losses as a result of the inability to construct well-diversified portfolios that are at or near the efficient frontier and of appropriate risk for their personal situations? It appears that either course of action can subject the plan sponsor to greater fiduciary risk.

Currently, it appears that colleges and universities are moving in the direction of protecting themselves against the mistakes of unqualified employees by taking such actions as reducing the number of available asset classes and investment choices. In the short-run, if properly executed, this might be a good strategy, as lawsuits to recover

actual losses are easier to bring than suits to recover the value of lost opportunities. On the other hand, the value of lost opportunities is likely to be much larger than the individual losses that arise from unskilled investment risk-taking, and the actual efforts of colleges and universities to protect against actual losses may increase the litigation risks that sponsors are seeking to avoid.

The objective of this paper is to evaluate the opportunity cost of employers' decisions to restrict the investment choices for 403(b) retirement plan participants. We focus, in particular on TIAA-CREF, the manager that controls over half of all 403(b) assets and serves nearly half of the 6.8 million 403(b) participants. We find that over a recent eight-year period, the menu of choices available from TIAA-CREF substantially underperformed what could have been achieved by the addition of a small number of index funds. TIAA-CREF's underperformance during our sample period was due to the lack of key investment classes, most importantly, a value index, an international equity index, and a REIT index.

Because of these missing asset classes, we estimate that for a highly loss-averse sophisticated investor, having access to a set of equity indexes in addition to the TIAA-CREF menu would have increased the value of terminal wealth over a forty-year work-life by 72.4 percent. For a highly loss-averse unsophisticated investor, who simply allocated investments equally across all options, we estimate that access to the indexes would increase the value of terminal wealth by 26.3 percent. To put these figures on a macroeconomic scale, if all TIAA-CREF participants were restricted to use only TIAA-CREF over a forty-year horizon, our estimate of the terminal wealth loss is between $629 billion and $2.318 trillion, depending on the mix of investor sophistication levels. While

the findings are specific to 403(b) retirement plans, the implications extend broadly to other defined contribution plans, including 401(k) plans, in which there are an estimated 37.1 million contributors, investing $134.7 billion annually.

Separate from the opportunity losses, we also find that restricting investment choices to those available from TIAA-CREF does not appear to reduce the risk of litigation based on actual losses. TIAA-CREF, though known for low fees, charges fees that are higher than those charged by large index funds managed by entities such as Vanguard and Fidelity. Further, in our sample period, a TIAA-CREF fund had the highest total risk of any investment choice and the second lowest realized performance. Given that TIAA-CREF's overall performance was worse than the portfolio of index funds during our sample period, one might surmise that the additional fees paid to TIAA-CREF were unwarranted and part of the actual losses that investors incurred.

While the focus of attention on ERISA compliance has been something of a bottom-up process, that seeks to avoid litigation exposure by trying to comply point by point with the provisions of the statute, a top-down approach would appear to be more meaningful. One attorney who works in the area proposes to focus on intent. He asks: "What is the intended purpose of ERISA? The obvious and only plausible answer is, the objective of the law is that every participant's account should be well-invested."[40]

From this perspective, the one-size-does-not-fit-all approach does not appear to work very well. Another possible approach may be to offer a narrow set of fairly well-diversified investment options plus enable participants to access a broader menu of options through a self-directed brokerage or mutual fund window. These brokerage or window accounts allow participants to invest in mutual funds, and possibly individual

[40] Fred Reish, "Beginning at the end," PlanSponsor 3-2005 p. 80.

stocks and/or bonds, that are outside the plan, and enable financially sophisticated employees to tailor their retirement portfolios to their own needs and risk/return profiles. However, window accounts do not help financially unsophisticated employees to construct optimal portfolios. For that purpose, the plan sponsor might include life-cycle and life-style funds that enable participants to select investments matching their own retirement horizons and life-style characteristics.

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Table 1

Retirement Savings Options at Leading Colleges and Universities

The table is based on the most current information, as reported to us by telephone interviews of benefits offices or on the school websites. The informaiton is current as of Summer 2005, and, in some cases, reflects planned changes. NA = the institution either has a defined benefit or a cash balance plan for employer plan, and TIAA-CREF is not an option for the supplemental plan. * = public institution. Rankings are from *U.S. News and World Report*, 2005.

Retirement Plan Options Among Top 50 National Universities

	Employer Plan				Supplemental Plan			
Institution	Limited to TIAA-CREF	Additional Choices	Vanguard Option	Fidelity Option	Limited to TIAA-CREF	Additional Choices	Vanguard Option	Fidelity Option
Harvard University	no	2	yes	yes	no	1	yes	no
Princeton University	yes				no	1	yes	no
Yale University	no	1	yes	no	no	1	yes	no
University of Pennsylvania	no	1	yes	no	no	1	yes	no
Duke University	no	4	yes	yes	no	4	yes	yes
Massachusetts Inst. of Tech.	NA	NA	NA	NA	NA	1	no	yes
Stanford University	no	2	yes	yes	no	2	yes	yes
California Institute of Tech.	yes				no	1	no	yes
Columbia University	no	2	yes	no	no	2	yes	no
Dartmouth College	no	2	no	yes	no	2	no	yes
Northwestern University	no	1	no	yes	no	1	no	yes
Washington University	no	1	yes	no	no	1	yes	no
Brown University	no	2	no	yes	no	2	no	yes
Cornell University	no	1	no	yes	no	1	no	yes
Johns Hopkins University	no	4	yes	yes	no	4	yes	yes
University of Chicago	no	1	yes	no	no	1	yes	no
Rice University	yes				no	1	no	yes
University of Notre Dame	no	2	yes	yes	no	2	yes	yes
Vanderbilt University	no	3	yes	yes	no	3	yes	yes
Emory University	no	2	yes	yes	no	2	yes	yes
U. of California-Berkeley*	NA	NA	NA	NA	NA	2	no	yes
Carnegie Mellon University	no	1	yes	no	no	1	yes	no
U. of Michigan-Ann Arbor*	no	1	no	yes	no	1	no	yes
University of Virginia *	no	2	yes	yes	no	2	yes	yes
Georgetown University	no	2	yes	yes	no	2	yes	yes
U. of California-Los Angeles*	NA	NA	NA	NA	NA	2	no	yes
Wake Forest University	no	2	yes	yes	no	2	yes	yes
Tufts University	no	1	no	yes	no	1	no	yes
U. of N. Carolina-Chapel Hill*	no	3	yes	yes	no	6	yes	yes
Univ. of Southern California	no	4	yes	yes	no	4	yes	yes
College of William and Mary	no	1	no	yes	no	4	no	yes
Brandeis University	no	1	no	yes	no	1	no	yes
New York University	no	1	yes	no	no	1	yes	no
U. of Wisconsin-Madison*	NA	NA	NA	NA	no	8	no	yes
Case Western Reserve Univ.	no	1	yes	no	no	1	yes	no
U. of California-San Diego*	NA	NA	NA	NA	NA	2	no	yes
Boston College	no	1	no	yes	no	1	no	yes
Lehigh University	yes				no	3	yes	yes
U. of Illinois -Urb.-Cham.*	no	3	no	no	no	4	no	yes
University of Rochester	no	3	yes	yes	no	3	yes	yes
Georgia Inst.of Tech.*	no	3	no	yes	no	9	no	yes
U. of California-Davis*	NA	NA	NA	NA	NA	2	no	yes
Tulane University	no	1	no	yes	no	1	no	yes
U. of California-Irvine*	NA	NA	NA	NA	NA	2	no	yes
U. of California-Santa Barb.*	NA	NA	NA	NA	NA	2	no	yes
Rensselaer Polytechnic Inst.	no	1	no	yes	no	1	no	yes
U. of Texas-Austin*	no	7	no	yes	no	57	no	yes
Univ. of Washington *	no	2	yes	yes	no	3	yes	yes
Pennsylvania State U. *	yes				no	5	yes	yes
University of Florida *	no	4	no	no	no	9	no	no
Total	**5**	**76**	**22**	**27**	**0**	**176**	**25**	**39**

Retirement Plan Options Among Top 50 Liberal Arts Colleges

	Employer Plan				Supplemental Plan			
Institution	Limited to TIAA-CREF	Additional Choices	Vanguard Option	Fidelity Option	Limited to TIAA-CREF	Additional Choices	Vanguard Option	Fidelity Option
Williams College	yes				yes			
Amherst College	yes				no	4	yes	yes
Swarthmore College	no	2	yes	no	no	2	yes	no
Wellesley College	yes				no	2	no	yes
Carleton College	yes				yes			
Pomona College	yes				yes			
Bowdoin College	no	1	no	yes	no	2	no	yes
Davidson College	yes				yes	0	no	no
Haverford College	no	1	no	yes	no	1	no	yes
Wesleyan University	no	1	no	yes	no	4	yes	yes
Middlebury College	yes				yes			
Vassar College	yes				yes			
Claremont McKenna Coll.	yes				yes			
Smith College	no	3	no	yes	no	3	no	yes
Washington and Lee Univ.	yes				yes			
Colgate University	no	1	no	no	no	1	no	no
Grinnell College	yes				no	13	yes	yes
Harvey Mudd College	yes				yes			
Colby College	yes				yes			
Hamilton College	no	1	no	yes	no	1	no	yes
Bryn Mawr College	no	1	yes	no	no	1	yes	no
Bates College	yes				yes			
Oberlin College	yes				yes			
Mt. Holyoke College	no	1	no	yes	no	2	yes	yes
Trinity College	yes				no	3	yes	yes
Bucknell University	yes				no	1	no	yes
Macalester College	no	1	yes	no	no	1	yes	no
Scripps College	yes				yes			
Barnard College	yes				yes			
Kenyon College	yes				yes			
College of the Holy Cross	no	1	yes	no	no	1	yes	no
Lafayette College	no	1	no	yes	no	1	no	yes
Colorado College	yes				yes			
Sewanee - Univ. of the South	no	1	no	yes	no	1	no	yes
Bard College	yes				yes			
Connecticut College	yes				yes			
Whitman College	yes				yes			
Franklin and Marshall Coll.	no	1	no	no	no	1	no	no
Furman University	no	2	no	yes	no	2	no	yes
Dickinson College	yes				no	1	no	yes
Union College	no	1	no	yes	no	1	no	yes
Centre College	yes				yes			
DePauw University	no	2	no	yes	no	2	no	yes
Occidental College	yes				yes			
Gettysburg College	yes				no	3	yes	yes
Rhodes College	no	1	no	no	no	1	no	no
Skidmore College	no	1	no	yes	no	1	no	yes
Sarah Lawrence College	yes				yes			
Wabash College	no	1	no	no	no	1	no	no
Denison University	no	2	no	no	no	2	no	no
Total	**29**	**27**	**4**	**12**	**22**	**59**	**10**	**19**

Table 2

TIAA-CREF Retirement Investments and Vanguard Index Funds

The table includes all available TIAA-CREF retirement investment vehicles except the Traditional Annuity and all Vanguard Index Funds except for those intended for tax avoidance and those that involve custom blends. The table shows the inception date of each vehicle, descriptive information on the investment style, sector, and orientation, and indicators of how the vehicle is used in the analysis. A "one" under H1 indicates that the vehicle is used in the primary analysis of performance with and without Vanguard index funds. Because Vanguard's Prime Money Market returns are almost indistinguishable from those of the CREF Money Market, the Vanguard money market funds are excluded and the CREF Money Market fund is used as a proxy. Because TIAA Real Estate is not eligible for retirement investment in some states and in some plans, and because it is not consistently marked to market, it is excluded in the H1 analysis. The H2 analysis adds TIAA Real Estate as an option. April 1, 1997 is used as that starting date of the analysis, because that is the first date when all currently-offered TIAA-CREF instruments are available. Accordingly, Vanguard funds that initiated after that date are excluded from the analysis.

Fund/Manager	First Date	H1	H2	Style	D/E	Sector	Company's Description of Investment Objective
TIAA-CREF							
CREF Money Market	3/2/1992	1	1	Active	Money	Dollar-den.	Seeks high current income consistent with liquidity and capital preservation.
CREF Bond Market	3/2/1992	1	1	Active	Debt	Domestic	Seeks favorable long-term returns, mainly through high current income consistent with capital appreciation.
CREF Stock	3/2/1992	1	1	Active	Equity	Broad-based	Seeks favorable long-term returns through capital appreciation and current income. Avoids the extremes of conservatism and high risk.
CREF Global Equities	5/1/1992	1	1	Active	Equity	Dom. and For.	Offers participation in stock markets around the world, including the U.S., for diversification and growth potential.
CREF Social Choice	3/2/1992	1	1	Active	Comb.	Broad-based	Holds stocks, bonds and money issues (1) not invested in alcohol, tobacco, weapons, nuclear (2) environment-friendly and civic-minded.
CREF Growth	4/29/1994	1	1	Mixed	Equity	Cap. Appr.	Seeks favorable long-term returns, mainly through capital appreciation, from a portfolio of stocks we believe are poised for superior growth.
CREF Equity Index	4/29/1994	1	1	Passive	Equity	Domestic	A highly diversified portfolio designed to track the overall U.S. stock market as represented by the Russell 3000® Index.
TIAA Real Estate	10/2/1995		1	Active	R.E.	Direct and Mkt.	Seeks favorable long-term returns through capital appreciation and rental income.
CREF Inflation-Linked Bonds	4/1/1997	1	1	Active	Debt	Dom. and For.	Seeks long-term returns that keep pace with inflation. Invests largely in inflation-linked securities.
Vanguard							
500 Index	3/27/1987	1	1	Passive	Equity	Domestic	Seeks to track the performance of a benchmark index that measures the investment return of large-capitalization stocks.
Total Bond Market Index	6/4/1990	1	1	Passive	Debt	Broad-based	Seeks to track the performance of a broad, market-weighted bond index.
European Stock Index	11/1/1990	1	1	Passive	Equity	Foreign	Seeks to track the performance of the Morgan Stanley Capital International® (MSCI) Europe Index.
Pacific Stock Index	11/1/1990	1	1	Passive	Equity	Foreign	Seeks to track the performance of the Morgan Stanley Capital International® (MSCI) Pacific Index.
Small Cap Index	1/18/1991	1	1	Passive	Equity	Domestic	Seeks to track the performance of a benchmark index that measures the investment return of small-capitalization stocks.
Extended Market Index	7/8/1991	1	1	Passive	Equity	Domestic	Seeks to track the performance of a benchmark index that measures the investment return of small- and mid-capitalization stocks.
Growth Index	3/11/1993	1	1	Passive	Equity	Domestic	Seeks to track the performance of a benchmark index that measures the investment return of large-capitalization growth stocks.
Value Index	3/11/1993	1	1	Passive	Equity	Domestic	Seeks to track the performance of a benchmark index that measures the investment return of large-capitalization value stocks.
Emerging Mkts Stock Index	9/12/1995	1	1	Passive	Equity	Foreign	Seeks to track the performance of the Select Emerging Markets Index.
Short-Term Bond Index	6/20/1996	1	1	Passive	Debt	Domestic	Seeks to track the performance of a market-weighted bond index with a short-term dollar-weighted average maturity.
Interm-Term Bond Index	6/20/1996	1	1	Passive	Debt	Domestic	Seeks to track the performance of a market-weighted bond index with an intermediate-term dollar-weighted average maturity.
Long-Term Bond Index	6/20/1996	1	1	Passive	Debt	Domestic	Seeks to track the performance of a market-weighted bond index with a long-term dollar-weighted average maturity.
Balanced Index	6/20/1996	1	1	Passive	Comb.	Domestic	With 60% seeks to track the investment performance of the stock market. With 40% seeks to track the investment performance of a bond index.
Total Stock Mkt Index	6/20/1996	1	1	Passive	Equity	Broad-based	Seeks to track the performance of a benchmark index that measures the investment return of the overall stock market.
Total Intl Stock Index	6/28/1996	1	1	Passive	Equity	Foreign	Seeks to track the Total International Composite Index - a combination of European, Pacific, and Emerging Markets Index Funds.
REIT Index	6/28/1996	1	1	Passive	R.E.	Domestic	Seeks to track the performance of a benchmark index that measures the performance of publicly traded equity REITs.
Mid Capitalization Index	5/28/1998			Passive	Equity	Domestic	Seeks to track the performance of a benchmark index that measures the investment return of mid-capitalization stocks.
Small Cap Growth Index	5/28/1998			Passive	Equity	Domestic	Seeks to track the performance of a benchmark index that measures the investment return of small-capitalization growth stocks.
Small Cap Value Index	5/28/1998			Passive	Equity	Domestic	Seeks to track the performance of a benchmark index that measures the investment return of small-capitalization value stocks.
Developed Markets Index	7/17/2000			Passive	Equity	Foreign	Seeks to track the performance of the Morgan Stanley Capital International® (MSCI) Europe, Australasia, Far East (EAFE) Index.
Calvert Social Index	8/8/2000			Passive	Equity	Domestic	Seeks to track the performance of the Calvert Social Index.
Large Cap Index	2/3/2004			Passive	Equity	Domestic	Seeks to track the performance of a benchmark index that measures the investment return of large-capitalization stocks.

Figure 1

Annualized Means and Standard Deviations of Returns by Investment Vehicle
(Based on Monthly data from April 1, 1997 to March 31, 2005)

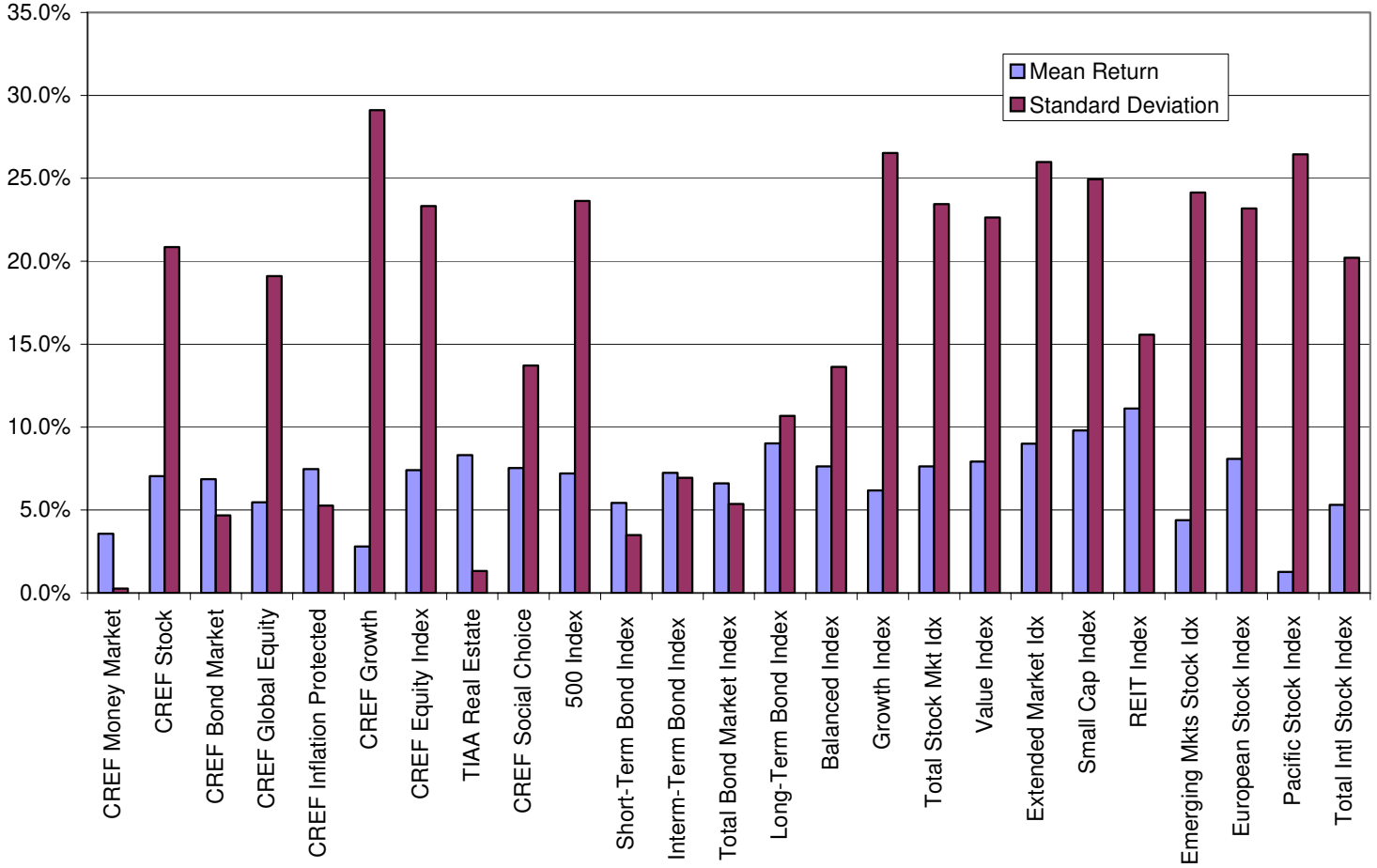
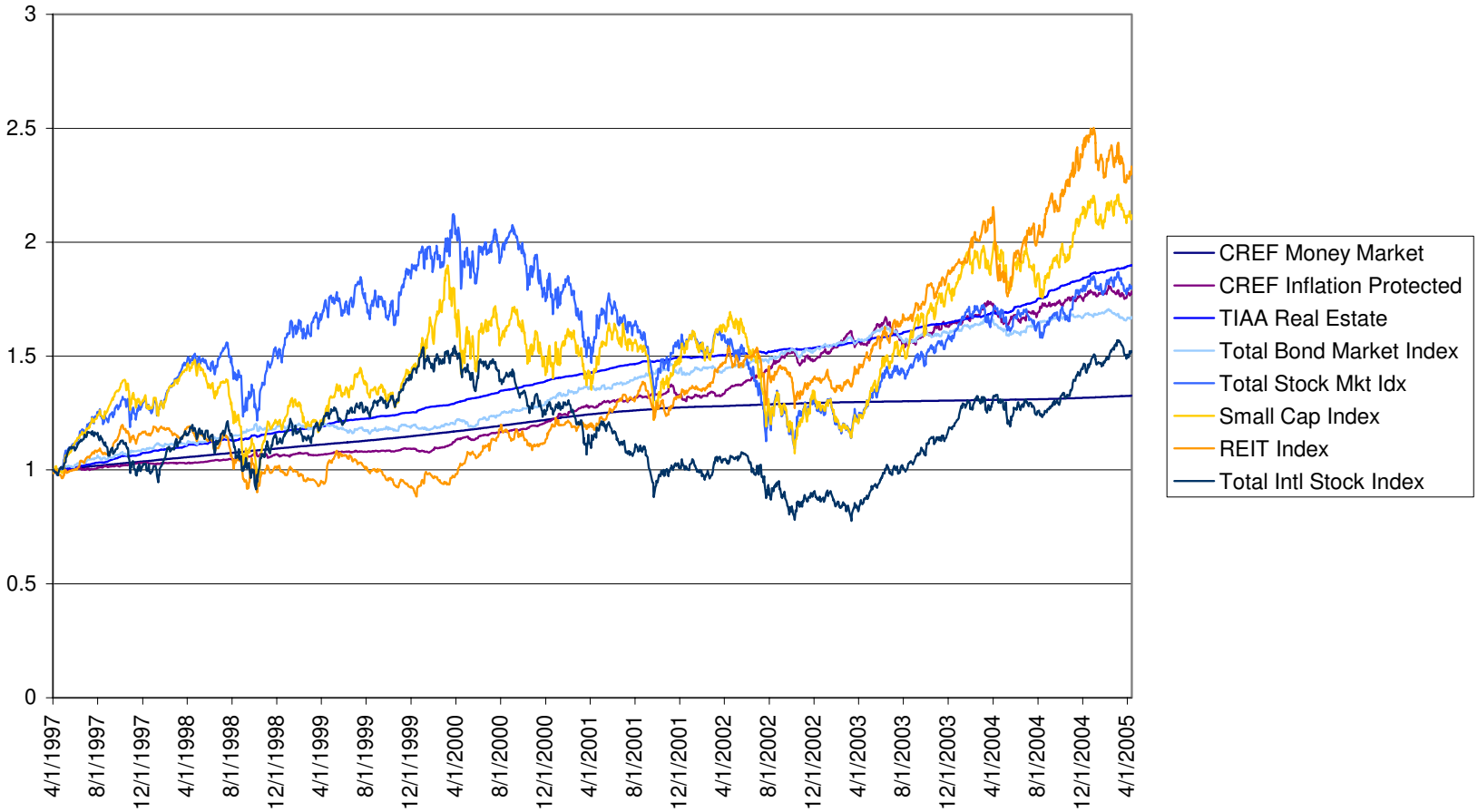


Figure 2

Price Indicies of Representative Asset Classes

The figure shows the value over time, of $1 invested on April 1, 1997, with all distributions reinvested.



Sources: Index unit values are reported daily on the the TIAA-CREF and Vanguard websites and on Yahoo Financial.

Table 3

Investment Vehicle Correlations of Quarterly Returns

April 1, 1997 through March 31, 2005

The table shows correlations of quarterly returns for all investment vehicles with returns data available since at least April 1, 1997. TIAA-CREF investment vehicles are listed first, and Vanguard index funds are listed second. Bolded figures indicate correlation coefficients of at least 0.95. Investment vehicles that are highly correlated with each other make limited contributions to diversification of retirement savings portfolios. The CREF Money Market fund is assumed to have a zero correlation with other funds.

	TIAA-CREF Investment Vehicles								Vanguard Index Funds															
	CREF Bond	CREF Infl Prot.	CREF Stock	CREF Equity Index	CREF Social Choice	CREF Growth	CREF Global	TIAA Real Estate	Total Bond Index	Short Term Bond Index	Interm. Term Bond Index	Long Term Bond Index	Balanced Index	500 Index	Growth Index	Value Index	Total Stock Index	Extended Market Index	Small Cap Index	European Market Index	Pacific Market Index	Emerging Market Index	Total Internatl Index	Real Estate Index
CREF Bond	1	0.73	(0.47)	(0.46)	(0.33)	(0.50)	(0.49)	0.11	**0.99**	0.92	**0.97**	0.93	(0.37)	(0.46)	(0.47)	(0.38)	(0.47)	(0.46)	(0.47)	(0.38)	(0.51)	(0.59)	(0.50)	(0.02)
CREF Inflation Protected	0.73	1	(0.51)	(0.51)	(0.44)	(0.52)	(0.50)	(0.01)	0.72	0.64	0.73	0.75	(0.44)	(0.53)	(0.55)	(0.44)	(0.51)	(0.41)	(0.39)	(0.48)	(0.24)	(0.32)	(0.43)	0.15
CREF Stock	(0.47)	(0.51)	1	**1.00**	**0.98**	**0.95**	**0.97**	0.15	(0.42)	(0.48)	(0.41)	(0.34)	**0.99**	**0.99**	0.94	0.93	**0.99**	0.94	0.92	0.90	0.68	0.77	0.91	0.40
CREF Equity Index	(0.46)	(0.51)	**1.00**	1	**0.98**	**0.96**	**0.96**	0.16	(0.41)	(0.46)	(0.40)	(0.33)	**0.99**	**1.00**	**0.95**	0.93	**1.00**	**0.95**	0.92	0.87	0.63	0.75	0.87	0.39
CREF Social Choice	(0.33)	(0.44)	**0.98**	**0.98**	1	0.93	0.93	0.18	(0.23)	(0.35)	(0.27)	(0.20)	**0.99**	**0.99**	0.93	0.93	**0.98**	0.89	0.87	0.86	0.60	0.69	0.85	0.40
CREF Growth	(0.50)	(0.52)	**0.95**	**0.96**	0.93	1	0.93	0.10	(0.46)	(0.49)	(0.44)	(0.35)	**0.95**	**0.95**	**0.98**	0.80	**0.96**	0.93	0.85	0.79	0.64	0.71	0.82	0.26
CREF Global	(0.49)	(0.50)	**0.97**	**0.96**	0.93	0.93	1	0.13	(0.46)	(0.51)	(0.44)	(0.37)	**0.95**	**0.95**	0.93	0.87	**0.96**	0.93	0.89	0.92	0.73	0.79	0.94	0.32
TIAA Real Estate	0.11	(0.01)	0.15	0.16	0.18	0.10	0.13	1	0.16	0.08	0.13	0.16	0.18	0.15	0.06	0.25	0.15	0.14	0.18	0.16	(0.05)	0.00	0.07	0.44
Total Bond Index	**0.99**	0.72	(0.42)	(0.41)	(0.28)	(0.46)	(0.46)	0.16	1	0.94	**0.98**	0.93	(0.31)	(0.41)	(0.43)	(0.33)	(0.42)	(0.44)	(0.41)	(0.36)	(0.49)	(0.56)	(0.48)	0.03
Short Term Bond Index	0.92	0.64	(0.48)	(0.46)	(0.35)	(0.49)	(0.51)	0.08	0.94	1	0.92	0.79	(0.37)	(0.45)	(0.46)	(0.38)	(0.46)	(0.48)	(0.45)	(0.45)	(0.48)	(0.56)	(0.53)	(0.04)
Interm. Term Bond Index	**0.97**	0.73	(0.41)	(0.40)	(0.27)	(0.44)	(0.44)	0.13	**0.98**	0.92	1	0.93	(0.31)	(0.40)	(0.42)	(0.31)	(0.41)	(0.42)	(0.41)	(0.34)	(0.47)	(0.49)	(0.45)	0.02
Long Term Bond Index	0.93	0.75	(0.34)	(0.33)	(0.20)	(0.35)	(0.37)	0.16	0.93	0.79	0.93	1	(0.23)	(0.33)	(0.34)	(0.27)	(0.34)	(0.32)	(0.33)	(0.27)	(0.46)	(0.48)	(0.40)	0.03
Balanced Index	(0.37)	(0.44)	**0.99**	**0.99**	**0.99**	**0.96**	**0.96**	0.18	(0.31)	(0.37)	(0.31)	(0.23)	1	**0.99**	0.94	0.93	**0.99**	**0.96**	0.91	0.86	0.61	0.73	0.86	0.42
500 Index	(0.46)	(0.53)	**0.99**	**1.00**	**0.99**	**0.95**	**0.95**	0.15	(0.41)	(0.45)	(0.40)	(0.33)	**0.99**	1	**0.96**	0.93	**0.99**	0.92	0.89	0.88	0.63	0.73	0.87	0.35
Growth Index	(0.47)	(0.55)	0.94	**0.95**	0.93	**0.98**	0.93	0.06	(0.43)	(0.46)	(0.42)	(0.34)	0.94	**0.96**	1	0.78	**0.95**	0.88	0.80	0.81	0.64	0.68	0.82	0.20
Value Index	(0.38)	(0.44)	0.93	0.93	0.93	0.80	0.87	0.25	(0.33)	(0.38)	(0.31)	(0.27)	0.93	0.93	0.78	1	0.92	0.85	0.89	0.85	0.55	0.71	0.83	0.51
Total Stock Index	(0.47)	(0.51)	**0.99**	**1.00**	**0.98**	**0.96**	**0.96**	0.15	(0.42)	(0.46)	(0.41)	(0.34)	**0.99**	**0.99**	**0.95**	0.92	1	**0.96**	0.92	0.87	0.65	0.77	0.88	0.39
Extended Market Index	(0.48)	(0.41)	0.94	**0.95**	0.89	0.93	0.93	0.14	(0.44)	(0.48)	(0.42)	(0.32)	**0.96**	0.92	0.88	0.85	**0.96**	1	**0.95**	0.80	0.66	0.80	0.84	0.46
Small Cap Index	(0.47)	(0.39)	0.92	0.92	0.87	0.85	0.89	0.18	(0.41)	(0.45)	(0.41)	(0.33)	0.91	0.89	0.80	0.89	0.92	**0.95**	1	0.81	0.63	0.81	0.84	0.61
European Market Index	(0.38)	(0.48)	0.90	0.87	0.88	0.79	0.92	0.16	(0.36)	(0.45)	(0.34)	(0.27)	0.86	0.88	0.81	0.85	0.87	0.80	0.81	1	0.60	0.69	0.94	0.36
Pacific Market Index	(0.51)	(0.24)	0.68	0.63	0.60	0.64	0.73	(0.05)	(0.49)	(0.48)	(0.47)	(0.46)	0.61	0.63	0.64	0.55	0.65	0.66	0.63	0.60	1	0.78	0.83	0.26
Emerging Market Index	(0.59)	(0.32)	0.77	0.75	0.69	0.71	0.79	0.00	(0.56)	(0.56)	(0.49)	(0.48)	0.73	0.73	0.68	0.71	0.77	0.80	0.81	0.69	0.78	1	0.85	0.45
Total International Index	(0.50)	(0.43)	0.91	0.87	0.85	0.82	0.94	0.07	(0.48)	(0.53)	(0.45)	(0.40)	0.86	0.87	0.82	0.83	0.88	0.84	0.84	0.94	0.83	0.85	1	0.38
Real Estate Index	(0.02)	0.15	0.40	0.39	0.40	0.26	0.32	0.44	0.03	(0.04)	0.02	0.03	0.42	0.35	0.20	0.51	0.39	0.40	0.01	0.36	0.26	0.45	0.38	1

Figure 3

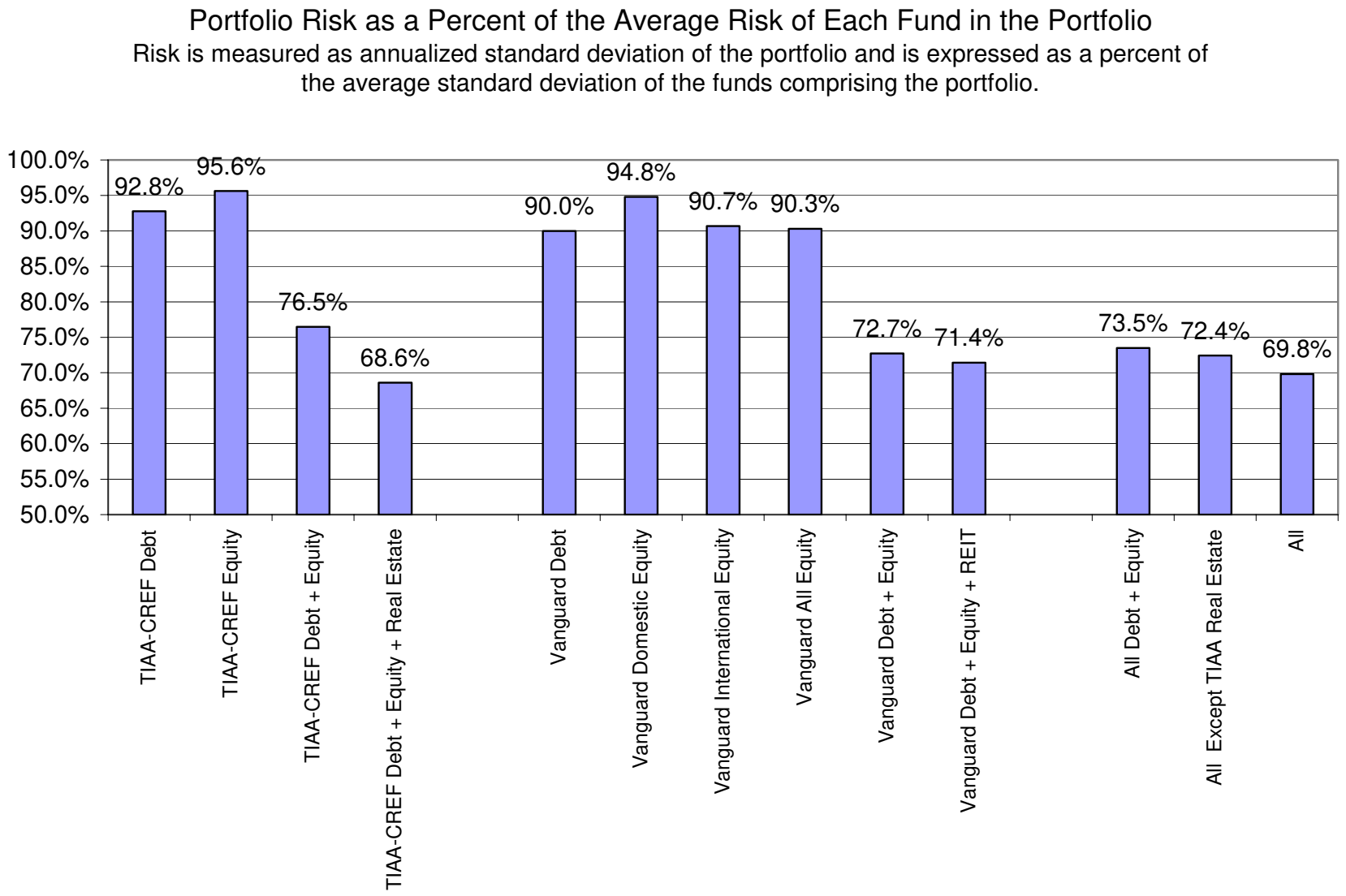
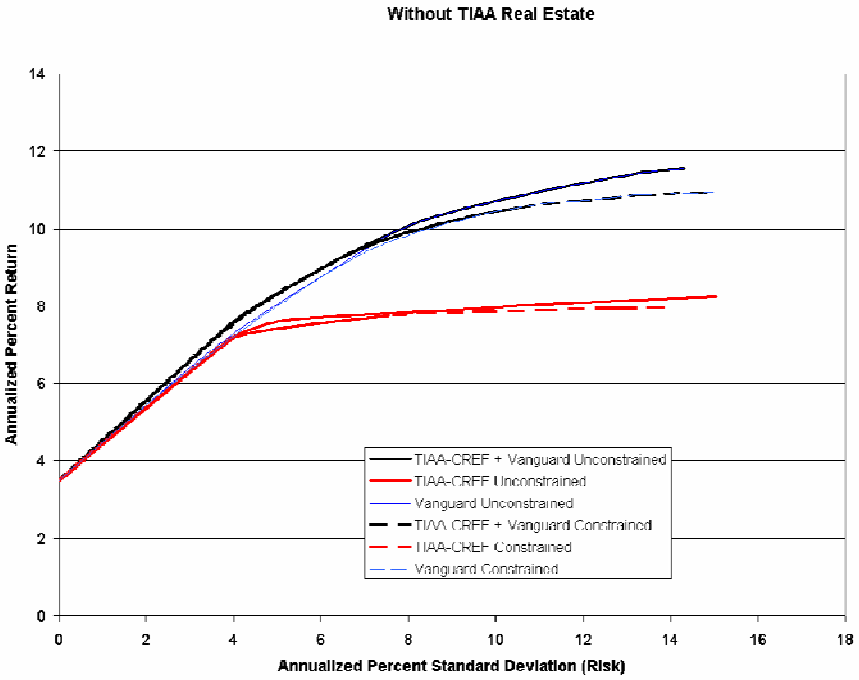

Portfolio Risk as a Percent of the Average Risk of Each Fund in the Portfolio
Risk is measured as annualized standard deviation of the portfolio and is expressed as a percent of the average standard deviation of the funds comprising the portfolio.
100.0%
95.0%
90.0%
85.0%
80.0%
75.0%
70.0%
65.0%
60.0%
55.0%
50.0%
92.8%
95.6%
76.5%
68.6%
90.0%
94.8%
90.7%
90.3%
72.7%
71.4%
73.5%
72.4%
69.8%
TIAA-CREF Debt
TIAA-CREF Equity
TIAA-CREF Debt + Equity
TIAA-CREF Debt + Equity + Real Estate
Vanguard Debt
Vanguard Domestic Equity
Vanguard International Equity
Vanguard All Equity
Vanguard Debt + Equity
Vanguard Debt + Equity + REIT
All Debt + Equity
All Except TIAA Real Estate
All

Figure 4

Efficient Frontiers

The figure shows maximized expected returns subject to risk, based on monthly returns from April 1, 1997 through March 31, 2005. Constrained results have maximum weights of 30 percent for TIAA-CREF + Vanguard and for Vanguard Only, and 42.9 percent for TIAA-CREF Only when TIAA Real Estate is excluded, and 37.5 percent when it is included.

Panel (a)



Panel (b)

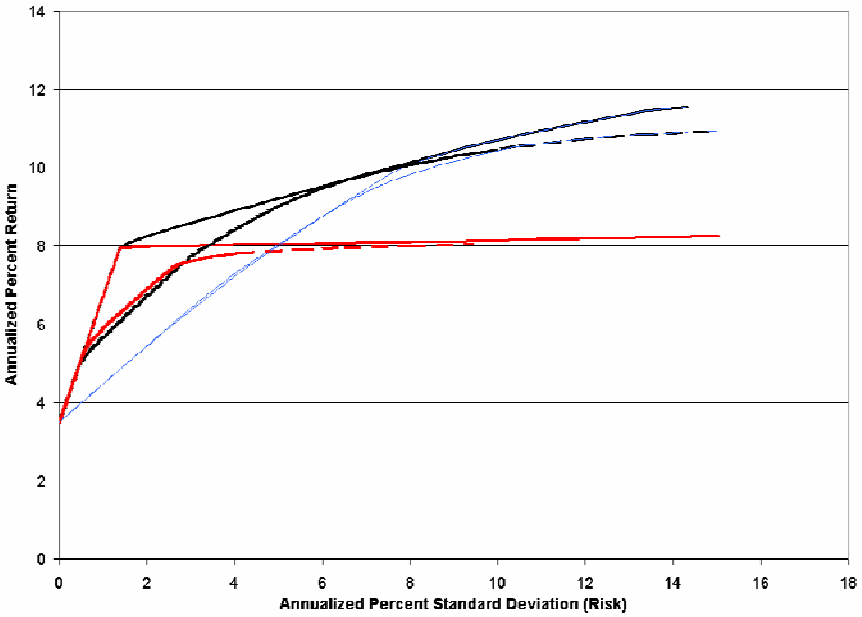


Figure 5

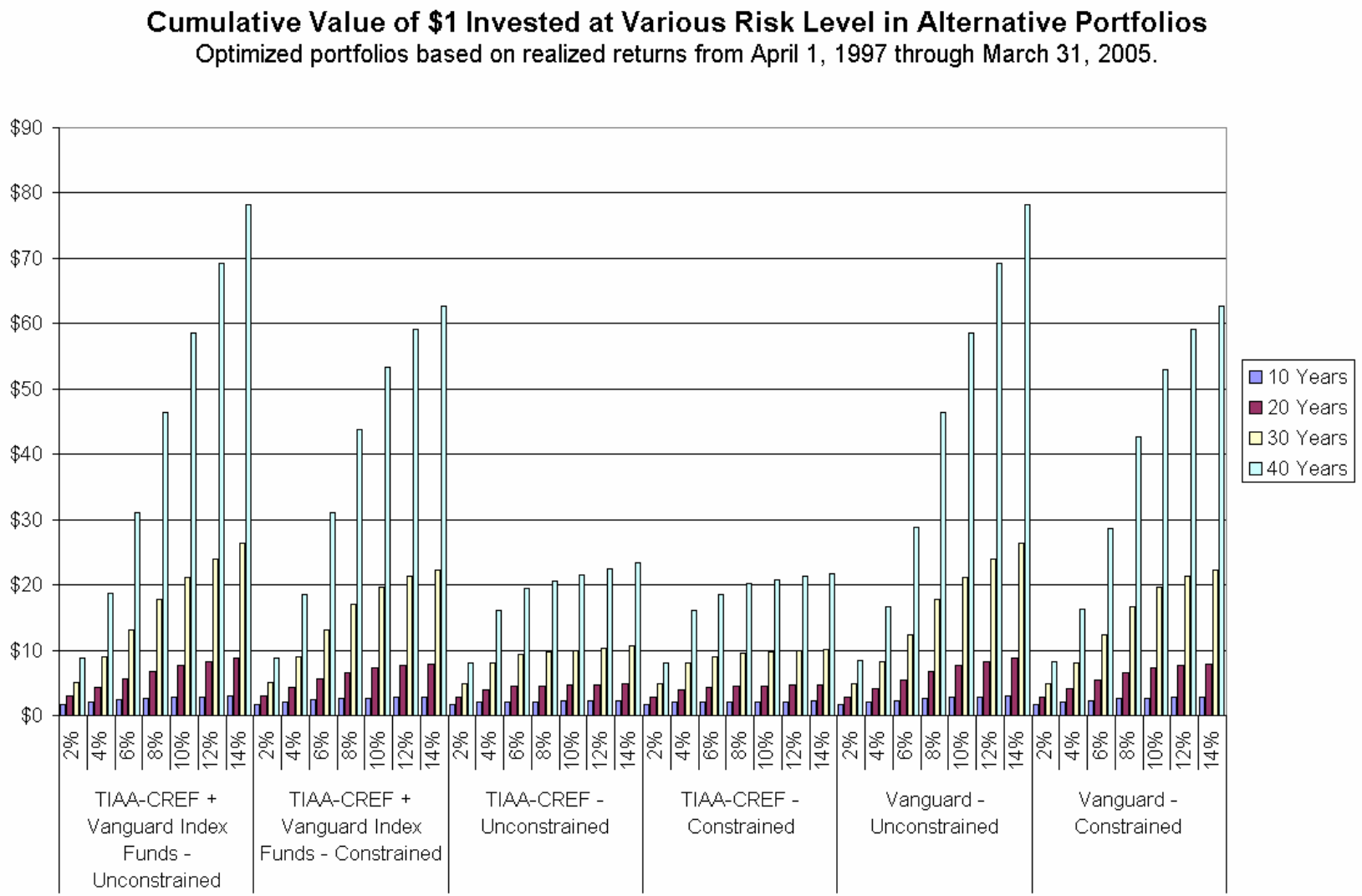

Cumulative Value of $1 Invested at Various Risk Level in Alternative Portfolios
Optimized portfolios based on realized returns from April 1, 1997 through March 31, 2005.
$90
$80
$70
$60
$50
$40
$30
$20
$10
$0
2%
4%
6%
8%
10%
12%
14%
TIAA-CREF + Vanguard Index Funds - Unconstrained
TIAA-CREF + Vanguard Index Funds - Constrained
TIAA-CREF - Unconstrained
TIAA-CREF - Constrained
Vanguard - Unconstrained
Vanguard - Constrained
10 Years
20 Years
30 Years
40 Years

Table 4

Portfolio Allocation by Broad Asset Class, Investment Options, and Risk Level

Optimized asset allocations based on realized monthly performance from April 1, 1997 through March 31, 2005. Allocations are grouped according to broad asset classes and are stratified by annualized standard deviation of returns. Comparison asset allocations and realized annual returns are shown for the combined set of investment instruments of TIAA-CREF + Vanguard, TIAA-CREF Only, and Vanguard Only. "Unconstrained" portfolio allocations are restricted to non-negative positions. "Constrained" portfolio allocations are restricted to non-negative positions and to a maximum allocation to any investment vehicle other than money of the greater of 30 percent or 3/n, where n = the number of available investment vehicles. Thus, for TIAA-CREF + Vanguard and Vanguard Only the constrained maximum equals 30 percent; for TIAA-CREF Only it equals 42.9 percent. Constraints are applied to individual investment vehicles. Thus, percentage allocations to broad asset classes can be higher

TIAA-CREF and Vanguard Indexes - Unconstrained

Risk	Return	Money	Debt	Equity	R.E.	Non-Money Allocation CREF	Vanguard
2.0%	5.6%	42%	49%	5%	4%	56%	44%
4.0%	7.6%	0%	81%	10%	9%	81%	19%
6.0%	9.0%	0%	67%	13%	20%	41%	59%
8.0%	10.1%	0%	52%	15%	33%	0%	100%
10.0%	10.7%	0%	31%	16%	53%	0%	100%
12.0%	11.2%	0%	12%	18%	69%	0%	100%
14.0%	11.5%	0%	0%	7%	93%	0%	100%

TIAA-CREF and Vanguard Indexes - Constrained

Risk	Return	Money	Debt	Equity	R.E.	Non-Money Allocation CREF	Vanguard
2.0%	5.6%	42%	49%	5%	4%	56%	44%
4.0%	7.6%	0%	80%	10%	10%	60%	40%
6.0%	9.0%	0%	67%	13%	20%	38%	62%
8.0%	9.9%	0%	48%	22%	30%	18%	82%
10.0%	10.4%	0%	34%	36%	30%	4%	96%
12.0%	10.7%	0%	21%	49%	30%	0%	100%
14.0%	10.9%	0%	8%	62%	30%	0%	100%

TIAA-CREF - Unconstrained

Risk	Return	Money	Debt	Equity	R.E.
2.0%	5.4%	48%	47%	5%	0%
4.0%	7.0%	0%	88%	12%	0%
6.0%	7.7%	0%	65%	35%	0%
8.0%	7.8%	0%	48%	52%	0%
10.0%	8.0%	0%	34%	66%	0%
12.0%	8.1%	0%	20%	80%	0%
14.0%	8.2%	0%	7%	93%	0%

TIAA-CREF - Constrained

Risk	Return	Money	Debt	Equity	R.E.
2.0%	5.4%	48%	47%	5%	0%
4.0%	7.2%	0%	86%	14%	0%
6.0%	7.6%	0%	54%	46%	0%
8.0%	7.8%	0%	43%	57%	0%
10.0%	7.9%	0%	33%	67%	0%
12.0%	7.9%	0%	19%	81%	0%
14.0%	8.0%	0%	1%	99%	0%

Vanguard - Unconstrained

Risk	Return	Money	Debt	Equity	R.E.
2.0%	5.4%	27%	63%	5%	5%
4.0%	7.3%	0%	79%	9%	12%
6.0%	8.8%	0%	66%	13%	21%
8.0%	10.1%	0%	52%	15%	33%
10.0%	10.7%	0%	31%	16%	53%
12.0%	11.2%	0%	12%	18%	69%
14.0%	11.5%	0%	0%	7%	93%

Vanguard - Constrained

Risk	Return	Money	Debt	Equity	R.E.
2.0%	5.4%	37%	53%	5%	5%
4.0%	7.2%	0%	78%	9%	13%
6.0%	8.8%	0%	66%	13%	21%
8.0%	9.8%	0%	47%	23%	30%
10.0%	10.4%	0%	32%	38%	30%
12.0%	10.7%	0%	21%	49%	30%
14.0%	10.9%	0%	8%	62%	30%

Table 5

Optimal Asset Allocation based on Tolerance for Value at Risk and Investment Horizon

The table shows optimal portfolio weights for broad asset classes, based on the sets of available investment vehicles for TIAA-CREEF separately and for TIAA-CREF and Vanguard Indexes, combined. Portfolios weights corresponding to various discrete risk levels up to 14 percent are estimated based on realized monthly returns from April 1, 1997 through March 31, 2005. Optimal portfolios given risk aversion are determined by investment horizon and tolerance for exposure to value at risk. The one-sigma weights correspond to VAR of 16 percent, the two-sigma weights correspond to VAR of 2.5 percent, and the three sigma weights correspond to VAR of 0.1 percent. Weights for Vanguard only are not shown, but are similar to those for the combined TIAA-CREF and Vanguard portfolios.

All Unconstrained	Horizon	1	2	3	4	5	6	7	8	9	10	11	12
	Risk	**4**	**10**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**
1 Sigma	Money												
	Debt	81%	31%										
	Equity	10%	16%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%
	R.E.	9%	53%	93%	93%	93%	93%	93%	93%	93%	93%	93%	93%
	Risk	**0**	**0**	**0**	**8**	**10**	**14**	**14**	**14**	**14**	**14**	**14**	**14**
2 Sigma	Money	100%	100%	100%									
	Debt				52%	31%							
	Equity				15%	16%	7%	7%	7%	7%	7%	7%	7%
	R.E.				33%	53%	93%	93%	93%	93%	93%	93%	93%
	Risk	**0**	**0**	**0**	**0**	**0**	**6**	**8**	**10**	**14**	**14**	**14**	**14**
3 Sigma	Money	100%	100%	100%	100%	100%							
	Debt						67%	52%	31%				
	Equity						13%	15%	16%	7%	7%	7%	7%
	R.E.						20%	33%	53%	93%	93%	93%	93%

All Constrained	Horizon	1	2	3	4	5	6	7	8	9	10	11	12
	Risk	**4**	**10**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**
1 Sigma	Money												
	Debt	80%	34%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%
	Equity	10%	36%	62%	62%	62%	62%	62%	62%	62%	62%	62%	62%
	R.E.	10%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
	Risk	**0**	**0**	**0**	**6**	**10**	**12**	**14**	**14**	**14**	**14**	**14**	**14**
2 Sigma	Money	100%	100%	100%									
	Debt				67%	34%	21%	8%	8%	8%	8%	8%	8%
	Equity				13%	36%	49%	62%	62%	62%	62%	62%	62%
	R.E.				20%	30%	30%	30%	30%	30%	30%	30%	30%
	Risk	**0**	**0**	**0**	**0**	**0**	**6**	**8**	**10**	**12**	**14**	**14**	**14**
3 Sigma	Money	100%	100%	100%	100%	100%							
	Debt						67%	48%	34%	21%	8%	8%	8%
	Equity						13%	22%	36%	49%	62%	62%	62%
	R.E.						20%	30%	30%	30%	30%	30%	30%

TIAA-CREF Unconstrained	Horizon	1	2	3	4	5	6	7	8	9	10	11	12
	Risk	**0**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**
1 Sigma	Money	100%											
	Debt		65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
	Equity		35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%
	R.E.												
	Risk	**0**	**0**	**0**	**4**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**
2 Sigma	Money	100%	100%	100%									
	Debt				88%	65%	65%	65%	65%	65%	65%	65%	65%
	Equity				12%	35%	35%	35%	35%	35%	35%	35%	35%
	R.E.												
	Risk	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**6**	**6**	**6**	**6**	**6**
3 Sigma	Money	100%	100%	100%	100%	100%	100%						
	Debt							65%	65%	65%	65%	65%	65%
	Equity							35%	35%	35%	35%	35%	35%
	R.E.												

TIAA-CREF Constrained	Horizon	1	2	3	4	5	6	7	8	9	10	11	12
	Risk	**0**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**
1 Sigma	Money	100%											
	Debt		54%	54%	54%	54%	54%	54%	54%	54%	54%	54%	54%
	Equity		46%	46%	46%	46%	46%	46%	46%	46%	46%	46%	46%
	R.E.												
	Risk	**0**	**0**	**0**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**
2 Sigma	Money	100%	100%	100%									
	Debt				54%	54%	54%	54%	54%	54%	54%	54%	54%
	Equity				46%	46%	46%	46%	46%	46%	46%	46%	46%
	R.E.												
	Risk	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**6**	**6**	**6**	**6**	**6**
3 Sigma	Money	100%	100%	100%	100%	100%	100%						
	Debt							54%	54%	54%	54%	54%	54%
	Equity							46%	46%	46%	46%	46%	46%
	R.E.												

Table 6

Expected Terminal Values of Annually Rebalanced Portfolios Optimized by Risk Tolerance

The table shows terminal values of investments of $1 per year in an annually optimized portfolio over the work-life of the employee. Values in the table are based on the assumption that the retiree plans to convert to a fixed payment life annuity at the date of retirement. Portfolios weights corresponding to various discrete risk levels up to 14 percent are estimated based on realized monthly returns from April 1, 1997 through March 31, 2005. Optimal portfolios given risk aversion are determined by investment horizon and tolerance of value at risk. The one-sigma weights correspond to VAR of 16 percent, the two-sigma weights correspond to VAR of 2.5 percent, and the three sigma weights correspond to VAR of 0.1 percent. The assumption of $1 per year is equivalent to the alternative assumption of one dollar invested the first year, with annual contributions increasing at the inflation rate, and with table values being stated in present dollar at the time of the initial investment.

Years of Investment	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**
Cumulative Value of $1 per year with VAR 1 Sigma								
TIAA-CREF + Vanguard Unconstrained	6.7	18.3	38.3	72.8	132.3	234.9	411.8	716.9
TIAA-CREF + Vanguard Constrained	6.7	17.8	36.6	68.0	120.7	209.1	357.4	606.1
TIAA-CREF Unconstrained	6.1	15.3	29.0	49.5	80.2	126.1	194.8	297.6
TIAA-CREF Constrained	6.1	15.5	29.5	50.9	83.1	131.9	205.8	317.6
Vanguard Unconstrained	6.5	17.6	36.9	70.0	127.2	225.9	396.1	689.6
Vanguard Constrained	6.4	17.2	35.2	65.4	116.1	201.2	343.9	583.2
Cumulative Value of $1 per year with VAR 2 Sigma								
TIAA-CREF + Vanguard Unconstrained	5.8	15.3	31.6	59.8	108.5	192.3	337.0	586.5
TIAA-CREF + Vanguard Constrained	5.8	14.9	30.2	55.9	99.1	171.4	292.7	496.3
TIAA-CREF Unconstrained	5.7	13.9	26.3	44.8	72.5	113.9	175.8	268.5
TIAA-CREF Constrained	5.7	14.2	27.0	46.3	75.6	119.9	186.9	288.4
Vanguard Unconstrained	5.8	15.3	31.6	59.8	108.5	192.3	337.0	586.5
Vanguard Constrained	5.8	14.9	30.3	56.1	99.3	171.9	293.6	497.7
Cumulative Value of $1 per year with VAR 3 Sigma								
TIAA-CREF + Vanguard Unconstrained	5.5	13.6	27.3	51.1	92.0	162.6	284.4	494.4
TIAA-CREF + Vanguard Constrained	5.5	13.5	26.8	49.1	86.5	149.3	254.5	431.1
TIAA-CREF Unconstrained	5.5	12.8	23.7	40.0	64.3	100.8	155.3	236.9
TIAA-CREF Constrained	5.5	12.9	23.9	40.6	65.9	104.3	162.2	250.0
Vanguard Unconstrained	5.5	13.2	26.2	48.8	87.7	154.7	270.4	469.8
Vanguard Constrained	5.5	13.1	25.7	46.9	82.4	142.0	241.9	409.4

Table 7

Comparison of Portfolio Opportunites with Naïve (1/n) Investing

Annualized expected returns and standard deviations based on equal investments in all available investment funds, and lower confidence limits based on risk aversion defined by one, two, and three standard deviations below the expected return. Results are based on monthly realized returns from April 1, 1997 through March 31, 2005.

Annualized Expected Return and Risk

		Without TIAA Real Estate			With TIAA Real Estate		
		TIAA-CREF + Vanguard	TIAA-CREF Only	Vanguard Only	TIAA-CREF + Vanguard	TIAA-CREF Only	Vanguard Only
Standard Deviation		**10.99%**	**9.89%**	**10.99%**	**10.56%**	**8.82%**	**10.99%**
Expected Return		**7.37%**	**6.49%**	**7.58%**	**7.43%**	**6.75%**	**7.58%**
	Year						
Cumulative Expected Values							
	10	2.04	1.88	2.08	2.05	1.92	2.08
	20	4.15	3.52	4.31	4.20	3.69	4.31
	30	8.44	6.60	8.95	8.60	7.10	8.95
	40	17.19	12.39	18.59	17.61	13.65	18.59
Lower Confidence Limits of Cumulative Returns							
1 Sigma	1	0.964	**0.966**	0.966	0.969	**0.979**	0.966
	2	0.997	0.994	1.002	1.005	**1.015**	1.002
	3	1.047	1.037	1.055	1.057	**1.064**	1.055
	4	1.109	1.088	1.120	1.121	**1.122**	1.120
	5	1.181	1.149	1.195	1.195	1.189	1.195
	6	1.263	1.216	1.281	1.279	1.264	1.281
	7	1.354	1.292	1.377	1.372	1.347	1.377
	8	1.455	1.375	1.483	1.476	1.437	1.483
	9	1.567	1.465	1.600	1.590	1.536	1.600
	10	1.689	1.563	1.729	1.714	1.643	1.729
	15	2.480	2.187	2.566	2.523	2.323	2.566
2 Sigma	1	0.854	**0.867**	0.856	0.863	**0.891**	0.856
	2	0.842	**0.854**	0.846	0.855	**0.890**	0.846
	3	0.857	**0.865**	0.864	0.874	**0.911**	0.864
	4	0.889	0.891	0.900	0.910	**0.946**	0.900
	5	0.936	0.928	0.949	0.959	**0.992**	0.949
	6	0.994	0.974	1.012	1.020	**1.048**	1.012
	7	1.064	1.030	1.086	1.093	**1.113**	1.086
	8	1.145	1.095	1.172	1.177	**1.188**	1.172
	9	1.237	1.169	1.271	1.273	1.271	1.271
	10	1.341	1.251	1.381	1.380	1.364	1.381
	15	2.054	1.804	2.141	2.114	1.982	2.141
3 Sigma	1	0.744	**0.768**	0.746	0.757	**0.803**	0.746
	2	0.687	**0.715**	0.691	0.706	**0.765**	0.691
	3	0.667	**0.694**	0.674	0.691	**0.758**	0.674
	4	0.670	**0.693**	0.680	0.698	**0.769**	0.680
	5	0.690	**0.707**	0.704	0.723	**0.795**	0.704
	6	0.725	0.732	0.743	0.761	**0.832**	0.743
	7	0.773	0.769	0.795	0.814	**0.880**	0.795
	8	0.834	0.815	0.862	0.878	**0.938**	0.862
	9	0.908	0.872	0.941	0.956	**1.007**	0.941
	10	0.994	0.938	1.034	1.046	**1.085**	1.034
	15	1.629	1.421	1.715	1.705	1.640	1.715