

Analysis of Investments State of Connecticut ARP and 403(b) Plan

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Introduction

In the summer 2007 issue of *Financial Management*, John Angus, William Brown, Janet Kiholm Smith, and Richard Smith published a comparison study of the historical performance of TIAA-CREF retirement annuities relative to a somewhat broader menu of investment options that included standard index mutual funds.¹ The study is titled, "What's in Your 403(b)? Academic Retirement Plans and the Costs of Underdiversification." Because of its relatively long history with index funds, the authors based their analysis on a selection of funds offered by Vanguard, but indicated that index funds offered by other managers would be expected to perform similarly. In the abstract of their study, the authors summarize their findings as follows:

Sponsors of defined contribution retirement plans typically limit the investment choices of plan participants to a small number of investment managers and a limited number of investment vehicles. Such restrictions may limit excessive risk-taking by participants but also may preclude opportunities for efficient diversification. Many college and university 403(b) plans have restricted investment choices to the retirement annuities offered by TIAA-CREF, the current manager of over half of all 403(b) contributions. Using 10 years of historical data, we study the efficiency of this TIAA-CREF opportunity set relative to a larger set that includes several standard index funds. Extrapolations must be interpreted with caution. Assuming optimal rebalancing, depending on loss aversion and diversification constraints, the historical sample of returns implies that over a 20-year remaining work life, an employee with an expanded menu that includes standard index funds could gain over 40% in terminal wealth compared to one who is restricted to TIAA-CREF retirement annuities. Even when a naïve diversification strategy of equally weighting (1/n) all available funds is used, the expanded menu outperforms the restricted portfolio by more than 25% over 20 years. These differences generally are significant at conventional levels based on parametric and nonparametric testing and do not appear to result from idiosyncratic market performance during the sample period.

In 2005, the State of Connecticut made substantial changes to the investment menu of its defined contribution plans, including the Alternate Retirement Plan ("ARP") offered to employees of colleges and universities and the 403(b) plan offered to employees of

¹ "What's in Your 403(b)? Academic Retirement Plans and the Costs of Underdiversification," John Angus, William O. Brown, Janet Kiholm Smith, Richard Smith, *Financial Management* • Summer 2007 • pages 1 – 38.

educational institutions and hospitals. The investment options offered in the ARP been exclusively limited to TIAA-CREF retirement annuity investments since 1976. In the 403(b) plan, a substantial number of participants were invested exclusively in TIAA-CREF retirement annuities, even though other vendors' products were also offered.

According to Thomas C. Woodruff, Ph.D., Director of the Retirement and Benefit Services Division of the Office of the Comptroller, the State replaced the TIAA-CREF retirement annuity investments in order to streamline administration and provide participants with better opportunities to construct diversified portfolios. The new investment line-up includes TIAA-CREF mutual funds (institutional share classes), Vanguard index funds, Vanguard lifestyle/target date funds, and "best-in-class" actively managed funds.

On behalf of the Retirement and Benefit Services Division, Dr. Woodruff asked the authors to replicate their analysis using the new investment options available to participants in the State of Connecticut ARP and 403(b) plan. The requested analysis was undertaken by two of the authors of the original study, John Angus and Richard Smith. Professor Angus is Dean of the School of Mathematical Sciences at Claremont Graduate University. Professor Smith is Professor of Financial Management (on leave) in the Peter F. Drucker Graduate School of Management at Claremont Graduate University and is the Ralph W. Leatherby Chair of Entrepreneurship and Private Equity at Chapman University.

This report summarizes the analysis performed by Professors Angus and Smith on behalf of the State of Connecticut.

Overview

We use historical fund returns data for the 10-year period ending March 2007 to compare the achievable performance of the investment options now available to participants in the State ARP and 403(b) plan to the achievable returns yielded by investing only in the menu of TIAA-CREF retirement annuities formerly available to plan participants. We also compare the performance of the ARP/403(b) plan investment vehicles to the expanded menu of investment options included in the *Financial Management* study. The expanded set used in that study was intended to represent the returns achievable from a well-diversified set of index-fund investment options that includes, among others, international funds, small-cap funds, and value funds. As in the *Financial Management* study, we exclude from our analysis investment options that are not consistently marked to market and that do not provide immediate liquidity.

Summary of Findings

Over a 20-year investment horizon of annual investments, and optimally rebalancing to take account of changes in employee preferences as retirement age approaches, we find that for a highly risk tolerant individual, over the 10-year period ending March 2007, an initial \$1 investment, with subsequent investments increasing at the inflation rate plus one percent would grow to a terminal value that is more than three times as large with the current ARP menu of investment choices as with TIAA-CREF only, and is more about twice as high as the ending value from a menu that is limited to TIAA-CREF Retirement Annuities and Vanguard index funds. In part these differences may be due to the method used by the State to select the actively managed funds included in the menu. However, even a naive strategy of investing equally in all investment options yields performance for the ARP/403(b) plan menu that is roughly twice as high as with TIAA-CREF only over a 15-year period. We also find that the State's model portfolios have historical performance that is substantially better

than the TIAA-CREF model portfolio performance when comparisons are based on the qualitatively described risk tolerances reflected in the model portfolios. For example a \$1 investment for 15 years in the ARP/403(b) plan Aggressive model portfolio would reach a value that is approximately 50% higher than a \$1 investment in the TIAA-CREF Aggressive model portfolio.²

State of Connecticut Investment Options

Table 1 shows the complete menu of investment options currently available to ARP/403(b) plan participants. The investment menu includes several life-cycle or life-style asset allocation funds, which are a substitute means of investing retirement savings, in lieu of investing in a portfolio of specific style funds. It is not appropriate to include the asset allocation funds in our analysis. The menu of options also includes two equity social choice funds. As these funds have restricted investment choices and are designed to trade off financial and social returns, they, too, are excluded from the analysis of financial performance. Finally, ARP/403(b) plan participants also have a stable value fund option that seeks to provide returns that are similar to but higher than money market fund returns. The stable value fund is analogous to an insurance product that seeks to provide a guaranteed minimum return and the potential for a higher return. The stable value fund is analogous to a money market fund. Because of its limited history and the absence of specific monthly return information, we do not include the stable value fund in the analysis. Instead, we assume that ARP participants, if they desire a stable value asset, would invest in a standard money market fund.

The historical performance analysis covers a 10-year period ending March 2007. As some of the investment vehicles in the ARP/403(b) plan menu do not have a full 10-year history, we use actual fund returns to the extent available. For any period between April 1997 and the fund's inception date we use the returns of a surrogate index to represent the performance of the investment vehicle during that time. Thus, for example, institutional shares in the Vanguard Inflation Protected Securities Fund were not offered until January 2003. In lieu of performance data for the period between April 1997 and December 2002, we use the Lehman Brothers U.S. Global TIPS Index. Table 1 shows the inception date of each ARP/403(b) plan instrument and any surrogate index used in lieu of instrument returns for those with less than 10 years of historical data as of March 2007. The specific surrogates were selected by the advisor to the ARP/403(b) plan. All expense-adjusted historical return information for the investment vehicles and the surrogates was also provided by the State's advisor. We reviewed the returns information for completeness and obvious errors but, beyond that, we relied on the accuracy of information supplied on behalf of the State of Connecticut by the plan's advisor. We also reviewed the advisor's selection of surrogate indexes and believe that the indexes appropriately represent the asset classes of the funds with which they are associated.

Comparison Investment Vehicles

Table 2 lists the investment vehicles used to compare performance of investments in the ARP/403(b) plan menu to the menu of TIAA-CREF Retirement Annuities and the expanded menu (based on the *Financial Management* study) that includes a set of Vanguard index funds the authors of that study considered adequate to offer plan participants the ability to

² The comparisons in this paragraph are based on realized historical risk and return results and may not be representative of future performance.

construct a well-diversified portfolio. Table 2 provides information on each fund's inception date, investment style, sector focus, and investment objective.

The TIAA-CREF list includes all TIAA-CREF Retirement Annuities except the TIAA Traditional Annuity and the TIAA Real Estate Fund. The TIAA Traditional Annuity is essentially an insurance product rather than a mutual fund. Assets in this account are illiquid and can only be transferred over a 10-year period. We do not include the TIAA Traditional Annuity in the study (nor did we in the *Financial Management* study) because of the lack of liquidity, the absence of consistent marking to market and the lack of a consistent return series. The TIAA Real Estate fund does not satisfy the necessary conditions for inclusion in the study. It is an insurance product whose assets consist primarily of direct real estate investments that are not regularly marked to market. While historical returns are available, they are mismeasured because underlying assets are normally only appraised annually, which results in understated and incorrectly timed information on actual volatility of returns. In recognition of this, and for other reasons, TIAA-CREF restricts the liquidity of investments in the TIAA Real Estate Annuity. Were we to include this vehicle in the study, our statistical analysis would understate the volatility and overweight the instrument in an optimized portfolio.

The Vanguard list in Table 2 includes all Vanguard index funds established prior to April 1997 with the exception of those designed for tax avoidance or those involving custom blends. The Vanguard list covers such important sectors as international equities, small-cap equities, and value stocks, which are not covered by the listed TIAA-CREF annuity investments.

The ARP/403(b) list in Table 2 includes all of the investment options analyzed and indicates the surrogate index used to provide return data for any investment option that had less than a 10-year history. For the reasons noted above, we excluded the ARP's/403(b) plan's stable value fund, lifestyle funds and social choice funds from this study.

Throughout the study, we compare the current ARP/403(b) plan menu to the menu of TIAA-CREF Retirement Annuities and to the broader menu that includes TIAA-CREF and the Vanguard index funds ("TIAA-CREF + Vanguard"). Comparisons to TIAA-CREF Retirement Annuities provide an indication of the improvement in performance that is achievable due to the State of Connecticut's change to its new menu of investment options. Comparisons to the broader menu, TIAA-CREF + Vanguard measure the performance of the State's new menu relative to a well-diversified benchmark that includes TIAA-CREF plus key index funds. Thus, the main difference between the ARP/403(b) plan menu and the TIAA-CREF + Vanguard menu is that the ARP/403(b) plan menu includes actively managed funds in addition to index funds.

There are two caveats with regard to performance comparisons involving the ARP menu. First, as previously mentioned, some of the ARP/403(b) plan funds do not have complete return histories and when they do not, surrogate index returns have been substituted. Second, the actively managed funds in the ARP/403(b) plan menu are described as having been selected as "best-in-class" for their respective classes. Because this selection occurred in 2005 some of the historical performance of the funds would have been known to those making the selections. If the selection was based partly on the realized performance of the fund relative to its class, or if the selection of classes to include in the menu was influenced by realized performance of the class, expected achievable difference in performance could

be overstated.³ As the TIAA-CREF + Vanguard menu is constructed on the basis of structural rules (all TIAA-CREF Retirement Annuities that are liquid and marked to market daily plus all Vanguard Index funds with at least 10 years of data) it is not affected by possible selection bias. Thus, it can be viewed as providing a lower bound, very conservative estimate of the performance improvement that results just from providing more complete opportunities to diversify investments. Conversely, because the ARP/403(b) plan menu may incorporate some positive selection bias with regard to the actively managed funds, the difference in performance between the ARP/403(b) plan menu and TIAA-CREF + Vanguard can be considered an upper bound estimate of the expected added performance from the inclusion of actively managed funds.

Performance of Individual Investment Vehicles

Figure 1 shows the 10-year historical risk and return profiles of the individual investment vehicles involved in the analysis. One noteworthy indication of the figure is that the TIAA-CREF investment vehicles tend to have low historical returns relative to either the Vanguard index funds or the ARP/403(b) investment choices. TIAA-CREF has no vehicles returning as much as 10% per year on average.⁴ In contrast, several of the Vanguard funds have historical returns in the 10% to 15% range, and two of the ARP/403(b) plan funds have historical returns in excess of 15%. In general, the risk levels of the TIAA-CREF menu (measured as annualized standard deviation of monthly returns) are lower than for the other two. However, in the *Financial Management* study, we find that the difference in risk between TIAA-CREF and Vanguard are not statistically significant at conventional levels. That is, the differences in observed risk over the 10-year sample period are too small to support an inference that TIAA-CREF risk levels can be expected to be lower over other time periods. Moreover, this comparison of mean returns and standard deviation does not take account of potential diversification. Risk levels of the ARP/403(b) plan menu are similar to those of the Vanguard menu. Thus, the higher returns of the ARP/403(b) plan menu are not associated with taking on greater risk at the individual fund level.

Historical Cumulative Returns of Individual Investments

Figure 2 shows the cumulative value of a hypothetical investment of \$1 in the different investment vehicles included in the ARP/403(b) plan menu plus the CREF Money Fund, which is used as a proxy for the plan's stable value investment. The cumulative returns, in addition to showing cumulative relative performance sometimes provide different results than comparisons of mean returns, as in Figure 1. This is because the cumulative value depends on the specific sequencing of returns over time, whereas the comparisons in Figure 1 do not.⁵ In Figure 2, the two top performing funds are the Fidelity VIP Mid Cap Fund and

³ The State selected index funds in every asset class considered necessary to construct a diversified portfolio. Per comments of Dr. Woodruff there was no bias in the selection of asset classes

⁴ The TIAA-CREF menu in this figure includes the TIAA Real Estate fund. In the figure, the drastically understated risk of this instrument is readily apparent, especially when compared to the risk levels of the Vanguard REIT fund, which are marked to market on a consistent basis. Differences in reported returns of the Vanguard REIT fund and the Vanguard REIT fund as held by the State of Connecticut appear to reflect differences in investor shares versus institutional shares and expense charges to the funds.

⁵ To illustrate, if a one-dollar investment is equally likely to increase in value or decrease in value by 50% each period, a two-period investment can end up being worth \$2.25 (1.5 x 1.5), \$0.75 (1.5 x 0.5 or 0.5 x 1.5), or \$0.25 (0.5 x 0.5). The average value after two period (comparable to

the J.P. Morgan Mid Cap Value Fund. It is apparent that these funds were not as negatively affected as the others by the tech-stock decline that began in 2000. This could be due to the general nature of mid-cap equities, particularly if mid-caps tend to systematically underweight tech stocks, but probably is due at least in part to intentional underweighting of the high-tech sector by the managers of these actively managed funds. The TIAA-CREF Mid-Cap Blend Index Fund shows a more typical decline pattern beginning in 2000. As can be seen in the figure, the equity funds outperformed all of the debt funds during the 10-year period. The overall pattern of cumulative results is consistent with the average returns shown in Figure 1.

In addition to its menu of individual investment choices, the State of Connecticut, through its advisors, also suggests several “model portfolios” using funds in the ARP/403(b) plan investment menu, designed for investors with different risk tolerances. In **Figure 3**, we plot the cumulative performance of each of the model portfolios based on its current weights across investment options. While some of the actively managed assets selected for inclusion in the menu may reflect a hindsight bias, this does not appear to be the case for the model portfolios. Although the mid-cap stocks were top performers during the historical sample period, the model portfolios do not allocate resources to the mid-cap vehicles. Thus, even if the individual vehicles included in the menu might reflect a hindsight bias, the model portfolios appear not to do so. Accordingly, they provide a good basis for making performance comparisons of risk and return.⁶

TIAA-CREF also provides suggested model portfolios based on their retirement annuity products. In Figure 3, we compare the cumulative performance of ARP/403(b) plan and TIAA-CREF model portfolios, adjusted to be based only on fully liquid, continuously marked-to-market instruments. In lieu of the Connecticut Stable Value fund and the TIAA Traditional Annuity, we substitute the returns on the TIAA-CREF Money Market Fund. Also, because the TIAA Real Estate fund is not consistently marked to market, we use the returns of the Vanguard REIT Index when real estate is specified in one of TIAA-CREF’s model portfolios. These are similar to the adjustments made in the *Financial Management* study to enable us to make a valid comparison of performance. In Figure 3, ARP model portfolio performance is shown in bold lines that are shaded red and TIAA-CREF model portfolio performance is shown in fine lines that are shaded blue. The Connecticut model portfolios outperform the TIAA-CREF models based on qualitative descriptions of risk tolerance. Moreover, the Connecticut models conform to expectations in that the riskier models outperform the lower risk models.

Figure 3 also shows the cumulative performance for three naïve strategies: an equal-weighted strategy of investing in all Connecticut instruments and an equal-weighted strategy of investing in all TIAA-CREF + Vanguard instruments, and an equal-weighted strategy of investing in all TIAA-CREF Annuities. In this comparison we use the TIAA-CREF Money Market in both as a generic money market fund. Results are shown in the figure. The naïve strategy for the Connecticut ARP/403(b) plan investment menu has higher cumulative performance. The ending value of an initial \$1 investment using the Connecticut

what is shown in Figure 1) is \$1, but the realized value depends on which of the four possible sequences actually occurs.

⁶ For details on the allocations in the model portfolios see the State of Connecticut’s “Portfolio Allocation Worksheet,” C06-0214-006R (2/06)

ARP/403(b) plan menu is \$2.85 compared to \$2.24 for TIAA-CREF + Vanguard and \$1.96 for TIAA-CREF.

Portfolio Diversification

The risk and return properties of individual instruments in the menu of choices are partly mitigated by diversification. Individual instruments that have high risk may not contribute much to overall portfolio risk if the risks are not highly correlated with other instruments. As a first step to examining the potential diversification benefits of the different menus, we compute and report the historical correlation coefficients of returns for the different instruments. Results of this analysis are shown in Table 3. For TIAA-CREF, the correlations tend to be high (4 of 21 coefficients (19%) are 0.95 or higher). Among the Vanguard index funds, 8 of 120 coefficients (6.7%) are 0.95 or higher. For Connecticut ARP/403(b) plan instruments, only 4 of 136 coefficients (2.9%) are 0.95 or higher. Thus, at this basic level, the Connecticut ARP/403(b) plan options offer greater potential for diversification. It appears, based on these bivariate relationships, that participants using TIAA-CREF only are exposed to a degree of risk that they cannot effectively mitigate through diversification among available options.

Aggregating to a higher level, but still using arbitrary equal weighting over investment vehicles, provides an indication of the diversification benefits of different asset classes compared to a portfolio where all of the risks were perfectly correlated. The lower the average correlation, the greater the diversification resulting from a naïve strategy of investing in a portfolio that is equally weighted over all of the investment options. For debt, domestic equity, all equity, and all debt plus equity and all funds, the menu of choices available to Connecticut ARP/403(b) plan participants offers diversification potential that is similar to that of TIAA-CREF + Vanguard. Both of these menus offer greater potential diversification than can be achieved using only the TIAA-CREF Retirement Annuities.

Optimized Portfolios

In **Figure 5**, we use the historical returns in an optimization model to determine optimal weights of investment vehicles at different levels of risk. The figure shows achievable risk-and-return combinations for the Connecticut ARP/403(b) plan menu, the TIAA-CREF menu, and the TIAA-CREF + Vanguard menu. We consider two separate optimization scenarios, one with unconstrained weight in any instrument and one where the maximum weight in an instrument other than money market is constrained not to exceed 1/3. In general, the constraints reduce performance somewhat, particularly at the high end of achievable performance. However, the constraints help to mitigate idiosyncratic performance in the historical sample. As shown in the figure, the Connecticut ARP/403(b) plan menu offers substantially higher achievable performance than either of the other two. The difference in optimized performance relative to TIAA-CREF + Vanguard is due to inclusion of actively managed funds in the Connecticut ARP/403(b) plan menu and places significant weight on the mid-cap equities that demonstrated superior performance during the sample period. Thus, to a degree, the difference may be due to selection bias. As noted earlier, the performance of TIAA-CREF + Vanguard can be viewed as a conservative lower bound on expected ex ante performance of the Connecticut ARP/403(b) plan menu. However, the difference between TIAA-CREF + Vanguard and TIAA-CREF only is free of any possible selection bias.

Risk and Return of Model and Naïve Portfolios

In **Figure 6**, in addition to the efficient frontiers from the optimization, we plot the risk and return profiles of the model portfolios and the naïve strategies. The Connecticut ARP/403(b) plan model portfolios consistently provide higher risk-adjusted returns than do the TIAA-CREF model portfolios. Also, the naïve strategy of equally weighting the ARP/403(b) plan menu of investment choices offers substantially higher return and somewhat higher risk than does equal-weighting the TIAA-CREF menu. Recall that these model portfolios substitute money market fund returns for Stable Value or Traditional Annuity and a REIT fund index for the TIAA Real Estate annuity. These substitutions are necessary for reasons discussed above and are not expected to materially affect the relative performance comparisons.

Cumulative Returns of Optimized Portfolios

In **Figure 7**, we use the historical average monthly returns optimized to various risk levels to estimate cumulative values of a \$1 investment over various holding periods from 5 to 20 years. As the figure shows, the cumulative returns over moderate to long holding periods are much higher for the Connecticut ARP/403(b) plan menu than for the TIAA-CREF menu or the TIAA-CREF + Vanguard menu. To a substantial extent, the difference between the Connecticut ARP/403(b) plan return and the TIAA-CREF + Vanguard return is attributable to high weights placed on Connecticut ARP/403(b) plan mid-cap options. However, the difference between TIAA-CREF + Vanguard and TIAA-CREF only can be regarded as a conservative estimate of the value expected to be added by the new Connecticut ARP/403(b) plan menu.

Structures of Optimized Portfolios

Table 4 presents descriptive information on the compositions of optimized portfolios at various risk levels. These percentages are based on optimizations that exclude the TIAA Real Estate Annuity. Nonetheless, in the TIAA-CREF + Vanguard portfolio the allocations to the Vanguard REIT fund are very high. In contrast, for the Connecticut ARP/403(b) plan menu, allocations to real estate are lower and more of the portfolio is allocated to equities (including mid-cap). For all groups, allocations to debt decline rapidly as the target risk level increases. International equities receive a relatively large allocation in the TIAA-CREF + Vanguard menu compared to the Connecticut ARP/403(b) plan menu. The TIAA-CREF only menu has no vehicle with a substantial international allocation. Even the Global Equities fund is predominantly domestic.

Optimal Allocations by Tolerance for Value-at-Risk

Table 5 examines the interdependence between the optimal portfolio weighting, the expected holding period of the investment (until retirement), and the investor's tolerance for risk of loss. In this analysis we limit the comparison to the Connecticut ARP/403(b) plan menu and the TIAA-CREF menu, and the TIAA-CREF + Vanguard menu. In all cases, but particularly for the Connecticut ARP/403(b) plan menu, the dynamic optimization indicates that investors would want to concentrate on equity and real estate until the last few years before retirement and then would shift fairly quickly to money market only.

Cumulative Value of Annual Retirement Investments over a Work-life

In **Table 6** we use the annually optimized returns given investor-specific risk tolerance to determine the cumulative value of a growing annuity of retirement investments. The individual's real wages are assumed to grow at 1% per year and the real risk-free rate is assumed to be 1% per year. These assumptions are consistent with aggregate macroeconomic data for the US. The table compares the Connecticut ARP/403(b) plan menu to the TIAA-CREF and TIAA-CREF + Vanguard menus.⁷ For a highly risk tolerant individual, with a 20 year work-life and constraining allocations not to exceed 1/3 of total assets, invested in the year, the cumulative value of investments beginning at \$1 per year is \$134.57 in the Connecticut ARP/403(b) plan menu, compared to \$ 38.50 for TIAA-CREF only and \$66.13 in the TIAA-CREF + Vanguard menu. Results for other risk tolerance levels are similar but the differences are not as great in dollar terms due to the more conservative strategies. To illustrate, a very highly risk averse investor might elect to invest only in the money market fund, regardless of the other assets in the menu, in which case there would be no difference in performance across the different menus.⁸ The differences are lower for investors with shorter horizons.

In part the difference between the cumulative performance of the Connecticut ARP/403(b) plan menu may be due to selection bias associated with ex post observability. However, again the TIAA-CREF + Vanguard provides a conservative lower bound estimate of the advantage of the Connecticut ARP/403(b) plan menu relative to TIAA-CREF only.

Performance of Model and Naïve Portfolios

In some respects, the most reliable comparisons of the Connecticut ARP/403(b) plan and TIAA-CREF menus are those based on model portfolios and naïve strategies. In particular, these approaches place little (if any) weight on the realized performance of specific investment vehicles during the sample period. Thus, they are less prone to reflect selection biases than are the optimized portfolio results. Further, these approaches present more realistic indications of what is achievable than do the optimized results, which are *ex post*.

The cumulative values in **Table 7** show returns at the lower bound of the investor's risk tolerance level. Thus, for example, comparing the naïve strategies of an investor with a one-sigma tolerance for risk (relatively risk tolerant) and a 15-year investment horizon, the lower bound value of the Connecticut ARP/403(b) plan menu is 4.806, as opposed to 2.563 for TIAA-CREF only and 3.227 for TIAA-CREF + Vanguard. To the extent that the Connecticut ARP/403(b) plan menu has any selection bias, its effect is reduced because the naïve rule equally weights all investment options. Possibly even stronger, comparisons of the model portfolios show that much higher returns are available to Connecticut ARP/403(b) plan members under the current investment menu as compared to the TIAA-CREF menu that was in place prior to 2005. For the aggressive portfolio and a risk tolerant investor with a 15-year horizon, the Connecticut ARP/403(b) plan menu has a lower bound value of 6.036 compared to 3.822 for TIAA-CREF. Comparisons for other model portfolios are similar.

⁷ Again, similar information for TIAA-CREF only is presented in the *Financial Management* study.

⁸ If the Stable Value fund offers returns in excess of money market returns, then the ARP menu would be superior even for this group. However, as discussed above, we are unable to examine this comparison.

Table 1

State of Connecticut - Alternate Retirement Plan - Investment Options

Asset allocation funds and equity social choice funds are excluded from the analysis, as is the State's stable value fund (which is an insurance-type product that does not provide immediate liquidity). For investment options with less than 10 years of returns data ending with March 2007, a designated surrogate index is used to complete the series for 10 years of monthly returns.

Fun Name	Fund Focus	Class Designation	Included	Initiated	Surrogate (after 4/1/1997)
Vanguard Target Retirement 2015 Fund	Asset Allocation	Investor Shares			
Vanguard Target Retirement 2025 Fund	Asset Allocation	Investor Shares			
Vanguard Target Retirement 2035 Fund	Asset Allocation	Investor Shares			
Vanguard Target Retirement 2045 Fund	Asset Allocation	Investor Shares			
Vanguard Target Retirement Income Fund	Asset Allocation	Investor Shares			
Vanguard Inflation-Protected Secur. Fund	Bonds	Institutional Shares	x	12/12/2003	LB US Global TIPS Index
Vanguard Total Bond Market Index Fund	Bonds	Institutional Shares	x	9/18/1995	
TIAA-CREF Equity Index Fund	Large Cap Value	Institutional Class	x	7/1/1999	Russell 3000 Index
Vanguard Index Fund	Large Cap Value	Institutional Shares	x	7/31/1990	
Vanguard FTSE Social Index Fund	Large Cap Growth	Institutional Shares			
TIAA-CREF Mid-Cap Blend Index Fund	Small/Mid/Specialty	Institutional Class	x	10/1/2002	Russell Mid-Cap Index
TIAA-CREF Small-Cap Blend Index Fund	Small/Mid/Specialty	Institutional Class	x	10/1/2002	Russell 2000 Index
Vanguard REIT Index Fund	Small/Mid/Specialty	Institutional Shares	x	12/2/2003	MSCI U.S. REIT Index
TIAA-CREF Inst. Intl. Equity Index Fund	Global/International	Institutional Class	x	10/1/2002	MSCI EAFE Index
Calvert Social Invstmt. Fund Bond Port.	Bonds	Class I	x	3/31/2000	LB US Credit Index
PIMCO Total Return Fund	Bonds	Institutional Shares	x	5/11/1987	
Hartford Capital Appreciation HLS Fund	Large Cap Value	Class IA	x	4/2/1984	
TIAA-CREF Social Choice	Large Cap Value	Initial Class			
Fidelity VIP Contrafund Portfolio	Large Cap Growth	Initial Class	x	1/3/1995	
The Growth Fund of America	Large Cap Growth	Class R-5	x	12/1/1973	
Fidelity VIP Mid Cap Portfolio	Small/Mid/Specialty	Initial Class	x	12/28/1998	S&P MidCap 400 Index
JPMorgan Mid Cap Value Fund	Small/Mid/Specialty	Class I	x	11/13/1997	Russell Mid-Cap Value Index
Vanguard Explorer Fund	Small/Mid/Specialty	Admiral Shares	x	11/12/2001	Russell 2500 Growth Index
EuroPacific Growth Fund	Global/International	Class R-5	x	4/16/1984	

Table 2

TIAA-CREF Retirement Investments, Vanguard Index Funds, and State of Connecticut Options

This table lists all of the funds used in our analysis, along with each fund's inception date, investment style, sector and orientation. The starting date of the analysis is April 1, 1997. All TIAA-CREF retirement annuities in existence on that date have been included except the Traditional Annuity and TIAA Real Estate Fund. These funds were excluded because neither is consistently marked to market. The Vanguard list includes all Vanguard index funds with an inception date before April 1, 1997 but excludes funds intended for tax avoidance or involving custom blends. Because Vanguard's Prime Money Market fund returns are virtually indistinguishable from those of the CREF Money Market, we use the CREF Money Market fund as a proxy. Some of the State of Connecticut funds included in our analysis were initiated after April 1, 1997. A benchmark index has been used as a surrogate to complete a 10-year return series.

Fund/Manager	First Date	Style	D/E	Sector	Company's Description of Investment Objective
TIAA-CREF					
CREF Money Market	3/2/1992	Active	Money	Dollar-den.	Seeks high current income consistent with liquidity and capital preservation.
CREF Bond Market	3/2/1992	Active	Debt	Domestic	Seeks favorable long-term returns, mainly through high current income consistent with capital appreciation.
CREF Stock	3/2/1992	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	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	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	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	Passive	Equity	Domestic	A highly diversified portfolio designed to track the overall U.S. stock market as represented by the Russell 3000® Index.
CREF Inflation-Linked Bonds	4/1/1997	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	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	Passive	Debt	Broad-based	Seeks to track the performance of a broad, market-weighted bond index.
European Stock Index	11/1/1990	Passive	Equity	Foreign	Seeks to track the performance of the Morgan Stanley Capital International® (MSCI) Europe Index.
Pacific Stock Index	11/1/1990	Passive	Equity	Foreign	Seeks to track the performance of the Morgan Stanley Capital International® (MSCI) Pacific Index.
Small Cap Index	1/18/1991	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	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	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	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	Passive	Equity	Foreign	Seeks to track the performance of the Select Emerging Markets Index.
Short-Term Bond Index	6/20/1996	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	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	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	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	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	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	Passive	R.E.	Domestic	Seeks to track the performance of a benchmark index that measures the performance of publicly traded equity REITs.
State of Connecticut					
The Growth Fund of America	1-Dec-73	Active	Equity	Domestic	Seeks to provide long-term growth of capital through a diversified portfolio of common stocks.
Hartford Cap Apprcn HLS	2-Apr-84	Active	Equity	International	Seeks growth of capital, normally invests at least 65% in common stocks, may invest 35% in foreign issuers.
EuroPacific Growth Fund	16-Apr-84	Active	Equity	Foreign	Seeks to provide long-term growth of capital by investing in companies based outside the United States.
PIMCO Total Return Fund	11-May-87	Active	Debt	Domestic	Seeks total return consistent with preservation of capital, normally invests at least 65% of assets in debt securities.
Vanguard® Inst Index Fund	31-Jul-90	Passive	Equity	Domestic	Seeks to track the performance of the Standard & Poor's 500 Index.
Fidelity® VIP Contrafund	3-Jan-95	Active	Equity	Domestic	Invests primarily in common stock of companies whose value FMR believes is not fully recognized.
Vanguard® Total Bond Index	18-Sep-95	Passive	Debt	Domestic	Seeks to track the performance of the Lehman Brothers Aggregate Bond Index.
JP Morgan Mid Cap Value	13-Nov-97	Active	Equity	Domestic	Seeks capital appreciation by investing at least 80% of assets in equity securities of mid-cap companies.
Fidelity® VIP Mid Cap Port	28-Dec-98	Active	Equity	Domestic	Seeks total return by investing in mid-cap equities.
TIAA-CREF Inst Eqty Indx	1-Jul-99	Passive	Equity	Domestic	Seeks long-term total return, mainly from appreciation, by tracking the overall U.S. equity markets.
Calvert Soc Invest Bond Port	31-Mar-00	Active	Debt	Domestic	Seeks current income and preservation of capital by investing at least 80% of assets in fixed-income securities.
Vanguard® Explorer™ Fund	12-Nov-01	Active	Equity	Domestic	Broadly diversified portfolio of small-capitalization growth stocks.
TIAA-CREF Inst Intl Eqty	1-Oct-02	Passive	Equity	Foreign	Seeks long-term total return through capital appreciation, by investing primarily in foreign equity based on a market index.
TIAA-CREF Inst Mid-Cap	1-Oct-02	Passive	Equity	Domestic	Seeks long-term total return through capital appreciation by investing in equity securities of medium-sized domestic companies.
TIAA-CREF Inst Small-Cap	1-Oct-02	Passive	Equity	Domestic	Seeks long-term total return through capital appreciation by investing in equity securities of smaller domestic companies.
Vanguard® REIT Index Fund	2-Dec-03	Passive	R.E.	Domestic	Seeks to track the performance of the MSCI® US REIT Index.
Vanguard® Infl Protect Secur	12-Dec-03	Passive	Debt	Domestic	Seeks inflation protection and income consistent with Treasury inflation-protected securities.

Figure 1

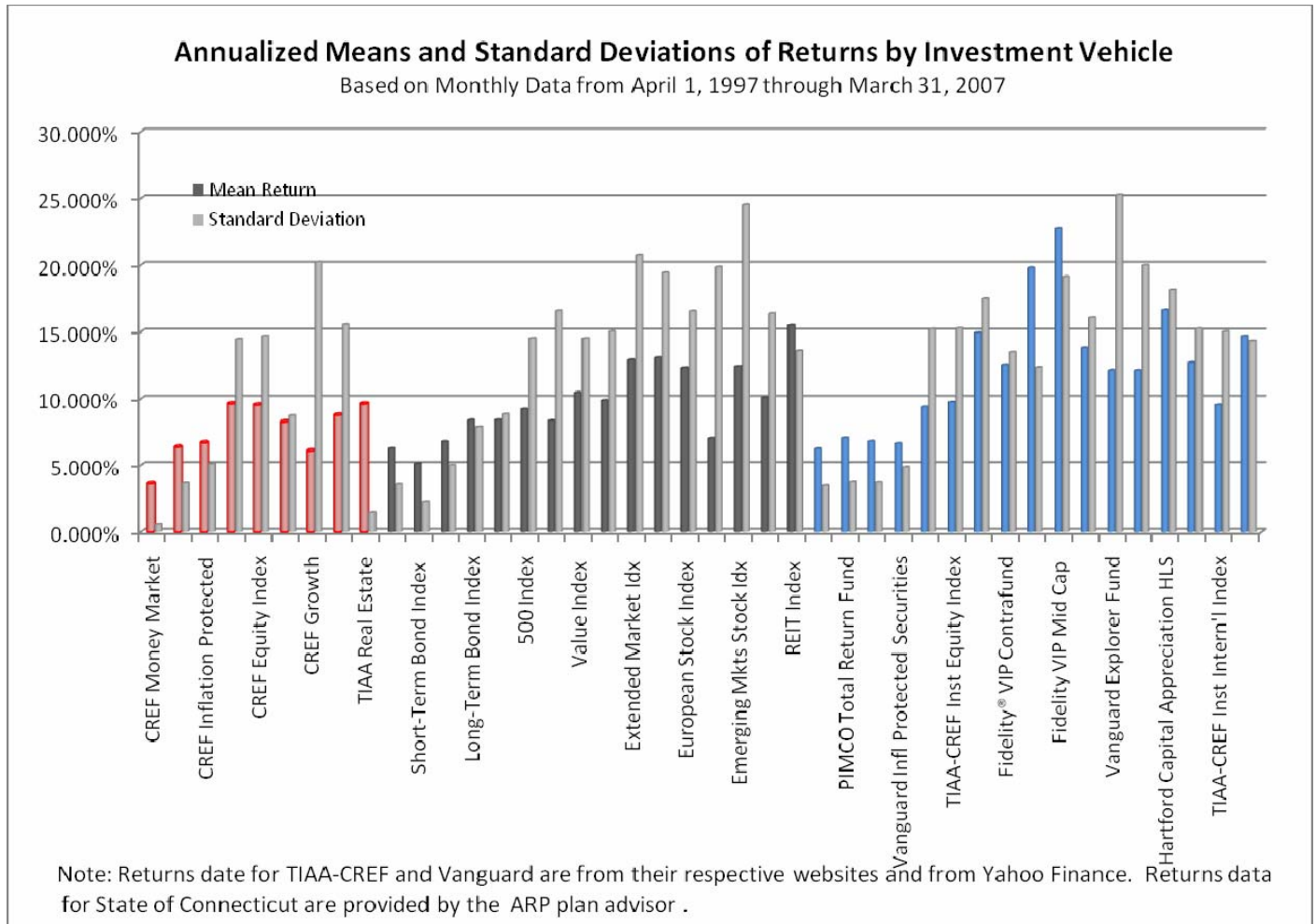
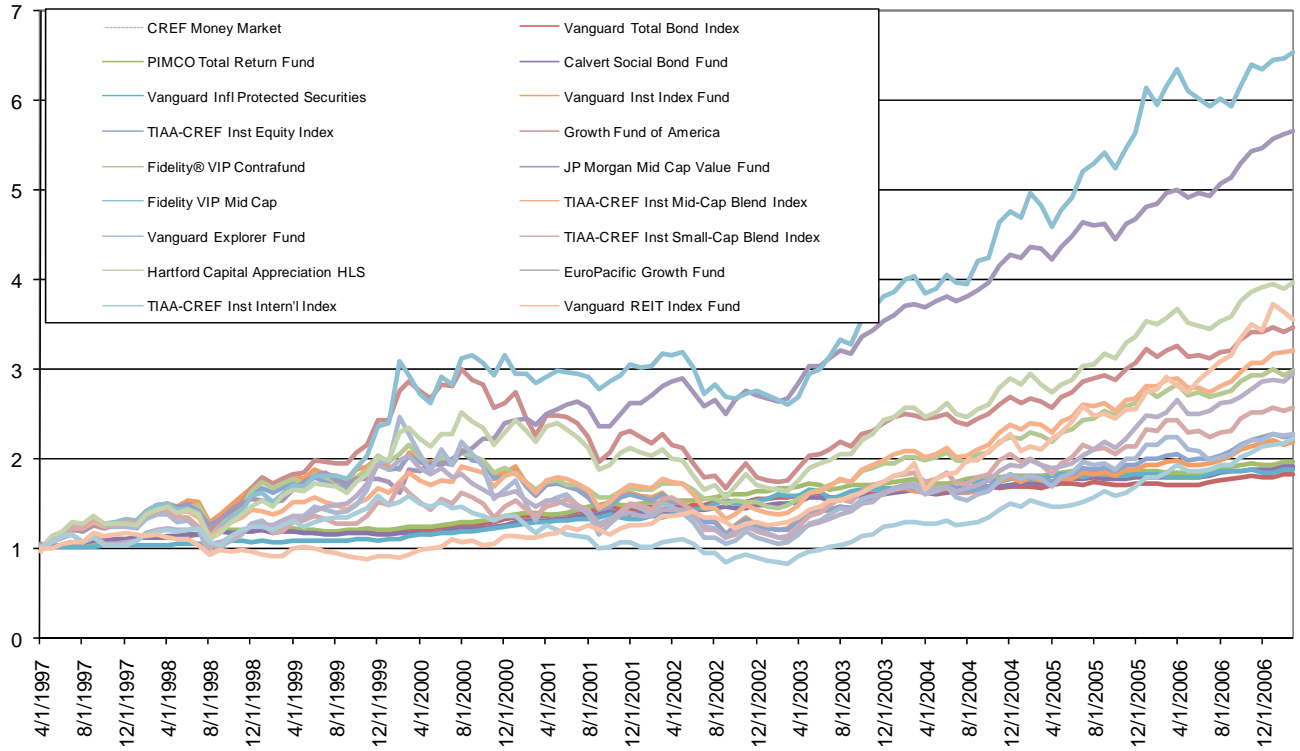


Figure 2

Price Indices of Investment Vehicles of State of Connecticut
The value over time, of \$1 invested on April 1, 1997, with all distributions reinvested.



Sources: Returns information were supplied by the plan advisor on behalf of the State of Connecticut.

Figure 3

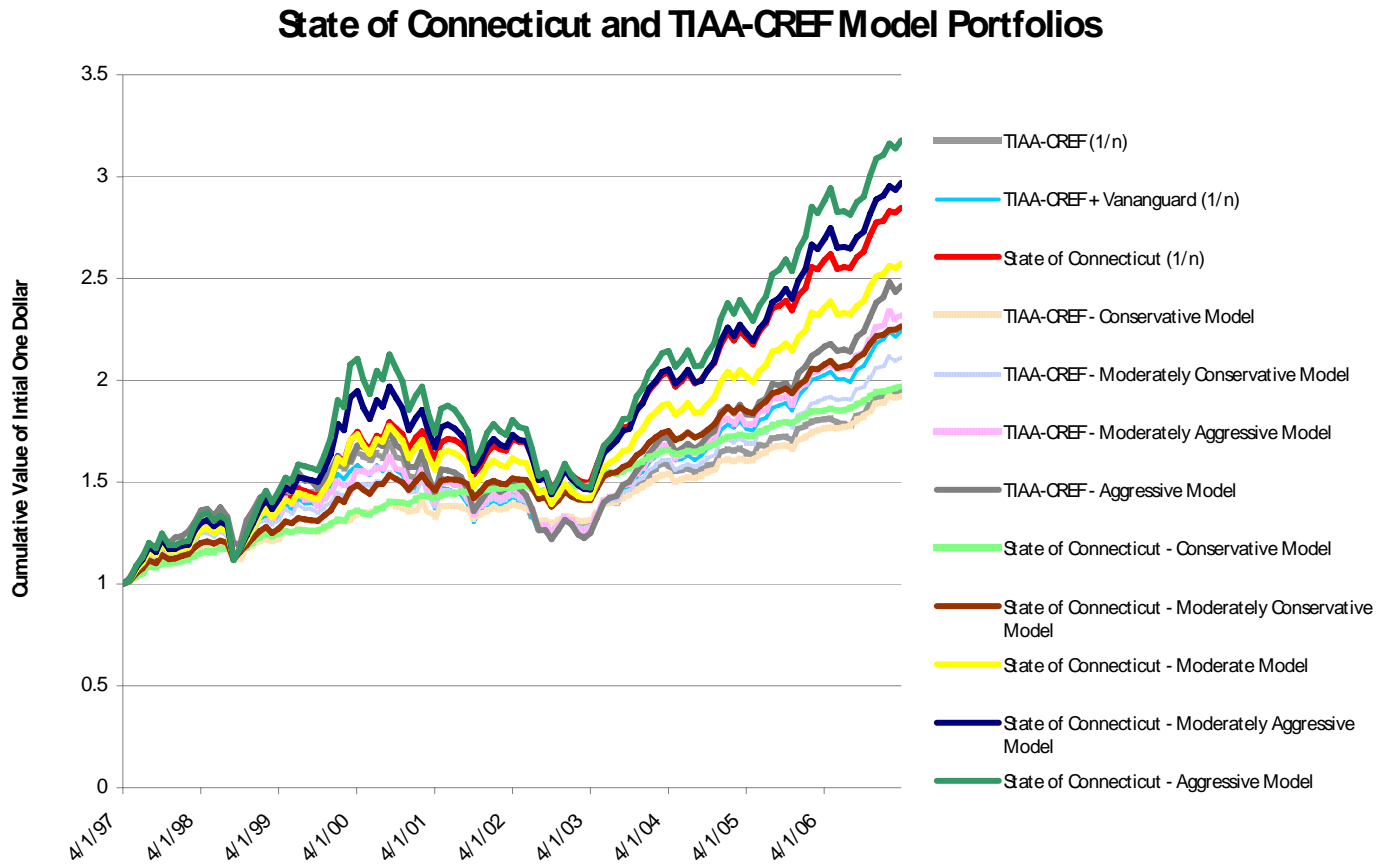


Table 3

Investment Vehicle Correlations of Monthly Returns																																												
April 1, 1997 through March 31, 2007																																												
TIAA-CREF Investment Vehicles																	Vanguard Index Funds															State of Connecticut ARP Funds												
CREF Bond	CREF Int.	CREF Stock	CREF Equity	CREF Social	CREF Growth	CREF Global	Total Bond	Short Term	Interm. Term	Long Term	Balanced	500	Growth	Value	Total Stock	Extnd. Mkt	Small Cap	Euro. Pacif.	Emerg. Mkt	Total Int.	REIT	Van. Total	PIMCO Tot.	Calvt. Soc.	Van. Inst.	Van. Inst.	T-C Inst.	Growth of Fd	Fid. VIP	JPM Mid	Fid. Mid	T-C Mid	Van. Explor	T-C Sm	Hart. Cap.	EuroP acific	Van. Intern	REIT						
Market	Prot.	Stock	Index	Choice	Growth	Equity	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index	Index		
CREF Bond Market	1	0.76	(0.14)	(0.13)	0.06	(0.15)	(0.15)	0.99	0.93	0.98	0.95	0.03	(0.12)	(0.13)	(0.09)	(0.13)	(0.15)	(0.16)	(0.12)	(0.11)	(0.18)	(0.14)	0.06	0.92	0.92	0.85	0.70	(0.10)	(0.10)	(0.13)	(0.07)	(0.07)	(0.03)	(0.10)	(0.12)	(0.12)	(0.10)	(0.16)	(0.14)	0.05				
CREF Inflation Protected	0.76	1	(0.15)	(0.15)	(0.00)	(0.15)	(0.17)	0.75	0.67	0.77	0.78	(0.04)	(0.15)	(0.17)	(0.09)	(0.16)	(0.15)	(0.15)	(0.16)	0.03	(0.13)	(0.11)	0.09	0.74	0.72	0.65	0.95	(0.16)	(0.17)	(0.16)	(0.15)	(0.06)	(0.07)	(0.12)	(0.14)	(0.16)	(0.12)	(0.15)	(0.15)	0.08				
CREF Stock	(0.14)	(0.15)	1	0.99	0.96	0.93	0.95	(0.12)	(0.20)	(0.13)	(0.09)	0.97	0.98	0.93	0.90	0.99	0.86	0.82	0.85	0.65	0.79	0.87	0.30	(0.11)	(0.10)	0.01	(0.15)	0.91	0.92	0.86	0.80	0.65	0.62	0.86	0.79	0.76	0.86	0.83	0.83	0.25				
CREF Equity Index	(0.13)	(0.15)	0.99	1	0.97	0.94	0.92	(0.11)	(0.19)	(0.12)	(0.08)	0.98	0.99	0.94	0.91	0.99	0.85	0.80	0.79	0.60	0.75	0.81	0.30	(0.10)	(0.10)	0.02	(0.16)	0.91	0.91	0.85	0.78	0.66	0.58	0.85	0.77	0.74	0.84	0.78	0.77	0.24				
CREF Social Choice	0.06	(0.00)	0.96	0.97	1	0.88	0.85	0.07	(0.01)	0.07	0.10	0.97	0.98	0.92	0.91	0.95	0.76	0.70	0.75	0.57	0.69	0.77	0.32	0.07	0.07	0.17	(0.02)	0.90	0.89	0.79	0.75	0.68	0.52	0.81	0.68	0.65	0.78	0.73	0.74	0.25				
CREF Growth	(0.15)	(0.15)	0.53	0.94	0.88	1	0.90	(0.14)	(0.20)	(0.14)	(0.11)	0.93	0.92	0.96	0.74	0.95	0.87	0.78	0.70	0.58	0.69	0.74	0.16	(0.12)	(0.13)	(0.02)	(0.16)	0.62	0.63	0.85	0.71	0.44	0.54	0.75	0.79	0.68	0.78	0.72	0.69	0.11				
CREF Global Equity	(0.15)	(0.17)	0.95	0.92	0.85	0.90	1	(0.14)	(0.21)	(0.14)	(0.12)	0.92	0.89	0.87	0.78	0.94	0.90	0.85	0.90	0.69	0.80	0.92	0.24	(0.12)	(0.11)	(0.01)	(0.17)	0.83	0.86	0.88	0.82	0.51	0.72	0.83	0.85	0.80	0.88	0.90	0.87	0.21				
Total Bond Market Index	0.99	0.75	(0.12)	(0.11)	0.07	(0.14)	(0.14)	1	0.93	0.98	0.96	0.05	(0.10)	(0.12)	(0.07)	(0.11)	(0.13)	(0.14)	(0.11)	(0.10)	(0.17)	(0.13)	0.08	0.92	0.92	0.85	0.69	(0.08)	(0.09)	(0.12)	(0.07)	(0.05)	(0.03)	(0.09)	(0.11)	(0.10)	(0.08)	(0.14)	(0.13)	0.07				
Short-Term Bond Index	0.93	0.67	(0.20)	(0.19)	(0.01)	(0.20)	(0.21)	0.93	1	0.92	0.83	(0.04)	(0.17)	(0.18)	(0.15)	(0.19)	(0.21)	(0.23)	(0.19)	(0.11)	(0.24)	(0.20)	0.01	0.87	0.87	0.76	0.61	(0.15)	(0.16)	(0.19)	(0.14)	(0.12)	(0.07)	(0.18)	(0.19)	(0.16)	(0.21)	(0.20)	0.01					
Interm-Term Bond Index	0.98	0.77	(0.13)	(0.12)	0.07	(0.14)	(0.14)	0.98	0.92	1	0.96	0.04	(0.11)	(0.13)	(0.07)	(0.12)	(0.14)	(0.15)	(0.11)	(0.10)	(0.17)	(0.13)	0.08	0.92	0.91	0.85	0.71	(0.09)	(0.09)	(0.12)	(0.07)	(0.05)	(0.03)	(0.09)	(0.11)	(0.10)	(0.09)	(0.15)	(0.14)	0.07				
Long-Term Bond Index	0.95	0.78	(0.09)	(0.08)	0.10	(0.11)	(0.12)	0.96	0.83	0.96	1	0.07	(0.07)	(0.09)	(0.04)	(0.08)	(0.10)	(0.11)	(0.10)	(0.13)	(0.16)	(0.13)	0.11	0.89	0.86	0.84	0.71	(0.06)	(0.07)	(0.09)	(0.06)	(0.02)	(0.02)	(0.06)	(0.08)	(0.08)	(0.07)	(0.13)	(0.13)	0.08				
Balanced Index	0.03	(0.04)	0.97	0.98	0.97	0.93	0.92	0.05	(0.04)	0.04	0.07	1	0.97	0.93	0.87	0.99	0.88	0.82	0.78	0.59	0.75	0.80	0.31	0.81	0.05	0.04	0.17	(0.05)	0.89	0.90	0.86	0.79	0.61	0.63	0.85	0.80	0.76	0.85	0.78	0.76	0.25			
500 Index	(0.12)	(0.15)	0.98	0.99	0.98	0.92	0.89	(0.10)	(0.17)	(0.11)	(0.07)	0.97	1	0.95	0.92	0.98	0.78	0.73	0.77	0.59	0.72	0.79	0.27	(0.09)	(0.09)	0.02	(0.15)	0.91	0.91	0.82	0.75	0.67	0.51	0.81	0.70	0.66	0.80	0.76	0.76	0.22				
Growth Index	(0.13)	(0.17)	0.93	0.94	0.92	0.96	0.87	(0.12)	(0.18)	(0.13)	(0.09)	0.93	0.95	1	0.75	0.94	0.79	0.70	0.70	0.59	0.65	0.74	0.16	(0.10)	(0.10)	(0.01)	(0.18)	0.85	0.84	0.80	0.72	0.48	0.49	0.72	0.70	0.61	0.74	0.72	0.69	0.10				
Value Index	(0.09)	(0.09)	0.90	0.91	0.91	0.74	0.78	(0.07)	(0.15)	(0.07)	(0.04)	0.87	0.92	0.75	1	0.88	0.66	0.66	0.74	0.51	0.70	0.74	0.40	(0.07)	(0.07)	0.05	(0.09)	0.86	0.85	0.72	0.69	0.81	0.46	0.81	0.60	0.63	0.75	0.70	0.74	0.35				
Total Stock Mkt Idx.	(0.13)	(0.16)	0.99	0.99	0.95	0.95	0.94	(0.11)	(0.19)	(0.12)	(0.08)	0.99	0.98	0.94	0.88	1	0.90	0.84	0.80	0.61	0.77	0.82	0.29	(0.10)	(0.10)	0.03	(0.16)	0.89	0.91	0.87	0.79	0.62	0.63	0.86	0.82	0.77	0.86	0.80	0.78	0.24				
Extended Market Idx	(0.15)	(0.15)	0.86	0.85	0.76	0.87	0.90	(0.13)	(0.21)	(0.14)	(0.10)	0.88	0.78	0.79	0.66	0.90	1	0.96	0.74	0.56	0.78	0.77	0.30	(0.11)	(0.13)	0.03	(0.14)	0.72	0.78	0.86	0.75	0.43	0.77	0.84	0.94	0.89	0.86	0.76	0.69	0.26				
Small Cap Index	(0.16)	(0.15)	0.82	0.80	0.70	0.78	0.85	(0.14)	(0.23)	(0.15)	(0.11)	0.82	0.73	0.70	0.66	0.84	0.96	1	0.73	0.51	0.76	0.75	0.39	(0.11)	(0.12)	0.03	(0.14)	0.66	0.73	0.82	0.71	0.48	0.77	0.83	0.91	0.92	0.84	0.73	0.67	0.34				
European Stock Index	(0.12)	(0.16)	0.85	0.79	0.75	0.70	0.90	(0.11)	(0.19)	(0.11)	(0.10)	0.78	0.77	0.70	0.74	0.80	0.74	0.73	1	0.58	0.73	0.94	0.29	(0.10)	(0.09)	(0.02)	(0.18)	0.74	0.76	0.73	0.72	0.54	0.64	0.76	0.70	0.71	0.76	0.85	0.90	0.26				
Pacific Stock Index	(0.11)	0.03	0.65	0.60	0.57	0.58	0.69	(0.10)	(0.11)	(0.10)	(0.13)	0.59	0.59	0.59	0.51	0.61	0.56	0.51	0.58	1	0.70	0.81	0.16	(0.02)	(0.02)	0.03	0.06	0.51	0.51	0.50	0.52	0.31	0.46	0.50	0.51	0.45	0.57	0.70	0.72	0.13				
Emerging Mkts Stock Idx.	(0.18)	(0.13)	0.79	0.75	0.69	0.69	0.80	(0.17)	(0.24)	(0.17)	(0.16)	0.75	0.72	0.65	0.70	0.77	0.78	0.76	0.73	0.70	1	0.85	0.38	(0.16)	(0.14)	(0.01)	(0.11)	0.72	0.75	0.74	0.69	0.54	0.65	0.78	0.76	0.75	0.80	0.85	0.81	0.36				
Total Int'l Stock Index	(0.14)	(0.11)	0.87	0.81	0.77	0.74	0.92	(0.13)	(0.20)	(0.13)	(0.13)	0.80	0.79	0.74	0.74	0.82	0.77	0.75	0.94	0.81	0.85	1	0.29	(0.10)	(0.08)	(0.00)	(0.11)	0.75	0.76	0.74	0.73	0.53	0.66	0.77	0.73	0.72	0.80	0.91	0.93	0.26				
REIT Index	0.06	0.09	0.30	0.30	0.32	0.16	0.24	0.08	0.01	0.08	0.11	0.31	0.27	0.16	0.40	0.29	0.30	0.39	0.29	0.16	0.38	0.29	1	0.08	0.06	0.15	0.13	0.30	0.33	0.25	0.29	0.48	0.27	(0.43)	0.29	0.45	0.30	0.28	0.30	0.95				
Van. Total Bond Index	0.92	0.74	(0.11)	(0.10)	0.07	(0.12)	(0.12)	0.92	0.87	0.92	0.89	0.05	(0.09)	(0.10)	(0.07)	(0.10)	(0.11)	(0.11)	(0.10)	(0.02)	(0.16)	(0.10)	0.08	1	0.97	0.91	0.75	(0.11)	(0.12)	(0.14)	(0.08)	(0.08)	(0.03)	(0.11)	(0.13)	(0.12)	(0.10)	(0.13)	(0.13)	0.05				
PIMCO Tot. Retrn Fund	0.92	0.72	(0.10)	(0.10)	0.07	(0.13)	(0.11)	0.92	0.87	0.91	0.86	0.04	(0.09)	(0.10)	(0.07)	(0.10)	(0.13)	(0.12)	(0.08)	(0.02)	(0.14)	(0.08)	0.06	0.97	1	0.89	0.71	(0.08)	(0.10)	0.13	(0.05)	(0.06)	(0.00)	(0.10)	(0.14)	(0.12)	(0.09)	(0.12)	(0.11)	0.03				
Calvt. Soc. Bond Fund	0.85	0.65	0.01	0.02	0.17	(0.02)	(0.01)	0.85	0.76	0.85	0.84	0.17	0.02	(0.01)	0.05	0.03	0.03	0.03	(0.02)	0.03	(0.01)	(0.00)	0.15	0.91	0.89	1	0.65	0.05	0.05	0.03	0.08	0.04	0.09	0.06	0.03	0.06	0.06	0.01	0.01	0.14				
Van. Infl. Prot. Secur.	0.70	0.95	(0.15)	(0.16)	(0.02)	(0.16)	(0.17)	0.69	0.61	0.71	0.71	(0.05)	(0.15)	(0.18)	(0.09)	(0.16)	(0.14)	(0.14)	(0.18)	0.06	(0.11)	(0.11)	0.13	0.75	0.71	0.65	1	(0.20)	(0.20)	(0.19)	(0.16)	(0.07)	(0.06)	(0.15)	(0.16)	(0.18)	(0.14)	(0.17)	(0.17)	0.11				
Van. Inst. Index Fund	(0.10)	(0.16)	0.91	0.91	0.90	0.82	0.83	(0.08)	(0.15)	(0.09)	(0.06)	0.89	0.91	0.85	0.86	0.89	0.72	0.66	0.74	0.51	0.72	0.75	0.30	(0.11)	(0.08)	0.05	(0.20)	1	0.99															

Figure 4

Portfolio Risk as a Percent of the Average Risk of Each Fund in the Portfolio

Risk is measured as the annualized standard deviation of monthly returns from April 1, 1997 through March 31, 2007. Figures in parentheses are numbers of funds in group.

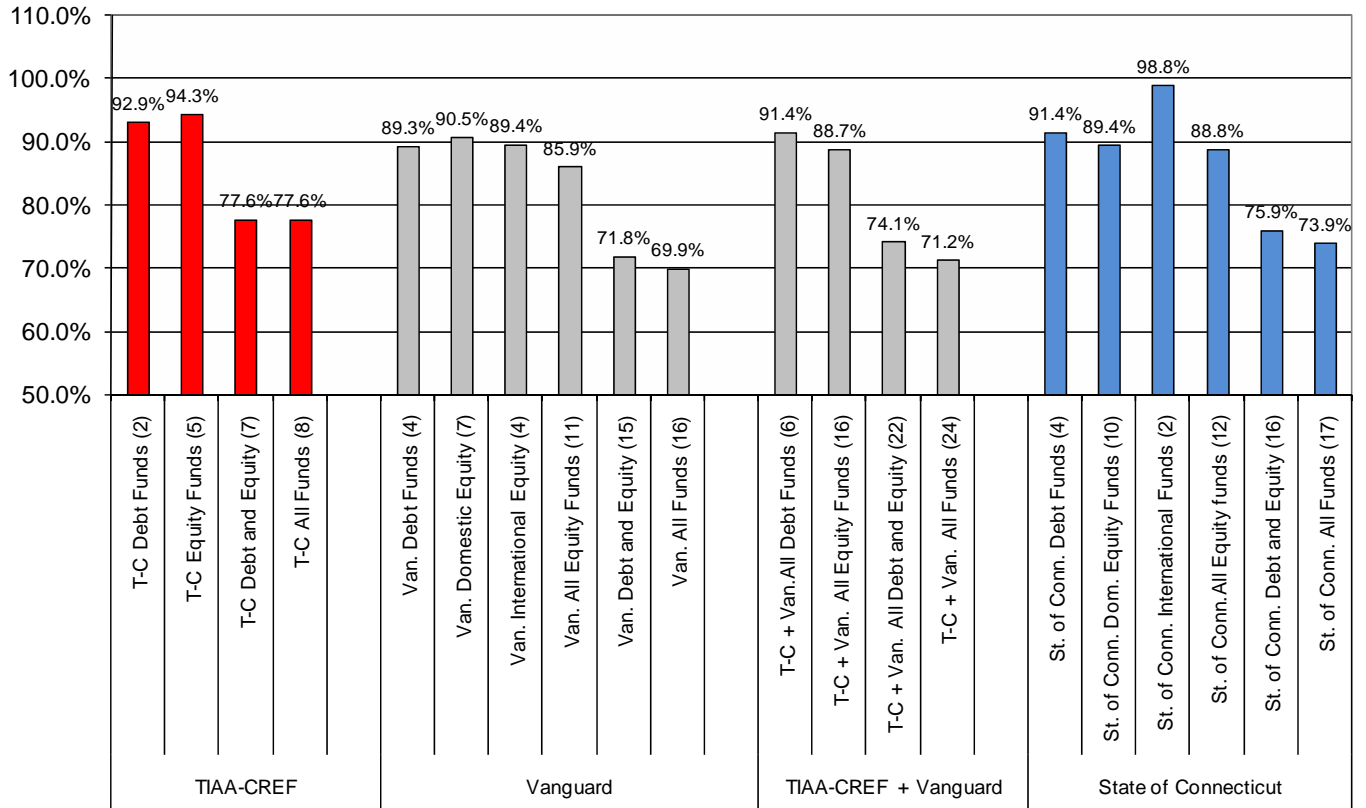


Figure 5

Efficient Frontier Without TIAA Real Estate

Maximum expected returns subject to risk, based on monthly returns from April 1, 1997 through March 31, 2007. Constrained results have maximum weights of one-third in any fund except money market.

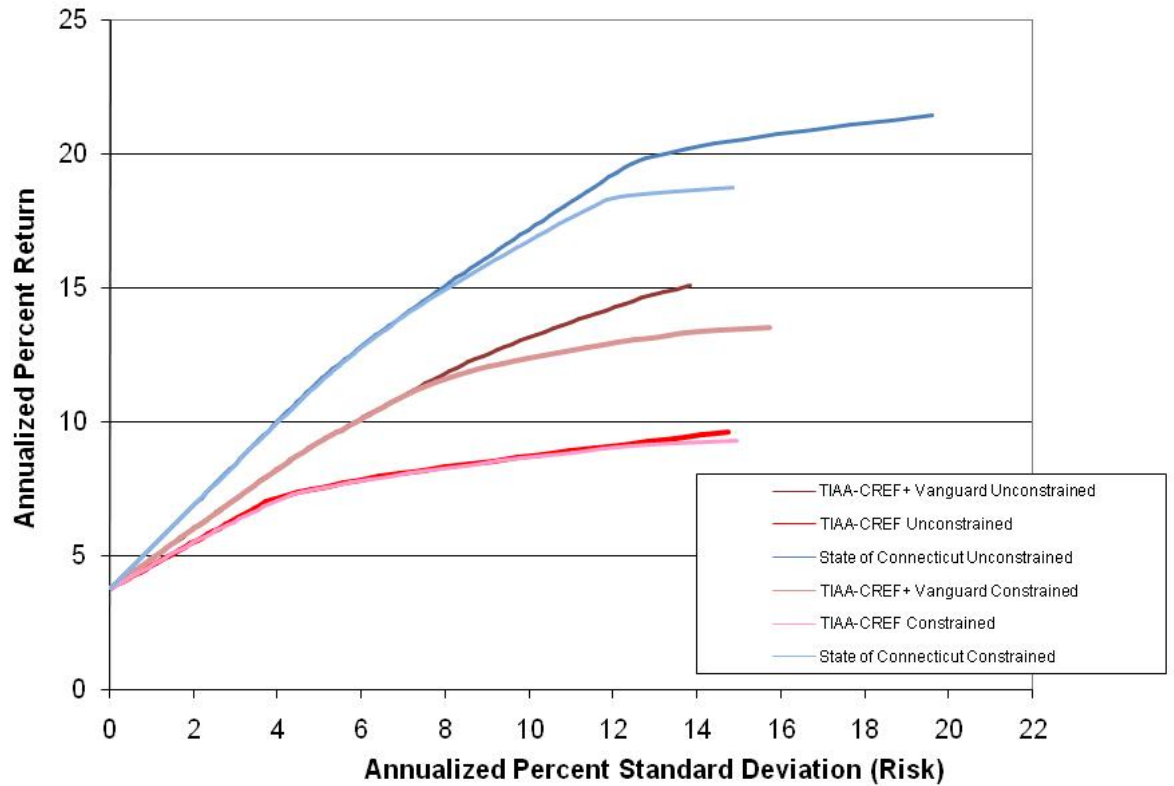
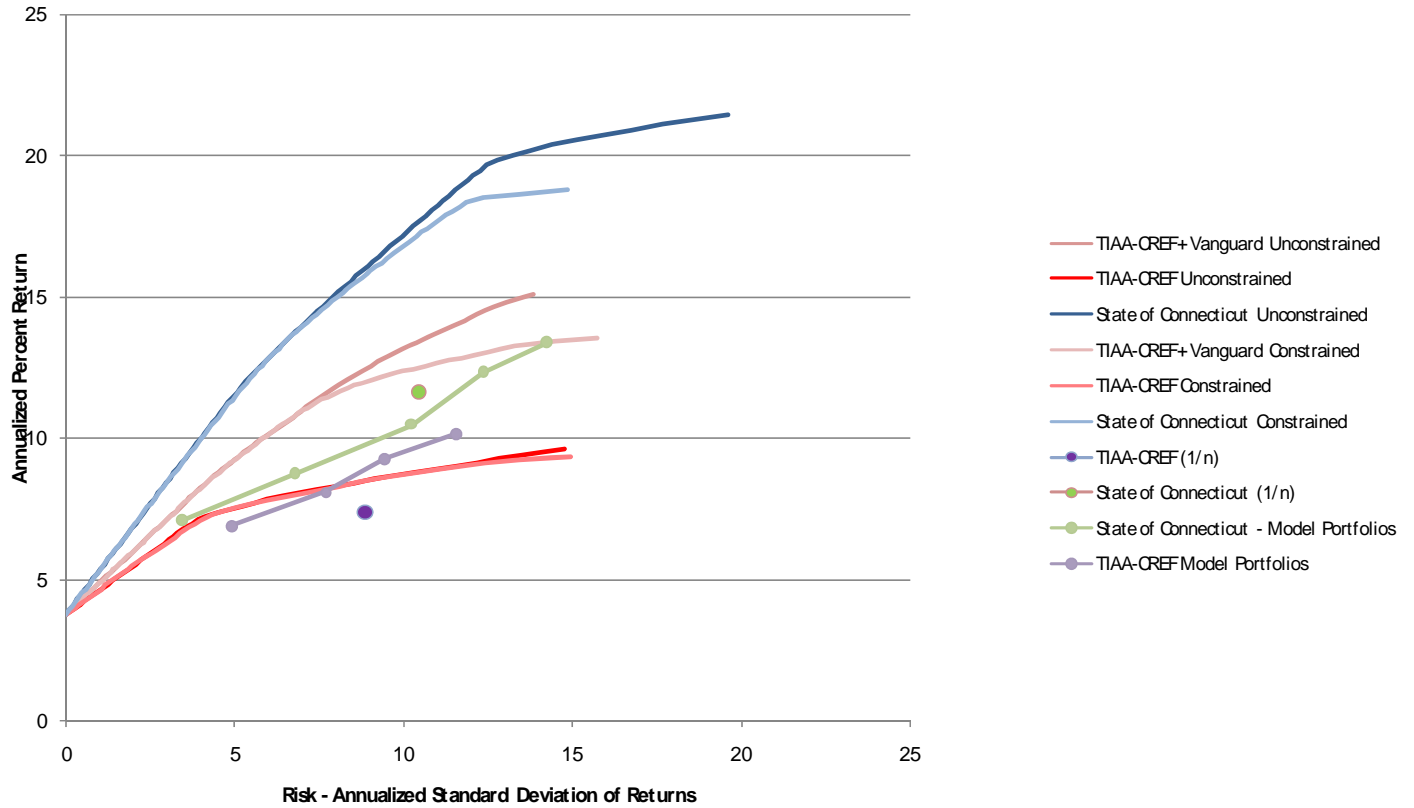


Figure 6

Efficient Frontiers of TIAA-CREF+ Vanguard and State of Connecticut with Naive and Model Portfolios



Maximum expected returns subject to risk, based on monthly returns from April 1, 1997 through March 31, 2007. Constrained results have maximum weights of one-third in any fund except money.

Figure 7

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, 2007. Risk is measured as annualized standard deviation of portfolio returns. Constrained results have maximum weights of one-third in any fund except money.

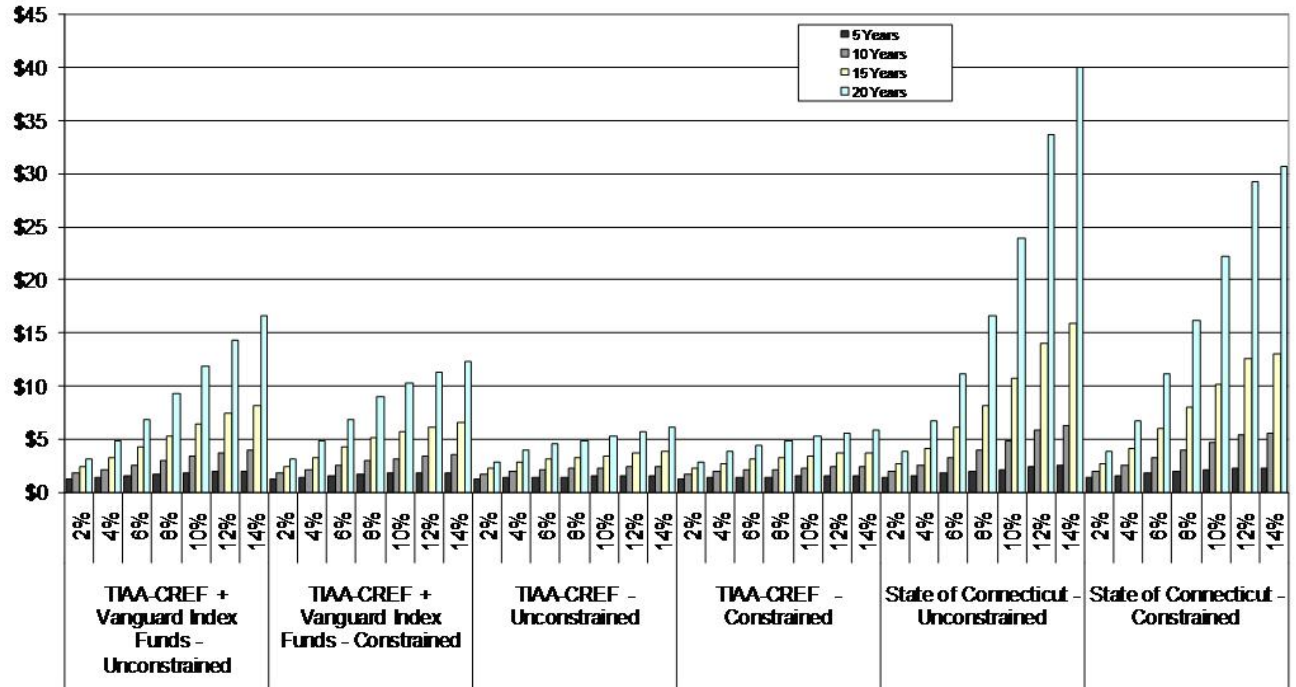


Table 4

Portfolio Allocation by Broad Asset Class, Investment Options, and Risk Level
(Excluding the TIAA Real Estate Annuity)

Optimized asset allocations based on realized monthly performance from April 1, 1997 through March 31, 2007. 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 and State of Connecticut. "Unconstrained" portfolio allocations are restricted to non-negative positions. "Constrained" portfolio allocations are restricted to non-negative positions and to a maximum allocation of one-third in any investment vehicle other than money market. Risk levels shown are from 1% to 19% or the maximum if 19% is not achievable.

TIAA-CREF - Unconstrained

Risk	Return	Money	Debt	Equity	
2.0%	5.5%	45%	47%	8%	
4.0%	7.2%	0%	80%	20%	
6.0%	7.8%	0%	62%	38%	
8.0%	8.3%	0%	46%	54%	
10.0%	8.7%	0%	31%	69%	
12.0%	9.1%	0%	18%	82%	
14.0%	9.5%	0%	5%	95%	

TIAA-CREF - Constrained

Risk	Return	Money	Debt	Equity	
2.0%	5.5%	47%	45%	8%	
4.0%	7.1%	2%	67%	31%	
6.0%	7.8%	0%	56%	44%	
8.0%	8.3%	0%	33%	67%	
10.0%	8.7%	0%	31%	69%	
12.0%	9.0%	0%	8%	92%	
14.0%	9.2%	0%	0%	100%	

TIAA-CREF and Vanguard Indexes - Unconstrained

Risk	Return	Money	Debt	Equity	R.E.	Equity Allocation	
						Dom. Equity	Int. Equity
2.0%	6.02%	42%	45%	5%	8%	1%	4%
4.0%	8.25%	0%	74%	9%	17%	1%	7%
6.0%	10.13%	0%	57%	13%	31%	1%	11%
8.0%	11.82%	0%	42%	16%	42%	1%	15%
10.0%	13.16%	0%	22%	15%	62%	0%	15%
12.0%	14.26%	0%	6%	15%	79%	0%	15%
13.0%	14.77%	0%	0%	11%	89%	0%	11%

TIAA-CREF and Vanguard Indexes - Constrained

Risk	Return	Money	Debt	Equity	R.E.	Equity Allocation	
						Dom. Equity	Int. Equity
2.0%	6.02%	42%	45%	5%	8%	1%	4%
4.0%	8.24%	0%	73%	9%	18%	1%	8%
6.0%	10.13%	0%	57%	13%	31%	1%	11%
8.0%	11.60%	0%	39%	27%	33%	5%	22%
10.0%	12.37%	0%	23%	43%	33%	15%	28%
12.0%	12.92%	0%	10%	57%	33%	23%	33%
14.0%	13.39%	0%	0%	67%	33%	39%	28%

State of Connecticut - Unconstrained

Risk	Return	Money	Debt	Equity	R.E.	Equity Allocation	
						Dom. Equity	Int. Equity
2.0%	6.90%	56%	29%	13%	1%	0.1325	0.0000
4.0%	10.03%	13%	59%	27%	2%	0.2650	0.0000
6.0%	12.83%	0%	52%	45%	3%	0.4468	0.0000
8.0%	15.09%	0%	34%	62%	4%	0.6187	0.0000
10.0%	17.20%	0%	17%	78%	5%	0.7794	0.0000
12.0%	19.24%	0%	0%	94%	6%	0.9352	0.0000
14.0%	20.26%	0%	0%	100%	0%	1.0000	0.0000
16.0%	20.75%	0%	0%	100%	0%	1.0000	0.0000
18.0%	21.15%	0%	0%	100%	0%	1.0000	0.0000

State of Connecticut - Constrained

Risk	Return	Money	Debt	Equity	R.E.	Equity Allocation	
						Dom. Equity	Int. Equity
2.0%	6.90%	56%	29%	13%	1%	0.1325	0.0000
4.0%	9.97%	16%	54%	28%	2%	0.2766	0.0000
6.0%	12.80%	0%	52%	45%	3%	0.4488	0.0000
8.0%	14.94%	0%	34%	55%	11%	0.5496	0.0000
10.0%	16.78%	0%	18%	64%	18%	0.6413	0.0000
12.0%	18.39%	0%	0%	68%	32%	0.6667	0.0125
14.0%	18.68%	0%	0%	93%	7%	0.6667	0.2585

Table 5

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

Optimal portfolio weights for broad asset classes, based on the sets of available investment vehicles. Portfolios weights corresponding to various discrete risk levels up to 19 percent are estimated based on monthly returns from April 1, 1997 through March 31, 2007. Optimal portfolios given loss aversion are determined based by investment horizon and tolerance for exposure to the risk of a realized return less than the return from investing in the CREF Money Market fund (VAR). 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.

		Horizon														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
TIAA-CREF	Unconstrained	Risk (%)	0	4	4	4	6	6	6	10	14	14	14	14	14	14
		Money	100%													
		Debt		80%	80%	80%	62%	62%	31%	5%	5%	5%	5%	5%	5%	5%
		Equity		20%	20%	20%	38%	38%	69%	95%	95%	95%	95%	95%	95%	95%
		Risk (%)	0	0	0	2	4	4	4	4	6	6	6	8	14	14
		Money	100%	100%	100%	45%	47%	80%	80%	80%	62%	62%	62%	46%	5%	5%
	2 Sigma	Debt				80%	80%	20%	20%	20%	38%	38%	38%	54%	95%	95%
		Equity				0	20%	20%	20%	20%	38%	38%	38%	54%	95%	95%
		Risk (%)	0	0	0	0	0	4	4	4	4	4	4	4	6	6
		Money	100%	100%	100%	100%	100%									
		Debt						80%	80%	80%	80%	80%	80%	80%	62%	62%
		Equity						20%	20%	20%	20%	20%	20%	20%	38%	38%
TIAA-CREF	Constrained	Risk (%)	0	4	4	4	6	6	6	10	12	12	12	14	14	14
		Money	100%	2%	2%	2%										
		Debt		67%	67%	67%	56%	56%	31%	8%	8%	8%				
		Equity		31%	31%	31%	44%	44%	69%	92%	92%	92%	100%	100%	100%	100%
		Risk (%)	0	0	0	2	4	4	4	4	6	6	6	8	10	12
		Money	100%	100%	100%	47%	2%	2%	2%	2%	56%	56%	56%	33%	31%	8%
	2 Sigma	Debt				2%	67%	67%	67%	67%	56%	56%	56%	67%	69%	92%
		Equity				8%	31%	31%	31%	31%	44%	44%	44%	67%	69%	92%
		Risk (%)	0	0	0	0	0	2	4	4	4	4	4	6	6	6
		Money	100%	100%	100%	100%	100%	47%	2%	2%	2%	2%	2%	56%	56%	56%
		Debt						45%	67%	67%	67%	67%	67%	56%	56%	56%
		Equity						8%	31%	31%	31%	31%	31%	44%	44%	44%
TIAA-CREF + Vanguard	Unconstrained	Risk (%)	5	9	13	14	14	14	14	14	14	14	14	14	14	14
		Money	71%													
		Debt	22%	31%												
		Equity	2%	16%	11%											
		R.E.	4%	53%	89%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
		Risk	0	0	9	9	12	13	14	14	14	14	14	14	14	14
	2 Sigma	Money	100%	100%												
		Debt			31%	31%	6%									
		Equity			16%	15%	11%									
		R.E.			53%	53%	79%	89%	100%	100%	100%	100%	100%	100%	100%	100%
		Risk	0	0	0	0	9	9	13	14	14	14	14	14	14	14
		Money	100%	100%	100%	100%										
TIAA-CREF + Vanguard	Constrained	Risk	4	7	8	9	12	13	14	14	14	14	14	14	14	14
		Money	73%	50%	39%	31%	10%	40%								
		Debt	90%	16%	27%	36%	57%	62%	67%	67%	67%	67%	67%	67%	67%	67%
		Equity	18%	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%
		R.E.	0	0	5	7	8	8	9	10	13	14	14	14	14	14
		Risk	0	0	0	0	5	7	8	8	9	9	11	13	14	14
	2 Sigma	Money	100%	100%												
		Debt			65%	50%	39%	39%	31%	23%	40%					
		Equity			11%	16%	27%	27%	36%	33%	62%	67%	67%	67%	67%	67%
		R.E.			25%	33%	33%	33%	33%	43%	33%	33%	33%	33%	33%	33%
		Risk	0	0	0	0	5	7	8	8	9	9	11	13	14	14
		Money	100%	100%	100%	100%										
State of Connecticut	Unconstrained	Risk	12	13	13	14	16	19	19	19	19	19	19	19	19	19
		Money														
		Debt														
		Equity	94%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
		R.E.	6%													
		Risk	0	6	12	13	13	14	15	19	19	19	19	19	19	19
	2 Sigma	Money	100%													
		Debt		52%												
		Equity		45%	94%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
		R.E.		3%	6%											
		Risk	0	0	5	12	13	13	13	14	16	19	19	19	19	19
		Money	100%	100%												
State of Connecticut	Constrained	Risk	8	12	12	12	12	12	13	14	14	14	14	14	14	14
		Money														
		Debt	34%													
		Equity	55%	68%	68%	68%	68%	68%	83%	93%	93%	93%	93%	93%	93%	93%
		R.E.	11%	32%	32%	32%	32%	32%	17%	7%	7%	7%	7%	7%	7%	7%
		Risk	0	6	11	12	12	12	12	12	13	14	14	14	14	14
	2 Sigma	Money	100%													
		Debt														
		Equity		52%	9%	68%	68%	68%	68%	83%	93%	93%	93%	93%	93%	93%
		R.E.		45%	24%	32%	32%	32%	32%	17%	7%	7%	7%	7%	7%	7%
		Risk	0	0	5	8	12	12	12	12	12	13	13	14	14	14
		Money	100%	100%												
State of Connecticut	Constrained	Risk														
		Money														
		Debt														
		Equity														
		R.E.														
		Risk														
	3 Sigma	Money														
		Debt														
		Equity														
		R.E.														
		Risk														
		Money														

Table 6

Expected Terminal Values of Annually Rebalanced Portfolios Optimized by Risk Tolerance

Real cumulative terminal values of investments of \$1 per year in the first year (20 years before retirement), with real wage growth of 1% per year. The real risk free rate is assumed to be 1% per year. Investments are made in an annually optimized portfolio over the assumed 20-year work-life of the employee. Values are based on the assumption that the participant plans to convert to a fixed payment life annuity at retirement. Portfolios weights corresponding to discrete risk levels up to the highest achievable expected return are estimated based on monthly returns from April 1, 1997 through March 31, 2007. Optimal portfolios are determined by investment horizon and tolerance of value at risk. One-sigma corresponds to VAR of 16 percent, two-sigma correspond to VAR of 2.5 percent, and three sigma correspond to VAR of 0.1 percent. Results assuming constant real wages and investment of \$1 per year in real terms are similar.

Years of Investment	5	10	15	20
Cumulative Value of an initial \$1 per year with VAR 1 Sigma				
TIAA-CREF Unconstrained	6.54	14.61	25.21	39.22
TIAA-CREF Constrained	6.53	14.55	24.92	38.49
TIAA-CREF + Vanguard Unconstrained	7.89	21.30	44.18	83.21
TIAA-CREF + Vanguard Constrained	7.45	19.00	37.25	66.13
State of Connecticut Unconstrained	9.73	31.19	79.20	186.57
State of Connecticut Constrained	9.06	27.03	62.90	134.57
Cumulative Value of an initial \$1 per year with VAR 2 Sigma				
TIAA-CREF Unconstrained	6.19	13.32	22.08	33.59
TIAA-CREF Constrained	6.19	13.29	21.97	33.16
TIAA-CREF + Vanguard Unconstrained	6.81	17.88	36.79	69.04
TIAA-CREF + Vanguard Constrained	6.60	16.15	31.17	54.92
State of Connecticut Unconstrained	7.94	24.89	62.75	147.45
State of Connecticut Constrained	7.79	23.02	53.39	114.05
Cumulative Value of an initial \$1 per year with VAR 3 Sigma				
TIAA-CREF Unconstrained	6.10	12.64	20.41	30.23
TIAA-CREF Constrained	6.10	12.55	20.19	29.74
TIAA-CREF + Vanguard Unconstrained	6.21	15.22	30.60	56.84
TIAA-CREF + Vanguard Constrained	6.17	14.26	26.64	46.23
State of Connecticut Unconstrained	7.03	21.24	52.78	123.33
State of Connecticut Constrained	6.89	19.70	45.12	95.90

Table 7

Comparison of Portfolio Opportunities with Naïve (1/n) Investing and Model Portfolios

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. Bold figures indicate highest lower confidence bound cumulative return given the holding period. Results are based on monthly realized returns from April 1, 1997 through March 31, 2007.

Annualized Expected Return and Risk												
	TIAA-CREF + Vanguard (1/n)	TIAA-CREF (1/n)	TIAA-CREF - Conservative Model	TIAA-CREF - Moderately Conservative Model	TIAA-CREF - Moderately Aggressive Model	TIAA-CREF - Aggressive Model	State of Connecticut (1/n)	State of Connecticut - Conservative Model	State of Connecticut - Moderately Conservative Model	State of Connecticut - Moderate Model	State of Connecticut - Moderately Aggressive Model	State of Connecticut - Aggressive Model
Expected Return	8.93%	7.37%	6.89%	8.09%	9.28%	10.16%	11.63%	7.09%	8.76%	10.49%	12.35%	13.39%
Standard Deviation	9.89%	8.86%	4.90%	7.70%	9.44%	11.58%	10.46%	3.42%	6.77%	10.21%	12.35%	14.24%
Year												
Cumulative Expected Values												
5	1.53	1.43	1.40	1.48	1.56	1.62	1.73	1.41	1.52	1.65	1.79	1.87
10	2.35	2.04	1.95	2.18	2.43	2.63	3.01	1.98	2.32	2.71	3.20	3.51
15	3.61	2.91	2.72	3.21	3.79	4.27	5.21	2.79	3.53	4.46	5.73	6.59
20	5.54	4.15	3.79	4.74	5.90	6.93	9.03	3.94	5.37	7.35	10.26	12.35
Lower Confidence Limits of Cumulative Returns												
1 Sigma												
1	0.990	0.985	1.020	1.004	0.998	0.986	1.012	1.037	1.020	1.003	1.000	0.992
2	1.047	1.028	1.073	1.059	1.061	1.050	1.098	1.099	1.087	1.076	1.087	1.084
3	1.121	1.084	1.137	1.129	1.142	1.136	1.210	1.169	1.169	1.172	1.204	1.211
4	1.210	1.152	1.208	1.211	1.237	1.241	1.344	1.247	1.264	1.286	1.346	1.368
5	1.313	1.229	1.286	1.303	1.347	1.364	1.500	1.332	1.371	1.418	1.514	1.556
10	2.040	1.757	1.793	1.933	2.130	2.266	2.675	1.876	2.103	2.388	2.813	3.064
15	3.227	2.563	2.528	2.914	3.420	3.822	4.806	2.662	3.264	4.069	5.254	6.036
2 Sigma												
1	0.892	0.897	0.971	0.927	0.904	0.870	0.907	1.003	0.952	0.901	0.876	0.849
2	0.907	0.902	1.004	0.951	0.927	0.886	0.950	1.050	0.991	0.932	0.913	0.883
3	0.950	0.931	1.052	0.996	0.978	0.936	1.029	1.110	1.052	0.995	0.990	0.965
4	1.013	0.975	1.110	1.057	1.049	1.010	1.135	1.179	1.129	1.082	1.099	1.084
5	1.092	1.031	1.177	1.131	1.136	1.105	1.266	1.256	1.219	1.190	1.237	1.238
10	1.728	1.476	1.638	1.690	1.832	1.900	2.344	1.768	1.888	2.065	2.422	2.614
15	2.844	2.220	2.338	2.615	3.054	3.374	4.401	2.530	3.002	3.673	4.776	5.484
3 Sigma												
1	0.793	0.808	0.922	0.850	0.810	0.754	0.803	0.968	0.884	0.798	0.753	0.707
2	0.767	0.777	0.935	0.842	0.794	0.722	0.802	1.002	0.896	0.787	0.738	0.682
3	0.779	0.778	0.967	0.863	0.815	0.735	0.848	1.051	0.935	0.818	0.776	0.718
4	0.815	0.798	1.012	0.903	0.860	0.778	0.926	1.110	0.993	0.877	0.852	0.799
5	0.871	0.833	1.067	0.959	0.925	0.846	1.032	1.179	1.068	0.961	0.961	0.920
10	1.415	1.196	1.483	1.446	1.533	1.534	2.014	1.660	1.674	1.742	2.031	2.163
15	2.461	1.877	2.149	2.317	2.689	2.925	3.996	2.397	2.739	3.278	4.298	4.933
Two-tailed Tests of Differences in Monthly Portfolio Returns (n = 120)												
	Means Test p-value	Medians Test p-value	Signed-Rank p-value									
TIAA-CREF + Vanguard v. State of Connecti	0.049	0.022	0.023									